WETLANDS AND SUBAQUEOUS LANDS SECTION PERMIT APPLICATION FORM

For Subaqueous Lands, Wetlands, Marina and 401 Water Quality Certification Projects

State of Delaware
Department of Natural Resources and Environmental Control
Division of Water

Wetlands and Subaqueous Lands Section

APPLICATION FOR APPROVAL OF
SUBAQUEOUS LANDS, WETLANDS, MARINA
AND WATER QUALITY CERTIFICATION PROJECTS

Last Revised on: March 28, 2017

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

Application Instructions:

1. Complete each section of this basic application and appropriate appendices as thoroughly and accurately as possible. Incomplete or inaccurate applications will be returned.

2. All applications must be accompanied by a scaled plan view and cross-section view plans that show the location and design details for the proposed project. Full construction plans must be submitted for major projects.

3. All applications must have an original signature page and proof of ownership or permitted land use agreement.

4. Submit an original and two (2) additional copies of the application (total of 3) with the appropriate application fee and public notice fee* (prepared in separate checks) to:

Department of Natural Resources and Environmental Control
Wetlands and Subaqueous Lands Section
89 Kings Highway
Dover, Delaware 19901

*Application and public notice fees are non-refundable regardless of the Permit decision or application status.

5. No construction may begin at the project site before written approval has been received from this office.

Helpful Information:

1. Tax Parcel Information:

New Castle County	(302) 395-5400
Kent County	(302) 736-2010
Sussex County	(302) 855-7878

2. Recorder of Deeds:

New Castle County	(302) 571-7550
Kent County	(302) 744-2314
Sussex County	(302) 855-7785

3. A separate application and/or approval may be required through the Army Corps of Engineers. Applicants are strongly encouraged to contact the Corps for a determination of their permitting requirements. For more information, contact the Philadelphia District Regulator of the Day at (215) 656-6728 or visit their website at: http://www.nap.usace.army.mil/Missions/Regulatory.aspx.

4. For questions about this application or the Wetlands and Subaqueous Lands Section, contact us at (302) 739-9943 or visit our website at: http://www.dnrec.delaware.gov/wr/Services/Pages/WetlandsAndSubaqueousLands.aspx. Office hours are Monday through Friday 8:00 AM to 4:30 PM, except on State Holidays.

APPLICANT'S REVIEW BEFORE MAILING

DID YOU COMPLETE THE FOLLOWING?

✓	Yes	BASIC APPLICATION
✓	Yes	SIGNATURE PAGE (Page 3)
✓	Yes	APPLICABLE APPENDICES
✓	Yes	SCALED PLAN VIEW
✓	Yes	SCALED CROSS-SECTION OR ELEVATION VIEW PLANS
✓	Yes	VICINITY MAP
✓	Yes	COPY OF THE PROPERTY DEED & SURVEY
N/A	Yes	THREE (3) COMPLETE COPIES OF THE APPLICATION PACKET
✓	Yes	APPROPRIATE APPLICATION FEE & PUBLIC NOTICE FEE (Separate checks made payable to the State of Delaware)

Submit 3 complete copies of the application packet to:

Department of Natural Resources and Environmental Control
Wetlands and Subaqueous Lands Section
89 Kings Highway
Dover, Delaware 19901

Before signing and mailing your application packet, please read the following:

The Department requests that the contractor or party who will perform the construction of your proposed project, if other than the applicant, sign the application signature page along with the applicant in the spaces provided. When the application is signed by the contractor as well as the applicant, the Department will issue the Permit to both parties. For Leases, the contractor will receive a separate construction authorization that will make them subject to all of the terms and conditions of the Lease relating to the construction

Section 1: Applicant Identification

1. Applicant's Name: Middlesex Beach Association
   Mailing Address: PO Box 584
   Bethany Beach, DE 19930
   Telephone #: (240) 485-4213
   Fax #:
   E-mail: sand@middlesexbeach.org

2. Consultant's Name: Tyler Littlefield
   Mailing Address: 295 N Green Meadows Dr Suite A
   Wilmington, NC 28405
   Company Name: Gahagan & Bryant Associates
   Telephone #: (910) 313-3338
   Fax #:
   E-mail: trlittlefield@gba-inc.com

3. Contractor's Name: Not known at this time
   Mailing Address:
   Company Name:
   Telephone #:
   Fax #:
   E-mail:

Section 2: Project Description

4. Check those that apply:
☒ New Project/addition to existing project? ☐ Repair/Replace existing structure? (If checked, must answer #16)

5. Project Purpose (attach additional sheets as necessary):
The purposes of this project are to provide increased protection to property and structures from coastal storm damage and additional recreational beach area through maintenance of a replenishment project conducted in 2007. The project will supplement maintenance of the Federal replenishment project in Bethany Beach.

6. Check each Appendix that is enclosed with this application:

	A. Boat Docking Facilities		G. Bulkheads		N. Preliminary Marina Checklist
	B. Boat Ramps	X	H. Fill		O. Marinas
	C. Road Crossings		I. Rip-Rap Sills and Revetments		P. Stormwater Management
	D. Channel Modifications/Dams		J. Vegetative Stabilization		Q. Ponds and Impoundments
	E. Utility Crossings		K. Jetties, Groins, Breakwaters	x	R. Maintenance Dredging
	F. Intake or Outfall Structures		M. Activities in State Wetlands		S. New Dredging

Section 3: Project Location

7. Project Site Address: Middlesex Beach
   Sussex County, DE
   County: ☐ N.C. ☐ Kent ☒ Sussex
   Site owner name (if different from applicant):
   Address of site owner:

8. Driving Directions: Approximately 450 ft. east of Route 1 in Middlesex Beach, Sussex County, DE. The project site is located along the Atlantic Ocean. (Attach a location road map with the site indicated on the map).
(Attach a vicinity map identifying road names and the project location)

9. Tax Parcel ID Number: 134-17.16-117.00 Subdivision Name: Middlesex Beach

WSLS Use Only: **Permit #s:** _____ _____ _____ _____

Type **SP** ☐ **SL** ☐ **SU** ☐ **WE** ☐ **WQ** ☐ **LA** ☐ **SA** ☐ **MP** ☐ **WA** ☐

Corps Permit: SPGP 18 ☐ **20** ☐ **Nationwide Permit #:** _____ **Individual Permit #** _____
Received Date: _____ **Project Scientist:** _____
Fee Received? Yes ☐ **No** ☐ **Amt: $** _____ **Receipt #:** _____
Public Notice #: _____ **Public Notice Dates: ON** _____ **OFF** _____

Section 3: Project Location (Continued)

10. Name of waterbody at Project Location: Atlantic Ocean waterbody is a tributary to: N/A

11. Is the waterbody: ☒ Tidal ☐ Non-tidal Waterbody width at mean low or ordinary high water _____

12. Is the project: ☒ On public subaqueous lands? ☒ On private subaqueous lands?*
☐ In State-regulated wetlands? ☐ In Federally-regulated wetlands?

*If the project is on private subaqueous lands, provide the name of the subaqueous lands owner:
Middlesex Beach Association
(Written permission from the private subaqueous lands owner must be included with this application)

13. Present Zoning: ☐ Agricultural ☒ Residential ☐ Commercial ☐ Industrial ☐ Other

Section 4: Miscellaneous

14. A. List the names and complete mailing addresses of the immediately adjoining property owners on all sides of the project (attach additional sheets as necessary):
Town of Bethany Beach, PO Box 109, Bethany Beach, DE 19930
CMFF Sea Colony GL LLC, 31255 Americana Parkway, Shelbyville, DE 19930
Robert & Patricia Stillman, 2147 Waterford Dr, Lancaster, PA 17601 (Adjacent to the South)

B. For wetlands and marina projects, list the names and complete mailing addresses of property owners within a 1,000 foot radius of the project (attach additional sheets as necessary):
N/A

15. Provide the names of DNREC and/or Army Corps of Engineers representatives whom you have discussed the project with:
Eddie Meade, DNREC; Michael Yost, USACE; Pete Gori, USACE
Rebecca Bobola, DNREC; Jamie Colligan, USACE; Mike Snyder, DNREC

A. Have you had a State Jurisdictional Determination performed on the property? ☒ Yes ☐ No
B. Has the project been reviewed in a monthly Joint Permit Processing Meeting? ☒ Yes ☐ No
*If yes, what was the date of the meeting? July 17, 2025

16. Are there existing structures or fill at the project site in subaqueous lands? ☐ Yes ☒ No
*If yes, provide the permit and/or lease number(s):

*If no, were structures and/or fill in place prior to 1969? ☐ Yes ☒ No

17. Have you applied for or obtained a Federal permit from the Army Corps of Engineers?
☐ No ☐ Pending ☒ Issued ☐ Denied Date: January 1, 2007
Type of Permit: Section 10 and Section 404 Federal Permit or ID #: _____

18. Have you applied for permits from other Sections within DNREC?
☐ No ☐ Pending ☒ Issued ☐ Denied Date: 11/7/2007 Permit #: SP-488/07_WQ-489/07_
Type of permit (circle all that apply): Septic Well (NPDES) Storm Water
Other: _____

Section 5: Signature Page

19. Agent Authorization:

If you choose to complete this section, all future correspondence to the Department may be signed by the duly authorized agent. In addition, the agent will become the primary point of contact for all correspondence from the Department.

I do not wish to authorize an agent to act on my behalf ☐

I wish to authorize an agent as indicated below ☒

I, Middlesex Beach Association (Name of Applicant), hereby designate and authorize Gahagan & Bryant Associates (Name of Agent) to act on my behalf in the processing of this application and to furnish any additional information requested by the Department.

Authorized Agent's Name: Tyler Littlefield
Mailing Address: 295 N Green Meadows Dr. Suite A
Wilmington, NC 28405

Telephone #: 910-313-3338
Fax #:
E-mail: trlittlefield@gba-onc.com

20. Agent's Signature:

I hereby certify that the information on this form and on the attached plans are true and accurate to the best of my knowledge. I further understand that the Department may request information in addition to that set forth herein if deemed necessary to appropriately consider this application.

Agent's Signature — Date: 11/11/2025

21. Applicant's Signature:

I hereby certify that the information on this form and on the attached plans are true and accurate to the best of my knowledge and that I am required to inform the Department of any changes or updates to the information provided in this application. I further understand that the Department may request information in addition to that set forth herein if deemed necessary to appropriately consider this application. I grant permission to authorized Department representatives to enter upon the premises for inspection purposes during working hours.

Applicant's Signature — Date: October 18,2025

Steven B. Larsen
Print Name

22. Contractor's Signature:

I hereby certify that the information on this form and on the attached plans are true and accurate to the best of my knowledge, and that I am required to inform the Department of any changes or updates to the information provided in this application. I further understand that the Department may request information in addition to that set forth herein if deemed necessary to appropriately consider this application.

____N/A_____
Contractor's Name

___N/A_____
Date

____N/A_____
Print Name

FILL

Please make sure answers to all of the questions in this appendix correspond to information on the application drawings.

1. How many linear feet will the fill extend channelward of the:
   a. Tidal waters: mean high water line? 129 ft.
      mean low water line? 121.5 ft.
   b. Non-tidal waters: ordinary high water line? N/A ft.

2. What is the area of fill that will be located:
   a. on subaqueous land (channelward of mean high water) 468,449 sq. ft.
   b. on vegetated wetlands? N/A sq. ft.

3. What is the source of the fill?
   _____ Hauled in from upland sources: What is the source company/location/parcel number?
   Yes Obtained from dredged material: Complete Dredging Appendix.

4. What is the total volume of fill? 103,000 per event cubic yards
   a. What is the total fill per running foot of shoreline? 52.8 cubic yards

5. What method will be used to place the fill?
   Beach fill will be hydraulic method using either a cutter suction pipeline dredge or hopper dredge equipped with a pumpout capability or a combination of both.

6. State the type and composition percentage of the fill material (e.g. sand 80%, silt 5%, clay 15%, etc.)
   Fine to medium sands, poorly graded to well sorted (See Project Reference 2)

7. How will the fill be retained? Complete appropriate appendix.
   See detailed project approach in 401 request.

8. What type of vegetation or ground cover will be provided for the filled area(s) to prevent soil erosion and help keep sediment from reaching State waters?
   N/A

9. Describe the type(s) of structure(s) to be erected on the filled area (if any). Complete appropriate appendix.
   N/A

MAINTENANCE DREDGING OR EXCAVATING

- If dredged material is to be placed in a disposal site, a separate map showing the location of the disposal site should be attached. This drawing must indicate the proposed retention levees, weirs, spillways, and/or devices for retaining the materials.

- Bottom samples to determine heavy metals or other toxic materials must be taken and analyzed if deemed necessary by the DNREC staff. The responsibility, as well as the expense incurred for obtaining and analyzing these samples, must be borne by the applicant.

- If maintenance dredging is to be done, evidence of previous dredging must be provided. Any previously issued permit with drawings which indicates the date the dredging occurred, the area involved and dredging depth constitutes acceptable proof.

- Please make sure answers to all of the questions in this appendix correspond to information on the application drawings.

1. How many cubic yards of material will be MAINTENANCE DREDGED or excavated channelward of the:

   a. Tidal waters: mean high water line? N/A cu. yds.
   mean low water line? 103,000 per event cu. yds.
   b. Non-tidal waters: ordinary high water line? N/A cu. yds.

Does this account for the total volume of proposed dredging for the project? X Yes _____ No
If there is new dredging associated with this project (dredging beyond previously authorized dimensions) please fill out appendix S for new dredging.

2. What will be the dimensions of the dredged or excavated area relative to mean low water (for tidal areas only) or ordinary water level (for non-tidal areas only)?
   _____ length _____ depth _____ base width _____ top width
   Refer to the plan drawings for dimensions of the borrow area.
3. What are average existing depths in area of proposed dredging? 32 to 52 ft. (mlw/ohw)
   Include a survey of proposed and existing depths on application drawings.
   See Limits of Borrow Area Figure

4. What is the proposed dredging depth in relation to surrounding bathymetry? < or = to 55 ft.(mlw/ohw)
   Indicate both proposed depths and surrounding depths on attached drawings.
   See Limits of Borrow Area Figure

5. By what method(s) (hydraulic, clamshell or other) will the dredging be done? If other, explain:
   Dredging will be hydraulic method utilizing either a cutter suction pipeline dredge or hopper dredge equipped with pumpout capability or a combination of both.

6. What is proximity of the dredging project to the nearest creek bank or banks? N/A ft.
   What are existing land uses along this bank(s)?

   Describe the existing shoreline along this bank (vegetation, rip-rap, bulkhead, etc.).

   Bare sand with minimal vegetation

7. Describe characteristics of the material to be disposed including:
   a. Physical nature of material (i.e. sand, silt, clay, etc.). Give percentages of various fractions if available.
      Fine to medium sands, poorly graded to well sorted (see Project Reference 2)

   b. Chemical composition of material - Many areas have sediments with high concentration of pollutants (chemicals, organics etc.) which may be re-suspended or reintroduced into the water. For heavily industrialized sites, a chemical analysis of this material should be provided (if applicable). See Project Reference 2

   c. What are the dewatering properties of material to be disposal of?

      See detailed project approach in 401 request

8. How will the dredged or excavated material be transported to its disposal area?

   See detailed project approach in 401 request

9. Land Disposal Areas.

   a. Describe dimensions, characteristics and exact locations of the proposed dredged material disposal site (provide photographs, directions to, and complete plans of disposal site).
      Relatively narrow, sandy coastal barrier beach fronting coastal development. Accompanying project plans and photographic print show the exact location of the project area.
   b. Describe method of dredged material containment (embarkment, behind bulkhead, etc.)
      See detailed project approach in 401 request
   c. What type of leachates will be produced by the spoil material and what is planned for the protection of groundwater? Not applicable to this permit
   d. Disposal site coordinates 38°31'54"N 75°03'16"W
      38°31'31"N latitude 75°03'10"W longitude
      Refer to project plans for the coordinates of the borrow and placement areas
   e. What methods will be used to ensure that spoil water does not adversely affect water quality both during construction and after completion of the project?
      See detailed project approach in 401 request
   f. Describe present land use of the disposal site.
      Private beach community

10. Water Disposal Areas/ Beneficial Use Projects
    Describe methods to be used for water disposal including volumes and site selection, and containment (if applicable). Include Fill or Wetland Appendix if applicable.

    See detailed project approach in
    401 request

11. Describe the existing water characteristics at the site, including chemical analysis for water quality.
    Site is beach with open ocean water (average salinity of 33 ppt). Site does not have any industrial input and may occasionally receive runoff during rain events.

12. Identify the dredging and disposal schedule to ensure that operations do not degrade water quality during times of anadromous fish migration.
    Dredging will be consistent with the recommendations and guidance of DNREC Division of Fish and Wildlife Based on DNREC's Environmental Review for this project, as well as the appropriate Federal regulatory agencies (USACE).

13. Has an Erosion and Sediment Control Plan been approved by the designated plan approval agency for the project? An Erosion and Sediment Control Plan is required for any project disturbing more than 5,000 square feet of uplands. Final approved plans must be received by this office prior to permit issuance.

____ Yes ____ No _X_ Not required

Important time of year restriction information:

Please be advised that all dredging in the Inland Bays must be undertaken between September 1 and December 31 in order to protect summer and winter flounder and other aquatic species. Dredging in other Delaware waters may also be subject to certain time of year restrictions in order to protect fish and wildlife. Contact DNREC for more specific information regarding the restrictions that may apply within your project area.

Middlesex Beach Association
PO Box 584
Bethany Beach, DE 19930
EIN: 51-0101015
August 13, 2025

To Whom It May Concern:

Mr. Tyler Littlefield of Gahagan & Bryant Associates, Inc. has been retained by the Middlesex Beach Association Inc. He is authorized to act on our behalf for the sole purpose as follows:

Obtaining all regulatory approvals for Middlesex Beach which may be required for the replenishment of the beach at Middlesex Beach either as a standalone project or in conjunction with the anticipated periodic nourishment of the Federal Shore Protection Project at Bethany Beach and South Bethany, Sussex County, Delaware.

Respectfully submitted,

David A. Wiecking
President, Board of Directors
Middlesex Beach Association, Inc.

Gahagan & Bryant Associates, Inc.
295-A N Green Meadows Drive
Wilmington, NC 28405
(910) 313-3338 Fax (910) 313-6822
www.gba-inc.com | info@gba-inc.com

January 08, 2026

Mr. Jason Baumgartner
Wetland and Waterways Section
DNREC – Division of Water
89 Kings Highway
Dover, DE 19901

Re: Water Quality Certification Middlesex Beach Association

Dear Mr. Baumgartner:

Middlesex Beach Association is not in a current state of emergency where sand replenishment is imminently needed but they currently do not have any measures in place to restore their beach and protect infrastructure if a catastrophic storm were to hit. By filing and obtaining the necessary permits, Middlesex hopes to achieve approval from DNREC and the Corps giving them the option to participate in future federal replenishment cycle. Middlesex participation in the renourishment cycle would be beneficial to neighboring beaches, extending the longetive of the Corps project.

Please find the photo attachments included on the following pages as supplemental background information on the current site conditions of Middlesex Beach Association. The scatter plots following those photographs include observed data collected from DNREC's water quality monitoring station (177694) in South Bethany Beach.

Sincerely,

Tyler Littlefield, PE
Agent

Cc: Jacy Craig, P.E., M.E
Cc: Aidan Duffy

Photos taken on October 11, 2025

Figure 1: Facing East

Figure 2: Facing West

Figure 3: Facing Northeast

Figure 4: Facing Southeast

Photos taken on October 31, 2025

Figure 5: Facing East

Figure 6: Facing West

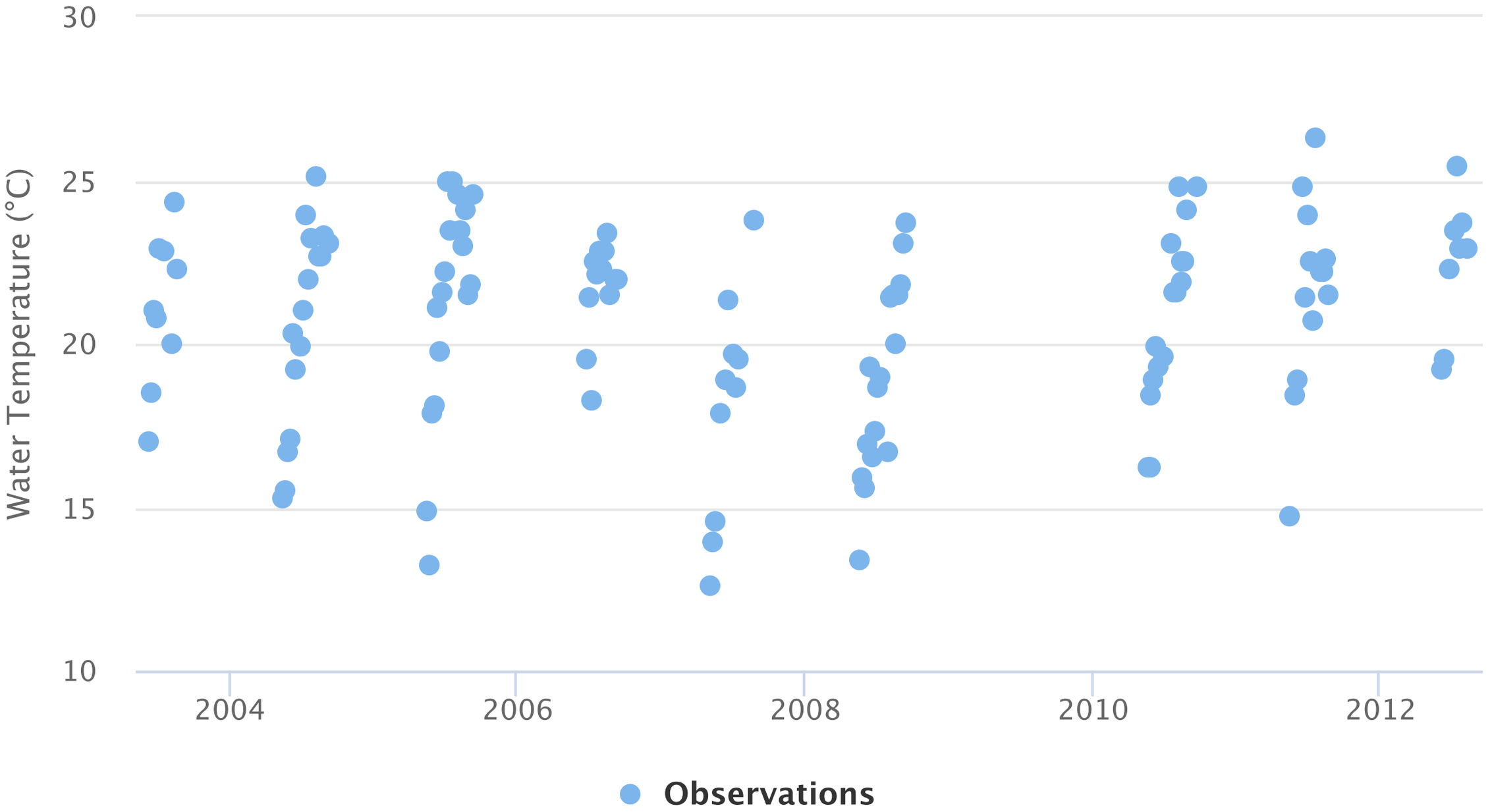
Figure 7: Facing Northeast

Figure 8: Facing Southeast

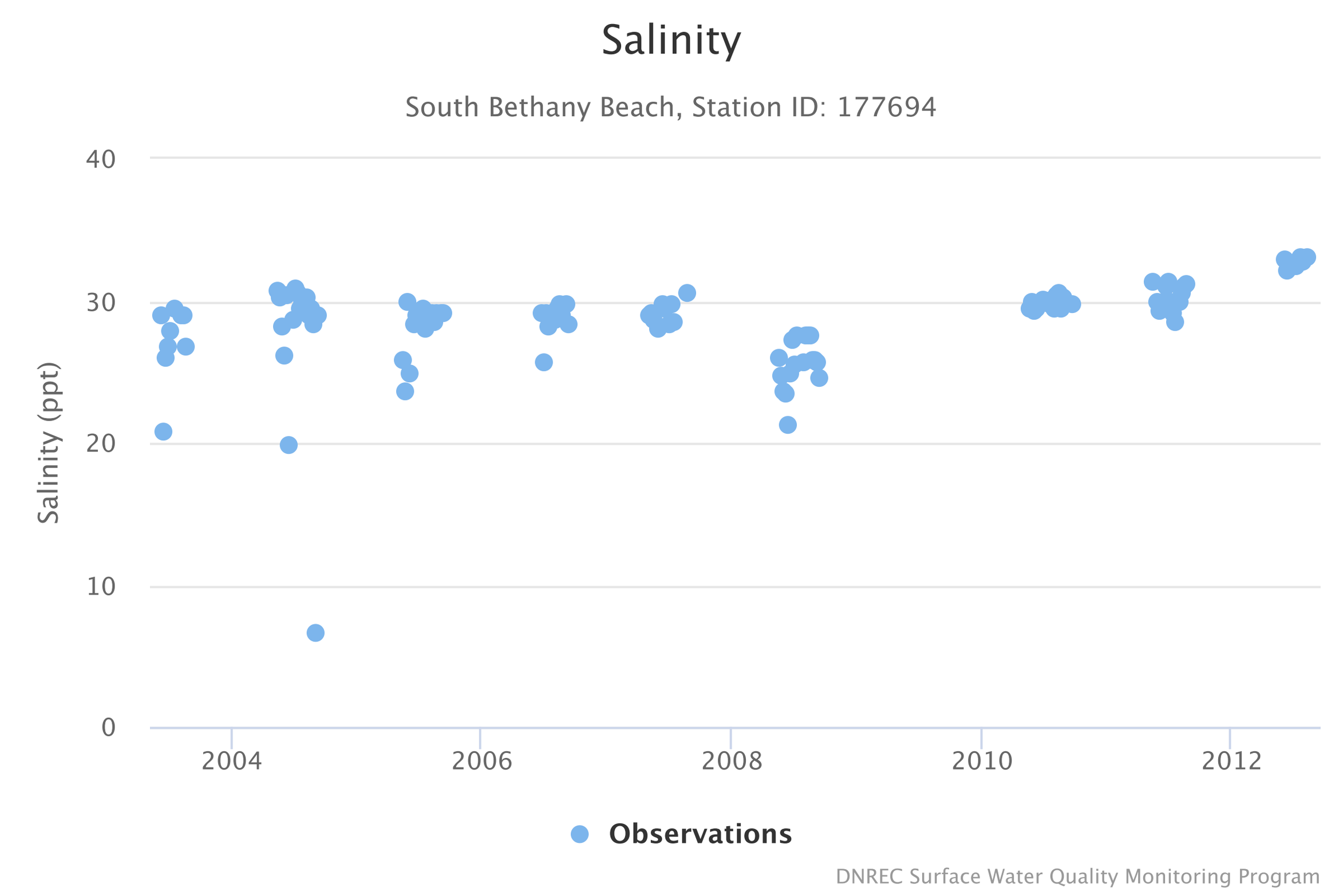
Figure 9: Facing South

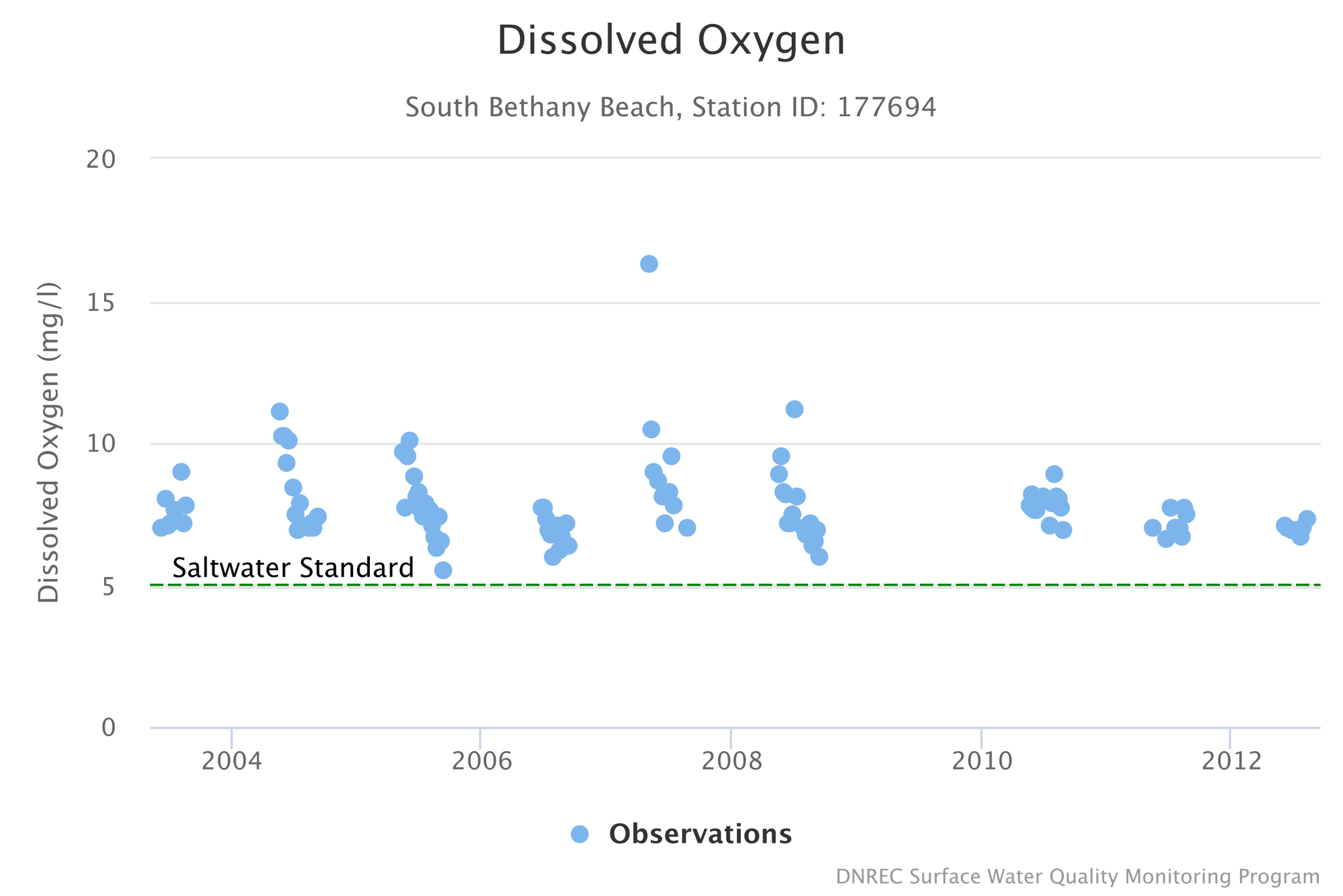
Water Temperature

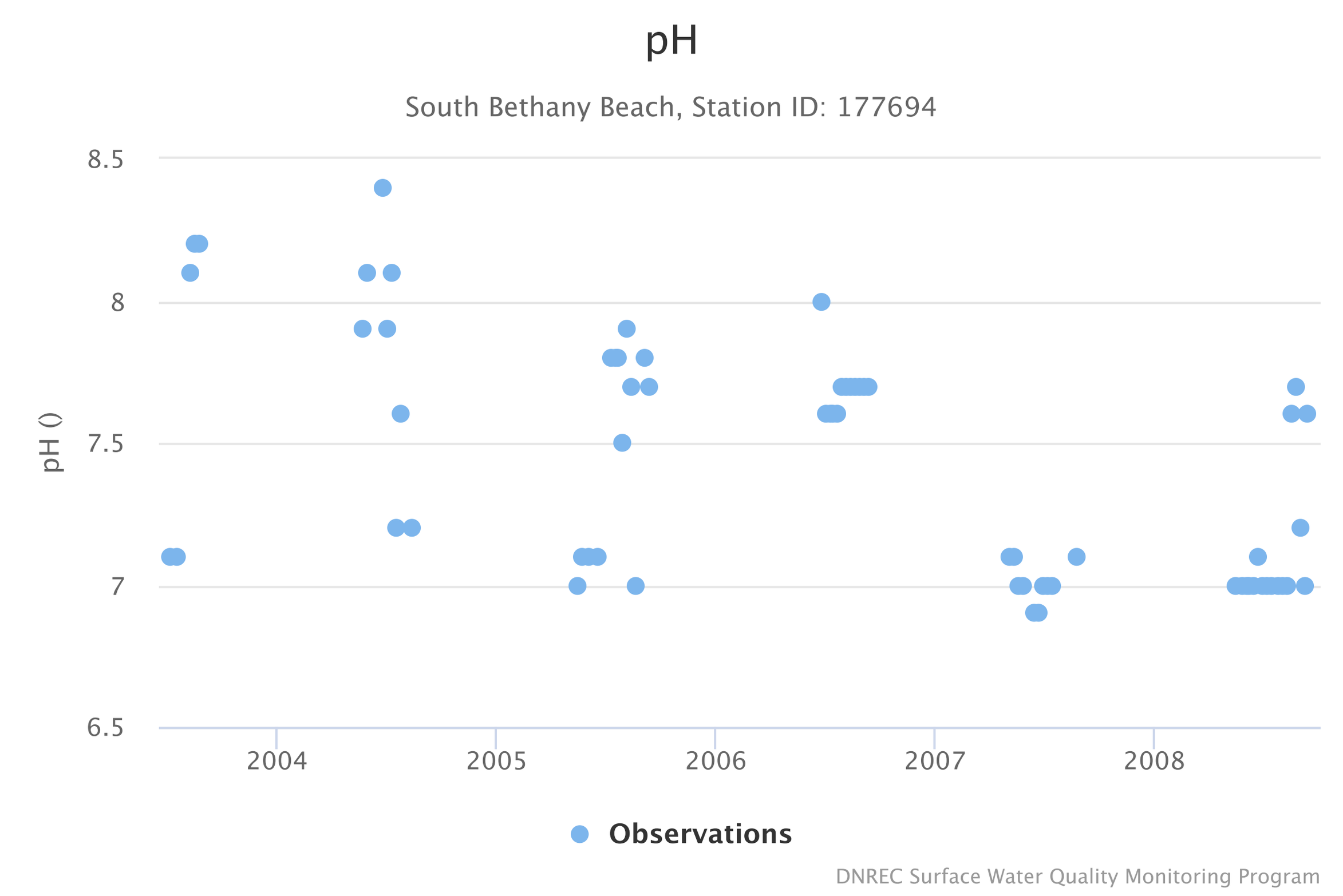
South Bethany Beach, Station ID: 177694



DNREC Surface Water Quality Monitoring Program

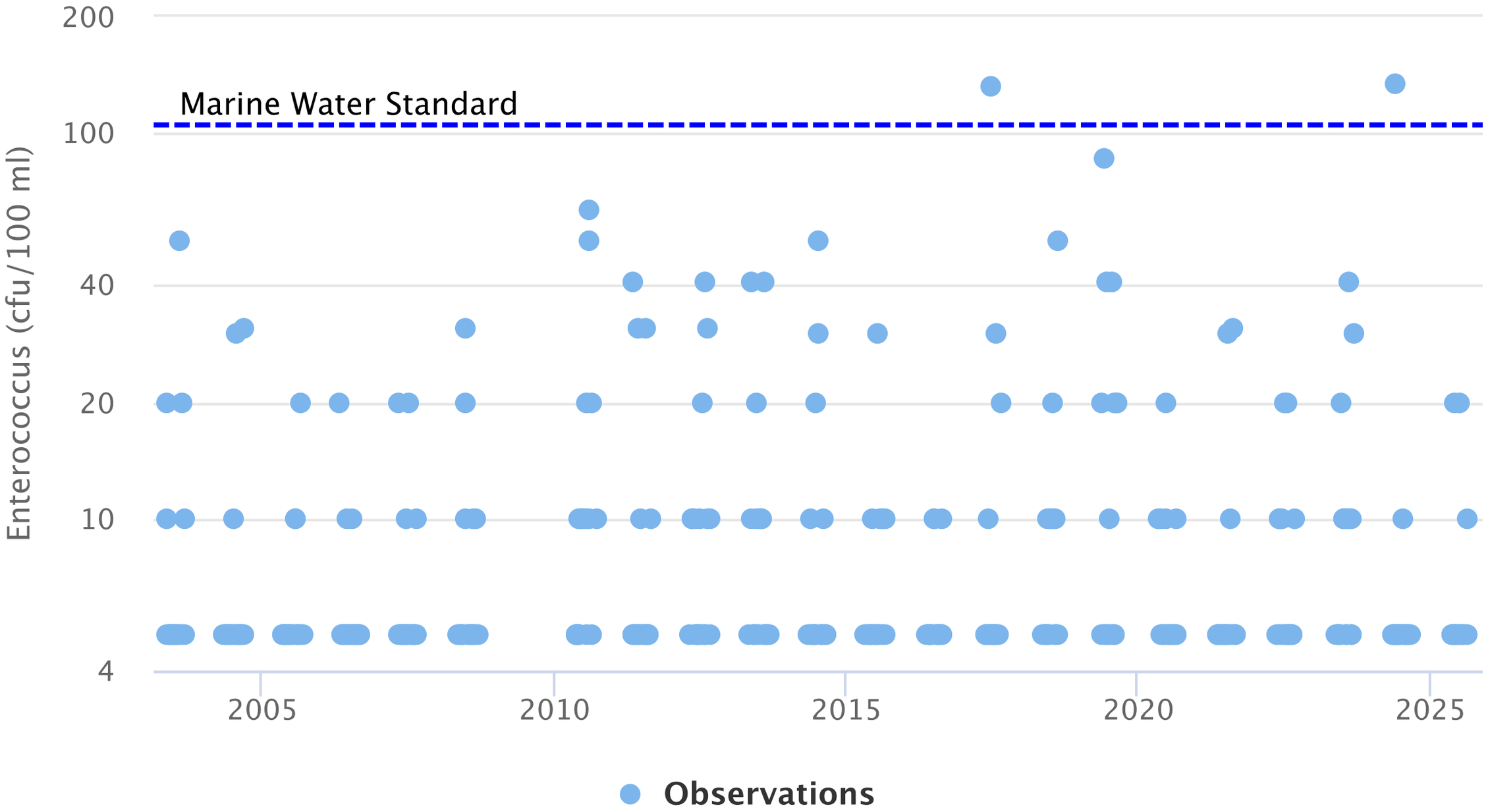

Salinity
South Bethany Beach, Station ID: 177694
40
30
20
10
0
Salinity (ppt)
2004
2006
2008
2010
2012
Observations
DNREC Surface Water Quality Monitoring Program


Dissolved Oxygen
South Bethany Beach, Station ID: 177694
Dissolved Oxygen (mg/l)
20
15
10
5
0
Saltwater Standard
2004
2006
2008
2010
2012
Observations
DNREC Surface Water Quality Monitoring Program


pH
South Bethany Beach, Station ID: 177694
8.5
8
7.5
7
6.5
pH ()
2004
2005
2006
2007
2008
Observations
DNREC Surface Water Quality Monitoring Program

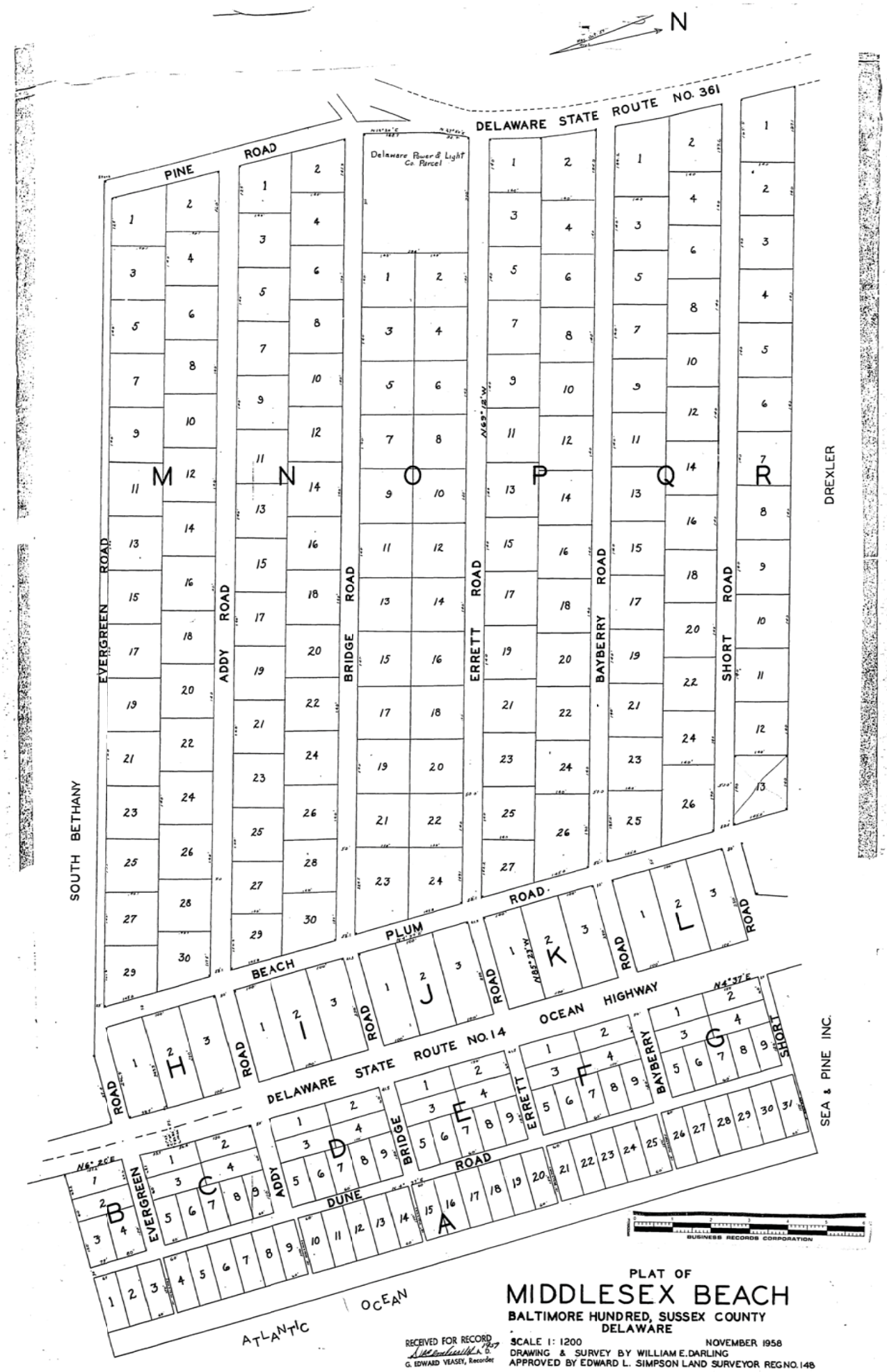
Enterococcus

South Bethany Beach, Station ID: 177694



DNREC Surface Water Quality Monitoring Program

#3



RECEIVED FOR RECORD
Dec. 14 A.D. 1959
G. EDWARD VEASEY, Recorder

PLAT OF

MIDDLESEX BEACH

BALTIMORE HUNDRED, SUSSEX COUNTY
DELAWARE

SCALE 1: 1200 NOVEMBER 1958
DRAWING & SURVEY BY WILLIAM E. DARLING
APPROVED BY EDWARD L. SIMPSON LAND SURVEYOR REG. NO. 148

RECEIVED FOR RECORD
Dec. 14 A.D. 1959
G. EDWARD VEASEY, Recorder

#4

DEED

THIS DEED, Made the 4th day of April, in the year of our Lord, one thousand nine hundred and fifty-nine,

BETWEEN, WILLIAM R. ERRETT, JR., Surviving Trustee in Dissolution of and for The Bethany Beach Improvement Company, a dissolved Delaware corporation, WILLIAM R. ERRETT, JR., Trustee under Deed of Trust from Melvin Hopkins, etux, dated September 25, 1946, JOHN W. HUDSON, Trustee u/w Edwin R. Errett, deceased, DOROTHY ERRETT, single, JANE E. ERRETT, single, MARJORIE R. ERRETT, single, WILLIAM R. ERRETT, JR., and MARGARET P. ERRETT, his wife, HELEN C. ERRETT HOURDEQUIN, and L. REMY HOURDEQUIN, her husband, STANLEY W. ADDY, Successor Trustee u/w Jennie William Addy, deceased, CHARLES E. ADDY, and MARTHA JEAN ADDY, his wife, STANLEY W. ADDY and MARY MARGARET ADDY, his wife, MARY JANE ADDY BRALEY and SILAS A. BRALEY, JR., her husband, MARY A. J. SHORT, widow, WILLIAM P. SHORT, JR., and MARY E. SHORT, his wife, MARY A. S. LIGHTHIPE and HAROLD H. LIGHTHIPE, her husband, STANLEY W. ADDY, Surviving Trustee under Deed of Trust from The Bethany Beach Improvement Company, a Delaware corporation now dissolved, dated July 15, 1940, [illegible]A AND PINES, INC., a Delaware corporation, ELIZABETH MILLS DREXLER, widow, RICHARD F. HALL and ELIZABETH H. HALL, his wife, parties of the first part, and MARGARET DUNNING, single, of Georgetown, Delaware, party of the second part,

WITNESSETH, that the said parties of the first part, for and in consideration of the sum of ONE DOLLAR ($1.00), and other valuable and lawful considerations, lawful money of the United States of America, the receipt whereof is hereby acknowledged, hereby grant and convey unto the said party of the second part, her heirs and assigns forever,

ALL of their several, respective rights, titles, interests,

claims, and demands whatsoever, either in law or equity, in and to ALL AND SINGULAR the lands and premises defined and delineated upon a certain plot entitled "PLAT OF LANDS FORMERLY OF BETHANY BEACH IMPROVEMENT CO., SEA & PINE, INC., LOUIS A. DREXLER, and SOUTH BETHANY", situate in Baltimore Hundred, Sussex County, Delaware; which plot is dated November 1958, was surveyed and drawn by William E. Darling and approved by E. L. Simpson, Land Surveyor, and is about to be recorded in the Office of the Recorder of Deeds, in and for Sussex County, at Georgetown, Delaware; and which lands and premises defined and delineated thereon and thereby, are more particularly bounded and described as follows: BEGINNING at a concrete monument set along the easterly right of way line of Delaware State Route No. 361 and forming the Northwest corner of these lands and the Southwest corner of other lands of Drexler; thence, South 69 degrees 12 minutes East, 533.8 feet; thence, South 87 degrees 40 minutes East, 177.5 feet; thence, South 72 degrees 58 minutes East, 85.4 feet; thence, South 77 degrees 28 minutes East, 103.8 feet, thence, South 50 degrees 28 minutes East, 46.6 feet; thence, South 63 degrees 40 minutes East, 113.7 feet; thence, South 36 degrees 30 minutes East, 92.2 feet; thence, South 69 degrees 12 minutes East, 746.3 feet; thence, South 4 degrees 37 minutes West, 100 feet; thence, South 70 degrees 12 minutes East, about 134.2 feet; thence, South 85 degrees 23 minutes East, 65 feet; thence, South 23 degrees 48 minutes West, 17.1 feet; thence, South 68 degrees 12 minutes East, about 119.6 feet to a concrete monument set along the westerly righteof-way line of Delaware State Highway Route No. 14; thence, by and with the same course last mentioned, crossing said Highway, about 105 feet to another concrete monument set along the easterly right-of-way line of said Highway, North 4 degrees 37 minutes East, 56.7 feet to another concrete monument, being a common corner for the lands and premises

hereby conveyed and lands of Sea and Pines, Inc.; thence, by and with the line of lands of Sea and Pines, Inc., South 85 degrees 23 minutes East, about 482.3 feet, to the waters edge of the Atlantic Ocean; thence, by and with the waters edge of the Atlantic Ocean, along the course of approximately South 4 degrees 37 minutes West, about 2050.6 feet, to the northerly boundary line of lands of Richard F. Hall, etux. (South Bethany); thence, by and with the northerly line of lands of said Hall, North 69 degrees 12 minutes West, about 244.5 feet; thence, North 83 degrees 23 minutes West, 257.8 feet to another concrete monument set along the easterly right-of-way line of Delaware State Route No. 14, aforesaid; thence, by and with the easterly right-of-way line of said Highway, North 6 degrees 20 minutes East, 71.6 feet to another concrete monument set along the easterly right-of-way line of said Highway; thence, crossing said Highway and continuing along the same course, by and with the northerly line of lands of said Hall and wife, North 69 degrees 12 minutes West, for the total distance of about 2,504.4 feet to a stone forming the southwestern corner of the lands and premises hereby conveyed; thence, North 6 degrees 18 minutes East, 646.8 feet; thence, North 51 degrees 33 minutes East, 48 feet; thence, North 19 degrees 20 minutes East, 341.9 feet; thence, North 11 degrees 43 minutes East, 665.3 feet; thence, South 71 degrees 32 minutes East, about 38.3 feet to a point along the Easterly right-of-way line of Delaware State Route No. 361; thence, by and with the Easterly right-of-way line of Delaware State Route No. 361, in a Northerly direction, for a distance of 158 feet to a concrete monument, being home to the point or place of BEGINNING, be the contents thereof what they may.

BEING all and singular the lands and premises which the parties of the first part hereto have agreed to convey unto the party of the second part hereto, in and by a certain Settlement Agreement dated April 4, 1959, between William R. Errett, Jr., etal, which is about to be recorded in the office of the Recorder of Deeds, aforesaid, as reference thereto being had will more fully and at large appear.

IN WITNESS WHEREOF, the respective parties of the first part individual and fiduciary have hereunto set their hands and affixed their seals, and the party of the first part corporate hereto has caused these presents to be signed by its President, and its corporate seal by him hereunto affixed, attested by its Secretary, pursuant to an appropriate resolution of its Board of Directors duly authorizing the same, all as of the day and year first above written.

Signed, sealed and delivered in the presence of:

William R. Errett (SEAL)
William R. Errett, Jr., Surviving Trustee in Dissolution of and for The Bethany Beach Improvement Company, a Dissolved Delaware Corporation

William R. Errett (SEAL)
William R. Errett, Jr., Trustee under Deed of Trust from Melvin Hopkins, etux, dated September 25, 1946.

John W. Hudson (SEAL)
John W. Hudson, Trustee u/w Edwin R. Errett, Deceased

(SEAL)
Dorothy Errett

Jane E. Errett (SEAL)
Jane E. Errett

Marjorie R. Errett (SEAL)
Marjorie R. Errett

William R. Errett (SEAL)
William R. Errett, Jr.

(SEAL)
Margaret P. Errett

Helen G. Errett Hourdequin (SEAL)
Helen G. Errett Hourdequin

L. Remy Hourdequin (SEAL)
L. Remy Hourdequin

Stanley W. Addy (SEAL)
Stanley W. Addy, Successor Trustee u/w Jennie Williams Addy, Deceased

Charles E. Addy (SEAL)
Charles E. Addy

Martha Jean Addy (SEAL)
Martha Jean Addy

Stanley W. Addy (SEAL)
Stanley W. Addy

Mary Margaret Addy (SEAL)
Mary Margaret Addy

Mary Jane Addy Braley (SEAL)
Mary Jane Addy Braley

(SEAL)

Mary A. J. Short (SEAL)
Mary A. J. Short

William P. Short, Jr. (SEAL)
William P. Short, Jr.

Mary E. Short (SEAL)
Mary E. Short

Mary A. S. Lighthipe (SEAL)
Mary A. S. Lighthipe

Harold H. Lighthipe (SEAL)
Harold H. Lighthipe

Stanley W. Addy (SEAL)
Stanley W. Addy, Surviving Trustee under Deed of Trust from The Bethany Beach Improvement Company, a Delaware corporation now dissolved, dated July 15, 1940

(SEAL)
Silas A. Braley, Jr.

SEA AND PINES, INC.

Alice E. Leyba

By: Roy B. Dale
President

Attest: Judson W. Richardson
Secretary

Mary J. Smith

Elizabeth Mills Drexler (SEAL)

Mary J. Smith

Richard F. Hall (SEAL)

Mary J. Smith

Elizabeth H. Hall (SEAL)

STATE OF PENNSYLVANIA }
SS
COUNTY OF [illegible] }

BE IT REMEMBERED, that on this 24th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, WILLIAM R. ERRETT, JR., Surviving Trustee in Dissolution of and for The Bethany Beach Improvement Company, a dissolved Delaware corporation, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

[signature]
Notary Public
Notary Public, [illegible], Chester County
My Commission Expires [illegible]

STATE OF OHIO }
SS
COUNTY OF Hamilton }

BE IT REMEMBERED, that on this 27th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, JOHN W. HUDSON, Trustee u/w Edwin R. Errett, deceased, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

[signature]
Notary Public
DORIS A. FURTHMILLER
Notary Public, Hamilton County, Ohio
My Commission Expires Sep. 27, 1960

STATE OF PENNSYLVANIA }
COUNTY OF Chester } SS

BE IT REMEMBERED, that on this 7th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, DOROTHY ERRETT, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be her act anddeed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

Notary Public, Avondale, Chester County
My Commission Expires September 30, 1962

STATE OF PENNSYLVANIA }
COUNTY OF Chester } SS

BE IT REMEMBERED, that on this 7th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, JANE E. ERRETT, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be her act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

Notary Public, Avondale, Chester County
My Commission Expires September 30, 1962

STATE OF NEW YORK }
COUNTY OF New York } SS

BE IT REMEMBERED, that on this 16th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, MARJORIE R. ERRETT, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be her act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

NOTARY PUBLIC ... New York ... Certificate filed in New York County ... Term Expires March 30, 1960

George Rieus
Notary Public

STATE OF PENNSYLVANIA }
COUNTY OF Chester } SS

BE IT REMEMBERED, that on this 17th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, WILLIAM R. ERRETT, JR., and MARGARET P. ERRETT, his wife, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

Notary Public, Avondale, Chester County
My Commission Expires December 30, 1962

STATE OF PENNSYLVANIA }
COUNTY OF Chester } SS

BE IT REMEMBERED, that on this 7th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, HELEN G. ERRETT HOURDEQUIN and L. REMY HOURDEQUIN, her husband, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

Notary Public, Avondale, Chester County
My Commission Expires December 23, 1962

STATE OF PENNSYLVANIA }
COUNTY OF Ch. Co. } SS

BE IT REMEMBERED, that on this 9th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, WILLIAM R. ERRETT, JR., Trustee under Deed of Trust from Melvin Hopkins, etux, dated September 25, 1946, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

Notary Public, Avondale, Chester County
My Commission Expires December 23, 1962

STATE OF New Jersey]
COUNTY OF Atlantic] SS

BE IT REMEMBERED, that on this 26 day of ~~April~~, May A. D. 1959, personally appeared before me, the subscriber, a Notary Public for the State and County aforesaid, RUBY R. VALE, President of SEA AND PINES, INC., a Delaware corporation, party to the foregoing Settlement Agreement, known to me personally to be such, and he acknowledged the above and foregoing Settlement Agreement to be his own proper act and deed and the act and deed of said, Sea and Pines, Inc.,; and that he did thereunto subscribe his name as such President, and affix the corporate seal of such corporation thereto, attested by the Secretary thereof, pursuant to an appropriate resolution of its Board of Directors first duly authorizing the same.

WITNESS my hand and seal of office the day and year first above written.

NOTARY PUBLIC of NEW JERSEY
My Commission Expires Aug. 10, 1961

Notary Public

STATE OF DELAWARE]
COUNTY OF] SS

BE IT REMEMBERED, that on this 31st day of ~~April~~ August, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, ELIZABETH MILLS DREXLER, widow, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be her act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

JAN 16 1959

STATE OF DELAWARE]
SS
SUSSEX COUNTY]

BE IT REMEMBERED, that on this 4th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, MARY A. J. SHORT, MARY A. S. LIGHTHIPE, HAROLD H. LIGHTHIPE, her husband, WILLIAM P. SHORT, JR., and MARY E. SHORT, his wife, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Mildred C. Carpenter
Notary Public

STATE OF PENNSYLVANIA]
SS
COUNTY OF ALLEGHENY]

BE IT REMEMBERED, that on this 27th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, STANLEY W. ADDY, Surviving Trustee under Deed of Trust from The Bethany Beach Improvement Company, a Delaware corporation now dissolved, dated July 15, 1940, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

E. Dean [illegible]
Notary Public
My Commission Expires
January 7, 1963

STATE OF PENNSYLVANIA }
COUNTY OF ALLEGHENY } SS

BE IT REMEMBERED, that on this 25th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, STANLEY W. ADDY and MARY MARGARET ADDY, his wife, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

STATE OF MICHIGAN }
COUNTY OF MIDLAND } SS

BE IT REMEMBERED, that on this 11th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, MARY JANE ADDY BRALEY and SILAS A. BRALEY, JR., her husband, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

WILLIAM H. CHILDS
Notary Public, Midland County, Mich.
My Commission Expires 5-12-62

STATE OF PENNSYLVANIA }
COUNTY OF Allegheny } SS

BE IT REMEMBERED, that on this 27th day of April, A. D. 1959, personaly appeared before me the subscriber, a Notary Public for the State and County aforesaid, STANLEY W. ADDY, Successor Trustee u/w Jennie Williams Addy, deceased, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

E. DEAN HOFF, Notary Public

E. Dean Hoff
Notary Public

STATE OF MARYLAND }
COUNTY OF Montgomery } SS

BE IT REMEMBERED, that on this 1st day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, CHARLES E. ADDY and MARTHA JEAN ADDY, his wife, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Eugene E. Hutchinson-Wilkerson
Notary Public

My commission expires May 4, 1959

STATE OF ~~Maryland~~ Delaware |
SS
COUNTY OF Sussex |

BE IT REMEMBERED, that on this 27th day of ~~April~~ July, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, RICHARD F. HALL and ELIZABETH H. HALL, his wife, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Mary J. Smith
Notary Public

MARY J. SMITH NOTARY PUBLIC SUSSEX COUNTY, DELAWARE JAN 1 8 1959

RECEIVED FOR RECORD
December 8th A. D. 1959
G. EDWARD VEASEY, Recorder

PURCHASERS REPORT MADE
This 8th day of Dec. 1959
Board of Assessment of Sussex County
By Thos. N. Layton Ores.

D E E D

THIS DEED, Made this 14th day of December, in the year of Our Lord, one thousand nine hundred fifty-nine.

BETWEEN, MARGARET DUNNING, single woman, of Georgetown, Sussex County, Delaware, party of the first part, and MIDDLESEX BEACH ASSOCIATION, a Delaware corporation, of Bethany Beach, Delaware, party of the second part,

WITNESSETH: That the party of the first part, for and in consideration of the sum of One ($1.00) Dollar, lawful money of the United States of America, and other valuable and lawful considerations, to her in hand paid by the party of the second part, the receipt whereof is hereby acknowledged, hereby grants and conveys unto the party of the second part, its Successors and Assigns forever,

ALL those certain lots, strips, pieces or parcels of land, situate, lying and being in MIDDLESEX BEACH, Baltimore Hundred, Sussex County, Delaware, which are shown and designated upon a certain Plot entitled "Plat of MIDDLESEX BEACH", Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William E. Darling, and approved by Edward L. Simpson, Land Surveyor, which plot is now of record in the Office of the Recorder of Deeds, in and for Sussex County, at Georgetown, Delaware, in Plot Book 3, Page 22, as follows: Evergreen Road; Addy Road; Bridge Road, Errett Road, Bayberry Road; Short Road; Pine Road; Beach Plum Road; Dune Road; Five 10' Walkways and one 5' Walkway, through Block A, between Dune Road to the west and the beach to the east; and all that land or beach area between the northerly and southerly limits of Middlesex Beach, lying between Block A to the west and the waters of the Atlantic Ocean to the east, all as reference thereunto being had unto said Plot will more fully and at large appear.

BEING a part of the lands and premises heretofore conveyed unto this grantor by William R. Errett, Jr., et al, in and by their certain Deed of Bargain and Sale, dated April 4, 1959, and now of record in the Office of the Recorder of Deeds, aforesaid, in Deed Book 512, Page 377, &c., pursuant to a Settlement Agreement made and entered into between William R. Errett, Jr., et al, dated April 4, 1959, and now of record in the Office of the Recorder of Deeds, aforesaid, in Deed Book 512, Page 335, &c., all as reference thereto being had will more fully and at large appear.

IN WITNESS WHEREOF, the party of the first part has hereunto set her hand and seal the day and year first abovewritten.

Signed, sealed and delivered
in the presence of:

Winnie M. Kreer

Margaret Dunning (SEAL)

STATE OF DELAWARE }
SS
COUNTY OF SUSSEX }

BE IT REMEMBERED, That on this 14th day of December, A. D. 1959, personally came before me, the subscriber, a Notary Public for the State and County aforesaid, MARGARET DUNNING, single woman, party to this indenture, known to me personally to be such, and she acknowledged this indenture to be her deed.

GIVEN under my hand and seal of office, the day and year aforesaid.

Winnie M. Kreer
Notary Public

PURCHASERS REPORT MADE
This 14th day of Dec. 1959
Board of Assessment of Sussex County
By Thos. N. Layton Pres.

RECEIVED FOR RECORD
December 14 A. D. 1959
G. EDWARD VEASEY, Recorder

COORDINATE TABLE

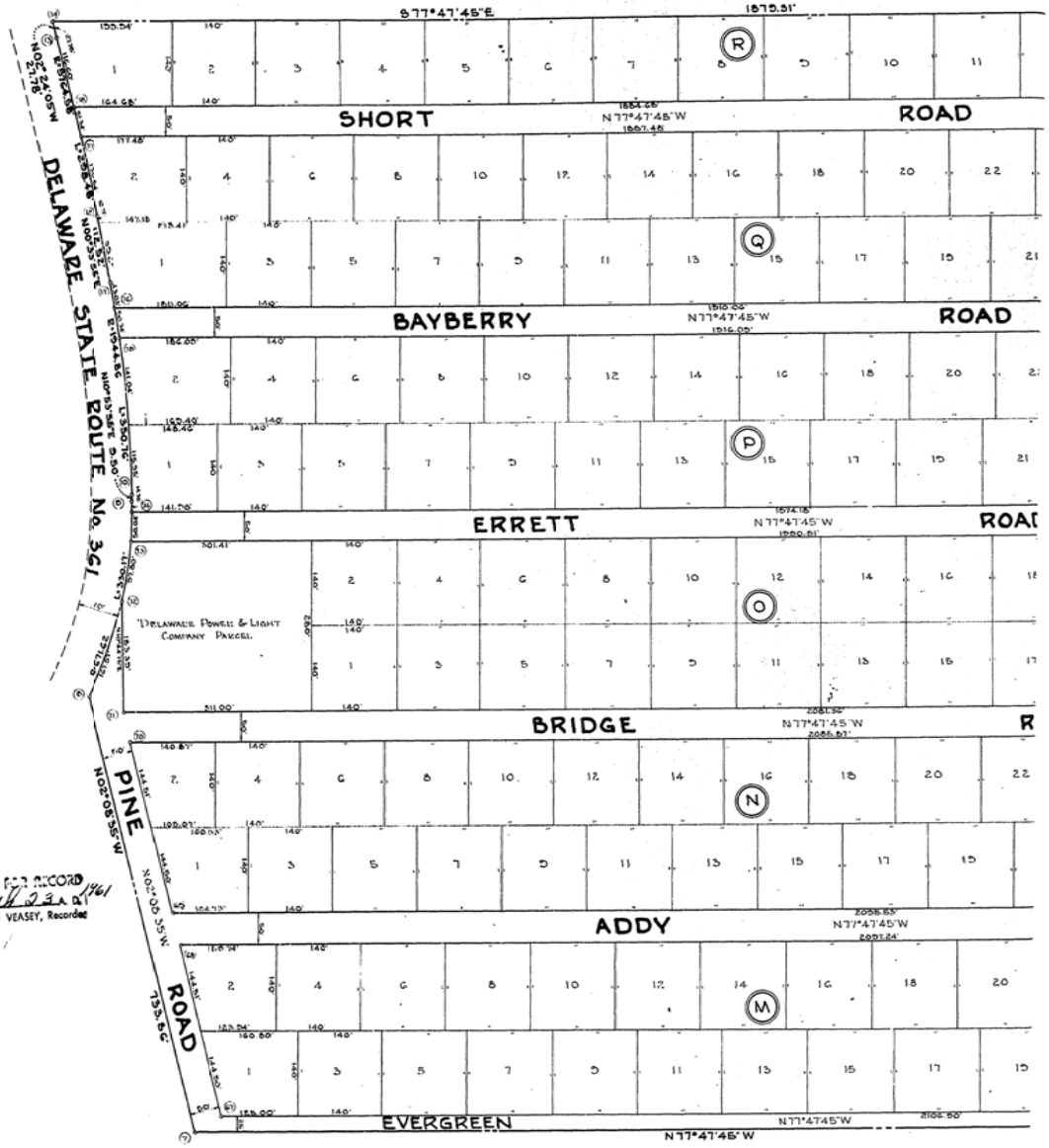
No.	NORTH	EAST	No.	NORTH	EAST	No.	NORTH	EAST	No.	NORTH	EAST
1	189333.56	603847.81	21	191357.55	603259.86	41	150087.88	602750.40	61	150067.18	601346.58
2	189169.66	604115.87	22	191414.88	603856.58	42	150003.00	602753.57	62	150376.90	602567.15
3	189079.21	603612.52	23	191445.70	603734.51	43	149881.98	603308.29	63	150384.37	602970.80
4	189060.04	603611.98	24	185710.46	603411.93	44	185911.08	603311.54	64	150033.82	602991.04
5	189068.39	603513.81	25	185716.03	603411.46	45	185703.65	603311.86	65	149986.89	602994.68
6	189648.78	603157.73	26	185888.93	603402.04	46	185686.84	603008.88	66	150690.74	603014.85
7	190103.24	602096.12	27	190009.98	603303.42	47	190088.60	603044.47	67	150136.12	602988.60
8	190084.90	602878.67	28	190089.83	603350.16	48	190036.83	603041.00	68	150424.33	602544.80
9	191180.80	601016.78	29	190359.11	603360.33	49	190334.61	603020.18	69	150476.80	602542.87
10	191160.18	601018.52	30	190460.51	603366.48	50	190376.21	603017.30	70	150765.81	602032.07
11	191180.65	601083.90	31	190670.70	603381.63	51	190676.48	602986.48	71	150816.88	602032.87
12	191621.16	601064.21	32	190741.10	603387.70	52	190716.85	602983.60	72	150356.46	602967.04
13	191597.65	601045.83	33	191040.41	603521.93	53	191016.17	602972.78	73	151083.52	601001.42
14	191543.85	601048.67	34	191050.78	603318.46	54	151066.03	602962.31	74	151136.40	601013.77
15	191560.08	602885.81	35	191063.40	603218.71	55	151365.33	602948.45	75	151414.97	601050.31
16	191481.05	602852.81	36	191033.62	603227.18	56	151484.63	602880.63	76	151468.63	601082.93
17	191431.20	602843.63	37	190734.04	603243.00	57	151382.71	602880.25	77	151781.71	601084.42
18	191414.32	602841.10	38	190692.84	603245.86	58	151061.86	602910.45	78	151803.06	601083.84
19	191462.97	603088.12	39	190353.56	603266.70	59	151005.35	602925.10	79	185660.60	603413.67
20	191407.12	603086.66	40	190352.16	603265.58	60	150715.06	602943.54			

CURVE TABLE

CURVE	CENTRAL ANGLE	RADIUS	ARC	TAN. DIST.	CHORD BEARING	CHORD DIST.
9	28° 10' 00"	671.62'	330.17	168.50	N24°55'55"E	326.85
10	10° 20' 00"	1044.86'	360.76	175.36	N05°43'55"E	350.28
12	02° 58' 00"	5764.58'	298.48	149.27	N00°55'05"W	298.45
22	01° 45' 00"	5775.58'	176.16	88.09	N03°58'45"W	176.16
44	01° 45' 00"	5615.58'	170.17	85.05	N03°58'45"W	170.16

NOTE:

3



RECEIVED FOR RECORD
March 23 A.D. 1961
at EDWARD VEASEY, Recorder

NOTES: 1. The courses shown on this Revised Plat are based on Grid North as compared to the Magnetic courses shown on the Original Plat of Middlesex Beach, of record in Plat Book 3, Page 22.
2. The lot lines of each lot as shown upon this Revised Plat have been reconciled with the lot lines of each corresponding lot shown upon the original Plat of Middlesex Beach which is of record in Plat Book 3, Page 22, so that both of such plats may be used interchangeably to designate a particular lot as shown upon either plat.

PURDUM & JESCHKE
CONSULTING ENGINEERS AND LAND SURVEYORS
2415 MARYLAND AVENUE
BALTIMORE 18, MARYLAND

BUSINESS RECORDS CORPORATION

REGISTERED LAND SURVEYOR 20-LS-206 DELAWARE

H. LeRoy Whitley Jr.
H. LEROY WHITLEY Jr. Reg. No. 204

NOTE. Coordinates and bearings shown hereon are based on the U.S.C.G.S. grid system. Stations and values used are as follows. Values are as corrected by Baltimore Office, U.S.C.G.S. November, 1960.

Station		
Cedar Patch E.M.*3	N211521.19	E 601004.29
North	N 191676.43	E 602866.61
Tunnel *2 E.M.*2	N 187055.24	E 596380.85

REVISED PLAT OF
MIDDLESEX BEACH
BALTIMORE HUNDRED, SUSSEX CO. DELAWARE

SCALE: 1"=100' JANUARY 11, 1961

BUSINESS RECORDS CORPORATION

DEED OF EASEMENT

THIS DEED OF EASEMENT, Made this 17th day of December, A.D. 1959,

BETWEEN, MIDDLESEX BEACH ASSOCIATION, a corporation of the State of Delaware, of Bethany Beach, Delaware, party of the first part, and ALL PRESENT AND FUTURE OWNERS OF ANY LOT OR LOTS SITUATE IN MIDDLESEX BEACH, as shown upon a certain plot entitled "Plat of MIDDLESEX BEACH", Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William B. Darling, and approved by Edward L. Simpson, Land Surveyor, and now of record in the Office of the Recorder of Deeds, in and for Sussex County, at Georgetown, Delaware, in Plot Book No. 3, Page 22, parties of the second part, WITNESSETH:

WHEREAS, Margaret Dunning, in and by her certain deed of bargain and sale, dated December 14, 1959, and now of record in the Office of the Recorder of Deeds, aforesaid, in Deed Book 512, Page 518, &c., has conveyed unto the party of the first part hereto all that land or beach area between the northerly and southerly limits of Middlesex Beach, lying between Block A to the west and the waters of the Atlantic Ocean to the east, as shown and designated upon a certain plot entitled "Plat of MIDDLESEX BEACH", Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William B. Darling, and approved by Edward L. Simpson, Land Surveyor, which is now of record in the Office of the Recorder of Deeds, aforesaid, in Plot Book No. 3, Page 22, as reference thereto being had will more fully and at large appear; and

WHEREAS, it is the intent and purpose of these presents to define and make certain the status of the title to, the rights in and the privileges over such land or beach area,

NOW, THEREFORE, the party of the first part, for and in consideration of the sum of ONE DOLLAR ($1.00), lawful money of the United States of America, and other valuable and lawful considerations to it in hand paid, the receipt whereof is hereby acknowledged,

does hereby grant and convey unto the parties of the second part, their heirs, successors and assigns forever, as the case may be, a perpetual easement and right of way, to be enjoyed in common by all the parties of the second part, their heirs, successors and assigns forever, as the case may be, for the uses and purposes hereinafter set forth, in and upon, through and across, over and from,

> ALL THAT certain lot, piece or parcel of land or beach area, situate, lying and being in MIDDLESEX BEACH, Baltimore Hundred, Sussex County, Delaware, between the northerly and southerly limits of Middlesex Beach, lying between Block A to the west and the Atlantic Ocean to the east, as shown and designated upon a certain Plot entitled "Plat of MIDDLESEX BEACH", Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William B. Darling, and approved by Edward L. Simpson, Land Surveyor, which plot is now of record in the Office of the Recorder of Deeds, in and for Sussex County, at Georgetown, Delaware, in Plot Book No. 3, Page 22, all as reference thereunto being had will more fully and at large appear.

TO HAVE AND TO HOLD the above described perpetual easement and right of way in and upon, through and across, over and from, the abovedescribed tract, piece and parcel of land unto all and singular the said parties of the second part and their respective heirs, successors and assigns, as the case may be, in common, to and for the following uses and purposes:

(1) For ingress, egress, regress and passage to and from their respective lots situate in Blocks A to R, inclusive, of Middlesex Beach Development, as shown upon the Plat thereof, and the waters of the Atlantic Ocean, for themselves, and their families, members of their household, tenants, guests and invitees, and none other; and

(2) For a place of recreation, including sun bathing, for themselves, and their families, members of their household, tenants, guests and invitees, and none other,

FURTHER, the party of the first part, for itself and its successors and assigns, does covenant, promise and agree to and with the parties of the second part, their respective heirs, successors and assigns, as the case may be, that no building, structure or obstruction of any kind shall ever be erected or constructed upon said tract, piece or parcel of land above described, nor shall any business or commercial enterprise be operated or conducted thereon, without first obtaining the unanimous written consent of the

record owners of all the lots in Block A of Middlesex Beach.

PROVIDED, that nothing herein contained shall in anywise restrict or limit the free and natural drifting of sand, or the construction of any and all sand fences, and barriers, bulkheads, jetties, groins and the like as may be necessary or designed to safeguard and protect such beach area, as well as all of the land area of Middlesex Beach, from the forces of erosion by wind or water.

IN WITNESS WHEREOF, the party of the first part, pursuant to an appropriate resolution of its Board of Directors duly authorizing the same, has caused these presents to be signed by its President and its corporate seal to be by him hereunto affixed, attested by its Secretary, the day and year first abovewritten.

Signed, sealed and delivered in the presence of:

Minnie M. Kacer

MIDDLESEX BEACH ASSOCIATION

By: William R. Smith Jr.
President

Attest: Nelson J. Shaffer
Secretary

MIDDLESEX BEACH ASSOCIATION INCORPORATED DELAWARE

STATE OF DELAWARE }
SS
COUNTY OF SUSSEX }

BE IT REMEMBERED, That on this 17 day of December, in the year of our Lord, one thousand nine hundred and fifty-nine, personally came before me, the subscriber, a Notary Public for the State and County aforesaid, William R. Perrott Jr., President of MIDDLESEX BEACH ASSOCIATION, a corporation existing under the laws of the State of Delaware, party to this Indenture known to me personally to be such, and acknowledged this Indenture to be his act and deed and the act and deed of said corporation, that the signature of the President thereto is in his own proper handwriting and the seal affixed is the common and corporate seal of said corporation, and that his act of sealing, executing, acknowledging and delivering said Indenture was duly authorized by a resolution of the Board of Directors of said corporation.

GIVEN under my hand and seal of office, the day and year aforesaid.

Notary Public

RECEIVED FOR RECORD
December 17 A. D. 1959
G. EDWARD VEASEY, Recorder

DEED OF EASEMENT

THIS DEED OF EASEMENT, Made this 17th day of December, A. D. 1959,

BETWEEN, MIDDLESEX BEACH ASSOCIATION, a corporation of the State of Delaware, of Bethany Beach, Delaware, party of the first part, and ALL PRESENT AND FUTURE OWNERS OF ANY LOT OR LOTS SITUATE IN MIDDLESEX BEACH, as shown upon a certain plot entitled "Plat of MIDDLESEX BEACH", Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William B. Darling, and approved by Edward L. Simpson, Land Surveyor, and now of record in the Office of the Recorder of Deeds, in and for Sussex County, at Georgetown, Delaware, in Plot Book No. 3, Page 22, parties of the second part, WITNESSETH:

WHEREAS, Margaret Dunning, in and by her certain deed of bargain and sale, dated December 14, 1959, and now of record in the Office of the Recorder of Deeds, aforesaid, in Deed Book 512, Page 518, &c., has conveyed unto the party of the first part hereto all those certain lots, pieces, strips or parcels of land, which are shown and designated upon a certain Plot entitled "Plat of MIDDLESEX BEACH", Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William B. Darling, and approved by Edward L. Simpson, Land Surveyor, as "Dune Road", "Beach Plum Road", "Pine Road", "Evergreen Road", "Addy Road", "Bridge Road", "Errett Road", "Bayberry Road", "Short Road", Five "10' Walkways" and One "5' Walkway"; which Plot is now of record in the Office of the Recorder of Deeds, aforesaid, in Plot Book No. 3, Page 22, as reference thereto being had will more fully and at large appear; and

WHEREAS, it is the intent and purpose of these presents to define and make certain the status of the title to, the rights in, and the privileges over the lands comprising and designated on said plat as "Dune Road", "Beach Plum Road", "Pine Road", "Evergreen Road", "Addy Road", "Bridge Road", "Errett Road", "Bayberry Road", "Short Road", Five "10' Walkways" and One "5' Walkway";

NOW THEREFORE, the party of the first part, for and in consideration of the sum of ONE DOLLAR ($1.00), lawful money of the United States of America, and other valuable and lawful considerations, to it in hand paid, the receipt whereof is hereby acknowledged, does hereby grant and convey unto the parties of the second part, their heirs, successors and assigns forever, as the case may be, a perpetual easement or right of way, to be enjoyed in common by all the parties of the second part, their heirs, successors and assigns forever, as the case may be, for the uses and purposes hereinafter set forth, in and upon, through and across, over and from, the lands comprising and designated on said plat as "Dune Road", "Beach Plum Road", "Pine Road", "Evergreen Road", "Addy Road", "Bridge Road", "Errett Road", "Bayberry Road", "Short Road", Five "10' Walkways", and One "5' Walkway".

TO HAVE AND TO HOLD the above described perpetual easement or right of way in and upon, through and across, over and from, the lands aforedesignated unto all and singular the said parties of the second part, and their respective heirs, successors and assigns, as the case may be, in common, to and for the following uses and purposes:

(1) As ways or means of ingress, egress, regress and passage to and from their respective lots situate in Blocks A to R, inclusive, of Middlesex Beach Development, as shown upon said official plat thereof, aforesaid, for themselves, and their families, members of their household, tenants, guests and invitees, and none other.

PROVIDED, that title to all such lands aforedesignated as ways or means of ingress, egress, regress and passage is hereby expressly reserved unto the party of the first part, its successors and assigns, and neither the filing and recording of the aforesaid plat, nor any supplement, amendment, modification or revision thereto or thereof, nor the sale and/or conveyance of any lots by reference to said plat, or any supplement, amendment, modification or revision thereto or thereof, nor the sale and/or conveyance of any lots by reference on said plat or any supplement, amendment, modification or revision thereto or thereof, shall constitute or in any manner be construed or considered as a dedication of the ways or means of ingress, egress, regress or passage, nor as a dedication of any other

lands shown upon said plat or any supplement, amendment, modification or revision thereto or thereof;

RATHER, the party of the first part, its successors and assigns, retains the right to convey, in the future, unto any public authority, all or any part of its right, title and interest in and to all or any part of said ways or means of ingress, egress, regress or passage, should the party of the first part, or its successors or assigns, deem it expedient so to do; and,

FURTHER, the party of the first part, its successors and assigns, also retains the right to dedicate to public use, all or any part of such ways or means of ingress, egress, regress or passage, at any future time, should the said party of the first part, or its successors or assigns, deem it expedient so to do; and,

FURTHER, the party of the first part reserves unto itself, its successors and assigns, all easements and rights of way over, upon and under the lands comprising and designated on said plat as "Dune Road", "Beach Plum Road", "Pine Road", "Evergreen Road", "Addy Road", "Bridge Road", "Errett Road", "Bayberry Road", "Short Road", Five "10' Walkways" and One "5' Walkway", for the erection, construction, maintenance, and use of poles, wires, pipe lines, conduits, and the necessary, proper, or desirable attachments in connection therewith, for the transmission of electricity for lighting, heating, telephone, and other purposes; for public and private sewers; storm water drains; land drains; pipe lines for supplying gas, water and heat; and for any other public or quasi-public utility or function conducted, maintained, or performed in any manner above, upon or beneath the surface of the ground; and the party of the first part, its successors, assigns, agents and employees, as well as representatives of utility companies, private or quasi-public, and representatives of public agencies, with the permission of the party of the first part, its successors and assigns, shall have the right to enter upon such strips of land designated as aforesaid for any of the utilitarian purposes for which such easements and rights of way are reserved, as aforesaid.

IN WITNESS WHEREOF, the party of the first part, pursuant to an appropriate resolution of its Board of Directors duly

authorizing the same, has caused these presents to be signed by its President and its corporate seal to be by him hereunto affixed, attested by its Secretary, the day and year first above written.

Signed, sealed and delivered
in the presence of:

Minnie M. Kreer

MIDDLESEX BEACH ASSOCIATION

By: William R. Smith
President

Attest: William R. Smith
Secretary

_____

STATE OF DELAWARE }
SS
COUNTY OF SUSSEX }

BE IT REMEMBERED, That on this 17 day of December, in the year of our Lord, one thousand nine hundred and fifty-nine, personally came before me, the subscriber, a Notary Public for the State and County aforesaid, William K. Everett, Jr., President of MIDDLESEX BEACH ASSOCIATION, a corporation existing under the laws of the State of Delaware, party of this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed and the act and deed of said corporation, that the signature of the President thereto is in his own proper handwriting and the seal affixed is the common and corporate seal of said corporation, and that his act of sealing, executing, acknowledging and delivering said Indenture was duly authorized by a resolution of the Board of Directors of said corporation.

GIVEN under my hand and seal of office, the day and year aforesaid.

Silvia M. Kreer
Notary Public

RECEIVED FOR RECORD
December 17 A. D. 1959
G. EDWARD VEASEY, Recorder

#13

DEED OF EASEMENT

THIS DEED OF EASEMENT, Made this 28th day of Nov., A. D. 1975,

B E T W E E N

THE MIDDLESEX BEACH ASSOCIATION, a corporation of The State of Delaware, of Bethany Beach, Delaware, party of the first part,

A N D

SUSSEX COUNTY, a political subdivision of the State of Delaware, party of the second part.

W I T N E S S E T H :

The party of the first part hereto, for and in consideration of the sum of ONE DOLLAR ($1.00), and other valuable and lawful consideration, cash in hand paid, the receipt whereof is hereby acknowledged, has this day bargained and sold, and by these presents does bargain, sell, convey, transfer and deliver unto the party of the second part a permanent easement and right-of-way, including the perpetual right to enter upon the streets, roads, avenues, alleys, and other thoroughfares within the limits of Middlesex Beach at any time that it may see fit to construct, install, maintain, replace and repair underground pipelines and/or mains for the purpose of conveying sewage and water over, across, through and under the streets, roads, alleys, and other thoroughfares within the limits of Middlesex Beach, together with the right to excavate and refill ditches and/or trenches for the location of said pipelines and/or mains, and the further right to remove trees, bushes, undergrowth and other obstructions interfering with the location, construction, installation, replacement, repair and maintenance of said pipelines and/or mains upon the following terms and conditions:

1. That all streets shall be restored to substantially their original condition as determined by Sussex County;

2. That this easement does not grant permission for any construction, maintenance, replacement, repair, or installation in any State maintained highway, which said permission must be received from the Department of Highways and Transportation;

3. That any construction, maintenance, installation, replacement and repair, except of an emergency nature, must be scheduled so as not to obstruct both ends of a street in any one block at any one time;

4. That on streets where there are dead ends, such streets shall not be blocked at the open end during any weekend or overnight except for work of an emergency nature;

5. That the party of the second part has the right to remove "access limiting structures" at the end of the streets during construction, replacement or repair provided that such structures shall be restored to substantially their original condition as determined by Sussex County.

Easement on property to be conveyed by Middlesex Beach Association situated in Baltimore Hundred, Sussex County, Delaware as shown upon a certain plot entitled "Plot of Middlesex Beach," Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William B. Darling, and approved by Edward L. Simpson, Land Surveyor, now of record in the Office of the Recorder of Deeds in and for Sussex County, at Georgetown, Delaware, in Plot Book No. 3, Page 22.

TO HAVE AND TO HOLD said easements and right-of-way unto the party of the second part, its successors and assigns forever.

The party of the first part does hereby covenant with the party of the second part that it is lawfully seized and possessed of the streets, alleys, roads, and other public thoroughfares within the corporate limits of Middlesex Beach and that the President and Secretary of Middlesex Beach have a good right and lawful authority to grant this easement, that it is free from all encum-

brances and that the party of the first part will forever warrant and defend the title thereto against the lawful claim of any persons whomsoever.

IN WITNESS WHEREOF, the party of the first part has caused this easement to be executed by its proper corporate officers and its corporate seal to be hereunto affixed duly attested by its Secretary, the day and year first abovewritten.

Sealed and delivered
in the presence of:

MIDDLESEX BEACH ASSOCIATION

By: Margaret P. Hoch
President

Attest: Barbara Slocum
Secretary

STATE OF Del.
SS:
COUNTY OF Sussex

BE IT REMEMBERED, That on this 28th day of Nov., A. D. 1975, personally came before me, the Subscriber, a Notary Public for the State and County aforesaid, Margaret P. Haskins, President of MIDDLESEX BEACH ASSOCIATION, a corporation of The State of Delaware, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed and the act and the deed of the said corporation; that the signature of the President is in his own proper handwriting; that the seal affixed is the common and corporate seal of the said corporation duly affixed by its authority; and that the act of signing, sealing, acknowledging and delivering the said Indenture was first duly authorized by resolution of the Board of Directors of said corporation.

GIVEN under my hand and seal of office, the day and year aforesaid.

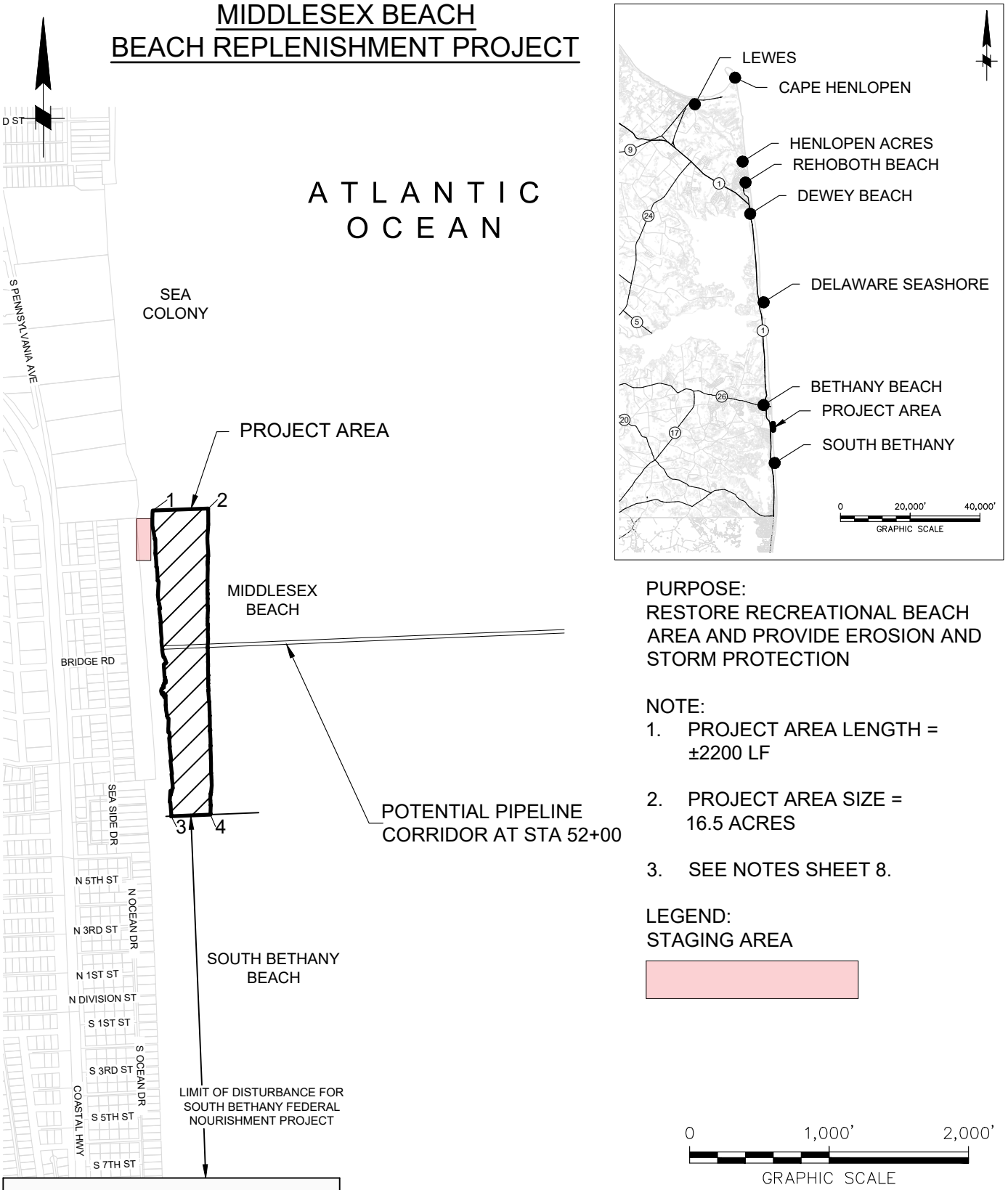
CLAYTON L. RINGLER NOTARY PUBLIC REHOBOTH BEACH, DELAWARE

Notary Public

RECEIVED
MARY ANN McCABE
MAY 18 11 27 AM '76
RECORDER OF DEEDS
SUSSEX COUNTY

Sussex County
6-4-76

MIDDLESEX BEACH
BEACH REPLENISHMENT PROJECT



PURPOSE:
RESTORE RECREATIONAL BEACH AREA AND PROVIDE EROSION AND STORM PROTECTION

NOTE:
1. PROJECT AREA LENGTH = ±2200 LF
2. PROJECT AREA SIZE = 16.5 ACRES
3. SEE NOTES SHEET 8.

LEGEND:
STAGING AREA

0 1,000' 2,000'
GRAPHIC SCALE

DELAWARE STATE PLANE COORDINATE SYSTEM, ZONE 0700 (NAD83, US SURVEY FT)		
	EASTING	NORTHING
1	760238.280	191540.293
2	760635.253	191553.533
3	760370.222	189347.567
4	760652.158	189359.069

FOR PERMIT USE ONLY
NOT FOR CONSTRUCTION

BEACH REPLENISHMENT PROJECT

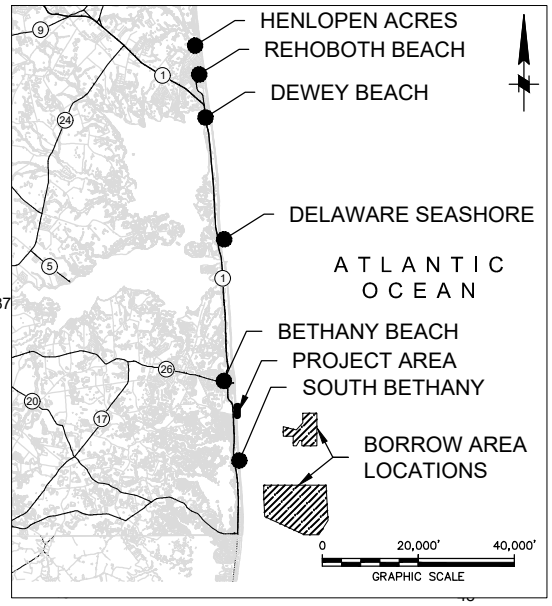
AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOCIATION, INC.
P.O BOX 584
BETHANY BEACH, DELAWARE 19930

GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

DATE: 01/06/26 REV

PROPOSED FENWICK ISLAND & AREA E BORROW AREA LOCATIONS



LIMITS OF DISTURBANCE FOR BETHANY BEACH FEDERAL NOURISHMENT PROJECT

ROUTE 26

BETHANY BEACH

PROJECT AREA

1.83 MILES

BORROW AREA E

LIMITS OF DISTURBANCE FOR SOUTH BETHANY FEDERAL NOURISHMENT PROJECT

2.94 MILES

FENWICK ISLAND STATE PARK

ATLANTIC OCEAN

LITTLE ASSAWOMAN BAY

BORROW AREA FENWICK ISLAND

LIMITS OF DISTURBANCE FOR FENWICK ISLAND FEDERAL NOURISHMENT PROJECT

ROUTE 54

DE

MD

ASSAWOMAN BAY

OCEAN CITY

NOTES:

1. REFERENCE: NOAA CHART 12214 (51ST EDITION, MAR. 2019 LAST CORRECTION: 2/5/2020) & NOAA CHART 12211 (48TH EDITION, DEC. 2018 LAST CORRECTION: 4/22/2020)
2. DEPTH SHOWN IN FEET BELOW M.L.W

0 6,000' 12,000'

GRAPHIC SCALE

FOR PERMIT USE ONLY
NOT FOR CONSTRUCTION

BEACH REPLENISHMENT PROJECT IN ATLANTIC OCEAN

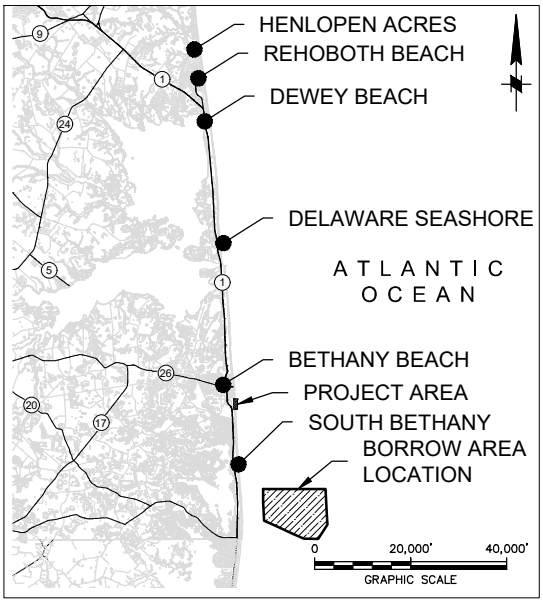
AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOCIATION, INC.
P.O. BOX 584
BETHANY BEACH, DELAWARE 19930

GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

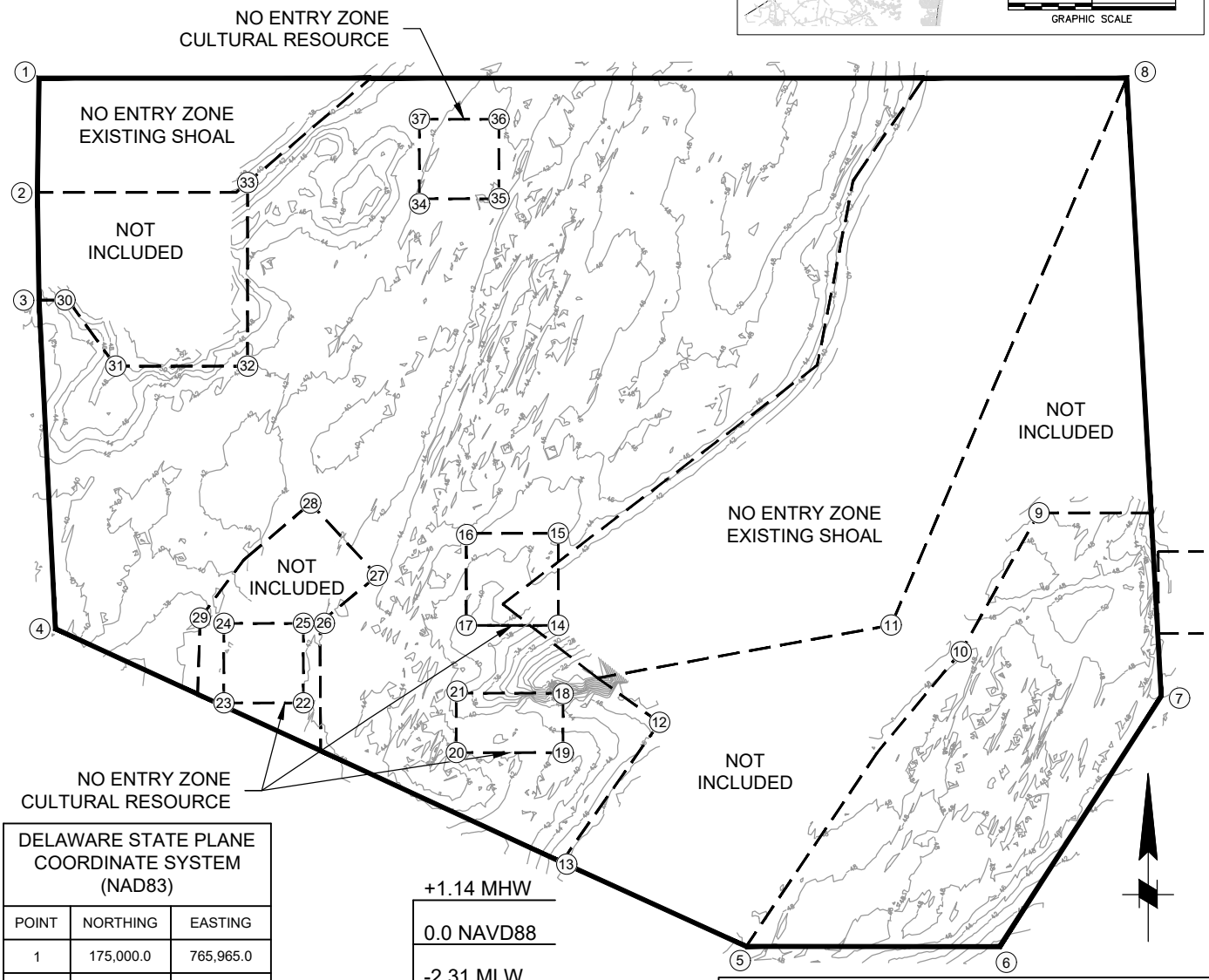
DATE: 01/02/26 REV

LIMITS OF BORROW AREA
FENWICK ISLAND



NOTES:

1. BORROW AREA SIZE = 2,708 ACRES
2. HORIZONTAL COORDINATES REFERENCED TO NAD83 DELAWARE STATE PLANE, ZONE 0700, US SURVEY FOOT.
3. VERTICAL DATUM REFERENCED TO NAVD88.
4. CONTOURS SHOWN ARE FROM A SURVEY CONDUCTED BY TRIANGLE SURVEYS, INC. IN AUGUST 2018 AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME.
5. THE MAXIMUM ALLOWABLE DEPTH FOR DREDGING SHALL NOT EXCEED A DEPTH OF 5 FEET BELOW THE EXISTING BOTTOM ELEVATION AND SHALL NOT EXCEED ELEVATION -50 FEET NAVD 88.



DELAWARE STATE PLANE COORDINATE SYSTEM (NAD83)		
POINT	NORTHING	EASTING
1	175,000.0	765,965.0
2	173,634.1	765,945.6
3	172,349.0	765,967.0
4	168,421.8	766,161.8
5	164,626.9	774,416.1
6	164,625.9	777,446.4
7	167,616.0	779,377.4
8	175,000.0	778,964.6

+1.14 MHW

0.0 NAVD88

-2.31 MLW

DATUM ELEVATION (FT)
NOT TO SCALE

0 2,000' 4,000'

GRAPHIC SCALE

FOR PERMIT USE ONLY
NOT FOR CONSTRUCTION

BEACH REPLENISHMENT PROJECT
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOCIATION, INC.
P.O. BOX 584
BETHANY BEACH, DELAWARE 19930

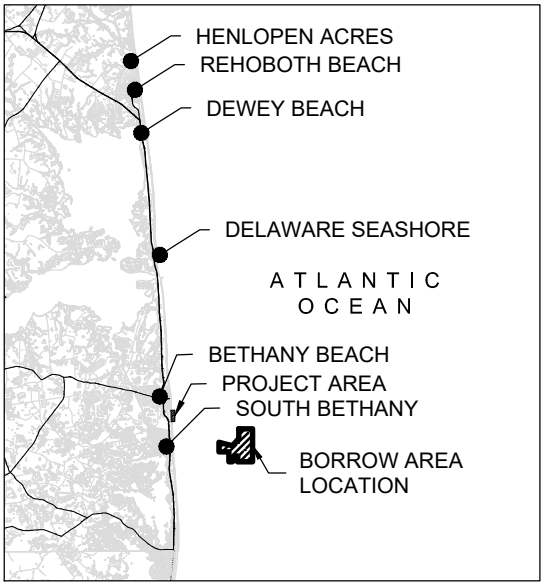
GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

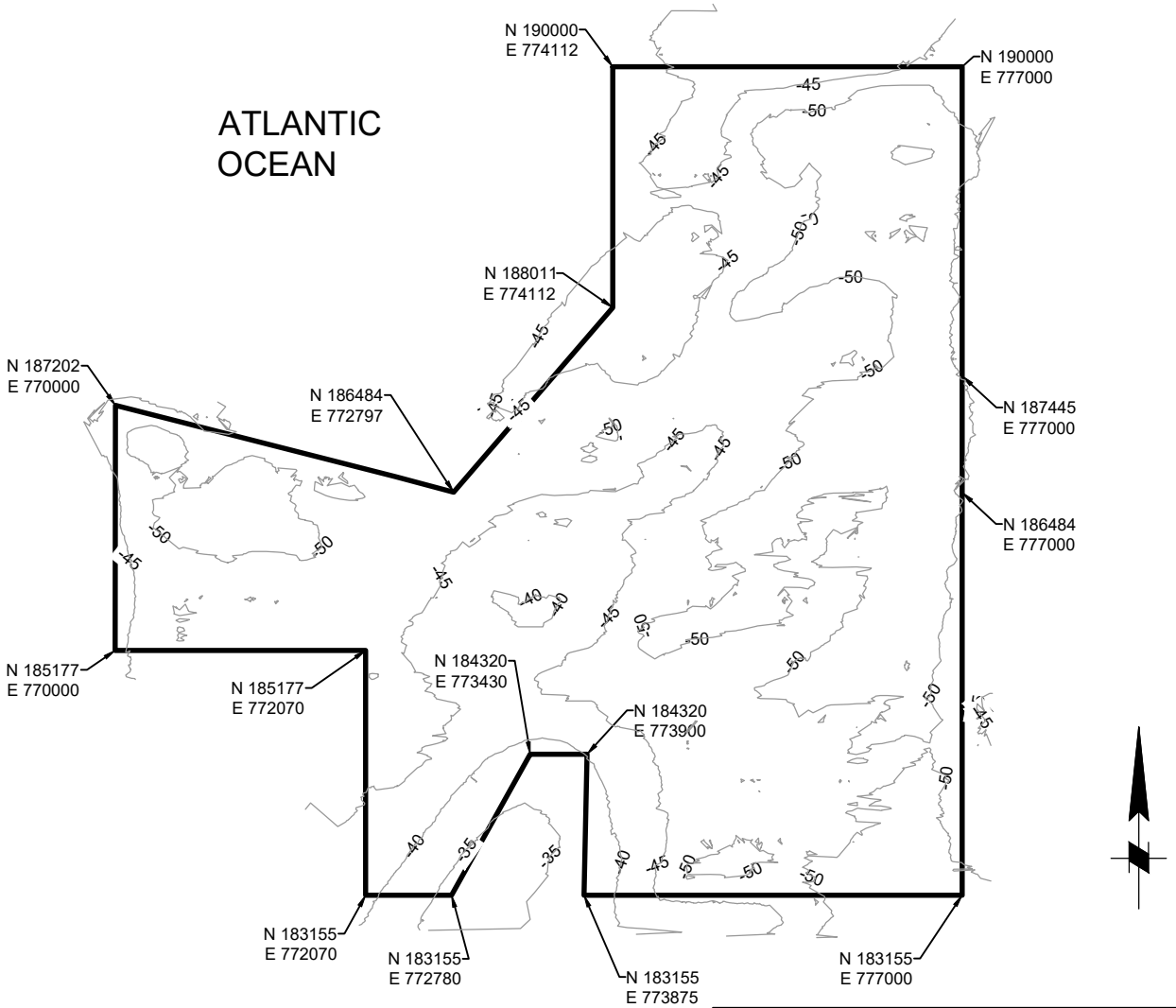
DATE: 01/06/26 REV

LIMITS OF BORROW AREA
AREA E

NOTES:

1. BORROW AREA SIZE = 697 ACRES
2. HORIZONTAL COORDINATES REFERENCED TO NAD83 DELAWARE STATE PLANE, ZONE 0700, US SURVEY FOOT.
3. VERTICAL DATUM REFERENCED TO NAVD88.
4. CONTOURS SHOWN ARE FROM A SURVEY CONDUCTED BY GAHAGAN & BRYANT ASSOCIATES IN FEBRUARY 2021 AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME.
5. THE MAXIMUM ALLOWABLE DEPTH FOR DREDGING SHALL NOT EXCEED A DEPTH OF 5 FEET BELOW THE EXISTING BOTTOM ELEVATION AND SHALL NOT EXCEED ELEVATION -53 FEET NAVD 88.





+1.14 MHW

0.0 NAVD88

-2.31 MLW

DATUM ELEVATION (FT)
NOT TO SCALE

0 1,500' 3,000'

GRAPHIC SCALE

FOR PERMIT USE ONLY
NOT FOR CONSTRUCTION

BEACH REPLENISHMENT PROJECT
IN ATLANTIC OCEAN

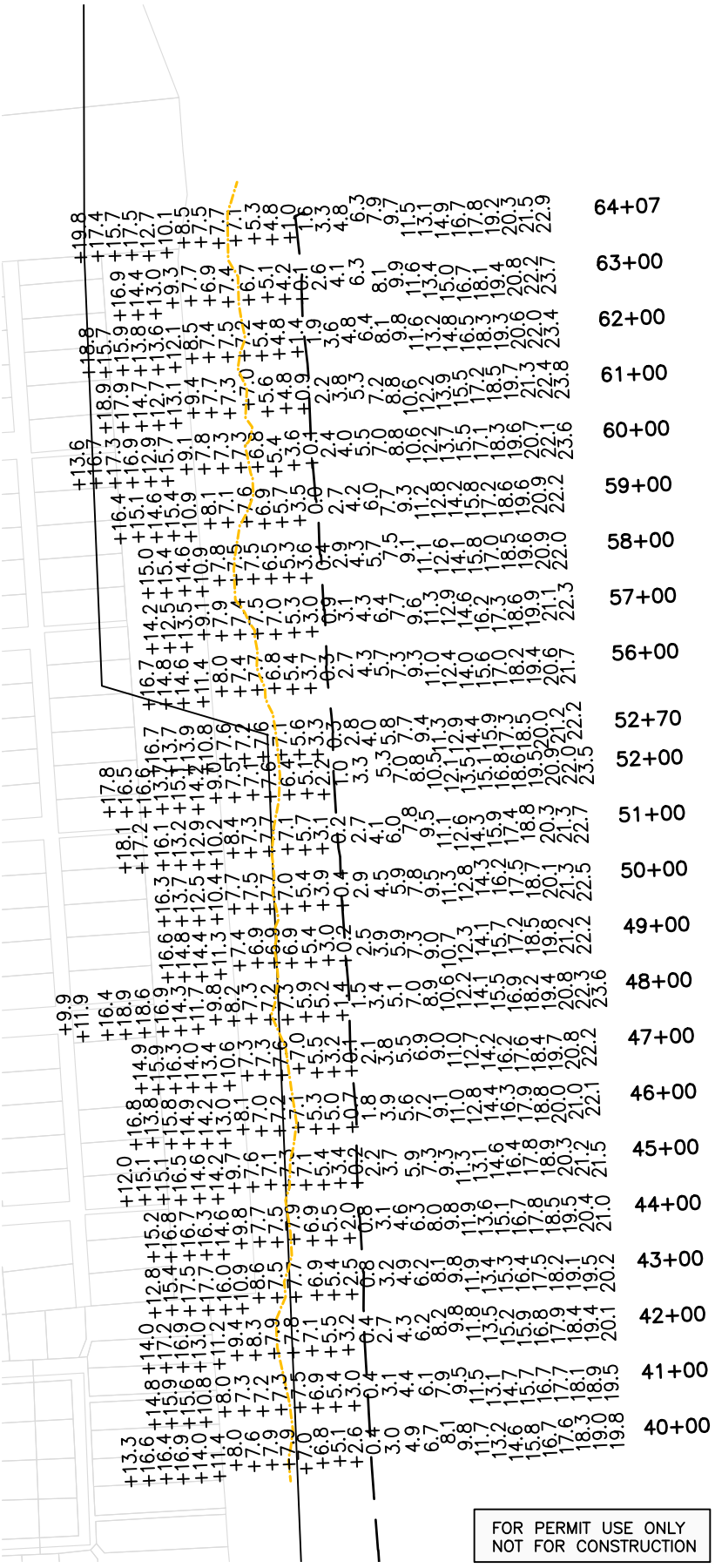
AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOCIATION, INC.
P.O. BOX 584
BETHANY BEACH, DELAWARE 19930

GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

DATE: 01/06/26 REV

MIDDLESEX BEACH
BEACH REPLENISHMENT PROJECT



LEGEND:

HIGH TIDE LINE

MEAN HIGH WATER

BASELINE

DELAWARE PARCEL LINES

NOTES:

1. PROJECT AREA LENGTH = ±2200 LF
2. SURVEY DATA SHOWN WAS COLLECTED ON AUGUST 13, 2025 BY GAHAGAN & BRYANT ASSOCIATES(GBA) AND IS REFERENCED TO NAVD88. SOUNDINGS PRECEDED BY A "+" ARE ABOVE THE REFERENCE PLANE.
3. SEE NOTES SHEET 8.

+1.14 MHW
0.0 NAVD88
-2.31 MLW

DATUM ELEVATION (FT)
NOT TO SCALE

0 300' 600'

GRAPHIC SCALE

FOR PERMIT USE ONLY
NOT FOR CONSTRUCTION

BEACH REPLENISHMENT PROJECT

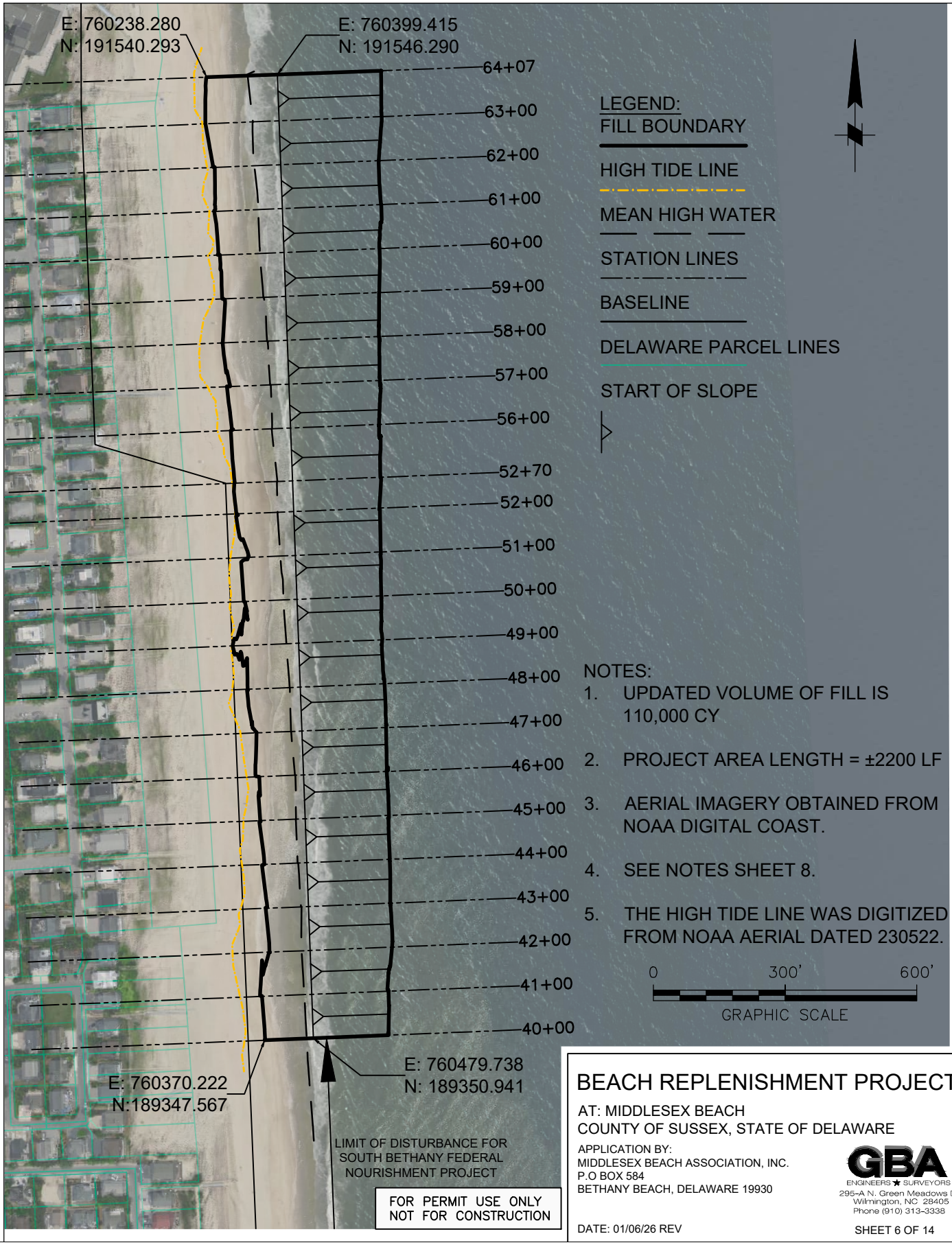
AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOCIATION, INC.
P.O BOX 584
BETHANY BEACH, DELAWARE 19930

GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

DATE: 01/06/26 REV

MIDDLESEX BEACH
FEDERAL BEACH REPLENISHMENT PROJECT TIE-IN OPTION



BEACH REPLENISHMENT PROJECT

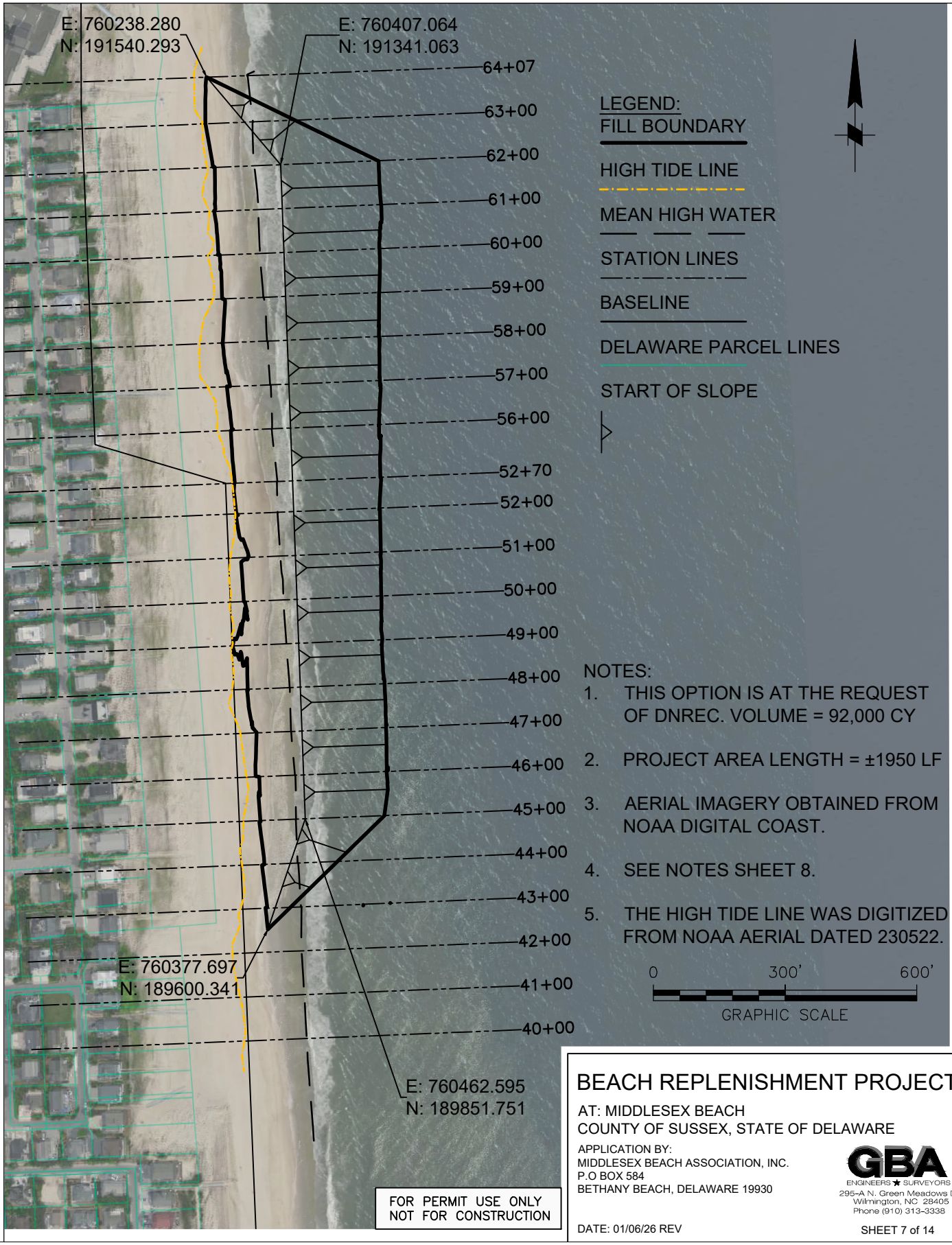
AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOCIATION, INC.
P.O BOX 584
BETHANY BEACH, DELAWARE 19930

GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

DATE: 01/06/26 REV

MIDDLESEX BEACH
STAND ALONE BEACH REPLENISHMENT OPTION



BEACH REPLENISHMENT PROJECT

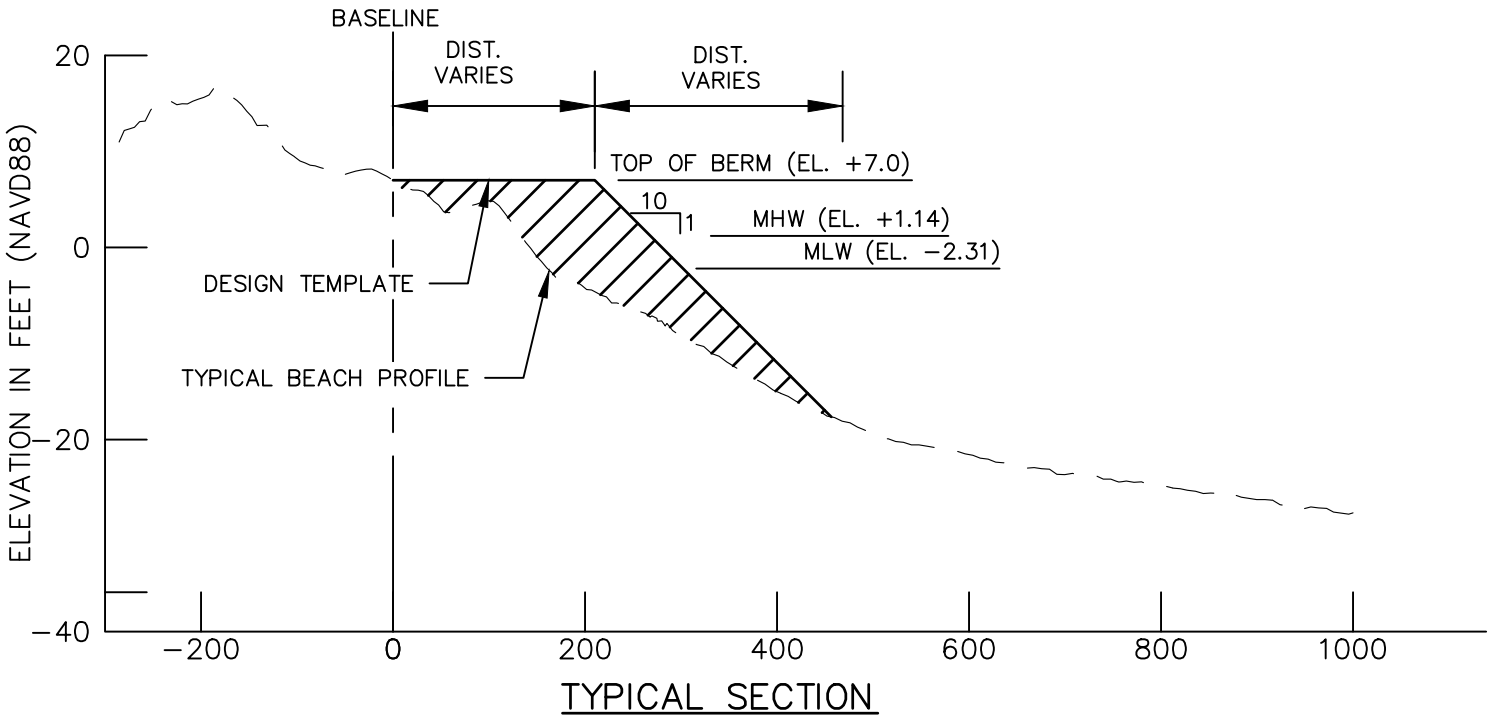
AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOCIATION, INC.
P.O BOX 584
BETHANY BEACH, DELAWARE 19930

GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

DATE: 01/06/26 REV

MIDDLESEX BEACH DESIGN FILL SECTION



TYPICAL SECTION

NOTES:

1. RANGE OF TIDE INFORMATION OBTAINED FROM NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION (NOAA) VDATUM TRANSFORMATION PROGRAM, VERSION 4.6.1 AT THE PROJECT MIDPOINT.
2. SOUNDING DATA DEPICTED IN THESE PLANS IS REPRESENTATIVE OF A LARGER DATA SET WHICH WAS COLLECTED USING AN ECHOSOUNDER (ODOM CV200) AT A FREQUENCY OF 200 KILOHERTZ. THE DATA SET WAS REDUCED FOR CLARITY AND CORRECTED IN REAL TIME VIA REAL TIME KINEMATIC (RTK) CORRECTIONS.
3. THE INFORMATION DEPICTED IN THESE PLANS REPRESENT THE RESULTS OF SURVEYS CONDUCTED ON AUGUST 13, 2025 AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME.
4. BEACH FILL TEMPLATE AND FILL EXTENTS SHOWN IN THESE PLANS IS FOR PERMITTING PURPOSES ONLY AND THE TEMPLATE WAS OBTAINED FROM 2022 USACE BEACH NOURISHMENT PROJECT INCLUDING SOUTH BETHANY BEACH (SOLICITATION NO:W912BU22B0017). MIDDLESEX INTENDS TO MAINTAIN THE SAME TEMPLATE AS THE USACE PROJECT. CONSTRUCTION BEACH FILL TEMPLATE WILL BE DETERMINED BY USACE DURING THE NEXT NOURISHMENT CYCLE AND BY EXISTING BEACH CONDITIONS AT THE TIME OF THE EVENT.
5. ONCE A FEDERAL NOURISHMENT PROJECT IS ANNOUNCED, MIDDLESEX WILL CONDUCT A SURVEY OF THE BEACH AND BORROW SITE AND PROVIDE COMPLETE CONSTRUCTION PLANS WITH REVISED TEMPLATES TO DNREC AND USACE FOR APPROVAL.

+1.14 MHW

0.0 NAVD88

-2.31 MLW

DATUM ELEVATION (FT)
NOT TO SCALE

FOR PERMIT USE ONLY
NOT FOR CONSTRUCTION

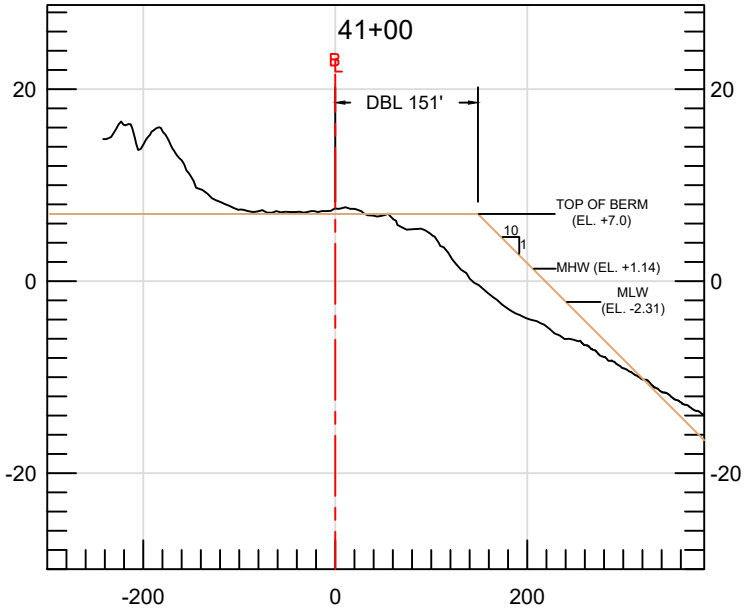
BEACH REPLENISHMENT PROJECT

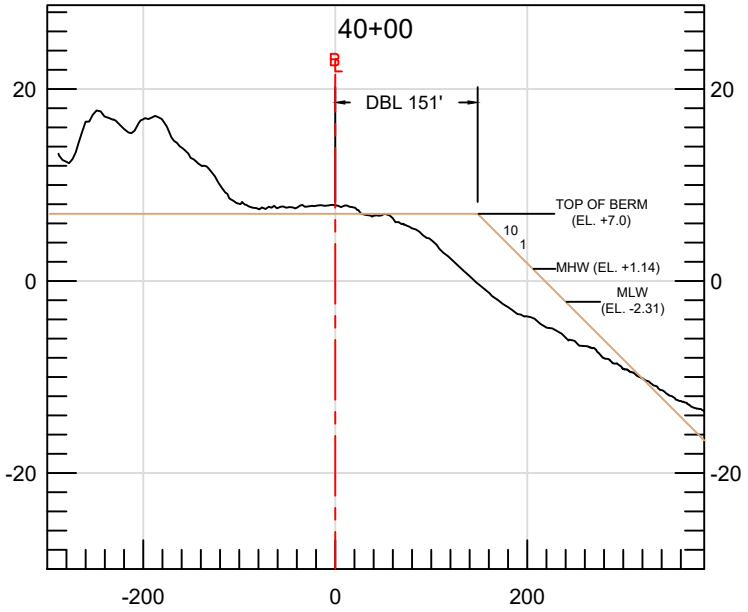
AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

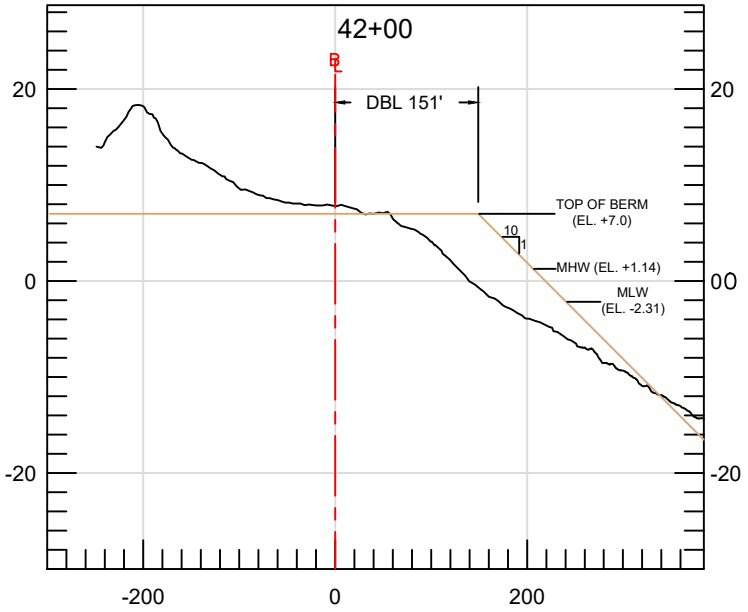
APPLICATION BY:
MIDDLESEX BEACH ASSOCIATION, INC.
P.O BOX 584
BETHANY BEACH, DELAWARE 19930

GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

DATE: 01/02/26 REV







H Scale : 1" = 200' V Scale : 1" = 20'

BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX,
STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOC., INC.
P.O BOX 584
BETHANY BEACH, DELAWARE
19930

DATE: 01/06/26 (REV)

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ENGINEERS ★ SURVEYORS
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Wilmington, NC 28405
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SHEET 9 OF 14

NOTES:
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2. VERTICAL DATUM IS REFERENCED TO NAVD88.
3. HORIZONTAL DATUM IS REFERENCED TO NAD83.
4. BASELINE IS ONLY SHOWN AT STATIONS 40+00 TO 52+70 DUE TO THE LANDWARD SHIFT OF ALIGNMENT AT 52+70.
5. DBL REPRESENTS DISTANCE FROM BASE LINE.
6. SEE NOTES SHEET 8.

LEGEND:

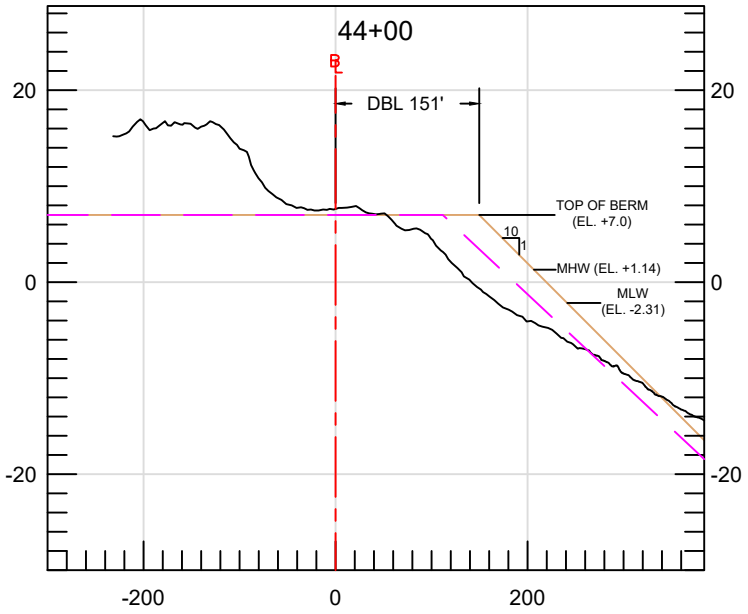
SURVEY DATA

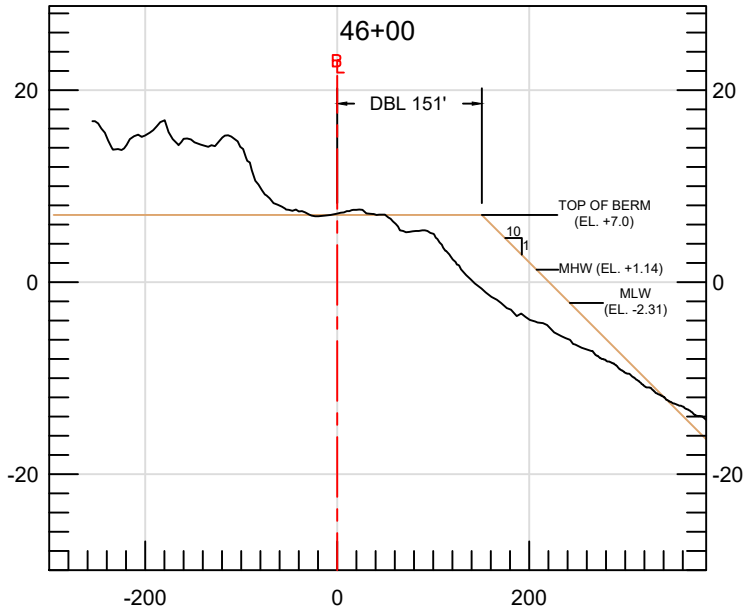
BEACH FILL TEMPLATE

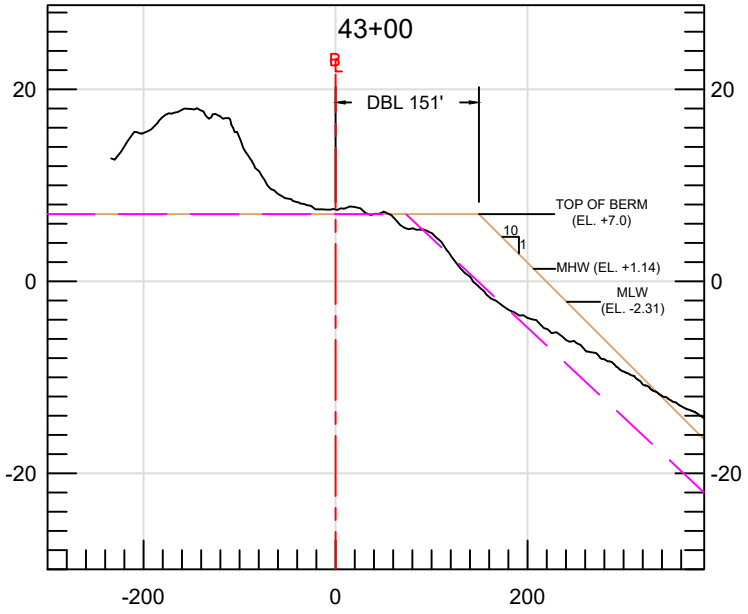
BASELINE

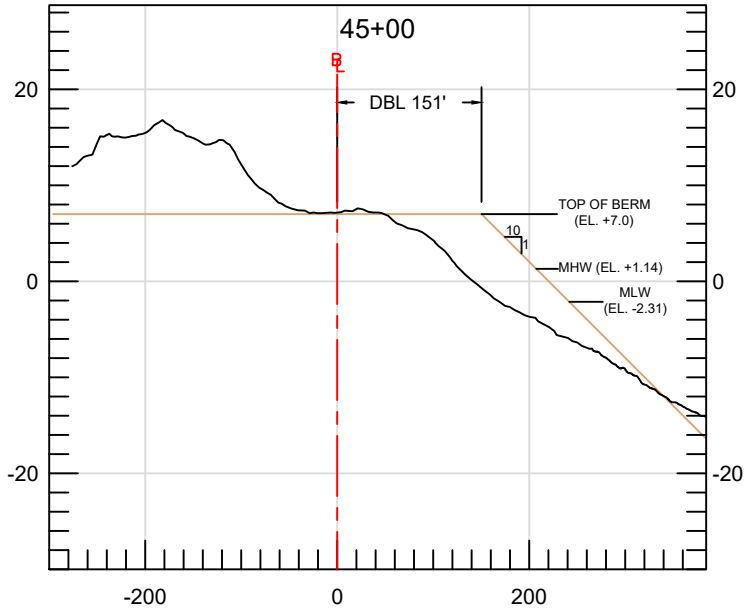
STAND ALONE TEMPLATE

FOR PERMIT USE ONLY NOT FOR CONSTRUCTION









H Scale : 1" = 200' V Scale : 1" = 20'

BEACH CROSS SECTIONS
IN ATLANTIC OCEAN
AT: MIDDLESEX BEACH
COUNTY OF SUSSEX,
STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOC., INC.
P.O BOX 584
BETHANY BEACH, DELAWARE
19930

DATE: 01/06/26 (REV)

GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

SHEET 10 OF 14

NOTES:
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6. SEE NOTES SHEET 8.

LEGEND:

SURVEY DATA

BEACH FILL TEMPLATE

BASELINE

STAND ALONE TEMPLATE

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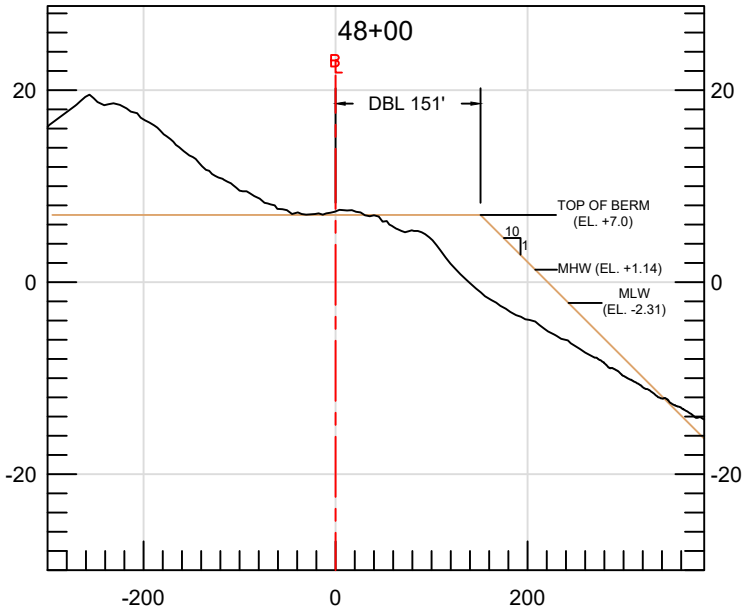

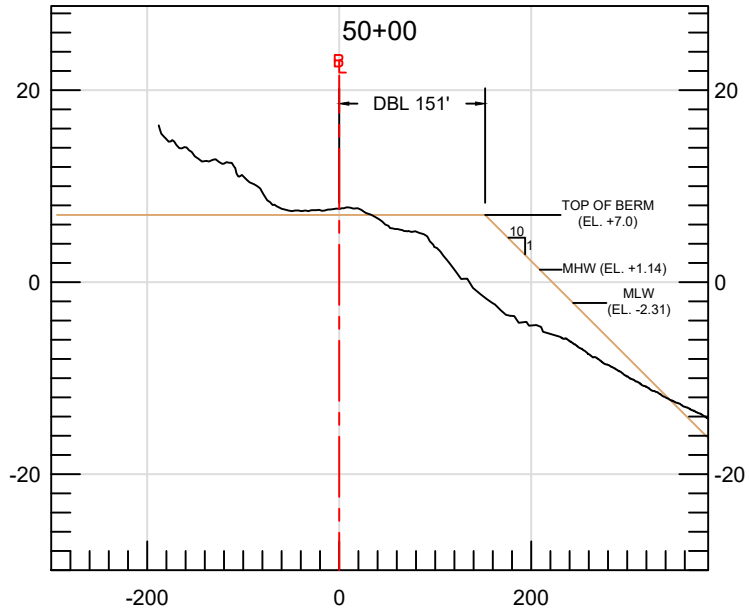

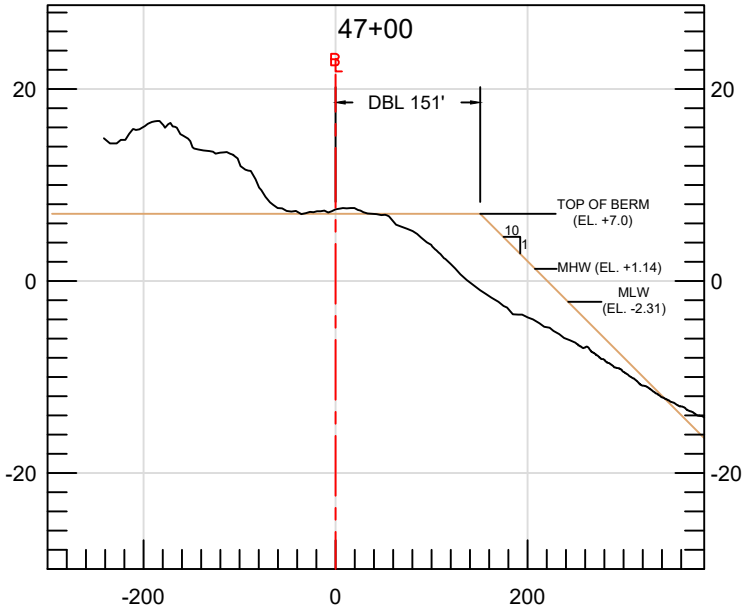

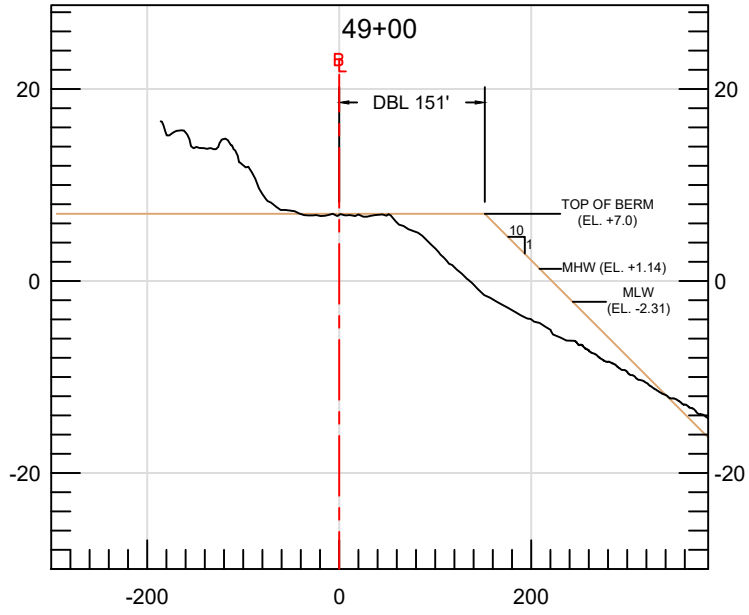

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BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX,
STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOC., INC.
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BETHANY BEACH, DELAWARE
19930

DATE: 01/06/26 (REV)

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SHEET 11 OF 14

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LEGEND:

SURVEY DATA

BEACH FILL TEMPLATE

BASELINE

STAND ALONE TEMPLATE

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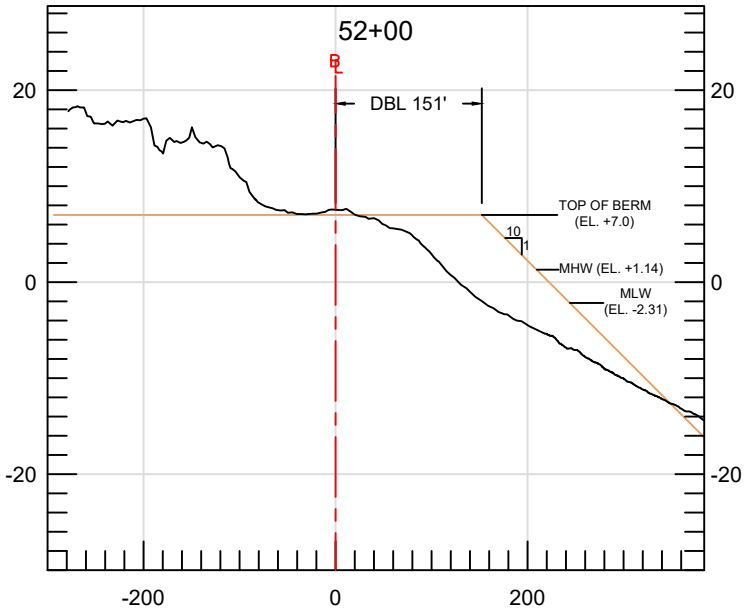

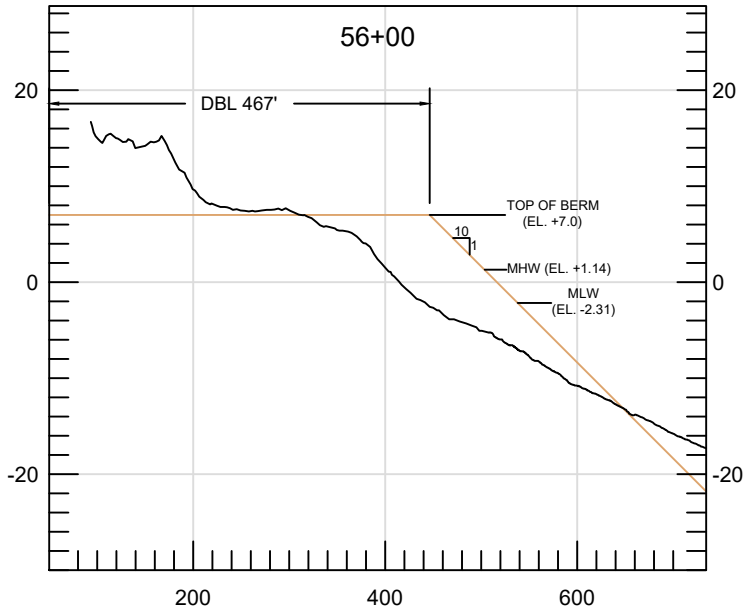

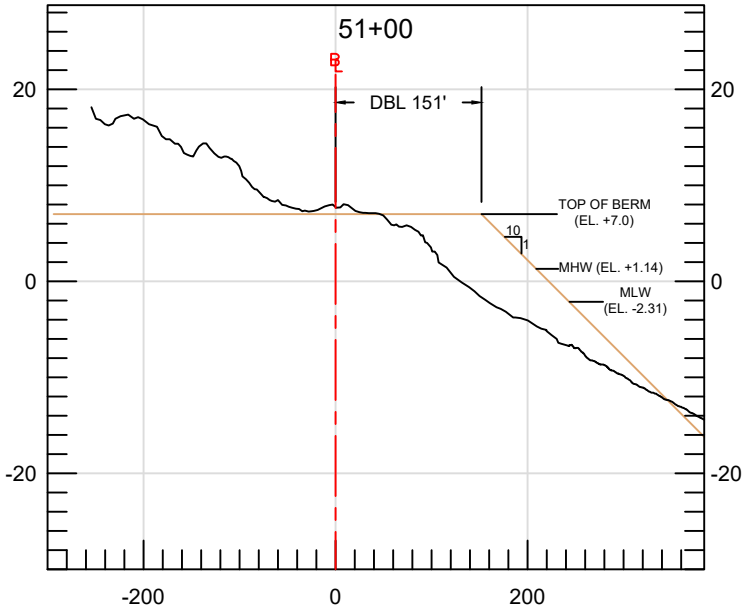

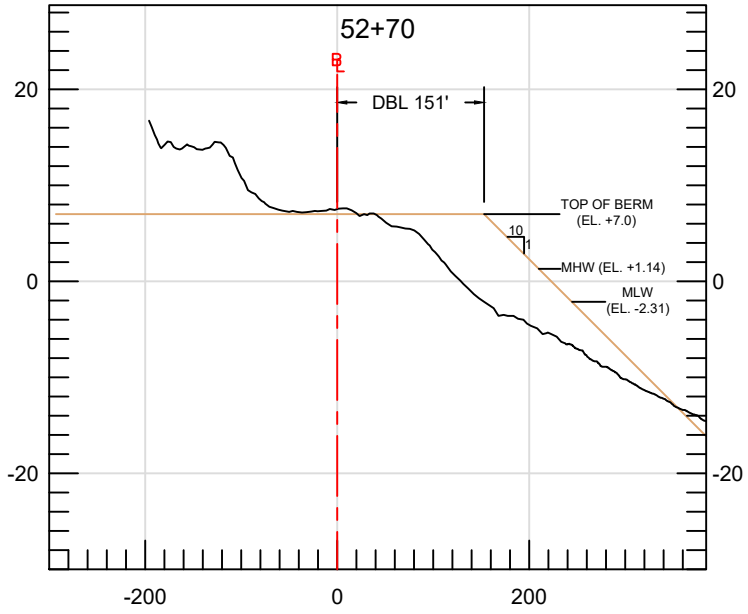

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BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX,
STATE OF DELAWARE

APPLICATION BY:
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P.O BOX 584
BETHANY BEACH, DELAWARE
19930

DATE: 01/06/26 (REV)

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Wilmington, NC 28405
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SHEET 12 OF 14

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LEGEND:

SURVEY DATA

BEACH FILL TEMPLATE

BASELINE

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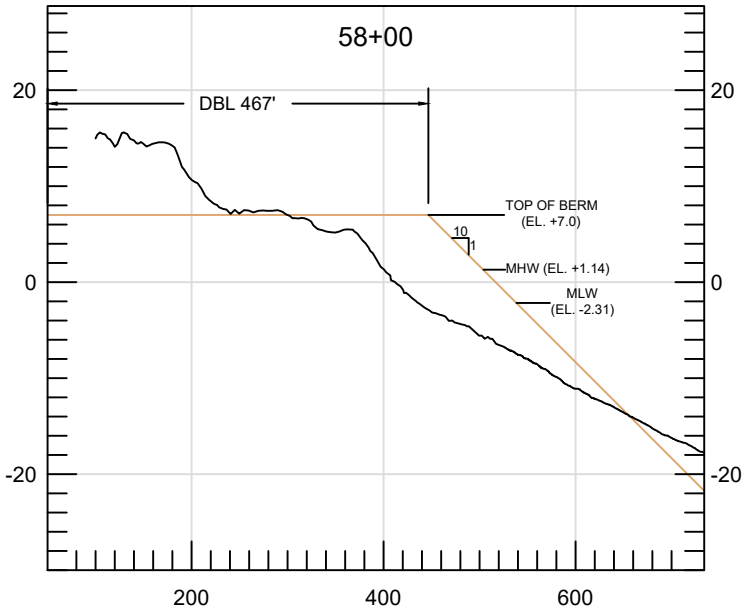

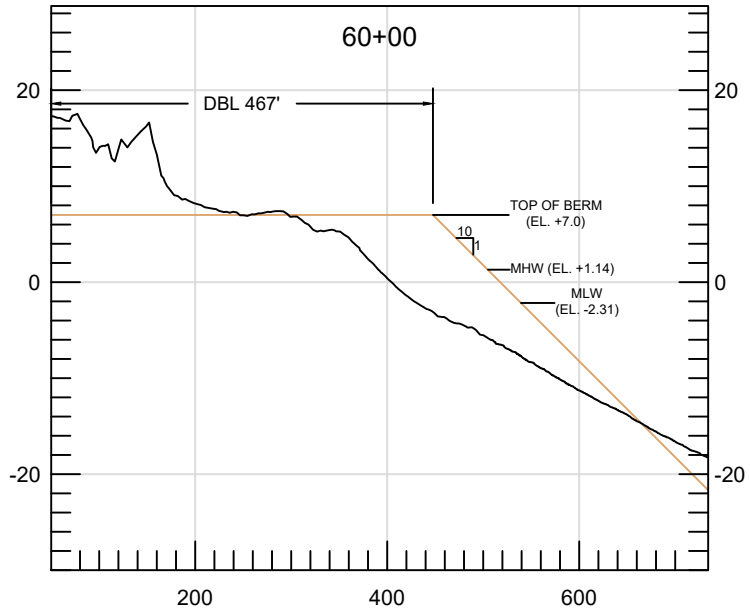

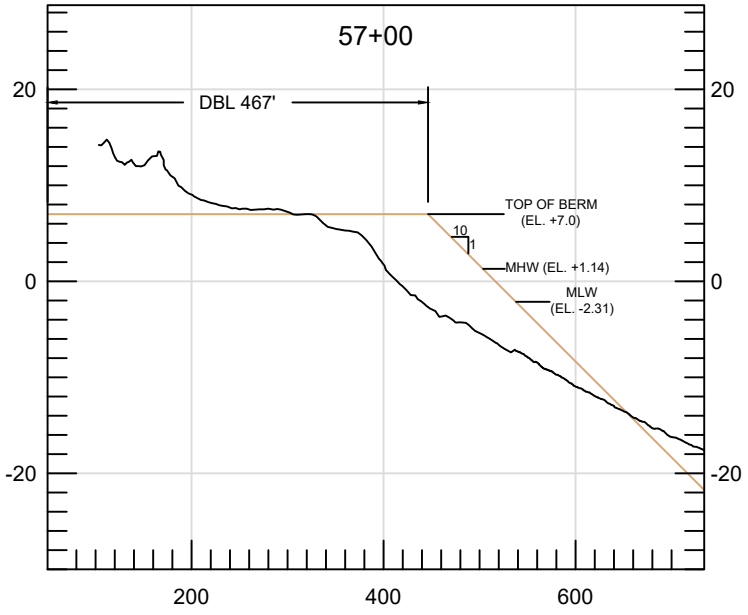

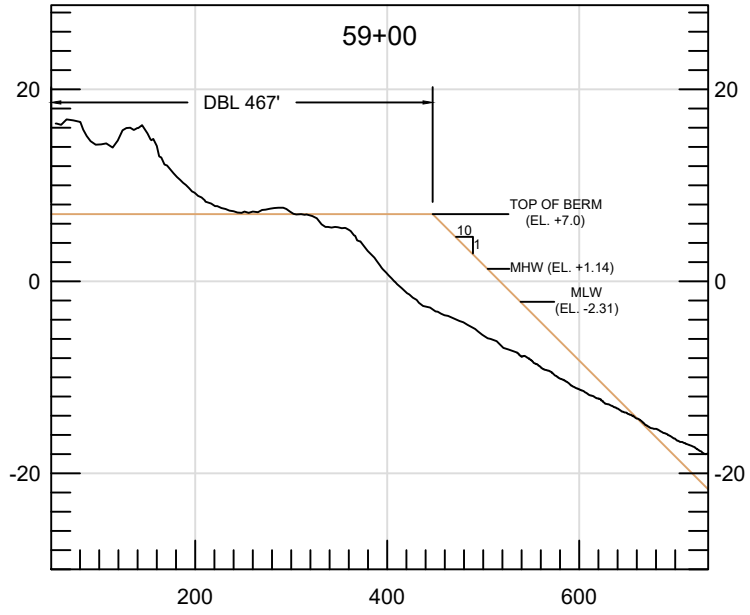

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BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX,
STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOC., INC.
P.O BOX 584
BETHANY BEACH, DELAWARE
19930

DATE: 01/06/26 (REV)

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ENGINEERS ★ SURVEYORS
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Wilmington, NC 28405
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SHEET 13 OF 14

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LEGEND:

SURVEY DATA

BEACH FILL TEMPLATE

BASELINE

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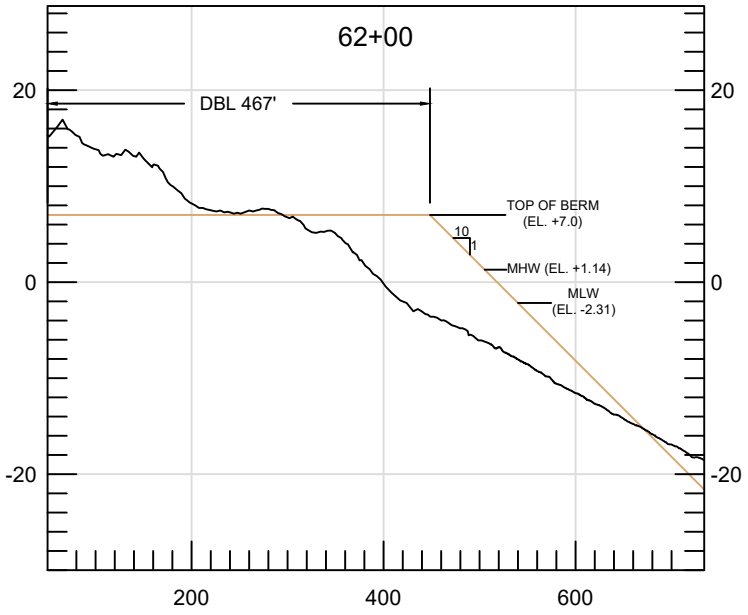

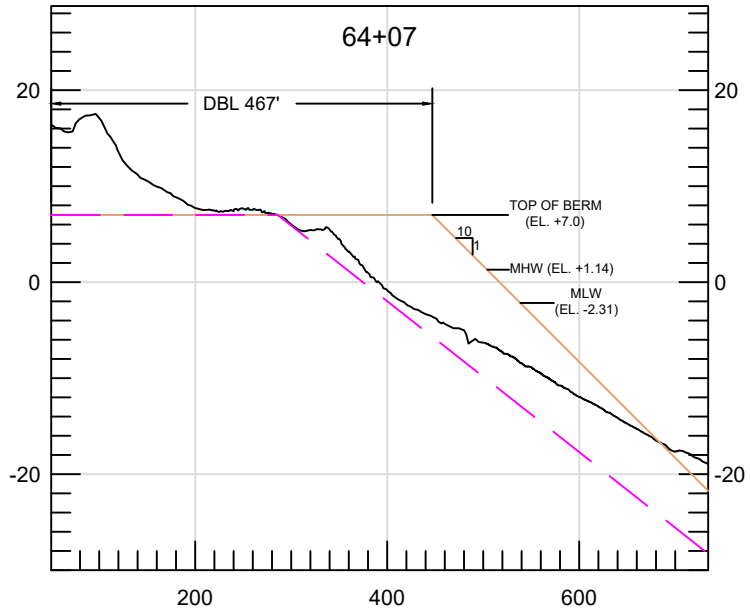

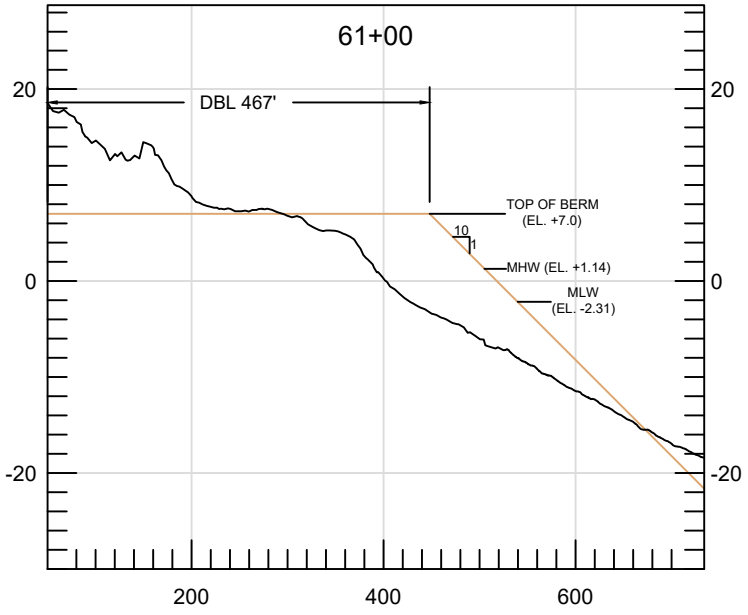

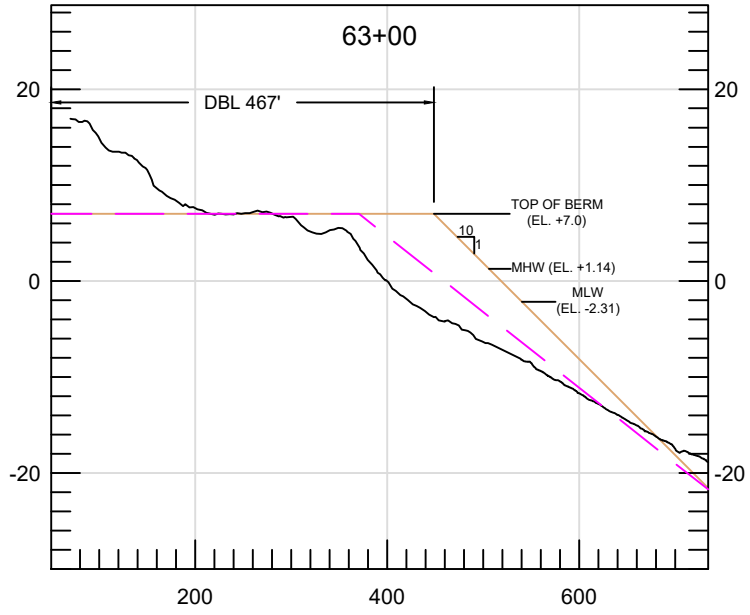

H Scale : 1" = 200' V Scale : 1" = 20'

BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX,
STATE OF DELAWARE

APPLICATION BY:
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SHEET 14 OF 14

NOTES:
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6. SEE NOTES SHEET 8.

LEGEND:

SURVEY DATA

BEACH FILL TEMPLATE

BASELINE

STAND ALONE TEMPLATE

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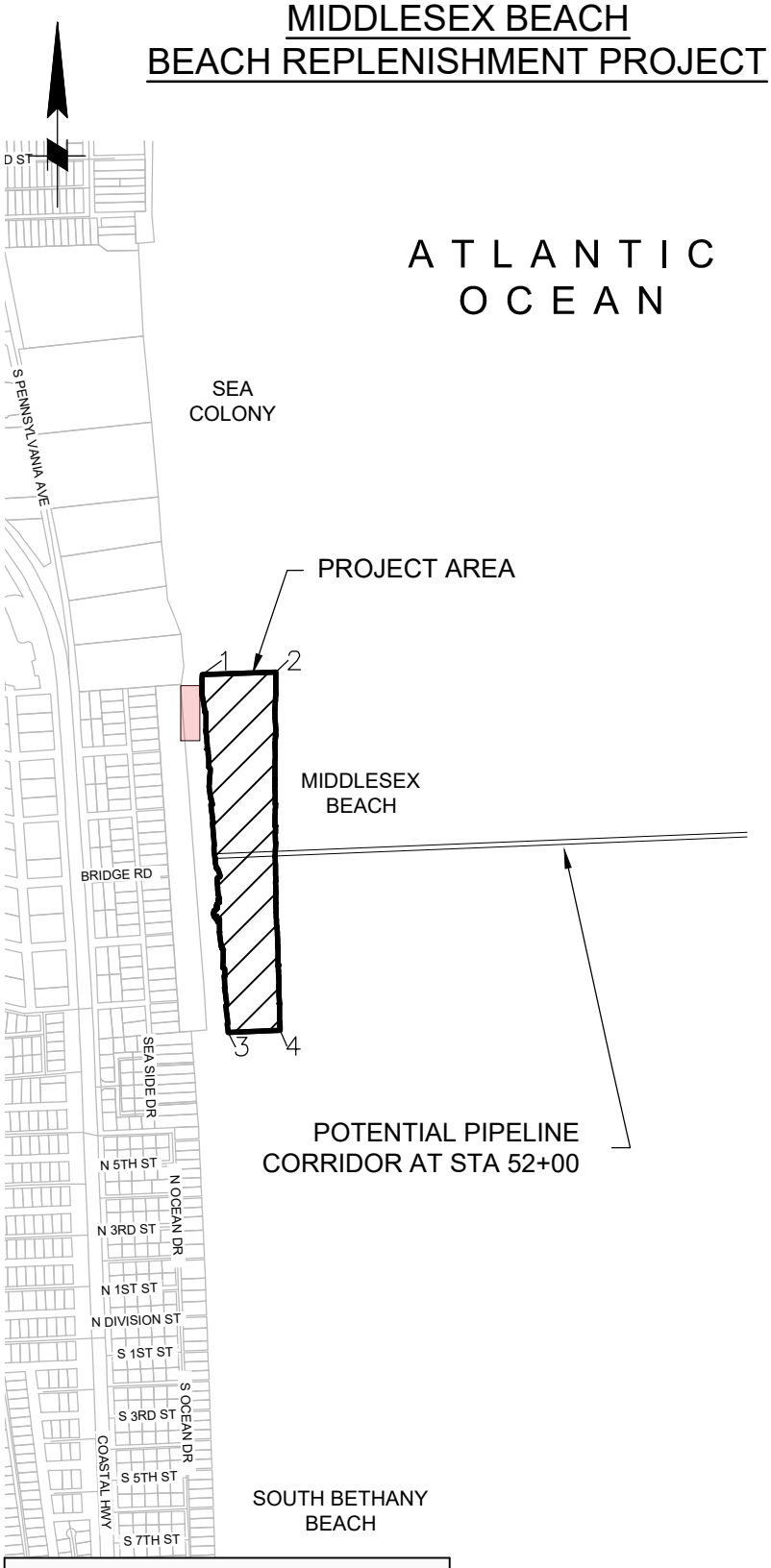
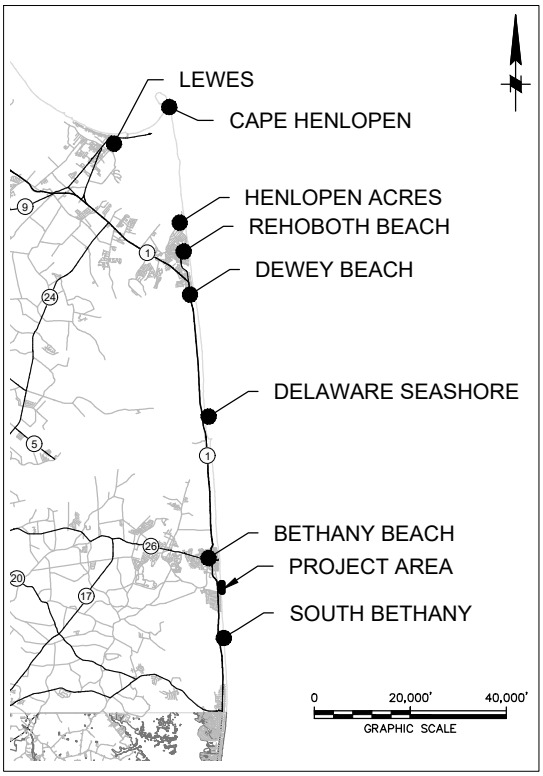
MIDDLESEX BEACH
BEACH REPLENISHMENT PROJECT





PURPOSE:
RESTORE RECREATIONAL BEACH AREA AND PROVIDE EROSION AND STORM PROTECTION

NOTE:
1. PROJECT AREA LENGTH = ±1950 LF
2. PROJECT AREA SIZE = 15 ACRES
3. SEE NOTES SHEET 7.

LEGEND:
STAGING AREA

0 1,000' 2,000'
GRAPHIC SCALE

DELAWARE STATE PLANE COORDINATE SYSTEM, ZONE 0700 (NAD83, US SURVEY FT)		
	EASTING	NORTHING
1	760238.194	191540.251
2	760635.253	191553.533
3	760377.659	189600.405
4	760659.652	189612.210

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BEACH REPLENISHMENT PROJECT

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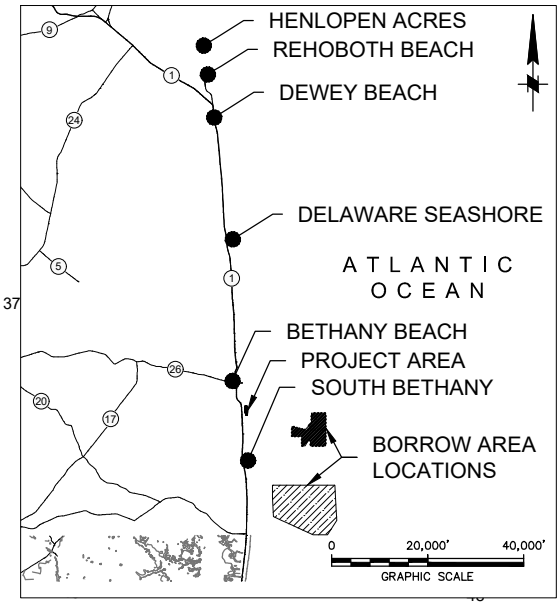
Phone (910) 313-3338

DATE: 10/03/25

PROPOSED FENWICK ISLAND & AREA E BORROW AREA LOCATIONS



ROUTE 26

BETHANY BEACH

PROJECT AREA

1.83 MILES

BORROW AREA E

2.94 MILES

ATLANTIC OCEAN

LITTLE ASSAWOMAN BAY

FENWICK ISLAND STATE PARK

BORROW AREA FENWICK ISLAND

ROUTE 54

DE

MD

ASSAWOMAN BAY

OCEAN CITY

NOTES:

1. REFERENCE: NOAA CHART 12214 (51ST EDITION, MAR. 2019 LAST CORRECTION: 2/5/2020) & NOAA CHART 12211 (48TH EDITION, DEC. 2018 LAST CORRECTION: 4/22/2020)
2. DEPTH SHOWN IN FEET BELOW M.L.W

0 6,000' 12,000'

GRAPHIC SCALE

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BEACH REPLENISHMENT PROJECT IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
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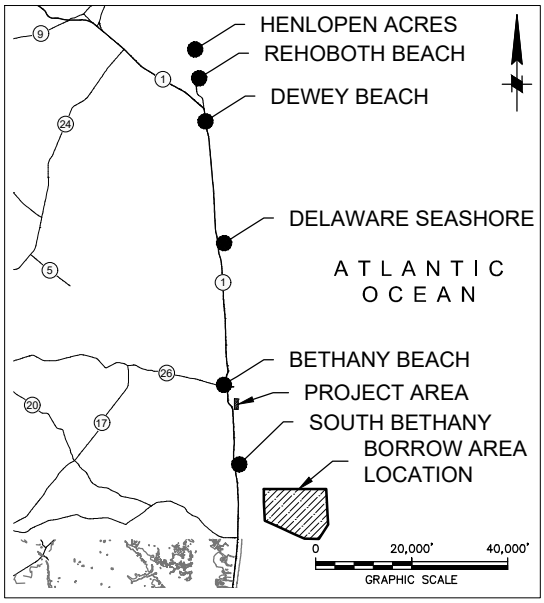
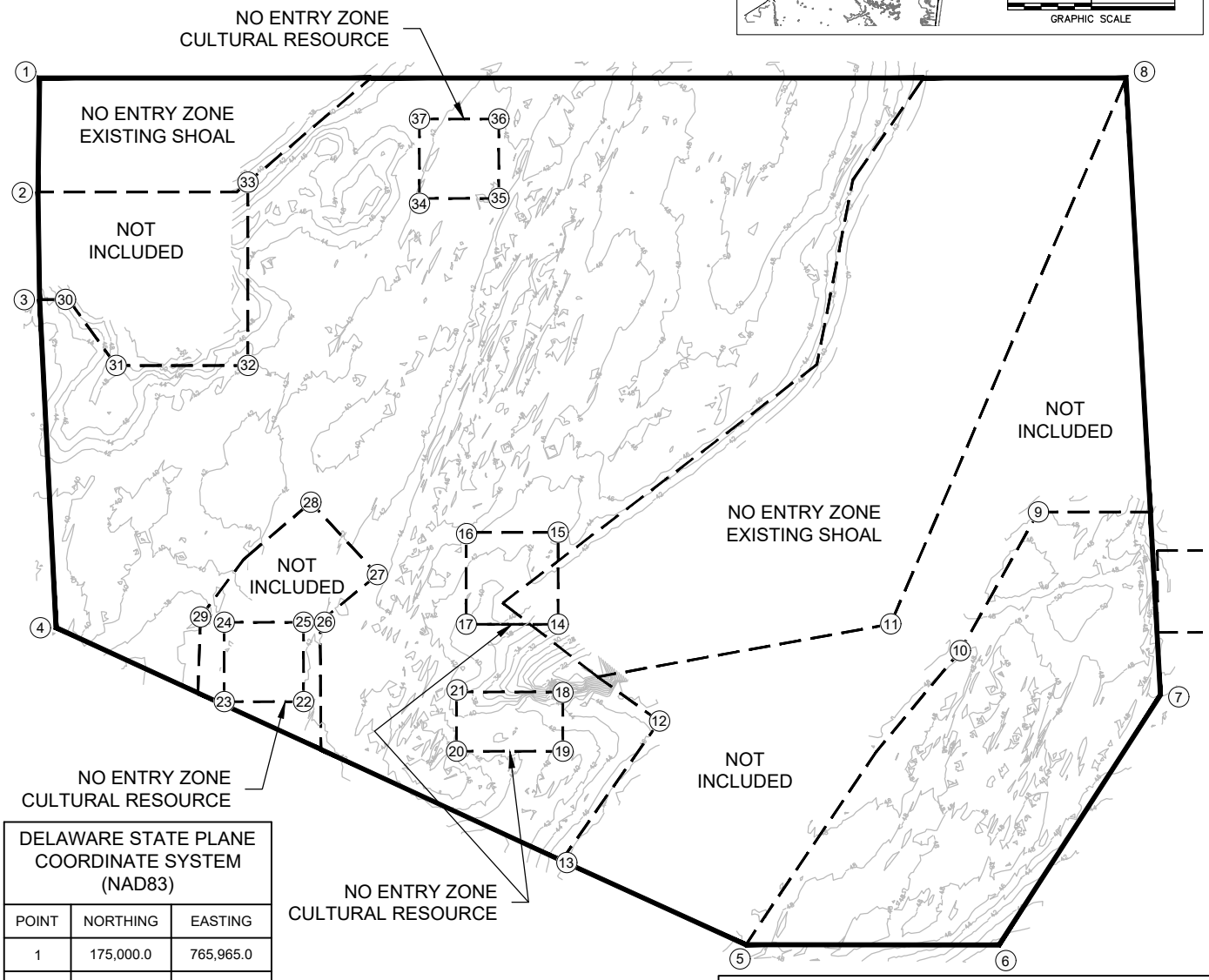
DATE: 10/03/25

LIMITS OF BORROW AREA
FENWICK ISLAND



NOTES:

1. BORROW AREA SIZE = 2,708 ACRES
2. CONTOURS SHOWN REPRESENT EXISTING CONDITIONS AT THE TIME OF SURVEY
3. SURVEY PERFORMED BY TRIANGLE SURVEYS ON SEPTEMBER 27, 2018
4. BORROW AREA DIMENSIONS AND SURVEY DATA FROM "FENWICK AFTER DREDGING BORROW AREA SURVEY" PERFORMED BY TRIANGLE SURVEYS, INC. SURVEY DATES: 08/10-08/11/2018



DELAWARE STATE PLANE COORDINATE SYSTEM (NAD83)		
POINT	NORTHING	EASTING
1	175,000.0	765,965.0
2	173,634.1	765,945.6
3	172,349.0	765,967.0
4	168,421.8	766,161.8
5	164,626.9	774,416.1
6	164,625.9	777,446.4
7	167,616.0	779,377.4
8	175,000.0	778,964.6

0 2,000' 4,000'

GRAPHIC SCALE

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BEACH REPLENISHMENT PROJECT
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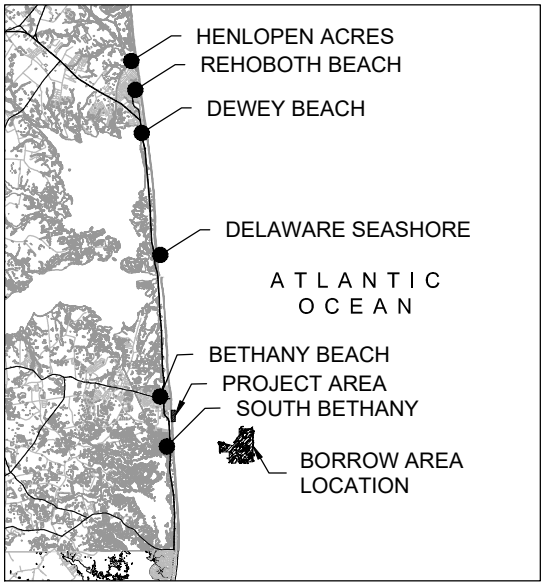
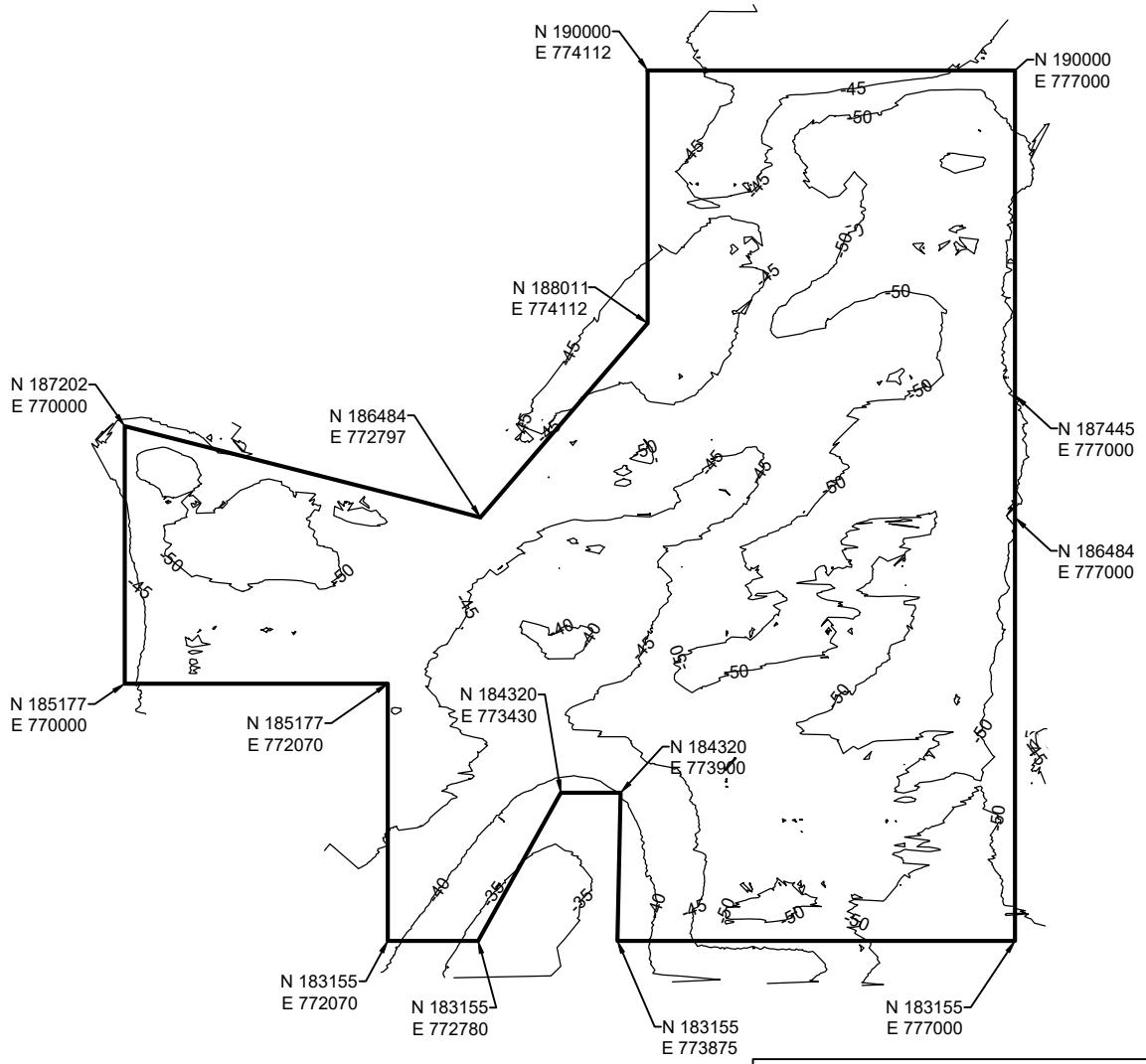
DATE: 10/03/25

LIMITS OF BORROW AREA
AREA E



NOTES:

1. HORIZONTAL COORDINATES REFERENCED TO NAD83 DELAWARE STATE PLANE, ZONE 0700, US SURVEY FOOT.
2. VERTICAL DATUM REFERENCED TO NAVD88.
3. BORROW AREA SIZE = 697 ACRES
4. CONTOURS SHOWN ARE FROM A SURVEY CONDUCTED BY GAHAGAN & BRYANT ASSOCIATES IN FEBRUARY 2021 AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISITING AT THAT TIME.



ATLANTIC
OCEAN

0 1,500' 3,000'

GRAPHIC SCALE

FOR PERMIT USE ONLY
NOT FOR CONSTRUCTION

BEACH REPLENISHMENT PROJECT
IN ATLANTIC OCEAN

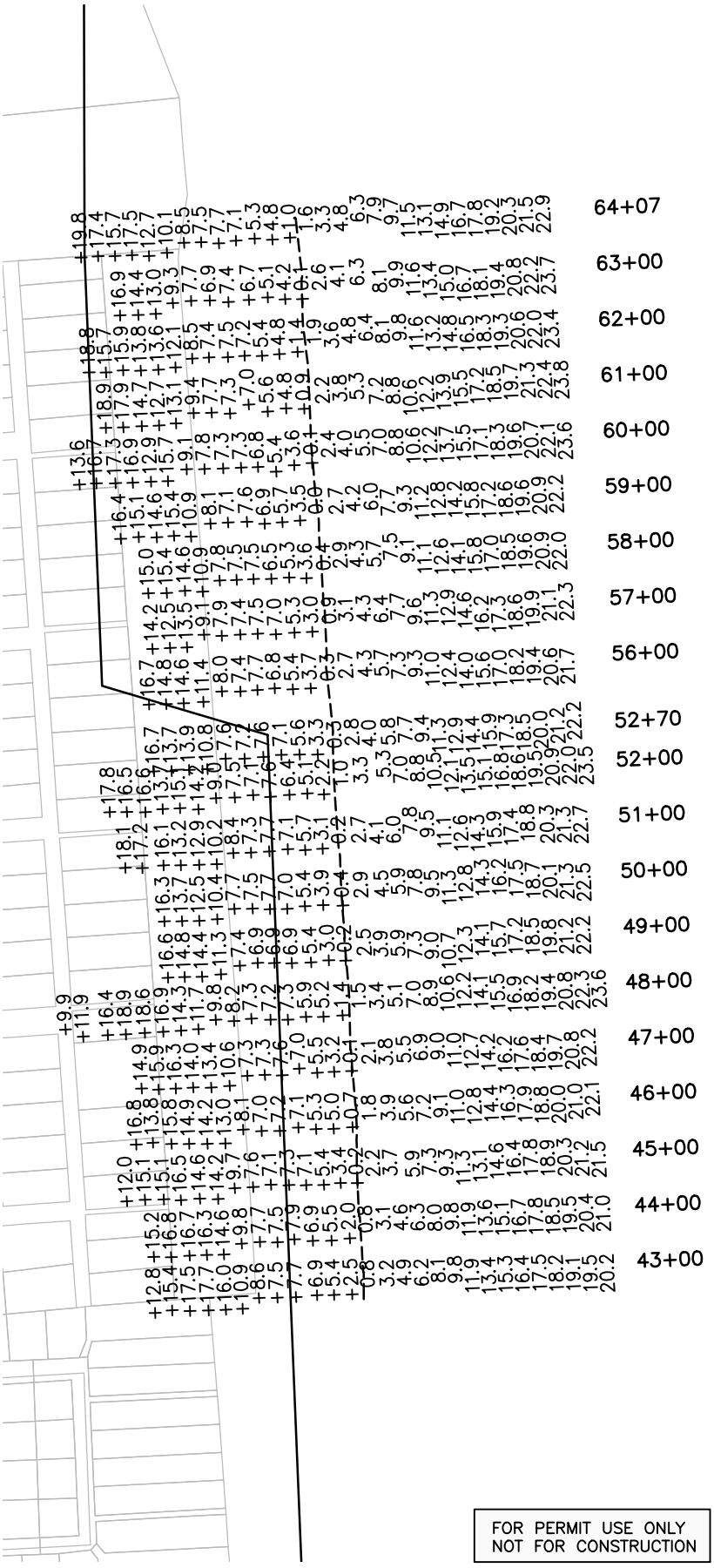
AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOCIATION, INC.
P.O. BOX 584
BETHANY BEACH, DELAWARE 19930

GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

DATE: 10/03/25

MIDDLESEX BEACH
BEACH REPLENISHMENT PROJECT



LEGEND:

MEAN HIGH WATER

BASELINE

DELAWARE PARCEL LINES

NOTES:

1. PROJECT AREA LENGTH = ±1950 LF
2. SURVEY DATA SHOWN WAS COLLECTED ON AUGUST 13, 2025 BY GAHAGAN & BRYANT ASSOCIATES(GBA) AND IS REFERENCED TO NAVD88. SOUNDINGS PRECEDED BY A "+" ARE ABOVE THE REFERENCE PLANE.
3. SEE NOTES SHEET 7.

+1.14 MHW
0.0 NAVD88
-2.31 MLW

DATUM ELEVATION (FT)
NOT TO SCALE

0 300' 600'

GRAPHIC SCALE

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BEACH REPLENISHMENT PROJECT

AT: MIDDLESEX BEACH
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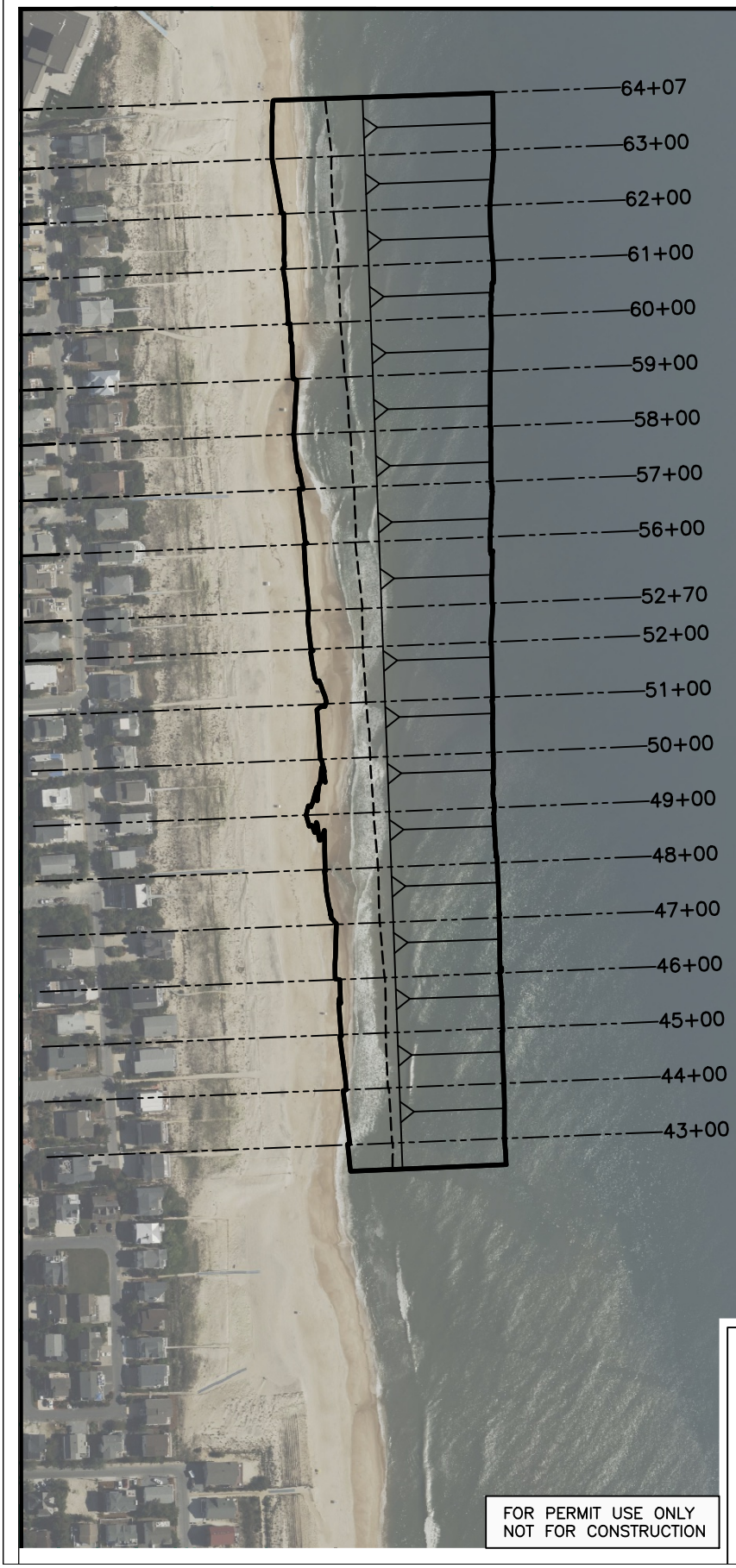
Phone (910) 313-3338

DATE: 10/03/25

MIDDLESEX BEACH
BEACH REPLENISHMENT PROJECT



LEGEND:

FILL BOUNDARY

MEAN HIGH WATER

STATION LINES

BASELINE

DELAWARE PARCEL LINES

START OF SLOPE

NOTES:

1. PROJECT AREA LENGTH = ±1950 LF
2. AERIAL IMAGERY OBTAINED FROM BING.
3. SEE NOTES SHEET 7.

0 300' 600'

GRAPHIC SCALE

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NOT FOR CONSTRUCTION

BEACH REPLENISHMENT PROJECT

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COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
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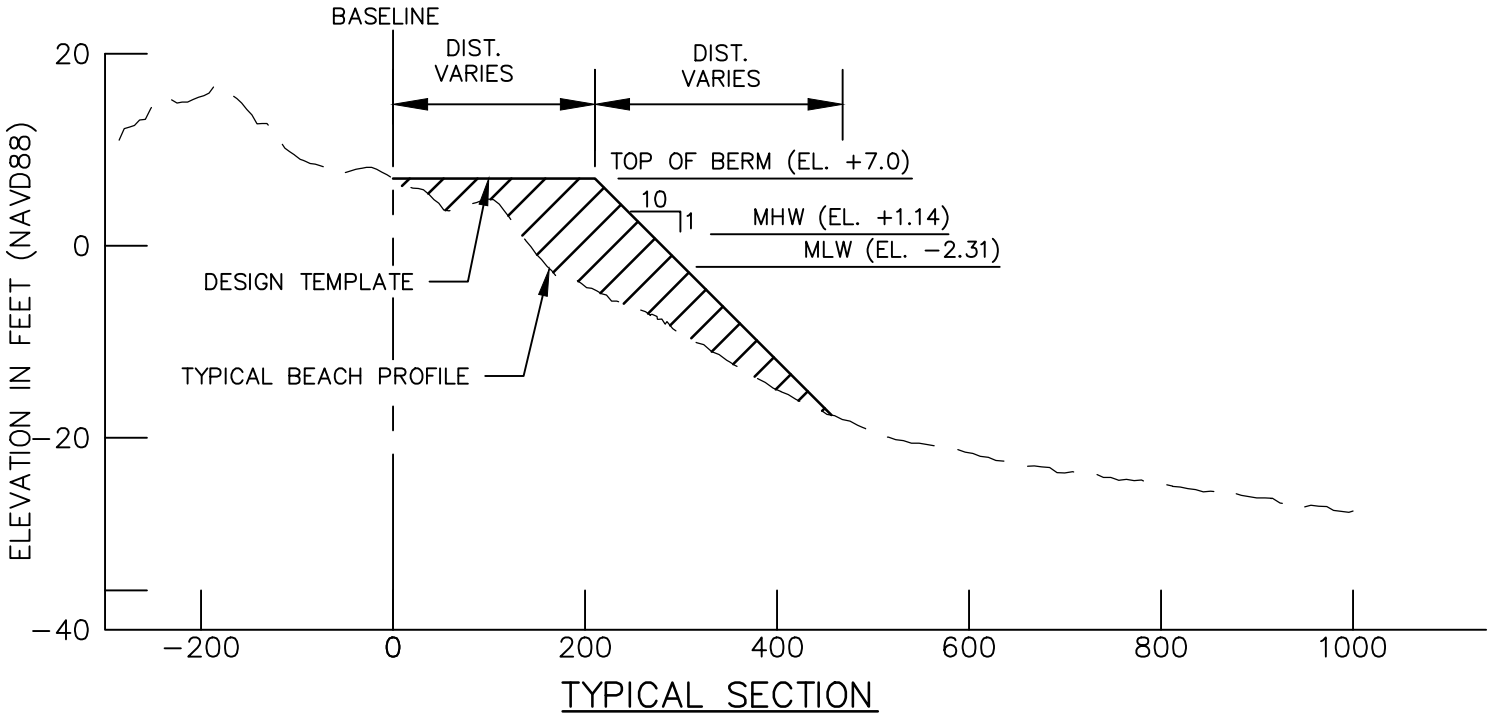
DATE: 10/03/25

MIDDLESEX BEACH DESIGN FILL SECTION



TYPICAL SECTION

NOTES:

1. RANGE OF TIDE INFORMATION OBTAINED FROM NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION (NOAA) VDATUM TRANSFORMATION PROGRAM, VERSION 4.6.1 AT THE PROJECT MIDPOINT.
2. SOUNDING DATA DEPICTED IN THESE PLANS IS REPRESENTATIVE OF A LARGER DATA SET WHICH WAS COLLECTED USING AN ECHOSOUNDER (ODOM CV200) AT A FREQUENCY OF 200 HERTZ. THE DATA SET WAS REDUCED FOR CLARITY AND CORRECTED IN REAL TIME VIA REAL TIME KINEMATIC (RTK) CORRECTIONS.
3. THE INFORMATION DEPICTED IN THESE PLANS REPRESENT THE RESULTS OF SURVEYS CONDUCTED ON AUGUST 13, 2025 AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME.
4. BEACH FILL TEMPLATE AND FILL EXTENTS SHOWN IN THESE PLANS IS FOR PERMITTING PURPOSES ONLY AND THE TEMPLATE WAS OBTAINED FROM 2022 USACE BEACH NOURISHMENT PROJECT INCLUDING SOUTH BETHANY BEACH (SOLICITATION NO:W912BU22B0017). MIDDLESEX INTENDS TO MAINTAIN THE SAME TEMPLATE AS THE USACE PROJECT. CONSTRUCTION BEACH FILL TEMPLATE WILL BE DETERMINED BY USACE DURING THE NEXT NOURISHMENT CYCLE AND BY EXISTING BEACH CONDITIONS AT THE TIME OF THE EVENT.
5. ONCE A FEDERAL NOURISHMENT PROJECT IS ANNOUNCED, MIDDLESEX WILL CONDUCT A SURVEY OF THE BEACH AND PROVIDE COMPLETE CONSTRUCTION PLANS WITH REVISED TEMPLATES TO DNREC FOR APPROVAL.

+1.14 MHW

0.0 NAVD88

-2.31 MLW

DATUM ELEVATION (FT)
NOT TO SCALE

FOR PERMIT USE ONLY
NOT FOR CONSTRUCTION

BEACH REPLENISHMENT PROJECT

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
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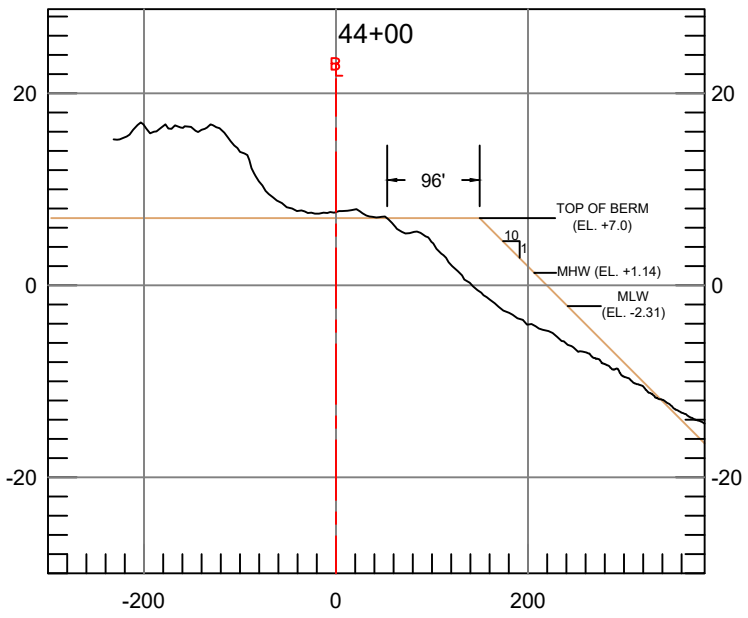
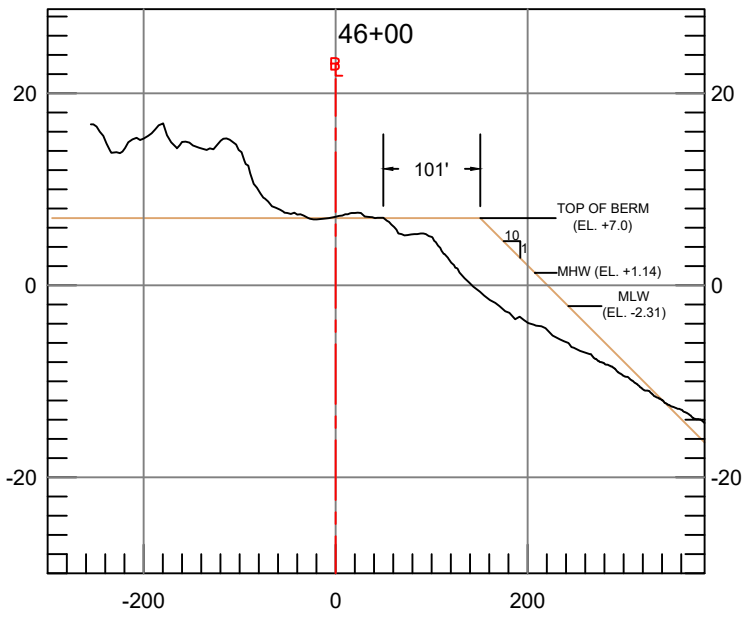
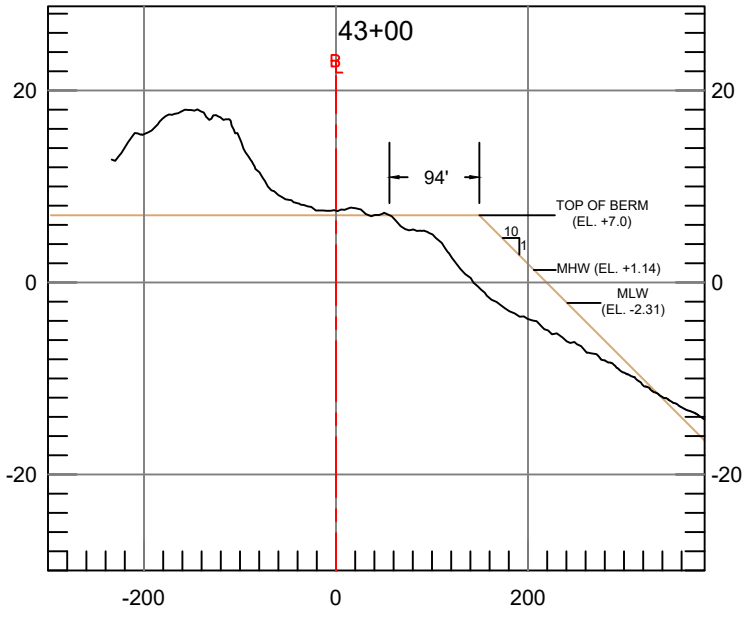
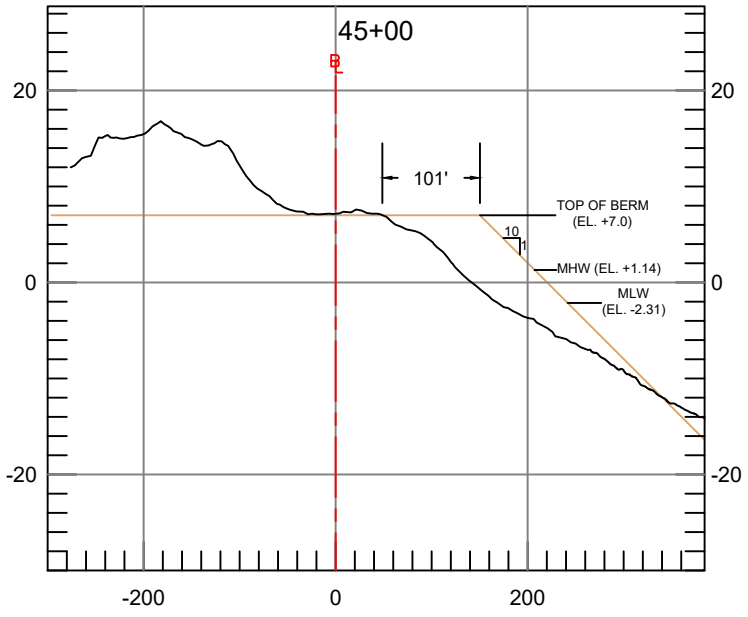








H Scale : 1" = 200' V Scale : 1" = 20'

BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX,
STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOC., INC.
P.O BOX 584
BETHANY BEACH, DELAWARE
19930

DATE: 10/03/25

GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

SHEET 8 OF 12

NOTES:
1. SURVEY DATA SHOWN WAS COLLECTED ON AUGUST 13, 2025 BY GAHAGAN & BRYANT ASSOCIATES (GBA).
2. VERTICAL DATUM IS REFERENCED TO NAVD88.
3. HORIZONTAL DATUM IS REFERENCED TO NAD83.
4. BASELINE IS ONLY SHOWN AT STATIONS 43+00 TO 52+70 DUE TO THE LANDWARD SHIFT OF ALIGNMENT AT 52+70.
5. SEE NOTES SHEET 7.

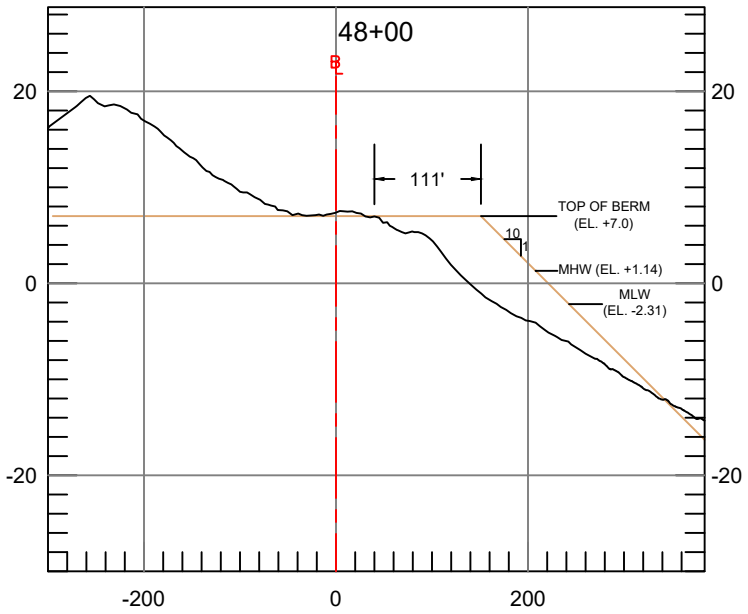
LEGEND:

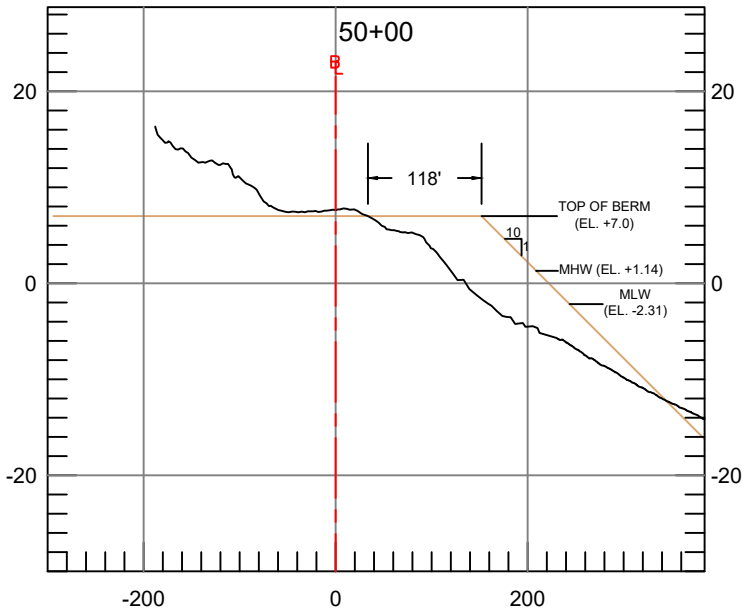
SURVEY DATA

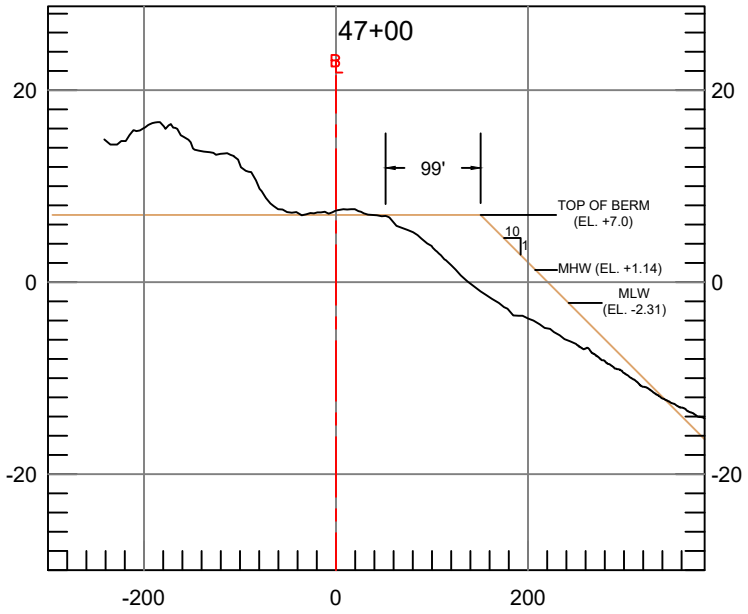
BEACH FILL TEMPLATE

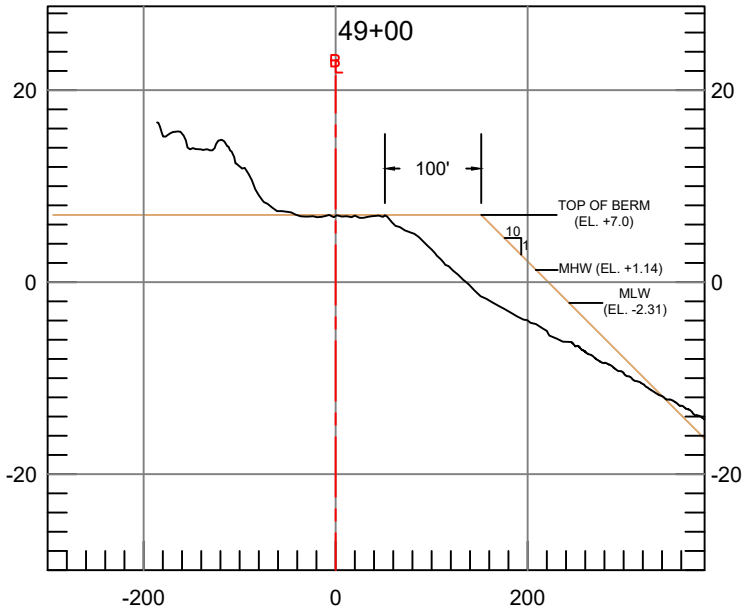
BASELINE

FOR PERMIT USE ONLY NOT FOR CONSTRUCTION









H Scale : 1" = 200' V Scale : 1" = 20'

BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX,
STATE OF DELAWARE

APPLICATION BY:
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19930

DATE: 10/03/25

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SHEET 9 OF 12

NOTES:
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5. SEE NOTES SHEET 7.

LEGEND:

SURVEY DATA

BEACH FILL TEMPLATE

BASELINE

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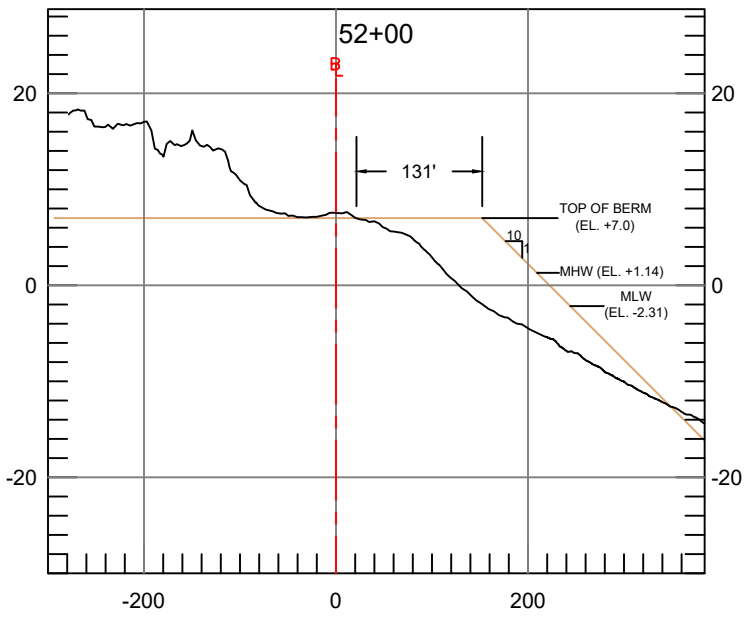

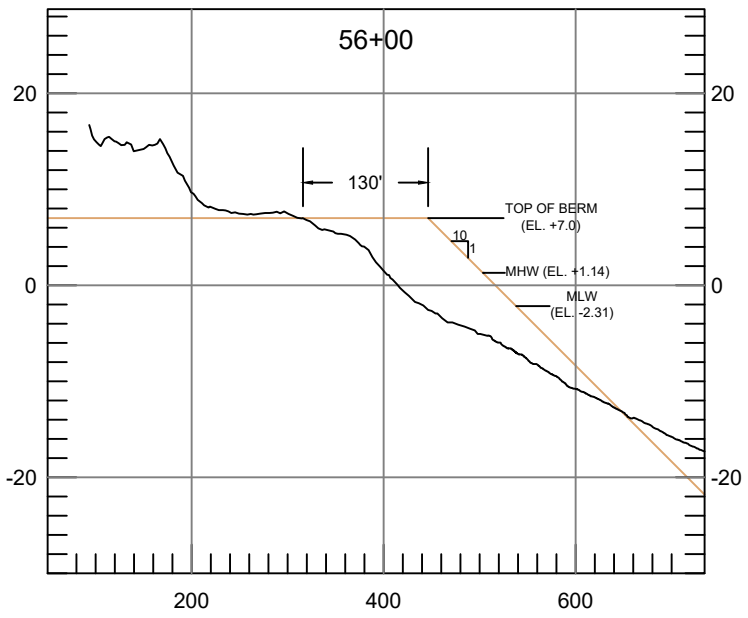

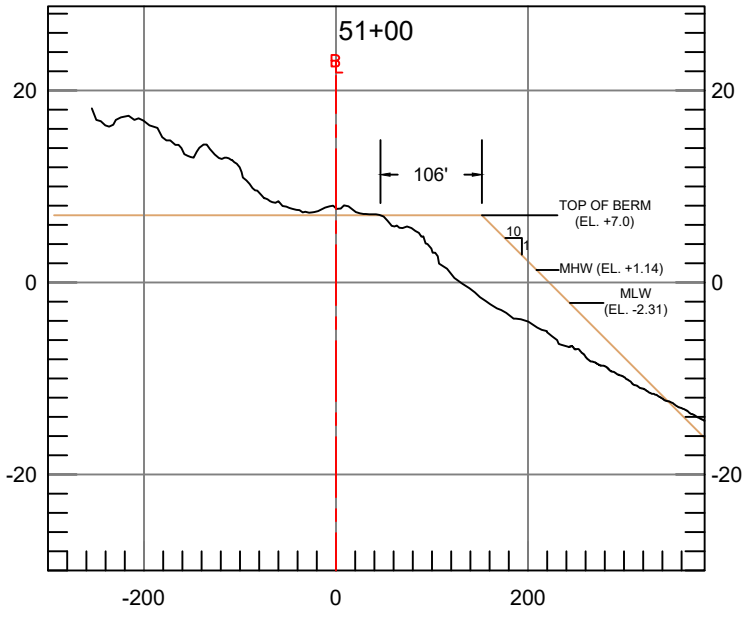

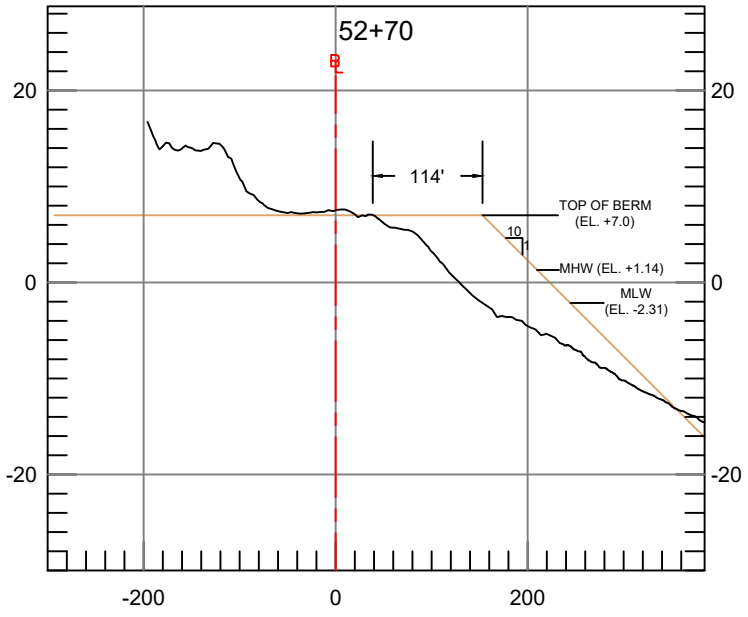

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BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX,
STATE OF DELAWARE

APPLICATION BY:
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19930

DATE: 10/03/25

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SHEET 10 OF 12

NOTES:
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5. SEE NOTES SHEET 7.

LEGEND:

SURVEY DATA

BEACH FILL TEMPLATE

BASELINE

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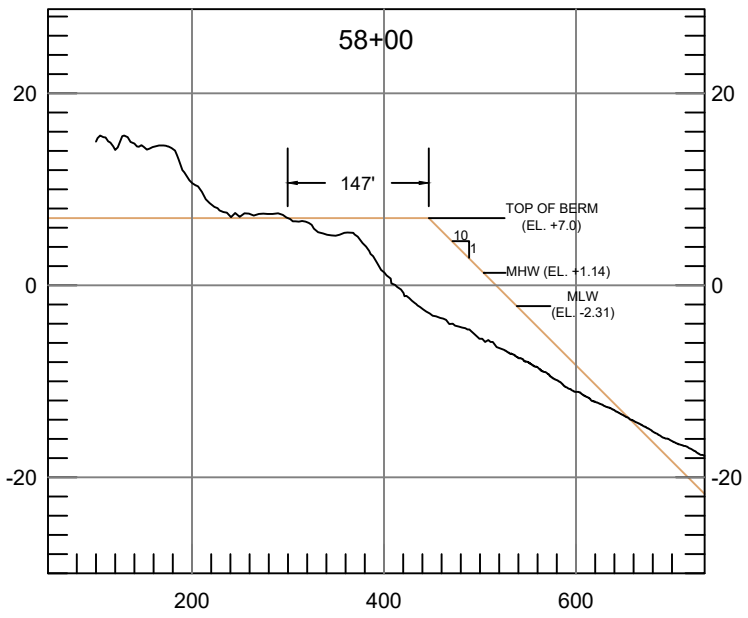

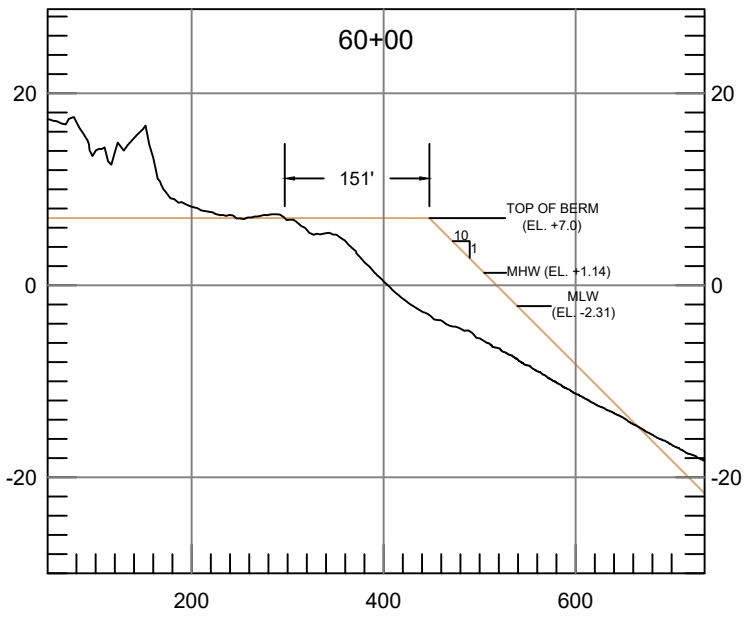

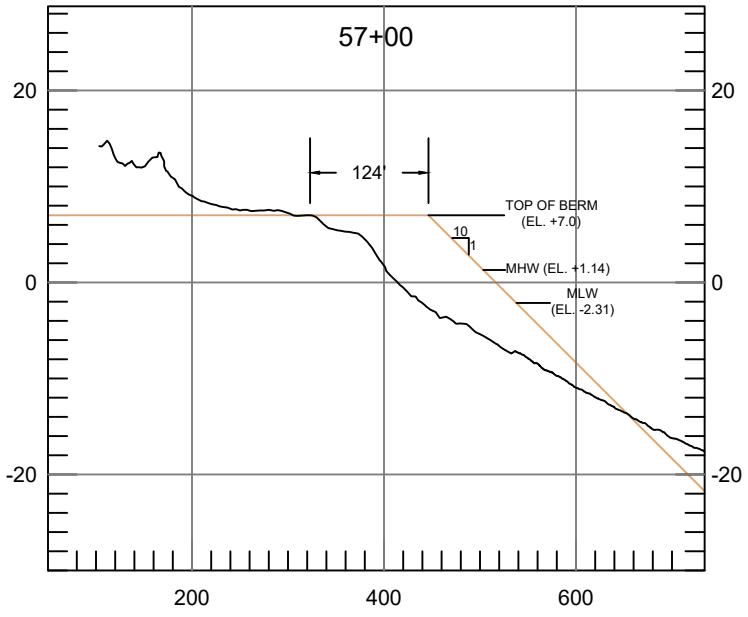

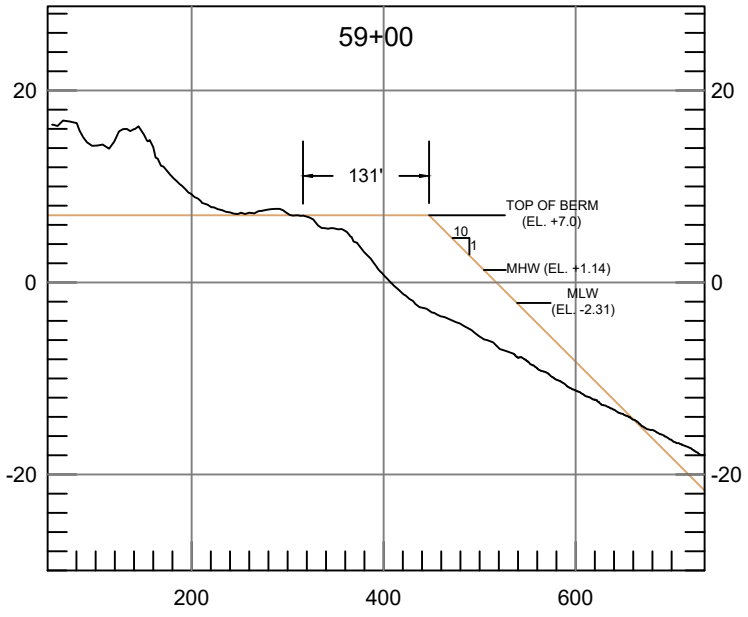

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BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX,
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19930

DATE: 10/03/25

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SHEET 11 OF 12

NOTES:
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5. SEE NOTES SHEET 7.

LEGEND:

SURVEY DATA

BEACH FILL TEMPLATE

BASELINE

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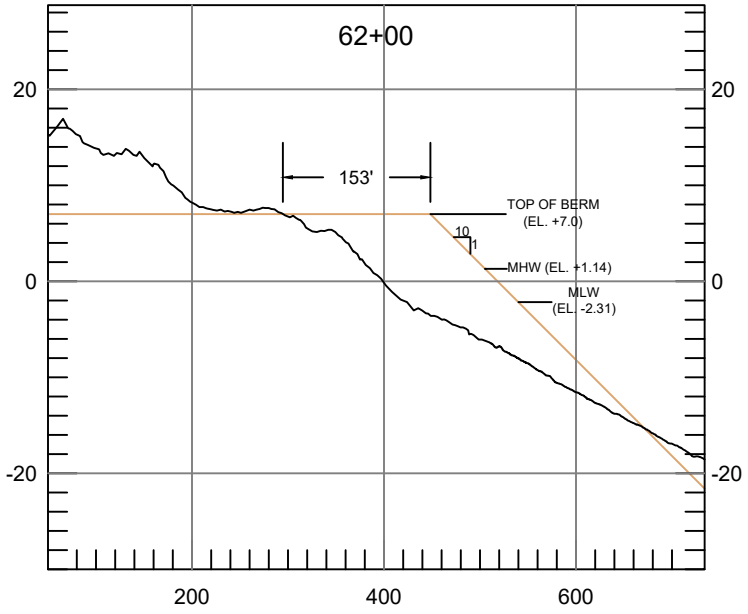

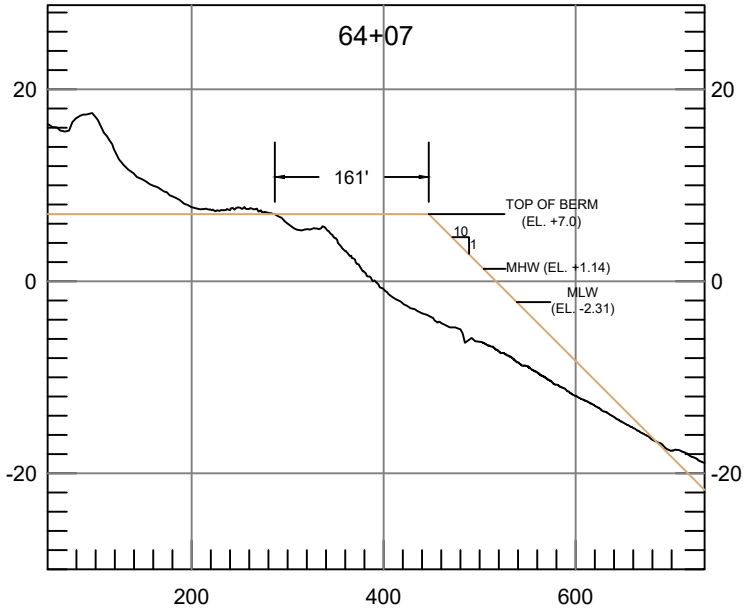

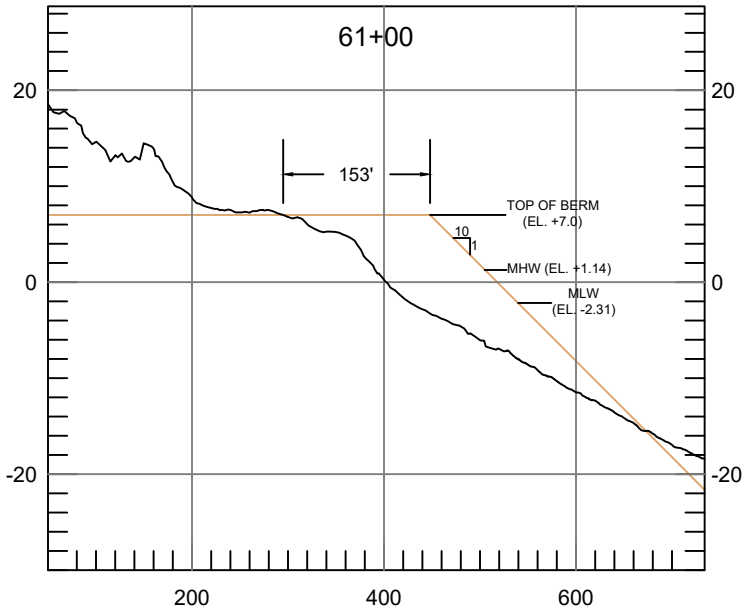

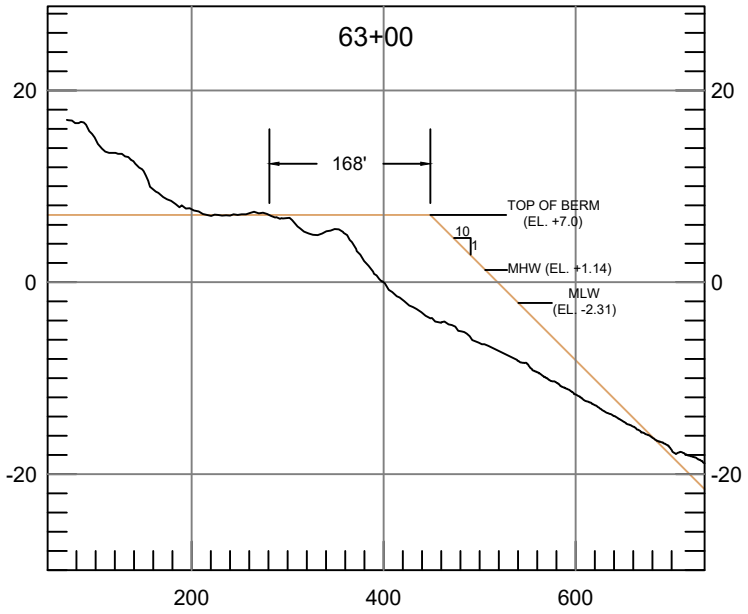

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BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX,
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SHEET 12 OF 12

NOTES:
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5. SEE NOTES SHEET 7.

LEGEND:

SURVEY DATA

BEACH FILL TEMPLATE

BASELINE

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401 Water Quality Certification Request – Middlesex Colony Beach Association

(1) Project Proponent:

On behalf of the Middlesex Beach Association, I hereby submit a 401 Water Quality Certification Request to conduct periodic beach replenishment activities, by hydraulic dredge method, along a 1,950 +/- linear foot stretch of shoreline extending from the southern limits of Sea Colony Beach Association to the northern limits of South Bethany Beach, Sussex County, Delaware. It is intended that the work be conducted coincidently and in conjunction with periodic nourishment of the Federal project at Bethany Beach and South Bethany. In addition to providing increased recreational and property protection benefits to the Middlesex Beach Community, this work will supplement and increase the relative longevity of the Federal project.

The project will help mitigate the effects of beach erosion at both Middlesex Beach and adjacent beach property. Because of the effects of wave action and natural sand migration, sand fill placed at Middlesex Beach will increase the longevity of beaches conjoining the Middlesex property. This project should be considered beneficial to both Middlesex Beach and adjoining property (including the federal project at Bethany/South Bethany) in terms of protection from storm damage and coastal erosion.

Point of Contact:

Tyler Littlefield, PE (Agent)
295 N Green Meadows Drive, Suite A
Wilmington, NC 28405
trlittlefield@gba-inc.com
(910) 313-3338

(2) Proposed Project:

The proposed activity involves periodically dredging by hydraulic method, using either a cutter-suction pipeline dredge or a hopper dredge with pumpout capability and a monobuoy system, approximately 103,000 ± cubic yards of sand (per event, current estimate) from an offshore borrow area and depositing is as beachfill along a 1,950± linear foot stretch of shoreline extending from the southern limits of the Sea Colony Beach Association to the northern limits of South Bethany Beach, Sussex County, Delaware. The project is intended to adjoin the full berm section of the Coastal Storm Risk Management Project at South Bethany Beach and taper into Sea Colony. The borrow sources for the project fill area are Fenwick Island and/or Borrow Area “E”.

If a pipeline dredge is utilized, sand will be excavated from the borrow source and pumped directly to the project fill area using both floating and submerged pipeline. A booster pump(s) may be used depending upon the pumping capabilities of the equipment employed. If a hopper dredge with pumpout capability is employed, sand will be raised by dredge pumps through dragarms connected to dredge intake heads in contact with the borrow source bottom and discharged into hoppers built within the vessel. When hopper capacity is reached, the vessel will transport the material to a monobuoy pumpout facility which will be anchored offshore at the project site in water

deep enough to accommodate the dredge (25 to 30 feet). A submerged pipeline will run from the pumpout facility to the shoreline. The dredge will then anchor and its pumpout line will be attached to the facility and sand will be hydraulically transported (pumped) to the beach via the submerged pipeline. The sand will be transferred up and down the beach at the project fill areas using additional pipeline as necessary.

Once sand has been placed at the project fill areas by either one or both of the aforementioned methods, earth-moving equipment (bulldozers) will be used to shape the material to the approved design template.

Based on past experience, dredging sand from Borrow Site "E" has a potential for encountering unexploded ordnance (UXO) associated with past military artillery target practice activities along the Atlantic Ocean coastline. To minimize UXO from entering in the dredge during borrow site dredging, the dredge intake will be fitted with a longitudinal bar-screen. This screen will have a maximum opening of 38 millimeters (1.5 inches) between adjacent bars and will be constructed out of material that is very durable and wear resistant. During dredging operations, these screens will be inspected daily to assure their functionality. If rock, rubble, ordnance or other debris larger than 38 millimeters (1. 5 inches) in diameter are found on the beach, the contractor will shut-down, remove the object(s) and correct the problem. During pumping operations, the contractor will provide personnel to maintain visual control at the end of the discharge line. Shore to dredge contact will be maintained such that dredging can be halted in case of an emergency.

(3) Applicable federal license/ permit (expired permits attached):

Federal Consistency Certification renewal took place in 2007, and a deed of easement was granted for Middlesex from the Delaware Department of Natural Resources and Environmental Control to coordinate with the U.S. Army Corps of Engineers and participate in Bethany Beach/ South Bethany Beach Storm Damage Reduction Project. A permit with DNREC was issued on 11/07/2007 (Permit # SP-488/07) and (Permit # WQ-489/07). These have since expired and do not have a current active permit.

(4) Location and Nature of any potential discharge that may result from proposed project and location of receiving waters:

Discharge on the Middlesex beachfront will be in the form of a slurry of sand and water originating from the Atlantic Ocean from nearby borrow sites (within 7 miles). Training dikes will be used to control the slurry discharge on the beach and allow the suspended sand to settle out. The resultant discharge will flow freely back into the Atlantic Ocean and is not expected to have any negative impacts on the project area or nature.

(5) Methods and means proposed to monitor the discharge and the equipment or measures planned to treat control and manage discharge:

The material will be pumped onto the beach and heavy equipment including bulldozers and loaders will be there to help contain the material being placed. This will be dependent on the contractors preferred method, but more than likely, temporary

"dikes" on the beach will be used to contain the slurry mixture of material onto the beach. As the material drains and dries, it will be graded out into the design template.

(6) List of other federal, interstate, tribal, state, territorial or local agency authorizations required for the proposed project including all approvals or denials already received:

Permit applications that will be submitted to DNREC:

- Subaqueous lands and 401 Water Quality Certification
- Federal Consistency
- Coastal Construction/ Placement of Sand Fill

Permit applications that will be submitted to USACE:

- Section 408 review
- Section 10/404

(7) Documentation that a pre-filing meeting request was submitted to the certifying authority at least 30 days prior to submitting the certification request:

JPP Meeting was attended on July 17, 2025

(8) *'The project proponent hereby certifies that all information contained herein is true, accurate, and complete to the best of my knowledge and belief'*

(9) *'The project proponent hereby requests that the certifying authority review and take action on this CWA 401 certification request within the applicable reasonable period of time.'*

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES &
ENVIRONMENTAL CONTROL
DIVISION OF WATER RESOURCES
89 KINGS HIGHWAY
DOVER, DELAWARE 19901

WETLANDS & SUBAQUEOUS
LANDS SECTION

TELEPHONE (302) 739-9943
FACSIMILE (302) 739-6304

Subaqueous Lands Permit: SP-488/07
Water Quality Certification: WQ-489/07
Date of Issuance: 11/7/2007
Construction Expiration Date: 2/8/2008
Amended Date:

SUBAQUEOUS LANDS PERMIT/WATER QUALITY CERTIFICATION GRANTED TO THE MIDDLESEX BEACH ASSOCIATION TO HYDROLICALLY DREDGE APPROXIMATELY 85,500 CUBIC YARDS OF SAND FROM OFFSHORE BORROW AREA "E" AND DEPOSIT IT ALONG 1,900 LINEAR FEET OF SHORELINE EXTENDING FROM THE NORTHERN LIMITS OF MIDDLESEX BEACH SOUTH TO THE SOUTHERN LIMITS OF MIDDLESEX BEACH, BETHANY BEACH, SUSSEX COUNTY, DELAWARE

Middlesex Beach Association
c/o Mr. David Wiecking
P.O. Box 173
Bethany Beach, DE 19930

Pursuant to the provisions of 7 Del. C., Section 7203, the Department's Regulations Governing the Use of Subaqueous Lands, 7 Del. C., Section 6003, the Department's Regulations Governing the Control of Water Pollution and Section 401 of the Clean Water Act, permission is hereby granted on this 7th day of November A.D. 2007, to construct the above referenced project in accordance with the approved plans for this Permit/Certification (4 Sheets) as approved on November 6, 2007, and letters of request received by this Division on October 16, 2007 and November 5, 2007.

WHEREAS, pursuant to the provisions of 7 Del. C., 7203, the Secretary of the Department of Natural Resources and Environmental Control through his duly authorized representative finds that it is not contrary to the public interest if this project is approved subject to the terms and conditions herein set forth.

WHEREAS, in accordance with the provisions of Section 401 of the Clean Water Act, 33 U.S.C. Section 1341 and 7 Del. C., Chapter 60, the State of Delaware, by and through the Department of Natural Resources and Environmental Control, certifies that the permitted activity will be conducted in a manner which will not violate the applicable water quality standards of the State of Delaware, subject to the terms and conditions of this approval.

This Permit/Certification is issued subject to the following conditions:

SPECIAL CONDITIONS

1. The conditions contained herein shall be incorporated into any and all construction contracts and other ancillary documents associated with earth disturbance and any other activities directly or indirectly associated with construction or maintenance which may impact subaqueous lands associated with this project. The permittee and contractor are responsible to ensure that the workers executing the activities authorized by this Permit/Certification have full knowledge of, and abide by, the terms and conditions of this Permit/Certification.

2. This Permit/Certification represents a transfer to the Middlesex Beach Association of a portion of the beach replenishment authorized under Subaqueous Permit SP-345/04 and WQ-346/04 originally granted to the Division of Soil and Water Conservation.

3. This Permit/Certification authorizes Middlesex Beach as the Permittee responsible for the placement of approximately 85,500 cubic yards of sand from Borrow Area "E" and deposit along 1,900 linear feet of shoreline at Middlesex Beach.

4. All dredging is to be conducted in a manner consistent with sound conservation and water pollution practices.

5. Construction shall be conducted so as not to violate the State of Delaware Department of Natural Resources and Environmental Control, "Surface Water Quality Standards" dated July 11, 2004.

6. To minimize the potential for unexploded ordinance to enter the dredge, a screen device with a mesh size no greater than 1.5 inches square shall be employed during all dredging operations within borrow site "E". Screens shall be inspected daily to ensure their functionality.

7. The end of the discharge line shall be monitored during pumping operations. If any particles larger than 1.5 inches are observed, dredging operations shall be shut down until screening devices are functioning properly.

8. Piping plover, a federally protected species of shorebird, is known to nest on Atlantic Coast beaches in Delaware. Prior to the placement of the beach replenishment material, representatives from the Division of Fish and Wildlife shall inspect the disposal area to determine whether any nesting is occurring. While nesting is unlikely within the project area due to its heavy recreational use and timing of dredging operations, if any piping plover nests are found within the project limits, dredging operations shall shut down until nesting activity for the season has ended.

9. A copy of this Permit/Water Quality Certification must be available on-site during all phases of construction activity.

10. The dredging in subaqueous lands shall be for the explicit purpose of beach replenishment as stated in the application.

11. Erosion and sediment control measures shall be implemented in accordance with the specifications and criteria in the current Delaware Erosion and Sediment Control Handbook, so as to minimize entry and dispersal of sediment and other contaminants in surface waters.

12. All construction debris, excavated material, brush, rocks and refuse incidental to such work shall be placed above the influence of surface waters.

13. In order to protect the Federally threatened loggerhead turtle (Caretta caretta), and the Federally endangered Kemp's ridley turtle (Lepidochelys kempi), green sea turtle (Chelonia mydas), and leatherback turtle (Dermochelys coriacea), the permittee shall implement the following monitoring protocol during all hopper dredging operations occurring between June 1 and November 30:

    A trained sea turtle observer, approved by the National Marine Fisheries Service (NMFS), shall be employed aboard the dredge to monitor for the presence of sea turtles and/ or sea turtle parts being pulled into the hopper during dredging operations. If sea turtle parts are observed, dredging operations shall cease until the NMFS determines it is safe to restart operations.

14. All dredging activity shall comply with the requirements of the National Marine Fisheries Service.

15. There shall be no movement of equipment within State regulated wetlands or subaqueous lands not specifically authorized by this permit. Any equipment traversing wetlands and subaqueous lands as may be authorized by this Permit/Certification shall be supported on mats. Any areas disturbed pursuant to this authorization shall be returned to pre-construction conditions/elevations and appropriately stabilized.

16. The work authorized by this Permit/Certification is subject to the terms and conditions of the final Department of the Army Individual Permit.

GENERAL CONDITIONS

1. The project is to be maintained in accordance with the plans submitted and attached hereto. Any activities not specifically authorized herein may require authorization from this office prior to the initiation of construction. A determination on the need for a supplemental approval will be made by this office pursuant to the permittee submitting written notification and revised plans indicating project changes to this office.

2. Representatives of the Department of Natural Resources and Environmental Control may inspect the project and may collect any samples or conduct any tests that are deemed necessary.

3. This Permit/Certification does not cover the structural stability of the replenishment project.

4. Any actions, operations or installations which are considered by the Department to be contrary to the best interests of the public shall constitute reason for the discontinuance and/or removal of said action, operation or installation.

5. The issuance of this Permit/Certification does not imply approval of any other part, phase, or portion of any overall project the permittee may be contemplating.

6. This Permit/Certification is subject to the terms and conditions contained in any easement, license or lease that may have been granted by the State or any political subdivision, board, commission or agency of the State in the vicinity of the project.

7. This Permit/Certification and authorization are granted for the purposes as stated herein. Any other use without prior approval shall constitute reason for this Permit/Water Quality Certification being revoked.

8. This Permit/Certification is personal and may not be transferred without the prior written consent of the Department. Prior to the transfer of the adjacent upland property, the permittee shall obtain the written consent of the Department to transfer this Permit/Certification to the new upland property owner. Failure to obtain such written consent may result in the revocation of this Permit/Certification and the removal of all structures authorized by this Permit/Certification at the expense of the permittee.

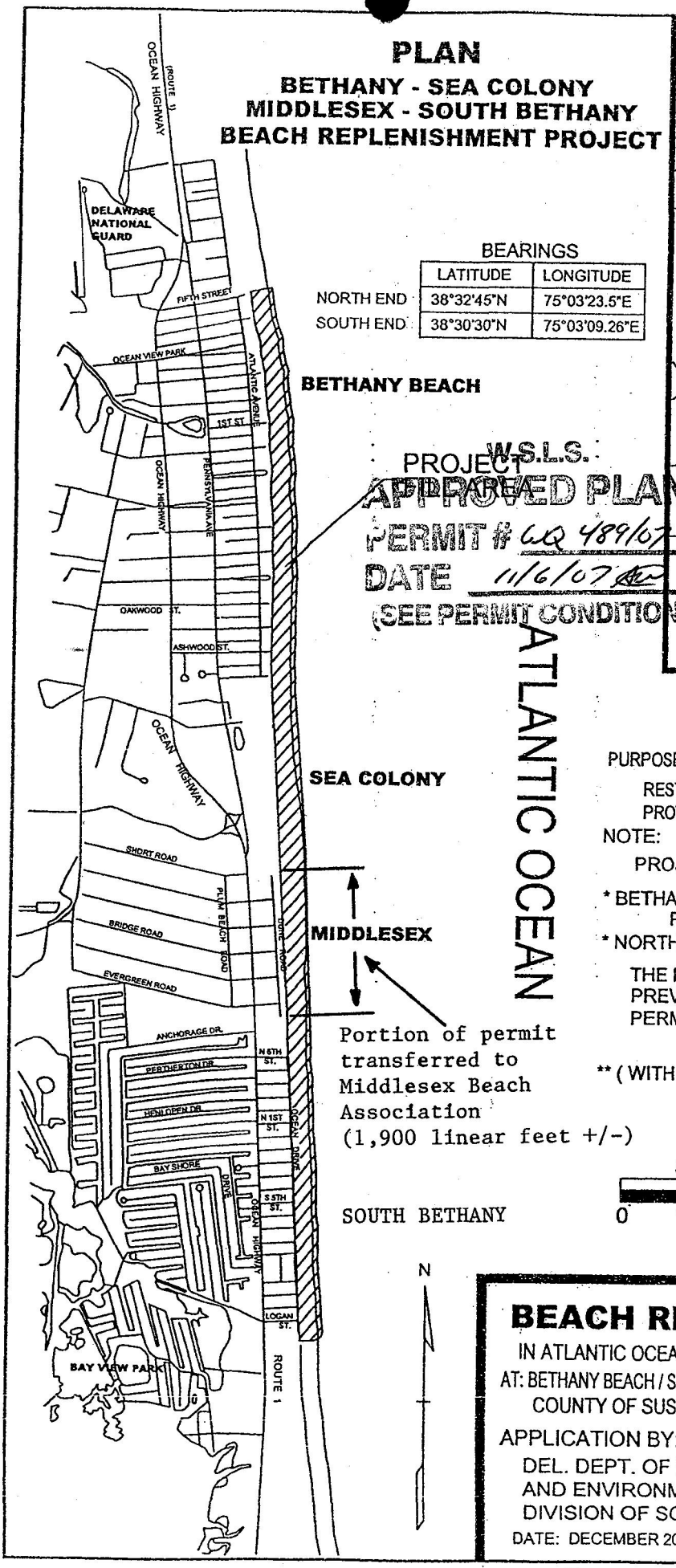
9. The permittee shall at all times comply with all applicable laws and regulations of the Department of Natural Resources and Environmental Control.

10. The issuance of this Permit/Water Quality Certification does not constitute approval for any of the activities as may be required by any other local, state or federal governmental agency.

IN WITNESS WHEREOF, I, Laura M. Herr, the duly authorized representative of John A. Hughes, Secretary, Department of Natural Resources and Environmental Control, have hereunto set my hand this 7th day of November 2007.

Laura M. Herr, the duly authorized representative
of John A. Hughes, Secretary, Department of the
Natural Resources and Evironmental Control

PLAN
BETHANY - SEA COLONY
MIDDLESEX - SOUTH BETHANY
BEACH REPLENISHMENT PROJECT



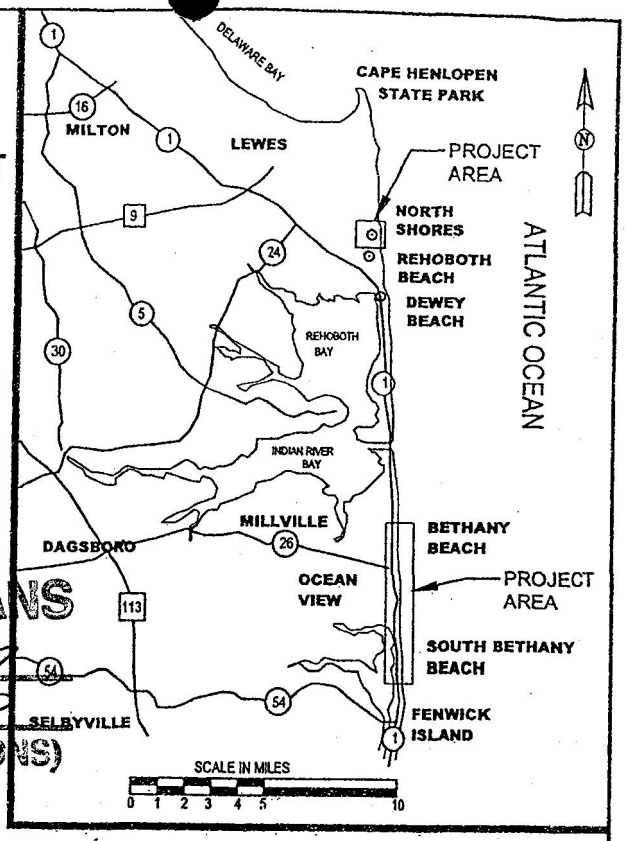
BEARINGS

	LATITUDE	LONGITUDE
NORTH END	38°32'45"N	75°03'23.5"E
SOUTH END	38°30'30"N	75°03'09.26"E

PROJECT AREA

W.S.L.S.

APPROVED PLANS
PERMIT # CQ 489/07
DATE 11/6/07
(SEE PERMIT CONDITIONS)



LOCATION MAP

PURPOSE:

RESTORE RECREATIONAL BEACH AREAS AND PROVIDE EROSION AND STORM PROTECTION

NOTE:

PROJECT AREA LENGTH = 3.0 MILES*

* BETHANY, SEA COLONY, MIDDLESEX, SOUTH BETHANY PROJECT AREA LENGTH = 2.6 MILES

* NORTH SHORES PROJECT AREA LENGTH = 0.4 MILES

THE PROJECT LIMITS ARE THE SAME AS THOSE PREVIOUSLY AUTHORIZED BY D.O.A.
PERMITS: CENAP-OP-R-199800591-23
CENAP-OP-R-199801157-23 **

** (WITH THE EXCEPTION OF A NEW BORROW SOURCE FOR THE NORTH SHORES PROJECT AREA)

Portion of permit transferred to Middlesex Beach Association (1,900 linear feet +/-)

SCALE IN FEET
0 1000 2000 4000

N

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BEACH REPLENISHMENT PROJECT

IN ATLANTIC OCEAN

AT: BETHANY BEACH / SEA COLONY / MIDDLESEX / SOUTH BETHANY/ NORTH SHORES
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:

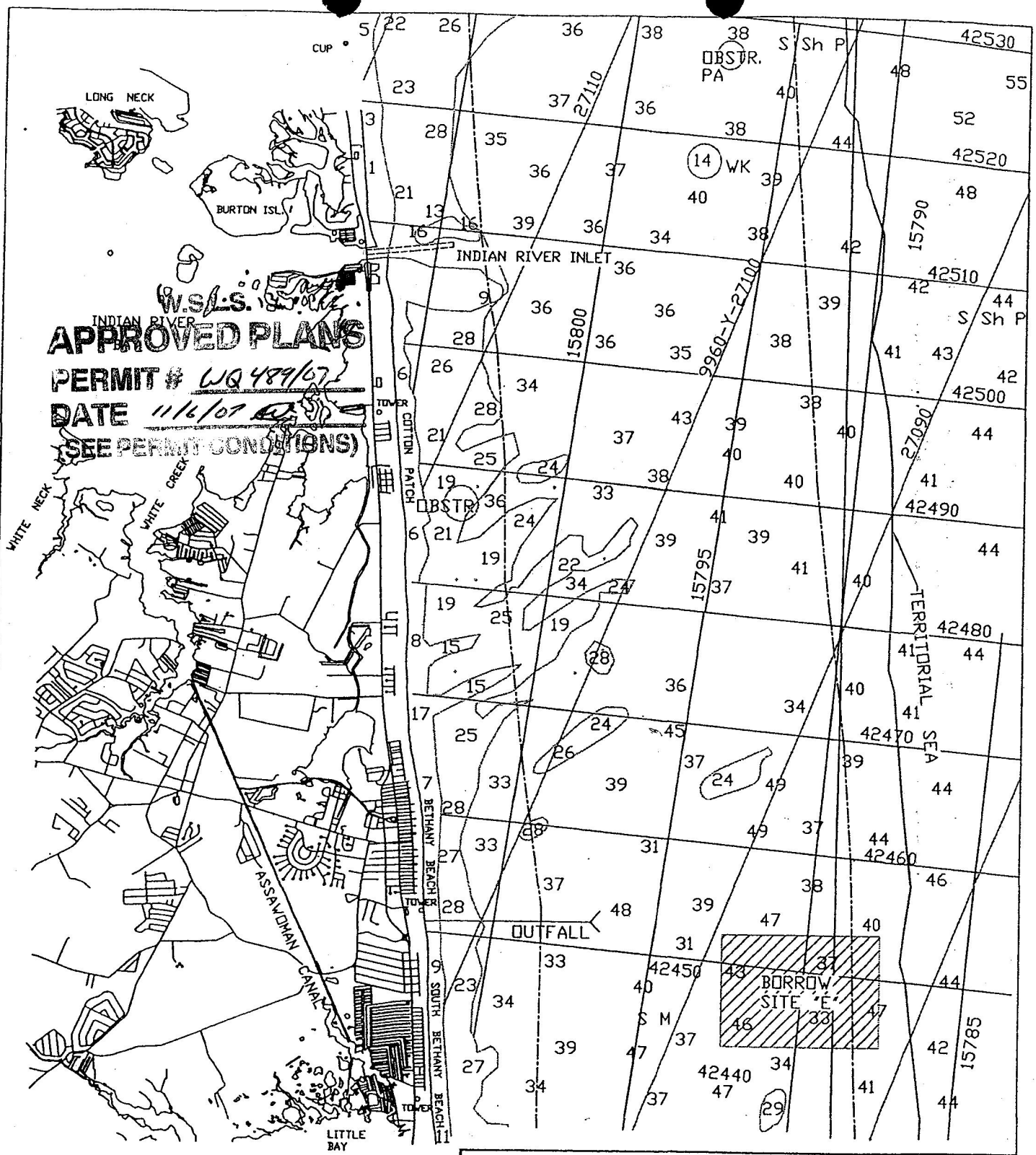
DEL. DEPT. OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION

DATE: DECEMBER 2004

E-1

SHEET 1 of 9

E-1



PROPOSED BORROW SITE "E" LOCATION

REFERENCE: N.O.A.A. CHART 12214:
DEPTHS SHOWN IN FEET BELOW M.L.W.

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BEACH REPLENISHMENT PROJECT

IN ATLANTIC OCEAN

AT: BETHANY BEACH / SEA COLONY / MIDDLESEX / SOUTH BETHANY / NORTH SHORES

COUNTY OF SUSSEX, STATE OF DELAWARE

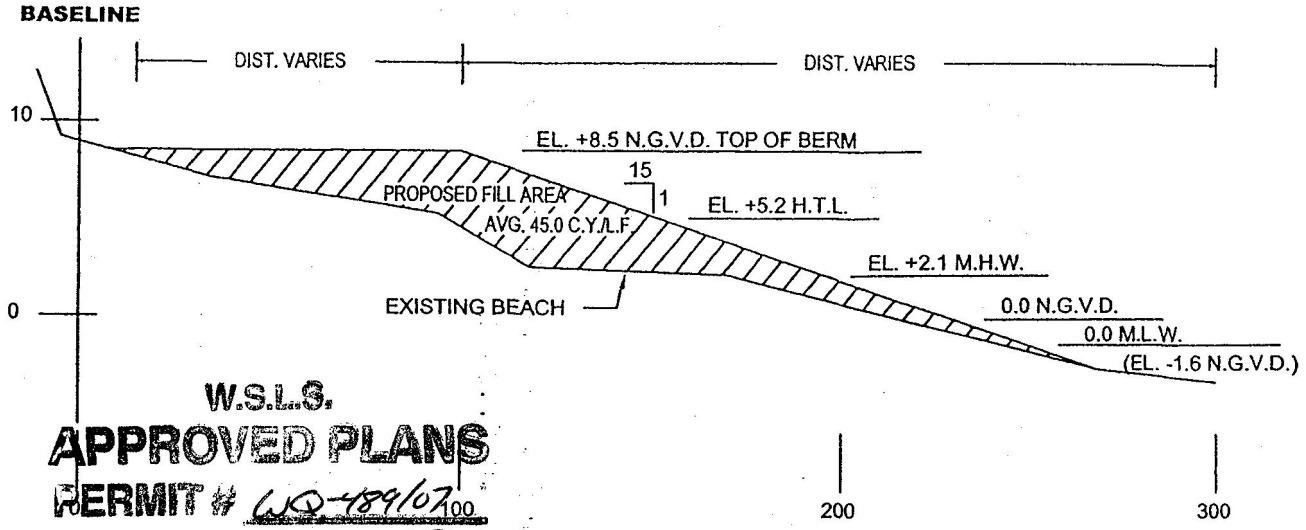
APPLICATION BY:

DEL. DEPT. OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION

DATE: DECEMBER 2004

E-5

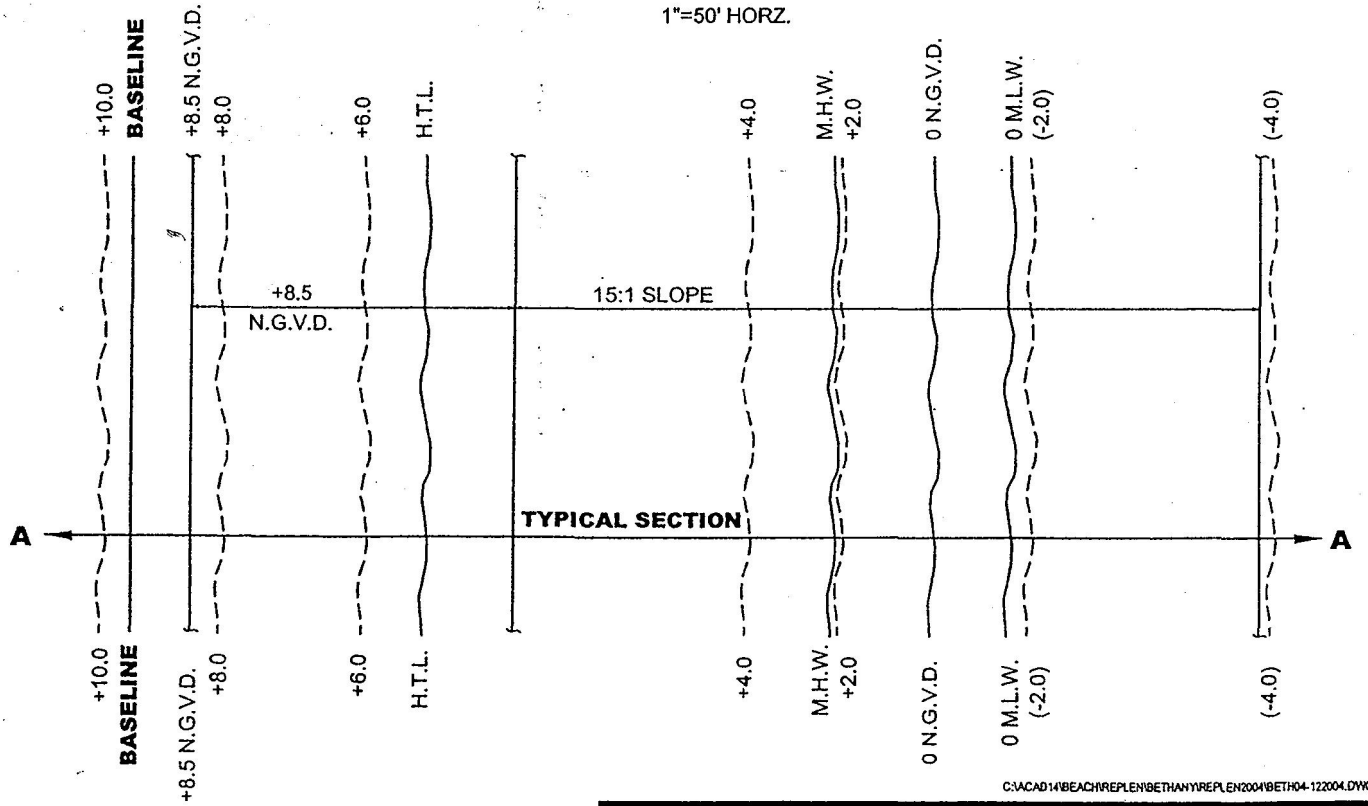
SEA COLONY & MIDDLESEX BEACH
DESIGN FILL SECTION



APPROVED PLANS
PERMIT # WQ-489/07
DATE 11/6/07
(SEE PERMIT CONDITIONS)

TYPICAL SECTION A-A

SCALE: 1"=10' VERT.
1"=50' HORZ.



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TYPICAL PLAN

SCALE: 1"=50'
DATUM: N.G.V.D.

MEAN TIDAL RANGE = 3.7'

BEACH REPLENISHMENT PROJECT

IN ATLANTIC OCEAN .

AT: BETHANY BEACH / SEA COLONY / MIDDLESEX / SOUTH BETHANY / NORTH SHORES

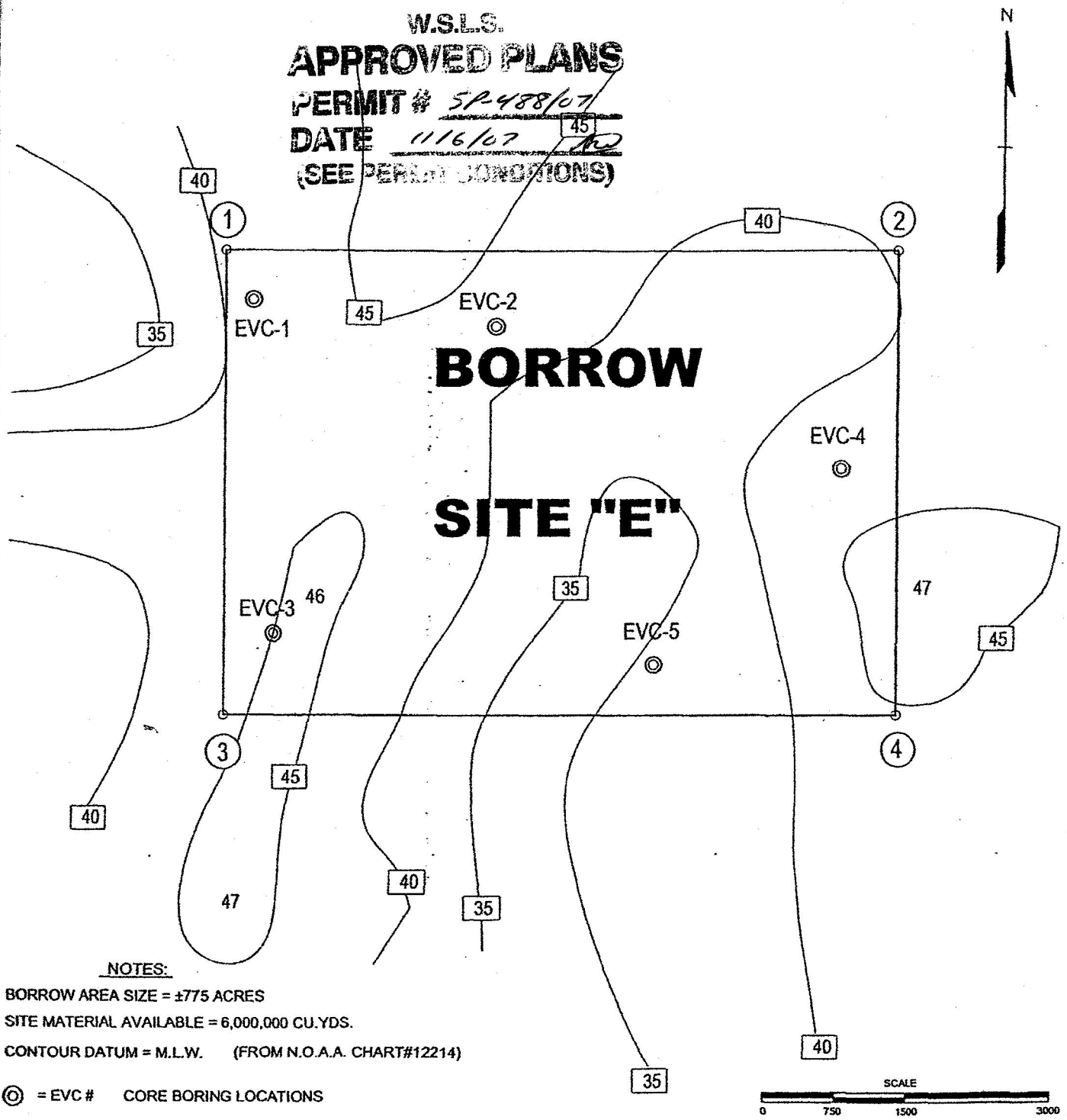
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:

DEL. DEPT. OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION

DATE: DECEMBER 2004 E-3 SHEET 3 OF 9

W.S.L.S.
APPROVED PLANS
PERMIT # SP-488/07
DATE 11/6/07
(SEE PERMIT CONDITIONS)



NOTES:

BORROW AREA SIZE = ±775 ACRES

SITE MATERIAL AVAILABLE = 6,000,000 CU.YDS.

CONTOUR DATUM = M.L.W. (FROM N.O.A.A. CHART#12214)

◎ = EVC # CORE BORING LOCATIONS

LIMITS OF BORROW AREA		
POINT	COORDINATES	
	NORTHING	EASTING
①	N 190000	E 770000
②	N 190000	E 777000
③	N 185177	E 770000
④	N 185177	E 777000

STATE PLANE COORDINATES
BASED ON NAD - 1983

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BEACH REPLENISHMENT PROJECT

IN ATLANTIC OCEAN

AT: BETHANY BEACH / SEA COLONY / MIDDLESEX / SOUTH BETHANY / NORTH SHORES
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
DEL. DEPT. OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION

DATE: DECEMBER 2004 E-6 SHEET 6 of 9

DEPARTMENT OF NATURAL RESOURCES
AND
ENVIRONMENTAL CONTROL

NOTICE OF AUTHORIZATION

Permit/Lease No. and Description: SP-488/07, WQ-489/07 To hydrolically dredge approximately 85,500 cubic yards of sand from offshore Borrow Area "E" and deposit it along 1,900 linear feet of shoreline extending from the northern limits of Middlesex Beach south to the Southern limits of Middlesex Beach, Bethany Beach, Sussex County, Delaware

Issued to: The Middlesex Beach Association

Location of Work: Same as above

Date of Expiration: 2/08/2008

DISPLAY THIS CERTIFICATE IN A HIGHLY VISIBLE LOCATION ON THE JOB SITE.

Laura M. Herr, Program Manager
Wetlands & Subaqueous Lands Section

November 18, 2025
Mr. Michael Yost
Regulatory Branch
U.S. Army Corps of Engineers- Philadelphia District
100 Penn Square East
Philadelphia, PA 1907-3390

Re: Section 408 Review for Periodic Beach Replenishment at Middlesex Beach, Sussex County, DE

Dear Mr. Michael Yost,

On behalf of the Middlesex Beach Association, Gahagan and Bryant Associates hereby submits this Section 408 Review package as a requirement for a Middlesex Beach replenishment project, which the U.S. Army Corps of Engineers (USACE) has determined would modify a federal project. This Section 408 application is submitted in conjunction with a ten (10) year Department of the Army Permit application to conduct periodic beach replenishment activities along a 1,950+/- linear foot stretch of shoreline extending from the southern limits of the private community of Sea Colony Beach, Sussex County, Delaware to the northern limits of South Bethany Beach, Sussex County, Delaware. As described more fully below, such a replenishment for the Middlesex beach would only occur in conjunction with a replenishment project for the adjoining or proximate beaches of South Bethany and Bethany Beach. This application is for the purpose of permitting Middlesex to participate and/or coordinate with USACE in such a project. We believe participation by Middlesex Beach Association would benefit and not burden those efforts.

Before providing the more detailed material in support of Middlesex's Section 408 review, we note the following regarding Middlesex's application. Under prior permits issued by the State of Delaware and the Department of the Army, Middlesex has participated in the past in at least one replenishment project, in approximately 2007. Middlesex Permits associated with that project have expired and Middlesex has not sought to renew them until this current application. Although there have been subsequent replenishment projects in the surrounding beaches since that time, Middlesex Beach has proven to be mostly resilient in the face of the tidal actions, storms, and other factors which have necessitated beach nourishment.

However, the purpose of the current application is to position Middlesex for the option of participating in future replenishment projects, with the decision regarding its actual participation in a particular project to be made at the time when a project may be initiated with proper notice given to USACE to ensure smooth coordination. Any participation by Middlesex would be dependent on the severity of the beach conditions that Middlesex may be experiencing at that time. While it is possible that current beach conditions will persist and future participation would not be necessary, Middlesex is deeply concerned at the prospect of more frequent and more intense storms in the near future. Should the Delaware coast sustain a severe hit from a hurricane or experience sustained beach erosion from the seemingly more frequent and intense nor'easters that impact the coast, Middlesex risks having its beach destroyed and without the proper permits in place, there is no viable option for replenishment.

In order to keep mobilization and demobilization costs to a minimum, with respect to any future project Middlesex might participate in, Middlesex proposes to utilize the same dredging contractor(s) and methods selected by the Corps for the beach nourishment authorized in the project entitled the *Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach and South Bethany, Delaware* project, in order to perform similar nourishment at Middlesex Beach, located adjacent to and in between Sea Colony

and South Bethany beach. As described above, Middlesex will only exercise this proposed option when its beach is in need of nourishment, e.g. after a major storm event or after persistent and severe beach erosion. Middlesex is aware that periodic nourishment of the federal project for the surrounding beaches is anticipated on a three (3) year cycle. Middlesex would have any future beach nourishments coincide with one or more of these federal nourishment projects. The quantity of sand placed during a periodic nourishment event will vary with the condition of the beach at the time of placement. However, the seaward limits of the project template shown in the plan drawings or any template approved by USACE, will not be exceeded. The estimated fill quantity for this project is 103,000 cubic yards (CY) per event of clean sands.

Middlesex Beach intends to show continued strong cooperation with the Corps to facilitate the approval of this project. Middlesex Beach Association's strong commitment to the regional community and replenishment projects and the work of the USACE has been repeatedly demonstrated in connection with past projects. Although Middlesex has not participated in any project since the one noted above over 15 years ago, it has facilitated past projects with USACE by repeatedly agreeing to allow access to Middlesex Beach for the movement of heavy equipment and personnel between South Bethany and Bethany as those beaches were replenished. This was done in recognition of the importance the Corps' beach fill projects have for Delaware beach communities. We understand that Middlesex Beach's cooperation in these projects in allowing the movement of equipment directly across its beach between replenishment sites has resulted in material cost saving to the projects.

In addition, conversations with personnel at the Delaware Department of Natural Resources and Environmental Control (DNREC) have indicated that a beach nourishment project at Middlesex Beach would be beneficial to the coastal sand system in the area because such nourishment would enhance the benefit and longevity of any replenishment on adjacent beach properties. This is because sand placed as part of a replenishment inevitably migrates away from the replenished beach after the project is completed due to the effects of wave/tidal action and other natural occurrences. This is particularly the case when an adjoining beach is eroded, leaving a gap of sand fill on the shoreline between the replenished beach and the eroded beach. However, to the extent Middlesex is able to participate in a given replenishment project, sand fill placed at Middlesex Beach will increase the longevity of conjoining beaches, such as Bethany and South Bethany, and preserve the beneficial impact of the Federal project. Middlesex is directly south of Sea Colony Beach Association, who is already permitted for a replenishment within the next federal cycle, and Sea Colony is south of Bethany Beach. Therefore, a beach renourishment for the stretch of Middlesex would prevent a "gap" from forming between Bethany and South Bethany that would likely decrease the effectiveness of the federal project in terms of storm protection and flooding prevention.

For this reason, Middlesex's participation in a future project should be considered beneficial to the federal project at Bethany and South Bethany in terms of protection from storm damage and coastal erosion. Given the benefits the Federal Government will receive, and since Middlesex would pay for the incremental costs associated with its participation, this modification should be complementary to that interest.

To the extent Middlesex participates in a particular future project, Middlesex would plan to match the Corps' plans and specifications, and with the exception of extending the beach fill template to include Middlesex Beach, we can say with reasonable certainty that the impact on the federal project and the public interest will result in a net positive. Middlesex understands the resources, time and money that the federal and state parties have put into maintaining and studying the current borrow sources. Middlesex is therefore willing to contribute to this research by paying a "finder's fee" per cy of material removed from the borrow sites. The main impact to the project will be the minor depletion of approximately 103,000 cy per event from the sand source at Borrow Areas "E" and/or "Fenwick Island", which will constitute only

a small fraction of the total federal project placement volume. Any federal or state laws or regulations will be followed in the federal project, therefore they will be followed in this proposed modification.

Enclosed for your review is a Section 408 analysis document along with other references to assist in your review. Please refer to the nine (9) sections in the attached document for our analysis on the required Section 408 Review subjects. Supplemental information for the proposed project is also included and listed here as follows:

1. Environmental Questionnaire for Corps of Engineers Permit Applications w/ Photograph attachments and NOAA Essential Fish Habitat Worksheet.
2. An assortment of plan drawings including a Project Area Plan View, a Borrow Area Plan Views, and a Fill Plan with Cross Sections.
3. The Middlesex Beach Association Deed and Plat, describing the real estate boundaries for the entire community, including the beach at the proposed work area
4. A list of names and addresses of surrounding property owners
5. "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach/South Bethany Interim Feasibility Study, Final Feasibility Report and Environmental Impact Statement, June 1998". (The report was prepared by the U.S. Army Corps of Engineers, Philadelphia District for the State to determine an implementable solution and the extent of federal participation in a storm damage reduction project for the towns of Bethany Beach and South Bethany, Delaware. It contains relevant site specific physical, biological and cultural information for the project area);Catalog Record: Bethany Beach / South Bethany interim... | HathiTrust Digital Library
6. "Sediment Contaminant and Geotechnical Testing for Proposed Sand Sources - Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach/South Bethany and Fenwick Island Storm Damage Reduction Projects", 2004, Versar, Inc., Columbia, Maryland, for the U.S. Army Corps of Engineers, Philadelphia District. (The report provides relevant sediment chemistry information and grain size analysis on Borrow Site "E", the borrow source for the project area)
7. "Baseline Biological Monitoring of Two Offshore Sand Sources Along The Delaware Atlantic Coast (Fenwick Island Borrow Area and Area E"). (The report provides relevant sediment chemistry information and grain size analysis on Borrow Site "E").

Your timely response to this request would be most appreciated. Please contact me if you have any questions or require additional information concerning this project.

Sincerely,

Tyler Littlefield, P.E

Division Manager

1. Written Request for Approval of the Project Modification

Project description
The proposed activity involves periodically dredging by hydraulic method, using either a cutter-suction pipeline dredge or a hopper dredge with pumpout capability and a monobuoy system, approximately 103,000 ± cubic yards per event of sand (current estimate) from an offshore borrow area and depositing is as beachfill along a 1,950± linear foot stretch of shoreline extending from the southern limits of the private community Sea Colony Beach Association in Sussex County, Delaware to the northern limits of the town of South Bethany Beach in Sussex County, Delaware. The project is intended to adjoin, the full berm section of the Federal Shore Protection Project at Bethany Beach and front the tapered section of that project into South Bethany. The borrow sources for the project fill area are Fenwick Island and/or "E".

If a pipeline dredge is utilized, sand will be excavated from the borrow source and pumped directly to the project fill area using both floating and submerged pipeline. A booster pump(s) may be used depending upon the pumping capabilities of the equipment employed. If a hopper dredge with pumpout capability is employed, sand will be raised by dredge pumps through dragarms connected to dredge intake heads in contact with the borrow source bottom and discharged into hoppers built within the vessel. When hopper capacity is reached, the vessel will transport the material to a monobuoy pumpout facility which will be anchored offshore at the project site in water deep enough to accommodate the dredge (25 to 30 feet). A submerged pipeline will run from the pumpout facility to the shoreline. The dredge will then anchor and its pumpout line will be attached to the facility and sand will be hydraulically transported (pumped) to the beach via the submerged pipeline. The sand will be transferred up and down the beach at the project fill areas using additional pipeline as necessary.

Once sand has been placed at the project fill areas by either one or both of the aforementioned methods, earth-moving equipment (bulldozers) will be used to shape the material to the approved design template.

Based on past experience, dredging sand from Borrow Site "E" has a potential for encountering unexploded ordnance (UXO) associated with past military artillery target practice activities along the Atlantic Ocean coastline. To minimize UXO from entering in the dredge during borrow site dredging, the dredge intake will be fitted with a longitudinal bar-screen. This screen will have a maximum opening of 38 millimeters (1.5 inches) between adjacent bars and will be constructed out of material that is very durable and wear resistant. During dredging operations, these screens will be inspected daily to assure their functionality. If rock, rubble, ordnance or other debris larger than 38 millimeters (1. 5 inches) in diameter are found on the beach, the contractor will shut-down, remove the object(s) and correct the problem. During pumping operations, the contractor will provide personnel to maintain visual control at the end of the discharge line. Shore to dredge contact will be maintained such that dredging can be halted in case of an emergency.

Refer to the attached plan drawings for the exact location of the fill and borrow areas and construction specifications.

Timing/ Logistics
The dredging and placement of beach fill may occur at any time most convenient for USACE. Two logical options for dredging and placement are (1) continue to fill from south Bethany all the way north to the northern limits of Middlesex Beach or (2) the dredging and placement for Middlesex occurs after the federal project has been completed. Both options are suitable for Middlesex. Option 1 may slightly

increase the federal project completion timeline, since there will be a greater volume of material to be dredged and deposited before the Corps completes their project. In the case of option 2, USACE timing and logistics should be unaffected by this proposal as a separate contract engaged in by the contractor.

Purpose/Need of Modification

The purpose of the project is to periodically replace sand lost from this section of Atlantic Ocean coastline as a result of coastal storms and background erosion since the last Middlesex Beach replenishment project was completed in this area in 2007. Sediment transport along the Atlantic coast of Delaware predominately moves in a northward direction. However, there is a reversal in the dominant sediment transport direction at the southern extent of the Delaware coast. The region of Middlesex Beach's shoreline experiences a predominantly southward drift at a rate of 125,000 to 200,000 CY per year (see pages 16-18 of Reference #5). The project will help reverse the effects of beach erosion at both Middlesex Beach and adjacent beach properties. The modification will provide increased protection benefits from storm damage, coastal erosion, and add to the recreational value of the Middlesex Beach community. Based on knowledge of sediment transport along coastlines, and conversations with DNREC, adding sands to this coastal system will also supplement and increase the relative longevity of adjoining coastal property, including the federal project.

Middlesex Beach requests this proposed nourishment project in order to save on mobilization/ demobilization costs associated with dredging work. Middlesex Beach is a small private community with limited funds to nourish their beach property. In the reach that encompasses Bethany, South Bethany, and Middlesex Beach, the shoreline recedes an average of one foot per year (see pages 18-19 of Reference #5). Without this benefit of cost savings by using the same contractor and borrow area of the federal project, Middlesex Beach will not be able to afford to replenish their beach sands on a regular basis. This would eventually result in large shoreline recession on their property and potentially reduce the longevity of the federal project adjoining Middlesex Beach. This action alternative would cause a number of negative effects on the community and surrounding area. A no action scenario would deprive the area of a healthy beach which is an important economic and recreative resource. A receded beach also greatly increases the risk of property damage from storm surges and coastal erosion, thereby increasing the likelihood of federal funding from FEMA being spent to mitigate this potential damage.

Sections 10/404/103 Statement

Gahagan and Bryant Associates (GBA) as an authorized agent of Middlesex Beach anticipates submitting an authorization permit application pursuant to Sections 10/404 on November 17th, 2025. GBA already attended a virtual Joint Permit Processing (JPP) meeting held by DNREC on July 17, 2025.

Real Estate Statement

This proposed work will involve the use of both public property under the utilization of USACE and private property owned by Middlesex Beach Association. See Section 3 for additional detail.

Anticipated Project Start Date

The project is anticipated to coincide with the Bethany/ South Bethany beach nourishment project expected to commence in 2026, after the beach nourishment in the Spring of 2023, if their beach is in need of the three (3) year average nourishment at such a time. If Middlesex Beach determines their property has sufficient longevity at that time, they will opt-out of participation of that dredging and placement event and decide to opt-in to a future event. The Association is willing to be flexible on the start date in order to accommodate the preferred start date of USACE and their contractor.

2. Technical Analysis and Adequacy of Design

The proposed action for this Middlesex Beach nourishment is to mimic the design plans and specifications for the USACE *Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach and South Bethany, Delaware* project. This will include using the same sand source borrow area that USACE chooses for their project, but it is envisioned that Borrow Area "E" and Borrow Area Fenwick Island nearby will be the source utilized for the project. The nourishment fill template will also be designed to be the same dimensions as the USACE project. Since the USACE project directly adjoins Middlesex Beach property on the south end, the USACE project template can be extended to the north end of Middlesex Beach in the final design plans. Reference #6 & #7 Versar Reports, prepared for USACE, detail the sediment chemistry and grain size analysis of Borrow Area "E".

Operation and Maintenance Requirements

The proposed action will not require any operation or maintenance after the project is complete. The beach will likely require future nourishments; however these nourishments can be considered separate from the proposed action discussed herein. They will only be required if, and when, Middlesex Beach requests modification to an additional federal nourishment. All other operation and maintenance activities at Middlesex Beach will be performed at the care and discretion of Middlesex Beach Association.

Planning level designs (see attached) have been prepared as part of the submittal for regulatory permits.

3. Real Estate Analysis

The real estate involved in this project includes the subaqueous sand source know as Borrow Area "E" Borrow Area "Fenwick Island", the Middlesex Beach project area, and the property surrounding Middlesex Beach.

Borrow Area Analysis

The proposed borrow area known as Borrow Area "E" and "Fenwick Island" is a subaqueous source for clean sands used for beach nourishments in the general vicinity. Borrow Area E and Borrow Area Fenwick Island are public property and are used mainly by USACE for beach fill projects. USACE used Borrow Area E for their 2022 *Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach and South Bethany, Delaware.*

See attached drawings for Boundary limits for Borrow Area "E" and Borrow Area "Fenwick Island".

Project Area (Middlesex Beach) Analysis

The Middlesex Beach Association is a private, unincorporated community whose boundaries extend to the Atlantic Ocean, ending at the Mean Low Water (MLW) line. The subaqueous land beyond the MLW line is public property. The proposed sand placement area will occur both on Middlesex's private property and on public property.

See attachment 3 for The Middlesex Beach Association Deed and Plat, describing the real estate boundaries for the entire community, including the beach at the proposed work area. This attachment includes a map describing Middlesex community property.

Surrounding Property Analysis
Directly north of the project there is a small private beach owned by Sea Colony Beach Association, a private community which owns their section of the beach. North of Sea Colony is the public beach of North Bethany, owned by the state of Delaware and maintained by USACE. South of Middlesex is the public beach of South Bethany, also owned by Delaware and maintained by USACE.

See attached for a list of names and addresses of surrounding property owners.

4. Discussion of Residual Risk

This proposed action does not pose increased risk to any life or property. The proposed project will mitigate the effects of natural coastal erosion, decrease the risk of storm surge flooding, and increase the longevity of the surrounding beaches, including USACE maintained beach nourishment projects. Just as the federal project is designed to reduce storm damage and coastal erosion along the Delaware coast in Bethany and South Bethany, this work will similarly have a protective effect on the community landward of the work. The net effect of the proposed modification will result in decreased risk of flooding and storm damage. Therefore, this modification will not incur damages more frequently as a result of flooding that will require federal assistance under PL 84-99.

5. Discussion of Executive Order 11988

Executive Order 11988 has been considered with regard to this proposed beach nourishment and will not be in conflict with any provisions in the order.

The sand fill placement area is located within NFIP Flood Zone “VE”.

The proposed nourishment will not increase the risk of damage from flood to itself or the surrounding area. The added beach fill will increase storm surge protection to the coastal community in the area. In the case where the beach nourishment does not take place, the forces of coastal erosion could deplete the sand in the Middlesex and surrounding system, thereby increasing the risk of a coastal flooding event. Such a case would be antithetical to the purpose of Executive Order 11988.

The alternatives to beach replenishment include man-made structures, such as seawalls and sandbags, can limit the effects of beach erosion. Such alternatives can both disrupt natural ecosystems and hinder the beauty of the area, all while having high initial costs. These alternatives would also negatively impact the recreational value of the beach. Manmade structures can also accelerate beach erosion at the extremities of the structure, therefore harming the beaches on the property adjoining the protected beach. In this case, the adjoining properties include federally maintained beach.

Beach replenishment is the most viable and effective form of coastal erosion protection for the Middlesex Beach community because it increases the recreational value of the beach, preserves both Middlesex and adjoining coastline, and is economically viable.

6. Environmental Protection Compliance

The proposed work will mimic the Plans and Specifications of the USACE "*Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach and South Bethany, Delaware"* project. Since the proposed action will be the same as USACE's beach nourishment, and USACE will be compliant with all environmental regulations, work on Middlesex Beach can also be done with the same precautions and should be considered in compliance with all applicable environmental regulations.

The only environmentally related differences between the proposed work and the federal project will be (1) an increased volume of dredging of approximately 103,000 +/- CY of clean sand from Borrow Area "E" and/or Borrow Area "Fenwick Island" and (2) extending the placement area of clean sand to Middlesex Beach. The extra dredging should have no substantial environmental impact beyond the regular impact of dredging already approved by USACE. The impacts of dredging usually can result in temporary increased turbidity around the source area and a temporary impact on the benthic community in the affected dredging locations. Environmental windows for dredging followed by USACE will be in place to protect endangered species that could be affected by this work. Placement of sand at Middlesex Beach could also potentially impact state and federal protected species. An Environmental Review performed by DNREC (see attached) details the potential species impacted by the proposed work in Borrow Area "E" and the placement site at Middlesex Beach. The species affected at Middlesex Beach are also potentially present in the locations of the federal project, meaning protection measures will already be in place for the wildlife. The review also provides recommendation for dredging and placement with regard to the protected species. The recommendations provided therein, along with any other environmental measures required by USACE will be followed.

There are no known properties listed on, or eligible for listing on, the National Register of Historic Places that would be affected by the proposed activity. The plan has been designed to avoid archaeologically sensitive areas, and is therefore not expected to impact any cultural resources.

As part of the federal consistency permit application, any applicable federal regulations will be recognized and followed. The applicant will comply with all recommended actions that result from DNREC's review of the *Coastal Zone Management Act Federal Consistency Form* or resulting from this Section 408 Review. In addition to environmental considerations based on DNREC's Environmental Review and the Federal Consistency form; environmental regulations were also considered for this proposed project to be in accordance with the following federal laws:

1. National Environmental Policy Act.
2. Endangered Species Act.
3. Fish and Wildlife Coordination Act (FWCA).
4. Marine Protection, Research and Sanctuaries Act
5. Wild and Scenic Rivers Act.
6. Coastal Zone Management Act
7. Clean Air Act
8. Hazardous, Toxic and Radioactive Waste (HTRW)
9. National Historic Preservation Act.
10. Noise Control Act.

7. Requester Review Plan Requirement

Not Yet Applicable.

8. Other Information

Other documentation not included in this submittal, that could be useful to your review, but still being processed by federal/state agencies:

1. Department of the Army Permit - Section 404/ 10
2. Subaqueous Lands Lease/ Water Quality Certification
3. Division of Fish and Wildlife Environmental Review Request Form

9. Written Requests

Assuming the 408 Review Request is approved, could our Corps representative please also review and sign the *GARFO ESA Section 7: NLAA Program Verification Form* that is attached to this DOD Safe upload?

Middlesex Beach Association
PO Box 584
Bethany Beach, DE 19930
EIN: 51-0101015
August 13, 2025

To Whom It May Concern:

Mr. Tyler Littlefield of Gahagan & Bryant Associates, Inc. has been retained by the Middlesex Beach Association Inc. He is authorized to act on our behalf for the sole purpose as follows:

Obtaining all regulatory approvals for Middlesex Beach which may be required for the replenishment of the beach at Middlesex Beach either as a standalone project or in conjunction with the anticipated periodic nourishment of the Federal Shore Protection Project at Bethany Beach and South Bethany, Sussex County, Delaware.

Respectfully submitted,

David A. Wiecking
President, Board of Directors
Middlesex Beach Association, Inc.

ENVIRONMENTAL QUESTIONNAIRE
FOR CORPS OF ENGINEERS PERMIT APPLICATIONS
Philadelphia District, Corps of Engineers
Philadelphia, Pennsylvania 19107
CENAP-OP-R

INTRODUCTION AND INSTRUCTIONS

The District Engineer is required by law to assess the initial, cumulative, and long-term effects of any proposed permit on all aspects of the environment.

To speed the analysis of the probable impact of the proposed work, each applicant is required to submit appropriate environmental data as part of a permit application. We ask that you provide a thorough description of your proposed project and answer each question as it applies to the work and the results of that work. Complete and accurate answers will prevent unnecessary delays in processing your permit application

Parts I and II will be filled out by all applicants. Part I is self-explanatory. In Part II, the Environmental Impact Checklist, you should indicate the impacts of your project on all aspects of the environment that are listed. Use the space under "Qualifying Remarks" to indicate the specific impacts that your project will have. This may include types of plants or animals affected, specific adverse, beneficial, or mitigative effects, changes to existing conditions, etc. Although space for answers has been provided, you may wish to supply additional information on attached pages. If you do not anticipate an impact on a certain item, simply place a check in the "No" column.

Part III will be filled out by all applicants applying for a permit to perform dredging.

Part IV will be filled out by all applicants applying for a permit to perform filling operations. This includes activities such as filling behind bulkheads.

Refer any questions you may have concerning this supplemental form to the Regulatory Branch at (215) 656-6728.

PART I

I. PROJECT DESCRIPTION:

A. General Site Location: Accurately locate the project site with respect to State, county, or other subdivision, and in relation to streams and rivers.
The project is located on the beach front of Middlesex Beach Association in Bethany Beach, DE in Sussex County. The dredging will occur in the Atlantic Ocean.

B. Specific Site Locations: Completely locate the project site with respect to cove, creek, property owner, plot number, etc.
See permit plans (Reference #2) for details on the exact location.

C. Description of Proposed Action: Carefully describe the action proposed, including the method of construction, equipment, and materials to be used. Details in your description are important. Attach additional sheets if necessary.

The project is a beach renourishment in front of Middlesex Beach Association where sand will be dredged from Borrow Area "E" and/or "Fenwick Island". The material will be pumped onto the beach for a stretch of 1,950 linear feet for approximately 103,000 cy.

D. Purpose of Proposed Action: Define the purpose of the proposed structure or work. For example, the purpose of bulkheading may be to stabilize an eroding bank; whereas, the purpose for a pier may be for the mooring of a private boat, for access to a public or private facility, for a marina, or for another purpose.
The purpose of the project is to renouish an eroding beach in front of Middlesex Beach to increase protection to inland communities from potential storms while also aiding in the longevity of federal beach renouishment projects surrounding Middlesex Beach.

E. Submit color photographs of the site, with explanations of the views shown (prints only). Photographs help us to better understand your project. The more photographs you provide, the easier it is to understand and process your application.
See attached photographs:
1. This photo is from Google Earth and was taken by Jesse Holloway. This photo shows a photograph from the beach face of Middlesex Beach during a low tide one morning of September 2014. The photo is directed North and shows the Sea Colony hotels in the distance.
2. This photo is an aerial image displaying Middlesex Beach from the east. It was captured using the Sussex County, Delaware GIS website. In the photo, a section of South Bethany can be seen on the left side and a section of Sea COlony Beach can be seen on the right side. Everything in between those properties belongs to Middlesex Beach Association and is the beach where this permit applies.

PART II – ENVIRONMENTAL IMPACT CHECKLIST			
ENVIRONMENTAL IMPACT	**YES**	**NO**	**QUALIFYING REMARKS**
A. Physical			
1. Topography	X		Will be placing above MLW
2. Geological Elements and Leaching		X	
3. Air		X	
4. Transportation		X	
5. Handling of Hazardous Materials		X	
6. Spoil Disposal		X	
7. Sewage and Solid Wastes		X	
8. Water Resources			
a. Water Quality		X	
b. Hydrography, Circulation, Littoral Drift.	X		Placed sand fill will be suspended and transported due to currents and waves
c. Ground Water		X	
B. Biological			
1. Vegetation			
a. Terrestrial		X	
b. Aquatic		X	
2. Fish and Wildlife			
a. Mammals		X	
b. Birds		X	
c. Amphibians		X	
d. Reptiles		X	
e. Fish		X	
f. Shellfish		X	
g. Invertebrates		X	
3. Rare or Endangered Species		X	

ENVIRONMENTAL IMPACT	YES	NO	QUALIFYING REMARKS
C. Cultural			
1. Land Use	X		Provides storm surge protection for inland communities. Work will be conducted in the off-season of nesting and tourism to allow access to the beach
2. Population Density and Trends		X	
3. Regional Development		X	
4. Historic Places		X	
5. Archaeological Sites		X	
6. Aesthetics	X		Will improve the beach in front of Middlesex as well as surrounding federal beaches since it will continue the nourishment complete to those beaches without an eye-sore of a smaller beach
7. Utilities		X	
8. Transportation Systems		X	
9. Recreation	X		Will improve the beach for coastal recreation purposes
10. Public Health		X	
D. Other Factors			
1. Secondary Effects		X	
2. Controversiality		X	
3. Is significant dredging involved?	X		Material will need to be dredged for placement. Work will be performed with a federal project and pay a "compensation fee" for using federal borrow areas.
4. Is significant filling involved?	X		103,000 cy of sand per event will be placed along 1,950 linear feet of shoreline to match the template of surrounding federal beaches

Part III

Considerations of a Dredging Proposal:

A. Describe characteristics and locations of the proposed dredged material disposal site. Provide photographs.

The material will be placed on the beach front of Middlesex located between Bethany Beach and South Bethany. The sand will come from Borrow Area "E" and/ or "Fenwick Island" which are used for the surrounding federal beach renourishment projects. Therefore, the sand will match all surrounding beaches in quality. Since this is a private beach, a compensation fee will be paid for material taken from state land. Please see the attached plans for the disposal site.

B. Is there a comprehensive plan for disposal sites that takes into account the accumulative effect over time and the decreasing amount of suitable sites for disposal?

The material will be compensated with a "Finder's fee" to compensate the state and federal parties for this investments in the borrow site and investigations of other potential sites.

C. Describe the present land use of the disposal site.

Currently the disposal site is a private beach community used for recreation and inland community storm protection.

D. Describe characteristics of the material to be disposed, including:

1. Physical source of material (i.e. sand, silt, clay, etc.) Give percentages of the various fractions if available.

The material from these borrow areas is primarily fine to medium sands, poorly graded to well sorted material . Sediment characteristic analysis is available from Reference # 6: Sediment Contaminant and Geo-technical Testing for Proposed Sand Sources by Versar.

2. Chemical composition of material: Many areas, especially marinas, highly industrialized areas, etc., have sediments with high concentrations of pollutants (chemicals, organic material, etc.). These materials may be re-suspended or reintroduced into the water and result in serious environmental damage. If your proposed dredging is in an area such as described above, a chemical analysis of the material to be dredged should be provided.

N/A

3. Dewatering properties of the material to be disposed.

Material will be pumped onto the beach where water will run back into the ocean.

4. Compactability of material and settling rates of material to be disposed.

The material is primarily sand and settling rapidly.

5. Dredging and disposal schedule to insure that operations do not degrade water quality during times of anadromous fish migration.

No dredging will be occur in time frames of concern.

E. When the project involves land disposal, discuss the following:

1. Method of disposal to be utilized, i.e., pipeline discharge, barge, hopper (underway or stationary).

Material will be disposed using a pipeline to discharge it onto the beach. Until the project is bid, it is unknown if it will be a hopper or cutter dredge.

2. Describe method of dredged material containment (i.e. embankment, behind bulkhead, etc.)

It will be dependent on the contractor to decide their preferred method but most likely the material will be pumped into a dike on the beach to be graded out to template.

3. What type of leachates will be produced from the spoil material and what is planned for protection of the groundwater?

No leachates expected

4. Methods to insure that spoil water does not adversely affect water quality, both during construction and after completion of the project.

No spoil water expected

5. Provisions for monitoring during discharge: water quality, sediment transport, and precautions to prevent "short-circuiting" dumping.

Material will be analyzed as it is disposed on the beach.

F. Consider and discuss the following for water disposal:

1. Describe methods to be used for water disposal, including volumes and site selection.

No water disposal expected

2. Describe the existing water characteristics at the site, including chemical analysis for water quality.

No abnormalities in existing water. The water is saltwater with a normal salinity and turbidity range.

G. Discuss the frequency and amount of maintenance dredging which will be required; discuss the resulting impacts.

Dredging will be performed as needed when there is a federal dredging project occurring for neighboring towns. This typically occurs every three years. Middlesex does not expect to participate in all of them.

H. Alternatives.

1. Discuss all alternatives to the project, including the "no action" alternative.

Hydraulic or hopper dredging is the most efficient and effective optoin. A "no action" alternative would lead to continued beach erosion that would threaten private and public infrastructure.

2. Discuss alternative types and methods of dredging and disposal, such as pipeline discharge, barging, or hopper method.

Depending on the dredge type used, two alternatives will be in place. If a cutter is used, the dredge will be anchored in the borrow area while digging and continuously pumping out. If a hopper is used, the dredge will dig in the borrow site without anchoring and will sail to the end of a pipeline to pump out on the beach.

3. Discuss alternatives to dredging.

One alternative to dredging is hauling sand by truck. This would be a much more expensive alternative and would have a longer timeline and be more disruptive to local traffic.

4. Discuss alternative areas of sites for spoil disposal.

No spoils expected.

5. Discuss impact of port docking patterns upon the demand for dredging. Can alternative patterns reduce the amount of dredging required to support port operations?

Not expected near ports.

6. Support alternative means of construction that would prevent or minimize water quality degradation using EPA standards for guidance.

No water quality degradation required.

7. State in detail impacts resulting in alternative locations for the proposed project.

No alternative location expected. Material will be take from Borrow Area "E" or "Fenwick Island"

Part IV

CONSIDERATIONS OF A FILLING PROPOSAL:

A. Describe in detail the existing characteristics of the area proposed for filling (i.e. aquatic area, marsh, mudflat, swamp, etc.). In your description, be sure to include the types of vegetation present and the types of animals that use the area. Provide photographs.

B. Give the following information in regard to the project size:
   1. Total area to be filled.

      Area will vary depending on before dredge surveys at the time of dredging. However, a survey was performed in August 2025 by GBA and has was used to calculate an estimate volume of material needed. In addition, past dredging projects were reviewed and showed to average 103,000 cy of sand/event. Therefore, the expected fill is for 1,950 linear feet of beach with 103,000 cy of sand/event.

   2. Size of underwater area to be filled.
      The toe of fill may extend to a depth of approximately 5 to 15 ft below MLW depending on the quantity of fill. It will be dependent upon surveys and material available at the time of the dredging event.

   3. Area of intertidal zone to be filled.
      The toe of fill may extend to a depth of approximately 5 to 15 ft below MLW depending on the quantity of fill.

   4. Area of wetlands to be filled.
      No wetlands in fill

   5. Proposed height of fill.
      Max elevation of 7' on the berm then a slope to existing to match surrounding federal beach template.
   6. Volume of material that will be used in filling.
      Volume will be based on before dredge surveys but is expected to be around 103,000 cy/event.

C. Describe in detail the material to be used as fill including as follows:
   1. Type of fill to be used (sand, stone, rubble, etc.). If the material is a composite (i.e., rubble), list the types of materials it will contain.
      Sand will be used

   2. Give the specific location of the source of this material.
      "Borrow Area E" and/or "Fenwick Island"

   3. What types of leachates will be produced from the fill material and what is planned for protection of surface and groundwater?
      N/A

D. Carefully describe the method of fill, including the following:
   1. Method of fill placement, including equipment used in deposition and grading. *Material will be pumped onto the beach through a discharge pipe to an active work zone. Heavy equipment including bull dozers and loaders will be used to move, grade and build the beach with the deposited material. Loaders will be used to add additonal pipe to the pump out line as the beach is built*
   2. Method of stabilization of banks from erosion sloughing, wave action, boat wakes, etc.
      The beach will be built to the existing template that has shown to hold up to wave action. Loss is expected since it is part of the littoral processes but the berm and slope will be built to a sustainable level. All pipes will be submerged and/or anchored to combat wave action.
   3. Method of stabilization of the surface of the fill.
      The bull dozers will establish a termporary dike to capture the material being discharged while it is being grades into place.

4. Length of time needed for completion of the project. State if filling will be continuous, intermittent, etc.

The project will take approximately a week with no down time. This will occur ideally during a Federal beach project while a dredging company is already onsite.

5. Method of controlling turbidity when filling an underwater area.

Temporary dikes to catch the material and only allow water to run off as it is pumped onto the beach

E. Purpose of the Project:

1. What is the intended use of the filled area?

The area is intended for storm protection for inland communities and recreation

2. What structures, if any, will be constructed on the fill?

N/A

3. What benefits would you gain from the proposed fill?

It will provide protection to the inland coastal communities from potential storms. It will also benefit the surrounding public beaches since Middlesex will be built to match the public beach and can help minimize the erosion

F. Alternatives

1. Discuss the "no action" alternative and how this would affect your present and future plans for the development of the area.

If a project is deemed necessary and a "no action" alternative is taken, that would lead to increased erosion and potential damage to public and private infrastructure.

2. Discuss alternative locations for the proposed fill.

Material will only be placed in template in front of Middlesex

3. Discuss the use of elevated structures (i.e. causeways, elevated platforms, etc.) in place of the proposed fill.

None expected

4. Discuss any other alternatives you have considered prior to formulating the presently submitted proposal.

Before submitting, it was discussed researching and attempting to permit a borrow area solely for Middlesex Beach. However, after conversations with the USACE of Philadelphia, those efforts are already being completed by federal and state parties.

Middlesex Beach Attachment 1

09/2019

Middlesex Beach Aerial Attachment 2

03/20/2019

NOAA Fisheries Greater Atlantic Regional Fisheries Office Essential Fish Habitat (EFH) Assessment & Fish and Wildlife Coordination Act (FWCA) Consultation Worksheet

August 2021 rev.

Authorities

The Magnuson Stevens Fishery Conservation and Management Act (MSA) requires federal agencies to consult with NOAA Fisheries on any action or proposed action authorized, funded, or undertaken by such agency that may adversely affect essential fish habitat (EFH) identified under the MSA. This process is guided by the requirements of our EFH regulation at 50 CFR 600.905, which mandates the preparation of EFH assessments and generally outlines each agency's obligations in the consultation process.

The Fish and Wildlife Coordination Act (FWCA) requires that all federal agencies consult with NOAA Fisheries when proposed actions might result in modifications to a natural stream or body of water. The FWCA also requires that federal agencies consider the effects that these projects would have on fish and wildlife and must also provide for improvement of these resources. Under the FWCA, we work to protect, conserve and enhance species and habitats for a wide range of aquatic resources such as shellfish, diadromous species, and other commercially and recreationally important species that are not federally managed and do not have designated EFH.

It is important to note that these consultations take place between NOAA Fisheries and federal action agencies. **As a result, EFH assessments, including this worksheet, must be provided to us by the federal agency, not by permit applicants or consultants.**

Use of the Worksheet

This worksheet can serve as an EFH assessment for **Abbreviated EFH Consultations**, and as a means to provide information on potential effects to other NOAA trust resources considered under the FWCA. An abbreviated consultation allows us to determine quickly whether, and to what degree, a federal action may adversely affect EFH. Abbreviated consultation procedures can be used when federal actions do not have the potential to cause substantial adverse effects on EFH and when adverse effects could be alleviated through minor modifications.

The intent of the EFH worksheet is to provide a guide for determining the information needed to fully assess the effects of a proposed action on EFH. In addition, the worksheet may be used as a tool to assist you in developing a more comprehensive EFH assessment for larger projects that may have more substantial adverse effects to EFH. However, for large, complex projects that have the potential for significant adverse effects, an **Expanded EFH Consultation** may be warranted and the use of this worksheet alone is not appropriate as your EFH assessment.

An **adverse effect** is any impact that reduces the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

Consultation under the MSA is not required if there is no adverse effect on EFH or if no EFH has been designated in the project area. However, because the definition of "adverse effect" is very broad, most in-water work will result in some level of adverse effect requiring consultation with us, even if the impact is temporary or the overall result of the project is habitat restoration or enhancement. It is important to remember that an adverse effect determination is a trigger to consult with us. It does not mean that a project cannot proceed as proposed, or that project modifications are necessary. An adverse effect determination under the EFH provisions of the MSA simply means that the effects of the proposed action on EFH must be evaluated to determine if there are ways to avoid, minimize, or offset adverse effects. Additional details on EFH consultations, tools, and resources, including frequently asked questions can be found on our website.

Instructions

This worksheet should be used as your EFH assessment for **Abbreviated EFH Consultations** or as a guide to develop your EFH assessment. It is not appropriate to use this worksheet as your EFH assessment for large, complex projects, or those requiring an Expanded EFH Consultation.

When completed fully and with sufficient information to clearly describe the activities proposed, habitats affected, and project impacts, as well as the measures taken to avoid, minimize or offset any unavoidable adverse effects, this worksheet provides us with required components of an EFH assessment including:

1. A description of the proposed action.
2. An analysis of the potential adverse effects on EFH and the federally managed species.
3. The federal agency's conclusions regarding the effects of the action on EFH.
4. Proposed mitigation, if applicable.

When completing this worksheet and submitting information to us, it is important to ensure that sufficient information is provided to clearly describe the proposed project and the activities proposed. At a minimum, this should include the public notice (if applicable) or project application and project plans showing:

- location map of the project site with area of impact.
- existing and proposed conditions.
- all in-water work and the location of all proposed structures and/or fill.
- all waters of the U.S. on the project site with mean low water (MLW), mean high water (MHW), high tide line (HTL), and water depths clearly marked.
- Habitat Areas of Particular Concern (HAPCs).
- sensitive habitats mapped, including special aquatic sites (submerged aquatic vegetation, saltmarsh, mudflats, riffles and pools, coral reefs, and sanctuaries and refuges), hard bottom or natural rocky habitat areas, and shellfish beds.
- site photographs, if available.

Your analysis of effects **should focus on impacts that reduce the quality and/or quantity of the habitat or result in conversion to a different habitat type** for all life stages of species with designated EFH within the action area. Simply stating that fish will move away or that the project

will only affect a small percentage of the overall population is not a sufficient analysis of the effects of an action on EFH. Also, since the intent of the EFH consultation is to evaluate the direct, indirect, individual and cumulative effects of a particular federal action on EFH and to identify options to avoid, minimize or offset the adverse effects of that action, is it not appropriate to conclude that an impact is minimal just because the area affected is a small percentage of the total area of EFH designated. The focus of the consultation is to reduce impacts resulting from the activities evaluated in the assessment. Similarly, a large area of distribution or range of the fish species is also not appropriate rationale for concluding the impacts of a particular project are minimal.

Use the information on the our EFH consultation website and NOAA's EFH Mapper to complete this worksheet. The mapper is a useful tool for viewing the spatial distribution of designated EFH and HAPCs. Because summer flounder HAPC (defined as: " all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH") does not have region-wide mapping, local sources and on-site surveys may be needed to identify submerged aquatic vegetation beds within the project area. The full designations for each species may be viewed as PDF links provided for each species within the Mapper, or via our website links to the New England Fishery Management Councils Omnibus Habitat Amendment 2 (Omnibus EFH Amendment), the Mid-Atlantic Fishery Management Councils FMPs (MAMFC - Fish Habitat), or the Highly Migratory Species website. Additional information on species specific life histories can be found in the EFH source documents accessible through the Habitat and Ecosystem Services Division website. This information can be useful in evaluating the effects of a proposed action. Habitat and Ecosystem Services Division (HESD) staff have also developed a technical memorandum *Impacts to Marine Fisheries Habitat from Non-fishing Activities in the Northeastern United States,* NOAA Technical Memorandum NMFS-NE-209 to assist in evaluating the effects of non-fishing activities on EFH. If you have questions, please contact the HESD staff member in your area to assist you.

Federal agencies or their non-federal designated lead agency should email the completed worksheet and necessary attachments to the HESD New England (ME, NH, MA, CT, RI) or Mid- Atlantic (NY, NJ, PA, DE, MD, VA) Branch Chief and the regional biologist listed on the Contact Regional Office Staff section on our EFH consultation website and listed below.

We will provide our EFH conservation recommendations under the MSA, and recommendations under the FWCA, as appropriate, within 30 days of receipt of a **complete** EFH assessment for an abbreviated consultation. Please ensure that the EFH worksheet is completed in full and includes detail to minimize delays in completing the consultation. If we are unable to assess potential impacts based on the information provided, we may request additional information necessary to assess the effects of the proposed action on our trust resources before we can begin a consultation. If the worksheet is not completely filled out, it may be returned to you for completion. **The EFH consultation and our response clock does not begin until we have sufficient information upon which to consult**.

If this worksheet is not used, you should include all the information required to complete this worksheet in your EFH assessment. The level of detail that you provide should be commensurate with the magnitude of impacts associated with the proposed project. You may need to prepare a more detailed EFH assessment for more substantial or complex projects to fully characterize the effects of the project and the avoidance and minimization of impacts to EFH. The format of the EFH worksheet may not be sufficient to incorporate the extent of detail required for large-scale projects, and a separate EFH assessment may be required.

Regardless of the format, you should include an analysis as outlined in this worksheet for an expanded EFH assessment, along with any additional necessary information including:

- the results of on-site inspections to evaluate habitat and site-specific effects.
- the views of recognized experts on habitat or the species that may be affected.
- a review of pertinent literature and related information.
- an analysis of alternatives that could avoid or minimize adverse effects on EFH.

For these larger scale projects, interagency coordination meetings should be scheduled to discuss the contents of the EFH consultation and the site-specific information that may be needed in order to initiate the consultation.

Please contact our Greater Atlantic Regional Fisheries Office, Protected Resources Division regarding potential impacts to marine mammals or threatened and endangered species and the appropriate consultation procedures.

HESD Contacts*

New England - ME, NH, MA, RI, CT

Chris Boelke, Branch Chief	christopher.boelke@noaa.gov
Mike Johnson - ME, NH	mike.r.johnson@noaa.gov
Kaitlyn Shaw - ME, NH, MA	kaitlyn.shaw@noaa.gov
Sabrina Pereira -RI, CT	sabrina.pereira@noaa

Mid-Atlantic - NY, NJ, PA, MD, VA

Karen Greene, Branch Chief	karen.greene@noaa.gov
Jessie Murray - NY, Northern NJ (Monmouth Co. and north)	jessie.murray@noaa.gov
Keith Hanson - NJ (Ocean Co. and south), DE and PA, Mid-Altantic wind	keith.hanson@noaa.gov
Maggie Sager - NJ (Ocean Co. and south), DE and PA	lauren.m.sager@noaa.gov
Jonathan Watson - MD, DC	jonathan.watson@noaa.gov
David O'Brien - VA	david.l.obrien@noaa.gov

Ecosystem Management (Wind/Aquaculture)

Peter Burns, Branch Chief	peter.burns@noaa.gov
Alison Verkade (NE Wind)	alison.verkade@noaa.gov
Susan Tuxbury (wind coordinator)	susan.tuxbury@noaa.gov

***Please check for the most current staffing list on our contact us page prior to submitting your assessment.**

EFH Assessment Worksheet rev. August 2021

Please read and follow all of the directions provided when filling out this form.

1. General Project Information

Date Submitted: 11/18/2025

Project/Application Number:

Project Name: Middlesex Beach Replenishment

Project Sponsor/Applicant: Middlesex Beach Association

Federal Action Agency (or state agency if the federal agency has provided written notice delegating the authority[1]): USACE

Fast-41: Yes ☐ No ☑

Action Agency Contact Name: Michael Yost

Contact Phone: Contact Email: michael.d.yost@usace.army.mil

Address, City/Town, State:

United States Army Corp Philadelphia District

2. Project Description

[2]Latitude: 38.522803° Longitude: -75.053006°

Body of Water (e.g., HUC 6 name): Atlantic Ocean

Project Purpose:

To dredge sand from Borrow Areas "E" and "Fenwick Island" to the beach in front of the private community, Middlesex Beach Association as part of a beach renourishment project

Project Description:

The project will require a dredge to dig in Borrow Areas "E" and/or "Fenwick Island" to excavate and transport ~103,000 cy/event of sand through an outfall pipe onto the beach in front of Middlesex Beach Association. This project will be in conjuncture with the federal dredging projects when they occur for Bethany and South Bethany beaches. The material will be place on 1,950' of beach and placed to the template provided for the surrounding federal beaches to ensure a smooth transition.

Anticipated Duration of In-Water Work including planned Start/End Dates and any seasonal restrictions proposed to be included in the schedule:

It is anticipated to take 7.5 days based off the quantity of 103,000 cy. The work will occur when the dredging company completes Bethany or South Bethany and the direction of their choosing and will occur in the early Spring before turtle nesting season.

[1] A federal agency may designate a non-Federal representative to conduct an EFH consultation by giving written notice of such designation to NMFS. If a non-federal representative is used, the Federal action agency remains ultimately responsible for compliance with sections 305(b)(2) and 305(b)(4)(B) of the Magnuson-Stevens Act. [2] Provide the decimal, or the degrees, minutes, seconds values for latitude and longitude using the World Geodetic System 1984 (WGS84) and negative degree values where applicable.

3. Site Description

EFH includes the biological, chemical, and physical components of the habitat. This includes the substrate and associated biological resources (e.g., benthic organisms, submerged aquatic vegetation, shellfish beds, salt marsh wetlands), the water column, and prey species.

Is the project in designated EFH[3]? ☑ Yes ☐ No

Is the project in designated HAPC? ☑ Yes ☐ No

Does the project contain any Special Aquatic Sites[4]? ☐ Yes ☑ No

Is this coordination under FWCA only? ☐ Yes ☑ No

Total area of impact to EFH indicate sq ft or acres: 14ac (beach), 2708ac (Fenwick), 697ac (E)

Total area of impact to HAPC (indicate sq ft or acres): 14ac (beach), 2708ac (Fenwick), 697ac (E)

Current range of water depths at MLW	Salinity range (PPT):	Water temperature range (°F):
5' to -50' MLW	34 to 37	40-76

[3]Use the tables in Sections 5 and 6 to list species within designated EFH or the type of designated HAPC present. See the worksheet instructions to find out where EFH and HAPC designations can be found. [4] Special aquatic sites (SAS) are geographic areas, large or small, possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important easily disrupted ecological values. These areas are generally recognized as significantly influencing or positively contributing to the general overall environmental health or vitality of the entire ecosystem of a region. They include sanctuaries and refuges, wetlands, mudflats, vegetated shallows, coral reefs, and riffle and pool complexes (40 CFR Subpart E). If the project area contains SAS (i.e. sanctuaries and refuges, wetlands, mudflats, vegetated shallows/SAV, coral reefs, and/or riffle and pool complexes, describe the SAS, species or habitat present, and area of impact.

4. Habitat Types

In the table below, select the location and type(s) for each habitat your project overlaps. For each habitat type selected, indicate the total area of expected impacts, then what portion of the total is expected to be temporary (less than 12 months) and what portion is expected to be permanent (habitat conversion), and if the portion of temporary impacts will be actively restored to pre- construction conditions by the project proponent or not. A project may overlap with multiple habitat types.

Habitat Location	Habitat Type	Total impacts (lf/ft²/ft³)	Temporary impacts (lf/ft²/ft³)	Permanent impacts (lf/ft²/ft³)	Restored to pre-existing conditions?*
Marine	Shore (unconsolidated)	1950 lf	1950 lf		Yes
Marine	Substrate (sand/shell)	2708 ac	2708 ac		No
Marine	Substrate (sand/shell)	697 ac	697 ac		No
Select one	Select One				Select one
Select one	Select One				Select one
Select one	Select One				Select one
Select one	Select One				Select one
Select one	Select One				Select one

*Restored to pre-existing conditions means that as part of the project, the temporary impacts will be actively restored,such as restoring the project elevations to pre-existing conditions and replanting. It does not include natural restoration or compensatory mitigation.

Submerged Aquatic Vegetation (SAV) Present?:

Yes: ☐ No: ☑

If the project area contains SAV, or has historically contained SAV, list SAV species and provide survey results including plans showing its location, years present and densities if available. Refer to Section 12 below to determine if local SAV mapping resources are available for your project area.

Sediment Characteristics:

The level of detail required is dependent on your project – e.g., a grain size analysis may be necessary for dredging. In addition, if the project area contains rocky/hard bottom habitat [6](pebble, cobble, boulder, bedrock outcrop/ledge) identified as Rocky (coral/rock), Substrate (cobble/gravel), or Substrate (rock) above, describe the composition of the habitat using the following table.

Substrate Type* (grain size)	Present at Site? (Y/N)	Approximate Percentage of Total Substrate on Site
Silt/Mud (<0.063mm)	Select one	
Sand (0.063-2mm)	Yes	100
Rocky: Pebble/Gravel /Cobble(2-256mm)**	Select one	
Rocky: Boulder (256-4096mm)**	Select one	
Rocky: Coral	Select one	
Bedrock**	Select one	

[6]The type(s) of rocky habitat will help you determine if the area is cod HAPC.

* Grain sizes are based on Wentworth grain size classification scale for granules, pebbles, cobbles, and boulders.

** Sediment samples with a content of 10% or more of pebble-gravel-cobble and/or boulder in the top layer (6-12 inches) should be delineated and material with epifauna/macroalgae should be differentiated from bare pebble-gravel-cobble and boulder.

If no grain size analysis has been conducted, please provide a general description of the composition of the sediment. If available please attach images of the substrate.

The project will occur on a beach where the sediment is expected to be 100% sand material.\
Previous geotech information was performed for the borrow areas and is attached.

Diadromous Fish (migratory or spawning habitat- identify species under Section 10 below):

Yes: ☐ No: ☑

5. EFH and HAPC Designations

Within the Greater Atlantic Region, EFH has been designated by the New England, Mid-Atlantic, and South Atlantic Fisheries Management Councils and NOAA Fisheries. Use the EFH mapper to determine if EFH may be present in the project area and enter all species and life stages that have designated EFH. Optionally, you may review the EFH text descriptions linked to each species in the EFH mapper and use them to determine if the described habitat is present at your project site. If the habitat characteristics described in the text descriptions do not exist at your site, you may be able to exclude some species or life stages from additional consideration. For example, the water depths at your site are shallower that those described in the text description for a particular species or life stage. We recommend this for larger projects to help you determine what your impacts are.

Species Present	EFH is designated/mapped for:				What is the source of the EFH information included?
	EFH: eggs	EFH: larvae	EFH: juvenile	EFH: adults/ spawning adults	
summer flounder	☐	☐	☑	☐	EFH Mapper
Atlantic herring	☐	☐	☑	☐	EFH Mapper
red hake	☐	☐	☑	☐	EFH Mapper
windowpane flounder	☐	☐	☑	☑	EFH Mapper
little skate	☐	☐	☑	☑	EFH Mapper
Select One	☐	☐	☐	☐	Select One
Select One	☐	☐	☐	☐	Select One
Select One	☐	☐	☐	☐	Select One
Select One	☐	☐	☐	☐	Select One
Select One	☐	☐	☐	☐	Select One
Select One	☐	☐	☐	☐	Select One

6. Habitat Areas of Particular Concern (HAPCs)

HAPCs are subsets of EFH that are important for long-term productivity of federally managed species. HAPCs merit special consideration based their ecological function (current or historic), sensitivity to human-induced degradation, stresses from development, and/or rarity of the habitat.While many HAPC designations have geographic boundaries, there are also habitat specific HAPC designations for certain species, see note below. Use the EFH mapper to identify HAPCs within your project area. Select all that apply.

☑	Summer flounder: SAV[7]	☐	Alvin & Atlantis Canyons
☐	Sandbar shark	☐	Baltimore Canyon
☐	Sand Tiger Shark (Delaware Bay)	☐	Bear Seamount
☐	Sand Tiger Shark (Plymouth-Duxbury-Kingston Bay)	☐	Heezen Canyon
☐	Inshore 20m Juvenile Cod[8]	☐	Hudson Canyon
☐	Great South Channel Juvenile Cod	☐	Hydrographer Canyon
☐	Northern Edge Juvenile Cod	☐	Jeffreys & Stellwagen
☐	Lydonia Canyon	☐	Lydonia, Gilbert & Oceanographer Canyons
☐	Norfolk Canyon (Mid-Atlantic)	☐	Norfolk Canyon (New England)
☐	Oceanographer Canyon	☐	Retriever Seamount
☐	Veatch Canyon (Mid-Atlantic)	☐	Toms, Middle Toms & Hendrickson Canyons
☐	Veatch Canyon (New England)	☐	Washington Canyon
☐	Cashes Ledge	☐	Wilmington Canyon
☐	Atlantic Salmon		

[7] Summer flounder HAPC is defined as all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH. In locations where native species have been eliminated from an area, then exotic species are included. Use local information to determine the locations of HAPC.

[8] The purpose of this HAPC is to recognize the importance of inshore areas to juvenile Atlantic cod. The coastal areas of the Gulf of Maine and Southern New England contain structurally complex rocky-bottom habitat that supports a wide variety of emergent epifauna and benthic invertebrates. Although this habitat type is not rare in the coastal Gulf of Maine, it provides two key ecological functions for juvenile cod: protection from predation, and readily available prey. See EFH mapper for links to text descriptions for HAPCs.

7. Activity Details

Select all that apply	Project Type/Category
☐	Agriculture
☐	Aquaculture - List species here:
☐	Bank/shoreline stabilization (e.g., living shoreline, groin, breakwater, bulkhead)
☑	Beach renourishment
☑	Dredging/excavation
☐	Energy development/use e.g., hydropower, oil and gas, pipeline, transmission line, tidal or wave power, wind
☑	Fill
☐	Forestry
☐	Infrastructure/transportation (e.g., culvert construction, bridge repair, highway, port, railroad)
☐	Intake/outfall
☐	Military (e.g., acoustic testing, training exercises)
☐	Mining (e.g., sand, gravel)
☐	Overboard dredged material placement
☐	Piers, ramps, floats, and other structures
☐	Restoration or fish/wildlife enhancement (e.g., fish passage, wetlands, mitigation bank/ILF creation)
☐	Survey (e.g., geotechnical, geophysical, habitat, fisheries)
☐	Water quality (e.g., storm water drainage, NPDES, TMDL, wastewater, sediment remediation)
☐	Other:

8. Effects Evaluation

Select all that apply	Potential Stressors Caused by the Activity	Select all that apply and if temporary[9] or permanent		Habitat alterations caused by the activity
		Temp	Perm	
☑	Underwater noise			
☑	Water quality/turbidity/ contaminant release	☑	☐	Water depth change
☑	Vessel traffic/barge grounding	☐	☐	Tidal flow change
☑	Impingement/entrainment	☑	☐	Fill
☐	Prevent fish passage/spawning	☐	☐	Habitat type conversion
☑	Benthic community disturbance	☐	☐	Other:
☐	Impacts to prey species	☐	☐	Other:

[9] Temporary in this instance means during construction. [10] Entrainment is the voluntary or involuntary movement of aquatic organisms from a water body into a surface diversion or through, under, or around screens and results in the loss of the organisms from the population. Impingement is the involuntary contact and entrapment of aquatic organisms on the surface of intake screens caused when the approach velocity exceeds the swimming capability of the organism.

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Details - project impacts and mitigation

Briefly describe how the project would impact each of the habitat types selected above and the amount (i.e., acreage or sf) of each habitat impacted. Include temporary and permanent impact descriptions and direct and indirect impacts. For example, dredging has a direct impact on bottom sediments and associated benthic communities. The turbidity generated can result in a temporary impact to water quality which may have an indirect effect on some species and habitats such as winter flounder eggs, SAV or rocky habitats. The level of detail that you provide should be commensurate with the magnitude of impacts associated with the proposed project. Attach supplemental information if necessary.

Dredging activities in Borrow Area "E" or Fenwick Island Borrow site will have a direct impact on bottom sediment and associated benthic communities. This impact will be mitigated by only dredging in the permitted environmental window and limiting the footprint of excavation in the borrow area to only the minimum area needed for sand recovery.
Placement of dredge material on Middlesex Beach front may cause a temporary increase in turbidity which can indirectly effect some flounder species. This work will be performed in the appropriate environmental window to limit any adverse impacts on fish species.

What specific measures will be used to avoid and minimize impacts, including project design, turbidity controls, acoustic controls, and time of year restrictions? If impacts cannot be avoided or minimized, why not?

The project will only occur during the recommended environmental window from December 15th to March 15th to minimize the impact on fish and the surrounding environment. Dredges will be equipped with screens on the intakes to minimize impingement/entrainment. Training dikes will be used on the beach fill slow the flow of dredge material and reduce the amount of turbidity entering back into the Atlantic Ocean.

Is compensatory mitigation proposed? Yes ☐ No ☑

If compensatory mitigation is not proposed, why not? If yes, describe plans for compensatory mitigation (e.g. permittee responsible, mitigation bank, in-lieu fee) and how this will offset impacts to EFH and other aquatic resources. Include a proposed compensatory mitigation and monitoring plan as applicable.

The renourishment project is not expected to require compensatory mitigation.

9. Effects of Climate Change

Effects of climate change should be included in the EFH assessment if the effects of climate change may amplify or exacerbate the adverse effects of the proposed action on EFH. Use the Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathways (RCP) 8.5/high greenhouse gas emission scenario (IPCC 2014), at a minimum, to evaluate the future effects of climate change on the proposed projections. For sea level rise effects, use the intermediate-high and extreme scenario projections as defined in Sweet et al. (2017). For more information on climate change effects to species and habitats relative to NMFS trust resources, see Guidance for Integrating Climate Change Information in Greater Atlantic Region Habitat Conservation Division Consultation Processes.

1. Could species or habitats be adversely affected by the proposed action due to projected changes in the climate?If yes, please describe how:

No

2. Is the expected lifespan of the action greater than 10 years? If yes, please describe project lifespan:

No

3. Is climate change currently affecting vulnerable species or habitats, and would the effects of a proposed action be amplified by climate change? If yes, please describe how:

No

4. Do the results of the assessment indicate the effects of the action on habitats and species will be amplified by climate change? If yes, please describe how:

No

5. Can adaptive management strategies (AMS) be integrated into the action to avoid or minimize adverse effects of the proposed action as a result of climate? If yes, please describe how:

No

10. Federal Agency Determination

Federal Action Agency's EFH determination (select one)	
☐	There is no adverse effect[7] on EFH or EFH is not designated at the project site. EFH Consultation is not required. This is a FWCA only request.
☑	The adverse effect[7] on EFH is not substantial. This means that the adverse effects are no more than minimal, temporary, or can be alleviated with minor project modifications or conservation recommendations. This is a request for an abbreviated EFH consultation.
☐	The adverse effect[7] on EFH is substantial. This is a request for an expanded EFH consultation. We will provide more detailed information, including an alternatives analysis and NEPA documents, if applicable.

[7] An adverse effect is any impact that reduces the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

11. Fish and Wildlife Coordination Act

Under the FWCA, federal agencies are required to consult with us if actions that the authorize, fund, or undertake will result in modifications to a natural stream or body of water. Federal agencies are required to consider the effects these modifications may have on fish and wildlife resources, as well as provide for the improvement of those resources. Under this authority, we consider the effects of actions on NOAA-trust resources, such as anadromous fish, shellfish, crustaceans, or their habitats, that are not managed under a federal fisheries management plan. Some examples of other NOAA-trust resources are listed below. Some of these species, including diadromous fishes, serve as prey for a number of federally-managed species and are therefore considered a component of EFH pursuant to the MSA. We will be considering the effects of your project on these species and their habitats as part of the EFH/FWCA consultation process and may make recommendations to avoid, minimize or offset and adverse effects concurrently with our EFH conservation recommendations.

Please contact our Greater Atlantic Regional Fisheries Office, Protected Resources Division regarding potential impacts to marine mammals or species listed under the Endangered Species Act and the appropriate consultation procedures.

Fish and Wildlife Coordination Act Resources	
Species known to occur at site (list others that may apply)	**Describe habitat impact type (i.e., physical, chemical, or biological disruption of spawning and/or egg development habitat, juvenile nursery and/or adult feeding or migration habitat). Please note, impacts to federally listed species of fish, sea turtles, and marine mammals must be coordinated with the GARFO Protected Resources Division.**
alewife	
American eel	
American shad	
Atlantic menhaden	
blue crab	
blue mussel	
blueback herring	
Eastern oyster	
horseshoe crab	
quahog	
soft-shell clams	
striped bass	
other species:	
other species:	
other species:	

12. Useful Links

National Wetland Inventory Maps
EPA's National Estuary Program (NEP)
Northeast Regional Ocean Council (NROC) Data Portal
Mid-Atlantic Regional Council on the Ocean (MARCO) Data Portal

Resources by State

Maine
Maine Office of GIS Data Catalog
Town shellfish information including shellfish conservation area maps
State of Maine Shellfish Sanitation and Management
Eelgrass maps
Casco Bay Estuary Partnership
Maine GIS Stream Habitat Viewer

New Hampshire
NH Statewide GIS Clearinghouse, NH GRANIT
NH Coastal Viewer
State of NH Shellfish Program

Massachusetts
MA DMF Shellfish Sanitation and Management Program
MassGIS Data (Including Eelgrass Maps)
MA DMF Recommended TOY Restrictions Document Massachusetts
Bays National Estuary Program
Buzzards Bay National Estuary Program
Massachusetts Division of Marine Fisheries
Massachusetts Office of Coastal Zone Management

Rhode Island
RI Shellfish and Aquaculture
RI Shellfish Management Plan
RI Eelgrass Maps
Narragansett Bay Estuary Program
Rhode Island Division of Marine Fisheries
Rhode Island Coastal Resources Management Council

Connecticut

CT Bureau of Aquaculture

Natural Shellfish Beds in CT

Eelgrass Maps

Long Island Sound Study

CT GIS Resources

CT DEEP Office of Long Island Sound Programs and Fisheries

CT River Watershed Council

New York

Eelgrass Report

Peconic Estuary Program

NY/NJ Harbor Estuary Program

New York GIS Clearinghouse

New Jersey

Submerged Aquatic Vegetation Mapping

Barnegat Bay Partnership

NJ GeoWeb

NJ DEP Shellfish Maps

Pennsylvania

Delaware River Management Plan

PA DEP Coastal Resources Management Program

PA DEP GIS Mapping Tools

Delaware

Partnership for the Delaware Estuary

Center for Delaware Inland Bays

Delaware FirstMap

Maryland

Submerged Aquatic Vegetation Mapping

MERLIN (Maryland's Environmental Resources and Land Information Network)

Maryland Coastal Atlas

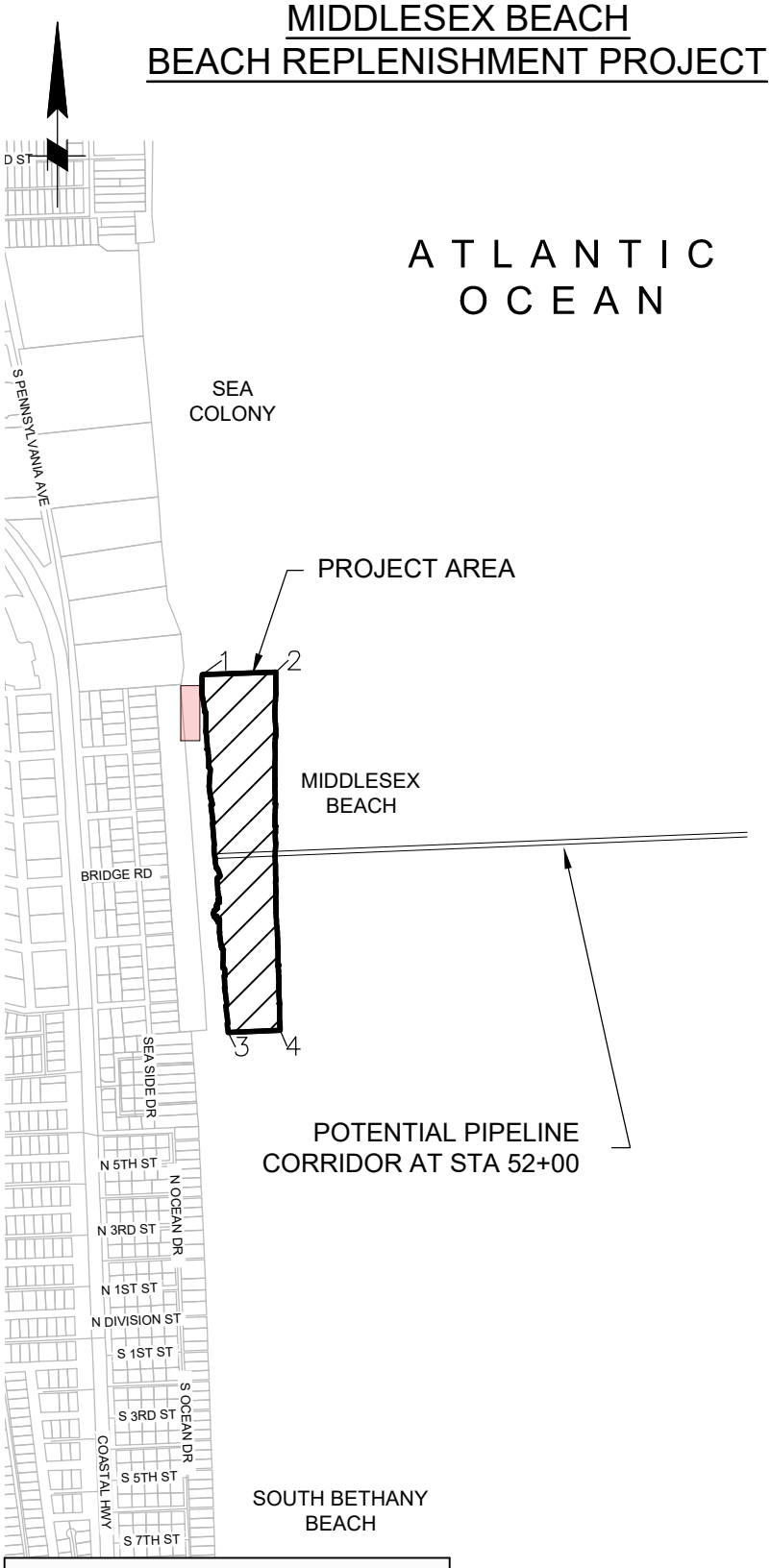
Maryland Coastal Bays Program

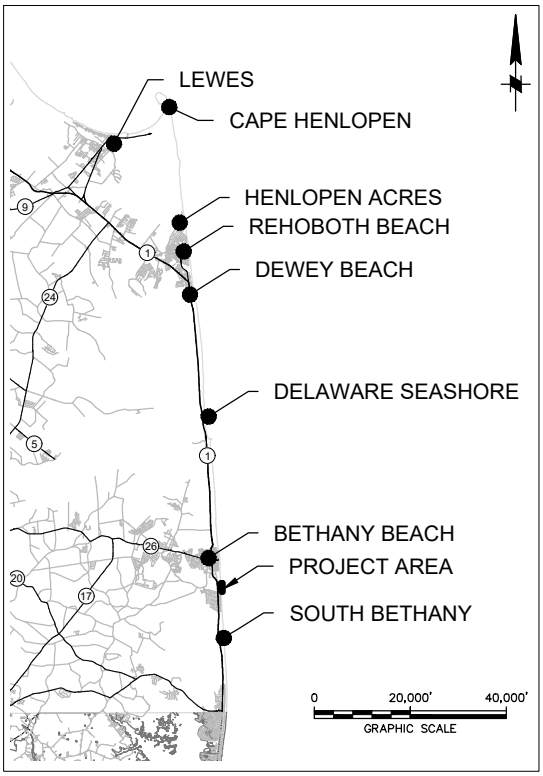
Virginia

VMRC Habitat Management Division

Submerged Aquatic Vegetation mapping

MIDDLESEX BEACH
BEACH REPLENISHMENT PROJECT





PURPOSE:
RESTORE RECREATIONAL BEACH AREA AND PROVIDE EROSION AND STORM PROTECTION

NOTE:
1. PROJECT AREA LENGTH = ±1950 LF
2. PROJECT AREA SIZE = 15 ACRES
3. SEE NOTES SHEET 7.

LEGEND:
STAGING AREA

0 1,000' 2,000'
GRAPHIC SCALE

DELAWARE STATE PLANE COORDINATE SYSTEM, ZONE 0700 (NAD83, US SURVEY FT)		
	EASTING	NORTHING
1	760238.194	191540.251
2	760635.253	191553.533
3	760377.659	189600.405
4	760659.652	189612.210

FOR PERMIT USE ONLY
NOT FOR CONSTRUCTION

BEACH REPLENISHMENT PROJECT

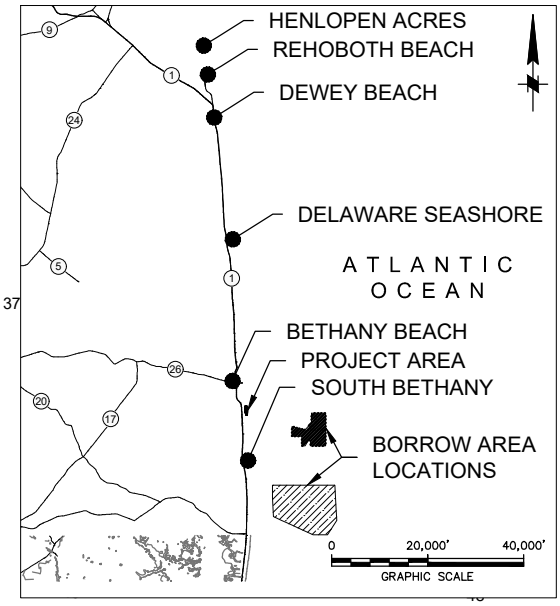
AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOCIATION, INC.
P.O BOX 584
BETHANY BEACH, DELAWARE 19930

GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

DATE: 10/03/25

PROPOSED FENWICK ISLAND & AREA E BORROW AREA LOCATIONS



ROUTE 26

BETHANY BEACH

PROJECT AREA

1.83 MILES

BORROW AREA E

2.94 MILES

ATLANTIC OCEAN

LITTLE ASSAWOMAN BAY

FENWICK ISLAND STATE PARK

BORROW AREA FENWICK ISLAND

ROUTE 54

DE

MD

ASSAWOMAN BAY

OCEAN CITY

NOTES:

1. REFERENCE: NOAA CHART 12214 (51ST EDITION, MAR. 2019 LAST CORRECTION: 2/5/2020) & NOAA CHART 12211 (48TH EDITION, DEC. 2018 LAST CORRECTION: 4/22/2020)
2. DEPTH SHOWN IN FEET BELOW M.L.W

0 6,000' 12,000'

GRAPHIC SCALE

FOR PERMIT USE ONLY
NOT FOR CONSTRUCTION

BEACH REPLENISHMENT PROJECT IN ATLANTIC OCEAN

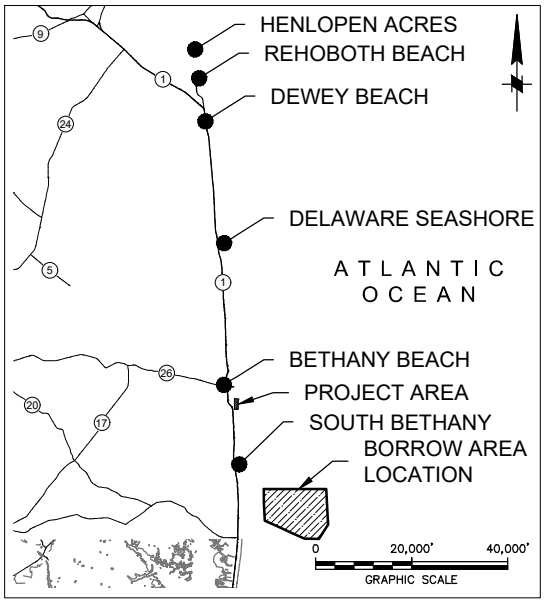
AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOCIATION, INC.
P.O. BOX 584
BETHANY BEACH, DELAWARE 19930

GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

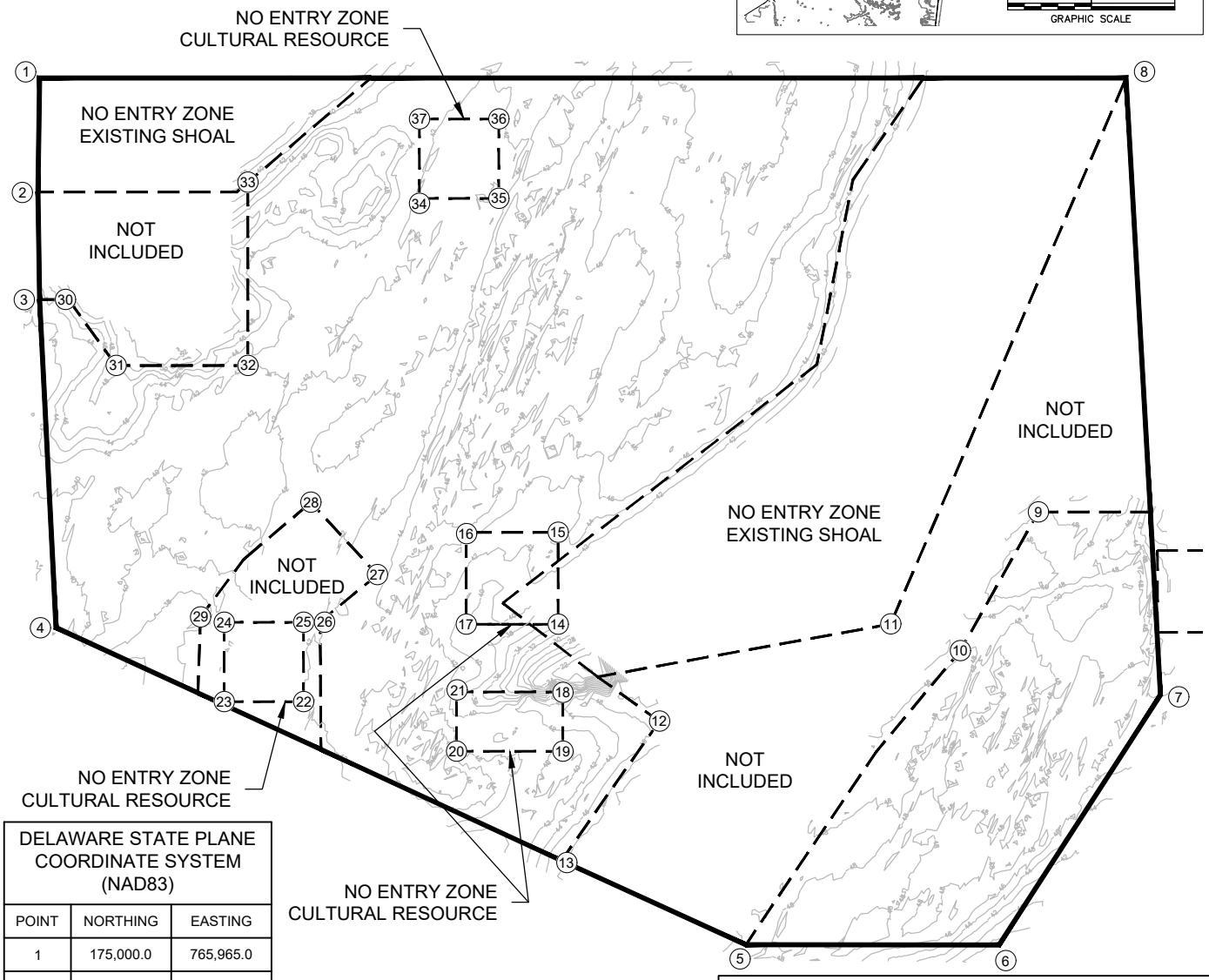
DATE: 10/03/25

LIMITS OF BORROW AREA
FENWICK ISLAND



NOTES:

1. BORROW AREA SIZE = 2,708 ACRES
2. CONTOURS SHOWN REPRESENT EXISTING CONDITIONS AT THE TIME OF SURVEY
3. SURVEY PERFORMED BY TRIANGLE SURVEYS ON SEPTEMBER 27, 2018
4. BORROW AREA DIMENSIONS AND SURVEY DATA FROM "FENWICK AFTER DREDGING BORROW AREA SURVEY" PERFORMED BY TRIANGLE SURVEYS, INC. SURVEY DATES: 08/10-08/11/2018



DELAWARE STATE PLANE COORDINATE SYSTEM (NAD83)		
POINT	NORTHING	EASTING
1	175,000.0	765,965.0
2	173,634.1	765,945.6
3	172,349.0	765,967.0
4	168,421.8	766,161.8
5	164,626.9	774,416.1
6	164,625.9	777,446.4
7	167,616.0	779,377.4
8	175,000.0	778,964.6

0 2,000' 4,000'

GRAPHIC SCALE

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BEACH REPLENISHMENT PROJECT
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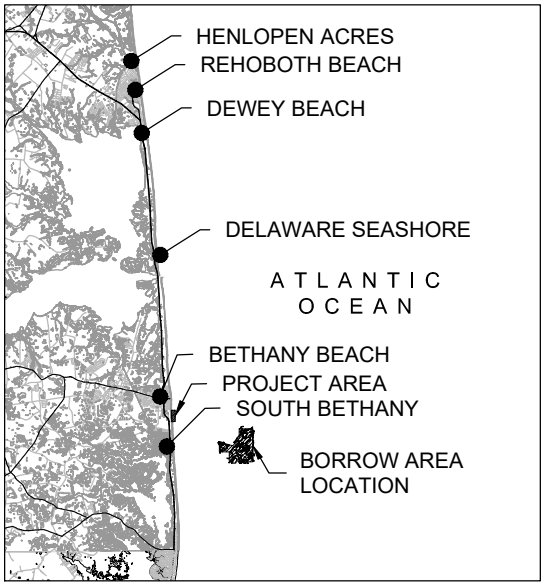
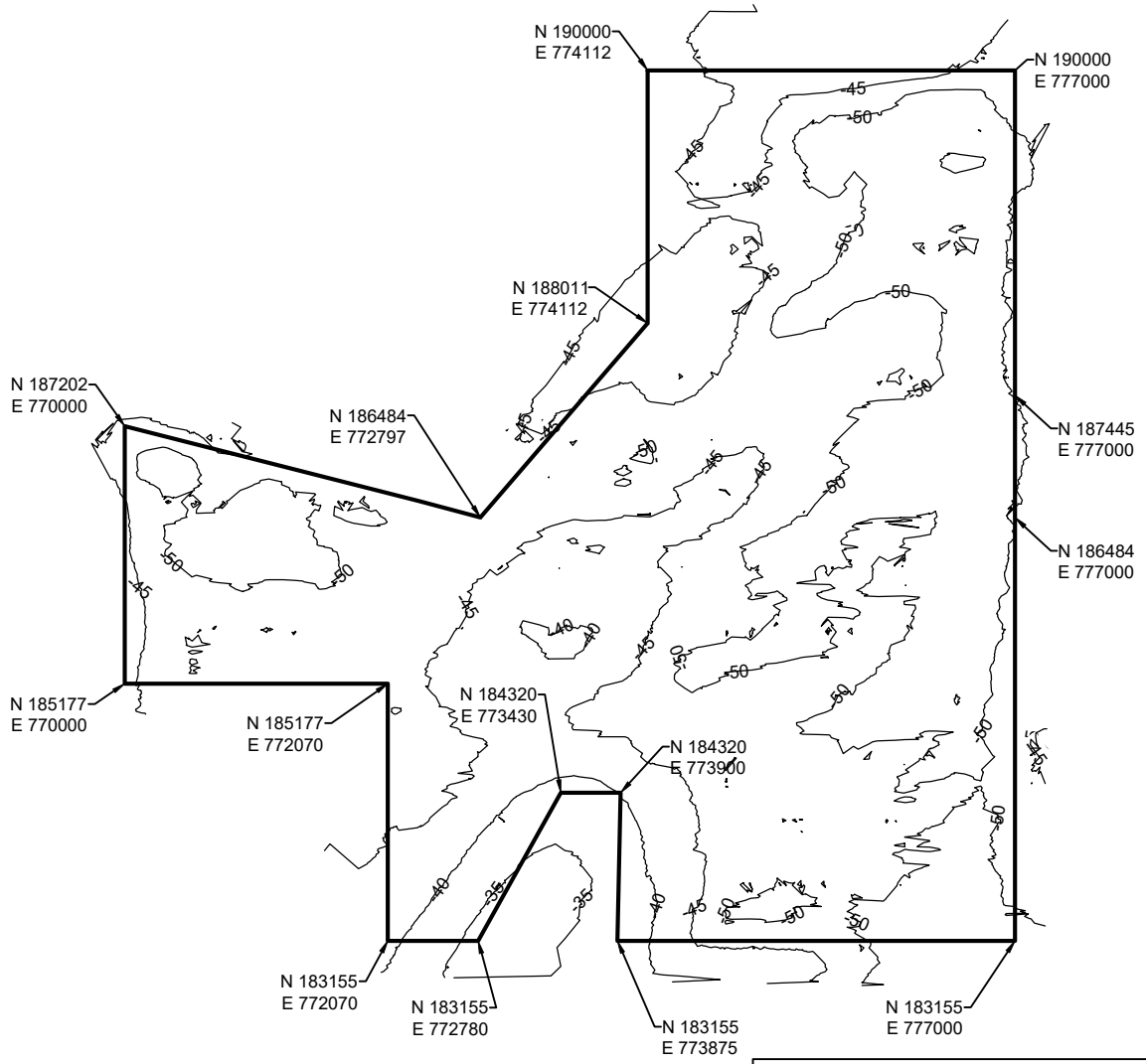
LIMITS OF BORROW AREA
AREA E



NOTES:

1. HORIZONTAL COORDINATES REFERENCED TO NAD83 DELAWARE STATE PLANE, ZONE 0700, US SURVEY FOOT.
2. VERTICAL DATUM REFERENCED TO NAVD88.
3. BORROW AREA SIZE = 697 ACRES
4. CONTOURS SHOWN ARE FROM A SURVEY CONDUCTED BY GAHAGAN & BRYANT ASSOCIATES IN FEBRUARY 2021 AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISITING AT THAT TIME.



ATLANTIC
OCEAN

0 1,500' 3,000'

GRAPHIC SCALE

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BEACH REPLENISHMENT PROJECT
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

APPLICATION BY:
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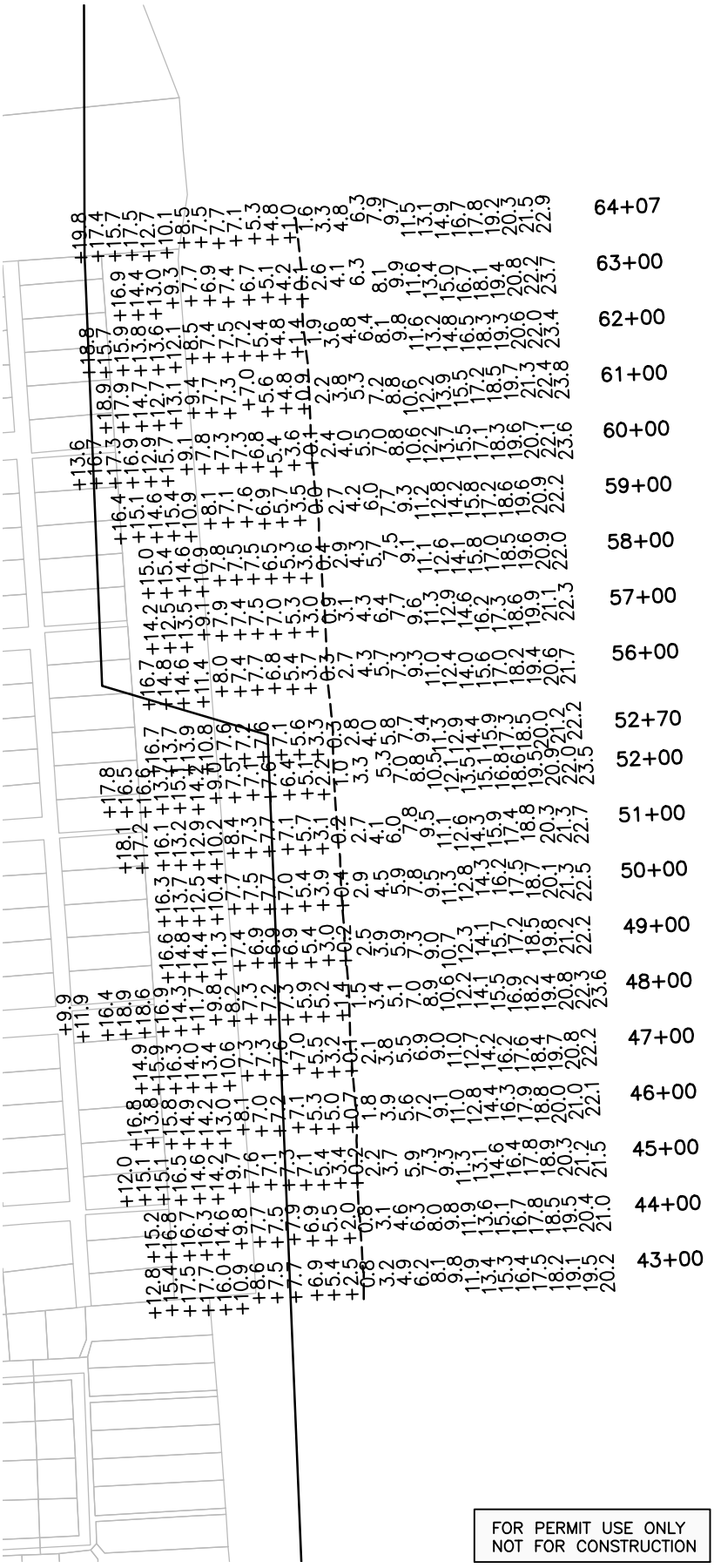
MIDDLESEX BEACH
BEACH REPLENISHMENT PROJECT



LEGEND:

MEAN HIGH WATER

BASELINE

DELAWARE PARCEL LINES

NOTES:

1. PROJECT AREA LENGTH = ±1950 LF
2. SURVEY DATA SHOWN WAS COLLECTED ON AUGUST 13, 2025 BY GAHAGAN & BRYANT ASSOCIATES(GBA) AND IS REFERENCED TO NAVD88. SOUNDINGS PRECEDED BY A "+" ARE ABOVE THE REFERENCE PLANE.
3. SEE NOTES SHEET 7.

+1.14 MHW
0.0 NAVD88
-2.31 MLW

DATUM ELEVATION (FT)
NOT TO SCALE

0 300' 600'

GRAPHIC SCALE

FOR PERMIT USE ONLY
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BEACH REPLENISHMENT PROJECT

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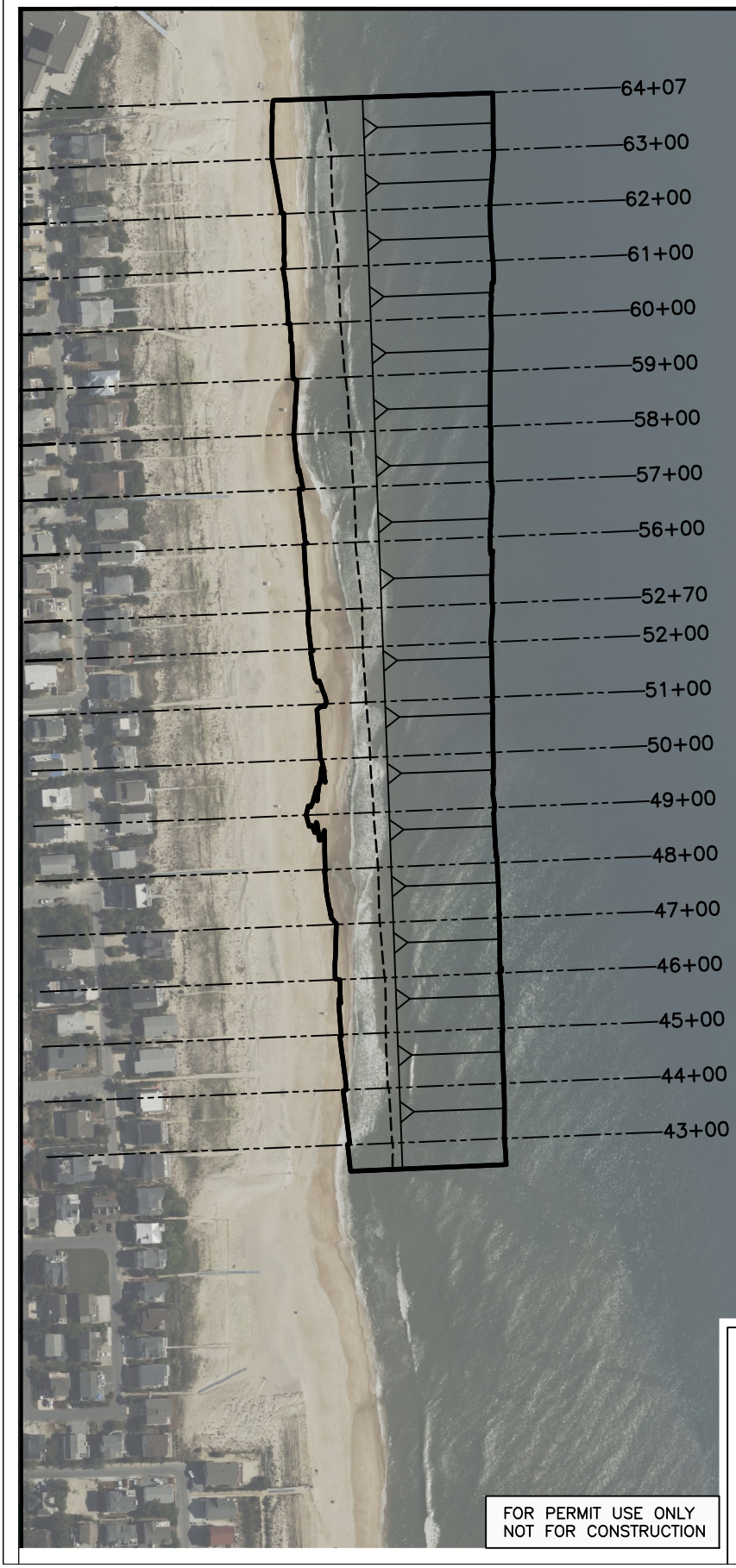
DATE: 10/03/25

MIDDLESEX BEACH
BEACH REPLENISHMENT PROJECT



LEGEND:

FILL BOUNDARY

MEAN HIGH WATER

STATION LINES

BASELINE

DELAWARE PARCEL LINES

START OF SLOPE

NOTES:

1. PROJECT AREA LENGTH = ±1950 LF
2. AERIAL IMAGERY OBTAINED FROM BING.
3. SEE NOTES SHEET 7.

0 300' 600'

GRAPHIC SCALE

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BEACH REPLENISHMENT PROJECT

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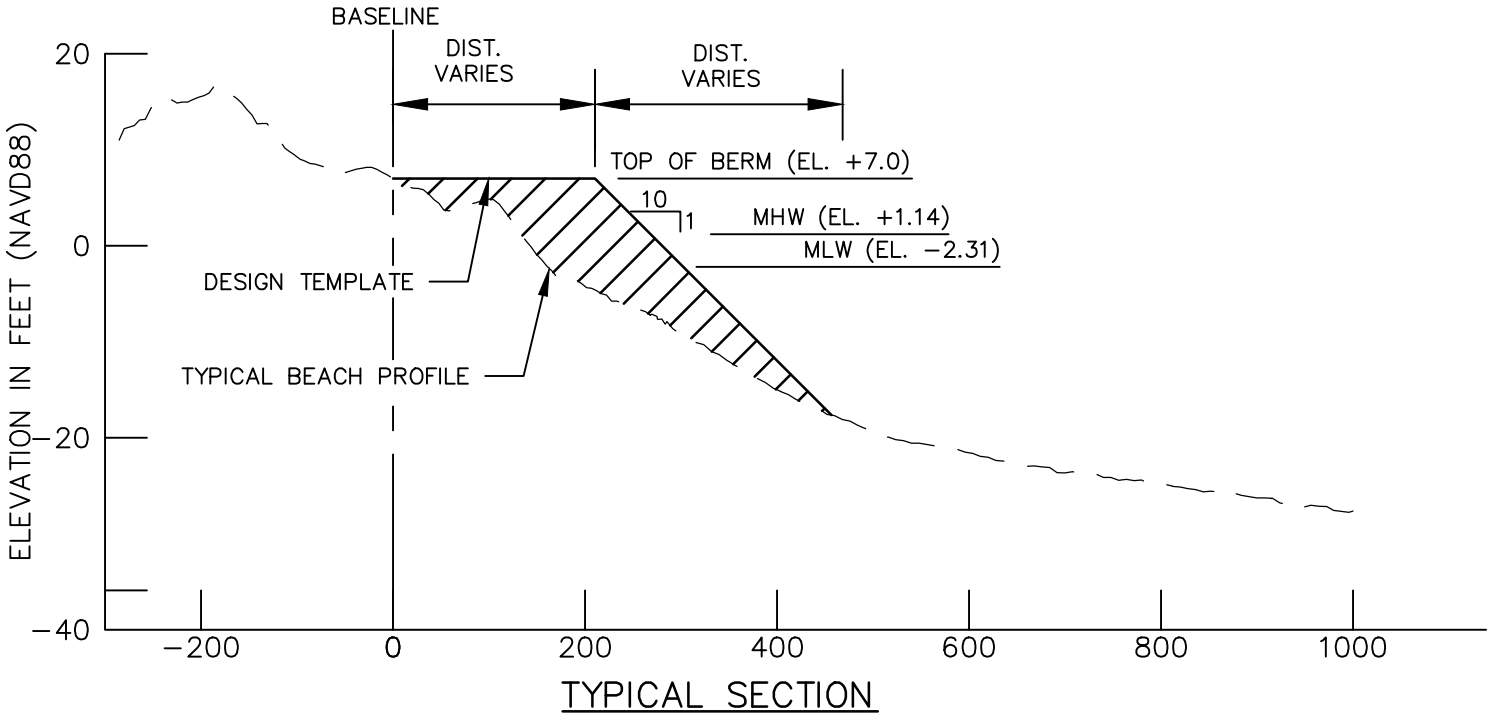
MIDDLESEX BEACH DESIGN FILL SECTION



TYPICAL SECTION

NOTES:

1. RANGE OF TIDE INFORMATION OBTAINED FROM NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION (NOAA) VDATUM TRANSFORMATION PROGRAM, VERSION 4.6.1 AT THE PROJECT MIDPOINT.
2. SOUNDING DATA DEPICTED IN THESE PLANS IS REPRESENTATIVE OF A LARGER DATA SET WHICH WAS COLLECTED USING AN ECHOSOUNDER (ODOM CV200) AT A FREQUENCY OF 200 HERTZ. THE DATA SET WAS REDUCED FOR CLARITY AND CORRECTED IN REAL TIME VIA REAL TIME KINEMATIC (RTK) CORRECTIONS.
3. THE INFORMATION DEPICTED IN THESE PLANS REPRESENT THE RESULTS OF SURVEYS CONDUCTED ON AUGUST 13, 2025 AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME.
4. BEACH FILL TEMPLATE AND FILL EXTENTS SHOWN IN THESE PLANS IS FOR PERMITTING PURPOSES ONLY AND THE TEMPLATE WAS OBTAINED FROM 2022 USACE BEACH NOURISHMENT PROJECT INCLUDING SOUTH BETHANY BEACH (SOLICITATION NO:W912BU22B0017). MIDDLESEX INTENDS TO MAINTAIN THE SAME TEMPLATE AS THE USACE PROJECT. CONSTRUCTION BEACH FILL TEMPLATE WILL BE DETERMINED BY USACE DURING THE NEXT NOURISHMENT CYCLE AND BY EXISTING BEACH CONDITIONS AT THE TIME OF THE EVENT.
5. ONCE A FEDERAL NOURISHMENT PROJECT IS ANNOUNCED, MIDDLESEX WILL CONDUCT A SURVEY OF THE BEACH AND PROVIDE COMPLETE CONSTRUCTION PLANS WITH REVISED TEMPLATES TO DNREC FOR APPROVAL.

+1.14 MHW

0.0 NAVD88

-2.31 MLW

DATUM ELEVATION (FT)
NOT TO SCALE

FOR PERMIT USE ONLY
NOT FOR CONSTRUCTION

BEACH REPLENISHMENT PROJECT

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX, STATE OF DELAWARE

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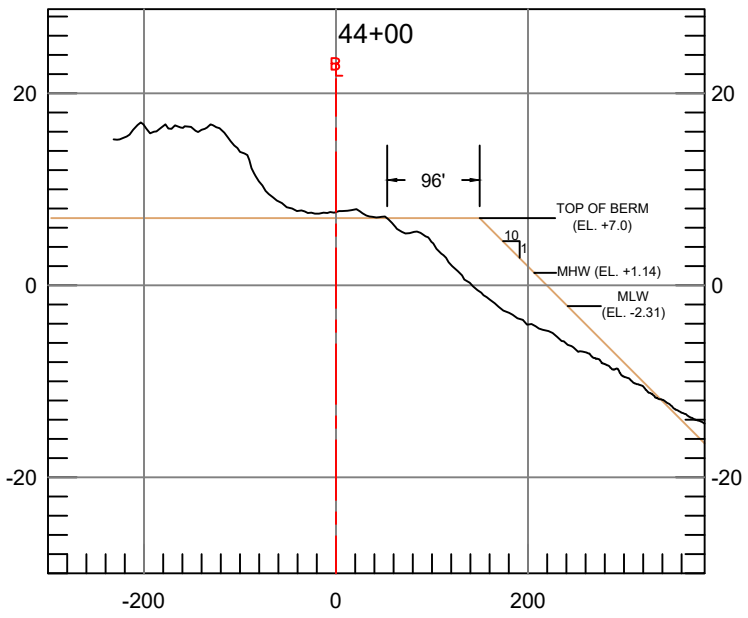
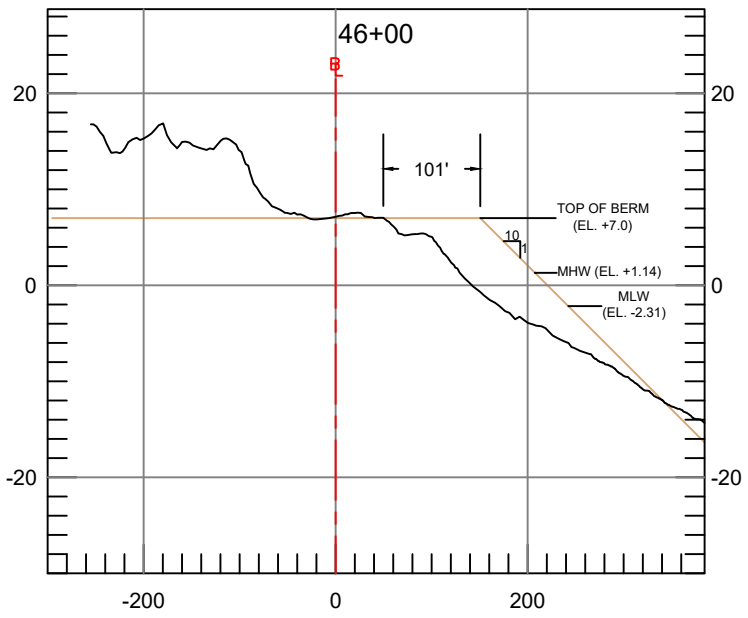
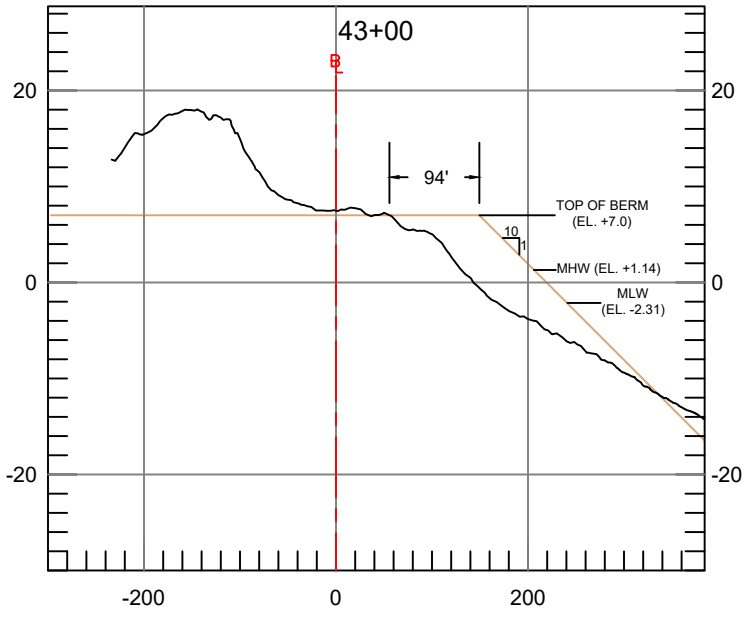
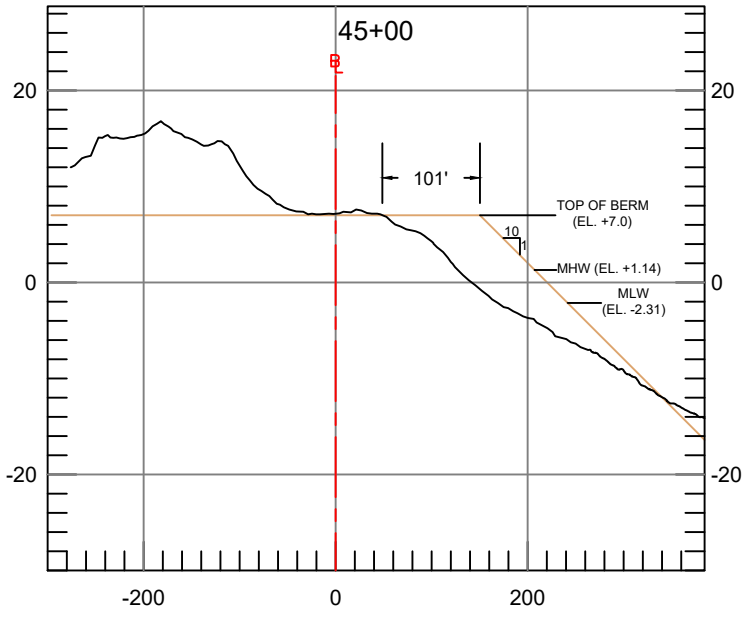








H Scale : 1" = 200' V Scale : 1" = 20'

BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX,
STATE OF DELAWARE

APPLICATION BY:
MIDDLESEX BEACH ASSOC., INC.
P.O BOX 584
BETHANY BEACH, DELAWARE
19930

DATE: 10/03/25

GBA
ENGINEERS ★ SURVEYORS
295-A N. Green Meadows Dr.
Wilmington, NC 28405
Phone (910) 313-3338

SHEET 8 OF 12

NOTES:
1. SURVEY DATA SHOWN WAS COLLECTED ON AUGUST 13, 2025 BY GAHAGAN & BRYANT ASSOCIATES (GBA).
2. VERTICAL DATUM IS REFERENCED TO NAVD88.
3. HORIZONTAL DATUM IS REFERENCED TO NAD83.
4. BASELINE IS ONLY SHOWN AT STATIONS 43+00 TO 52+70 DUE TO THE LANDWARD SHIFT OF ALIGNMENT AT 52+70.
5. SEE NOTES SHEET 7.

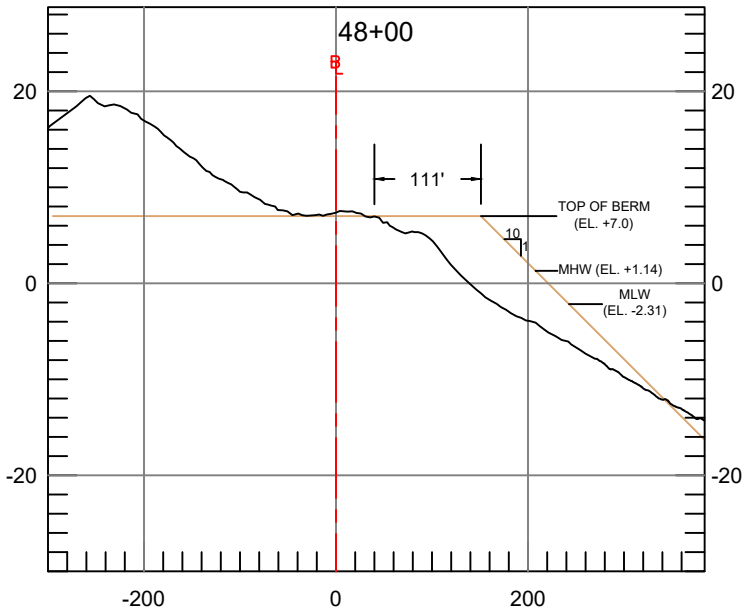
LEGEND:

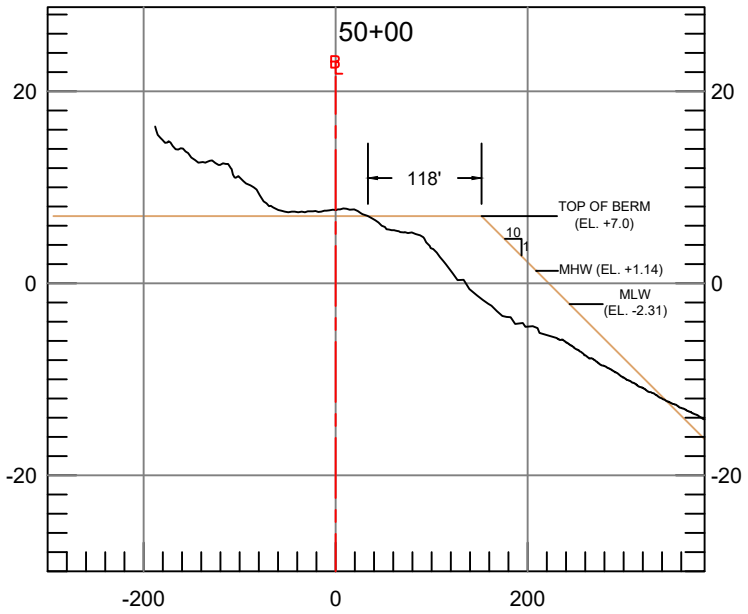
SURVEY DATA

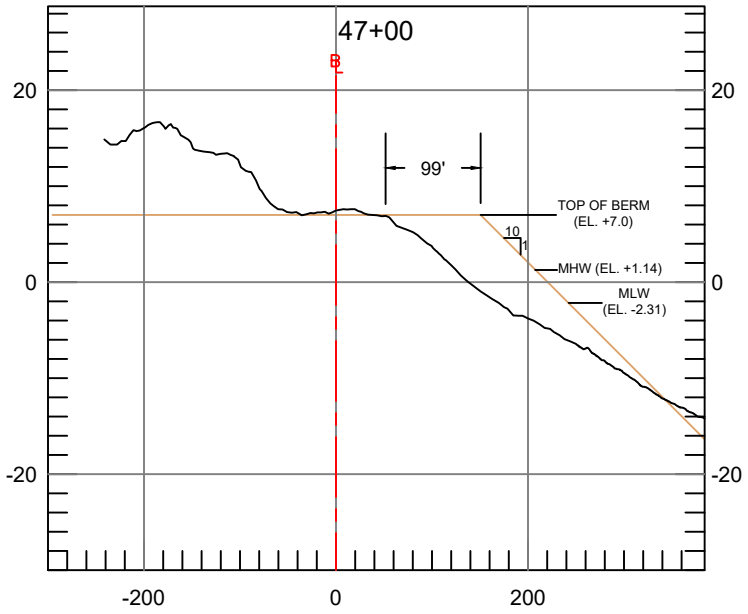
BEACH FILL TEMPLATE

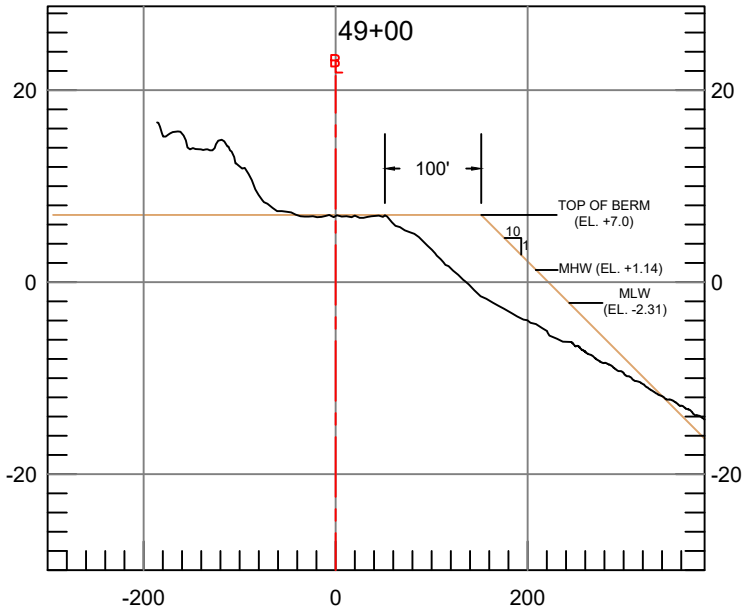
BASELINE

FOR PERMIT USE ONLY NOT FOR CONSTRUCTION









H Scale : 1" = 200' V Scale : 1" = 20'

BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
COUNTY OF SUSSEX,
STATE OF DELAWARE

APPLICATION BY:
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P.O BOX 584
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19930

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GBA
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SHEET 9 OF 12

NOTES:
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4. BASELINE IS ONLY SHOWN AT STATIONS 43+00 TO 52+70 DUE TO THE LANDWARD SHIFT OF ALIGNMENT AT 52+70.
5. SEE NOTES SHEET 7.

LEGEND:

SURVEY DATA

BEACH FILL TEMPLATE

BASELINE

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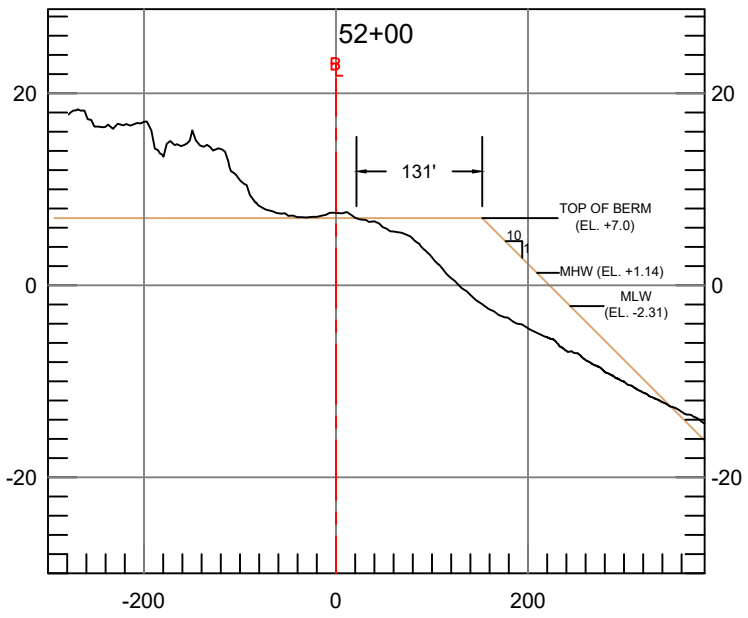

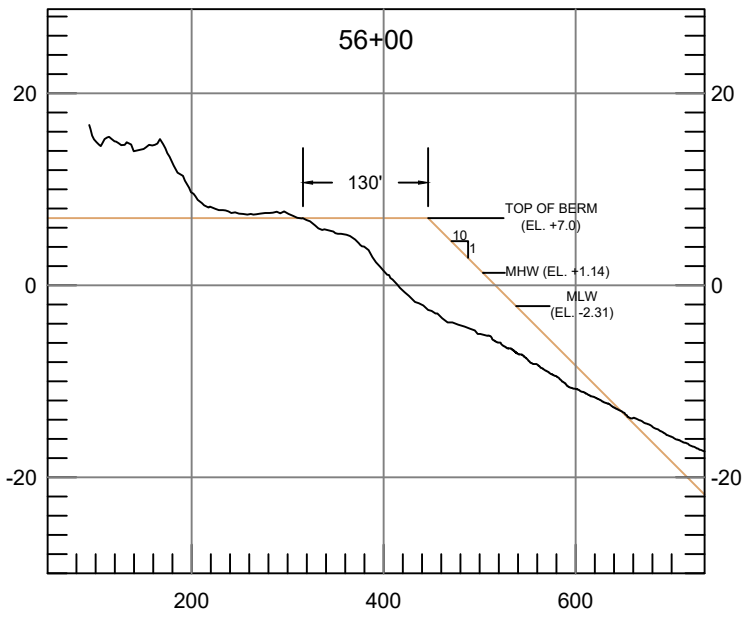

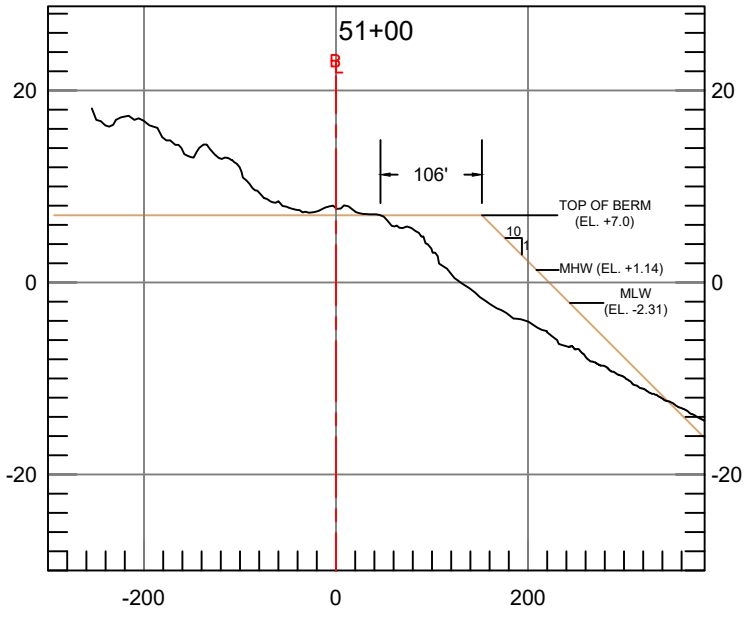

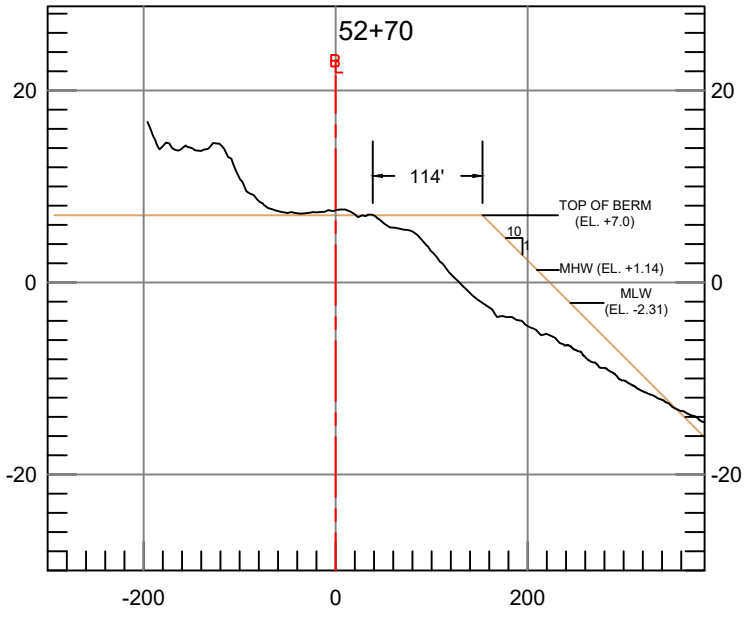

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BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

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SHEET 10 OF 12

NOTES:
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3. HORIZONTAL DATUM IS REFERENCED TO NAD83.
4. BASELINE IS ONLY SHOWN AT STATIONS 43+00 TO 52+70 DUE TO THE LANDWARD SHIFT OF ALIGNMENT AT 52+70.
5. SEE NOTES SHEET 7.

LEGEND:

SURVEY DATA

BEACH FILL TEMPLATE

BASELINE

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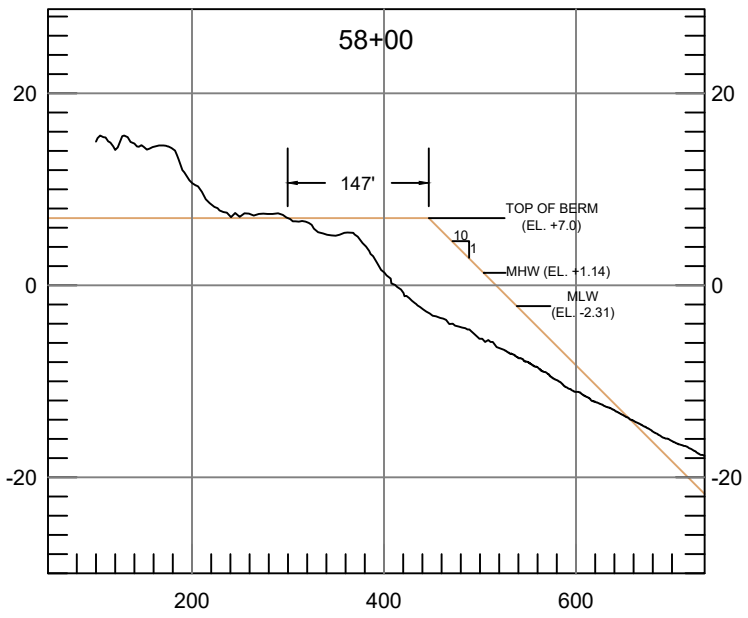

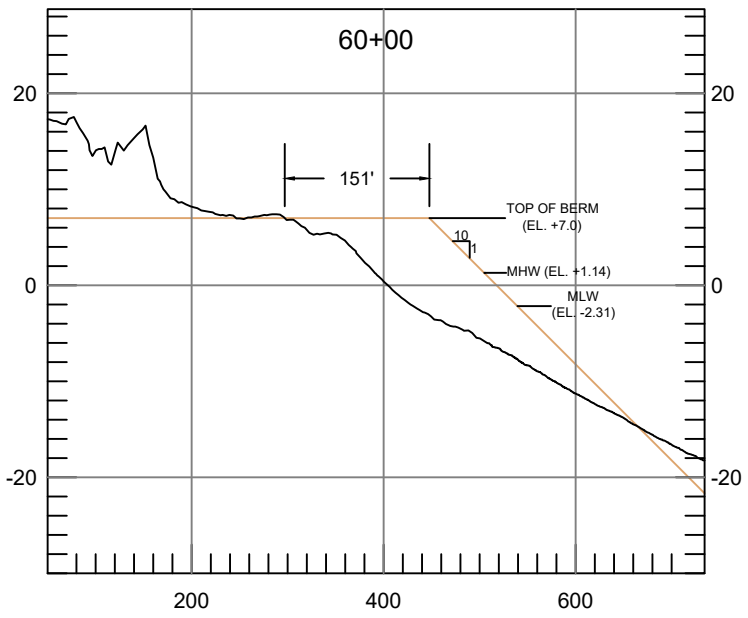

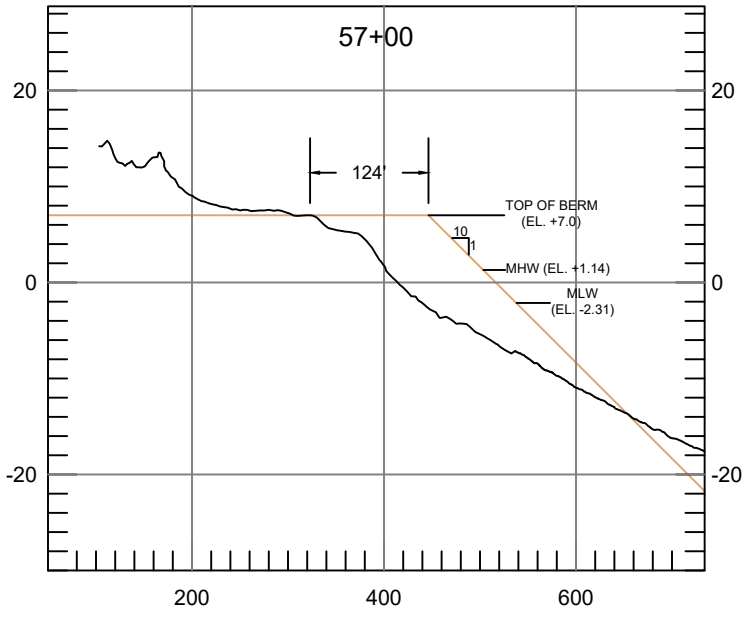

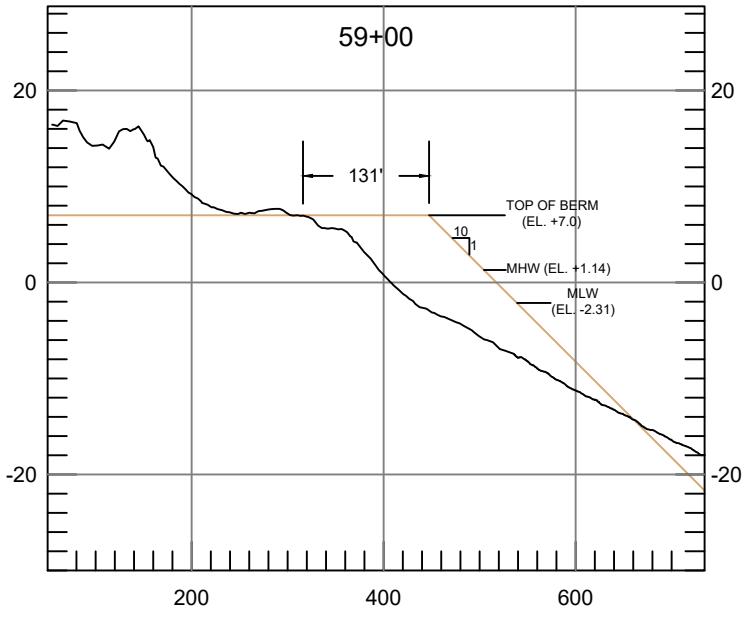

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BEACH CROSS SECTIONS
IN ATLANTIC OCEAN

AT: MIDDLESEX BEACH
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SHEET 11 OF 12

NOTES:
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2. VERTICAL DATUM IS REFERENCED TO NAVD88.
3. HORIZONTAL DATUM IS REFERENCED TO NAD83.
4. BASELINE IS ONLY SHOWN AT STATIONS 43+00 TO 52+70 DUE TO THE LANDWARD SHIFT OF ALIGNMENT AT 52+70.
5. SEE NOTES SHEET 7.

LEGEND:

SURVEY DATA

BEACH FILL TEMPLATE

BASELINE

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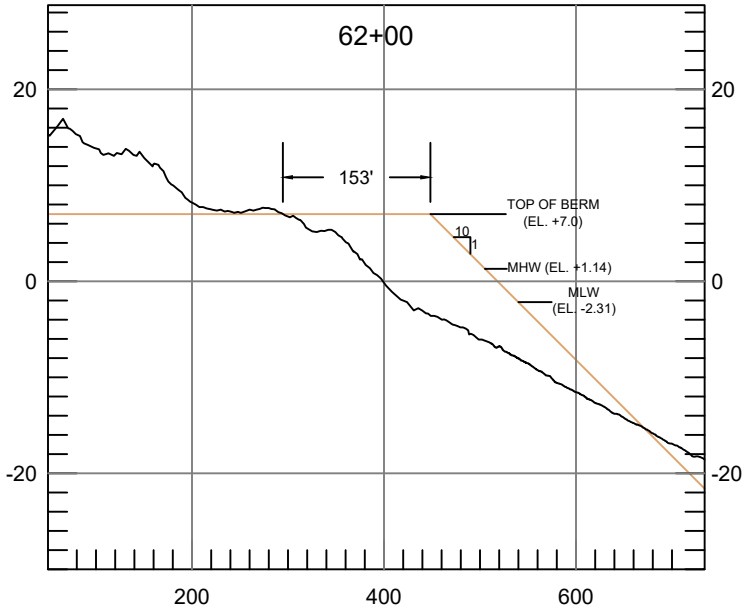

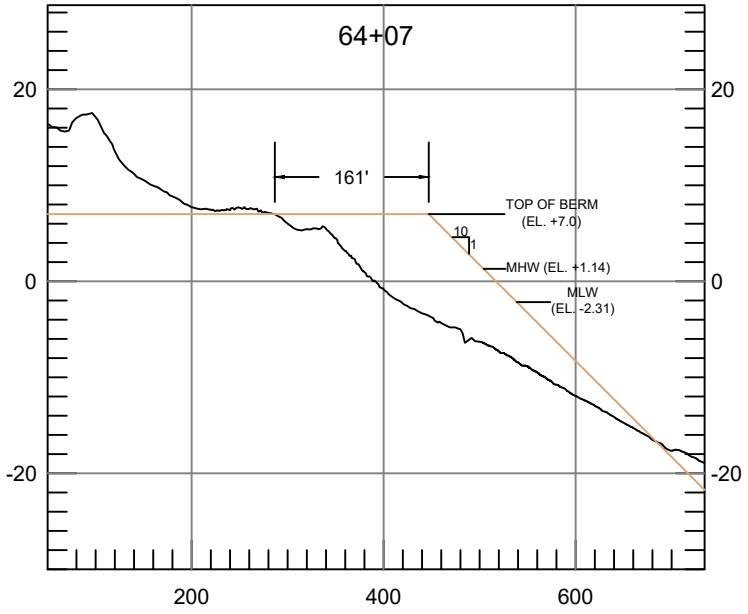

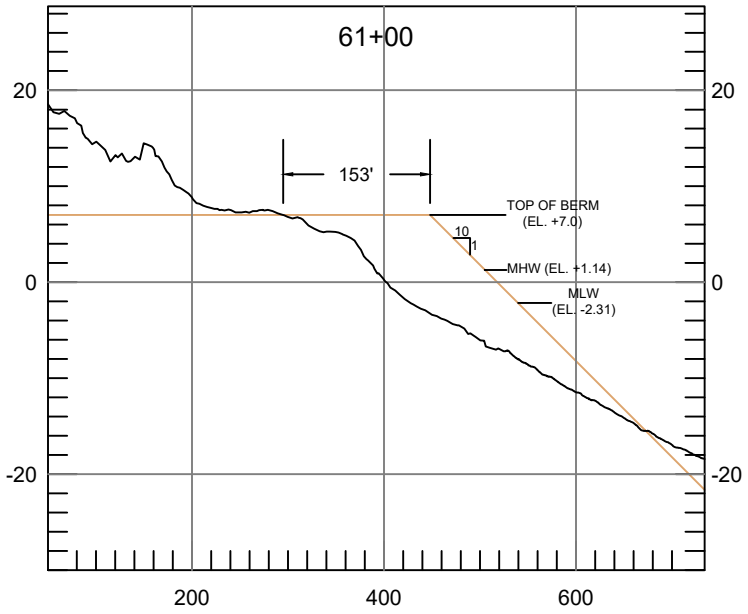

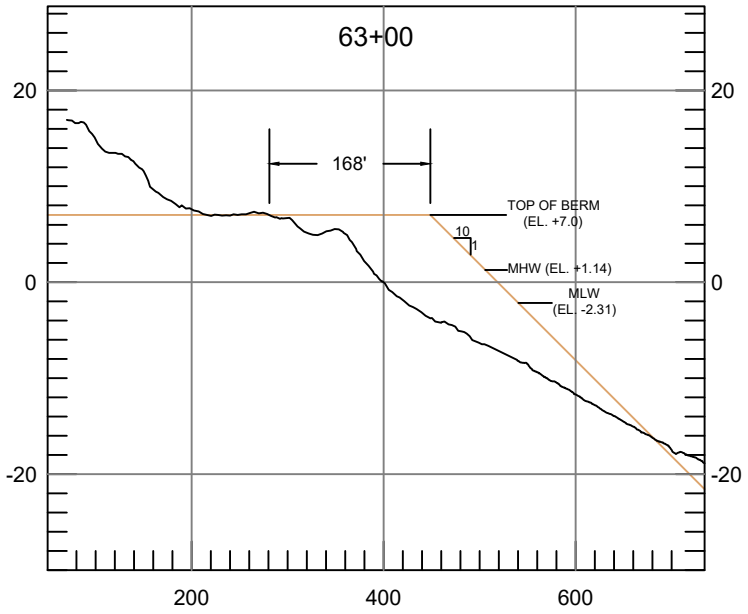

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BEACH CROSS SECTIONS
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SHEET 12 OF 12

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5. SEE NOTES SHEET 7.

LEGEND:

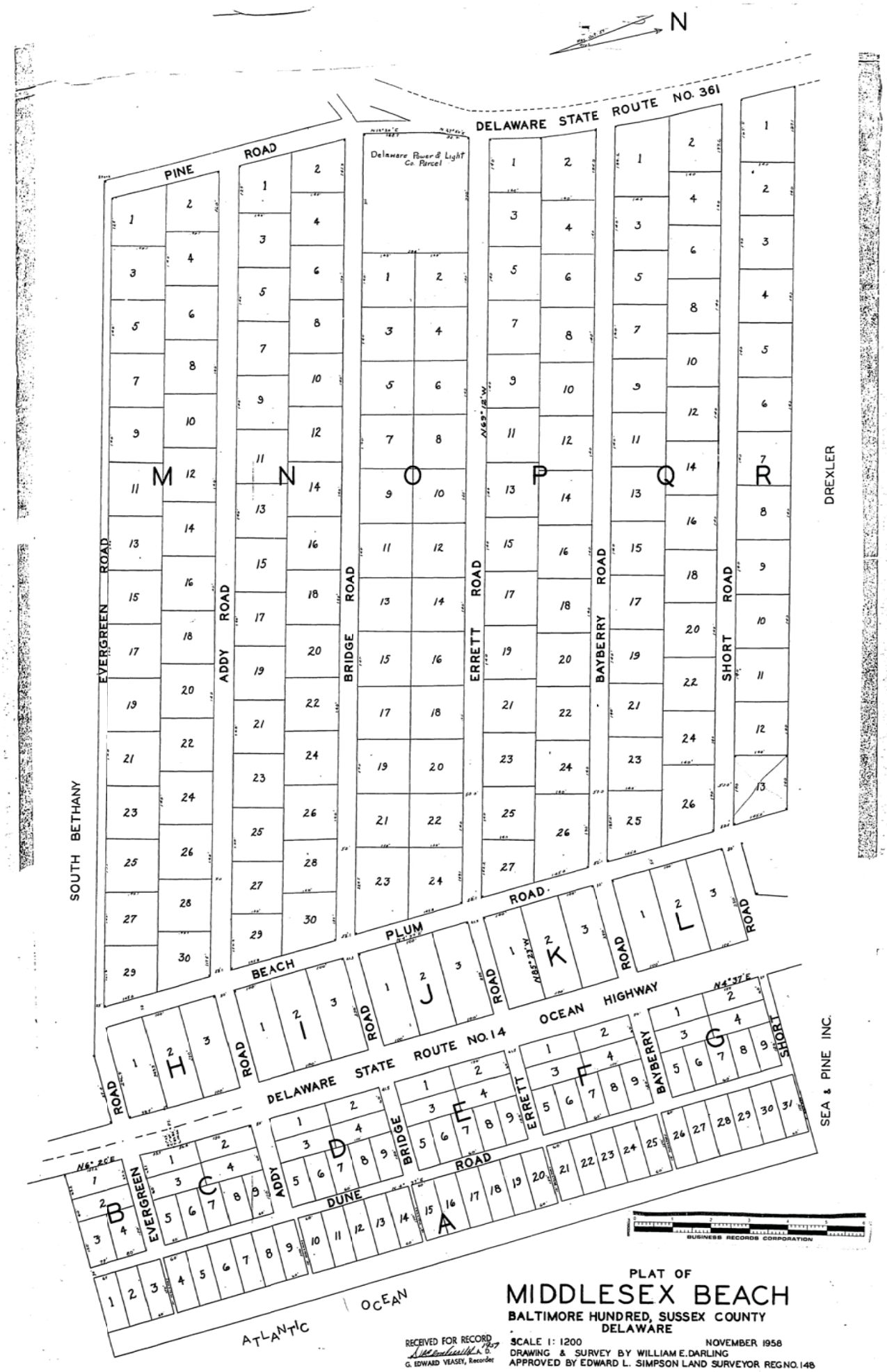
SURVEY DATA

BEACH FILL TEMPLATE

BASELINE

FOR PERMIT USE ONLY NOT FOR CONSTRUCTION

#3



RECEIVED FOR RECORD
Dec. 14 A.D. 1959
G. EDWARD VEASEY, Recorder

PLAT OF

MIDDLESEX BEACH

BALTIMORE HUNDRED, SUSSEX COUNTY
DELAWARE

SCALE 1: 1200 NOVEMBER 1958
DRAWING & SURVEY BY WILLIAM E. DARLING
APPROVED BY EDWARD L. SIMPSON LAND SURVEYOR REG. NO. 148

RECEIVED FOR RECORD
Dec. 14 A.D. 1959
G. EDWARD VEASEY, Recorder

#4

DEED

THIS DEED, Made the 4th day of April, in the year of our Lord, one thousand nine hundred and fifty-nine,

BETWEEN, WILLIAM R. ERRETT, JR., Surviving Trustee in Dissolution of and for The Bethany Beach Improvement Company, a dissolved Delaware corporation, WILLIAM R. ERRETT, JR., Trustee under Deed of Trust from Melvin Hopkins, etux, dated September 25, 1946, JOHN W. HUDSON, Trustee u/w Edwin R. Errett, deceased, DOROTHY ERRETT, single, JANE E. ERRETT, single, MARJORIE R. ERRETT, single, WILLIAM R. ERRETT, JR., and MARGARET P. ERRETT, his wife, HELEN C. ERRETT HOURDEQUIN, and L. REMY HOURDEQUIN, her husband, STANLEY W. ADDY, Successor Trustee u/w Jennie William Addy, deceased, CHARLES E. ADDY, and MARTHA JEAN ADDY, his wife, STANLEY W. ADDY and MARY MARGARET ADDY, his wife, MARY JANE ADDY BRALEY and SILAS A. BRALEY, JR., her husband, MARY A. J. SHORT, widow, WILLIAM P. SHORT, JR., and MARY E. SHORT, his wife, MARY A. S. LIGHTHIPE and HAROLD H. LIGHTHIPE, her husband, STANLEY W. ADDY, Surviving Trustee under Deed of Trust from The Bethany Beach Improvement Company, a Delaware corporation now dissolved, dated July 15, 1940, [illegible]A AND PINES, INC., a Delaware corporation, ELIZABETH MILLS DREXLER, widow, RICHARD F. HALL and ELIZABETH H. HALL, his wife, parties of the first part, and MARGARET DUNNING, single, of Georgetown, Delaware, party of the second part,

WITNESSETH, that the said parties of the first part, for and in consideration of the sum of ONE DOLLAR ($1.00), and other valuable and lawful considerations, lawful money of the United States of America, the receipt whereof is hereby acknowledged, hereby grant and convey unto the said party of the second part, her heirs and assigns forever,

ALL of their several, respective rights, titles, interests,

claims, and demands whatsoever, either in law or equity, in and to ALL AND SINGULAR the lands and premises defined and delineated upon a certain plot entitled "PLAT OF LANDS FORMERLY OF BETHANY BEACH IMPROVEMENT CO., SEA & PINE, INC., LOUIS A. DREXLER, and SOUTH BETHANY", situate in Baltimore Hundred, Sussex County, Delaware; which plot is dated November 1958, was surveyed and drawn by William E. Darling and approved by E. L. Simpson, Land Surveyor, and is about to be recorded in the Office of the Recorder of Deeds, in and for Sussex County, at Georgetown, Delaware; and which lands and premises defined and delineated thereon and thereby, are more particularly bounded and described as follows: BEGINNING at a concrete monument set along the easterly right of way line of Delaware State Route No. 361 and forming the Northwest corner of these lands and the Southwest corner of other lands of Drexler; thence, South 69 degrees 12 minutes East, 533.8 feet; thence, South 87 degrees 40 minutes East, 177.5 feet; thence, South 72 degrees 58 minutes East, 85.4 feet; thence, South 77 degrees 28 minutes East, 103.8 feet, thence, South 50 degrees 28 minutes East, 46.6 feet; thence, South 63 degrees 40 minutes East, 113.7 feet; thence, South 36 degrees 30 minutes East, 92.2 feet; thence, South 69 degrees 12 minutes East, 746.3 feet; thence, South 4 degrees 37 minutes West, 100 feet; thence, South 70 degrees 12 minutes East, about 134.2 feet; thence, South 85 degrees 23 minutes East, 65 feet; thence, South 23 degrees 48 minutes West, 17.1 feet; thence, South 68 degrees 12 minutes East, about 119.6 feet to a concrete monument set along the westerly righteof-way line of Delaware State Highway Route No. 14; thence, by and with the same course last mentioned, crossing said Highway, about 105 feet to another concrete monument set along the easterly right-of-way line of said Highway, North 4 degrees 37 minutes East, 56.7 feet to another concrete monument, being a common corner for the lands and premises

hereby conveyed and lands of Sea and Pines, Inc.; thence, by and with the line of lands of Sea and Pines, Inc., South 85 degrees 23 minutes East, about 482.3 feet, to the waters edge of the Atlantic Ocean; thence, by and with the waters edge of the Atlantic Ocean, along the course of approximately South 4 degrees 37 minutes West, about 2050.6 feet, to the northerly boundary line of lands of Richard F. Hall, etux. (South Bethany); thence, by and with the northerly line of lands of said Hall, North 69 degrees 12 minutes West, about 244.5 feet; thence, North 83 degrees 23 minutes West, 257.8 feet to another concrete monument set along the easterly right-of-way line of Delaware State Route No. 14, aforesaid; thence, by and with the easterly right-of-way line of said Highway, North 6 degrees 20 minutes East, 71.6 feet to another concrete monument set along the easterly right-of-way line of said Highway; thence, crossing said Highway and continuing along the same course, by and with the northerly line of lands of said Hall and wife, North 69 degrees 12 minutes West, for the total distance of about 2,504.4 feet to a stone forming the southwestern corner of the lands and premises hereby conveyed; thence, North 6 degrees 18 minutes East, 646.8 feet; thence, North 51 degrees 33 minutes East, 48 feet; thence, North 19 degrees 20 minutes East, 341.9 feet; thence, North 11 degrees 43 minutes East, 665.3 feet; thence, South 71 degrees 32 minutes East, about 38.3 feet to a point along the Easterly right-of-way line of Delaware State Route No. 361; thence, by and with the Easterly right-of-way line of Delaware State Route No. 361, in a Northerly direction, for a distance of 158 feet to a concrete monument, being home to the point or place of BEGINNING, be the contents thereof what they may.

BEING all and singular the lands and premises which the parties of the first part hereto have agreed to convey unto the party of the second part hereto, in and by a certain Settlement Agreement dated April 4, 1959, between William R. Errett, Jr., etal, which is about to be recorded in the office of the Recorder of Deeds, aforesaid, as reference thereto being had will more fully and at large appear.

IN WITNESS WHEREOF, the respective parties of the first part individual and fiduciary have hereunto set their hands and affixed their seals, and the party of the first part corporate hereto has caused these presents to be signed by its President, and its corporate seal by him hereunto affixed, attested by its Secretary, pursuant to an appropriate resolution of its Board of Directors duly authorizing the same, all as of the day and year first above written.

Signed, sealed and delivered in the presence of:

William R. Errett (SEAL)
William R. Errett, Jr., Surviving Trustee in Dissolution of and for The Bethany Beach Improvement Company, a Dissolved Delaware Corporation

William R. Errett (SEAL)
William R. Errett, Jr., Trustee under Deed of Trust from Melvin Hopkins, etux, dated September 25, 1946.

John W. Hudson (SEAL)
John W. Hudson, Trustee u/w Edwin R. Errett, Deceased

(SEAL)
Dorothy Errett

Jane E. Errett (SEAL)
Jane E. Errett

Marjorie R. Errett (SEAL)
Marjorie R. Errett

William R. Errett (SEAL)
William R. Errett, Jr.

(SEAL)
Margaret P. Errett

Helen G. Errett Hourdequin (SEAL)
Helen G. Errett Hourdequin

L. Remy Hourdequin (SEAL)
L. Remy Hourdequin

Stanley W. Addy (SEAL)
Stanley W. Addy, Successor Trustee u/w Jennie Williams Addy, Deceased

Charles E. Addy (SEAL)
Charles E. Addy

Martha Jean Addy (SEAL)
Martha Jean Addy

Stanley W. Addy (SEAL)
Stanley W. Addy

Mary Margaret Addy (SEAL)
Mary Margaret Addy

Mary Jane Addy Braley (SEAL)
Mary Jane Addy Braley

(SEAL)

Mary A. J. Short (SEAL)
Mary A. J. Short

William P. Short, Jr. (SEAL)
William P. Short, Jr.

Mary E. Short (SEAL)
Mary E. Short

Mary A. S. Lighthipe (SEAL)
Mary A. S. Lighthipe

Harold H. Lighthipe (SEAL)
Harold H. Lighthipe

Stanley W. Addy (SEAL)
Stanley W. Addy, Surviving Trustee under Deed of Trust from The Bethany Beach Improvement Company, a Delaware corporation now dissolved, dated July 15, 1940

(SEAL)
Silas A. Braley, Jr.

SEA AND PINES, INC.

Alice E. Leyba

By: Roy B. Dale
President

Attest: Judson W. Richardson
Secretary

Mary J. Smith

Elizabeth Mills Drexler (SEAL)

Mary J. Smith

Richard F. Hall (SEAL)

Mary J. Smith

Elizabeth H. Hall (SEAL)

STATE OF PENNSYLVANIA }
SS
COUNTY OF [illegible] }

BE IT REMEMBERED, that on this 24th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, WILLIAM R. ERRETT, JR., Surviving Trustee in Dissolution of and for The Bethany Beach Improvement Company, a dissolved Delaware corporation, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

[signature]
Notary Public
Notary Public, [illegible], Chester County
My Commission Expires [illegible]

STATE OF OHIO }
SS
COUNTY OF Hamilton }

BE IT REMEMBERED, that on this 27th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, JOHN W. HUDSON, Trustee u/w Edwin R. Errett, deceased, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

[signature]
Notary Public
DORIS A. FURTHMILLER
Notary Public, Hamilton County, Ohio
My Commission Expires Sep. 27, 1960

STATE OF PENNSYLVANIA }
COUNTY OF Chester } SS

BE IT REMEMBERED, that on this 7th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, DOROTHY ERRETT, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be her act anddeed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

Notary Public, Avondale, Chester County
My Commission Expires September 30, 1962

STATE OF PENNSYLVANIA }
COUNTY OF Chester } SS

BE IT REMEMBERED, that on this 7th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, JANE E. ERRETT, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be her act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

Notary Public, Avondale, Chester County
My Commission Expires September 30, 1962

STATE OF NEW YORK }
COUNTY OF New York } SS

BE IT REMEMBERED, that on this 16th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, MARJORIE R. ERRETT, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be her act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

NOTARY PUBLIC ... New York ... Certificate filed in New York County ... Term Expires March 30, 1960

George Rieus
Notary Public

STATE OF PENNSYLVANIA }
COUNTY OF Chester } SS

BE IT REMEMBERED, that on this 17th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, WILLIAM R. ERRETT, JR., and MARGARET P. ERRETT, his wife, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

Notary Public, Avondale, Chester County
My Commission Expires December 30, 1962

STATE OF PENNSYLVANIA }
COUNTY OF Chester } SS

BE IT REMEMBERED, that on this 7th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, HELEN G. ERRETT HOURDEQUIN and L. REMY HOURDEQUIN, her husband, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

Notary Public, Avondale, Chester County
My Commission Expires December 23, 1962

STATE OF PENNSYLVANIA }
COUNTY OF Ch. Co. } SS

BE IT REMEMBERED, that on this 9th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, WILLIAM R. ERRETT, JR., Trustee under Deed of Trust from Melvin Hopkins, etux, dated September 25, 1946, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

Notary Public, Avondale, Chester County
My Commission Expires December 23, 1962

STATE OF New Jersey]
COUNTY OF Atlantic] SS

BE IT REMEMBERED, that on this 26 day of ~~April~~, May A. D. 1959, personally appeared before me, the subscriber, a Notary Public for the State and County aforesaid, RUBY R. VALE, President of SEA AND PINES, INC., a Delaware corporation, party to the foregoing Settlement Agreement, known to me personally to be such, and he acknowledged the above and foregoing Settlement Agreement to be his own proper act and deed and the act and deed of said, Sea and Pines, Inc.,; and that he did thereunto subscribe his name as such President, and affix the corporate seal of such corporation thereto, attested by the Secretary thereof, pursuant to an appropriate resolution of its Board of Directors first duly authorizing the same.

WITNESS my hand and seal of office the day and year first above written.

NOTARY PUBLIC of NEW JERSEY
My Commission Expires Aug. 10, 1961

Notary Public

STATE OF DELAWARE]
COUNTY OF] SS

BE IT REMEMBERED, that on this 31st day of ~~April~~ August, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, ELIZABETH MILLS DREXLER, widow, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be her act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

JAN 16 1959

STATE OF DELAWARE]
SS
SUSSEX COUNTY]

BE IT REMEMBERED, that on this 4th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, MARY A. J. SHORT, MARY A. S. LIGHTHIPE, HAROLD H. LIGHTHIPE, her husband, WILLIAM P. SHORT, JR., and MARY E. SHORT, his wife, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Mildred C. Carpenter
Notary Public

STATE OF PENNSYLVANIA]
SS
COUNTY OF ALLEGHENY]

BE IT REMEMBERED, that on this 27th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, STANLEY W. ADDY, Surviving Trustee under Deed of Trust from The Bethany Beach Improvement Company, a Delaware corporation now dissolved, dated July 15, 1940, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

E. Dean [illegible]
Notary Public
My Commission Expires
January 7, 1963

STATE OF PENNSYLVANIA }
COUNTY OF ALLEGHENY } SS

BE IT REMEMBERED, that on this 25th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, STANLEY W. ADDY and MARY MARGARET ADDY, his wife, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Notary Public

STATE OF MICHIGAN }
COUNTY OF MIDLAND } SS

BE IT REMEMBERED, that on this 11th day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, MARY JANE ADDY BRALEY and SILAS A. BRALEY, JR., her husband, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

WILLIAM H. CHILDS
Notary Public, Midland County, Mich.
My Commission Expires 5-12-62

STATE OF PENNSYLVANIA }
COUNTY OF Allegheny } SS

BE IT REMEMBERED, that on this 27th day of April, A. D. 1959, personaly appeared before me the subscriber, a Notary Public for the State and County aforesaid, STANLEY W. ADDY, Successor Trustee u/w Jennie Williams Addy, deceased, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

E. DEAN HOFF, Notary Public

E. Dean Hoff
Notary Public

STATE OF MARYLAND }
COUNTY OF Montgomery } SS

BE IT REMEMBERED, that on this 1st day of April, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, CHARLES E. ADDY and MARTHA JEAN ADDY, his wife, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Eugene E. Hutchinson-Wilkerson
Notary Public

My commission expires May 4, 1959

STATE OF ~~Maryland~~ Delaware |
SS
COUNTY OF Sussex |

BE IT REMEMBERED, that on this 27th day of ~~April~~ July, A. D. 1959, personally appeared before me the subscriber, a Notary Public for the State and County aforesaid, RICHARD F. HALL and ELIZABETH H. HALL, his wife, parties to this Indenture, known to me personally to be such, and acknowledged this Indenture to be their act and deed.

WITNESS my hand and seal of office the day and year aforesaid.

Mary J. Smith
Notary Public

MARY J. SMITH NOTARY PUBLIC SUSSEX COUNTY, DELAWARE JAN 1 8 1959

RECEIVED FOR RECORD
December 8th A. D. 1959
G. EDWARD VEASEY, Recorder

PURCHASERS REPORT MADE
This 8th day of Dec. 1959
Board of Assessment of Sussex County
By Thos. N. Layton Ores.

D E E D

THIS DEED, Made this 14th day of December, in the year of Our Lord, one thousand nine hundred fifty-nine.

BETWEEN, MARGARET DUNNING, single woman, of Georgetown, Sussex County, Delaware, party of the first part, and MIDDLESEX BEACH ASSOCIATION, a Delaware corporation, of Bethany Beach, Delaware, party of the second part,

WITNESSETH: That the party of the first part, for and in consideration of the sum of One ($1.00) Dollar, lawful money of the United States of America, and other valuable and lawful considerations, to her in hand paid by the party of the second part, the receipt whereof is hereby acknowledged, hereby grants and conveys unto the party of the second part, its Successors and Assigns forever,

ALL those certain lots, strips, pieces or parcels of land, situate, lying and being in MIDDLESEX BEACH, Baltimore Hundred, Sussex County, Delaware, which are shown and designated upon a certain Plot entitled "Plat of MIDDLESEX BEACH", Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William E. Darling, and approved by Edward L. Simpson, Land Surveyor, which plot is now of record in the Office of the Recorder of Deeds, in and for Sussex County, at Georgetown, Delaware, in Plot Book 3, Page 22, as follows: Evergreen Road; Addy Road; Bridge Road, Errett Road, Bayberry Road; Short Road; Pine Road; Beach Plum Road; Dune Road; Five 10' Walkways and one 5' Walkway, through Block A, between Dune Road to the west and the beach to the east; and all that land or beach area between the northerly and southerly limits of Middlesex Beach, lying between Block A to the west and the waters of the Atlantic Ocean to the east, all as reference thereunto being had unto said Plot will more fully and at large appear.

BEING a part of the lands and premises heretofore conveyed unto this grantor by William R. Errett, Jr., et al, in and by their certain Deed of Bargain and Sale, dated April 4, 1959, and now of record in the Office of the Recorder of Deeds, aforesaid, in Deed Book 512, Page 377, &c., pursuant to a Settlement Agreement made and entered into between William R. Errett, Jr., et al, dated April 4, 1959, and now of record in the Office of the Recorder of Deeds, aforesaid, in Deed Book 512, Page 335, &c., all as reference thereto being had will more fully and at large appear.

IN WITNESS WHEREOF, the party of the first part has hereunto set her hand and seal the day and year first abovewritten.

Signed, sealed and delivered
in the presence of:

Winnie M. Kreer

Margaret Dunning (SEAL)

STATE OF DELAWARE }
SS
COUNTY OF SUSSEX }

BE IT REMEMBERED, That on this 14th day of December, A. D. 1959, personally came before me, the subscriber, a Notary Public for the State and County aforesaid, MARGARET DUNNING, single woman, party to this indenture, known to me personally to be such, and she acknowledged this indenture to be her deed.

GIVEN under my hand and seal of office, the day and year aforesaid.

Winnie M. Kreer
Notary Public

PURCHASERS REPORT MADE
This 14th day of Dec. 1959
Board of Assessment of Sussex County
By Thos. N. Layton Pres.

RECEIVED FOR RECORD
December 14 A. D. 1959
G. EDWARD VEASEY, Recorder

COORDINATE TABLE

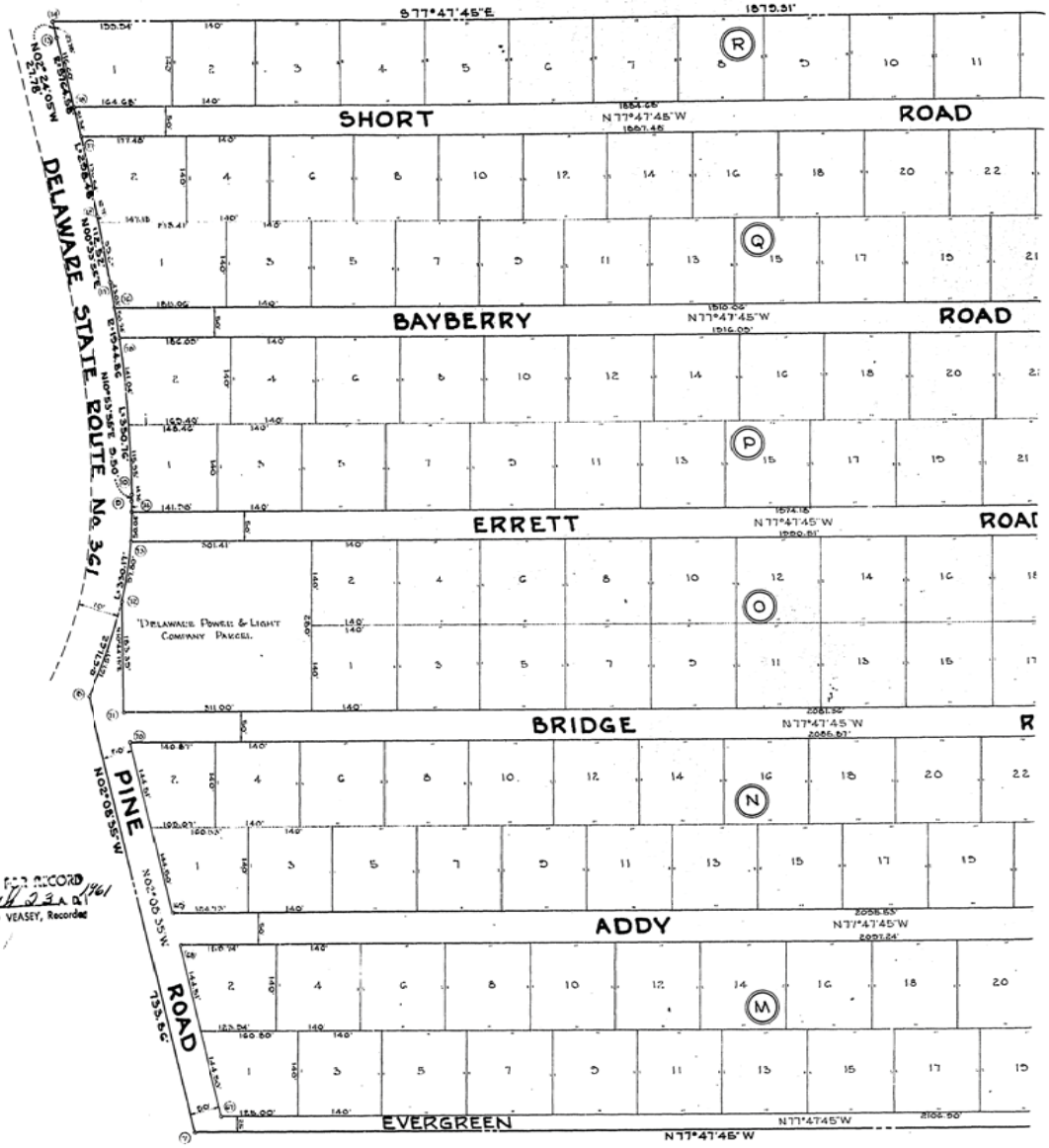
No.	NORTH	EAST	No.	NORTH	EAST	No.	NORTH	EAST	No.	NORTH	EAST
1	189333.56	603847.81	21	191357.55	603259.86	41	150087.88	602750.40	61	150067.18	601346.58
2	189169.66	604115.87	22	191414.88	603856.58	42	150003.00	602753.57	62	150376.90	602567.15
3	189079.21	603612.52	23	191445.70	603734.51	43	149881.98	603308.29	63	150384.37	602970.80
4	189060.04	603611.98	24	185710.46	603411.93	44	185911.08	603311.54	64	150033.82	602991.04
5	189068.39	603513.81	25	185716.03	603411.46	45	185703.65	603311.86	65	149986.89	602994.68
6	189648.78	603157.73	26	185888.93	603402.04	46	185686.84	603008.88	66	150690.74	603014.85
7	190103.24	602096.12	27	190009.98	603303.42	47	190088.60	603044.47	67	150136.12	602988.60
8	190084.90	602878.67	28	190089.83	603350.16	48	190036.83	603041.00	68	150424.33	602544.80
9	191180.80	601016.78	29	190359.11	603360.33	49	190334.61	603020.18	69	150476.80	602542.87
10	191160.18	601018.52	30	190460.51	603366.48	50	190376.21	603017.30	70	150765.81	602032.07
11	191180.65	601083.90	31	190670.70	603381.63	51	190676.48	602986.48	71	150816.88	602032.87
12	191621.16	601064.21	32	190741.10	603387.70	52	190716.85	602983.60	72	150356.46	602967.04
13	191597.65	601045.83	33	191040.41	603521.93	53	191016.17	602972.78	73	151083.52	601001.42
14	191543.85	601048.67	34	191050.78	603318.46	54	151066.03	602962.31	74	151136.40	601013.77
15	191560.08	602885.81	35	191063.40	603218.71	55	151365.33	602948.45	75	151414.97	601050.31
16	191481.05	602852.81	36	191033.62	603227.18	56	151484.63	602880.63	76	151468.63	601082.93
17	191431.20	602843.63	37	190734.04	603243.00	57	151382.71	602880.25	77	151781.71	601084.42
18	191414.32	602841.10	38	190692.84	603245.86	58	151061.86	602910.45	78	151803.06	601083.84
19	191462.97	603088.12	39	190353.56	603266.70	59	151005.35	602925.10	79	185660.60	603413.67
20	191407.12	603086.66	40	190352.16	603265.58	60	150715.06	602943.54			

CURVE TABLE

CURVE	CENTRAL ANGLE	RADIUS	ARC	TAN. DIST.	CHORD BEARING	CHORD DIST.
9	28° 10' 00"	671.62'	330.17	168.50	N24°55'55"E	326.85
10	10° 20' 00"	1044.86'	360.76	175.36	N05°43'55"E	350.28
12	02° 58' 00"	5764.58'	298.48	149.27	N00°55'05"W	298.45
22	01° 45' 00"	5775.58'	176.16	88.09	N03°58'45"W	176.16
44	01° 45' 00"	5615.58'	170.17	85.05	N03°58'45"W	170.16

NOTE:

3



RECEIVED FOR RECORD
March 23 A.D. 1961
at EDWARD VEASEY, Recorder

NOTES: 1. The courses shown on this Revised Plat are based on Grid North as compared to the Magnetic courses shown on the Original Plat of Middlesex Beach, of record in Plat Book 3, Page 22.
2. The lot lines of each lot as shown upon this Revised Plat have been reconciled with the lot lines of each corresponding lot shown upon the original Plat of Middlesex Beach which is of record in Plat Book 3, Page 22, so that both of such plats may be used interchangeably to designate a particular lot as shown upon either plat.

PURDUM & JESCHKE
CONSULTING ENGINEERS AND LAND SURVEYORS
2415 MARYLAND AVENUE
BALTIMORE 18, MARYLAND

BUSINESS RECORDS CORPORATION

REGISTERED LAND SURVEYOR 20-LS-206 DELAWARE

H. LeRoy Whitley Jr.
H. LEROY WHITLEY Jr. Reg. No. 204

NOTE. Coordinates and bearings shown hereon are based on the U.S.C.G.S. grid system. Stations and values used are as follows. Values are as corrected by Baltimore Office, U.S.C.G.S. November, 1960.

Station		
Cedar Patch E.M.*3	N211521.19	E 601004.29
North	N 191676.43	E 602866.61
Tunnel *2 E.M.*2	N 187055.24	E 596380.85

REVISED PLAT OF
MIDDLESEX BEACH
BALTIMORE HUNDRED, SUSSEX CO. DELAWARE

SCALE: 1"=100' JANUARY 11, 1961

BUSINESS RECORDS CORPORATION

DEED OF EASEMENT

THIS DEED OF EASEMENT, Made this 17th day of December, A.D. 1959,

BETWEEN, MIDDLESEX BEACH ASSOCIATION, a corporation of the State of Delaware, of Bethany Beach, Delaware, party of the first part, and ALL PRESENT AND FUTURE OWNERS OF ANY LOT OR LOTS SITUATE IN MIDDLESEX BEACH, as shown upon a certain plot entitled "Plat of MIDDLESEX BEACH", Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William B. Darling, and approved by Edward L. Simpson, Land Surveyor, and now of record in the Office of the Recorder of Deeds, in and for Sussex County, at Georgetown, Delaware, in Plot Book No. 3, Page 22, parties of the second part, WITNESSETH:

WHEREAS, Margaret Dunning, in and by her certain deed of bargain and sale, dated December 14, 1959, and now of record in the Office of the Recorder of Deeds, aforesaid, in Deed Book 512, Page 518, &c., has conveyed unto the party of the first part hereto all that land or beach area between the northerly and southerly limits of Middlesex Beach, lying between Block A to the west and the waters of the Atlantic Ocean to the east, as shown and designated upon a certain plot entitled "Plat of MIDDLESEX BEACH", Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William B. Darling, and approved by Edward L. Simpson, Land Surveyor, which is now of record in the Office of the Recorder of Deeds, aforesaid, in Plot Book No. 3, Page 22, as reference thereto being had will more fully and at large appear; and

WHEREAS, it is the intent and purpose of these presents to define and make certain the status of the title to, the rights in and the privileges over such land or beach area,

NOW, THEREFORE, the party of the first part, for and in consideration of the sum of ONE DOLLAR ($1.00), lawful money of the United States of America, and other valuable and lawful considerations to it in hand paid, the receipt whereof is hereby acknowledged,

does hereby grant and convey unto the parties of the second part, their heirs, successors and assigns forever, as the case may be, a perpetual easement and right of way, to be enjoyed in common by all the parties of the second part, their heirs, successors and assigns forever, as the case may be, for the uses and purposes hereinafter set forth, in and upon, through and across, over and from,

> ALL THAT certain lot, piece or parcel of land or beach area, situate, lying and being in MIDDLESEX BEACH, Baltimore Hundred, Sussex County, Delaware, between the northerly and southerly limits of Middlesex Beach, lying between Block A to the west and the Atlantic Ocean to the east, as shown and designated upon a certain Plot entitled "Plat of MIDDLESEX BEACH", Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William B. Darling, and approved by Edward L. Simpson, Land Surveyor, which plot is now of record in the Office of the Recorder of Deeds, in and for Sussex County, at Georgetown, Delaware, in Plot Book No. 3, Page 22, all as reference thereunto being had will more fully and at large appear.

TO HAVE AND TO HOLD the above described perpetual easement and right of way in and upon, through and across, over and from, the abovedescribed tract, piece and parcel of land unto all and singular the said parties of the second part and their respective heirs, successors and assigns, as the case may be, in common, to and for the following uses and purposes:

(1) For ingress, egress, regress and passage to and from their respective lots situate in Blocks A to R, inclusive, of Middlesex Beach Development, as shown upon the Plat thereof, and the waters of the Atlantic Ocean, for themselves, and their families, members of their household, tenants, guests and invitees, and none other; and

(2) For a place of recreation, including sun bathing, for themselves, and their families, members of their household, tenants, guests and invitees, and none other,

FURTHER, the party of the first part, for itself and its successors and assigns, does covenant, promise and agree to and with the parties of the second part, their respective heirs, successors and assigns, as the case may be, that no building, structure or obstruction of any kind shall ever be erected or constructed upon said tract, piece or parcel of land above described, nor shall any business or commercial enterprise be operated or conducted thereon, without first obtaining the unanimous written consent of the

record owners of all the lots in Block A of Middlesex Beach.

PROVIDED, that nothing herein contained shall in anywise restrict or limit the free and natural drifting of sand, or the construction of any and all sand fences, and barriers, bulkheads, jetties, groins and the like as may be necessary or designed to safeguard and protect such beach area, as well as all of the land area of Middlesex Beach, from the forces of erosion by wind or water.

IN WITNESS WHEREOF, the party of the first part, pursuant to an appropriate resolution of its Board of Directors duly authorizing the same, has caused these presents to be signed by its President and its corporate seal to be by him hereunto affixed, attested by its Secretary, the day and year first abovewritten.

Signed, sealed and delivered in the presence of:

Minnie M. Kacer

MIDDLESEX BEACH ASSOCIATION

By: William R. Smith Jr.
President

Attest: Nelson J. Shaffer
Secretary

MIDDLESEX BEACH ASSOCIATION INCORPORATED DELAWARE

STATE OF DELAWARE }
SS
COUNTY OF SUSSEX }

BE IT REMEMBERED, That on this 17 day of December, in the year of our Lord, one thousand nine hundred and fifty-nine, personally came before me, the subscriber, a Notary Public for the State and County aforesaid, William R. Perrott Jr., President of MIDDLESEX BEACH ASSOCIATION, a corporation existing under the laws of the State of Delaware, party to this Indenture known to me personally to be such, and acknowledged this Indenture to be his act and deed and the act and deed of said corporation, that the signature of the President thereto is in his own proper handwriting and the seal affixed is the common and corporate seal of said corporation, and that his act of sealing, executing, acknowledging and delivering said Indenture was duly authorized by a resolution of the Board of Directors of said corporation.

GIVEN under my hand and seal of office, the day and year aforesaid.

Notary Public

RECEIVED FOR RECORD
December 17 A. D. 1959
G. EDWARD VEASEY, Recorder

DEED OF EASEMENT

THIS DEED OF EASEMENT, Made this 17th day of December, A. D. 1959,

BETWEEN, MIDDLESEX BEACH ASSOCIATION, a corporation of the State of Delaware, of Bethany Beach, Delaware, party of the first part, and ALL PRESENT AND FUTURE OWNERS OF ANY LOT OR LOTS SITUATE IN MIDDLESEX BEACH, as shown upon a certain plot entitled "Plat of MIDDLESEX BEACH", Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William B. Darling, and approved by Edward L. Simpson, Land Surveyor, and now of record in the Office of the Recorder of Deeds, in and for Sussex County, at Georgetown, Delaware, in Plot Book No. 3, Page 22, parties of the second part, WITNESSETH:

WHEREAS, Margaret Dunning, in and by her certain deed of bargain and sale, dated December 14, 1959, and now of record in the Office of the Recorder of Deeds, aforesaid, in Deed Book 512, Page 518, &c., has conveyed unto the party of the first part hereto all those certain lots, pieces, strips or parcels of land, which are shown and designated upon a certain Plot entitled "Plat of MIDDLESEX BEACH", Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William B. Darling, and approved by Edward L. Simpson, Land Surveyor, as "Dune Road", "Beach Plum Road", "Pine Road", "Evergreen Road", "Addy Road", "Bridge Road", "Errett Road", "Bayberry Road", "Short Road", Five "10' Walkways" and One "5' Walkway"; which Plot is now of record in the Office of the Recorder of Deeds, aforesaid, in Plot Book No. 3, Page 22, as reference thereto being had will more fully and at large appear; and

WHEREAS, it is the intent and purpose of these presents to define and make certain the status of the title to, the rights in, and the privileges over the lands comprising and designated on said plat as "Dune Road", "Beach Plum Road", "Pine Road", "Evergreen Road", "Addy Road", "Bridge Road", "Errett Road", "Bayberry Road", "Short Road", Five "10' Walkways" and One "5' Walkway";

NOW THEREFORE, the party of the first part, for and in consideration of the sum of ONE DOLLAR ($1.00), lawful money of the United States of America, and other valuable and lawful considerations, to it in hand paid, the receipt whereof is hereby acknowledged, does hereby grant and convey unto the parties of the second part, their heirs, successors and assigns forever, as the case may be, a perpetual easement or right of way, to be enjoyed in common by all the parties of the second part, their heirs, successors and assigns forever, as the case may be, for the uses and purposes hereinafter set forth, in and upon, through and across, over and from, the lands comprising and designated on said plat as "Dune Road", "Beach Plum Road", "Pine Road", "Evergreen Road", "Addy Road", "Bridge Road", "Errett Road", "Bayberry Road", "Short Road", Five "10' Walkways", and One "5' Walkway".

TO HAVE AND TO HOLD the above described perpetual easement or right of way in and upon, through and across, over and from, the lands aforedesignated unto all and singular the said parties of the second part, and their respective heirs, successors and assigns, as the case may be, in common, to and for the following uses and purposes:

(1) As ways or means of ingress, egress, regress and passage to and from their respective lots situate in Blocks A to R, inclusive, of Middlesex Beach Development, as shown upon said official plat thereof, aforesaid, for themselves, and their families, members of their household, tenants, guests and invitees, and none other.

PROVIDED, that title to all such lands aforedesignated as ways or means of ingress, egress, regress and passage is hereby expressly reserved unto the party of the first part, its successors and assigns, and neither the filing and recording of the aforesaid plat, nor any supplement, amendment, modification or revision thereto or thereof, nor the sale and/or conveyance of any lots by reference to said plat, or any supplement, amendment, modification or revision thereto or thereof, nor the sale and/or conveyance of any lots by reference on said plat or any supplement, amendment, modification or revision thereto or thereof, shall constitute or in any manner be construed or considered as a dedication of the ways or means of ingress, egress, regress or passage, nor as a dedication of any other

lands shown upon said plat or any supplement, amendment, modification or revision thereto or thereof;

RATHER, the party of the first part, its successors and assigns, retains the right to convey, in the future, unto any public authority, all or any part of its right, title and interest in and to all or any part of said ways or means of ingress, egress, regress or passage, should the party of the first part, or its successors or assigns, deem it expedient so to do; and,

FURTHER, the party of the first part, its successors and assigns, also retains the right to dedicate to public use, all or any part of such ways or means of ingress, egress, regress or passage, at any future time, should the said party of the first part, or its successors or assigns, deem it expedient so to do; and,

FURTHER, the party of the first part reserves unto itself, its successors and assigns, all easements and rights of way over, upon and under the lands comprising and designated on said plat as "Dune Road", "Beach Plum Road", "Pine Road", "Evergreen Road", "Addy Road", "Bridge Road", "Errett Road", "Bayberry Road", "Short Road", Five "10' Walkways" and One "5' Walkway", for the erection, construction, maintenance, and use of poles, wires, pipe lines, conduits, and the necessary, proper, or desirable attachments in connection therewith, for the transmission of electricity for lighting, heating, telephone, and other purposes; for public and private sewers; storm water drains; land drains; pipe lines for supplying gas, water and heat; and for any other public or quasi-public utility or function conducted, maintained, or performed in any manner above, upon or beneath the surface of the ground; and the party of the first part, its successors, assigns, agents and employees, as well as representatives of utility companies, private or quasi-public, and representatives of public agencies, with the permission of the party of the first part, its successors and assigns, shall have the right to enter upon such strips of land designated as aforesaid for any of the utilitarian purposes for which such easements and rights of way are reserved, as aforesaid.

IN WITNESS WHEREOF, the party of the first part, pursuant to an appropriate resolution of its Board of Directors duly

authorizing the same, has caused these presents to be signed by its President and its corporate seal to be by him hereunto affixed, attested by its Secretary, the day and year first above written.

Signed, sealed and delivered
in the presence of:

Minnie M. Kreer

MIDDLESEX BEACH ASSOCIATION

By: William R. Smith
President

Attest: William R. Smith
Secretary

_____

STATE OF DELAWARE }
SS
COUNTY OF SUSSEX }

BE IT REMEMBERED, That on this 17 day of December, in the year of our Lord, one thousand nine hundred and fifty-nine, personally came before me, the subscriber, a Notary Public for the State and County aforesaid, William K. Everett, Jr., President of MIDDLESEX BEACH ASSOCIATION, a corporation existing under the laws of the State of Delaware, party of this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed and the act and deed of said corporation, that the signature of the President thereto is in his own proper handwriting and the seal affixed is the common and corporate seal of said corporation, and that his act of sealing, executing, acknowledging and delivering said Indenture was duly authorized by a resolution of the Board of Directors of said corporation.

GIVEN under my hand and seal of office, the day and year aforesaid.

Silvia M. Kreer
Notary Public

RECEIVED FOR RECORD
December 17 A. D. 1959
G. EDWARD VEASEY, Recorder

#13

DEED OF EASEMENT

THIS DEED OF EASEMENT, Made this 28th day of Nov., A. D. 1975,

B E T W E E N

THE MIDDLESEX BEACH ASSOCIATION, a corporation of The State of Delaware, of Bethany Beach, Delaware, party of the first part,

A N D

SUSSEX COUNTY, a political subdivision of the State of Delaware, party of the second part.

W I T N E S S E T H :

The party of the first part hereto, for and in consideration of the sum of ONE DOLLAR ($1.00), and other valuable and lawful consideration, cash in hand paid, the receipt whereof is hereby acknowledged, has this day bargained and sold, and by these presents does bargain, sell, convey, transfer and deliver unto the party of the second part a permanent easement and right-of-way, including the perpetual right to enter upon the streets, roads, avenues, alleys, and other thoroughfares within the limits of Middlesex Beach at any time that it may see fit to construct, install, maintain, replace and repair underground pipelines and/or mains for the purpose of conveying sewage and water over, across, through and under the streets, roads, alleys, and other thoroughfares within the limits of Middlesex Beach, together with the right to excavate and refill ditches and/or trenches for the location of said pipelines and/or mains, and the further right to remove trees, bushes, undergrowth and other obstructions interfering with the location, construction, installation, replacement, repair and maintenance of said pipelines and/or mains upon the following terms and conditions:

1. That all streets shall be restored to substantially their original condition as determined by Sussex County;

2. That this easement does not grant permission for any construction, maintenance, replacement, repair, or installation in any State maintained highway, which said permission must be received from the Department of Highways and Transportation;

3. That any construction, maintenance, installation, replacement and repair, except of an emergency nature, must be scheduled so as not to obstruct both ends of a street in any one block at any one time;

4. That on streets where there are dead ends, such streets shall not be blocked at the open end during any weekend or overnight except for work of an emergency nature;

5. That the party of the second part has the right to remove "access limiting structures" at the end of the streets during construction, replacement or repair provided that such structures shall be restored to substantially their original condition as determined by Sussex County.

Easement on property to be conveyed by Middlesex Beach Association situated in Baltimore Hundred, Sussex County, Delaware as shown upon a certain plot entitled "Plot of Middlesex Beach," Baltimore Hundred, Sussex County, Delaware, dated November, 1958, as drawn and surveyed by William B. Darling, and approved by Edward L. Simpson, Land Surveyor, now of record in the Office of the Recorder of Deeds in and for Sussex County, at Georgetown, Delaware, in Plot Book No. 3, Page 22.

TO HAVE AND TO HOLD said easements and right-of-way unto the party of the second part, its successors and assigns forever.

The party of the first part does hereby covenant with the party of the second part that it is lawfully seized and possessed of the streets, alleys, roads, and other public thoroughfares within the corporate limits of Middlesex Beach and that the President and Secretary of Middlesex Beach have a good right and lawful authority to grant this easement, that it is free from all encum-

brances and that the party of the first part will forever warrant and defend the title thereto against the lawful claim of any persons whomsoever.

IN WITNESS WHEREOF, the party of the first part has caused this easement to be executed by its proper corporate officers and its corporate seal to be hereunto affixed duly attested by its Secretary, the day and year first abovewritten.

Sealed and delivered
in the presence of:

MIDDLESEX BEACH ASSOCIATION

By: Margaret P. Hoch
President

Attest: Barbara Slocum
Secretary

STATE OF Del.
SS:
COUNTY OF Sussex

BE IT REMEMBERED, That on this 28th day of Nov., A. D. 1975, personally came before me, the Subscriber, a Notary Public for the State and County aforesaid, Margaret P. Haskins, President of MIDDLESEX BEACH ASSOCIATION, a corporation of The State of Delaware, party to this Indenture, known to me personally to be such, and acknowledged this Indenture to be his act and deed and the act and the deed of the said corporation; that the signature of the President is in his own proper handwriting; that the seal affixed is the common and corporate seal of the said corporation duly affixed by its authority; and that the act of signing, sealing, acknowledging and delivering the said Indenture was first duly authorized by resolution of the Board of Directors of said corporation.

GIVEN under my hand and seal of office, the day and year aforesaid.

CLAYTON L. RINGLER NOTARY PUBLIC REHOBOTH BEACH, DELAWARE

Notary Public

RECEIVED
MARY ANN McCABE
MAY 18 11 27 AM '76
RECORDER OF DEEDS
SUSSEX COUNTY

Sussex County
6-4-76

Aberbach, Robert & Carolyn
43 Dune Road
Bethany Beach DE 19930
(302) 539-3399
(703) 244-2207
raberbach@aol.com
caberbach@aol.com

Adams, Thomas & Sharon
13 Bridge Road
716 Halstead Road
Wilmington, DE 19803
(302)478-3267
(302) 539-7051
(302) 981-5316
thaswa@comcast.net

Ahamad, Kalad & Danielle Rouiller
9 & 11 Short
743 N. Riverside Drive
Crownsville, MD 21032
(443) 255-5381
danielle_rouiller@yahoo.com

Aiello, Thomas & Kathleen
32 E. Short
4831 Foxhall Crescent, NW
Washington, DC 20007
(202) 337-0965
(703) 288-6430
aiellokc@gmail.com
Taiello@alvarezandmarsal.com

Aiyer, Sri-Ram & Jeannie
28 Dune
7207 Brennon Lane
Chevy Chase, MD 20815
(302) 537-5844
(301) 986-0110
(202) 550-0546
aiyersriram@gmail.com

Al-Sowayel, Naila & Anthony Nozzoli
4 Dune
4200 Wisconsin Avenue NW,
#106-80
Washington, DC 20016
(202) 438-4522
(202) 438-4533
(202) 246-6618
aanozzoli@gmail.com

Alter, Nora
18 Addy
1936 Pine Street
Philadelphia, PA 19103
(302) 539-5123
(352) 226-2155
nalter@temple.edu

Ambrose, Michael
14, 16 Dune
925 Greenwood Avenue
Wyncote, PA 19095
(302) 537-6458
(215) 885-5567
(267) 241-0616
mjambrose@yahoo.com

Andreas, Christopher & Andrita
52 Dune
9430 Cornwell Farm Dr.
Great Falls, VA 22066
(703) 855-3385
cmajandreas@gmail.com

Arnold, Robert & Carol Ann Gray
Joseph & Melissa Gray
34 E. Short
3850 Birdsville Road
Davidsonville, MD 21035
(410) 991-7174
joseph.gray@comcast.net
mgray3540@comcast.net

Ball, Lynne
32 E. Bayberry
Bethany Beach, DE 19930
(703) 850-9333
lynnesball@gmail.com

Barila, Tim & Mary
13 Errett
Bethany Beach, DE 19930
(310) 785-6109 (Tim)
(410) 499-2611 (Mary)
tbarila23@gmail.com
mlbarila@gmail.com

Barkdoll, Ann, Saya & Rachel Minton
33 E. Bayberry
35 Congressional Ct.
Magnolia, DE 19962
(302) 538-5065
annbarkdoll@comcast.net

Barrett, Judith & Richard
19 Addy
30774 Sharon Slater Pass, #
1102
Milton, DE 19968
(443) 604-1509
(443) 517-3369
brjbarrett@aol.com

Barry, Jr., C. Eric
On Point Treasure, LLC
14 Addy
Bethany Beach, DE 19930
(302) 537-1916
(410) 360-0033
ebarry@freshcoatpainters.com

Bartman, Bill & Barbara
13 Bayberry
1276 Laurelwood Road
Pottstown, PA 19465
(610) 327-2094
(484) 467-7247
ski4124@aol.com
bar357@aol.com

Bennett, Judy
D M F Associates, Inc.
2 Beach Plum
34026 Coastal Highway
Bethany Beach, DE 19930
(302) 539-8615
(302) 539-4011
(302) 423-7803
judyteeth38@aol.com

Berner, Michael
Bethany Coastal, LLC,
8, 10(A) Beach Plum
P.O. Box 230370
Las Vegas, NV 89105
(717) 364-7901
mdb@bernergroup.com
bernergroup@icloud.com

Billings, Walter, III
2 Bridge
2310 Creswell Road
Bel Air, MD 21015

(410) 808-0178
waltbillings@comcast.net

Binkley, Larry & Andrea
21 Bayberry
Bethany Beach, DE 19930
(410) 952-6066
(410) 336-8876
lebinkley@verizon.net
abinkley@verizon.net

Bloch, Richard & Susan
22 Dune
4335 Cathedral Avenue, NW
Washington, DC 20016
(302) 539-6904
(202) 363-7979
(202) 641-5811
blochdc@gmail.com
bloch@law.georgetown.edu

Bohrer, Chris & Tanya
DEX 9 LLC
49 Dune
28200 Clarksburg Rd.
Damascus, MD 20872
(240) 876-6306 (Chris)
(301) 785-9622 (Tanya)
Chrisbohrer@comcast.net
Tanyabohrer@comcast.net

Bolasky, Brenda & David
15 Errett
105 S. Church Street
Macungie, PA 18062
(610) 217-9090
brenda.bolasky@gmail.com
greg@gregskinner.com

Brack, Dennis & Cindy
9 Errett
7704 Tauxemont Road
Alexandria, VA 22308
(703) 660-0675
(202) 547-1176
ccampbellbrack@gmail.com

Bradley, Paul & Karen
13 Short
1207 Hilltop Avenue
Wilmington, DE 19809
(302) 798-6864
(302) 229-1460
pbradley28@comcast.net
kbradley453@gmail.com

Brandt, Sally
31 E. Errett
1 Gramby Ct.
La Plata, MD 20646
(301) 399-2879
shbrandt@gmail.com

Branstad, Martha
23 Bridge
804 Merridale Blvd.
Mt. Airy, MD 21771
(301) 938-5020
(301) 787-9561
mbran005@gmail.com
kebranstad@gmail.com

Brooks, Jonathan & Emilie Hyams
32 Bridge
4408 Chalfont Pl.
Bethesda, MD 20816
(520) 991-8486
emilie.hyams@gmail.com
brooksjo2@yahoo.com

Burbage, Jack
14, 16, 18 Beach Plum
9919 Stephen Decatur Highway
Ocean City, MD 21842
(410) 213-1900
spielstick@bwdc.com

Byrne, Ann
137 Evergreen
3936 Rickover Road
Silver Spring, MD 20902
(301) 523-8563
annhbyrne@yahoo.com
pointelander@hotmail.com

Capon, Jonathan & Shawn
115 Evergreen, 24 Beach Plum
972 Dogwood Drive
Delray Beach, FL 33483
(301) 717-3563
(703) 969-8921
jcapon@valcourt.net
shawncapon0316@gmail.com

Certo, Richard & Jane
2 Short
121 N. Pleasant Ave.
Ridgewood, NJ 07450
(908) 531-0654 (Rich)
(201) 675-0007 (Jane)
rgcerto@gmail.com
janecerto121@gmail.com

Chappell, Pamela
10 Errett
Bethany Beach, DE 19930
(302) 539-4732
pam.chappell@verizon.net

Chason, Craig & Helen
19 Dune
4517 Garfield Street, NW
Washington, DC 20007
(202) 329-7775
(703) 770-7947
helenchason@gmail.com

Chodnicki, Chris & Lisa
19 Errett
11775 Chapel Estates Drive
Clarksville, MD 21029
(410) 977-9433
chris.s.chodnicki@gmail.com
lisachodnicki@verizon.net

Cicero, Frank
3 Short
315 Rogers Heights Road
Annapolis, MD 21401
(724) 255-8854
cicero@84lumbar.com

Clarke, Cory & Kevin
3 Addy
9414 Arnon Chapel Road
Great Falls, VA 22066
(302) 829-1375
(703) 268-5889
cs9414@hotmail.com
kevinc703@outlook.com

Coffay, Molly & John
Coffay Family LLC
58 Dune
19 Westspring Way
Lutherville, MD 21093

(443) 386-6799
mcoffay@verizon.net

Cohee, H. Linden & Bette
18 Bridge
31 Hayride Lane
Taneytown, MD 21787
(410) 336-6901
(410) 756-6777
l_bcohee@msn.com

Cohen, Neri & Ilene
4 Bridge
10 E. Lee St., #702
Baltimore, MD 21202
(410) 458-3042
(410) 207-9174
nmcohen@comcast.net
imgcohen@gmail.com

Condon, Thomas
Condon Family Trust
35 Dune
6403 Foggy Hills Way
Clifton, VA 20124
(302) 539-9007
(703) 631-0864
(202) 433-5454
TJCMFCplus@aol.com

Courtis, John & Angela
32 E. Addy
7902 Crestdale Drive
Potomac, MD 20854
(240) 752-4959
(240) 403-0277
sjcInc@verizon.net

Craver, Jon & Patty
28 Bridge
307 Sinegar Place
Great Falls, VA 22066
(703) 404-4047
(703) 405-4612
(703) 851-2755
pattycraver@aol.com
jon.d.craver@gmail.com

Crawford, Kate & Marty Shecter
19 Bayberry
1309 Magnolia Road
Silver Spring, MD 20905
(301) 908-8858
(301) 580-0140
calibanlives@msn.com
emmettlives@gmail.com

Cullen, Jack & Carolyn
33 Bridge
14731 Crossway Road
Rockville, MD 20853
(301) 943-5724
(240) 606-9540
carolyn.cullen@me.com
jackcullen1958@gmail.com

Cullen, John & Susan
Placide, Rick & Nancy
37 Dune
66 Franklin St. #418
Annapolis, MD 21401
(617) 913-0869 Cullen
(804) 840-3234 Placide
jscullen@yahoo.com
placidesix@yahoo.com

Cyr, Mark & Margie
25 Addy
Bethany Beach, DE 19930
(302) 604-0063 (Mark)
(302) 470-5755 (Margie)
mark@25addyroad.org
margie@25addyroad.org

D'Aiuto, Joan
3 Bayberry
1015 Race Street
Perkasie, PA 18944
(215) 350-8453
perkasie71person@gmail.com

Dawson, James & Joan
38 Dune
540 Innsbruck Avenue
Great Falls, VA 22066
(703) 296-5680
(301) 792-0132
Skipdawson57@gmail.com

DeBois, Michelle
40 Dune
P.O. Box 127
Bethany Beach, DE 19930
(302) 539-9282
(410) 979-0133
michelle.debois@gmail.com

DeBold, Daniel & Aldona
9 Bayberry
17812 Overwood Drive
Olney, MD 20832
(301) 924-3751
(240) 778-4492
aldona36@yahoo.com
daniel.debold@yahoo.com

Dempsey, James & Holly Fluty Dempsey
11 Bridge
6120 Plainview Road
Bethesda, MD 20817
(571) 265-5576 (Jim)
dempseyjim@msn.com
hfdathome@gmail.com

Deraska, Diane J.
3 Dune Rd LLC
3 Dune
2934 Cinnamon Bay Circle
Naples, FL 34119
(917) 748-7000
Bear.orsa@yahoo.com

Deraska, Don & Tricia
32 E. Evergreen
Bethany Beach, DE 19930
(781) 367-1271 (Don)
(781) 367-1248 (Tricia)
tderaska@deraskalaw.com
deraska@comcast.net
donderaska@gmail.com

Deraska, Donald
Evergreen Seaside, LLC
34 E. Evergreen
32 E. Evergreen Road
Bethany Beach, DE 19930
(781) 367-1271 (Don)
(781) 367-1248 (Tricia)
tderaska@deraskalaw.com
deraska@comcast.net
donderaska@gmail.com

Deraska, Donald
Windsor Seaside Serenity, LLC
33 E. Evergreen
32 E. Evergreen Road
Bethany Beach, DE 19930
(781) 367-1271 (Don)

(781) 367-1248 (Tricia)
tderaska@deraskalaw.com
deraska@comcast.net
donderaska@gmail.com

DeWitt, Elise & Steve
20 Bayberry
7584 Seabrook Lane
Springfield, VA 22153
(703) 447-3423
(703) 674-9063
s_edewitt@msn.com

Driesell Kammeier, Carolyn
PCC Driesell LLC
10 Dune
1114 General Lafayette Blvd
West Chester, PA 19382
(757) 321-3959
CDKammeier@gmail.com

Dryden, Kathy & Larry
20 & 22 Beach Plum
P.O. Box 157
Bethany Beach, DE 19930
(443) 783-2166
kldryden@gmail.com

David Ducey Trust
Ducey, David
15 Short
13913 Grey Colt Drive
Gaithersburg, MD 20878
(301) 340-9650
(301) 661-6661
dducey@verizon.net

Eisenbrandt, Fred
34 Addy Road LLC
34 E. Addy
2721 Caves Road
Owings Mills, MD 21117
(302) 537-2633
feisenbrandt3@gmail.com

Elias, Andrew & Debra Curtis
8 Bridge
314 5th Street, SE
Washington, DC 20003
(202) 528-4597
(202) 744-3276
andy.c.elias@gmail.com
debrascurtis@gmail.com

Errett, Terry & Trang Bowers
Errett Legacy Properties, LLC
30 Dune
135 Saint Moritz Drive
Wilmington, DE 19807
(302) 345-5812 (Terri)
(703) 470-3366 (Trang)
trangbowers@aol.com
terryerrett@gmail.com

Fegley, Amanda Hurt & Andrew
54 Dune
238 Prince George Street
Annapolis, MD 21401
(410) 268-3989
(410) 271-5470
(410) 353-3204
fegley4a@verizon.net

Fernandes, Conrad & Lynn Bufka
111 Evergreen
12902 Ruxton Road
Silver Spring, MD 20904
(240) 907-6722
conradzen@gmail.com
lbufka@gmail.com

Finder, Benjamin & Cindy
27 Addy
12400 Bacall Lane
Potomac, MD 20854
(301) 919-5323
(301) 258-5113
(301) 814-1217
BenF12400@aol.com
cindyfinder@gmail.com

Finley, Virginia
12 Short
Bethany Beach, DE 19930
(703) 772-6256
ginfin4@gmail.com

Finnegan, Brian & Melissa
31 Short
137 Forge Road
Glen Mills, PA 19342
(610 551-9483 (Melissa)
(215) 764-7682 (Brian)
melissafinnegan@verizon.net
31bridgeroad@gmail.com

Fisher, Carey & Mary Beth
4 Short
4120 Saul Road
Kensington, MD 20895
(301) 648-4758
(240) 271-6553
ctmbfisher@gmail.com

Flaherty, Joan
30 Bridge
15998 Garden Gate Court
Montclair, VA 22025
(703) 670-4756
frenchifl@aol.com

Foreman-LaManna, Rachel
Carol Tucker-Foreman
Michael LaManna
11 Dune
18254 AshMill Terrace
Leesburg, VA 20176
(302) 541-9435
(240) 994-0967 (Rachel)
(202) 441-4510 (Carol)
beachgirlieforever@gmail.com
carol@tuckfore.com

Forma, Mark
27 Dune
1868 Columbia Rd NW #307
Washington, DC 20009
(302) 539-3964
(202) 738-2874
marforma@aol.com

Friedman, Barbara & Andrew
Robert Kaufman
16 Errett
12012 Bogan Court
Potomac, MD 20854
(301) 613-3590
(202) 215-3157
barbara.a.friedman@gmail.com
rkaufman@gmail.com

Gale, Kenneth & Gail Munion
7 Bridge
1251 Thomas Oakes Drive
Pottstown, PA 19465

(610) 323-2776
(610) 999-2061
kgale2000@gmail.com

Gardner, Julie & Jamie Moul
15 Addy
228 Osprey Dr.
Edenton, NC 27932
(201) 401-0504
(828) 963-0124
gardner505@gmail.com
mouljl@retired.appstate.edu

Gay, Diane
113 Evergreen
Bethany Beach, DE 19930
(703) 819-0590
diane612@gmail.com

Gesell, Richard & Carol
23 Dune
Bethany Beach, DE 19930
(302) 539-9263
(301) 233-3436
rfgesell@aol.com

Gilliss, Edward & Barbara
121 Evergreen
521 Yarmouth Road
Towson, MD 21286
(410) 337-7440
(410) 823-1800
egilliss@rmmr.com
barbedgilliss@gmail.com

Glasgow, Thomas & Nancy
11 Errett
9126 Potomac Ridge Road
Great Falls, VA 22066
(703) 615-0830 (Nancy)
(703) 615-0829 (Tom)
taglasgow@aol.com

Gordon, Michael & Susan Marshall
Livingston; Jerry Malmo
12 Addy
1331 Park Road, NW
Washington, DC 20010
(202) 674-1123
(301) 602-5939
(703) 626-8638
(206) 715-8017
gbimichael@gmail.com
jmalmo@hotmail.com

Graves, William & Christina
Linda & Roger Heald
Patricia L. Smith
135 Evergreen
20616 Dubois Ct.
Montgomery Village, MD 20886
(301) 461-4530 (Linda)
(703) 801-1924 (Bill)
(240) 476-7057 (Patricia)
linda_a_heald@yahoo.com
bluebelleforestfarm@gmail.com
Pat.L.Smith51@gmail.com

Greenblum, Neil & Phyllis
2 Bayberry
2150 N. Ocean Blvd #3N
Boca Raton, FL 33431
(301) 520-5063
pgreenblum@gmail.com
ngreenblum@gmail.com

Griffin, Kathleen & Kenneth
16 Bridge
14570 Triadelphia Mill Road
Dayton, MD 21036
(443) 250-1482
(410) 794-6300
kengriffin1482@gmail.com

Grundhoefer, Kathy, Trust
5 Dune
635 Silver Creek Drive
Winter Springs, FL 32708
(407) 415-7230
katgrundy2@gmail.com

Gross, Jill & Donnie
Gross Family LLP
48 Dune
11305 Crossing Glen Court
Potomac, MD 20854
(301) 370-2224
(301) 762-3464
(301) 367-2224
jillgross83@gmail.com
dgross@livevarsity.com

Gruenspecht, Howard & Susan
1 Errett
66 Ellsworth Heights Street
Silver Spring, MD 20901
(202) 256-9113
(301) 320-6309
hsgruenspecht@gmail.com

Gruzin, Mark & Marla
9 Dune
9816 Bald Cypress Drive
Rockville, MD 20850
(240) 688-1524
mgruzin@verizon.net
marlabethg@verizon.net

Hall, Miriam
5 Short
Bethany Beach, DE 19930
(301) 651-3936
miriamrhall@gmail.com

Haller, Stacy
18 Bayberry
1401 Aintree Drive
Rockville, MD 20850
(240) 499-4487
stacyph@aol.com

Hamilton
7 Dune
1636 Cliff Drive
Edgewater, MD 21037
(302) 539-9079
(301) 651-3669
phamilton@wahamilton.com

Hathway, Charles & Maureen
25 Dune
2104 Cascade Road
Silver Spring, MD 20902
(301) 649-2771
(301) 452-7742
mbhathway@gmail.com
charleshathway06@gmail.com
chathway@bmcproperties.com

Hendrick, Mary & Edward J. III
4Bayberry
1408 Mission Rd.
Lancaster, PA 17601
(717) 725-0701
ehendrick2424@gmail.com
mbhendrick24@gmail.com

Hickman LP
Hickman LP, J & N
50 Dune, 26, 28 Beach Plum
P.O. Box 1
Bethany Beach, DE 19930
(302) 539-8000
lighthousepm@mchsi.com

Hillebrecht, Wayne & Susan
2 Addy
1847 Windovr Way
West Chester, PA 19382
(302) 537-9052
(610) 793-3945
(610) 529-1707 (Susan)
whillebrecht@yahoo.com
susanh409@gmail.com

Hodgson, Patricia
131 Evergreen
102 Wynleigh Dr. E
Wilmington, DE 19807
(302) 690-2264
tomgh@comcast.net

Holle, Jim & Dee
23 Bayberry
41 Beach Street
East Hanover, NJ 07936
(201) 919-6823
(862) 485-0028
d.holle@verizon.net
jim@jimholle.com

Ighemat, Farid & Danielle
25 Errett
827 Byers Road
Chester Springs, PA 19425
(302) 616-3627
(484) 885-8150
(267) 640-4391
ighematda@yahoo.com

Imus, Abby & Neil
34 Dune
7171 Woodmont Avenue #811
Chevy Chase, MD 20815
(301) 523-2224
(202) 390-7078
nwaki@msn.com
nwimus@gmail.com

Irmer, Robert & Martine
1 Addy
512 N. Alfred St.
Alexandria, VA 22314
(703) 244-0011
(703) 346-7283
Robirmer@gmail.com
martineirmer@gmail.com

Johnson, Dean & Maida
56 Dune
2342 Ballard Way
Ellicott City, MD 21042
(443) 742-8851
(443) 226-3222
deanjohnson443@outlook.com
meadjohnson2342@yahoo.com

Johnson, Kip & Judy Brocies
60 Dune
4820 Cumberland Avenue
Chevy Chase, MD 20815
(302) 539-2534
(301) 657-8123
(202) 637-2260
everett.johnson@lw.com

Gerald Kafka & Rita Cavanagh Kafka Family LLC
2 Dune
306 First Street
Annapolis, MD 21403-2605
(301) 518-2583
(301) 651-6588
gakafka@gmail.com
rita.cavanagh1@gmail.com

Kahn, Neil & Jennifer Berk
9 Addy
2207 Cross Country Boulevard
Baltimore, MD 21209
(410) 365-7334
nkahn@gggco.com

Katowitz, Janet
8 Short
1425 N. Carolina Avenue, NE
Washington, DC 20002
(202) 251-2967
janet@sagemediaplanning.com

Kazemzadeh, Ali & Jennifer
6 Dune
Bethany Beach, DE 19930
(301) 873-0394
davcomdan@gmail.com

Kellermann, H. Craig
34 Bridge
Bethany Beach, DE 19930
(302) 537-1560
(302) 515-5627
hcraigkellermann@gmail.com

King, Michael & Jacqueline
12, 13 Dune
14909 Poplar Hill Road
Darnestown, MD 20874
(302) 539-0126
(301) 963-4626
(240) 388-5321
deborah.king@hotmail.com

Kruger, Tristram
41 Dune
9641 Accord Drive
Potomac, MD 20854
(301) 814-1626
(301) 983-2283
(301) 983-2290
dr.tris@verizon.net

Kuczynski, Irving & Eileen Kennedy
24 Bridge
1407 Ridge View Way, NW
Washington, DC 20007
(302) 537-6351
(202) 361-0090
(703) 655-6217
ikuczynski@aol.com

Kuhn, Steve
30 Addy
Bethany Beach, DE 19930
(703) 212-7533
s.kuhn2@verizon.net

Kurtzman, Christopher & Linda
15 Bridge
Bethany Beach, DE 19930
(410) 241-5837 (Chris)
(410) 241-1315 (Linda)
chriskurt1@gmail.com

Lindakurt1@gmail.com

LaFleur, Janet
Janet C LaFleur Revocable Trust
123 Evergreen
9201 Belmart Road
Potomac, MD 20854
(301) 580-3621
janetlafleur@aol.com

Laigle, Matthew & Alexandra
5 Errett
45065 Smiths Nursery Road
Hollywood, MD 20636
(240) 577-9740
(301) 535-6963
MrLaigle@gmail.com
lularoethelaigles@gmail.com

Larkin, Richard Andrew (Drew) & Leslie Sutton
12 Bridge
12 Lennox Avenue
Severna Park, MD 222146
(410) 440-0463 (Drew)
(410) 733-4591 (Leslie)
larkinlax@aol.com
lalalark7@gmail.com

Larsen, Steven
6 Bridge
5436 Merriam Street
Bethesda, MD 20814
(240) 485-4213
stevenblarsen@outlook.com

Lazorchak, Carrie
62 Dune
Bethany Beach, DE 19903
(443) 306-9074
(410) 465-4594
(301) 928-8822
clazorchak@verizon.net
klazorchak@verizon.net

LAZ, Inc.
Lazorchak, Veronica
53 Dune
42060 Briarberry Place
Leesburg, VA 20176
(703) 727-5955 (Veronica)
(703) 77-5956 (Dave)
vlazorchak@aol.com
drlazor@aol.com

LeConte, William
21 Bridge
739 Tahoma Farm Road
Westminster, MD 21584
(410) 218-2471
wleconte@hotmail.com

LePage, Todd & Melissa
18 Errett
309 Rockwell Terrace
Frederick, MD 21701
(443) 812-1079
thelepages@yahoo.com

Lescht, Alan & Ellen
51 Dune
11009 Larkmeade Lane
Potomac, MD 20854
(202) 285-5184
alan.lescht@leschtlaw.com

Levri, Candice
20 Bridge
4401 Everett Street
Kensington, MD 20895
(301) 897-9362
candi@fastmail.com

Lewes Farmers Market
Ratner, Andrew
10 (B) Beach Plum, 12 Beach Plum
37230 Rehoboth Avenue Ext
Rehoboth Beach, DE 19971
(302) 227-6101
andrewratner@gottogollo.com

Lewis, Janet Lee
6 Errett
1226 North Pegram Street
Alexandria, VA 22304
(703) 587-4332
jleelewis124@gmail.com

Liddle, Virginia & David
5 Addy
Bethany Beach, DE 19930
(703) 282-2608
(703) 625-1720
personalnoteva@gmail.com
dliddle6703@gmail.com

Lightsey, Kristi & John Welch
17 Addy
23504 Buckridge Drive
Damascus, MD 20872
(301) 351-6488
kristi.lightsey@gmail.com
Jcwelch327@gmail.com

Lubben, Gary & Babette
Gary Lubben Trust & Babette Lubben Trust
24 Dune
128 Hillcrest Road
New Canaan, CT 06840
(203) 856-5795
gary@lubbencap.com

Lyons, Kathy & John Eckrich
2 Errett
Bethany Beach, DE 19930
(302) 858-2528
(302) 604-4956 (John)
jekl10685@gmail.com

Maslen, Thomas & Carrie
11 Bayberry
8008 Herb Farm Drive
Bethesda, MD 20817
(202) 870-1949
carrie.maslen@gmail.com
temaslen@gmail.com

Matthews, Dia & Mickey
20 Errett
4824 Keswick Rd.
Baltimore, MD 21210
(302) 539-9045
(443) 255-6610
m.matthews@stantonchase.com

Mayhugh, Dean & Sharon
19 Bridge
Bethany Beach, DE 19930
(302) 537-1410
sharonmayhugh@icloud.com

McCulloh, Mark & Holly
31 E. Addy

7 Franklin Street
Annapolis, MD 21401
(410) 207-4550 (Mark)
(410) 746-5886
mccullohmark@gmail.com

McGill, John & Stephanie
139 Evergreen
3601 Rittenhouse Street., NW
Washington, DC 20015
(202) 802-1057
(301) 938-4886
jmcgill@cgsh.com
stephaniemcgill@verizon.net

Meere, Edward & Frances
127 Evergreen
Bethany Beach, DE 19930
(302) 448-0652
fmmeere@msn.com

Meltzer, Morris & Debbie
17 Bridge
Bethany Beach, DE 19930
(301) 509-8150
(301) 908-3394
momeltzer@gmail.com
debmeltz31@gmail.com

Mergler, Hal
13 Addy
3700 Russell Road
Woodbridge, VA 22192
(302) 539-7155
(703) 926-6642
mergleralice@gmail.com
halmergler@aol.com

Miehle, Richard & Mary Ann
22 Addy
739 Dick Avenue
Warminster, PA 18974
(215) 287-4566
(215) 355-5435
rmiehle@verizon.net

Mintz, Paul & Solange
12 Errett
200 Reading Boulevard
Wyomissing, PA 19610
(610) 372-4553
(610) 223-8287
paul.s.mintz@gmail.com
solangeim20@gmail.com

Moneymaker, David & Jami Stephens
James D. Moneymaker Trust
18 Short
550 W, Beechtree Lane
Wayne, PA 19087
(610) 840-3839 (Jami)
(610) 316-6310 (David)
jamistephens1@gmail.com
david.w.moneymaker@gmail.com

Moneymaker, Sally
117 Evergreen
Bethany Beach, DE 19930
(302) 258-4412
(732) 948-1573 (Julie)
moneymaker058@gmail.com
murphyjulie98@gmail.com

Moore, Mary
10 Short
4986 Sentinel Drive, Apt. 201
Bethesda, MD 20816
(202) 320-7227
dr.marymoore@gmail.com

Mott, Deborah
AddyRoad LLC
20 Addy
Bethany Beach, DE 19930
(703) 217-7648
dmott@addyroad.com

Mounteer, Kate & David Burgess
Catherine C. Mounteer Trust
4 Errett
Bethany Beach, DE 19930
(703) 598-2845 (Kate)
(703) 598-2182 (Dave)
mounteerkate@gmail.com
davidburgess0404@gmail.com

Murphy, Michael & Madeline
24 Errett
23980 Whitten Farm Court
Aldie, VA 20105
(703) 856-3571
(703) 932-9385
greenmntains@gmail.com
madmurphee@gmail.com

Myers, David & Krista
119 Evergreen
6701 Melody Lane
Bethesda, MD 20817
(240) 383-2512
(240) 426-9888
davidmyers3@mac.com
Kmyers80@comcast.met

Narmi, Jeff & Kathy Boland
21 Dune
103 Henne Road
Bernville, PA 19506
(610) 914-4591
(610) 488-9975
jeffreynarmi@gmail.com

Neaton Trust
Rebecca Neaton Renwick
22 Errett
18926 Munchy Branch Road
Rehoboth Beach, DE 19971
(302) 382-0990
rneaton@comcast.net

Nemeroff, Ed & Ellen
7 Addy
11836 Hunting Ridge Court
Potomac, MD 20854
(302) 829-8225
(301) 762-5738
(301) 873-8521
ejnemeroff@gmail.com
eonemeroff@gmail.com

Nicholson, Daniel & Kristin
1 Short
1105 Yorkshire Way
West Chester, PA 19382
(302) 559-7434
(856) 982-3513
daniel.t.nicholson@gmail.com
kristinnicholson8@gmail.com

Stella A Howell Mem LLC
Noble, Patricia & Mark Howell
34 E. Errett
467 Snow Mesa Court
Grand Junction, CO 81507
(970) 549-1692

(970) 208-4610
webpnoble@gmail.com

Timothy John O'Brien Trust
Lisa Marie O'Brien Trust
1 Dune
1159 Snowberry Street
Park City, UT 84098
(801) 209-6198
(435) 901-0325
obrienpcut@gmail.com

O'Gorman, Scott & Melissa
28 Addy
3233 N. Vernon Street
Arlington, VA 22207
(703) 608-4459
(703) 855-0327
Sogorman61@gmail.com

O'Mara, Michael
12 Bayberry
4208 N. Charles Street
Baltimore, MD 21218
(410) 271-6389
oneillfam2@gmail.com
mpomara@gmail.com

Oxman, Jeff & Mindy
6 Addy .
Bethany Beach, DE 19930
(301) 461-8595
ox4921@gmail.com
moxman0698@gmail.com

Paul, Carol & Stephen
8 & 21 Errett
5009 Patuxent Riding Lane
Bowie, MD 20715
(240) 398-6430
carol@MdCornMaze.com
carolwoopaul@gmail.com

Peizer, Jeremy & Valkiria
8 Addy
4201 Sleepy Lake Drive
Fairfax, VA 22033
(703) 691-7608
valpeizer@gmail.com
jrpeizer@gmail.com

Pichler, Gregory
20 Dune
5602 Glenwood Road
Bethesda, MD 20817
(301) 580-7294
gregory.pichler@gmail.com

Pruckmayr, Gerfried & Gertrude
15 Bayberry
221 Foxcatcher Lane
Media, PA 19063
(302) 539-4773
(610) 565-2523
pruckmayr@verizon.net

Quinlan, Megan & Nathan Seltzer Quinlan Trust
8 Dune, 10 Bayberry
10 Bayberry Road
Bethany Beach, DE 19930
(202) 637-2206
(617) 416-0133
meganequinlan@gmail.com
nathanseltzer@gmail.com

Radeline, Royce & Katherine Radeline
10 Bridge
Bethany Beach, DE 19930
(703) 447-5001
rradeline50@gmail.com

Raphael, Jerome & Barbara; Jim Everline
23 Addy
250 Jefferson Avenue
Haddonfield, NJ 08033
(609) 969-3181 (Jerry)
(301) 318-0397 (Jim)
lifeofjerry@gmail.com
jline55@aol.com

Raskauskas, Ann
32 Dune
778 Garfield Pkwy
Bethany Beach, DE 19930
(302) 537-4436
(302) 245-2154
ann@bethanyareearealty,com

Raskauskas, Joseph
JCR Properties, LLC
30 Beach Plum
P.O. Box 1509
Bethany Beach, DE 19930
(302) 539-6950
(302) 537-2000
jcrsr@aol.com

Rayburn, George & Kent
24 Addy
Bethany Beach, DE 19930
(302) 829-8545
(410) 608-6033 (George)
(410) 337-8516 (Kent)
akrbar@comcast.net
georgejrayburn@gmail.com

Riemer, Kasey & Mike McBride
10 Addy
310 Midland Avenue
Wayne, PA 19087
(610) 608-0050 (Kasey)
(610) 908-8429 (Mike)
kaseyriemer@gmail.com
mmcbride911@gmail.com

Reilly, Mark & Terri
7 Short
Bethany Beach, DE 19930
(302) 463-3283 (Terri)
(302) 521-9251 (Mark)
ttreilly7@gmail.com
mreilly72024@gmail.com

Rhue, Susan, Jennifer & David Ricketts
6 Short
Bethany Beach, DE 19930
(302) 537-5457
(240) 264-0049 (Jennifer)
suerhue39@gmail.com
djricketts@verizon.net

Richards, Robert & Terry
24 Bayberry
23101 Howard Chapel Road
Brookeville, MD 20833
(301) 642-6023
(301) 642-7023
gangy55@gmail.com
bobrichards@rrands.com

Rivest, Jeffrey & Michelle
29 Dune
114 Hoylake Court
Avondale, PA 19311

(410) 215-9945
(484) 459-1601
jeffrey.rivest1037@gmail.com

Robinson, Tom & Betty
18 Dune
2720 Buckthorn Way
Naples, FL 34105
(410) 608-1785 (Betty)
(443) 255-5036 (Tom)
bettyfrobinson@gmail.com
trobin7175@gmail.com

Robinson, Mark & Renee
7 Errett
Bethany Beach, DE 19930
(302) 539-0161
ryrobinson@verizon.net

Robinson, Mark
Robinson Trust
8 Bayberry
7 Errett Road
Bethany Beach, DE 19930

Ross, Alvin & Chris Powers
3 Bridge
P.O. Box 64
Bethany Beach, DE 19930
(302) 537-4407
(202) 215-4882
(703) 203-9196
cpandar@aol.com

Rossiter, Walter & Marie
11 Addy
26400 Forest Vista Drive
Clarksburg, MD 20871
(302) 537-9889
(301) 253-3534
(240) 678-3601
rmarie600@aol.com

Santmyer, Thomas & Deborah
129 Evergreen
23183 Cobb House Road
Middleberg, VA 20117
(703) 599-0114
(703) 471-4911
tjsantmyer@verizon.net

Sayles, Eric Trustee
Baybe Sayles Family Trust
5 Bayberry
4419 Volta Place, NW
Washington, DC 20007
(302) 829-1038
(202) 733-1573
(202) 232-7100
eric@sayleslegal.com

Schoonover, Sharon
16 Bayberry
Bethany Beach, DE 19930
(302) 539-2043
(302) 236-9261
schoonoversa@gmail.com

Schreiber, Erik, Daniel
42 Dune
6 Ocean Willow
Ocean View, DE 19970
(703) 626-3157
(703) 626-2292
customfit360de@gmail.com
customfit360de.office@gmail.com

Schwartz, Kathryn & Edward
20 Short
4904 Essex Avenue
Chevy Chase, MD 20815
(202) 320-8058
(202) 321-5153
kschwartz@ttrsir.com
ebschwartz79@gmail.com

Schell, Joshua and Christine
26 Addy
5404 23rd St. N
Arlington, VA 22205
(301) 802-8811 (Josh)
(301) 910-2289 (Christine)
jwschell7@gmail.com
cmcmulquin70@gmail.com

Seeto, Reginald & Rachel Kahn
47 Dune
148 Treehaven Street
Gaithersburg, DE 20878
(646) 422-9540
(240) 813-5621
(973) 641-0952
reg.seeto@gmail.com
raka339@yahoo.com

Selig, Carol & John Trimble Anderson Family LP
6 Bayberry
P.O. Box 1108
Bethany Beach, DE 19930
(302) 228-8234
(561) 274-4560
carolselig22@gmail.com

Sella, Edward & Paula
25 Short
2625 Dapple Grey Court
Olney, MD 20832
(302) 616-1124
(301) 933-6938
esella@spcfinancial.com

Sheffey, Tim & Patti
32 E. Errett
14 Stone Hedge Drive
Lebanon, PA 1704
(717) 926-5251 (Patti)
(717) 304-1058 (Tim)
tdshef@comcast.net

Bigeye Investments
Shields, Richard & Pat Casey
31 Dune
334 Lazywood Court
Millersville, MD 21108
(410) 987-5030
(410) 212-7433
rshields334@verizon.net

Silbermann, James
16 Short
6836 Corder Lane
Lorton, VA 22079
(703) 606-5825 (Jim)
terpinva@gmail.com

Smith, Francis & Tracey
Buxton Property LLC
19 Short
11514 Ridge Mist Terrace
Potomac, MD 20854
(301) 762-4564
(240) 604-4564
(240) 603-4564
pmrypmry@gmail.com
tsmi409@yahoo.com

Smith, Jr., Joedy & Carol
33 Dune
Bethany Beach, DE 19930
(443) 829-4689
(443) 845-2404
joedy.smith@gmail.com
33dune@gmail.com

Sokolowski, Sean & Dana
27 Errett
101 East Delaware Canal Court
Middletown, DE 19709
(302) 382-9773
beach27errett@hotmail.com
danasokolowski@hotmail.com

Sparrow, Jason & Emily
16 Addy
21562 Wild Timber Court
Broadlands, VA 20148
(703) 963-1581
16AddyBB@gmail.com

Spataro, Paul & Nancy
26 Bayberry
1010 Gleneagles Drive
York, PA 17404
(717) 767-2915
(717) 968-9518
pspatarosr@comcast.net
nancycspataro@gmail.com

Stoiber, Jeff & Maggie Hudak
23 Short
Bethany Beach, DE 19930
(202) 271-2217 (Jeff)
(202) 271-2212 (Maggie)
stoiberjeff@gmail.com
Hudak.maggie@gmail.com

Stokes, Jamie & Jim
29 Addy
8518 John S. Mosby Hwy.
Upperville, VA 20184
(703) 409-0158
jlastokes333@gmail.com

Stone, Mary Lynn & Joseph
46 Dune
23811 Kingston Creek Road
California, MD 20619
(301) 481-2594
(240) 925-4605
marylynn@c21nm.com

Swanson, Carl & Helen, Trust
Susie Friedel
22 Bayberry
309 S. Hughes Street
Apex, NC 27502
(919) 601-7243
(302) 616-3198
matchingheartsandhomes@gmail. com

Szkudlapski, Edward & Carol
14 Bayberry
6 Glenmore Drive
Glen Mills, PA 19342
(610) 742-9679
(610) 742-9681
eszkudlapski@gmail.com
carolszkud@gmail.com

Tarulli, Steven F.
Birdhouse Properties, Inc.
31 E. Evergreen
85 Kennedy Avenue
Rockville Centre, NY 11570
(516) 761-5123
dbsnow22@yahoo.com
s.tarulli4@gmail.com

Tarulli, Steven F.
Joberta Properties, Inc.
17 Dune
85 Kennedy Avenue
Rockville Centre, NY 11570
(516) 761-5123
dbsnow22@yahoo.com
s.tarulli4@gmail.com

Taylor, David & Lauri
1 Bridge
1208 Anchorage View Court
Baltimore, MD 21224
(410) 952-8502
davidgtaylor1000@gmail.com

Taylor, Chuck & Peggy
21 Short
Bethany Beach, DE 19930
(302) 841-8116 (Chuck)
(302) 228-1778 (Peggy)
chucktoolz@aol.com
peggychuckt@aol.com

Thelen Properties, LLC
Thelen, Gerhard & Lynn
26 Bridge
P.O. Box 820
Captiva, FL 33924
(404) 323-4913
(757) 777-6137
gthelen18@gmail.com
lthelen13@gmail.com

Thiede, John & Wendy
26 Short
Bethany Beach, DE 19930
(240) 678-6852 (John)
(302) 217-2045 (Wendy)
wendythiede@msn.com
jptheide62@msn.com

Thomas, Ron
14 Short
Bethany Beach, DE 19930
(302) 220-9341
rtfromde@yahoo.com

Thompson, Julie Germain & Russell Germain
33 E. Errett
17712 Leonard St.
Dumfries, VA 22026
(571) 237-5832 (Julie)
(703) 898-6619 (Rusty)
jttimes5@gmail.com
rustle.t@gmaila.com

Throop, Ellen & Katherine Parrish
14 Errett
746 Buckeye Court
Millersville, MD 21108
(410) 320-3987
(410) 320-5136
ellent2014@icloud.com
Katherine.T.parrish@leidos.com

Trzaska, RJ & Brandy Wellman
4 Addy
620 E. Custis Avenue
Alexandria, VA 22301
(443) 398-5776

(215) 279-1454
Wellman.brandy1@gmail.com
Rj.trzaska@gmail.com

Tyson, William & Mary
3 Errett
4100 Dresden Street
Kensington, MD 20895
(301) 942-7142
(240) 338-8577
mrltyson@aol.com

Uhas, Dave & Linda
Moser, Lisa
1 Bayberry
1479 Valley View Rd.
Pottstown, PA 19465
(610) 327-0250
(610) 256-3950
luhas@comcast.net
daviduhas15@ gmail.com

Van Ness, Elliott Scott
7 Bayberry
580 Evans Ave.
Warrenton, VA 20186
(703) 609-5099
vss1@verizon.net

Vollmer, Mary & Julie Hays
24 Short
662 East Rocks Drive
Sanibel, FL 33957
(239) 896-4071
vollmer.mary@gmail.com

von Fricken, Manfred & Linda
39 Dune
9320 Georgetown Pike
Great Falls, VA 22066
(703) 929-0089
(703) 909-4600
rgwmav@aol.com
lindavonfricken@gmail.com

von Halberg, Andrea & Heinzelmann
22 Bridge
4793 Ewing Road
Castro Valley, CA 94546
(510) 220-1444
cindy.wikler@comcast.net

Wack, Bettina & Todd Sapiro
17 Bayberry
419 Constitution Ave.
Washington, DC 20002
(301) 732-9172
bettinawack@yahoo.com

Ward, Ellen
36 Dune
1755 Meadow Hill Drive
Annapolis, MD 21409
(410) 757-9472

Weiner, Harriet & Louis
Bella Vista LLC
44 Dune
2925 38th Street NW
Washington, DC 20016
(215) 806-2612
(202) 510-4378
harteacher@gmail.com
loumweiner@gmail.com

Weissberg, Norm & Audrey
45 Dune
12605 Steeple Chase Way
Potomac, MD 20854
(240) 372-3532
normweissberg@gmail.com
jorsam23@yahoo.com

Welburn Management
McDonalds
4 & 6 Beach Plum
3477 Corporate Parkway #150
Center Valley, PA 18034
(484) 442-1342
(703) 580-9410
dpliszka@tmmcpa.com

Wenzinger, Don & Susan
17 Errett
4513 Mercer Place
Vestal, NY 13850
(607) 727-4006
dwenzinger1@stny.rr.com

Wheeler, Gloria
21 Addy
12261 Roundwood Road, #1203
Timonium, MD 21093
(410) 821-6816
annejung03@gmail.com

Whitmore, Denise & Dennis
23 Errett
12100 St. Paul Road
Clear Spring, MD 21722
(301) 598-1666 (Denise)
(240) 313-5031 (Dennis)
wieschd@gmail.com
pastordennis1995@gmail.com

Wiecking, David
15 Dune
5315 Waneta Road
Bethesda, MD 20816
(301) 520-4868
dave@dawbeach.com

Wilby, Gregory & Kathleen
Tumbleweed 2018, LLC
26 Dune
970 Melvin Road
Annapolis, MD 21403
(301) 651-4420
ktwilby@aol.com

Wilkenfeld, Jonathan
14 Bridge
2312 Tracy Place, NW
Washington, DC 20008
(202) 363-2934
(202) 352-8506
jwilkenf@umd.edu

Wilson, Donna & Steve Roman
9 Bridge
7220 Stover Drive
Alexandria, VA 22306
(703) 629-9043
(703) 660-6181
(703) 819-0794 (Steve)
pibanker@verizon.net
roman.steve@icloud.com

Winschel, Daniel
125 Evergreen
Bethany Beach, DE 19930
(757) 645-7346
(203) 581-4623
drwinsch@gmail.com

Witcover-Sandford, Amy

Jules Witcover Irrevocable Trust
34 E. Bayberry
210 Terry's Run
Yorktown, VA 23693-2549
(202) 441-6900
(347) 668-9009
(757) 508-1772 (Amy)
pwitcover@yahoo.com
amsandy.aws@gmail.com
jwitcover@gmail.com

Wood, Bob & Toni
31 E. Bayberry, 5 Bridge
31 E. Bayberry Road
Bethany Beach, DE 19930
(410) 353-6982
(443) 928-2925
tri-guy@comcast.net
toots_les@comcast.net

Wood, Joseph (IV) & Timothy
22 Short
2410 John Owings Road, South
Westminster, MD 21158
(410) 926-5789
(917) 414-4892
jlwood4th@gmail.com
twood19@gmail.com

Woolman, Jr., Joseph & Norma
33 E. Addy
12 Bridleshire Road
Newark, DE 19711
(302) 539-2268
(302) 528-6020
(443) 413-4838
joewool@verizon.net
joe@jrwoolman.com

Yates, William
17 Short
3443 Jones Road
Dunkirk, MD 20754
(301) 943-0013
(443) 646-6427
willyates@verizon.net

Youniss, Jim & Dorothy
25 Bayberry
6902 Forest Hill Drive
University Park, MD 20782
(301) 922-1892
(301) 467-6310
youniss@cua.edu
dayouniss@verizon.net

Zengerle, Joseph & Lynda
133 Evergreen
5108 Moorland Lane
Bethesda, MD 20814
(301) 652-4675
(301) 651-5534
(202) 285-0977
lzengerle2@gmail.com
zen_3@verizon.net

US Army Corps of Engineers
Philadelphia District

DELAWARE COAST
Cape Henlopen to Fenwick Island

DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY

FINAL FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT

JUNE 1998

DELAWARE COAST
Cape Henlopen to Fenwick Island
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY

SYLLABUS

This report presents the results of a feasibility phase study to determine an implementable solution and the extent of Federal participation in a storm damage reduction project for the towns of Bethany Beach and South Bethany, Delaware. This feasibility study was prepared based on the recommendations of the reconnaissance study completed in 1991, which identified a possible solution to the storm damage problems facing the Bethany Beach/South Bethany area. The reconnaissance study also determined that such a solution was in the Federal interest and identified the non-Federal sponsor. The feasibility study was cost shared between the Federal Government and the State of Delaware through the Delaware Department of Natural Resources and Environmental Control (DNREC), and was conducted under the provisions of the Feasibility Cost Sharing Agreement executed in May 1992. The feasibility study was initiated in April 1995 upon receipt of study funds.

The Bethany Beach/South Bethany area stretches for approximately two miles along the northern part of the Atlantic Ocean Coast of Delaware. The area has been subject to major flooding, erosion, and wave attack during storms, causing damage to structures, and, since 1992, twice resulting in the Bethany Beach/South Bethany area being declared a National Disaster Area by the President of the United States. In recent years, continued erosion has resulted in a reduction of the height and width of the beachfront, including the virtual destruction of the existing dune system, which has increased the potential for storm damage.

The feasibility study evaluated various alternative plans of improvement formulated on hurricane and storm damage reduction. The selected plan for the Bethany Beach/South Bethany project area is a beach fill consisting of a dune and berm configuration at a width of 150' (115' dune base width and 35' berm). The berm elevation is +7 ft-NAVD, and the dune elevation is +16 ft-NAVD. The plan configuration is the same for both the Bethany Beach and the South Bethany project areas. The selected plan includes dune grass, dune fencing, and suitable advance beach fill and periodic nourishment to ensure the integrity of the design. The plan requires approximately 3,453,000 cubic yards of initial fill to be placed from a designated offshore borrow site, and subsequent periodic nourishment of 480,000 cubic yards every three years thereafter.

Benefits in the feasibility report are based on a January 1997 price level, updated to May 1998. Costs in the report are based on a May 1998 price level. Project benefits and costs were determined at a discount rate of 7.125%. The economic analysis for the selected plan indicates that the proposed project will provide average annual benefits of $5,146,000 which when compared to average annual costs of $3,277,000, yields a benefit to cost ratio of 1.6 with $1,869,000 in net excess benefits.

The total initial construction cost of the project is currently estimated to be $22,094,000 (May 1998 price level). Under the provisions of Section 103 of the Water Resources Development Act of 1986 (WRDA 1986), the Federal share of this first cost is $14,361,000 (65%), and the non-Federal share is $7,733,000 (35%). Periodic nourishment costs are currently estimated at $4,528,000 on a three-year cycle for the life of the project.

The Administration has proposed a new cost sharing policy for the periodic nourishment of shore protection projects. Cost sharing of the initial cost of construction would be unchanged and will continue to be specified by Section 103 of WRDA 1986. Under the proposed cost sharing policy, periodic nourishment will generally be 35% Federal and 65% non-Federal. The non-Federal sponsor, DNREC, supports cost sharing of project features consistent with existing law and implementation of periodic nourishment elements consistent with cost sharing enacted by Congress in law.

DELAWARE COAST
Cape Henlopen to Fenwick Island
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY

DESCRIPTION OF SELECTED PLAN

Project Title: Delaware Coast from Cape Henlopen to Fenwick Island; Bethany Beach/South Bethany Interim Feasibility Study

Description: The proposed project provides a protective beach berm and dune system to reduce the potential for storm damage in the towns of Bethany Beach and South Bethany, Delaware.

Beach Fill		
Volume of Initial Fill	3,453,000 yd^3	
Volume of Renourishment Fill	480,000 yd^3	
Interval of Renourishment	3 years	
Length of Fill	14,950 lf	
Width of Berm and Dune Configuration (Bethany Beach & South Bethany)		150 ft
Width of Berm (Bethany Beach & South Bethany)		35 ft
Width of Dune Base (Bethany Beach & South Bethany)		115 ft
Width of Dune Crest (Bethany Beach & South Bethany)		25 ft
Elevations		
Dune Crest	+16 ft-NAVD	
Beach Berm	+ 7 ft-NAVD	
Slopes		
Dune (Landward)	1V:5H	
Dune (Seaward)	1V:5H	
Berm Crest to MLW (Foreshore Slope)	1V:15H	
MLW to Depth of Closure	Parallels Existing Slope	
Dune Appurtenances		
Planted Dune Grass	116,160 yd^2 (24 acres)	
Sand Fencing	27,425 l.f.	
Vehicle Access (Bethany Beach)	1 Crossover	
Pedestrian Access (Bethany Beach & South Bethany)	41 Walkovers	

Price Level	May 1998
Project Costs	
Initial Construction Cost	$22,094,000
Periodic Nourishment (Per Operation, 3-Year Cycle)	$ 4,528,000
Cost Apportionment (Initial Construction Cost)	
Federal (65%)	$14,361,000
Non-Federal (35%)	$ 7,733,000
Average Annual Costs (Discount Rate = 7.125%)	
Initial Construction	$1,626,000
Interest During Construction	$ 33,000
Periodic Nourishment	$1,573,000
Operation and Maintenance (OMRR&R) – Non-Federal	$ 45,000
TOTAL	$3,277,000
Average Annual Benefits (Discount Rate = 7.125%)	
Storm Damage Reduction	$3,936,000
Local Costs Forgone	$ 396,000
Benefits During Construction	$ 81,000
Recreation	$ 633,000
TOTAL	$5,146,000
Net Average Annual Benefits	$1,869,000
Benefit-Cost Ratio	1.6

NOTE: All elevations referenced to the North American Vertical Datum, 1988 (NAVD).

DELAWARE COAST
Cape Henlopen to Fenwick Island
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY

FEASIBILITY REPORT

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INTRODUCTION

1. The Delaware Coast from Cape Henlopen to Fenwick Island Feasibility Study is an ongoing study of the shore protection problems facing the entire ocean coast of Delaware. Due mainly to fiscal limitations on the part of the non-Federal sponsor, the Delaware Department of Natural Resources and Environmental Control (DNREC), the feasibility study was broken up into three interim studies staggered in time and covered by one overall Feasibility Cost Sharing Agreement (FCSA). The three interim studies and their respective durations include Rehoboth Beach/Dewey Beach (1992-1995), Bethany Beach/South Bethany (1995-1998) and Fenwick Island (1997-2000).

2. This feasibility report for the Bethany Beach/South Bethany Interim Feasibility Study will provide recommendations for future actions and programs to reduce storm damage and shoreline erosion as well as provide valuable information to coastal planners and engineers. This feasibility report presents the existing conditions, without-project analysis, plan formulation analysis and the selected plan for this second interim study of the Delaware Coast from Cape Henlopen to Fenwick Island Feasibility Study.

3. This document was prepared in accordance with ER 1105-2-100 ("Civil Works Planning Guidance Notebook"), ER 1110-2-1150 ("Engineering & Design for Civil Works Projects"), ER 1165-2-130 ("Federal Participation in Shore Protection") and other applicable guidance and regulations. The guidelines for planning water and related land resources activities as contained in the "Civil Works Planning Guidance Notebook", require that Federal water resources activities be planned for achieving national economic development (NED) objectives. NED objectives are to increase the value of the Nation's output of goods and services and improve national economic efficiency, consistent with protecting the Nation's environment pursuant to national environmental statutes, applicable executive orders and other Federal planning requirements.

4. Due to the level of detail included in the Engineering Technical Appendix, and the fact that the proposed project is not complex, a Design Memorandum (DM) should not be required. Therefore, it is expected that the Preconstruction Engineering and Design (PED) Phase should essentially consist of the development of Plans and Specifications (P&S).

STUDY AUTHORITY

5. The Delaware Coast from Cape Henlopen to Fenwick Island Feasibility Study is being conducted in response to a resolution adopted by the U. S. Senate Committee on Environment and Public Works on 23 June 1988 at the request of Senator William Roth, Jr. This resolution reads as follows:

"RESOLVED BY THE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS OF THE UNITED STATES SENATE, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the Rivers and Harbors Act, approved June 13, 1902, be, and is hereby requested to review the report on the Delaware Coast from Kitts Hummock to Fenwick Island, Delaware, published as House Document Number 85-216, and other reports, with a view to determining the advisability of providing improvements in the interest of beach erosion control, hurricane protection, and related purposes, along the Delaware Coast from Cape Henlopen to Fenwick Island. Included in this study will be the development of a physical and engineering data base on coastal area changes and processes, including appropriate monitoring during development of the data base, as the basis for actions to prevent the harmful effects of shoreline erosion and storm damage."

STUDY PURPOSE AND SCOPE

6. The purpose of the feasibility study is to evaluate an array of solutions to reduce storm damages, including shoreline protection measures, and if warranted, to select a plan of improvement. If such a plan is supported by the non-Federal sponsor and is environmentally and socially acceptable, the feasibility report would recommend an implementable solution for hurricane and storm damage reduction (H&SDR) for the area under study.

7. The principal focus of this interim study is on the problems associated with the persistent erosion and storm damage potential along the shoreline of Bethany Beach and South Bethany which has caused significant economic losses during past storm events. This report considers the results of the reconnaissance phase of this study and includes the results of additional analyses conducted during the feasibility phase. In addition to the plan recommended in the reconnaissance phase, the feasibility study considered a wide array of alternatives for comparison.

8. Field data collection efforts included in this study consist of offshore acoustic impedance surveys to identify potential offshore borrow areas; hydrographic and topographic surveys; wave hindcasting analyses; benthic sampling of the identified offshore borrow source; remote magnetometer surveys of the identified offshore borrow site to investigate the presence of cultural resources; sand samples from the beaches in Bethany Beach and South Bethany; and vibrocore samples from the identified offshore borrow source. Additional offshore sand borrow sites were identified for possible use during initial construction and periodic nourishment of the selected plan. Field investigations and office work involved analysis of the collected field data and other data pertinent to the storm damage problems facing Bethany Beach and South Bethany.

9. This feasibility report will:

   a. Provide a complete presentation of the existing conditions, without-project analysis, and plan formulation analysis for the Bethany Beach/South Bethany Interim Feasibility Study;

   b. Indicate compliance with applicable statutes, executive orders, and policies; and

   c. Provide a sound and documented basis for decision-makers at all levels to judge the recommended solutions.

10. This report includes detailed engineering and economic appendices, including cost estimates, to compare alternative plans of protection. Ultimately the goal of this study is to recommend a plan to reduce the hurricane and storm damage potential in the towns of Bethany Beach and South Bethany.

DESCRIPTION OF THE STUDY AREA

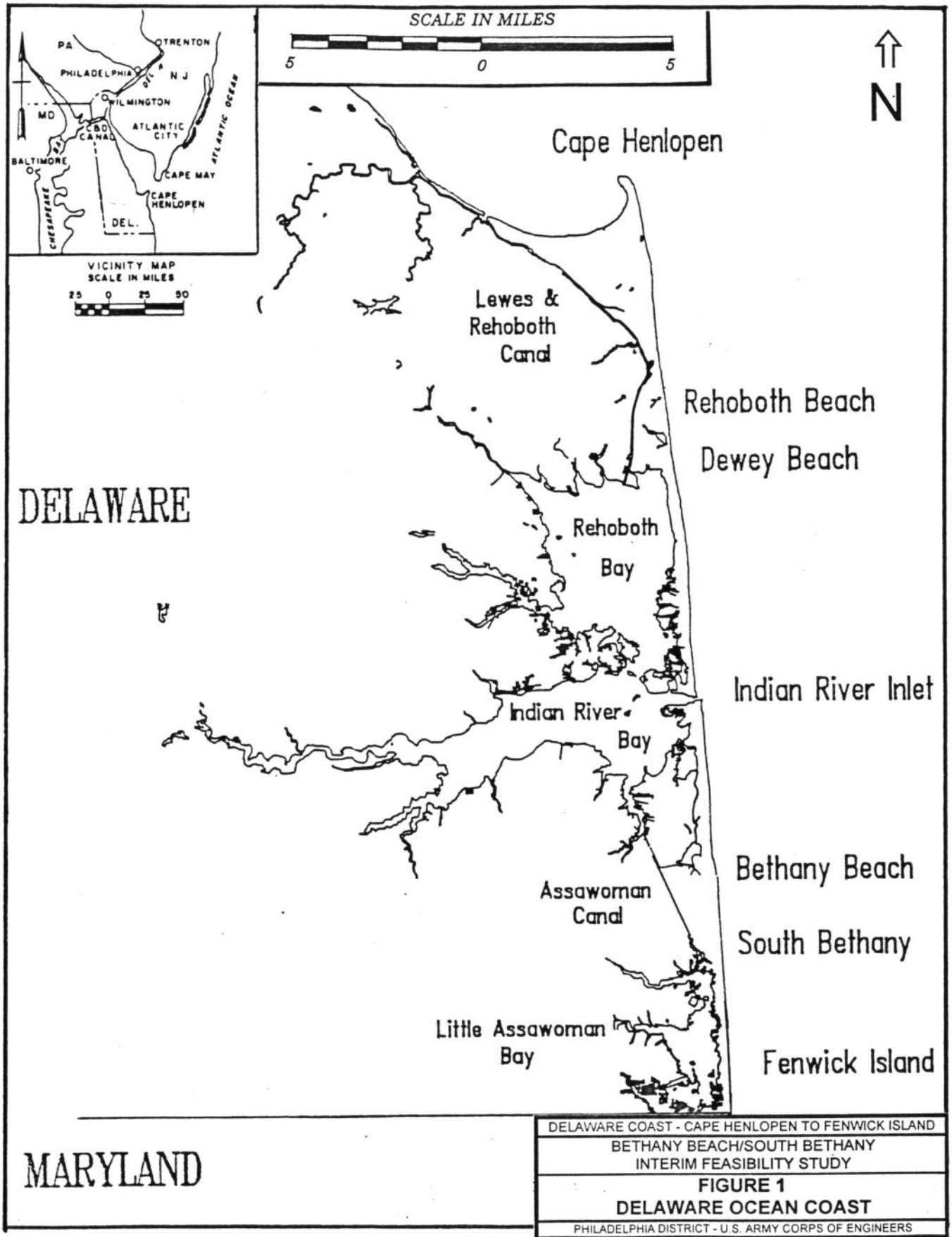
11. The Atlantic Coast of Delaware, located entirely in Sussex County, stretches from Cape Henlopen in the north to the southern border of Delaware with Maryland as shown in Figure 1. The Delaware Atlantic Coast is approximately 24 miles long and consists of six incorporated communities: Henlopen Acres, Rehoboth Beach, Dewey Beach, Bethany Beach, South Bethany, and Fenwick Island. Several unincorporated private developments also exist in the study area.

12. Three state parks are located along the coast. Cape Henlopen State Park is located in the northern part of the coast from Cape Henlopen to the private community of North Shores. Delaware Seashore State Park exists both north and south of Indian River Inlet in the central part of the coast. Fenwick Island State Park is located in the southern part of the coast between South Bethany and Fenwick Island.

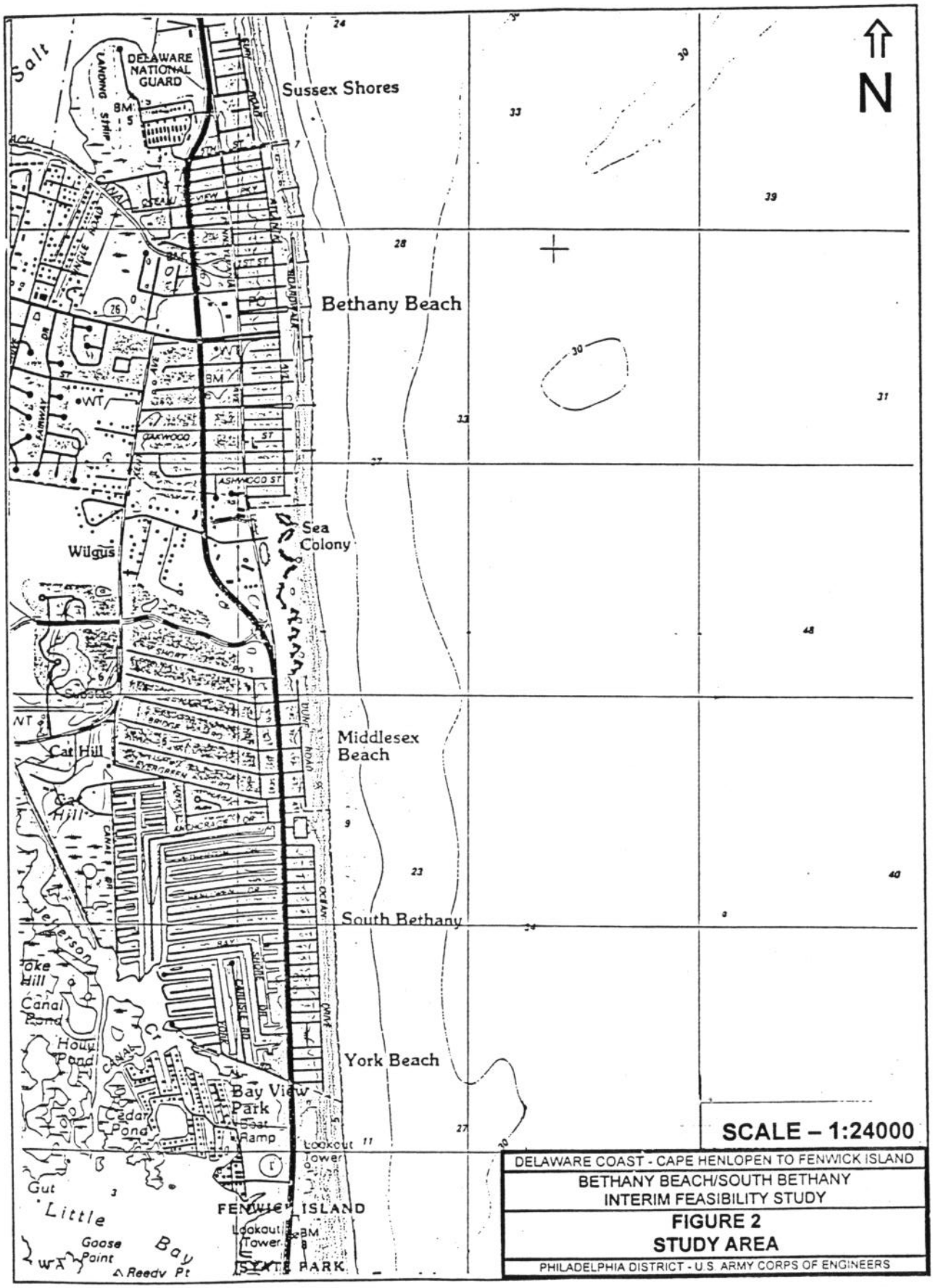
13. Three shallow water bays border the study area to the west. They are Rehoboth Bay, Indian River Bay, and Little Assawoman Bay.

14. From north to south the study area includes the incorporated town of Bethany Beach and the incorporated town of South Bethany. A project area map is shown in Figure 2.

15. **Bethany Beach.** The incorporated town of Bethany Beach, is headland and lies directly south of the unincorporated community called Sussex Shores. The town extends south for approximately one mile to the unincorporated community known as Sea Colony. The elevation of the beach is generally +6 ft-NAVD while the elevation of the upland area (developed area



DELAWARE COAST - CAPE HENLOPEN TO FENWICK ISLAND
BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY
FIGURE 1
DELAWARE OCEAN COAST
PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS



DELAWARE COAST - CAPE HENLOPEN TO FENWICK ISLAND

BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY

FIGURE 2
STUDY AREA

PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS

landward of the beach) generally ranges from +8 to +11 ft-NAVD. Along the beach are nine locally constructed groins. All of the groins are in generally good condition, functioning adequately and in no imminent danger of failing.

16. The town of Bethany Beach is highly developed with generally suburban characteristics. The main commercial district lies along Garfield Park, which runs from Route 1 in the west to the Atlantic Ocean in the east. Areas north and south of Garfield Park are generally residential in nature. Along the beach is a recreational boardwalk extending from just south of 2nd Street in the north, 2,050' south to Parkwood Street. Commercial businesses are established along the length of the boardwalk interspersed by residential structures.

17. **South Bethany.** The incorporated town of South Bethany lies directly south of the unincorporated area known as Middlesex Beach. The town extends south for approximately one mile to Fenwick Island State Park. South Bethany generally has the characteristics of a barrier island with the Atlantic Ocean to the east and Little Bay to the west. The width of the barrier island on which the southern half of the town of South Bethany lies averages approximately 2,200'. The elevation of the beach is generally +6 ft-NAVD while the elevation of the upland area generally ranges from +11 ft-NAVD in the northern part of the town to +8 ft-NAVD in the southern part of the town.

18. The town of South Bethany is highly developed with generally suburban characteristics. Route 1, which runs through the middle of town (north to south), is where most of the commercial businesses are located. The remainder of the town consists mainly of residential interests.

PRIOR STUDIES, REPORTS, AND RELATED PROJECTS

19. There exist numerous planned and completed shoreline protection programs and projects for the Atlantic Ocean Coast of Delaware. The projects have been initiated by the Federal Government and the State of Delaware. Descriptions of each of these projects are included in Table 1.

20. **Federal.** The history of Corps involvement along the Atlantic Ocean Coast of Delaware is long and involved. Before 1930, Federal Government involvement in shore protection was limited to protection of public property. With the enactment of The Rivers and Harbors Act of 1930 (Public Law 71-520, Section 2) the Chief of Engineers was authorized to conduct studies of erosion problems in cooperation with municipal and state governments in order to devise a means of preventing further erosion of the Nation's shores. Until 1946, Federal aid was limited to studies and technical advice. In that year, and again in 1956 (PL 84-826) and 1962 (PL 87-874), the law was amended to allow Federal participation in the cost of shore protection projects

and enabled limited contribution to the protection of private property, provided such protection would benefit the general public.

TABLE 1
PRIOR STUDIES AND REPORTS

REPORT TITLE	DATE	REMARKS
Delaware Coast from Kitts Hummock to Fenwick Island, H.D. 85-216	30 July 1957	Authorized Act of 3 July 1958 that entitled Federal participation in cost of restoration and subsequent periodic nourishment, not to exceed 10 years, of the shore from Rehoboth Beach to Indian River Inlet, DE. No action was taken.
Hurricane Study--Atlantic Coast of Southern New Jersey and Delaware, H.D. 89-238	December 1964	Chief of Engineers recommended that improvements for hurricane protection not be undertaken.
Delaware Coast Feasibility Report	1966	Recommended plans of improvement along entire ocean coastline of Delaware. Plans of improvement included beach nourishment, construction of dunes and bulkheads and rehab and replacement of existing structures. No action was taken.
Delaware Coast, Beach Erosion Control and Hurricane Protection, S.D. 90-90	2 July 1968	Review of H.D. 85-216. Recommends a project authorizing Federal participation in two reaches: Cape Henlopen to Indian River Inlet and Indian River Inlet to Fenwick Island. Led to 1972 GDM.
Delaware Coast, Beach Erosion Control and Hurricane Protection, GDM Phase I	December 1972	Generally, provided widening of the construction of a continuous dune to elevation +17.0 mlw except at developed areas where bulkheads would be built. Reaffirms project plan of S.D. 90.
Delaware Coast, Beach Erosion Control and Hurricane Protection, GDM Phase II	May 1975	Plan included beach fill with periodic nourishment for Reach 1 (Cape Henlopen to Indian River Inlet) and Reach 2 (Indian River Inlet to the DE-MD state line. Plan also included upgrading groins at Rehoboth Beach and rebuilding/upgrading groins at Bethany Beach. No action resulted.
Final Environmental Impact Statement--Draft Supplement for the Beach Erosion Control and Hurricane Protection Program for the Atlantic Coast of Delaware	1975	Draft Supplement EIS for the GDM Phase I of December 1972.
Delaware Coast Beach Erosion Control and Hurricane Protection, GDM Phase II, Supplement No. 1	February 1976	Responses to comments and/or questions pertaining to hydraulic design factors and criteria contained in the Delaware Coast Beach Erosion Control and Hurricane Protection GDM Phase II.
General Design Memorandum and Environmental Assessment, Atlantic Coast of Delaware (includes Atlantic Coast of Delaware Reevaluation Report)	November 1984	Examined three areas: north of Indian River Inlet, Bethany Beach to South Bethany, and interior shorelines of Indian River Inlet. Project recommended and resulted in construction of sand-bypass plant at Indian River Inlet and stone revetments on the north and south interior shore of the inlet.
Erosion Control Study--Detailed Project Report and Environmental Assessment	May 1985	Two reports that deal with the respective erosion problems of north and south interior shorelines of Indian River Inlet.
Delaware Coast from Cape Henlopen to Fenwick Island Reconnaissance Study	September 1991	Recommended further interim feasibility studies of storm damage reduction measures for Rehoboth Beach/Dewey Beach, Bethany Beach/South Bethany, and Fenwick Island.
Delaware Coast from Cape Henlopen to Fenwick Island-Rehoboth Beach/Dewey Beach Interim Feasibility Study	June 1996	Proposes a beach restoration project for the towns of Rehoboth Beach and Dewey Beach, DE. In addition, the report includes a general investigation of the coastal processes along the entire ocean coast of Delaware.

21. In a report dated 24 August 1936, the Shore Protection Board (now the Coastal Engineering Research Board) determined that the jetties prepared for Indian River Inlet would have little or no effect on the local beach erosion problem.

22. H. Com. 41, 75th Congress, 1st Session, authorized the Act of 26 August 1937. The Act authorized a 15-foot deep inlet channel to Indian River Bay, two jetties and a 15-foot deep channel in the bay to a point 7,000 feet from the ocean shoreline, thence decreasing to a 6-foot

depth.

23. The beach erosion control study covering the area from Kitts Hummock to Fenwick Island was conducted on a cooperative basis with the State of Delaware. The resulting report was submitted to Congress by the Secretary of the Army on 14 June 1957, and printed in House Document No. 216, 85th Congress, 1st Session. That report presented plans of shore protection for Kitts Hummock, Slaughter Beach, Broadkill Beach and Lewes Beach along the Delaware Bay shore of Delaware; and Bethany Beach and the reach from Rehoboth Beach to Indian River Inlet along the Atlantic Ocean Coast of Delaware. The plans of protection which were found suitable consisted of the artificial placement of material to widen the beaches, and the construction or repair of groins at various locations as required to assist in retaining the fill. The report concluded that improvements at all areas except the area from Rehoboth Beach to Indian River Inlet were not economically justified since the cost of providing protection would be in excess of the benefits that were reasonably assured from the proposed improvements.

24. The Rehoboth Beach to Indian River Inlet project was adopted by Congress in the Rivers and Harbors Act of 1958. The Act authorized Federal participation in cost of restoration and subsequent periodic nourishment, not to exceed 10 years, of the shore from Rehoboth Beach to Indian River Inlet, Delaware. Approximately 1,040,000 cubic yards (cy) of sand was placed on the beach in 1957, 1961, and 1963 under the authorization cited above, including the construction of an emergency dune and beach fill placed after the storm of March 1962. The material placed on the beaches during the period between 1957 and 1961 was substantially lost during the coastal storm of March 1962. Emergency work to restore the beaches and the construction of a new dune was undertaken by the Federal Government and was completed by September 1962.

25. A report entitled "After Action Report on Operation Five-High", dated August 1963 was prepared by the North Atlantic Division, Corps of Engineers. The report presents details concerning the extent and characteristics of the devastating coastal storm of 6-8 March 1962; the damages incurred; and emergency restoration work accomplished under provisions of Public Law 875, 81st Congress, by the North Atlantic Division in its area of responsibility along the coasts of New York, New Jersey, Delaware, Maryland, and Virginia.

26. A report on the hurricane damage prevention study of the Atlantic Ocean Coast of Southern New Jersey and Delaware was submitted to Congress in December 1964 and printed in House Document No. 38, 89th Congress, 1st Session. The Chief of Engineers recommended in the report that improvements for prevention of hurricane tidal flooding along the Atlantic Ocean Coast of Southern New Jersey and Delaware not be undertaken by the United States at that time. The study considered plans to provide complete protection along problem areas, and limited protection along other areas of the oceanfront. It was determined that complete protection could be provided for each problem area by a massive barrier-type structure, such as seawalls or dikes, which would not be feasible for both economic and aesthetic reasons. It was also determined

that partial protection could be provided by a stone revetment along the oceanfront, but this lower degree of protection could not be economically justified at any of the problem areas.

27. The Delaware Coast Feasibility Report of 1966, authorized under Section 103 of the Rivers and Harbors Act of 1962 and described in House Document No. 216, 85th Congress, 1st Session, focused on developing solutions for storm damage reduction for the Delaware Bay Coast as well as the Atlantic Ocean Coast of Delaware. The plans of improvement provide beach erosion control and hurricane protection for the entire Atlantic Coast of Delaware from Cape Henlopen to Fenwick Island. The plans consisted generally of the construction of dunes and the placement of beach fill, the construction of bulkheads at Rehoboth Beach, Dewey Beach and Bethany Beach, periodic nourishment of beaches, placement of sand fences, planting of dune grass, and the maintenance and replacement of existing shore protection structures. These plans were never implemented with the exception of advance construction of the feeder beach north of Indian River Inlet.

28. The Beach Erosion Control and Hurricane Protection Plan of Study--Advanced Engineering and Design dated 23 May 1983 provided the plan of study for the "Atlantic Coast of Delaware Reevaluation Report" (included as Appendix to General Design Memorandum (GDM) of 1984). This reevaluation report developed a scaled down version of the shore protection plan outlined in the Delaware Coast authorization of 1968. The reevaluation report and subsequent 1984 GDM focused on the areas: a) north of Indian River Inlet; b) Bethany Beach and; c) the north and south interior shorelines of Indian River Inlet. The erosion of the interior shorelines of Indian River Inlet was recommended to be pursued under the Continuing Authorities Program of Section 103 of the Rivers and Harbors Act of 1962, as amended. Stone revetments were completed in September 1989 to stabilize these shorelines.

29. The Delaware Coast GDM of 1984 addressed the erosion problems occurring at the shore immediately north of Indian River Inlet where Route 1 was being threatened. The recommended plan consisted of beach nourishment utilizing a fixed sand bypass plant at Indian River Inlet. The bypass plant, which was completed and went into full operation in 1990, is located on the south side of the inlet and consists of a semi-mobile jet pump system with an operations building containing the pumps. Sand is removed from the south jetty fillet area and pumped via pipeline over the Route 1 bridge to be discharged at various points along a 1,500-foot section of the shore north of the inlet. The plant was designed to pump on the average 100,000 cy of sand per year.

30. The Delaware Coast from Cape Henlopen to Fenwick Island--Rehoboth Beach/Dewey Beach Interim Feasibility Study addressed the hurricane and storm damage problems occurring along the shorelines of Rehoboth Beach and Dewey Beach. The NED plan consisted of beach nourishment along the oceanfront of both communities with the construction of a 125-foot berm topped by a +14 ft-NGVD dune in Rehoboth Beach and a 150-foot berm topped by a +14 ft-NGVD dune in Dewey Beach. The NED plan has been authorized by Congress for construction. As of the writing of this report, a Preconstruction Engineering and Design (PED) cost sharing

agreement is being negotiated with the State of Delaware. PED activities for the project can be initiated when the agreement is approved and executed.

31. **State.** A number of shore protection measures along the Atlantic Ocean Coast of Delaware have been undertaken by the state.

32. A report dated 18 January 1921 sponsored by the State of Delaware recommended construction of jetties and groins at Rehoboth Beach.

33. A total of 25 groins were constructed in the area between Rehoboth Beach and Bethany Beach by the State during the period between 1962 and 1964.

34. In 1963, the State of Delaware placed 590,000 cy of beach fill along the beach north of Indian River Inlet in accordance with the 3 July 1958 authorized project. The State awarded a contract in early November 1972 for the placement of approximately 600,000 cy of sand along the beach north of Indian River Inlet with the sand being obtained from the inlet. The project was accomplished in accordance with the plans under the authorization of Senate Document No. 90, and was eligible for Federal participation in the amount of 70% of the cost. The project when completed restored the beach and reinforced the dune along a one-mile stretch starting immediately north of the Indian River Inlet north jetty.

35. In the mid- to late-1980's, Delaware's southern beaches (Bethany Beach, South Bethany, and Fenwick Island) experienced a loss of shoreline protection due to chronic erosion problems. Considering the proximity of the nourishment project at Ocean City, Maryland and its associated equipment, DNREC contracted to have beach fill placed at all three towns utilizing this equipment. Subsequently, Fenwick Island was nourished in 1988 and 1992 and South Bethany and Bethany Beach were nourished in 1989 and 1992. The beach fill material for these efforts came from the borrow site cleared for Ocean City, Maryland. Approximately 1/3 of this borrow site lies within Delaware State waters. It was this portion of the borrow site that was used.

36. In the summer of 1994 DNREC, again taking advantage of the equipment in place for the Ocean City, Maryland Federal beach fill project, placed approximately 600,000 cy of beach fill material at Dewey Beach. In addition, maintenance fill was placed along the shorelines of Bethany Beach and South Bethany. DNREC also completed the rehabilitation of the groin seaward of Henlopen Hotel in Rehoboth Beach.

37. In addition to the reports presented above, studies and reports have been prepared by the Shore Protection Board, the State of Delaware, and the Corps of Engineers pertaining to the problems of flood control, coastal erosion, and shore protection. Several brief reconnaissance studies resulting from reports or complaints of beach erosion conditions at specific localities in the study area have also been made by the Corps of Engineers.

EXISTING CONDITIONS

PHYSICAL SETTING

38. **Tides.** Tides along the Delaware Coast are of the semi-diurnal type, with two nearly equal high tides and two nearly equal low tides. The average tidal period is 12 hours and 25 minutes, such that two full tidal periods require 24 hours and 50 minutes, shifting the time of occurrence of tide height extremes 50 minutes later each day. The ocean tidal ranges are published by the National Oceanic and Atmospheric Administration (NOAA). Mean and Spring tide ranges are listed in Table 2. Bethany Beach and South Bethany Beach are located south of Rehoboth Beach and north of Fenwick Island Light.

TABLE 2
OCEAN TIDE RANGE

LOCATION	MEAN TIDE RANGE	SPRING TIDE RANGE
Cape Henlopen	4.1'	4.9'
Rehoboth Beach	3.9'	4.7'
Fenwick Island Light	3.7'	4.5'
Ocean City, Maryland	3.5'	4.2'

39. **Wind.** Data on wind over the ocean are available from charts compiled and published by the U.S. Navy Hydrographic Office as well as the Coastal Engineering Research Center's (CERC) Wave Information Study (WIS) for the period 1956 through 1988. The available data show the prevailing wind direction at the Delaware Coast to be blowing offshore out of the southwestern and northwestern quadrants. However, winds from other directions are nearly as frequent. The winds blowing from the northeastern and southeastern quadrants have the largest influence on the direction of littoral transport and storm attack along the Atlantic Ocean shoreline of Delaware. In the 5° quadrangle nearest the Delaware Coast, the winds are distributed with respect to direction as follows: onshore (northeast, east, and southeast) 27%; alongshore (south and north) 11% and 15%, respectively; offshore (southwest, west, and northwest) 44%.

40. Long-term systematic data are available for Atlantic City, New Jersey, which is approximately 60 miles northeast of the study area, but considered valid as a regional source of data. Weather data was recorded at the Absecon Lighthouse from about 1902 to 1958, and from 1943 to the present at the National Aviation Facilities Experimental Center. The prevailing winds measured at Atlantic City are from the south and of moderate velocities between 14 and 28 miles per hour. Winds from the northeast have the greatest average velocity of approximately 20 miles per hour. The wind data from this record also show that winds in excess of 28 miles per

hour occur from the northeast more than twice as frequently as from any other direction.

41. **Waves.** Storm wave information, for use in modeling cross-shore change, is taken from a recent wave hindcast conducted by Offshore and Coastal Technologies-East, Inc. (OCTI) under contract to the Philadelphia District. Historic storm data were generated in the hindcast using a series of numerical models applied to two storm populations. The hindcast used 15 historic hurricanes and 15 historic northeasters that have affected District coastal areas in order to formulate the storm criteria. Normal condition wave information, for use in modeling longshore change, is taken from a recent Philadelphia District hindcast of 6 years of continuous waves (1987-1993) generated by a directional spectral method.

42. Also available is a 20-year hindcast of general wave climatology presented in the recent Corps of Engineers WIS prepared by CERC (Hubertz *et al.*, 1993). The wave statistics found in the WIS that are pertinent to the Delaware Coast are those for Stations 65 and 66, at a water depth of 18 meters (59.1 feet). Waves approach the coast from the northeast and southeast directions. The highest significant wave height reported in the hindcasts for Stations 65 and 66 was 7.7 meters (25') recorded during the northeaster of March 1962.

43. **Sea Level Rise.** Sea level rise is generally considered by the scientific and engineering communities to be a contributing factor to long-term coastal erosion and is also considered to increase the potential for coastal inundation. Because of the large variability and uncertainty of the climatic factors that affect sea level rise, predicting future trends with any certainty is difficult. Current Corps of Engineers guidance, ER 1105-2-100, states that the potential for relative sea level change should be considered in every coastal and estuarine (as far inland as the new head of tide) feasibility study that the Corps undertakes. Guidance states that The National Research Council (NRC) study on sea level rise, "Responding to Changes in Sea Level: Engineering Implications, 1987" will be used until more definitive data become available. Corps of Engineers policy calls for consideration of designs that are most appropriate for a range of possible future rates of rise.

44. ER 1105-2-100 requires a sensitivity analysis be conducted to determine any effect sea level change would have on plan evaluation and selection. The analysis should use the extrapolation of the local, historical record of relative sea level rise as the low level and Curve III from the NRC report as the high level. Based on historical gauge records between 1921 and 1986 at Lewes, Delaware, sea level has been rising at an approximate average rate of 0.0102 feet per year (Hicks and Hickman, 1988), which indicates a 0.51-foot rise in sea level over the 50- year period of analysis for the project. Curve III of the NRC report indicates a 1.4-foot rise over the 50-year period. Historical gauge records as well as NRC report data include subsidence. The ocean-stage frequency analysis, historic shoreline analysis, and required nourishment rate estimates incorporate the effects of sea level rise.

45. **Storms.** There are two major types of damaging storms that affect the Delaware Coast. They are "tropical", hurricanes and tropical storms, and "northeasters" or "extra-tropical" storms. Hurricanes usually diminish in intensity by the time they reach the Delaware Coast during their usual northward movement. No hurricane storm center has made landfall along the Delaware Coast since records have been kept (1871). However, several tropical storms and hurricanes have passed near the Delaware coastline in this period. A number of these have caused significant damage, including the great Atlantic hurricane of 1944. Northeasterly storms occur more frequently than hurricanes and usually are associated with longer durations of storm surge and high waves that cause considerable beach erosion and flooding along the coast of Delaware.

46. The most damaging storm to affect the study area during this century was the northeaster of March 6-8, 1962. The combined storm tide elevation of +8.1 ft-NGVD (adjusted for sea level rise) was the highest recorded in the period of record at Breakwater Harbor, Delaware. In recent years the area has experienced a high number of large Northeasters, which have produced stages among the highest in the period of record: October 1991 (the "Halloween" storm), January 1992, December 1992, March 1993, and March 1994. The January 1992 storm produced the second highest stage recorded at the Lewes gage, +7.0 ft-NGVD.

47. **Ocean Stage-Frequency.** The ocean stage-frequency relationship for the project area has been determined through a two-stage statistical fit to hindcast and historic measured data.

48. For more common events (up to the 10-year event) a stage-frequency relationship based upon a Weibull distribution fit to the maximum annual water levels measured at Lewes, Delaware over the last 80 years was utilized. This distribution has been used by the Philadelphia District in the past over the entire range of return periods and provides an excellent fit to the historic data up to the 10-year event. It may have overestimated water levels that occurred for higher-level events.

49. Ocean water levels for very extreme events (20-year storm and higher) were analyzed using storm hindcast results from the recent Delaware Bay and Atlantic Coast Hindcast performed by the Philadelphia District. In that study, the fifteen most severe hurricanes that occurred during the past century and the fifteen most severe northeasters that occurred during the past 42 years were numerically hindcasted, providing water levels during each storm at the project location. A best-fit Gumbel distribution was derived for that extreme storm population. The resulting stage-frequency relationship is presented in Table 3.

50. **Inland Bays Stage-Frequency.** During storms along the Delaware Coast, the open coast as well as the inland bays will become flooded above normal tidal levels due to increased flow through Indian River Inlet. Still water elevations in the inland bays were developed for the 10-, 50-, 100-, and 500-year storms in the 1992 Federal Emergency Management Agency's (FEMA) "Flood Insurance Study for Sussex County, Delaware". Still water elevations for all storm events to be considered in the modeling effort are listed in Table 4. It is assumed that there will be no surge barriers introduced in the inland bay since this study includes the oceanfront only,

thus there will be no anticipated difference in induced flooding in the inland bays between the without and with-project conditions.

TABLE 3 OCEAN STAGE-FREQUENCY DATA	
ANNUAL PROBABILITY OF EXCEEDANCE	**ELEVATION (ft-NAVD)**
0.5	5.3
0.2	5.6
0.1	6.5
0.05	7.8
0.02	8.6
0.01	9.7
0.005	10.8
0.002	11.2

TABLE 4 INLAND BAY FLOOD ELEVATIONS	
ANNUAL PROBABILITY OF EXCEEDANCE	**ELEVATION (ft-NAVD)**
0.5	3.7
0.2	4.7
0.1	5.4
0.05	6.1
0.02	7.0
0.01	7.8
0.005	8.5
0.002	9.4

51. **Geology.** Delaware encompasses segments of two regional physiographic-geologic provinces. The extreme northern portion of the state lies within the Appalachian Piedmont province, an area characterized by an exposed bedrock complex consisting of metamorphic and igneous rocks. The eroded surface of this complex slopes south and east to the sea, forming the depositional basement for the wedge-shaped mass of essentially unconsolidated sediments commonly referred to as the Atlantic Coastal Plain Province. This wedge, believed to reach a

thickness of approximately 7,800' at Fenwick Island, extends eastward beyond the edge of the continental shelf, which is considered a part of the Coastal Plain. As a result, this province can be divided into two sections: a submerged portion, commonly referred to as the continental shelf, and a subaerial or emerged portion, with the present Atlantic Coast shoreline forming the boundary between the two. The area under investigation lies totally within the Atlantic Coastal Plain approximately 85 miles southeast of the Fall Line (the exposed edge of the Piedmont), and encompasses segments from both the submerged and emerged portions of the provir ce. The boundary between the two portions is characterized by an ever-changing complex of depositional environments associated with the Atlantic barrier system. These environments, which include coastal marshes, tidal lagoons, and beach-dune complexes, represent the leading edge of an on-going marine transgression, which over the past 15,000 years has caused the shoreline complex to advance across approximately two-thirds of the Coastal Plain province to its present position. This transgression is occurring in response to a relative rising of the sea level. The current rate of rise is estimated to be approximately 1.02 feet per century along the Delaware Atlantic Ocean Coast.

52. The shoreline of the Atlantic Ocean Coast of Delaware consists of a continuous, wide, sandy baymouth barrier except for a break at Indian River Inlet. Coastal barrier beaches may be considered a continually moving geomorphic form with materials eroding from the beach face and accreting landward and upwards across the coastal lagoonal areas.

53. ***Surficial Deposits.*** The coastal area can be divided into two zones of similar geology: the Cape Henlopen Spit complex, and the baymouth barrier, lagoon, and highland complex between Rehoboth Beach and Fenwick Island. The Cape Henlopen complex is comprised of a washover barrier tract north of Rehoboth Beach extending to Cape Henlopen, a beach face/berm and dune system, and a large tidal flat. The stratigraphy of sediments in the spit dune area indicates beach and spit sands and gravels interbedded with shallow marine-estuarine silts (Kraft, University of Delaware).

54. The second area, the baymouth barrier, lagoon and highland complex is characterized by rapid erosion, predominantly coastal washover erosion. The barrier erodes at the beach face and nearshore area and accretes in a landward direction. The beach face is rather steep and the berm is comprised of horizontally laminated coarse to medium sand. A generalized vertical sequence of sediments found at Dewey Beach and south indicates dune washover sands overlying back barrier marsh sediments (clayey sand and peat) that contain tree stumps from an ancient pine forest. Below these are tidal delta sands and gravels followed by lagoonal sand and silt, and in some cases a small underlying pocket of beach sand. Marsh muds and peats are then encountered followed by a marsh fringe of muddy sand and grass roots and/or tree stumps. Pleistocene coastal sediments then form the base. When large storms occur, the beach berm sand may be washed over the barrier into coastal lagoons, sometimes exposing the marsh peats and tree stumps normally buried five to seven feet below the beach berm system. This extensive forest has been exposed along the length of the Delaware ocean coast, except at the Pleistocene

highlands at Bethany Beach and Rehoboth Beach. As a result of the beach erosion, rounded masses of peat and marsh mud, called "marshrollers", are often found moving along the surf adjacent to the eroding shoreline.

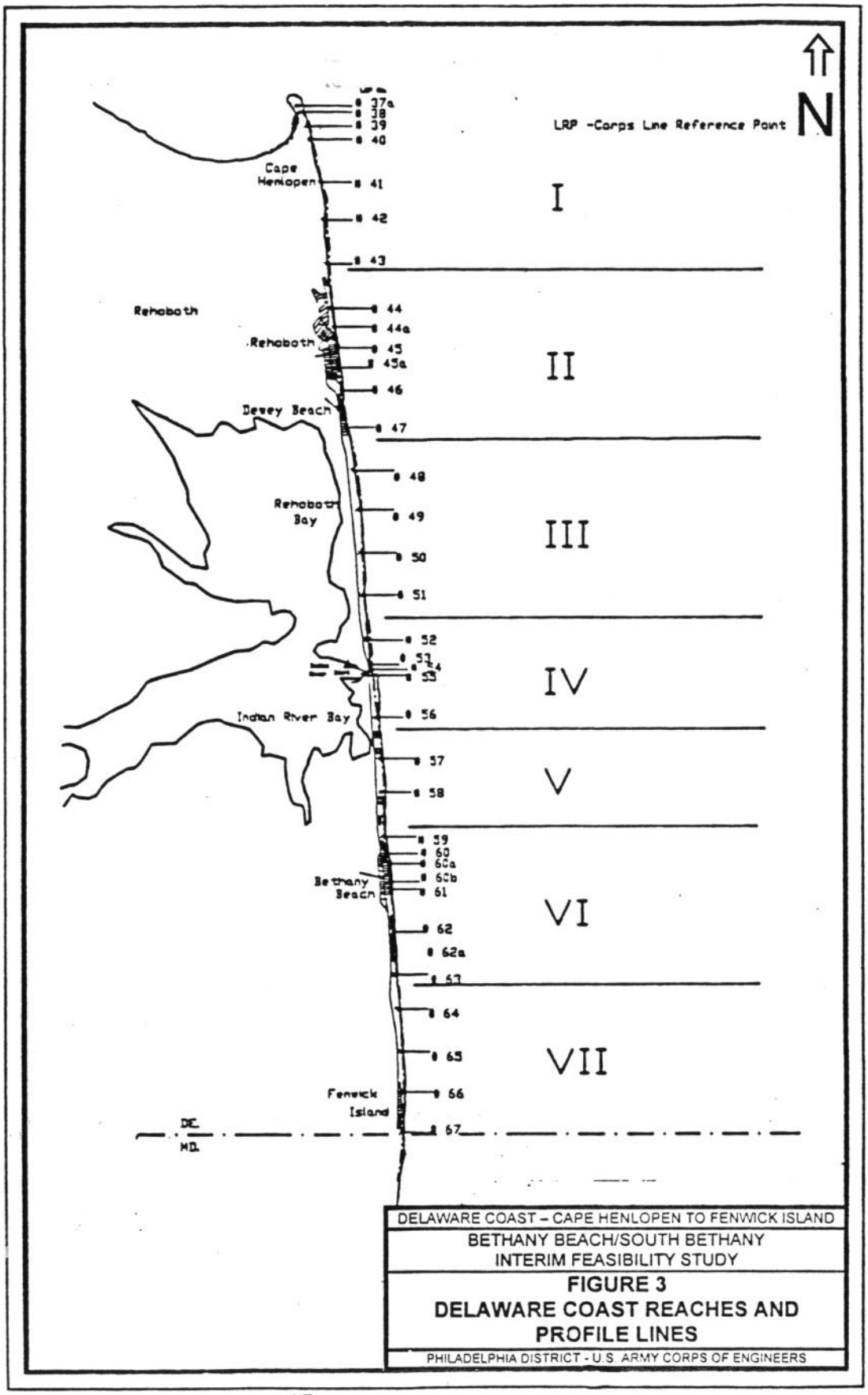
55. **Existing Beaches.** The Delaware ocean coastline, from the tip of Cape Henlopen south to the border of Delaware with Maryland, is approximately 126,500' (24 miles) in length. This shoreline was subdivided into seven reaches based on their similarities in profile configuration, local coastal processes, upland development, and geographical proximity. The individual reaches are listed in Table 5 and seen in Figure 3. Reach VI, just over 15,000' in length, contains Bethany Beach and South Bethany. Bethany Beach comprises the northern portion of the reach, and South Bethany comprises the southern portion of the reach. In between the two towns are the private Sea Colony complex and the unincorporated area of Middlesex Beach.

TABLE 5
SHORELINE REACH IDENTIFICATION FOR THE ATLANTIC COAST OF DELAWARE

REACH NUMBER	LENGTH	LIMITS
I	26,800'	Cape Henlopen to N. Rehoboth Beach
II	13,900'	Rehoboth Beach & Dewey Beach
III	18,300'	South of Dewey to 2 miles north of Indian River Inlet
IV	21,100'	Indian River Inlet area, 2 miles north and south
V	11,800'	2 miles south of the inlet to north of Bethany Beach
VI	15,200'	Bethany Beach & South Bethany
VII	19,400'	South Bethany to DE/MD border

56. Within Reach VI, the Bethany Beach area is a relatively low-lying headland shoreline and is only slightly less susceptible to inundation than barrier beaches. The general existing conditions for Bethany Beach consist of narrow beaches, little or no dunes with large sections of bulkhead backing the profiles and high backshore elevations. Bethany Beach has 9 groins that have acted to stabilize the shoreline in recent history. However, the other areas in Reach VI are outside of the groin field. South Bethany is characterized by its small beachface berm with little or no dunes and backshore areas of low elevations.

57. **Sediment Transport.** The Atlantic Ocean coastline of Delaware consists of approximately 24 miles of sandy shoreline that approximates a straight north-south line. Its continuity is interrupted only by Indian River Inlet midway. The coast is exposed to the essentially unlimited fetch of the open Atlantic Ocean from northeast through to the south, such that the physical processes of the shoreline are dominated by ocean waves. However, there are also regionally and locally important effects related to tidal circulation from the mouth of Delaware Bay and Indian


N
LRP -Corps Line Reference Point
37a
38
39
40
Cape Henlopen
41
42
43
I
Rehoboth
44
44a
45
45a
Rehoboth
46
II
Dewey Beach
47
48
Rehoboth Bay
49
50
III
51
52
53
54
55
IV
Indian River Bay
56
57
58
V
59
60
60a
60b
Bethany Beach
61
62
62a
63
64
VI
65
66
Fenwick Island
67
VII
DE
MD.
DELAWARE COAST – CAPE HENLOPEN TO FENWICK ISLAND
BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY
FIGURE 3
DELAWARE COAST REACHES AND
PROFILE LINES
PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS

River Inlet. The existence of tidal current effects has been recognized qualitatively for decades, but no investigation to date has attempted to resolve their relative magnitude of influence on longshore transport as compared to wave related effects.

58. At the northern end of the Atlantic Ocean coastline of Delaware, the historic northward growth of the spit of Cape Henlopen is graphic evidence of the predominant northward longshore transport at that locality. At Indian River Inlet, 13 miles south of Cape Henlopen, the predominant transport direction is also northward, as evidenced by long-term accretion of the beach south of the south jetty and erosion north of the north jetty. However, at Ocean City (Maryland) Inlet, located 9 miles south of Fenwick Island, predominant transport is clearly to the south as evidenced by accretion on the north (Ocean City) side of the inlet and significant erosion south of the inlet on Assateague Island. In the reach between Indian River Inlet and Ocean City Inlet there is a reversal in the direction of predominant longshore transport, which is referred to as a nodal zone.

59. A coast-wide analysis of sediment transport quantities determined potential net transport rates ranging between 150,000 to 250,000 cy per year northward at Cape Henlopen, 75,000 to 150,000 cy per year northward at Indian River Inlet, and 125,000 to 200,000 cy per year southward at the southern border of Delaware with Maryland. The gross transport quantities computed along the entire Delaware Coast area ranged from 700,000 to 900,000 cy per year.

60. **Historic Shorelines.** The historic shoreline analysis was conducted to document the past behavior of Delaware's Atlantic Ocean coastline in order to make a reasonable estimate of "background" or long-term steady-state rates of shoreline change. Sediment transport patterns and shoreline change data were analyzed coast-wide to develop the estimates of historical shoreline behavior for each reach. The present analysis relied on a variety of information sources including aerial photography, beach profiles, Wave Information Studies, and pertinent reports of previous analyses.

61. A systematic analysis of beach profile data at established Corps of Engineers - Line Reference Points (LRP) was carried out. The LRP Profiles represent a system of profile locations stretching from Cape Henlopen to the Delaware/Maryland border. The locations of the profile lines and their relationships to the various reaches are shown in Figure 3. The LRP's were first surveyed in 1964 then not again until 1982, but have been consistently monitored since then. The survey data from each LRP for all available years was plotted and shoreline position determined for each survey. A regression analysis was performed to determine the long-term trend at each LRP location. In order to supplement the profile data analysis, two independent sets of Delaware shoreline change maps, which include shorelines from the 1850's to 1988, were incorporated into the analysis. They were produced at the University of Maryland Laboratory for Coastal Research using a Metric Mapping technique (Galgano and Leatherman, 1988), and by the University of Virginia (Dolan *et al.*, 1978, 1990) using similar technique. Recent aerial photography and photogrammetry (1990 through 1993) were employed to update the above

analyses in order to estimate long-term change rates.

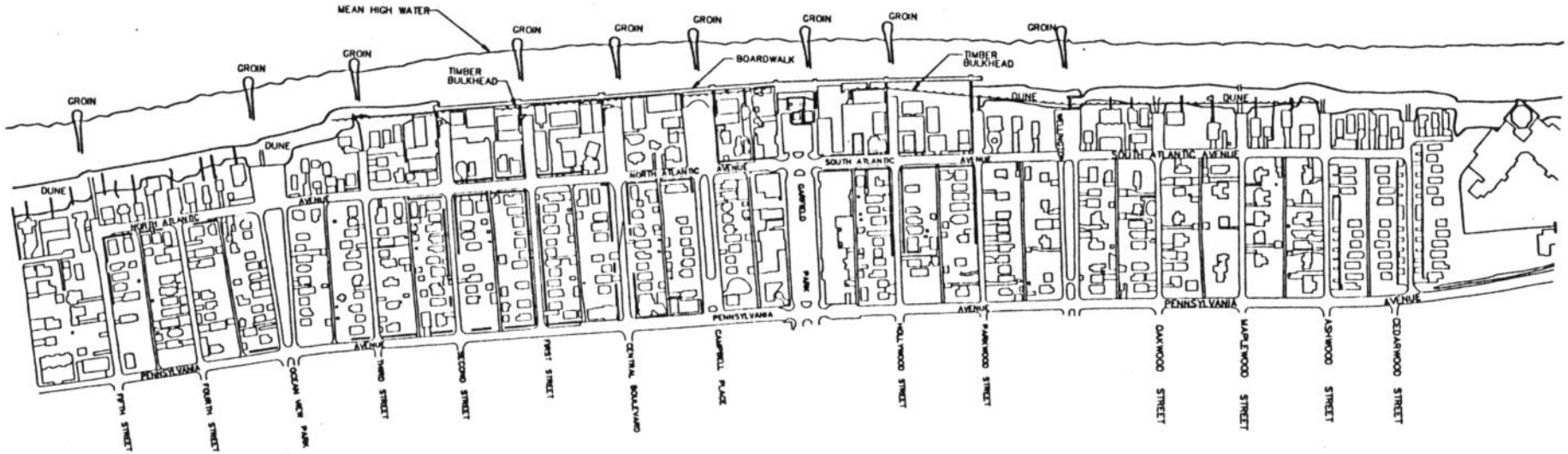
62. Table 6 presents a summary of the historic shoreline results. These were developed considering all of the available sources of historic shoreline information. A reasonable range and the average value of shoreline change rates are presented. The fluctuating rates within each reach indicate the variability spatially as well as temporally throughout the study area. It also serves to indicate the great potential for sediment movement along the entire Delaware shoreline. The average rate was adopted for use in estimating volumetric changes within each of the seven study reaches.

TABLE 6
HISTORICAL SHORELINE CHANGE

REACH	CHANGE RANGE (ft/yr)	AVERAGE RATE (ft/yr)
I	+3 to -10	-5
II	+3 to -6	-3
III	0 to -8	-5
IV	North: -5 to -10 South: +4 to -3	North: -7 South: +2
V	+3 to -5	-3
VI	+3 to -2	-1
VII	+1 to -5	-2

63. **Existing Coastal Structures.** There are at present nine groins within the study limits, all located in Bethany Beach. The groins are of stone, steel sheetpile, and timber crib construction. The groins were originally constructed in the 1930's and 1940's. Most of the groins have been rehabilitated since their original construction. See Figure 4 for locations. All of the groins were built by the State of Delaware.

64. In general, the groins located in Bethany Beach appear to be trapping sand along the shoreline. The landward sections of the timber and steel sheetpile groins appear to be in poor condition, but the outer rubble mound sections are in good condition. The groin at Garfield Parkway, which is steel sheetpile and stone filled timber crib, is in poor condition for its entire length. The rubble mound groins are all in good condition. Table 7 presents a summary of the existing groins. Photos of the groins are included in the Engineering Technical Appendix, Section 6.



BETHANY BEACH

GRAPHIC SCALE

(IN FEET)

DELAWARE COAST – CAPE HENLOPEN TO FENWICK ISLAND

BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY

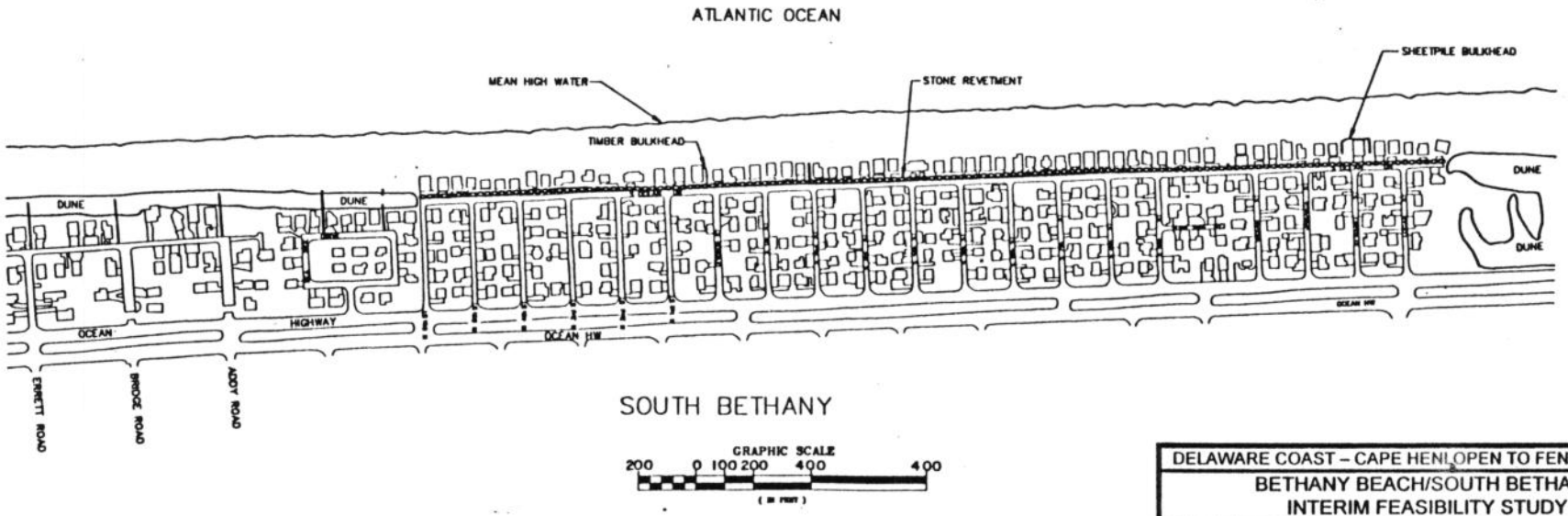
FIGURE 4

EXISTING FEATURES – BETHANY BEACH

PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS

TABLE 7 BETHANY BEACH, DELAWARE - EXISTING BEACH GROINS				
LOCATION	**TYPE OF CONSTRUCTION**	**LENGTH**	**CONDITION**	**YEAR BUILT**
Maplewood Street	Rubble mound	230'	Good	1987
Wellington Parkway	Rubble mound	180'	Good	1986
Garfield Parkway	Steel sheetpile and stone filled timber crib	190'	Poor	1940's-1950's
Hollywood Street	Rubble mound	200'	Good	1985
Campbell Place	Steel sheetpile, timber, and outer rubble mound	180'	Steel, timber-Poor Rubble mound-Good	1930's-1950's
First Street	Steel sheetpile, timber, and outer rubble mound	200'	Steel, timber-Poor Rubble mound-Good	1930's-1950's
Third Street	Steel sheetpile, timber, and outer rubble mound	220'	Steel, timber-Poor Rubble mound-Good	1930's-1950's
Ocean View Park	Steel sheetpile, timber, and outer rubble mound	240'	Fair	1937
Fifth Street	Steel sheetpile, timber, and outer rubble mound	260'	Steel, timber-Poor Rubble mound-Good	1930's-1950's

65. In Bethany Beach there are two bulkheads (elevation +13 ft-NAVD) protecting approximately 3,600', or 69%, of the oceanfront. The bulkheads are constructed of timber king piles and timber sheeting, and are anchored with steel tie rods and timber deadman. These bulkheads were built by private interests. There are two bulkheads in South Bethany located along approximately 150', or 4%, of the oceanfront. The bulkheads are of timber and steel sheetpile construction, and were built by individuals to protect private property. The bulkheads in both towns are generally in fair to good condition, effectively reducing erosion and inundation damages to areas landward. Locations are shown in Figures 4 and 5. See Tables 8 and 9 for a



DELAWARE COAST – CAPE HENLOPEN TO FENWICK ISLAND

BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY

FIGURE 5
EXISTING FEATURES – SOUTH BETHANY

PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS

summary of the bulkheads. Photos of the bulkheads are included in the Engineering Technical Appendix, Section 6.

TABLE 8
BETHANY BEACH, DELAWARE - EXISTING BULKHEADS

LOCATION	TYPE OF CONSTRUCTION	LENGTH	CONDITION	YEAR BUILT
Ashwood Street	Anchored timber bulkhead	1,750'	Good	1960's-1970's
Garfield Parkway	Anchored timber bulkhead	1,850'	Good	1960's-1970's

TABLE 9
SOUTH BETHANY, DELAWARE - EXISTING BULKHEADS

LOCATION	TYPE OF CONSTRUCTION	LENGTH	CONDITION	YEAR BUILT
N. First Street	Anchored timber bulkhead	150'	Good	1970
Kewanee Street	Steel sheetpile	200'	Fair-Poor	1970

66. A stone revetment is located along the oceanfront of South Bethany from Logan Street at the south end to N. 6th Street along the toe of Ocean Drive (see Figure 5). The revetment extends over 3,550' and is continuous except for gaps (150') where homeowners refused to build on their property. The revetment was constructed in the mid-1980's to protect the oceanfront road, Ocean Drive, from erosion during storms. Based on recent storm history, the revetment has been moderately successful at limiting erosion or recession of Ocean Drive. A more detailed description and photo is included in the Engineering Technical Appendix, Section 6.

67. **Storm Drain Outfalls.** There are no storm drain outfalls within the study limits.

68. **Boardwalk.** A boardwalk extends from the north end of Bethany Beach at 2nd Street south to Parkwood Street. The boardwalk is 12' wide, constructed of timber, and has been present in Bethany Beach for many years. The boardwalk was rebuilt in the early-1990's following coastal storms. The condition of the boardwalk is good. A more detailed description and photos are included in the Engineering Technical Appendix, Section 6.

SOCIAL AND ECONOMIC SETTING

69. **Population and Land Use.** The interim feasibility study area is comprised of Bethany Beach and South Bethany which lie within the 950 square miles of Sussex County. Sussex County is the southernmost and largest of the three counties in Delaware, encompassing 48% of the state's land. Although it is the largest of the counties it is also the least populated, with only 113,229 year round residents, totaling 17% of the state's permanent population, according to the 1990 Census.

70. The oceanfront of Bethany Beach is lined with hotel and condominium complexes as well as single-family residential structures. Data from the 1990 Census indicate there were a total of 2,074 housing units within the town, of which about 94% were single housing units. The median value of a single-family home in 1990 was $155,100.

71. Bethany Beach is heavily developed with very little available land in the town, particularly along the oceanfront. However, before any construction can begin, whether it is new construction or rehabilitation, property owners must receive the proper permits from DNREC. DNREC helps the applicant arrange meetings with the appropriate state officials as well as answering any questions on permit requirements. Bethany Beach also strictly adheres to FEMA guidelines. Structure foundations along the ocean block are mixed, with most structures built after the March 1962 storm on piles.

72. As of 1994, there were 340 year-round residents. Bethany Beach attracts thousands of summer residents every year with its beaches and its boardwalk. The boardwalk includes all the stores, fast food establishments, and arcades associated with such a feature. The town provides public access to the municipality's beach, and has many metered parking spaces.

73. The unincorporated communities of Sea Colony and Middlesex Beach are directly south of Bethany Beach. Sea Colony consists of a complex of multiple high-rise condominium buildings, and Middlesex Beach consists of residential structures.

74. South Bethany is situated approximately 3,500' south of Bethany Beach. The town of South Bethany has become a developed overflow area of Bethany Beach, with additional public beach access.

75. As of 1990, there were 846 housing units in South Bethany, of which 99% were single housing units. The median value of a single-family home in 1990 was $220,800. As of 1994, there were 186 year-round residents. Municipal revenue sources include property tax, parking permits, traffic tickets, building permits, and realty transfer fees. Delaware State Route 1 provides the sole means of access to both Bethany Beach and South Bethany. The largest portion of vacationers attracted to both communities are those staying overnight but less than a

week.

76. Both the State of Delaware and Sussex County are projected to increase in population over the next 20 years, but at a decreasing rate of growth. Sussex County is growing faster than the State of Delaware as a whole. Table 10 contains estimates of population by the Delaware Population Consortium, University of Delaware, College of Urban Affairs and Public Policy.

TABLE 10
TOTAL POPULATION

	1990	1995	2000	2005	2010	2020
DELAWARE	666,168	714,530	755,949	787,909	812,346	856,359
SUSSEX COUNTY	113,229	127,211	138,707	147,220	153,795	165,044

77. **Economic Development.** Major industries providing employment in the county (employing 5,000 and over, persons 16 years and over) as per the 1990 Census are construction (5,884 people), manufacturing of non-durable goods (6,925), and retail trade (9,921). Other industries providing employment are health services, educational services, food services; finance, insurance, and real estate; manufacturing of durable goods, wholesale trade; agriculture, forestry, and fisheries; transportation, public administration, communications, and other public utilities. The top industries by number of businesses as of 1993 in Sussex County were Special Trade Contractors (359 businesses), Eating and Drinking Places (312), Miscellaneous Retail Trade (287), and General Building Contractors (230). The number of employees in these top sectors is not large. In 1993, special trades contractors only averaged 5 employees per business in Sussex County, while eating and drinking places averaged 14 employees.

78. The estimated unemployment rate for Sussex County for 1997 was 4.0%. This was the same as the state average, and below the national average of 4.9%. Historically, for the decade, thus far, Sussex County has had a relatively low unemployment rate, paring at or below the national average for each of the years, and paring below the state average for four out of the eight years.

79. The coastal area differs from the rest of Sussex County and Delaware; it is devoid of manufacturing and is almost 100% reliant on the service/retail industry. In Sussex County, 1/3 of those employed in the county is in retail or services, while another 1/3 is in manufacturing. Bethany Beach, with an approximate 0.4-mile boardwalk, extending from 2nd Street to Parkwood Street, attracts thousands of summer visitors every year. The boardwalk contains apartments, condominiums, fast food establishments, hotels and motels, restrooms, and the beach patrol. Retail establishments are located predominantly along Garfield and West Pennsylvania Avenues. The town provides public access to the municipality's beach, and has many metered parking spaces along the streets. Still, parking may be difficult on weekends at the height of the tourist

season as the beach population soars on a typical holiday weekend. South Bethany, on the other hand, located about a mile south of Bethany is not commercialized. It caters to the cottage industry in providing accommodations for visitors.

80. The estimated median household income as of 1989 was $26,900 for Sussex County. As shown in Table 11, the coastal communities are considerably better off than the rest of Sussex County. Even when economically hard times hit the state economy (particularly poor agricultural crops or recession in the manufacturing industry), the economy of the Delaware Coast should remain buoyant as it serves as a summer resort for the residents of the regional urban and suburban areas.

TABLE 11
HOUSEHOLD INCOME
(1989 estimate)

NAME	HOUSEHOLD INCOME
United States	$28,908
Delaware	$32,068
Sussex County	$26,900
Bethany Beach	$30,000
South Bethany	$37,000

Source: 1990 U.S. Census Bureau

EXISTING ENVIRONMENTAL CONDITIONS

81. **The Study Area.** The Bethany Beach and South Bethany portion of the Delaware Atlantic Coast is composed of barrier and headland beaches with extensive development along the Atlantic Coast shorefront. The town of South Bethany is located at the northern portion of the barrier island, Fenwick Island, which is bordered to the south and east by the inland bays: Little Bay, Little Assawoman Bay, and Assawoman Bay. A major portion of Fenwick Island is undeveloped barrier island within Fenwick Island State Park. Bethany Beach for the most part, is a headland beach bordered on the northwest side by a large lake, Salt Pond, which may have been a remnant bay or lagoon prior to beach transgression. A barrier island exists further north of Bethany Beach, and contains several unincorporated beachfront developments. These developments are bordered to the west by Indian River Bay and to the north by Delaware Seashore State Park.

82. The beachfront along the study area is a high-energy beach subject to wind, waves, and currents from the Atlantic Ocean. The general topography of Bethany Beach and South Bethany

contains an abrupt beach slope that yields gradually to a shallow bottom (9-12 meters (m)) marked with slight depressions and ridges (Maurer *et al.*, 1974). A system of more pronounced submerged ridges and troughs occurs northeast of Bethany Beach.

83. **Water Quality of Delaware Atlantic Coastal Waters.**

84. ***Temperature and Salinity.*** Mixing occurs in nearshore waters due to the turbulence created from wave energy interacting with the bottom at shallower depths. Mixing becomes less prominent in greater depths where stratification can develop during warm periods. Water temperatures generally fluctuate seasonally. The average temperature range is from 3.70°C (January) to 21.4°C (October). The most pronounced temperature differences are found in the winter and summer months. Warming of coastal waters first becomes apparent near the coast in early spring, and by the end of April, thermal stratification may develop. Under conditions of high solar radiation and light winds, the water column becomes more strongly stratified during the months of July to September. The mixed layer may extend to a depth of only 12-13'. As warming continues, however, the thermocline may be depressed so that the upper layer of warm, mixed water extends to a depth of approximately 40'. Salinity concentration is chiefly affected by freshwater dilution. Salinity cycles result from the cyclic flow of streams and intrusions of continental slope water from far offshore onto the shelf. Continental shelf waters are the least affected by freshwater dilution, and have salinity concentrations varying between 30 parts per thousand (ppt) and 35 ppt. Coastal waters are more impacted by freshwater dilution and may have salinities as low as 27 ppt. Salinity is generally at its maximum at the end of winter. The voluminous discharge of fresh water from the land in spring reduces salinity to its minimum by early summer. Surface salinity increases in autumn when intrusions from offshore more than counterbalance the inflow of river water and when horizontal mixing becomes more active as horizontal stability is reduced. At Hen and Chickens Shoal and off South Bethany, salinity fluctuates little throughout the tidal cycle, depth, and between sampling stations, and was found to range from 28.5 ppt (July) to 30.7 ppt (November) (Maurer *et al.*, 1974). Mean dissolved oxygen values off South Bethany were 3.44 parts per million (ppm) (October) to 9.30 ppm (July) (Maurer *et al.*, 1974). Recent water sampling was conducted along with benthic sampling in July 1995 northeast of Bethany Beach (Area C) just above the substrate in depths ranging from 6.1 m to >12.2 m. The mean salinities ranged from 30.9 to 31.6 ppt in July. The mean bottom dissolved oxygen varied from 3.7 ppm (in deep areas) to 4.2 ppm (along sand ridges). Bottom temperatures ranged from 21.4°C to 23.7°C (Kelley *et al.*, 1996). Measurements of salinity, temperature, and dissolved oxygen were taken east of South Bethany (Area E) on December 12, 1997 (Scott and Bruce, 1998). The measurements taken at that time in December suggest a well-mixed homogenous water column. Water samples were collected at the surface (1.5') and near the bottom (30'). Both surface and bottom temperatures were identical at 7.8°C, and pH ranged from 8.02 at the surface to 7.98 at the bottom. Dissolved oxygen (DO) exhibited little variation with 11.2 milligrams/liter (mg/l) at the surface and 11.5 mg/l at the bottom. Salinity was the same for the surface and bottom at 30 ppt. Except for DO, these values fall within the range of values obtained off of South Bethany by Maurer *et al.* (1974) where temperature ranged from

4.6°C (January) to 20.5°C (July), DO ranged from 3.44 mg/l (October) to 9.30 mg/l (July), and salinity fluctuated very little from 30.7 ppt (November) to 28.5 ppt (July). Maurer *et al.* (1974) noted that in the summer samples, surface water temperatures were 1-4°C higher than bottom samples, which suggests that thermal stratification can occur in the summer months.

85. ***Water and Sediment Quality Parameters.*** Water quality is generally good in the nearshore because of the constant circulation provided by waves and currents. There are no stormwater sewer outfall pipes on the Atlantic Coast beach side in the Bethany Beach/South Bethany area. Stormwater in this area discharges west into the Inland Bays system. However, the Sussex County South Coastal Sewage Treatment Plant operates an ocean outfall that discharges treated wastewater approximately 1.25 miles offshore from the Sea Colony Condominiums. DNREC reports that water quality in the vicinity of the outfall is consistently good. However, as a precautionary measure, DNREC has established a 0.5-mile diameter buffer (mixing zone) around the South Coastal outfall. Within this zone, shellfish harvesting is prohibited. It should be noted that the nearest portion of a proposed borrow site, Area E, lies approximately 880' (0.33 miles) outside of the 0.5-mile buffer zone. DNREC monitors water quality for human health impacts by measuring Enterococcus bacteria levels of waters along the beaches of Bethany Beach and South Bethany. DNREC reports that beaches in the Bethany and South Bethany area have never been closed due to water quality exceedences (Jack Pingree, Shellfish and Recreational Water Branch - Personal Communication, 1996).

86. With exceptions to some small pocket areas, sediments in the borrow area are composed of medium to fine sands with very low amounts of silts and clays. Organic contaminants and metals are typically low in sediments dominated by sands. Therefore, it is expected that the proposed sand borrow area is not chemically contaminated because the substrate is primarily sand that has been subjected to a high-energy current regime. This coupled with the absence of dumping activities, industrial outfalls, or contaminated water suggests a low probability of sediment contamination.

87. **Terrestrial Ecology of Study Area.** The project area contains a high-energy beach with land features such as headlands and barrier island. Along the southern portion of the Delaware Coast (below Indian River Inlet), the barrier island is flanked on the west by both Indian River Bay and Little Assawoman Bay, and the Atlantic Ocean on the east. This area is fringed with saltmarshes on the west side of the barrier; however, the majority of the Bethany Beach/South Bethany study area is flanked on the west by headland. Along the Atlantic Coast beachfront within the Bethany Beach/South Bethany study area, primary and secondary dunes are basically non-existent through the majority of the project area due to high development and erosion. Exceptions to this are a portion of beach between Middlesex Beach and Bethany Beach where a constructed dune exists.

88. ***Beach and Dunes.*** Natural dunes are non-existent within the Bethany Beach/South Bethany study area where the shoreline contains heavy development consisting of residential houses and

commercial property. A man-made dune exists on the upper beach between Middlesex Beach and Bethany Beach; however, the nearest natural dunes are in the adjacent areas outside of the study area. In typical undisturbed beach profiles of the Delaware Atlantic Coast, the primary dune is the first dune landward from the beach. The flora of the primary dune is adapted to the harsh conditions present such as low fertility, heat, and high energy from the ocean and wind. The dominant plant on these dunes is American beachgrass (*Ammophila breviligulata*), which is tolerant to salt spray, shifting sands, and temperature extremes. American beachgrass is a rapid colonizer that can spread by horizontal rhizomes, and also has fibrous roots that can descend to depths of 3 feet to reach moisture. Beachgrass is instrumental in the development of dune stability, which opens up the dune to further colonization with more species like seaside goldenrod (*Solidago sempervirens*), sea rocket (*Cakile edentula*), and beach clotbur (*Xanthium echinatum*).

89. The secondary dunes lie landward of the primary dunes and tend to be more stable, resulting from the protection provided by the primary dunes. The increased stability also allows an increase in plant species diversity. Some of the plant species in this zone include: beach heather (*Hudsonia tomentosa*), coastal panic grass (*Panicum amarum*), saltmeadow hay (*Spartina patens*), broom sedge (*Andropogon virginicus*), beach plum (*Prunus maritima*), seabeach evening primrose (*Oenothera humifusa*), sand spur (*Cenchrus tribuloides*), seaside spurge (*Ephorbia polygonifolia*), joint-weed (*Polygonella articulata*), slender-leaved goldenrod (*Solidago tenuifolia*), and prickly pear (*Opuntia humifusa*).

90. Along undeveloped portions of the Delaware Atlantic coastline, the primary and secondary dunes grade into a zone of shrubby vegetation. These zones are typically located on the headlands or on the barrier flats of the barrier beaches. This zone is called the scrub-thicket zone where sand movement is more diminished. Many of the flora are dwarf trees and shrubs which include: wax-myrtle (*Myrica cerifera*), bayberry (*M. pensylvanica*), dwarf sumac (*Rhus copallina*), poison ivy (*Toxicodendron radicans*), black cherry (*Prunus serotina*), American holly (*Ilex opaca*), greenbrier (*Smilax spp.*), groundsel bush (*Baccharis halimifolia*), loblolly pine (*Pinus taeda*), pitch pine (*Pinus rigida*), Virginia creeper (*Parthenocissus quinquefolia*), beach plum (*Prunus maritima*), and the non-native Japanese black pine (*Pinus thunbergii*).

91. A number of non-marine mammals, reptiles, amphibians, and birds are associated with the dune habitat along the Delaware coastline. These species include: Fowler's toad (*Bufo woodhousei fowleri*), eastern hognose snake (*Heterodon platyrhinos*), box turtle (*Terrapene carolina*), raccoon (*Procyon lotor*), eastern cottontail (*Sylvilagus floridanus*), red fox (*Vulpes fulva*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pensylvanicus*), white-tailed deer (*Odocoileus virginianus*), savannah sparrow (*Passerculus sandwichensis*), song sparrow (*Melospiza melodia*), mourning dove (*Zenaida macroura*), gray catbird (*Dumetella carolinensis*), northern mockingbird (*Mimus polyglottos*), and brown thrasher (*Toxostoma rufum*).

92. Salt marshes are grasslands that occupy nearly level areas on the back-barrier flats adjacent to Rehoboth Bay, Indian River Bay, and Assawoman Bay and are semi-diurnally flooded by tides. The principal plant species is smooth cordgrass (*Spartina alterniflora*), although a number of succulent forbs (*Salicornia sp.*) also occur, and salt meadow cordgrass (*Spartina patens*) and common reed (*Phragmites australis*) may form a narrow band near more upland sections occupied by the type.

93. Several freshwater wetland pockets have formed within interdunal swales at Cape Henlopen State Park, Delaware Seashore State Park, and a short stretch of beach just north of Bethany Beach. These wetlands contain rare and unique plant communities, which include cranberry (*Vaccinium macrocarpon*) and sundew (*Drosera sp.*). No interdunal wetlands are present within the project area.

94. The upper beach or supralittoral zone typically lies below the primary dune and above the intertidal zone. An upper beach zone is present within the study area; however, it is subject to high disturbance from human activity. The upper beach zone is only covered with water during periods of extremely high tides and large storm waves. The upper beach habitat is characterized by sparse vegetation and few animals. This zone has fewer biological interactions than the dunes, and organic inputs are scarce. The most active organism in this zone is the ghost crab (*Ocypode quadrata*). This crab lives in semi-permanent burrows near the top of the shore, and it is known to be a scavenger, predator, and deposit sorter. The ghost crab is nocturnal in its foraging activities, remaining in its burrow during the day. In addition to ghost crabs, species of sand fleas or amphipods (Talitridae), predatory and scavenger beetles, and other transient animals may be found in this zone.

95. Many species of shorebirds inhabit the beach during the spring and fall migrations, although most are even more likely to be found on more protected sand and mud flats, tidal marshes, or along the Delaware Bay shoreline (especially in spring when large numbers of horseshoe crab eggs are available). Shorebirds feed on small individuals of the resident infauna and other small organisms brought in with waves. Common shorebird species include sanderling (*Calidris alba*), dunlin (*C. alpina*), semipalmated sandpiper (*C. pusilla*), western sandpiper (*C. mauri*), and willet (*Catoptrophorus semipalmatus*). Sanderling, dunlin, and western sandpiper also occur on the beach throughout the winter. Colonial nesting shorebird habitat is increasingly under pressure from development and human disturbance along Delaware's Atlantic beaches. Nesting birds such as common tern (*Sterna hirundo*), least tern (*Sterna antillarum*), black skimmer (*Rynchops niger*), and American oystercatcher (*Haematopus palliatus*) are frequent spring and summer inhabitants on unvegetated dunes and upper beaches at Cape Henlopen and Delaware Seashore State Parks. Undeveloped beaches such as these state parks are critical for nesting pairs of the Federal and state threatened piping plover (*Charadrius melodus*). High beachfront development and human disturbance in the Bethany Beach and South Bethany project area has consequently forced nesting shorebirds to seek the remaining undeveloped beaches.

96. Several species of gulls are common along Delaware's shores, and are attracted to forage on components of the beach wrack such as carrion and plant parts. These gulls include the laughing gull (*Larus atricilla*), herring gull (*L. argentatus*), and ring-billed gull (*L. delawarensis*).

97. **Aquatic Ecology of Affected Area.**

98. ***Upper Marine Intertidal Zone.*** The upper marine intertidal zone is also primarily barren; however, more biological activity is present in comparison to the upper beach. Organic inputs are derived primarily from the ocean in the form of beach wrack, which is composed of drying seaweed, tidal marsh plant debris, decaying marine animals, and miscellaneous debris that washed up and deposited on the beach. The beach wrack provides a cooler, moist microhabitat suitable to crustaceans such as the amphipods Orchestia *spp.* and *Talorchestia spp.*, also known as beach fleas. Beach fleas are important prey to ghost crabs. Various foraging birds and some mammals are attracted to the beach fleas, ghost crabs, carrion, and plant parts that are commonly found in beach wrack. The birds include gulls, shorebirds, fish crows, and grackles.

99. ***Intertidal Zone.*** The intertidal zone contains more intensive biological activity than the other zones. Shifting sand and pounding surf dominate a habitat that is inhabited by a specialized fauna. The beach fauna forms an extensive food-filtering system that removes detritus, dissolved materials, plankton, and larger organisms from in-rushing water. The organisms inhabiting the beach intertidal zone have evolved special locomotory, respiratory, and morphological adaptations that enable them to survive in this extreme habitat. Organisms of this zone are agile, mobile, and capable of resisting long periods of environmental stress. Most are excellent and rapid burrowers. Frequent inundation of water provides suitable habitat for benthic infauna; however, there may be a paucity in numbers of species. Intertidal benthic organisms tend to have a high rate of reproduction and a short (1 to 2 years) life span (Hurme and Pullen, 1988). This zone contains an admixture of herbivores, primary carnivores, and some high order carnivores. A number of interstitial animals (meiofauna) are present feeding among the sand grains for bacteria and unicellular algae, which are important in the beach food chain. In 1978, extensive sampling for invertebrate infauna was performed by the U.S. Fish and Wildlife Service (USFWS) and Corps of Engineers on the beaches within the Delmarva Peninsula, Maryland. There were four dominant species of invertebrate infauna in this zone, which were the mole crab (*Emerita talpoida*), a haustorid amphipod (*Haustorius canadensis*), the coquina clam (*Donax variabilis*), and spionid worm (*Scolelepis squamata*). The epifaunal blue crab (*Callinectes sapidus*) and the lady crab (*Ovalipes ocellatus*) were also found in or near this zone. These species withdraw to the nearshore subtidal zone during the winter months and return to the intertidal zone when conditions are more favorable. These invertebrates are prey to various shorebirds and nearshore fishes such as the Atlantic silverside (*Menidia menidia*), and juveniles of spot (*Leiostomus xanthurus*), kingfish (*Menticirrhus saxatilus*), and bluefish (*Pomatomus saltatrix*). The horseshoe crab (*Limulus polyphenus*) is a common inhabitant of Atlantic Coastal areas and utilizes the sandy beaches (particularly of Delaware Bay) to spawn. Due to the high-energy environment along the beachfront, it is an unlikely area for spawning; however, horseshoe

crabs are common in the nearshore and offshore areas.

100. Benthic macroalgae grow attached to the bottom substrate in the intertidal zone where they are alternately exposed and submerged as the tides ebb and flow. The substrate along the Delaware Atlantic Coast is mainly composed of shifting sands and shell fragments making it too unstable for large colonies of benthic algae to proliferate. Colonies do attach on hard, stable substrates provided by peat banks, shell bottoms, reefs, and man-made structures such as pilings, jetties, buoys, and bridges. Various species of benthic macroalgae representing the phyla Chlorophyta and Phaeophyta are found in Delaware's coastal waters.

101. Several rock groins in Bethany Beach represent an artificial rocky intertidal zone. In addition to providing a hard substrate for the attachment of benthic macroalgae, the groins also contain suitable habitats for a number of aquatic and avian species. Barnacles, small crustaceans, polychaetes, molluscs, and a variety of shorebirds may reside on, above, and around these structures.

102. ***Nearshore and Offshore Zones.*** The nearshore coastal zone generally extends seaward from the subtidal zone to well beyond the breaker zone (U.S. Army Corps of Engineers, 1984). This zone is characterized by intense wave energies that displace and transport coastal sediments. The offshore zone generally lies beyond the breakers and is a flat zone of variable width extending to the seaward edge of the Continental Shelf. The nearshore zone is described as an indefinite area that includes parts of the surf and offshore areas affected by nearshore currents (Hurme and Pullen, 1988). The boundaries of these zones may vary depending on relative depths and wave heights present. The nearshore of Bethany Beach/South Bethany contains an abrupt beach slope that yields gradually to a shallow bottom (9-12 m) containing slight depressions and ridges (Maurer *et al.*, 1974).

103. ***Plankton.*** Plankton are collectively a group of interacting minute organisms adrift in the water column. Plankton are commonly broken into two main categories: phytoplankton (plant kingdom) and zooplankton (animal kingdom).

104. Phytoplankton are the primary producers in the aquatic marine ecosystem, and are essential trophic links to higher organisms in the marine food chain. Light and chemical energy are converted into organic compounds that can be assimilated by higher organisms in the food chain. Phytoplankton production is dependent on light penetration, available nutrients, temperature, and wind stress. Phytoplankton production is generally highest in nearshore waters. Seasonal shifts in species dominance of phytoplankton are frequent. Dinoflagellates are generally abundant from summer through fall, and diatoms are dominant during the winter and early spring. Approximately 126 species of phytoplankton were identified in Delaware's coastal waters representing the following phyla: Chlorophyta, Chromophyta, Pyrrophyta, Euglenophyta, and Procaryota.

105. The most prevalent species and their season of dominance are as follows:

Nitzschia seriata - Winter
Skeletonema costatum - Late winter, early spring
Guinarkia flaccida - Spring
Pyramimonas sp. - Spring, early summer
Cryptomonas acuta - Summer
Katodinium rotundatum - Mid-summer
Chrysochromulina sp. – Summer

106. Zooplankton provide an essential trophic link between primary producers and higher organisms. Zooplankton represent the animals (vertebrates and invertebrates) that are adrift in the water column, and are generally unable to move against major ocean currents. Many organisms may be zooplankton at early stages in their respective life cycles only to be able to swim against the currents (nektonic) in a later life stage, or to be a part of the benthic community. Zooplankton are generally either microscopic or barely visible to the naked eye. Zooplankton typically exhibit seasonal variances in species abundance and distribution, which may be attributed to temperature, salinity, and food availability. In marine environments, seasonal peaks in abundance of zooplankton distinctly correlate with seasonal phytoplankton peaks. These peaks usually occur in the spring and fall. Sampling in the lower Delaware Bay by Watling and Maurer (1976) revealed the presence of 60 species representing the following phyla: Protozoa, Cnidaria, Ctenophora, Ectoprocta, Annelida, Mollusca, Arthropoda, Chaetognatha, and Chordata. Calanoid copepods are a dominant component of the zooplankton in Delaware coastal waters (Dupont *et al.*, 1972). Peaks in calanoid copepod dominance are known to occur during October-November, which may be attributed to the high phytoplankton productivity. Zooplankton species characteristic of coastal areas include Acartia *tonsa, Centropages humatus, C. furatus, Temora longicornis, Tortanus discaudatus, Eucalanus pileatus, Mysidopsis bigelowi* (mysid shrimp), and *Crangon septemspinosa* (sand shrimp).

107. ***Macroinvertebrates.*** The nearshore and offshore waters of the Delaware Coast contain a wide assemblage of invertebrate species inhabiting the benthic substrate and open water. Invertebrate Phyla existing along the coast are represented by Cnidaria (corals, anemones, and jellyfish), Platyhelminthes (flatworms), Nemertinea (ribbon worms), Nematoda (roundworms), Bryozoa, Mollusca (chitons, clams, mussels, etc.), Echinodermata (sea urchins, sea cucumbers, sand dollars, starfish), and the Urochordata (tunicates).

108. Benthic macroinvertebrates are those dwelling in the substrate (infauna) or on the substrate (epifauna). Benthic invertebrates are an important link in the aquatic food chain, and provide a food source for a variety of demersal fishes. Various factors such as hydrography, sediment type, depth, temperature, irregular patterns of recruitment, and biotic interactions (predation and competition) may influence species dominance in benthic communities. Benthic assemblages in Delaware coastal waters exhibit seasonal and spatial variability. Generally,

coarse sandy sediments are inhabited by filter feeders and areas of soft silt or mud are more utilized by deposit feeders.

109. Delaware Atlantic nearshore waters provide a dynamic, heterogeneous environment heavily influenced by the tidal flows and long shore currents. Although several pockets of fine materials are present within depressions and/or troughs, the inshore (within 3 miles) sediments in the vicinity of Bethany Beach are generally composed of medium to fine sands, which influence the composition of the benthic assemblage. The following benthic species were found to be most abundant in the nearshore waters off South Bethany (Maurer *et al.*, 1979): *Tellina agilis* (tellinid bivalvia), *Nucula proxima* (nuculid bivalvia), *Protohaustorius wigleyi* (haustorid amphipod), *Spiophanes bombyx* (spionid polychaeta), *Corophium tuberculatum* (Tubicolous amphipod), *Nephtys picta* (nephtyid polychaeta), *Spisula solidissima* (bivalve), *Sabellaria vulgaris* (polychaete), *Polygordius* sp. (polychaete), and *Nemertea* sp. (worm).

110. In December 1997, a benthic-sediment assessment (Scott and Bruce, 1998) was conducted on a 775-acre portion (middle portion) of Borrow Area E. Since Borrow Area E contains a relatively flat homogenous bottom, the sampling plan was modified from the plan that was previously used for Borrow Area C (Kelley *et al.*, 1996), which compared three different habitat types based on depth and sediment composition. The sampling plan for Borrow Area E investigated one habitat type, but comparisons were made to the habitat types of Borrow Area C. The benthic investigation conducted for Borrow Area E involved infaunal (within the substrate) sampling at 25 randomly selected stations utilizing a Young dredge. Fifteen of those stations were randomly selected for commercial surfclam (*Spisula solidissima*) sampling utilizing a conventional hydraulic clam dredge with a 72-inch knife. Larger benthic species not easily sampled with the Young dredge were recorded in the surfclam dredge samples.

111. Scott and Bruce (1998) found a total of 89 infauna and 8 epifauna taxa in the samples collected from Borrow Area E. The benthic community of the borrow area was dominated by the polychaete worms *Polygordius* spp. and *Spiophanes bombyx*, and oligochaete worms; however, these three taxa accounted for only 40% of the combined abundance of all of the taxa. Other abundant taxa in the samples include Nemertinea (worm), *Tellina agilis* (bivalve), *Tannaissus psammophilus* (an isopod-like arthropod), *Protohausotrius wigleyi* (amphipod), *Acanthohaustorius* spp. (amphipod), and Echinoidea (sea urchins and sand dollars). Dominant taxa found in Area C differed somewhat from the dominant taxa of Area E. Taxa that were dominant in Area C, but not dominant in Area E were the Polychaetes: *Amastigos caperatus*, *Mediomastus ambiseta*, and *Tharyx* sp.; Bivalves: *Ensis directus, Spisula solidissima*; Arthropods: *Chiridotea tuftsi, Parahaustorius longimerus*, and *Rhepoxynius hudsoni*. Taxa that were dominant in Area E but not in Area C were the Polychaetes: Sigalionidae and *Spiophanes bombyx*; and Echinoidea. Significant differences (measured statistically by using Analysis of Variance (ANOVA)) of some of the benthic community characteristics between Borrow Area E and C became evident in the comparisons. The Shannon-Wiener and Simpson's Dominance Indices were significantly higher for Area E when compared to the mean of all three habitats

combined for Area C. This may suggest that dominant taxa in Area E were more evenly distributed throughout the site than Area C, which would be expected based on the relatively homogeneous habitat type in Area E. Significant differences emerged for the total abundance, bivalve abundance, and biomass where the values were significantly lower for Area E than for combined habitats of Area C. The majority of these differences can be attributed to the high numbers encountered in the deep habitat of Area C. Another factor to consider is that sampling at Area C and Area E occurred at different times of the year, and that seasonal variations of species composition, dominance, density, and evenness can occur within the same habitat (Maurer *et al.*, 1979).

112. Eight epifaunal taxa were collected from the Young samples, which include gastropods (*Epitonium* spp., *Turbonilla interupta, T. stricta*), isopods (*Edotea triloba, Politolana concharum*), hermit crabs (*Pagarus annulipes, P. longicarpus*), and a tunicate (Ascidiacea). Megabenthic taxa (taxa > 2") were identified and recorded in the surfclam dredge tows. The most abundant species included knobbed whelk (*Buscyon carica*) (36.1/acre), horseshoe crab (*Limulus polyphemus*) (18.4/acre), lady crab (*Ovalipes ocellatus*) (12.6/acre), starfish (Asteridae) (11.4/acre), and rock crab (*Cancer irroratus*) (11.0/acre). Other benthic species caught include sand dollar (Echinoidea), channeled whelk (*Buscyon canaliculatum*), clearnose skate (*Raja eglanteria*), windowpane flounder (*Scopthalmus aquosus*), spider crab (*Libinia emarginata*), and hermit crab (*Pagarus* spp.).

113. Sediment samples obtained from the benthic grab samples were analyzed for grain sizes, silt-clay content, and total organic carbon content. Borrow Area E had significantly less silt/clay content than the deep habitat in Area C and significantly higher silt/clay content than the sandbar habitat in Area C, but the differences in silt/clay and total organic content percentages were within a range considered biologically inconsequential to benthic resources (Weisberg *et al.*, 1997; Scott and Bruce, 1998). Sediment analyses determined that the majority of the benthic stations in Area E contained medium to fine sands; however, a few stations contained a higher percentage of coarse to very coarse sand.

114. ***Finfish.*** The proximity of several embayments allows the coastal waters of Delaware to have a productive fishery. Many species utilize the estuaries of Delaware Bay, Rehoboth Bay, Indian River Bay, and Little Assawoman Bay for forage and nursery grounds. The finfish found along the Delaware Atlantic Coast are principally seasonal migrants. Winter is a time of low abundance and diversity as most species leave the area for warmer waters offshore and southward. During the spring, increasing numbers of fish are attracted to the Delaware Atlantic Coast because of its proximity to several estuaries that are utilized by these fish for spawning and nurseries. Peaks in the numbers of fish species generally occur in the fall; however it was noted that fish abundance was greatest off South Bethany during summer and fall (Maurer *et al.*, 1974).

Surveys of the finfish in Delaware's coastal waters have been conducted by Maurer and Tinsman (1980) and annually for several years by the National Marine Fisheries Service (NMFS).

Abundant finfish species in Delaware coastal waters include: red hake (*Urophycis chuss*), northern sea robin (*Prionotus carolinus*), spot (*Leiostomus xanthurus*), windowpane flounder (*Scopthalmus aquosus*), silver hake (*Merluccuns bilinearis*), clearnose skate (*Raja eglanteria*), hogchoker (*Trinectes maculatus*), and weakfish (*Cynoscion regalus*). Large numbers of bay anchovies (*Anchoa mitchilli*), butterfish (*Peprilus triacanthus*), scup (*Stenotomus chrysops*), weakfish, striped anchovy (*Anchoa hepsetus*), spot, and bluefish (*Pomatomus saltatrix*) are also present in coastal waters. The complete list of fishes collected in these trawl surveys is shown in Table 12. These surveys, however, do not include habitats associated with any bottom structures like breakwaters, rock jetties and groins, rough bottom off of Cape Henlopen, submerged wrecks, and artificial reefs. The following species are more associated with these structures: tautog (*Tautoga onitis*), gray triggerfish (*Balistes capriscus*), oyster toadfish (*Opsanus tau*), conger eel (*Conger oceanicus*), cunner (*Tantogolabrus adspersus*), and planehead filefish (*Monacanthus hispidus*) (Ekland, 1987).

TABLE 12
FISHES COLLECTED IN DELAWARE ATLANTIC COASTAL WATERS

COMMON NAME	SCIENTIFIC NAME
Red hake	*Urophycis chuss*
Northern sea robin	*Prionotus carolinus*
Spot	*Leiostomus xanthurus*
Windowpane	*Scophthalmus aquosus*
Silver hake	*Merluccuns bilinearis*
Clearnose skate	*Raja eglanteria*
Hogchoker	*Trinectes maculatus*
Weakfish	*Cynoscion regalus*
Butterfish	*Peprilus triacanthus*
Spotted hake	*Urophycis regius*
Little skate	*Raja eglanteria*
Striped sea robin	*Prionotus evolans*
Smooth dogfish	*Mustelus canis*
Summer flounder	*Paralichthys dentatus*
Spiny dogfish	*Squalus acanthias*
Atlantic menhaden	*Brevoortia tyrannus*
Bullnose ray	*Myliobatis fremenvilli*
Striped anchovy	*Anchoa hepsetus*
Ocean pout	*Macrozoarces americanus*
Scup	*Stenotomus chrysops*
Longhorn sculpin	*Myoxocephalus octodecemspinosus*
Atlantic herring	*Clupea harengus*
Atlantic croaker	*Micropogon undulatus*
Bluefish	*Pomatomus saltatrix*
Winter flounder	*Pseudopleuronectes americanus*
Striped bass	*Morone saxatilus*

TABLE 12 (CONTINUED) FISHES COLLECTED IN DELAWARE ATLANTIC COASTAL WATERS	
COMMON NAME	**SCIENTIFIC NAME**
American shad	*Alosa sapidissima*
Atlantic sturgeon	*Acipenser oxyrhynchus*
Striped burrfish	*Chilomycterus schoepfi*
Angel shark	*Squatina dumerili*
Northern stargazer	*Astroscopus guttatus*
Banded rudderfish	*Seriola zonata*
Bay anchovy	*Anchoa mitchilli*
Butterfish	*Peprilus triacanthus*
Blueback herring	*Alosa aestivalis*
American sand lance	*Ammodytes americanus*
Rough scad	*Trachurus lathami*
Alewife	*Alosa pseudoharengus*
Black sea bass	*Centropristis striata*
Atlantic silverside	*Menidia menidia*
Round herring	*Etrumeus teres*
Gulf stream flounder	*Citharichthys arctifrons*
Northern puffer	*Sphoeroides maculatus*
Striped cusk-eel	*Ophidion marginatum*
Winter skate	*Raja ocellata*
Blue runner	*Caranx crysos*
Atlantic moonfish	*Selene setapinnis*
Inshore lizzardfish	*Synodus foetens*
Spanish mackerel	*Scomberomorus maculatus*
Smallmouth flounder	*Etropus microstomus*
Sandbar shark	*Carcharhinus plumbeus*
Unicorn filefish	*Aluterus monoceros*
Atlantic menhaden	*Brevoortia tyrannus*
Atlantic sharpnose shark	*Rhizoprindon terraenovae*
Roughtail stingray	*Dasyatis centroura*
Sea raven	*Hemitripterus americanus*
Pigfish	*Orthopristis chrysoptera*
Northern kingfish	*Menticirrhus saxatilus*
Short bigeye	*Pristigenys alta*
Dusky shark	*Carcharhinus obscurus*
Striped burrfish	*Chilomycterus schoepfi*
Banded rudderfish	*Seriola zonata*
Atlantic angel shark	*Squatina dumerili*
Blotched cusk-eel	*Ophidion grayi*
Thresher shark	*Alopias vulpinus*
Threespine stickleback	*Gasterosteus aculeatus*
Naked goby	*Gobiosoma bosci*
Sources: Maurer and Tinsman (1980); NMFS Groundfish surveys from 1985-1989	

115. The numbers of fishes along the Delaware Atlantic Coast are generally not sufficient to support a significant commercial fishing industry; however, the Delaware Coast supports a diverse recreational fishery. Approximately 70% of Delaware's shore-based fishing is along the Atlantic Coast beaches and jetties (Seagraves, 1988). There are also many private/charter boat fishermen from Indian River Inlet and Lewes that fish the coastal area. The species caught usually include: bluefish (*Pomatomus saltatrix*), weakfish (*Cynoscion regalus*), croaker (*Micropogon undulatus*), spot (*Leiostomus xanthurus*), kingfish (*Menticirrhus saxatilus*), red drum (*Sciaenops ocellatus*), tautog (*Tautoga onitis*), summer flounder (*Paralichthys dentatus*), striped bass (*Morone saxatilus*), scup (*Stenotomus chrysops*), sharks, hakes (*Urophycis spp.*), sea bass (*Centropristis striata*), Atlantic mackerel (*Scomber scombrus*) and Spanish mackerel (*Scomberomorus maculatus*). A sea bass pot fishery and early spring gill net fishing targeting shad and weakfish are the only prevalent commercial fishing operations in the coastal waters of Delaware.

116. Common estuarine fishes present in the inland bays include bay anchovy (*Anchoa mitchilli*), Atlantic silverside (*Menidia menidia*), mummichog (*Fundulus heteroclitus*), striped killifish (*Fundulus majalis*), naked goby (*Gobiosoma bosci*), and hogchoker (*Trinectes maculatus*). The inland bays are important nurseries for a variety of commercial and recreational fishes including spot, croaker, weakfish, menhaden, bluefish, and summer flounder. The inland bays support shellfish like hard clam (*Mercenaria mercenaria*) and blue crab (*Callinectes sapidus*) for recreational and/or commercial fisheries. The inland bays are also important for supporting a variety of waterfowl, shorebirds, and wading birds.

117. ***Shellfish.*** The surfclam has been periodically harvested from Delaware's coastal waters for commercial purposes. The surfclam has a wide distribution and abundance within the mid-Atlantic region. They most commonly inhabit substrates composed of medium to coarse sand and gravel in turbulent waters just beyond the breaker zone (Fay *et al.*, 1983; Ropes, 1980). The abundance of adults varies from loose, evenly distributed aggregations to patchy, dense aggregations in the substrate (Fay *et al.*, 1983). Surfclams may reach sexual maturity their first year, with the entire population being sexually mature during their second year (Mid-Atlantic Fishery Management Council (MAFMC) - Letter dated 18 December 1995). Spawning may occur twice annually from mid-July until early August and from mid-October until early-November.

118. A peak in harvesting within Delaware's coastal waters occurred in the early 1970's where annual landings exceeded 8.5 million pounds, worth approximately $1.1 million. Shortly afterward, the stock experienced a rapid and severe decline, and by 1975 commercial harvesting had ceased. There has been no significant harvesting since then. The dominant 1976 year-class that supports New Jersey's inshore fishery did not occur in Delaware waters. Surveys conducted by the State in 1982, 1986, and 1992 confirmed that no significant numbers of commercial sized surfclams exist within Delaware's three-mile territorial limit (Personal communication with J. Tinsman, 1993). Despite the lack of commercially harvestable densities of surf clams, juvenile

and young adult forms of the surfclams have been identified from recent benthic infaunal sampling (Dames and Moore, 1993; Kelley *et al.*, 1996; Scott and Bruce, 1998). The benthic infaunal samples obtained from the Young dredge in December 1997 for Area E found surfclams in 48% of the samples, however, the abundance of surfclams was low and ranged from 0 to 45/m^2. In contrast, 75% of the samples in Area C contained surfclams. Mean abundance of surfclams per grab in Borrow Area E was 14.5/m^2, which is significantly lower than the mean abundance of 96.6/m^2 found in the sandbar habitat of Area C. The lower abundance of surfclams in the Area E sampling could be attributed to seasonal variations due to predation (G. Ruddy, USFWS - Personal communication). No clams longer than 2 cm were recorded in the benthic samples for Area E, which accounts for the relatively low mean biomass of 0.07 g/m^2.

119. In January 1998, a survey for commercial size densities was conducted within Area E utilizing a 65-foot commercial surfclam vessel, the Elizabeth C II, with a conventional hydraulic clam dredge with a 72-inch knife. The floor of the dredge was lined with 2-inch (51-mm) square rebar to retain smaller clams. A total of 15 (5-minute) tows were conducted at random locations within Area E. Although there were surfclam shells collected in the dredge, only one live surfclam measuring 120 mm (4.72 inches) was collected from all of the tows. These samples did not identify any large commercial size surfclams, which have a minimum size limit of approximately 12 cm. The average length of harvested surfclams is 14-15.25 cm. Surfclams often reach sexual maturity their first year, with the entire population being sexually mature during their second year. The surfclams found could likely contribute gametes for recruitment. This finding is consistent with surveys conducted by DNREC in 1982, 1984, and 1992, and the survey of Borrow Area C in 1996 (Burton, 1996) where no commercially exploitable densities of surfclams were found.

120. Although no commercially exploitable densities of surfclams exist in either Areas C or E, these areas may be designated as Essential Fish Habitat (EFH) for surfclams by the MAFMC under provisions of the re-authorized Magnuson Act of 1996 (Dr. Tom Hoff, MAFMC - Personal communication).

121. In addition to surfclams, the Delaware coastal area supports a small fishery for blue crabs (*Callinectes sapidus*), which are harvested in the winter by dredging. The fishery is usually limited to a few licenses to avoid over-harvesting this stock, which consists mainly of female crabs that would be spawning the following spring and summer. The major portion of the blue crab population remains in Delaware Bay.

122. ***Inland Bays.*** The Delaware coastal beaches are bordered on the west by three inland embayments: Rehoboth Bay, Indian River Bay, and Little Assawoman Bay. The inland bays are bordered extensively with tidal marshes composed of saltmarsh cordgrass *(Spartina alterniflora)*, saltmeadow hay *(S. patens)*, spike grass *(Distichlis spicata)*, and high tide bush *(Iva frutescens)* (Daiber *et al.*, 1976).

123. **Threatened and Endangered Species.** The only Federal or state listed endangered or threatened species known to occur near the project area on more than an occasional or transient basis is the piping plover (*Charadrius melodus*). These small shorebirds, which are classified as threatened on the Federal and state lists, nest on coastal beaches and dunes. Most of Delaware's Atlantic beach and dune system, except in high development areas, is potential nesting habitat. In recent years, piping plover have been nesting at Cape Henlopen and Delaware Seashore State Parks. The nesting season usually begins in late-March when the birds arrive and ends in July when the young are finally fledged. Shortly after hatching, the young leave the nest and begin foraging along the shoreline. The adults accompany the young during this critical period until they are fledged, 25-35 days later. The State of Delaware monitors the birds' nesting activities. The monitoring program includes annual surveys to detect nesting birds and installation of fencing to warn the public. No nesting is known to occur within the Bethany Beach/South Bethany study area.

124. The bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrinus anatum* and *F. p. tundrius*) are other avian threatened and endangered species that may be present on only an occasional or transient basis.

125. The Delaware Coast may be occasionally visited by five species of threatened and endangered sea turtles. These turtles include the loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), Kemp's ridley turtle (*Lepidochelys kempii*), and leatherback turtle (*Dermochelys coriacea*). The loggerhead turtle and Kemp's ridley turtle are particularly more common in Delmarva coastal waters during summer months. Historically, the breeding range of the loggerhead turtle may have extended to the Delaware Atlantic Coast, however, there are no known nesting sites reported in this stretch of coast. The other four species breed much further south from Florida through the Caribbean and Gulf of Mexico. Overall, sea turtle utility of Delaware's twenty-five mile stretch of Atlantic Ocean presently or historically has not been significant. Sea turtles primarily utilize Delaware coastal waters as a transportation route from the Gulf Stream to Delaware Bay, where significant numbers have been observed utilizing the Delaware Bay as a feeding area (Logothetis, 1994).

126. Six species of endangered whales may occasionally be encountered in nearshore waters along the Delaware Atlantic Coast during their migrations. These include sperm whale (*Physeter catodon*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), blue whale (*Balaenoptera musculus*), sei whale (*Balaenoptera borealis*), and black right whale (*Balaena glacialis*). The official list of threatened and endangered species in Delaware is shown in Table 13.

127. Two rare plant species, sea beach pigweed (*Amaranthus pumilus*) and chaffseed (*Schwalbea americana*), are found in beach and dune habitats in Delaware. There are no records of these species within the project area.

TABLE 13
OFFICIAL LIST OF ENDANGERED AND THREATENED WILDLIFE

COMMON NAME	SCIENTIFIC NAME	STATUS
Delmarva Fox Squirrel	*Sciurus niger cinereus*	SE, FE
Sperm Whale	*Physeter catodon*	SE, FE
Blue Whale	*Balaenoptera musculus*	SE, FE
Finback Whale	*Balaenoptera physalus*	SE, FE
Sei Whale	*Balaenoptera borealis*	SE, FE
Humpback Whale	*Megaptera novaeangliae*	SE, FE
Right Whale	*Eubalaena spp.* (all species)	SE, FE
Hawksbill Sea Turtle	*Eretmochelys imbricata*	SE, FE
Leatherback Sea Turtle	*Dermochelys coriacea*	SE, FE
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	SE, FE
Tiger Salamander	*Ambystoma tigrinum*	SE
Bog Turtle	*Clemmys muhlenbergii*	SE, FT
Cope's Gray Treefrog	*Hyla chrysoscelis*	SE
Barking Treefrog	*Hyla gratiosa*	SE
Bald Eagle	*Haliaeetus leucocephalus*	SE, FT
Peregrine Falcon	*Falco peregrinus*	SE, FE
Brown Pelican	*Pelecanus occidentalis*	SE
Shortnose Sturgeon	*Acipenser brevirostrum*	SE, FE
Piping Plover	*Charadrius melodus*	ST, FT
Green Turtle	*Chelonia mydas*	ST, FT
Loggerhead Turtle	*Caretta caretta*	ST, FT

KEY
FE – Federally Listed as "Endangered" SE - State Listed as "Endangered"
FT – Federally Listed as "Threatened" ST - State Listed as "Threatened"

Source: DNREC, Division of Fish and Wildlife

128. **Air Quality.** Through the State Implementation Program (SIP), air quality is managed by DNREC. The goal of the SIP is to meet and enforce the primary and secondary national ambient air quality standards for pollutants. Management concerns are focussed on any facility or combination of facilities that emit high concentrations of air pollutants into the atmosphere. Manufacturing facilities, military bases and installations, oil and gas rigs, oil and gas storage or transportation facilities, power plants, deep water ports, LNG facilities, geothermal facilities, highways, railroads, airports, ports, sewage treatment plants, and desalinization plants are facilities and activities that may cause air quality problems (NOAA & DECMP, 1980).

129. The DNREC Air Quality Management Section (AQMS) operates one air quality monitoring station in Sussex County at Seaford. Unlike the heavily populated and industrialized New Castle County, Sussex County is primarily rural without any significant sources contributing to air pollution. Overall, air quality in Sussex County is considered to be good, however, exceedences of air quality criteria for ozone designate Sussex County as "marginally" non-attainable in meeting air quality criteria for ozone. With the exception of ozone, all other air quality criteria are met in Sussex County (John Thomas, DNREC-AQMS - Personal communication).

130. **Hazardous, Toxic, and Radioactive Wastes (HTRW).** A literature review was conducted within the study area to assess the potential of encountering any contamination associated with HTRW. This literature review utilized various databases from the non-Federal sponsor, DNREC, the United States Environmental Protection Agency (USEPA), PCB-Waste Handlers (PADS), Small and Large Quantity Hazardous Waste Generators, and Treatment, Storage and Disposal of Hazardous Waste Facilities (HWDMS/RCRIS), National Priorities List (NPL), Facility Index System (FINDS) List, Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), Radioactive Materials (MLTS), Release of Toxic Chemicals to Air, Water, and Land (TRIS), Manufacturer or Importer of Toxic Substances (TSCA), Emergency Response Notification System (ERNS), Hazardous Materials Incident Report System (HMIRS), Delaware State Hazardous Waste Sites (SHWS), Leaking Underground Storage Tank Incidents (LUST), Registered Underground Storage Tank (UST), Solid Waste Facility/Landfills (SWF/LS), and State Hazardous Waste Sites (SHWS). No sites were identified from this database inventory search at or within three miles of the Delaware coastline.

131. The NOAA Cape Henlopen to Indian River Inlet Soundings Map indicates an area approximately three miles off the coast that has been designated a danger zone. Ocean-going vessels are permitted to navigate in this zone, however, all vessels are cautioned not to anchor, dredge, trawl, lay cable, or conduct any other activity that involves disturbing the substrate due to the potential danger from mines being buried within the substrate. The proposed sand borrow source is located outside of this area, and has been investigated by remote sensing magnetometer surveys during archaeological investigations.

132. Given the type of environmental settings within the study area and the associated land uses, the likelihood of encountering HTRW is extremely low. No immediate concerns were identified from site visits, regulatory agency contacts, and database searches. Therefore, further HTRW investigations for the Bethany Beach/South Bethany study area are not necessary.

EXISTING CULTURAL RESOURCES

133. **Prehistoric Resources.** The prehistoric occupation of Delaware and the Delmarva Peninsula has been categorized by archaeologists into three general periods of cultural development: Paleo-Indian (15,000 years before present (B.P.) - 8,500 B.P.), Archaic (8,500 B.P. - 5,000 B.P.), and Woodland (5,000 B.P. - 400 B.P.). Few Paleo-Indian sites have been located in the Delaware region of the Delmarva Peninsula. This is partly due to the low population density and nomadic lifestyle of the people from the period, as well as from the inundation of sites by sea level rise and burial under thick layers of alluvium and modern cultural deposits. Archaic period sites tend to be relatively small, suggesting short-term and intermittent occupations. Archaeological investigations have traditionally focused on Woodland period sites. Many Early-Woodland period base camps have been located along brackish rivers. By the Late-Woodland period, there is evidence of a further sedentary lifestyle with an increasing reliance on agriculture. Woodland sites have been identified on both the coastal marshes and in the mid-drainage areas in the region. Two prehistoric archaeological sites in the Bethany Beach area, the Poplar Thicket Site and the Wilcus Site, are listed on the National Register of Historic Places. These sites are well north and west of the project area and will not be affected by proposed construction.

134. **Historic Resources.** The early history of the Delaware Coast was marked by a succession of 17th century European expeditions. In 1631, the Dutch established the small whaling community and settlement of "Zwaanendael" near Cape Henlopen. The first Swedish expedition sailed into the Delaware Bay in 1638 and established the region's first permanent European settlement at Wilmington, Delaware. The project area exhibits numerous shorefront houses built between the early-1960's to the 1990's. These houses will not be impacted by proposed construction.

135. **Maritime Resources.** Although the Delaware Bay was documented in 1609 and explored by others in 1616, the first comprehensive navigational chart of the Delaware Coast vicinity was not completed until 1756. Privately published charts were available in the first half of the 19th century. However, standardized coastal charts were not initiated until the first United States Coast Survey was completed in the mid-19th century. In 1878, the United States Coast and Geodetic Survey began to periodically update the chart of the vicinity with detailed hydrographic information. The earliest known aid to navigation in Delaware was the Cape Henlopen Light, which was erected in 1767. A second light was constructed on Fenwick Island in 1858. Two breakwaters, creating a Harbor of Refuge, were constructed inside Cape Henlopen between 1828 and 1901 to provide vessels protection from storms and ice at the mouth of the bay. By the middle of the 19th century, the U.S. Coast Guard (USCG) had established a series of lifesaving stations at Lewes, Cape Henlopen, Rehoboth Beach, Indian River Inlet, Bethany Beach, and Fenwick Island. One historic property in the project vicinity, the Indian River Life Saving Service Station, is listed on the National Register of Historic Places. However, this property is

north of Indian River Inlet and is well outside of the project area.

136. Historic maritime activity within the project area was almost exclusively transient, with vessels crossing the area on coastal networks linking the Delaware ports and New York with other ports from Maine to Texas and the Caribbean to Central and South America. Over the years, many types of ships and vessels have wrecked while en route up and down the coast. Many vessels were lost along the coast in an attempt to reach the Harbor of Refuge. Coastal storms, treacherous northeast winds, and swift tidal currents coupled with historically heavy coastal traffic has caused the loss of dozens of documented sailing vessels, steamships, barges, tugs, and large modern ships off the Delaware Coast. A variety of potential submerged cultural resource types in the project vicinity could date from the first half of the 17th century through the Second World War. A remote sensing survey of the proposed borrow area identified no magnetic targets exhibiting shipwreck characteristics.

137. **Submerged Prehistoric Sites.** During the last glacial period, which terminated approximately 15,000 years ago, the sea level was 95-130 m. lower than current levels. The Delaware Atlantic shoreline at this time was on the edge of the modern continental shelf, some 50-60 km. from the present shoreline. According to area studies, the sea level rose at a steady pace between 7,000 B.P. and 3,000 B.P., with a slower rate of increase after ca. 3,000 B.P. There is a possibility that prehistoric Pleistocene land surfaces are buried under offshore deposits in the borrow area.

PROBLEM IDENTIFICATION

138. Water resource problems associated with the main study objectives are identified below. The problems which exist in the study area were identified during site visits, literature review, public and interagency coordination, surveys, and aerial reconnaissance flights.

139. **Problem Analysis.** The principal water resources problem categories identified in Bethany Beach and South Bethany are: 1) storm damage vulnerability with a high potential for storm-induced erosion, inundation, and wave attack which is exacerbated by; 2) long-term shoreline erosion.

140. The ground elevation of Bethany Beach decreases from +11 ft-NAVD in the north to +8 ft-NAVD in the south. Although there are dunes in the northern and southern parts of town, the ocean shoreline along the study area consists predominantly of a continuous strip of low-lying beach with a series of 9 groins along the oceanfront.

141. The ground elevation of South Bethany decreases from +10 ft-NAVD in the north to +8 ft-NAVD in the south. Although there are dunes in the very northern part of town, the ocean

shoreline along the study area consists predominantly of a continuous strip of low-lying beach. There are no groins along the oceanfront.

142. **Storm Damages.** The principal source of economic damages identified in Bethany Beach and South Bethany is storms. Severe storms in recent years have caused a reduction in the overall dune height and berm height and width along the study area. These existing conditions expose the towns of Bethany Beach and South Bethany to potentially catastrophic damage from ocean flooding and wave attack. Efforts undertaken to minimize losses associated with storm damage include building code improvements and building restrictions. However, many portions of the developed coast still remain vulnerable due to the proximity of structures to the ocean and the level of development.

143. ***Storm History.*** In recent years erosion problems have become more critical as several coastal storms have buffeted the Atlantic Coast of Delaware. Since the March 1962 storm, which caused $16.7 million in damages, the most notable storms have occurred in December 1974, October 1977, March 1984 (Figure 6), September 1984, November 1989, October 1991 (Figure 7), January 1992 (Figures 8 and 9), December 1992, and January 1996. It should be noted that the January 1992, December 1992, and January 1996 storms resulted in Presidential disaster declarations for Sussex County, which includes the entire Atlantic Ocean Coast of Delaware.

144. **Long-Term Shoreline Erosion.** Progressive and constant erosion is evident along the coastline of the study area. Historically, beach erosion has been recorded in Delaware since 1843, though according to Goodman (1973) it was not a significant problem until the 1950's when tourism, and hence development, increased and the economic impact of beach erosion became apparent. Local interests constructed groins in Bethany Beach between the 1930's and 1950's indicating that beach erosion was in fact a problem prior to 1950.

145. **Sponsor Concerns.** The non-Federal sponsor for this feasibility study is DNREC. DNREC's interests are to enter into a long-term partnership with the Federal Government to provide hurricane and storm damage protection for the towns of Bethany Beach and South Bethany in a manner that maximizes the use of limited state resources and funds.

FIGURE 6: MARCH 1984 STORM – SOUTH BETHANY

FIGURE 7: OCTOBER 1991 STORM – BETHANY BEACH

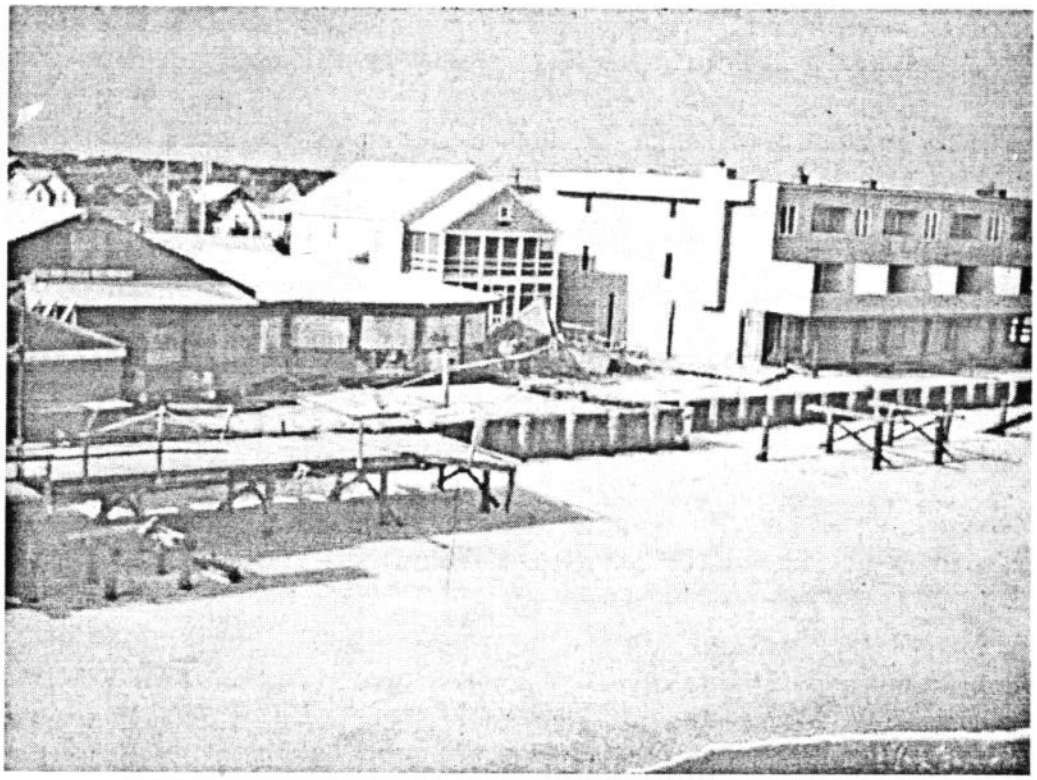
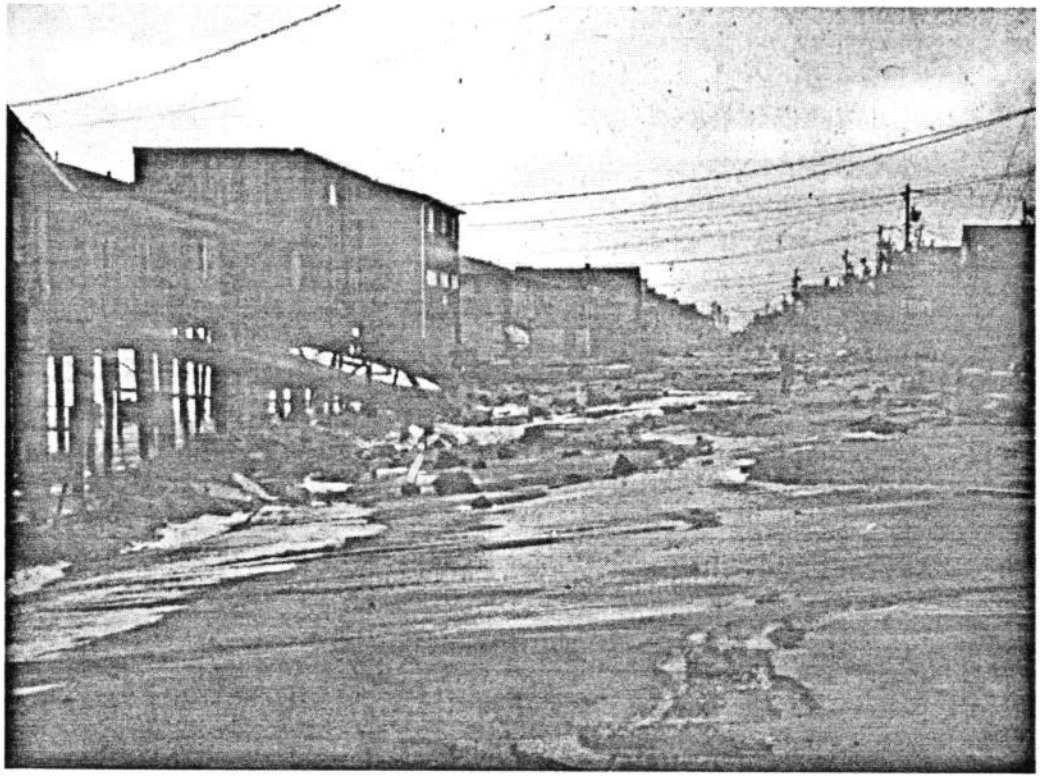


FIGURE 8: JANUARY 1992 STORM – BETHANY BEACH

FIGURE 9: JANUARY 1992 STORM – SOUTH BETHANY



WITHOUT-PROJECT CONDITIONS

146. **General.** In order to assess the "Without-project" conditions, the natural processes that affect the oceanfront were evaluated as they contribute to the Federal objective of hurricane and storm damage reduction. The objective of any plan of improvement is to reduce the damages caused by these processes. Storm erosion and inundation analyses were conducted for Bethany Beach and South Bethany to determine the potential for damages. Storm-induced erosion and coastal flooding were first evaluated for the without-project condition, which is a projection of conditions likely to occur without a Federal project in place. The economic impacts of the without-project scenario were then determined, providing the basis for comparing alternative shore protection features during plan formulation.

147. The without-project condition for this study made certain assumptions. The assumptions that follow were used in determining the future condition of the study area for the 50-year period of analysis following the base year, which is 2002.

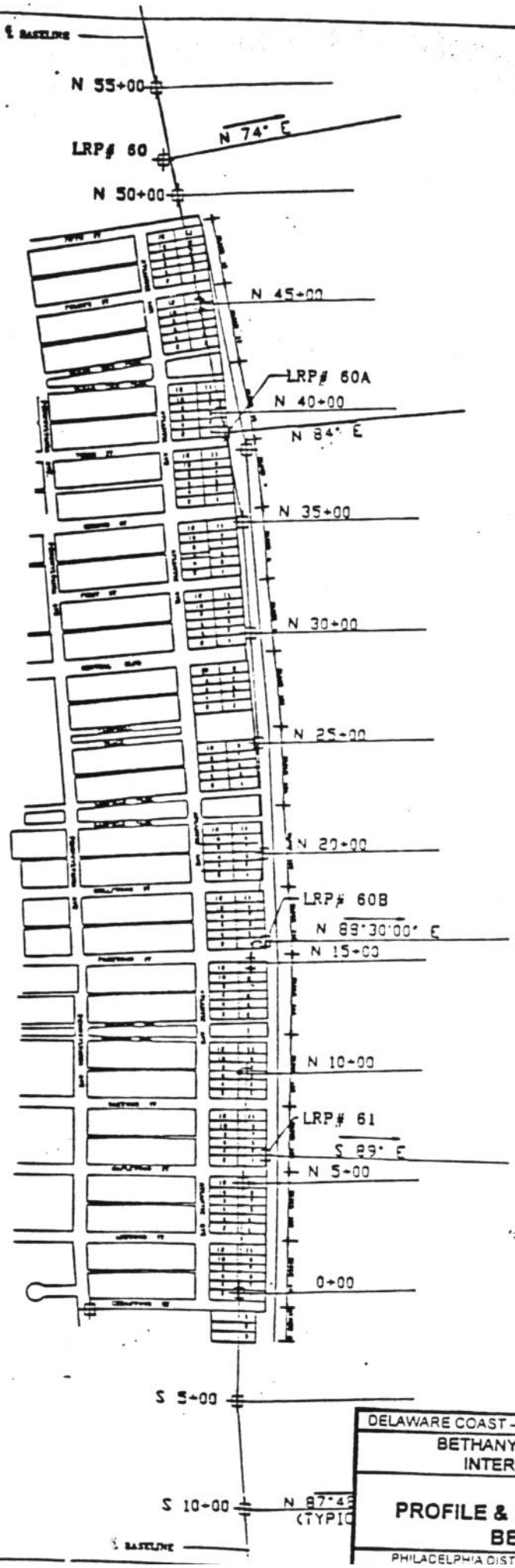
1) Long-term erosion will continue with no action by local concerns to correct or reduce the erosion until the erosion reaches a fixed point. That point is the bulkhead in Bethany Beach and the seaward edge of the oceanfront row of structures in South Bethany.

2) Replacement of damaged structures is assumed to be in-kind for both buildings and shore protection structures.

3) The average profile characteristics developed from recent beach surveys are considered to be the existing condition profiles used in the without-project analyses.

WITHOUT-PROJECT HYDRAULIC ANALYSIS

148. **Typical Profile Representation.** Profiles were chosen to represent the typical characteristics of existing conditions of the beach for the coastal processes analyses. The beach profile data was developed from survey data collected between 1982 and 1995 at Bethany Beach and South Bethany. Each profile in the project area is unique, including shore protection structures, and was developed for the average conditions. Profiles were then eroded back to the bulkhead in Bethany Beach and the seaward edge of the oceanfront row of structures in South Bethany. Each profile was extended landward using 1995 digital photogrammetry elevations, to allow for erosion and inundation computations into the community. A design baseline was established, from which all measurements of profile recession and inundation delineation are referenced. Figures 10 and 11 show the profile and baseline locations for Bethany Beach and South Bethany, respectively. Figure 12 represents an example of a profile through time utilized for the coastal processes analyses.



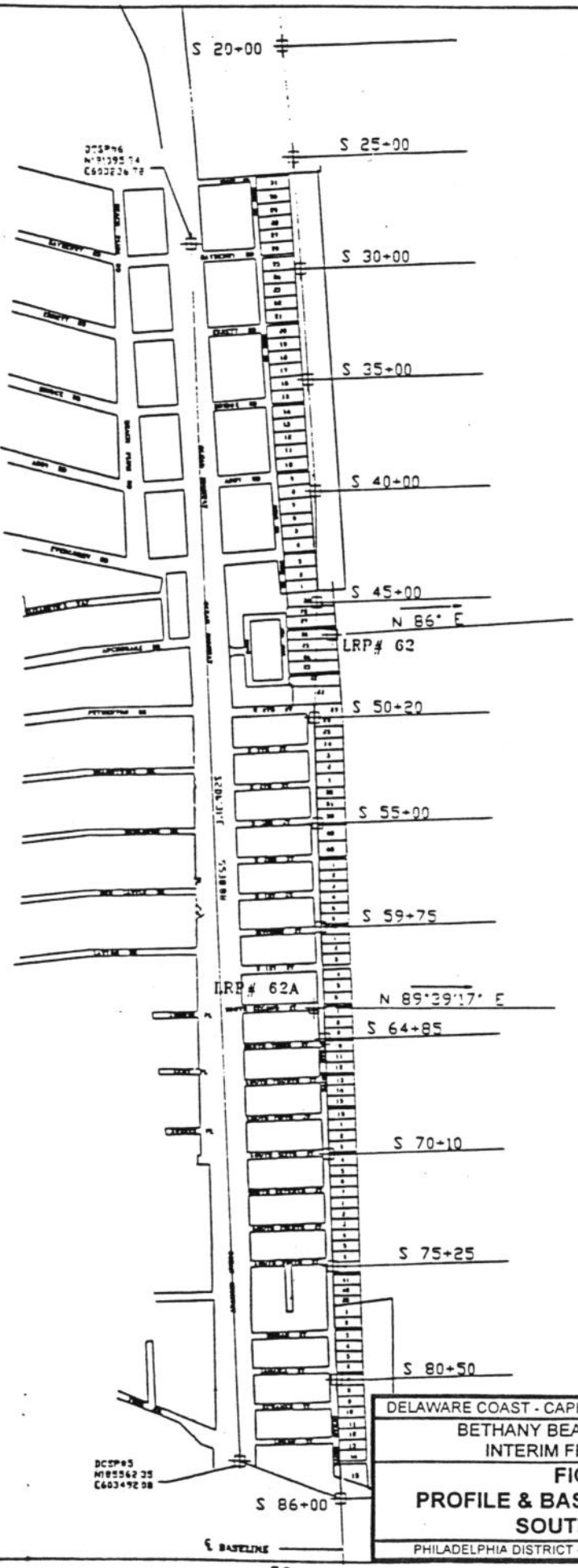
BETHANY BEACH

DELAWARE COAST – CAPE HENLOPEN TO FENWICK ISLAND

BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY

FIGURE 10
PROFILE & BASELINE LOCATIONS – BETHANY BEACH

PHILADELPHIA DISTRICT, U.S. ARMY CORPS OF ENGINEERS



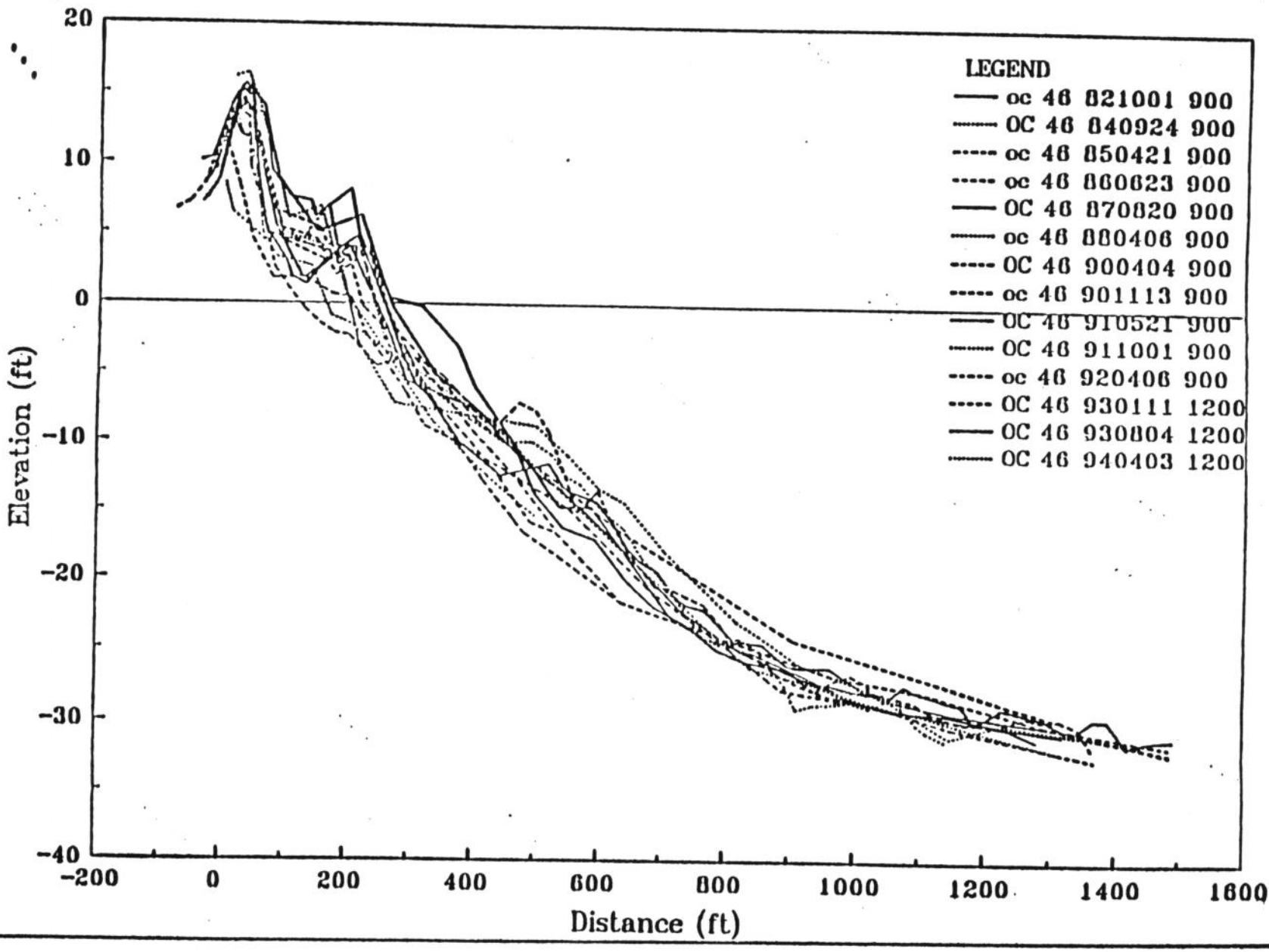
DELAWARE COAST - CAPE HENLOPEN TO FENWICK ISLAND

BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY

FIGURE 11
PROFILE & BASELINE LOCATIONS – SOUTH BETHANY

PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS

HISTORIC PROFILE DATA



DELAWARE COAST - CAPE HENLOPEN TO FENWICK ISLAND
BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY
FIGURE 12
EXAMPLE PROFILE
PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS

149. **Long-Term Erosion Rates.** Long-term shoreline change rates for each of the seven reaches shown in Figure 3 were estimated based on the historic record of shoreline position and profile surveys. The historical information shows a pattern of alternating accretion and erosion along the entire Delaware coastline. The observed erosion/accretion rates were averaged over varying shoreline lengths to normalize the effects of the fluctuations. Within Reach VI, which contains Bethany Beach and South Bethany, the rates of shoreline change ranged from +3 ft/yr (accretion) to -2 ft/yr (erosion). Based on the analysis of the historic data it was determined that the study area would be characterized by two zones of shoreline change rates. Bethany Beach is characterized as stable (0 ft/yr net movement), and South Bethany is characterized by a change rate of -1 ft/yr (erosion). These rates are utilized in estimating the background long-term volumetric erosion rates for the project area, and in establishing the base year estimate of starting conditions.

150. While Bethany Beach is characterized as stable and South Bethany is characterized by a low erosion rate, one must be cognizant that DNREC's Division of Soil and Water Conservation has introduced a large volume of fill to these areas in recent years. Table 14 lists the historic beach fills placed in the area from Bethany Beach to South Bethany, including the Sea Colony complex and Middlesex Beach areas. Had this fill not been placed, it is likely that a regression analysis would have indicated significantly higher erosion rates, and thus higher without-project damages.

TABLE 14
HISTORIC BEACH FILLS – BETHANY BEACH AND SOUTH BETHANY

LOCATION	DATE	VOLUME PLACED
Bethany Beach	1961	100,000 cy (1)
Bethany Beach	March 1962	69,700 cy (2)
Bethany Beach	June 1989	284,500 cy
Bethany Beach	October – November 1992	219,735 cy
Bethany Beach	August 1994	184,452 cy
Sea Colony	July 1989	132,600 cy
Middlesex Beach	October 1989	63,700 cy
South Bethany	March 1962	65,100 cy (2)
South Bethany	August – October 1989	231,600 cy
South Bethany	September – October 1992	192,749 cy (3)
South Bethany	August 1994	98,419 cy

NOTES:
(1) State Highway Department Project (State Highway Dept. was responsible for projects prior to 1972)
(2) Corps of Engineers/State Highway Department Project
(3) Fill tapered into state park land

151. **Storm Erosion and Inundation Analyses.** A brief summary of the mechanisms that result in beach erosion and inundation of communities from coastal storms is provided in this section. Although wind, storm track, central pressure, and precipitation are the primary meteorological factors affecting the damage potential of coastal storms, the major causes of damage and loss of life are storm surge, storm duration, and wave action.

152. Under storm conditions, there is typically a net increase in the ocean water level which is superimposed on the normal astronomic tide height fluctuations. The increase in water level caused by the storm is referred to as "storm surge". The effect of storm surge on the coast depends on the interaction between the normal astronomic tide and storm-produced water level rise. For example, if the time of normal high tide coincides with the maximum surge, the overall effect will be greater. If the surge occurs at low or falling tide, the impact will likely be lessened. The term "stage" as applied in this analysis pertains to the total water elevation, including both tide and storm surge components, relative to a reference datum (NAVD used herein). The term "surge" is defined as the difference between the observed stage and the stage that is predicted to occur due to normal tidal forces, and is thus a good indicator of the magnitude of storm intensity. Slowly moving northeasters may continue to build a surge that lasts through several high tides. Such a condition occurred during the devastating March 1962 storm that lasted for five high tides. In addition to storm surge, a rise in water level in the nearshore can occur due to wave setup. Although short period surface waves are responsible for minimal transport in the direction of wave propagation in open water, they may cause significant transport near shore upon breaking. Water propelled landward due to breaking waves moves rather rapidly, but water returned seaward under the influence of gravity is slower. This difference in transport rates in the onshore and offshore directions results in a pileup of water near shore, referred to as wave setup. Wave setup was computed and included in storm analysis.

153. Typically there is also an increase in absolute wave height and wave steepness (the ratio of wave height to wavelength). When these factors combine under storm conditions, the higher, steeper waves and elevated ocean stage cause a seaward transport of material from the beach profile. The net movement of material is from the foreshore seaward toward the surf zone. This offshore transport creates a wider, flatter nearshore zone over which the incident waves break and dissipate energy. The beach profile evolves in this manner toward an equilibrium configuration with the storm conditions.

154. **Modeling Storm-Induced Erosion.** Analyses of storm related erosion for coastal sites require either a long period of record over which the important storm parameters as well as the resultant storm erosion are quantified, or a model which is capable of realistically simulating the erosional effects of a particular set of storm parameters acting on a given beach configuration. There are very few locations for which the necessary period of prototype information is available to perform an empirical analysis of storm-induced erosion. This is primarily due to the difficulty of directly measuring many important beach geometry and storm parameters before, during, and immediately after a storm. Thus, a systematic evaluation of erosion under a range of possible

starting conditions requires that a numerical model approach be adopted for the study area.

155. The Corps of Engineers has developed, adopted, and released the numerical storm erosion model SBEACH (Storm-Induced BEAch CHange) for use by field offices. SBEACH is a geomorphic-based two-dimensional model that simulates beach profile change, including the formation and movement of major morphologic features such as longshore bars, troughs, and berms under varying storm waves and water levels (Rosati *et al.*, 1993). SBEACH has significant capabilities that make it useful for quantitative and qualitative investigation of short-term beach profile response to storms. Since SBEACH is based on cross-shore processes, caution should be used when using the model in the vicinity of inlets, structures, and areas with strong longshore gradient in transport processes.

156. Input parameters include varying water levels as produced by storm surge and tide, varying wave heights and periods, and an arbitrary grain size in the fine to medium sand range. The initial beach profile can be input as either an idealized dune and berm configuration or an arbitrary (surveyed) total profile configuration. SBEACH allows for variable cross-shore grid spacing, simulated water-level setup due to wind, includes advanced procedures for calculating the wave breaking index and breaker decay, and provides an estimation of dune overwash. Shoreward boundary conditions that may be specified include a vertical structure (that can fail due to either excessive scour or instability caused by wave action/water elevation) or a beach with a dune of arbitrary configuration.

157. **Development of Input Data.** For each town, transects were selected to represent the "average" shoreline structure or lack thereof, backshore configuration, and upland development conditions that exist within the town. Storm erosion, inundation, and wave attack were computed in SBEACH relative to the field survey baseline. All results presented in this section are provided relative to the hydraulic/economic reference line.

158. ***Profile Data.*** The present condition in the study area was represented by the average conditions developed from beach profiles surveyed between 1989 and 1995 eroded back to the bulkhead in Bethany Beach and the seaward edge of the oceanfront row of structures in South Bethany Beach. The State of Delaware has established a survey baseline with profiles located approximately every 500' throughout the study area. In addition, several Corps of Engineers - LRP profiles, which cover the entire Delaware coastline, are within or adjacent to the study area. Figures 10 and 11 present the location of the State of Delaware and Corps of Engineers beach profiles available for consideration in computing average conditions. Using available aerial photogrammetry, the chosen profiles were extended landward prior to being input to SBEACH to allow for computation of erosion, inundation, and wave attack damages into the community.

159. ***Existing Erosion Control Structures.*** The location of erosion control structures, predominantly a bulkhead in Bethany Beach and a revetment in South Bethany, were input into the SBEACH model. Based upon the erosion control structure characteristics, failure criteria

were delineated for each relevant profile. Erosion control structures were specified to fail due to three possible conditions: scour at the toe, sufficient damaging wave height, or extreme water level to cause structural failure. Table 15 presents the criteria used for determining failure of coastal structures located within the study area.

TABLE 15
COASTAL STRUCTURE LOCATIONS, FAILURE CRITERIA, AND WITHOUT-PROJECT FAILURE EVENTS
(all elevations in ft-NAVD)

AREA	STRUCTURE LOCATION	SCOUR DEPTH	WATER ELEVATION	WAVE HEIGHT	FREQUENCY
Bethany central	420	-4.3	12.2	8.0'	50-year
South Bethany south	475	-2.3	10.8	6.8'	10-year

NOTES:
1. Location measured feet landward of hydraulic/economic reference line
2. Areas not listed have no erosion control structures
3. Scour depth and water elevations are in ft-NAVD

160. ***Waves and Water Levels.*** Water level is the first-order forcing parameter controlling storm-induced beach profile change, normally exerting greater control over profile change during storms than either waves or wind. Water level consists of contributions from the tide, storm surge, wave and wind-induced setup, and wave runup. Tide and storm surge data are input to SBEACH, while wave and wind induced setup and wave runup is computed by the model. The combined time series of tide and surge is referred to as the "hydrograph of total water level". The shape of the hydrograph is characterized by its duration (time when erosive wave conditions and higher than normal water elevations occur) and by its peak elevation. Combined water level data for storms ranging from the 0.5- to 0.002-yearly exceedance frequency were taken from a hindcast developed for the Philadelphia District by OCTI, incorporating data from the regional database.

161. Elevated water levels accompanying storms allow waves to attack portions of the profile that are out of equilibrium with wave action because that area of the beach is not normally inundated. Wave height and period are combined in an empirical equation within SBEACH to determine if the beach will erode or accrete for a time step. When modeling beach erosion, a storm is not defined by the water level, wave height, or period alone, but by the combination of these parameters that produces offshore transport. For each of the storm events modeled in this analysis, wave data were also obtained from the previously mentioned hindcast.

162. **Calibration.** Calibration refers to the procedure of reproducing with SBEACH the change in profile shape produced by a storm. Due to the empirical foundation of SBEACH and the natural variability that occurs along the beach during storms, the model should be calibrated using data from beach profiles surveyed before and after storms at the project coast or a similar coast. The calibration procedure involves iterative adjustments of controlling simulation parameters until agreement is obtained between measured and simulated profiles.

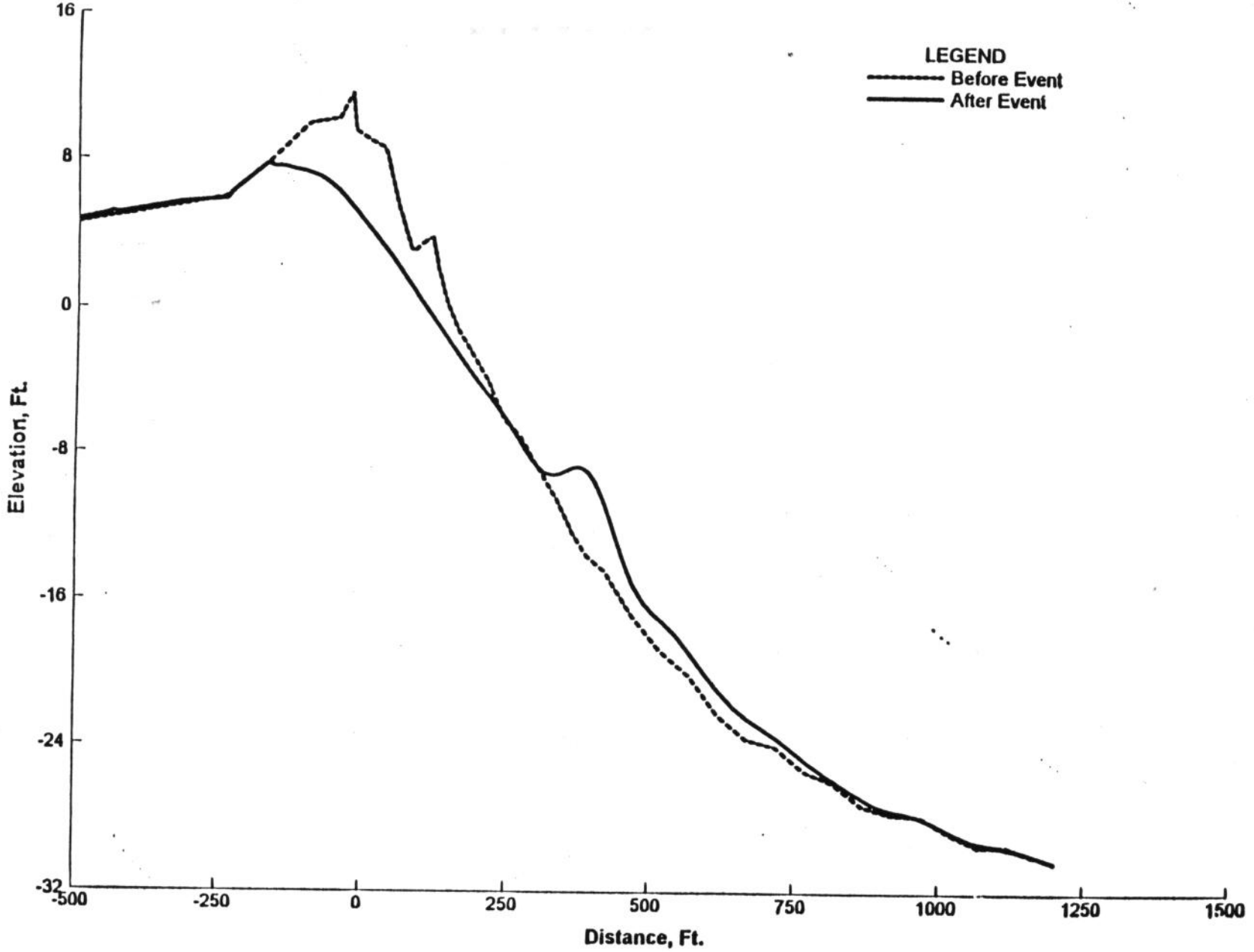
163. As pre- and post-storm profile surveys required for calibration were not available for the Bethany Beach and South Bethany Beach area, the calibration parameters determined in the Rehoboth Beach/Dewey Beach study were adopted for this study as the physical characteristics and processes of the two areas are very similar. The calibration effort in the Rehoboth Beach/Dewey Beach study made use of profile surveys taken just prior to and just after the December 1992 storm, as well as wave data for that storm which was available from the Dewey Beach directional wave gage.

164. The three main calibration parameters are: K, the transport rate coefficient, with a value of 1.2×10^{-6} m^4/N; E_{ps}, the coefficient for the slope dependent term, with a value of 0.003 m^2/s; and L_{amm}, the transport rate decay coefficient multiplier, with a value of 0.1 (dimensionless).

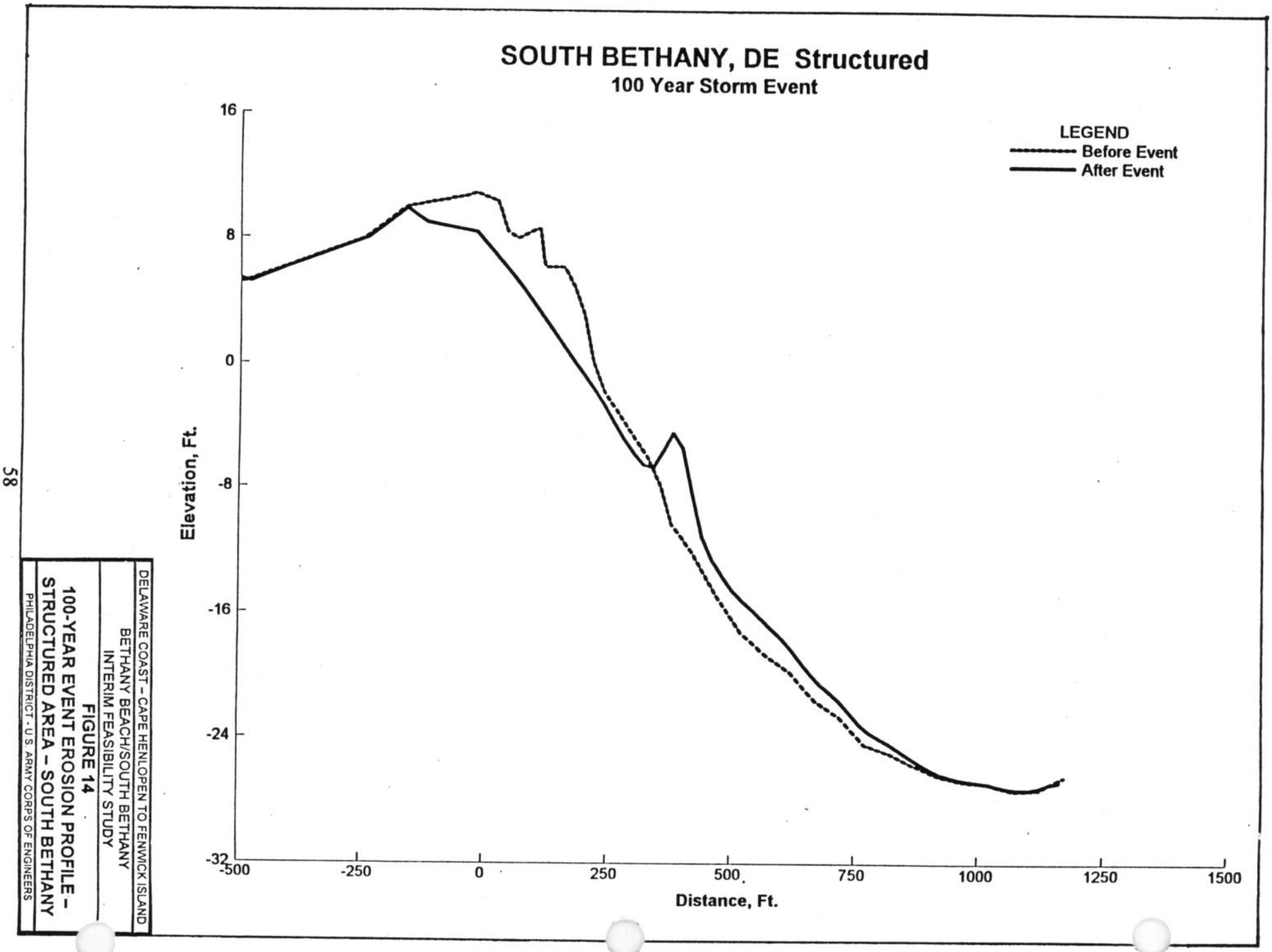
165. **Storm Erosion Simulations.** The SBEACH model was applied to predict storm-induced erosion for without-project conditions in the study area. All representative storm events were run against each of the chosen pre-storm profiles. Model output from each simulation includes a post-storm profile plot, and several report and post-processing files. In this analysis, profile retreat for a given storm event was measured landward from the hydraulic/economic reference line to the landward most location of a 1-foot erosion depth on the beach face. Figures 13, 14, 15, and 16 present the 100-year frequency storm erosion results for typical structured and unstructured areas within Bethany Beach and South Bethany. The figures show the input pre-storm and the resultant post-storm profiles based on SBEACH-predicted retreat due to the 100-year frequency storm event.

166. ***Analysis of Model Results.*** The SBEACH model analyzed the erosion control structures according to the failure criteria previously presented in Table 15. Results of the without-project storm erosion analysis are presented in Table 16. These values are used as input to the economic computation of damages associated with storm related erosion.

167. **Storm Inundation Evaluation.** The project area is subject to inundation from several sources including ocean waves overtopping the beach and/or protective structures as well as flooding from inland bay and canal sources. The inundation can be categorized as two separate phenomena: 1) Flooding due to super-elevation of the water surfaces surrounding the project area, and 2) wave attack, the direct impact of waves and/or high-energy runup on coastal structures. In order to quantify the effects from flooding and wave attack, all inundation events are based on the ocean stage-frequency as discussed in an earlier section. Because the wave-



DELAWARE COAST - CAPE HENLOPEN TO FENWICK ISLAND
BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY
FIGURE 13
100-YEAR EVENT EROSION PROFILE – STRUCTURED AREA - BETHANY BEACH
PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS



DELAWARE COAST – CAPE HENLOPEN TO FENWICK ISLAND

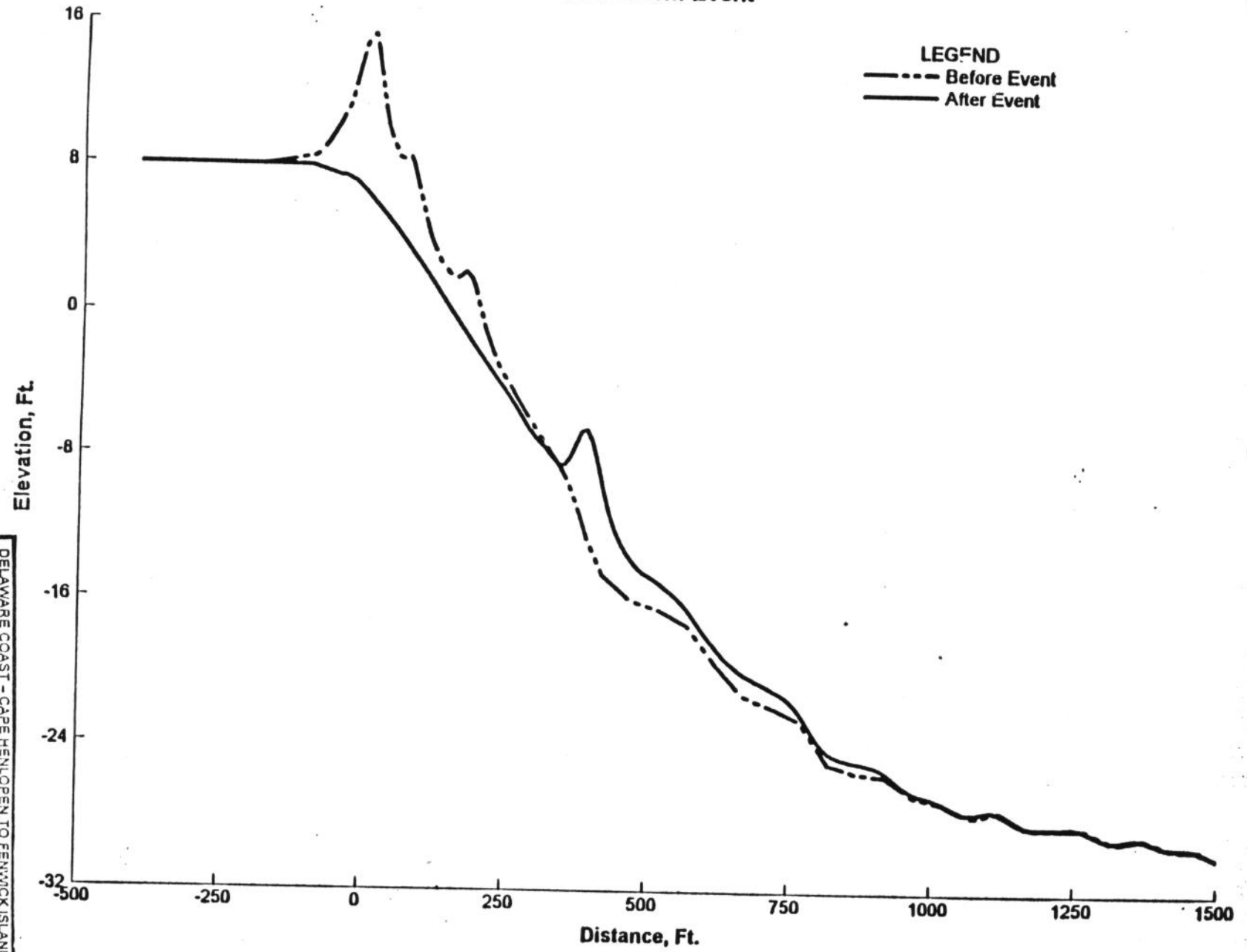
BETHANY BEACH/SOUTH BETHANY

INTERIM FEASIBILITY STUDY

FIGURE 14

100-YEAR EVENT EROSION PROFILE – STRUCTURED AREA – SOUTH BETHANY

PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS



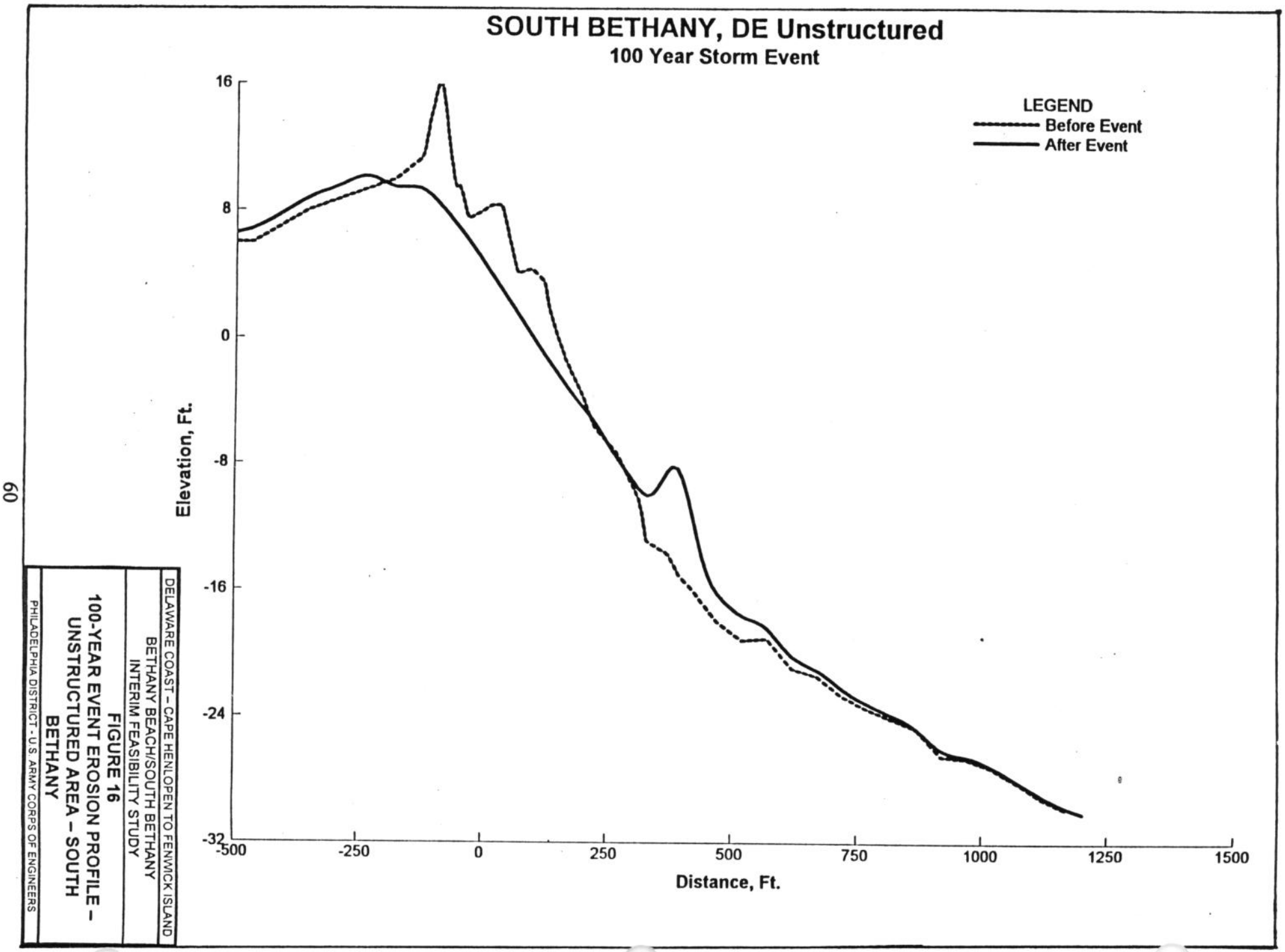
DELAWARE COAST - CAPE HENLOPEN TO FENWICK ISLAND

BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY

FIGURE 15

100-YEAR EVENT EROSION PROFILE - UNSTRUCTURED AREA - BETHANY BEACH

PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS



DELAWARE COAST – CAPE HENLOPEN TO FENWICK ISLAND

BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY

FIGURE 16
100-YEAR EVENT EROSION PROFILE – UNSTRUCTURED AREA – SOUTH BETHANY

PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS

effect contribution to total water level at the shoreline can be significant, wave setup is estimated and added to the stage-frequency curve for determination of the static flooding impact. Higher water elevations associated with wave runup were also evaluated at all vertical structures and profile crest locations.

TABLE 16
PREDICTED EROSION POSITIONS FOR WITHOUT-PROJECT CONDITIONS
(feet landward of hydraulic/economic reference line)

AREA	2-YR	5-YR	10-YR	20-YR	50-YR	100-YR	200-YR	500-YR
Bethany north	415	455	465	500	525	530	550	570
Bethany central	420	420	420	525	575	625	650	670
Bethany south	400	430	460	490	525	540	555	593
South Bethany north	350	436	447	455	490	515	535	555
South Bethany south	445	475	525	560	620	680	690	710

168. **Flooding.** The project area is subject to flooding from back bay and adjacent waterways as well as direct ocean inundation. Construction of the proposed beach erosion control features will not significantly reduce the flood depths caused by the elevated stage of the surrounding waters. This elevated stage flooding is referred to as static or still water. The effects due to wave setup are considered in the inundation stage-frequency curve for assessing the impacts to the project area from flooding. Table 17 presents the adopted total inundation stage-frequency data from Table 3, adjusted to include the estimated setup at the selected recurrence intervals.

TABLE 17
INUNDATION FREQUENCY-STAGE PLUS WAVE SETUP

ANNUAL EXCEEDENCE PROBABILITY	WATER SURFACE ELEVATION (ft-NAVD)
0.50	9.1
0.20	9.2
0.10	10.9
0.05	12.1
0.02	12.3
0.01	13.9
0.005	16.3
0.002	16.5

169. The estimated "back bay and canal" flooding levels were presented previously in Table 4. The added still water flooding from overtopping of the coastal structures and dunes were incorporated into the wave attack analysis.

170. **Inland Wave Attack and Inundation Analysis.** The SBEACH model calculates nearshore wave characteristics, wave runup, wave setup, and elevation of the beach profile for each hindcasted event. The wave runup and wave setup values are used, along with the eroded beach elevations, to determine inland water surface profiles, inland wave characteristics, and volumes of eroded material which in turn are used to assess economic damages. Total water elevation profiles are constructed for each extreme event across the entire profile. The inland wave attack and inundation methodology used in this project is based upon FEMA guidelines for coastal flooding analysis. The procedure divides storm conditions into four cases:

- Case 1: Entire storm-generated profile is inundated;
- Case 2: The top of the dune/profile crest is above the maximum water level, with wave runup greater than 3' above the dune crest elevation;
- Case 3: The top of the dune/profile crest is above the maximum water level, with wave runup exceeding but less than 3' above the dune crest elevation; and
- Case 4: The wave runup does not overtop the dune (in this case, the wave zone is limited to seaward of the dune).

171. ***Criteria for Damage.*** To evaluate the added potential for structural damage, the boundaries of the wave attack must be delineated, and the critical damage wave height identified. Return periods of 2-, 5-, 10-, 20-, 50-, 100-, 200-, and 500-years associated with the inundation frequency curve were evaluated for each of the chosen profiles. The analysis estimates the location of a wave attack line and the associated zones of high-energy stages across the profile. The wave attack line is the most landward position of the swash zone where the force due to waves exceeds the force required to damage typical coastal structures. Any structure located landward of this line is subject to the equivalent of still water flooding because the wave heights are not sufficient to cause the accelerated damages incurred seaward of the line. A 3-foot wave height is assumed as the minimum wave that would cause damage to typical structures. This is based on the Corps of Engineers report "Guidelines for Identifying Coastal High Hazard Zones", and FEMA's "Guidelines and Specifications for Wave Elevation Determination and V-Zone Mapping", which both report a 3-foot wave height as the critical wave for damage.

172. The bulkheads and revetments located in the project area reduce the direct impact from wave attack on structures and erosion damage. For all but the most extreme events, failure of the protective structures is required for significant wave attack to occur. However, extreme waves on certain cell profiles can plunge over the fixed barriers and attack the adjacent structures

causing significant damage. The recurrence intervals at which the protective structures will fail were determined in conjunction with the erosion analysis, and were previously presented in Table 15.

173. ***Without-project Inundation Results.*** The effects of stage plus setup, wave amplitude, and wave runup at structures or the profile crest location were incorporated into the total water level. The total water level is the combination of the computed stage, the setup, the amplitude of the maximum non-breaking wave that can exist within the region, and/or runup height above the estimated water level if waves are breaking on the beach face. The wave zone is the region in which a 3-foot or greater wave or a velocity flow that overtops the profile crest by 3' or more can be expected to exist. This zone is the area in which larger structural damages are expected to occur. The other zones are areas that are susceptible to flooding by overtopping and waves less than the 3-foot damaging wave. Table 18 lists the 3-foot damaging wave/runup impact zone measured in feet landward of the hydraulic/economic reference line for the selected storm events. These values are used as input to the economic computation of damages associated with storm related wave attack.

TABLE 18
PREDICTED WAVE IMPACT ZONE POSITIONS FOR WITHOUT-PROJECT CONDITIONS
(feet landward of hydraulic/economic reference line)

AREA	2-YR	5-YR	10-YR	20-YR	50-YR	100-YR	200-YR	500-YR
Bethany north	415	455	465	550	625	1,250	1,270	1,268
Bethany central	420	420	420	600	695	1,400	1,400	1,400
Bethany south	400	430	460	540	625	1,235	1,250	1,250
South Bethany north	350	436	447	480	540	665	1,330	1,330
South Bethany south	445	475	525	585	670	830	1,540	1,531

174. In accordance with FEMA guidance, inundation profiles were computed for each of the chosen profiles in the study area to determine the total water level across the beach profile and into the community. The total water level, including stage, setup and runup or wave crest elevation, is the maximum water elevation across the profile. The total water elevation profile for each representative profile throughout Bethany Beach and South Bethany is presented in the Engineering Technical Appendix, Section 2. Table 19 represents the unstructured area south of the bulkhead in Bethany Beach. The total water level is listed in ft-NAVD at several locations along the profile, measured in feet landward of the hydraulic/economic reference line. The eight pairs of rows are read from top to bottom, 2- through 500-year event. The columns alternately

list distance landward of the hydraulic/economic reference line and water elevation. At the 100-year event the water level at 0' landward of the reference line is +19.3 ft-NAVD. Reading across the row to 850' landward of the reference line, the elevation is +12.4 ft-NAVD. The next value is the first entry on the line below, 1,050' landward of the reference line, at an elevation of +11.0 ft-NAVD. These values are used as input to the economic computations of damages.

TABLE 19
INUNDATION ANALYSIS RESULTS - BETHANY SOUTH
(DIST: feet landward of hydraulic/economic reference line)
(ELEV: total water surface elevation, ft-NAVD)

EVENT	DIST	ELEV	DIST	ELEV	DIST	ELEV	DIST	ELEV
2-YR	0	11.9	400	9.5	420	10.1	480	0.0
	800	0.0	1,150	0.0				
5-YR	0	12.1	430	10.1	480	10.2	525	0.0
	800	0.0	1,150	0.0				
10-YR	0	13.9	460	10.7	510	10.2	550	9.0
	800	9.0	1,150	9.0				
20-YR	0	16.2	490	11.6	540	10.5	580	10.0
	800	10.0	1,150	10.0				
50-YR	0	17.4	525	12.8	575	11.5	700	10.5
	800	10.5	1,150	10.5				
100-YR	0	19.3	540	16.4	650	14.4	850	12.4
	1,050	11.0	1,150	11.0				
200-YR	0	21.2	555	18.2	705	16.2	905	14.2
	1,055	12.2	1,150	11.5				
500-YR	0	21.4	593	18.4	793	16.4	993	14.4
	1,100	12.4	1,150	11.8				

WITHOUT-PROJECT ECONOMIC ANALYSIS

175. **Structure Inventory and Replacement Costs.** A total of 292 structures in the ocean block of Bethany Beach, and 272 in South Bethany were evaluated for existing conditions. Each structure was specifically inventoried and mapped on aerial photography at a scale of 1"=50'. Database information collected included address, construction and quality type, and number of stories. First floor elevations, ground elevations, and type of foundations were obtained in cooperation with DNREC as an in-kind service. For multi-family residential and commercial structures, the number of units and names of businesses were also gathered. Assimilation of this data was enhanced by aerial ortho-digital mapping utilizing the MIPS (Micro Imaging Processing System) geographic information system. Also included was information concerning tax data, such as square footage, number of bathrooms, type of heating systems, and the presence of basements, fireplaces, garages, and central air conditioning along with the structure's age. This information, along with quality and condition, was entered into the Marshall and Swift Residential and Commercial Software Estimator, which calculates depreciated replacement cost value. Only the replacement cost value for the first two floors (vulnerable to storm damage) of high rise buildings located in Bethany Beach was entered into the database and used to estimate damages.

176. The associated content value of each structure was assumed to be 30% of the structural replacement cost. This was based on personal interviews and walk through tours of homes.

177. **Storm Damage Methodology.** Without-project condition damages were calculated for eight frequency storm events (2-, 5-, 10-, 20-, 50-, 100-, 200-, and 500-year) for erosion, wave, and inundation damage to structures, infrastructure, and improved property. The calculations for the structural property storm damages were performed using COSTDAM (Coastal Storm Damage Assessment Model); a computer model that estimates damages resulting from coastal storm processes. COSTDAM reads a "Structure" file that contains the database information for each structure inventoried. COSTDAM concurrently reads a "Control" file that contains the frequency parameters for the representative hydraulic profiles used to characterize the erosion, wave, and inundation mechanisms.

178. COSTDAM checks if a structure has been damaged by wave attack, based on the relationship between the structure's first floor elevation and the total water elevation that sustains a wave in the wave zone. Then COSTDAM checks for erosion damage at a structure. Finally, COSTDAM calculates inundation damages if the water elevation is higher than the first floor elevation based on Food Insurance Administration (FIA) depth-damage curves adjusted for increased saltwater damagibility. To avoid double counting, if damage occurs by more than one mechanism, COSTDAM takes the maximum damage of any one given mechanism (erosion, wave, or inundation) and disregards the rest of the damages from the structure's total damages. Expected average annual damages (EAD) are then calculated.

179. **Structure Damages.** The three damage mechanisms analyzed in this study are erosion, wave, and inundation. Due to the fact that wave and inundation damages are related, they are lumped into one category called wave/inundation. The following sections, in addition to summarizing the amounts of damages in each category, describe the methodology used to derive the amount of damages for each mechanism.

180. ***Erosion Damages.*** The distance between the reference line and the oceanfront and back walls of structures were measured in AutoCAD using the georeferenced MIPS mapping of the study area and input into the Structure file. It was assumed that a structure is destroyed at the point that the land below the structure is eroded halfway through the structure if the structure is not on a pile foundation. If the structure is on piles, erosion needs to retreat entirely through the footprint before total damage is claimed. Before total failure for both foundation types, the percent damage claimed is equal to the proportion of erosion under the structure's footprint compared to the total footprint. Certain structures, however, were exempted from erosion damages due to the quality/depth of pile construction.

181. A unique situation exists in South Bethany with respect to the erosion damage criteria. The first row of structures fronting the ocean actually lies seaward of the natural dune. The current position of Ocean Drive, just landward of the first row of structures and parallel to the shoreline, is where the natural dune was originally located. All of the structures in the oceanfront row are on piles. The height of these structures ranges from approximately 5' to 10' above the present height of the existing berm (+6 ft-NAVD). Erosion alone will not cause them to fail. Since they are so high, the splash-up effect of wave action that would result in the failure of others that lie only a few feet above grade is negligible for these structures. Therefore, it was assumed that the first row of structures in South Bethany will only fail due to the impacts of wave and inundation as described below.

182. Without-project EAD to structures due to erosion, at the January 1997 price level, are $1,168,000 for Bethany Beach and $512,000 for South Bethany. Total damages to structures due to erosion for both communities are $1,680,000.

183. ***Wave/Inundation Damages.*** A structure is considered damaged by a wave when there is sufficient force in the total water elevation to destroy it. Partial wave damages are not calculated; instead, the structure is subject to inundation damages. A flood can potentially cause damages to property and their contents through several mechanisms. The predominant damage-inducing mechanisms, as typical to riverine systems, are depth and duration of flooding. However, ocean flooding has been shown to cause more damages than inundation in fresh water for the same depth. Also, the depth and velocity of the floodwater may be sufficient to result in structural damage and ultimately failure.

184. Depth-damage curves were used to estimate the damage to structures. The distinguishing characteristics of these curves were foundation type and the number of stories in the structure.

For commercial structures, the business activity was also a distinguishing factor for content. The depth-damage curves encode the percent damaged at various depths relative to the first floor. Without-project EAD to structures due to waves/inundation, at the January 1997 price level, are $1,563,000 for Bethany Beach and $861,000 for South Bethany. Total damages to structures due to waves/inundation for both communities are $2,424,000.

185. ***Total Damages to Structures.*** Without-project EAD to structures, at the January 1997 price level, are $2,731,000 for Bethany Beach and $1,373,000 for South Bethany. Total damages to structures in the entire study area total $4,104,000.

186. **Improved Property Damages.** In addition to erosion damage to structures, damage to the land the structures occupy (henceforth called improved property) was calculated. The improved property value was determined by comparing market value of the improved property to the cost of filling in the eroded land for reutilization and using the least expensive of the two values. The cost of filling/restoring the improved property is based on a typical 100' by 50' lot for the different depths, widths, and cubic yards of erosion produced by storms. The two options were compared for costs. The cost of filling/restoring the eroded improved property was the less costly of the two options, and was estimated to be an average of only 68% of the market value of the improved property. The cost of fill was prorated for the width of each reach to estimate total damages. Without-project EAD for improved property, at the January 1997 price level, are $80,000 for Bethany Beach and $77,000 for South Bethany. Total improved property damages for both communities are $157,000.

187. **Infrastructure Damages.** Infrastructure damage was assessed by estimating the value of the infrastructure from the baseline to the 500-year erosion outline of the study area. The percent damage per frequency for the infrastructure components was determined to derive a frequency-erosion damage relationship. The replacement cost of roads is not a fixed value and decreased with greater quantities eroded reflecting economies of scale. Without-project EAD for infrastructure (roads, utilities, bulkhead, revetment, boardwalk), at the January 1997 price level, are $205,000 for Bethany Beach and $218,000 for South Bethany. Total infrastructure damages for both communities are $423,000.

188. **Emergency/Clean-Up Costs.** Clean-up costs for individual structures are based on the time for clean-up and additional meal and travel costs. Travel and meal costs are included as opposed to evacuation costs because the vast majority of residential structures and even many commercial structures are occupied only on a seasonal basis, and even then, not always by the structure's owner. Clean-up costs are only applied to those structures affected by a particular storm event.

189. Emergency and clean-up costs were calculated for the study area. This includes local, county, and state governments and non-profit emergency service organizations. The costs are based on FEMA Damage Survey Reports (DSR's) for the January and December 1992 storms,

which had stage frequencies of approximately 5- and 15-year events. Because of the lack of historical information, emergency and clean-up costs for larger events were extrapolated. The expected average annual emergency/clean-up costs, at the January 1997 price level, are $45,000 for Bethany Beach and $95,000 for South Bethany. Total emergency/clean-up costs for both communities are $140,000.

190. **Back Bay Residual Damages.** COSTDAM was also run for the stages associated with back bay (still water) inundation for South Bethany. These damages represent inundation damages that will not be eliminated by a project on the oceanfront. Damages due to backbay effects were decoupled from the damages due to oceanfront erosion, wave attack, and inundation. This avoids overestimating benefits in the with-project condition for those cases where damages are reduced or eliminated for structures once eroded or damaged by wave attack but may still incur some damages due to inundation from the back bay. Bethany Beach does not experience back bay inundation because uplands are behind the ocean block. However, Bethany Beach has experienced residual flooding due to clogged storm drains.

191. **Without-Project Damages/Costs.** The without-project condition was computed based on hydrologic and hydraulic profiles and structure characteristics of the study area. There are a total of 289 structures in the 500-year storm zone for Bethany Beach, and 263 for South Bethany. Table 20 displays the cumulative residential and commercial structure distribution by frequency zone.

192. The without-project damages and costs were computed based on an average annual series using the Fiscal Year 1998 discount rate of 7.125% for the 50-year period of analysis at the January 1997 price level. Total without-project condition expected annual damages/costs are $3,061,000 for Bethany Beach and $1,763,000 for South Bethany. Total damages for both communities are $4,824,000. Table 21 shows EAD by category.

TABLE 20
STRUCTURE DISTRIBUTION BY STORM FREQUENCY ZONE

EVENT	NUMBER OF INVENTORIED STRUCTURES			CUMULATIVE TOTAL	
	EROSION	WAVE	INUNDATION	RESIDENTIAL	COMMERCIAL
BETHANY BEACH					
2-YR	0	0	0	0	0
5-YR	7	0	0	7	0
10-YR	9	0	21	29	1
20-YR	35	7	101	120	23
50-YR	49	19	131	169	30
100-YR	41	199	24	223	41
200-YR	25	242	19	245	41
500-YR	19	258	12	248	41
SOUTH BETHANY					
2-YR	0	0	0	0	0
5-YR	0	0	4	4	0
10-YR	7	4	12	23	0
20-YR	46	11	37	94	0
50-YR	67	30	47	144	0
100-YR	66	95	30	191	0
200-YR	54	165	35	254	0
500-YR	54	176	33	263	0

TABLE 21
EXPECTED AVERAGE ANNUAL DAMAGES/COSTS BY CATEGORY
(January 1997 price level)

CATEGORY	DAMAGES/COSTS		
	BETHANY BEACH	SOUTH BETHANY	TOTAL
STRUCTURES	**$2,731,000**	**$1,373,000**	**$4,104,000**
EROSION	$1,168,000	$512,000	$1,680,000
WAVE/INUNDATION	$1,563,000	$861,000	$2,424,000
IMPROVED PROPERTY	**$80,000**	**$77,000**	**$157,000**
INFRASTRUCTURE	**$205,000**	**$218,000**	**$423,000**
ROADS/UTILITIES	$24,000	$42,000	$66,000
BOARDWALK	$91,000		$91,000
BULKHEAD	$90,000		$90,000
REVETMENT		$176,000	$176,000
EMERGENCY/CLEAN-UP	**$45,000**	**$95,000**	**$140,000**
TOTAL EAD	**$3,061,000**	**$1,763,000**	**$4,824,000**

PLAN FORMULATION

PLANNING NEEDS, OBJECTIVES, AND CONSTRAINTS

193. The purposes of this section are to provide background on the criteria used in the formulation process and to present the procedures followed from the identification of the study objectives to the identification of the selected plan. The results of these efforts are discussed in the succeeding sections. The formulation process involved establishment of plan formulation rationale, identification and screening of shore protection measures, and assessment and evaluation of detailed plans which are responsive to the identified problems and needs.

194. **Current Needs.** Over the years, erosion has seriously reduced the ability of the shoreline in the study area to provide adequate storm damage protection for the towns of Bethany Beach and South Bethany. Continuation of this historic trend will increase the potential for economic losses and the threat to human life and safety.

195. The purpose of the feasibility study is to evaluate and, if warranted, recommend an implementable plan which provides protection to the towns of Bethany Beach and South Bethany against storm damage. This report considers various alternative solutions to reducing storm damage within the project area.

196. **Planning Objectives.** Planning objectives were identified based on problems, needs, and opportunities as well as existing physical and environmental conditions present in the project area.

197. In general, the prime Federal objective is to contribute to NED consistent with protecting the Nation's environment. The pursuit and attainment of this objective must be consistent with national legal statutes, applicable executive orders, and other Federal planning requirements. The general and specific planning objectives for the Bethany Beach/South Bethany Interim Feasibility Study take an integrated systematic approach to the solution of the erosion and inundation problems associated with coastal storms and long-term erosion in the towns of Bethany Beach and South Bethany. Accordingly, the following general and specific objectives have been identified.

General:

- Meet the specified needs and concerns of the general public.
- Respond to expressed public desires and preferences.
- Be flexible to accommodate changing economic, social, and environmental patterns

and changing technologies.

- Integrate with, and be complementary to, other related programs in the study area.
- Be implementable with respect to financial and institutional capabilities and public support.

Specific:

- Reduce the threat of potential future damages due to the effects of storms, with emphasis on inundation and recession of the shoreline.
- Mitigate the effect of, or prevent the long-term erosion that is expected to continue.
- In accordance with the limits of institutional participation, all plan components must meet NED objectives.
- Where possible, preserve and maintain the environmental character of the areas under study, including such considerations as aesthetic, environmental, and social concerns, as directly related to plans formulated for implementation by the Corps.

198. **Planning Constraints.** Planning constraints are technical, environmental, economic, regional, social, and institutional considerations that act to reduce the theater of possible solutions. The following are established as planning constraints for the study:

Technical Constraints:

- Plans must represent sound, safe, acceptable engineering solutions.
- Plans must comply with Corps regulations.
- Plans must be realistic and reflect state-of-the-art measures and analysis techniques. They must not rely on future research and development of key components.
- Plans that consider elimination of a segment of the project area must ensure that the elimination of such areas does not adversely affect the protected areas or the areas that have been eliminated.
- Federal participation in the cost of restoration of beaches shall be limited so that the proposed beach will not extend seaward of the historical shoreline of record.

- The design of protective structures should, as a minimum, demonstrate that they will satisfactorily perform for design events up to and including the annual frequency that has a 50% probability of being exceeded during the 50-year period of economic analysis (See Engineering Technical Appendices).

Economic Constraints:

- Plans must be efficient. They must represent optimal use of resources in an overall sense. Accomplishment of one economic purpose cannot unreasonably impact another economic system.

- The economic justification of the proposed project must be determined by comparing the average annual tangible economic benefits that would be realized over the period of analysis with the average annual costs. The average annual benefits must equal or exceed the annual costs.

- Federal participation in storm damage reduction projects requires that the project be economically justified primarily on benefits associated with storm damage reduction. For Federal funds to be used to support storm damage reduction projects, greater than 50% of the project costs must be offset by priority benefits.

Environmental Constraints:

- Plans cannot have an unreasonably negative impact on environmental resources.

- Where a potential impact is established, plans must consider mitigation or replacement and should adopt such measures, if justified.

- National Environmental Policy Act (NEPA) documentation must be fully coordinated.

- Water quality standards must be maintained during construction activities in accordance with water quality certification requirements.

- Plans should avoid the destruction or disruption of manmade and natural resources, aesthetic and cultural values, community cohesion, and the availability of public facilities and services.

Regional and Social Constraints:

- The needs of other regions must be considered, and one area cannot be favored to the unacceptable detriment of another.

- Consideration should be given to public health, safety, and social well-being, including possible loss of life.

- Plans should minimize the displacement of people, businesses, and livelihoods of residents in the project area.

- Plans should minimize the disruption of normal and anticipated community and regional growth.

- Wherever possible, provide an aesthetically balanced and consistent appearance.

- Avoid the destruction or disruption of manmade and natural resources, aesthetic and cultural values, community cohesion, and the availability of public facilities and services.

Institutional Constraints:

- Plans must be consistent with existing Federal, state, and local laws.

- Public access plans must be obtained for those areas where sand is proposed to be placed creating new beaches, unless such placement is purely incidental to project function or for cost savings to the Federal Government.

- Plans must be locally supported to the extent that local interests must, in the form of a signed Project Cooperation Agreement (PCA), guarantee items of local cooperation including cost sharing.

- Local interests must agree to provide public access to the beach in accordance with all requirements of state laws and regulations.

PLAN FORMULATION

199. This section describes the formulation procedure and results for the Bethany Beach/South Bethany Interim Feasibility Study. The purpose of formulation is to identify plans that are publicly acceptable, implementable, and feasible from economic, environmental, engineering, and social standpoints.

200. ER 1105-2-100 requires the systematic preparation and evaluation of alternative solutions for addressing identified problems, needs and opportunities under the objectives of NED consistent with protecting the Nation's environment.

201. The formulation was undertaken in three phases, or cycles: Cycle 1 - Initial Screening of Solutions Considered, Cycle 2 - In-depth Evaluation and Screening of Solutions Considered, and Cycle 3 - Optimization of the Selected Alternative Solutions. By analyzing the alternative solutions in this manner, one can formulate the solution that best fits the planning objectives and constraints in a logical and efficient fashion.

202. **Damage Mechanisms.** Alternative solutions considered include those that provide storm damage protection from a number of possible damage mechanisms:

(1) long-term erosion
(2) storm recession
(3) inundation
(4) wave attack

203. Recreation benefits achieved by any of the alternative plans are considered to be incidental to the storm damage reduction objectives of the study and are not used in project formulation. The storm damage mechanisms are briefly described in the following paragraphs.

204. ***Long-term Erosion Damage.*** Generally, erosion damages refer to the long-term loss of dry land area due to deficits in littoral sediment transport, impact of sea level rise, and the long-term net impact of storms. Long-term erosion may itself cause economic losses and will reduce the amount of protective beach area resulting in increased future storm damage.

205. ***Storm Recession Damage.*** The project area is subject to significant storm-induced shoreline recession that becomes increasingly more damaging as long-term erosion reduces the protective buffer of the beach. Unlike long-term erosion, which is assumed to be retarded by intervention at bulkheads and major access roads, storm recession occurs over a relatively short period of time during the course of a storm. Thus, storm recession is considered capable of impacting buildings, including those fronted by protective structures such as bulkheads and dunes.

206. ***Inundation Damage.*** Flooding from the convergence of tides and storm surge coupled with waves running over the shorefront, or overtopping protective structures, and across upland causes damage to homes, businesses, and public facilities. The extent and severity of flooding is expected to increase in relation to continued increases in sea level.

207. ***Wave Attack.*** Structures along the oceanfront are subject to significant forces due to impacts of waves breaking against the structure or the run-up associated with waves breaking seaward of the structure. The forces associated with such waves, and the associated run-up, are capable of causing structural failure due to overturning or lateral displacement.

CYCLE 1 - INITIAL SCREENING OF SOLUTIONS CONSIDERED

208. In Cycle 1, storm damage reduction measures are identified and evaluated individually and in combination on the basis of their suitability, applicability, and merit in meeting the planning objectives and constraints for the study. Without undertaking an in-depth analysis, the goal of Cycle 1 is to screen out those alternatives which obviously do not fulfill the storm protection needs of the study or are inappropriate due to other factors such as prohibitively high costs that are associated with some of the alternatives. Judgements are made about each alternative based on knowledge gained from researching past reports and the professional experience of study team members and other District personnel. In addition, in the spirit of our partnership agreement with the non-Federal sponsor, DNREC, each of the alternatives are evaluated and discussed in terms of the sponsor's views concerning its effectiveness in meeting the needs along the coast.

209. Relative costs for each alternative solution are determined in a qualitative manner. For this analysis, relative costs are defined as the total cost of the project as compared to the without-project damages, or pool of potential benefits. The following paragraphs summarize the objectives and evaluation of each of the alternative solutions considered in Cycle 1.

210. There are two categories of solutions considered for implementation in the Bethany Beach/South Bethany study area, non-structural measures and structural measures. Non-structural measures are those measures that control or regulate the use of land and buildings such that damages to property are reduced or eliminated. No attempt is made to reduce, divert, or otherwise control the rate of erosion. Structural measures are generally those that act to block or otherwise interfere with inundation and erosive coastal processes or which restore or nourish beaches to compensate for erosion and inundation.

211. Shore protection measures were evaluated individually and in combination on the basis of their suitability, applicability, and merit in meeting the specific needs, objectives, and constraints of the study. The project alternative measures considered are as follows:

Non-structural Measures

- No Action
- Regulation of Future Development
- Permanent Evacuation

Structural Measures

- Berm Restoration
- Berm and Dune Restoration
- Berm and Dune Restoration with Groin Field (South Bethany only)
- Berm Restoration with Bulkhead (South Bethany only)

- Berm and Dune Restoration with Offshore Detached Breakwater
- Seawall
- Berm Restoration with Seawall
- Perched Beach with Berm and Dune Restoration
- Submerged Reef
- Offshore Submerged Feeder Berm
- Beach Dewatering

212. It should be noted that the above alternatives (bulkhead, dune, and seawall) were evaluated in configurations that would provide similar storm damage protection.

213. **No Action.** The no action alternative imposes no measures to provide erosion control, recreational beach or storm damage protection to structures landward of the beachfront. This alternative solution would not check the continuing erosion of the beaches, nor would it prevent property from being subjected to higher storm damages from beach recession, flooding, and wave attack. The nine existing groins in Bethany Beach would eventually deteriorate, and cause the State of Delaware to rehabilitate them at high cost, or risk further accelerating the loss of beach. This plan fails to meet any of the objectives or needs of the study. Therefore, this alternative was not considered in Cycle 2.

214. **Regulation of Future Development.** Regulation or land use controls could be enacted through codes, ordinances, or other regulations to minimize the impact of erosion on lands that could be developed for the future. This measure lends itself to relatively large, continuous undeveloped areas rather than developed areas. At this time there is virtually no oceanfront that is not developed. Therefore, additional regulation to prevent new development would have little impact. Since this alternative solution is not practical, it was not considered further in the Cycle 2 analysis.

215. **Permanent Evacuation.** Permanent evacuation of the existing developed areas subject to inundation or erosion damages involves the acquisition of affected lands and structures either by purchase or, if necessary, through the exercise of powers of eminent domain. Following this action, all commercial, industrial, and residential property in areas subject to erosion or inundation damages are either demolished or relocated to another site. Undoubtedly, roads, water supply facilities, electric power, and telephone and sewerage utilities would also have to be relocated. The lands acquired in this manner could be used for undeveloped parks, or other purposes that would not result in material damage from erosion or inundation. The towns of Bethany Beach and South Bethany have been intensely developed. Any structures to be relocated would almost certainly have to be placed outside of the existing town limits. Due to the level of development in the study area, this alternative solution would be prohibitively expensive and does not meet the objectives of the study. Therefore, this alternative was not considered in Cycle 2.

216. **Berm Restoration.** This alternative involves the placement of material (sand) from an offshore borrow source directly onto the beach in order to widen and stabilize the existing berm profile. Usually the sand is pumped onto the existing shore using a dredge pipeline. An appropriate design uses borrow material that has similar properties to the existing native beach sand. In addition, the restored beach is graded to a certain design elevation and width to provide the desired level of storm protection. The constructed berm will require future additional sand placement, nourishment, on a periodic basis so that the design berm width and elevation is maintained. Because this alternative meets the study objectives, has a moderate relative cost, and is technically feasible, it was considered further in Cycle 2 for the entire study area.

217. **Berm and Dune Restoration.** This alternative provides the same berm restoration effort as described above with additional sand placed upon the berm to create a dune at a designed elevation and width. The dune provides additional protection against storm surge similar to that of a bulkhead. Because this alternative meets the study objectives, has a moderate relative cost, and is technically feasible, it was considered further in Cycle 2 for the entire study area.

218. **Berm and Dune Restoration with Groin Field.** This alternative provides the same berm and dune restoration effort as described above. Groins are coastal structures built perpendicular to the shoreline and are designed to trap some of the littoral drift. The typical groin extends from the upper beach face into the surf zone. A properly designed groin field will reduce erosion, and when done in tandem with a beach fill project, will reduce the frequency of needed beach nourishment. However, a groin field will not provide additional protection from storm surge. For this reason, a groin field would only be included in the Federal project if its cost were offset by the savings realized from a decrease in cost for periodic nourishment of the berm. Because this alternative solution meets the study objectives, may decrease nourishment costs enough to justify itself, and is technically feasible, it was considered further in Cycle 2 for South Bethany, which currently lacks a groin field. In Bethany Beach, all of the groins are in fair physical condition and appear to be functioning adequately. Modification of existing groins at Bethany Beach would only be addressed if the selected plan would require a redesign of the current groin field.

219. **Berm Restoration with Bulkhead.** This alternative provides the same berm restoration effort as described above with the addition of a bulkhead. A bulkhead protects upland areas from erosion and inundation damage. Since 69% of Bethany Beach and 4% of South Bethany have existing timber bulkheads parallel to the oceanfront, this alternative examined extending the timber bulkhead walls along the entire length of the study area. While the bulkhead will protect upland areas from inundation, beach restoration will limit erosion in front of the bulkhead and hence will provide additional protection to upland areas. Because this alternative meets the study objectives, has a high but possibly acceptable relative cost, and is technically feasible for the study area, it was considered further in Cycle 2.

220. **Berm and Dune Restoration with Offshore Detached Breakwater.** This alternative provides the same berm and dune restoration plan as described above with the addition of an offshore detached breakwater along the length of the study area. The offshore detached breakwater is a structure that reduces the incident wave energy impacting the beaches thus reducing erosion. In many cases, the offshore detached breakwater is a series of rubble mound structures that are visible from the beach during periods of low tide. The berm and dune restoration aspect of this option provides the needed storm protection. Since an offshore detached breakwater does not protect against storm surge, the required initial beach fill is the same as described above for the berm and dune restoration alternative. In order to be included in the Federal project, the cost of this alternative solution would have to be offset by the savings from a decrease in periodic nourishment costs and reduced wave energy during a storm. In addition, this alternative has many other problems: constructability, aesthetics, and safety. Since construction of the breakwater must be done entirely from the water, all construction materials must be brought in on barges and all equipment used must be secured to jack-up barges. This effort introduces the additional difficulty of working in an open ocean environment. For these reasons, the cost to construct an offshore breakwater in the open ocean environment is prohibitively high and would not be offset by a decrease in cost for periodic nourishment and reduced wave energy during a storm. Therefore, this alternative was not considered in Cycle 2.

221. **Seawall.** This alternative includes the construction of a "Galveston-type" seawall placed along the entire length of the study area with a top elevation of +18 ft-NAVD, replacing all existing dunes. This structure includes fronting toe scour stone protection, pile supports, and underlying sheeting to reduce underseepage. This alternative solution would not provide any recreational beach restoration, but would provide storm damage protection consistent with other structural alternatives. It was determined that the relative cost for such a project would be prohibitively high. For this reason, this alternative was not considered in Cycle 2.

222. **Berm Restoration with Seawall.** This alternative consists of the same berm restoration plan as described above with the addition of a Galveston-type seawall also as described above. However, the cost for this alternative would not be offset by savings from reduced inundation and would therefore be prohibitively high. Therefore, this alternative solution was not considered in Cycle 2 for the same reasons that the seawall alternative above was eliminated.

223. **Perched Beach with Berm and Dune Restoration.** This alternative provides the same berm and dune restoration plan described above with the addition of a submerged stone rubble mound structure which is used to support the offshore end of the placed beach fill. The placement of the rubble mound structure would eliminate the outer part of beach profile near its closure with the ocean bottom. Therefore, the actual amount of fill material to be placed is less than in the berm and dune restoration alternative. The submerged rubble mound structure acts in the same way as the natural bar formed offshore during storm events, creating a "perched beach" with a wider berm. The main problem with this alternative is that angled swell scours in front of and behind the offshore structure results in the need for heavy maintenance to keep the structure

functioning. In addition, interception of littoral drift will cause erosion downcoast. Due to the high expenses needed to maintain this structure, and the fact that perched beaches are usually associated with reclamation in lower wave energy environments, which is not an objective of this study, this alternative was not considered in Cycle 2.

224. **Submerged Reef.** This alternative solution involves the use of interlocking concrete units that form an offshore reef. This reef is intended to dissipate incident wave energy during storms, and to prevent outgoing currents from carrying sand to deeper water. Experience to date with this alternative along the New Jersey shore is still questionable. The units have a tendency to sink, and the installation off Avalon, New Jersey has some of the erosion problems associated with the perched beach concept. In addition, there is a high cost associated with this alternative. Therefore, this alternative was not considered further in Cycle 2.

225. **Offshore Submerged Feeder Berm.** Potentially high costs associated with onshore placement have led to the development of alternative less expensive methods of beach nourishment. One such method is nearshore berm placement. In some areas, nearshore berms can reduce wave damage and provide sand to the littoral system with a cost as little as half that of onshore placement (Allison and Pollock, 1993 & McLellan et. al, 1990).

226. Prototype experience with offshore submerged feeder berms is limited, and proper design techniques are still being researched and developed. For the berm to function successfully as a beach nourishment technique, several factors such as berm depth, wavelength, wave height, and wave velocity must be within suitable ratios (Hands and Allison, 1991). Long-term sediment transport trends, both longshore and cross-shore, must be examined. The berm placement site must be an appropriate distance downdrift of an inlet or jetty to reduce the tendency of the sediment to return to the inlet or be caught by the jetty (McLellan et. al, 1990).

227. Because nearshore placement has had mixed results, and current design techniques are limited and unproven; nearshore placement is a higher risk option than direct onshore placement at Bethany Beach and South Bethany. Also, because nourishment areas are located adjacent to potential borrow sources, the difference in cost between direct onshore and nearshore placement may not be significant. Therefore, this alternative was not considered further in Cycle 2.

228. **Beach Dewatering.** The concept of beachface drainage as a method to increase beach stability has been tried in Florida and Denmark. Sand in the swash zone is typically in a buoyant state. Erosion is diminished by beach dewatering due to the discontinuity in the water table and the drained sand, and due to the intergranular pressure and stability which occurs because of the vertical downward flow of water. Accretion is promoted because the sediment-laden swash is absorbed by the dewatered sand, causing a deposition of new sand on the foreshore slope.

229. Beach dewatering technology and performance is still unproven for an open ocean coastal environment. Tests have been completed on a small scale, but should not be extrapolated to a

large project such as this. Costs would have to be offset by reduced nourishment requirements. Life cycle costs for such a large-scale implementation are unknown. For these reasons, this alternative was not considered further in Cycle 2.

CYCLE 2 – IN-DEPTH EVALUATION AND SCREENING OF SOLUTIONS CONSIDERED

230. The Cycle 1 screening process is summarized in Table 22. The purpose of Cycle 2 is to further winnow down the number of alternatives that remain after Cycle 1 screening. Further screening of alternatives in Cycle 2 is accomplished through a comparison of annualized cost and the effectiveness of each alternative to provide protection from storm damage. In addition, consideration is given to periodic nourishment as well as alternative borrow sources. Only those alternatives that are practical in terms of the engineering, economic, environmental, and social impacts after the completion of Cycle 2 remain for consideration in Cycle 3.

TABLE 22
CYCLE 1 – RESULTS OF INITIAL SCREENING

ALTERNATIVE	TECHNICALLY APPROPRIATE?	MEET OBJECTIVES?			RELATIVE COST	CONSIDER FURTHER IN CYCLE 2?
		EROSION	INUNDATION	WAVE ATTACK		
No Action	No. Provides no measures to prevent damages from storms or long-term erosion for the study area.	No	No	No	None	No
Regulation of Future Development	No. Provides no measures to prevent damages from storms or long-term erosion for the study area because there is virtually no undeveloped land.	No	No	No	Low	No
Non-structural Alternatives	No. Involves the acquisition of all affected lands and structures either by purchase or through powers of eminent domain.	No	No	No	Very High	No
Berm Restoration	Yes. Berm pushes the breaker zone and the erosion profile seaward. Provides sacrificial sediment during storms as well as recreational beach.	Yes	No	Partial	Moderate	Yes

TABLE 22 CONTINUED
CYCLE 1 – RESULTS OF INITIAL SCREENING

ALTERNATIVE	TECHNICALLY APPROPRIATE?	MEET OBJECTIVES?			RELATIVE COST	CONSIDER FURTHER IN CYCLE 2?
		EROSION	INUNDATION	WAVE ATTACK		
Berm and Dune Restoration	Yes. Berm pushes the breaker zone and erosion and inundation profile seaward. Provides sacrificial sediment during storms as well as recreational beach. Dunes can provide buffer during storms and can provide aesthetic value by planting with dune grass. Dune grass helps to stabilize the dune for storm protection.	Yes	Yes	Yes	Moderate	Yes
Berm and Dune Restoration with Groin Field (South Bethany only)	Yes. Costs of the groin field must be offset by reduced periodic nourishment requirements. This option could also reduce long-term erosion and stabilize South Bethany. Can cause down drift erosion.	Yes	No	Yes	High	Yes
Berm Restoration with Bulkheading	Yes. Bulkheads perform the same function as dunes but is more costly and may require toe protection.	Yes	Yes	Yes	High	Yes
Berm and Dune Restoration with Offshore Detached Breakwater	Partial. Costs must be offset by reduced periodic nourishment requirements.	Partial	No	Partial	Very High	No
Seawall	Yes. Seawall performs the same function as bulkhead and dune, but is much more costly. There is debate that seawalls can exacerbate erosion.	Partial	Yes	Yes	Very High	No

TABLE 22 CONTINUED
CYCLE 1 – RESULTS OF INITIAL SCREENING

ALTERNATIVE	TECHNICALLY APPROPRIATE?	MEET OBJECTIVES?			RELATIVE COST	CONSIDER FURTHER IN CYCLE 2?
		EROSION	INUNDATION	WAVE ATTACK		
Berm Restoration with Seawall	Yes. Seawall perfor ns the same functions as bulkhead and dune, but is much more costly. There is a debate that seawalls can exacerbate erosion.	Partial	Yes	Yes	Very High	No
Perched Beach	Partial. Costs must be offset by reduced periodic nourishment requirements. Less viable in high wave energy environments.	Partial	No	Partial	High	No
Submerged Reef	Partial. Costs must be offset by reduced periodic nourishment requirements. Existing submerged reef in New Jersey has not retained beach fill.	Partial	No	Partial	High	No
Offshore Submerged Feeder Berm	Partial. Costs must be less than direct placement of material on beach. Success is highly dependent on wave conditions.	Partial	Partial	Partial	Low	No
Beach Dewatering	Partial. Technology and performance is still unproven for an open ocean coastal environment. Requires an initial beach fill placement. Costs would have to be offset by reduced nourishment requirements. Life cycle costs for such an implementation are unknown.	Partial	Partial	Partial	Moderate	No

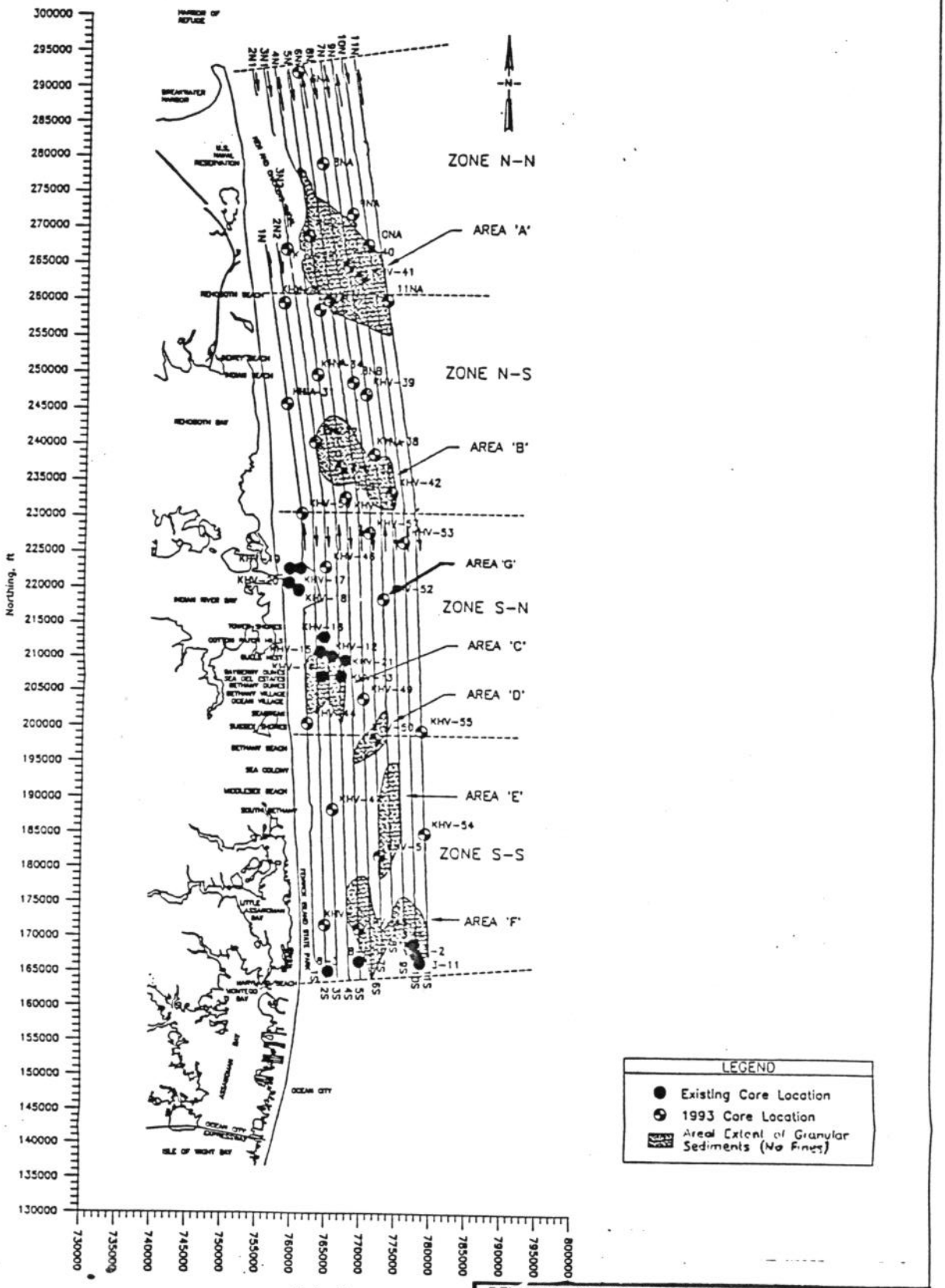
231. Since all of the plans to be analyzed in Cycle 2 include some aspect of beach fill, an investigation was undertaken to identify a suitable borrow source. The utilization of an upland borrow source was ruled out due to the volume of sand needed for a beach fill project in the study area, distance of such sources, the expense of retrieving sand from these sources, and impacts on the roads and the local economy. The following sections discuss the investigation conducted by the Philadelphia District to identify an offshore sand borrow source.

232. **Previous Investigations.** Initial sampling off the Delaware Coast was performed for the Atlantic Coast of Delaware GDM in 1975. Three vibrocores, KHV-9 through KHV-11, were performed in the Hen and Chickens Shoal area. In these cores, material consisted of fine to medium sand with a gravelly zone in KHV-11 between 11' and 15' below the surface. An additional ten vibrocores, KHV-12 through KHV-21, were performed during April and May 1984 off the Delaware Coast in the vicinity of Indian River Inlet and Bethany Beach. Four of the cores were performed in an area approximately 2.5 miles southeast of Dewey Beach; however, the sand layer was too thin for practical use, precluding the area from further investigation.

233. **Offshore Borrow Investigation.** The reconnaissance study report identified borrow areas for the entire Delaware Coast based upon previous investigations. In order to specifically identify sources of sand borrow for beach replenishment at Bethany Beach and South Bethany, a geoacoustic survey of the entire Delaware Coast was performed for the Philadelphia District by the U.S. Army Corps of Engineers Waterways Experiment Station (WES). This information, coupled with 27 new vibrocores, was used to map all sediments beneath the bottom from 0.5 miles to 3.5 miles offshore, covering the area from Cape Henlopen to Fenwick Island at the Maryland border. Due to the proximity to the project site and the cost involved in transporting material, only areas south of Indian River Inlet were considered as potential borrow sites for Bethany Beach and South Bethany. Figure 17 shows the location of the vibrocores and the potential borrow areas identified in the study. Use of the recently developed acoustic system, in addition to the vibrocore exploration, enabled the District to save a substantial amount of money while compiling an unprecedented record of offshore deposits.

234. **Geoacoustic Subbottom Profile.** An acoustic survey of the Delaware Coast from Cape Henlopen to Fenwick Island was conducted by WES from 27 September 1992 to 2 October 1992. The entire area off the Atlantic Coast of Delaware was surveyed at this time. The survey was performed aboard the research vessel *Cape Henlopen*, operated by the University of Delaware, College of Marine Studies (Lewes, Delaware). Multiple low-frequency acoustic systems were deployed to provide data across the frequency spectrum between 500 and 5000 Hz. Both digital and analog reflection data were collected as well as high-frequency bathymetry information. The survey control and horizontal positioning were provided by a Differential Global Positioning System (DGPS).

235. Twenty-seven vibrocore samples, KHV-31 to KHV-58, were collected by Alpine Ocean Seismic Survey, Inc. in the Atlantic Ocean off the coast of Delaware, within the limits of the



DELAWARE COAST - CAPE HENLOPEN TO FENWICK ISLAND

BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY

FIGURE 17
VIBROCORE LOCATIONS, SAND DEPOSITS, & POTENTIAL BORROW AREAS

PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS

acoustic survey. See Figure 17 for sampling locations. Cores KHV-44 and KHV-49 were performed in the area off Bethany Beach that was considered to be under investigation for this project. This area was denoted as "Borrow Area C". The samples were collected from 7 June 1993 through 17 June 1993, to depths of 20' below the bottom. The fieldwork included positioning of the vessel, obtaining continuous core samples by vibration, field logging of the samples, and obtaining penetrometer records. The fieldwork was conducted aboard the research vessel *Atlantic Twin*. Scientific Environmental Application, Inc. performed the geotechnical analysis of the vibrocore samples. Data from the vibrocore investigation was used to calibrate and confirm data collected in the acoustic survey. It should be noted that Area C has been determined not to have sufficient quantities of beach fill material, and has subsequently been ruled out as a potential borrow area.

236. The technology utilized to define the subbottom characteristics was developed by WES. The geoacoustic survey was different from past seismic surveys in that it utilized acoustic impedance to delineate grain sizes and densities within the sand gradation band. Stratigraphy sections were developed along approximately 270 miles of survey lines. The information is invaluable to this project and all future work that will be performed off the Delaware Coast. The Delaware Coast project is the first to utilize this technology in an ocean environment. The geoacoustic investigation of the Delaware Atlantic Coast from Cape Henlopen to Fenwick Island is included in the Engineering Technical Appendix, Section 4.

237. **Offshore Vibrocore Investigation.** Another vibrocore investigation was conducted in the summer of 1997 in the Atlantic Ocean off the coast of Delaware, between Indian River Inlet and Fenwick Island. A total of 22 vibrocores, KHV-59 to KHV-80, were collected from 17 June 1997 through 26 June 1997, to depths of 20' below the mudline. The samples were collected by Alpine Ocean Seismic Survey, Inc., under the oversight of Woodward-Clyde Federal Services. The fieldwork was conducted aboard the research vessel *Atlantic Twin*, and included the positioning of the vessel, obtaining continuous core samples by vibration and jetting, field logging of the samples, and obtaining penetrometer records. The locations of the vibrocores were selected by the District based on the results of the geoacoustic survey and vibrocore data obtained from a previous investigation. The District performed the geotechnical testing and analysis of the vibrocore samples in-house. A copy of the Woodward-Clyde report is presented in the Engineering Technical Appendix, Section 4.

238. **Beach Sampling.** The State of Delaware conducted beach sampling for the Philadelphia District. Samples were collected following the procedures outlined in the U.S. Army Corps of Engineers Coastal Engineering Technical Note titled "Native Beach Assessment Techniques for Beach Fill Design" (CETN II-29, dated December 1991). Samples were obtained along 39 historical survey lines (LRP-38 through LRP-67) on the coast from Cape Henlopen to Fenwick Island. Two sets of beach samples have been collected to account for seasonable variability of the sediments. The summer beach was collected in August 1993; the winter beach was collected in December 1993 and March 1994. The winter sampling was split due to the loss of the sampler

during the December sampling. The samples were recovered at mid-berm, berm crest, mean high tide, mid-tide, mean low tide, -6, -12, -18, -24, and -30 ft-NGVD to accurately define the grain size of the entire active beach profile. Eight of the survey lines are located in the Bethany Beach/South Bethany project area. These are LRP-59, 60, 60A, 60B, 61, 62, 62A, and 63. Due to the voluminous nature of the test data, Table 23 summarizes the calculated composite mean and sorting values for each line within the project area for both summer and winter beaches. The locations of the survey lines are shown in Figures 10 and 11.

TABLE 23
SURVEY LINE MATERIAL COMPOSITE SUMMARY

COMPOSITE SURVEY LINE	SUMMER 1993		WINTER 1993-94	
	MEAN DIAMETER, M_ϕ	STANDARD DEVIATION, σ_ϕ	MEAN DIAMETER, M_ϕ	STANDARD DEVIATION, σ_ϕ
LRP - 59	1.76	0.84	1.73	0.74
LRP - 60	1.92	0.98	1.93	1.03
LRP - 60A	1.98	1.13	1.75	1.06
LRP - 60B	1.90	1.26	1.86	1.09
LRP - 61	1.94	1.12	1.80	1.04
LRP - 62	1.87	1.16	1.61	1.07
LRP - 62A	1.70	1.33	1.70	1.03
LRP - 63	1.91	1.03	1.69	1.12

239. **Borrow Area Suitability Procedure.** Borrow material should be the same size, or slightly coarser, than the native beach material. If the borrow material has a significantly smaller grain size, the profile will be out of equilibrium with the local wave and current environment, and would be more quickly eroded either offshore or alongshore. The analysis compared the borrow material characteristics to those of the native beach sediments to determine its suitability as beach fill. The analysis was performed following the procedure developed by James (1975) and presented in the U.S. Army Corps of Engineers' "Shore Protection Manual" (1984). The analysis results in the computation of an "adjusted fill factor" or overfill factor, R_A, and a "nourishment factor", R_J. R_A estimates the volume of fill material needed to produce one cubic yard of stable beach material after equilibrium (when the beach and native materials are compatible) is reached. Consequently, overfill factors are greater than or equal to one. For example, an overfill factor of 1.2 would indicate that 1.2 cy of borrow material would be required to produce 1.0 cy of stable beach material. This technique assumes that both the native and composite borrow material distributions are nearly lognormal. The nourishment factor is a

measure of the stability of the placed borrow material relative to the native beach sand. For example, a nourishment factor of 0.33 would mean that nourishment using the borrow material would be required 1/3 as often as nourishment using the same type of material that is currently on the beach.

240. **Borrow Area Identification.** The results of the geoacoustic and vibrocore investigations and analysis indicate that several practical sand borrow areas exist for the Bethany Beach/South Bethany project. These areas are denoted as Borrow Areas C, D, E, and G in Figure 17. One other area, Area F, is not considered part of this study since it is anticipated to be used for nourishment at Fenwick Island, Delaware.

241. Subsequent to the receipt of the WES geoacoustic report in 1993, Area C was designated as the borrow site for the Bethany Beach/South Bethany Interim Feasibility Study. This site was chosen based on its proximity to the project area, preliminary estimate of any future project needs, and estimates of the amount of material available in the this site. Cultural surveys were subsequently completed at this site simultaneously with the work being carried out on the Hen and Chickens Shoal borrow site for the Rehoboth Beach/Dewey Beach Interim Feasibility Study.

242. Area C was originally designated as the initial source of beach fill for the Bethany Beach/South Bethany project, and contains approximately 5 million cy of relatively fine-grained sands with an overfill factor of 1.5. It was determined, however, that Area C did not contain enough material to supply the project for the 50-year period of analysis, estimated at 14 million cy, and was eliminated from consideration.

243. The three remaining borrow areas were investigated to determine whether they had sufficient amounts of quality material required for the 50-year period of analysis. One of the areas is denoted in the WES report as Area D, and the material in this area is characterized by vibrocore KHV-50. Areas E and G were identified by the District as potential borrow areas based on the results of the geoacoustic survey and the characterization of the sands within the sites from vibrocores KHV-51 and KHV-52, respectively. All three areas are within 3 miles of the Delaware coastline. Distances from the project area to Areas D, E, and G average 2.5 miles, 3.2 miles, and 5.4 miles, respectively.

244. The geoacoustic profile and vibrocore data were used to determine the volume and characteristics of the beach-quality sand in each borrow area. Area D is an offshore shoal that contains approximately 8 million cy of poorly graded sand. However, the sand is located under a 2-foot thick layer of clay that is unsuitable for use as beach fill material. Area E has little bathymetric relief and contains approximately 25 million cy of beach-quality material ranging in nature from poorly graded to well graded sand. Area G, which also has little bathymetric relief, contains approximately 90 million cy of beach-quality material that ranges in grain size from sandy to gravelly material. The 1997 vibrocore investigation was conducted to further characterize the material in Areas E and G, and to delineate the extent of their boundaries.

245. The overfill factor was computed based on the weighted averages of the grain size distribution of the potential borrow materials. For the three borrow areas, the overfill factor was approximately equal to 1. Since Area D did not contain enough material for the 50-year analysis period, and is covered with a 2-foot layer of clay, it was eliminated from consideration. Both Area E and Area G would contain enough material to supply the initial construction and nourishment needs of a proposed Bethany Beach/South Bethany project. Because of its location closer to the project area, and the generally finer material contained therein, Area E was selected as the preferred borrow site.

246. The selected borrow site, Area E, for the Bethany Beach/South Bethany Interim Feasibility Study is located within State of Delaware waters (*i.e.* <3 miles offshore). Coordination has been performed with the Minerals Management Service (MMS) with respect to data exchange and exploration of sand sources. Approval from the MMS will not be required to utilize the borrow area for actual beach replenishment, since it is within the territorial waters of the State of Delaware.

247. **Native Beach Materials.** Utilizing the U.S. Army Corps of Engineers Automated Coastal Engineering System (ACES), composite beach grain size curves were developed for Bethany Beach and South Bethany. Based on a winter and summer beach composite from the eight survey lines in the project area, the mean grain size is 1.81 phi units (0.29 mm), and the standard deviation in phi units is 1.07. This corresponds to poorly graded, or well sorted, fine to medium sands.

248. **Borrow Area Materials.** In general, the material encountered within the limits of Area E is a beach fill consisting of poorly graded and well graded, fine to coarse sands. The Unified Soil Classification System (USCS) classifies these soils as either SP or SW. Grain size ranges from –0.45 to 2.51 phi (1.36 to 0.18 mm) with a great majority around 1.4 phi (0.37 mm). Results of this material sampling in addition to the vibrocore analysis are included in Table 24. Test results and logs are contained in the Engineering Technical Appendix, Section 4.

249. **Compatibility Analysis.** The suitability of the borrow area material was determined using the overfill ratio (USACE, 1984) combined with engineering judgement. The overfill ratio indicates the volume of borrow area material necessary to equal one cubic yard of native beach fill. Using sediment characteristics shown in the preceding tables and the native beach characteristics, the phi mean difference ratio and sorting ratio were calculated. Using the "Shore Protection Manual", the overfill and nourishment factors, R_A and R_J, were determined for individual vibrocores. Vibrocores KHV-59 through KHV-69, which characterize Area E, where used in the analysis. Weighted averages were used in the determination of the mean and standard deviation of the vibrocore composites to compensate for variations in the strata. Based upon the results of the 1997 vibrocores and the acoustic geological cross sections through the borrow area, it is evident that sufficient quantities of high-quality beach sand are available. The material is generally finer than the native sediments, resulting in calculated overfill factors ranging from 1.0

to 1.3. The majority of the sediment within the borrow area limits have an average overfill factor of 1.0.

TABLE 24
BORROW AREA E MATERIAL CHARACTERISTICS

VIBROCORE	MEAN GRAIN SIZE, M_ϕ	STANDARD DEVIATION, σ_ϕ	OVERFILL FACTOR, R_A	NOURISHMENT FACTOR, R_J
KHV-61	1.52	1.13	1.00	0.51
KHV-62	1.08	1.24	1.00	0.42
KHV-63	1.56	0.96	1.00	0.86
KHV-64	2.04	1.00	1.35	1.31
KHV-65	0.99	1.28	1.00	0.37
KHV-66	1.60	1.04	1.00	0.83
KHV-67	1.49	1.08	1.00	0.72
KHV-68	1.84	0.80	1.29	1.27
KHV-69	1.57	0.88	1.00	0.88

250. The results of the vibrocore and geoacoustic survey of the delineated borrow area, combined with sediment analysis of the Bethany Beach and South Bethany beaches, were used to evaluate the suitability of borrow area sands as beach fill. Based upon this data, sands with an average overfill factor of 1.0 were determined to comprise about 85% of the total borrow area.

251. **Overfill Factor Application.** The overfill factor, as previously stated, is the amount of borrow material required to produce one cubic yard of native beach material after sorting losses. Sorting losses will occur during a period after initial placement, as the active profile is subjected to continuous wave and current energy. Equilibrium is reached as the finer material is sorted from the profile. Common Corps of Engineers practice is to place the first nourishment cycle along with the placement of the initial quantity required. This ensures that the level of protection for the beach remains throughout the first cycle of erosion. Theoretically, at the end of the first cycle, the advance nourishment quantity has eroded and the second nourishment cycle quantity is placed. The design template remains intact. This cycle will be repeated through the life of the project. This methodology demonstrates that the initial beach fill quantity that is placed is actually never exposed to the energy that sorts the beach sediments. Only the advanced nourishment quantity and subsequent nourishment quantities comprise the "active profile". Therefore, the borrow area overfill factor (in this case, 1.0), is also applied to the nourishment quantities.

252. **Aesthetic Comparison of Native Material to Borrow Material.** The native beach material at Bethany Beach and South Bethany, characterized by LRP-59 through 63, is predominately a fine to medium sand with little fines and trace gravel. The sand located in Area E has been determined to be a gray and tan, medium to fine sand with some fines (silt and/or clay) and gravel. For comparison, the sand in the Fenwick Island borrow area is also a gray and tan, medium to fine sand with some fines and gravel.

253. The material in Area E is very compatible with the native material of Bethany Beach and South Bethany. In general this sand is coarser than the native beach material, however, it is not drastically different in composition. Scarping could be a problem if the material was very coarse, such as coarse sand or gravel, because the internal angle of friction is high. Also, less scarping would occur if the material were finer. Since the native beach material and the borrow material are relatively close in composition, the scarping potential should be reduced to a minimum.

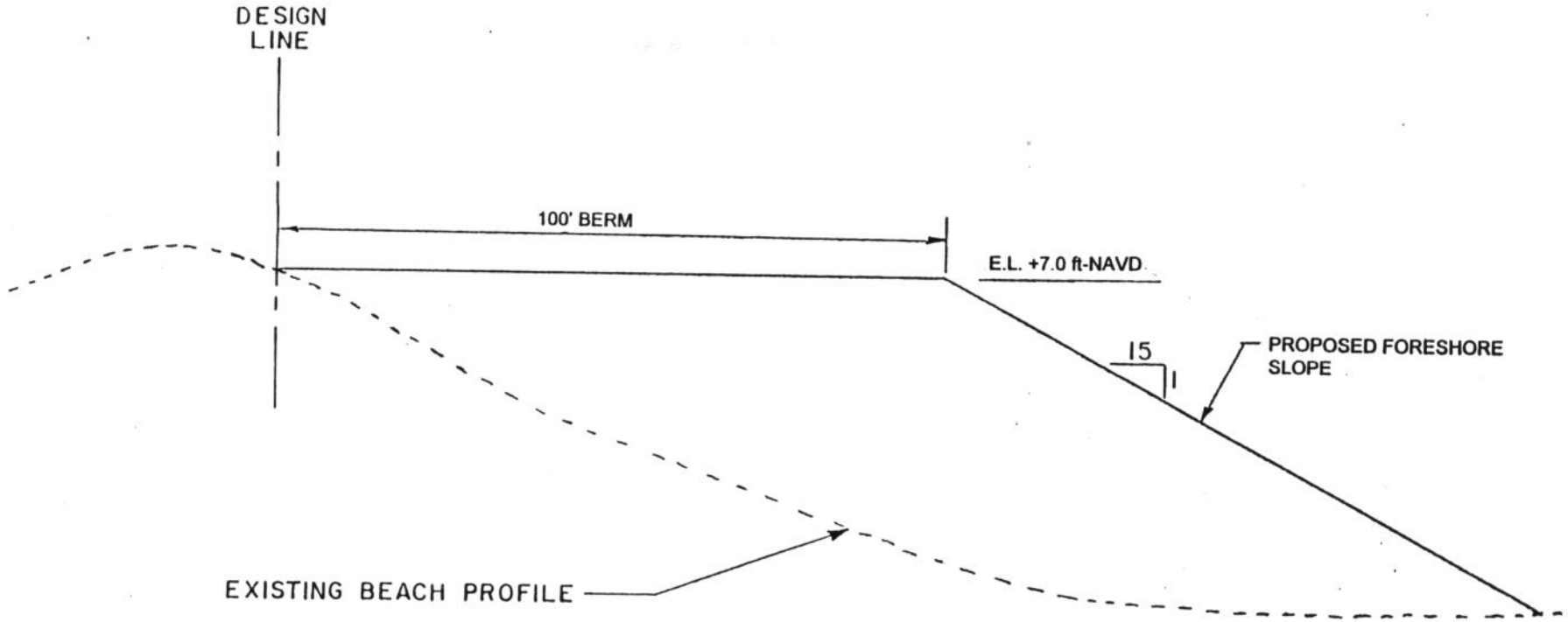
PLANS CONSIDERED IN CYCLE 2

254. The following sections describe the plans considered for further analysis in Cycle 2. General designs for this phase of screening were chosen after reviewing accepted coastal engineering practice, existing conditions in the study area, results of the without-project analysis, the "Shore Protection Manual", and CETN II-5.

255. **Berm Restoration.** A typical section for berm restoration along the study area is shown in Figure 18. The design berm, having a height of +7 ft-NAVD, width of 100', and a foreshore slope of 1V:15H, was chosen for analysis in Cycle 2. The sand would be placed over lengths of approximately 5,200' and 4,000' along the public shorelines of Bethany Beach and South Bethany, respectively. The beach fill quantities used for cost estimating purposes were obtained using the typical sections and lengths mentioned above. The preliminary annualized cost estimate for construction of the berm restoration alternative is shown in Table 25. When compared to the annualized damages, it can be seen that this alternative is relatively inexpensive. Therefore, this plan was further considered in Cycle 3.

256. **Berm and Dune Restoration.** This alternative consists of the same berm restoration plan as stated above, except set upon the berm is a dune with an elevation of +14 ft-NAVD, a top width of 25', and side slopes of 1V:5H. A preliminary design section of this alternative solution is shown in Figure 19.

257. Annualized cost estimates for construction of the berm and dune restoration plan are shown in Table 25. When compared to the annualized damages, it can be seen that this alternative is relatively inexpensive. This alternative was considered further in Cycle 3.



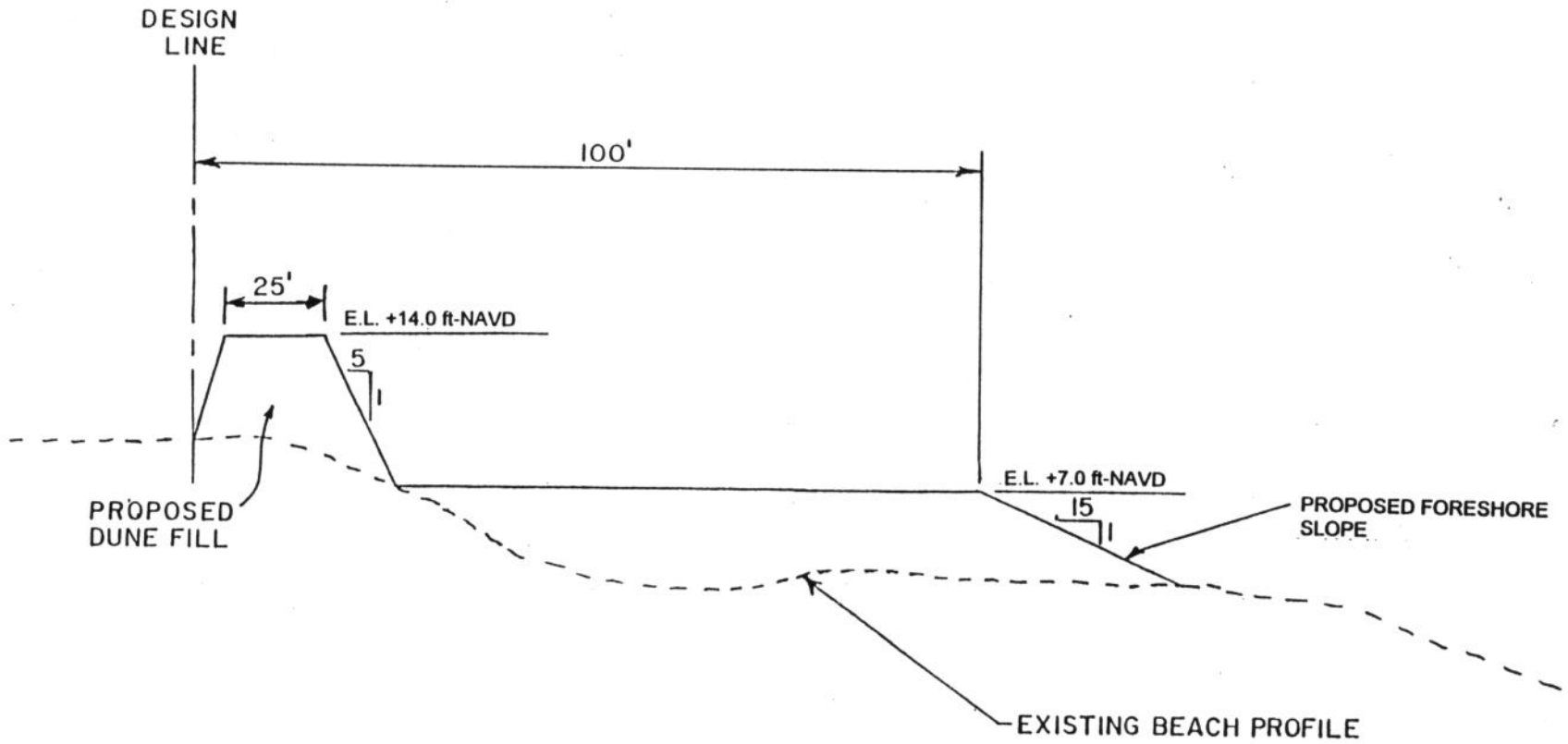
NOT TO SCALE

DELAWARE COAST - CAPE HENLOPEN TO FENWICK ISLAND

BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY

FIGURE 18
TYPICAL SECTION – BERM RESTORATION

PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS



NOT TO SCALE

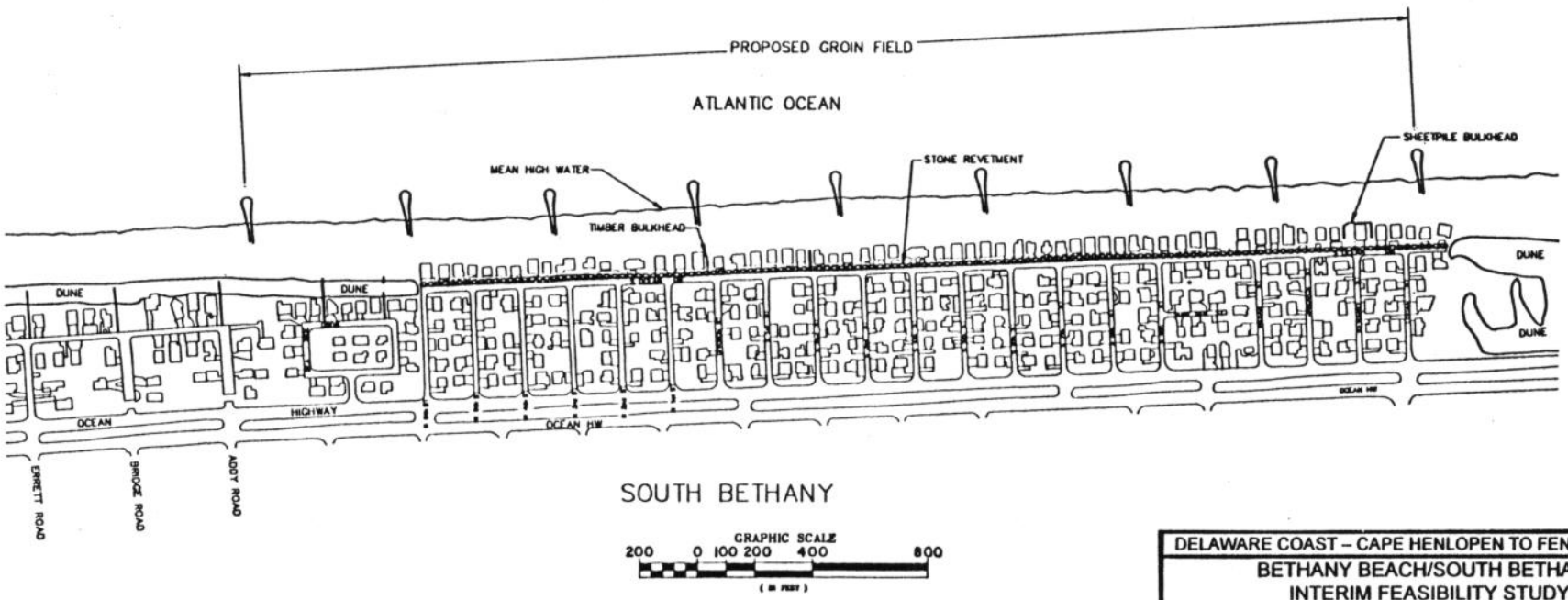
DELAWARE COAST – CAPE HENLOPEN TO FENWICK ISLAND
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY
FIGURE 19 **TYPICAL SECTION – BERM & DUNE RESTORATION**
PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS

258. **Berm and Dune Restoration with Groin Field.** The berm and dune would be designed as described above with the inclusion of a groin field in South Bethany. As mentioned previously, the existing groins in Bethany Beach are functioning well with the possible exception of the Garfield Parkway groin. The Garfield Parkway groin continues to function though it is exposed to the predominant wave action from the northeast and has been damaged in recent storm events. It is, however, not in imminent danger of failing.

259. During Cycle 2, it was assumed that nine groins, approximately 500' apart, would be constructed in South Bethany. A plan view of the proposed groin field and a cross section of a typical groin considered for the alternative are shown in Figures 20 and 21, respectively. The groin field would be constructed in conjunction with the berm and dune restoration plan as shown in Figure 19. The preliminary annualized cost estimate for construction of the berm and dune restoration along the entire study area with a new groin field for South Bethany is shown in Table 25. As can be seen, this alternative is less than the total annualized damages. However, since the purpose of the groin field is to retain sand on the berm, and does not contribute to storm damage reduction, it would have to be justified by comparing the cost of construction against the savings realized from reduced periodic nourishment. In order to determine whether construction of the groin field in South Bethany would be justified on these grounds, this alternative solution was considered further in Cycle 3.

260. **Berm Restoration with Bulkhead.** In addition to the berm restoration plan described above, a bulkhead would be constructed of timber pile and sheeting along the entire oceanfront of the study area. Timber piles 30' long and 12" in diameter would be used to anchor the bulkhead into the ground. The beach fill design would not include a dune, since the bulkhead would provide similar storm surge protection. To protect the entire length of the study area would require the new construction of approximately 5,600' of bulkhead. The new bulkhead would tie into the existing sections of timber bulkhead along the oceanfront. The beach fill placed shoreward of the proposed bulkhead would be identical to the berm restoration alternative described above. A typical section of the proposed bulkhead is shown in Figure 22. The preliminary annualized cost of this alternative is presented in Table 25. Even though this alternative meets the study objectives, the annualized cost is relatively high in proportion to the annualized damages. In addition, the bulkhead performs virtually the same function as a dune (as described above in the Berm and Dune Restoration alternative solution), but has a much higher relative cost. Therefore, this alternative was not considered further in Cycle 3.

261. Table 25 summarizes the Cycle 2 screening by discussing the technical performance, economic analysis, environmental and social impacts, and annualized costs associated with each alternative plan considered.

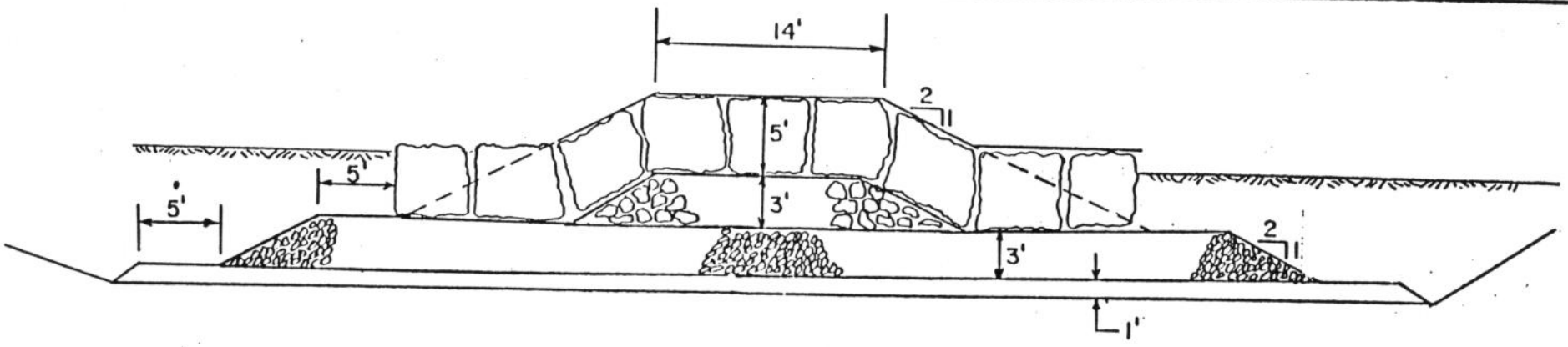


DELAWARE COAST – CAPE HENLOPEN TO FENWICK ISLAND

BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY

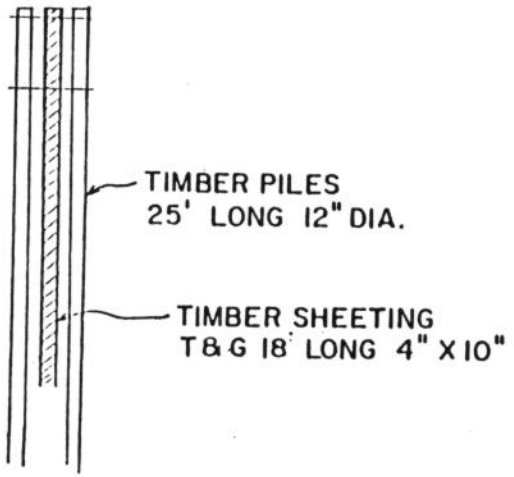
FIGURE 20
PROPOSED GROINS – SOUTH BETHANY

PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS



GROIN OUTER RUBBLE
MOUND STRUCTURE

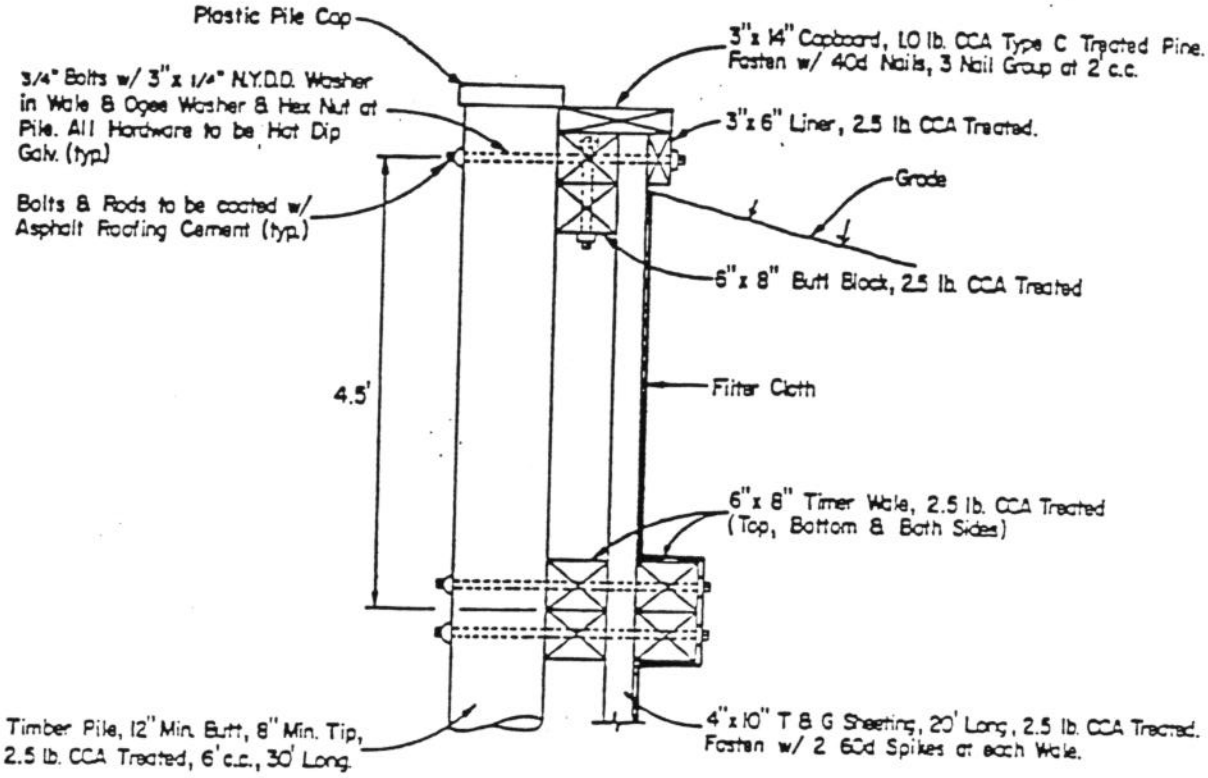
CAPSTONE	4 - 10 TON
CORESTONE	750# - 1 TON
MATSTONE	50# - 100#
BEDDING	6" STONE



TIMBER PILING & SHEETING
LANDWARD SECTION

SOUTH BETHANY ONLY

DELAWARE COAST - CAPE HENLOPEN TO FENWICK ISLAND
BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY
FIGURE 21
TYPICAL SECTION - GROIN
PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS



TYPICAL SECTION
BULKHEAD

DELAWARE COAST – CAPE HENLOPEN TO FENWICK ISLAND
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY
FIGURE 22 **TYPICAL SECTION – BULKHEAD**
PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS

TABLE 25
CYCLE 2 – RESULTS OF IN-DEPTH SCREENING

ALTERNATIVE	PRELIMINARY DESIGN CONSIDERATIONS	ENVIRONMENTAL CONSIDERATIONS	SOCIAL CONSIDERATIONS	PRELIMINARY ANNUALIZED COSTS (1/97 P.L.)	TOTAL WITHOUT-PROJECT ANNUALIZED DAMAGES (1/97 P.L.)	CONSIDER FURTHER IN CYCLE 3?	REMARKS
Berm Restoration	Berm: 100' wide, +7 ft-NAVD elevation for the entire study area	Can smother and/or kill organisms in borrow area	Provide usable beach area	$1,720,000	$4,824,000	Yes	Adverse environmental impacts can be minimized through coordination with environmental agencies
Berm and Dune Restoration	Berm: 100' wide, +7 ft-NAVD, topped by Dune: 25' top width, +14 ft-NAVD	Can smother organisms and kill organisms in borrow area	Provide usable beach area Dunes may cause some inconveniences to residents	$1,790,000	$4,824,000	Yes	Adverse environmental impacts can be minimized through coordination with environmental agencies
Berm and Dune Restoration with Groin Field (South Bethany only)	South Bethany: same as berm and dune restoration with the addition of timber groins with armor stone protecting the seaward third Groins: 300' long, 750-foot spacing	Same as berm and dune restoration, although some construction is performed in submerged lands	Same as berm and dune restoration, but there may be aesthetic problems with hardened structures	$2,046,000	$4,824,000	Yes	Costs must be offset by reduced periodic nourishment requirements and reduction in the long-term erosion rate
Berm Restoration with Bulkhead	Timber sheeting along approximately 11,150' of study area, anchored with timber piles (30' long, 12-inch diameter)	Same as berm restoration	Same as berm restoration	$2,372,000	$4,824,000	No	Bulkheads perform the same function as dunes, but are more costly

SOLUTIONS RECOMMENDED FOR OPTIMIZATION IN CYCLE 3

262. The Cycle 1 and Cycle 2 screening process eliminated most of the alternative structural project features considered in this study. The solutions considered for optimization in Cycle 3 to determine the recommended (NED) plan for the study area include:

- Berm Restoration
- Berm and Dune Restoration
- Berm and Dune Restoration with Groin Field (for South Bethany only)

CYCLE 3 - OPTIMIZATION OF THE SELECTED ALTERNATIVE SOLUTIONS

263. This section discusses the process undertaken to optimize the alternative solutions recommended after Cycle 2 screening.

264. **Incremental Analysis.** In order to properly formulate the NED plan, two discrete incremental reaches were established for this study; one for Bethany Beach and one for South Bethany. The incremental reaches are based on existing economic and physical conditions, while ensuring that the recommended project is constructable and each reach functions properly and independently. These reaches are based on the type and extent of development, dissimilarities in the typical beach and upland profiles comprising the without-project condition, and background erosion rate. Also taken into account is the existence of the groin field and predominantly bulkheaded shorefront at Bethany Beach. Sufficient differences exist in the without-project conditions for both Bethany Beach and South Bethany to affect project optimization. Therefore, incremental justification is warranted.

265. **Assumptions for Berm and Dune Analysis.** The alternative of beach nourishment requires optimization of the berm width and the dune height for both Bethany Beach and South Bethany. The methodology followed to optimize these features is accomplished by varying parameters between a set of boundary conditions established at the beginning of the analysis. In developing these boundary conditions, the "Shore Protection Manual", CETN II-5, the existing conditions in the study area, and accepted coastal engineering practice were considered.

266. Normally, berm width is referenced from the seaward toe of the dune. However, for the sake of optimizing the berm and dune restoration alternative, it was assumed that the project is essentially a berm with a dune placed upon it. In this case, the width of the berm is referenced from the design line as described below, which corresponds to the landward toe of the dune structure. For formulation purposes, combinations of berm and dune restoration were analyzed and presented in the report and appendices by width of the associated berm, which includes the portion beneath the dune. The report will describe the selected plan using normal berm width

reference practice.

Berm and Beach Fill Assumptions:

- Design berm heights for each alternative have an elevation set at the natural berm crest elevation as determined by review of historical profiles. It was determined that the prevailing natural berm height in the study area is +7 ft-NAVD.

- The slope of the design beach fill is based on historical profiles, and is set at the average slope of the beach, both onshore and offshore. The prevailing historical foreshore slope within the project area is approximately 1V:15H. Seaward of the mean low water mark the slope is approximately 1V:25H. These slopes are used for the design beach fill out to the depth of closure.

- All berm widths are referenced from a design baseline which is in general alignment with the seaward edge of the boardwalk in Bethany Beach and the seaward edge of the seaward-most deck in South Bethany.

- An interval between berm widths is chosen so that the optimum berm width can more easily be identified. This interval is set wide enough to discern significant differences in costs and benefits between alternatives, but not so great that the NED plan cannot be accurately determined. In order to satisfy these criteria a 50-foot interval is used.

- Since the average width of the without-project condition along the length of the study area is greater than 50', the minimum berm width analyzed is 100'. This design alternative requires beach fill for some locations to establish a consistent height and includes advanced nourishment along the entire study area to ensure a constant design template between nourishment cycles.

- The largest design berm width is based on an analysis of the average existing beach profile and determining how far offshore the beach fill could go before the quantities required to construct such a berm clearly would increase faster than the additional benefits captured. It is also assumed that after a certain distance offshore, the amount of benefits captured by larger berms would level out. Based on this analysis, the largest berm width considered is 250'.

- All beach fill alternatives include a taper at each project terminus to transition the constructed project into the existing condition beaches outside the project area. This is to reduce erosional losses due to discontinuities in the shoreline orientation. Guidance provided by the "Shore Protection Manual" and CETN-II-6 is utilized for designing the beach fill tapers.

Dune Assumptions:

- The lowest design dune height should be significantly above the height of the berm in order to provide for additional storm damage protection, principally in the form of reduced inundation and wave attack damages. Based on results of the without-project analysis and historical dune performance during storms, it was estimated that dune heights of +14 ft-, +16 ft-, and +18 ft-NAVD would be required to capture significant benefits within this study area. The highest dune considered should not exceed the natural dune height in the study area, which is estimated to be +18 ft-NAVD. In addition, dunes above +18 ft-NAVD were found to be unacceptable due to social and regional constraints.

- Dune alternatives are designed so that the landward toe begins at the same design line used for the delineation of berm width. Based on existing dune widths and previous experience, each dune alternative is designed with a 25-foot top width.

- The landward and seaward slopes of the design duneface are based on the existing profiles and the grain size analysis of the existing beach and the material in the borrow area. From these analyses, slopes of 1V:5H are used.

Groin Assumptions:

- A groin field is ultimately included in the selected plan if the cost of building it is offset by the savings due to reduction in the periodic nourishment quantity.

Borrow Area Assumptions:

- Beach fill for the proposed project is available from Borrow Area E, which contains approximately 25 million cy of suitable beach fill material with an estimated overfill factor of 1.0. Borrow Area E is located approximately 3.2 miles from of the Bethany Beach/South Bethany project area. It is assumed that Borrow Area E contains sufficient material to supply the initial construction and nourishment needs of project alternatives.

268. **Preliminary Screening of Beach Restoration Alternatives.** Based on the assumptions discussed above, a matrix of 16 combinations of berm widths and dune heights was generated. These design alternatives represented the total pool of alternatives that were considered as potentially viable combinations that would be appropriate for the study area. A preliminary evaluation of the matrix was then performed in an effort to reduce the total number of hydraulic (SBEACH) and economic model runs utilized during the optimization analysis to identify the NFD plan.

269. Table 26 summarizes the full matrix of initial alternatives considered. Several alternatives were eliminated from detailed economic analysis based upon the preliminary evaluation of the matrix. The 100-foot with the +16 ft- and +18 ft-NAVD dune alternatives were identified as non-constructable given the footprint requirements of the dune. Initial modeling efforts and quantity calculations were completed to further refine the number of alternatives for full analysis. It was determined that the 100-foot berm plan would provide relatively little reduction of storm damages. The 200-foot berm only and +14 ft-NAVD dune alternatives were eliminated since it was determined that they would provide little difference in benefits between the similar 150- and 250- foot plans. The 200-foot berm with +18 ft-NAVD dune and 250-foot berm with +16 ft-NAVD dune alternatives were eliminated, as the higher quantities required would not result in a commensurate increase in storm damage reduction performance. The 100-foot berm with +14 ft-NAVD dune and the 250-foot berm with +18 ft-NAVD alternatives were retained in order to bracket the NED plan with plans of lower net benefits.

TABLE 26
ALTERNATIVES CONSIDERED DURING OPTIMIZATION
(Dune height in ft-NAVD)

BERM WIDTH			
100'	**150'**	**200'**	**250'**
~~No Dune~~	No Dune	~~No Dune~~	No Dune
14' Dune	14' Dune	~~14' Dune~~	14' Dune
~~16' Dune~~	16' Dune	16' Dune	~~16' Dune~~
~~18' Dune~~	18' Dune	~~18' Dune~~	18' Dune

270. The nine remaining alternatives within the matrix were then subjected to detailed storm response evaluations to determine the reduction in storm damages. Preliminary construction quantities were calculated, from which the cost of each alternative was estimated. These results were utilized to assess the performance of each alternative and provide a basis of comparison for determining the NED plan.

OPTIMIZATION OF ALTERNATIVE PLANS

271. **General.** Benefits and costs for both Bethany Beach and South Bethany were developed for the alternative plans discussed above to optimize the NED plan in the study area. This was accomplished using the same numerical modeling techniques utilized in the without-project analysis coupled with engineering and technical assessments to interpret model results as applied

to the various alternatives. Reduced damages based on the predicted reduction in storm impacts due to the with-project alternatives were compared to the without-project results to generate project benefits. Costs for each alternative were estimated based on standard construction practices and District experience in the construction of beach nourishment projects.

272. **Storm Impacts.** The with-project conditions are the conditions that are expected based on the predicted impacts of storm events on the various project alternatives. The periodic nourishment associated with the project is designed to insure the integrity of the project design. In the case of beach fill, this ensures the project design cross section will be maintained and the elimination of shoreline recession due to long-term erosion. However, coastal processes will continue to impact the shoreline along the project area. Storm-induced erosion, wave attack, and inundation were evaluated for the with-project conditions using the same methodologies utilized in the without-project analyses. The following sections describe the coastal processes that were used to estimate the with-project damages.

273. ***Storm-Induced Erosion.*** The numerical model SBEACH was applied to predict storm-induced erosion for the with-project conditions for the study area. All SBEACH input variables were identical to the without-project runs except the input profiles were modified to include the alternative beach fill designs. As in the without-project condition, storm events from 5- to 500-year frequencies were analyzed on the with-project alternatives. Model results were reviewed and analyzed for reasonableness as applied to the varying with-project alternatives. A summary of the with-project erosion results is presented in the Engineering Technical Appendix, Section 2.

274. ***Storm Inundation.*** The post-storm recession profiles generated by SBEACH were used to analyze flooding and wave attack using the same methodology described in the without-project analyses. The wave height-frequency and stage-frequency data utilized to assess the alternative designs were identical to that used for the without-project conditions. The Engineering Technical Appendix (Section 2) lists the 3-foot damaging wave impact zones for the beach fill alternatives within each reach for the 5- through 500-year event as well as the total water elevation profile. Similar inundation profiles were computed in order to determine the total water level across the beach profile and into the community.

275. **Periodic Nourishment Requirements.** In order to maintain the integrity of the design beach fill alternatives, beach fill nourishment must be included in the project design. If periodic nourishment were not performed throughout the life of the project, longshore and cross-shore sediment transport mechanisms, separate from storm-induced erosion, would act to erode the design beach. This erosion would reduce the protection from storm damage afforded by the project design. The nourishment quantities are considered sacrificial material that acts to ensure the integrity of the project design. Various coastal processes were analyzed to develop an estimate of the required annual nourishment fill volumes.

276. The nourishment parameters were developed by considering long-term historic erosion losses using shoreline recession rates developed for the sediment budget, volumetric analysis of recent beach replenishment operations and beach profiles (1989 and 1995), losses due to the predicted rate of sea level rise, and losses due to storm-induced erosion. The results of these analyses were compared and the volumetric requirements were combined to obtain the total nourishment needs for each of the project alternatives.

277. ***Long-term Rates.*** Utilizing the long-term shoreline change rates, recent beach fill history, and recent volumetric profile analysis, unique nourishment rates were estimated for the Bethany Beach and South Bethany reaches of the project area for each of the considered alternatives.

278. ***Rate of Sea Level Rise.*** Using the current projected rate of sea level rise of 0.0102 feet per year and the Bruun method, the distance of shoreline retreat due to sea level rise over the 50-year period of analysis was determined. This rate of retreat was combined with the long-term erosion losses to develop the overall nourishment estimates for each alternative. Table 27 presents the adopted overall nourishment estimates for the beach fill design alternatives.

TABLE 27
ANNUAL NOURISHMENT ESTIMATES
(cy/yr)

BERM WIDTH	BETHANY BEACH	SOUTH BETHANY	TOTAL PROJECT
100'	80,000	60,000	140,000
150'	90,000	70,000	160,000
200'	110,000	80,000	190,000
250'	130,000	100,000	230,000

279. **Major Replacement.** Major replacement quantities were developed in accordance with ER 1110-2-1407 to identify additional erosional losses from the project due to higher intensity (low frequency) storm events. The nourishment rates developed for the project alternatives include losses due to storms that have occurred within the analysis period, storms of approximately 50-year return period and more frequent are encompassed in those rates. Major replacement losses are computed as the losses that would occur from the 50% risk event over the project life. The annual percent frequency event with a 50% risk during the 50-year period of analysis is 1.37%. The period of record for stages recorded at the study area is approximately 73 years, with the storm of record being the March 1962 northeaster. This storm not only produced the stage of record, but by far also induced the greatest loss of beach material during the period. The 1962 northeaster was considered to be the 50% risk event for the purposes of the major

replacement analysis. SBEACH was employed to compute volumetric erosion from the selected beach alternative design profiles utilizing the 1962 northeaster hydraulic input parameters. Water levels and waves were hindcasted at the study area for the storm, and all model parameters used were identical for the without- and with-project analyses. Volumetric storm-induced erosion was computed within each reach for the design beach profiles and then an average loss quantity was computed within Bethany Beach and South Bethany. The computed results show little variation in volumetric erosion between profiles. Based on local profile analyses and experience developed at the Philadelphia and other Corps coastal Districts, it is estimated that approximately 60% of the material displaced during large storms will return to the foreshore within weeks, and only the remaining 40% will require mechanical replacement. As a conservative estimate of the necessary major replacement quantity, a volume equal to 60% of the estimated storm eroded volume will require mechanical placement onto the subaerial beach to regain the design cross section and insure the predicted level of storm damage reduction.

280. It is estimated that volumes of 288,000 and 248,000 cy at Bethany Beach and South Bethany, respectively, would be required to perform major replacement in response to the 50% risk event. The estimated major replacement volume for the total project would be 536,000 cy.

281. **Economic Evaluation of Alternative Plans.** Economic benefits for the design alternatives are derived from the reduction in storm damages, reduced maintenance costs to existing structures, local costs forgone, reduced emergency/clean-up costs, and recreation. Recreation is not a Federal priority benefit category and is not utilized in the optimization of the selected plan. The benefits leading to project optimization are summarized below and discussed in more detail in the Economic Analysis Appendix.

282. ***Economic Benefits.*** Optimization of the alternatives was based on the priority benefit category of storm damage reduction indexed to the January 1997 price level. A summary of the reduction in storm damages attributable to the varying with-project alternatives in each project area is listed in Table 28. These benefits represent the direct reduction in erosion, wave attack, and inundation to the structures, improved property, and infrastructure, and also include the reduced emergency/clean-up costs within the study area.

283. Local costs foregone represent an additional NED benefit category that is appropriate for incorporation into this assessment of economic benefits. The State of Delaware has provided repeated beach fill efforts in an attempt to maintain the beaches from eroding beyond a critical point to reduce the storm vulnerability of the communities. With construction of a Federal project, future local efforts would become redundant, and thus unnecessary. Therefore, an estimate of the costs to perform future nourishment efforts by the state was incorporated into the total NED benefits as local costs foregone. These costs were based on an assessment of past nourishment quantities and practices, as well as anticipated future nourishment requirements that the state would need in order to "hold-the-line". Based on a 3-year cycle, the estimated historical expenditure of $545,000 per community, with major replacement occurring in year 24 of the

period of analysis, was used to determine local costs forgone. Local costs forgone were applied to each of the alternatives. The average annual cost for the forgone maintenance efforts by the State of Delaware as a result of a project were determined to be $200,000 for Bethany Beach and $196,000 for South Bethany. The estimated annual local costs forgone for the entire project was $396,000.

284. ***Economic Costs.*** Initial construction and nourishment costs were developed for the various alternatives evaluated. The costs were annualized for comparison to the average annual benefits for individual project alternatives. As mentioned previously, recreation benefits were not used in the optimization procedure. The costs include estimates for initial construction, periodic nourishment, and major replacement. They were annualized over the 50-year period of economic analysis at a discount rate of 7.125%. The costs for the two individual incremental reaches (Bethany Beach and South Bethany) were prorated based on the quantities required to construct the alternative.

TABLE 28
STORM DAMAGE REDUCTION BY ALTERNATIVE
(January 1997 price level)

BERM WIDTH	DUNE HEIGHT (ft-NAVD)	W/OUT-PROJECT STORM DAMAGES	WITH-PROJECT STORM DAMAGES	STORM DAMAGE REDUCTION BENEFITS	% LOWER
BETHANY BEACH					
150'	No Dune	$3,061,000	$1,207,000	$1,854,000	61
250'			$1,070,000	$1,991,000	65
100'	14		$1,256,000	$1,805,000	59
150'			$817,000	$2,244,000	73
250'			$526,000	$2,535,000	83
150'	16		$621,000	$2,440,000	80
200'			$447,000	$2,614,000	85
150'	18		$632,000	$2,429,000	79
250'			$424,000	$2,637,000	86
SOUTH BETHANY					
150'	No Dune	$1,763,000	$866,000	$897,000	51
250'			$567,000	$1,196,000	68
100'	14		$844,000	$919,000	56
150'			$365,000	$1,398,000	79
250'			$285,000	$1,478,000	84
150'	16		$267,000	$1,496,000	85
200'			$204,000	$1,559,000	88
150'	18		$243,000	$1,520,000	86
250'			$132,000	$1,6[illegible],000	93

TABLE 28 CONTINUED
STORM DAMAGE REDUCTION BY ALTERNATIVE
(January 1997 price level)

BERM WIDTH	DUNE HEIGHT (ft-NAVD)	W/OUT-PROJECT STORM DAMAGES	WITH-PROJECT STORM DAMAGES	STORM DAMAGE REDUCTION BENEFITS	% LOWER
TOTAL PROJECT					
150'	No Dune	$4,824,000	$2,073,000	$2,751,000	57
250'			$1,637,000	$3,187,000	66
100'	14		$2,100,000	$2,724,000	56
150'			$1,182,000	$3,642,000	75
250'			$811,000	$4,013,000	83
150'	16		$888,000	$3,936,000	82
200'			$651,000	$4,173,000	87
150'	18		$875,000	$3,949,000	82
250'			$556,000	$4,268,000	88

285. ***Economic Optimization.*** The average annual costs are subtracted from average annual benefits to calculate net benefits. The plan with the highest net benefits is the NED plan. Table 29 summarizes the average annual benefits (AAB), average annual costs (AAC), net benefits (NET), and benefit-cost ratio (BCR) for each alternative in the matrix. Table 29 also shows the results of the economic optimization for each reach and the total project area.

286. As shown in Table 29, the highest net benefits in Bethany Beach were realized for the 150-foot wide berm with +16 ft-NAVD dune alternative. In South Bethany, slightly higher net benefits were realized for the 150-foot wide berm with +18 ft-NAVD dune alternative than the +16 ft-NAVD dune. However when consideration was given to the resulting variation of the project dune heights between the two communities, higher construction and nourishment costs, and social constraints associated with the higher dune, it was judged that these factors outweighed the realization of a minimal increase in net benefits. In addition, based upon the assessment of costs and benefits associated with the total project, the 150-foot wide berm with +16 ft-NAVD dune alternative realized the greatest net benefits, making it the NED plan.

TABLE 29
BENEFIT/COST ANALYSIS MATRIX

DUNE HEIGHT (ft-NAVD)		BERM WIDTH			
		100'	150'	200'	250'
BETHANY BEACH					
No Dune	A/B AAC NET BCR	Eliminated in preliminary screening	$2,053,000 $1,598,000 $455,000 1.28	Eliminated in preliminary screening	$2,190,000 $2,308,000 -$118,000 0.95
+14	AAB AAC NET BCR	$2,004,000 $1,334,000 $670,000 1.50	$2,444,000 $1,629,000 $815,000 1.50		$2,734,000 $2,375,000 $359,000 1.15
+16	AAB AAC NET BCR	Inappropriate design template	$2,639,000 $1,631,000 $1,008,000 1.62	$2,813,000 $1,991,000 $822,000 1.41	Eliminated in preliminary screening
+18	AAB AAC NET BCR		$2,628,000 $1,648,000 $980,000 1.59	Eliminated in preliminary screening	$2,836,000 $2,400,000 $436,000 1.18
SOUTH BETHANY					
No Dune	AAB AAC NET BCR	Eliminated in preliminary screening	$1,093,000 $1,361,000 -$268,000 0.80	Eliminated in preliminary screening	$1,393,000 $1,943,000 -$550,000 0.72
+14	AAB AAC NET BCR	$1,115,000 $1,146,000 -$31,000 0.97	$1,596,000 $1,393,000 $203,000 1.15		$1,677,000 $2,003,000 -$326,000 0.84
+16	AAB AAC NET BCR	Inappropriate design template	$1,692,000 $1,393,000 $299,000 1.21	$1,755,000 $1,640,000 $115,000 1.07	Eliminated in preliminary screening
+18	AAB AAC NET BCR		$1,716,000 $1,407,000 $309,000 1.22	Eliminated in preliminary screening	$1,827,000 $2,024,000 -$197,000 0.90

TABLE 29 CONTINUED BENEFIT/COST ANALYSIS MATRIX					
DUNE HEIGHT (ft-NAVD)		BERM WIDTH			
		100'	150'	200'	250'
TOTAL PROJECT					
No Dune	AAB AAC NET BCR	Eliminated in preliminary screening	$3,146,000 $2,959,000 $187,000 1.06	Eliminated in preliminary screening	$3,583,000 $4,251,000 -$668,000 0.84
+14	AAB AAC NET BCR	$3,119,000 $2,480,000 $639,000 1.26	$4,040,000 $3,022,000 $1,018,000 1.34		$4,411,000 $4,378,000 $33,000 1.01
+16	AAB AAC NET BCR	Inappropriate design template	$4,331,000 $3,024,000 $1,307,000 1.43	$4,568,000 $3,631,000 $937,000 1.26	Eliminated in preliminary screening
+18	AAB AAC NET BCR		$4,344,000 $3,055,000 $1,289,000 1.42	Eliminated in preliminary screening	$4,663,000 $4,424,000 $239,000 1.05

287. **Groin Analysis.** Groins control the rate of longshore sediment transport through a project area and reduce the rate of sediment lost alongshore to downdrift beaches. When designed properly, they are effective in stabilizing beaches and reducing nourishment rates where sediment is lost by alongshore movement. An analysis was performed to determine the impact of a groin field in the project areas on the estimated nourishment rate requirements. The expected reduction in maintenance costs associated with the revised nourishment rates was compared to the costs associated with construction of the groin field to determine if the structures were economically feasible.

288. Placement of a groin system in South Bethany would be beneficial in interrupting longshore transport, potentially reducing the amount of material lost downdrift. However, during storm events the prevailing direction of incident waves is often shore normal, resulting in minimal longshore transport but significant onshore/offshore transport. The groin field would have little influence on losses due to storms. Natural recovery (wave action) is not expected to adequately replenish the area. Therefore, nourishment rates are not expected to be significantly reduced to the level that a groin field would be economically justified.

289. Within Bethany Beach there is an existing groin field. The existing groins would be covered by the project design template and be rendered ineffective for interrupting longshore sediment transport. This has been illustrated during the recent beach fills in the area carried out by the State of Delaware. The analyses to determine the required nourishment rates for the

proposed project took this into account. The Bethany Beach groin field has historically acted to stabilize the shoreline; however, it provides little protection from severe coastal storms. In order for the groins to be effective, they would have to be rehabilitated and lengthened to extend beyond proposed beach fill design and advanced nourishment profiles. The proposed design of the groin field for South Bethany would have similar spacing as exists in Bethany Beach and would have lengths extending beyond the design and advanced nourishment beach fill profiles of the proposed project. The design and construction of the groin fields is discussed in the Engineering Technical Appendix, Section 6.

290. Placement of groins at South Bethany and modification to the existing groins at Bethany Beach are estimated, conservatively, to potentially reduce nourishment requirements by 40% in the project area. Though nourishment requirements would be reduced within the project reaches, it is likely that the presence of additional groins in South Bethany and extended groins in Bethany Beach would result in an increased sand deficit between the two towns. This would require additional placement of material to offset the effects of the deficit along the beaches of the Sea Colony and Middlesex Beach communities. This mitigation of downdrift/updrift impacts may in fact require more material than the amount reduced from project nourishment. Table 30 presents the estimated nourishment requirement if a groin field were constructed in South Bethany as part of the selected plan.

TABLE 30
ESTIMATE OF ANNUAL NOURISHMENT REQUIREMENT IN SOUTH BETHANY
(cy/yr)

Without Groin Field	70,000
With Groin Field	42,000
Reduction in Nourishment	28,000

291. The annualized cost of the proposed groin field is $387,000, while the annualized savings (benefits) in reduced periodic nourishment associated with construction of the groin field is $139,856. Therefore, the placement of a groin field in combination with the berm and dune restoration plan at South Bethany is not justified. Considering the relatively high cost to low benefit realized for placement of groins at South Bethany, the cost of modifying the existing groin field at Bethany Beach would likely outweigh the benefits as well. Therefore, groin modifications are not recommended for Bethany Beach.

292. **Options for Project Terminus.** Consideration was given to four possible alternatives for providing a physical terminus at each end of the project segments:

- Terminal groins
- Ending the beach fill for each segment at the town boundaries without tapers
- Tapering the beach fill within each segment so that tapers end at the town boundaries
- Tapering the beach fill for each segment beginning at the town boundaries

The following paragraphs describe each of the alternatives.

293. ***Terminal Groins.*** An analysis was performed to evaluate the advantages obtained by constructing terminal groins. Terminal groins could be constructed at the ends of the project segments to contain beach fill material within the project area or control the rate at which it is lost by longshore transport. The reduced volume of material bypassing the terminal groins may allow smaller nourishment quantities or possibly increase nourishment intervals. However, the area downdrift of the terminal groins would be adversely impacted proportional to the benefits obtained for the project.

294. The effect of placing a terminal groin at the southern end of Bethany Beach and at the northern end of South Bethany results in essentially closing in the private communities of Middlesex Beach and Sea Colony, which lie between the two project segments. This could result in adverse impacts to the Bethany Beach project area and to the private communities due to predominant net northerly transport in the study area. Construction of a terminal groin at the northern terminus of South Bethany would have the effect of impounding sediment on the updrift side which could reduce the overall required maintenance for the project. However, the sediment that would naturally be transported north into Middlesex Beach and Sea Colony would be reduced, thus causing a deficit of sand in these communities that would result in an increase in shoreline recession. To eliminate the adverse effects would require additional material to be included in the estimated quantity required for the initial and periodic nourishment for the South Bethany project area. The additional material would likely offset any reduction in the project nourishment quantity.

295. A terminal groin could be designed which would allow for bypassing of essentially the current background rate from South Bethany into the private communities. However, this would mean that the project reach would not experience a reduction in required nourishment due to the terminal groin, and may actually experience an increase in required nourishment due to changed wave diffraction patterns. Therefore, the project would still be required to provide the same amount of nourishment over the life of the project with the additional cost to build and maintain a large terminal structure.

296. The inclusion of a terminal groin as the terminus of the southern end of the Bethany Beach project segment would result in sand accumulating on the updrift side within Sea Colony,

while encouraging erosion on the downdrift side within the project area. To compensate for the increased erosion rates, the project would need to include either a larger quantity of initial fill or an increase in the quantity and/or frequency of periodic nourishment. This would greatly increase the cost of the project, while creating spillover benefits for the private communities. To reduce the effects of erosion on the Bethany Beach segment, the terminal structure would have to be long enough to protect the southern edge of the project area from direct wave attack. This would result in a larger cost for such a terminal structure while still requiring an increase in periodic nourishment for the project area.

297. Analysis determined that the inclusion of a terminal groin at the northern and southern end of each project area would not substantially reduce the nourishment quantities required to maintain the project integrity, and may actually cause an increase in required nourishment quantities. Due to the adverse impacts to the project areas and private communities, the associated cost of construction and maintenance, and the possible need to place additional sand to offset erosive effects, the construction of a terminal groin was found unacceptable for the Bethany Beach/South Bethany project.

298. ***Ending Each Project Segment at Town Boundaries.*** Abruptly ending the placement of beach fill at the northern and southern town boundaries of each project area would result in rapid erosion of the ends of the project, thereby jeopardizing its structural integrity. An eroded condition at the ends of the project segments would result in less protection from storm damages in these areas and redistribution of material outside the project area. This is unacceptable with respect to the project purpose, is not in accordance with the design parameters of the "Shore Protection Manual", and therefore is not recommended as a terminus option for the project.

299. ***Tapers Ending at Town Boundaries.*** Tapers which begin to transition within the towns of Bethany Beach and South Bethany and end the beach fill at the northern and southern boundaries of the towns would not provide adequate, uniform storm damage protection to structures and infrastructure at the ends of the project segments. As the tapers narrow toward the ends of the project segments, less protection would be afforded in the taper zones than at mid-segment. Since the purpose of the project is to provide a uniform level of protection along the entire length of the project segments, this terminus option is not recommended for the project.

300. ***Tapers Beginning at Town Boundaries.*** Tapers which transition into the existing coastline beginning at the northern and southern boundaries of the towns would allow for a uniform level of protection along the entire length of each of the project segments. Tapering the project segments in this fashion provides a low cost alternative to construction of terminal groins and avoids the downdrift impacts associated with them.

301. It should be noted that north of Bethany Beach lies the unincorporated community of Sussex Shores. Between Bethany Beach and South Bethany lie the unincorporated communities of Sea Colony and Middlesex Beach. Each community features restricted-access private

beaches. South of South Bethany lie the public beaches of Fenwick Island State Park. The taper zones for this alternative extend into these areas north and south of the project segments. The tapers are integral project features necessary to assure the engineering integrity of the selected plan, which was formulated exclusively on benefits realized from storm damage reduction along the public shorelines of the towns of Bethany Beach and South Bethany.

302. With the exception of the area south of South Bethany, the tapers would transition into private property. Any protective benefits to the private shores, however, would be incidental to the objective of storm damage reduction in the towns of Bethany Beach and South Bethany. For this reason, benefits to the private beach communities were not claimed for inclusion in plan formulation. The dune system for each project segment would transition into the existing system at a relatively short distance beyond the town boundaries when compared to the overall length of the tapers. The private communities already maintain their beaches for storm protection. As such, any incidental protection afforded by the project tapers would be minor, particularly since the project dune system does not extend along the entire taper length and the amount of beach fill material placed on private shores decreases as the tapers narrow toward their end points. In addition, the ends of the southern Bethany Beach and northern South Bethany tapers are separated by nearly 700', providing no additional benefits to private shoreline property in this reach. For these reasons, it was determined that transition of the tapers into private shores was in accordance with guidelines for Federal participation in the project.

303. Tapers result in no expected adverse downdrift impacts, allow for a uniform level of protection across the project area, and are less costly than terminal groins. Therefore, it was recommended that the project terminuses be tapers beginning at the project/town boundaries and transitioning into the existing dune and berm system on the northern and southern ends of each segment. Table 31 summarizes the project terminus options.

304. **Transition Taper.** The proposed project for Bethany Beach and South Bethany will cause the shoreline to protrude seaward of the existing shoreline. Special care must be taken at the ends of each project segment to minimize end losses. The transition angles will cause sediment transport rates to deviate from transport rates for the existing shoreline angle. The deviation in sediment transport rates at the project ends may result in sediment moving out of the nourished area at a higher rate than normal. An analysis was performed to find the appropriate taper angle that would minimize the deviation from the normal rate of erosion and maximize the beach fill longevity. Comparing the relative shifts in shoreline orientation on the net sediment transport in the project areas using the Corps modeling program SEDTRAN and the WIS Station 65 database of waves, a transition angle of 5° was determined to be a reasonable value for the northern tapers. The 5° angle reduced end loses by balancing the predicted transport values, which resulted in a negligible net value over the 20-year hindcast. Using this methodology, the angle for the southern and northern transitions will be different. However, when balancing the cost of a longer taper (*i.e.* smaller transition angle) versus the benefit of reduced end losses for the north and south, a similar taper angle of 5° for both transition ends is reasonable.

TABLE 31 SUMMARY OF PROJECT TERMINUS OPTIONS			
OPTION	**RELATIVE COST**	**RECOMMEND?**	**REMARKS (+ or -)**
Terminal Groins	High	No	High cost alternative (-) Significant impacts on communities downdrift of project segments may require mitigation (-) Additional nourishment needed to address downdrift effects could offset the reduction of nourishment quantities resulting from placement of groin (-)
End Segments at Town Boundaries	Low	No	Low cost alternative (+) Placement of beach fill material on public shores only (+) Rapid erosion at end points would jeopardize structural integrity of project (-) Reduced level of protection at end points (-)
Tapers Ending at Town Boundaries	Low	No	Low cost alternative (+) Placement of beach fill material on public shores only (+) No expected adverse downdrift impacts (+) Reduced level of protection in taper zones (-)
Tapers Beginning at Town Boundaries	Low	Yes	Low cost alternative (+) Uniform level of protection across project segments (+) No expected adverse downdrift impacts (+) Requires placement of beach fill materials on private shores (-)

305. Based on the effective width estimates developed during plan formulation, it is possible to determine the appropriate taper length for each berm width alternative based on the 5° taper angle. Without inclusion of the proposed tapers at the project segment ends, the nourishment requirements of the project will be substantially increased. Table 32 presents the estimated taper lengths for each berm width alternative.

TABLE 32 TAPER LENGTHS FOR DIFFERENT BERM WIDTH ALTERNATIVES (5° Transition Angle)				
PROJECT SEGMENT	**BERM WIDTH**			
	100'	**150'**	**200'**	**250'**
Bethany Beach	630'	1,260'	1,890'	2,520'
South Bethany	1,030'	1,540'	2,060'	2,570'

306. The selected plan incorporates a 1,260-foot taper from the northern and southern ends of the Bethany Beach project segment, and a 1,540-foot taper from the northern and southern ends of the South Bethany project segment. These tapers are considered the optimal design necessary to ensure project integrity. The tapers will transition into the existing beach to the north and south of each segment. It should be noted that the northern taper out of South Bethany transitions into the existing shoreline just beyond the boundary of the town, due to the fact that the beach width going north out of South Bethany increases almost to the width of the proposed project. Therefore, based on the current beach configurations, the amount of sand actually being placed on private shores to the north of the South Bethany project area is very small.

SELECTED PLAN

307. **Identification of the NED Plan.** The National Economic Development Plan is defined as the plan that maximizes beneficial contributions to the Nation while meeting planning objectives. Most of the beach fill plans considered meet the planning objectives in that they provide a degree of storm damage protection that is greater than the cost of implementation. The NED plan for the Bethany Beach/South Bethany project area is a beach fill consisting of a dune and berm configuration at a width of 150' (115' dune base width and 35' berm), berm elevation of +7 ft-NAVD, and dune elevation of +16 ft-NAVD. The plan configuration is the same for both the Bethany Beach and South Bethany project areas. The plan was chosen because it provided the maximum net benefits based on storm damage reduction. It is expected that the NED plan will be constructed at the same time and under the same contract for both towns.

308. **Description of the Selected Plan.** This section describes the selected plan for the study area. Details of the selected plan are shown in Figures 23, 24, 25, and 26.

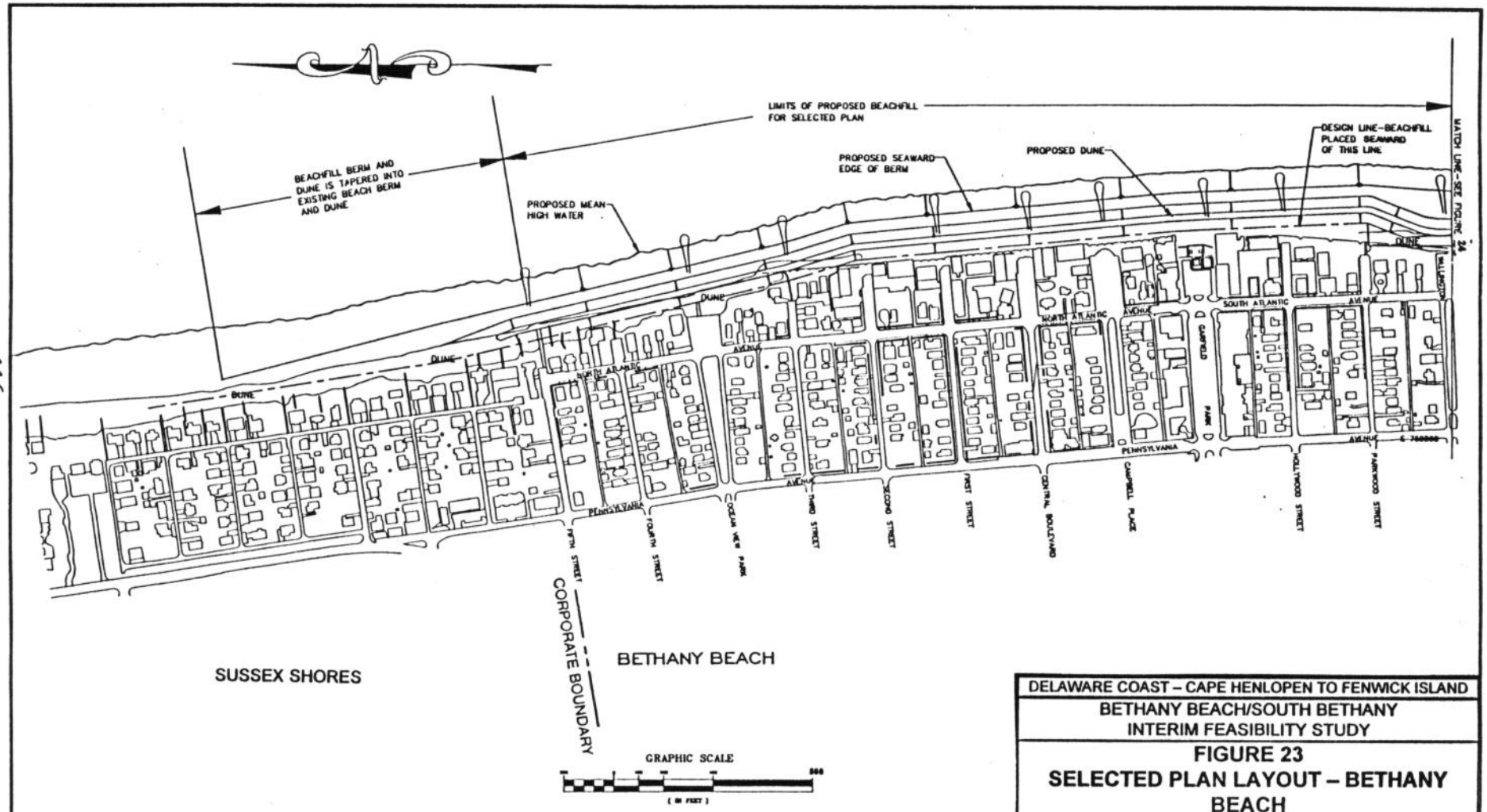
- The proposed storm damage reduction plan consists of a project in two segments, one covering the town of Bethany Beach and the other covering the town of South Bethany. Analyses were completed for each town since each has a distinct physical area and is separated from the other by approximately 3,500' of private beach.

- For both towns the selected plan is a dune and berm configuration extending seaward 150' from the design line. From the seaward toe of the dune, the berm extends 35' toward the foreshore of the project at an elevation of +7 ft-NAVD. It is important to note that this represents the minimum expected berm width prior to periodic nourishment of the project. The project calls for a slope of 1V:15H along the foreshore from the crest of the berm to mean low water (MLW). From MLW seaward, the slope parallels the existing bottom profile to the depth of closure.

- The beach fill for the Bethany Beach segment of the project extends along the entire length of the town (≈5,200'), and tapers into the existing coastline at a distance of 1,260' north and south of the town boundaries. Likewise, the beach fill for the South Bethany segment extends along the entire length of the town (≈4,000') with tapers extending 1,540' to the north and south of the town borders. The total length of the proposed beach fill project for the two towns is approximately 14,950'.

- The project calls for construction of a dune with a top elevation of +16 ft-NAVD in both segments. The top width of the dune is 25'. The slope of both the landward and seaward faces of the dune is 1V: 5H. The bottom width of the dune is 115'.

- A total of approximately 3,453,000 cy of sand is needed for initial construction of the project.

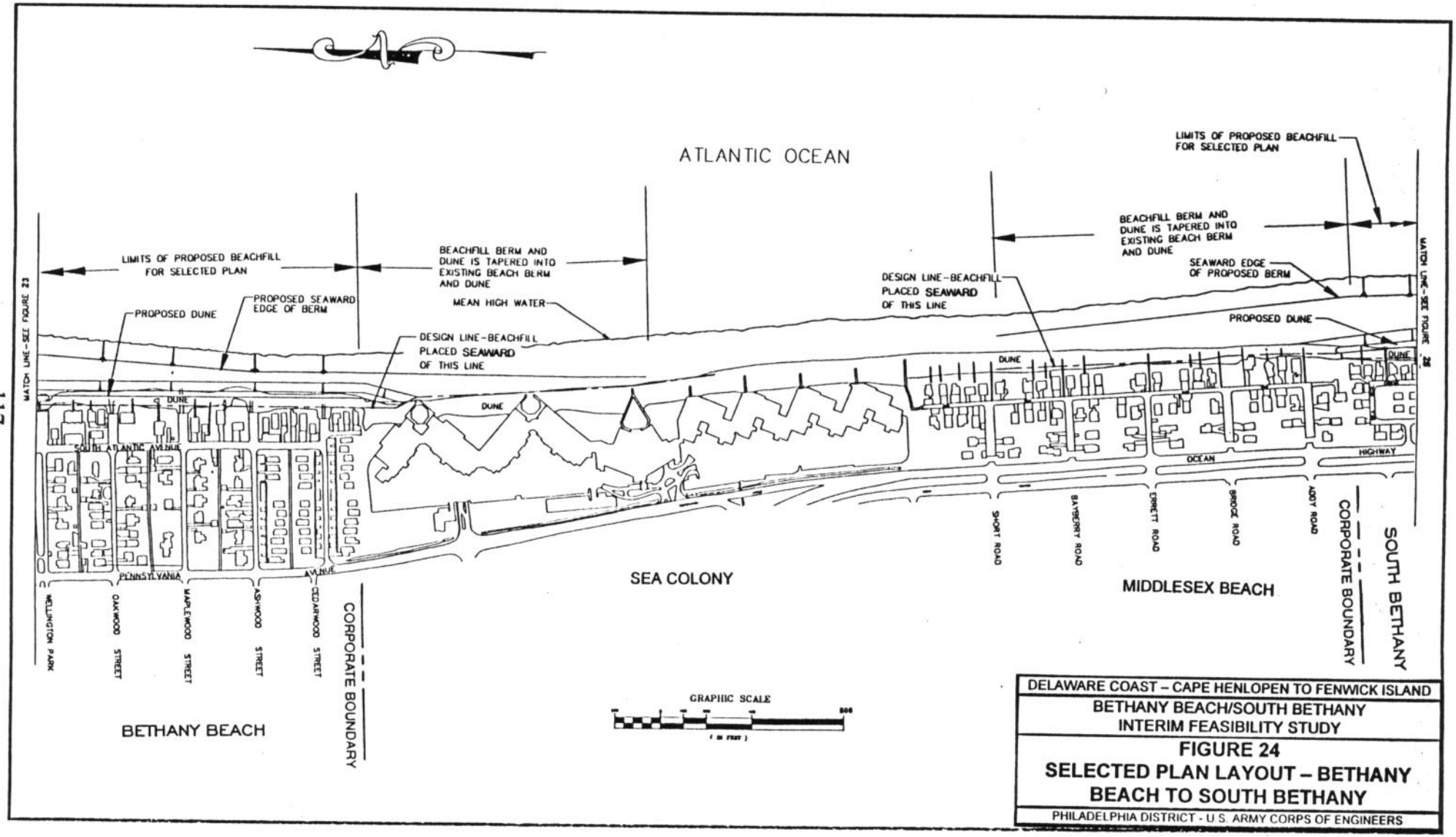


DELAWARE COAST – CAPE HENLOPEN TO FENWICK ISLAND

BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY

FIGURE 23
SELECTED PLAN LAYOUT – BETHANY BEACH

PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS

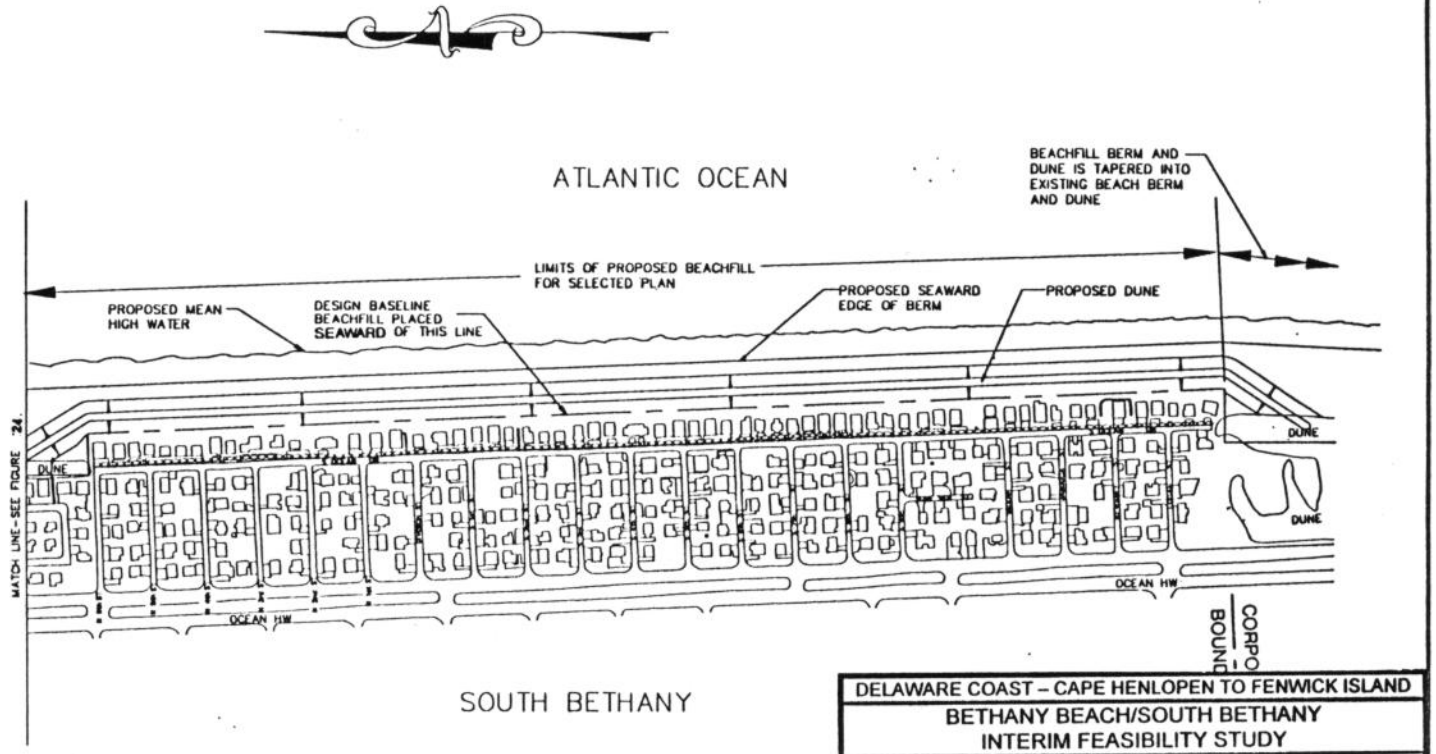


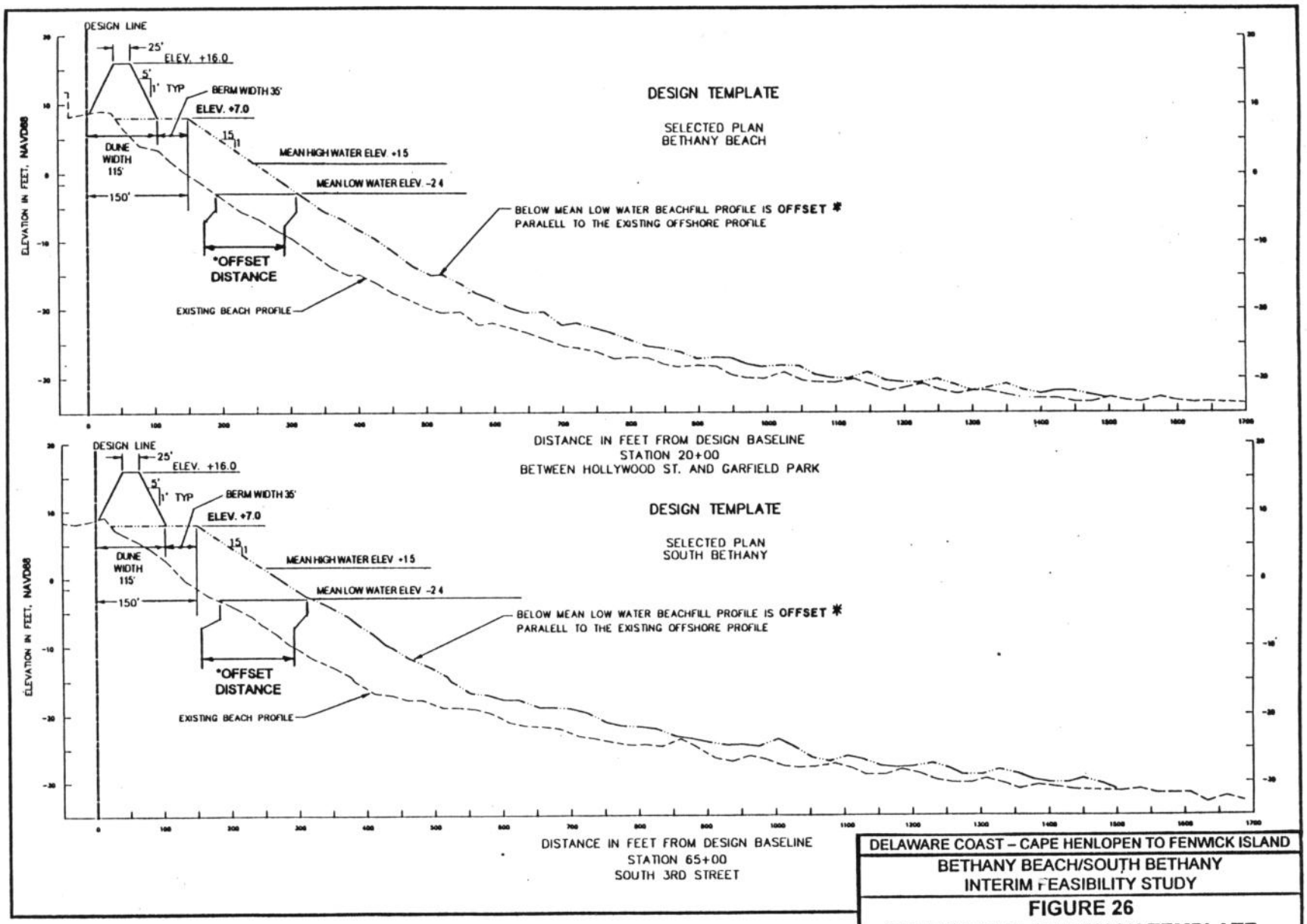
DELAWARE COAST – CAPE HENLOPEN TO FENWICK ISLAND

BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY

FIGURE 24
SELECTED PLAN LAYOUT – BETHANY BEACH TO SOUTH BETHANY

PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS


ATLANTIC OCEAN
BEACHFILL BERM AND DUNE IS TAPERED INTO EXISTING BEACH BERM AND DUNE
LIMITS OF PROPOSED BEACHFILL FOR SELECTED PLAN
PROPOSED MEAN HIGH WATER
DESIGN BASELINE BEACHFILL PLACED SEAWARD OF THIS LINE
PROPOSED SEAWARD EDGE OF BERM
PROPOSED DUNE
DUNE
DUNE
MATCH LINE-SEE FIGURE 24
OCEAN HW
OCEAN HW
SOUTH BETHANY
GRAPHIC SCALE
DELAWARE COAST – CAPE HENLOPEN TO FENWICK ISLAND
BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY
FIGURE 25
SELECTED PLAN LAYOUT – SOUTH BETHANY
PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS



DELAWARE COAST – CAPE HENLOPEN TO FENWICK ISLAND

BETHANY BEACH/SOUTH BETHANY
INTERIM FEASIBILITY STUDY

FIGURE 26
SELECTED PLAN DESIGN TEMPLATE – BETHANY BEACH & SOUTH BETHANY

PHILADELPHIA DISTRICT - U.S. ARMY CORPS OF ENGINEERS

- Twenty-four acres of planted dune grass and 27,425' of sand fence are needed for entrapment of sand on the dune and to delineate walkovers and vehicle access ramps.

- Forty-one dune walkovers are included, one at each street end, in Bethany Beach and South Bethany. One vehicle access way over the dune is included in Bethany Beach, while access for South Bethany is located approximately a ¼ mile south of the southern limit of town in the State Beach area.

- Nourishment of approximately 480,000 cy of beach fill material from Borrow Area E is expected to be needed every 3 years for the 50-year period of analysis.

- To properly assess the functioning of the proposed plan, the placed beach fill, borrow area, shoreline, wave, and littoral environment will be monitored. This monitoring is incorporated into the costs for periodic nourishment as it is considered a necessary part of continuing project construction. Environmental monitoring during initial construction and periodic nourishment operations will be accomplished through fieldwork and coordination with other interested agencies, and is included as a component of engineering and design efforts for this project. An estimate of environmental monitoring costs is presented in the Engineering Technical Appendix, Section 5.

309. **Summary.** This design is complete and is consistent with Corps criteria as described in the "Shore Protection Manual", CETN-II-5, CETN-II-6, and accepted engineering practice. Completion of a Design Memorandum is not necessary. Subject to approval, the study can proceed to development of plans and specifications.

310. **Borrow Area**. Area E contains approximately 25 million cy of suitable beach fill material with an estimated overfill factor of 1.0. An extensive vibrocore investigation was conducted to determine the characteristics of the potential borrow material and the extent of the area. Final environmental coordination and documentation for the use of Area E will be accomplished prior to construction. If permits are obtained before initial construction, this site will be utilized for initial construction and all periodic nourishment requirements. Details of the borrow site and borrow material are provided in the Engineering Technical Appendix, Section 4.

311. **Periodic Nourishment.** Based on the history of beach fill longevity within the Bethany Beach/South Bethany study area, as well as experience gained from beach fill operations and longevity at Fenwick Island, Delaware and Ocean City, Maryland, the recommended cycle of nourishment for the selected plan was determined to be three years. As the nourishment cycle is increased, the risk of a large storm occurring during the interval between nourishment operations as well as the risk of a higher energy year, one outside the envelope represented by the sample wave record, increases significantly. These risks grow with each year the cycle is increased. The annual predicted nourishment rate should not be viewed as a single number, but as an envelope containing a specified percentage of all possible shorelines. At the present time, there is no

generally accepted method or guidelines to quantify this risk and apply it to the economic analysis, but common sense dictates that the increase in this risk would diminish returns as the nourishment cycle is lengthened.

312. Many researchers have found that the rate of loss of fill material is proportional to the quantity placed at one time, and recommend frequent placement of small nourishment volumes with a cycle of between 2 to 4 years.

313. Thus based on model results, historical predictions, and past experiences within the present study areas and other nearby Delaware and Maryland beaches, a 3-year nourishment cycle with a total of 480,000 cy per cycle is recommended.

314. **Engineering and Design (E&D) for Periodic Nourishment.** A beach fill project has a specific longevity and must undergo periodic inspection, maintenance, and nourishment in order to preserve project functionality over the designed lifetime. The project monitoring plan will document beach fill performance and determine conditions within the borrow areas. Periodic assessments will assist in determining nourishment quantities and cycle of future beach fill efforts based on actual trends of project behavior. The assessment program for the project was developed in accordance with EM-1110-2-1004, ER-1110-2-1407, CETN-II-26, and CETN-II-35. The following items are included in the proposed monitoring program: pre- and post-construction monitoring will consist of beach profile surveys, hydrographic surveys of the borrow area, sediment sampling of the beach and borrow areas, aerial photography, and tidal data collection. Laboratory and data analyses will be conducted regularly using the field data collected in the program. The proposed monitoring program will begin at the initiation of pre-construction efforts and continue throughout the life of the project. The monitoring program is further described in the Engineering Technical Appendix, Section 2.

315. **Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R).** Coordination has been accomplished with DNREC, the non-Federal sponsor, and they are fully aware of their obligations concerning operation and maintenance of the Federal project. The monitoring plan, including those aspects of which are non-Federal responsibilities, will be included in the OMRR&R manual.

316. The annual operation and maintenance of the proposed project includes maintaining the dunes and dune crossovers (pedestrian and vehicle access areas), beach shaping, and beach surveys. The dunes will be maintained by shaping the sand with heavy equipment to ensure the presence of the design template. In addition, sand fencing, dune crossovers, and planted dune grass that becomes damaged or suffers deterioration over time will be replaced or maintained as needed. Beach surveys will be performed semiannually along 24 survey lines within the project area.

317. Table 33 lists the current expenditures by the State of Delaware for maintenance of the existing dune area. Also included in this table are the estimated expenditures for the proposed project. The incremental difference between what the state currently spends and the estimated cost to maintain the proposed project is taken as the OMRR&R cost for the purpose of assessing the total economic impacts of the proposed project. The annual cost for these OMRR&R activities is estimated to be $45,000 and is based on operation and maintenance experience for similar beach fill projects within the Philadelphia District. The non-Federal sponsor is responsible for 100% of the cost for these OMRR&R activities.

TABLE 33
ESTIMATED ANNUAL OMRR&R COSTS FOR THE SELECTED PLAN
(May 1998 price level)

ACTIVITY	CURRENT EXPENDITURES	ESTIMATED EXPENDITURES	INCREMENTAL DIFFERENCE
Beach Surveys	$28,800	$28,800	$ 0
Beach Shaping	$36,000	$60,000	$24,000
Dune Grass	$ 0	$ 8,000	$ 8,000
Dune Fences	$ 4,000	$10,000	$ 6,000
Crossovers	$ 2,000	$ 9,000	$ 7,000
TOTAL ESTIMATED ANNUAL OMRR&R COSTS			**$45,000**

318. **Benefits During Construction.** The selected plan will be constructed over six months with an additional month before and after construction for mobilization and demobilization. Significant portions of the beach will be fully nourished before the project is completed in its entirety. The portions of the beach nourished early in the construction phase will provide storm damage reduction benefits. The estimated annualized benefits during construction for the selected plan, at the January 1997 price level, are $81,000 ($67,000 for Bethany Beach and $14,000 for South Bethany).

319. **Recreation Benefits.** Incidental recreation benefits are included in the economic assessment of total benefits of the selected plan. The Delaware beaches are consistently the leading travel destination in the state, and account for half of tourist visitations. In 1991, the Delaware Development Office adopted the following tourism policy for the state:

> To develop tourism as an industry that contributes to economic growth, while fostering the preservation of natural and cultural resources that improve the quality of life for both the state's citizens and those who travel to Delaware.

320. It is expected that local and state efforts to attract visitation, and expand their associated facilities, will continue. The Delaware beaches play an extremely significant role in the well-being of Delaware's tourism industry and the state's overall economy.

321. A contingent value method survey was completed by the University of Delaware for the Corps of Engineers to determine willingness to pay for the existing beach and an enhanced beach. This was done on a regional basis, encompassing the major beach communities of Rehoboth Beach, Dewey Beach, Bethany Beach, South Bethany, and Fenwick Island. The work was undertaken in two distinct parts. The first part consisted of interviewing recreational beach users in the five ocean beach communities during the summer of 1993. The second part of the study involved developing a mail-survey instrument and sending it to 1,004 randomly selected residents within the Mid-Atlantic Region. In total, 910 individuals provided responses through the on-site and mail survey efforts. The findings of the survey efforts are reported in the Economic Analysis Appendix.

322. Recreation benefits were calculated assuming an average of 100 square feet of beach space is utilized per beach user, and the recreational season consists of 97 days, reflecting a 30% loss of days due to inclement weather. The difference between the average willingness-to-pay value between the without- and with-project conditions was determined to be $0.69 for Bethany Beach and $0.58 for South Bethany. There is no net increase in capacity between the without- and with-project conditions as the proposed plan adds a dune and dune grass that do not provide additional recreational beach area. Benefits do not accrue from increased capacity, but rather from an increase in the value of the recreation experience. Average annual recreation benefits, at the January 1997 price level, are $380,200 for Bethany Beach and $253,200 for South Bethany, rounded to $633,000 for the total project.

323. **NED Benefits Summary.** Table 34 presents a summary of the average annual NED benefits associated with the selected plan.

TABLE 34 AVERAGE ANNUAL NED BENEFITS OF SELECTED PLAN (January 1997 price level, total updated to May 1998 price level)			
BENEFIT CATEGORY	**BETHANY BEACH**	**SOUTH BETHANY**	**TOTAL PROJECT**
STORM DAMAGE REDUCTION	**$2,440,000**	**$1,496,000**	**$3,936,000**
Structures	$2,144,000	$1,139,000	$3,283,000
Infrastructure	$197,000	$211,000	$408,000
Improved Property	$77,000	$74,000	$151,000
Emergency/Clean-up	$22,000	$72,000	$94,000
LOCAL COSTS FORGONE	**$200,000**	**$196,000**	**$396,000**
BENEFITS DURING CONSTRUCTION	**$67,000**	**$14,000**	**$81,000**
RECREATION	**$380,000**	**$253,000**	**$633,000**
TOTALS (January 1997 P.L.)	$3,087,000	$1,959,000	$5,046,000
TOTALS (Updated to May 1998 P.L.)	**$3,148,000**	**$1,998,000**	**$5,146,000**

PROJECT IMPACTS

324. **Impacts to Environmental Resources.** The primary adverse impact of the beach nourishment alternative is the temporary disturbance and destruction of existing benthic resources from dredging at the borrow area and fill placement along the shorefront. Dredging in the borrow area will result in a temporary destruction of the benthic community; however, rapid recolonization is expected to occur within one year of the dredging. Minor shifts in benthic community composition may occur following recolonization. Disturbance to benthic organisms will have minor temporary impacts on food sources for finfish. Beach fill operations along Bethany Beach and South Bethany will result in temporary degradation of the existing beach habitat during initial construction and periodic nourishment. Existing benthic organisms on the beach would become buried as a result of beach filling operations. Due to the presence of species adapted to high-energy and dynamic conditions, recolonization of the beach area is expected to be rapid. The portion of benthic habitat covered by any seaward extension of the beach would represent a long-term loss; however, this would be offset by the creation of similar habitat. The partial burial of groin structures that exist in the project area would represent a long-term loss of rocky inter-tidal habitat occupied by aquatic invertebrates that attract birds and fish. Fish and avian utilization of the immediate shoreline area for feeding would be temporarily disrupted; however, they are expected to return immediately after the disturbance. Dredging and the hydraulic placement of beach fill material will result in temporary higher turbidity levels at the borrow site and waters along the shoreline during construction.

325. **Impacts to Cultural Resources.** On the basis of the current project plan, the Corps is of the opinion that this project will have no adverse effect on significant cultural resources. Onshore beach and nearshore underwater project areas are located in a highly unstable and shifting coastal environment where the likelihood for intact and undisturbed cultural resources is considered extremely minimal. The results of documentary review and a shoreline pedestrian survey indicated no historic structural remains or prehistoric material in the beach area. A remote sensing survey was not conducted in the nearshore project area due to unsafe conditions in a very high-energy tidal surf zone. The three listed National Register properties in the Bethany Beach/South Bethany vicinity are located outside of the project area and will not be impacted by proposed construction.

326. The remote sensing investigation of Area C identified one magnetic target exhibiting shipwreck characteristics; however, Area C is not being pursued as a sand source. The Corps of Engineers is of the opinion that proposed sand borrowing activities from the middle portion of Borrow Area E will have no effect on significant cultural resources. The remote sensing survey found no indication of submerged cultural resources in this area. Delaware State Historic Preservation Office (DESHPO) Section 106 consultation is ongoing and will be concluded prior to any construction activity.

327. Vibrocore samples taken from the borrow area to a depth of 20' below the ocean floor revealed a series of shoaled sand deposits with no substantial clay or organic layers indicating buried Pleistocene land surfaces. As currently planned, the dredging depth of the borrow area over the life of the project will not exceed this 20-foot depth.

328. **Impacts on Sediment Transport.** A drift reversal (or nodal) zone exists along the Atlantic Coast of Delaware, with its location ranging from several miles south of Indian River Inlet to the southern limit of Fenwick Island. Sediment north of the nodal zone moves predominantly to the north, and sediment south of the nodal zone moves predominantly to the south. Sediment within the nodal zone is just as likely to move north as it is to move south.

329. The 20-year WIS hindcast was used to estimate sediment transport potential at Bethany and South Bethany beaches for a range of shoreline orientations throughout the project areas. Over the twenty years simulated, the net transport direction for each case was found to be in the northerly direction for both towns. Results from any one individual year differed ranging from net southerly transport on the order of 50,000 cy, to net northerly transport of over 500,000 cy. It is felt that based on the wave analysis and results reported from previous researchers, that the nodal zone is located to the south of the project area. Within the project area the transport can exhibit reversals in annual net transport, but it is predominately north directed, though small. No significant impacts to sediment transport are expected.

330. **Impacts on Aesthetics.** Project dimensions for the berm elevation and foreshore and nearshore slopes were chosen to approximate the natural dimensions of the beach as determined

from historical profiles. The maximum dune height considered during plan formulation was chosen so as not to exceed the natural dune height in the study area, estimated to be +18 ft-NAVD. The maximum berm width considered during formulation was determined based upon the average existing beach profile. Dune height and berm width for the selected plan was chosen based upon optimizing the dimensions of these features to maximize net NED benefits.

331. The native beach material at Bethany Beach and South Bethany is predominately a fine to medium sand with little fines and trace gravel. Material from the borrow area can be described as a gray and tan, medium to fine sand with some fines (silt and/or clay) and gravel. This material is compatible with the native material of Bethany Beach and South Bethany. In general, it is coarser than the native beach material; however, it is not drastically different in composition. Scarping could be a problem if the material were very coarse, and less so if it were finer. Since the native beach material and the borrow material are relatively close in composition, the potential for scarping is expected to be minimal. In addition, the sorting and distribution of sand that occurs with exposure to wave and current action would eventually result in a naturally graded beach similar to what existed prior to introduction of new sand.

332. The placement of beach fill for berm and dune restoration is a more natural and soft structural solution to reducing storm damages in Bethany Beach and South Bethany than other engineered measures considered. With the exception of short-term impacts during construction, overall aesthetics of the beach would be improved as a result. A berm and dune system that approximates the natural dimensions of the beach would be more aesthetically pleasing and attractive to residents and tourists. Despite the visual benefits the berm and dune restoration alternative would provide, a restored dune might inhibit ocean views in some areas of the project. Obstruction of an ocean view is likely to occur from the ground level; thus areas that do not have raised structures (higher than the proposed dune elevation of +16 ft-NAVD) would lose an ocean view. Partial obstruction of an ocean view would occur along the boardwalk in Bethany Beach where the boardwalk elevation is +13 ft-NAVD. This would result in a 3-foot visual obstruction along the deck of the boardwalk. Once the proposed beach fill is in place, however, the wave break zone will be much further from the boardwalk. This would make the waves easier to see from the boardwalk, minimizing negative aesthetic impacts.

COST OF THE SELECTED PLAN

333. **Cost Estimate for the Selected Plan.** The estimated total annualized cost of the selected plan is $3,277,000 ($1,550,000 for Bethany Beach and $1,727,000 for South Bethany), based on a 50-year period of economic analysis and a discount rate of 7.125% (May 1998 price level). This includes the annualized costs of initial construction, interest during construction, periodic nourishment, and OMRR&R.

334. ***Initial Construction Cost.*** The estimated initial construction cost for the selected plan is $22,094,000. This includes costs for project planning, engineering, and design (PE&D); real estate (Acquisitions and Condemnations, including administrative costs); site preparation and project materials and placement (mob & demob; placement of fill, dune grass, and sand fence); construction management (S&A); and associated contingencies. A summary of the initial construction cost is shown in Table 35.

335. PE&D costs include preparation of plans and specifications; obtaining preconstruction environmental and cultural permits and clearances; and development and execution of the Project Cooperation Agreement (PCA). PE&D costs for the selected plan are estimated to be approximately $680,000.

336. Real estate costs (shown under "Lands and Damages" in Table 35) include estimates based on the acquisition of permanent and temporary easements for those properties affected by project construction. Real estate costs for the selected plan are estimated to be approximately $324,000 ($123,000 for Bethany Beach and $201,000 for South Bethany).

337. Site preparation and project materials and placement costs (shown under "Beach Replenishment" in Table 35) include estimates for construction mobilization, demobilization, and preparatory site work, and placement of sand fill for berm and dune restoration, planted dune grass, and sand fencing. These costs are estimated to be approximately $20,458,000 for the selected plan.

338. Construction management costs include estimates for supervision and administration (S&A) activities in overseeing project construction efforts. These costs are estimated to be approximately $632,000 for the selected plan.

339. The estimated annualized cost of initial construction of the project is $1,626,000 ($638,000 for Bethany Beach and $988,000 for South Bethany).

340. ***Interest During Construction.*** The cost of interest during construction (IDC) was computed in accordance with procedure contained in ER 1105-2-100d. IDC was computed based on a 20-month period for PE&D and project construction. The duration of PE&D is estimated to be 12 months, and construction of the project is estimated to be 8 months, including one month each for mobilization (month 13) and demobilization (month 20). It is assumed that PE&D costs would be evenly distributed over the 12-month period. It is also assumed that construction costs for each project segment would be distributed evenly over their respective 3-month construction periods (months 14-16 for Bethany Beach and months 17-19 for South Bethany). The estimated annualized cost of IDC is $33,000 ($22,000 for Bethany Beach and $11,000 for South Bethany).

TABLE 35
SUMMARY OF INITIAL CONSTRUCTION COST FOR SELECTED PLAN
(May 1998 price level)

ITEM DESCRIPTION	QTY	UNIT	UNIT PRICE	ESTIMATED AMOUNT	CONT	TOTAL
LANDS AND DAMAGES						
ACQUISITIONS	---	Job	LS	$275,225	$41,284	$316,509
Bethany Beach				$103,525	$15,529	$119,054
South Bethany				$171,700	$25,755	$197,455
CONDEMNATIONS	---	Job	LS	$6,500	$976	$7,476
Bethany Beach				$3,250	$488	$3,738
South Bethany				$3,250	$488	$3,738
TOTAL LANDS AND DAMAGES				**$281,725**	**$42,260**	**$323,985**
BEACH REPLENISHMENT						
MOBILIZATION, DEMOBILIZATION, & PREPARATORY WORK	---	Job	LS	$496,326	$59,559	$555,885
Bethany Beach				$454,939	$54,593	$509,532
South Bethany				$41,387	$4,966	$46,353
SAND FILL PLACEMENT	3,452,987	CY		$16,869,678	$2,530,452	$19,400,130
Bethany Beach	1,456,517		$4.29	$6,248,458	$937,269	$7,185,727
South Bethany	1,996,470		$5.32	$10,621,220	$1,593,183	$12,214,403
DUNE GRASS	116,160	SY	$2.78	$322,925	$48,439	$371,364
SAND FENCE	27,425	LF	$4.15	$113,814	$17,072	$130,886
TOTAL BEACH REPLENISHMENT				**$17,802,743**	**$2,655,522**	**$20,458,265**
PLANNING, ENGINEERING, AND DESIGN (PE&D)	---	Job	LS	**$591,000**	**$88,650**	**$679,650**
CONSTRUCTION MANAGEMENT (S&A)	---	Job	LS	**$550,000**	**$82,500**	**$632,500**
PROJECT TOTALS						
TOTAL INITIAL CONSTRUCTION COST				$19,225,468	$2,868,932	$22,094,400
TOTAL INITIAL CONSTRUCTION COST (rounded)				**$19,225,000**	**$2,869,000**	**$22,094,000**

341. ***Periodic Nourishment Costs.*** Periodic nourishment costs include all efforts associated with continuing construction of the selected plan. These efforts include periodic placement of additional beach fill material to ensure the design template of the project remains intact. It also includes an estimate of major replacement of project features at some point during the period of analysis. In addition, engineering and design efforts related to project performance monitoring to support periodic nourishment needs assessments are included.

342. Periodic nourishment of the selected plan is expected to occur on a 3-year cycle subsequent to the completion of initial construction. It is assumed that Borrow Area E will be utilized for all required periodic nourishment. Based on a volume of 480,000 cy for each nourishment cycle, the cost per operation is estimated to be approximately $4,528,000. The estimated annualized cost of periodic nourishment operations is approximately $1,336,000 for the selected plan ($735,000 for Bethany Beach and $601,000 for South Bethany).

343. Major replacement is expected to be necessary during the life of the project to ensure its integrity. The estimated cost of major replacement is approximately $7,815,000. To account for this aspect of periodic nourishment, it is assumed that major replacement will occur at the mid-point of the period of analysis, year 24. The estimated annualized cost of major replacement is approximately $110,000 ($60,000 for Bethany Beach and $50,000 for South Bethany).

344. Engineering and design efforts in support of periodic nourishment needs assessments are estimated to cost approximately $158,000 initially, then $119,000 and $130,000 every other year for the remainder of the project life. The estimated annualized cost of these periodic nourishment related efforts is approximately $127,000 ($70,000 for Bethany Beach and $57,000 for South Bethany).

345. **Benefits of the Selected Plan.** The estimated total annualized benefits of the selected plan are $5,146,000 ($3,148,000 for Bethany Beach and $1,998,000 for South Bethany), based on a 50-year period of economic analysis and a discount rate of 7.125% (May 1998 price level). This includes the annualized benefits from storm damage reduction, local costs forgone, benefits during construction, and recreation. A comparison of the annualized benefits and annualized costs is shown in Table 36.

346. **Net Benefits of the NED Plan.** The combined project (both segments) for the study area provides total average annual benefits of $5,146,000 ($3,148,000 for Bethany Beach and $1,998,000 for South Bethany) at a total average annual project cost of $3,277,000 ($1,550,000 for Bethany Beach and $1,727,000 for South Bethany). The total annualized net benefits of the selected plan are $1,869,000 ($1,598,000 for Bethany Beach and $271,000 for South Bethany).

347. ***Benefit-Cost Ratio.*** The benefit-cost ratio of the selected plan is 1.6 (2.0 for Bethany Beach and 1.2 for South Bethany).

TABLE 36 BENEFIT-COST COMPARISON FOR SELECTED PLAN			
DISCOUNT RATE	**7.125%**		
PERIOD OF ECONOMIC ANALYSIS	**50 years**		
PRICE LEVEL	**May 1998**		
BASE YEAR	**2002**		
AVERAGE ANNUAL BENEFITS (AAB)	**BETHANY BEACH**	**SOUTH BETHANY**	**TOTAL PROJECT**
STORM DAMAGE REDUCTION	**$2,440,000**	**$1,496,000**	**$3,936,000**
Structures	$2,144,000	$1,139,000	$3,283,000
Infrastructure	$197,000	$211,000	$408,000
Improved Property	$77,000	$74,000	$151,000
Emergency/Clean-up	$22,000	$72,000	$94,000
LOCAL COSTS FORGONE	**$200,000**	**$196,000**	**$396,000**
BENEFITS DURING CONSTRUCTION	**$67,000**	**$14,000**	**$81,000**
RECREATION	**$380,000**	**$253,000**	**$633,000**
TOTAL AAB (January 1997 P.L.)	$3,087,000	$1,959,000	$5,046,000
TOTAL AAB (Updated to May 1998 P.L.)	**$3,148,000**	**$1,998,000**	**$5,146,000**
AVERAGE ANNUAL COSTS (AAC)	**BETHANY BEACH**	**SOUTH BETHANY**	**TOTAL PROJECT**
INITIAL CONSTRUCTION (including Real Estate, PE&D, and S&A)	**$638,000**	**$988,000**	**$1,626,000**
INTEREST DURING CONSTRUCTION	**$22,000**	**$11,000**	**$33,000**
PERIODIC NOURISHMENT (including Major Replacement and E&D Efforts)	**$865,000**	**$708,000**	**$1,573,000**
OMRR&R COSTS	**$25,000**	**$20,000**	**$45,000**
TOTAL AAC (May 1998 price level)	**$1,550,000**	**$1,727,000**	**$3,277,000**
NET BENEFITS	**$1,598,000**	**$271,000**	**$1,869,000**
BENEFIT-COST RATIO	**2.0**	**1.2**	**1.6**

COST APPORTIONMENT

348. The selected plan is justified on benefits associated with storm damage reduction. There are no separable recreation features included with this project. Recreation benefits resulting from the selected plan are not required for justification and are assumed to be incidental to the project. In accordance with Section 103 of the Water Resources Development Act of 1986 (WRDA 1986) and appropriate Federal regulations such as ER 1165-2-130, Federal participation in a

project formulated for hurricane and storm damage reduction is 65% of the estimated total initial project construction costs including lands, easements, rights-of-way, relocations, and dredged material disposal areas (LERRD).

349. The basis for determining the cost sharing responsibilities for the protected areas of the project is as follows: total length of the protected area, minus the length of undeveloped reaches, divided by the total length of the protected area, multiplied by 65% Federal share. Any undeveloped privately owned reaches would be cost shared as 100% non-Federal responsibility.

350. As the entire length of the protected reaches in the project area is developed and fronted by publicly owned shores, with the exception of the taper zones, the Federal apportionment of initial construction costs is 65%. The tapers have been shown to be the appropriate means by which to terminate the project reaches and are required to ensure the structural integrity of the project. As such, the taper zones are cost shared in accordance with the percentage resulting from the protected area, 65% Federal. Under WRDA 1986 guidelines, periodic nourishment would be cost shared in the same proportion as initial construction. Table 37 summarizes the project cost sharing estimates consistent with WRDA 1986.

351. The Administration has proposed a new cost sharing policy for the periodic nourishment of shore protection projects. Cost sharing of the initial cost of construction is unchanged and will continue to be specified by Section 103 of WRDA 1986. Under the proposed cost sharing policy, periodic nourishment will generally be 35% Federal and 65% non-Federal. WRDA 1986 cost sharing rules pertaining to shore ownership and public use will continue to be applied (*i.e.* Protection of private undeveloped lands will continue to be 100% non-Federal). Table 37 also summarizes the project cost sharing estimates consistent with the Administration proposal.

352. **Construction and Funding Schedule.** It is estimated that initial construction of the proposed project will require a period of eight months, including one month each for project mobilization and demobilization. A separate Project Management Plan (PMP) will describe the activities leading to, through, and after construction of the selected plan. An estimated schedule of expenditures by year will be included in the PMP.

LOCAL COOPERATION

353. In accordance with Section 105(a)(1) of WRDA 1986, the Bethany Beach/South Bethany Interim Feasibility Study was cost shared 50%-50% between the Federal Government and the State of Delaware. The non-Federal sponsor, DNREC, has demonstrated its intent to support a project for storm damage reduction in the towns of Bethany Beach and South Bethany through contribution of funds, ongoing coordination, and participation in a public meeting to present the findings of the feasibility study.

TABLE 37
PROJECT COST SHARING FOR THE SELECTED PLAN
(May 1998 price level)

ITEM					COST
INITIAL CONSTRUCTION COST (Includes LERRD, PE&D, S&A)					$22,094,000
PERIODIC NOURISHMENT – 3-year cycle					$4,528,000
PROJECT FEATURE	**FEDERAL**		**NON-FEDERAL**		**TOTAL**
	COST	**%**	**COST**	**%**	
PER WATER RESOURCES DEVELOPMENT ACT OF 1986					
Initial Construction Costs (Cash Contributions)	$14,361,000		$7,409,000		$21,770,000
Initial Construction Costs (LERRD Credit)	$0	0	$324,000	100	$324,000
Total Initial Construction Costs	**$14,361,000**	**65**	**$7,733,000**	**35**	**$22,094,000**
Total Periodic Nourishment Costs - 50 years (Includes major replacement and E&D costs)	**$53,288,000**	**65**	**$28,693,000**	**35**	**$81,981,000**
ULTIMATE PROJECT COST*	$67,649,000		**$36,426,000**		**$104,075,000**
PER PROPOSED ADMINISTRATION POLICY					
Initial Construction Costs (Cash Contributions)	$14,361,000		$7,409,000		$21,770,000
Initial Construction Costs (LERRD Credit)	$0	0	$324,000	100	$324,000
Total Initial Construction Costs	**$14,361,000**	**65**	**$7,733,000**	**35**	**$22,094,000**
Total Periodic Nourishment Costs - 50 years (Includes major replacement and E&D costs)	**$28,693,000**	**35**	**$53,288,000**	**65**	**$81,981,000**
ULTIMATE PROJECT COST*	$43,054,000		**$61,021,000**		**$104,075,000**

***NOTE:** Ultimate project cost does not include OMRR&R costs throughout the project life which are estimated at $2,250,000 ($45,000/yr) and are the responsibility of the non-Federal sponsor.

PROJECT COOPERATION AGREEMENT

354. A fully coordinated Project Cooperation Agreement package (to include the non-Federal sponsor's financing plan) will be prepared subsequent to the approval of the feasibility phase and will reflect the recommendations of this interim feasibility study. DNREC has indicated support for the recommendations presented in this feasibility report and the desire to execute a PCA for

the recommended plan.

355. In the PCA, the non-Federal sponsor agrees to comply with all applicable Federal laws and policies and other requirements, including but not limited to:

- Provide non-Federal costs assigned to hurricane and storm damage reduction as further specified below:

  (1) Enter into an agreement which provides, prior to construction, 25% of preconstruction engineering and design (PED) costs;

  (2) Provide, during construction, any additional funds needed to cover the non-Federal share of PED costs;

  (3) Provide all lands, easements, and rights-of-way, including suitable borrow areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the initial construction, periodic nourishment, operation, and maintenance of the project;

  (4) Provide during construction any additional funding amounts necessary to make its total contribution equal to 35% of initial project costs assigned to hurricane and storm damage reduction;

  (5) Provide during construction of each periodic nourishment 65% of periodic nourishment costs assigned to hurricane and storm damage reduction;

- For so long as the project remains authorized, operate, maintain, and repair the completed project, or functional portion of the project, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and regulations and any specific directions prescribed by the Federal Government;

- Give the Federal Government a right to enter, in a reasonable manner, upon property that the non-Federal sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating or completing the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall operate to relieve the non-Federal sponsor of responsibility to meet its obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;

- Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, operation, maintenance, repair, replacement, and

rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors;

- Keep and maintain books, records, and other evidence pertaining to costs and expenses incurred pursuant to the project in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

- Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law (PL) 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or, under lands, easements, or rights-of-way that the Federal Government determines to be required for the initial construction, periodic nourishment, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

- Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, periodic nourishment, operation, or maintenance of the project;

- Agree that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, and repair the project in a manner that will not cause liability to arise under CERCLA;

- If applicable, comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1957 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for the initial construction, periodic nourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

- Comply with all applicable Federal and state laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C 701b-12), requiring non-Federal preparation and implementation of flood plain management plans;

- Provide 35% of that portion of total historic preservation, mitigation, and data recovery costs attributable to hurricane and storm damage reduction, and 65% of those costs assigned to periodic nourishment that are in excess of 1% of the total amount authorized to be appropriated for the project;

- Participate in and comply with applicable Federal flood plain management and flood insurance programs;

- Within 1 year after the date of signing a project cooperation agreement, prepare a floodplain management plan designed to reduce the impact of future flood events in the project area. The plan shall be prepared in accordance with guidelines developed by the Federal Government and must be implemented not later than 1 year after completion of construction of the project;

- Prescribe and enforce regulations to prevent obstruction of or encroachment on the project that would reduce the level of protection it affords or that would hinder future periodic nourishment and/or the operation and maintenance of the project;

- Not less than once each year, inform affected interests of the extent of protection afforded by the project;

- Publicize flood plain information in the area concerned, and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the flood plain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

- For so long as the project remains authorized, the non-Federal sponsor shall ensure continued conditions of public ownership and use of the shore upon which the amount of Federal participation is based;

- Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;

- Recognize and support the requirements of Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element; and

- At least twice annually and after storm events, perform surveillance of the beach to determine losses of nourishment material from the project design section and advance nourishment section and provide the results of such surveillance to the Federal Government.

COORDINATION

356. In an effort to keep the non-Federal sponsor involved and informed of study progress, close coordination through telephone conversations and formal and informal meetings continued throughout the feasibility phase. In addition, newsletters were distributed through general mailings describing the ongoing feasibility study efforts.

357. Coordination efforts shall continue through the authorization phase, including coordination of this report with other state and Federal agencies.

FINAL
ENVIRONMENTAL IMPACT STATEMENT (FEIS)

DELAWARE COAST FROM CAPE HENLOPEN TO FENWICK ISLAND FEASIBILITY STUDY
BETHANY BEACH AND SOUTH BETHANY INTERIM FEASIBILITY STUDY
SUSSEX COUNTY, DELAWARE

JUNE 1998

PREPARED BY:
UNITED STATES ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT
PLANNING DIVISION
ENVIRONMENTAL RESOURCES BRANCH
WANAMAKER BUILDING, 100 PENN SQUARE EAST
PHILADELPHIA, PA 19107-3390

Final Environmental Impact Statement
Delaware Coast from Cape Henlopen to Fenwick Island Feasibility Study
Bethany Beach and South Bethany Interim Feasibility Study, Sussex County, Delaware

Proposed Action: Storm damage reduction for Bethany Beach and South Bethany utilizing beachfill to construct a protective berm and dune for these communities.

Location of Action: The proposed project site is located along the Atlantic Coast shoreline within the towns of Bethany Beach and South Bethany, Sussex County, Delaware. The specific areas involved are the beaches and nearshore zones of Bethany Beach and South Bethany along with one offshore sand borrow site (Area E). Coordinates for the impacted areas extend linearly along the shoreline from approximately N38°32'47", W75°03'18" South to N38°30'30", W75°03'07". The approximate center of the proposed offshore sand borrow site (Area E) is located at N38°30.85', W75°00.4'.

Type of Statement: Final Environmental Impact Statement (FEIS)

Lead Agency: U.S. Army Corps of Engineers, Philadelphia District

Cooperating Agencies: Delaware Department of Natural Resources and Environmental Control

For further information: Robert L. Callegari, Chief, Planning Division
Attn: Steve Allen, Environmental Resources Branch
U.S. Army Engineer District, Philadelphia
Wanamaker Building, 100 Penn Square East
Philadelphia, Pennsylvania 19107-3390 Telephone: (215) 656-6555

Abstract: This study evaluates existing environmental conditions and shore protection problems facing Bethany Beach and South Bethany along the Atlantic Coast of Delaware.

Bethany Beach and South Bethany are extensively developed shore communities in Delaware, which play a principal role in the well being of Delaware's tourism industry. Significant beach and dune erosion has left these communities vulnerable to storm damages and with reduced recreational opportunities. Severe storms in recent years have caused a reduction in the overall beach height and width along the study area, which, along with the absence of suitable dunes, exposes the towns of Bethany Beach and South Bethany to catastrophic damage from ocean flooding and wave attack.

After evaluating several structural and non-structural storm damage reduction alternatives including no action, permanent evacuation, regulation of future development, berm and dune restoration, seawalls, perched beach, offshore submerged feeder berm, beach dewatering, submerged reefs, and combinations of berm and dune restoration with groin field, seawall, bulkhead, and perched beach, the recommended plan was determined to be berm and dune restoration utilizing sand obtained from an offshore borrow source. Specifically, the proposed plan for Bethany Beach and South Bethany is beachfill with a berm width of 150 ft. and a dune with an elevation of +16 ft NAVD. The berm in both communities would be filled to an elevation of +7 ft NAVD, and would have a foreshore slope of 1V:15H to mean low water (MLW), and below MLW, the slope runs generally parallel to the existing profile slope out to the depth of closure. A total sand fill quantity of 3,453,000 cubic yards is needed for the initial fill placement in Bethany Beach and South Bethany. In order to maintain the berm and dunes, renourishment of approximately 480,000 cubic yards of sand fill from the offshore borrow area would be required every 3 years for the 50 year project life. Two areas were identified as potential offshore sand borrow sources (Area C and Area E). Supplemental information for Area E was obtained subsequent to the Draft Environmental Impact Statement (DEIS), and was evaluated in a Supplemental Draft Environmental Impact Statement (SDEIS). Based on the findings in the SDEIS, Area E is the preferred sand borrow source. The constructed dunes in Bethany Beach and South Bethany would be stabilized with sand fencing and planted beachgrass, and beach access would be maintained by constructing dune walkovers.

The FEIS determined that the proposed action would have beneficial effects on socioeconomics within the communities of Bethany Beach and South Bethany, and localized, temporary and minor effects on water quality, benthic resources, and fisheries. A Section 404 (b)(1) evaluation has been prepared and is included in the Final Environmental Impact Statement. This evaluation concludes that the proposed action would not result in any significant environmental impacts relative to the areas of concern under Section 404 of the Federal Clean Water Act.

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1.0 SUMMARY

1.1 PURPOSE AND NEED

The purpose of this statement is to evaluate the anticipated environmental impacts of the alternatives with emphasis on the selected plan that was developed for storm damage reduction at Bethany Beach and South Bethany, Sussex County, Delaware.

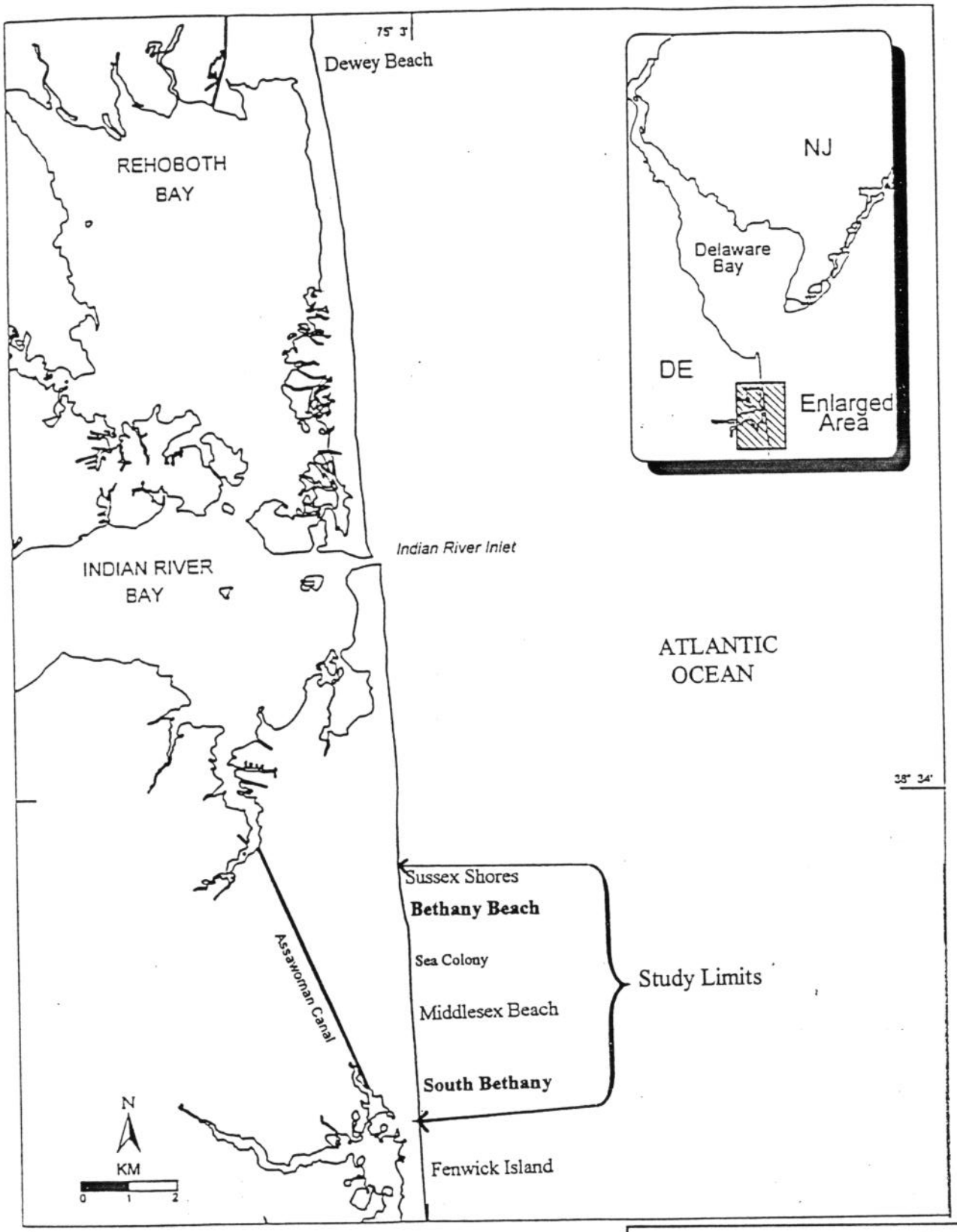
The need to which the U.S. Army Corps of Engineers, Philadelphia District is responding is based on the need to reduce the potential for storm damage to the structures and property associated with the communities of Bethany Beach and South Bethany, Delaware.

The principal source of economic damages identified in Bethany Beach and South Bethany are storms. Severe storms in recent years have caused a reduction in the overall beach height and width along the study area. This as well as the absence of significant dunes exposes the towns of Bethany Beach and South Bethany to catastrophic damage from ocean flooding and wave attack.

1.2 BACKGROUND

The study location (Figure 1-1 and 1-2) is a segment of Atlantic Coast beach in Sussex County, Delaware that extends from Bethany Beach to South Bethany. The incorporated town of Bethany Beach, is a headland and lies directly south of the unincorporated community called Sussex Shores. The town extends south for approximately 1 mile to the unincorporated community known as Sea Colony. The elevation of the beach is generally +6 ft NAVD while the elevation of the upland area (developed area landward of the beach) generally ranges from +8 ft to +11 ft NAVD. Along the beach are 9 locally constructed groins. All of the groins are in generally good condition, functioning and in no imminent danger of failing. The town of Bethany Beach is highly developed with generally suburban characteristics. The main commercial district lies along Garfield Park which runs from Route 1 in the west to the Atlantic Ocean in the east. Areas north and south of Garfield Park are generally residential in nature. Along the beach is a recreational boardwalk extending from just south of 2nd Street in the north 2,050 feet south to Parkwood street. Commercial businesses are established along the length of the boardwalk interspersed by residential structures.

The incorporated town of South Bethany lies directly south of the unincorporated area known as Middlesex Beach. The town extends south for approximately 1 mile to Fenwick Island State Park. South Bethany generally has the characteristics of a barrier island with the Atlantic Ocean to the east and Little Bay to the west. The width of the barrier island on which the southern half of the town of South Bethany lies is generally 2,200 feet. The elevation of the beach is generally +6 ft NAVD while the elevation of the upland area generally ranges from +11 ft NAVD in the northern part of the town to +8 ft NAVD in the southern part of the town.



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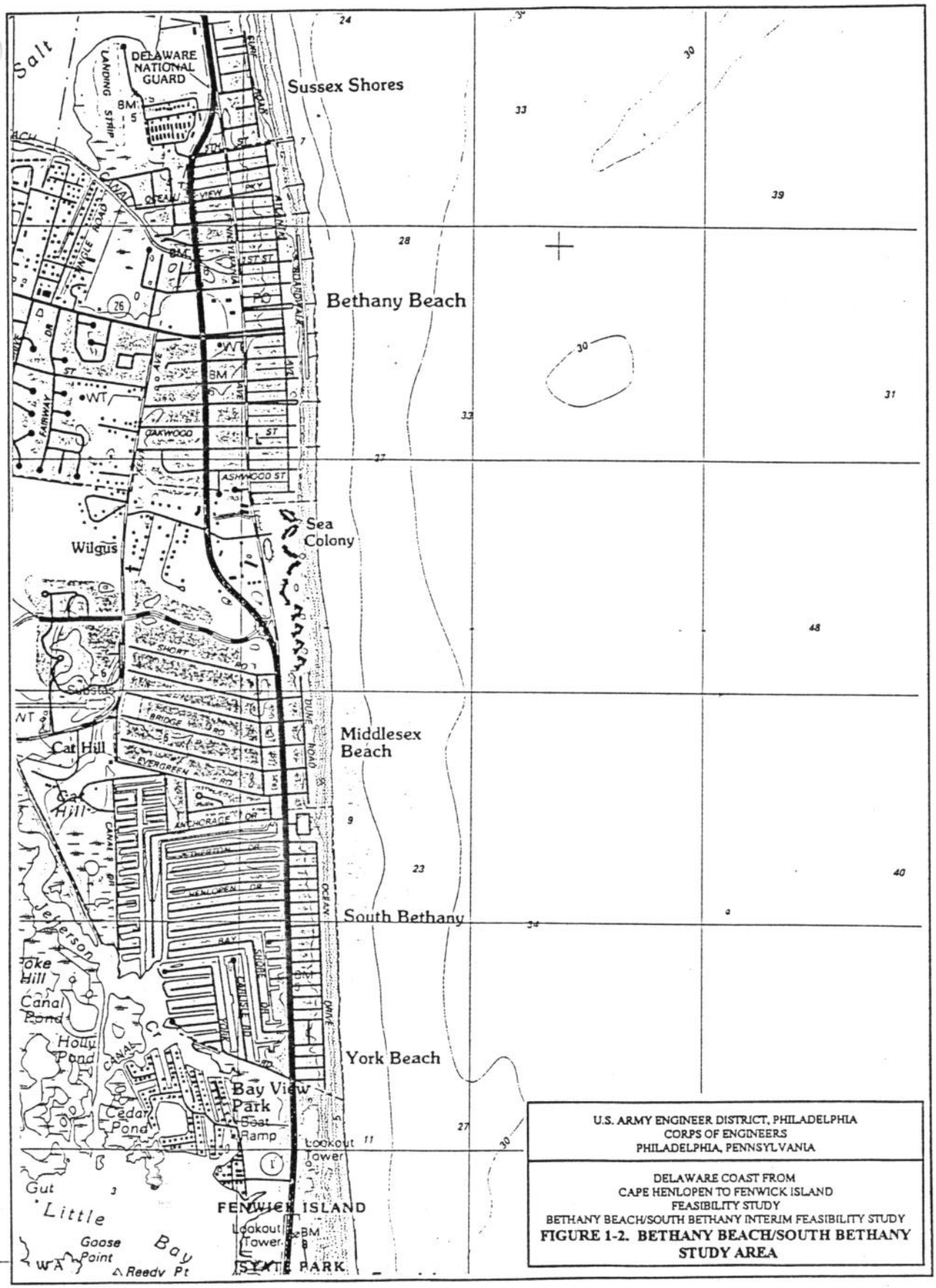
PHILADELPHIA, PENNSYLVANIA

DELAWARE COAST FROM
CAPE HENLOPEN TO FENWICK ISLAND
FEASIBILITY STUDY
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY

FIGURE 1-1. BETHANY BEACH/SOUTH BETHANY STUDY AREA



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PHILADELPHIA, PENNSYLVANIA

DELAWARE COAST FROM
CAPE HENLOPEN TO FENWICK ISLAND
FEASIBILITY STUDY
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY

FIGURE 1-2. BETHANY BEACH/SOUTH BETHANY STUDY AREA

The town of South Bethany is highly developed with generally suburban characteristics. Route 1, which runs through the middle of town (north to south), is where most of the commercial businesses are located. The remainder of the town consists mainly of residential interests.

The communities of Bethany Beach and South Bethany are among Delaware's prime shore recreational areas. The beaches along with the boardwalk in Bethany Beach are among the main attractions of the area. It is this beach which has been subject to erosion by storms and wave action. Within this area, structural damage has occurred through direct wave action, particularly at those locations where at times there is virtually no remaining beach to protect the structures lining the shore.

Efforts have been made to remedy the problem of beach loss within the project area since the early 1900's. These have included both numerous studies and actual construction. A total of 25 stone and timber groins were constructed in the area between Rehoboth Beach and Bethany Beach by the State during the period between 1962 and 1964. Nine of these groins are present within the Bethany Beach study area.

In the mid to late 1980s, Delaware's southern beaches (Bethany Beach, South Bethany and Fenwick Island) experienced a loss of shoreline protection due to chronic erosion problems. This erosion was severe enough for the State of Delaware to undertake emergency measures in order to reduce the vulnerability of these towns to storm damages. This was made possible by the Delaware Department of Natural Resources and Environmental Control (DNREC) being able to take advantage of mobilized equipment for the Federal Ocean City, MD shore protection project. Considering the proximity of the nourishment project at Ocean City, MD and its associated equipment, DNREC contracted to have beachfill placed at all three towns utilizing this equipment. Subsequently, Fenwick Island was nourished in 1988 and 1992 and South Bethany and Bethany Beach were nourished in 1989 and 1992.

In the summer of 1994 , DNREC, again taking advantage of the equipment in place for the Ocean City, MD Federal beachfill project, placed approximately 600,000 cubic yards of beachfill material at Dewey Beach. In addition, maintenance fill was also placed along the shorelines of Bethany Beach and South Bethany.

It should be noted that DNREC has obtained a Department of the Army Permit (CENAP-OP-R-199800591-23) to hydraulically dredge and discharge approximately 250,000 cubic yards of sand along Bethany Beach and 200,000 cubic yards of sand along South Bethany to replenish the eroded beaches. The material would be obtained from an offshore sand borrow site identified as Area "E" in the Feasibility Study. This work is expected to be conducted during the summer of 1998 (Robert Henry DNREC, personal communication). The beach replenishment project is an interim measure to restore eroded beaches at Bethany Beach and South Bethany, and is not considered part of the Federal project as proposed in this document.

This Feasibility study is being conducted in response to the need for Federal participation in providing storm damage reduction at Bethany Beach and South Bethany. The Feasibility study non-Federal sponsor is DNREC.

1.3 ALTERNATIVES

A number of structural and non-structural storm damage reduction alternatives were identified and evaluated individually and in combination on the basis of their suitability, applicability and merit in meeting the planning objectives, planning constraints, economic criteria, environmental criteria and social criteria for the study. The following paragraphs describe several of the alternatives considered, however, a more detailed analysis of the alternatives screening is presented in Section 3.0 of this statement and in the Main Report.

Three levels of screening investigated an array of structural and non-structural alternatives that address storm damage reduction for the communities of Bethany Beach and South Bethany. The first level of screening (Cycle 1) involved the following alternatives:

- No action
- Regulation of Future Development
- Permanent Evacuation
- Berm Restoration
- Berm and Dune Restoration
- Berm and Dune Restoration w/Groin Field (South Bethany Only)
- Seawall
- Berm Restoration with Seawall
- Berm Restoration with Bulkhead
- Perched Beach with Berm and Dune Restoration
- Submerged Reef
- Offshore Submerged Feeder Berm
- Beach Dewatering

Several of the alternatives were eliminated after the first level of screening based on engineering, environmental, socio-economic and relative costs. All of the alternatives remaining after Cycle 1 screening involved the use of beachfill and periodic beach nourishment. The remaining alternatives considered for Cycle 2 Screening were:

- Berm Restoration
- Berm & Dune Restoration
- Berm and Dune Restoration with Groin Field (South Bethany Only)
- Berm Restoration with Bulkhead

Cycle 2 screening further winnowed down the number of alternatives. Only those alternatives that are practical, in terms of the engineering, economics, environmental, social

impacts, and costs remained after the completion of Cycle 2. Only Berm Restoration with Bulkhead was eliminated because it has the same function as a berm w/ a dune, but at a much higher cost.

Since all of the plans to be analyzed in Cycle 2 include some aspect of beachfill placement, an investigation was undertaken to identify a suitable borrow source. The utilization of an upland borrow source was ruled out due to the volume of sand needed for a beachfill project in the study area, distance of such sources, the expense of retrieving sand f om these sources and impacts on the roads and the local economy. Three potential offshore sand borrow areas were identified at this level, however, only two areas, "C" and "E", were considered further. Areas C and E were originally proposed in the Draft Environmental Impact Statement (DEIS). A Supplemental Draft Environmental Impact Statement (SDEIS) was subsequently prepared and circulated after information pertaining to fisheries, aquatic biota, cultural resources, and sand quantities was obtained for Area E. In the SDEIS, Area E was identified as the preferred borrow source. Based on concerns for benthic and fisheries impacts, Area C was withdrawn as a borrow source.

The alternatives remaining after Cycle 2 analysis and considered for optimization in Cycle 3 analysis were:

- Berm Restoration
- Berm and Dune Restoration
- Berm and Dune Restoration with Groin Field (for South Bethany only)

Cycle 3 analysis involved optimization of the remaining alternatives into various configurations that were compared against their relative costs. Most of the beachfill plans considered meet the planning objectives in that they provide a degree of storm damage protection, which is greater than the cost of implementation. The optimization in Cycle 3 identified the National Economic Development Plan (NED), which is the plan that maximizes beneficial contributions to the Nation while meeting planning objectives. The Cycle 3 screening concluded that only berm and dune restoration utilizing sandy material dredged from a nearby offshore source should be considered further. The NED plan identified for Bethany Beach is beachfill with a berm width of 150 ft. and a dune with an elevation of +16 ft NAVD and for South Bethany the NED plan is beachfill with a 150 ft. berm width and dune with an elevation of +16 ft NAVD. These plans were chosen because they provided the maximum net excess benefits over costs based on storm damage reduction. The details of the NED Plan are discussed in greater detail in Section 3.0 of this statement or in the Main Report.

1.4 MAJOR CONCLUSIONS AND FINDINGS

Berm and dune restoration utilizing beachfill w/periodic sand nourishment represents one of the least environmentally damaging structural methods for reducing potential storm damages at a reasonable cost and in a way that is both socially acceptable and yet is feasible and proven to

work in high energy environments. The somewhat transient nature of beachfill is actually advantageous because the beachfill is capable of being dynamic and adjusting to changing conditions until equilibrium can again be achieved. Despite being structurally flexible, the created beach can effectively dissipate high storm energies, although at its own expense. Costly rigid structures like seawalls and breakwaters utilize massive amounts of material foreign to the existing environment to absorb the force of the waves. Berm and dune restoration w/nourishment uses material typical of the adjacent areas, sand, to buffer the shoreline structures against storm damage. Consequently, this alternative is more aesthetically pleasing as it represents the smallest departure from the existing conditions in a visual and physical sense unlike groins. When the protective beach is totally dispersed by the wave action, the original beach remains. On the other hand, bulkheads, seawalls, and revetments may lead instead to eventual loss of beach as the end of their project life is approached.

Some of the suggested non-structural storm damage reduction alternatives are currently being practiced, such as development regulation. Consequently, implementation is somewhat of a moot point. Others such as land acquisition are prohibitively expensive and are socially unacceptable in any event.

1.5 AREAS OF CONCERN

During the course of the feasibility study, several issues were identified regarding the proposed action that required consideration in this Final Environmental Impact Statement (FEIS). A project of this nature will have temporary adverse impacts on water quality and aquatic organisms. Dredging will increase suspended solids and turbidity at the point of dredging and at the discharge (beachfill) site. The area to be dredged and the area where the material will be deposited will be subject to extreme disturbance. Many of the benthic organisms will become smothered at the beachfill site. Dredging will result in the temporary complete loss of the benthic community in the borrow area. These disruptions are expected to be of short-duration and of minor significance. Rapid recolonization of the borrow site by benthic organisms is expected to occur after dredging ceases (Saloman *et al.*, 1982; Cutler and Mahadevan., 1982; and Hurme and Pullen. 1988). Dredging will consequently temporarily displace a food source for most finfish. Delaware coastal waters including the borrow area supported a historically productive surfclam (*Spisula solidissima*) fishery, however; currently, there are no commercially viable densities along the Delaware Coast. Periodic maintenance disturbances subsequent to the initial dredging may have adverse effects on any potential recovery of the surfclam fishery.

Concerns regarding the use of a hopper dredge and its potential impact on Federally listed threatened and endangered sea turtles were raised with respect to this project. A Biological Assessment that discusses Philadelphia District hopper dredging activities and potential effects on Federally threatened or endangered species of sea turtles has been prepared, and was formally submitted to the National Marine Fisheries Service in accordance with Section 7 of the Endangered Species Act. NMFS has subsequently issued a Biological Opinion, which discusses their requirements to be in compliance with the Endangered Species Act.

1.6 ENVIRONMENTAL STATUTES AND REQUIREMENTS

Preparation of the DEIS, SDEIS, and FEIS has included several scoping and coordination meetings and correspondence with appropriate Federal and State resource agencies, local agencies and interested public. Section 401 Clean Water Act Water Quality Certification has been requested from the Delaware Department of Natural Resources and Environmental Control (DNREC). A concurrence of Federal consistency with the Delaware Coastal Zone Management Program, in accordance with Section 307(c) of the Coastal Zone Management Act, has been requested from DNREC. A Section 404(b)(1) evaluation has been prepared and is included as Section 8.0 of the FEIS. This evaluation concludes that the proposed action would not result in any significant environmental impacts relative to the areas of concern under Section 404 of the Clean Water Act. In accordance with the Fish and Wildlife Coordination Act (FWCA), a planning aid report and section 2(b) report were obtained and are provided in Appendix A of the FEIS and comment/response section, respectively, and in the pertinent correspondence section of the main report. A Statement of Conformity is presented in Section 9.0 of the FEIS concluding that the proposed project would be in compliance with Section 176(c)(1) of the Clean Air Act Amendments of 1990.

Compliance will be met for most of the environmental quality statutes and environmental review requirements with distribution of the FEIS. Table 1-2 provides a list of Federal environmental quality statutes applicable to this statement, and their compliance status relative to the current stage of project review.

TABLE 1-1 . COMPLIANCE WITH ENVIRONMENTAL QUALITY PROTECTION STATUTES AND OTHER ENVIRONMENTAL REVIEW REQUIREMENTS

FEDERAL STATUTES	COMPLIANCE W/PROPOSED PLAN
Archeological - Resources Protection Act of 1979, as amended	Full
Clean Air Act, as amended	Full
Clean Water Act of 1977	Partial
Coastal Barrier Resources Act	N/A
Coastal Zone Management Act of 1972, as amended	Partial
Endangered Species Act of 1973, as amended	Full
Estuary Protection Act	Full
Federal Water Project Recreation Act, as amended	N/A
Fish and Wildlife Coordination Act	Full
Land and Water Conservation Fund Act, as amended	N/A

Table 1-1 Continued on Next Page

TABLE 1-1 . COMPLIANCE WITH ENVIRONMENTAL QUALITY PROTECTION STATUTES AND OTHER ENVIRONMENTAL REVIEW REQUIREMENTS	
Magnuson-Stevens Fishery Conservation and Management Act of 1996	Full
Marine Protection, Research and Sanctuaries Act	Full
National Historic Preservation Act of 1966, as amended	Full
National Environmental Policy Act, as amended	Partial
Rivers and Harbors Act	Full
Watershed Protection and Flood Prevention Act	N/A
Wild and Scenic River Act	N/A
Executive Orders, Memorandums, etc.	
EO 11988, Floodplain Management	Full
EO 11990, Protection of Wetlands	Full
EO12114, Environmental Effects of Major Federal Actions	Full
EO 12989, Environmental Justice in Minority Populations and Low-Income Populations	Full
County Land Use Plan	Full

Full Compliance - Requirements of the statute, EO, or other environmental requirements are met for the current stage of review.
Partial Compliance - Some requirements of the statute, E.O., or other policy and related regulations remain to be met.
Noncompliance - None of the requirements of the statute, E.O., or other policy and related regulations have been met.
N/A - Statute, E.O. or other policy and related regulations are not applicable.

2.0 NEED FOR AND OBJECTIVE OF ACTION

2.1 NEED

The proposed action is based on a need for storm damage reduction, which benefits the communities of Bethany Beach and South Bethany. The need for storm damage reduction is based on storm damage vulnerability with a high potential for storm-induced erosion, inundation and wave attack, which is exacerbated by long term shoreline erosion. The problems which exist in the study area were identified during site visits, literature review, public and interagency coordination, surveys and aerial reconnaissance flights.

Problem Analysis. The principal water resources problem categories identified in Bethany Beach and South Bethany are 1) storm damage vulnerability with a high potential for storm-induced erosion, inundation and wave attack which is exacerbated by 2) long term shoreline erosion.

The ground elevation of Bethany Beach decreases from +11' NAVD in the north to +8' NAVD in the south. Although there are dunes in the northern and southern parts of town, the ocean shoreline along the study area consists predominantly of a continuous strip of low lying beach with a series of 9 groins along the oceanfront.

The ground elevation of South Bethany decreases from +10' NAVD in the north to +8' NAVD in the south. Although there are dunes in the very northern part of town, the ocean shoreline along the study area consists predominantly of a continuous strip of low lying beach. There are no groins along the oceanfront.

Storm Damages. The principal source of economic damages identified in Bethany Beach and South Bethany are storms. Severe storms in recent years have caused a reduction in the overall dune height and berm height and width along the study area. These existing conditions expose the towns of Bethany Beach and South Bethany to potentially catastrophic damage from ocean flooding and wave attack.

Storm History. In recent years erosion problems have become more critical as several coastal storms have buffeted the Atlantic coast of Delaware. Since the March 1962 storm (Figure 3 of Main Report) which caused, in 1962 dollars, $16.7 million in damages, the most notable storms have occurred in December 1974, October 1977, March 1984, September 1984, October 1991, January 1992 and December 1992 and January 1996. It should be noted that the January 1992 (Figures 4 and 5 of Main Report), December 1992 (Figure 6 of Main Report), and January 1996 storms resulted in the President of the United States declaring Sussex County, DE, which includes the entire Atlantic Ocean coast of Delaware, a National Disaster Area.

Long Term Shoreline Erosion. Progressive and constant erosion is evident along the coastline of the study area. Historically, beach erosion has been recorded in Delaware since

1843, though according to Goodman (1973), it was not a significant problem until the 1950's when tourism, and hence development, increased, and the economic impact of beach erosion became apparent. Local interests constructed groins in Bethany Beach between the 1930's and the 1950's indicating that beach erosion was in fact a problem prior to 1950. Efforts undertaken to minimize losses associated with storm damage include building code improvements and building restrictions. However, many portions of the developed coast still remain vulnerable due to the proximity of structures to the beach and the level of development.

It should be noted that simply because an area may exhibit relative stability or a low background erosion rate does not preclude the need to fully address options for additional shore protection. As mentioned earlier, in the case of Bethany Beach and South Bethany, which lost a great deal of beach elevation during recent storms, much of the existing beachfront lacks an adequate dune system.

2.2 OBJECTIVES

Planning objectives were identified based on problems, needs and opportunities as well as existing physical and environmental conditions present in the project area.

In general, the prime Federal objective is to contribute to the National Economic Development (NED) account consistent with protecting the Nation's environment. Both of these objectives must be consistent with national legal statutes, applicable executive orders, and other Federal planning requirements. The general and specific planning objectives for the Bethany Beach/South Bethany Interim Feasibility Study take an integrated systematic approach to the solution of the erosion and inundation problems associated with coastal storms in the towns of Bethany Beach and South Bethany. Accordingly, the following general and specific objectives have been identified:

General:

- Meet the specified needs and concerns of the general public.
- Respond to expressed public desires and preferences.
- Be flexible to accommodate changing economic, social and environmental patterns and changing technologies.
- Integrate with and be complementary to other related programs in the study area.
- Be implementable with respect to financial and institutional capabilities and public support.

Specific:

- Reduce the threat of potential future damages due to the effects of storms, with an emphasis on inundation and recession of the shoreline.
- Mitigate the effect of, or prevent, the long-term erosion that is now being experienced.
- In accordance with the limits of institutional participation, all plan components must maximize NED (National Economic Development) benefits.
- Enhance the recreational potential of the area.
- Where possible, preserve and maintain the environmental character of the areas under study, including such considerations as aesthetic, environmental and social concerns, as directly related to plans formulated for implementation by the Corps.

2.3 PROJECT AUTHORITY

The Delaware Coast from Cape Henlopen to Fenwick Island Feasibility Study is being conducted in response to a resolution adopted by the U. S. Senate Committee on Environment and Public Works dated 23 June 1988. This resolution reads as follows:

> "RESOLVED BY THE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS OF THE UNITED STATES SENATE, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the Rivers and Harbors Act, approved June 13, 1902, be, and is hereby requested to review the report on the Delaware Coast from Kitts Hummock to Fenwick Island, Delaware, published as House Document Number 85-216, and other reports, with a view to determining the advisability of providing improvements in the interest of beach erosion control, hurricane protection, and related purposes, along the Delaware Coast from Cape Henlopen to Fenwick Island. Included in this study will be the development of a physical and engineering data base on coastal area changes and processes, including appropriate monitoring during development of the data base, as the basis for actions to prevent the harmful effects of shoreline erosion and storm damage."

2.4 PUBLIC CONCERNS

Discussions and scoping meetings with the public, local, State, and Federal agencies produced several concerns that were either environmental or socio-economic in nature.

The non-Federal sponsor for this feasibility study is the Delaware Department of Natural

Resources and Environmental Control (DNREC). Currently, DNREC's concern, within the scope of this interim feasibility study, is with shore protection problems at Bethany Beach and South Bethany. The State is interested in a long term Federal shore protection project due to funding constraints which prohibit the State and local governments from carrying out a long term shore protection program on their own.

Siting of a sand borrow area was a primary environmental concern raised for this project. Issues involved with borrow area selection included the presence/absence of significant cultural resources, benthic resources, fisheries impacts, threatened and endangered species, water quality impacts, hydrodynamic modifications, and sand grain size compatibilities with beach material. Some of these issues required further investigation and are discussed in Sections 4.0, 5.0, and 8.0 of this statement.

2.5 RELATED ACTIONS

As discussed in Section 1.2, DNREC has conducted several beachfill actions prior to the initiation of this study. Currently, DNREC has obtained a Department of the Army Permit (CENAP-OP-R-199800591-23) to hydraulically dredge and discharge approximately 250,000 cubic yards of sand along Bethany Beach and 200,000 cubic yards of sand along South Bethany to replenish the eroded beaches. The material would be obtained from the offshore sand borrow area identified as Area "E" in the Feasibility Study. This work is expected to be conducted during the summer of 1998 (Robert Henry DNREC, personal communication). The beach replenishment project is an interim measure to restore eroded beaches at Bethany Beach and South Bethany, and is not considered part of the Federal project as proposed in this document.

3.0 ALTERNATIVES

3.1 PLAN FORMULATION

The Plan Formulation Section of the Main Report provides a basis on the selection of an optimized plan that meets the needs and objectives identified during the Feasibility Study. The purpose of formulation is to identify plans which are publicly acceptable, implementable, and feasible from economic, environmental, engineering and social standpoints.

ER 1105-2-100 requires the systematic preparation and evaluation of alternative solutions for addressing identified problems, needs and opportunities under the objective of National Economic Development (NED) consistent with protecting the Nation's environment.

The formulation was undertaken in three phases, or cycles: Cycle 1- Initial Screening of Solutions Considered, Cycle 2- In Depth Evaluation and Screening of Solutions Considered and Cycle 3- Optimization of the Selected Alternative Solution. By analyzing the alternative solutions in this manner one can formulate the solution that best fits the planning objectives and constraints in a logical and efficient fashion.

3.1.1 Damage Mechanisms

Alternative solutions considered include those which provide storm damage protection from a number of possible damage mechanisms:

(1) long term erosion
(2) storm recession
(3) inundation
(4) wave attack

Long Term Erosion Damage. Generally, erosion damages refer to the long-term loss of dry land area due to deficits in littoral sediment transport, impact of sea level rise and the long-term net impact of storms. Long term erosion may itself cause economic losses and will reduce the amount of protective beach area resulting in increased future storm damage.

Storm Recession Damage. The project area is subject to significant storm induced shoreline recession which becomes increasingly more damaging as long-term erosion reduces the protective buffer of the beach. Unlike long-term erosion, which is assumed to be stopped by intervention at bulkheads and major access roads, storm recession occurs over a relatively short period of time during the course of a storm. Thus, storm recession is considered capable of impacting buildings, including those fronted by protective structures, such as bulkheads and dunes.

Inundation Damage. Flooding from the convergence of tides and storm surge coupled with waves running over the shorefront, or overtopping protective structures, and across dry land causes damage to homes, businesses and public facilities. The extent and severity of flooding is expected to increase in relation to continued increases in sea level.

Wave Attack. Structures along the oceanfront are subject to significant forces due to impacts of waves breaking against the structure or the run-up associated with waves breaking seaward of the structure. The forces associated with such waves, and the associated run-up, are capable of causing structural failure due to overturning or lateral displacement.

3.2 CYCLE 1 - INITIAL SCREENING OF SOLUTIONS CONSIDERED

In Cycle 1, storm damage reduction measures are identified and evaluated individually and in combination on the basis of their suitability, applicability and merit in meeting the planning objectives, planning constraints, economic criteria, environmental criteria and social criteria for the study. Without undertaking an in-depth analysis, the goal of Cycle 1 analysis screens out those alternatives which obviously do not fulfill the storm protection needs of the study or are inappropriate due to other factors such as prohibitively high costs that are associated with some of the alternatives. Judgements are made about each alternative based on knowledge gained from researching past reports, the professional experience of study team members and other District personnel. In addition, in the spirit of our partnership agreement with the non-federal sponsor, DNREC, each of the alternatives are evaluated and discussed in terms of the sponsor's views concerning it's effectiveness in meeting the needs along the coast.

Relative costs for each alternative solution are determined in a qualitative manner, as shown in Table 3-1. For this analysis, relative costs are defined as the total cost of the project as compared to the without-project damages, or pool of potential benefits. The following paragraphs summarize the objectives and evaluation of each of the above alternative solutions considered in Cycle 1.

There are two categories of solutions considered for implementation in the Bethany Beach/South Bethany study area, namely, nonstructural measures and structural measures. Nonstructural measures are those measures which control or regulate the use of land and buildings such that damages to property are reduced or eliminated. No attempt is made to reduce, divert, or otherwise control the rate of erosion. Structural measures are generally those which act to block or otherwise interfere with inundation and erosive coastal processes or which restore or nourish beaches to compensate for erosion and block inundation.

TABLE 3-1
BETHANY BEACH/SOUTH BETHANY OCEAN FRONT
CYCLE 1 - FIRST LEVEL SCREENING RESULTS

Alternative	Technical Appropriateness	Meet Objectives?			Relative Cost	Further Consideration in Cycle 2?
		Erosion	Inundation	Wave Attack		
No Action	No. Provides no measures to prevent damages from storms or long term erosion for the study area.	No	No	No	None	No
Regulation of Future Development	No. Provides no measures to prevent damages from storms or long term erosion for the study area because there is virtually no undeveloped land.	No	No	No	Low	No
Nonstructural Alternatives	No. Involves the acquisition of all affected lands and structures either by purchase or through powers of eminent domain.	No	No	No	Very High	No
Berm Restoration	Yes. Berm pushes the breaker zone and the erosion profile seaward. Provides sacrificial sediment during storms as well as recreational beach.	Yes	No	Partial	Moderate	Yes
Berm and Dune Restoration	Yes. Berm pushes the breaker zone and erosion and inundation profile seaward. Provides sacrificial sediment during storms as well as recreational beach. Dunes can provide buffer during storms and can provide aesthetic value by planting with dune grass. Dune grass helps to stabilize the dune for storm protection.	Yes	Yes	Yes	Moderate	Yes
Berm and Dune Restoration with Groin Field (South Bethany only)	Yes. Costs of the groin field must be offset by reduced periodic nourishment requirements. This option could also reduce long term erosion and stabilize South Bethany. Can cause down drift erosion.	Yes	No	Yes	High	Yes
Berm Restoration with Bulkheading	Yes. Bulkheads perform the same function as dunes but is more costly and may require toe protection.	Yes	Yes	Yes	High	Yes
Berm and Dune Restoration with Offshore Detached Breakwater	Partial. Costs must be offset by reduced periodic nourishment requirements.	Partial	No	Partial	Very High	No

Table 3-1 continued on next page.

TABLE 3-1 CONTINUED
BETHANY BEACH/SOUTH BETHANY OCEAN FRONT
CYCLE 1 - FIRST LEVEL SCREENING RESULTS

Seawall	Yes. Seawall performs the same function as bulkhead and dune but is much more costly. There is debate that seawalls can exacerbate erosion.	Partial	Yes	Yes	Very High	No
Berm Restoration with Seawall	Yes. Seawall performs the same functions as bulkhead and dune but is much more costly. There is a debate that seawalls can exacerbate erosion.	Partial	Yes	Yes	Very High	No
Perched Beach	Partial. Costs must be offset by reduced periodic nourishment requirements. Less viable in high wave energy environments.	Partial	No	Partial	High	No
Submerged Reef	Partial. Costs must be offset by reduced periodic nourishment requirements. Existing submerged reef in NJ has not retained beachfill.	Partial	No	Partial	High	No
Offshore Berm	Partial. Costs must be less than direct placement of material on beach. Success is highly dependant on wave conditions.	Partial	Partial	Partial	Low	No
Beach Dewatering	Partial. Technology/performance is still unproven for an open ocean coastal environment. Requires an initial beachfill placement. Costs would have to be offset by reduced nourishment requirements. Life cycle costs for implementation are unknown.	Partial	Partial	Partial	Moderate	No

Shore protection measures were evaluated individually and in combination on the basis of their suitability, applicability, and merit in meeting the specific needs, objectives and constraints of the study. The project alternative measures considered are as follows:

Nonstructural Measures

- No Action
- Regulation of Future Development
- Permanent Evacuation

Structural Measures

- Berm Restoration
- Berm and Dune Restoration
- Berm and Dune Restoration with Groin Field (South Bethany only)
- Berm Restoration with Bulkhead (South Bethany only)
- Berm and Dune Restoration with Offshore Detached Breakwater
- Seawall
- Berm Restoration with Seawall
- Perched Beach with Berm and Dune Restoration
- Submerged Reef
- Offshore Submerged Feeder Berm
- Beach Dewatering

It should be noted that the above alternatives (bulkhead, dune, seawall) were evaluated in configurations which would provide similar storm damage protection.

3.2.1 Non-Structural Storm Damage Reduction Alternatives

No Action. The no action alternative imposes no measures to provide erosion control, recreational beach or storm damage protection to structures landward of the beach front. This alternative solution would not check the continuing erosion of the beaches, nor would it prevent property from being subjected to higher storm damages from beach recession, flooding and wave attack. The nine existing groins in Bethany Beach would eventually deteriorate, and force the State of Delaware to rehabilitate these groins at high cost, or risk further accelerating the loss of beach. This plan fails to meet any of the objectives or needs of the study. Therefore, this alternative was not considered in Cycle 2.

Regulation of Future Development. Regulation or land use controls could be enacted through codes, ordinances, or other regulations to minimize the impact of erosion on lands which could be developed for the future. This measure lends itself to relatively large, continuous undeveloped areas rather than developed areas. At this time there is virtually no oceanfront that is not developed. Therefore, additional regulation to prevent new development would have little impact. Since this alternative solution is not practical it was not considered further in the Cycle 2 analysis.

Permanent Evacuation. Permanent evacuation of the existing developed areas subject to inundation or erosion damages involves the acquisition of affected lands and structures either by purchase or, if necessary, through the exercise of powers of eminent domain. Following this action, all commercial, industrial and residential property in areas subject to erosion or inundation damages are either demolished or relocated to another site. Undoubtedly, roads, railroads, water supply facilities, electric power, and telephone and sewerage utilities would also have to be relocated. The lands acquired in this manner could be used for undeveloped parks, or other purposes, that would not result in material damage from erosion or inundation. The towns of Bethany Beach and South Bethany have been intensely developed. Any structures to be relocated would almost certainly have to be placed outside of the existing town limits. Due to the level of development in the study area, this alternative solution would be prohibitively expensive and does not meet the objectives of the study. Therefore, this alternative was not considered in Cycle 2.

3.2.2 Structural Storm Damage Reduction Alternatives

Berm Restoration. This alternative involves the placement of beach fill material (sand), from an offshore borrow source, directly onto the beach in order to widen and stabilize the existing berm profile. Usually the sand is pumped onto the existing shore using a dredge. An appropriate design uses borrow material that has similar properties to the existing native beach sand. In addition, the restored beach is graded to a certain design elevation and width to provide the desired level of storm protection. The constructed berm requires additional sand placement, renourishment, on a periodic basis so that the design berm width and elevation is maintained. Because this alternative meets the study objectives, has a moderate relative cost, and is technically feasible, it was considered further in Cycle 2 for the entire study area.

Berm and Dune Restoration. This alternative provides the same berm restoration effort as described above with additional sand placed upland of the beach to create a dune at a designed elevation and width. The dune provides additional protection against storm surge similar to that of a bulkhead. Because this alternative meets the study objectives, has a moderate relative cost and is technically feasible, it was considered further in Cycle 2 for the entire study area.

Berm and Dune Restoration with Groin Field. This alternative provides the same berm and dune restoration effort as described above. Groins are coastal structures built perpendicular to the shoreline and are designed to trap some of the littoral drift. The typical groin extends from the upper beach face into the surf zone. A properly designed groin field will reduce erosion, and, when done in tandem with a beachfill project, will reduce the frequency of needed beach renourishment. However, a groin field will not provide adequate protection from storm surge. For this reason a groin field would only be included in the Federal project if it's cost is offset by the savings realized from a decrease in cost for periodic nourishment of the berm. Because this alternative solution meets the study objectives, may decrease renourishment costs enough to justify itself and is technically feasible it will be considered further in Cycle 2 for South Bethany which currently lacks a groin field. In Bethany Beach all of the groins are in fair physical

condition and appear to be functioning adequately. Modification of existing groins at Bethany Beach would only be addressed if the selected plan would require a redesign of the current groin field.

Berm Restoration with Bulkhead. This alternative provides the same berm restoration effort as described above with the addition of a bulkhead. A bulkhead protects upland areas from erosion and inundation damage. Since 69% of Bethany Beach and 4% of South Bethany have existing timber bulkheads parallel to the ocean front, this alternative examined extending the timber bulkhead walls along the entire length of the study area. While the bulkhead will protect upland areas from inundation, beach restoration will limit erosion in front of the bulkhead and hence will provide additional protection to upland areas. This alternative meets the study objectives, has a high, but possibly acceptable, relative cost and is technically feasible for the study area, therefore this alternative was considered further in Cycle 2.

Berm and Dune Restoration with Offshore Detached Breakwater. This alternative provides the same berm and dune restoration plan as described above with the addition of an offshore detached breakwater along the length of the study area. The offshore detached breakwater is a structure which reduces the incident wave energy impacting the beaches thus reducing erosion. In many cases the offshore detached breakwater is a series of rubble mound structures that are visible from the beach during periods of low tide. The berm and dune restoration aspect of this option provides the needed storm protection. Since an offshore detached breakwater does not protect against storm surge, the required initial beachfill is the same as described above for the berm and dune restoration alternative. In order to be included in the Federal project the cost of this alternative solution would have to be offset by the savings from a decrease in periodic nourishment costs and reduced wave energy during a storm. In addition, this alternative has many other problems: constructability, aesthetics, and safety. Since construction of the breakwater must be done entirely from the water, all construction materials must be brought in on barges and all equipment used must be secured to jack-up barges. This effort introduces the additional difficulty of working in an open ocean environment. For these reasons the cost to construct an offshore breakwater in the open ocean environment would not be offset by a decrease in cost for periodic nourishment and reduced wave energy during a storm. Therefore, the relative cost was determined to be prohibitively high. Therefore, this alternative was not considered in Cycle 2.

Seawall. This alternative includes the construction of a "Galveston type" seawall placed along the entire length of the study area, replacing all existing dunes, with a top elevation of +20' NGVD to prevent overtopping from a 50 year storm event. This structure includes fronting toe scour stone protection, pile supports and underlying sheeting to reduce underseepage. This alternative solution would not provide any recreational berm restoration but would provide storm damage protection consistent with other structural alternatives. It was determined that the relative cost for such a project would be prohibitively high. For this reason this alternative was not considered in Cycle 2.

Berm Restoration with Seawall. This alternative consists of the same berm restoration plan as described above with the addition of a "Galveston type" seawall also as described above. However, the cost for this alternative would not be offset by savings from reduced inundation and would therefore be prohibitively high. Therefore, this alternative solution was not considered in Cycle 2 for the same reasons that the seawall alternative above has been eliminated.

Perched Beach with Berm and Dune Restoration. This alternative provides the same berm and dune restoration plan described above with the addition of a submerged stone rubble mound structure which is used to support the offshore end of the placed beachfill. The placement of the rubble mound structure would eliminate the outer part of beach profile near its closure with the ocean bottom. Therefore, the actual amount of fill material to be placed is less than in the berm and dune restoration alternative. The submerged rubble mound structure acts in the same way as the natural bar formed offshore during storm events creating a "perched beach" with a wider berm. The main problem with this alternative is that angled swell scours in front of and behind the offshore structure resulting in the need for heavy maintenance to keep the structure functioning. In addition, interception of littoral drift will cause erosion downcoast. Due to the high expenses needed to maintain this structure and the fact that perched beaches are usually associated with reclamation, in lower wave energy environments, which is not an objective of this study, this alternative was not considered in Cycle 2.

Submerged Reef. This alternative solution involves the use of interlocking concrete units which form an offshore reef. This reef is intended to dissipate incident wave energy during storms, and to prevent outgoing currents from carrying sand to deeper water. Experience to date with this alternative along the New Jersey shore is still questionable. The units have a tendency to sink and the installation off Avalon, NJ has some of the erosion problems associated with the perched beach concept. In addition, there is a high cost associated with this alternative. Therefore, this alternative was not considered further in Cycle 2.

Offshore Submerged Feeder Berm. Potentially high costs associated with onshore placement have led to the development of alternative less expensive methods of beach nourishment. One such method is nearshore berm placement. In some areas, nearshore berms can reduce wave damage and provide sand to the littoral system with a cost as little as half that of onshore placement (Allison and Pollock, 1993 and McLellan *et al.* 1990).

Prototype experience with offshore submerged feeder berms is limited, and proper design techniques are still being researched and developed. For the berm to function successfully as a beach nourishment technique, several factors such as berm depth, wavelength, wave height and wave velocity must be within suitable ratios (Hands and Allison, 1991). Long term sediment transport trends, both longshore and cross-shore, must be examined. The berm placement site must be an appropriate distance down drift of an inlet or jetty to reduce the tendency of the sediment to return to the inlet or be caught by the jetty (McLellan *et al.* 1990).

Because nearshore placement has had mixed results and current design techniques are limited and unproven, nearshore placement is a higher risk option than direct onshore placement at Bethany Beach and South Bethany. Also, because nourishment areas are located adjacent to the potential borrow sources, the difference in cost between direct onshore and nearshore placement may not be significant. Therefore, this alternative was not considered further in Cycle 2.

Beach Dewatering. The concept of beachface drainage as a method to increase beach stability has been tried in Florida and Denmark. Sand in the swash zone is typically in a buoyant state. Erosion is diminished by beach dewatering due to the discontinuity in the water table and the drained sand, and due to the intergranular pressure and stability which occurs because of the vertical downward flow of water. Accretion is promoted because the sediment laden swash is absorbed by the dewatered sand, causing a deposition of new sand on the foreshore slope.

Beach dewatering technology and performance is still unproven for an open ocean coastal environment. Tests have been completed on a small scale but should not be extrapolated to a large project such as this. Costs would have to be offset by reduced nourishment requirements. Life cycle costs for a large scale implementation are unknown. For these reasons, this alternative was not considered further in Cycle 2.

3.2.3 Comparative Environmental Impact Analysis of the Cycle 1 Alternatives

Table 3-2 summarizes environmental impacts of all of the alternatives considered in Cycle 1 analysis. Since a number of alternatives involve impacts on shoreline and offshore resources, two evaluations were done for each resource category (if applicable). For each resource category and the corresponding alternative, the first abbreviation represents the impact evaluation for shoreline and nearshore resources and the second abbreviation represents the impact evaluation for offshore resources.

3.3 ALTERNATIVE PLANS CONSIDERED IN CYCLE 2

Cycle 2 Analysis evaluated alternative plans that were selected from the Cycle 1 Analysis for further study. The alternative plans investigated in Cycle 2 are:

- Berm Restoration
- Berm and Dune Restoration
- Berm and Dune Restoration with Groinfield
- Berm Restoration with Bulkhead

General designs for this phase of screening were chosen after reviewing accepted coastal engineering practice, existing conditions in the study area, results of the without-project analysis, the Shore Protection Manual and CETN II-5. Table 3-3 discusses the technical performance,

TABLE 3-2
COMPARATIVE ENVIRONMENTAL IMPACT ANALYSIS OF CYCLE 1 ALTERNATIVES

ALTERNATIVE	RESOURCE CATEGORIES													
	Air Quality	Topography and Soils	Ground-water	Hydrody-namics	Water Quality	Wet-lands	Terrestrial Ecology	Aquatic Ecology			Endangered Species	Cultural Resources	Socio-economics	Aesthetics
								Soft-bottom Benthic Organisms	Fisheries					
									Shell-fish	Fin-fish				
No Action	NE	SAP NE	NE NE	NE NE	NE NE	NE N/A	MAP N/A	NE NE	NE NE	NE NE	NE NE	NE NE	SAP	NE NE
Regulation of Future Development	NE	SAP NE	NE NE	NE NE	NE NE	NE N/A	NE N/A	NE NE	NE NE	NE NE	NE NE	NE NE	NE	NE NE
Permanent Evacuation	MBP	SAP NE	NE NE	NE NE	NE NE	NE N/A	BP N/A	NE NE	NE NE	NE NE	NE NE	NE NE	SAP	BP NE
Berm Restoration	MAT	SBP MAP	NE NE	NE NE	MAT MAT	NE N/A	BP N/A	AT AT	AT AT	AT AT	NE *NE	NE NE	SBP	BP NE
Berm and Dune Restoration	MAT	SBP MAP	NE NE	NE NE	MAT MAT	NE N/A	BP N/A	AT AT	AT AT	AT AT	NE *NE	NE NE	SBP	BP NE
Berm and Dune Restoration w/Groin Field (South Bethany Only)	MAT	SBP MAP	NE NE	BP NE	MAT MAT	NE N/A	BP N/A	MAP AT	AT AT	AT AT	NE *NE	NE NE	SBP	BP NE
Berm Restoration w/ Bulkhead	MAT	BP MAP	NE NE	NE NE	MAT MAT	NE N/A	MBP N/A	AT AT	AT AT	AT AT	NE *NE	NE NE	SBP	MBP NE
Berm and Dune Restoration w/ Offshore Detached Breakwater	MAT	SBP MAP	NE NE	BP NE	MAT MAT	NE N/A	BP N/A	MAP AT	AT AT	AT AT	NE *NE	NE NE	SBP	MAP NE

Table 3-2 Continued on Next Page

TABLE 3-2
COMPARATIVE ENVIRONMENTAL IMPACT ANALYSIS OF CYCLE 1 ALTERNATIVES

ALTERNATIVE	RESOURCE CATEGORIES													
	Air Quality	Topography and Soils	Ground-water	Hydrody-namics	Water Quality	Wet-lands	Terrestrial Ecology	Aquatic Ecology			Endangered Species	Cultural Resources	Socio-economics	Aesthetics
								Soft-bottom Benthic Organisms	Fisheries					
									Shell-fish	Fin-fish				
Seawall	MAT	AP NE	NE NE	AP NE	MAT NE	NE N/A	AP N/A	AP NE	AP NE	NE NE	NE NE	NE NE	MBP	SAP NE
Berm Restoration with Seawall	MAT	BP MAP	NE NE	NE NE	MAT MAT	NE N/A	MBP N/A	AT AT	AT AT	AT AT	NE *NE	NE NE	SBP	MBP NE
Perched Beach w/Berm and Dune Restoration	MAT	SBP MAP	NE NE	BP NE	MAT MAT	NE N/A	BP N/A	MAT MAT	MAT MAT	MAT MAT	NE *NE	NE NE	SBP	BP NE
Submerged Reef	MAT	BP NE	NE NE	BP NE	MAT NE	NE N/A	BP N/A	MAP NE	MAP NE	BP NE	NE *NE	NE NE	BP	NE NE
Offshore Submerged Feeder Berm	MAT	BP MAP	NE NE	BP NE	MAT MAT	NE N/A	BP N/A	MAT MAT	MAT MAT	MAT MAT	NE *NE	NE NE	BP	BP NE
Beach Dewatering	U	U NE	U NE	U NE	U NE	U N/A	U N/A	U NE	U NE	U NE	NE NE	NE NE	U	NE NE

SAP (Significant Adverse Permanent) - Effect(s) are significantly adverse to affected resource, and are a long-lasting condition
SBP(Significant Beneficial Permanent) - Effect(s) are significantly beneficial to affected resource, and are a long-lasting condition
SAT (Significant Adverse Temporary) - Effect(s) are significantly adverse to affected resource, but are a temporary condition
SBT (Significant Beneficial Temporary) - Effect(s) are significantly beneficial to affected resource, but are a temporary condition
AP (Adverse Permanent) - Action has long-term adverse effect(s) on affected resource
BP (Beneficial Permanent) - Action has long-term beneficial effect(s) on affected resource
AT (Adverse Temporary) - Action has short-term adverse effect(s) on affected resource
BT (Beneficial Temporary) - Action has short-term beneficial effect(s) on affected resource
MAP (Minor Adverse Permanent) - Action has long-term, but minor adverse effect(s) on affected resource
MBP (Minor Beneficial Permanent) - Action has long-term, but minor beneficial effect(s) on affected resource
MAT (Minor Adverse Temporary) - Action has short-term, but minor adverse effect(s) on affected resource
MBT (Minor Beneficial Temporary) - Action has short-term, but minor beneficial effect(s) on affected resource
NE (No Effect) - Action has no effect(s) on resource
U (Unknown) - degree and duration of effect(s) on affected resource is unknown
* Action has potential adverse effect(s) on resource

TABLE 3-3
BETHANY BEACH/SOUTH BETHANY OCEAN FRONT
CYCLE 2 - SCREENING RESULTS

Alternative	Preliminary Design Considerations	Environmental Considerations	Social Considerations	Preliminary Annualized Costs	Total Without-project Annualized Damages	Further Consideration in Cycle 3?	Remarks
Berm Restoration	Berm: 100' wide, +7 ft-NAVD elevation for the entire study area	Can smother and kill organisms in borrow area and beachfill placement area. Temporary disruption of food	Provide usable beach area.	$1,720,000	$4,824,000	Yes	Adverse environmental impacts can be minimized through coordination with environmental agencies.
Berm and Dune Restoration	Berm: 100' wide, +7 ft-NAVD, topped by Dune: 25' top width, +14 ft-NAVD	Can smother and kill organisms in borrow area and beachfill placement area. Temporary disruption of food source for finfish.	Provide usable beach area. Dunes may cause some inconveniences to residents.	$1,790,000	$4,824,000	Yes	Adverse environmental impacts can be minimized through coordination with environmental agencies.
Berm and Dune Restoration with Groin Field (South Bethany only)	South Bethany: same as berm and dune restoration with the addition of timber groins with armor stone protecting the seaward third. Groins would be 300' in length and spaced 750' apart.	Same as berm and dune restoration although some construction is performed in submerged lands.	Same as berm and dune restoration but there may be aesthetic problems with hardened structures.	$2,046,000	$4,824,000	Yes	Costs must be offset by reduced periodic nourishment requirements and reduction in the long term erosion rate.
Berm Restoration with Bulkhead	Timber sheeting anchored with timber piles 30' long with 12" diameter. approx. 11,150 l.f. along study area.	Same as berm and dune restoration.	Same as berm and dune restoration.	$2,372,000	$4,824,000	No	Bulkheads perform the same function as dune but are more costly. Road ends are existing low points in elevation.

economic analysis, environmental, and social impacts and annualized costs associated with each plan. These plans are presented in greater detail in the Main Report.

Berm Restoration. A typical section for berm restoration along the study area is shown in Figure 20 of the Main Report. The design berm having a height of +8 ft NGVD, a design width of 100' and a foreshore slope of 1V:15H was chosen. The sand would be placed over a length of approximately 13,200 l.f. along Bethany Beach and South Bethany. The sand borrow source is located approximately 2.5 miles offshore in approximately 30-40 feet of water. The beachfill quantities used for cost estimating purposes were obtained using the typical sections and lengths mentioned above. Preliminary annualized cost estimates for construction of the berm restoration alternative is shown in Table 3-3 and Table 25 of the Main Report. When compared to the annualized damages, it can be seen that this alternative is relatively inexpensive. Therefore, this item will be considered in Cycle 3.

Berm and Dune Restoration. Consists of the same berm restoration plan, as stated above, a 100 ft. design berm width, on top of which is a dune with an elevation of +14 ft. NAVD, a top width of 25 ft. and side slopes of 1V:5H. The dune extends for the length of the study area, approximately 13,200 feet. A preliminary design section of this alternative solution is shown in Figure 19 of the Main Report.

Annualized cost estimates for construction of the berm restoration and dune are shown in Table 3-3. When compared to the annualized damages, it can be seen that this alternative is relatively inexpensive. This alternative will be considered further in Cycle 3.

Berm and Dune Restoration with Groin Field. The berm and dune would be designed as described above with the inclusion of a groin field in South Bethany. As mentioned previously, the existing groins in Bethany Beach are functioning well with the possible exception of the Garfield Parkway groin. The Garfield Parkway groin continues to function, it is exposed to the predominant wave action from the northeast and has been damaged in recent storm events but is not in imminent danger of failing.

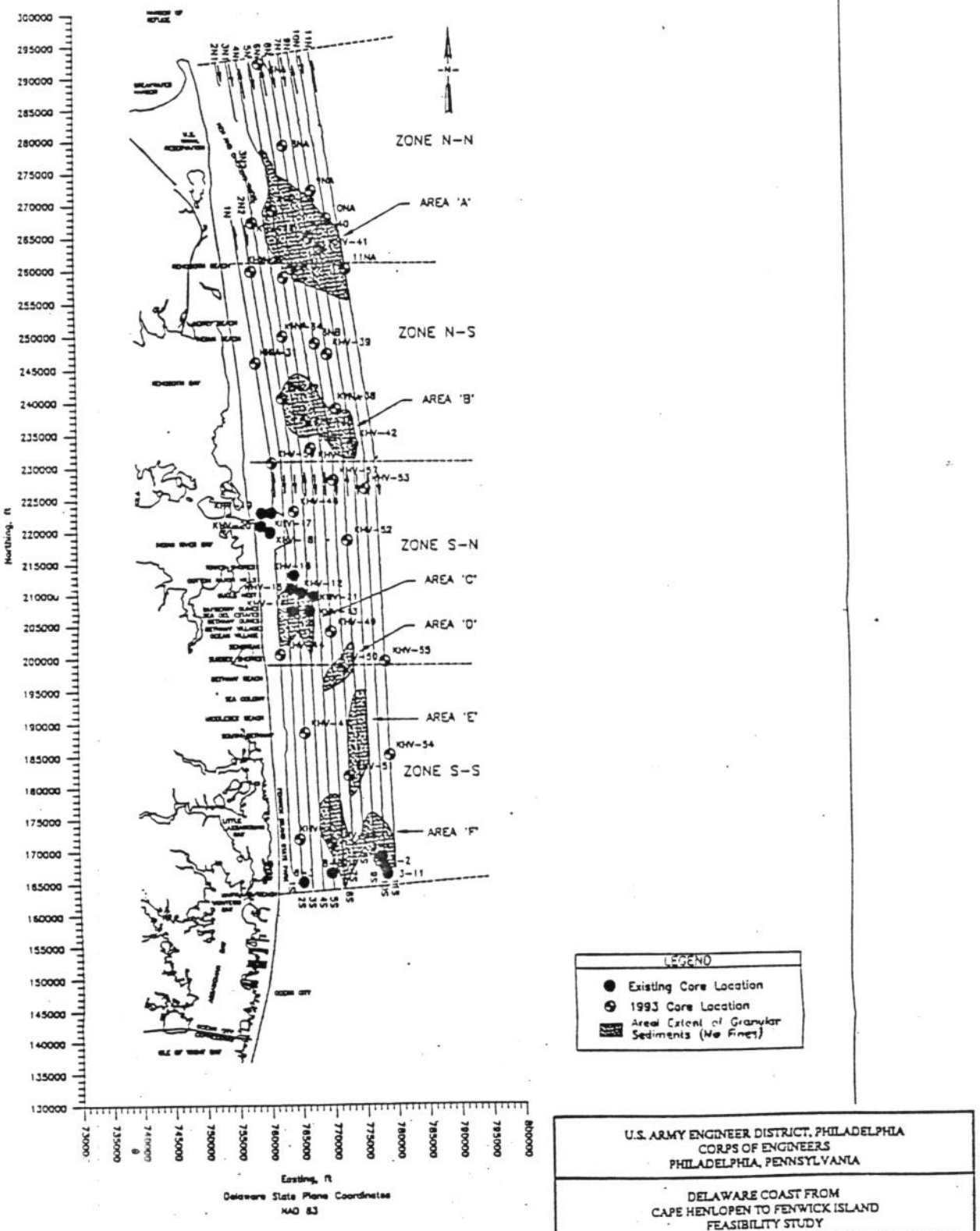
Nine groins would be constructed in South Bethany approximately 500' apart. A plan view of the proposed groin field and a cross section of a typical groin considered for the alternative are shown in Figures 20 and 21 of the Main Report. The groin field would be constructed in conjunction with the berm and dune restoration plan as shown in Figure 19 of the Main Report. The preliminary annualized cost estimates for construction of the berm and dune restoration along the entire study area with a new groin field for South Bethany are shown in Table 3-3t. As can be seen, this alternative is relatively inexpensive compared to the annualized damages. However, since the purpose of the groin field is to retain sand on the berm, and does not contribute to storm damage reduction, it will have to be justified by comparing the cost of construction against the savings realized from reduced periodic nourishment. In order to determine whether the construction of the groin field in South Bethany is justified on these grounds, this alternative solution will be considered further in Cycle 3.

Berm Restoration with Bulkhead. In addition to the berm restoration plan described above, a bulkhead would be constructed of timber pile and sheeting along the entire oceanfront of the study area. Timber piles 30' long and 12" diameter would be used to anchor the bulkhead into the ground. The beachfill design would not include a dune, since the bulkhead would provide similar storm surge protection. To protect the entire length of the study area would require the construction of approximately 5,600 l.f. of bulkhead. The new bulkhead would tie into the existing sections of timber bulkhead along the ocean front. The beachfill placed shoreward of the proposed bulkhead would be identical to the berm restoration alternative described above. A typical section of the proposed bulkhead is shown in Figure 22 of the Main Report. The preliminary annualized cost of this alternative is presented in Table 3-3. Even though this alternative meets the study objectives, the annualized cost is relatively high in proportion to the annualized damages. In addition, the bulkhead performs virtually the same function as a dune (as described above in the Berm and Dune Restoration alternative solution) but has a much higher relative cost. Therefore, this alternative will not be considered further in Cycle 3.

3.3.1 Identification of Sand Borrow Areas

Since all of the plans to be analyzed in Cycle 2 include some aspect of beachfill placement, an investigation was undertaken to identify a suitable sand borrow source. The utilization of an upland sand borrow source was ruled out due to the volume of sand needed for a beachfill project in the study area, distance of such sources, the expense of retrieving sand from these sources and impacts on the roads and the local economy.

The results of the geoacoustic and vibracore investigations and analysis indicate that several practical sand borrow areas exist for the Bethany Beach/South Bethany project (Figure 3-1). Four areas were considered as potential sand sources identified as Area C, Area D, Area E, and an undefined area (Area G) within zone S-N in the vicinity of vibracore KHV-52. In the DEIS, Area C was designated as the initial source of beachfill for the Bethany Beach/South Bethany project, which was estimated to contain approximately 5 million cubic yards of suitable sand fill material. This area consists of relatively fine grained sands with an overfill factor of 1.5. Area C is approximately 940 acres in size, and lies approximately 3.2 miles northwest of the project site and entirely within Delaware state waters. However, since the plans being considered for optimization require more than 5 million cubic yards of material over 50 years, borrow Area C was considered to be insufficient as a source of sand over the entire project life. In addition, significant concerns were raised by resource agencies and the public over the utilization of Area C and it's impacts on fisheries and potential alterations to coastal hydrodynamics on the adjacent beaches. Therefore, Area C was eliminated as a sand source. Area D was eliminated because it partially lies within the ½ mile buffer zone around the South Coastal Sewage Treatment Plant discharge outfall, and that it contains a 2 foot thick layer of clay on the surface. Area E has little bathymetric relief and contains approximately 25 million cubic yards of beach-quality material ranging in nature from poorly graded to well graded sand. The area within zone S-N (Area G) also has little bathymetric relief and was estimated to contain



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FEASIBILITY STUDY
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY

FIGURE 3-1. BETHANY BEACH/SOUTH BETHANY AREAS IDENTIFIED AS SUITABLE SAND BORROW SOURCES FOR BEACHFILL

approximately 90 million cubic yards of beach-quality material, which ranges in grain size from sandy to gravelly material. All four areas are within 3 miles of the Delaware coastline. Pumping distances to borrow areas D, E and N-S (Area G) average 2.5 miles, 3.2 miles, and 5.4 miles respectively. Area E was selected for further investigations because it is within 3.2 miles of pumping distance, whereas Area G is approximately 5.4 miles in pumping distance.

3.3.1.1 Geotechnical Analysis

During the original investigation of borrow sites conducted by the U.S. Army Corps of Engineers - Waterways Experiment Station (WES), only one vibrocore was taken in the vicinity of Area E. The geoacoustical data indicated that a substantial amount of beachfill material was contained within this area. As a result, a more in-depth investigation was conducted in order to better characterize the suitability of the borrow material within Area E. A total of six (6) vibrocores (KHV-63, 64, 65, 66, 67, and 68) were taken in and around this area. The work was performed by Woodward-Clyde Federal Services which contracted Alpine Ocean Seismic Survey, Inc. to perform the vibrocoring operations. Woodward-Clyde presented its findings in a draft report, "Results of Vibrocore Program; Offshore Fenwick Island, Delaware," dated 12 September 1997. The vibrocores indicated that surficial sand deposits are approximately 15-20 feet thick.

Subsequently, the Philadelphia District performed particle size analysis on all of the samples taken during the investigation. The results of the study of the borrow area, combined with sediment analysis of the Bethany Beach and South Bethany beaches, were used to evaluate the suitability of Borrow Area E sands as beachfill. The analysis was performed utilizing the Automated Coastal Engineering System (ACES) computer program, which follows the procedure presented in the U.S. Army Corps of Engineers Shore Protection Manual (1984). Using the results of the aforementioned analyses, it was determined that a majority of Area E has an overfill factor equal to 1.0 when compared to the native material along the beaches of Bethany and South Bethany. This indicates that sands in Area E are closely matched to native beach sands. It has been previously estimated that the area contains approximately 25 million cubic yards of sand. An area consisting of approximately 3,500 acres was identified as containing suitable material (Figure 3-2). A 775 acre portion of this area (middle portion) was further investigated for benthic and cultural resources. The northern and southern portions of Borrow Area E have not been investigated for benthic and cultural resources, however, they are being considered for potential utilization if expansion of the middle portion is necessary during the 50-year project life. Additional resource studies may be required prior to any expansion into these areas.

3.4 ALTERNATIVE PLANS CONSIDERED IN CYCLE 3

The Cycle 1 and Cycle 2 screening process eliminated most of the alternative projects considered in this study. The solutions recommended for optimization to determine the NED plan for the study area in Cycle 3 include:

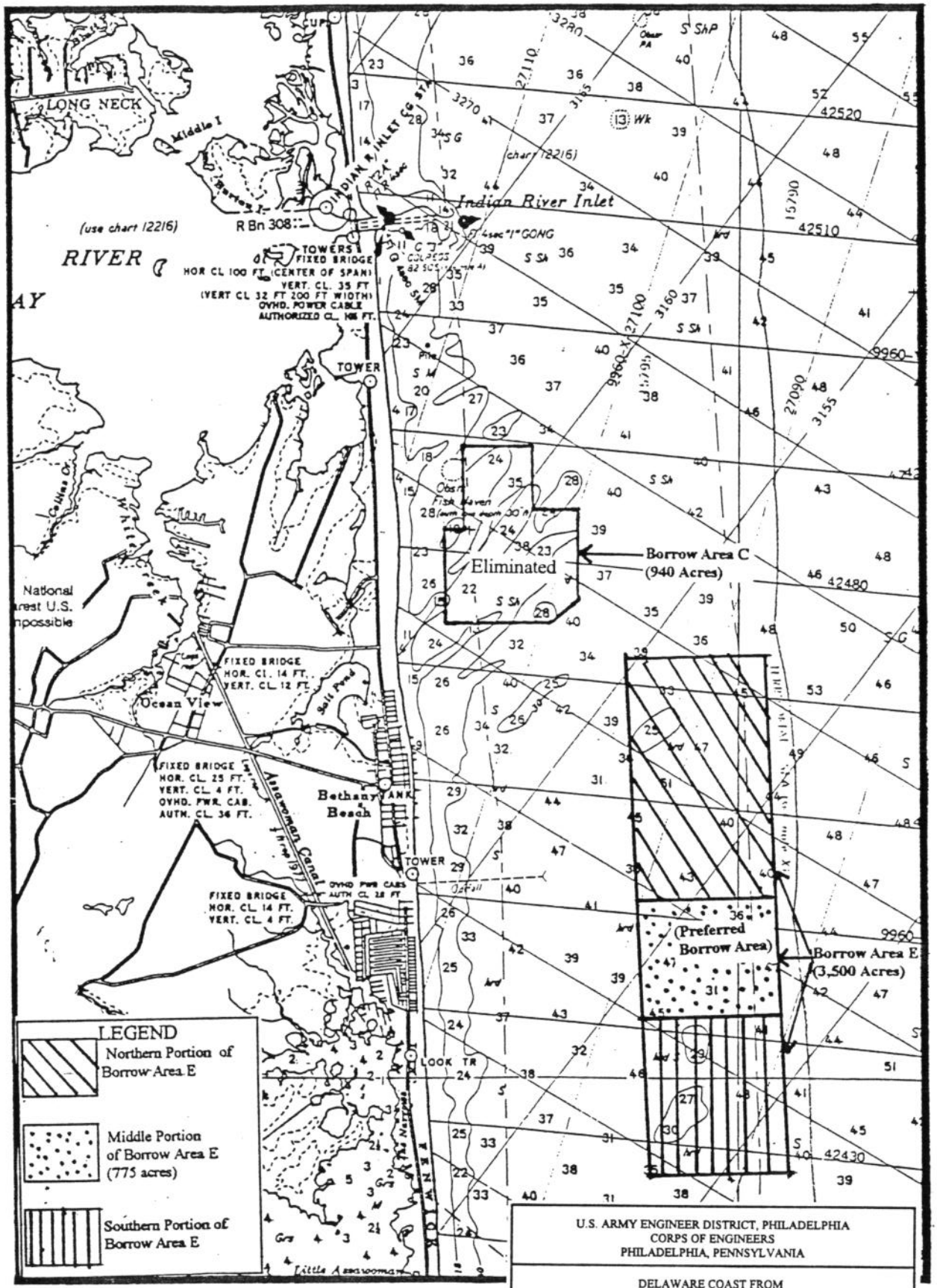

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FIGURE 3-2. LOCATION OF BORROW AREA E AND ITS SUBDIVIDED PORTIONS

- Berm Restoration
- Berm and Dune Restoration
- Berm and Dune Restoration with Groin Field (for South Bethany only)

3.4.1 Cycle 3 - Optimization of the Selected Alternative Solutions

Cycle 3 Analysis involved the optimization of several various configurations involving the heights and widths of the berm and dunes along with their relative costs. This also included optimization of periodic nourishment cycles and quantities. Most of the beachfill plans considered meet the planning objectives in that they provide a degree of storm damage protection which is greater than the cost of implementation. Optimization analyses of these plans have resulted in the identification of the National Economic Development (NED) Plan, which is defined as the plan that maximizes beneficial contributions to the Nation while meeting planning objectives. For purposes of brevity, detailed optimization of Cycle 3 alternatives was not presented in this EIS, however, a more definitive description of the Cycle 3 optimization analyses is provided in the Main Report.

3.5 PREFERRED ALTERNATIVE: BERM AND DUNE RESTORATION

3.5.1 Identification of the NED Plan

The preferred alternative is also the NED plan. The NED plan for Bethany Beach is beachfill with a berm width of 150 ft. and a dune with an elevation of +16 ft NAVD, and for South Bethany, the NED plan is beachfill with a 150 ft. berm width and dune with an elevation of +16 ft NAVD. These plans were chosen because they provided the maximum net excess benefits over costs based on storm damage reduction.

3.5.2 Preferred Sand Borrow Area Option

Based on the findings of estimated sand quantities, sand grain size compatibilities, benthic and fishery resource impacts and cultural resources, Borrow Area E is the preferred site for development as a source of sand for the berm and dune restoration plan described in the Feasibility Report and DEIS. Physical and biological characteristics of Areas C and E are compared in the Affected Environment Section and Environmental Consequences Section of this document. Based on these findings, the use of Area E is expected to have less adverse effects on fisheries and aquatic biota when compared to Area C. Area E also contains sufficient quantities of suitable sand to support the project for initial construction and periodic nourishments over a 50-year project life. Utilization of Area E would involve dredging within the middle portion of Area E (775 acres), however, expansion into the northern and/or southern portions of Area E may be necessary if suitable sand becomes depleted from the middle portion area during the 50-year project. In general, the amount of area required for material is proportional to the depth of dredging (assuming that surficial sands are 15-20 feet thick as indicated in vibrocores).

Table 3-4 provides an estimated amount of area within Area E that would be required and different depth of dredging scenarios considered.

Table 3-4. Estimates of Area Required for Sand Borrow Operations with Respect to Dredging Depths within Borrow Area E.

	ESTIMATED SAND QUANTITY REQUIRED (cubic yards)	ESTIMATED AMOUNT OF BORROW AREA REQUIRED WITH A 5 FOOT DEEPENING	ESTIMATED AMOUNT OF BORROW AREA REQUIRED WITH A 10 FOOT DEEPENING	ESTIMATED AMOUNT OF BORROW AREA REQUIRED WITH A 12 FOOT DEEPENING
Initial Beachfill	3,453,000 cy	428 acres	214 acres	178 acres
Periodic Nourishment Per 3 yr. Cycle	480,000 cy	60 acres	30 acres	25 acres
50-Year Project Total	11,450,000 cy	1,419 acres	709 acres	591 acres

The sand requirements for initial fill, 3-year periodic nourishment cycles, and total beachfill required for the entire 50-year project are based on projected estimates based on long-term historic erosion losses using shoreline recession rates developed for the sediment budget, volumetric analysis of recent beach replenishment operations and beach profiles (1989 and 1995), losses due to the predicted rate of sea level rise, and losses due to storm-induced erosion. However, actual quantities may vary depending on changing conditions such as significant storm events or periods of stability. Based on the estimated quantities of sand required in Table 3-4, the 12-foot deepening scenario requires the least area for borrow for initial beachfill (178 acres) and periodic nourishment (25 acres/cycle). The utilization of the 12 foot-deepening scenario would minimize the need to expand from the middle portion into the northern and/or southern portions of Area E. It should be noted that any future expansion into the northern and/or southern portions of Area E would require baseline investigations for benthic resources, fisheries, and cultural resources.

3.5.3 Description of the Selected Plan

This section describes the selected plan for the study area. Details of the selected plan are shown in Figures 3-3, 3-4, 3-5 and 3-6.

- The proposed hurricane and storm damage reduction plan consists of two distinct areas under one project. One covers the town of Bethany Beach and the other covers the town of South Bethany. Each project was optimized separately since each town is a distinct physical area and is separated from the other by approximately 3,500 feet of private beach.

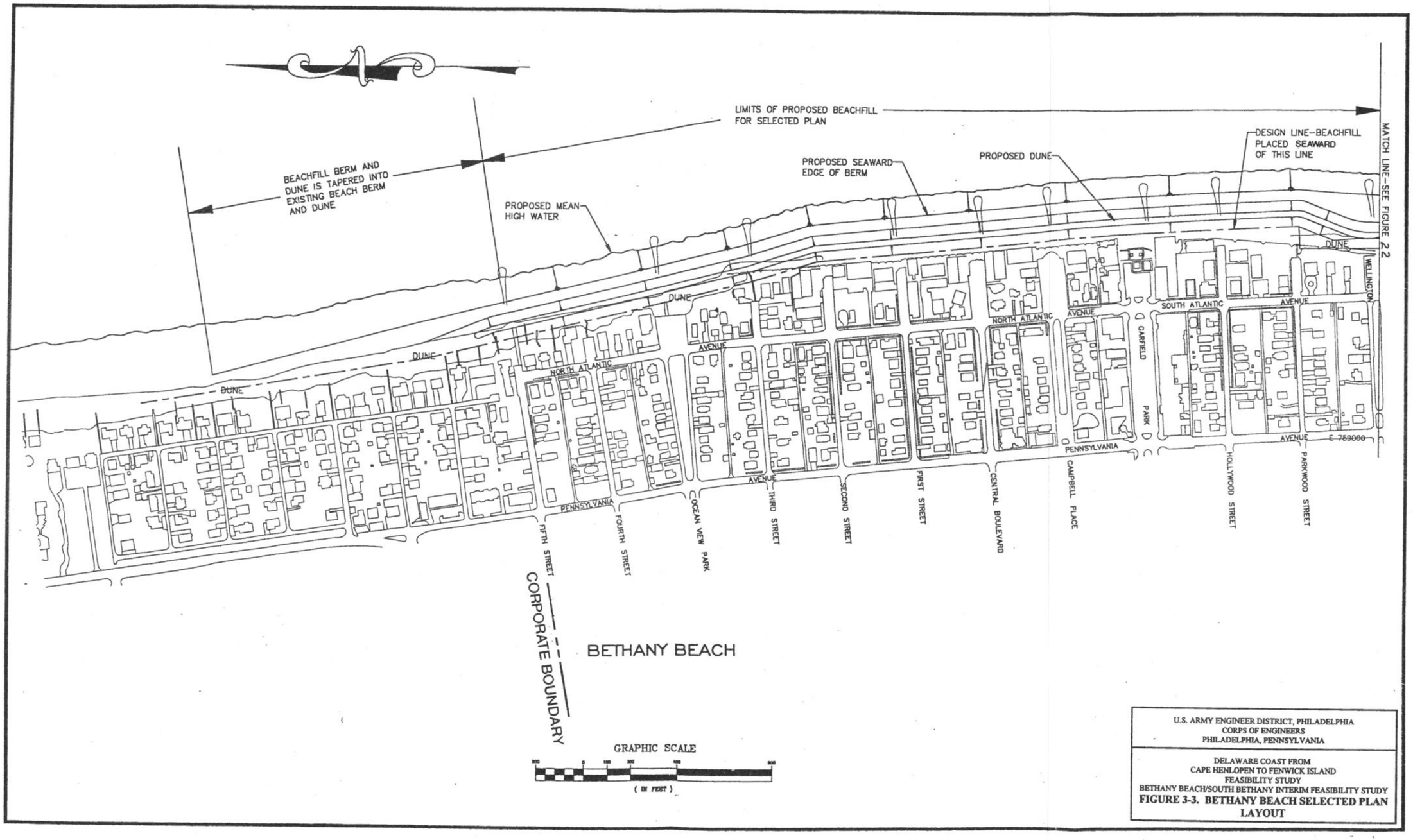

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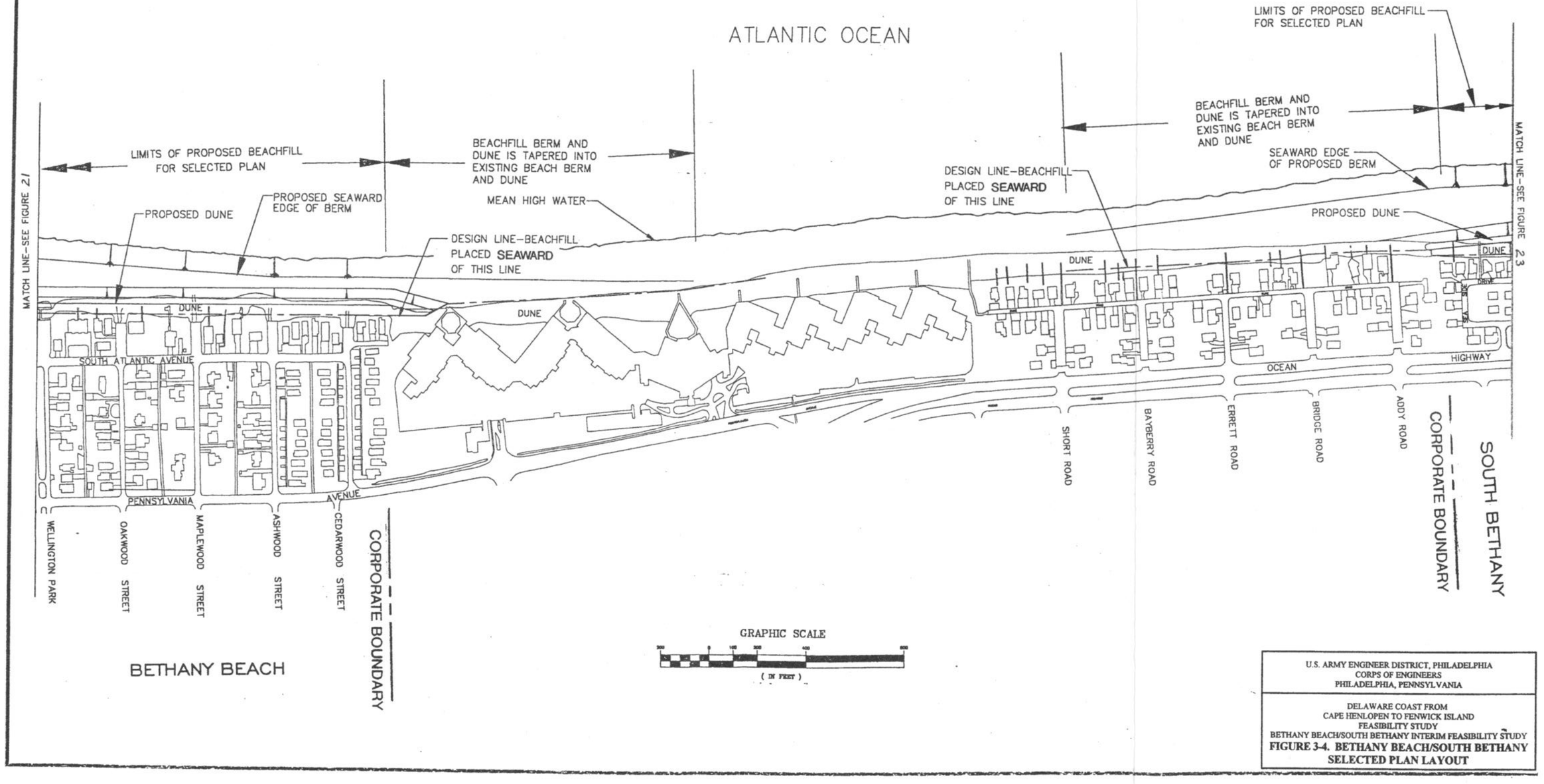
FIGURE 3-3. BETHANY BEACH SELECTED PLAN LAYOUT



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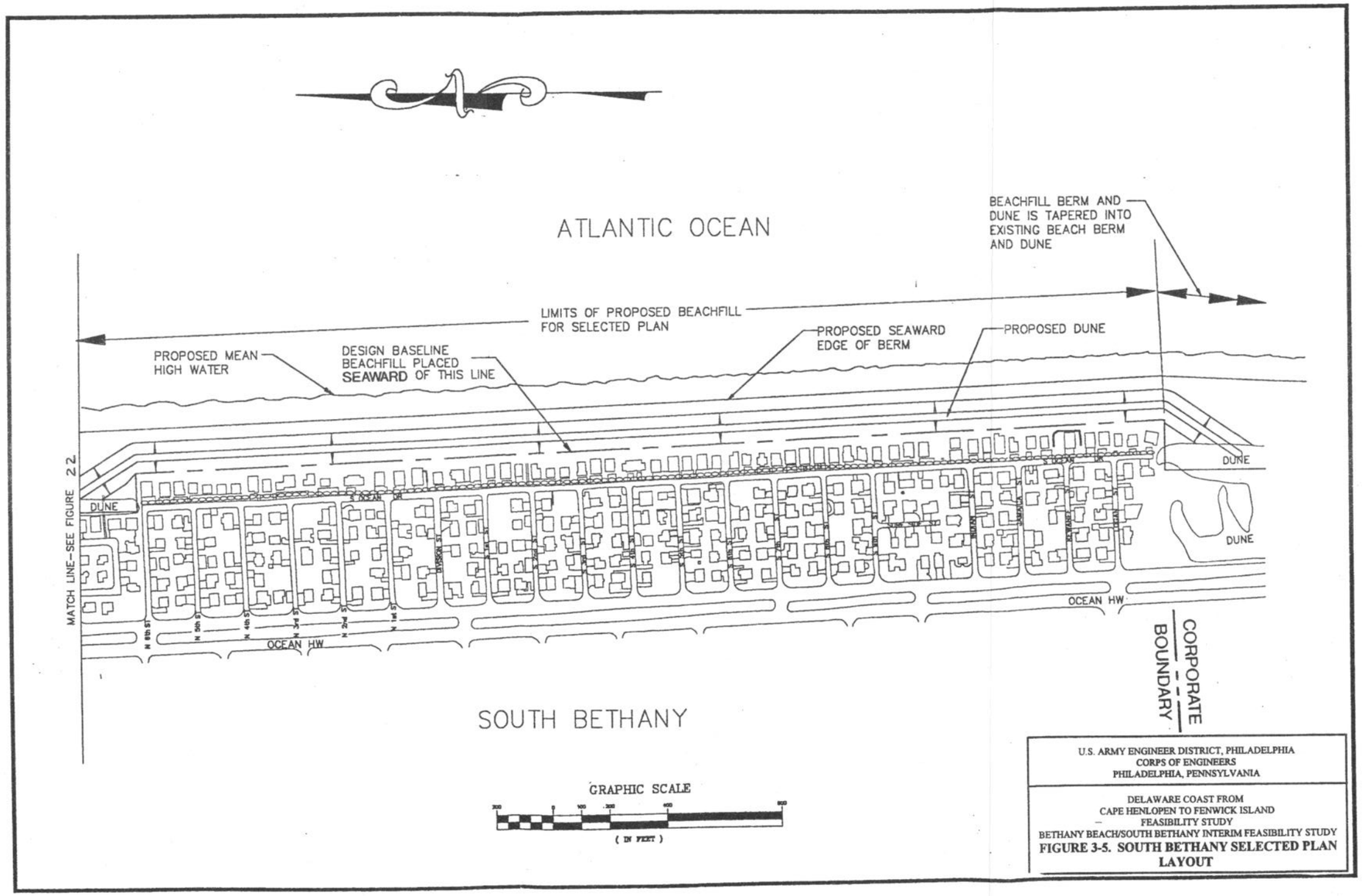
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY

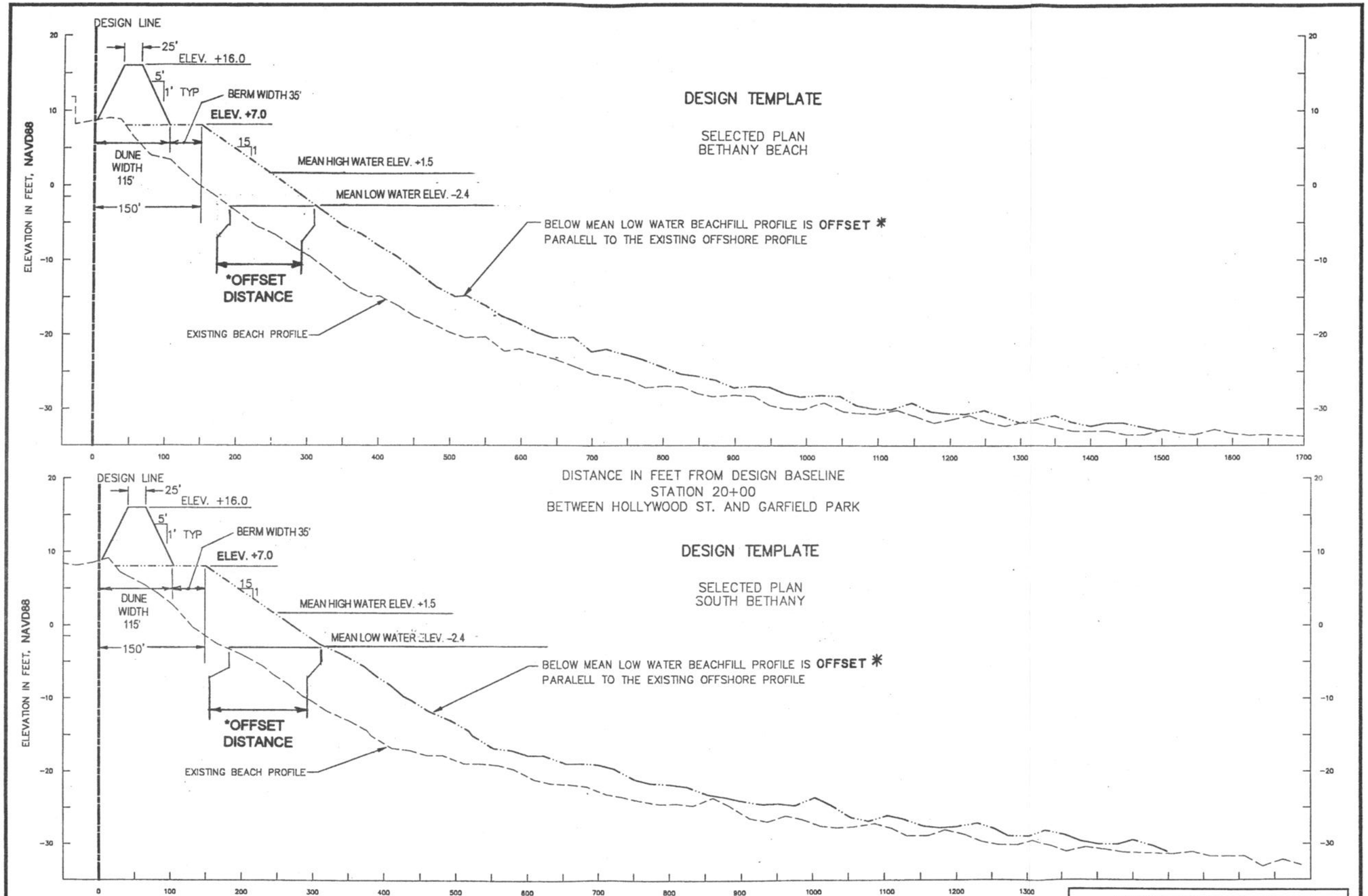
FIGURE 3-4. BETHANY BEACH/SOUTH BETHANY SELECTED PLAN LAYOUT



U.S. ARMY ENGINEER DISTRICT, PHILADELPHIA
CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

DELAWARE COAST FROM
CAPE HENLOPEN TO FENWICK ISLAND
– FEASIBILITY STUDY
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY

FIGURE 3-5. SOUTH BETHANY SELECTED PLAN LAYOUT



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PHILADELPHIA, PENNSYLVANIA

DELAWARE COAST FROM
CAPE HENLOPEN TO FENWICK ISLAND
FEASIBILITY STUDY
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY

FIGURE 3-6. BETHANY BEACH/SOUTH BETHANY SELECTED PLAN DESIGN TEMPLATE

- For Bethany Beach, the selected plan requires a berm extending seaward 150 ft from the design line at an elevation of +7 ft. NAVD. For South Bethany, the selected plan requires a berm extending seaward 150 ft from the design line at an elevation of +7 ft. NAVD. Both berm plans have a foreshore slope of 1V:15H to mean low water (MLW). From MLW seaward, the slope parallels the bottom out to the depth of closure.

- The beachfill project for Bethany Beach extends along the entire length of the town with the taper area extending approximately 1,000 ft. to the north and south of the town borders. Likewise, the beachfill project for South Bethany extends along the entire length of the town with the taper area extending approximately 1,000 ft. to the north and south of the town borders. The total length of both proposed beachfill projects is approximately 14,950 l.f.

- On top of both berm plans in both communities a dune with a top elevation of +16 ft NAVD and a top width of 25 ft would be constructed. The landward and seaward slope of the dune face would be 1V:5H.

- A total sand fill quantity of 3,453,000 cubic yards is needed for the initial fill placement in Bethany Beach and South Bethany.

- Dune restoration requires 24 acres of planted dune grass and 23,157 l.f. of sand fence for entrapment of sand on the dune, delineating walkovers, and vehicle access ramps.

- 41 dune walkovers are provided (one at each street end) and 1 vehicle accessway over the dune in Bethany Beach. The vehicle access for South Bethany is located approximately a quarter mile south of the southern limit of town in the State Beach area.

- The selected plan includes renourishment consisting of approximately 480,000 cubic yards of sandy beachfill from the offshore borrow area(s) every 3 years for the 50 year project life, which would be required to maintain the design template.

- Beachfill for the proposed project is available from the area identified as Area E.

- To properly assess the functioning of the proposed plan, monitoring of the placed beachfill, borrow area, shoreline, wave and littoral environment is included with the plan. Environmental monitoring is being addressed through coordination with other interested agencies, and is included in the final costs for this project. The proposed environmental monitoring plan is presented in Section 5.21 and Appendix A.

3.6 SUMMARY OF ENVIRONMENTAL EFFECTS OF THE PREFERRED ALTERNATIVE (NED PLAN)

The primary adverse impact of the berm and dune restoration with periodic beach nourishment alternative is the temporary disturbance and destruction of existing benthic resources from dredging operations at the borrow area and fill placement areas along the shorefront. Dredging in the borrow area will result in a temporary destruction of the benthic community, however, rapid recolonization is expected to occur within one to two years from the dredging. Minor shifts in benthic community composition may occur following recolonization. Beachfill operations along Bethany Beach and South Bethany will result in temporary degradation of the existing beach habitat during initial construction and the periodic nourishments. Existing benthic organisms on the beach would become buried as a result from the beachfilling operations. Due to the presence of species adapted to high energy and dynamic conditions, recolonization of the beach area is expected to be rapid. The portion of benthic habitat covered by any seaward extension of the beach would represent a long-term loss, however, this would be offset by the creation of similar habitat. The partial burial of the groins in the project area would represent a long-term loss of rocky inter-tidal habitat occupied by aquatic invertebrates that attract birds and fish. Fish and avian utilization of the immediate shoreline area for feeding would be temporarily disrupted, however, they are expected to return immediately after the disturbance. Dredging and the hydraulic placement of beachfill material will result in temporary higher turbidity levels at the borrow site and waters along the shoreline during construction, however, this will be minimal due to the coarse nature of the beachfill material. The use of a hopper dredge has the potential to entrain threatened and endangered migrating sea turtles during dredging operations if conducted between the months of June and November. The District would employ National Marine Fisheries Service (NMFS) approved observers on the dredge as required in Formal Coordination pursuant to Section 7 of the Endangered Species Act to monitor for any turtles. A brief comparison of the preferred alternative with the no action alternative is provided in Table 3-5.

TABLE 3-5
COMPARATIVE IMPACT ANALYSIS OF POTENTIAL EFFECTS OF THE NO ACTION ALTERNATIVE AND THE BERM AND DUNE RESTORATION ALTERNATIVE

Resource:	No Action	Berm and Dune Restoration
Air	No effect	Temporary degradation due to construction equipment activities which produce smoke, noise, and emissions
Topography and Soils	Continued beach erosion; other than profile, nature of substrate will not change	Beach elevation will be increased; substrate will be basically unchanged
Groundwater	No effect	No effect
Hydrodynamics	No effect	Minor alteration of the local circulation pattern in the immediate vicinity of the borrow area
Water Quality	No effect	Temporary degradation due to sediment resuspension from dredging and beach settling/washout
Wetlands	No effect	No effect
Terrestrial Ecology	No effect	Less mobile organisms will be buried during fill placement; other communities will be temporarily displaced
Aquatic Ecology	No effect	Benthic communities will be temporarily destroyed by dredging activities; this would include some surfclam stocks. Benthic habitat will be temporarily disrupted until recolonization occurs. Finfish habitat will be temporarily disturbed by construction activities and a food source lost until benthic invertebrates recolonize the borrow area.
Endangered Species	No Effect	Utilization of a hopper dredge could entrain threatened and endangered sea turtles during dredging activities.
Cultural Resources	No Effect	No Effect
Socio-economic	Risk of storm damages to property will increase. Continued loss of recreational opportunities will result in decreased revenues from tourism and also a subsequent decrease in employment levels.	Erosion protection measures will reduce risk of damage to shore-front property. This will enhance viability of local economy. A short-term effect of construction will be a partial loss of beach use. On a long-term basis, recreational opportunities will be increased, which would permit tourism related businesses to continue at least at current levels.

4.0 AFFECTED ENVIRONMENT

4.1 THE PROJECT SITE

The Bethany Beach and South Bethany portion of the Delaware Atlantic Coast is composed of barrier and headland beaches with extensive development along the Atlantic Coast shorefront. The town of South Bethany is located at the northern portion of the barrier island, Fenwick Island, which is bordered to the south and east by the inland bays: Little Bay, Little Assawoman Bay, and Assawoman Bay. A major portion of Fenwick Island is undeveloped barrier island within Fenwick Island State Park. Bethany Beach for the most part, is a headland beach bordered on the northwest side by a large lake, Salt Pond, which may have been a remnant bay or lagoon prior to beach transgression. A barrier island exists further north of Bethany Beach, and contains several unincorporated beachfront developments. These developments are bordered to the west by Indian River Bay and to the north by Delaware Seashore State Park.

The beachfront along the study area is a high energy beach subject to wind, waves, and currents from the Atlantic Ocean. The general topography of Bethany Beach and South Bethany contains an abrupt beach slope that yields gradually to a shallow bottom (9-12 m) marked with slight depressions and ridges (Maurer *et al.*, 1974). A system of more pronounced submerged ridges and troughs occurs northeast of Bethany Beach.

Borrow Area E lies approximately 9,600 to 16,600 feet offshore of Bethany Beach and South Bethany and extends south to Fenwick Island State Park (Figure 3-2). The total area encompasses approximately 3,500 acres, however, only a 775 acre portion of the site was investigated for benthic and cultural resources for this study. Borrow Area E contains a relatively flat, homogenous, submarine bottom with depths ranging from 33 ft. to 48 ft. Bottom sediments are predominantly medium sands with some areas containing gravel. Fine grained materials may be found in occasional slight depressions and in vibrocore strata (Maurer *et al*,. 1974; Woodward Clyde, 1997; Scott and Bruce, 1998).

4.2 CLIMATE

4.2.1 Temperature and Precipitation

The Delaware Bay and Atlantic Ocean coastal region experiences a moderate climate associated with the low elevations of the Coastal Plain and the presence of the large water bodies. A moderate winter season results from winds which are heated by warmer water temperatures of the ocean and bays and blown inland. Summer temperatures are in turn moderated by locally generated winds or sea breezes. The warmest period of the year is normally during late July when maximum afternoon temperatures average 89°F. Temperatures exceeding 90°F occur an average of 31 days per year. The coldest period of the year is during late January and early February when early morning temperatures average 24°F. A minimum temperature of 32°F or lower occurs on an average of 90 days per year. Lewes, Delaware has an average annual

temperature of 56°F. Lewes experiences an average temperature of 35°F in January and a July average of 75°F. The average winter frost penetration ranges from 12 to 24 inches. Daily temperature variations along the shore range from 10°F to 20°F throughout the year and are generally much less over the water (Maurer *et al.*, 1974).

Precipitation is generally distributed uniformly throughout the year. August is normally the wettest month, and February is the driest month. Droughts may occur during any month or season, but serious droughts are most frequent during the summer. The average annual precipitation for Lewes is 45 inches. Snowfall averages 16 inches annually at Lewes. Snow is not uncommon along the coast but usually melts rapidly because of lack of cover. Relative humidity along the coast averages 82% annually. Lowest mean relative humidity occurs during November and December (78%), and highest mean relative humidity (84%-86%) occurs from April through August. Monthly mean air temperatures and precipitation are provided in Table 4-1.

4.2.2 Wind

Prevailing winds at Breakwater Harbor are from the southwest, however, winds from other directions are nearly as frequent. The average annual wind-speed along the Delaware Coast is 14.5 mph. In the 5-degree quadrangle nearest the Delaware coast, the winds over the offshore areas are distributed with respect to direction as follows: onshore (northeast, east and southeast) 27 percent; (south) 11 percent; offshore (southwest, west and northwest) 44 percent; and (north) 15 percent. Weather data from Atlantic City, New Jersey, which is approximately 50 miles northeast of the study area, but considered valid as a regional source of data, determined that prevailing winds measured at Atlantic City are from the south and of moderate velocities between 14 to 28 mph. Winds from the northeast have the greatest average velocity of approximately 20 mph. The wind data also show that winds in excess of 28 miles per hour occur from the northeast more than twice as frequently as from any other direction. Winds of 50 mph or more may accompany severe thunderstorms, hurricanes, and general winter storms.

4.2.3 Storms

There are two major types of damaging storms which affect the Delaware coast. They are known as "tropical" (hurricanes and tropical storms) and "extra-tropical" (northeasters) storms. Hurricanes usually diminish in intensity by the time they reach the Delaware coast during their usual northward movement. Remarkably, Delaware has escaped major damages from hurricanes this century. No hurricane storm center has made landfall along the Delaware coast since records have been kept (1871); however, several tropical storms and hurricanes have passed near the Delaware coastline in this period. Northeasters occur more frequently than hurricanes and usually are associated with longer durations of storm surge and high waves, which cause

considerable beach erosion along the Delaware coast. Storm surge data for the Delaware Coast is provided in Table 4-2.

The most damaging storm to affect the study area during this century was the northeaster of March 6-8, 1962. Two low-pressure areas joined in the ocean off the Mid-Atlantic coast and remained stationary for several days. The sustained high winds over the long fetch produced large waves and a storm surge which lasted over five consecutive high tides. The storm occurred during a period of unusually high astronomical tides. The combined storm tide elevation of 8.1 feet NGVD was the highest recorded in the period of record at Breakwater Harbor, Delaware. Damages resulting from the 1962 storm exceeded $16 million (US Army Corps of Engineers, 1975).

TABLE 4-1. MONTHLY MEAN AIR TEMPERATURES AND PRECIPITATION DATA FROM LEWES, DELAWARE DURING THE PERIOD FROM 1960-1990.

Month	Mean Temperature (°F)	Mean Precipitation (in.)
January	34.6	3.47
February	36.1	3.33
March	43.3	4.21
April	53.1	3.41
May	62.1	3.54
June	70.7	3.7
July	75.2	4.16
August	74.3	5.36
September	68.4	3.26
October	57.5	3.33
November	48.0	3.49
December	38.5	3.82
Annual	55.5	44.67

Source: Climatological Data Annual Summary Maryland and Delaware 1992; 96:13. NOAA/National Weather Service and received at the National Climatic Data Center, Asheville, North Carolina

TABLE 4-2. BREAKWATER HARBOR, LEWES, DELAWARE. TWENTY HIGHEST RECORDED ANNUAL PEAK STAGES 1919 TO 1992

Rank	Max Stage Ft NGVD(1)	Storm Type(2)	Date
1	8.1	NE	3/6/1962
2	7.3	NE	1/4/1992
3	6.7	NE	3/3/1994
4	6.6	HUR	9/27/1985
5	6.6	NE	10/25/1980
6	6.6	HUR	10/22/1961
7	6.5	NE	3/29/1984
8	6.3	HUR	10/14/1977
9	6.2	NE	10/31/1991
10	6.2	NE	10/23/1953
11	6.1	NE	12/22/1972
12	6.0	NE	1/13/1964
13	6.0	NE	12/9/1973
14	6.0	NE	1/11/1947
15	5.9	NE	1/10/1956
16	5.9	NE	1/2/1987
17	5.9	NE	11/10/1969
18	5.8	HUR	12/12/1960
19	5.8	NE	1/29/1922
20	5.7	NE	5/24/1967

1 Values rounded to nearest 0.1 ft.
2 HUR = hurricane, NE = northeaster

4.2.4 Air Quality

Through the State Implementation Program (SIP), air quality is managed by the Delaware Department of Natural Resources and Environmental Control. The goal of the State Implementation Plan is to meet and enforce the primary and secondary national ambient air quality standards for pollutants. Management concerns are focussed on any facility or combination of facilities which emit high concentrations of air pollutants into the atmosphere. Manufacturing facilities, military bases and installations, oil and gas rigs, oil and gas storage or transportation facilities, power plants, deepwater ports, LNG facilities, geothermal facilities, highways, railroads, airports, ports, sewage treatment plants, and desalinization plants are facilities and activities that may cause air quality problems (NOAA & DECMP, 1980).

The State of Delaware Air Quality Management Section operates one air quality monitoring station in Sussex County at Seaford. Unlike the heavily populated and industrialized New Castle County, Sussex County is primarily rural without any significant sources contributing to air pollution. Overall, air quality in Sussex County is considered to be good, however, exceedences of air quality criteria for ozone designate Sussex County as "marginally" non-attainable in meeting air quality criteria for ozone. With the exception of ozone, all other air quality criteria are met in Sussex County (Personal communication with John Thomas-DNREC Air Quality Management Section).

4.3 GEOLOGY, SOILS, AND TOPOGRAPHY

4.3.1 Geology

Delaware encompasses segments of two regional physiographic-geologic provinces. The extreme northern portion of the State lies within the Appalachian Piedmont province, an area characterized by an exposed bedrock complex consisting of metamorphic and igneous rocks. The eroded surface of this complex slopes south and east to the sea, forming the depositional basement for the wedge-shaped mass of essentially unconsolidated sediments commonly referred to as the Atlantic Coastal Plain Province. This wedge, believed to reach a thickness of approximately 7,800 feet at Fenwick Island, extends eastward beyond the edge of the continental shelf, which is considered a part of the Coastal Plain. As a result, this province can be divided into two sections: a submerged portion, commonly referred to as the continental shelf, and a subaerial or emerged portion, with the present Atlantic Coast shoreline forming the boundary between the two. The area under investigation lies totally within the Coastal Plain approximately 85 miles southeast of the Fall Line (the exposed edge of the Piedmont), and encompasses segments from both the submerged and emerged portions of the province. The boundary between the two portions is characterized by an ever-changing complex of depositional environments associated with the Atlantic barrier system. These environments, which include coastal marshes, tidal lagoons and beach-dune complexes, represent the leading edge of an on-going transgression, which over the past 15,000 years has caused the shoreline complex to advance across approximately two-thirds of the Coastal Plain province to its present position.

This transgression is occurring in response to a relative rising of the sea level. The current rate of rise is estimated to be approximately one foot per century along the Delaware Atlantic Coast.

The shoreline of the Atlantic Coast of Delaware consists of a continuous, wide, sandy baymouth barrier except for a break at Indian River Inlet. Coastal barrier beaches may be considered a continually moving geomorphic form with materials eroding from the beach face and accreting landward and upwards across the coastal lagoonal areas.

4.3.2 Soils and Topography

The Coastal area can be divided into two zones of similar geology; the Cape Henlopen spit complex; and the baymouth barrier, lagoon, and highland complex between Rehoboth Beach and Fenwick Island. The Cape Henlopen complex is comprised of a washover barrier tract north of Rehoboth Beach extending to Cape Henlopen, a beach face/berm and dune system, and a large tidal flat. The stratigraphy of sediments in the spit dune area indicate beach and spit sands and gravels interbedded with shallow marine-estuarine silts (Kraft, 1971).

The second area, the baymouth barrier, lagoon and highland complex is characterized by rapid erosion, predominantly coastal washover erosion. The barrier erodes at the beach face and nearshore area and accretes in a landward direction. The beach face is rather steep and the berm is comprised of horizontally laminated coarse to medium sand. A generalized vertical sequence of sediments found at Dewey Beach and south indicate dune washover sands overlying back barrier marsh sediments (clayey sand and peat), which contain tree stumps from an ancient pine forest. Below this are tidal delta sands and gravels followed by lagoonal sand and silt, and in some cases a small underlying pocket of beach sand. Marsh muds and peats are then encountered followed by a marsh fringe of muddy sand and grass roots and/or tree stumps. Pleistocene coastal sediments then form the base. When large storms occur, the beach berm sand may be washed over the barrier into coastal lagoons, sometimes exposing the marsh peats and tree stumps normally buried five to seven feet below the beach berm system. This extensive forest has been exposed along the length of the Delaware Coast, except at the Pleistocene highlands at Bethany and Rehoboth Beach. As a result of the beach erosion, rounded masses of peat and marsh mud called "marshrollers" are often found moving along the surf adjacent to the eroding shoreline.

The subtidal topography off Cape Henlopen differs from areas further south along the coast (ie. Bethany Beach). Maurer *et al.* (1974) describes the subtidal bottom off Cape Henlopen as a beach sloping to a flat shallow bottom (9 m), rising on Hen and Chickens Shoal, then dropping rapidly into a series of deep holes (24 m) and elongated depressions. The general topography of Bethany Beach and South Bethany contains an abrupt beach slope that yields gradually to a shallow bottom (9-12 m) marked with slight depressions and ridges (Maurer *et al.*, 1974). A system of more pronounced submerged ridges and troughs occurs northeast of Bethany Beach. Borrow Area E contains a relatively flat, homogenous, submarine bottom with depths ranging from 10 m (33 ft) to 14.5 m (48 ft).

4.4 COASTAL HYDRAULICS

4.4.1 Tides

The Delaware coast experiences semidiurnal tides where two nearly equal high tides and two nearly equal low tides occur daily. The average tidal period is 12 hours and 25 minutes, which produces two full tidal periods requiring 24 hours and 50 minutes. These periods result in the tide height extremes (highs and lows) to appear almost one hour (50 minutes) later each day. Fenwick Island experiences a mean tide range of 3.7 feet with a spring tide range of 4.5 feet.

4.4.2 Waves

Meteorological data collected over the open ocean for a period of 20 years (1956-1976) are used to calculate sea and swell conditions at 3 hour intervals. This procedure is known as hindcasting, which is the best available procedure to describe local wave regimes. Two stations (WIS 65 and 66) along the Delaware coastline at water depths of 18 meters (59.1 ft.) were used to represent the southern and northern Delaware coastlines. Wave statistics developed include: "significant wave height", which is the average height of the highest one-third of the waves during a given time interval; "wave period", which is the period corresponding to the peak in the wave energy-period spectrum; and "wave direction", which is the mean direction from which the waves are moving relative to true north. The highest significant wave heights reported from the 3 hour hindcasts for Station 65, and 66 are 7.7 meters (25 feet), and 5.0 meters (16.5 feet), respectively. These values were both recorded during the March 1962 Northeaster. Waves approach the coast from NNE, NE, E, SE, and S for each station, with the most frequent occurrence from the east and southeast directions. The actual wave spectrum at any particular time may show considerable local variation as the computed waves offshore at a depth of 18 meters propagate landward and are modified by localized irregular bathymetry, shoreline stabilization structures and the tidal currents from the Delaware Bay and Indian River Inlet.

In order to obtain localized wave data within the project area, a directional wave gage was deployed offshore of Dagsworthy Street in the town of Dewey Beach. The gage was deployed in October 1992 and was operated without interruption through December 1993. During the 15 months the gage was deployed, the observed data shows the same trend as the 20 year WIS hindcast. The predominant wave direction is from the east and southeast, with the highest waves being recorded from the east-northeast during storms. The highest wave height recorded was during the December 1992 Northeaster at 4.1 meters (13.5 feet).

4.4.3 Currents

There are two general classes of currents which can cause tangible effects on the stability of the study area shoreline. The first class is referred to as tidal currents, which are generated by hydraulic head differences between water levels in the ocean and the back bay areas. The

periodic rise and fall of the ocean water level adjacent to barrier islands is the principal driving force for the ebb and flood of tidal currents. Tidal inlets such as Indian River Inlet provide the connection between ocean and back bay areas and constitute the zone in which the effects of tidal currents are most pronounced. The tidal currents at inlets can be important mechanisms for transport of sediments in the coastal zone, particularly as they interact with longshore wave induced currents and wind to shape many of the typical morphological features associated with barrier island-tidal inlet zones. The second general class of currents considered important to coastal shoreline stability is the longshore current. These currents are set up in the breaker zone adjacent to beaches, and are caused by the longshore component of momentum in the waves breaking at an angle relative to the shore alignment. The turbulence associated with wave breaking causes suspension of sediments which can then be transported in the along-shore direction by the longshore current. The Bethany Beach/South Bethany portion of the Delaware Atlantic Coast does not exhibit a strong predominance in sand transport in any direction. Whereas the predominant direction of the longshore transport of sand at Rehoboth Beach and Dewey Beach is northward. The lack of a predominant direction of sand transport at Bethany Beach/South Bethany suggest that this area is within a nodal zone. The exact location of this nodal zone is not known, however, it generally extends from Indian River Inlet to southern Fenwick Island in Delaware.

4.5 WATER QUALITY OF DELAWARE ATLANTIC COASTAL WATERS

4.5.1 Temperature and Salinity

Mixing occurs in nearshore waters due to the turbulence created from wave energy interacting with the bottom at shallower depths. Mixing becomes less prominent in greater depths where stratification can develop during warm periods. Water temperatures generally fluctuate seasonally. The average temperature range is from 3.7°C (January) to 21.4°C (October). The most pronounced temperature differences are found in the winter and summer months. Warming of coastal waters first becomes apparent near the coast in early spring, and by the end of April, thermal stratification may develop. Under conditions of high solar radiation and light winds, the water column becomes more strongly stratified during the months of July to September. The mixed layer may extend to a depth of only 12 to 13 feet. As warming continues, however, the thermocline may be depressed so that the upper layer of warm, mixed water extends to a depth of approximately 40 feet. Salinity concentration is chiefly affected by freshwater dilution. Salinity cycles result from the cyclic flow of streams and intrusions of continental slope water from far offshore onto the shelf. Continental shelf waters are the least affected by freshwater dilution, and have salinity concentrations varying between 30 parts per thousand (ppt) and 35 ppt. Coastal waters are more impacted by freshwater dilution and may have salinities as low as 27 ppt. Salinity is generally at its maximum at the end of winter. The voluminous discharge of fresh water from the land in spring reduces salinity to its minimum by early summer. Surface salinity increases in autumn when intrusions from offshore more than counterbalance the inflow of river water and when horizontal mixing becomes more active as horizontal stability is

reduced. At Hen and Chickens Shoal and off South Bethany, Maurer *et al.* (1974) states that salinity fluctuates little throughout the tidal cycle, depth, and between sampling stations, and was found to range from 28.5 ppt (July) to 30.7 ppt (November). Mean dissolved oxygen values off South Bethany were 3.44 ppm (October) to 9.30 ppm (July) (Maurer *et al.*, 1974). Recent water sampling was conducted along with benthic sampling in July, 1995 within Area C just above the substrate in depths ranging from 6.1 m to >12.2 m. The mean salinities ranged from 30.9 to 31.6 ppt in July. The mean bottom dissolved oxygen varied from 3.7 ppm (in deep areas) to 4.2 ppm (along sand ridges). Bottom temperatures ranged from 21.4 C to 27.7°C (Kelley *et al.* 1996). Measurements of salinity, temperature and dissolved oxygen were taken by Scott and Bruce (1998) for Area E on December 12, 1997. The measurements taken at that time in December suggest a well-mixed homogenous water column. Water samples were collected in the surface (1.5 ft.) and near the bottom (30 ft.). Both surface and bottom temperatures were identical at 7.8°C. pH ranged from 8.02 at the surface to 7.98 at the bottom. Dissolved oxygen (DO) exhibited little variation with 11.2 mg/l at the surface and 11.5 mg/l at the bottom. Salinity was the same for the surface and bottom at 30 ppt. Except for DO, these values fall within the range of values obtained off of South Bethany by Maurer *et al.* (1974) where temperature ranged from 4.6°C (January) to 20.5°C (July), DO ranged from 3.44 mg/l (October) to 9.30 mg/l (July), and salinity fluctuated very little from 30.7 ppt. (November) to 28.5 ppt. (July). Maurer *et al.* (1974) noted that in the summer samples, surface water temperatures were 1-4°C higher than bottom samples, which suggests that thermal stratification can occur in the summer months.

4.5.2 Water Quality Parameters

Water quality is generally good in the nearshore because of the constant circulation provided by waves and currents. There are no stormwater sewer outfall pipes on the Atlantic Coast beach side in the Bethany/South Bethany area. Stormwater in this area discharges west into the Inland Bays system. However, the Sussex County South Coastal Sewage Treatment Plant operates an ocean outfall that discharges treated wastewater approximately 1.25 miles offshore from the Sea Colony Condominiums. DNREC reports that water quality in the vicinity of the outfall is consistently good. However, as a precautionary measure, DNREC has established a 0.5 mile-diameter buffer (mixing zone) around the South Coastal outfall. Within this zone, shellfish harvesting is prohibited. It should be noted that the nearest portion of Borrow Area E lies approximately 880 ft. (0.33 miles) outside of the 0.5 mile buffer zone. DNREC monitors water quality for human health impacts by measuring Enterococcus bacteria levels of waters along the beaches of Bethany Beach and South Bethany. DNREC reports that beaches in the Bethany and South Bethany area have never been closed due to water quality exceedences (Jack Pingree -Shellfish and Recreational Water Branch, Personal Communication, 1996).

With exceptions to some small pocket areas, sediments in the borrow area are composed of medium to fine sands with very low amounts of silts and clays. The mean silt-clay content and total organic content values for surficial sediments were 2.37% and 0.35%, respectively. Organic contaminants and metals are typically low in sediments dominated by sands. Therefore,

it is expected that the proposed sand borrow area is not chemically contaminated because the substrate is primarily sand that has been subjected to a high energy-current regime. This coupled with the absence of dumping activities, industrial outfalls, or contaminated water suggest a low probability of sediment contamination.

4.6 TERRESTRIAL ECOLOGY OF AFFECTED AREA

4.6.1 General

The project area contains a high energy beach with land features such as headlands and barrier island. Along the southern portion of the Delaware Coast (below Indian River Inlet), the barrier island is flanked on the west by both Indian River Bay and Little Assawoman Bay and the Atlantic Ocean on the east. This area is fringed with saltmarshes on the west side of the barrier, however, the majority of the Bethany Beach/South Bethany study area is flanked on the west by headland. Along the Atlantic Coast beachfront within the Bethany/South Bethany study area, primary and secondary dunes are basically non-existent throughout the majority of the project area due to high development and erosion. Exceptions to this are a portion of beach between Middlesex Beach and Bethany Beach where a constructed dune exists.

4.6.2 Dunes

Natural dunes are non-existent within the Bethany Beach/South Bethany study area where the shoreline contains heavy development consisting of residential houses and commercial property. A man-made dune exists on the upper beach between Middlesex Beach and Bethany Beach, however, the nearest natural dunes are in the adjacent areas outside of the study area. In typical undisturbed beach profiles of the Delaware Atlantic Coast, the primary dune is the first dune landward from the beach. The flora of the primary dune are adapted to the harsh conditions present such as low fertility, heat, and high energy from the ocean and wind. The dominant plant on these dunes is American beachgrass (*Ammophila breviligulata*), which is tolerant to salt spray, shifting sands and temperature extremes. American beachgrass is a rapid colonizer that can spread by horizontal rhizomes, and also has fibrous roots that can descend to depths of 3 feet to reach moisture. Beachgrass is instrumental in the development of dune stability, which opens up the dune to further colonization with more species like seaside goldenrod (*Solidago sempervirens*), sea-rocket (*Cakile edentula*) and beach clotbur (*Xanthium echinatum*).

The secondary dunes lie landward of the primary dunes, and tend to be more stable resulting from the protection provided by the primary dunes. The increased stability also allows an increase in plant species diversity. Some of the plant species in this zone include: beach heather (*Hudsonia tomentosa*), coastal panic grass (*Panicum amarum*), saltmeadow hay (*Spartina patens*), broom sedge (*Andropogon virginicus*), beach plum (*Prunus maritima*), seabeach evening primrose (*Oenothera humifusa*), sand spur (*Cenchrus tribuloides*), seaside spurge (*Ephorbia polygonifolia*), joint-weed (*Polygonella articulata*), slender-leaved goldenrod (*Solidago tenuifolia*), and prickly pear (*Opuntia humifusa*).

Along undeveloped portions of the Delaware Atlantic Coastline, the primary and secondary dunes grade into a zone of shrubby vegetation. These zones are typically located on the headlands or on the barrier flats of the barrier beaches. This zone is called the scrub-thicket zone where sand movement is more diminished. Many of the flora are dwarf trees and shrubs which include: wax-myrtle (*Myrica cerifera*), bayberry (*M. pensylvanica*), dwarf sumac (*Rhus copallina*), poison ivy (*Toxicodendron radicans*), black cherry (*Prunus serotina*), American holly (*Ilex opaca*), greenbrier (*Smilax spp.*), groundsel bush (*Baccharis halimifolia*), loblolly pine (*Pinus taeda*), pitch pine (*Pinus rigida*), Virginia creeper (*Parthenocissus quinquefolia*), beach plum (*Prunus maritima*), and the non-native Japanese black pine (*Pinus thunbergii*).

A number of non-marine mammals, reptiles, amphibians and birds are associated with the dune habitat along the Delaware coastline. These species include: Fowler's toad (*Bufo woodhousei fowleri*), eastern hognose snake (*Heterodon platyrhinos*), box turtle (*Terrapene carolina*), raccoon (*Procyon lotor*), eastern cottontail (*Sylvilagus floridanus*), red fox (*Vulpes fulva*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pensylvanicus*), white-tailed deer (*Odocoileus virginianus*), savannah sparrow (*Passerculus sandwichensis*), song sparrow (*Melospiza melodia*), mourning dove (*Zenaida macroura*), gray catbird (*Dumetella carolinensis*), northern mockingbird (*Mimus polyglottos*), and brown thrasher (*Toxostoma rufum*).

Salt marshes are wetlands that occupy nearly level areas on the back-barrier flats adjacent to Rehoboth Bay, Indian River Bay, and Assawoman Bay and are semi-diurnally flooded by tides. The principal plant species is smooth cordgrass (*Spartina alterniflora*), although a number of succulent forbs (*Salicornia sp.*) also occur, and salt meadow cordgrass (*Spartina patens*) and common reed (*Phragmites australis*) may form a narrow band near more upland sections occupied by the type.

Several freshwater wetland pockets have formed within interdunal swales at Cape Henlopen State Park, Delaware Seashore State Park, and a short stretch of beach just north of Bethany Beach. These wetlands contain rare and unique plant communities which include cranberry (*Vaccinium macrocarpon*) and sundew (*Drosera sp.*). No interdunal wetlands are present within the project area.

4.6.3 Upper Beach

The upper beach or supralittoral zone typically lies below the primary dune and above the intertidal zone. An upper beach zone is present within the study area, however, it is subject to high disturbance from human activity. The upper beach zone is only covered with water during periods of extremely high tides and large storm waves. The upper beach habitat is characterized by sparse vegetation and few animals. This zone has fewer biological interactions than the dunes, and organic inputs are scarce. The most active organism in this zone is the ghost crab (*Ocypode quadrata*). This crab lives in semi-permanent burrows near the top of the shore, and it is known to be a scavenger, predator, and deposit sorter. The ghost crab is nocturnal in its

foraging activities, and it remains in its burrow during the day. In addition to ghost crabs, species of sand fleas or amphipods (Talitridae), predatory and scavenger beetles and other transient animals may be found in this zone.

Many species of shorebirds inhabit the beach during the spring and fall migrations, although most are even more likely to be found on more protected sand and mud flats, tidal marshes, or along the Delaware Bay shoreline (especially in spring when large numbers of horseshoe crab eggs are available). Shorebirds feed on small individuals of the resident infauna and other small organisms brought in with waves. Common shorebird species include sanderling (*Calidris alba*), dunlin (*C. alpina*), semipalmated sandpiper (*C. pusilla*), western sandpiper (*C. mauri*), and willet (*Catoptrophorus semipalmatus*). Sanderling, dunlin, and western sandpiper also occur on the beach throughout the winter. Colonial nesting shorebird habitat is increasingly under pressure from development and human disturbance along Delaware's Atlantic beaches. Nesting birds such as common tern (*Sterna hirundo*), least tern (*Sterna antillarum*), black skimmer (*Rynchops niger*) and American oystercatcher (*Haematopus palliatus*) are frequent spring and summer inhabitants on unvegetated dunes and upper beaches at Cape Henlopen and Delaware Seashore State Parks. Undeveloped beaches such as these State Parks are critical for nesting pairs of the Federal and State threatened piping plover (*Charadrius melodus*). High beachfront development and human disturbance in the Bethany Beach and South Bethany project area has consequently forced nesting shorebirds to seek the remaining undeveloped beaches.

Several species of gulls are common along Delaware's shores, and are attracted to forage on components of the beach wrack such as carrion and plant parts. These gulls include the laughing gull (*Larus atricilla*), herring gull (*L. argentatus*), and ring-billed gull (*L. delawarensis*).

4.7 AQUATIC ECOLOGY OF AFFECTED AREA

4.7.1 Upper Marine Intertidal Zone

The upper marine intertidal zone is also primarily barren, however, more biological activity is present in comparison to the upper beach. Organic inputs are derived primarily from the ocean in the form of beach wrack, which is composed of drying seaweed, tidal marsh plant debris, decaying marine animals, and miscellaneous debris that washed up and deposited on the beach. The beach wrack provides a cooler, moist microhabitat suitable to crustaceans such as the amphipods: *Orchestia spp.* and *Talorchestia spp.*, which are also known as beach fleas. Beach fleas are important prey to ghost crabs. Various foraging birds and some mammals are attracted to the beach fleas, ghost crabs, carrion and plant parts that are commonly found in beach wrack. The birds include gulls, shorebirds, fish crows, and grackles.

4.7.2 Intertidal Zone

The intertidal zone contains more intensive biological activity than the other zones. Shifting sand and pounding surf dominate a habitat which is inhabited by a specialized fauna. The beach fauna forms an extensive food-filtering system which removes detritus, dissolved materials, plankton, and larger organisms from in-rushing water. The organisms inhabiting the beach intertidal zone have evolved special locomotory, respiratory, and morphological adaptations which enable them to survive in this extreme habitat. Organisms of this zone are agile, mobile, and capable of resisting long periods of environmental stress. Most are excellent and rapid burrowers. Frequent inundation of water provides suitable habitat for benthic infauna, however, there may be a paucity in numbers of species. Intertidal benthic organisms tend to have a high rate of reproduction and a short (1 to 2 years) life span (Hurme and Pullen, 1988). This zone contains an admixture of herbivores and carnivores. A number of interstitial animals (meiofauna) are present feeding among the sand grains for bacteria and unicellular algae, which are important in the beach food chain. In 1978, extensive sampling for invertebrate infauna was performed by the U.S. Fish and Wildlife Service and Corps of Engineers on the beaches within the Delmarva Peninsula, Maryland. There were four dominant species of invertebrate infauna in this zone, which were the mole crab (*Emerita talpoida*), a haustorid amphipod (*Haustorius canadensis*), the coquina clam (*Donax variabilis*), and spionid worm (*Scolelepis squamata*). The epifaunal blue crab (*Callinectes sapidus*) and the lady crab (*Ovalipes ocellatus*) were also found in or near this zone. These species withdraw to the nearshore subtidal zone during the winter months and return to the intertidal zone when conditions are more favorable. These invertebrates are prey to various shorebirds and nearshore fishes such as the Atlantic silverside (*Menidia menidia*), and juveniles of spot (*Leiostomus xanthurus*), kingfish (*Menticirrhus saxatilus*), and bluefish (*Pomatomus saltatrix*). The horseshore crab (*Limulus polyphenus*) is a common inhabitant of Atlantic Coastal areas and utilizes the sandy beaches (particularly of Delaware Bay) to spawn. Due to the high energy environment along the beachfront, it is an unlikely area for spawning, however, horseshoe crabs are common in the nearshore and offshore areas.

Benthic macroalgae grow attached to the bottom substrate in the intertidal zone where they are alternately exposed and submerged as the tides ebb and flow. The substrate along the Delaware Atlantic Coast is mainly composed of shifting sands and shell fragments making it too unstable for large colonies of benthic algae to proliferate. Colonies do attach on hard, stable substrates provided by peat banks, shell bottoms, reefs, and man-made structures such as pilings, jetties, buoys and bridges. Various species of benthic macroalgae representing the phyla Chlorophyta and Phaeophyta are found in Delaware's coastal waters.

Several rock groins in Bethany Beach represent an artificial rocky intertidal zone. In addition to providing a hard substrate for the attachment of benthic macroalgae, the groins also contain suitable habitats for a number of aquatic and avian species. Barnacles, small crustaceans, polychaetes, molluscs and a variety of shorebirds may reside on, above and around these structures.

4.7.3 Nearshore and Offshore Zones

The nearshore coastal zone generally extends seaward from the subtidal zone to well beyond the breaker zone (U.S. Army Corps of Engineers, 1984). This zone is characterized by intense wave energies that displace and transport coastal sediments. The offshore zone generally lies beyond the breakers and is a flat zone of variable width extending to the seaward edge of the Continental Shelf. Hurme and Pullen (1988) describe the nearshore zone as an indefinite area that includes parts of the surf and offshore areas affected by nearshore currents (Figure 4-1). The boundaries of these zones may vary depending on relative depths and wave heights present. The

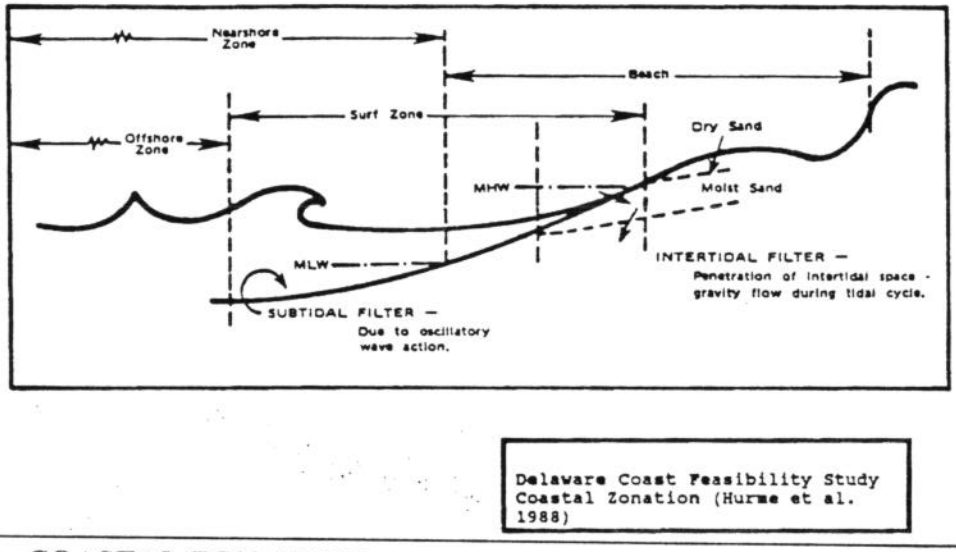


FIGURE 4-1. COASTAL ZONATION

nearshore of Bethany Beach/South Bethany contains an abrupt beach slope that yields gradually to a shallow bottom (9-12m) containing slight depressions and ridges (Maurer *et al.* 1974).

4.7.3.1 Plankton

Plankton are collectively a group of interacting minute organisms adrift in the water column. Plankton are commonly broken into two main categories: phytoplankton (plant kingdom) and zooplankton (animal kingdom).

Phytoplankton are the primary producers in the aquatic marine ecosystem, and are converted into organic compounds which can be assimilated by higher organisms in the food chain. Phytoplankton production is dependent on light penetration, available nutrients,

temperature and wind stress. Phytoplankton production is generally highest in nearshore waters. Seasonal shifts in species dominance of phytoplankton are frequent. Dinoflagellates are generally abundant from summer through fall and diatoms are dominant during the winter and early spring. Approximately 126 species of phytoplankton were identified in Delaware's coastal waters representing the following phyla: Chlorophyta, Chromophyta, Pyrrophyta, Euglenophyta, and Procaryota. The most prevalent species and their season of dominance are as follows:

Nitzschia se iata - winter
Skeletonema costatum - late winter, early spring
Guinarkia flaccida - spring
Pyramimonas sp. - spring, early summer
Cryptomonas acuta - summer
Katodinium rotundatum - mid-summer
Chrysochromulina sp. - summer

Zooplankton provide an essential trophic link between primary producers and higher organisms. Zooplankton represent the animals (vertebrates and invertebrates) that are adrift in the water column, and are generally unable to move against major ocean currents. Many organisms may be zooplankton at early stages in their respective life cycles only to be able to swim against the currents (nektonic) in a later life stage, or to be a part of the benthic community. Zooplankton are generally either microscopic or barely visible to the naked eye. Zooplankton typically exhibit seasonal variances in species abundance and distribution, which may be attributed to temperature, salinity and food availability. In marine environments, seasonal peaks in abundance of zooplankton distinctly correlate with seasonal phytoplankton peaks. These peaks usually occur in the spring and fall. Sampling in the lower Delaware Bay by Watling and Maurer (1976) revealed the presence of 60 species representing the following phyla: Protozoa, Cnidaria, Ctenophora, Ectoprocta, Annelida, Mollusca, Arthropoda, Chaetognatha and Chordata. Calanoid copepods are a dominant component of the zooplankton in Delaware coastal waters (Dupont,1972). Peaks in calanoid copepod dominance are known to occur during October-November, which may be attributed to the high phytoplankton productivity. Zooplankton species characteristic of coastal areas include: *Acartia tonsa, Centropages humatus, C. furatus, Temora longicornis, Tortanus discaudatus, Eucalanus pileatus, Mysidopsis bigelowi* (mysid), and *Crangon septemspinosa* (sand shrimp).

4.7.3.2 Benthic Macroinvertebrates

The nearshore and offshore waters of the Delaware Coast contain a wide assemblage of invertebrate species inhabiting the benthic substrate and open water. Invertebrate Phyla existing along the coast are represented by Cnidaria (corals, anemones, jellyfish), Platyhelminthes (flatworms), Nemertinea (ribbon worms), Nematoda (roundworms), Bryozoa, Mollusca (chitons, clams, mussels, etc.) Echinodermata (sea urchins, sea cucumbers, sand dollars, starfish), and the Urochordata (tunicates).

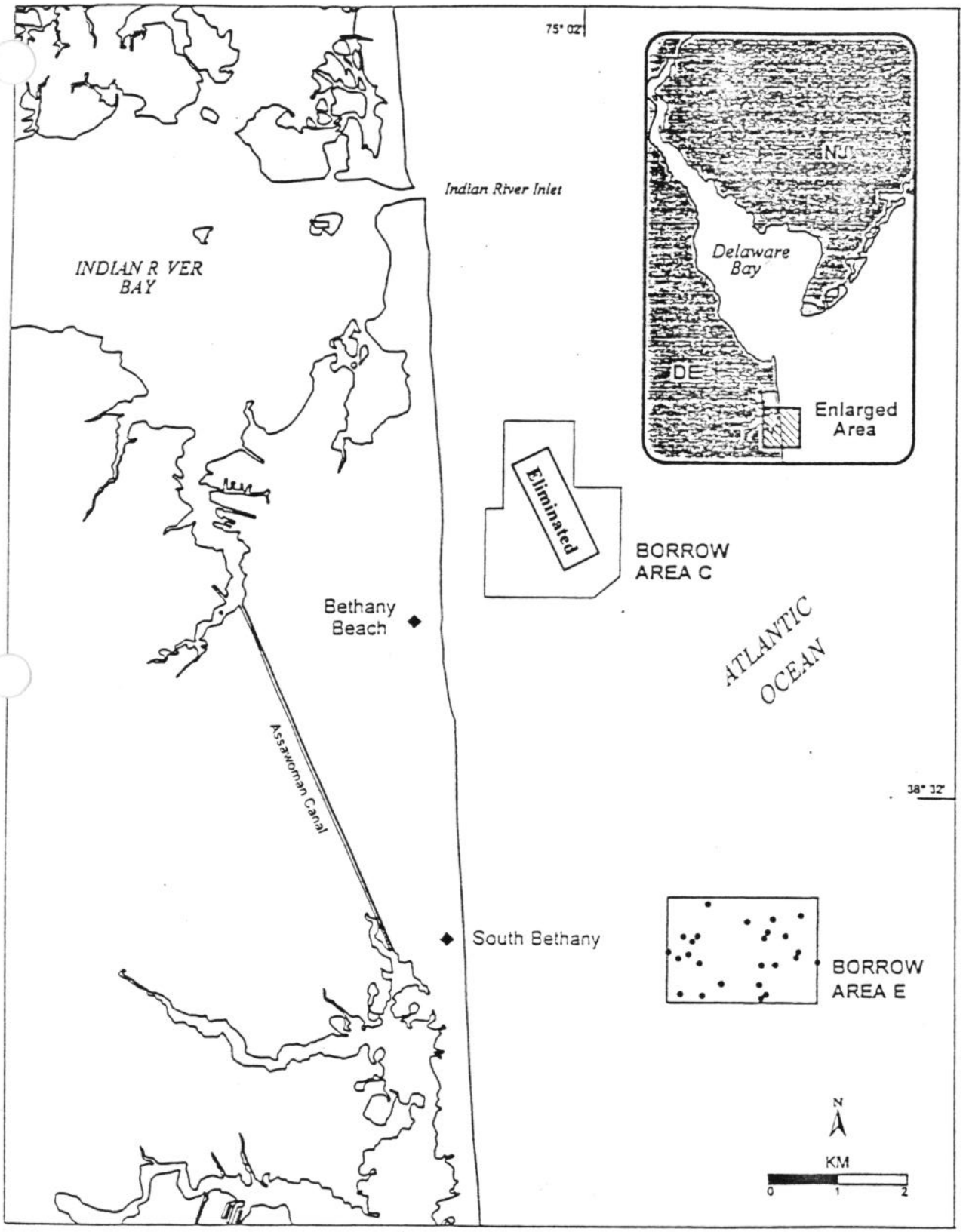
Benthic macroinvertebrates are those organisms dwelling in the substrate (infauna) or on the substrate (epifauna). Benthic invertebrates are an important link in the aquatic food chain, and provide a food source for a variety of demersal fishes. Various factors such as hydrography, sediment type, depth, temperature, irregular patterns of recruitment and biotic interactions (predation and competition) may influence species dominance in benthic communities. Benthic assemblages in Delaware coastal waters exhibit seasonal and spatial variability. Generally, coarse sandy sediments are inhabited by filter feeders and areas of soft silt or mud are more utilized by deposit feeders.

Delaware Atlantic nearshore waters provide a dynamic, heterogeneous environment heavily influenced by the tidal flows and long shore currents. Although several pockets of fine materials are present within depressions and/or troughs, the inshore (within 3 miles) sediments in the vicinity of Bethany Beach are generally composed of medium to fine sands, which influence the composition of the benthic assemblage. The following benthic species were found to be most abundant in the nearshore waters off South Bethany by Maurer *et al.* (1979): *Tellina agilis* (tellinid bivalvia), *Nucula proxima* (nuculid bivalvia), *Protohaustorius wigleyi* (haustorid amphipod), *Spiophanes bombyx* (spionid polychaeta), *Corophium tuberculatum* (Tubicolous amphipod), *Nephtys picta* (nephtyid polychaeta), *Spisula solidissima* (bivalve), *Sabellaria vulgaris* (polychaete), *Polygordius* sp. (polychaete), and *Nemertea* sp. (worm).

In July 1995, a benthic-sediment assessment focussing on infaunal species was conducted by Kelley *et al.* 1996 in the originally proposed offshore sand borrow area (Area C) located northeast of Bethany Beach (Figure 4-2). Since this area was omitted as a sand borrow site, the following discussion will focus primarily on benthic sampling conducted for Area E. Comparisons between Area E and Area C are made where appropriate.

In December 1997, a benthic-sediment assessment (Scott and Bruce, 1998) was conducted on a 775 acre portion (middle portion) of Borrow Area E (Figure 4-2). Since Borrow Area E contains a relatively flat homogenous bottom, the sampling plan was modified from the plan that was previously used for Borrow Area C (Kelley et al. 1996), which compared three different habitat types based on depth and sediment composition. The sampling plan for Borrow Area E investigated one habitat type, but comparisons were made to the habitat types of Borrow Area C. The benthic investigation conducted for Borrow Area E involved infaunal (within the substrate) sampling at 25 randomly selected stations utilizing a Young (formerly described as the Young Modified Van Veen) dredge. Fifteen of those stations were randomly selected for commercial surfclam (*Spisula solidissima*) sampling utilizing a conventional hydraulic clam dredge with a 72-inch knife. Larger benthic species not easily sampled with the Young dredge were recorded in the surfclam dredge samples.

Scott and Bruce (1998) found a total of 89 infauna and 8 epifauna taxa in the samples collected from Borrow Area E. The benthic community of the borrow area was dominated by the polychaete worms: *Polygordius* spp. and *Spiophanes bombyx*, and oligochaete worms, however, these three taxa accounted for only 40% of the combined abundance of all of the taxa. Other



U.S. ARMY ENGINEER DISTRICT, PHILADELPHIA
CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

DELAWARE COAST FROM
CAPE HENLOPEN TO FENWICK ISLAND
FEASIBILITY STUDY
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY

FIGURE 4-2. LOCATION OF PROPOSED SAND BORROW AREA E OFF OF SOUTH BETHANY, DELAWARE AND THE LOCATION OF INDIVIDUAL BENTHIC SAMPLING STATIONS

abundant taxa in the samples include Nemertinea (worm), *Tellina agilis* (bivalve), *Tannaissus psammophilus* (an isopod-like arthropod), *Protohausotrius wigleyi* (amphipod), *Acanthohaustorius* spp. (amphipod), and Echinoidea (sea urchins and sand dollars). Dominant taxa found in Area C differed somewhat from the dominant taxa of Area E. Taxa that were dominant in Area C, but not dominant in Area E were the Polychaetes: *Amastigos caperatus*, *Mediomastus ambiseta*, and *Tharyx* sp.; Bivalves: *Ensis directus, Spisula solidissima*; Arthropods: *Chiridotea tuftsi, Parahaustorius longimerus*, and *Rhepoxynius hudsoni*. Taxa that were dominant in Area E but not in Area C were the Polychaetes: Sigalionidae and *Spiophanes bombyx*; and Echinoidea. The benthic community characteristics for Borrow Area E and Borrow Area C are summarized and compared in Table 4-3. Significant differences (measured statistically by using Analysis of Variance (ANOVA)) of some of the benthic community characteristics between Borrow Area E and C became evident in the comparisons. The Shannon-Wiener and Simpson's Dominance Indices were significantly higher for Area E when compared to the mean of all three habitats combined for Area C. This may suggest that dominant taxa in Area E were more evenly distributed throughout the site than Area C, which would be expected based on the relatively homogeneous habitat type in Area E. Significant differences emerged for the total abundance, bivalve abundance, and biomass, where the values were significantly lower for Area E than for combined habitats of Area C. The majority of these differences can be attributed to the high numbers encountered in the deep habitat of Area C. Another factor to consider is that sampling at Area C and Area E occurred at different times of the year, and that seasonal variations of species composition, dominance, density, and evenness can occur within the same habitat (Maurer et al. 1979).

Eight epifaunal taxa were collected from the Young samples, which include: gastropods (*Epitonium* spp., *Turbonilla interupta, T. stricta*), isopods (*Edotea triloba, Politolana concharum*), hermit crabs (*Pagarus annulipes, P. longicarpus*), and a tunicate (Ascidiacea). Megabenthic taxa (taxa > 2") were identified and recorded in the surfclam dredge tows. The most abundant species included knobbed whelk (*Buscyon carica*) (36.1/acre), horseshoe crab (*Limulus polyphemus*) (18.4/acre), lady crab (*Ovalipes ocellatus*) (12.6/acre), starfish (Asteridae) (11.4/acre), and rock crab (*Cancer irroratus*) (11.0/acre). Other benthic species caught include sand dollar (Echinoidea), channeled whelk (*Buscyon canaliculatum*) , clearnose skate (*Raja eglanteria*), windowpane flounder (*Scopthalmus aquosus*), spider crab (*Libinia emarginata*), and hermit crab (*Pagarus* spp.).

Sediment samples obtained from the benthic grab samples were analyzed for grain sizes, silt-clay content, and total organic carbon content (Table 4-4). Borrow Area E had significantly less silt/clay content than the deep habitat in Area C and significancy higher silt/clay content than the sandbar habitat in Area C, but the differences in silt/clay and total organic content percentages were within a range considered biologically inconsequential to benthic resources (Weisberg et al. 1997, Scott and Bruce, 1998). Sediment analyses determined that the majority of the benthic stations in Area E contained medium to fine sands, however, a few stations contained a higher percentage of coarse to very coarse sand.

TABLE 4-3. MEAN CONDITION OF BENTHIC INFAUNAL MACROINVERTEBRATE COMMUNITIES COMPARED FOR HABITATS OF AREAS E AND C (Kelley *et al.* 1996; Scott and Bruce, 1998).

Parameter	Borrow Area E	Borrow Area C			
		Sandbar	Sandbar-trough	Deep	Area C Habitats Combined
Total Number of Taxa (not a mean value)	89				122
Number of Taxa (#/sample)	19.8 [a,]	14.2	18.2	23.7	18.5
Shannon-Wiener Index	3.48 [b,c,d]	3.13	3.03	2.58	2.91
Simpson's Dominance Index	0.86 [b,c,d]	0.83	0.80	0.71	0.78
Total Abundance (#/m^2)	1,870 [b,c,d]	1,371	3,485	9,864	4,902
Amphipod Abundance (#/m^2)	199	233	390	256	292
Bivalve Abundance (#/m^2)	119 [a,b,c,d]	409	1,305	3,653	1,789
Polychaete Abundance (#/m^2)	985 [a,c]	214	1,392	5,377	2,328
Biomass (g/m^2)	5.47 [c,d]	5.04	5.66	12.74	7.82
Amphipod Biomass (g/m^2)	0.10 [b,c,d]	0.12	0.04	0.03	0.06
Bivalve Biomass (g/m^2)	0.11 [b,c,d]	4.37	4.62	11.39	6.79
Polychaete Biomass (g/m^2)	0.31	0.23	0.43	0.53	0.39
Number of Samples	25	12	12	12	36

[a] Significantly different than the sandbar habitat in Area C
[b] Significantly different than the sandbar-trough habitat in Area C
[c] Significantly different than the deep habitat in Area C
[d] Significantly different than the combined habitats in Area C

TABLE 4-4. MEANS OF SEDIMENT PARAMETERS FOR BORROW AREA E AND THE HABITATS OF AREA C. (Standard error of estimate in parenthesis).

Parameter	Borrow Area E	Borrow Area C		
		Sandbar	Sandbar-trough	Deep
Depth at MLW (m)	12.9 [a] (0.3)	7.4 (0.2)	9.8 (0.2)	12.5 (0.2)
Silt-clay Content (% < 63 µm)	2.37 [a,b] (0.12)	0.93 (0.07)	2.46 (0.41)	4.33 (0.69)
Total Organic Content (%)	0.35 [b] (0.2)	0.33 (0.05)	0.45 (0.04)	0.58 (0.05)

[a] Mean is significantly different than mean of sandbar habitat of Area C
[b] Mean is significantly different than mean of the deep habitat of Area C

4.7.3.3 Fisheries

4.7.3.3.1 Shellfish

The surfclam has been periodically harvested from Delaware's coastal waters for commercial purposes. The surfclam has a wide distribution and abundance within the mid-Atlantic Region (Figure 4-3). They most commonly inhabit substrates composed of medium to coarse sand and gravel in turbulent waters just beyond the breaker zone (Fay *et al.*, 1983; Ropes, 1980). The abundance of adults varies from loose, evenly distributed aggregations to patchy, dense aggregations in the substrate (Fay *et al.*, 1983). Surfclams may reach sexual maturity their first year, with the entire population being sexually mature during their second year (Mid Atlantic Fishery Management Council, letter dated 18 December 1995). Spawning may occur twice annually from mid-July to early August and from mid-October to early November.

A peak in harvesting within Delaware's coastal waters occurred in the early 1970's where annual landings exceeded 8.5 million pounds worth approximately $1.1 million. Shortly afterward, the stock experienced a rapid and severe decline, and by 1975, commercial harvesting had ceased. There has been no significant harvesting since then. The dominant 1976 year-class which supports New Jersey's inshore fishery, did not occur in Delaware waters. Surveys conducted by the State in 1982, 1986, and 1992 confirmed that no significant numbers of commercial sized surfclams exist within Delaware's three-mile territorial limit (Personal communication with J. Tinsman 1993). Despite the lack of commercially harvestable densities of surf clams, juvenile and young adult forms of the surfclams have been identified from recent benthic infaunal sampling (Dames and Moore 1993; Kelley et al. 1996; Scott and Bruce 1998).

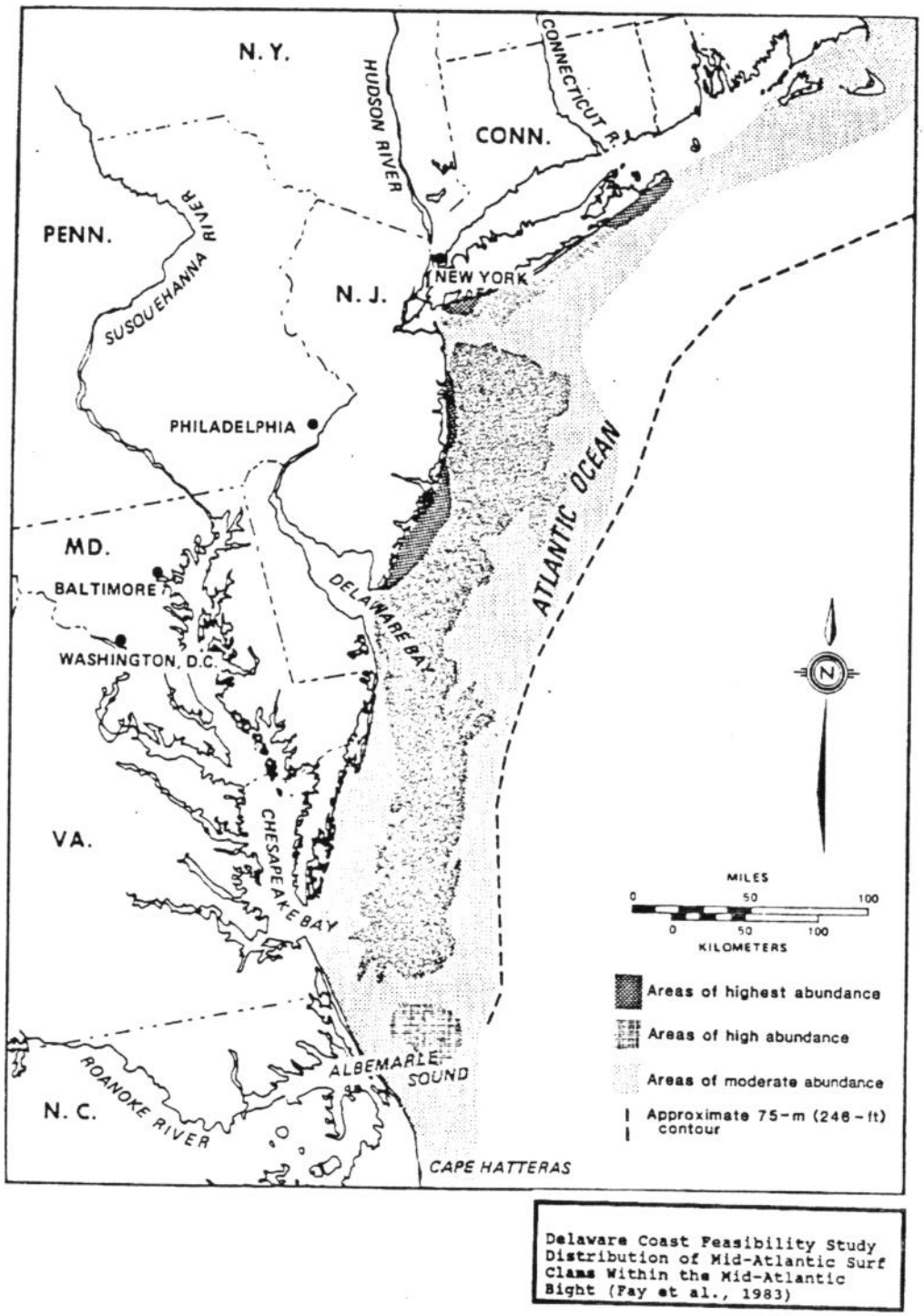


FIGURE 4-3. DISTRIBUTION OF MID-ATLANTIC SURFCLAMS WITHIN THE MID-ATLANTIC BIGHT.

The benthic infaunal samples obtained from the Young dredge in December 1997 for Area E found surfclams in 48% of the samples, however, the abundance of surfclams was low and ranged from 0 to 45/m^2. In contrast, 75% of the samples in Area C contained surfclams. Mean abundance of surfclams per grab in Borrow Area E was 14.5 /m^2, which is significantly lower than the mean abundance of 96.6/m^2 found in the sandbar habitat of Area C (see Table 4-5). The lower abundances of surfclams in the Area E sampling could be attributed to seasonal variations in abundance due to predation (G. Ruddy - USFWS, personal communication). No clams longer than 2 cm were recorded in the benthic samples for Area E, which accounts for the relatively low mean biomass of 0.07 g/m^2 .

In January 1998, a survey for commercial size densities was conducted within Area E utilizing a 65-foot commercial surfclam vessel (the Elizabeth C II) with a conventional hydraulic clam dredge with a 72-inch knife. The floor of the dredge was lined with two inch (51mm) square rebar to retain smaller clams. A total of 15 (5 minute) tows was conducted at random locations within Area E. Although there were surfclam shells collected in the dredge, only one live surfclam measuring 120 mm (4.72 inches) was collected from all of the 15 (5 minute) tows. These samples did not identify any large commercial size surfclams, which have a minimum size limit of approximately 12 cm. The average length of harvested surfclams is between 14 - 15.25 cm. Surfclams often reach sexual maturity their first year, with the entire population being sexually mature during their second year. The surfclams found in the Versar study could likely contribute gametes for recuritment. This finding is consistent with surveys conducted by DNREC in 1982, 1984, and 1992, and the survey of Borrow Area C in 1996 (Burton, 1996) where no commercially exploitable densities of surfclams were found.

Although no commercially exploitable densities of surfclams exist in either Areas C or E, these areas may be designated as Essential Fish Habitat (EFH) for surfclams by the Mid -Atlantic Fishery Management Council (MAFMC) under provisions of the reauthorized Magnuson Act of 1996 (Dr. Tom Hoff - MAFMC, personal communication).

The Delaware coastal area supports a small fishery for blue crabs (*Callinectes sapidus*), which are harvested in the winter by dredging. The fishery is usually limited to a few licenses to avoid over-harvesting this stock, which consists mainly of female crabs that would be spawning the following spring and summer. The major portion of the blue crab population remains in Delaware Bay.

4.7.3.3.2 Finfish

The proximity of several embayments allows the coastal waters of Delaware to have a productive fishery. Many species utilize the estuaries of Delaware Bay, Rehoboth Bay, Indian River Bay, and Little Assawoman Bay for forage and nursery grounds. The finfish found along the Delaware Atlantic coast are principally seasonal migrants. Winter is a time of low abundance and diversity as most species leave the area for warmer waters offshore and southward. During the spring, increasing numbers of fish are attracted to the Delaware Atlantic coast because of its

TABLE 4-5. MEAN ABUNDANCE AND BIOMASS OF THE SURFCLAM IN GRAB SAMPLES FROM BORROW AREA E AND THE THREE HABITATS OF AREA C. (Standard error of estimate in parenthesis).

Parameter	Borrow Area E	Borrow Area C		
		Sandbar	Sandbar-trough	Deep
Mean abundance (#/m^2)	14.5* (3.4)	96.6 (35.6)	51.1 (33.9)	56.8 (24.5)
Mean abundance of clams longer than 2 cm (#/m^2)	0* (0)	3.8 (2.5)	0 (0)	0 (0)
Mean Biomass (g/m^2)	0.07 (0.02)	1.23 (0.87)	0.43 (0.26)	0.42 (0.28)
Frequency of Occurrence (%)	48.0%	75.0%	41.7%	66.7%
Number of Samples	25	12	12	12

* Significantly different than the sandbar habitat of Area C.

proximity to several estuaries which are utilized by these fish for spawning and nurseries (USACE 1996). Peaks in the numbers of fish species generally occur in the fall, however, Maurer *et al.* (1974) noted that fish abundance was greatest off South Bethany during summer and fall.

Surveys of the finfish in Delaware's coastal waters have been conducted by Maurer and Tinsman (1980), and annually for several years by the National Marine Fisheries Service. Abundant finfish species in Delaware coastal waters include: red hake (*Urophycis chuss*), northern sea robin (*Prionotus carolinus*), spot (*Leiostomus xanthurus*), windowpane flounder (*Scopthalmus aquosus*), silver hake (*Merluccuns bilinearis*), clearnose skate (*Raja eglanteria*), hogchoker (*Trinectes maculatus*),and weakfish (*Cynoscion regalus*). Large numbers of bay anchovies (*Anchoa mitchilli*), butterfish (*Peprilus triacanthus*), scup (*Stenotomus chrysops*), weakfish, striped anchovy (*Anchoa hepsetus*), spot, and bluefish (*Pomatomus saltatrix*) are also present in coastal waters. The complete list of fishes collected in these trawl surveys is shown in Table 4-6. These surveys, however, do not include habitats associated with any bottom structures like breakwaters, rock jetties and groins, rough bottom off of Cape Henlopen, submerged wrecks and artificial reefs. The following species are more associated with these structures: tautog (*Tautoga onitis*), gray triggerfish (*Balistes capriscus*), oyster toadfish (*Opsanus tau*), conger eel (*Conger oceanicus*), cunner (*Tantogolabrus adspersus*), and planehead filefish (*Monacanthus hispidus*) (Ekland, 1987).

The numbers of fish along the Delaware Atlantic Coast are generally not sufficient to

TABLE 4-6. FISHES COLLECTED IN DELAWARE ATLANTIC COASTAL WATERS

Common Name	Scientific Name
Red hake	*Urophycis chuss*
Northern sea robin	*Prionotus carolinus*
Spot	*Leiostomus xanthurus*
Windowpane	*Scophthalmus aquosus*
Silver hake	*Merluccuns bilinearis*
Clearnose skate	*Raja eglanteria*
Hogchoker	*Trinectes maculatus*
Weakfish	*Cynoscion regalus*
Butterfish	*Peprilus triacanthus*
Spotted hake	*Urophycis regius*
Little skate	*Raja eglanteria*
Striped sea robin	*Prionotus evolans*
Smooth dogfish	*Mustelus canis*
Summer flounder	*Paralichthys dentatus*
Spiny dogfish	*Squalus acanthias*
Atlantic menhaden	*Brevoortia tyrannus*
Bullnose ray	*Myliobatis fremenvilli*
Striped anchovy	*Anchoa hepsetus*
Ocean pout	*Macrozoarces americanus*
Scup	*Stenotomus chrysops*
Longhorn sculpin	*Myoxocephalus octodecemspinosus*
Atlantic herring	*Clupea harengus*
Atlantic croaker	*Micropogon undulatus*
Bluefish	*Pomatomus saltatrix*
Winter flounder	*Pseudopleuronectes americanus*
Striped bass	*Morone saxatilus*
American shad	*Alosa sapidissima*
Atlantic sturgeon	*Acipenser oxyrhynchus*
Striped burrfish	*Chilomycterus schoepfi*
Angel shark	*Squatina dumerili*
Northern stargazer	*Astroscopus guttatus*
Banded rudderfish	*Seriola zonata*
Bay anchovy	*Anchoa mitchilli*
Butterfish	*Peprilus triacanthus*
Blueback herring	*Alosa aestivalis*
American sand lance	*Ammodytes americanus*
Rough scad	*Trachurus lathami*
Alewife	*Alosa pseudoharengus*
Black sea bass	*Centropristis striata*
Atlantic silverside	*Menidia menidia*
Round herring	*Etrumeus teres*
Gulf stream flounder	*Citharichthys arctifrons*
Northern puffer	*Sphoeroides maculatus*

Table 4-6 continued on next page

TABLE 4-6. FISHES COLLECTED IN DELAWARE ATLANTIC COASTAL WATERS (continued)	
Common Name	**Scientific Name**
Striped cusk-eel	*Ophidion marginatum*
Winter skate	*Raja ocellata*
Blue runner	*Caranx crysos*
Atlantic moonfish	*Selene setapinnis*
Inshore lizzardfish	*Synodus foetens*
Spanish mackerel	*Scomberomorus maculatus*
Smallmouth flounder	*Etropus microstomus*
Sandbar shark	*Carcharhinus plumbeus*
Unicorn filefish	*Aluterus monoceros*
Atlantic menhaden	*Brevoortia tyrannus*
Atlantic sharpnose shark	*Rhizoprindon terraenovae*
Roughtail stingray	*Dasyatis centroura*
Sea raven	*Hemitripterus americanus*
Pigfish	*Orthopristis chrysoptera*
Northern kingfish	*Menticirrhus saxatilus*
Short bigeye	*Pristigenys alta*
Dusky shark	*Carcharhinus obscurus*
Banded rudderfish	*Seriola zonata*
Blotched cusk-eel	*Ophidion grayi*
Thresher shark	*Alopias vulpinus*
Threespine stickleback	*Gasterosteus aculeatus*
Naked goby	*Gobiosoma bosci*

Source: Maurer and Tinsman (1980) and National Marine Fisheries Service Groundfish Surveys from 1985-1989.

support a significant commercial fishing industry, however, the Delaware coast supports a diverse recreational fishery. Approximately 70% of Delaware's shore-based fishing is along the Atlantic coast beaches and jetties (Seagraves, 1988). There are also many private/charter boat fisherman from Indian River Inlet and Lewes that fish the coastal area. The species caught usually include: bluefish (*Pomatomus saltatrix*), weakfish (*Cynoscion regalus*), croaker (*Micropogon undulatus*), spot (*Leiostomus xanthurus*), kingfish (*Menticirrhus saxatilus*), red drum (*Sciaenops ocellatus*), tautog (*Tautoga onitis*), summer flounder (*Paralichthys dentatus*), striped bass (*Morone saxatilus*), scup (*Stenotomus chrysops*), sharks (*Mustelus canis, Squalus acanthiias*), hakes (*Urophycis spp.*), sea bass (*Centropristis striata*), Atlantic mackerel (*Scomber scombrus*) and Spanish mackerel (*Scomberomorus maculatus*). A sea bass pot fishery and early spring gill net fishing targeting shad and weakfish are the only prevalent commercial fishing operations in the coastal waters of Delaware.

Under provisions of the Magnuson-Stevens Act, areas along the Delaware Atlantic Coast including Borrow Area C and E may be considered Essential Fish Habitat (EFH) for species with Fishery Management Plans (FMP's). The proposed project may affect EFH along the Delaware Atlantic Coast for finfish species such as bluefish (*Pomatomus saltatrix*), summer flounder (*Paralichthys dentatus*), and scup (*Stentomus chrysops*). The Mid-Atlantic Fishery Management Council (MAFMC) is currently amending all FMP's, which are to be submitted to the Secretary of Commerce by October, 1998 (Dr. Tom Hoff - MAFMC, personal communication).

4.7.4 Inland Bays

The Delaware coastal beaches are bordered on the west by three inland embayments: Rehoboth Bay, Indian River Bay, and Little Assawoman Bay. The inland bays are bordered extensively with tidal marshes composed of saltmarsh cordgrass *(Spartina alterniflora)*, saltmeadow hay *(S. patens)*, spike grass *(Distichlis spicata)*, and high tide bush *(Iva frutescens)* (Daiber and Smith, 1976).

Common estuarine fishes present in the inland bays include: bay anchovy (*Anchoa mitchilli*), Atlantic silverside (*Menidia menidia*), mummichog (*Fundulus heteroclitus*), striped killifish (*Fundulus majalis*), naked goby (*Gobiosoma bosci*), and hogchoker (*Trinectes maculatus*). The inland bays are important nurseries for a variety of commercial and recreational fishes including: spot, croaker, weakfish, menhaden, bluefish, and summer flounder. The inland bays support shellfish like hard clam (*Mercenaria mercenaria*) and blue crab (*Callinectes sapidus*) for recreational and/or commercial fisheries. The inland bays are also important for supporting a variety of waterfowl, shorebirds, and wading birds.

4.8 THREATENED AND ENDANGERED SPECIES

The only Federal or State listed endangered or threatened species known to occur near the project area on more than an occasional or transient basis is the piping plover (*Charadrius melodus*). These small shorebirds, which are classified as threatened on both the Federal and State lists, nest on coastal beaches and dunes. Most of Delaware's Atlantic beach and dune system, except in high development areas is potential nesting habitat. In recent years, piping plover have been nesting at Cape Henlopen and Delaware Seashore State Parks. The nesting season usually begins in late March when the birds arrive and ends in July when the young are finally fledged. Shortly after hatching, the young leave the nest and begin foraging along the shoreline. The adults accompany the young during this critical period until they are fledged 25-35 days later. The State of Delaware monitors the bird's nesting activities. The monitoring program includes annual surveys to detect nesting birds and installation of fencing to warn the public. No nesting is known to occur within the Bethany Beach/South Bethany study area.

The bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrinus anatum* and *F. p. tundrius*) are other avian threatened and endangered species that may be present on only an occasional or transient basis.

The Delaware coast may be occasionally visited by five species of threatened and endangered sea turtles. These turtles include the loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), Kemp's ridley turtle (*Lepidochelys kempii*) and leatherback turtle (*Dermochelys coriacea*). The loggerhead turtle and Kemp's ridley turtle are particularly more common in Delmarva coastal waters during summer months. Historically, the breeding range of the loggerhead turtle may have extended to the Delaware Atlantic Coast, however, there are no known nesting sites reported in this stretch of coast. The

other four species breed much further south from Florida through the Caribbean and Gulf of Mexico. Overall, sea turtle utility of Delaware's twenty-five mile stretch of Atlantic Ocean presently or historically has not been significant. Sea turtles primarily utilize Delaware coastal waters as a transportation route from the Gulf Stream to Delaware Bay, where significant numbers have been observed utilizing the Delaware Bay as a feeding area (Logothetis,1994).

Six species of endangered whales may occasionally be encountered in nearshore waters along the Delaware Atlantic Coast during their migrations. These include sperm whale (*Physeter catodon*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), blue whale (*Balaenoptera musculus*), sei whale (*Balaenoptera borealis*) and black right whale (*Balaena glacialis*). The official list of threatened and endangered species in Delaware is in Table 4-7.

Two rare plant species, sea beach pigweed (*Amaranthus pumilus*) and chaffseed (*Schwalbea americana*), are found in beach and dune habitats in Delaware. There are no records of these species within the immediate project area.

4.9 CULTURAL RESOURCES

In preparing the FEIS, the Corps has consulted with the Delaware State Historic Preservation Office (DESHPO) and other interested parties to identify and evaluate historic properties in order to fulfill its responsibilities under the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR Part 800. As part of this work, a remote sensing underwater investigation was conducted in the original project borrow area (Area C). Investigators identified one remote sensing target exhibiting potential shipwreck characteristics. The final report of this study, entitled *Submerged Cultural Resources Investigation, Delaware Atlantic Coast From Cape Henlopen to Fenwick Island* (Dolan Research, 1995), is included in the Engineering Technical Appendix, and was submitted to the DESHPO for review and comment on February 14, 1994. Based on the results of this earlier investigation, the District determined that the potential for submerged cultural resources in Borrow Area E was substantial. Therefore, a remote sensing investigation was conducted within a 1,100 acre portion of Borrow Area E (Dolan Research, Inc. 1998). Researchers did not identify any submerged remote sensing targets exhibiting cultural resource characteristics in this portion of the borrow area. DESHPO consultation is ongoing and will be finalized prior to any project action. The following is taken largely from the above referenced report.

TABLE 4-7. LIST OF ENDANGERED AND THREATENED WILDLIFE SPECIES OF DELAWARE[1]		
Common Name	**Scientific Name**	**Status**
Delmarva Fox Squirrel	*Sciurus niger cinereus*	SE, FE
Sperm Whale	*Physeter catodon*	SE, FE
Blue Whale	*Balaenoptera musculus*	SE, FE
Finback Whale	*Balaenoptera physalus*	SE, FE
Sei Whale	*Balaenoptera borealis*	SE, FE
Humpback Whale	*Megaptera novaeangliae*	SE, FE
Right Whale	*Eubalaena spp.* (all species)	SE, FE
Hawksbill Sea Turtle	*Eretmochelys imbricata*	SE, FE
Leatherback Sea Turtle	*Dermochelys coriacea*	SE, FE
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	SE, FE
Tiger Salamander	*Ambystoma tigrinum*	SE
Bog Turtle	*Clemmys muhlenbergii*	SE, FT
Cope's Gray Treefrog	*Hyla chrysoscelis*	SE
Barking Treefrog	*Hyla gratiosa*	SE
Bald Eagle	*Haliaeetus leucocephalus*	SE, FT
Peregrine Falcon	*Falco peregrinus*	SE, FE
Brown Pelican	*Pelecanus occidentalis*	SE
Shortnose Sturgeon	*Acipenser brevirostrum*	SE, FE
Piping Plover	*Charadrius melodus*	ST, FT
Green Turtle	*Chelonia mydas*	ST, FT
Loggerhead Turtle	*Caretta caretta*	ST, FT

KEY
FE- Federally Listed as "Endangered"
SE- State Listed as "Endangered"
FT- Federally Listed as "Threatened"
ST- State Listed as "Threatened"
(Source: Delaware Department of Natural Resources and Environmental Control, Division of Fish and Wildlife)

4.9.1 Prehistoric Resources

The prehistoric occupation of Delaware and the Delmarva Peninsula has been categorized by archaeologists into three general periods of cultural development: Paleo-Indian (15,000 years before present (B.P.) - 8,500 B.P.), Archaic (8,500 B.P. - 5,000 B.P.), and Woodland (5,000 B.P. - 400 B.P.). The Paleo-Indian period is the time of the earliest human occupation of the Delmarva Peninsula. Few Paleo-Indian sites have been located in Delaware. This is partly due to the low population density and nomadic lifestyle of the people from the period, as well as from the inundation of sites by sea level rise and burial under thick layers of alluvium and modern cultural deposits. The current Delaware coastline was covered by inland forests during the Paleo-Indian period, with tributary rivers flowing eastward towards the ancestral Delaware River. Paleo-Indian groups would have occupied coastal areas, but these geographic locations currently lie on the continental shelf and are submerged. Therefore, any evidence of Paleo-Indian occupation along the Delaware Atlantic coastline would not directly relate to coastal environments but to exploitation of inland forest/riverine habitats. In Delaware, isolated fluted point finds and possible site locations appear to be related to lithic sources and areas favorable for hunting inland game near freshwater locations.

Archaic period peoples responded to the changed environmental conditions of the post-Pleistocene by exploiting a greater variety of resources. Archaeological investigations have shown that Archaic period sites tend to be relatively small, suggesting short-term and intermittent occupations in areas adjacent to interior freshwater swamps and bay/basin locations. Coastal tidal salt marshes and estuarine environments remained food resource-rich habitats available for exploitation. The prehistoric period that is best represented is the Woodland period, which is characterized by the introduction of pottery, increasing cultural diversity, and the evolution of a sedentary lifestyle that increasingly relied on agriculture. Woodland period culture remained intact until European contact. Woodland period sites have been identified on both the coastal marshes and in the mid-drainage areas in the region. Archaeological sites from this period produce distinctive ceramic forms and small triangular projectile points indicative of bow-and-arrow technology. Two prehistoric archaeological sites in the Bethany Beach vicinity, the Poplar Thicket Site and the Wilcus Site, are listed on the National Register of Historic Places. These sites are well north and west of the project area and will not be affected by proposed construction.

4.9.2 Historic Resources

The early history of the Delmarva Peninsula was marked by a succession of 16th and 17th century European expeditions such as those by Giovanni de Verrazano (1524), Estevan Gomez (1525), Henry Hudson (1609) and Cornelius Hendrickson (1614). European settlement in Delaware was initially focussed near Lewes. As early as 1622, a brick house was apparently in existence near the bay on Lewes Creek. In 1623, the Dutch East India Company constructed the first of several fortifications on the east shore of the bay. This was followed in the early 1630's by the creation of a Dutch patroonship, also centered in the vicinity of present day Lewes. A

small whaling community known as "Zwaanendael" was established near Cape Henlopen in 1631 and abandoned a few years later due to local Indian conflict. The first Swedish expedition sailed into the Delaware in 1638 and established the region's first permanent European settlement at Wilmington, Delaware following the construction of Fort Christina. There appears to have been minimal European settlement activity along Delaware's Atlantic coastal area below Lewes in the first half of the 17th century.

The Dutch re-established control in the Lower Delaware in the early 1650's with the construction of Fort Casmir, on the site of present-day New Castle. "Zwaanendael" was re-colonized in 1658. However, the region remained strongly Swedish in a cultural sense as evidenced by a preference for log- constructed houses. The period of Dutch control was short-lived as the English took over all Dutch holdings in the Middle Atlantic region in 1664. For the entire later Colonial period, central and southern Delaware remained predominantly agricultural with dispersed farmsteads and a loosely defined road network. A "long lot" settlement pattern emphasized the importance of river and coastal transportation over roads. The project area contains numerous shorefront houses built between the early 1960's - 1990's. These houses will not be impacted by proposed construction. One National Register listed historic property, the Indian River Life Saving Service Station, is north of the Indian River Inlet and well outside of the project area.

4.9.3 Maritime Resources

Although the Delaware Bay was visited by Henry Hudson in 1609 and explored by others within the next decade, the first comprehensive navigational chart of the Delaware Coast vicinity was not completed until 1776. In that year Joshua Fisher charted the waters of the Delaware Bay and provided the first bottom contours based on soundings. Privately published charts were available in the first half of the 19th century. However, standardized coastal charts were not initiated until the first United States Coast Survey was completed in the mid-19th century. In 1878, the United States Coast and Geodetic Survey began to periodically update the vicinity chart with detailed hydrographic information.

The earliest known aid to navigation in Delaware was the Cape Henlopen Light which was erected in 1767. A second light was constructed on Fenwick Island in 1858. Two breakwaters were constructed inside Cape Henlopen between 1869 and 1901. This "Harbor of Refuge" provided vessels protection from storms and ice. By the middle of the nineteenth century the U.S. Coast Guard had established a series of lifesaving stations at Lewes, Cape Henlopen, Rehoboth Beach, Indian River Inlet, Bethany Beach and Fenwick Island. Historic maritime activity within the project area was almost exclusively transient, with vessels crossing the area on coastal networks linking the Delaware River Ports and New York with other ports from Maine to Texas and the Caribbean to Central and South America.

Over the years, many types of ships and vessels have wrecked while enroute up and down the coast. Many vessels were lost along the coast in an attempt to reach the Harbor of Refuge.

Coastal storms, treacherous northeast winds and swift tidal currents coupled with historically heavy coastal traffic has caused the loss of dozens of documented sailing vessels, steamships, barges, tugs and large modern ships off the Delaware Coast. A variety of potential submerged cultural resource types in the project vicinity could date from the first half of the seventeenth century through the Second World War. The remote sensing investigation identified one magnetic target exhibiting shipwreck characteristics in Area C. A remote sensing investigation was conducted within a 1,100 acre portion of Borrow Area E (Dolan Research, Inc. 1998). Researchers did not identify any submerged remote sensing targets exhibiting cultural resource characteristics in this portion of Area E.

4.9.4 Submerged Prehistoric Sites

During the last glacial period, which terminated approximately 15,000 years ago, the sea level was 95 to 130 meters lower than current levels. The Delaware Atlantic shoreline at this time was on the edge of the modern continental shelf, some 50 to 60 kilometers of the present shoreline. According to area studies, the sea level rose at a steady pace between 7000 B.P. and 3000 B.P., with a slower rate of increase after ca. 3000 B.P. There is a possibility that prehistoric pleistocene landsurfaces are buried under shoaled offshore sand deposits at the borrow area.

4.10 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTES (HTRW)

A literature review was conducted within the study area to assess the potential of encountering any contamination associated with HTRW. This literature review utilized various databases from Delaware DNREC, the United States Environmental Protection Agency (USEPA), PCB-Waste Handlers (PADS), Small and Large Quantity Hazardous Waste Generators, and Treatment, Storage and Disposal of Hazardous Waste Facilities (HWDMS/RCRIS), National Priorities List (NPL), Facility Index System (FINDS) List, Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), Radioactive Materials (MLTS), Release of Toxic Chemicals to Air, Water, and Land (TRIS), Manufacture or Importer of Toxic Substances (TSCA), Emergency Response Notification System (ERNS), Hazardous Materials Incident Report System (HMIRS), DE State Hazardous Waste Sites (SHWS), Leaking Underground Storage Tank Incidents (LUST), Registered Underground Storage Tank (UST), and Solid Waste Facility/Landfills (SWF/LS), and State Hazardous Waste Sites (SHWS). No sites were identified from this database inventory search.

Given the type of environmental settings within the study area and the associated land uses, the likelihood of encountering HTRW's is extremely low. No immediate concerns were identified from site visits, regulatory agency contacts, and database searches, therefore, any further HTRW investigations for the Bethany Beach/South Bethany study area are not necessary.

4.11 SOCIO-ECONOMIC RESOURCES

4.11.1 Social and Economic Setting

Population and Land Use. The interim feasibility study area is comprised of Bethany Beach and South Bethany which lie within the 950 square miles of Sussex County. Sussex County is the southernmost and largest of the three counties in Delaware, encompassing 48% of the state's land. Although it is the largest of the counties it is also the least populated, with only 113,229 year round residents, totaling 17% of the state's permanent population, according to the 1990 Census.

The oceanfront of Bethany Beach is lined with hotel and condominium complexes as well as the typical summer cottages. There are a total of 2,074 housing units within the town, of which about 94% were single housing units. The median value of a single family home in 1990 was $155,100.

Bethany Beach is heavily developed with very little available land in the city, particularly along the ocean front. However, before any construction can begin, whether it is new construction or rehabilitation, property owners must receive the proper permits from DNREC. DNREC helps the applicant arrange meetings with the appropriate state officials as well as answer any questions on permit requirements. Bethany Beach also strictly adheres to the Federal Emergency Management Agency (FEMA) guidelines. The structures' foundations along the ocean block are mixed, with most structures built after the March 1962 storm on piles. While, according to the 1990 Census, there are only 326 year-round residents, Bethany Beach attracts thousands of summer residents every year with its beaches and its own boardwalk. The boardwalk is predominantly residential with a few commercial structures. Garfield Parkway, which is perpendicular to the boardwalk, provides public access to the municipality's beach, and has many metered parking spaces. Still, parking may be difficult on weekends at the height of the tourist season.

The unincorporated communities of Sea Colony and Middlesex Beach are directly south of Bethany Beach. Presently, Sea Colony consists of a multiple building high rise condominium complex and Middlesex Beach consists of residential structures.

South Bethany is situated approximately 3,500 ft. south of Bethany Beach. The town of South Bethany has become a developed overflow area of Bethany Beach, with additional public beach access.

There are 846 housing units in South Bethany of which 99% are single housing units. All revenues come from property tax, parking permits, traffic tickets, building permits and realty

transfer fees. Delaware State Route One provides the sole means of access to both Bethany Beach and South Bethany. The largest portion of vacationers attracted to both communities are those staying overnight but less than a week.

Both the State of Delaware and Sussex County are projected to increase in population over the next twenty years, but at a decreasing rate of growth. Sussex County is growing faster than the state of Delaware as a whole. Table 4-8 contains estimates of population by the Delaware Population Consortium, University of Delaware, College of Urban Affairs and Public Policy.

TABLE 4-8. TOTAL POPULATION

	1985	1990	1995	2000	2005	2010
Delaware	625,950	682,700	714,530	784,850	820,500	845,000
Sussex County	107,450	113,229	132,400	142,700	151,700	162,350

Economic Development. Major industries providing employment in the county (employing 5,000 and over, persons 16 years and over) as per the 1990 Census are construction (5,884 people), manufacturing of nondurable goods (6,925), and retail trade (9,921). Other industries providing employment are health services, educational services, food services; finance, insurance, and real estate; manufacturing of durable goods, wholesale trade; agriculture, forestry, and fisheries; transportation, public administration, communications, and other public utilities. The top sectors in 1993 in Sussex County were Special Trade Contractors (359 businesses), Eating and Drinking Places (312), Miscellaneous Retail Trade (287), and General Building Contractors (230). The number of employees in these top sectors are not large. In 1993, special trades contractors only averaged 5 employees per business in Sussex County, while eating and drinking places averaged 14 employees.

The estimated unemployment rate for Sussex County for 1995 was 4.6%. This was slightly above the state average of 4.3%, and below the national average of 5.6%. Historically, for the decade, thus far, Sussex County has had a relatively low unemployment rate, paring below the national average for each of the years, and paring below the state average for three out of the six years.

The coastal area differs from the rest of Sussex County, and Delaware, in its reliance on the tourism industry rather than agriculture and manufacturing/processing. In Sussex County, 1/3 of those employed in the county are in retail or services, while another 1/3 are in manufacturing. The coastal study area is devoid of manufacturing, relying almost 100% on the service/retail industry. Bethany Beach, with an approximate 0.4 mile boardwalk, extending from 2nd Street to Parkwood Street, attracts thousands of summer visitors every year. The boardwalk contains

apartments, condominiums, fast food establishments, hotels and motels, restrooms and the beach patrol. Retail establishments are located predominantly along Garfield and West Pennsylvania Avenues. The town provides public access to the municipality's beach, and has many metered parking spaces along the streets. Still, parking may be difficult on weekends at the height of the tourist season as the beach population soars on a typical holiday weekend. South Bethany, on the other hand, located about a mile south of Bethany is not commercialized. It caters to the cottage industry in providing accommodations to visitors.

The estimated household income in 1989 was $26,900 for Sussex County. As shown in Table 4-9, the coastal communities are considerably better off than the rest of Sussex County. Even when economically hard times hit the State's economy (particularly poor agricultural crops or recession in the manufacturing industry), the economy of the Delaware coast should remain buoyant as it serves as a summer resort for the residents of the regional urban and suburban areas.

TABLE 4-9. PER CAPITA INCOME

NAME	HOUSEHOLD INCOME 1989 est
United States	$28,908
Delaware	$32,068
Sussex County	$26,900
Bethany Beach	$30,000
South Bethany	$37,000

Source: 1990 U.S. Census Bureau

5.0 ENVIRONMENTAL CONSEQUENCES

5.1 COMPARATIVE EFFECTS OF ALTERNATIVES

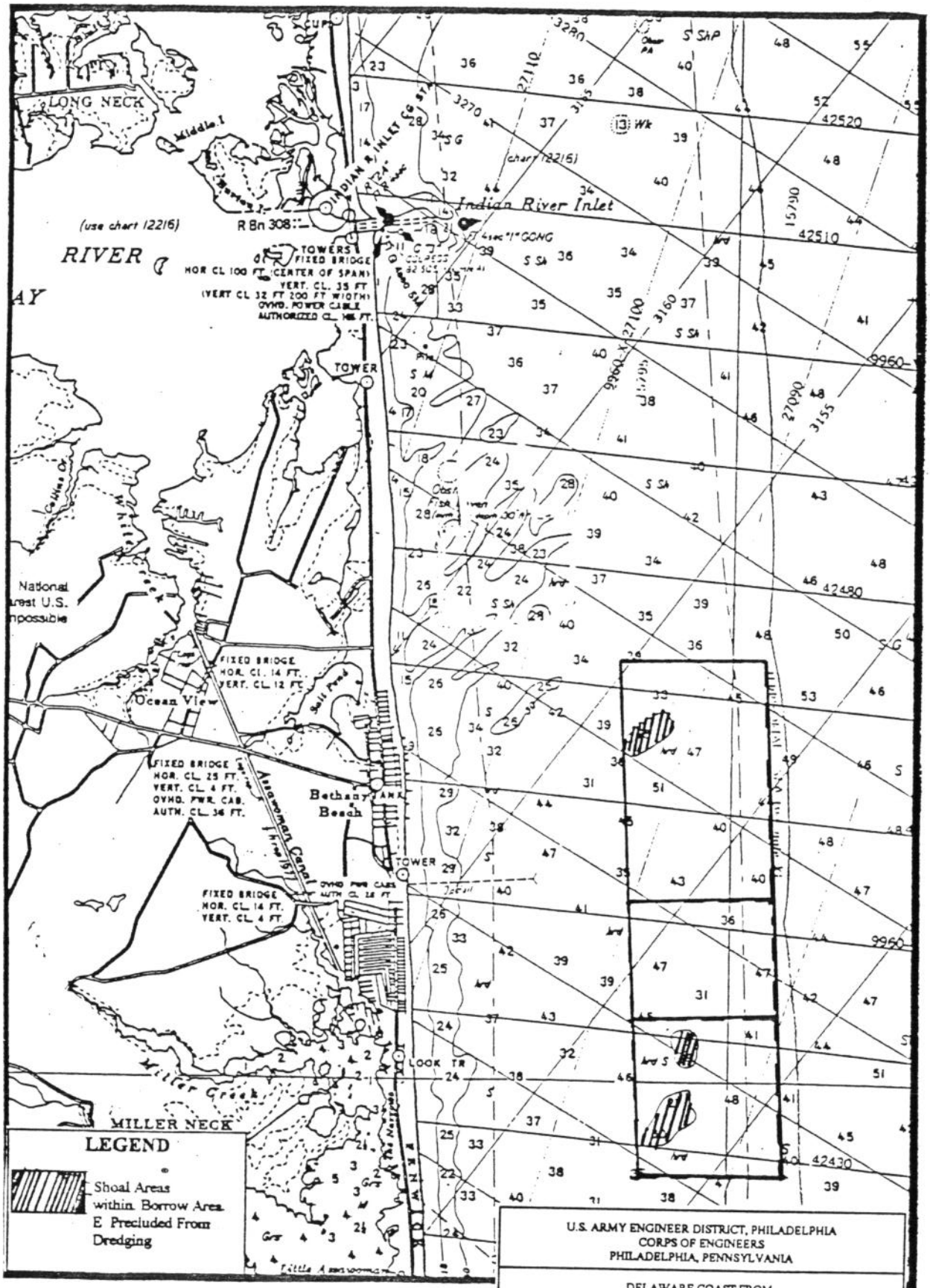
All of the alternatives considered result in some form of a beneficial or adverse socio-economic or environmental impact. The no action alternative will allow the continuation of existing conditions as well as the existing processes which currently modify those conditions. The following discussion will focus on the impacts of the berm and dune restoration with periodic beach nourishment alternative, however, the impacts associated with the no action alternative will be discussed when appropriate. A brief summary comparing the effects of all of the alternatives is presented in Tables 3-2 and 3-5 in Section 3.0 of the EIS.

5.2 TOPOGRAPHY AND SOILS

Under the no action alternative, erosion would continue and more beach would be lost. Without further engineering efforts, the existing bulkheads and erosion control measures would be rendered ineffective or breached as the beach profile became steeper and the wave energy became more severe.

The berm and dune restoration alternative would result in topographical changes in the sand borrow site. Two borrow areas (C and E) were evaluated. Borrow Area C contains a system of pronounced submerged ridges and troughs, which lie northeast of Bethany Beach. The mean depth of the ridges (sandbar) is 24.5 ft (7.35 m) mlw, the sandbar trough mean depth is 32.6 ft (9.80 m), and the deep areas (southeastern portion of site) is 41.5 ft. (12.45 m). Dredging would reduce the ridges by approximately ten feet, which would increase the depths from 24.5 ft. to 34.5 ft. As stated previously, the amount of suitable sandy material in this area is not sufficient to support a 50-year project (with initial beachfill placement and periodic nourishment), therefore, the sand ridges would be greatly reduced even if dredging depths were reduced to less than ten feet. As such, utilization of Borrow Area C would result in significant topographic changes before the site is depleted of suitable sand resources.

The alternative Borrow Area E consists of a significantly different bathymetry and topography. Borrow Area E is nearly five times the distance from the coastline than Borrow Area C, and it lies in deeper water (33 ft. - 48 ft.). With the exception of three small shoal areas that rise up to approximately 30 feet in depth in the southern and northern portion of the 3,500 acre site (see Figure 5-1), the bottom contains little topographic relief. Dredging the site will significantly alter the bathymetry, however, the topographic structure would remain similar to existing conditions. This relies heavily on the dredging techniques and depths of dredging. Abrupt cuts into the substrate could result in the creation of pits, which would be undesirable from a biological perspective. The site is in a less dynamic area and it is likely that the area would not quickly fill in with sand. Creation of pits could produce local changes in hydrodynamics, which could accumulate fine-grained materials. These impacts could be reduced if dredging cuts were limited to a relatively shallow depth (< 12 feet) and the edges of the cuts


LONG NECK
Middle I
Indian River Inlet
(use chart 12216)
RIVER
AY
TOWER
TOWERS
FIXED BRIDGE
HOR CL 100 FT (CENTER OF SPAN)
VERT. CL. 35 FT.
(VERT CL 32 FT 200 FT WIDTH)
OVHD. POWER CABLE
AUTHORIZED CL. 135 FT.
National
Forest U.S.
Impossible
FIXED BRIDGE
HOR. CL. 14 FT.
VERT. CL. 12 FT.
Ocean View
FIXED BRIDGE
HOR. CL. 25 FT.
VERT. CL. 4 FT.
OVHD. PWR. CAB.
AUTH. CL. 36 FT.
Assawoman Canal
Bethany
Beach
TOWER
FIXED BRIDGE
HOR. CL. 14 FT.
VERT. CL. 4 FT.
Miller Creek
MILLER NECK
LOOK TR
Little Assawoman Bay
LEGEND
Shoal Areas
within Borrow Area
E Precluded From
Dredging
U.S. ARMY ENGINEER DISTRICT, PHILADELPHIA
CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA
DELAWARE COAST FROM
CAPE HENLOPEN TO FENWICK ISLAND
FEASIBILITY STUDY
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY
FIGURE 5-1. SHOAL AREAS WITHIN BORROW
AREA E THAT ARE PRECL DED FROM
DREDGING

were gradually blended in with the surrounding outside bathymetries. No significant changes in bottom substrate are anticipated. Vibrocore data suggests that sand deposit thicknesses range from 15 - 20 feet (or deeper), therefore, similar substrate would be exposed after dredging. If dredging is required to be expanded from the middle portion of Area E into the northern and/or southern portions, the three shoal areas described above would be avoided to maintain similar topographic relief. Topographic relief may even be enhanced if the bottom surrounding the shoal areas was lowered from dredging.

Regarding the beach, the berm restoration would result in a berm 150 feet wide at both Bethany Beach and South Bethany raising both berms to an elevation of +7 feet NAVD. The construction of a dune at +16 feet NAVD would significantly modify the topography of the existing beach.

Results from coastwide acoustic subbottom profiling and vibrocores indicate that several potential sand borrow areas exist for the Bethany Beach/South Bethany area. Two areas ("C" and "E") were originally considered for use in this study, however, Area C was eliminated. Area E was found to contain large quantities of fine to medium sands, which were determined to be compatible beachfill based on the utilization of the U.S. Army Corps of Engineers Automated Coastal Engineering System. Consequently, the substrate of the proposed beach should be similar in nature to the existing beach. Renourishment is not expected to be required more often than if materials compatible with native beach materials were used.

5.3 GROUNDWATER

For the berm and dune restoration alternative and all of its construction options, the effects of proposed construction and possible offshore borrow operation on the quality of production well water in the project area would be negligible. According to Miller (1971), most municipal and public water supply wells in the affected area draw from the Columbia (Pleistocene) Aquifer. The proposed sand borrow site, Area E, represents a hydrogeologic disconnection from the water supply aquifers. Furthermore, it is anticipated that once dredging is completed, the same sand deposit would be exposed that existed prior to dredging. Based on the nature of fresh-saltwater interaction and the hydrogeologic disconnection of the borrow area, it is believed that the dredging will have no impacts on the freshwater aquifers in the area.

5.4 HYDRODYNAMICS AND SEDIMENT TRANSPORT

Dredging within borrow area E would have negligible or no effects on nearshore sedimentation patterns and wave conditions. This is based on experience with numerical modeling on areas similar to these (*"Atlantic Coast of Maryland Hurricane Protection Project"* (August 1989), Appendix B, Section 5) where the results indicated that the simulated dredging of the borrow site down to the surrounding bathymetry appeared to have very little effect on wave patterns and longshore sediment transport potential. This modeling also indicated that wave run-

up at the beach face also appeared to be unchanged when dredging was performed at the site. Borrow Area E lies 9,600 feet (nearly 2 miles) from the coastline of Bethany Beach and South Bethany in depths ranging from 33 ft. - 48 ft. Because of the distance of the borrow area to the coastline and the deeper bathymetries present within the proposed borrow area, no adverse effects on wave climate to the shoreline are anticipated by removal of sand. Therefore, no significant hydrodynamic changes along the coastline that would exacerbate shoreline erosion are expected. However, it is recommended that dredging should not exceed more than twelve vertical feet of sediment, or excavate significantly deeper than surrounding bathymetry from the borrow area bottom to avoid having any measurable effects.

A drift reversal, or nodal, zone exists along the Atlantic Coast of Delaware, with its location ranging from several miles south of Indian River Inlet to the southern limit of Fenwick Island. Sediment north of the nodal zone moves predominantly to the north, and sediment south of the nodal zone moves predominantly to the south. Sediment within the nodal zone is just as likely to move north as it is to move south.

The 20-year WIS hindcast was used to estimate sediment transport potential at Bethany and South Bethany beaches for a range of shoreline orientations throughout the project areas. Over the twenty years simulated, the net transport direction for each case was found to be in the northerly direction for both towns. Results from any one individual year differed ranging from net southerly transport on the order of 50,000 cy, to net northerly transport of over 500,000 cy. It is felt that based on the wave analysis and results reported from previous researchers, that the nodal zone is located to the south of the project area. Within the project area the transport can exhibit reversals in annual net transport, but it is predominately north directed though small. No significant impacts to sediment transport are expected.

5.5 WATER QUALITY

The dredging associated with the berm and dune restoration alternative would result in short-term adverse impacts to water quality in the immediate vicinity of the dredging and beach nourishment operations. Dredging in the proposed borrow area will generate turbidity resulting in sedimentation impacts within the immediate vicinity of the operations. Short-term increased turbidity can effect organisms in several ways. Primary production in phytoplankton and/or benthic algae may become inhibited from turbidity. Suspended particulate matter can clog gills and inhibit filter-feeding species. Reilly *et al.* 1983 determined that high turbidity could inhibit recruitment by pelagic larval stocks. In addition, midwater nekton like finfish and mobile benthic invertebrates may migrate outside of the area where turbidity and deposition occur.

The amount of turbidity and its associated plume is mainly dependent on the grain size of the material. Generally, the larger the grain-size, the smaller the area of impact. The period of turbidity is also less with larger grain-sized materials. The proposed borrow location contains medium to fine sands, which are coarser grained than silts and clays. Turbidity resulting from

the resuspension of these sediments is expected to be localized and temporary in nature. Utilization of a hydraulic dredge with a pipeline delivery system will help minimize the impact, however, some disturbance will occur.

Similar effects to water quality on aquatic organisms could likely be incurred from the deposition of borrow material on the beach. Increased turbidity resulting from the deposition of a slurry of sand will be temporary in nature and localized. This effect will not be significant as turbidity levels are naturally high in the high-energy surf zone. Organisms in the surf zone versus deep water areas will be less likely to suffer adverse effects from turbidity because they have already adapted to these conditions. Fine sediments winnowed from the deposited material are transported by waves and currents into the nearshore with varying environmental impacts from a few months to at least seven years (Hurme and Pullen, 1988). Parr *et al.* (1978) determined that fine materials were rapidly sorted out and transported offshore after beach deposition. In their study, the dredged material had a much higher silt content than the beach, however, all of the silt was removed within 5 months. The selection of borrow material from a high energy environment should minimize the fine particle content. Material taken from the borrow area will have low quantities of silt, therefore, high levels of turbid waters after deposition should not persist.

Dredging deep pits in a sand borrow site can significantly alter circulation patterns in the borrow area resulting in decreased dissolved oxygen (DO) levels or increased hydrogen sulfide levels (National Research Council, 1995; Murawski, 1969; Saloman, 1974). Monitoring of DO would be performed during the initial dredging operations to determine if dredging depths should be adjusted to avoid creating anoxic zones in the post-dredging environment of the borrow area.

With respect to Borrow Area E, the South Coastal Sewage Treatment Plant operates an outfall approximately 4,400 ft. (0.83 miles) from the nearest portion of the borrow site. The borrow site lies approximately 1,760 feet (0.33 miles) outside of the ½ mile buffer zone that prohibits shellfish harvesting within it. Coordination was conducted with the Shellfish and Recreational Water Branch of the Delaware Department of Natural Resources and Environmental Control, and no concerns were identified with regard to Borrow Area E utilization and impacts on human health. Water quality monitoring at the beach would be conducted during beachfill operations to measure any increases in indicator bacteria. Bacteria level data will be coordinated with Delaware Department of Natural Resources and Environmental Control - Shellfish and Recreational Water Branch.

The borrow material is not expected to be chemically contaminated. The use of beach nourishment quality sand from a high energy, well-mixed environment coupled with the absence of nearby dumping activities, industrial outfalls, or heavily contaminated water infers that there is a low probability that the borrow material would be contaminated by chemical pollutants (U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, 1991).

5.6 TERRESTRIAL ECOLOGY

5.6.1 Effects on Flora and Fauna of Upper Beach

Construction of the beach nourishment alternative would result in the initial placement of approximately 3.45 million cubic yards of sand on the beach with subsequent periodic nourishments of approximately 480,000 cubic yards every 3 years for a project life of 50 years. This construction will greatly disturb the impacted beach area, however, impacts to terrestrial species are expected to be minor and temporary. The existing species inhabiting the beach are generally capable of surviving adverse conditions, and most are capable of migrating out of the impacted area. Therefore, impacts are not expected to be significant. It would be reasonable to expect recolonization from adjacent areas shortly after the end of construction and a rapid return to pre-construction conditions.

5.7 AQUATIC ECOLOGY

5.7.1 Effects of Beachfill Placement on Benthos

The majority of the impacts of beachfill placement will be felt on organisms in the intertidal zone and nearshore zones. The nearshore and intertidal zone is highly dynamic, harsh, and is characterized by great variations in various abiotic factors. Approximately 250 acres of aquatic habitat (below mean high water) will be impacted by beachfill placement. This also includes approximately 17 acres of intertidal beach habitat to be affected by beachfill placement. Fauna of the intertidal zone is highly mobile and respond to stress by displaying large diurnal, tidal, and seasonal fluctuations in population density (Reilly and Bellis, 1983). Despite the resiliency of intertidal benthic fauna, the initial effect of beachfill deposition will be the smothering and mortality of existing benthic organisms within the shallow nearshore (littoral) zone. This will initially reduce species diversity and number of animals. Burial of less mobile species such as amphipods and polychaete worms would result in losses, however, densities and biomasses of these organisms are relatively low on beaches. Beach nourishment may also inhibit the return of adult intertidal organisms from their nearshore-offshore overwintering refuges, cause reductions in organism densities on adjacent unnourished beaches, and inhibit pelagic larval recruitment efforts. Parr *et al.* (1978) notes that the nearshore community is highly resilient to this type of disturbance, however, the offshore community is more susceptible to damage by receiving high sediment loads from fines sorting-out from a beachfill. The ability of a nourished area to recover depends heavily on the grain size compatibilities of material pumped on the beach (Parr *et al.*,1978). Reilly and Bellis (1978) conclude that nourishment initially destroys existing macrofauna, however, recovery is usually rapid after the pumping operation ceases. Recovery of the macrofaunal component may occur within one or two seasons if grain sizes are compatible with the natural beach sediments. However, the benthic community may be somewhat different from the original community. Hurme and Pullen (1988) caution, "Macrofauna recover quickly because of short life cycles, high reproductive potential, and planktonic recruitment from unaffected areas. However, the recolonization community may differ considerably from the

original community. Recolonization depends on the availability of larvae, suitable conditions for settlement, and mortality. Once established, it may be difficult for the original community species to displace the new colonizers." Benthic recovery on the beach/intertidal zone may become hampered by the three-year periodic nourishments. Based on the above mentioned studies, the benthic community may take 1-2 years to recover. With a three-year renourishment cycle, the benthic community may be in a higher than normal state of flux due to periodic disturbances from re-nourishment. It is conceivable that the benthic community may attain a recovered state for a period of 1-2 years before being distu bed again by a re-nourishment cycle.

Grain size compatibility analyses conducted on suitable sediments within the borrow site indicate that there will be relatively low levels of fine sediments placed on the beach at Bethany Beach and South Bethany. Some pockets of fine sediments were identified in some of the deeper areas within the borrow site. These areas would be avoided because the fine-grained material is not suitable beachfill material. Parr *et al.* (1978) recommend that to minimize biological impacts, the percentage of fine sediments (smaller than 125 micrometers) should be low to minimize siltation and consequent deposition offshore, which may create anoxic conditions in the sediment. The berm restoration would be conducted in a manner that approximates the existing beach profile. The approximate area of intertidal and shallow nearshore habitat lost resulting from the beachfill would be likewise created seaward. Therefore, no significant loss of intertidal or shallow nearshore habitat is expected.

5.7.2 Effects on Benthos at Borrow Site

The primary ecological impact of dredging the sand borrow site will be the complete removal of the existing benthic community through entrainment into the dredge. Estimates of sandy marine benthic habitat disturbed with respect to dredging depths are provided in Table 5-1. Dredging will primarily involve the immediate destruction of infaunal and some of the less mobile epifaunal organisms. Mortality of these organisms will occur as they pass through the dredge device and/or as a result of being transplanted into an unsuitable habitat. A secondary disturbance would be the generation of turbidity and deposition of sediments on the benthic community adjacent to the dredging. Despite the initial effects of dredging on the benthic community, recolonization is anticipated to occur within one year. Depending on the post-dredging conditions, recovery of the benthic community can be variable by taking a few months to several years (National Research Council, 1995). Saloman *et al.* (1982) determined that short-term effects of dredging lasted about one year resulting in minor sedimentological changes, and a small decline in diversity and abundance within the benthic community. The recovery of a borrow area is dependent upon abiotic factors such as the depth of the borrow pits, and the rate of sedimentation in the borrow pits following the dredging. Dredging a borrow pit can result in changes that affect circulation patterns resulting in pits where fine sediments can become deposited, which may lead to hypoxia or anoxia in the pit. Accumulations of fine sediment may also shift a benthic community from predominantly a filter-feeding community to a deposit-feeding community. It is important that for recovery, the bottom sediments are composed of the same grain sizes as the pre-dredge bottom. Cutler and Mahadevan (1982) investigated long-term

effects of dredging on the benthic community and noted that faunal composition was different than the pre-dredge community, however, the difference was attributed more to normal seasonal and spatial variations. In this study, it was determined that there were no significant differences in the benthic communities and sediment parameters between borrow sites and surrounding areas. Periodic disturbances from maintenance of the project may favor the development of benthic communities composed primarily of colonizers. Assuming that the same location is dredged every three years, the secondary benthic community may be in a higher state of flux than the original community. This may, in effect, favor more r-selected (rapid reproduction, short life span) benthic species in the sand borrow impact area over the 50-year project life. In addition, benthic organism abundances may be lower than normal. However, this may not be the case if subsequent dredging cycles are conducted at different locations within the borrow area. This would allow disturbed areas from previous dredging disturbances to become recolonized.

Benthic investigations in and around the borrow site indicate the presence of a benthic community that has abundances and diversity typical for nearshore waters (within 3 miles of the shoreline) of the middle Atlantic Coast (U.S. EPA , 1994; Kelley *et al.*, 1996; Scott and Bruce, 1998 and USFWS, 1996). Shifts in benthic community composition can be expected if the physical habitat is significantly different than the pre-dredging habitat. Since Area E is in a less dynamic area (as opposed to a high energy ebb shoal or inlet area), little replenishment of sand into the area is expected after dredging ceases. Therefore, the recruitment of benthic species similar to the existing community requires the exposure of a similar substrate after dredging operations terminate. Vibrocore data confirm that thick deposits of surficial sands exist within the area. These thick deposits are expected to contain enough sand to allow for dredging in the borrow area without depleting the sand source. Dredging 10-12 feet of material is expected to result in leaving 3-10 feet of similar substrate material to remain. Dredging depths can affect the amount of aerial extent of benthic habitat impacted. Table 5-1 provides different scenarios pertaining to dredging depths within the borrow site and the amount of benthic habitat disturbed over a fifty-year project life. This table assumes that approximately 3.45 million cubic yards of beachfill is required for initial placement and 480,000 cubic yards would be required through periodic nourishment every 3 years over a 50-year project life.

Table 5-1 illustrates that dredging to deeper depths would result in less benthic habitat being disturbed. However, dredging deep pits can significantly alter circulation patterns resulting in decreased dissolved oxygen (DO) levels or increased hydrogen sulfide levels (National Research Council, 1995; Murawski, 1969; Saloman, 1974). Deep pits can also accumulate more fine-grained particles such as silts and clays, which may shift the benthic community composition. Hurme and Pullen (1988) recommend that borrow materials be obtained from broad, shallow pits

TABLE 5-1. AREAS OF BENTHIC HABITAT IMPACTED WITH RESPECT TO DREDGING DEPTHS WITHIN BORROW AREA E. (Percentages in parenthesis represent the amount of benthic habitat impacted along the Delaware Atlantic Coast within the three mile territorial limit)

	SAND QUANTITY REQUIRED (cubic yards)	BENTHIC HABITAT IMPACTED WITH A 5 FOOT DEEPENING	BENTHIC HABITAT IMPACTED WITH A 10 FOOT DEEPENING	BENTHIC HABITAT IMPACTED WITH A 12 FOOT DEEPENING
Initial Beachfill	3,453,000 cy	428 acres	214 acres	178 acres
Periodic Nourishment Per 3 yr. Cycle	480,000 cy	60 acres	30 acres	25 acres
50-Year Project Total	11,450,000 cy	1,419 acres (2.6%)	709 acres (1.3%)	591 acres (1.1%)

in nearshore waters with actively shifting bottoms, which would allow for sufficient surficial layer of similar sediments for recolonization. Also, it is suggested that DO levels are monitored within the borrow area during dredging operations in the areas already dredged to determine if the depth should be modified (T. Hoff-MAFMC, personal communication). If DO levels are consistently low, the dredging contractor would be required to dredge within the borrow area to a higher depth. In addition, the dredging contractor would be required to taper the borrow area edges into the surrounding outside bathymetries. This would be done to avoid the creation of steep walls along the borrow area edges, which would minimize adverse effects on circulation within the borrow area.

Measures that would minimize the adverse effects of dredging in the borrow area such as dredging in a manner as to avoid the creation of deep pits, avoiding previously dredged areas to allow for recruitment and recolonization, dredging during lowest biological activity, and the utilization of a hydraulic dredge with a pipeline delivery system to help minimize turbidity will be considered.

5.7.3 Effects of Groin Burial on Marine Biota

Nine groins in Bethany Beach, which represent artificial rocky intertidal habitat, will be subject to sand burial from placement of beachfill. The landward ends of the groins would be permanently covered with sand. Once covered, the landward ends of the groins would not be available for fishermen to use nor to provide habitat for invertebrates, finfish, and shorebirds. Non-mobile organisms and intertidal dwellers would be affected by burial from the placement of sand. The fill placement over the groins is expected to re-establish sandy bottomed intertidal habitat.

5.7.4 Impacts on Fisheries

5.7.4.1 Shellfish

Since the 1970's, there have been no commercially harvestable stocks of surfclams within the inshore 3-mile territorial limit of Delaware's Atlantic Coast. For this reason, it can be expected that there will be no significant adverse impacts to this fishery from initial project construction. However, potential conflicts with periodic operation and maintenance of the project and the surf-clam fishery may arise during the 50-year life of the project. The proposed borrow site contains habitat suitable for surfclams, however, potential future impacts were minimized by selecting Area E, which does not support as high of densities of juvenile surfclams as Area C does. Recent surveys (DNREC 1992; Burton 1996; Scott and Bruce 1998) failed to find any commercially exploitable densities in and around the proposed sand borrow site. Periodic dredging may have adverse impacts on a recovering surfclam fishery. Recent benthic studies (US. EPA 1994; Kelley *et al.* 1995; Scott and Bruce 1998) indicate that there is a juvenile surfclam population within areas C and E, however, commercial surveys by Burton (1996) and Scott and Bruce (1998) indicate that these juveniles are not reaching commercial sizes and densities. Heavy predation on surfclams may be a contributing factor as to why they are not reaching large sizes (Dr. Hoff-MAFMC, personal communication), however, the juvenile class found in the benthic studies could support a future commercial fishery (T. Goodger - NMFS, personal communication). However, the presence of juvenile surfclams may not be associated with the development of commercially exploitable stock (USFWS, 1996). Based on the rapid sexual maturity rates of surfclams, the juvenile clams found in U.S. EPA (1994), Kelley et al. (1996) and Scott and Bruce (1998) benthic surveys may be contributing gametes for some recruitment within the study area.

Two alternative borrow areas (C and E) were evaluated for juvenile and commercially exploitable surfclam densities. The ridge and swale habitat found in Area C was identified as having greater habitat value for surfclams (Personal communication with J. Tinsman - DNREC, T. Hoff -MAFMC, and T. Goodger - NMFS). Although factors such as seasonal variability and predation may affect abundances of surfclams, the benthic samples obtained in Area E exhibited significantly lower mean abundances in density and sizes when compared to the sandbar habitat of Area C. Mean biomass of surfclams in Area E was also less than those of Area C (see Table 4-5) (Scott and Bruce 1998). Commercial surfclam surveys conducted for Area E and Area C resulted in no commercially harvestable densities, however, the small clams found in high densities in the benthic samples of Area C could potentially restore the commercial fishery that existed historically (NMFS letter dated 10/03/97). This could apply for Area E also, however, surfclam fishery managers have indicated that commercial clammers typically show a preference for working the ridge and swale habitats as those in Area C over flat bottom areas like Area E (Personal communication with J. Tinsman - DNREC, T. Hoff -MAFMC, and T. Goodger - NMFS). Utilizing Area E is expected to have less of an adverse effect on a potentially recovering surfclam fishery, however, monitoring would need to be conducted periodically throughout the project life to identify any commercial densities or potential commercial densities in the undredged portions and the previously dredged portions of Area E. Adverse effects to a

potentially recovering fishery could be minimized by implementing the following measures: leave suitable sandy substrate after dredging is completed and avoid the creation of deep anoxic pits. Because sand resources within Area E are expected to be finite, dredging would be conducted only once at a location within Area E, which would avoid subsequent disturbances from periodic nourishment activities. This would allow for better conditions for recovery.

Under the provisions of the reauthorized Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) of 1996, the National Marine Fisheries Service (NMFS) in conjunction with the Mid-Atlantic Fishery Management Council (MAFMC) are responsible for developing the description and identification of essential fish habitat (EFH) in their fishery management plans (FMPs). EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The surfclam is a management species where EFH may apply (personal communication with Dr. Tom Hoff- MAFMC). At this time, the MAFMC is revising the FMP for surfclams and it is expected to be submitted to the Secretary of Commerce by October 1998. Although EFH has not been designated for Delaware coastal waters, the Philadelphia District will initiate consultation procedures with NMFS upon designation of EFH, as required under the Magnuson-Stevens Act of 1996 (T. Goodger - NMFS, personal communication).

5.7.4.2 Finfish

With the exception of some small finfish, most bottom and pelagic fishes are highly mobile and should be capable of avoiding entrainment into the dredging intake stream. It is anticipated that some finfish would avoid the turbidity plume while others may become attracted to the suspension of food materials in the water column. Little impacts to fish eggs and larvae are expected because these life stages are widespread throughout the Middle Atlantic Bight, and not particularly concentrated in the borrow site or surf zone of the project area (Grosslein and Azarovitz, 1982).

The primary impact to fisheries will be felt from the immediate loss of a food source by disturbing benthic macroinvertebrate communities. Demersal finfish feed heavily on bottom dwelling species, thus, the loss of benthos and epibenthos entrained or smothered during the project will temporarily disrupt the food chain in the impact area. This effect is expected to be temporary as these areas become rapidly recolonized by infaunal and epifaunal macroinvertebrates. Table 5-1 shows that dredging for the initial beachfill would result in initial high losses of benthic forage habitat depending on the depth dredged (172 - 415 acres). However, this area would be left for benthic recruitment and recolonization, which could take several months to several years. After initial beachfill placement, periodic beach nourishments could disrupt benthic forage habitat at 30-71 acres at a time. However, each portion of Area E utilized for periodic nourishment would also be left for recolonization by benthic species. Although total disturbance to benthic forage habitat could be 667 acres to 1,600 acres over a 50-year project life (w/ periodic nourishment every 3 years), areas previously dredged through the

initial beachfill along with earlier periodic nourishments are expected to recover. This would mean that a loss of benthic forage habitat would occur at a location where the previous dredging cycle occurred, which may last a few months to a few years.

Borrow Area E contains a relatively flat, featureless bottom when compared to Borrow Area C. The combination of various diverse physical characteristics (topography, sediment type) of Area C provide a more diverse habitat, which would benefit finfish seeking a relatively protected bottom with diverse food resources. The type of bottom in Area C is relatively uncommon in the Mid-Atlantic area (J. Tinsman - DNREC- personal communication). Conversely, Area E contains little variation in bottom topography and sediment type. Three shoal areas in the potential expansion areas (northern and southern portions) of Area E are being precluded from any future dredging if expansion is required outside of the designated middle portion of Area E (see Figure 5-1). The benthic food sources found in Area E are typical for Mid-Atlantic coastal areas (Scott and Bruce 1998). From a fisheries standpoint, Area E is a preferable site over Area C in order to minimize impacts to fish resources.

Like the surfclam, areas within Delaware coastal waters may be designated essential fish habitat (EFH) for managed finfish species like bluefish (*Pomatomus saltatrix*), summer flounder (*Paralichthys dentatus*), and scup (*Stenotomus chrysops*) (Personal communication with Dr. Tom Hoff - MAFMC, T. Goodger - NMFS). Although EFH has not been designated for Delaware coastal waters, the Philadelphia District will initiate consultation procedures with NMFS as required under the Magnuson-Stevens Act of 1996 for EFH.

5.8 THREATENED AND ENDANGERED SPECIES

The piping plover, which is State and Federally listed as threatened, is an inhabitant of Delaware's sandy beaches. Nesting sites of this species have been primarily limited to Cape Henlopen State Park and Delaware Seashore State Park. No known nesting sites have been identified within the study area. Based on the high development and human disturbance, it is unlikely for piping plovers to nest within the project area. USFWS (1996) states that "except for occasional transient individuals, no Federally listed or proposed endangered or threatened species under the jurisdiction of the Fish and Wildlife Service are known to exist in the project impact area. Therefore, no Biological Assessment or further Section 7 Consultation pursuant to the Endangered Species Act of 1973 is required with the Fish and Wildlife Service."

From June through November, Delaware's coastal waters may be inhabited by transient sea turtles, especially the loggerhead (Federally listed threatened) or the Kemp's ridley (Federally listed endangered). Sea turtles have been known to be adversely impacted during dredging operations that have utilized a hopper dredge. Dredging encounters with sea turtles have been more prevalent among waters of the southern Atlantic and Gulf coasts, however, incidences of "taking" sea turtles have been increasing in waters of the Middle Atlantic Coast in hopper dredges, which utilize high-suction heads. Formal coordination with the National Marine

Fisheries Service (NMFS) in accordance with Section 7 of the Endangered Species Act has been undertaken on all Philadelphia District Corps of Engineers dredging projects utilizing a hopper dredge that may have impacts to Federally threatened or endangered species (including shortnose sturgeon, sea turtles, and marine mammals). A Biological Assessment (USACE, 1995) that discusses Philadelphia District hopper dredging activities and potential effects on Federally threatened or endangered species of sea turtles has been prepared, and was formally submitted to NMFS in accordance with Section 7 of the Endangered Species Act. A Biological Opinion (NMFS, 1996) from NMFS was completed and submitted to the Corps on November 26, 1996. The Biological Opinion provides several measures to avoid or minimize the potential for adverse effects on threatened and endangered species. Measures relevant to this project suggest that dredging (w/ a hopper dredge) be avoided between June 1 and November 30. However, if dredging (w/ a hopper dredge) must be conducted during this period, a NMFS- approved, trained sea turtle/marine mammal observer is required to be present on the dredge. The Biological Opinion provides for incidental take limits for sea turtles, and states that Section 7 Consultation must be reinitiated if the take level for any one species is exceeded (NMFS, 1996). Adherence to the findings and conditions of the Biological Opinion will insure compliance with Section 7 of the Endangered Species Act.

5.9 IMPACTS ON CULTURAL RESOURCES

5.9.1 Project Impact Areas for Cultural Resource Review

Proposed project construction has the potential to impact cultural resources in three areas. These are the existing beach, the near-shore sand placement area, and the offshore borrow area. In the existing beach and near-shore sand placement areas, potential impacts to cultural resources could be associated with the placement and compaction of sand during berm and dune construction. Sand dredging activities in the offshore borrow area could impact historic properties.

5.9.2 Impacts to Cultural Resources

On the basis of the current project plan, the Corps is of the opinion that this project will have no adverse effect on significant cultural resources in onshore beach and near-shore underwater project areas. These two areas are located in a highly unstable and shifting coastal environment where the likelihood for intact and undisturbed cultural resources is considered extremely minimal. A review of site records and historic maps indicates a low probability for historic structural remains in the project beach area. No cultural resources were identified during a low-tide shoreline pedestrian survey conducted by the District archaeologist. A remote sensing survey was not conducted in the underwater near-shore project area due to unsafe conditions in the very high energy tidal surf zone. The three properties in the Bethany Beach area currently listed on the National Register of Historic Places are located outside of the project area and will not be impacted by proposed construction.

5.9.3 Offshore Borrow Area

The remote sensing investigation of Area C identified one magnetic target exhibiting shipwreck characteristics, however, Area C is not being pursued as a sand source. The Corps of Engineers is of the opinion that proposed sand borrowing activities from the middle portion of Borrow Area E will have no effect on significant cultural resources. The remote sensing survey found no indication of submerged cultural resources. Delaware State Historic Preservation Office (DESHPO) Section 106 consultation is ongoing and will be concluded prior to any construction activity.

Vibracore samples taken from the borrow area to a depth of 20 feet below the ocean floor indicate a series of shoaled sand deposits with no substantial clay or organic layers indicating buried Pleistocene land surfaces. As currently planned, the dredging depth of the borrow area over the life of the project will not exceed this 20 foot depth.

5.9.4 Section 106 Coordination

The report of the remote sensing investigation, entitled *Submerged Cultural Resources Investigation, Delaware Atlantic Coast From Cape Henlopen to Fenwick Island* (Cox, 1994), was submitted to the Delaware State Historic Preservation Office (DESHPO) for Section 106 review and comment on February 14, 1994 (see Appendix A of Main Report).

Based on a review of project documentation, low-tide pedestrian survey and the cultural resources investigation report, the District finds that the project plan, as proposed, will have no adverse effect on significant cultural resources. DESHPO Section 106 consultation for the project is ongoing and will be completed prior to construction.

5.10 IMPACTS ON NOISE AND AIR QUALITY

Minor short-term impacts to air quality and noise levels would result from the construction phases of the berm and dune restoration alternative. Dredging activities and grading equipment use would produce noise levels in the 70 to 90 dBA (50 feet from the source) range but these would be restricted to the beach area. These noises would be masked by the high background levels of the surf or dissipated by distance. Ambient air quality would also be temporarily degraded, but emission controls and limited duration aid in minimizing the effects. In the case of equipment use associated with the periodic nourishment efforts, conducting the work in the off-season would further minimize the impact.

Noise and air quality impacts would be restricted to site construction preparation (generally beginning two weeks prior to dredging) and the actual dredging and placement operation. Noise is limited to the utilization of heavy equipment such as bulldozers to manipulate the material during placement. Additional noise may be caused by a pumpout station, if necessary. Depending on future circumstances, the construction may be conducted overnight to meet

construction schedules. Both municipalities of Bethany Beach and South Bethany have restrictive noise ordinances, however, local officials have indicated that construction activities such as this project would be exempt from noise ordinances.

Air quality impacts would similarly be limited to emissions from the heavy equipment and pumpout station (if used). Pollutant emissions discharged from heavy equipment such as dredges and dozers are regulated by the EPA on the engine manufacturers. Since dredging operations would be conducted in a "marginal" non-attainment area for ozone, equipment operations would not have any long-term adverse effects on the attainment criteria in Sussex County. Dredging and its associated construction activities is considered to be a temporary mobile operation not requiring an air quality permit from the State to be in compliance with the State Implementation Plan (Personal communication with Mr. John Thomas-DNREC Air Quality Management Section). A statement of conformity with the State Implementation Plan is provided on page 9-1 of this document.

5.11 IMPACTS ON SOCIO-ECONOMIC RESOURCES

The no action alternative would allow the beach to continue to erode, and this would increase the risk of damage to private property from flooding or direct wave action as the protective beach decreased in size. Property values would also fall as this risk became more and more perceived by the market. Recreational opportunities would also decrease with the size of the beach. This would be translated into lost tourism revenue which would have a secondary effect on employment.

Delaware beaches are consistently the number one travel destination in Delaware, and account for half of the State's visitations. It is expected that local and State efforts to attract visitation and expand their associated facilities will continue. The Delaware beaches play an extremely significant role in the well being of Delaware's tourism industry and in Delaware's overall economy.

Under the berm and dune restoration alternative, the beach berm created by the placement of suitable material and periodic nourishment would permit the accommodation of both present and expected future demands for recreational beach area along Bethany Beach and South Bethany. This influx of seasonal population is reflected by a greater demand for social services such as housing, transportation, health, safety, and sanitation facilities. Bethany Beach and South Bethany are supported by a tourist economy which they cannot afford to lose, and their expansion would provide fuller employment and greater revenues. As the demand for recreation gradually increases, it is expected that State and local efforts would be made to satisfy these needs. Because of this, noise and air quality levels would similarly degrade through personal activity and auto utilization. They will not however, become a significant problem.

Various indicators of the presence and/or level of Corps activity in beachfront communities

generally have no statistically significant relation to development in those areas. Thus, the statistical evidence indicates that the effect of the Corps on induced development is, at most, insignificant, compared to the general forces of economic growth which are stimulating development in these areas, many of which are induced through other municipal infrastructure developments such as roads, wastewater treatment facilities, etc. (U.S. Army Corps of Engineers, 1995).

5.12 RECREATION AND BEACH ACCESS

The proposed project as a secondary benefit, may improve opportunities for recreational beach use. Recreational shore and surf fishing will be temporarily affected by the project, since the public and fishermen will not be permitted to enter the actual work segments. However, since the project will be constructed in sections, only those sections actually under construction will be closed to the public. Impacts to shore and surf fishing access will be localized and relatively short-lived. A minor impact on recreational fishing will result from covering the existing groins with sand.

The proposed project will not impede public access to the beach. Public access to the beaches in Bethany Beach and South Bethany would be maintained by the construction of dune walkovers. Vehicle access ramps would be provided to allow for beach access for authorized vehicles.

5.13 AESTHETICS

Project dimensions for the berm elevation and foreshore and nearshore slopes were chosen to approximate the natural dimensions of the beach as determined from historical profiles. The maximum dune height considered during plan formulation was chosen so as not to exceed the natural dune height in the study area, estimated to be +18 ft-NAVD. The maximum berm width considered during formulation was determined based upon the average existing beach profile. Dune height and berm width for the selected plan was chosen based upon optimizing the dimensions of these features to maximize net NED benefits.

The native beach material at Bethany Beach and South Bethany is predominately a fine to medium sand with little fines and trace gravel. Material from the borrow area can be described as a gray and tan, medium to fine sand with some fines (silt and/or clay) and gravel. This material is compatible with the native material of Bethany Beach and South Bethany. In general, it is coarser than the native beach material, however, it is not drastically different in composition. Scarping could be a problem if the material was very coarse, and less so if it were finer. Since the native beach material and the borrow material are relatively close in composition, the potential for scarping is expected to be minimal. In addition, the sorting and distribution of sand that occurs with exposure to wave and current action would eventually result in a naturally graded beach similar to what existed prior to introduction of new sand.

The placement of beachfill for berm and dune restoration is a more natural and soft structural solution to reducing storm damages in Bethany Beach and South Bethany. With the exception of short-term impacts during construction, overall aesthetics of the beach would be improved as a result. A natural-looking beach and dune would be more aesthetically pleasing and attractive to residents and tourists. Despite the visual benefits the berm and dune restoration alternative would provide, a restored dune may inhibit ocean views in some project impact areas. Obstruction of an ocean view is likely to occur from the ground level, thus areas that do not have raised structures (higher than the proposed dune elevation of +16 feet NAVD) would lose an ocean view. Partial obstruction of an ocean view would occur along the boardwalk in Bethany Beach where the boardwalk elevation is +13 feet NAVD. This would result in a 3 foot visual obstruction along the base of the boardwalk. Once the proposed beachfill for the 150 ft. wide berm restoration is in place, however, the area where the waves break will be much further from the base of the boardwalk. This would make the waves easier to see from the boardwalk, thus minimizing negative aesthetic impacts.

5.14 ENVIRONMENTAL JUSTICE

The proposed action (berm and dune restoration) for Bethany Beach and South Bethany identified in this Feasibility Study is expected to comply with Executive Order 12989-Environmental Justice in Minority Populations and Low-Income Populations, dated February 11, 1994. The proposed action is not located in close proximity to a minority or low-income community, therefore, no impacts are expected to occur to any minority or low-income communities in the area.

5.15 UNAVOIDABLE ADVERSE IMPACTS

The long-term adverse impact of the no action alternative would not be to the natural environment but to the regional economic environment. Tourism and utilization would decrease as beach loss continues. As the risk of storm damage increases, property values would decrease. Actual storm damage and higher insurance premiums would erode business profits.

The long-term adverse impact of the beach nourishment alternative would be the decreased benthic community standing stocks, which would be affected during each dredging operation.

5.16 SHORT-TERM USES OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

The no action alternative does not involve short-term uses but would affect the long-term economy of the project area as indicated in Section 5.11. On the other hand, the berm and dune restoration alternative would enhance the economy by storm damage reduction as well as by providing additional recreational area.

5.17 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The no action alternative does not involve a commitment of resources. The berm and dune restoration alternative would involve the utilization of time and fossil fuels which are irreversible and irretrievable. Impacts to the benthic community would not be irreversible as benthic communities would redevelop with cessation of all dredging activity.

5.18 CUMULATIVE EFFECTS

Cumulative Impacts as defined in CEQ regulations is the "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

Projects of this nature using beachfill from an offshore borrow site are becoming increasingly common in coastal areas as areas of high development become susceptible to the erosive forces present. Numerous beachfill projects have been conducted along the Atlantic Coast since the 1960's by local, State and Federal agencies as well as private interests. Depending on circumstances such as the methods being utilized to alleviate the coastal erosion and ensuing storm damages and the existing ecological and socio-economic conditions, it is difficult to gauge the net cumulative effects of these actions. The scientific literature generally supports that beachfill projects, if planned properly, have short-term and minor adverse ecological effects, however, we are not aware of any studies that consider regional or national cumulative impacts of these projects on resources of concern.

With the exception to the sand bypass plant at Indian River Inlet, there are no other current active Federal beach nourishment projects along the Delaware Atlantic Coast. The State of Delaware has implemented several shore protection measures involving beachfill since the early 1960's. The most recent efforts involved the State placing beachfill at Fenwick Island in 1998 and 1992. Bethany Beach and South Bethany received beachfill in 1989, 1992, and 1994. Beachfill was also placed at Dewey Beach in 1994. All of these recent efforts utilized sand borrow areas offshore of Fenwick Island and the southern portion of Hen and Chickens Shoal.

Future foreseeable Federal actions in the State of Delaware involve the interim Feasibility Studies conducted or being conducted for Rehoboth Beach/Dewey Beach, Bethany Beach/South Bethany and Fenwick Island. In 1996, the Philadelphia District Corps of Engineers identified a plan to place approximately 7 million cubic yards of beachfill over a 50-year project life along the shorelines of Rehoboth Beach and Dewey Beach. This beachfill quantity of 7 million cubic yards includes periodic nourishment every 3-years during this 50-year period. A sand borrow source of 1,120 acres was identified on the southern portion of Hen and Chickens Shoal offshore of northern Rehoboth Beach. The use of this site combined with the proposed sand borrow site

for Bethany Beach/South Bethany (Area E) represent an estimated net disturbance of approximately 1,800 acres of sandy marine benthic habitat over a 50-year period. This would result in the disturbance of approximately 3.4% of marine benthic habitat within Delaware's territorial waters. Currently, the Fenwick Island area is being investigated for a potential storm damage reduction project. A number of shore protection alternatives are being evaluated at this time, therefore, a plan involving beachfill has not been identified. However, if a plan is recommended that is similar in scope, another offshore sand borrow area may be required. A potential sand borrow area was identified offshore from Fenwick Island. A conservative estimate of 1,000 acres may be required over a 50-year project. This combined with the Federal proposals for Rehoboth Beach/Dewey Beach and Bethany Beach/South Bethany could disturb a net area of approximately 2,800 acres of sandy marine benthic habitat over a 50-year period, which represents approximately 5.3% of marine benthic habitat within Delaware's territorial waters. This is predicated upon a Federal plan involving beachfill being identified for Fenwick Island. It should be noted that with implementation of any one of the Federal projects, State of Delaware activities utilizing beachfill would be greatly reduced or no longer required for the respective project area(s).

With respect to the action as proposed for Bethany Beach and South Bethany in this statement, concerns were raised with regard to the adverse cumulative impact resulting from the loss of sandy shoal or ridge and swale habitat in the region. Utilization of Borrow Area E would avoid this type of habitat because of the relatively flat, featureless topography that exists. Three small shoal areas identified in the potential expansion areas of Area E were precluded (see Figure 5-1). Therefore, the proposed use of Borrow Area E would avoid adverse cumulative effects of removing sandy shoal or ridge and swale habitat, however, disturbance of marine benthic habitat is unavoidable.

Table 5-1 illustrates marine benthic habitat impacted compared with three dredging depth scenarios within the borrow site: 5 ft, 10 ft, and 12 ft. The twelve foot deepening represents the least cumulative impact on disturbing marine benthic habitat over a 50-year period with periodic beach nourishment. This scenario results in the net disturbance of approximately 591 acres, which represents approximately 1.1% of the inshore marine benthic habitat along the Delaware Atlantic Coast. Lesser dredging depths (5 or 10 ft.) result in the disturbance of larger areas with net disturbed areas of 1,600 acres and 800 acres, respectively. It should be noted that these disturbances do not represent permanent losses of benthic habitat. Areas disturbed from a previous nourishment cycle would be avoided in subsequent nourishment cycles to become recolonized with benthic organisms. As discussed previously, these disturbances are considered a temporary impact because of expected rapid recolonization rates along with the fact that bottom structure would not be adversely impacted or lost. Therefore, cumulative impacts with respect to the use of Borrow Area E on marine biota are not considered to be significantly adverse. Project monitoring would identify any significant adverse impacts, which could be addressed through modifications to project operation.

Cumulative impacts involving marine intertidal organisms were assessed for the proposed

Federal actions along Delaware's Atlantic coast. Beachfill is proposed for a 13,500 linear foot segment of beach for the Rehoboth Beach/Dewey Beach project and a total of 14,950 linear feet for Bethany Beach/South Bethany. This constitutes a total of 28,450 linear feet (5.4 miles) of beach proposed for beachfill, which represents approximately 22% of Delaware's Atlantic coastline. It was estimated that a total of approximately 28 acres of sandy marine intertidal habitat would be periodically impacted for the combined Rehoboth Beach/Dewey Beach project and Bethany Beach/South Bethany project. Because a Federal plan has not been identified for Fenwick Island at this time, no estimates of impacted shoreline and intertidal habitat are available. The intertidal and nearshore zones are characteristic of naturally high disturbance from pounding waves and shifting sands encountered along the beaches. The adaptive measures utilized by the organisms that inhabit these areas involve high mobility and rapid reproduction, therefore, any impact involving beachfill is expected to be temporary. Because of these reasons, the cumulative impacts resulting from periodic disturbances utilizing beachfill on intertidal and nearshore organisms is not expected to be significant.

5.19 MITIGATION MEASURES

Mitigation measures are methods and techniques that can be implemented to reduce the amount of adverse environmental impacts during and after construction. The following sequence of steps, in order of priority, was identified in the Council on Environmental Quality's 1978 Regulations and should be considered in the planning process:

1. Avoid the impact by not taking a certain action or parts of the action.
2. Minimize impacts by limiting the degree or magnitude of the action and its implementation.
3. Rectify the impact by repairing, rehabilitating, or restoring the affected environment.
4. Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action.
5. Compensate for the impact by replacing or providing substitute resources or environments.

Mitigation measures were adopted for the proposed action for storm damage reduction at Bethany Beach and South Bethany. The abandonment of sand Borrow Area C and use of Area E utilizes "avoidance and minimization" as described in the Council on Environmental Quality's 1978 regulations. By not developing Area C as a sand borrow source, mitigation by avoidance is being implemented due to the more significant natural resource values placed on Area C. As an alternative, utilizing Area E minimizes adverse impacts on marine biota. However, as discussed in the preceding paragraphs, the berm and dune restoration alternative does contain unavoidable impacts to several environmental resources of concern. These impacts can be minimized by implementing several measures during construction, and operation and maintenance of the project. Mitigation measures recommended for construction, and operation and maintenance of the project involve minimizing impacts to: benthic resources, fisheries, endangered species, recreation and noise. The following measures are recommended, however, their implementation

is dependent upon the circumstances that may be encountered at the time of project construction or periodic maintenance.

5.19.1 Benthic Resources

The majority of unavoidable impacts are likely to be incurred on the benthic communities within the project area. Measures to minimize the effects of dredging in the borrow area will include dredging in a manner as to avoid the creation of deep pits, alternating locations of periodic dredging, conducting dredging during months of lowest biological activity (when possible), and the utilization of a pipeline delivery system to help minimize turbidity. Implementation of a benthic monitoring program concurrent with periodic maintenance activities would document project impacts and aid in avoiding impacts to sensitive areas during the periodic maintenance activities.

5.19.2 Fisheries

Adverse impacts to a potentially recovering surfclam population may be minimized by implementing a monitoring program for the subsequent periodic dredging in the borrow site. This monitoring may be necessary to determine if there is a commercially viable population of surfclams, and to locate areas within the proposed borrow site where surfclam densities are low enough to avoid the destruction of any significant stocks. Coordination with the appropriate resource agencies prior to periodic dredging for beach maintenance will be conducted to determine if and/or where surfclam monitoring is necessary. Impacts could be further minimized by allowing for the post-dredging conditions to contain suitable benthic substrate for recolonization and recruitment.

5.19.3 Threatened and Endangered Species

Based on coordination with appropriate resource agencies and the high development in the project impact site, it is unlikely for piping plovers to nest within the project area. However, if a piping plover nest is discovered within the project area prior to the commencement of the initial beach nourishment and periodic maintenance activities, the Corps will contact the Delaware Department of Natural Resources and Environmental Control Division of Fish and Wildlife and the U.S. Fish and Wildlife Service to determine appropriate measures to protect the piping plovers from being disturbed. These measures may include establishing a buffer zone around the nest and limiting construction in these areas to periods outside of the nesting season (1 April - 1 September).

Depending on the timing of the dredging and the type of dredge to be used, it may be necessary to implement mitigative measures to avoid adversely impacting threatened or endangered sea turtles. If a hopper dredge (with suction head) is used between June and November, NMFS approved turtle/marine mammal monitors would be present on the dredge

and would follow procedures as required in the NMFS Biological Opinion (NMFS, 1996).

5.19.4 Recreation

Beachfill operations typically occur within isolated segments, subsequently moving as the work progresses. As each work segment is completed, it can be opened for recreational use. This would allow access for recreation in all areas outside of the segment under construction.

5.19.5 Air Quality and Noise

Air quality and noise impacts can be reduced by utilizing heavy machinery fitted with approved muffling apparatus that reduces noise, vibration, and emissions. Construction activities can be scheduled for normal daytime hours to further reduce noise impacts to the surrounding communities.

5.20 NEED FOR SUPPLEMENTAL INVESTIGATIONS AND DOCUMENTATION

Supplemental information pertaining to the use of Borrow Area E was presented in a Supplemental Draft Environmental Impact Statement, which satisfies NEPA requirements for modifications to the plan as proposed in the DEIS. However, the northern and southern portion of Borrow Area E were not studied for cultural and natural resources. These areas may be utilized if the middle portion becomes depleted over the 50-year project, or if some unforseen circumstance requires the use of these areas. Prior to any expansion into the northern and southern portions, resource agencies may require that cultural, benthic and fisheries investigations be performed. Any expansion into the northern and southern portions of Area E would require appropriate permits or permit modifications and public notification.

5.21 ENVIRONMENTAL MONITORING

Environmental monitoring has been designated as an integral component of the Engineering and Design (E & D) for initial construction and for each 3-year periodic nourishment cycle under the proposed plan. Three types of monitoring may be required: (1) benthic investigations of the sand borrow areas (2) monitoring pursuant to Section 7 of the Endangered Species Act for sea turtles during dredging activities, and (3) water quality monitoring.

5.21.1 Benthic Monitoring

The objectives of the benthic monitoring are to document physical and biological changes of the impacted benthic environment in the sand borrow areas, and to provide updated data on unimpacted portions of the borrow area that would be dredged in the next nourishment cycle. As

part of the benthic monitoring plan, the dredging contractor(s) for the initial construction and periodic nourishment cycles will be required to record the coordinates of the locations of where the dredging had occurred, and to measure the bathymetry of these areas before and after the dredging is completed. This would help avoid dredging deep pits (> 12 ft.), and to document the locations of where the impacts have occurred for follow-up investigations. The impacted areas would be subsequently studied within a period of 2-3 years following dredging to document any changes in the bathymetry, sediment composition, and benthic macroinvertebrate community since it was last dredged. This would be accomplished by conducting comparisons with the baseline bathymetric, sediment composition, and benthic macroinvertebrate data. A baseline benthic study and surfclam survey was conducted for borrow Area E. In addition, monitoring for any significant concentrations of commercial surfclam stocks would be conducted in areas proposed for periodic nourishment within the confines of the established borrow site to determine if there is a viable surfclam fishery over a 50-year project life.

Specific details of the benthic monitoring would be developed and coordinated with the appropriate resource agencies prior to each periodic nourishment cycle. This allows for the Corps and other resource agencies to remain flexible to better determine monitoring needs, data gaps, and appropriate methodologies. At a minimum, the benthic monitoring would be consistent with the baseline benthic studies and surfclam surveys.

5.21.2 Threatened and Endangered Species Monitoring

As discussed previously in this document (Sections 4.8 and 5.8), there is a potential for the dredging required under the selected plan to have adverse impacts on several marine species (particularly sea turtles) protected under the Endangered Species Act. A Biological Opinion (NMFS, 1996) from the National Marine Fisheries Service (NMFS) was issued to the Philadelphia District as part of formal Section 7 Endangered Species Act consultation. The Biological Opinion requires that if a hopper dredge is used during the months of June through November, the Corps is required to have a trained, NMFS approved sea turtle/marine mammal observer. The monitoring specifications were provided by NMFS in the Biological Opinion, and are presented in Appendix A of this document (EIS). It should be noted that sea turtle/marine mammal observers are required only when a hopper dredge is used between June and November. The use of other dredges (such as bucket or hydraulic dredges) during this period or the use of a hopper dredge outside of this period do not require an observer/monitoring.

5.21.3 Water Quality Monitoring

Water quality monitoring will include monitoring of dissolved oxygen (DO) in the borrow site before, during and after dredging to determine if local hydrodynamics are adversely affected in the borrow site causing anoxic conditions near the bottom. DO levels will be monitored to determine if corrective measures in dredging technique are necessary or if different dredging depths should be used. Also, beach water quality would be monitored during beachfill operations to monitor for bacteria levels associated with sewage systems. This monitoring would

be consistent with State of Delaware methods for monitoring beach water quality. Monitoring data will be reported to the Delaware Department of Natural Resources and Environmental Control - Shellfish and Recreational Water Branch.

6.0 LIST OF PREPARERS

6.1 INDIVIDUAL CONTRIBUTORS AND THEIR RESPONSIBILITIES

The following individuals were primarily responsible for the preparation and technical support for this Environmental Impact Statement.

Individual	Responsibility
Jerry Pasquale B.S. Biology M.S. Ecology 15 Years EA and EIS Preparation and Review Experience	Technical Review and Oversight.
Steve Allen B.S. Biology 7 Years EA and EIS Preparation and Review Experience	Scoping, EIS Preparation and Coordination
Mike Swanda B.A. Archaeology M.A. Archaeology 22 Years Cultural Resource Experience	Scoping, EIS Preparation (Cultural Resources)
Shawn Hanrahan B.S. Physical Oceanography M.S. Applied Ocean Science 6 Years Project Management Experience	Study Manager
Timothy DeWire B.S. Civil Engineering 6 Years Project Management Experience	Study Manager
Keith Watson B.S. Civil Engineering M.S. Civil Engineering 13 Years Coastal Engineering Experience	Hydraulic/Coastal Engineering
Daniel Abecassis B.A. Economics 10 Years Planning Experience	Economic analysis

Thomas Heary, P.E. B.S. Civil Engineering 10 Years Project Design Experience	Civil Works Design Engineering
Michael Carnivale B.S. Civil Engineering 4 Years Geotechnical Engineering Experience	Borrow Area & Beachfill Analysis
Sterling Johnson B.S. Materials Science and Engineering Certified Cost Consultant 7 Years Cost Engineering Experience	Project Cost Estimation
Dwight Pakan, P.E. B.S. Civil Engineering M.S. Civil Engineering 12 Years Project Management Experience	Civil Works Project Management

6.2 STUDIES CONDUCTED FOR OR REPORTED IN THIS DRAFT ENVIRONMENTAL IMPACT STATEMENT

6.2.1 Benthic Evaluation

"An Evaluation and Comparison of Benthic Community Assemblages within a Potential Offshore Sand Borrow Site for the Bethany Beach and South Bethany, Delaware Interim Feasibility Study" (Kelley *et al.* 1996).

"Surfclam Survey - Delaware Coast - Cape Henlopen to Fenwick Island Feasibility Study Bethany Beach and South Bethany Interim Feasibility Study Sussex, County Delaware" (Burton 1996).

"An Evaluation and Comparison of Benthic Community Assemblages and Surfclam Populations within a Potential Offshore Sand Borrow Site (Site "E") for the Bethany Beach and South Bethany, Delaware Interim Feasibility Study" (Scott and Bruce 1998) in Appendix A of the Technical Appendices.

6.2.2 Cultural Resources

"Submerged Cultural Resources Investigation, Delaware Atlantic Coast From Cape Henlopen to Fenwick Island" (Dolan Research, Inc. 1995) in Appendix A of the Technical Appendices.

"Submerged Cultural Resources Investigation Delaware Atlantic Coast From Cape Henlopen to Fenwick Island - Addendum - Borrow Area "E" (Dolan Research, Inc. 1998) in Appendix A of the Technical Appendices.

7.0 PUBLIC INVOLVEMENT

A notice of intent to prepare a Draft Environmental Impact Statement (DEIS) for the Bethany Beach and South Bethany Storm Damage Reduction Project was published in the Federal Register on 30 July 1996. Several coordination/scoping meetings were held with Federal, State and local resource agencies. Agencies notified of this study included the U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (USEPA), National Marine Fisheries Service (NMFS), Delaware Department of Natural Resources and Environmental Control (DNREC), and Delaware State Historic Preservation Office. Information in this document was generated based on comments and concerns of the interested public. The Draft Environmental Impact Statement (DEIS) was circulated to the public for comment on 29 August 1997. Subsequently, a Supplemental Draft Environmental Impact Statement (SDEIS) was prepared and circulated to the public/resource agencies on 24 April 1998. A Public Meeting was held on 13 May 1998 to describe the feasibility study findings and proposed project features to the interested public and to solicit public comments on the proposed action. All comments received on the DEIS and SDEIS are addressed in the Comment/Response Section.

A Planning Aid Report prepared by the USFWS is provided in the pertinent correspondence section (Appendix A) of the FEIS and in Appendix B of the Main Report. A Section 2(b) Fish and Wildlife Coordination Act Report was prepared by the USFWS upon public circulation of the Draft Environmental Impact Statement and is provided in the Comment/Response Section of Appendix B (Main Report). This report provides official USFWS comments on the project pursuant to the Fish and Wildlife Coordination Act. Coordination letters and comments received for this study are also presented in the pertinent correspondence section (Appendix A) of the FEIS and in Appendix B (Main Report).

A copy of the DEIS and SDEIS was provided to the following individuals/agencies for review in addition to the interested public that requested copies :

Honorable Joseph R. Biden, Jr.
Federal Building
Rm 6021
844 King St.
Wilmington, Delaware 19801

Honorable William V. Roth, Jr.
Federal Building
Rm 3021
844 King St.
Wilmington, Delaware 19801

Honorable Michael N. Castle
Frear Federal Building
Suite 2005
Dover, Delaware 19901

Honorable Thomas R. Carper
Governor, State of Delaware
Tatnall Building
William Penn St.
Dover, Delaware 19901

Mr. Richard Sanderson, Director
Office of Federal Activities
EIS Filing Section (2252)
U.S. Environmental Protection Agency
Arial Rios Bldg. (South Oral Lobby)
Mail Code 2251-A
1200 Pennsylvania Ave., NW
Washington, DC 20044

Ms. Donna S. Wieting, Acting Director
Ecology & Conservation Div.
National Oceanic &
Atmospheric Administration
Commerce Building, Room 5813
Washington, DC 20230

Mr. Paul Cromwell
Department of Health & Human
Services
Room 531H Humphrey Building
200 Independence Avenue, SW
Washington, DC 20585

Mr. Robert Stern, Director
Office of Environmental Compliance
Department of Energy, Room 3G092
1000 Independence Avenue, SW
Washington, DC 20585

Mr. Larry Zensinger, Chief
Hazard Mitigation Branch
Public Assistance Division
Federal Emergency Management Admin.
500 C. Street, SW, Room 714
Washington, DC 20472

Mr. Robert Bush, Executive Director
Advisory Council on Historic
Preservation
The Old Post Office Building, Rm 809
1100 Pennsylvania Avenue, NW
Washington, DC 20004

Mr. Roy E. Denmark, Jr.
NEPA Review Coordinator
3EP30
U.S. Environmental
Protection Agency Region III
841 Chestnut Building
Philadelphia, PA 19107

Mr. Timothy Goodger
National Marine Fisheries Service
Oxford Laboratory
Railroad Avenue
Oxford, Maryland 21654

Dr. Willie Taylor, Director
Office of Environmental Policy &
Compliance
U.S. Department of the Interior
1849 C Street, NW Room 2340
Washington, DC 20240

Mr. John P. Wolflin, Supervisor
Chesapeake Field Office
U.S. Fish and Wildlife Service
177 Admiral Cochrane Drive
Annapolis, Maryland 21401

Mr. Roger V. Amato
Minerals Management Service
INTERMAR
381 Elden St.
Herndon, VA 22070-4817

Mr. Michael Stomackin
Environmental Officer
U.S. Department of Housing
and Urban Development
60 Park Place
Newark, NJ 07102

Ms. Rita Calvan
Regional Director
Federal Emergency Management Admin.
Region III, Liberty Square Building
105 South 7th Street
Philadelphia, PA 19106

Mr. John J. Gilbert
Division Administrator
Federal Highway Administration
Federal Office Building, Room 2101
300 S. New Street, P.O. Box 517
Dover, Delaware 19904

Commander - OAN
Fifth Coast Guard District
Federal Building
431 Crawford Street
Portsmouth, Virginia 23705-5004

Mr. David R. Keifer, Executive Director
Mid-Atlantic Fishery Management Council
Room 2115 Federal Building
300 South New Street
Dover, Delaware 19901-6790

Mr. Kenneth D. Woodruff
State of Delaware
Delaware Geological Survey
University of Delaware
Newark, Delaware 19716

Ms. Sarah Cooksey
Delaware Coastal Management Program
Division of Soil and Water
Conservation
Delaware Department of Natural
Resources and Environmental Control
89 Kings Highway, P.O. Box 1401
Dover, Delaware 19903

Mr. Gerard L. Esposito, Director
Division of Water Resources
Delaware Department of Natural
Resources and Environmental Control
89 Kings Highway
P.O. Box 1401
Dover, Delaware 19903

Mr. John Hughes, Director
Division of Soil and Water
Conservation
Delaware Department of Natural
Resources and Environmental Control
89 Kings Highway, P.O. Box 1401
Dover, Delaware 19903

Mr. William Moyer
Delaware Department of Natural
Resources and Environmental Control
Division of Water Resources
Wetlands and Aquatic Protection
Section
89 Kings Highway, P.O. Box 1401
Dover, Delaware 19903

Mr. Andrew T. Manus, Director
Division of Fish and Wildlife
Delaware Department of Natural
Resources and Environmental Control
89 Kings Highway, P.O. Box 1401
Dover, Delaware 19903

Mr. Nicholas A. Dipasquale, Director
Division of Air and Waste Management
Delaware Department of Natural Resources
and Environmental Control
89 Kings Highway, P.O. Box 1401
Dover, Delaware 19903

Christophe A.G. Tulou, Secretary
Delaware Department of Natural Resources
and Environmental Control
89 Kings Highway, P.O. Box 1401
Dover, Delaware 19903

Mr. Charles A. Salkin, Director
Division of Parks and Recreation
Delaware Department of Natural
Resources and Environmental Control
89 Kings Highway, P.O. Box 1401
Dover, Delaware 19903

Ms. Faye L. Stocum
State of Delaware
Department of State
Division of Historical and Cultural
Affairs
15 The Green
Dover, Delaware 19901

Ms. Francine Booth
Executive Department
Budget Office
State Single Point of Contact
Thomas Collins Bldg.
Dover, Delaware 19903

Ms. Elesa Cottrell
State Conservationist
1203 College Park Drive
Dover, Delaware 19904

Mr. Robert L. Stickels
County Administrator
P.O. Box 589
Georgetown, Delaware 19947

Dr. Evelyn M. Mauermeyer
Coastal & Estuarine Research, Inc.
Marine Studies Complex
P.O. Box 674
Lewes, Delaware 19958

Dr. Robert A. Dalrymple, Director
Center for Applied Coastal Research
University of Delaware
Newark, Delaware 19716

J.M. Falk, Marine Recreation Specialist
University of Delaware
College of Marine Studies
700 Pilottown Road
Lewes, Delaware 19958-1298

Mr. Fred Schmidt
Documents Librarian
Colorado State University
Fort Collins, CO 80523

Mr. Michael D'Amico
Sierra Club
Appalachian Regional Office
P.O. Box 160
Nassau, Delaware 19969

Mr. Carl Solberg
Delaware Chapter of the Sierra Club
P.O. Box 1908
Dover, Delaware 19903-1908

8.0 EVALUATION OF 404 (b)(1) GUIDELINES

I. PROJECT DESCRIPTION

A. Location

The proposed project site is located along the Atlantic Coast shoreline within the towns of Bethany Beach and South Bethany, Sussex County, Delaware. The specific areas involved are the beaches and nearshore zones of Bethany Beach and South Bethany along with one offshore sand borrow site (Area E). Coordinates (DE State Plane NAD 83 (ft.)) for the impacted areas extend linearly along the shoreline from approximately 199 185N, 759 607E (Bethany Beach) south to 185 329N, 760536E (South Bethany). The approximate corners of the entire borrow area (3,500 acres) are located at the following coordinates (DE State Plane NAD 83 (ft.)): (1) 200 000 N, 770 000E (2) 200 000N, 777 000E (3) 178 000 N, 770 000E (4) 178 000, 777 000E. Material required for initial construction and periodic nourishment will be obtained from the middle portion of Area E (775 acres), however, expansion may be required into the northern and/or southern portions of Area E during the 50-year project life. Coordinates for the corners of the middle portion of Area E are located at: (1) 190 000N, 770 000E (2) 190 000N, 777 000E (3) 185 177 N, 770 000E (4) 185 177N, 777 000E.

B. General Description

The proposed project involves reducing potential storm damages at Bethany Beach and South Bethany, Delaware by the placement of dredged material (sand) obtained from the offshore sand borrow site(s) on the beachfront in the form of a berm and dune. Specifically, the proposed plan for Bethany Beach is beachfill with a berm width of 150 ft. and a dune with an elevation of +16 ft NAVD and for South Bethany the plan is beachfill with a 150 ft. berm width and dune with an elevation of +16 ft NAVD. These plans were chosen because they provided the maximum net excess benefits over costs based on storm damage reduction. Details of the selected plan are shown in Figures 3-3 through 3-6 of the FEIS.

The proposed hurricane and storm damage reduction plan consists of two distinct project areas, one covering the town of Bethany Beach and the other covering the town of South Bethany. Each project was optimized separately since each town is a distinct physical area and is separated from the other by approximately 3,500 feet of private beach.

For Bethany Beach, a berm would extend seaward 150 ft from the design line at an elevation of +7 ft NAVD. For South Bethany, a berm would extend seaward 150 ft from the design line at an elevation of +7 ft NAVD. Both berm plans would have a foreshore slope of 1V:15H to mean low water (MLW). From MLW seaward, the slope would parallel the bottom out to the depth of closure.

The beachfill project for Bethany Beach extends along the entire length of the town with the taper area extending approximately 1,000 ft. to the north and south of the town borders. Likewise, the beachfill project for South Bethany extends along the entire length of the town with the taper area extending approximately 1,000 ft. to the north and south of the town borders. The total length of both proposed beachfill projects is approximately 14,950 l.f.

On top of both berm plans in both communities a dune would be constructed with a top elevation of +16 ft NAVD and a top width of 25 ft. The landward and seaward slope of the dune face would be 1V:5H.

A total sand fill quantity of 3,453,000 cubic yards is needed for the initial fill placement in Bethany Beach and South Bethany.

24 acres of planted dune grass and 23,157 l.f. of sand fence for entrapment of sand on the dune and delineating walkovers and vehicle access ramps would be installed.

41 dune walkovers (one at each street end) and 1 vehicle access way over the dune in Bethany Beach would be provided. The vehicle access for South Bethany is located approximately a quarter mile south of the southern limit of town in the State Beach area.

Renourishment of approximately 480,000 cubic yards of sand fill from the offshore borrow area every 3 years for the 50 year project life is included.

Beachfill for the proposed project would be obtained from one offshore borrow area (Area E) located approximately 1.9 -3.0 miles offshore of the Bethany Beach/South Bethany area.

C. Authority and Purpose

The authority for the proposed project is the resolution of the Committee on Environment and Public Works of the United States Senate dated 23 June 1988. This resolution reads as follows:

> "RESOLVED BY THE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS OF THE UNITED STATES SENATE, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the Rivers and Harbors Act, approved June 13, 1902, be, and is hereby requested to review the report on the Delaware Coast from Kitts Hummock to Fenwick Island, Delaware, published as House Document Number 85-216, and other reports, with a view to determining the advisability of providing improvements in the interest of beach erosion control, hurricane protection, and related purposes, along the Delaware Coast from Cape Henlopen to Fenwick Island. Included in this study will be the development of a physical and engineering data base on coastal area changes and processes, including appropriate monitoring during development of the data base, as the

basis for actions to prevent the harmful effects of shoreline erosion and storm damage."

The purpose of the project is to reduce storm damages to the beaches and oceanfront structures of Bethany Beach and South Bethany, Sussex County, Delaware.

D. General Description of Dredged or Fill Material

1. The proposed dredged material is medium to fine sand with small amounts of gravel present. Clay, silt, and organic content are low with neutral pH and low fertility..

2. The quantity required is estimated to be approximately 3.45 million cubic yards initially with approximately 480,000 cubic yards every 3 years comprising periodic nourishment over a 50-year project life.

3. The proposed source of the borrow material is from a relatively flat area (Area E) approximately 1.9 miles offshore from Bethany Beach and South Bethany. The size of the borrow area is approximately 3,500 acres (total). 775 acres of Area "E" (middle portion) will be used for initial construction and periodic nourishments, however, the remaining portions of Area E (northern and/or southern portions) may be used if future expansion is required. The mean depth within the borrow area is -42.6 feet MLW. Dredging would occur in depths ranging from -33 feet to -48 feet MLW.

E. Description of the Proposed Discharge Site

1. The proposed discharge location is depicted in Figures 3-2 through 3-6 of the FEIS.

2. The proposed discharge is comprised of an eroding berm approximately 14,950 linear feet long with a minimum design berm width of 150 feet in Bethany Beach and South Bethany. The total area impacted from beachfill placed below mean high water is approximately 140 acres in Bethany Beach and 110 acres in South Bethany. The total intertidal area impacted is approximately 9 acres in Bethany Beach and 8 acres in South Bethany.

3. The proposed discharge site is unconfined with placement to occur on a shoreline area.

4. The type of habitat present at the proposed location is marine sandy beach intertidal/subtidal, nearshore, and offshore habitat.

5. Berm and Dune restoration will be accomplished by the placement of beachfill. This plan will require approximately 3.45 million cubic yards of sand for initial beachfill placement with approximately 480,000 cubic yards for periodic re-

nourishments every 3 years over a 50 year project life. The proposed plan includes approximately a total of 14,950 linear feet of beachfill to be placed. A 1,000 ft. taper would extend beyond the northern and southern limits of both communities. The beachfill placement will result in a berm width of 150 ft and elevation of +7 ft. NAVD in both communities. A dune at an elevation of +16 feet NAVD would also be constructed in both communities.

6. Initial construction would result in the placement of approximately 105,100 cubic yards of sand at Bethany Beach and 125,800 cubic yards of sand at South Bethany between Mean High Water and Mean Low Water (Intertidal Zone). Approximately 934,100 cubic yards of sand at Bethany Beach and 1,118,400 cubic yards of sand at South Bethany would be placed below Mean High Water during initial construction. Approximately 829,000 cubic yards of sand at Bethany Beach and 992,600 cubic yards of sand at South Bethany would be placed below Mean Low Water (MLW).

F. Description of Disposal Method

A hydraulic dredge or hopper dredge would be used to excavate the borrow material from the borrow area. The material would be transported using a pipeline delivery system to the beachfill placement site. Subsequently, final grading would be accomplished using standard construction equipment.

II. FACTUAL DETERMINATION

A. Physical Substrate Determinations

1. The final proposed elevation of the beach substrate after fill placement would be +7 feet NAVD at the top of the berm. The proposed profile would have a foreshore slope of 15H:1V and an underwater slope that parallels the existing bottom to the depth of closure.

2. The sediment type involved would be clean sand.

3. The planned construction would establish a construction template which is higher than the final intended design template or profile. It is expected that compaction and erosion would be the primary processes resulting in the change to the design template. Also, the loss of fine grain material into the water column would occur during the initial settlement.

4. The proposed construction would result in removal of the benthic community from the borrow area, and burial of the existing beach and nearshore benthic communities wher this material is put in place during berm construction.

5. Other effects would include a temporary increase in suspended sediment load and a change in the beach profile, particularly in reference to elevation.

6. Topographic changes in the offshore borrow area would result from deepening the existing flat bottom by ten to twelve feet. Creation of deep pits in the offshore area would be avoided.

6. Actions taken to minimize impacts include selection of fill material that is similar in nature to the pre-existing substrate, and the avoidance of the creation of deep pits from sand extraction from the borrow site . Also, standard construction practices to minimize turbidity and erosion would be employed.

B. Water Circulation, Fluctuation, and Salinity Determinations

1. Water. Consider effects on:

   a. Salinity - No effect.
   b. Water chemistry - No significant effect.
   c. Clarity - Minor short-term increase in turbidity during construction.
   d. Color - No effect.
   e. Odor - No effect.
   f. Taste - No effect.
   g. Dissolved gas levels - No significant effect.
   h. Nutrients - Minor effect.
   i. Eutrophication - No effect.
   j. Others as appropriate - None.

2. Current patterns and circulation

   a. Current patterns and flow - Circulation would only be impacted by the proposed work in the immediate vicinity of the borrow area, and in the beach zone where the existing circulation pattern would be offset seaward the width of the beach nourishment.

   b. Velocity - No effects on tidal velocity and longshore current velocity regimes.

   c. Stratification - Thermal stratification occurs beyond the mixing region created by the surf zone. There is a potential for both winter and summer stratification. The normal pattern should continue after construction of the proposed project.

d. Hydrologic regime - The regime is largely marine and oceanic. This will remain the case following construction of the proposed project.

3. Normal water level fluctuations - The tides are semidiurnal with a mean tide range of 3.9 feet and a spring tide range of 4.7 feet in the ocean. Construction of the proposed work would not affect the tidal regime.

4. Salinity gradients - There should be no significant effect on the existing salinity gradients.

5. Actions that will be taken to minimize impacts- None are required: however, the borrow area would be excavated in a manner to approximate natural slopes and contours to ensure normal water exchange and circulation. Utilization of sand from a clean, high energy environment and its excavation with a hydraulic dredge would also minimize water chemistry impacts.

C. Suspended Particulate/Turbidity Determinations

1. Expected Changes in Suspended Particulates and Turbidity Levels in the Vicinity of the Disposal Site and Borrow Site - There would be a short-term elevation of suspended particulate concentrations during construction phases in the immediate vicinity of the dredging and the discharge. Elevated levels of particulate concentrations at the discharge locations may also result from "washout" after beachfill is placed.

2. Effects (degree and duration) on Chemical and Physical Properties of the Water Column -

a. Light penetration - Short-term, limited reductions would be expected at the borrow and discharge sites from dredge activity and berm washout, respectively.

b. Dissolved oxygen - There is a potential for a decrease in dissolved oxygen levels but the anticipated low levels of organics in the borrow material should not generate a high, if any, oxygen demand.

c. Toxic metals and organics - Because the borrow material originates from a clean, high energy environment, and because it is essentially all medium to fine sand, no toxic metals or organics are anticipated.

d. Pathogens - Pathogenic organisms are not known or expected to be a problem in the borrow or beachfill placement area. The nearest portion of the sand borrow area is outside of the 1/2 mile shellfish harvest buffer

zone of the South Coastal Wastewater Treatment Plant outfall pipe. This buffer zone was established by DNREC. Water quality monitoring for pathogens would be coordinated with DNREC during beachfill placement.

e. Aesthetics - Construction activities and the initial construction template associated with the fill site would result in a minor, short-term degradation of aesthetics.

3. Effects on Biota

a. Primary production, photosynthesis - Minor, short-term effects related to turbidity.

b. Suspension/filter feeders - Minor, short-term effects related to suspended particulates outside the immediate deposition zone. Sessile organisms would be subject to burial if within the deposition area.

c. Sight feeders - Minor, short-term effects related to turbidity.

4. Actions taken to minimize impacts include the selection of clean sand with a small fine grain component and a low organic content. Standard construction practices would also be employed to minimize turbidity and erosion.

D. Contaminant Determinations

The discharge material is not expected to introduce, relocate, or increase contaminant levels at either the borrow or placement sites. This is assumed based on the characteristics of the sediment, the proximity of the borrow site to sources of contamination, the area's hydrodynamic regime, and existing water quality.

E. Aquatic Ecosystem and Organism Determinations

1. Effects on Plankton - The effects on plankton should be minor and mostly related to light level reduction due to turbidity. Significant dissolved oxygen level reductions are not anticipated.

2. Effects on Benthos - Although there is a major disruption of the benthic community in the borrow area when the fill material is excavated, the 404(b)(1) analysis focuses on the disposal area effects. Here the disruption is as significant as the entire community is subject to burial or displacement; however, the actual biomass of organisms impacted is far less due to the more dynamic environmental conditions present on the beach and in the surf zone. The loss is somewhat offset

by the expected rapid opportunistic recolonization from adjacent areas that would occur following cessation of construction activities. Recolonization is expected to occur in the disposal (beachfill placement) area through horizontal and in some cases vertical migrations of benthos. Recolonization within the borrow area is expected to occur via pelagic larval recruitment and horizontal migrations.

3. Effects on Nekton - Only a temporary displacement is expected as the nekton would probably avoid the active work area.

4. Effects on Aquatic Food Web - Only a minor, short-term impact on the food web is anticipated. This impact would extend beyond the construction period until the recolonization of buried areas had occurred.

5. Effect on Special Aquatic Sites - No special aquatic sites are present within the project area.

6. Threatened and Endangered Species - The piping plover (*Charadrius melodus*), a Federal and State threatened species, utilizes sandy beach habitat. This bird nests on the beach, however, no nesting sites have been reported within the project area. Several species of threatened and endangered sea turtles may be migrating through the sand borrow area depending on the time of year. Sea turtles have been known to become entrained and subsequently destroyed by suction hopper dredges. Use of a hopper dredge during a time of high likely presence in the area could potentially entrain and destroy a sea turtle(s).

7. Other Wildlife - The proposed plan would not significantly affect other wildlife.

8. Actions to minimize impacts - Impacts to benthic resources can be minimized at the borrow area by dredging in a manner as to avoid the creation of deep pits and allow disturbed areas in the borrow site to recover without future disturbance from dredging. Depending on the timing of the dredging and the type of dredge to be used, it may be necessary to implement mitigative measures to avoid adversely impacting threatened or endangered sea turtles. If a hopper dredge (with suction head) is used, measures to avoid or minimize impacts to these species may include utilizing NMFS approved turtle monitors, as required in formal Section 7 Endangered Species Act coordination. It is not necessary to implement this measure if dredging is conducted within the winter months when turtle activity is lowest in this area or if a hopper dredge is not required.

F. Proposed Disposal (Beachfill Placement) Site Determinations

1. Mixing Zone Determination

   a. Depth of water - 0 to-20 feet mean low water
   b. Current velocity - Generally under 3 feet per second
   c. Degree of turbulence - Moderate to high
   d. Stratification - None
   e. Discharge vessel speed and direction - Not applicable
   f. Rate of discharge - Typically this is estimated to be 780 cubic yards per hour
   g. Dredged material characteristics - medium-fine sand
   h. Number of discharge actions per unit time - Continuous over the construction period

2. Determination of compliance with applicable water quality standards - Prior to construction, a Section 401 Water Quality Certificate and consistency concurrence with the State's Coastal Zone Management Program will be obtained from the State of Delaware.

3. Potential Effects on Human Use Characteristics -

   a. Municipal and private water supply - No effect
   b. Recreational and commercial fisheries - Short-term effect during construction; there would be a minor loss of surfclam stocks within the borrow area from dredging. Loss of benthos would result in temporary loss of food source for finfish.
   c. Water related recreation - Short-term effect during construction
   d. Aesthetics - Short-term effect during construction
   e. Parks, national and historic monuments, national seashores, wilderness areas, etc. - No effect

G. Determination of Cumulative Effects on the Aquatic Ecosystem- None anticipated.

H. Determination of Secondary Effects on the Aquatic Ecosystem -Any secondary effects would be minor and of short duration.

III. FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

A. No significant adaptation of the Section 404(b)(1) Guidelines were made relative to this evaluation.

B. The alternative measures considered for accomplishing the project objectives are detailed in Section 3.0 of the FEIS document of which this 404(b)(1) analysis is a part.

C. A Section 401 water quality certificate will be obtained from the Delaware Department of Natural Resources and Environmental Control.

D. The proposed action will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

E. The proposed action will comply with the Endangered Species Act of 1973. Formal Section 7 coordination procedures have been completed.

F. The proposed action will not violate the protective measures for any Marine Sanctuaries designated by the Marine Protection, Research, and Sanctuaries Act of 1972.

G. The proposed action will not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. Significant adverse effects on life stages of aquatic life and other wildlife dependent on aquatic ecosystems; aquatic ecosystem diversity, productivity, and stability; and recreational, aesthetic, and economic values will not occur.

H. Appropriate steps to minimize potential adverse impacts of the discharge on aquatic systems include selection of borrow material that is low in silt content, has little organic material, and is uncontaminated.

I. On the basis of the guidelines, the proposed disposal (beachfill placement) site for the dredged material is specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem.

9.0 CLEAN AIR ACT STATEMENT OF CONFORMITY

CLEAN AIR ACT
STATEMENT OF CONFORMITY
BETHANY BEACH AND SOUTH BETHANY INTERIM FEASIBILITY STUDY
SUSSEX COUNTY, DELAWARE

Based on the conformity analysis in the subject report, I have determined that the proposed action conforms to the applicable State Implementation Plan (SIP), the Environmental Protection Agency had no adverse comments under their Clean Air Act authority. No comments from the state air quality management district were received during coordination of the draft feasibility report. The proposed project would comply with Section 176 (c)(1) of the Clean Air Act Amendments of 1990.

7/9/98
Date

Jeff M. Ryscavage
Major, Corps of Engineers
Acting District Engineer

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APPENDIX A
MONITORING SPECIFICATIONS FOR HOPPER DREDGES

APPENDIX A

Monitoring Specifications for Hopper Dredges

I. EQUIPMENT SPECIFICATIONS

A. Baskets or screening must be installed over either the hopper inflows or overflows with openings of approximately 4 inches by 4 inches to provide 100% coverage of all dredged material and shall remain in place during all dredging operations between June 1 and November 30 of any calendar year.

B. Suction pumps on the dredge should not be activated until the dragheads are in the sediment, and will be turned off before the dragheads are raised.

C. Floodlights must be installed to allow the NMFS-approved observer to safely observe and monitor the baskets or screens.

D. Sufficient time must be allotted between each dredging cycle for the NMFS-approved observer to inspect the baskets and screens for sea turtles and/or turtle parts and document the findings.

II. OBSERVER PROTOCOL

A. A NMFS-approved observer with demonstrated ability to identify sea turtle species and marine mammals must be placed aboard the dredge(s) being used; starting immediately upon project commencement to monitor for the presence of sea turtles and/or sea turtle parts being pulled into the hopper during dredging operations and marine mammals in the vicinity of dredge and disposal operations.

B. One NMFS-approved observer is to be onboard for the first week of dredging and subsequent shifts would proceed one week on and one week off duty until project completion or mid-November, whichever comes first. While onboard, observers shall provide the required inspection coverage on a rotating basis of six hours on and six hours off each day. Combined monitoring periods would then represent 50% of total dredging time through one dredging cycle with 25% of total dredging time having been monitored by observers. Observer data will be evaluated after the first cycle of dredging to determine if monitoring is necessary for the next cycle of dredging (not to be confused with loading cycle).

C. During the required inspection coverage, the trained sea turtle/marine mammal NMFS-approved observer shall inspect the galvanized screens at the

completion of each loading cycle for sea turtles or sea turtle parts. Observation sheets and major incident reports shall be prepared by the observer using a format approved by NMFS (copy attached). The observation sheet shall be completed for each loading cycle, whether sea turtles/marine mammals are present or not. Weekly reports including all completed load sheets and relevant incident reports, as well as a final report, are to be submitted to the attention of Laurie Silva, NMFS, Habitat and Protected Resources Division, One Blackburn Drive, Gloucester, Massachusetts 01930 and the Regulatory Branch of the Philadelphia Corps of Engineers within seven days of completion of each observation period.

D. For each sighting of an endangered or threatened marine species, record the following information (the attached "Daily Whale Reporting Form" can be used for marine mammals):

(1) Date, time, coordinates of vessel
(2) Visibility, weather, seastate
(3) Vector of sighting (distance, bearing)
(4) Duration of sighting
(5) Species and number of animals
(6) Observed behaviors (feeding, diving, breaching, etc.)
(7) Description of interaction with the operation

E. If any parts or whole turtles are taken incidental to the project(s), Laurie Silva [(508)281-9291] or Kim Thounhurst [(508)281-9138] must be contacted within 24 hours of the take. Any dead sea turtles or turtle parts taken shall be placed in plastic bags and labeled to note location, load number, and time taken, and placed in cold storage. Dead turtles or turtle parts will be further labeled as recent or old kills based on evidence such as fresh blood, odor, and length of time in water since death. Disposition of dead sea turtles or sea turtle parts will be determined by NMFS. Live, uninjured or live, injured turtles will be held onboard the dredge until such time as the trained NMFS-approved observer decides that the turtle is ready for release away from the dredge site, or should be transported to the appropriate stranding network members (**for New Jersey**) the Marine Mammal Stranding Center, P.O. Box 773, Brigantine, NJ (Bob Schoelkopf (609)266-0538) for rehabilitation, and (**for Delaware**) the Delaware Division of Natural Resources and Environmental Control (Leon Spence (302)739-4782).

Any marine mammal injuries or mortality should be reported immediately to the appropriate stranding network member listed in the preceding paragraph **and** NMFS stranding network coordinator, Kim Thounhurst at (508)281-9138.

COMMENTS AND RESPONSES FOR DRAFT FEASIBILITY REPORT AND DRAFT ENVIRONMENTAL IMPACT STATEMENT

UNITED STATES DEPARTMENT OF COMMERCE
Office of the Under Secretary for
Oceans and Atmosphere
Washington, D.C. 20230

October 6, 1997

Mr. Robert L. Callegari
Chief, Planning Division
Philadelphia District, COE, DOE
Wanamaker Building, 100 Penn Square East
Philadelphia, Pennsylvania 19107-~~3291~~3310

Dear Mr. Callegari:

Enclosed are comments on the Draft Environmental Impact Statement for Delaware Coast from Cape Henlopen to Fenwick Island South Bethany, Delaware. We hope our comments will assist you. Thank you for giving us an opportunity to review this document.

Sincerely,

Susan B. Fruchter

Susan B. Fruchter
Acting NEPA Coordinator

Enclosure

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
National Geodetic Survey
Silver Spring, Maryland 20910-3282

SEP 2 9 1997

MEMORANDUM FOR: Donna Wieting
Acting Director, Ecology and Conservation Office

FROM: for Captain Lewis A. Lapine, NOAA
Director, National Geodetic Survey

SUBJECT: DEIS-9708-06--Delaware Coast from Cape Henlopen to Fenwick Island, South Bethany, Delaware

The subject statement has been reviewed within the areas of the National Geodetic Survey's (NGS) responsibility and expertise and in terms of the impact of the proposed actions on NGS activities and projects.

All available geodetic control information about horizontal and vertical geodetic control monuments in the subject area is contained on the NGS home page at the following Internet World Wide Web address: http://www.ngs.noaa.gov. After entering the NGS home page, please access the topic "Products and Services" and then access the menu item "Data Sheet." This menu item will allow you to directly access geodetic control monument information from the NGS data base for the subject area project. This information should be reviewed for identifying the location and designation of any geodetic control monuments that may be affected by the proposed project.

1. If there are any planned activities which will disturb or destroy these monuments, NGS requires not less than 90 days' notification in advance of such activities in order to plan for their relocation. NGS recommends that funding for this project includes the cost of any relocation(s) required.

For further information about these monuments, please contact John Spencer; SSMC3, NOAA, N/NGS; 1315 East West Highway; Silver Spring, Maryland 20910; telephone: 301-713-3169; fax: 301-713-4175.

This beach erosion control effort will involve initial beach fill and subsequent replenishment every three years using sand from designated offshore borrow sites. It will also involve planting of dune grasses and fencing of dune areas. It will not

1. No geodetic control monuments were located within the project impact area. The Philadelphia District will contact NGS if plans change that may affect any monuments.

directly affect the safety of navigation in the area or changes to charted shoreline on charts 12211, 12214, and 12216. Any significant deepening of charted borrow areas would be reflected on future editions based on project completion surveys provided by the U.S. Army Corps of Engineers. There are no related references to the beach area in United States Coast Pilot 3.

For further information about these charting activities, please contact Howard Danley, NOAA, NOS, Office of Coast Survey, N/CS28, 1315 East West Highway, Silver Spring, Maryland 20910.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Habitat Conservation Division
904 South Morris Street
Oxford, Maryland 21654

3 October 1997

MEMORANDUM FOR: Susan B. Fruchter

FROM: Tim Goodger

SUBJECT: DEIS - 9708-06--Delaware Coast from Cape Henlopen to Fenwick Island South Bethany, Delaware

We have reviewed the referenced document, and offer the attached comments for your consideration.

General Comments: The document attempts to diminish potential impacts to the proposed borrow area, Site C. Site C supports a diverse and abundant benthic community, including high densities of juvenile surf clams (Spisula solidissima). The ecological productivity of Site C can be attributed to a variety of factors, in particular the structural heterogeneity associated with its ridge and swale bathymetry, which will be substantially degraded by project implementation.

1.

2. As stated in the document, Site C does not contain sufficient material (14.2 million cubic yards) to sustain the project for its intended 50-year life. The site contains 5 million cubic yards of usable material, which only provides enough sand for the initial nourishment and two maintenance cycles. Consequently, borrow material existing in the site will be exhausted long before the effective life of the project is complete. Because the sand suitable for beach nourishment is found in the ridges, the site will be leveled or converted to borrow pits following implementation, and an additional site still will be needed to complete the project. In any event, the structural component of the habitat, as well as suitable grain-size sediments, will be lost rendering it unsuitable for recolonization by many of the species now found there, especially the surf clam.

3. Site E has been identified as a potential supplementary borrow site which has not as yet been characterized. It is also stated in the feasibility study (page V-6) that, should all approvals be obtained prior to initial construction, all the borrow could and would be mined from Site E, which has a capacity of 25 million cubic yards. In light of the known habitat values associated with Site C, as well as its lack of capacity to satisfy the project needs, we recommend that project implementation be deferred until evaluation of Site E is completed.

Specific Comments:

4. 3.3.1 Identification of Sand Borrow Areas (pp 3-14--3-16): It is stated that two potential borrow areas, sites E and N-S, have suitable volumes of sand to satisfy nourishment needs for the life of the project. Further, it is stated that Site E will be characterized for engineering, environmental, and cultural factors. No additional reference, however, is made to Site N-S. Will Site N-S be further evaluated; and if not, why not? We reiterate our position that no dredging occur in Site C prior to completion of the evaluation of alternative sites.

5. 4.7.3.3.1 Shellfish (pp 4-16--4-23): Undue emphasis is placed in this section, and elsewhere in the document, on the fact that no commercial quantities of surf clams were found in the proposed borrow site. Little emphasis, however, is placed on the relatively high densities of juvenile surf clams reported from the July 1995 survey (96.59/m2), and the potential for this stock to restore the commercial fishery that existed historically. The 2 cm clams that

1. Area C is no longer considered a sand borrow site for this project. The Supplemental Draft Environmental Impact Statement (SDEIS) identified Area E as the preferred sand borrow site. Area E contains substantially less structural heterogeneity than Area C, therefore, we expect fisheries impacts to be reduced by utilizing Area E.

2. Based on recent analyses on Area E, Area E contains sufficient quantities to support initial sand placement and periodic nourishments over the 50-year project. Therefore, utilization of Area C will not be required.

3. Please see responses 1 and 2.

4. In paragraph 3.3.1 of the FEIS, it is stated that two potential borrow areas exist. Site E and S-N (not N-S) both contain enough material to supply the 50-year project life for the proposed Bethany Beach/South Bethany project. Site S-N has been renamed Area "G", and contains approximately 90 million yd^3 of beach quality material. Since Area C did not contain adequate quantities, Area E was chosen as the proposed sand source. During the subsequent investigation of Area E, several vibrocores were taken in Area G (Area S-N) to classify the material in the event that the material in Area E was deemed unsuitable. Any reference to Area S-N will be changed to Area G to avoid any future confusion.

were collected are probably young of the year spawned the preceding fall, which would not recruit into the fishery until reaching 12 cm, at approximately age 7 (MAFMC, FMP for Surf Clam and Ocean Quahog Fishery, Amendment #8, 1988). Conceivably, even after considering annual natural mortality, sufficient numbers could survive to support a commercial fishery early in the next century. This, however, cannot be definitively determined without future monitoring. Regardless, no expectations for a commercial fishery can be realized if the habitat is irreparably degraded through sand mining.

5.7.4 **Shellfish** (pp 5-6--5-7): Comments relative to Section 4.7.3.3.1 also pertain to this section.

6. **5.19 MITIGATION MEASURES** (page 5-13): As stated, the first premise of mitigation is avoidance. If, following completion of evaluations for Site E and Site N-S, it is found that alternative sand mining areas are available that will result in less significant adverse impacts than will result at Site C, sand mining at Site C should be avoided.

5.21.1 Benthic Monitoring (page 5-16, paragraph 1, last sentence): Comments relative to Section 4.7.3.3.1 also pertain to this statement.

5. The text was modified to discuss surfclam densities of Area E and compare with Area C. The mean abundance of juvenile surfclams (< 2 cm) was significantly lower in Area E than the sandbar habitat of Area C. Only one commercial sized surfclam (120 mm) was found in the commercial surveys for Area E.

6. As stated in responses 1 and 2, Area C was dropped from consideration after various analyses were completed for Area E. It is expected that utilization of Area E would further minimize adverse effects.

United States Department of the Interior

OFFICE OF THE SOLICITOR
Washington, D.C. 20240

OCT - 7 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corps of Engineers
Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Re: Public Notice No. CENAP-PL-E-97-08, Beach Nourishment, Delaware Coast From Cape Henlopen to Fenwick Island-Bethany Beach/South Bethany Interim Feasibility Study Sussex County, Delaware

Dear Mr Callegari:

The U.S. Army Corps of Engineers (Corps) is considering the referenced project, which includes using sand obtained from an offshore borrow site for beach nourishment in Sussex County, Delaware. Under the Submerged Lands Act, 43 U.S.C. §§ 1301-1315, the proposed work would extend Delaware's coastline. Thus the State/Federal offshore boundary would be extended, thereby reducing the area of Federal jurisdiction on the outer Continental Shelf. Specifically, the State/Federal offshore boundary in Blocks 419, 463 and 507 on Official Protraction Diagram NJ 18-5 would be extended seaward.

In the case of non-Federal projects that extend the coastline, the Code of Federal Regulations, 33 C.F.R. § 320.4(f), requires that applications for Corps permits which would extend the coastline be reviewed by the Solicitor of the Department of the Interior before the Corps takes any final action. The Solicitor's Office routinely requests the Corps to obtain a disclaimer from the State prior to approval of such permits. In the disclaimer, the State would agree that the proposed work does not extend the State/Federal offshore boundary. Such a disclaimer would not affect property or claims to which the State is otherwise entitled.

1. Although 33 C.F.R. § 320.4(f) does not apply to Federal projects, we believe that the United States should take similar steps to protect its interest in offshore lands when it undertakes a Federal project. Therefore, we request that prior to conducting the beach nourishment, the Corps obtain a disclaimer from Delaware agreeing that the proposed work will not affect the State/Federal offshore boundary.

1. Please refer to the disclaimer letter from Delaware (following this letter). The Delaware disclaimer concerns a Department of the Army Permit for beach replenishment (to be conducted by the State) along three areas (including Bethany Beach/South Bethany) of Delaware's coastline. Delaware provided us this disclaimer for the Federal project in response to comment #1.

If Delaware refuses to provide a disclaimer, we request that the Corps meet with us to discuss this issue prior to your final determination regarding the implementation of the beach nourishment project.

If you have any questions, please contact Howard Chalker of my staff at (202) 208-5370.

Sincerely,

Peter J. Schaumberg
Deputy Associate Solicitor
Division of Mineral Resources

cc: Regional Mgr., Atlantic OCS Region, MMS
Chief, OCS Survey Group, MMS

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
89 KINGS HIGHWAY
P.O. BOX 1401
DOVER, DELAWARE 19903
TELEPHONE: (302) 739-4411

April 9, 1998

Lt. Col. Robert B. Keyser
District Engineer
U.S. Army Corps of Engineers
Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

RE: Public Notice CENAP-OP-R-199800591-23
Beach Nourishment, Towns of Dewey Beach, Bethany Beach, South Bethany and Fenwick Island, Sussex County, Delaware

Dear Colonel Keyser:

The State of Delaware fully supports the proposed beach replenishment project at Dewey Beach, Bethany Beach, South Bethany and Fenwick Island, in Sussex County, Delaware. It would extend the current shoreline a maximum of 130 feet seaward (east). The Department of the Interior is concerned that this extension would likewise extend the State's offshore boundary. However, the sole purpose of this project is to restore the mean high tide line to its location prior to recent storm damage.

It is Delaware's opinion that its offshore boundary was not affected by the avulsion resulting from recent storm damage to its shoreline and, therefore, that Delaware's offshore boundary would likewise not be affected by this project. The appropriate State claim of ownership, in its view, is the area measured from the mean high water line at each project location before recent storm damage out to a line three (3) miles offshore.

The Department of the Interior does not intend that the State of Delaware waive any of its proper claim of title. However, it does require that the State waive any reliance upon this project extending the State's territorial boundary.

Accordingly, the State of Delaware agrees that the project referenced above is not intended to affect the delimitation of the coastline with respect to the Federal Submerged Lands Act and the subsequent location of the State/Federal offshore boundary.

Based upon the final determination by the United States Supreme Court in United States of America v Alaska, No. 118, original, 1992, it is acknowledged that the Secretary of the Army has the legal authority under the River and Harbors Act to condition the permit for the aforementioned project, should one be issued, on this disclaimer.

Sincerely,

John A. Hughes
Director

cf: Mr. Peter J. Schaumberg
✓Mr. Frank J. Cianfrani
Mr. John Brundage

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
Custom House, Room 244
200 Chestnut Street
Philadelphia, Pennsylvania 19106-2904

IN REPLY REFER TO:

October 8, 1997

ER 97/505

Robert L. Callegari, Chief
Planning Division, Philadelphia District
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

The Department of the Interior (Department) has reviewed the Philadelphia District's April 1997 report entitled "Bethany Beach/South Bethany Interim Feasibility Study, Draft Feasibility Report and Draft Environmental Impact Statement." Please consider these comments in completing the final version of the report.

General Comments

The document adequately describes most anticipated adverse impacts for which the Department has jurisdiction or special expertise. We recommend the following modifications for inclusion in the final document in order to clarify specific portions of the text.

Specific Comments

1. P. II-29. The status of the bald eagle should be changed from Federally "endangered" to "threatened". Also, please note that the bog turtle is Federally proposed as threatened.

2. P. DEIS 5-5. The document states that it would be preferable to alternate the borrow locations because it would allow more time for the disturbed area to be recolonized. This reasoning overlooks the impact on the benthic organisms at the new borrow location. A better reason to vary the borrow locations is that this would reduce the potential for creating undesirable deep pits or causing other substantial changes in the bottom topography. Please note this in the text.

Thank you for the opportunity to present these comments. Any questions or further coordination on fish and wildlife resources should be directed to George Ruddy of the U.S. Fish and Wildlife Service's Chesapeake Bay Field Office at (410) 573-4528.

Sincerely,

Don Henne
Regional Environmental Officer

1. Concur. Please refer to Table 4-7 for changes.

2. Section 5.7.2 of the FEIS was modified to discuss the use of Area E. The use of Area E requires that dredging be conducted only once at a location within Area E, therefore, previously dredged areas will not be disturbed in subsequent nourishment cycles. Dredging will be no deeper than 12 feet below surrounding bathymetries to minimize the potential creation of deep anoxic pits. Monitoring would be conducted to document recolonization of benthos and any adverse hydrodynamic changes in previously dredged areas.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
841 Chestnut Building
Philadelphia, Pennsylvania 19107-4431

OCT 1 4 1997

Lt. Colonel Robert B. Keyser
District Engineer
U S. Corps of Engineers
100 Penn Square East
Philadelphia, PA 19107-3390

RE: Draft Environmental Impact Statement (DEIS) Delaware Coast from Cape Henlopen to Fenwick Island Feasibility Study, Bethany Beach and South Bethany Interim Feasibility Study Sussex County, Delaware

Dear Lt. Colonel Keyser:

In accordance with the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, EPA has reviewed the draft Environmental Impact Statement (DEIS) for the above referenced project. The DEIS provides an objective evaluation of a wide range of both non-structural and structural alternatives to reduce storm damage and provide erosion control for the communities of Bethany Beach and South Bethany Beach, including the no action alternative. We have rated the recommended plan, berm and dune restoration utilizing sand from an offshore borrow site, as LO (Lack of Objections). We concur with the alternatives screening process and optimization analyses used to develop and evaluate the recommended plan and the optimization alternatives of berm restoration and berm and dune restoration with groin field (South Bethny only). We have assigned the rating of LO (Lack of Objections) to these other alternatives and EC (Environmental Concerns) to the No Action alternative. EPA has assigned an overall rating of 1 (Adequate) to the document with the understanding that a that a Supplemental EIS will be prepared to address the alternative borrow site (Site E) that will be used for periodic renourishment over the 50 year life of the project. A copy of the EPA rating system is enclosed for your reference.

The communities of Bethany Beach and South Bethany Beach are shore recreational areas whose main attractions are their beaches. Storms and direct wave action have resulted in significant beach erosion and little protection is afforded to shore structures. This lack of beach, combined with the absence of significant dunes, presents the potential for catastrophic damage to these communities from ocean flooding and wave attack. The proposed project will utilize beachfill to construct a protective berm and dune for these communities to reduce storm damage.

We agree that most of the beachfill optimization alternatives meet the planning objectives by providing storm damage protection which is greater that the cost of implementation. We concur with the selection of the preferred alternative, which is the recommended plan, since it maximizes benefits while meeting plan objectives. The recommended plan for both Bethany Beach and South Bethnay is beachfill with a berm width of 150 ft. and a dune with a top elevation of +16 ft. NAVD and a top width of 25 ft. The berm is both communities would be filled to an elevation +7 ft. NAVD and would have a foreshore slope of 1V:15H to Mean Low Water (MLW). From MLW seaward, the slope parallels the bottom out to the depth of closure. The beach fill area extends along the entire length of both towns with the taper areas extending approximately 1,000 ft. to the north and south of the towns' borders A total of approximately 2,748,000 cubic yards of sand is needed for the initial fill placement. Renourishment of the berm and dunes would require approximately 480,000 cubic yards of sand fill every 3 years over the 50 year project life The plan proposes that beachfill material will be dredged from two offshore borrow areas Site C covers 940 acres and Site E is 775 acres

Our review of the plan and the DEIS has determined that no major adverse environmental impacts are likely to occur from the proposed project. Placement of beachfill material will provide protection from further erosion. Fill placement will result in destruction of benthic organisms but recolonization of the beach area is expected to be fairly rapid. Direct and indirect impacts are expected to occur from dredging of material from the offshore borrow sites. Direct impacts include short term increases in turbidity, destruction of nekton and dislocation of fishes. We agree that these impacts are temporary and not expected to be significant. Benthic habitat will be impacted in Site C (940 acres) and Site E (775 acres) over the 50 year life of the project. Benthic organisms will be destroyed as a direct result of dredging while habitat may be impacted due to changes in circulation from deepening that can result in the accumulation of fine grained sediments. We are in agreement that the recolonization of borrow areas is expected within one to two years following dredging. Habitat impacts can be minimized by avoiding the dredging of deep pits in both borrow sites. Impacts to habitat can also be minimized by utilizing different areas of the borrow site (Site E) for fill material for periodic nourishment. This would allow for recolonization of benthic habitat between dredging cycles. Although there are presently no commercially exploitable densities of the surfclam in the proposed borrow area (Site C) we are concerned that periodic dredging may have adverse impacts on a recovering surfclam fishery. The proposed sand borrow site (Site C) has a population of juvenile surfclams and has supported a surfclam fishery in the past. We strongly support the implementation of a monitoring plan to determine areas of potentially significant stocks so these areas may be avoided during dredging operations.

1. The Supplemental EIS that is to be prepared for Site E during the PED phase of the study will also contain the results of a baseline surfclam survey for this site. It is expected that any constraints to using Site E will be determined at that time.

2. We are also concerned that the cumulative impacts of dredging in offshore areas are currently not well evaluated. Although cumulative impacts to the offshore borrow sites may be minimized by leaving the area with some topographic relief and with dredged deepened areas connected with existing deep areas the cumulative impacts to the habitat value of offshore shoals and the consumption of mineral resources due to their increasing use as sand sources for beach nourishment should be examined from a regional standpoint.

Thank you for the opportunity to comment on the DEIS. We look forward to reviewing the SEIS that will be prepared for this project. Please contact Marria O'Malley Walsh at (717) 628-9685 if you have any questions regarding our comments.

Sincerely,

John Forren, Program Manager
NEPA & Wetlands Regulatory Review

1. A supplemental Draft Environmental Impact Statement (SDEIS) was completed and circulated for agency/public review prior to preparation of the FEIS. The SDEIS identified Area E as the preferred sand borrow source. This was based on geotechnical, benthic, fisheries and cultural resource analyses conducted on this area. Therefore, Area C was eliminated as a sand source.

2. Cumulative effects of dredging sandy shoals were minimized by utilizing Area E and eliminating Area C. Unlike Area C, Area E contains a relatively flat, featureless bottom. Three shoal areas were identified in the northern and southern portions of Area E, however, these shoals would be precluded from any future dredging (see Figure 5-1 of FEIS).

MID-ATLANTIC FISHERY MANAGEMENT COUNCIL

Dr. James H. Gilford
Chairman

Anthony D. DiLernia
Vice Chairman

ROOM 2115 FEDERAL BUILDING
300 South New Street
Dover, Delaware 19901-6790
302-674-2331
FAX 302-674-5399

David R. Keifer
Executive Director

14 October 1997

Mr. Robert Callegari
Chief, Planning Division
U.S. Army Corps of Engineers
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

We have reviewed the Bethany Beach/South Bethany Interim Feasibility Study DEIS. I have enclosed our letter of 25 March 1996 where Dr. Tom Hoff, of my staff, identified
1. our major concern as focused on the impact to surfclams. We still have the same concerns as we had a year and a half ago in that the preferred offshore borrow area has very high levels of small surfclams.

2. The primary borrow area (Area C) has a pronounced ridge and swale topography, as opposed to the other borrow areas which are generally flat bottom or gently sloping areas. The diversity of habitats offered in ridge and swale areas is much greater offering physically and biologically enhanced habitat for fish and shellfish. While commercial size surfclams are not currently present at borrow area C, this ridge and swale area is the type of bottom that commercial surfclam fishermen typically fish. These habitats will be lost once the topographic features are disturbed with the beach replenishment.

3. The NMFS is in the process of publishing final rules for identifying essential fish habitat (EFH), as required under the reauthorized Magnuson/Stevens Act of 1996. Surfclams are not overfished and thus the guidance for the delineation of EFH is not as clear as the guidance is for overfished resources, however we envision a ridge and swale topography as being quite important for the continued successful management of this 40+ million dollar industry. Please consider other borrow areas rather than this ridge and swale.

I hope these comments are helpful. Please do not hesitate to call with any questions.

Sincerely yours,

David R. Keifer

David R. Keifer

1. The letter from 3/25/96 is presented in the pertinent correspondence section.

2. Area C was eliminated as a sand borrow source. The FEIS identifies Area E as the preferred sand source. As stated in the FEIS, Area E does not contain the diversity in habitats that Area C does, therefore, we believe that the utilization of Area E would have lesser adverse effects on fishery resources.

3. The Philadelphia District recognizes that the impacted areas may be designated EFH. The District will continue to coordinate the project with NMFS and the Mid-Atlantic Fishery Management Council to minimize adverse effects on EFH or potential EFH.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401

October 17, 1997

Lt. Colonel Robert B. Keyser
District Engineer
U.S. Army Corps of Engineers
100 Penn Square East
Philadelphia, PA 19107-3390

Attn: Steve Allen

Re: Bethany Beach/South Bethany
Interim Feasibility Study

Dear Colonel Keyser:

This constitutes the report of the U.S. Fish and Wildlife Service on the storm damage reduction project proposed for Bethany Beach and South Bethany, Sussex County, Delaware. It is submitted in accordance with section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*) and Section 7 of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*). The Service previously submitted planning aid reports dated January 1991 and November 1996. The present report summarizes pertinent information from our previous reports and sets forth the Service's official position on the Corps' recommended plan as described in the draft feasibility report and environmental impact statement dated April 1997.

PROJECT DESCRIPTION

The recommended plan provides a 150-foot wide berm with an elevation of +7 feet NAVD and a vegetated dune with an elevation of +16 feet NAVD at both Bethany Beach and South Bethany. Sand fencing would be emplaced to help stabilize the dune. Numerous dune walkovers would be constructed to provide pedestrian beach access. A vehicle access way over the dune would be constructed at Bethany Beach.

The total length of shoreline receiving beachfill is 14,950 feet. The initial project construction will require the placement of 2,748,100 cubic yards of sand dredged from offshore. The project will also provide periodic replenishment of the beachfill over the 50-year project life. The maintenance is expected to consist of replenishment with 480,000 cubic yards of sand every

three years. Two sand borrow areas have been identified for the project. Borrow area C, which is located approximately 1 mile offshore, northeast of Bethany Beach, is designated to provide the sand for the initial project. Borrow area E, which is located approximately 2.5 miles offshore from South Bethany, has been identified as the sand source for maintenance of the project.

FISH AND WILDLIFE RESOURCES WITHOUT THE PROJECT

The project shoreline consists of an ocean fronting open sand beach. Dense residential and commercial development occupies the shoreline immediately landward of the beach. Consequently, human activity on the beach, especially in the summer is intense. Both Bethany Beach and South Bethany have undergone several beach replenishment operations in the past, including recent projects in 1989, 1992, and 1994. Wildlife use of the beach is primarily by tolerant species and/or life stages, and transient species. Gulls, which commonly rest on the beach, are the most conspicuous inhabitants. Shorebirds, particularly sanderling (*Calidris alba*), periodically forage along the water's edge. The aquatic areas support a variety of benthic macroinvertebrates. The mole crab (*Emerita talpoida*), coquina clam (*Donax variabilis*), a polychaete worm (*Scolelepis squamata*), and an haustorid amphipod (*Haustorius canadensis*) are typical inhabitants of the intertidal zone. Beyond the surf zone the invertebrate community becomes more diverse. Fish species which may commonly occur in the surf and near shore areas include: Atlantic silverside (*Menidia menidia*), spot (*Leiostomus xanthurus*), kingfish (*Menticirrhus saxatilus*), bluefish (*Pomatomus saltatrix*), striped bass (*Morone saxatilus*), weakfish (*Cynoscion regalis*), and summer flounder (*Paralichthys dentatus*).

Borrow site C consists of a series of ridges and swales lying 0.4 to 1.7 miles offshore. Sampling showed that the area supports an invertebrate community composed primarily of infaunal species typical of the mid-Atlantic coastal region. Juvenile surf clams (*Spisula solidissima*), an important commercial species, are common, but the area does not support a commercially harvestable population. A wide variety of seasonal migrant fishes occur. Most species tend to move into the area as the water warms in the spring. The number of species tends to increase during the spring and summer. Winter is a time of low abundance as most species leave the area for warmer waters offshore and southward. Recreational fishing is fairly common throughout the coastal region, but the borrow area is not especially favored over other areas. There is little commercial fishing activity since commercial trawling is prohibited within Delaware's 3-mile territorial limit. Some gill net fishing may occur in the spring for shad and weakfish. Bird species which may be found feeding and/or resting in this area include gulls, terns, scoters, oldsquaw, red-throated loon, and red-breasted merganser. Sea turtles, especially loggerhead, but also Kemp's ridley, green, and leatherback may occur in the area from June to November. The bottlenose dolphin is the most common marine mammal to occur in the area.

Borrow area E was identified late in the study. Consequently, this site has not been as carefully scrutinized as area C. At this time it does not appear that this site contains any particular additional biological resources that would preclude its use. We understand that the Corps will be conducting a more detailed analysis of this site during the next study phase. This will include

sampling benthic invertebrates and taking vibracores to better characterize the sediments. The proximity of the South Bethany wastewater treatment plant outfall is another issue that will need to be evaluated.

Threatened and Endangered Species

Several species of Federally listed threatened and endangered turtles may occur in the vicinity of the proposed borrow areas from June to November. These include the loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*), green (*Chelonia mydes*), and leatherback (*Demochelys kempii*). Other Federally listed species may occur within the project area on an occasional or transient basis. These include certain migratory birds and marine mammals that are not expected to be affected by the project.

BIOLOGICAL EFFECTS OF THE PROJECT

By mimicking a naturally functioning system the proposed beach replenishment and dune creation should minimize the potential for any long-term adverse environmental impacts. During the initial construction and subsequent replenishment operations the existing invertebrate fauna inhabiting the intertidal and adjacent subtidal area would be adversely affected by burial or high levels of suspended sediment. The reduction in the benthic community will reduce the food available for bottom feeding fishes, crabs, and shorebirds. Most of these motile species will not be impacted directly as they will avoid the area during construction. Since the initial tests indicate that the replenishment material would be similar in composition to the existing beach material, the infaunal community should recover to pre-project levels of abundance and species composition within a few months.

The construction of the dune will provide an additional habitat component to the upper beach. However, its habitat value will be limited because of the high level of development and human activity in the immediate area.

Dredging at the sand borrow sites will remove the existing benthic invertebrate community. The rate, extent, and character of the recolonization will be affected by the change in the topography of the area. Dredging deep pits could alter the hydrodynamic conditions and result in the accumulation of silty sediments. This would in turn change the composition of the benthic community. Since the borrow areas are located in relatively high wave energy areas, it is unlikely that poor water quality conditions or other particularly adverse ecological effects would develop.

Both borrow sites contain ridges or other areas of topographic relief which could be reduced or eliminated by the sand borrowing operations. While we do not have information to indicate that these particular sites are particularly attractive for fish, it is generally believed that higher relief areas hold greater populations of fish than flat featureless bottom. By preferentially selecting ridges and shoals as sand borrow sources, the bottom habitat heterogeneity would be diminished

and the local fish populations could be affected. Because of the increasing need for sand for beach replenishment projects in many coastal areas there could be a significant cumulative loss of habitat value over time. It may be possible to lessen the loss of bottom habitat complexity by conducting the borrow operations in a manner which would retain some degree of topographic variation.

If the dredging is conducted using a hopper dredge, it is possible that there could be some entrainment of sea turtles which are listed under the Endangered Species Act. We understand that the Corps has formally consulted with the National Marine Fisheries Service in accordance with Section 7 of the Act to ensure that the potential for impacting sea turtles is minimized.

CONCLUSIONS

1. The proposed plan for beach replenishment and dune creation is not expected to produce any long-term environmental impacts at the project shoreline. The primary impact will be to the benthic community which is expected to recolonize readily. The impacts at the offshore borrow sites would likely be more significant and longer lasting. Undesirable effects could result if the sand dredging produces deep pits or substantively reduces bottom topographic features. We recommend that a dredging plan be developed during the advanced planning stage of the project to minimize adverse topographic changes. We request that you coordinate this plan with the Service as well as the proposed baseline studies on the biological and physical characteristics of borrow site E. We also want to stress the importance of your plan to conduct post-construction monitoring at the borrow sites. If there are any questions, please contact George Ruddy at (410) 573-4528.

Sincerely,

for John P. Wolflin
Supervisor
Chesapeake Bay Field Office

1. The selection of sand borrow Area E was coordinated with the Service subsequent to this letter. The dredging plan to be developed in the Plans and Specifications Phase will be developed with input from resource agencies (including US Fish and Wildlife Service) to minimize adverse effects on ecological resources. Also, monitoring plans will be developed with resource agency input.

STATE OF DELAWARE
DEPARTMENT OF STATE
DIVISION OF HISTORICAL AND CULTURAL AFFAIRS
HISTORIC PRESERVATION OFFICE
15 THE GREEN
DOVER • DE • 19901-3611

PH: (302) 739-5685 FAX: (302) 739-5660

October 6, 1997

Mr. Robert L. Callegari
Chief, Planning Division
Philadelphia District, Corps of Engineers
100 Penn Square East
Philadelphia, PA 19107-3391

ATTN: Michael Swanda, Environmental Resources Branch

Dear Mr. Callegari:

This letter is pursuant to my receipt and review of the document entitled *Delaware Coast From Cape Henlopen to Fenwick Island - Bethany Beach/South Bethany Interim Feasibility Study - Draft Feasibility Report and Draft Environmental Impact Statement.* Based on this review, it is our opinion the Corps has not completed its requirement to identify all National Register listed, and/or eligible historic properties within the potential area of effect, as required following the Advisory Council on Historic Preservation's (Council) regulations (36 CFR 800) to fulfill its responsibility to comply with Section 106 of the National Historic Preservation Act of 1966, as amended. Cultural resource survey results identified the lack of any known or anticipated historic properties in the onshore beach and near-shore underwater project areas. A remote sensing survey of the off-shore Borrow "Area C" generated a magnetic target with a signature suggesting a submerged shipwreck is present. Since, Borrow "Area C" is not adequate for the entire life of the project, another borrow source has subsequently been identified. This is off-shore Borrow "Area E." As in the case of "Area C," a cultural resource survey of this area of the project will be required to identify whether any significant historic properties may be present therein and, if present, what effect the use of this additional borrow source will have thereon.

As this document notes, it is the intention of the Corps to avoid the potential historic shipwreck in Borrow "Area C" by employing protective measures (buoying and a + 200 ' buffer around the perimeter of the target). Such a treatment of this historic property is, in our opinion, suitable to afford us the opportunity to concur with a "No Adverse Effect" determination, pursuant to 36 CFR 800.5(d) of the Council's regulations. If subsequent remote sensing survey results for Borrow "Area E" identify additional targets with significant magnetic signatures, this Office would entertain extending its concurrence with a "No Adverse Effect" determination to such historic properties if the same protective measures to be used in "Area C" can be successfully

1. Borrow Area E was investigated for cultural resources in January 1998 (Dolan Research, Inc. 1998). No remote sensing targets exhibiting cultural resource characteristics were identified. The results of this work will be coordinated with the DESHPO, and Section 106 consultation will be concluded prior to any construction activity.

employed.

We anticipate receiving and reviewing the results of the additional cultural resource survey prior to the issuance of the Final Environmental Impact Statement for this project. In the interim, if you have any questions, please do not hesitate to contact me at the above address or by e-mail at fstocum@state.de.us . Thank you.

Sincerely,

Faye L. Stocum
Archaeologist

cc: Charlene Dwin-Vaughn, ACHP
Jennifer Lukens, CZMP

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
89 KINGS HIGHWAY
PO BOX 1401
DOVER, DELAWARE 19903
TELEPHONE: (302) 739-3451

October 10, 1997

Mr. Robert L. Callegari
Department of the Army
Philadelphia District, Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

RE: Federal Consistency Certification for the Bethany Beach/South Bethany Interim Feasibility Study Draft Feasibility Report & Environmental Impact Statement

Dear Mr. Callegari:

This letter is to notify you that the Delaware Coastal Management Program (DCMP) has received and reviewed the Army Corps of Engineers' consistency determination for the *Bethany Beach/South Bethany Interim Feasibility Study-Draft Feasibility Report & Environmental Impact Statement*.

As indicated in the Draft Environmental Impact Statement (DEIS), borrow area "C" does not contain enough material for the 50 year project life and other areas are being considered as alternative borrow sites, specifically area "E". Area "E" is known to contain enough material for the 50 year project life that meets the needs of suitable sandy material, however, this borrow area has not been fully characterized yet. The DEIS does indicate that benthic investigations, cultural investigations, and vibracore samples will be conducted in the next phase of this study.

Comments received from the DNREC Division of Fish and Wildlife indicate that the borrow area known as area "C", with it's ridge and swale topography, is a preferred habitat for surf clams (please refer to the attached memorandum). Although this area is not known to contain a commercially viable surf clam population it is an ideal habitat for this species.

Based upon the habitat potential in borrow area "C" and the planned detailed investigations for the use of borrow area "E", the DCMP at this time conditionally concurs with the consistency determination for the *Bethany Beach/South Bethany Interim Feasibility Study-Draft Feasibility Report & Environmental Impact Statement*. The DCMP requests that additional information on borrow area "E" as outlined above be collected during the next phase of this project's development and be made available to the DCMP as part of this project's evaluation.

1. Information pertaining to Area E was collected and presented in the Supplemental Draft Environmental Impact Statement (SDEIS). Based on this new information, Area E was determined to be the preferred sand borrow source and Area C was therefore, abandoned.

Since this project and decisions related to its actual implementation will be done in phases, and pursuant to *15 CFR 930*, the DCMP will require another consistency determination for the *Final Environmental Impact Statement* to ensure that the project is consistent to the maximum extent practicable with the enforceable policies of the DCMP.

If you have any questions or concerns regarding this consistency please call me at (302) 739-3451.

Sincerely,

Sarah W. Cooksey, Administrator
Delaware Coastal Management Program

SWC/jll
Enclosure

MEMORANDUM OCT - 6

STATE OF DELAWARE

DEPARTMENT OF NATURAL RESOURCES

& ENVIRONMENTAL CONTROL

DIVISION OF FISH AND WILDLIFE

TO: Sarah Cooksey, Administrator DCMP

FROM: Jeff C. Tinsman, E.S. IV, Delaware Fish and Wildlife

SUBJECT: Comments on USACOE Bethany Beach Interim Feasibility Study and Draft EIS (April 1997)

DATE: September 25, 1997

I have reviewed the Feasibility Study and Draft EIS concerning beach replenishment of the Bethany Beach/S.Bethany area and offer the following comments:

1. This proposed project differs from other Corps. beach replenishment projects in Delaware in that the proposed primary borrow area (Area C) has a pronounced ridge and swale topography. Other borrow areas such as the Rehoboth/Dewey and Fenwick Island sites are in flat bottom or gently sloping areas. The diversity of habitats offered in ridge and swale areas is much greater offering physically and biologically enhanced habitat to fish and shellfish.

2. Ridge and swale topography is formed and maintained by currents (tidal, littoral, etc) and prevailing and episodic wind conditions. They indicate a relatively high energy environment. Once established, this structure serves to dissipate wave energy from storm waves, offshore. Reduced fetch inshore of these structures minimizes the height and energy of waves eventually hitting the beach. Eradication of this structure (as is proposed) may subject the beach, proposed for protection, to higher energy waves and inadvertently work against project goals.

3. As I have commented at previously held scoping meetings, shoal tops and edges are preferred habitat for the surf clam, *Spisula solidissima*. During the three surveys conducted by DNREC (1982,1984, and 1992) commercial surf clammers were allowed to select what they considered to be the best habitat to sample within one square mile sample quadrants. Invariably, they selected shoal edges, where they were available, over flat bottom areas. Hen and Chickens shoal and its edges were worked extensively during the early 1970's, when commercial harvesting was done in state waters. Even if a commercially exploitable surf clam resource has not been reestablished when the proposed replenishment is to be conducted, a significant amount of prime habitat will be lost when these shoals are eradicated. It is not clear to me that the Essential Fish Habitat provisions of the revised Magnuson Act are consistent with this activity. While not

1. Subsequent to the DEIS, Area E was selected as the preferred sand borrow source, and Area C was abandoned. Area E contains a relatively flat, featureless topography (with the exception of 3 shoal areas). The three shoal areas are precluded from any potential future expansion into the northern and/or southern portions of Area E.

2. See response #1.

3. See response #1. A monitoring program is being developed in consultation with fisheries resource agencies (including DNREC) in order to identify any future commercial densities of surfclams within the borrow area during the project life. The District will coordinate with NMFS, MAFMC, and DNREC if the borrow Area (E) is designated EFH.

overfished throughout its range, surf clams have been depleted in state waters for over 20 years. Prior to 1975 millions of pounds of clam meats were harvested in Delaware waters each year.

4. 4. Ridge and swale topography offers a variety of sediment types and this is reflected in a diverse benthic community based on differing sediment preferences of many benthic organisms. The benthic data provided was divided into three sub-sets. The diversity of each sub-set is typical of Mid-Atlantic, shallow oceanic habitats as stated in the EIS. (Table 4-4). However, I have not seen diversity measures applied to all the pooled data. I would like to see various indices calculated for the entire borrow site to give a more meaningful measure of diversity for comparison with other habitats in this region. The combination of physically and biologically diverse habitat should also benefit a diverse fish community seeking a relatively protected bottom with diverse food resources. This type of bottom is relatively uncommon in the Mid-Atlantic area where relatively flat bottom, with minimal vertical profile is most common.

5. 5. Should the surf clam resource become reestablished in state waters during the 50 year life of this project, the Division of Fish and Wildlife would have serious concerns about use of borrow sites for beach replenishment.

6. While I support the decision to replenish Bethany Beach, I have previously expressed two fisheries-related concerns with the project: First, that no commercially viable surf clam resource is present and second, that the ridge/swale topography not be eradicated (surf clam habitat maintained). I strongly urge the Corps. to identify a flat bottom site as an alternative to site C.

cc: Andrew T. Manus, Director
Richard W. Cole, Marine Fisheries Program Manager

4. A benthic study (Scott and Bruce 1998) was performed for Area E. Benthic community parameters were compared with Area C and other regional benthic studies. This study was forwarded to DNREC - Division of Fish and Wildlife for review. In general, Area E had lesser total number of taxa, total mean abundance, and total bivalve abundance than Area C.

5. See response #3.

6 See response #1.

TOWN OF SOUTH BETHANY

402 Evergreen Road
South Bethany, Delaware 19930
(302) 539-3653

September 22, 1997

Mr. Steve Allen
Environmental Resource Branch
Department of the Army
Philadelphia District, Corps of Engineers
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3391

Re: Bethany Beach/South Bethany Interim Feasibility Study
Volume I, April 1997

Dear Mr. Allen:

We fully appreciate the time and effort put forth in this fine interim feasibility study report. After digesting the information furnished, we would like to make the following recommendations: (1) increase the berm width to 200 feet; (2) increase the berm elevation to 8.0 feet; (3) change the slope below the berm to a "1 on 20" elevation minus 1.5 feet and a "1 on 15" below elevation minus 1.5 feet; and (4) use another borrow area with much coarser sand.

1. We believe a 150 foot berm would eliminate our beach and only provide surge protection. The main beneficiaries would be the existing beach home. It appears South Bethany would lose approximately 4,000 feet of beach. This is unacceptable.

Raising the berm elevation would reduce the effect of the dune and provide a more natural beach. The South end of South Bethany adjacent to the Delaware State Park Area is where the Ocean broke through to the Little Assawoman Bay back in 1962. This breakthrough also occurred in January 1992 Storm. The State Park never replenished their beach and this area is starving for sand. Our beach replenishment programs started at the town property line and did little, if anything at all, to alleviate this problem. Ocean City's 10 miles of beach was designed with an 8.5 foot berm and it appears to be successful. This is less than 5 miles South of South Bethany.

2. We believe the change in slope to "1 on 20" would have a tendency to reduce shore breaks. This slope, again, was very successful in Ocean City. Why not go alone with a proven system in similar waters.

1. The selected plan of improvement is the National Economic Development (NED) plan, defined as the plan that maximizes beneficial contributions to the Nation while meeting planning objectives. Variance from the dimensions of the NED plan could be pursued as a locally preferred plan provided it is economically justified and the non-Federal sponsor would be willing to absorb 100% of project costs in excess of the cost estimate for the NED plan.

The 150-foot wide berm and 16-foot high dune were determined to be the optimally sized components based upon NED criteria. The 7-foot berm elevation was selected based upon historical beach profiles that indicated this is the natural berm height for the project area.

2. The 1 on 15 slope was selected for the Bethany Beach/South Bethany project because it matches the existing beach slope. In addition, the nature of the borrow material, which is very close to that of native beach material, prevents a more gradual slope. If the borrow material was finer grained, then it may have been possible to use a more gradual slope, however, a finer grained material would require a greater overfill factor. This would require placement of larger quantities of material to produce a stable beach, resulting in higher project costs.

Vibrocores taken in the Fenwick borrow area, which was used for the Ocean City beachfill indicates that the borrow material is slightly finer that that in the Bethan borrow area (Area E). The 1 on 20 slope that is believed to exist at Ocean City is most likely attributed to the nature of the native and borrow fill material.

3. We would like to see much coarser sand in this project. The overfill factor should be approximately one. This is close to the natural beach sand that once existed. South Bethany is 4,500 feet in length, and this project produces a protruding point in relationship to our neighbors. We will have two transitions, one on the State Park side and the other on the Middlesex side. We want to hold as much sand in the design template as long as possible; therefore, fine sand is totally unacceptable. The State Park beach and dune sand was dredged from Little Assawoman Bay after the 1962 storm.

4. The benefit/cost ratio presented in Table 30 shows a positive ratio for a 200' and 250' berm. The minor changes will likely produce a minor revision to the 1.21 ratio (200' berm).

5. A major problem resulting from a 16 foot high dune is obstructed of line of sight from beach front homes first floor to the beach. Most homes first floor elevation is 16 feet or less. Once a dune is built with a four foot high snow fence on top (total height of 20 feet) to protect the beach grass, some homes will be unable to view a 200' berm beach from their second story windows.

We strongly recommend you give these recommendations careful consideration. We want most of the people from South Bethany supporting this project.

Sincerely,

TOWN OF SOUTH BETHANY

Herbert E. Schaefer

Herbert E. Schaefer
Mayor

HES/tlb

3. Material from the recommended borrow area (Area E) is generally coarser than that of Area C, the proposed borrow area presented in the draft report. The overfill factor for material from Area E is 1.0.

4. No response required.

5. See response to #1.

DELAWARE ENVIRONMENTAL, INC.
RD 3, BOX 79 DAGSBORO, DELAWARE 19939 (302)-732-9858

August 29, 1997

To: Robert L. Callegari
Chief, Planning Division
Philadelphia District
USACOE

Subject: CENAP-PL-E-97-08

Robert,

Up front I want you to know that my understanding of the dynamics involved with the undertaking of a study of this magnitude is some what limited. So you can take these comments with a grain of salt.

My educational back ground has touched a little on Marine systems. I am familiar with the process of how barrier islands are continuously migrating towards the main-land. I believe that this would hold true for the study area in question.

I am personally on a sea-saw when it comes to beach replenishment. One side says let the marine system do what it has been doing for millions of years. The other says do what ever is feasible to save the area, and the investment individuals have in the area. My problem is with the latter. I feel that it would be only fair that the individuals who chose to invest and build on a land form that is in constant motion, would have to bear the brunt of the cost of such a study. I also feel that any measures undertaken to slow this migration process also be funded by the same individuals.

1. On a different tack, I remember seeing a system of low berms that when placed several yards off shore and below the surface, could help reduce the wave action thus minimizing the adverse transportation of beach material. Is such a system feasible for the study area?

Comments should be directed to the undersigned;

K. Mason Smawley
Biologist

Wetland Biologist & Certified Professional Soil Scientist

1. Consideration was given to a plan consisting of an offshore submerged feeder berm as described on pages IV-11 and IV-12 of the Final Feasibility Report and pages 3-8 and 3-9 of the FEIS.

SEPTEMBER 30, 1997

ROBERT L. CALLEGARI
CHIEF, PLANNING DIVISION
PHILADELPHIA DISTRICT
U.S. ARMY CORPS OF ENGINEERS

RE: PUBLIC NOTICE NO. CENAP-PL-E-97-08
SHORE PROTECTION, DELAWARE
NEED FOR PUBLIC HEARING

DEAR SIR,

IN COMPLIANCE WITH INSTRUCTIONS IN ABOVE DESIGNATED PUBLIC NOTICE, I REQUEST THAT A PUBLIC HEARING BE HELD TO CONSIDER THIS PROPOSAL FOR THE FOLLOWING DETAILED REASONS:

1. **THE PROPOSAL LACKS SPECIFICS** REGARDING CLAIMS ABOUT REDUCED RECREATIONAL OPPORTUNITIES, SEVERE STORMS IN RECENT YEARS VS PRIOR YEARS, CLAIMS OF HAVING EVALUATED ALTERNATIVE SOLUTIONS, AND FOR THE NEED TO SUBSIDIZE THESE AREAS/TOWNS WITH FEDERAL OR STATE TAX MONIES.

2. THE PROPOSED PLAN WOULD COST IN EXCESS OF FIFTEEN MILLION DOLLARS TO INITIATE AND IN EXCESS OF EIGHT HUNDRED THOUSAND DOLLARS PER YEAR (AVERAGE) TO MAINTAIN FOR THE NEXT FIFTY YEARS. THOSE AMOUNTS DO NOT REFLECT INFLATION FACTORS WHICH WILL OCCUR. THE PLAN WILL RELY UPON CURRENTLY UNBORN TAXPAYERS TO SUBSIDIZE, WITHOUT GIVING THEM A CHOICE IN THE MATTER. ONE GOOD STORM COULD WIPE OUT THE FIFTEEN MILLION DOLLAR INVESTMENT IN ONE SWOOP AND NECESSITATE HAVING TO BE REBUILT FOR THE SAME COST OR HIGHER.

3. THE PLAN CLEARLY BENEFITS PRIVATE COMMUNITIES AND BEACHES BY PROVIDING SAND PAID FOR BY AVERAGE TAXPAYERS YET DENYING **THEM** THE MEANS TO ACCESS THE BEACHES THEY WOULD BE PROVIDING TO THE PRIVATE SECTORS. THE COMMUNITIES CLEARLY DENY ACCESS TO THE GENERAL TAXPAYER WHO IS EXPECTED TO SUBSIDIZE THIS PROJECT. **LAWS CLEARLY FORBID SUCH EXPENDITURES OF FUNDS.** THE TOWNS CLAIMING TO PROVIDE PUBLIC BEACHES IN FACT DO NOT PROVIDE THE MEANS FOR THE PUBLIC TO GAIN ACCESS TO THESE BEACHES IN MOST INSTANCES OR DELIBERATELY RESTRICTS THE NUMBER OF PEOPLE WHO CAN HAVE PUBLIC ACCESS. THIS IS DONE SIMPLY BY LIMITING AVAILABLE PARKING SLOTS OR BY FAILING TO PROVIDE ANY PARKING SLOTS AT ALL. WHEN PARKING IS ONLY AT HOMES WHICH ONLY THE AFFLUENT CAN AFFORD TO RENT, THEN THE POOR AMONG US CANNOT GAIN ACCESS TO THE BEACHES WE ARE BEING ASKED TO PROVIDE. THIS IS A FACT.

4. ALL PRIOR HISTORY IN THIS AREA PROVES THAT WHAT IS TAKEN AWAY BY ONE NORTHEASTER IS RETURNED BY ONE SOUTHEASTER. IT HAS BEEN SHIFTING SINCE THE BEGINNING OF RECORDED HISTORY. THE LOCALS HAVE NEVER BUILT PERMANENT STRUCTURES IN HARMS WAY ALONG THESE BEACHES FOR THIS REASON. SINCE PERMANENT STRUCTURES ARE BEING BUILT IN HARM'S WAY BY THE AFFLUENT,

1. A public meeting was held on 13 May 1998 to discuss comments on the report. Sections of the Main Report, which address the issues cited are: erosion history (III), storm history (III), plan formulation (IV), and project cost sharing (V).

2. Corps of Engineers reports use a constant dollar approach and do not include inflation in the analyses of benefits or costs. The project provides for periodic nourishment and major replacement during its life to assure that more significant damages to structures and infrastructure are reduced.

3. The public access plan completed for this study concluded that Bethany Beach and South Bethany adequately provide for general public access and are eligible for Federal participation in a shore protection project.

4. Although the movement of sand along a beach involves seasonal onshore-offshore and longitudinal movement, a net erosion is experienced in the project areas, which has only been compensated for by previous beachfill efforts. The report demonstrates that continued beachfill as a Federal project is economical.

FOR THEIR OWN QUESTIONABLE PURPOSES WHY SHOULD THIS OBLIGATE AVERAGE TAXPAYERS TO FOOT THE BILL TO PROTECT THEM FROM THEIR OWN FOLLY AND GREED?

5. THE TOURIST SEASON DOES LITTLE FOR THE LOCAL POPULATION SINCE MOST OF THE INCOME GOES OUT OF STATE TO LARGER BUSINESSES OR TO ABSENTEE LANDLORDS. THE SUMMER JOBS DO NOT SUPPORT THE NEEDS OF A FULL TIME POPULATION. EROSION IS NOT A PROBLEM FOR DELAWARE TAXPAYERS! OUR BEACHES WILL ALWAYS RECEIVE SUMMER VISITORS, WHETHER REPLENISHED OR NOT. THEY ALWAYS HAVE AND ALWAYS WILL. THE REPLENISHMENT ONLY HELPS THE GREEDY. RETIRED PEOPLE WILL CONTINUE TO MOVE HERE EVEN IF THIS PROJECT IS CANCELLED.

5.

6. CLAIMS THAT THERE WILL BE NO NEGATIVE IMPACTS CANNOT BE SUPPORTED BY KNOWN FACTS. THERE IS A SHIPWRECK ON AREA C AND THAT IS NOTED ON CURRENT MAPS. THAT FACT ALONE PROVES THAT THE EXPERTS CLAIMS CANNOT BE DEPENDED UPON. DREDGING WILL ALWAYS IMPACT NEGATIVELY ON WILDLIFE...ALWAYS HAS AND ALWAYS WILL...IT IS A PROVEN FACT.

6.

7. NORTH CAROLINA HAS ADOPTED A RETREAT PLAN AND ONE MUST QUESTION WHY THAT STATE BELIEVES RETREAT IS BEST IF DELAWARE BELIEVES REPLENISHMENT IS BEST. TAXPAYERS IN DELAWARE OR IN NORTH CAROLINA ARE BEING SOLD LESS THAN HONEST BILLS OF GOOD BY THEIR STATE. WHICH IS IT? I THINK THE TAXPAYERS NEED TO BE ABLE TO HEAR THE ANSWER TO THIS QUESTION, IN PERSON!

FINALLY, IT IS A KNOWN FACT THAT THE SEA IS RISING AND THE LAND IS SINKING. THOSE FACTS ALONE TELL US THAT IT IS A FOLLY TO TRY TO STEM THE COURSE OF NATURAL EVENTS. NORTH CAROLINA IS RIGHT. JUST BECAUSE A FEW PEOPLE HAVE DECIDED TO BUILD EXPENSIVE PERMANENT STRUCTURES IN SUCH CONDITIONS DOES NOT JUSTIFY RESCUING THEM WITH TAX DOLLARS ESPECIALLY WHEN IT IS COMING FROM THE VERY PEOPLE WHO ARE BEING DENIED ACCESS TO THE SHORELINE. I WILL BE GLAD TO PROVE MY CLAIMS AND I WOULD LIKE TO BE GIVEN PROOF OF THE CLAIMS IN THIS PROPOSAL.

7.

IT MAKES NO SENSE TO HITCH AN "EXPENSIVE" STUD BULL TO PULL A WAGON OF MANURE THROUGH A SWAMP OF QUICK SAND..ANY FARMER WORTH HIS SALT WOULD TELL US THAT...UNLESS HE WAS TRYING TO UNLOAD A WORTHLESS BULL AND USELESS MANURE TO GREENHORNS SO HE COULD USE THEIR MONEY TO RESCUE HIMSELF FROM HIS OWN STUPID INVESTMENTS.

PLEASE ACKNOWLEDGE RECEIPT OF THIS REQUEST BEFORE THE END OF THE SPECIFIED PERIOD OF OCTOBER 14, 1997. THANK YOU FOR THIS OPPORTUNITY TO PARTICIPATE AS A TAXPAYER.

SINCERELY,

J. L. Stafford

J. L. STAFFORD RR 2 BX 110 MILLVILLE, DEL 19970 539-4469

5. Past beachfill efforts have been completed by the state previously at 100% state expense. Implementation of a Federal project will reduce state expenditures to the level of non-Federal cost sharing requirements.

6. The borrow area for the project has shifted to Area E. The final Environmental Impact Statement addresses the negative impacts, which result from construction in accordance with the National Environmental Policy Act (NEPA) requirements.

7. Significant debate occurs nationally over this philosophical question on shore protection. Where development has not occured to a significant degree, it may be most prudent to restrict development as a non-structural solution. However, where significant development has already occurred, it is difficult to simply abandon the shoreline to the forces of nature. Therefore, different approaches may make sense for areas with different characteristics.

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

October 3, 1997

Dear Mr. Callegari,

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, " Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach, South Bethany Interim Feasibility Study", pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects property owners who are either "borrowers", or "lenders" of the sand used in the replenishment project. In addition, the project contains health risks and adversely affects the economic well-being of both residents and the general public.

For these reasons and for those issues outlined in the attachment, I am requesting the following:

1. A public hearing to be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable for holding a larger than average public gathering of this type.
2. All affected property owners - both borrowers and lenders- on the East side of Route One be informed by mail of this proposed project and of the hearing, providing not less than 60 days' notice.
3. All residents and other interested parties west of Route One to a distance of five miles be notified via notice displayed conspicuously for 90 days in all public buildings, by newspaper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Sincerely

Douglas T. Parsons
8 Farmington Ct
Chevy Chase, MD 20815

1.

1. A publicized public meeting was held in the Millville Firehall (Millville, DE) on May 13, 1998. A written transcript of this meeting is available upon request. Public notices were sent out in advance of the public meeting, notifying Federal, state and local agencies, adjacent property owners, and the interested public. Notices were also provided to known local newspapers, libraries, and other public buildings. The public notice was also displayed on the Philadelphia District internet website.

ISSUES FROM THE BEACH REPLENISHMENT PROPOSAL

2. 1. No considerations are evident in the proposal to protect buildings in South Bethany that were built on dunes and are now seaward and beyond the building line.

3. 2. No details of who bears the brunt of the economic/tax revenue raising proposals necessary for Sussex County to raise its one-third portion of the project as this is not a state-funded project and current state revenues for beach replenishment from the hotel tax are minuscule, less than $1,000,000 per year.

4. 3. Using borrow site D raises some health risks as it is within a quarter mile of the sewage outflow. This raises health risk concerns regarding timing of the work (summer, when there is heavy sewage outflow into the ocean) and the quality of the sand pumped onto the beach which will be tainted by the treated sewage.

5. 4. With regard to borrow site C, this seems to be a source of natural protection, a shallow sandbar fronting all of North Bethany that is of a very low depth, some 19 feet, and which according to the National Academy of Sciences Natural Resource Council Report (1995), shoals of this depth should not be disturbed as their protective value against storms will be minimized.

6. 5. No studies have been done on the North Bethany coastline to suggest potential effects of storms on that portion of the beach if that area is used as a borrow site, nor does the study address how damage to that area would be handled.

2. The positioning of the proposed project was selected so as to provide protection seaward of the first row of structures in the towns of Bethany Beach and South Bethany.

3. The proposed project is to be constructed and maintained through a joint agreement between the Federal government and the State of Delaware. The non-Federal share of project costs is the responsibility of the local sponsor, the Delaware Department of Natural Resources and Environmental Control. Prior to construction, the non-Federal sponsor must prepare a project financing plan that outlines the means by which its share of funds will be provided.

4. Although Area D was identified as a potential site in preliminary investigations, it is not a proposed site for this project. The proposed site (Area E) is located approximately 0.83 miles from the South Coastal Sewage Treatment Plant outfall pipe. The Delaware Department of Natural Resources and Environmental Control (DNREC) maintains a 1/2 mile buffer zone around this outfall where shellfish harvesting is prohibited. The nearest portion of the proposed borrow site is located approximately 1,760 feet outside of this buffer zone. Through coordination with DNREC, no health risk concerns were raised with regard to the use of Area E, however, the District will implement water quality monitoring during beachfill/construction activities.

5. As stated in the Feasibility Report/FEIS, Borrow Area C was eliminated as a sand source for this project. Borrow Area E, which is predominantly offshore of Bethany Beach and South Bethany, is the proposed sand source.

6. Because Area C was eliminated, there are no concerns regarding potential adverse effects on the North Bethany shoreline resulting from sand removal.

* The above responses also pertain to the following comment letters, which contain the same comments.

1708 Ruxton Road
Ruxton, MD 21204
(410)821-7960
Oct. 2, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

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For these reasons and for those issues delineated in the attachment, I am requesting the following:

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2. All affect property owners - both beneficiaries and borrowers on the East side of Route One be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.

3. All residents and other interested parties west of Route One to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by newspaper and other suitable means of communication for a 2 week period prior to the hearing. The notice should inform the reader that the proposal has an ecomonic and health impact on them.

We own property at 20 S. Ocean Way, Seabreak, Bethany Beach, De 19930.
Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Brian C. Rogers

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

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Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Robert Seested, Jr.
L. Victor Seested, Jr.
Box 39
Ashton, MD. 20861

Mercy

os
ief Executive Officer

Mercy Health Corporation
of Southeastern Pennsylvania

One Bala Plaza, Suite 402
Bala Cynwyd, PA 19004
(610) 660-7440

October 3, 1997

Mr. Robert L. Callegari
U.S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Attention: Environmental Resources Branch

Dear Mr. Callegari:

I own a home in Seabreak, Delaware. I am requesting a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach, South Bethany Interim Feasibility Study, " pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

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Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Plato A. Marinakos

PAM/md

PAUL D. MULDOWNEY
P.O. BOX 478
HAGERSTOWN, MARYLAND 21741

October 3, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

It has been brought to my attention that there is a proposed beach replenishment project to be done by the Corps of Engineers which directly affects the Delaware coast line from Cape Henlopen to the Maryland line. I am keenly interested because I am a property owner at North Bethany Beach.

This project could adversely affect the general area in which I own property. I am, therefore, adamantly requesting a public hearing regarding this project because of the possible health risk and the adverse economic impact on me as a resident, and the general public.

So that all issues may be addressed fairly, I urge you to hold this public hearing sometime in the second quarter of 1998 to provide adequate time for the property owners and the Corps of Engineers to address all concerns.

If the project is to be fairly discussed, public notices should be sent by your office directly to all affected property owners. Adequate notice should be given, and all means should be used to advertise this hearing.

I hereby request that you advise me as soon as a decision is made to conduct this public hearing.

Yours truly,

Paul D. Muldowney

PDM/sjh

THIS LETTER MUST BE RECEIVED PRIOR TO OCTOBER 14, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia Pennsylvania 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick- Island Bethany Beach-So. Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

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Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

M.R. Pristach

Bulls Neck Property Owners

Mr. M. R. Pristach
1715 Maxwell Ct.
Mc Lean, VA 22101-5459

Certd. Ret Receipt
P 051 851 250

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia Pennsylvania 19107-3390

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Very truly yours,

Mr & Mrs William C. Burke
#5 Bayberry Dunes.
Bethany, De.

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U.S. Army Corp of Engineers
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Very truly yours,

Paul L. Andrews
23 Surfside Dr.
Bethany Beach DE 19930

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U.S. Army Corp of Engineers
Wanamaker Bldg
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-all residents and other interested parties west of route one to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by news paper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

John + Gloria Kellaway
5-1 Ocean Village Dr. DE

ISSUES RAISED FROM A READING OF THE PROPOSAL

1. NO CONSIDERATIONS ARE EVIDENT IN PROPOSAL TO PROTECT BUILDINGS IN SOUTH BETHANY THAT WERE BUILT ON DUNES AND ARE NOW SEAWARD AND BEYOND THE BUILDING LINE.

2. NO DETAILS OF BEARS THE BRUNT OF THE ECONOMIC/TAX REVENUE RAISING PROPOSALS NECESSARY FOR SUSSEX COUNTY TO RAISE ITS ONE THIRD PORTION OF THE PROJECT AS THIS IS NOT A STATE FUNDED PROJECT AND CURRENT STATE REVENUE FOR BEACH REPLENISHMENT FROM THE HOTEL TAX ARE MINUSCULE, LESS THAN ONE MILLION PER YEAR.

3. Using borrow site D raise some health risks as it is within a quarter mile of the sewage outflow. This raises health risk concerns regarding timing of the work (summer when there is heavy sewage outflow into the ocean) and the quality of the sand pumped onto the beach which will be tainted by the treated sewage.

4. With regard to borrow site C, this seems to be a source of natural protection, a shallow sandbar fronting all of North Bethany that is of a very low depth , some 19 feet, and which according to the National Academy of Sciences Natural Resource Council Report (1995), shoals of this depth should not be disturbed as their protective value against storms will be minimized.

5. No studies have been done on the North Bethany coastline to suggest potential effects of storms on that portion of the beach if that area is used as a borrow site, nor does the study address how damage to that area would be handled.

THIS LETTER MUST BE RECEIVED PRIOR TO OCTOBER 14, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia Pennsylvania 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick- Island.Bethany Beach-So. Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issue delineated in the attachment I am requesting the following:
-a public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hold a larger than average public gathering of this type.
-all affected property owners - both beneficiaries and borrowers - on the East side of route one be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.
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Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Peter L. Sachs
Bethany Beach, De. 19930
P O Box 247

ISSUES RAISED FROM A READING OF THE PROPOSAL

1. NO CONSIDERATIONS ARE EVIDENT IN PROPOSAL TO PROTECT BUILDINGS IN SOUTH BETHANY THAT WERE BUILT ON DUNES AND ARE NOW SEAWARD AND BEYOND THE BUILDING LINE.

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U.S. Army Corp of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia Pennsylvania 19107-3390

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The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issue delineated in the attachment I am requesting the following:
-a public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hold a larger than average public gathering of this type.
-all affected property owners - both beneficiaries and borrowers - on the East side of route one be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.
-all residents and other interested parties west of route one to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by news paper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

President
Ocean Village Homeowners Association
P.O. Box 1184
Bethany Beach DE 19930

THIS LETTER MUST BE RECEIVED PRIOR TO OCTOBER 14, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach, South Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issues delineated in the attachment, I am requesting the following:

- A public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hold a larger than average public gathering of this type.
- All affect property owners - both beneficiaries and borrowers - on the East side of route one be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.
- All residents and other interested parties west of route one to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by news paper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours, Bonnie B Bennu

8701 Cider Brook Way
Potomac, MD 20854
October 6, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia Pennsylvania 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick- Island.Bethany Beach-So. Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issue delineated in the attachment I am requesting the following:
-a public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hold a larger than average public gathering of this type.
-all affected property owners - both beneficiaries and borrowers - on the East side of route one be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.
-all residents and other interested parties west of route one to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by news paper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Jorge V. Ribas

JORGE V. RIBAS

SEABREAK HOMEOWNERS ASSOCIATION

October 6, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Cost from Cape Henlopen to Fenwick Island, Bethany Beach-So., Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

We are dismayed that we have received no formal notice of the proposed beach replenishment project, despite the fact that we are property owners in the North Bethany community of Seabreak and our community will be directly affected by the proposal.

Although we have not had sufficient time to study the proposal, we understand the proposed project may disturb the natural, protective sandbar that fronts North Bethany. Moreover, we understand the proposal presents potentially serious health and economic problems that have not been fully explored or disclosed.

For these reasons, on behalf of the entire Seabreak community, we request that:

1. A public hearing be held at a time sufficient to allow a full and complete discussion of the proposal;
2. Not less than 60 days formal notice of the proposal and a hearing date to all affected property owners east of Route 1; and
3. Not less than 60 days notice (by conspicuous display of signs and other suitable means) to all residents and interested parties west of Route 1 along the affected area.

Please advise us as soon as possible whether, and when, there will be a public hearing.

Thank you for your prompt consideration of our request and concerns.

Very truly yours,

Jay F. Carr
President
Seabreak Homeowners Association

Business Address:
100 Crystal A Drive
Hershey, PA 17033

JFC:shp

PO Box 1345
Bethany Beach, Delaware
October 6, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Callegari:

This correspondence is sent to you to request a PUBLIC HEARING to discuss the proposed beach replenishment project outlined in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach, South Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project is a huge undertaking and affects the lives and property of thousands of people. It is inconceivable that such an influential project would be planned without either the input of involved citizens or without sufficient public notice. The proposed project negatively affects property owners who are both recipients and borrowers of said cubic yards of sand.

For these reasons and for those delineated in the enclosed attachment, I am requesting the following:

- a public hearing be held in the spring at a time sufficient to allow full and complete discussion of concerns and in a location suitable to hold a larger than average public gathering.
- all affected property owners on the East side of Route #1 be informed by mail of said proposed project and of the hearing, providing not less than 60 days notice.
- all residents and other interested parties west of Route #1 to a distance of 5 miles be notified via: notice displayed conspicuously for 90 days in all public buildings; by newspaper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on all citizens.

Please advise me as soon as a decision is made to move forward with a public hearing.

Sincerely,

Sandra J. Diefenderfer

ISSUES RAISED FROM A READING OF THE PROPOSAL

1. No considerations are evident in the proposal to protect buildings in South Bethany that were built on the dunes and are now seaward a and beyond the building line.

2. No details of who bears the brunt of the economic/ tax revenue raising necessary for Sussex County to contribute the one third portion of the project as this is not a state funded project and current state revenue for beach replenishment from the hotel tax are minuscule.

3. Using BORROW SITE D raises some health risks as it is within a quarter mile of sewage outflow. This raises health risk concerns regarding timing of the work (summer when there is heavy sewage outflow into the ocean) and the quality of the sand pumped onto the beach which will be tainted by the treated sewage.

4. With regard to BORROW SITE C, this seems to be a source of natural protection. A shallow sandbar that fronts all of North Bethany is of lo depth, some 19 feet, and which according to the National Academy of Sciences Natural Resource Council Report (1995), shoals of this depth should not be disturbed as their protective value against storms will be minimized.

5. No studies have been done on the North Bethany coastline to suggest potential effects of storms on that portion of the beach if that area is used as a borrow site, nor does the study address how damage to that area would be handled.

Henry Dryfoos IV
P. O. Box 993
Bethany Beach, DE 19930

October 7, 1997

Mr. Robert L. Callegari
Attn. Environmental Resources Branch
U. S. Army Corps of Engineers
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach, South Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08 dated August 25, 1997.

The proposed project negatively affects property owners who are recipients as well as those who are borrowers. Also, the project contains health risks (sewage outflow into the ocean) and adversely affects the economic well being of residents and the general public.

For these reasons and for those reasons delineated in the attachment, I am requesting the following:

1. That a public hearing be held in the spring at a time sufficient to allow full and complete discussion in a location suitable for a public gathering of this type.
2. That all affected property owners (both beneficiaries and borrowers) on the East side of Route One be informed by mail of this proposed project and the nearing date at least 60 days in advance.
3. That all interested parties West of Route One to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings and in newspapers and other suitable means of communication for a two week period prior to the hearing. These notices should inform the reader that that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Henry Dryfoos IV

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coat from Cape Henlopen to Fenwick-Island Bethany Beach-So. Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project may negatively affect both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons I am requesting the following:

- a public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hold a larger than average public gathering of this type.

- all affected property owner both beneficiaries and borrowers on the East side of route one will be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.

-all residents and other interested parties west of route one to a distance of 5 miles will be notified via notice displayed conspicuously for 90 days in all public buildings, by news paper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

James E. Farr
24 Surf Side Drive
Gulls Nest Delaware
Mailing Address
6609 Kenedy Drive
Chevy Chase, Maryland 20815

JEF gb
cc: Joe Falzone, Gulls Nest

THIS LETTER MUST BE RECEIVED PRIOR TO OCTOBER 14, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia Pennsylvania 19107-3390

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Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Alan Kreindler

27 Surfside Drive
Gull's Nest
Bethany, DE

October 7, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach, South Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

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Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Peter J. Hondru
2010 Kilmer Road
Manheim, PA 17545

ISSUES RAISED FROM A READING OF THE PROPOSAL

1. No considerations are evident in proposal to protect buildings in South Bethany that were built on dunes and are now seaward and beyond the building line.

2. No details of who bears the brunt of the economic/tax revenue raising proposals necessary for Sussex County to raise its one third portion of the project as this is not a state funded project and current state revenue for beach replenishment from the hotel tax are minuscule, less than one million per year.

3. Using borrow site D raises some health risks as it is within a quarter mile of the sewage outflow. This raises health risk concerns regarding timing of the work (summer when there is heavy sewage outflow into the ocean) and the quality of the sand pumped onto the beach which will be tainted by the treated sewage.

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5. No studies have been done on the North Bethany coastline to suggest potential effects of storms on that portion of the beach if that area is used as a borrow site, nor does the study address how damage to that area would be handled.

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Wanamaker Bldg
100 Penn Square East
Philadelphia Pennsylvania 19107-3390

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Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Jenaro Simpson

OCTOBER 7, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia Pennsylvania 19107-3390

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Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

JENARO D. SIMPSON
PRESIDENT
BAYBERRY DUNES ASSOCIATION
P.O. BOX 427
BETHANY BEACH, DE 19930

ISSUES RAISED FROM A READING OF THE PROPOSAL

1. NO CONSIDERATIONS ARE EVIDENT IN PROPOSAL TO PROTECT BUILDINGS IN SOUTH BETHANY THAT WERE BUILT ON DUNES AND ARE NOW SEAWARD AND BEYOND THE BUILDING LINE.

2. NO DETAILS OF BEARS THE BRUNT OF THE ECONOMIC/TAX REVENUE RAISING PROPOSALS NECESSARY FOR SUSSEX COUNTY TO RAISE ITS ONE THIRD PORTION OF THE PROJECT AS THIS IS NOT A STATE FUNDED PROJECT AND CURRENT STATE REVENUE FOR BEACH REPLENISHMENT FROM THE HOTEL TAX ARE MINUSCULE, LESS THAN ONE MILLION PER YEAR.

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BNR Management, Inc.

Property Management
Leasing
Sales
Investments

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia Pennsylvania 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick- Island Bethany Beach-So. Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

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Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Paul H Nawood

Samuel J.Mendicino
414 Garden Lane
Bryn Mawr, PA 19010
tele& fax # 610-525 2225

10/7/97

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari,

This is a request for a public hearing to discuss the proposed beach replenishment project detailed in the report; "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach, So. Bethany Interim Feasibility Study", pursuant to Public Notice CENAP-PLE97-08, dated August 25, 1997.

The proposed project negatively affects property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well-being of both residents and the general public.

For these reasons and for those delineated in the attachment, I am requesting the following:

-a public hearing to be held in the spring of 1998 at a time sufficient to allow full and complete discussion and airing of concerns and in a location large enough to accommodate a larger than average public gathering.

-that all affected property owners, both beneficiaries and borrowers, on the east side of Route 1, be informed by mail of this proposed project and of the hearing, providing no less than 60 days notice.

-that all residents and other interested parties, west of Route 1 to a distance of 5 miles, be notified via notice displayed conspicuously for 90 days in all public buildings, by newspaper and other suitable means of communication for a 2 week period prior to the hearing. The notice should inform them that the proposal has an economic and health impact on them.

Please advise as soon as a decision is made to move forward with a public hearing. Direct all correspondence to our Bryn Mawr, PA address, as above. Thank you.

Sincerely yours,

Samuel J. Mendicino and Beverly R. Mendicino
41 Surfside Drive
Noth Bethany Beach, DE 19930

ISSUES RAISED FROM A READING OF THE PROPOSAL

1. NO CONSIDERATIONS ARE EVIDENT IN PROPOSAL TO PROTECT BUILDINGS IN SOUTH BETHANY THAT WERE BUILT ON DUNES AND ARE NOW SEAWARD AND BEYOND THE BUILDING LINE.

2. NO DETAILS OF BEARS THE BRUNT OF THE ECONOMIC/TAX REVENUE RAISING PROPOSALS NECESSARY FOR SUSSEX COUNTY TO RAISE ITS ONE THIRD PORTION OF THE PROJECT AS THIS IS NOT A STATE FUNDED PROJECT AND CURRENT STATE REVENUE FOR BEACH REPLENISHMENT FROM THE HOTEL TAX ARE MINUSCULE, LESS THAN ONE MILLION PER YEAR.

3. Using borrow site D raise some health risks as it is within a quarter mile of the sewage outflow. This raises health risk concerns regarding timing of the work (summer when there is heavy sewage outflow into the ocean) and the quality of the sand pumped onto the beach which will be tainted by the treated sewage.

4. With regard to borrow site C, this seems to be a source of natural protection, a shallow sandbar fronting all of North Bethany that is of a very low depth , some 19 feet, and which according to the National Academy of Sciences Natural Resource Council Report (1995), shoals of this depth should not be disturbed as their protective value against storms will be minimized.

5. No studies have been done on the North Bethany coastline to suggest potential effects of storms on that portion of the beach if that area is used as a borrow site, nor does the study address how damage to that area would be handled.

October 8, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Sq. E.
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, 'Delaware Coast from Cape Henlopen to Fenwick-Island, Bethany Beach-So. Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issues delineated in the attachment I am requesting the following:

- A public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hole a larger than average public gathering of this type.
- All affected property owners - both beneficiaries and borrowers - on the East side of route one be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.
- All residents and other interested parties west of route one to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by news paper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

William C Martindale Jr

Owner
32 Bayberry Dunes
N. Bethany, De.

H. K. Dugdale
Post Office Box 1392
Wilmington, Delaware 19899

Mr. Robert L. Callegari
Attn: Env. Res. Branch
U. S. Army Corps of Engrs.
Wanamaker Bldg.,100 Penn Sq, E.
Phila., PA 19107-3390

Dear Mr. Callegari: Oct. 8, 1997

My wife and I own a house in Sea Break, on the ocean just north of Bethany Beach, Delaware.

We are very concerned about the proposed beach replenishment project: " Delaware Coast from Cape Henlopen to Fenwich Island, Bethany Beach, South Bethany Interim Feasibility Study" pursuant to Public Notice CENAP-PL-E97-08, dated Aug. 25, 1997"

The proposed project adversely affects us as property owners - contains health risks and adversely affects both our well being and that of the general public.

We therefore respectfully request:

1. A public hearing in Spring 1998.
2. That we be informed of this hearing, in advance at least 60 days, so we can attend.
3. All residents west of route #1 be notified by a display in public buildings, newspaper, etc. two weeks in advance of the hearing.

Please notify us, at the address on this letterhead, in advance, so we can attend this hearing.

Thank you very much for doing the above.

Sincerely,

Mr/Mrs HK Dugdale

Mr. and Mrs. H. K. Dugdale

Our beach property is # 45 Sea Break, Sussex County,DE

THIS LETTER MUST BE RECEIVED PRIOR TO OCTOBER 14, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia Pennsylvania 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick- Island Bethany Beach-So. Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issue delineated in the attachment I am requesting the following:
-a public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hold a larger than average public gathering of this type.
-all affected property owners - both beneficiaries and borrowers - on the East side of route one be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.
-all residents and other interested parties west of route one to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by news paper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Gerard Hansen
Bills West

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach, South Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issues delineated in the attachment, I am requesting the following:

- A public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hold a larger than average public gathering of this type.
- All affect property owners - both beneficiaries and borrowers - on the East side of route one be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.
- All residents and other interested parties west of route one to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by news paper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

William E. & Harriette Lamo

THIS LETTER MUST BE RECEIVED PRIOR TO OCTOBER 14, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach, South Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issues delineated in the attachment, I am requesting the following:

- A public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hold a larger than average public gathering of this type.
- All affect property owners - both beneficiaries and borrowers - on the East side of route one be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.
- All residents and other interested parties west of route one to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by news paper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Ann M. Barnes

THIS LETTER MUST BE RECEIVED PRIOR TO OCTOBER 14, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach, South Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issues delineated in the attachment, I am requesting the following:

- A public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hold a larger than average public gathering of this type.
- All affect property owners - both beneficiaries and borrowers - on the East side of route one be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.
- All residents and other interested parties west of route one to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by news paper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Adele Barakat
114 Deer Path
Kennett Sq Pa
19348

ISSUES RAISED FROM A READING OF THE PROPOSAL

1. No considerations are evident in proposal to protect buildings in South Bethany that were built on dunes and are now seaward and beyond the building line.

2. No details of who bears the brunt of the economic/tax revenue raising proposals necessary for Sussex County to raise its one third portion of the project as this is not a state funded project and current state revenue for beach replenishment from the hotel tax are minuscule, less than one million per year.

3. Using borrow site D raises some health risks as it is within a quarter mile of the sewage outflow. This raises health risk concerns regarding timing of the work (summer when there is heavy sewage outflow into the ocean) and the quality of the sand pumped onto the beach which will be tainted by the treated sewage.

4. With regard to borrow site C, this seems to be a source of natural protection, a shallow sandbar fronting all of North Bethany that is of a very low depth, some 19 feet, and which according to the National Academy of Sciences Natural Resource Council Report (1995), shoals of this depth should not be disturbed as their protective value against storms will be minimized.

5. No studies have been done on the North Bethany coastline to suggest potential effects of storms on that portion of the beach if that area is used as a borrow site, nor does the study address how damage to that area would be handled.

Mr Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia Pennsylvania 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick- Island Bethany Beach-So. Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issue delineated in the attachment I am requesting the following:
-a public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hold a larger than average public gathering of this type.
-all affected property owners - both beneficiaries and borrowers - on the East side of route one be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.
-all residents and other interested parties west of route one to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by news paper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours, Jack J Mooney

Jack & Barbara Mooney
Bayberry Dunes
P.O. Box 1621
Bethany Beach, DE 19930

ESSAYONS !! CLASS OF '59-'60

OCEAN RIDGE ASSOCIATION
c/o Coastal Resorts Management
P. O. Drawer L
Bethany Beach, DE 19930
302/537-6706 or 800/909-2764

October 9, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U. S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

On behalf of the Ocean Ridge Association, this is to request a public hearing to discuss the proposed beach replenishment project ("the proposed project") detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island-Bethany Beach-So. Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08 dated August 25, 1997. I am the President of the Association, which consists of 66 lot owners (55 of whom have homes built on their lot) of the Ocean Ridge community, in North Bethany Beach, Delaware.

While the Ocean Ridge community clearly would be adversely affected by the proposed project, it also is clear that the project would negatively affect both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well-being of both residents and general public. For these reasons, I request the following:

- A public hearing to be held in the Spring of 1998, at a time sufficient to allow for the full and complete discussion and airing of concerns;
- All affected property owners, both beneficiaries and borrowers, on the east side of Route 1 be notified by mail of the proposed project and of the hearing, providing not less than 60 days notice; and
- All residents and other interested parties west of Route 1, to a distance of 5 miles, be notified via notice displayed conspicuously for 90 days in all public buildings, and by newspaper and other suitable means of communications for a two-week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made concerning the public hearing.

Very truly yours,

Richard S. Rodin/sb

Richard S. Rodin
President

MICHAEL S. PINKERT
705 Potomac Knolls Drive
McLean, Virginia 22102

October 10, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Callegari:

I am a home owner with beach front property in the North Bethany developments of Ocean Ridge and Gulls Nest. The purpose of this letter is to request a public hearing to discuss the proposed beach replenishment project detailed in the report "Delaware Coast from Cape Henlopen to Fenwick - Island Bethany Beach - South Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

As a member of Ocean Ridge's Board of Directors, I would like to state that neither our association, nor any of the other North Bethany Beach Homeowner Associations that we are aware of, were given any notice of the proposed dredging operation in our area. Evidently, this notice was placed in local papers in the middle of winter when none of the homeowners were living in their beach properties.

The more we learn about this proposed project, the more concerned we are becoming that this dredging operation will negatively affect property owners that are both recipients and borrowers. In addition, we feel the project contains health risks and adversely affects the economic well being of not only the residents, but the public in general.

For these reasons, I am requesting the following:

1. A public hearing be held in the spring with enough notice that would be sufficient to allow a full and complete discussion and airing of concerns at a location large enough to hold a larger than average public gather of this type.

2. All property owners, both beneficiaries and borrowers on the east side of Route One be informed by mail of this proposed project and of the hearing, and at least 60 days notice be given.

3. All residents and other interested parties west of Route One to a distance of five miles be notified via notice displayed conspicuously in public buildings, as well as by news paper and other suitable means of communication for a two week period prior to the hearing. This notice should inform the reader that the proposal has an economic and health impact on them.

I would appreciate you advising me as soon as possible with your decision to move forward with the public hearing.

Very truly yours,

Michael S. Pinkert

796 Stephanie Circle
Great Falls, VA 22066
October 13, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Callegari:

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island-Bethany Beach-So. Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issues delineated in the attachment I am requesting the following:

- A public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hold a larger than average public gathering of this type.
- All affected property owners - both beneficiaries and borrowers - on the East side of Route One be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.
- All residents and other interested parties west of route one to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by news paper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

W. Martin Jones Carol Jones

Owners: 50 Seagull Way, North Bethany, DE.

ISSUES RAISED FROM A READING OF THE PROPOSAL

1. NO CONSIDERATIONS ARE EVIDENT IN PROPOSAL TO PROTECT BUILDINGS IN SOUTH BETHANY THAT WERE BUILT ON DUNES AND ARE NOW SEAWARD AND BEYOND THE BUILDING LINE.

2. NO DETAILS OF BEARS THE BRUNT OF THE ECONOMIC/TAX REVENUE RAISING PROPOSALS NECESSARY FOR SUSSEX COUNTY TO RAISE ITS ONE THIRD PORTION OF THE PROJECT AS THIS IS NOT A STATE FUNDED PROJECT AND CURRENT STATE REVENUE FOR BEACH REPLENISHMENT FROM THE HOTEL TAX ARE MINUSCULE, LESS THAN ONE MILLION PER YEAR.

3.Using borrow site D raise some health risks as it is within a quarter mile of the sewage outflow. This raises health risk concerns regarding timing of the work (summer when there is heavy sewage outflow into the ocean) and the quality of the sand pumped onto the beach which will be tainted by the treated sewage.

4 With regard to borrow site C, this seems to be a source of natural protection, a shallow sandbar fronting all of North Bethany that is of a very low depth , some 19 feet, and which according to the National Academy of Sciences Natural Resource Council Report (1995), shoals of this depth should not be disturbed as their protective value against storms will be minimized.

5. No studies have been done on the North Bethany coastline to suggest potential effects of storms on that portion of the beach if that area is used as a borrow site, nor does the study address how damage to that area would be handled.

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BETHANY VILLAGE OWNERS ASSOCIATION, INC.
P.O. Box 1117
Bethany Beach, DE 19930

October 13, 1997

Mr. Robert I. Callegari
U.S. Army Corp of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390
ATTN: Environmental Resources Branch

RE: Bethany Beach Replenishment Project

Dear Mr. Callegari:

On behalf of the Bethany Village Owners Association and the over 30 homeowners in Bethany Village, this letter is to request a public hearing to discuss the proposed beach replenishment project detailed in the report "Delaware Coast from Cape Henlopen to Fenwick Island and Rehoboth Beach/Dewey Beach Interim Feasibility Study" pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects both property owners who are borrowers and lenders. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

The proposal does not address, among other things, the following items:

1. No consideration is given to protecting buildings in South Bethany that are built on the dunes and that are eastward beyond the building line.

2. No details are provided on the economic effect on Sussex County's obligation to raise its portion of funding the project.

3. Using Borrow Site D raises health risks in that it is within a one-quarter mile of sewage outflow.

4. Borrow Site C provides a natural source of protection to the North Bethany beaches and which, according to the National Academy of Science Natural Resources Council Report (1995), should not be disturbed due to the minimal depth of the shoals involved and their protective value against storms.

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5. No studies have been performed on the North Bethany coastline to suggest potential effects of storms on that portion of the beach if that borrow site is used, nor does it address how damage to that area would be rectified.

For these reasons, we are requesting the following:

1. A public hearing be held in the spring with sufficient notice to allow full and complete discussion and airing of concerns and in a suitable location to hold a larger than average public gathering.

2. All affected property owners - both lenders and borrowers - on the east side of Route One be informed by mail of this proposed project and of the hearing, with not less than 60 days advance notice.

3. All residents and other interested parties in the area five miles west of Route One be notified via notice displayed conspicuously in all public buildings for 60 days prior to the hearing, and in the local press and other suitable means of communication for a two week period prior to the hearing.

All notices must inform the reader of the importance of this proposal and that it may have an economic and health impact on them.

Thank you for your prompt attention to this matter which is important to all of us. We must develop a plan that takes into consideration the interests of all concerned and which is developed through the participation of all interested parties. To do so requires widespread and sufficient advance notice of the proposed plan and an opportunity for meaningful public participation.

Please advise me as soon as a decision is made to move forward with a public hearing. You may reach me at my office at (202) 414-6121 or by notifying by me by mail at 9820 Whetstone Drive, Gaithersburg, MD 20879.

Very truly yours,

Richard S. Garabedian
President - BVOA

8519 Quaint Lane
Vienna, VA
October 13, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Callegari:

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The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issues delineated in the attachment I am requesting the following:

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- All affected property owners - both beneficiaries and borrowers - on the East side of Route One be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.
- All residents and other interested parties west of route one to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by news paper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Linda Cordovana David Tondreau

Owners: 50 Seagull Way, North Bethany, DE.

ISSUES RAISED FROM A READING OF THE PROPOSAL

1. NO CONSIDERATIONS ARE EVIDENT IN PROPOSAL TO PROTECT BUILDINGS IN SOUTH BETHANY THAT WERE BUILT ON DUNES AND ARE NOW SEAWARD AND BEYOND THE BUILDING LINE.

2. NO DETAILS OF BEARS THE BRUNT OF THE ECONOMIC/TAX REVENUE RAISING PROPOSALS NECESSARY FOR SUSSEX COUNTY TO RAISE ITS ONE THIRD PORTION OF THE PROJECT AS THIS IS NOT A STATE FUNDED PROJECT AND CURRENT STATE REVENUE FOR BEACH REPLENISHMENT FROM THE HOTEL TAX ARE MINUSCULE, LESS THAN ONE MILLION PER YEAR.

3. Using borrow site D raise some health risks as it is within a quarter mile of the sewage outflow. This raises health risk concerns regarding timing of the work (summer when there is heavy sewage outflow into the ocean) and the quality of the sand pumped onto the beach which will be tainted by the treated sewage.

4. With regard to borrow site C, this seems to be a source of natural protection, a shallow sandbar fronting all of North Bethany that is of a very low depth , some 19 foot, and which according to the National Academy of Sciences Natural Resource Council Report (1995), shoals of this depth should not be disturbed as their protective value against storms will be minimized.

5. No studies have been done on the North Bethany coastline to suggest potential effects of storms on that portion of the beach if that area is used as a borrow site, nor does the study address how damage to that area would be handled.

Pohanka
Automotive Group
Over 75 Years of Service

October 13, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

I am the homeowner at 25 Surfside Drive, Gull's Nest, Bethany Beach, Delaware.

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island.Bethany Beach-So. Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issue delineated in the attachment I am requesting the following:

- a public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hold a larger than average public gathering of this type.

- all affected property owners - both beneficiaries and borrowers - on the East side of route one be informed by mail of this proposed project and of the hearing, providing not less than 60 days notice.

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all residents and other interested parties west of route one to a distance of 5 miles be notified via notice displayed conspicuously for 90 days in all public buildings, by newspaper and other suitable means of communication for a two week period prior to the hearing. The notice should inform the reader that the proposal has an economic and health impact on them.

Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

John J. Pohanka
301-899-0941 (office)

JJP/cz

Pohanka
Automotive Group

LAW OFFICES

O'DONOGHUE & O'DONOGHUE

DONALD J. CAPUANO
JAMES R. O'CONNELL (D.C. & MD.)
ROBERT MATISOFF
JOYCE A. MADER (D.C. & PA.)
SALLY M. TEDROW
BRIAN A. POWERS
JOHN L. BOHMAN
JOSEPH P. BOYLE (D.C., MD. & PA.)
FRANCIS J. MARTORANA
NICHOLAS R. FEMIA (D.C. & PA.)
ELLEN O. BOARDMAN
CHARLES W. GILLIGAN (D.C. & MD.)
LOUIS P. MALONE III
JOHN LEARY (PA. ONLY)

PHYLLIS C. BORZI
OF COUNSEL

4748 WISCONSIN AVENUE, N.W.
WASHINGTON, D.C. 20016
(202) 362-0041
TELECOPIER (202) 362-2640

9 NORTH ADAMS STREET
ROCKVILLE, MD. 20850
(301) 251-0929

1056 PUBLIC LEDGER BUILDING
INDEPENDENCE SQUARE
PHILADELPHIA, PA. 19106
(215) 629-4970

MARY C. FELLER (D.C. & PA.)
JOHN R. HARNEY
R. RICHARD HOPP (D.C. & MD.)
GERARD M. WAITES (PA. ONLY)
SCOTT A. CRONIN (PA. ONLY)
JOHN M. McINTIRE (D.C. & MD.)
DAVID D. CAPUANO (PA. ONLY)
MARK W. KUNST (D.C. & MD.)
KENNETH M. JOHNSON (D.C. & VA.)
LINDA DELIVORIAS (MD. ONLY)
BENJAMIN N. DAVIS (D.C. & MD.)

MARTIN F. O'DONOGHUE
(1902-1973)
PATRICK C. O'DONOGHUE
(1930-1979)

VIA FACSIMILE AND MAIL

October 14, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Callegari:

The undersigned is the owner of a house at 2 Sea Gull Way, Gull's Nest, Sussex County, Delaware.

This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick-Island Bethany Beach-So. Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

The proposed project negatively affects both property owners who are recipients and borrowers. In addition, the project contains health risks and adversely affects the economic well being of both residents and the general public.

For these reasons and for those issues delineated in the attachment to the Study, I am requesting the following:

- a public hearing be held in the spring at a time sufficient to allow full and complete discussion and airing of concerns and in a location suitable to hold a larger than average public gathering of this type.

- all affected property owners-both beneficiaries and borrowers-on the East side of Route One be informed by mail of this proposed project and of the hearing, providing not less than 60-days notice.

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Please advise me as soon as a decision is made to move forward with a public hearing.

Very truly yours,

Donald J. Capuano

DJC:lmf

cc: Nancy Stack, President
Gull's Nest Homeowners' Assoc.
Joseph Falzon

THIS LETTER MUST BE RECEIVED PRIOR TO OCTOBER 14, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia Pennsylvania 19107-3390

Dear Mr. Callegari.

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Very truly yours,

Leslie Barrett Rothblat
Lauren C. Rothblat

57

ISSUES RAISED FROM A READING OF THE PROPOSAL

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DENNIS VICK
8510 COUNTRY CLUB DR
BETHESDA MD 20817

OCT. 13, 1997

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Very truly yours,

Capt & Mrs Richard A Pfeil, USN (Ret)

P.S. We have been out of country. This mail delivered during our absence. Please consider this fact in your decision(s).

Thank you.
R Pfeil

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Very truly yours,

Robert and Nancy Brown
5101 Reducing Dr.
Alexandria, VA 22312-2044

ZELIC A. GLESSNER
2215 ST. PAUL ST.
BALTO. MD 21218
10/8/97

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

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ZELIC A. GLESSNER
OWINGS: 13 S. OCEAN WAY, SEA COLONY
BETHANY DEL

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2. No details of who bears the brunt of the economic/tax revenue raising proposals necessary for Sussex County to raise its one third portion of the project as this is not a state funded project and current state revenue for beach replenishment from the hotel tax are minuscule, less than one million per year.

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Anne G. Gressen
2215 St. Paul St
Balto. Md. 21218
410-467

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U.S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

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OWNER: 135 OCEAN WAY
SOUTH ATLANTIC
BETHANY BEL.

09

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135 Blake Rd.
Norfolk, VA 23505
October 13, 1997

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Philadelphia, Pennsylvania 19107-3390

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Very truly yours,

Nicholas Cordovana Betty Cordovana

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Owners: 50 Seagull Way, North Bethany, DE

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Very truly yours,

Barbara L Davis
1234 Powder Rd
Sykesville, MD 21784

ORIGINAL

BEFORE THE
U.S. ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT

BETHANY BEACH INTERIM FEASIBILITY STUDY

DRAFT FEASIBILITY REPORT
DRAFT ENVIRONMENT IMPACT STATEMENT

COMMENTS OF
ATLANTIC WATERGATE ASSOCIATION

William S. Green
Chairman, Legal Committee
6506 Kenhowe Drive
Bethesda, Maryland 20817
Phone: 301-229-6566
Fax: 301-229-6566

These comments are submitted by Watergate Association, Inc. (commonly known as Atlantic Watergate Association), a homeowners' group of 65 owners, located in North Bethany Beach . The Association's location is shown on the attached map, extracted from the draft EIS, which also indicates the proximity of the proposed borrow area C.

At this stage, the Association takes no position on the need for the proposed project of beach replenishment. The political forces backing the replenishment project are too powerful for a homeowners' group to challenge. Suffice it to say that serious doubts exist as to the necessity of expending Federal funds for this project.

I. The Association submits that both the Feasibility Study and the EIS are defective because they do not sufficiently analyze the consequences of utilizing site C as the borrow area for the proposed replenishment .While the EIS, for instance, laudably gives much attention to peregrine falcons, sea turtle and beach pigweed (DEIS 4-27), scant attention is given to the physical and socio-economical impact on the North Bethany area which will suffer the burden of the site C dredging.

1.

The EIS (and the feasibility study) gives us the number of homes in South Bethany (II-14), the number of year-round residents in Bethany (ibid.) BUT WHERE IS THE COMPARABLE INFORMATION FOR NORTH BETHANY?

2.

Reading both documents one gets the impression that the land area near site C is a vast littoral Sahara, devoid of homes and population. Yet this is the area which will supply the replenishment material for the communities further south. If the function of the EIS is to provide information for the decisionmakers, then the information should be balanced in content. A document which devotes pages to details about Bethany, South Bethany and

1. Borrow Area C was withdrawn in favor of Borrow Area E located offshore of Bethany Beach and South Bethany.

2. The purpose of the feasibility study is to assess the need for, and the formulation of, a Federal storm damage reduction project for the incorporated towns of Bethany Beach and South Bethany. The majority of the area described as North Bethany, and Atlantic Watergate in particular, is outside of the study area and beyond the limits of the proposed project. As such, inclusion of population and housing characteristics for this area is not required.

Fenwick, but not a word to North Bethany is not only deficient, but raises the serious question that no consideration was given to North Bethany and the impact of the project upon the lives and interests of the people of that area. It also raises the question whether both of these documents were prepared as a ritualistic justification for an already predetermined project, rather than a serious effort to evaluate alternatives.

II. The obvious excuse for this lack of information regarding North Bethany is the statements in the EIS "Dredging within borrow areas 'C' and 'E' would have negligible effects on near shore sedimentation patterns and wave conditions." This sweeping conclusion is based on" numerical modeling on areas similar to ours in the Maryland Hurricane Protection project conducted in 1989. (DEIS 5-2). That study pertained to Ocean City some six miles to the south of area C, while North Bethany is about a mile north of area C. Having concluded that there would be no hydrodynamic effects — based on studies conducted elsewhere — the DEIS proceeds in typically Federalese form as follows:

> The dredging associated with the berm and dune restoration alternative would result in short-term impacts to water quality in the immediate vicinity of the dredging and beach nourishment operations. Dredging in the proposed borrow area will generate turbidity resulting in sedimentation impacts within the immediate vicinity of the operations. Short-term increased turbidity can effect organisms in several ways. Primary production in phytoplankton and/or benthic algae may become inhibited from turbidity. Suspended particulate matter can clog gills and inhibit filter-feeding species. Reilly et. al. 1983 determined that high turbidity could inhibit recruitment by pelagic larval stocks. In addition, midwater nekton like finfish and mobile benthic invertebrates may migrate outside of the area where turbidity and deposition occur.

DEIS 5-2.

3. It is to be noted that the duration of the "short-term adverse impacts" is not defined, nor is the extent of the "immediate vicinity."

3. This pertains to the impacts on water quality in the form of turbidity caused by the resuspension of material generated during dredging and beachfilling operations. Because of the coarse nature of the beachfill quality of the material, adverse impacts are expected to be localized (within project impact area - ie. Offshore borrow and beachfill placement sites) and short-term (during the duration of the operation).

Translated into English, the EIS concedes that adverse impacts to water quality of unknown duration will take place in the undefined neighborhood of the dredging.

4. The EIS further states that 940 acres of sandy marine benthic habitat will be impacted by the dredging and will be completely eliminated. It concludes a lengthy analysis by stating

> Measures that would minimize the effects of dredging in the borrow area include dredging in a manner as to avoid the creation of deep pits, alternating locations of periodic dredging, dredging during lowest biological activity, and the utilization of a hydraulic dredge with a pipeline delivery system to help minimize turbidity will be considered.

DEIS 5-6.

This statement that certain remedial measures "will be considered" is hardly a justification for the disturbance being proposed, nor is it an assurance that once these measures have been "considered" they will be, in fact, effectuated.

The EIS (p. 5-8) after stating that the piping plover, a state and Federally endangered bird, nests in sandy beaches, notes that nesting sites "have been primarily limited to Cape Henelopen State Park and Delaware Seashore State Park." (emphasis added). Then it proceeds to say that "no nesting sites have been identified within the study area." THE DELAWARE SEASHORE STATE PART ADJOINS OUR ASSOCIATION'S AREA AND PLOVER

5. NESTS HAVE BEEN LOCATED WITHIN SEVERAL HUNDRED FEET OF OUR AREA. Is it possible that the "study area" does not include North Bethany?

These cited examples clearly indicate that the preparers of the Feasibility Report and the EIS totally ignored the North Bethany area and the impact of the proposed action upon our community.

III. North Bethany is a populated area whose prosperity depends on the integrity of the beach. Although one cannot discern this fact from reading the EIS, North Bethany

4. The EIS did not state that "940 acres of sandy marine habitat will be completely eliminated". It is true that dredging would remove the existing benthic community as a direct and immediate effect in the area being dredged. However, the EIS cites that recolonization is expected to occur soon after the immediate removal of the benthos. It is important to note that the dredging would not result in the complete removal of the benthic community in 940 acres of the borrow site all at one time. Approximately 940 acres would have been disturbed over a period of 50-years allowing areas dredged in previous years to become recolonized by benthos. This does not imply that 940 acres of sandy marine benthic habitat would be eliminated permanently. It should also be noted that the 940 acres pertained to Borrow Area C, which was subsequently withdrawn.

5. The EIS focussed on the potential effects of beachfill operations on the piping plover. Delaware Seashore State Park is located well outside of the beachfill placement impact area, therefore, the discussion is limited only to the beachfill placement impact areas of Bethany Beach, South Bethany, and their taper zones.

encompasses hundreds of ocean-block dwelling units which, like the communities on whose behest the project is undertaken, depend on the beach for this ambiance. The attached map (Ex. 2) shows the major subdivisions of North Bethany.

One of the reasons the drafters of the documents under consideration did not pay attention to North Bethany is that it is a disenfranchised community composed of summertime residents whose principal homes are elsewhere. Since the area is an unincorporated community of Sussex County, it has no voice, no representation, no indication on a map. In the wintertime, the whole area is deserted. It is important to know that any public notices published in newspapers or broadcast locally in the winter have no impact on this area because there is not one to read them or hear them. If the protest from North Bethany does not equal the cheering from the southern communities, it is because North Bethany owners live elsewhere and probably do not even know of this proposal, in the absence of an organized community structure to lead the cheering.

Any damage done to the beach would impair the very reason for the existence of the community. People have invested fortunes and dreams into this community. Yet the document, which has the potential of impairing its very core existence does not even notice the fact that the community exists.

The documents are shoddy and defective. The taxpayers deserve a better product for their money.

CONCLUSIONS AND RECOMMENDATIONS

Because the EIS and Feasibility Study do not measure up to the standards expected of documents of this kind, we recommend that:

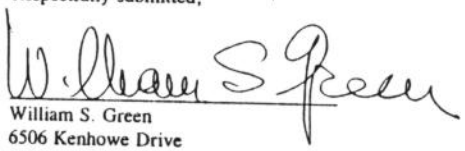
1. the documents be withdrawn;

6.

2. new documents be prepared which objectively analyze the problems and solutions in plain English; and

3. that no action be taken on this project until there has been an adequate comment period on these documents.

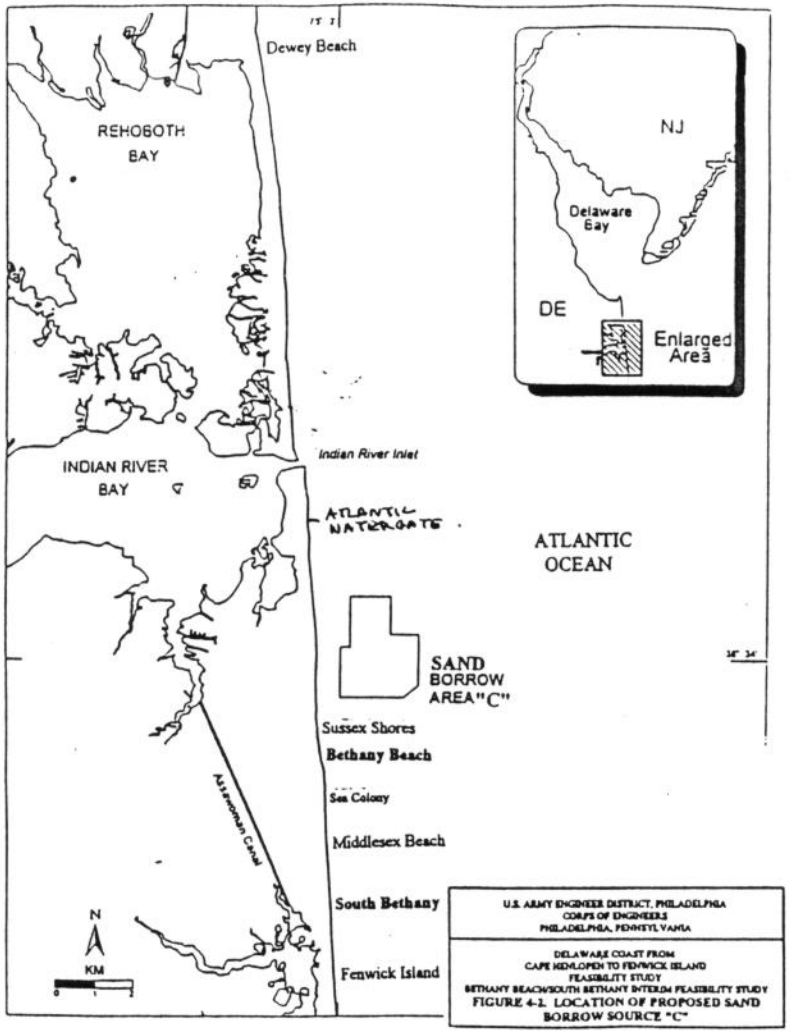
Respectfully submitted,



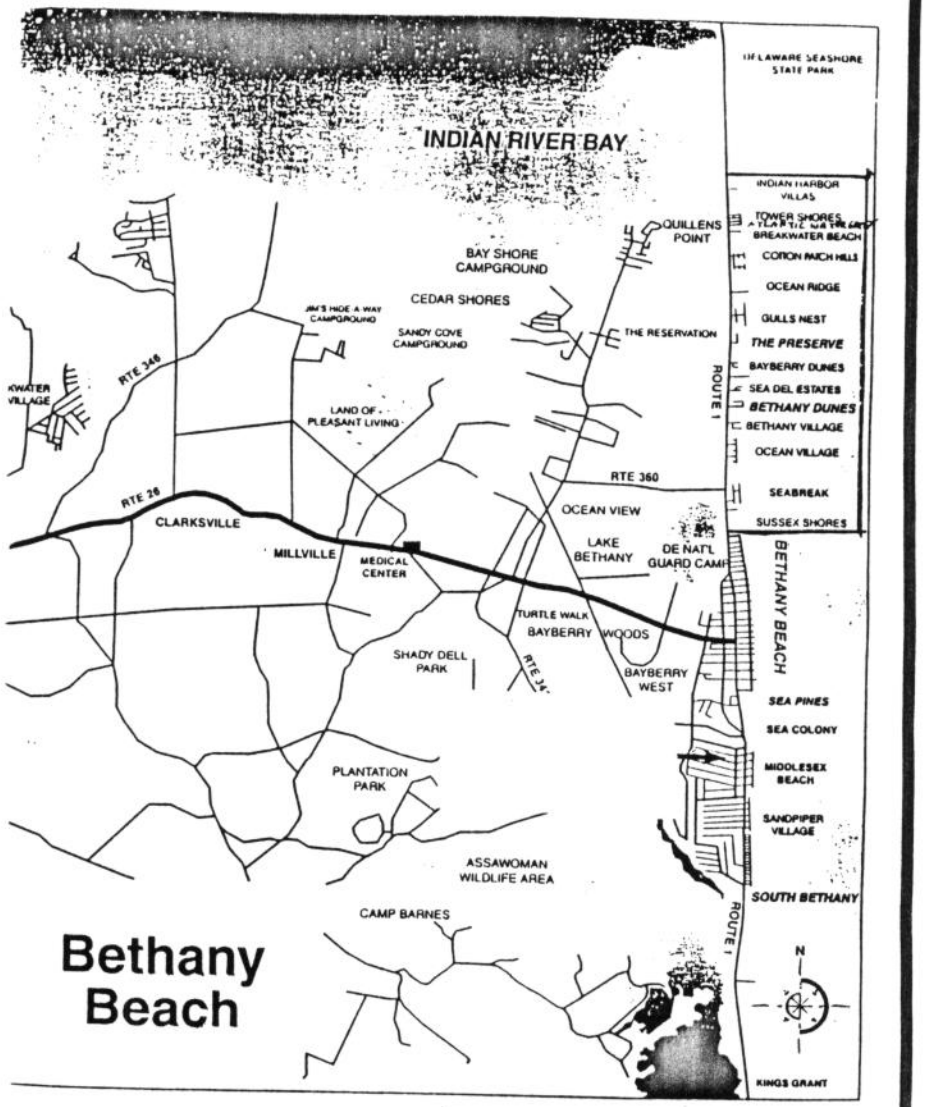
William S. Green
6506 Kenhowe Drive
Bethesda, MD 20817
(301) 229-6566
Fax: (301) 229-6566

Chairman, Legal Committee
Atlantic Watergate Association
North Bethany Beach, Delaware

6. The documents were prepared in accordance with U.S. Army Corps of Engineers Planning Guidance, and were found to meet the Planning Guidance requirements. A Supplemental Draft Environmental Impact Statement (SDEIS) was prepared and circulated to the public for comment subsequent to the public review of the Draft EIS. The SDEIS evaluated the potential use of an alternative sand borrow area (Area E) in accordance with the National Environmental Policy Act (NEPA), as amended. Public comment periods for the DEIS and SDEIS were in accordance with NEPA and ER-200-2-2 (U.S. Army Corps of Engineers Environmental Quality Procedures for Implementing NEPA).


Dewey Beach
REHOBOTH BAY
NJ
Delaware Bay
DE
Enlarged Area
Indian River Inlet
INDIAN RIVER BAY
ATLANTIC NAVIGATE
ATLANTIC OCEAN
SAND BORROW AREA "C"
Sussex Shores
Bethany Beach
Sea Colony
Middlesex Beach
South Bethany
Fenwick Island
N
KM
U.S. ARMY ENGINEER DISTRICT, PHILADELPHIA
CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA
DELAWARE COAST FROM
CAPE HENLOPEN TO FENWICK ISLAND
FEASIBILITY STUDY
BETHANY BEACH/SOUTH BETHANY INTERIM FEASIBILITY STUDY
FIGURE 4-2. LOCATION OF PROPOSED SAND BORROW SOURCE "C"

DEIS 4-17


INDIAN RIVER BAY
DELAWARE SEASHORE STATE PARK
INDIAN HARBOR VILLAS
TOWER SHORES
BREAKWATER BEACH
COTTON PATCH HILLS
OCEAN RIDGE
GULLS NEST
THE PRESERVE
BAYBERRY DUNES
SEA DEL ESTATES
BETHANY DUNES
BETHANY VILLAGE
OCEAN VILLAGE
SEABREAK
SUSSEX SHORES
QUILLENS POINT
BAY SHORE CAMPGROUND
CEDAR SHORES
JIM'S HIDE A WAY CAMPGROUND
SANDY COVE CAMPGROUND
THE RESERVATION
ROUTE 1
RTE 346
KWATER VILLAGE
LAND OF PLEASANT LIVING
RTE 360
RTE 26
CLARKSVILLE
OCEAN VIEW
LAKE BETHANY
DE NAT'L GUARD CAMP
MILLVILLE
MEDICAL CENTER
TURTLE WALK
BAYBERRY WOODS
BAYBERRY WEST
SHADY DELL PARK
RTE 34
BETHANY BEACH
SEA PINES
SEA COLONY
MIDDLESEX BEACH
SANDPIPER VILLAGE
PLANTATION PARK
ASSAWOMAN WILDLIFE AREA
SOUTH BETHANY
CAMP BARNES
ROUTE 1
N
KINGS GRANT
Bethany Beach

PAUL D. MULDOWNEY
P.O. BOX 478
HAGERSTOWN, MARYLAND 21741

October 3, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

It has been brought to my attention that there is a proposed beach replenishment project to be done by the Corps of Engineers which directly affects the Delaware coast line from Cape Henlopen to the Maryland line. I am keenly interested because I am a property owner at North Bethany Beach.

This project could adversely affect the general area in which I own property. I am, therefore, adamantly requesting a public hearing regarding this project because of the possible health risk and the adverse economic impact on me as a resident, and the general public.

1. So that all issues may be addressed fairly, I urge you to hold this public hearing sometime in the second quarter of 1998 to provide adequate time for the property owners and the Corps of Engineers to address all concerns.

If the project is to be fairly discussed, public notices should be sent by your office directly to all affected property owners. Adequate notice should be given, and all means should be used to advertise this hearing.

I hereby request that you advise me as soon as a decision is made to conduct this public hearing.

Yours truly,

Paul D. Muldowney

PDM/sjh

01

1. Please refer to Response #1 to Mr. Douglas T. Parson's letter dated 10/3/97.

CARDIOVASCULAR
& THORACIC SURGERY
ASSOCIATES, P.C.
Adult & Pediatric

Edward A. Ectrak, M.D.
Han M. Speir, M.D.
Bechara F. Ikl, M.D.
Selvon L. Burton, M.D.
Robert L. Albus, M.D.
Paul S. Mavsmmara, M.D.
Paul D. Kiernan, M.D.
John R. Garrett, M.D.
John W. Rhee, M.D.

October 5, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

As follow-up of information with regard to potential and proposed beach replenishment project for Bethany, South Bethany and Fenwick Island coastal areas, I write this note seeking a thorough public discourse prior to implementation of any replenishment project.

While I live on the north side of Bethany, the issues raised regarding the above-mentioned proposal are significant, both concerning possible use of sewage-tainted sand on the "recipient" beach, as well as the unknown factors that may be unleashed by taking sand from borrow site "C" that seems to provide some natural protection along North Bethany of very low depth (some 19 feet) and which, according to my sources, cite the National Academy of Sciences natural resources codicile (1995) that shoals of this depth should not be disturbed as their protective value against storms may be eroded...thus endangering any "donor" beaches. 1.

Hoping that this information may be of interest to you, I respectfully request a public hearing prior to any proposal or implementation with the regard to the above-mentioned.

Sincerely yours,

Paul D Kiernan (pm)

Paul D. Kiernan, M.D.

PDK/pam

3301 Woodburn Road • Suite 301 • Annandale, Virginia 22003 • (703) 280-5858 • Fax (703) 849-0874
4320 Seminary Road • Alexandria, Virginia 22304 • (703) 504-7880 • Fax (703) 504-7815
1635 North George Mason Drive • Suite 200 • Arlington, Virginia 22205 • (703) 558-6491 • Fax (703) 524-4365

1. Please refer to Responses 1 - 6 to Mr. Douglas T. Parson's letter dated 10/3/97.

RD# 5
4 Canal Lane
Seaford, DE 19973

October 6, 1997

ATTN: Mr. Robert L. Callegari
Environmental Resources Branch
U. S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

RE: Public Notice No. CENAP-PL-E-97-08—Request for Public Hearing

Dear Mr. Callegari,

Sussex Shores Beach Association strongly supports the State of Delaware and the federal government efforts to improve the beaches of Delaware. However, as President of the Sussex Shores Beach Association and as an individual owner and resident in Sussex Shores I am requesting that a public hearing be held to address issues and concerns relative to the report titled: Delaware Coast from Cape Henlopen to Fenwick Island-Bethany Beach/South Bethany Interim Feasibility Study-Draft Feasibility Report and Draft Environmental Impact Statement.

Sussex Shores is an unincorporated oceanfront community directly north of Bethany Beach, Delaware. The community includes 82 single family residential homes and 18 condominium units. Sussex Shores Beach Association was formed in 1958. The objectives of the officers on behalf of the Association are to provide protection of the homeowners' investments in their homes and property, the roads, dunes, beach, and the safety of the residents, tenants, and guests. The Sussex Shores Beach Association and residents have spent considerable resources over the last 39 years maintaining the dunes and protecting the natural environment of the beach. It has been frequently stated by the Delaware Department of Natural Resources and by staff members of the Philadelphia Corps of Engineers that Sussex Shores beach and dunes are the best maintained along the Delaware Atlantic Coast. Beachgrass has been consistently planted by the Association to maintain the stability of the dunes.

The subject Feasibility Study addresses the need for shore protection and storm damage reduction for the communities of Bethany Beach and South Bethany, Sussex County, Delaware. The proposed plan for Bethany Beach and South Bethany is beachfill with a berm width of 150 ft. and a dune with a top elevation of + 16 NAVD. A total of approximately 2,748,000 cubic yards of sand would be required for initial beachfill

placement in Bethany Beach and South Bethany. The report also notes that renourishment of the sand would be required every 3 years over the 50-year project life. The draft Environmental Impact Statement dated April 1997 evaluated the anticipated environmental impacts of the alternatives of the selected plan and the need to reduce the potential for storm damage to the structures and property associated with the communities of Bethany Beach and South Bethany, Delaware.

Neither report addresses the environmental, economic or recreational impacts of the proposed plan on the communities adjacent to Bethany Beach and South Bethany, and more specifically, Sussex Shores. For this reason, Sussex Shores Beach Association and its citizens and I are requesting a Public Hearing be held to consider this proposal. The meeting should be held in the spring at a time sufficient to allow full and complete discussion of the issues of concern. The reasons for holding the public hearing include the following:

1. The Delaware Department of Natural Resources, in the summer of 1994, in conjunction with a beachfill project at Dewey Beach, placed maintenance fill along the shorelines of Bethany Beach and South Bethany. The beachfill material for this effort came from with the borrow site cleared for the Rehoboth Beach/Dewey Beach Interim Feasibility Study on Hen and Chicken Shoal. As a result of this activity Sussex Shores received a significant amount of backdrift on our beaches. The sand is dark, coarse, gravelly, and noticeably different than the native sand. We do not know what the impact of increased sand on our beach that is different from the native sand will do to the seemingly natural protection from the storm damage that we might otherwise have

2. We are concerned with any possible long term adverse impact of beach nourishment which might result in increased storm damage as well as a possible decrease in our natural sand, thereby resulting in decreased property values.

3. We have experienced significant scarping of the beach resulting in a shorebreak or drop-off which results in a serious safety situation for our swimmers. It appears that the coarseness of the selected sand from the borrow site is directly proportional to the amount of drop-off we can expect. We have no assurance that the sand selected will not result in increased scarping of our beach. The public hearing should address the safety of the citizens swimming on Sussex Shore beaches. Alternatives such as creation of an offshore sandbar diffusing the waves already requires further consideration and discussion.

4. We do not think the cumulative impact of utilizing sandy shoal habitat for borrow material has been adequately addressed on a regional basis in the report. Depending on the selection of the borrow site or, as outlined in the proposed feasibility study, the use of two sites, Sussex Shores beach and dunes can be seriously impacted by the removal of such a significant amount of sand off-shore so close to our community. A study of the impact on the regional beaches, specifically those that are near the borrow sites, needs to be made. The modeling performed in 1989 may not provide sufficient evidence of no impact on the wave,conditions or nearshore sedimentation. What reasonable assurances do the citizens of Sussex Shores have that the dredging contractor will adhere to recommendations regarding depth of dredging? What

1. According to the Delaware Department of Natural Resources and Environmental Control, the material used for the 1994 Bethany nourishment project did not come from the Hen and Chickens Shoal. It came from a borrow site east of Fenwick Island that has been used for previous Fenwick Island, South Bethany and Bethany Beach replenishment projects. While this material is darker and coarser than the native material on the beach, it is also more resistive to erosional forces. In addition, any longshore influx of sand from Bethany Beach provides a supply which assists in keeping the dune and beach system at Sussex Shores intact. It is likely that sand placement at Bethany Beach has resulted in enhanced protection for Sussex Shores rather than diminishment.

2. Borrow Area C, which lies in the vicinity of Sussex Shores, was previously identified as the initial source of material for the proposed project. Further consideration has eliminated Area C in favor of Area E, which lies offshore of South Bethany. It is not anticipated that Sussex Shores will face increased storm damage or loss of sand as the result of the Bethany Beach/South Bethany project.

3. The texture of the borrow material from Area E is much closer to that of the native material of Sussex Shores and Bethany Beach than sand from either Area C or the Fenwick area. It is expected that through natural sorting and distribution, the beach will assume grade characteristics similar to those that existed prior to the introduction of new sand.

4. See response to #2.

enforcement actions can be taken if they are not in compliance with contract provisions since it would be after the fact?

5. 5. The COE notes on page IV-1 of the Feasibility Study that the general and specific planning objectives were identified. As stated, the prime Federal objective is to contribute to the National Economic Development account consistent with protecting the Nation's environment. Planning constraints included regional and social, and specifically "consideration should be given to public, health, safety and social well-being, including possible loss of life." The proposed plan could result in significant backdrift and scarping on our beach. This could pose considerable health and safety dangers.

6. 6. Planning constraints also require the plans to "avoid the destruction or disruption of man made and natural resources, aesthetic and cultural values, ..." We believe that the aesthetic of Sussex shores natural beauty must be considered in light of the possible use of unattractive and coarse sand that will build up on the beach with construction and continual nourishment of Bethany Beach.

We request that these concerns be addressed in a public hearing. We do not think the concerns, safety, and impacts on the adjacent communities have been addressed in this study or the accompany environmental impact statement. We would appreciate hearing from you regarding our request. I can be reached at (302) 628-9427.

Sincerely yours,

Robert Heyssel,
President

cc: John Hughes, Director, Division of Soil and Water Conversation, Delaware Department of Natural Resources and Environmental Control

5. See response to #3.

6. See response to #3.

Louis J. Tiches
P.O. Box 478
Hag. MD 21741

October 7, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

I am a resident and owner of a home in North Bethany Beach. The proposal to remove certain quantities of sand from our area to solve a problem in another area of the beach is a typical example of robbing Peter to pay Paul.

1. No one in your organization can convince me that they are 100% unequivocally positive that by doing so, somewhere down the road there will not occur an ecological consequence of this action.

2. I would presume that public hearings are required in this matter, and I look forward to the opportunity of voicing my disagreement with this philosophy, recognizing that sand is obviously available from the ocean floor and can easily be pumped in from that area to avoid creating a problem in North Bethany and then having two problem areas to cope with.

Very truly yours,

Louis J. Tiches

LJT/sjh

1. Ecological consequences of the proposed action are discussed in detail in Section 5.0 Environmental Consequences of the FEIS.

2. Please refer to Response #1 to Mr. Douglas T. Parson's letter dated 10/3/97.

2611 Old Taneytown Road
Westminster, MD 21158
October 7, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Bldg
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Sir;

As homeowners in the Gull's Nest neighborhood of Bethany Beach, Delaware, we are concerned about the proposed beach replenishment project as described in the report, "Delaware Coast from Cape Henlopen to Fenwick Island etc. Interim Feasibility Study". We are requesting a public hearing to discuss the ramifications of this project as it quite possibly affects in a negative fashion both the areas providing the sand and those receiving it.

1. We strongly urge you to hold a public hearing with sufficient notice to all concerned, to include all affected property owners, residents and other interested parties west of route one.

Please inform us as soon as decisions have been made regarding these hearings. Thank you for your help and consideration of these issues important to so many.

Most sincerely,

Robert + Carolyn Scott

Mr. and Mrs. Robert Twining Scott

1. Please refer to Response #1 to Mr. Douglas T. Parson's letter dated 10/3/97.

THE BREAKWATER BEACH HOMEOWNERS ASSOCIATION OF NORTH BETHANY, DELAWARE

October 7, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Callegari:

1. This letter is on behalf of the Breakwater Beach Homeowners Association of North Bethany, Delaware. We request a public hearing to discuss the proposed beach replenishment project detailed in the report," Delaware Coast from Cape Henlopen to Fenwick Island-Bethany Beach - South Bethany Interim Feasibility Study" pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

2. The members of our Association are particularly concerned that the removal of material from the off-shore sandbar will remove an important barrier and thereby increase the intensity and damage from storms.

3. It is also clear that there will be significant costs resulting from this project, and our members would like to know what the cost parameters will be. The discussions with those familiar with the project do not give us much confidence in terms of the benefits that are expected to accrue from this project.

4. To answer these and other concerns, a public hearing should be held in the spring with sufficient advance notice so that all affected parties will have the opportunity to appear and participate. It also is important that an opportunity be provided for technical experts to have an opportunity to testify regarding the report and the proposed project.

Sincerely,

Nelson Denlinger

Nelson Denlinger
President
Breakwater Beach Association

5213 Worthington Drive
Bethesda, Maryland 20816

1. & 2. Please refer to Response #1, #5, and #6 to Mr. Douglas T. Parson's letter dated 10/3/97.

3. An analysis of benefits and costs for the proposed project was completed in accordance with applicable Corps of Engineers guidance and regulations and in coordination with appropriate resource agencies. The findings of the feasibility study and anticipated project impacts are described in the feasibility report and technical appendices..

4. Please refer to Response #1 to Mr. Douglas T. Parson's letter dated 10/3/97.

PAUL D. MULDOWNEY
P.O. BOX 478
HAGERSTOWN, MARYLAND 21741

October 7, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

On October 3, 1997 I corresponded with you relative to a proposed beach replenishment project to be done by the Corps of Engineers which directly affects the Delaware coast line from Cape Henlopen to the Maryland line. In that letter I strongly urged that a public hearing be held prior to any decisions.

I. I have since had an opportunity to review Volume 1 of the Bethany Beach/South Bethany Interim Feasibility Study, and I am shocked that you would consider borrowing from Area C which is in front of the MOST BEAUTIFUL, NATURAL BEACH ON THE EAST COAST. This beach and its natural protection which is directly related to Area C should not be tampered with in any way in an effort to replenish areas which are already subjected to erosion.

I have studied the Interim Feasibility Study in detail, and after having done so I must strenuously object to any tampering of the natural bottom directly off shore from North Bethany Beach.

Yours truly,

Paul D. Muldowney

PDM/sjh

1. Please refer to Responses #5 and #6 to Mr. Douglas T. Parson's letter dated 10/3/97.

1579 21st Ct. N.
Arlington, VA.
22209-1128

Oct. 8, '97

Mr. Robert Callegan
ATTN Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Bldg
100 Penn Sq. East
Philadelphia, PA
19107-3390

Dear Mr Callegan:

I own property at 26 Sandpiper Lane, Bayberry Dunes, W. Bethany, Delaware, + am deeply concerned & dismayed to hear of the Corps' beach replenishment project as outlined in the Interim Feasibility Study.

1. This is a written request for a public hearing on this proposed scheme.

Please notify me as to where & when said hearing will be held.

Sincerely,
E. Gifford Stark

1. Please refer to Response #1 to Mr. Douglas T. Parson's letter dated 10/3/97.

A. James O'Mara

3330 North Leisure World Boulevard, #1001
Silver Spring, Maryland 20906

October 8, 1997

Mr. Robert L. Callegari
Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Callegari:

1. This is to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick-Island, Bethany Beach-So. Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

I would like to understand this proposal further so I can judge its impact on our beach at Gulls Nest (North Bethany).

Please advise me pertaining to a public hearing.

Very truly yours,

A. James O'Mara

A. James O'Mara

AJO'M/clh

1. Please refer to Response #1 to Mr. Douglas T. Parson's letter dated 10/3/97.

LAW OFFICES
HEISE JORGENSEN & STEFANELLI P.A.
MONTVALE CENTER
18310 MONTGOMERY VILLAGE AVENUE, SUITE 400
GAITHERSBURG, MARYLAND 20879

JOHN I. HEISE, JR.
HERBERT W. JORGENSEN
RICHARD F. STEFANELLI
STEVEN P. HENNE
LOUIS S. PETTEY
ROBERT E. GOUGH
SAFIA S. KADIR
STEPHEN B. JACKSON

(301) 977-8400
METRO AREA LINE (301) 258-0400
FAX (301) 258-4003

October 8, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp of engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Re: Beach Replenish Project

Dear Mr. Callegari:

1. I am writing to request a public hearing to discuss the proposed beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick - Island Bethany Beach -So. Bethany Interim Feasibility Study".

2. My wife and I have a home in the Gulls Nest Subdivision, in North Bethany in the vicinity of Borrow Site C. We would object to sand being removed from that shallow sand bar because of its protective value against storms in this area.

Please let me know the date, time and place of the public hearing on this project.

Sincerely yours,

Richard F. Stefanelli

RFS:ceb
L:\LAW\RFS\LT97\PRSNL\BEACH\CALLELTR

1. Please refer to Response #1 to Mr. Douglas T. Parson's letter dated 10/3/97.

2. Please refer to Responses #5 and #6 to Mr. Douglas T. Parson's letter dated 10/3/97.

Ann C. Curley
10120 Darnuid Green Drive
Potomac, MD 20854

October 9, 1997

Mr. Robert L. Callegari
ATTN:Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

I am writing to request a public hearing on the proposed beach replenishment project described in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach and South Bethany Interim Feasibility Study," in Public Notice CENAP-PL-E97-08 of August 25, 1997.

1. I believe that a public hearing is necessary to examine in greater detail the positive and negative aspects of the proposed project on all the areas concerned. I would hope that it could be held at a future time and place that would allow interested parties and affected property owners to be notified in a timely manner.

I would appreciate being notified when such a public meeting is scheduled.
Thank you for your attention to my request.

Sincerely,

Ann C. Curley

Ann C. Curley
Bayberry Dunes

1. Please refer to Response #1 to Mr. Douglas T. Parson's letter dated 10/3/97.

P3

MARIE-LOUISE CARAVATTI

3425 "0" Street, N.W. • Washington, D.C. 20007 • (202) 965-0625

Mr. Robert L. Callegari
Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Bldg.
100 Penn Square East
Philadelphia, PA 19107-3390

October 10, 1997

Dear Mr. Callegari:

As Vice-President of the Board of Indian Harbor Villas Condominium Association I am hereby requesting that you hold a public hearing to discuss the proposed beach replenishment project detailed in the report "Delaware Coast from Cape Henlopen to Fenwick Island - Bethany Beach - South Bethany Interim Feasibility Study," pursuant to Public Notice CENAP-PL-E97-08, dated August 25, 1997.

Our condominium is located in North Bethany, which is one of the proposed "borrow sites". The residents are concerned that such decisions should be made without giving those affected an opportunity to learn what the proposed action would entail, and without any discussion of whether or how our community would be impacted. There is considerable concern that this action is being taken without a public hearing precisely because we would be negatively impacted. This is not good public policy on the part of the Army Corps, and can only lead to further controversy, misunderstanding, and unhappiness on the part of the residents. 1.

I urge you to give the residents the chance to learn about and to comment on your proposed actions.

Please advise me as soon as possible on your decision as to whether (and when) a public hearing will be held.

Sincerely,

Marie-Louise Caravatti

1. Please refer to Response #1 to Mr. Douglas T. Parson's letter dated 10/3/97.

STRESS MANAGEMENT CENTER

Rt. 1 Box 1387 • Bethany Beach, DE 19930 • (302) 537-0510

October 11, 1997

To: Robert Callegari

FROM: Anne Marie Connor

Re: Beach Replenishment Project
Delaware Beach Area

1. It has been brought to my attention that you are proposing a Beach Replenishment project of 150,000,000 over 50 years for the southern Coastal area of Delaware. As a property and business owner in the area I have not only some environmental concerns but also monetary concerns and am therefore requesting a Public Hearing be scheduled.

Thanking you in advance for your attention to this matter.

Sincerely,
Anne Marie Connor
P.O. Box 1387
Bethany Beach, De 19930

1. Please refer to Response #1 to Mr. Douglas T. Parson's letter dated 10/3/97.

P5

Oct. 12, 1997

Dear Mr. Callegari:

This is to ask you to please hold a public hearing re: the proposed beach replenishment project. As a homeowner on the east side of Route 1, north of Bethany Beach, I do not support this project and would like to have an opportunity to voice concerns.

Thank you,
Wendy Martucci
1 Kenwood Rd.
Balto MD 21210

1.

1. Please refer to Response #1 to Mr. Douglas T. Parson's letter dated 10/3/97.

13 October 1997

Mr. Robert L. Callegari
ATTN: Environmental Resource Branch
U.S. Army Corp of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Callegari:

I am writing to you requesting that a public hearing be held to discuss the proposed beach replenishment project detailed in the report "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach-South Bethany Interim Feasibility Study" pursuant to Public Notice CENAP-PL-E97-08 dated August 25, 1997.

1. The hearing should be held at a time and in a place to allow as many affected property owners to attend and express their views. In addition, notice of the hearing should be made by mail to all affected property owners - givers and receivers - in the affected areas.

2. The Corps as well as the DENREC should be prepared to explain to the public their proposal, research methodology, assumptions, findings both real and conjectured, and cost components both federal and local in current and inflated dollars over the life of the project. In addition, the Corps should be prepared to present and discuss the legally required impact statements which are referenced in the study but not in the public domain.

3. While I am not an expert in this area, the premise upon which the recommendations are made are faulty and based on research undertaken nearly a decade ago on an area that is nowhere near this area. The study seems to disregard conventional research and wisdom regarding beach replenishment and ignores the feasibility of other interventions. Moreover, the study suggests that the project will provide a permanent solution when in fact the proposed project is temporary at best and for which the costs over time may not be justified by the benefits.

Thank you so much for your time and attention to this request. I await a favorable reply.

Very truly yours,

Joseph A. Falzon
7607 Maryknoll Avenue
Bethesda, Maryland 20817

P. O. 1543.
Bethany Beach, Delaware

98

1. Please refer to Response #1 to Mr. Douglas T. Parson's letter dated 10/3/97.

2. The scope and findings of the feasibility study, the proposed project, and anticipated project impacts are described in the feasibility report/FEIS and technical appendices. Preparation of the report and FEIS was completed in accordance with applicable guidance and regulations and in coordination with appropriate resource agencies.

3. No response required.

October 14, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA. 19107-3390
FAX (215) 656-6543

Mr. Callegari:

I'm requesting a public hearing for the following reasons

1. reference Public Notice No. CENAP-PL-E-97-08.

2. 1. The only newspaper, to my knowledge, that published this public notice was "the News Journal". None of the "local" newspapers such as "the Wave" - the main paper for Bethany, S. Beth and Fenwick Island, never used notice to publish your PUBLIC NOTICE; even though, in the ACE file CENAP-IM-97-44 and CENAP-OP-R-19970174-23 which I obtained through F.O.I.A. it lists two U.S. post offices, three city + county governments and eight local newspapers from DOVER to Bethany Beach. The Bethany Beach post office did not post this notice either.

I do not read the News Journal, I only found out about this through a friend of mine. I informed the North Bethany committee's myself and they have responded as they deemed necessary. In general the "PUBLIC" had little NO KNOWLEDGE OF THIS NOTICE.

1. A publicized public meeting was held in the Millville Firehall (Millville, DE) on May 13, 1998. This meeting was consistent with a Public Hearing format with the exception that Corps staff were present to answer questions on the project. A written transcript of this meeting is available upon request.

2. Public notification announcing the availability of the Draft Environmental Impact Statement (DEIS)/Feasibility Report was provided to all known Federal, state, and local agencies/officials, and the known interested public. This public notice was also distributed utilizing a standard mailing list covering the Delaware coastal geographic area. This list is comprised of agencies and individuals that requested to be notified of all Corps actions involving the Delaware Coast. Several newspapers and local post offices are on this list, however, we cannot require them to publish or post our public notices. It should be noted that the notice of availability of the DEIS/Feasibility Report for public review and comment was published in the Federal Register on 29 August 1997.

2. As stated in this study, and as stated in "Endangered Species Monitoring Program Bethany Beach by Cecilia Miles, 1993., hopper dredges are detrimental to turtle populations. To try to preserve what few loggerhead turtles are left, hopper dredges should be banned from this project (Also see Dickerson et al. 1991. "Entrainment of sea turtles by hopper dredges...),

3. What effect on private communities and public access will this project have? Will the private communities within the project limits, including [illegible] See Colony be required to have public parking and public access, since State and Federal funds are being spent?

4. What effect would the utilization of Borrow Site 'C' have on the adjacent shoreline since it is only approximately 2000 ft offshore and has depths as shallow as 19 ft.? According to the National Academy of Science 1995 report on beach replenishment, borrow sites with depths less than the depth of closure (21 ft.) - should not be utilized.

5. Has the borrow site 'C' been tested to the South Coastal sewage outfall? Should the beaches be closed during dredging so as not to infect swimmers?

6. Since there is no taxing bill in place that would pay the local 35% share, where is that money going to come from?

Sincerely,
William J. Winkler (WILLIAM J. WINKLER)
P.O. Box 1400
Ocean View, De. 19970

3. If a hopper dredge is utilized from June through November, the Philadelphia District will implement sea turtle and marine mammal monitoring and mitigation measures pursuant to the requirements of the Biological Opinion issued by the National Marine Fisheries Service in accordance with Section 7 of the Endangered Species Act.

4. Public use will be available for the general public along the proposed project areas in Bethany Beach and South Bethany. The only exception to public use within the complete project are the taper areas that extend into Middlexex and Sea Colony between Bethany Beach and South Bethany, and Sussex Shores to the north of Bethany Beach. Middlesex, Sea Colony, and Sussex Shores are private communities, and public access is exempted for these portions of the project. The tapers are an integral feature of the project, and will not impact the requirements for public access for the remainder of the Bethany Beach and South Bethany project.

5. Subsequent to the public review of the DEIS/Feasibility Report, the proposed use of Borrow Area C was withdrawn in favor of Area E.

6. The proposed borrow Area E is outside of the 1/2 mile imposed shellfish harvesting buffer zone. Coordination was conducted with the Department of Natural Resources and Environmental Control, and no concerns were raised with regard to the borrow site location and the outfall. A water quality monitoring plan consistent with existing beach water quality monitoring procedures will be implemented during beachfill operations.

7. The 35% share of project costs is the responsibility of the non-Federal sponsor, the Delaware Department of Natural Resources and Environmental Control. Prior to construction, the non-Federal sponsor must prepare a project financing plan that outlines the means by which its share of funds will be provided.

Sierra Club

Appalachian Regional Office

P.O. Box 160
Nassau, Delaware 19969
October 14, 1997

Mr. Steve Allen, Project Manager
U.S. Army Corps of Engineers
Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Allen,

Re: Delaware Coast From Cape Henlopen to Fenwick Island: Bethany Beach/South Bethany Interim Feasibility Study

The following comments are submitted on behalf of the Sierra Club's Mid-Atlantic Water Quality Project and reflect our concerns about both regional and national environmental policy in relation to public participation in decisions affecting aquatic ecosystems.

1. We specifically call for public hearings to be held by the U.S. Army Corps of Engineers (COE) that adhere to requirements of the National Environmental Policy Act (NEPA). We would also draw your attention to recent analyses of the NEPA process by the Council on Environmental Quality that stress the importance of public involvement opportunities that go beyond the standard public hearing format and exceed legal requirements in order to improve the quality of projects and reduce impacts to the environment.

2. This document fails to adequately assess direct, secondary, and cumulative impacts from past, present, and future foreseeable hydromodification projects affecting this portion of the Mid-Atlantic seaboard. The impacts to fisheries (finfish and shellfish) alone, in both environmental and economic contexts, warrant considerably more attention and the use of the best science and technical tools to accomplish this assessment.

The region in question appears to have a critical ecological function for our fisheries many of which are currently under Multi-State and/or Federal Fishery Management Plans .

1. A publicized public meeting was held in the Millville Firehall (Millville, DE) on May 13, 1998. This meeting was consistent with a Public Hearing format with the exception that Corps staff were present to answer questions on the project. A written transcript of this meeting is available upon request. Public notices were sent out in advance of the public meeting, notifying Federal, state and local agencies, adjacent property owners, and the interested public. Notices were also provided to known local newspapers, libraries, and other public buildings. The public notice was also displayed on the Philadelphia District internet website.

2. The scope and findings of the feasibility study, the proposed project, and anticipated project impacts are described in the feasibility report, FEIS, and technical appendices. Preparation of the report and EIS was completed in accordance with applicable Corps of Engineers guidance and regulations, and in coordination with appropriate resource agencies. The EIS was prepared in accordance with NEPA/CEQ guidelines utilizing scientific references and outside expertise from various governmental and non-governmental resource agencies to assess the impacts and to mitigate the impacts associated with the proposed action.

3. Because the National Marine Fisheries Service has yet to publish final regulations for Essential Fish Habitat (EFH) as required under the Magnuson/Stevens Fisheries Conservation & Management Act of 1996 we request that the COE consider these regulations as "new information" to be addressed in the public hearings.

We look forward to expanded discussion of these and other topics at the public hearings.

Sincerely,

Michael J. D'Amico
Mid-Atlantic Water Coordinator
302-644-0627 (T)
302-644-9172 (F)
mike.damico@sierraclub.org

cc: Governor Carper
U. S. Senator Biden
U. S. Senator Roth
U.S. Representative Castle
State Senator Bunting
State Representative Price
Debbie Heaton, Delaware Chapter of Sierra Club
Regina Katz, Delaware Chapter of the Sierra Club
Cornelia Melvin, Delaware Chapter of the Sierra Club
Barbara Postles, Sierra Club Atlantic Coast Ecoregion
Joy Oakes, Sierra Club Appalachian Office

3. The Philadelphia District is aware of the potential designation of the borrow site as Essential Fish Habitat (EFH) as required under the Magnuson-Stevens Fisheries Conservation & Management Act of 1996. Activities such as the proposed action for Bethany Beach and South Bethany require consultation with the National Marine Fisheries Service (NMFS) if they impact EFH. Identification of EFH for management species is pending until October 1998. We intend on inititiating consultation procedures with NMFS, as required, if it is determined that the proposed activity would impact EFH.

LAW OFFICES

CRAMER & KLOPMAN

CHARTERED

216 NORTH ADAMS STREET

ROCKVILLE, MARYLAND 20850

(301) 424-0677

FAX (301) 340-6947

4301 GARDEN CITY DRIVE

SUITE 300

LANDOVER, MARYLAND 20785

M. MICHAEL CRAMER

BENJAMIN A. KLOPMAN

October 14, 1997

Mr. Robert L. Callegari
U.S. Army Corps. of Engineers
Environmental Resources Branch
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Callegari:

I write to you for information concerning the Delaware coast beach replenishment project.

Mr. Nelson Denlinger wrote to you on October 7, 1997 requesting a public hearing on the project.

1. Please advise me of the status of the request for a public hearing.

Sincerely,

M. Michael Cramer

MMC:jaq

cc: Mr. Nelson Denlinger

1. Please refer to Response #1 to Mr. Douglas T. Parson's letter dated 10/3/97.

October 3, 1997

22 South Ocean Ave
Bethany Beach, DE.

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

As property owners in the Seabreak community in North Bethany, we strongly object to not having received any formal notice of the beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach-So., Bethany Interim Feasibility Study."

1. We are concerned about the potential negative impact this proposal may have on our community and, therefore, believe it is critical that a public hearing be held to discuss fully all of the interests implicated in the proposal. Needless to say, this hearing should be well-publicized to all affected property owners and should be scheduled sufficiently far in advance that there will be adequate opportunity to review the proposal.

While we have not yet had an opportunity to study the proposal in detail, we note the following issues are serious and would appear to block any implementation of the proposal:

2. 1. Borrow site C is a source of natural protection, as a shallow sandbar fronting all of North Bethany. According to the National Academy of Sciences Natural Resource Council Report (1995), shoals of this depth should not be disturbed, as their value in protecting against storms will be degraded.

3. 2. No studies have been done on the North Bethany coastline to evaluate what affect storms will have on the North Bethany beach if the area is used as a borrow site. Further, the proposal does not address how increased storm damage to the beach would be handled.

Please let us have your response to our concerns and our request for a public hearing at your earliest convenience.

Very truly yours,

Jim & Sandy Johnson

Jim & Sandy Johnson

1. A publicized public meeting was held in the Millville Firehall (Millville, DE) on May 13, 1998. A written transcript of this meeting is available upon request.

2. As stated in the Feasibility Report/FEIS, Borrow Site C was eliminated as a sand source for this project. Borrow Site E, which is predominantly offshore of Bethany Beach and South Bethany, is the proposed sand source.

3. Because Site C was eliminated, there are no concerns regarding potential effects of sand removal near the North Bethany coastline.

* The above responses also pertain to the following comment letters, which contain the same comments.

10839 Lockland Road
Potomac, Maryland 20854

October 3, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

As property owners in the Seabreak community in North Bethany, we strongly object to not having received any formal notice of the beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach-So., Bethany Interim Feasibility Study."

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1. Borrow site C is a source of natural protection, as a shallow sandbar fronting all of North Bethany. According to the National Academy of Sciences Natural Resource Council Report (1995), shoals of this depth should <u>not</u> be disturbed, as their value in protecting against storms will be degraded.

2. No studies have been done on the North Bethany coastline to evaluate what affect storms will have on the North Bethany beach if the area is used as a borrow site. Further, the

proposal does not address how increased storm damage to the beach would be handled.

Please let us have your response to our concerns and our request for a public hearing at your earliest convenience.

Very truly yours,

Mary Rose Hughes

Peter C. Hughes

MRH:cdg

October 3, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

As property owners in the Seabreak community in North Bethany, we strongly object to not having received any formal notice of the beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach-So., Bethany Interim Feasibility Study."

We are concerned about the potential negative impact this proposal may have on our community and, therefore, believe it is critical that a public hearing be held to discuss fully all of the interests implicated in the proposal. Needless to say, this hearing should be well-publicized to all affected property owners and should be scheduled sufficiently far in advance that there will be adequate opportunity to review the proposal.

While we have not yet had an opportunity to study the proposal in detail, we note the following issues are serious and would appear to block any implementation of the proposal:

1. Borrow site C is a source of natural protection, as a shallow sandbar fronting all of North Bethany. According to the National Academy of Sciences Natural Resource Council Report (1995), shoals of this depth should not be disturbed, as their value in protecting against storms will be degraded.

2. No studies have been done on the North Bethany coastline to evaluate what affect storms will have on the North Bethany beach if the area is used as a borrow site. Further, the proposal does not address how increased storm damage to the beach would be handled.

Please let us have your response to our concerns and our request for a public hearing at your earliest convenience.

Very truly yours,

Richard & Heidi Meyer
53 SEAVIEW DR BETHANY BEACH, DE
SEA BREAK

October 3, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corp of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

As property owners in the Seabreak community in North Bethany, we strongly object to not having received any formal notice of the beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach-So., Bethany Interim Feasibility Study."

We are concerned about the potential negative impact this proposal may have on our community and, therefore, believe it is critical that a public hearing be held to discuss fully all of the interests implicated in the proposal. Needless to say, this hearing should be well-publicized to all affected property owners and should be scheduled sufficiently far in advance that there will be adequate opportunity to review the proposal.

While we have not yet had an opportunity to study the proposal in detail, we note the following issues are serious and would appear to block any implementation of the proposal:

1. Borrow site C is a source of natural protection, as a shallow sandbar fronting all of North Bethany. According to the National Academy of Sciences Natural Resource Council Report (1995), shoals of this depth should not be disturbed, as their value in protecting against storms will be degraded.

2. No studies have been done on the North Bethany coastline to evaluate what affect storms will have on the North Bethany beach if the area is used as a borrow site. Further, the proposal does not address how increased storm damage to the beach would be handled.

Please let us have your response to our concerns and our request for a public hearing at your earliest convenience.

Very truly yours,

Stephen L. Mitchell LOT 31 SEABREAK
BOX 1177
BETHANY BEACH DEL 19930

301 Center Hill Road
Wilmington, DE 19807
October 8, 1997

Mr. Robert L. Callegari
ATTN: Environmental Resources Branch
U. S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

As property owners in the Seabreak community north of Bethany Beach, Delaware, we strongly object to not having received any formal notice of the beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach, South Bethany Interim Feasibility Study."

We are concerned about the potential negative impact this proposal may have on our community, and therefore believe it is critical that a public hearing be held to discuss fully all of the interests implicated in the proposal. Needless to say, this hearing should be well-publicized to all affected property owners and should be scheduled sufficiently far in advance that there will be adequate opportunity to review the proposal.

While we have not yet had an opportunity to study the proposal in detail, we note the following issues are serious and would appear to block any implementation of the proposal:

1. Borrow site C is a source of natural protection as a shallow sandbar fronting all of North Bethany Beach. According to the National Academy of Sciences Natural Resource Council Report (1995), shoals of this depth should not be disturbed, as their value in protecting against storms will be degraded.

2. No studies have been done on the North Bethany coastline to evaluate what affect storms will have on the North Bethany beach if the area is used as a borrow site. Further, the proposal does not address how increased storm damage to the beach would be handled.

Please let us have your response to our concerns and our request for a public hearing at your earliest convenience.

Yours truly,

Robert A. Blickenstaff

Rebecca R. Blickenstaff

Robert and Rebecca Blickenstaff
Homeowners at:
50 North Seaview Drive
Seabreak
Bethany Beach, DE 19930

HERSHEY PASTA AND GROCERY GROUP

100 CRYSTAL A DRIVE, P.O. BOX 820, HERSHEY, PENNSYLVANIA 17033-0820 (717) 534-5337 FAX: (717) 534-3620

JAY F. CARR
President

October 6, 1997

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corp. of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

As property owners in the Seabreak community in North Bethany, we strongly object to not having received any formal notice of the beach replenishment project detailed in the report, "Delaware Coast from Cape Henlopen to Fenwick Island, Bethany Beach-So., Bethany Interim Feasibility Study."

We are concerned about the potential negative impact this proposal may have on our community and, therefore, believe it is critical that a public hearing be held to discuss fully all of the interests implicated in the proposal. Needless to say, this hearing should be well-publicized to all affected property owners and should be scheduled sufficiently far in advance that there will be adequate opportunity to review the proposal.

While we have not yet had an opportunity to study the proposal in detail, we note the following issues are serious and would appear to block any implementation of the proposal;

1. Borrow site C is a source of natural protection, as a shallow sandbar fronting all of North Bethany. According to the National academy of Sciences Natural Resource Council Report (1995), shoals of this depth should not be disturbed, as their value in protecting against storms will be degraded.
2. No studies have been done on the North Bethany coastline to evaluate what affect storms will have on the North Bethany beach if the area is used as a borrow site. Further, the proposal does not address how increased storm damage to the beach would be handled.

Please let us have your response to our concerns and our request for a public hearing at your earliest convenience.

Very truly yours,

Jay F. Carr

JFC:shp

COMMENTS AND RESPONSES FOR SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

UNITED STATES DEPARTMENT OF COMMERCE
Office of the Under Secretary for
Oceans and Atmosphere
Washington, D.C. 20230

May 18, 1998

Robert L. Callegari
Chief, Planning Division
US Army Corps of Engineers, Philadelphia District
Wanamaker Bldg, 100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

Enclosed are comments on the Draft Environmental Impact Statement for Delaware Coast from Cape Henlopen to Fenwick Island Feasibility Study Bethany Beach and South Bethany Sussex County, Delaware. We hope our comments will assist you. Thank you for giving us an opportunity to review this document.

Sincerely,

Susan Fruchter

Susan B. Fruchter
Acting NEPA Coordinator

Enclosure

MEMORANDUM FOR: Susan B. Fruchter
Acting NEPA Coordinator

FROM: Charles W. Challstrom
Acting Director, National Geodetic Survey

SUBJECT: DEIS-9804-09-Delaware Coast from Cape Henlopen to Fenwick Island Feasibility study Bethany Beach and south Bethany Sussex County, Delaware

The subject statement has been reviewed within the areas of the National Geodetic Survey's (NGS) responsibility and expertise and in terms of the impact of the proposed actions on NGS activities and projects.

All available geodetic control information about horizontal and vertical geodetic control monuments in the subject area is contained on the NGS home page at the following Internet World Wide Web address: http://www.ngs.noaa.gov. After entering the NGS home page, please access the topic "Products and Services" and then access the menu item "Data Sheet." This menu item will allow you to directly access geodetic control monument information from the NGS data base for the subject area project. This information should be reviewed for identifying the location and designation of any geodetic control monuments that may be affected by the proposed project.

1.

If there are any planned activities which will disturb or destroy these monuments, NGS requires not less than 90 days' notification in advance of such activities in order to plan for their relocation. NGS recommends that funding for this project includes the cost of any relocation(s) required.

For further information about these monuments, please contact Rick Yorczyk; SSMC3 8613, NOAA, N/NGS; 1315 East West Highway; Silver Spring, Maryland 20910; telephone: 301-713-3230 x142; fax: 301-713-4175.

This beach, berm, and dune restoration program along the Atlantic Coast shoreline should have no effect on the safety of marine navigation. The specific areas involved are the beaches and near shore zones of Bethany Beach and South Bethany. Minor revisions to the shoreline as

1. No geodetic control monuments were located within the project impact area. The Philadelphia District will contact NGS if plans change that may affect any monuments.

2. currently depicted on National Ocean Service charts may have to be made and there can be depth changes in the designated offshore sand borrow site. Therefore as built plans from the Corps of Engineers will be required this work.

For further information about these charting activities, please contact Howard Danley; NOAA, NOS, Office of Coast survey, N/CS28; SSMC3 7458, 1315 East West Highway; Silver Spring, Maryland 20910; telephone: (301)713-2732 x105.

2. Concur. Upon completion of initial construction, as built drawings will be prepared and submitted to NOAA, National Ocean Service.

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
Custom House, Room 244
200 Chestnut Street
Philadelphia, Pennsylvania 19106-2904

IN REPLY REFER TO

May 29, 1998

ER 98-258

Mr. Robert L. Callegari
Planning Division, Philadelphia District
U.S. Army Corps of Engineers
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

The Department of the Interior (Department) has reviewed the Philadelphia District's April 1998 report entitled "Supplemental Draft Environmental Impact Statement, Delaware Coast From Cape Henlopen To Fenwick Island Feasibility Study, Bethany Beach and South Bethany Interim Feasibility Study Sussex County, Delaware." Please consider these comments in completing the final version of the report.

General Comments

The document adequately describes most of the anticipated project effects for which the Department has jurisdiction or special expertise. We recommend the following modifications to clarify specific portions of the text.

Specific Comments

1. P.15. The proposal for monitoring dissolved oxygen during dredging may have limited value in predicting the potential for future low DO levels. While the relatively high circulation in this open coastal area should prevent low DO conditions even at the deepest proposed depth (12 feet), any potential deficit would probably only occur during mid to late summer when the water column is most stratified and biological demand is elevated. It is unlikely that the dredging would be conducted during this period because of the heavy human use of the beach at that time. Another confounding factor is that the potential for DO depression may actually decrease as the diameter of the dredge area increases because the more open situation should enhance circulation. We

2. suggest that DO measurements be conducted during the post-construction monitoring of bathymetry, sediment grain size, and benthic macroinvertebrate composition.

1. Concur. DO could be measured during the post-construction monitoring for bathymetry, sediment grain size, and benthic macroinvertebrate composition. This monitoring should be conducted in the summer months to coincide with any potential DO deficit in the borrow area.

2. We agree that a potential DO deficit could decrease as a larger area is affected, resulting in increased circulation. Post-construction monitoring of DO after each nourishment cycle would identify any potential changes in circulation and stratification during the summer months.

P.15. We do not agree that it is "essential" that this substrate in the post-dredge area be similar to the pre-dredge condition to ensure "proper recruitment" of benthic species. Since sandy habitat is widespread in this coastal area, exposing a different substate such as a shell layer or a clay bank could result in a beneficial increase in habitat diversity. In any case, any new substrate is likely to be covered over with the fine sands which dominate the bottom surface in this region. We suggest that the report simply state that the proposed dredging will not expose any different substrates that could alter the composition of the benthic invertebrate community.

3.

P.16. We do not believe that it is necessary or desirable to restrict dredging to one time per location. Repeated use of the same area would obviate the need to dredge previously unimpacted areas.

Thank you for the opportunity to present these comments. Any questions for further coordination on fish and wildlife resource issues should be directed to George Ruddy of the U.S. Fish and Wildlife Service's Chesapeake Bay Field Office at (410)573-4528.

4.

Sincerely,

Michael T. Chezik

Michael T. Chezik
Acting Regional Environmental Officer

3. We agree that exposing a different type of substrate may not be adverse, however, our intent is to provide a similar substrate that would have the highest probability of containing the same benthic community composition as before dredging without any net loss of sandy marine habitat. Our statement concerning this was modified on page 5-8 of the FEIS.

4. We do not anticipate any significant shoaling of sand in the borrow area that would allow us to reuse the same location for sand each nourishment cycle. Therefore, the maximum amount of sand would need to be extracted from a different location within the borrow area for each nourishment cycle. If post-construction monitoring reveals that sand shoaling occurs within the previously dredged locations, it may be possible to focus the dredging in this location to minimize total area disturbed over the 50-year project life.

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF FISH AND WILDLIFE
89 KINGS HIGHWAY
P.O. BOX 1401
DOVER, DELAWARE 19903

OFFICE OF THE
DIRECTOR

April 28, 1998

Robert L. Callegari, Chief Planning Division
Department of the Army
Philadelphia District, Corps of Engineers
Wanamaker Building 100 Penn Square East
Philadelphia, Pennsylvania 19107-3391

Dear Mr. Callegari:

Thank you for providing the opportunity for the Division of Fish and Wildlife to comment on the *Supplemental Draft Environmental Impact Statement (SDEIS) Delaware Coast from Cape Henlopen to Fenwick Island Feasibility Study, Bethany Beach and South Bethany Interim Feasibility Study, Sussex County, Delaware*. Based on our review, the preferred alternative sight (Area E) will have less of an adverse effect on the surfclam resource than the previously selected dredging sight (Area C). Although, no commercially exploitable densities of surfclams currently exist in either Area E or C, it appears that the sandbar habitat of Area C contains significant (96.6/m^2) densities of juvenile surfclams that may eventually contribute to the recovery of this stock. Therefore, we support the Corp's conclusions that Area E will have less adverse effect on fisheries and aquatic biota when compared to Area C.

1.

Sincerely,

Andrew T. Manus

Andrew T. Manus, Director
Division of Fish and Wildlife

1. No response required.

9

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF WATER RESOURCES
89 KINGS HIGHWAY, P.O. BOX 1401
DOVER, DELAWARE 19903

WETLANDS & SUBAQUEOUS LANDS SECTION

TELEPHONE (302) 739-4691
FACSIMILE (302) 739-6304

June 22, 1998

Mr. Robert L. Callegari, Chief
Planning Division
Philadelphia District, Corps of Engineers
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3391

RE: Bethany Beach/South Bethany
Beach Replenishment

Dear Mr. Callegari:

Based on a review of information provided to this office on the above referenced project, it is our intention to move forward with application for a Subaqueous Lands Permit and Section 401 Water Quality Certification. The application will be placed on public notice upon submittal of Final Feasibility Report/Environmental Impact Statement. Barring any insurmountable objections, it is our intention to issue the required approvals.

1.

If I can be of further assistance, please feel free to call.

Sincerely,

William F. Moyer

William F. Moyer
Section Manager
Wetlands and Subaqueous
Lands Section

pc: Robert Henry
Sarah Cooksey
Laura Herr

WFM/djr
wfm98047

1. Section 401 Water Quality Certification would be obtained prior to construction.

16 Seaside Drive,
PO Box 597,
South Bethany, DE 19930
May 11, 1998

Mr. Jerry Pisquale,
ATTN: Environmental Resources Branch,
U.S. Army Corps of Engineers,
Wanamaker Building,
100 Penn Square East,
Philadelphia, PA 19107-3390

Subject: Bethany Beach/South Bethany Interim Feasibility Study, Volume 1, April 1997 and Draft Feasibility Report, Draft Environmental Impact Statement, April, 1997 and Supplemental Draft Environmental Impact Statement, April, 1998

Dear Mr. Pisquale:

I have reviewed the above information and have several comments/questions on this vital project (hereinafter, the Project). I live directly behind the Sandpiper Village dune in South Bethany. I view the Project as absolutely vital to the future of South Bethany. Comments are intended only for the South Bethany portion of the Project but some may apply to the Bethany Beach portion. I hope you are able to address some of these issues at the May 13, 1998 hearing in Millville, DE. If you do not have time to analyze them before this meeting, I would be satisfied with a statement recognizing the issues raised and that you plan to address them as part of this Project.

PROJECT FUNDING

1. Adequate funding is essential to the success of the Project. The proposed 65% Federal funding seems reasonable. The apportionment of the remaining 35% of required funding among State, County and Town governments is separate from the design of the Project and needs to be addressed as a separate matter.

BENEFIT/COST ANALYSIS

2. The Benefits/Cost ratio needs to be revised to include benefits for areas protected by the taper zones: expected construction on vacant lots and renovations to existing structures over the Project life; the current lower interest rate; and the higher recreational benefits associated with the beach area as outlined in Attachment 1.

PROJECT DESIGN

Several questions need to be answered regarding the design of the Project.

3. 1. Storm conditions and duration for the February 4, 1998 Nor'easter were more severe than other storms. Please compare storm conditions used for the Project to those of the February 4 Nor'easter. The 2/4/98 storm lasted about 125 hours with peak water levels of 6.3 feet. The storm duration was the major factor in the damage to the Sandpiper Village dune.

1. The 35% share of project costs is the responsibility of the non-Federal sponsor, the Delaware Department of Natural Resources and Environmental Control. Prior to construction, the non-Federal sponsor must prepare a project financing plan that outlines the means by which its share of funds will be provided.

2. The final report presents a revision to the benefit cost analysis for the federal project. These revisions include the revised FY98 discount rate set for Civil Work Projects by the Corps, Washington, D.C. Office, revisions to current price levels, and updating of analytical models for assessment of storm damages. The taper area for Middlesex Beach was not included in the analysis since it is an incidental benefit. The purpose of the taper is not to extend protection of the proposed federal project, but to ensure sufficient storm protection to the boundaries of the project. However, recreational (beach use) benefits, which do not affect the justification and optimization of a federal projects were included as incidental benefits.

3. Storm wind, wave and water level data used for erosion and inundation modeling were determined based on historic data and hindcasting techniques. A total of 30 of the most severe storms to have impacted the Delaware coast were selected for the hindcasting study from a 102-year period of record: 15 hurricanes and 15 northeasters. Storm selection was based on the potential for wind, wave and storm surge-generation by the events. An analysis of storm peak waves and water levels was performed in order to formulate extreme design criteria for the project. A best-fit Gumbel distribution was developed using all of the data. Extremes were calculated for return periods of 2, 5, 10, 25, 50, 100, 200 and 500 years. Storm conditions such as occurred during the February 4, 1998 Northeaster fall within the conditions modeled.

4. 2. Attachment 2A outlines several factors where the design of the Project appears to be different than the positions provided in the US Army Corps of Engineers 1984 SHORE PROTECTION MANUAL of the Vicksburg Coastal Research Center. Please explain the reasoning for a Project design not meeting the criteria of the SHORE PROTECTION MANUAL.

5. 3. Attachment 2B lists several recommendations and questions regarding the design and installation of the Project. Your consideration of these recommendations and questions in the final design of the Project is requested. The most important recommendation is installing a 35 - 40' interlocking sheet piling wall in the middle of the proposed dune protecting the length of South Bethany. The expected increased one-time cost of about $1,500,000 is dramatically reduced when considered as an annual cost over the 50-year project life. After seeing first-hand the impact of the 2/4/98 Nor'easter on the Sandpiper Village dune, it is clear that a similar storm would have a catastrophic impact on a dune projecting out into the ocean, such as the one east of Ocean Drive.

These comments are offered with a view to securing a better-designed Project. I whole-heartedly support your efforts to improve the beaches and security of homes in this area. Not only will South Bethany benefit from proceeding with this Project but so will all the beach users from the rest of Delaware and surrounding states. Failure to protect our beaches and oceanfront homes would have a catastrophic effect on Eastern Sussex County and the State's schools. The beachfront area is the major source of the County's State school taxes even though the oceanfront towns and unincorporated areas are nearly bereft of students. These "beach" houses have a high value but they are predominantly vacant during the winter season.

Thank you for providing the opportunity to comment. I look forward to your comments and responses at the May 13 hearing and/or in subsequent correspondence.

Sincerely,

Ian W. Davidson

Ian W. Davidson

FAX CC (with attach): Mr. John Hughes, Director, Shorelines & Waterway Management, Dept. of Natural Res. & Envir. Control, State of Delaware
Mr. Herbert (Joe) Schaefer & Town Council, South Bethany, DE

4. In reference to the attachment 2A, the project design is consistent with the U.S. Army Corps of Engineers Shore Protection Manual. Page 5-21 of the manual contains the references to underwater slope and recreational use area contained in the comment as general characteristics, not design parameters for this project. The underwater slope of 1V:15H for this project is consistent with existing conditions at Bethany Beach and South Bethany, and therefore affords similar conditions for swimmers. The recreational use area of 75 square feet per bather was suggested for design of a beach for recreational purposes, however, the Bethany Beach and South Bethany project was designed for shore protection. Recreational benefits are incidental and were calculated using the 75 square feet per bather rationale. The width of the beach is selected based on an economic (non-recreational) optimization considering the benefits and costs of alternative projects as described in the plan formulation section of the report.

5. Consideration has been given to the recommendations and questions in Attachment 2B. (1) Interlocking sheetpile within the dune design is not as economical as the selected dune design since the added benefit would not outweigh the cost. Consideration was given to anchored bulkheads in the plan formulation analyses and they were eliminated as alternatives. (2) The underwater slope was selected to be compatible with existing underwater conditions in the project area as discussed in the response to attachment 2A. (3) Consideration was given to a groin at the north end of South Bethany rather than a taper. However, this was considered less desirable and cost effective due to its detrimental effects on adjacent shoreline areas as discussed in the Cycle 3 Formulation section of the report. (4) a 3-year cycle was selected to most effectively accomplish periodic nourishment for this project, based on its specific characteristics, which are different from the Ocean City project. If nourishment can more economically be done concurrently in a given year, this will be pursued. (5) The placement of snow fencing will be revisited during the preparation of project plans and specifications. It may be possible to minimize visual impacts by placement elsewhere on the dune section. (6) The berm width was established by economic optimization considering the shore protection benefits. It should be noted that the foreshore slope (about 75 feet to the high water line) and advanced nourishment material will provide additional area for recreational use. (7) The project as designed uses dune crossovers as the least expensive option for public access. During preparation of plans and specifications, the design of access will be finalized based on coordination with the sponsor. (8) Consideration was not given to a sand reserve south of South Bethany since this is an undeveloped area and fill would have to be placed at 100% local expense. The project areas will receive advanced nourishment material to maintain the design section between replenishment cycles.

Attachment 1

REVISIONS TO PROJECT BENEFITS/COST RATIO

(A) If the taper zone is extended to cover the private community of Middlesex, benefits (reduced storm damages and recreation) for the 55 existing and 22 future houses in this community need to be included. Also, with the taper zone extended on State Park beaches, benefits need to be included to the extent Route 1 storm damage is reduced and beach recreation is improved.

Estimated damaged structure savings for Middlesex:

Number of structures- 55

% of S Bethany ocean block structures- 55/272 X 100= 20.2

Increased Annual Savings- $928,000 X .202= $187,000

(No reduced damages assumed for infrastructure or emergency clean-up costs.)

(B) "Beach real estate" value is increasing, seemingly at a faster rate than national average, because the amount of oceanfront property is much more restricted. Over the 50-year Project life, empty lots will be built on and existing houses upgraded substantially. The feasibility study (171. Structure Inventory and Replacement Costs, p. III-17) states "A database of — 272 (structures) in the ocean block of South Bethany was compiled —". A review of Figures 26 and 27, Selected Plan Layout indicates there are 264 completed structures and 23 vacant lots. (The difference in the number of completed structures is probably related to metthod of counting multiple structures on 1 lot or 1 structure occupying 2 lots.) Project benefits should be increased to reflect reduced damage costs for added new and upgraded homes.

Number of vacant lots- 23

% of S Bethany ocean block structures- 23/272 X 100= 8.5

Increased Annual Savings- $928,000 X .085= $79,000

(No reduced damages assumed for upgraded structures.)

(C) Current long term interest rates are lower (in area of 6%) than the January 1997 level of 7.375% (Syllabus and 279. Economic Costs, p. IV-33). The current substantially lower interest rates will increase the annual savings attributable to benefits in future years dramatically.

(D) I understand a recent State tourism study shows substantially higher benefits for beach recreation. Recreational benefits need to be revised to consider the latest information.

01

Attachment 2
DESIGN AND CONSTRUCTION

A. DESIGN

	Project	US ACOE Manual
Slope Underwater	1V:15H	1:20 to 1:30
	Reduce danger to bathers from big waves.	
Dune Distance, Toe to High Water Line, Ft	35	600
Recreational Use Area, Sq Ft per bather	52.5	75 - 100
Beach Width with 3,000 bathers	35	50 - 67
	This assumes uniform distribution over beach.	

There is a need for a larger beach and a shallower, less dangerous, underwater slope!

B. RECOMMENDATIONS AND QUESTIONS

Recommendations

1. INTERLOCKING SHEET PILING WALL IN MIDDLE OF DUNE - The 2/4/98 Nor'easter nearly breached the dune in front of Sandpiper Village and I believe did breach the Middlesex dune. These dunes are in the natural dune line. Damages to a dune projecting 100+' east of the natural dune line from a similar storm would be disastrous as the dune would be lost and could not be replaced immediately. A 40' interlocking sheet piling dune wall, tied together at the top, covered by several inches of sand, and installed in the middle of the proposed dune would protect the back of the dune and the houses and infrastructure. Given the depth to which piling is driven, there should be minimal risk of failure. (Please note that a similar interlocking sheet piling wall installed at the Atlantic View Motel, Clayton Street at the Atlantic, Dewey Beach, DE survived the 2/4 storm and protected the motel and east Clayton St. Other oceanfront dunes in Dewey Beach were breached and streets flooded.) We need to use methods whose success is demonstrated. This dune wall should be installed on the Ocean Drive dune and also on the Sandpiper Village dune since Nor'easter waves will be directed into the Sandpiper Village dune. The sheet piling used needs to be a corrosion-resistant alloy to survive the 50-year project life and needs to have a Section Modulus of at least 30 cubic inches. The anticipated added cost for such a dune is $1,500,000.

2. UNDERWATER SLOPE - Provide underwater slope so that a depth of -21 feet is reached about 900 feet offshore (like Ocean City) not at 600 feet offshore in the Project.

3. GROIN AT NORTH END OF SOUTH BETHANY - Install a groin only at the north end of South Bethany to reduce drift of sand to the north. If Middlesex or the State decide to pay for the 35% non-Federal share for the taper zone for its beach, there is no need for this groin. South Bethany cannot be expected to pay for replenishment benefitting a private beach.

4. MAINTENANCE DREDGING CYCLE - Redo the study based on a 4-year maintenance cycle to coincide with Ocean City work. I believe this was past practice to reduce initial staging costs

5. SNOW FENCING - Provide snow fencing only at bottom of dunes and access walkways. A fence is not needed at the top of the dune. This will improve the view of ocean from shore.

6. BERM - Raise width of the berm to a least 200 feet to provide acceptable area for bathers. The rapid population growth in the Town and surrounding area will increase the number of beach-goers over the 50-year Project life. The Project should be designed for conditions expected over its life, not those at its onset. Raise berm height for the whole length to8' to provide more beach in this area without materially affecting the integrity of the dune.

7. WALKWAY - The Project needs specifications on beach access walkways in the areas of length and height. The walkway length needs to extend beyond the oceanfront leading edge so that the dune is not notched in at stairways. The dune will grow several feet seaward unless this is prevented by the walkway and beach traffic. The walkway must be elevated sufficiently to allow dune grass to be planted and grown under it. During recent Nor'easters, notches cut into the Sandpiper Village dune resulted in the 2 access areas eroding more quickly than the rest of the dune. The dune was nearly breached at both walkways; sand and water are still evident on Seaside Drive at these 2 spots; and the sand path leading to the dune cross-overs was eroded by carry-over of ocean waves.

8. SAND RESERVE AT SOUTH END OF BETHANY BEACH - Provide a significant reserve of sand on the State beach south of South Bethany to feed into the Town beach between replenishment cycles.

Questions

1. CONSTRUCTION TEMPLATE - What will be the construction template? It should allow for 4 years of erosion to the berm plus at least one severe Nor'easter .

2. BORROW AREA "E" - Has the use of using Borrow Area "E" been included in the study? Removing sand from this area will result in bigger onshore storm waves. (A variety of offshore shells, clams, starfish, conch and sand dollar, washed up during the February, 1998 Nor'easter. This illustrates that the offshore sand did protect the South Bethany beach during the storm.)

3. CONSTRUCTION MONITORING - What type of construction monitoring will be in place for sand quality and borrow area depth?

4. CONSTRUCTION SEASON - Does the design template envision winter conditions when there is less beach due to erosion and higher tides?

QUESTIONS: (1) The construction template will be developed during plans and specifications, and will account for the erosion anticipated between nourishments. Major replacement is also included once during the period of analysis according to Corps of Engineers guidance.

(2) Borrow Area E has been selected for inclusion in the selected plan. Evaluation of the borrow site concluded that it could be used with no detrimental effect onshore.

(3) Contractor monitoring is required during construction to assure compliance with the plans and specifications on sand quality and borrow area depth.

(4) The design template is based on the typical conditions anticipated, or an average of seasonal variations.

5/22/98

Dear Mr. Callegari,

I wish to go on record as being opposed to beach replenishment, especially in the summer season. Replenishment may help protect property but it makes for an unsafe beach for swimmers. There were an unusual number of neck and back injuries the first year replenishment was done at Bethany Beach.

1. My leg was jammed when a wave carried me in 3 feet or so and into the shelf at the edge of the water.

I have observed over the years that nature takes the sand out but also brings it back — creating a gradual sloping beach of fine sand. Man cannot improve on so better!

Yours truly,
Carol L. Howell

Mrs. Carol Howell
P.O. Box 518
Bethany Beach, DE 19930-0518

1. The slope of the proposed project was chosen to match the existing beach slope and the nature of the borrow material, which is close to that of the native beach material. It is not expected that the hazard to swimmers will be different from that presented by the existing beach.

Richard D. Copaken
1201 Pennsylvania Avenue, N.W.
Washington, D.C. 20004
(202) 662-5640

May 26, 1998

District Engineer
United States Army Corps of Engineers
Philadelphia District
Planning Division
Environmental Resources Branch
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107 - 3390

Dear Sir:

Pursuant to a resolution that was unanimously approved at the annual meeting of the Preserve Homeowners' Association of North Bethany Beach, Delaware, on May 23, 1998, and as President of the Preserve Homeowners' Association that is comprised of fifty-seven homeowners, and on behalf of that Association I wish to submit the following comments on the Supplemental Draft Environmental Impact Statement ("SDEIS"), Delaware Coast from Cape Henlopen to Fenwick Island Feasibility Study, Bethany Beach and South Bethany Interim Feasibility Study, Sussex County, Delaware, April, 1998:

1. Our Association is very grateful that the SDEIS reflects a wise decision to abandon from any further consideration Borrow Area C, and to recommend instead the use of Borrow Area E. On the basis of this fundamental change in the proposed action, for which our Association is profoundly grateful, the Preserve Homeowners' Association wishes to go on record as expressing its full support for the currently proposed sand replenishment program, provided that the use of Borrow Area E is confined to the middle section thereof, or, if additional sand is required, that dredging is extended only to the southern portion of this identified site, and not to its northern end.

We empathize with the plight of our neighbors to the south and we recognize the tremendous contribution that the proposed sand replenishment program would make to the well being of our larger community. We simply wish to avoid the needless creation at

1. Although our dredging activities would be concentrated within the middle portion of Area E, we may require the northern and southern portion to be used as potential expansion areas. Any potential future expansion into the northern and southern portions of Area E would require additional investigations and permits.

2. North Bethany of the very problem being addressed by this proposed project at Bethany and South Bethany, especially when there is a much better alternative sand Borrow site available at Site E whose coarser sand is more suitable and far more plentiful, and whose topography lends itself to such harvesting of sand without undue environmental degradation.

3. We understand that the 775 acre middle portion of Borrow Area E is more than sufficient to satisfy the entirety of the sand requirements of approximately 13 million cubic yards for the full 50 year life of the proposed sand replenishment program, if sand is taken to a depth of 12 feet. We note with approval the observation made at page 15 of the SDEIS that "[d]redging 10 - 12 feet of material is expected to result in leaving 3 - 10 feet of similar substrate material to remain," and the observation recorded at page 5 of the SDEIS that "[t]he utilization of the 12 food-deepening scenario would minimize the need to expand from the middle portion into the northern and/or southern portions of Area E."

4. We take some comfort from the assurance also recorded on page 5 that "any future expansion into the northern and/or southern portions of Area E would require baseline investigations for benthic resources, fisheries, and cultural resources."

We also wish to associate ourselves with the comments of the United States Department of Commerce, National Oceanic and Atmospheric Administration:

5. "We consider use of Site E as ecologically preferable to Site C, where benthic habitat is structurally more heterogeneous, which is biologically more productive and diverse, and where densities of juvenile surf clams may be commercially harvestable at maturity. We, therefore, recommend development of Site E as the preferred alternative, and that Site C be eliminated from further consideration."

Likewise, we wish specifically to associate ourselves with the comments of the Mid-Atlantic Fishery Management Council:

6. "We strongly consider use of Site E as ecologically preferable to Site C, where benthic habitat is structurally more heterogeneous. Site C is more biologically productive and diverse, and has significantly higher densities of juvenile surfclams which should become commercially harvestable when they mature. Therefore, we recommend development of Site E as the preferred alternative, and that Site C be eliminated from further consideration."

2. No response required.

3. No response required.

4. No response required.

5. No response required.

6. No response required.

We recognize and appreciate that the United States Army Corps of Engineers has expressed in the SDEIS its agreement with these well founded comments and recommendations.

7. We also wish to note that whereas Area C lies only 2,000 feet from shore in relatively shallow water, Borrow Area E lies much further from shore, approximately 9,600 to 16,600 feet offshore in considerably deeper water. We are very concerned that any removal of sand from Area C would destroy the protection this sand deposit has provided, the value of which has been recently demonstrated in the series of serious storms our beach has weathered so much better than adjoining areas that were not so protected.

8. We also take particular note of the mention at page 10 of the SDEIS that the Corps received a communication from the Mid-Atlantic Fishery Management Council ("MAFMC") that Borrow Area C "may be designated as Essential Fish Habitat (EFH) for surfclaims by the Mid-Atlantic Fishery Management Council (MAFMC) under provisions of the reauthorized Magnuson Act of 1996," and the recognition expressed at page 17 of the SDEIS that "Like the surfclam, areas within Delaware coastal waters may be designated essential fish habitat (EFH) for managed finfish species like bluefish (Pomatomus saltatrix), summer flounder (Paralichthys dentatus), and scup (Stenotomus chrysops)." We especially appreciated the acknowledgement expressed at page 17 of the SDEIS that "the Philadelphia District will initiate consultation procedures with NMFS as required under the Magnuson-Stevens Act of 1996 for EFH (designation of certain areas of Delaware coastal waters, such as Borrow Area C, as essential fish habitat)."

9. From the discussion that took place at the excellent public meeting on the SDEIS we learned that these designations of specific areas as "essential fish habitats" are due to be made in October of this year. We would be most grateful, indeed, if the Corps would relieve our remaining concern about the possible future use of Borrow Area C by supporting the designation of this area as an EFH in the course of the referenced consultations. We believe such designation would remove this important fish habitat and protective barrier permanently from any further consideration as a potential sand borrow site.

7. Further investigation has revealed that Borrow Area E contains sufficient material for initial construction as well as all required periodic nourishment. Borrow Area C is no longer being considered for use in this project.

8. No response required.

9. Designation of Area C as EFH is incumbent on the NMFS and MAFMC. Any future consideration of Area C would require consultation pursuant to Magnuson-Stevens Act requirements if the area is designated EFH. We note that since the feasibility report and FEIS do not propose Area C as a sand borrow source, any future consideration of Area C for use by the Corps of Engineers would require the preparation of another document in accordance with the National Environmental Policy Act (NEPA), as amended. Public involvement pursuant to NEPA and Council on Environmental Quality (CEQ) Guidelines would be required.

If this designation could be achieved in October, I wish to assure you that our Association and its members would do whatever it and we can do to assist the Corps in securing the necessary funding decisions to move forward with its worthwhile sand replenishment proposal.

Sincerely yours,

Richard D. Copaken
President
Preserve Homeowners' Association

cc: Mr. Jeff Tinsman
Dr. Tom Hoff
Mr. Tim Goodger

WILLIAM S. GREEN
6506 Kenhowe Drive
Bethesda, MD 20817
(301) 229-6566

May 29, 1998

Mr. Robert Callegari
Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Re: Bethany Beach et. al. Beach Replenishment EIS.

Dear Mr. Callegari,

This letter is being submitted as a matter of record in the comment period ending June 1, 1998 in the above matter.

1. We testified at the public hearing on May 13, 1998. Our testimony is incorporated herein (Because we have no printed transcript, we note that the testimony may be found as the lead-off public comment of the hearing). We also incorporate the comment of Mr. Shawn Haurahan, the presiding officer, at the conclusion of the hearing, that Site C (the North Bethany site) is no longer being considered as a Borrow Site.

2.

Respectfully submitted,

William S. Green
Chairman, Legal Committee
Atlantic Watergate Association

1. A written transcript of the public meeting on May 13, 1998 is provided in Appendix G. Copies of this appendix and/or the written transcript are available upon request.

2. Concur.

ROBERT CALLEGARI, ATTN:
ENVIRONMENTAL RESOURCES BRANCH,
U.S. ARMY CORPS OF ENGINEERS
WANAMAKER BUILDING
100 PENN SQUARE EAST
PHILADELPHIA, PA. 19107-3390

RE: BETHANY, SOUTH BETHANY 50 YEAR DREDGING PROJECT

TO WHOM IT MAY CONCERN,

AFTER CONSULTATION WITH A STATE ATTORNEY, I WAS ADVISED THAT WHENEVER STATE TAX DOLLARS ARE USED TO BENEFIT A PRIVATE PARTY IN ANY WAY OR FOR ANY REASON, THE PUBLIC CAN SUE TO GAIN EQUAL AND ACCESSIBLE PUBLIC ENTRY TO THE AREA BEING BENEFITED WITH TAX DOLLARS. I SPECIFICALLY DESCRIBED THE PLANNED PROJECT RECENTLY DISCUSSED AT THE MILLVILLE FIRE HALL AND ASKED FOR THE OPINION OF THE ATTORNEY GENERAL'S OFFICE REGARDING SUCH USE OF TAX MONEY ON PRIVATE BEACHES.

THIS OPINION WAS IN RESPONSE TO MY QUESTIONS ABOUT THE PUBLIC TRUST DOCTRINE, WHICH IS BINDING AGAINST ALL AGENCIES OF GOVERNMENT, BOTH STATE AND FEDERAL.

1. SOUTH BETHANY DOES NOT PROVIDE PUBLIC BATHROOMS. IT DOES NOT PROVIDE EQUAL PARKING OPPORTUNITIES TO THE PUBLIC. IT DOES NOT PROVIDE ADEQUATE PARKING SPACES TO THE PUBLIC. IT DOES NOT ADVERTISE IT'S PUBLIC STATUS TO THE GENERAL PUBLIC IN DELAWARE.

2. MIDDLESEX AND SEA COLONY DO NOT PROVIDE ADEQUATE ACCESS TO THE BEACHES IN FRONT OF THEIR PRIVATE COMMUNITIES. PUBLIC REST ROOMS ARE NOT AVAILABLE IN THOSE AREAS EITHER. THERE ARE NO PARKING SPACES WITHIN A REASONABLE DISTANCE OF THOSE BEACHES. ACCESS IS LIMITED TO THE ENDS OF THEIR BEACH AREAS, THUS DEPRIVING THE GENERAL PUBLIC OF EQUAL AND ADEQUATE ACCESS TO THE BEACHES, WHICH WILL BENEFIT FROM THE SAND DREDGING PROJECT.

3. BETHANY BEACH ALLOTS ONE HALF OF THEIR PARKING SPACES TO RESIDENTS AND BUSINESSES WHO HAVE PERMITS. THEY ALSO NEED BETTER AND MORE PARKING FOR DELAWARE TAX PAYERS TO USE IF THEY WANT TAX DOLLARS FOR THE PURPOSE OF PROTECTING THEIR PROPERTIES. SPECIAL PERMITS SHOULD BE ELIMINATED IN ALL TOWNS BENEFITING FROM TAX DOLLARS.

THE PROJECT WILL BE EXTREMELY EXPENSIVE AND WILL REQUIRE EVER INCREASING AMOUNTS OF TAX DOLLARS TO MAINTAIN.

1. Public use is a condition for Federal participation in shore protection and means "recreational use by all on equal terms and open to all regardless of origin or home area". Any device which would limit access to a specific segment of the population is prohibited, and would preclude Federal participation. As part of this study, a public access plan was developed, which concluded that Bethany Beach and South Bethany provided full public use for the general public in the project area. There are no operative restrictions to public use in place in either community. The project provides for 41 public accessways located at existing street ends where parking is available.

2. Middlesex and Sea Colony are private communities, which do not provide public access. Therefore, they are excluded from the project, except of taper areas, which extend beyond the beachfill length for protection of the project.

3. See response to comment #1.

THEREFORE I ENTER THE FOLLOWING PROTEST AND PROPOSAL:

PROTEST

THIS PLAN WILL SUBSIDIZE AFFLUENT PROPERTY OWNERS BY GIVING THEM ENGINEERED PROTECTION FROM STORM DAMAGES DUE TO ACTS OF NATURE. THE PLAN USES TAX DOLLARS BUT MAKES NO ATTEMPT TO COMPENSATE OR PROTECT THE TAX PAYERS IN RETURN. IT DOES NOT MEET THE REQUIREMENTS OF THE PUBLIC TRUST DOCTRINE. IT ALLOWS DELAWARE TO BYPASS THE INTENT OF THAT DOCTRINE.

PROPOSAL

1. REQUIRE PARKING SITES AND TRAMS SUCH AS REHOBOTH USES.
2. REQUIRE PUBLIC REST ROOM SITES IN SOUTH BETHANY BEACH.
3. REQUIRE ADVERTISEMENT IN DELAWARE NEWSPAPERS ADVISING THE GENERAL PUBLIC OF THE AVAILABILITY OF THESE BEACHES FOR THEIR USE AS COMPENSATION FOR THEIR TAX DOLLAR SUPPORT FOR THE INITIAL CONSTRUCTION PROJECT.
4. REQUIRE MIDDLESEX AND SEA COLONY TO PROVIDE A LINE OF ENTRY TO THEIR BEACHES THROUGH THEIR PROPERTIES AT THE POINT WHERE THEY ADJOIN, SO THE PUBLIC WILL HAVE EQUAL ACCESS TO THESE BEACHES (IF THEY INTEND TO ALLOW THE STATE TO PUMP SAND ON THE BEACHES IN FRONT OF THEM)..OR HAVE THE STATE CONDEMN A RIGHT OF WAY FOR THE USE OF THE PUBLIC... OR PAY A FAIR, BUT REASONABLE AMOUNT FOR SUCH A STRIP OF LAND.
5. HAVE THE PUBLIC (EVERYONE INCLUDING RESIDENTS OF THE TOWNS AND BEACHES) PAY A DAILY FEE WHENEVER THEY CHOOSE TO USE THE BEACH (IN ORDER TO HELP PAY FOR THE COST OF BEACH REPLENISHMENT ON A REGULAR BASIS)
6. DO NOT PARTICIPATE IN A PROJECT WHICH DISCRIMINATES AGAINST THE TAXPAYERS IN ANY WAY WHATSOEVER, REGARDLESS OF HOW THE PARTICIPATING SPONSOR MAY CHOOSE TO INTERPRET THE SITUATION AND OPPOSING DOCTRINE.

IF THE ARMY CORP OF ENGINEERS WILL NOT REQUIRE PROPER PUBLIC ACCESS AND AVAILABILITY AND AMENITIES, THEN THIS PROJECT IS NOT A PROPER CANDIDATE FOR TAXPAYER FUNDING FOR ANY REASON.

SINCERELY,

J. L. Stafford

J. L. STAFFORD
RR 2 BOX 110
MILLVILLE, DEL. 19970

The Sussex Post, Millsboro, Delaware, Wednesday, May 27, 1998

The perils of parking in Rehoboth

By **Ashley Gray**
For the Sussex Pos

DOWNSTATE — Weekend warriors braved Friday traffic to get to the beach. But the battle isn't over yet.

Now, they need to park.

For visitors to coastal towns, parking is not an easy endeavor, and for municipalities, it's an ongoing issue.

Rehoboth Beach

Rehoboth Beach commissioner Donald L. Derrickson has pushed a parking garage as the ideal solution to the city's problems since his election campaign last year.

The prospect of building one has resurfaced with downtown revitalization plans; the proposal is for a three-story garage that would hold about 230 cars, to be located behind the Rehoboth Beach Volunteer Fire Co. on Rehoboth Avenue.

The concept has gained support from business owners who want friendly parking for their customers and opposition from those people who do not think the parking volume justifies spending about $3 million.

Mr. Derrickson said he wants the city to decide if the parking garage is a viable project before he and other commercial-property owners pursue the costs, funding and design any further. But the concept, for him, is a no-brainer.

"I think it will actually help traffic. It will get people off the street," he said.

It will also provide convenient, no-hassle parking to customers so they will shop in Rehoboth Beach, Mr. Derrickson said. Now, downtown stores must compete with shopping centers, restaurants and retail stores on Del. 1, where parking is free and available, he said.

Commissioners Jack Hyde and Richard Sargent have voiced their opposition to the garage because of the location and because it will be vacant for a majority of the year.

Chip Hearn owns businesses in Rehoboth Beach and Dewey Beach, and admits that the dollars-and-cents issue is a tough one to justify a parking garage for the short peak season.

But the foremost need for resort towns is meeting th needs of customers. "(Peop.e) need to be able to park once they get here, or else, they're not going to come," he said.

"The bathrooms don't make money, but we gotta have them."

Rehoboth Beach already alleviated congestion in the residential area, cleaned up the entrance to town and is working to revitalize downtown, Mr. Hearn said. The garage would be the next step Rehoboth Beach could take toward accommodating visitors.

Main Street Association president Kathy K. McGuiness said her board hasn't taken a position on the parking garage, but personally, she supports it. "There's no doubt in my mind it's something that is needed," she said.

June 2, 1998

Mr. Robert L. Callegari
Environmental Resources Branch
U.S. Army Crops of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

At our May 23, 1998 Breakwater Beach Association owners meeting, the issue of the Army Corps of Engineers' Bethany Beach/South Bethany Interim Feasibility Study on beach replenishment was discussed by the attendees.

1. In fact, the members of the association have discussed this subject at our meetings over the past year. Their basic concern is that moving sand from the barrier off our coast will increase the vulnerability of our beach and dune to future nor 'easters. Our Vice President, Charles Guggenheimer, attended the May 13 meeting in Millville, and he has indicated the issues discussed and turnout of interested parties although he could not attend our May 23 meeting.

2. In discussing the options related to the proposed replenishment, the association members indicated that their first priority would be to have no sand moving or replenishment, and the second choice would be to take sand from site E rather than site C as was outlined at the May 13 meeting. The association members were also firm that no new taxes or tax increases be established to cover costs related to a replenishment program.

3. The May 22, 1998 issue of USA Today carried an article indicating that federal funding for beach replenishment is expected to decrease, and support for the program is waning. In addition, environmentalists say that replenishment doesn't last, and it is environmentally questionable.

4. We have been in touch with other associations, and they share these views. We would urge that these concerns be given serious consideration in the review process.

Sincerely,

Nelson Denlinger

Nelson Denlinger
President
Breakwater Beach Association

1. This comment refers to the originally proposed dredging within Borrow Area C, which was located 2,000 feet to 8,400 feet offshore from the North Bethany unincorporated communities. Area C has been subsequently abandoned in favor of Area E, which lies 9,600 feet to 16,600 feet offshore of Bethany Beach and South Bethany.

2. See response to comment #1.

3. The feasibility study has identified a project that is determined to be technically sound, economically cost effective over the life of the project, is socially and environmentally acceptable, and has broad local support. The Administration's budgetary policy has precluded further Federal participation in the design and construction of hurricane and storm damage reduction projects in recent years. However, the Administration recently sent to Congress a proposed change in cost-sharing of shore protection projects, which would place a greater financial responsibility with the non-Federal sponsor for periodic nourishments. This is expected to allow budgetary consideration of shore protection projects on an equal basis with other water resources development projects once new cost-sharing is enacted by Congress into law.

4. The project as designed includes provisions for advanced nourishment, which is the "sacrificial" portion of the replenished beach. Periodic nourishment on a 3-year cycle provides for the replenishment of sand that is lost in the interim. Please refer to Section 5.0 of the FEIS for detailed discussions on the environmental consequences of the proposed action.

16 Seaside Drive,
PO Box 597,
South Bethany, DE 19930
June 4, 1998

Mr. Jerry Pisquale,
ATTN: Environmental Resources Branch,
U.S. Army Corps of Engineers,
Wanamaker Building,
100 Penn Square East,
Philadelphia, PA 19107-3390

Subject: Bethany Beach/South Bethany Interim Feasibility Study, Volume I, April 1997 and Draft Feasibility Report, Draft Environmental Impact Statement, April, 1997 and Supplemental Draft Environmental Impact Statement, April, 1998

Dear Mr. Pisquale:

The following is submitted on the above Project following the May 13, 1998 Public Hearing in Millville, Delaware to obtain a more realistic benefits/cost ratio for the Project. There are two areas in my April 11 FAX to you where benefits for the proposed Project were understated and where May 13 explanations where unsatisfactory. Comments below provide a means to quantify benefits accurately for these two areas to improve assessment of Project benefits/cost ratio. I am sure that determining the most accurate benefits/cost ratio is a major focus of the Project. The comments address South Bethany but also apply to similar situations in Bethany Beach.

I. PROJECTED BUILDING IN SOUTH BETHANY

I. At the meeting it was stated that the study assumed the "status quo" for buildings in South Bethany over the project life. In other words, the assumption is that no building occurs in South Bethany for 50 years in the area East of Route 1 subject to storm damages. I think you would agree that this assumption is obviously wrong. The stated reason for the assumption was that costs of future buildings could not be projected with any accuracy. This is untrue and a suggested approach to estimate costs for future buildings in South Bethany accurately is given below.

Attached Exhibit 1 explains that South Bethany's property assessment valuation is fixed based on values as of June 18, 1976 and that the Town's property tax rate has not changed since 1987. The use of the June 18, 1976 value eliminates issues of changing sales values for shore properties and inflation in costs of construction. So the recent growth in property taxes based on 1976 building valuations will track the increased construction valuations in fixed dollars. Accordingly, future costs for South Bethany's buildings can be predicted with a high degree of accuracy from the Town's annual property taxes. Actual Town property taxes are listed for the years 1991 through 1998 in Exhibit 1. The annual average increase is more than 2%, although this has slowed to about 1 4% for the last 3 years. Use of a realistic growth rate for building construction costs will provide substantially higher benefits/cost ratio.

1. The structure values for the properties in Bethany Beach and South Bethany for the Shore Protection Feasibility Study have been determined using the Marshall and Swift Valuation Program based on replacement cost of the structures in the study area . It is recognized that market values within this coastal community are higher than that used in the storm damage analysis. The trend in historical property assessment has been presented to the Corps in Exhibit 1 -- South Bethany Property Taxes. However, the land value component of property value used for the National Economic Benefit analysis is based on the cost of fill (replacement) for the sand displaced by erosion during a storm, not its market value.

As far as future development is concerned, current regulations prohibit claiming national economic benefits (NED) for future development (in potentially developable land) that is within a storm damage area. It has been mentioned in the comment to the Corps that no new land development has occurred in the past seven years in South Bethany. Also, any expected inflation or costs is not a factor in the analysis, as benefits and costs are presented at the same constant price level.

Please use regression analysis on the tax data in Exhibit 1 to determine the historically correct growth rate of building costs for the area where building damage is reduced by the project and use this to forecast the value of damage avoided over the 50-year project life. This will provide a more realistic economic analysis and is consistent with normal business practices in economic analysis. Understatement of benefits in this area will be resolved.

2. TAPER ZONE BENEFITS

2. At the meeting, it was stated that it would be too complex to evaluate savings for the project in the area of the taper zones. Obviously, the addition of a 1,540' beach berm in front of southern Middlesex Beach will provide benefits. Failure to include these benefits results in a lower benefits/cost ratio. After reviewing your study, it is evident that you have the tools and skills to estimate savings from the project for the taper zone protecting Middlesex Beach. Obviously, substantial protection will be provided to existing and future structures in Middlesex Beach by the taper zone and by migration of sand north from the replenished South Bethany beach. Attached Exhibit 2 estimates a graduated reduction in storm damage benefits from south to north Middlesex Beach with initial annual benefits of $91,000. These benefits should also be escalated for building in future years. I could not determine a historical growth rate for Middlesex Beach; however, using the same growth rate as used for South Bethany should be a conservative approach. (East of Route 1, Middlesex has 21% vacant lots vs 8.5% in South Bethany.)

Please determine benefits for Middlesex Beach, including future construction, from the taper zone and include these as a project benefit. Obviously, additional recreational benefits for the taper zone should also be included because without this project, the recreational beach in Middlesex Beach would be substantially eliminated.

At the meeting, it was stated that the Washington office provides long-term interest rates each month and the rate provided the month in which the final report was issued would be used in project economics. **Please send me the long-term interest rates to be used in June, 1998 studies** for comparison to the current interest rate for 30-year U.S. treasury bonds.

I would like to thank you and the U.S. Army Corps of Engineers for their work on this project and for the professional and courteous manner in which you conducted the May 13 meeting. I would be pleased to discuss any questions you have on this letter or on my April 11 letter.

Sincerely,

Ian W. Davidson

Ian W. Davidson
President, South Bethany Property Owners Association

cc: Mr. John Hughes, DNREC; Mr. Joe Schaefer, South Bethany

2. Please refer to response #2 to Ian W. Davidson's letter dated 11 May1998.

EXHIBIT 1 - SOUTH BETHANY PROPERTY TAXES

The following information has been excerpted from A System Of Real Property Assessments In South Bethany, revised April 20, 1998 by Susanne J. Messick, Assistant Director of Assessments, Sussex County (phone 302-855-7824). (If you want a copy of this 10-page document please let me know.) It is provided so you can make a statistically correct projection for South Bethany building construction values:

(A) Property taxes payable in South Bethany are limited to a Town realty tax. (There is no Town of South Bethany personal property tax.)

(B) The Town of South Bethany has adopted Sussex County assessments for municipal purposes.

(C) Currently, Sussex County has assessed the value of land and improvements or structures at the value date of June 18, 1976, even though such assessments bear no proximate relationships to current values.

(D) South Bethany's property tax rate has been unchanged since 1987.

Since the assessments are set at 1976 values and the property tax rates have not changed, it is possible to project accurately the increased value of South Bethany buildings for future years in constant 1976 dollars from the change in Town taxes over the last several years. The Town has provided the information on Town property taxes shown below.

YEAR	PROPERTY TAX ($)	YEAR	PROPERTY TAX ($)
1991	165,039.47	1995	185,347.47
1992	170,484.65	1996	187,870.44
1993	176,065.27	1997	190,334.74
1994	179,886.41	1998	193,025.08

In seven years, the value of buildings in Town has increased by nearly 17%. Since no land was added nor new land developments occurred in this time, this increased value was created solely by additional building value.

Attachment 1, Section B of my May 11 FAX to you showed there are vacant lots in the area east of Route 1 and I know substantial renovations are occurring or have occurred on several properties since you made your initial estimate of potential storm damages. I am sure you agree that assuming no changes in this area over the life of the project results in a substantial understatement of damages avoided from implementing the project.

EXHIBIT 2 - MIDDLESEX BEACH TAPER ZONE BENEFITS

The taper zone extends from the south end of Middlesex Beach (north end of South Bethany) to Short Road in Middlesex Beach. There will be a gradual reduction in damage reduction from 100% at the south end of Middlesex Beach to an estimated 10% at the north end of Middlesex Beach. Even Sea Colony will receive benefits from the northward migration of sand placed on the beaches of South Bethany and Middlesex Beach. Shown below is a simplified estimate of reduced damages for Middlesex Beach which assumes Middlesex Beach ocean block houses receive the same damages as those in South Bethany. The count of houses and empty lots was made from Figure 26 - Selected Plan Layout for Bethany Beach to South Bethany in your April, 1997 Interim Feasibility Study. The Corps can provide more accurate estimates of damages avoided in Middlesex Beach in the same manner as used for the study of South Bethany structures.

LOCATION	HOUSES	EMPTY LOTS	HOUSE SAVING*	PROTECTION %	SAVINGS $
Seaside - Addy	4	4	3,412	90	12,283
Addy -Bridge	11	3	3,412	75	28,149
Bridge - Errett	11	3	3,412	60	22,519
Errett - Bayberry	12	2	3,412	40	15,013
Bayberry - Short	12	2	3,412	25	9,383
Short - North	11	2	3,412	10	3,752
TOTAL	**61**	**16**			**91,099**

* Average annual amount of damages avoided based on reduced damages to structures for South Bethany of $928,000 (erosion - 321,000 and wave/inundation - 607) on Table 20, page III-21 divided by 272 structures in the ocean block of South Bethany (Section 171, p III-17).

16 Seaside Drive,
PO Box 597,
South Bethany, DE 19930
June 7, 1998

Mr. Jerry Pisquale,
ATTN: Environmental Resources Branch,
U.S. Army Corps of Engineers,
Wanamaker Building,
100 Penn Square East,
Philadelphia, PA 19107-3390

Subject: Bethany Beach/South Bethany Interim Feasibility Study, Volume 1, April 1997 and Draft Feasibility Report, Draft Environmental Impact Statement, April, 1997 and Supplemental Draft Environmental Impact Statement, April, 1998

Dear Mr. Pisquale:

The following is submitted on the above Project following the May 13, 1998 Public Hearing in Millville, Delaware. We want to insure that the above project does not affect our current view of the ocean and beach from the first floor of our South Bethany oceanfront house which is already behind a dune that is an estimated 15 feet high..

We are located at 16 Seaside Drive (Lot 22 on the Town Plan), the second oceanfront home behind the Sandpiper Village Dune north of North 6th Street. We have owned our property since 1981, built a house in 1984 and renovated the house at a cost of well over $300,000 in 1997 before retiring here as a year-round South Bethany resident. We have always had an excellent, panoramic view of the beach and ocean As shown by the "CURRENT SITUATION" in Attached Exhibit 1 and we want to be sure that we retain this view.

Figure 27 of your April, 1997 Interim Feasibility Study shows the Project dune height at +16 ft NAVD and extending east of the current dune top by 90 - 130 feet. Our 1984 FEMA Elevation Certificate certifies that the bottom of the lowest floor beam is at an elevation of 16.73 feet, NGVD (mean sea level). Our view of the beach and ocean from the first floor of our home will be substantially eliminated by this new second dune to our great detriment as shown by "COE APRIL 1997 FEASIBILITY STUDY" in Exhibit 1. The detriment will be in the form of loss of pleasure of seeing the beach and ocean and also of loss of value should we sell the house at some future time. We will gain little protection by adding this new Project dune in front of our existing dune; however, we will gain significantly more protection by the extension of the beach berm by a minimum of 150 feet east of the beachfront houses on Ocean Drive. Oceanfront houses further north in Sandpiper Village will not suffer a loss of view because the new project dune will be essentially where the current sandpiper Village dune already is.

1.

1. The property is located in a transition area between two design lines, which results in a "double dune" construction in order to provide a smooth transition with continuous protection. Although aesthetic impacts may be unavoidable in this area, the transition design will be explored during the preparation of plans and specifications to minimize impacts using more detailed survey information when it is available.

We recommend an alternate plan for dune configuration so that our view of the beach and ocean will not be affected as shown by "PROPOSED DUNE" in Exhibit 1. It appears that the Project dune could be angled to join the current Sandpiper Village dune at a much sharper angle and reduced height. The ocean-side slope could be made more shallow to retain more sand and hence more protection in front of the existing dune whose height is raised to 16 feet. There is no reason to have two 16 foot dunes east of southern Sandpiper Village houses. Also, we would not want to leave up the fence atop the dune for any longer than needed to establish the dune grass. The Town has put fences only at the bottom of the new dunes and this has been successful in keeping people off the dunes.

Our lot extends 235.45 ft east of Seaside Drive. As such, our agreement would seem to be necessary to construct the new Project dune. We have readily agreed in the past and will continue to agree to maintenance and repairs to the current dune in its current location and at a height up to its original design. (We would not agree that a dune could be extended much further east at a height of 16 feet NAVD as this would substantially reduce our view of the beach and ocean as well as our enjoyment and our property value.) The berm is wide enough in this area to accept a revised reconfiguration without substantial impact on protection of the houses. Although I have not discussed this situation with either of my neighbors, I am sure they will have similar views, particularly Mrs. Green who owns 14 Seaside Drive (Lot 21).

As you know, we are strong supporters of your plan and trust that you can modify the dune so it will not be deleterious to our view and property value while providing essentially the same protection as your initial proposal. Please let me know what the difference in 16.73 ft NGVD vs the 16 ft NAVD and keep me informed of progress on the modifications we require.

Sincerely,

Ian W. Davidson

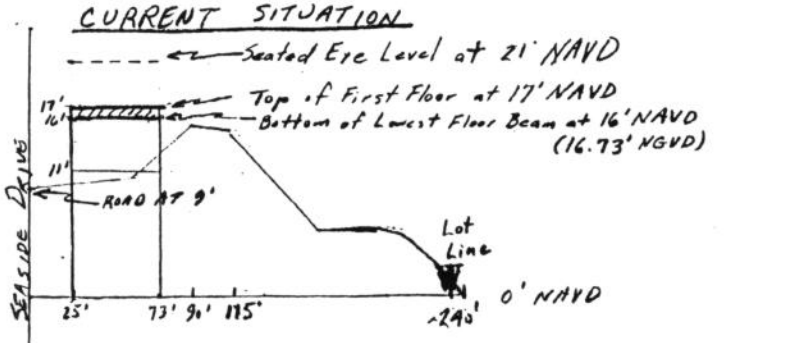
Ian W. Davidson
16 Seaside Drive

cc, with attachment; John Hughes, DNREC
Mayor Joe Schaefer, South Bethany

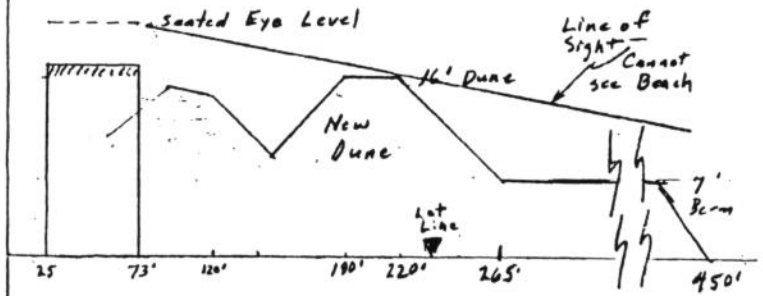
EXHIBIT 1

6/1/98

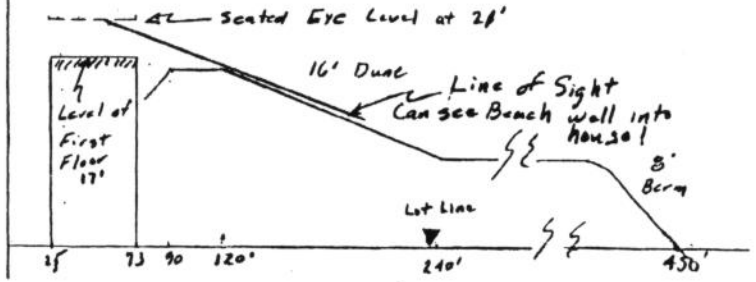
CURRENT SITUATION



COE APRIL 1997 FEASIBILITY STUDY



PROPOSED DUNE



8C

June 8, 1998

Robert L. Callegari
Attn: Steve Allen
U.S. Army Engineer District, Phila.
Wanamaker Bldg, 100 Penn Square East
Philadelphia, PA. 19107-3390
FAX (215) 656-6543

Ref: SDEIS Bethany & S. Bethany Interim Feasibility Study Sussex County, De.

Mr. Allen,

It was my pleasure meeting you at the May 13th public meeting in Millville, Delaware. Your presentation by you and your colleagues was done in a very professional manner. I'm sure with the workload of the ACOE there are times when things can be overlooked and that's probably why there is a comment period for your projects.

I'll put my comments in outline form to categorize and simplify.....

I. Subsidence and Sea Level Rise (pg II-5 #49 Bethany Feas. Study 1991 says 1.02 foot per century)

A. You mentioned at the May 13th meeting a 6" sea level rise in the "next" 50 years using Breakwater Harbor as a reference, since there the sea level rose 6" in the past 50 years.

B. No mention that the Mid-Atlantic Region is subsiding. Subsidence is equal to twice the average effect of the average global sea level rise.

1. Reference Emery 1991

1. a) REGIONAL SUBSIDENCE DUE TO PAST ICE AGE
[redacted] "peripheral fall".

1.) Weight of ice during ice age caused a huge depression in "the Hudson Valley". The mid-atlantic region was south of the ice flow. The Delaware area was pushed upwards. Since the end of the last ice age the Hudson Valley region is rising. The Delaware region is sinking.

2. Also check study by ACOE 1984 re. SUBSIDENCE.

3. Intergovernmental Panel on CLIMATE CHANGE, consists of approximately 2,000 scientists from around the world.

a.) Sea level RISE by the year 2100 (1995 report

1.) 38cm to 55 cm higher on global average (that's 15,2" to 22"/100 years

4. EPA PHILADELPHIA CONFERENCE on global CLIMATE CHANGE (FEB 1998).

a.) SEA LEVELS RISE 2 to 4 feet, double the world average - MID-ATLANTIC FORECAST (SEE NEWS JOURNAL article FEB 27, 1998 (encl.)).

5. "SEA LEVEL RISE - A GROWING THREAT to DELAWARE'S BEACHES" - 1997 Article DELAWARE CONSERVATIONIST (encl.)

a.) pg 6 table 2. This must be the figure you are using for a 6" sea-level rise over the 50 years of the proposed project in your calculations for how much sand will be needed to protect the

5 a.) coastline properties.. The problem is that your calculations for the next 50 years are based on what happened in the last 50 years.

1.) Sea level rise according to up to date scientific calculations are as follows:

NEXT 50 YEARS... 7.6" to 11"

The higher figure, 11", is being favored by the inter-governmental panel on climate change due to accelerated global warming and more recent discovery of volcanic activity on the Antarctic Continent. Continental ice flows are moving up to 1/2 mile/year into the ocean and melting.

2.) According to Brent Yarwin PhD, CLIMATOLOGY of PENN State, Subsidence is about 1/4cm/year in the mid-ATLANTIC REGION.

NEXT 50 YEARS - APPROX 5" SUBSIDENCE

SUBSIDENCE = 2 X AVERAGE EFFECT of GLOBAL SEA LEVEL RISE

= 10" SEA LEVEL RISE DUE TO SUBSIDENCE

II. Summary

A. SEA LEVEL RISE NEXT 50 YEARS = 11"

SUBSIDENCE " " " = 10"

TOTAL RELATIVE SEA LEVEL RISE 21"

Calculations can be different because of predictability; but one thing should be taken into consideration - your 6" sea level rise is 350% off

CONTINUE FROM PREVIOUS PAGE 301

consideration - your 6" sea level rise is 350% off

pg 4

1. the predicted relative sea level rise by over 2,000 scientists.

In your cost - Benefit Analysis, you may want to recalculate using the predicted sea level rise as your coefficient and calculation and not the 6" PAST HISTORY figure.

Sincerely,

William J. Winkler

P.O. Box 1400

Ocean View, De. 19970

cc. PRESIDENT CLINTON

cc. GOVERNOR CARPER

cc. SENATOR ROTH

cc SENATOR BIDEN

cc REP CASTLE

cc. ABC NEWS, JOHN STOSSEL

encl. NEWS JOURNAL ARTICLE 2/27/98

encl. 1987 article DELAWARE CONSERVATIONIST

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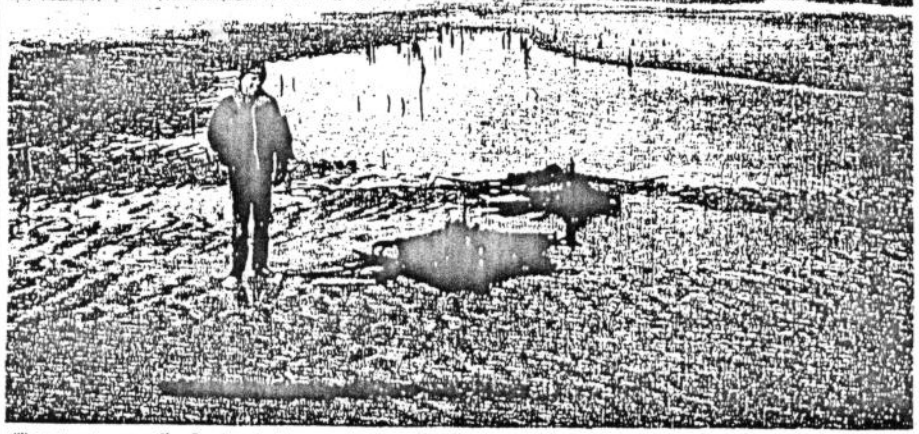
1. Information regarding Sea Level Rise cited in the Feasibility Study and the public meeting had been inappropriately referenced, and by the procedures given below, has since been superseded.

Analyses were completed in accordance with current Corps of Engineers guidance ER-1105-2-100 section 5-25, which requires that The National Research Council (NRC) study on sea level rise, Responding to Changes in Sea Level: Engineering Implications, 1987 be used until more definitive data become available. Corps of Engineers policy calls for consideration of designs, which are most appropriate for a range of possible future rates of rise. Strategies such as beachfill, which can be augmented in the future as more definitive information becomes available, should receive preference over those that would be optimal for a particular rate of rise, but unsuccessful for other possible outcomes. Potential sea level rise should be considered in every coastal study, with the degree of consideration dependent on the quality of the historical record for the study site.

Our regulation (ER 1105-2-100) recommends a sensitivity analysis be conducted to determine any effect sea level change would have on plan evaluation and selection. The analysis should use the extrapolation of the local, historical record of relative sea level rise as the low level and Curve III from the NRC report as the high level. Based on historical gauge records between 1921 and 1986 at Lewes, Delaware, sea level has been rising at an approximate rate of 0.0102 feet per year (Hicks and Hickman, 1988), which indicates a 0.51 foot rise in sea level over the fifty year project life. Curve III of the NRC report indicates a 1.4 foot rise over the fifty year project life (0.55 meters or 1.8 feet relative to 1986 levels, or 1.4 feet over the fifty year project life). Historical gauge records as well as NRC report data include the effects of subsidence. ER 1105-2-100 states that it may be appropriate to consider plans designed for base year conditions that also incorporate designs for future conditions. The selected plan at Bethany Beach/South Bethany includes a foreshore slope of 1V:15H, which indicates that approximately 8 to 21 ft. of shoreline retreat can be expected due to relative sea level rise over the 50-year project life. This was considered in future conditions analyses as a basis for evaluating project benefits and costs.

Sea Level Rise — A Growing Threat to Delaware's Beaches

DELAWARE CONSERVATIONIST SPRING 1987



These tree stumps, at Key Box Road in Delaware Seashore State Park, are visible usually only after storms that erode the beach. These stumps indicate that the area was once—probably about 400 years ago—an upland surface that is now flooded as sea level rises and the shoreline migrates landward. Photo by Robert D. Henry.

by
Robert Henry, Manager
DNREC Beach Preservation Section
&
Jeff Benoit, Coastal Geologist
Massachusetts Coastal Zone Management

"The path that society is following today is much like driving a car towards the edge of a cliff. We have a choice. We can go ahead, take no action and drive off the edge—figuring that, since the car will not hit the bottom of the canyon until our generation is long gone, the problem of coping with what we have made inevitable is for future generations to deal with. We can hope that they will learn how to adapt. On the other hand, we can put the brakes on now, before the car gets any closer to the edge of the cliff and before we reach a point where momentum will take us over the edge, with or without application of the brakes."

That analogy was made recently by Rhode Island Senator John Chaffee in his opening statement at a Senate hearing by the Subcommittee on Environmental Pollution. The subject: Ozone depletion, the "greenhouse effect," and climatic change. Chaffee was referring, in part, to the buildup of greenhouse gases, principally carbon dioxide (CO_2), in the atmosphere. Caused by deforestation and the unprecedented burning of fossil fuels (coal, oil and natural gas), this buildup threatens to warm the Earth significantly and could produce irreversible changes in the world's climate.

One of the more significant effects of this atmospheric warming trend would be an increase in the rate of sea level rise. Changes in the level of the sea have occurred in the past and are occurring even now. Throughout geologic history, sea level has risen and fallen by over 1,000 feet. These fluctuations have been due to changes in the size and shape of ocean basins, the amount of water in the oceans and the average density of seawater.

Although tectonic changes in the size and shape of ocean basins have caused the greatest changes in sea level over the last 100 million years, such changes are, in general, relatively slow. Of more importance to man have been the changes in sea level that have been caused by changes in climate.

During the last Ice Age (about 14,000 years ago), when massive glaciers covered most of northern North America, the world's oceans were more than 400 feet lower than today (Figure 1) and Delaware's Atlantic shoreline extended 80-100 miles farther seaward. As changes in global climate patterns warmed the earth, the Ice Age came to an end. The polar ice cap began to melt, and the seas began to rise. Rapid at first, the post-Ice Age warming slowed about 5,000 years ago. Today, this warming trend is on the rise again, thanks to a change in our atmosphere called the "greenhouse effect."

In the Earth's atmosphere, CO_2 acts like the glass in a greenhouse, trapping radiation as it leaves the earth and returning it as heat. Scientists have documented an increase in the amount of atmospheric CO_2 in recent years and predict that its levels will continue to rise as we burn more coal, oil and gas. Deforestation may contribute to the increase as well. Increased CO_2 will intensify the "greenhouse effect" and raise the Earth's surface temperatures; thus, the polar ice caps will melt more quickly, accelerating the rate of sea level rise. Scientists further predict that if temperatures rise enough to heat the upper layers of the ocean, its volume may expand, causing the increase in sea level to be even more dramatic.

The National Academy of Science (NAS) and the U.S. Environmental Protection Agency (EPA) have focused a great deal of attention on sea level rise in recent years. They predict that the "greenhouse effect" and increased global temperatures could raise sea level in some areas as much as six to eight feet in the next 100 years, with lower increases projected at other locations.

Though scientists agree that sea level is rising worldwide, when the rate of rise is measured at various locations on the globe, different values are recorded. The reason for this is simple: though sea level is rising at a generally uniform rate, the land along the ocean's edge is changing also. In some areas, where the land is rebounding from the tremendous weight of the glaciers that covered it for thousands of years, sea level rise is virtually imperceptible. Along the eastern coast of Canada, for example, the rate of rebound is actually greater than the rate of sea level rise. In other areas, where the land is stable, the rising sea is slowing consuming the coast. Lastly, some land areas are subsiding. Along the Gulf Coast of the U.S., for example, sea level rise is hastening the inevitable inundation of that rapidly sinking area. At Louisiana's current rate of loss—55 square miles per year—an area the size of Delaware would be lost in 36 years.

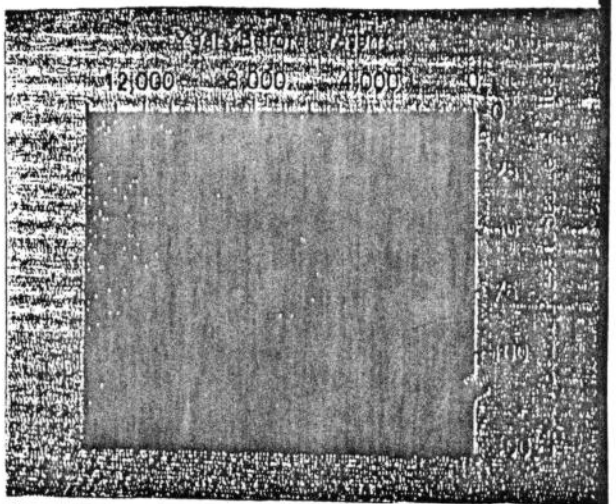


Figure 1 illustrates the general trend in sea level rise over the past 14,000 years. Illustration by Karin Grosz.

Clearly a single number cannot accurately describe the real effects of sea level rise worldwide. To better indicate how the level of the oceans is changing relative to the land scientists use relative sea level rise rates. The relative sea level rise rate for a particular location is determined by combining the estimates for global rise attributed to thermal expansion and snow and ice melt with the local subsidence rate. Table 1 presents estimates of

Table 1 - Local Subsidence Rates
(In Inches)

Portland ME	6	Pensacola FL	5
Boston MA	6	Galveston TX	22
Providence RI	6	Louisiana	2-3 ft
New York NY	7	San Diego CA	3
Sandy Hook NJ	13	Los Angeles CA	3
Atlantic City NJ	12	San Francisco CA	2
Baltimore MD	9	Honolulu HA	2
Ocean City MD	8	Astoria OR*	5
Portsmouth VA	11	Seattle WA	3
Charleston SC	9	Ketchikan AL*	-4
Mayport FL	4	Juneau AL*	-4
Miami Beach FL	5		

*Because parts of the northwest coast are emerging, local rise in sea level is less than worldwide in these areas.

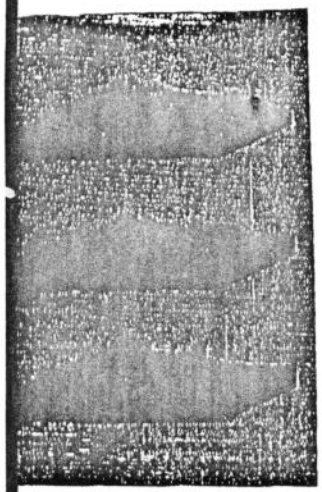


Figure 2 illustrates changes in shoreline position due to sea level rise. Illustration by Karin Gross.

local land subsidence, or in some cases, emergence rates per century for selected U.S. coastal locations. Since the table reflects subsidence, emergence rates, therefore, appear as negative numbers.

Table 2 summarizes the primary sources of sea level rise for the last century based on tidal gauge measurements. The table also includes projections for the next century from reports by NAS and EPA and then presents relative sea level rise rates using Ocean City, Maryland as an example.

Although scientists still may argue over exactly how much sea level will rise, most now agree that the rate at which it rises will increase in the near future. According to a recent EPA report entitled "Greenhouse Effect, Sea Level Rise and Salinity in the Delaware Estuary," we could expect a one-foot rise in sea level in this area in the next 40 years—almost as much as we had in the last 100 years. A one-foot rise in sea level would result in a landward movement of our beaches of from 100 to 300 feet, or more (Figure 2).

In Delaware's coastal zone, problems associated with sea level rise could be substantial. Not only could beaches erode more rapidly, but low-lying areas would flood more frequently, erosion control structures would be more easily "overtopped," some groundwater supplies could be contaminated by saltwater intrusion, the Delaware Bay oyster industry would be more susceptible to saltwater predators (such as the oyster drill and MSX), and much of Delaware's coastal wetlands could be destroyed by erosion and inundation.

Certainly, the potential for environmental—and human—tragedy exists. Unfortunately, coastal managers worldwide don't have all the answers. Today's plan of action appears based on recognition; we know with near-certainty that there will be an increased rate of sea level rise. While the actual severity of the problem remains difficult to determine, coastal managers today are at least armed with awareness and can assess potential areas now and plan for sea level changes in the decades to come.

Table 2 - Recent and Predicted Relative Sea Level Rise Rates for Ocean City, MD
(in inches)

	Last Century	Next Century	
		NAS	EPA
Thermal Expansion (global avg.)	2	12	18
Snow & Ice Melt (global avg.)	2	16	18-36
Local Subsidence (Ocean City, MD)	8	8	8
Relative Sea Level Rise (Ocean City, MD)	12 in.	36 in.	44-62 in.

Delaware Delicacies

Strawberries!

by Nancy I. Rolli

Conservationist Staff

Strawberries offer one of the garden's first pleasures by producing an excellent fruit which can be frozen to enjoy most of the year. Whether in jams, salads, and desserts, or by the handful, strawberries are a delicacy enjoyed by the whole family.

Here are some quick and colorful treats that you can make ahead and are sure to be enjoyed even by the pickiest eaters.

Strawberry Squares

1 cup flour
¼ cup brown sugar
½ cup chopped pecans
½ cup melted butter
2 egg whites
¼ cup sugar
1 large pkg. frozen strawberries
1 cup heavy cream (whipped)
1 tbsp. lemon juice

Stir together first 4 ingredients and spread in 9x13 pan. Bake at 325 F. for 15 minutes. Let cool 15 minutes. Combine egg whites, strawberries and juice, sugar and lemon juice. Beat in mixer until stiff peaks form (about 10 minutes). Fold in whipped cream (last) then spoon over the baked crumb crust. Serves 12.

Molded Strawberry Salad Dessert

1 cup applesauce
2 3-oz. pkgs. strawberry Jello
1 10-oz. bottle 7-Up
2 pkgs. frozen strawberries, thawed

Heat applesauce to boiling. Remove from heat. Add Jello. Stir in strawberries and 7-Up. Pour into mold. Chill. Serves 8.

The NewsJournal
Wilmington, Del.
119th year, No 298
A Gannett newspaper
KENT & SUSSEX
FRIDAY Feb. 27, 1998

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Del. gets a bleak global warming forecast

Coastline and wetlands may be lost to rising ocean levels, experts warn

By JEFF MONTGOMERY
Staff reporter

Rising sea levels threaten to erase Delaware's beaches and kill its coastal wetlands in the coming century, global warming experts said Thursday.

The experts are meeting in Dover during a two-day conference in Philadelphia to discuss global climate change and its impacts for the mid-Atlantic region.

Pessimistic forecasts of the rate at which the sea is rising are based on the assumption that the world will continue to produce greenhouse gases at roughly the same rate as it does now.

As a result, an 18-inch to 2-foot worldwide rise in the sea level may occur in 100 years, scientists say.

"We're going to suffer much more than sea level rise than many other places in the world," Yarnal predicted. Global weather patterns are expected to bring the mid-Atlantic region more severe droughts and to some cases reductions in average stream flows, he said.

Every 1-foot rise in Delaware's sea level threatens 100 to 300 feet of coastal land, the experts say. Delaware's tidal wetlands generally rise less than a foot above sea level.

"With a 2-foot sea level rise, you lose the ocean," said John A. Hughes, soil and water conservation director for Delaware's Department of Natural Resources and Environmental Control. "We're going to lose a lot of our wetlands."

Scientists called the Philadelphia conference as part of a national campaign for immediate, voluntary efforts to cut emissions of carbon dioxide and other greenhouse gases.

About 175 people attended the conference, which was sponsored by the Sierra Club and the University of Delaware's College of Marine Studies.

Jeanne Fox, director of the Sierra Club's Pennsylvania chapter, said the conference was designed to educate the public about global warming and to encourage citizens to lobby their elected officials to support efforts to reduce greenhouse gases.

Fox said she hopes the conference will help build support for the Kyoto Protocol, an international agreement signed in December by 160 countries, including the United States. The protocol would require the United States to reduce its greenhouse gas emissions by 7 percent below 1990 levels by the year 2012.

Fox said she is optimistic that the protocol will be ratified by the U.S. Senate, despite opposition from some members of Congress and from industry groups.

"We're not going to stop the process," she said. "We're going to keep pushing."

Yarnal said he is optimistic that the United States will ratify the protocol, but he said he is concerned that the agreement does not require developing countries, such as China and India, to reduce their greenhouse gas emissions.

"We're not going to solve the problem unless we get the developing countries involved," he said.

Yarnal said he is also concerned that the United States will not meet its goal of reducing greenhouse gas emissions to 1990 levels by the year 2000.

Yarnal said he is optimistic that the United States will

CONCLUSIONS AND RECOMMENDATIONS

358. As a requirement in completing the feasibility study, a public notice shall be issued to inform all interested parties of the plan selected herein. Because the design of the recommended plan is not technically complex and is essentially complete, a typical Design Memorandum will not be required before the initiation of construction. The only technical work remaining consists of developing plans and specifications for the proposed project. In addition, final environmental coordination and documentation can be accomplished concurrent with preparation of plans and specifications prior to construction. Following execution of a cost sharing agreement for Preconstruction Engineering and Design (PED), these activities will be cost shared on a 75% Federal, 25% non-Federal basis. In the event the PED efforts lead to construction, further reimbursement by the non-Federal sponsor would be made as a project cost shared item based on 65% Federal, 35% non-Federal cost share for construction.

359. The proposed storm damage reduction plan identified in this report consists of a project in two segments, one covering the town of Bethany Beach and the other covering the town of South Bethany. Project features include:

- For both towns, a dune and berm configuration extending seaward 150' from the design line. From the seaward toe of the dune, the berm extends 35' toward the foreshore of the project at an elevation of +7 ft-NAVD. It is important to note that this represents the minimum expected berm width prior to periodic nourishment of the project. The project calls for a slope of 1V:15H along the foreshore from the crest of the berm to mean low water (MLW). From MLW seaward, the slope parallels the existing bottom profile to the depth of closure.

- Beach fill for the Bethany Beach segment of the project extending along the entire length of the town (≈5,200'), tapering into the existing coastline approximately 1,260' to the north and south of the town boundaries. Likewise, the beach fill for the South Bethany segment extends along the entire length of the town (≈4,000') with tapers extending approximately 1,540' to the north and south of the town borders. The total length of the proposed beach fill project for the two towns is approximately 14,950'.

- Construction of a dune with a top elevation of +16 ft-NAVD in both segments. The top width of the dune is 25'. The slope of both the landward and seaward faces of the dune is 1V:5H. The bottom width of the dune is 115'.

- Approximately 3,453,000 cy of sand needed for initial construction of the project.

- Twenty-four acres of planted dune grass, and 27,425' of sand fence, for entrapment of sand on the dune and to delineate walkovers and vehicle access ramps.

- Forty-one dune walkovers, one at each street end, in Bethany Beach and South Bethany. One vehicle access way over the dune is included in Bethany Beach, while access for South Bethany is located approximately a ¼ mile south of the southern limit of town in the State Beach area.

- Nourishment of approximately 480,000 cy of beach fill material from Borrow Area E needed every 3 years for the 50-year period of analysis.

360. In order to properly assess the functioning of the proposed plan, the placed beach fill, borrow area, shoreline, wave, and littoral environment will be monitored. This monitoring is incorporated into the costs for periodic nourishment as it is considered a necessary part of continuing project construction. Environmental monitoring during initial construction and periodic nourishment operations will be accomplished through fieldwork and coordination with other interested agencies, and is included as a component of engineering and design efforts for this project. An estimate of environmental monitoring costs is presented in the Engineering Technical Appendix, Section 5.

361. Under cost sharing specified by Section 103 of the Water Resources Development Act of 1986, as amended, the currently estimated initial construction cost of $22,094,000 will be cost shared 65% Federal ($14,361,000) and 35% non-Federal ($7,733,000).

362. The Administration has proposed a new cost sharing policy for the periodic nourishment of shore protection projects. Cost sharing of the initial cost of construction is unchanged and will continue to be specified by Section 103 of WRDA 1986. Under the proposed policy, periodic nourishment will generally be 35% Federal and 65% non-Federal. The non-Federal sponsor, the State of Delaware Department of Natural Resources and Environmental Control, supports the implementation of the Bethany Beach/South Bethany project, and supports cost sharing of project features consistent with existing law and implementation of periodic nourishment elements consistent with cost sharing enacted by Congress in law.

363. The NED plan identified herein reflects the information available at the time, and current Departmental policies governing formulation of individual projects. This NED plan may be modified before being transmitted to Congress as a proposal for authorization and implementation funding. However, prior to transmittal to Congress, the non-Federal sponsor, the states, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

364. **Recommendations.** In making the following recommendations, I have given consideration to all significant aspects in the overall public interest, including environmental quality, social effects, economic effects, engineering feasibility, and compatibility of the project with the policies, desires, and capabilities of the State of Delaware and other non-Federal interests. I have evaluated several alternative plans for the purposes of Hurricane and Storm

Damage Reduction. A project has been identified that is technically sound, economically cost effective over the period of analysis of the project, is socially and environmentally acceptable, and has broad local support. Therefore, it is recommended that Federal participation be continued in the planning, design, and construction of a hurricane and storm damage reduction project for the towns of Bethany Beach and South Bethany, Delaware.

365. The plan being recommended is subject to modification at the discretion of the Commander, HQUSACE. The recommendations contained in this report reflect the information available at the time, and current Departmental policies governing formulation of individual projects. These recommendations may be modified before they are transmitted to Congress as proposals for authorization and implementation funding. However, prior to transmittal to Congress, the non-Federal sponsor, the states, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Jeff M. Ryscavage
Major, Corps of Engineers
Acting District Engineer

CENAD-DE (CENAP/Jun 96) (1105-2-10c) 1st End Mr. Pippens/8725
SUBJECT: Delaware Coast from Cape Henlopen to Fenwick Island - Bethany Beach/South Bethany Interim Final Feasibility Study and Final Environmental Impact Statement

Commander, North Atlantic Division, Corps of Engineers, ATTN: CENAD-ET-P, FT. Hamilton Military Community, 301 General Lee Avenue, Brooklyn, New York 11252

FOR COMMANDER, HQUSACE ATTN: Policy Review Branch, Policy Review and Analysis Division, Kingman Building, Fort Belvoir, Virginia 22060-5576

I generally concur in the Conclusions and Recommendations of the District Commander. The plan developed is technically sound, economically justified, and socially and environmentally acceptable and Federal participation in the design and construction of this hurricane and storm damage reduction project is recommended.

JERRY L. SINN
Major General, USA
Commanding

SEDIMENT CONTAMINANT AND GEOTECHNICAL TESTING FOR PROPOSED SAND SOURCES- DELAWARE COAST FROM CAPE HENLOPEN TO FENWICK ISLAND BETHANY BEACH/SOUTH BETHANY AND FENWICK ISLAND STORM DAMAGE REDUCTION PROJECTS

Prepared for

U.S. Army Corps of Engineers
Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Prepared by

Versar, Inc.
9200 Rumsey Road
Columbia, MD 21045

Contract No. DACW61-00-D-0009
Delivery Order No. 48

Prepared under the Supervision of
William H Burton

Principal Investigator

October 2004

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1.0 INTRODUCTION

The U.S. Army Corps of Engineers, Philadelphia District (USACE) retained the services of Versar, Inc. to perform sediment and water quality sampling and analyses for the Fenwick Island and Bethany Beach/South Bethany Storm Damage Reduction Projects. The samples were obtained from several potential sand sources identified during the project feasibility study. This report presents physical and chemical properties of sediments (obtained from vibrocores) and water quality within the proposed sand sources, which would be utilized for the placement of beachfill to increase the berm and dune dimensions in the communities of Fenwick Island, Bethany Beach and South Bethany. Because of the large quantities of sand required to be dredged from the proposed offshore sources, inorganic and organic analyses were performed to screen the sediments for contaminants and their suitability as beachfill quality material. Sediment contaminant levels were compared to Delaware Uniform Risk Based Standards and to concentrations known to provide adverse biological effects to marine organisms as presented by Long et al. (1995[1]). Water samples obtained from the bottom were compared to Delaware Marine Acute and Chronic Water Quality Criteria for aquatic life.

Vibrocore logs and sediment grain size distribution curves were developed to provide geotechnical data from the proposed sand sources to supplement existing physical sediment data on these sites. These analyses are necessary to compare with existing beach sands to assess the suitability and performance of the material as beachfill. The engineering properties of the material would be used to calculate overfill factors and quantities. In addition to the assessment of the material for its engineering properties, the physical data is useful for evaluating the material's recreational and ecological suitability and compatibility.

[1] Long, E.R.,D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environmental Management* 19:81-97

2.0 METHODS

2.1 SEDIMENT AND WATER CONTAMINANT TESTING

The sampling design and analysis plan for this project was developed by the USACE and followed recommended field and analytical methods summarized in *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters*, October 1997[2]. The sampling was conducted off the 55-foot US Sea Tow vessel between February 11 and 12, 2004 using their survey vessel the North Star 4. On-board Vibracoring services were provided by Aqua Survey, Inc. from Flemingtion, New Jersey using a Rosfelder designed 10-foot long electrically operated VT-4 vibracore. Although the VT-4 vibracore is capable of penetrating 10-feet of sediment the sediments encountered at the borrow sites were too dense for this device as only a maximum of about 6 feet of material could be retrieved.

Eighteen sediment cores from three potential borrow sites (E, Fenwick North, and Fenwick South) were collected with a ten-foot long 4-inch diameter vibracore in February 2004 (Figure 2-1). Five cores were collected within borrow site E and Fenwick North, and eight cores were taken in the Fenwick South borrow site. The vibracore tube was lined with a flexible plastic liner to eliminate cross-contamination and to allow the sediment core to be removed for sectioning, inspection, and subsampling. Target core penetration depth at each station was eight feet. Upon retrieval, each sediment core was inspected for grain size stratification. A vibrational core log was prepared for each successful core boring that included classifying the observed soil strata within the core as per ASTM D2487. Station locations were recorded using a Differential Global Positioning System (Figure 2-2, Table 2-1) and coring logs using ENG Form 1836 were maintained for each sample (see Appendix B).

Each sediment vibracore was separated into two depths strata: from 0 – 1.0 ft. in depth and 1.0 - <10.0 ft. in depth (depending on the core length retrieved). A total of 18 vibracores were collected to produce 36 composited samples to be analyzed for bulk sediment and grain size analysis. Bulk sediment tests included inorganics (Table 2-3), semivolatile organics (Table 2-4), pesticides, and PCBs (Table 2-5).

Water samples taken approximately one meter above the bottom were collected from one station in borrow area E and one in the Fenwick North borrow area. Bottom water was collected with a decontaminated Van Dorn design horizontal water bottle suspended approximately 1-meter off ocean bottom. Additionally, one equipment blank sample was prepared during the field collections by rinsing sample processing tools (e.g., stainless steel bowls and spoons) that came in contact with the sediments with laboratory grade water and analyzing the water for the suite of contaminants included in the study.

[2] NJDEP 1997. The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters. 55pp. plus Appendices.

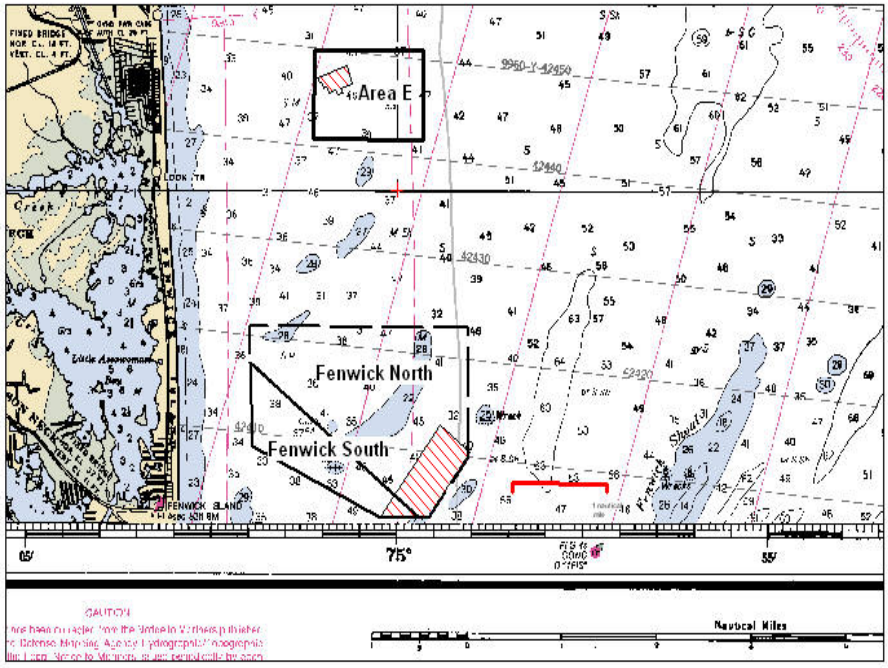
Water sample results were compared to marine water quality criteria (Delaware Water Quality for Protection of Aquatic Life). All sediment and water samples were stored a 4C° after initial collection. Sample containers were promptly shipped following collection to the contract laboratories performing chemical analysis. Lancaster Laboratories in Lancaster, PA performed all chemical analyses.

Two methods of sediment grain-size analysis were performed. The first was based on the method used for benthic borrow studies as specified in ASTM D422-63 and was used for the contaminant testing. Sieve sizes ranged from 4.75 (U.S. Standard Sieve No. 4) to 63μm (U.S. Standard Sieve No. 230). Sediments were categorized by Wentworth's classifications (Table 2-2). Total organic content (TOC) was measured by weight loss upon ignition at 500 °C for 4 hours. Sediment curves were produced based on Table 2-2 size categories. Samples processed using this procedure were EVC-1 to EVC-5 (two layers per station) and FVC-1 to FVC-13 (two layers per station) for a total of 36 sediment samples.

The second method also followed those described in ASTM D422 but a different series of sieves based on geotechnical needs were used. After sample collection, geotechnical engineers from the USACE Philadelphia District reviewed the coring logs to determine which cores had adequate retrieval to warrant geotechnical grain size analysis. The sieve nest used in this effort consisted of the following sieves: Nos. 4, 10, 20, 30, 40, 50, 70, 100, 140, 170 and 200 and sediment curves were based on these size classes. Grain size at D_{60}, D_{30}, and D_{10} and the sediment coefficients C_c and C_u were calculated as per the ASTM method. This analysis was performed on a total of 13 stations.

Cores from stations FVC-1, FVC-2, and FVC-9 had two distinct layers so a total of 16 samples were processed for this geotechnical survey. Cores from stations EVC-1, EVC-3, EVC-5, FVC-5, and FVC-8 were excluded from the geotechnical analysis because insufficient material was retrieved by the core. The hydrometer analysis was not performed for either analysis type.

FENWICK ISLAND AND BETHANY BEACH PROPOSED SAND BORROW AREAS



Areas Previously Dredged By Delaware DNREC

*Note: Area E and Fenwick North Lie Within A Historic Anti-Aircraft Artillery Target Range

Figure 2-1. General location of borrow sites E, Fenwick North, and Fenwick South

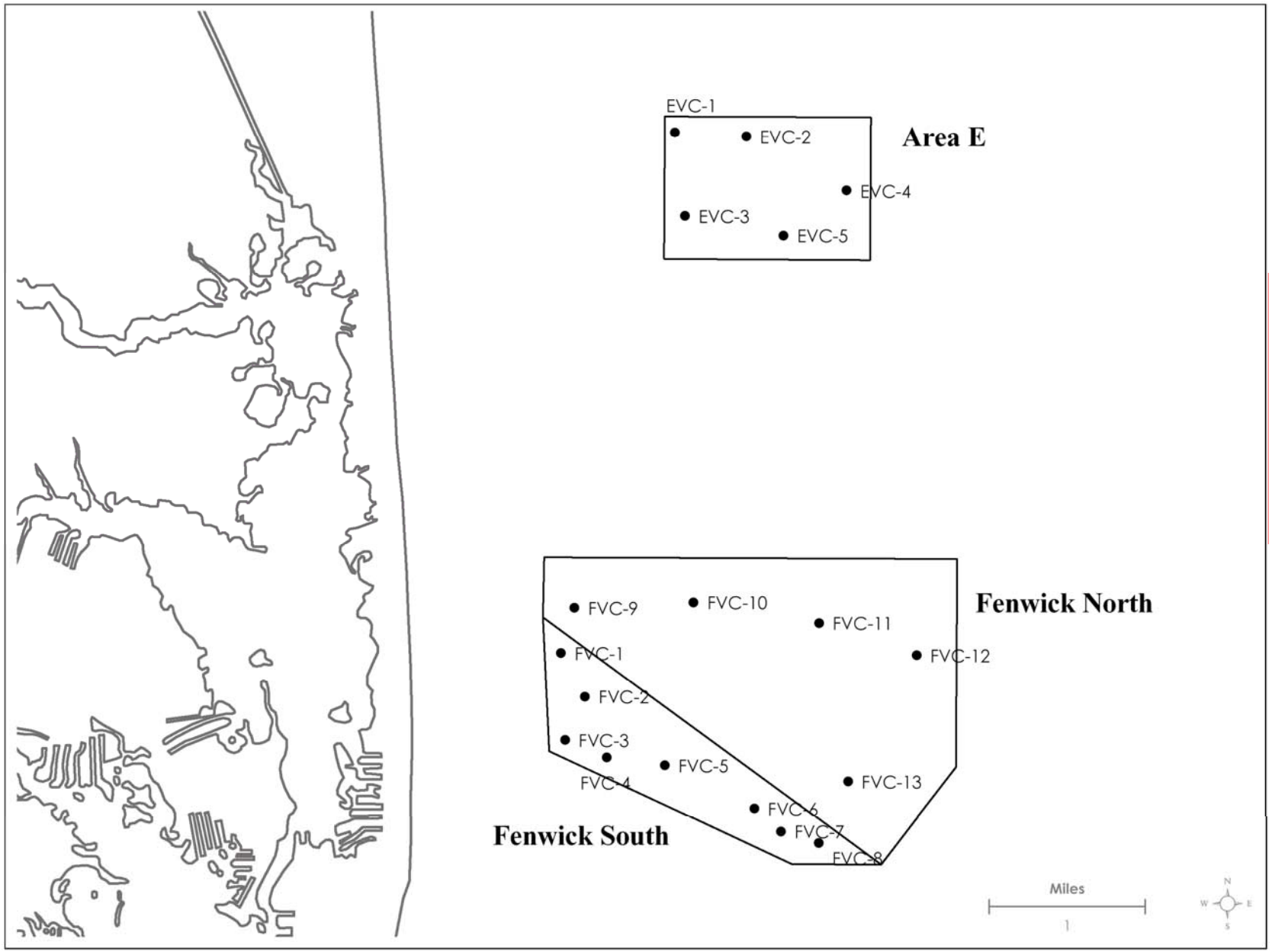


Figure 2-2. Map of the sediment cores locations within borrow sites E, Fenwick North, and Fenwick South

Table 2-1. Vibracore station locations at Fenwick Island borrow sites sampled in February 2004.

Borrow Area	Station	Longitude		Latitude	
		Degrees	Minutes	Degrees	Minutes
E	EVC-1	-75	1.0578	38	31.1754
	EVC-2	-75	0.5507	38	31.1542
	EVC-3	-75	0.9877	38	30.7096
	EVC-4	-74	59.8355	38	30.8514
	EVC-5	-75	0.2867	38	30.6018
Fenwick South	FVC-1	-75	1.8720	38	28.2630
	FVC-2	-75	1.6990	38	28.0190
	FVC-3	-75	1.8420	38	27.7750
	FVC-4	-75	1.5430	38	27.6780
	FVC-5	-75	1.1310	38	27.6340
	FVC-6	-75	0.4930	38	27.3920
	FVC-7	-75	0.3070	38	27.2620
	FVC-8	-75	0.0370	38	27.1990
Fenwick North	FVC-9	-75	1.7740	38	28.5150
	FVC-10	-75	0.9260	38	28.5450
	FVC-11	-75	0.3090	38	28.4290
	FVC-12	-74	59.3370	38	28.2500
	FVC-13	-74	59.8237	38	27.5424

Table 2-2. Sieve sizes used for sediment particle distribution and the Wentworth sediment size categories (Buchanan 1984)

Sieve Number	Sieve Size	Wentworth Size Category
4	4.75-mm	Pebble
10	2.00-mm	Granule
20	850-μm	Very Coarse Sand
40	425-μm	Coarse Sand
60	250-μm	Medium Sand
140	106-μm	Fine Sand
200	75-μm	Undefined
230	63-μm	Very Fine Sand
	< 63-μm	Silt-Clay

Table 2-3. Target analyte list and corresponding contract detection limits for inorganics

Parameter	Method (water)	Method (soil)	Detection Limits	
			Water (µg/L)	Soil (mg/Kg)
Aluminum	200.7	SW-846 6010A	200	40
Antimony	200.7	SW-846 6010A	60	12
Arsenic	200.7	SW-846 6010A	10	2
Barium	200.7	SW-846 6010A	200	40
Beryllium	200.7	SW-846 6010A	5	1
Cadmium	200.7	SW-846 6010A	5	1
Calcium	200.7	SW-846 6010A	5000	1000
Chromium	200.7	SW-846 6010A	10	2
Cobalt	200.7	SW-846 6010A	50	10
Copper	200.7	SW-846 6010A	25	5
Iron	200.7	SW-846 6010A	100	20
Lead	200.7	SW-846 6010A	3	0.6
Magnesium	200.7	SW-846 6010A	5000	1000
Manganese	200.7	SW-846 6010A	15	3
Mercury	245.1	SW-846 7471	0.2	0.1
Nickel	200.7	SW-846 6010A	40	8
Potassium	200.7	SW-846 6010A	5000	1000
Selenium	200.7	SW-846 6010A	5	1
Silver	200.7	SW-846 6010A	10	2
Sodium	NA	SW-846 6010A	5000	1000
Thallium	200.7	SW-846 6010A	10	2
Vanadium	200.7	SW-846 6010A	50	10
Zinc	200.7	SW-846 6010A	20	4

Table 2-4. Target compound list and corresponding contract required detection limits for semivolatile organics

Parameter	Method	Detection Limits	
		Water (µg/L)	Soil (µg/Kg)
Phenol	SW-846 2870	10	660
bis(2-Chloroethyl) ether	SW-846 2870	10	660
2-Chlorophenol	SW-846 2870	10	660
1,3-Dichlorobenzene	SW-846 2870	10	660
1,4-Dichlorobenzene	SW-846 2870	10	660
1,2-Dichlorobenzene	SW-846 2870	10	660
2-Methylphenol	SW-846 2870	10	660
2,2'-oxybis(1-Chloropropane)	SW-846 2870	10	660
4-Methylphenol	SW-846 2870	10	660
N-Nitroso-di-n-propylamine	SW-846 2870	10	660
Hexachloroethane	SW-846 2870	10	660
Nitrobenzene	SW-846 2870	10	660
Isophorone	SW-846 2870	10	660
2-Nitrophenol	SW-846 2870	10	660
2,4-Dimethylphenol	SW-846 2870	10	660
bis(2-Chloroethoxy) methane	SW-846 2870	10	660
2,4-Dichlorophenol	SW-846 2870	10	660
1,2,4-Trichlorobenzene	SW-846 2870	10	660
Naphthalene	SW-846 2870	10	660
4-Chloroaniline	SW-846 2870	20	1300
Hexachlorobutadiene	SW-846 2870	10	660
4-Chloro-3-methylphenol	SW-846 2870	20	1300
2-Methylnaphthalene	SW-846 2870	10	660
Hexachlorocyclopentadiene	SW-846 2870	10	660
2,4,6-Trichlorophenol	SW-846 2870	10	660
2,4,5-Trichlorophenol	SW-846 2870	10	660
2-Chloronapthalene	SW-846 2870	10	660
2-Nitroaniline	SW-846 2870	50	3300
Dimethylphthalate	SW-846 2870	10	660
Acenaphthylene	SW-846 2870	10	660
2,6-Dinitrotoluene	SW-846 2870	10	660
3-Nitroaniline	SW-846 2870	50	3300
2,4-Dinitrophenol	SW-846 2870	50	3300
4-Nitrophenol	SW-846 2870	50	3300
Dibenzofuran	SW-846 2870	10	660
2,4-Dinitrotoluene	SW-846 2870	10	660
Diethylphthalate	SW-846 2870	10	660

Table 2-4. (Continued)

Parameter	Method	Detection Limits	
		Water (µg/L)	Soil (µg/Kg)
4-Chlorophenyl-phenylether	SW-846 2870	10	660
Fluorene	SW-846 2870	10	660
4-Nitroaniline	SW-846 2870	20	830
4,6-Dinitro-2-methylphenol	SW-846 2870	50	3300
N-Nitrosodiphenylamine	SW-846 2870	10	660
4-Bromophenylphenylether	SW-846 2870	10	660
Hexachlorobenzene	SW-846 2870	10	660
Pentachlorophenol	SW-846 2870	50	3300
Phenanthrene	SW-846 2870	10	660
Anthracene	SW-846 2870	10	660
Carbazole	SW-846 2870	10	330
Di-n-butylphthalate	SW-846 2870	10	330
Fluoranthene	SW-846 2870	10	660
Pyrene	SW-846 2870	10	660
Butylbenzylphthalate	SW-846 2870	10	660
3,3'-Dichlorobenzidine	SW-846 2870	20	1300
Benzo(a)anthracene	SW-846 2870	10	660
Chrysene	SW-846 2870	10	660
bis-(2-Ethylhexyl)phthalate	SW-846 2870	10	660
Di-n-octylphthalate	SW-846 2870	10	660
Benzo(b)fluoranthene	SW-846 2870	10	660
Benzo(k)fluoranthene	SW-846 2870	10	660
Benzo(a)pyrene	SW-846 2870	10	660
Indeno(1,2,3-cd)pyrene	SW-846 2870	10	660
Dibenzo(a,h)anthracene	SW-846 2870	10	660
Benzo(g,h,i)perylene	SW-846 2870	10	660

Table 2-5. Target compound list and corresponding contract required detection limits for pesticides and PCBs

Parameter	Method	Detection Limits	
		Water (µg/L)	Soil (µg/Kg)
alpha-BHC	SW-846 8081A	0.05	1.9
beta-BHC	SW-846 8081A	0.05	3.3
delta-BHC	SW-846 8081A	0.05	1.7
gamma-BHC (Lindane)	SW-846 8081A	0.05	2
Heptachlor	SW-846 8081A	0.05	2.1
Aldrin	SW-846 8081A	0.05	2
Heptachlorepoxide	SW-846 8081A	0.05	2.1
Endosulfan I	SW-846 8081A	0.05	2.1
Dieldrin	SW-846 8081A	0.10	3.3
4,4'-DDE	SW-846 8081A	0.10	4.2
Endrin	SW-846 8081A	0.10	3.6
Endosulfan II	SW-846 8081A	0.10	3.3
4,4'-DDD	SW-846 8081A	0.10	4.2
Endosulfan sulfate	SW-846 8081A	0.10	3.6
4,4'-DDT	SW-846 8081A	0.10	3.6
Methoxychlor	SW-846 8081A	0.50	17
Endrin ketone	SW-846 8081A	0.10	3.3
Endrin aldehyde	SW-846 8081A	0.10	3.3
alpha-Chlordane	SW-846 8081A	0.05	1.7
gamma-Chlordane	SW-846 8081A	0.05	1.7
Toxaphene	SW-846 8081A	5.0	170
Aroclor-1016	SW-846 8082	1.0	33
Aroclor-1221	SW-846 8082	2.0	67
Aroclor-1232	SW-846 8082	1.0	33
Aroclor-1242	SW-846 8082	1.0	33
Aroclor-1248	SW-846 8082	1.0	33
Aroclor-1254	SW-846 8082	1.0	33
Aroclor-1260	SW-846 8082	1.0	33

3.0 RESULTS

3.1 SEDIMENT CONTAMINATION

The results of the bulk sediment testing for inorganics at the three borrow sites revealed that most of the parameters were below Delaware's Uniform Risk-Based Remediation Standards (URS). However, three parameters (aluminum, iron, and arsenic) were over the soil cleanup criteria for non-critical water resource areas. At borrow site E, arsenic exceeded the unrestricted use standard in the top and bottom portion of all samples but EVC-1 (Table 3-1). At the Fenwick North borrow site, arsenic levels were over the 0.43 mg/kg unrestricted risk-based level in all top and bottom core samples. Also, arsenic concentrations in the bottom composite for cores FVC-11 and FVC-12 were over the higher restricted use criterion of 3.8 mg/kg (Table 3-2). Core FVC-9 taken in the Fenwick North Borrow site resulted in aluminum concentrations over the 7,800 mg/kg unrestricted criterion in the top and bottom composites. Most of the Fenwick North cores resulted in iron concentrations over the unrestricted use criterion with the exception of the top portion of FVC-10 and FVC-13 (Table 3-2). Among the eight cores collected in the Fenwick South borrow site, the same three inorganic parameters were over risk-based standards in about the same frequency as Fenwick North (Table 3-3). Aluminum was over the unrestricted level in the bottom composite of cores FVC-1, FVC-2, and FVC-4 while arsenic was over its unrestricted level in all core composites. Similarly, iron concentration was over the unrestricted criterion of 2,300 mg/kg in all but a few composites. Comparison of the inorganic results to the NOAA sediment guidelines showed that all concentrations were below ER-L and ER-M values suggesting that the borrow site sediments are not currently toxic to aquatic organisms.

Either non-detections or low concentrations were observed for the analyses of semivolatile organics, pesticides, and PCBs (Tables 3-4 through 3-6). In most cases, these parameters were not detected in the bulk sediment tests. However, very low concentrations of bis 1,2-Ethylhexylphthalate (FVC-1 top-350 μg/kg) and gamma chlordane (FVC-2 top, FVC-3 bottom, and FVC-5 bottom from 0.71 μg/kg - 3.7 μg/kg) were detected. No values detected for the semivioatiles, and organic pesticides were above Delaware Uniform Risk-Based Remediation Standards for non-critical water resource areas and most were below the NOAA sediment guidelines for the protection of aquatic organisms (detection limits were consistently below criteria with a few exceptions). However, low level detections of the PCB aroclors 1254 and 1260 were observed in all three borrow sites in 8 out of 36 samples (EVC-2 top and bottom, EVC-4 top and bottom, FVC-3 bottom, FVC-5 top, FVC-8 top, FVC-9 bottom, and FVC-11 top). The detected aroclor concentrations varied from 4.7 μg/kg to 40 μg/kg, which exceeded the ER-L concentration (22 μg/kg) for total PCBs when they were summed-up per sample, and in one case, exceeded the ER-L for one individual arochlor detection. Most of these results were flagged (J) by the analytical lab indicating that the reported values was below the MDL for the instrument. Some sample material remained from the grain size samples for

core EVC-2 (bottom). This material came from the core section that had the highest non-flagged aroclor 1254 and 1260 detections in the original test. This sample was re-analyzed by the contract laboratory and the result was non-detect for PCBs suggesting that the original PCB hit may have been a lab error or that a PCB hot spot in the homogenized bowl was sub-sampled in the original collection. Sample FVC-8 (top) that had a high flagged aroclor 1254 and 1260 result in the original test was also reanalyzed and the second result was non-detect. As an additional check, FVC-4 (top) was re-analyzed and the result was non-detect for both tests.

Laboratory analysis certificates for the chemical testing are presented in Appendix A.

3.2 BOTTOM WATER CONTAMINATION

Organic and inorganic testing of the bottom water samples taken at two of the three potential borrow sites indicated that, with the exception of silver, all concentrations were below Delaware's acute and chronic marine water quality criteria (Tables 3-7 and 3-8).

3.3 GRAIN SIZE COMPOSITION

The core logs for sediments collected in the field are presented in Appendix B. Sediment grain size graphs for the two different processing methods are provided in Appendix C for the contaminant samples and Appendix D for the geotechnical samples. Tables with percent size category, D_{60}, D_{30}, and D_{10} and the sediment coefficients C_c and C_u are provided with the geotechnical graphs. Percentages of TOC, silt/clay, sand, and gravel for the contaminant samples are provided in Table 3-9.

The sediments collected for the contaminant study consisted mainly of sands and contained very little silt/clay particles. Only one station and layer (Station FVC-4, 1-4.0 ft) contained a silt/clay percentage above 10% (Table 3-9). Gravel sized particles were evident in several samples/layers including EVC-2, 0-1 ft (26.02%), FVC-4, 0-1 and 1-4.0 ft (43.66 and 15.47%), FVC-11, 0-1 ft (49%) and FVC-12, 1-4.0 ft (10.14%). Total organic carbon (TOC) in the samples was also low ranging from a high of 2.6% at FVC-9, 1-5.0 ft to a low of 0.23% at EVC-5, 0-1 ft (Table 3-9). Only three stations had a percent TOC above 1% (FVC-1, 1-5.7 ft, FVC-5, 1-3.3 ft and FVC-9, 1-5.0 ft).

Six of the 16 samples processed using the geotechnical method contained silt/clay (U.S. Sieve No. 200) percentages above 5% but none of these contained percentages over 10%. These samples included FVC-2, 5-6 ft (6.6%), FVC-3, 0-5 ft (6.3%), FVC-7, 0-5 ft (6.95%), FVC-9, 0-5 ft (7.41%), FVC-9, 5-6 ft (7.01%), and FVC-12, 0-1 ft (6.34%, Appendix D). All of these samples were classified as poorly graded sands with silts. The

other 10 stations contained silt/clay percentages below 5% and were classified as poorly graded sands based on the sediment coefficients. None of the 16 samples collected contained gravel sized particles (Appendix D).

Table 3-1. Results of inorganic sediment testing at the Fenwick Island borrow site E in February 2004

Analysis Name	Units	EVC-1		EVC-2		EVC-3		EVC-4		EVC-5		ERL	ERM	URS Non critical water	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom			Unrestricted	Restricted
Aluminum	mg/kg	5,660	7,790	1,630	6,630	1,300	1,150	1,210	1,540	798	731			7,800	200,000
Antimony	mg/kg	< 0.75	< 0.75	< 0.77	< 0.75	< 0.74	< 0.76	< 0.77	< 0.77	< 0.77	< 0.74			3.10	82.00
Arsenic	mg/kg	< 0.57	< 0.57	1.16	J 0.63	J 0.97	J 0.65	2.25	J 1.08	1.80	1.30	8.20	70.00	0.43	3.80
Barium	mg/kg	1.65	5.94	2.19	6.80	1.41	1.37	1.49	2.16	1.14	0.89			550	14,000
Beryllium	mg/kg	J 0.11	J 0.21	< 0.07	J 0.18	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07			16.00	410.00
Cadmium	mg/kg	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	1.20	9.60		
Calcium	mg/kg	157	142	397	241	183	185	543	615	383	882				
Chromium	mg/kg	4.94	5.76	3.33	7.55	2.19	1.98	2.63	3.27	1.97	1.52	81.00	370.00	270	610
Cobalt	mg/kg	J 0.33	J 0.42	J 0.54	0.61	J 0.51	J 0.31	0.90	0.85	0.64	0.75			470	12,000
Copper	mg/kg	J 0.49	6.46	J 1.12	J 1.04	J 0.45	J 0.44	J 0.49	J 0.63	J 0.41	J 0.48	34.00	270.00	310	8,200
Iron	mg/kg	1,120	1,300	1,530	1,890	1,440	1,120	2,100	1,800	1,320	1,410			2,300	61,000
Lead	mg/kg	J 1.40	J 1.30	J 2.00	J 1.59	J 1.27	J 1.05	J 1.76	J 1.57	J 1.17	J 1.19	46.70	218.00	400	1,000
Magnesium	mg/kg	345	309	514	618	323	325	437	558	370	315				
Manganese	mg/kg	5.58	4.39	12.00	11.40	14.90	6.12	18.20	12.20	25.30	6.80			160	4,100
Mercury	mg/kg	< 0.003	< 0.003	J 0.004	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	0.15	0.71	10	610
Nickel	mg/kg	1.45	1.62	1.35	2.81	J 1.07	J 1.03	1.17	1.51	J 0.94	J 0.90	20.90	51.60	160	4,100
Potassium	mg/kg	190	195	253	427	146	144	184	252	138	122				
Selenium	mg/kg	< 0.53	< 0.53	< 0.55	J 0.59	< 0.53	< 0.54	< 0.55	< 0.55	< 0.55	< 0.53			39	1,000
Silver	mg/kg	< 0.17	< 0.17	< 0.17	< 0.17	< 0.17	< 0.17	< 0.18	< 0.17	< 0.18	< 0.17	1.00	3.70	39	1,000
Sodium	mg/kg	1,780	1,600	2,080	2,140	1,620	1,770	1,840	1,970	2,130	1,650				
Thallium	mg/kg	< 1.06	< 1.05	< 1.08	< 1.06	< 1.05	< 1.06	< 1.09	< 1.08	< 1.09	< 1.05			18	220
Vanadium	mg/kg	3.83	4.11	5.20	7.22	4.57	3.67	5.53	5.47	4.19	4.82			55	1,400
Zinc	mg/kg	5.61	5.43	7.20	7.75	4.53	3.49	6.93	6.41	4.70	4.30	150.00	410.00	2,300	61,000
Moisture	%	13.60	13.40	15.40	15.30	13.60	14.30	14.50	13.90	15.40	14.70				
Oil & Grease	mg/kg	< 498	< 497	< 508	< 508	< 498	< 502	J 522	< 499	< 508	< 504				
pH	Std. Units	8.30	8.00	8.60	8.50	8.60	8.60	8.50	8.60	8.40	8.80				mg/kg

= Exceeds URS restricted criteria

= Exceeds URS unrestricted criteria

Table 3-2. Results of inorganic sediment testing at the Fenwick North borrow site in February 2004

Analysis Name	Units	FVC-9		FVC-10		FVC-11		FVC-12		FVC-13		ERL	ERM	URS Non Critical Water	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom			Unrestricted	Restricted
Aluminum	mg/kg	12,700	21,300	1,200	4,280	2,080	15,600	3,930	12,500	930	3,910			7,800	200,000
Antimony	mg/kg	< 0.75	< 0.81	< 0.75	< 0.74	< 0.75	< 0.81	< 0.79	< 0.80	< 0.74	< 0.75			3.10	82.00
Arsenic	mg/kg	1.55	J 0.92	J 1.05	1.27	J 1.05	3.96	2.94	4.98	J 1.00	3.63	8.20	70.00	0.43	3.80
Barium	mg/kg	5.71	15.40	1.97	5.92	3.72	38.00	8.46	27.50	1.40	6.01			550	14,000
Beryllium	mg/kg	J 0.23	J 0.50	J 0.07	J 0.16	J 0.11	0.70	J 0.20	0.82	< 0.07	J 0.19			16.00	410.00
Cadmium	mg/kg	J 0.09	< 0.07	< 0.06	< 0.06	< 0.06	J 0.27	J 0.22	J 0.24	< 0.06	J 0.08	1.20	9.60		
Calcium	mg/kg	474	253	265	401	669	1,600	2,300	929	331	949				
Chromium	mg/kg	11.10	16.10	2.58	5.78	4.36	26.10	9.92	19.50	2.24	7.14	81.00	370.00	270	610
Cobalt	mg/kg	1.16	1.76	J 0.54	1.61	1.30	6.61	2.35	6.65	J 0.55	2.27			470	12,000
Copper	mg/kg	2.31	3.41	J 0.92	J 0.98	1.31	12.10	3.97	9.44	J 0.68	1.86	34.00	270.00	310	8,200
Iron	mg/kg	3,720	3,740	1,710	2,620	2,360	13,100	5,250	14,000	1,620	4,870			2,300	61,000
Lead	mg/kg	3.68	4.54	J 1.62	J 1.58	J 1.32	5.60	5.68	5.87	J 1.33	2.43	46.70	218.00	400	1,000
Magnesium	mg/kg	903	1,020	429	704	821	4,480	1,600	4,140	419	1,170				
Manganese	mg/kg	21.30	17.30	9.95	20.10	21.00	126.00	56.50	129.00	8.33	48.00			160	4,100
Mercury	mg/kg	J 0.006	< 0.003	J 0.005	< 0.003	< 0.003	< 0.003	J 0.032	< 0.003	< 0.003	< 0.003	0.15	0.71	10	610
Nickel	mg/kg	4.65	6.01	J 1.12	2.77	2.74	16.80	5.44	14.90	J 1.08	4.57	20.90	51.60	160	4,100
Potassium	mg/kg	627	730	216	429	398	2,450	855	2,260	189	633				
Selenium	mg/kg	< 0.54	< 0.58	< 0.53	< 0.53	< 0.53	< 0.58	< 0.56	< 0.57	< 0.52	< 0.53			39	1,000
Silver	mg/kg	< 0.17	< 0.18	< 0.17	< 0.17	< 0.17	< 0.18	< 0.18	< 0.18	< 0.17	< 0.17	1.00	3.70	39	1,000
Sodium	mg/kg	2,090	2,730	1,780	1,850	2,320	3,150	2,460	3,080	1,820	2,070				
Thallium	mg/kg	< 1.06	< 1.14	< 1.05	< 1.05	< 1.06	< 1.14	< 1.12	< 1.12	< 1.03	< 1.05			18	220
Vanadium	mg/kg	14.00	16.60	5.71	9.68	6.86	38.80	11.90	24.80	5.23	11.00			55	1,400
Zinc	mg/kg	15.40	18.90	5.43	7.97	8.83	39.40	24.50	39.90	5.02	13.70	150.00	410.00	2,300	61,000
Moisture	%	13.20	19.00	13.50	13.90	14.50	18.50	17.50	17.20	13.60	13.10				
Oil & Grease	mg/kg	< 495	< 531	< 497	< 499	J 889	< 528	2,060	< 519	< 498	< 495				
pH	Std. Units	8.60	8.40	8.60	8.20	8.50	8.40	8.40	8.30	8.50	8.40				mg/kg

= Exceeds URS restricted criteria

= Exceeds URS unrestricted criteria

Table 3-3. Results of inorganic sediment testing at the Fenwick South borrow site in February 2004

Analysis Name	Units	FVC-1		FVC-2		FVC-3		FVC-4		FVC-5	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Aluminum	mg/kg	3,520	11,400	1,960	12,500	1,200	7,570	1,580	8,340	1,310	7,270
Antimony	mg/kg	< 0.77	< 0.78	< 0.75	< 0.79	< 0.73	< 0.79	< 0.75	< 0.75	< 0.72	< 0.76
Arsenic	mg/kg	1.60	J 0.67	2.83	J 0.84	< 0.55	J 0.95	1.35	1.68	1.76	3.01
Barium	mg/kg	6.85	8.50	2.19	11.30	2.21	31.80	12.10	15.40	1.75	33.10
Beryllium	mg/kg	J 0.14	J 0.16	J 0.09	J 0.28	< 0.07	J 0.13	J 0.08	J 0.26	< 0.06	J 0.37
Cadmium	mg/kg	< 0.06	< 0.06	J 0.07	< 0.06	< 0.06	J 0.07	< 0.06	< 0.06	< 0.06	< 0.06
Calcium	mg/kg	396	181	266	295	1,130	445	535	564	565	820
Chromium	mg/kg	6.79	7.62	2.84	10.60	2.18	7.68	2.84	12.70	2.55	13.50
Cobalt	mg/kg	1.49	0.68	0.80	1.33	0.60	2.01	0.75	3.04	0.61	6.83
Copper	mg/kg	2.05	1.30	1.30	2.31	J 0.73	2.73	J 0.76	4.65	J 0.72	3.65
Iron	mg/kg	3,850	2,090	2,680	3,310	1,240	3,230	2,410	5,920	2,310	5,410
Lead	mg/kg	J 2.32	2.70	J 2.06	3.22	J 1.10	J 1.98	J 1.14	3.59	J 1.60	2.72
Magnesium	mg/kg	1,010	490	445	949	403	1,070	462	1,930	405	1,720
Manganese	mg/kg	24.60	9.83	25.10	23.10	9.72	27.50	9.94	47.00	16.20	49.60
Mercury	mg/kg	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	J 0.009	J 0.006	J 0.006
Nickel	mg/kg	3.22	3.24	1.43	4.50	1.39	4.81	1.16	6.44	J 1.07	11.20
Potassium	mg/kg	624	324	215	571	205	573	228	1,210	186	983
Selenium	mg/kg	< 0.55	< 0.55	< 0.53	< 0.56	< 0.52	< 0.56	< 0.53	< 0.53	< 0.51	< 0.54
Silver	mg/kg	< 0.18	< 0.18	< 0.17	J 0.29	< 0.17	< 0.18	< 0.17	< 0.17	< 0.16	< 0.17
Sodium	mg/kg	2,250	1,880	1,880	2,240	1,730	1,980	1,640	2,220	1,620	2,260
Thallium	mg/kg	< 1.08	< 1.10	< 1.05	< 1.11	< 1.03	< 1.12	< 1.05	< 1.06	< 1.02	< 1.07
Vanadium	mg/kg	11.90	9.28	7.46	19.10	4.24	10.40	5.64	16.50	6.40	20.00
Zinc	mg/kg	11.50	7.56	8.84	13.20	4.07	13.60	4.92	22.30	6.44	27.60
Moisture	%	15.80	16.00	14.20	16.30	12.30	17.50	13.10	13.60	10.20	15.60
Oil & Grease	mg/kg	< 511	< 512	< 501	< 514	< 490	1,670	< 495	< 498	< 479	< 509
pH	Std. Unit	8.40	8.20	8.50	8.20	8.30	8.20	8.50	8.50	8.70	8.50
	= Exceeds URS restricted criteria										
	= Exceeds URS unrestricted criteria										

Table 3-3a. (Continued)

Analysis Name	Units	FVC-6		FVC-7		FVC-8		ERL	ERM	URL Non Critical Water	
		Top	Bottom	Top	Bottom	Top	Bottom			Unrestricted	Restricted
Aluminum	mg/kg	2,910	4,200	2,510	5,870	1,290	1,970			7,800	200,000
Antimony	mg/kg	< 0.78	< 0.78	< 0.77	< 0.78	< 0.76	< 0.75			3.10	82.00
Arsenic	mg/kg	2.43	J 0.93	1.61	3.41	J 1.15	1.17	8.20	70.00	0.43	3.80
Barium	mg/kg	6.43	7.99	5.00	9.01	1.66	2.60			550	14,000
Beryllium	mg/kg	J 0.16	J 0.37	J 0.13	J 0.34	< 0.07	< 0.07			16.00	410.00
Cadmium	mg/kg	J 0.13	< 0.06	J 0.13	J 0.15	< 0.06	< 0.06	1.20	9.60		
Calcium	mg/kg	18,400	662	3,670	923	692	719				
Chromium	mg/kg	6.63	7.50	5.43	9.93	3.06	3.92	81.00	370.00	270	610
Cobalt	mg/kg	1.61	3.14	1.22	5.17	0.75	1.00			470	12,000
Copper	mg/kg	2.85	2.08	1.24	3.73	J 0.56	J 0.62	34.00	270.00	310	8,200
Iron	mg/kg	4,830	4,500	3,080	5,850	1,880	2,520			2,300	61,000
Lead	mg/kg	4.45	2.50	J 2.20	3.10	J 1.64	J 1.21	46.70	218.00	400	1,000
Magnesium	mg/kg	1,070	1,310	1,110	1,780	498	667				
Manganese	mg/kg	38.00	39.30	25.80	68.20	11.10	13.80			160	4,100
Mercury	mg/kg	J 0.011	J 0.005	< 0.003	< 0.003	< 0.003	< 0.003	0.15	0.71	10	610
Nickel	mg/kg	3.69	6.04	2.72	8.97	1.17	1.71	20.90	51.60	160	4,100
Potassium	mg/kg	566	695	506	898	217	317				
Selenium	mg/kg	J 0.74	< 0.56	< 0.55	< 0.55	< 0.54	< 0.53			39	1,000
Silver	mg/kg	< 0.18	< 0.18	< 0.18	< 0.18	< 0.17	< 0.17	1.00	3.70	39	1,000
Sodium	mg/kg	2,920	2,300	2,440	2,280	2,090	1,980				
Thallium	mg/kg	< 1.11	< 1.11	< 1.08	< 1.10	< 1.07	< 1.06			18	220
Vanadium	mg/kg	12.60	11.60	7.90	14.80	5.22	6.71			55	1,400
Zinc	mg/kg	19.10	26.50	9.92	25.20	6.32	6.26	150.00	410.00	2,300	61,000
Moisture	%	17.50	18.30	16.60	16.80	14.80	13.70				
Oil & Grease	mg/kg	< 521	J 961	< 516	< 517	< 505	< 498				
pH	Std. Units	8.50	8.40	8.40	8.20	8.60	8.60				mg/kg
	= Exceeds URS restricted criteria										
	= Exceeds URS unrestricted criteria										

Table 3-4. Results of organic sediment testing at the Fenwick Island borrow site E in February 2004

Analysis Name	Units	EVC-1		EVC-2		EVC-3		EVC-4		EVC-5		ERL	ERM	URS Non critical water	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom			Restricted	Unrestricted
1,2,4-Trichlorobenzene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			78,000	2,000,000
1,2-Dichlorobenzene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			560,000	5,000,000
1,3-Dichlorobenzene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			230,000	5,000,000
1,4-Dichlorobenzene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			27,000	240,000
2,2'-oxybis(1-Chloropropane)	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39				
2,4,5-Trichlorophenol	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			780,000	5,000,000
2,4,6-Trichlorophenol	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			58,000	520,000
2,4-Dichlorophenol	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			23,000	610,000
2,4-Dimethylphenol	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			160,000	4,100,000
2,4-Dinitrophenol	µg/kg	< 770	< 770	< 790	< 790	< 770	< 780	< 780	< 770	< 790	< 780			16,000	410,000
2,4-Dinitrotoluene	µg/kg	< 77	< 77	< 79	< 79	< 77	< 78	< 78	< 77	< 79	< 78			16,000	410,000
2,6-Dinitrotoluene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			7,800	200,000
2-Chloronaphthalene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39				
2-Chlorophenol	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			39,000	1,000,000
2-Methylnaphthalene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			160,000	4,100,000
2-Methylphenol	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39	70	670	390,000	5,000,000
2-Nitroaniline	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			470	12,000
2-Nitrophenol	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39				
3,3'-Dichlorobenzidine	µg/kg	< 77	< 77	< 79	< 79	< 77	< 78	< 78	< 77	< 79	< 78			1,400	13,000
3-Nitroaniline	µg/kg	< 77	< 77	< 79	< 79	< 77	< 78	< 78	< 77	< 79	< 78				
4,6-Dinitro-2-methylphenol	µg/kg	< 190	< 190	< 200	< 200	< 190	< 190	< 190	< 190	< 200	< 200			80	2,000
4-Bromophenyl-phenylether	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39				
4-Chloro-3-methylphenol	µg/kg	< 77	< 77	< 79	< 79	< 77	< 78	< 78	< 77	< 79	< 78				
4-Chloroaniline	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			31,000	820,000
4-Chlorophenyl-phenylether	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39				
4-Methylphenol	µg/kg	< 77	< 77	< 79	< 79	< 77	< 78	< 78	< 77	< 79	< 78			39,000	5,000,000
4-Nitroaniline	µg/kg	< 77	< 77	< 79	< 79	< 77	< 78	< 78	< 77	< 79	< 78				
4-Nitrophenol	µg/kg	< 190	< 190	< 200	< 200	< 190	< 190	< 190	< 190	< 200	< 200			63,000	1,600,000
Acenaphthene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39	16	500	470,000	5,000,000
Acenaphthylene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39	44	640		
Aldrin	µg/kg	< 0.59	< 0.59	< 0.60	< 0.60	< 0.59	< 0.60	< 0.60	< 0.59	< 0.60	< 0.60			40	340
Alpha BHC	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20			100	910
Alpha Chlordane	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20				
Anthracene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39	85.30	1100	1,000,000	5,000,000

Table 3-4. (Continued)

Analysis Name	Units	EVC-1		EVC-2		EVC-3		EVC-4		EVC-5		ERL	ERM	URS Non critical water	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom			Restricted	Unrestricted
Benzo(a)anthracene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39	261	1600	880	7,800
Benzo(a)pyrene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39	430	1600	90	780
Benzo(b)fluoranthene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			880	7,800
Benzo(g,h,I)perylene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39				
Benzo(k)fluoranthene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			8,800	78,000
Beta BHC	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20			350	3,200
bis(2-Chloroethoxy)methane	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39				
bis(2-Chloroethyl)ether	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			200	5,200
bis(2-Ethylhexyl)phthalate	µg/kg	< 190	< 190	< 200	< 200	< 190	< 190	< 190	< 190	< 200	< 200			46,000	410,000
Butylbenzylphthalate	µg/kg	< 77	< 77	< 79	< 79	< 77	< 78	< 78	< 77	< 79	< 78			930,000	5,000,000
Carbazole	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			32,000	290,000
Chrysene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39	384	2800	87,000	780,000
Delta BHC	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20				
Dibenz(a,h)anthracene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39	63.40	260	90	780
Dibenzofuran	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			31,000	820,000
Dieldrin	µg/kg	< 0.38	< 0.38	< 0.39	< 0.39	< 0.38	< 0.39	< 0.39	< 0.38	< 0.39	< 0.39			40	360
Diethylphthalate	µg/kg	< 77	< 77	< 79	< 79	< 77	< 78	< 78	< 77	< 79	< 78			1,000,000	5,000,000
Dimethylphthalate	µg/kg	< 77	< 77	< 79	< 79	< 77	< 78	< 78	< 77	< 79	< 78			1,000,000	5,000,000
Di-n-butylphthalate	µg/kg	< 77	< 77	< 79	< 79	< 77	< 78	< 78	< 77	< 79	< 78				
Di-n-octylphthalate	µg/kg	< 77	< 77	< 79	< 79	< 77	< 78	< 78	< 77	< 79	< 78			160,000	4,100,000
Endosulfan I	µg/kg	< 0.51	< 0.51	< 0.52	< 0.52	< 0.51	< 0.51	< 0.51	< 0.51	< 0.52	< 0.52			47,000	1,200,000
Endosulfan II	µg/kg	< 0.38	< 0.38	< 0.39	< 0.39	< 0.38	< 0.39	< 0.39	< 0.38	< 0.39	< 0.39			47,000	1,200,000
Endosulfan Sulfate	µg/kg	< 0.38	< 0.38	< 0.39	< 0.39	< 0.38	< 0.39	< 0.39	< 0.38	< 0.39	< 0.39				
Endrin	µg/kg	< 0.58	< 0.58	< 0.59	< 0.72	< 0.58	< 0.58	< 0.58	< 0.58	< 0.59	< 0.59			2,300	61,000
Endrin Aldehyde	µg/kg	< 1.20	< 1.20	< 1.20	< 1.40	< 1.20	< 1.20	< 1.20	< 1.20	< 1.20	< 1.20				
Endrin Ketone	µg/kg	< 0.38	< 0.38	< 0.39	< 0.39	< 0.38	< 0.39	< 0.39	< 0.38	< 0.39	< 0.39				
Fluoranthene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39	600	5100	310,000	5,000,000
Fluorene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39	19	540	310,000	5,000,000
Gamma BHC - Lindane	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20			490	4,400
Gamma Chlordane	µg/kg	< 0.35	< 0.35	< 0.35	< 0.35	< 0.35	< 0.35	< 0.35	< 0.35	< 0.35	< 0.35				
Heptachlor	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20			140	1,300
Heptachlor Epoxide	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20			70	630
Hexachlorobenzene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			400	3,600
Hexachlorobutadiene	µg/kg	< 77	< 77	< 79	< 79	< 77	< 78	< 78	< 77	< 79	< 78			8,200	73,000

Table 3-4. (Continued)

Analysis Name	Units	EVC-1		EVC-2		EVC-3		EVC-4		EVC-5		ERL	ERM	URS Non critical water	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom			Restricted	Unrestricted
Hexachlorocyclopentadiene	µg/kg	< 190	< 190	< 200	< 200	< 190	< 190	< 190	< 190	< 200	< 200			10,000	1,400,000
Hexachloroethane	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			46,000	410,000
Indeno(1,2,3-cd)pyrene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			870	7,800
Isophorone	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			670,000	5,000,000
Methoxychlor	µg/kg	< 4.60	< 4.60	< 4.70	< 4.70	< 4.60	< 4.70	< 4.70	< 4.60	< 4.70	< 4.70			39,000	1,000,000
Naphthalene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39	160	2100	160,000	4,100,000
Nitrobenzene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			3,900	100,000
N-Nitroso-di-n-propylamine	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			90	820
N-Nitrosodiphenylamine	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			130,000	1,200,000
p,p-DDD	µg/kg	< 0.67	< 0.67	< 0.69	< 0.68	< 0.67	< 0.68	< 0.68	< 0.67	< 0.69	< 0.68	2.20	27	2,700	24,000
p,p-DDE	µg/kg	< 0.38	< 0.38	< 0.39	< 0.39	< 0.38	< 0.39	< 0.39	< 0.38	< 0.39	< 0.39			1,900	17,000
p,p-DDT	µg/kg	< 0.38	< 0.38	< 0.39	< 0.39	< 0.38	< 0.39	< 0.39	< 0.38	< 0.39	< 0.39			1,900	17,000
PCB-1016	µg/kg	< 3.80	< 3.80	< 3.90	< 3.90	< 3.80	< 3.90	< 3.90	< 3.80	< 3.90	< 3.90			82000	5000
PCB-1221	µg/kg	< 12	< 12	< 12	< 12	< 12	< 12	< 12	< 12	< 12	< 12			3000	300
PCB-1232	µg/kg	< 5.00	< 5.00	< 5.10	< 5.10	< 5.00	< 5.00	< 5.00	< 5.00	< 5.10	< 5.00			3000	300
PCB-1242	µg/kg	< 4.60	< 4.60	< 4.70	< 4.70	< 4.60	< 4.70	< 4.70	< 4.60	< 4.70	< 4.70			3000	300
PCB-1248	µg/kg	< 6.90	< 6.90	< 7.10	< 7.10	< 6.90	< 7.00	< 7.00	< 7.00	< 7.10	< 7.00			3000	300
PCB-1254	µg/kg	< 3.80	< 3.80	< 3.90	38.00	< 3.80	< 3.90	J 16.00	J 8.30	< 3.90	< 3.90			3000	300
PCB-1260	µg/kg	< 3.80	< 3.80	< 3.90	40.00	< 3.80	< 3.90	J 20.00	J 7.90	< 3.90	< 3.90			3000	300
Pentachlorophenol	µg/kg	< 190	< 190	< 200	< 200	< 190	< 190	< 190	< 190	< 200	< 200			5,300	48,000
Phenanthrene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39	240	1500	1,000,000	5,000,000
Phenol	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39			1,000,000	5,000,000
Pyrene	µg/kg	< 39	< 38	< 39	< 39	< 39	< 39	< 39	< 39	< 39	< 39	665	2600	230,000	5,000,000
Toxaphene	µg/kg	< 13	< 13	< 13	< 13	< 13	< 13	< 13	< 13	< 13	< 13			580	5,200

Table 3-5. Results of organic sediment testing at the Fenwick North borrow site in February 2004

Analysis Name	Units	FVC-9		FVC-10		FVC-11		FVC-12		FVC-13		ERL	ERM	URS Non Critical Water	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom			Restricted	Unrestricted
1,2,4-Trichlorobenzene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			78,000	2,000,000
1,2-Dichlorobenzene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			560,000	5,000,000
1,3-Dichlorobenzene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			230,000	5,000,000
1,4-Dichlorobenzene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			27,000	240,000
2,2'-oxybis(1-Chloropropane)	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38				
2,4,5-Trichlorophenol	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			780,000	5,000,000
2,4,6-Trichlorophenol	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			58,000	520,000
2,4-Dichlorophenol	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			23,000	610,000
2,4-Dimethylphenol	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			160,000	4,100,000
2,4-Dinitrophenol	µg/kg	< 770	< 820	< 770	< 770	< 780	< 820	< 810	< 810	< 770	< 770			16,000	410,000
2,4-Dinitrotoluene	µg/kg	< 77	< 82	< 77	< 77	< 78	< 82	< 81	< 81	< 77	< 77			16,000	410,000
2,6-Dinitrotoluene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			7,800	200,000
2-Chloronaphthalene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38				
2-Chlorophenol	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			39,000	1,000,000
2-Methylnaphthalene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			160,000	4,100,000
2-Methylphenol	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38	70	670	390,000	5,000,000
2-Nitroaniline	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			470	12,000
2-Nitrophenol	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38				
3,3'-Dichlorobenzidine	µg/kg	< 77	< 82	< 77	< 77	< 78	< 82	< 81	< 81	< 77	< 77			1,400	13,000
3-Nitroaniline	µg/kg	< 77	< 82	< 77	< 77	< 78	< 82	< 81	< 81	< 77	< 77				
4,6-Dinitro-2-methylphenol	µg/kg	< 190	< 210	< 190	< 190	< 190	< 200	< 200	< 200	< 190	< 190			80	2,000
4-Bromophenyl-phenylether	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38				
4-Chloro-3-methylphenol	µg/kg	< 77	< 82	< 77	< 77	< 78	< 82	< 81	< 81	< 77	< 77				
4-Chloroaniline	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			31,000	820,000
4-Chlorophenyl-phenylether	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38				
4-Methylphenol	µg/kg	< 77	< 82	< 77	< 77	< 78	< 82	< 81	< 81	< 77	< 77			39,000	5,000,000
4-Nitroaniline	µg/kg	< 77	< 82	< 77	< 77	< 78	< 82	< 81	< 81	< 77	< 77				
4-Nitrophenol	µg/kg	< 190	< 210	< 190	< 190	< 190	< 200	< 200	< 200	< 190	< 190			63,000	1,600,000
Acenaphthene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38	16	500	470,000	5,000,000
Acenaphthylene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38	44	640		
Aldrin	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			40	340
Alpha BHC	µg/kg	< 0.59	< 0.63	< 0.59	< 0.59	< 0.60	< 0.63	< 0.62	< 0.62	< 0.59	< 0.59			100	910
Alpha Chlordane	µg/kg	< 0.20	< 0.21	< 0.20	< 0.20	< 0.20	< 0.21	< 0.21	< 0.21	< 0.20	< 0.20				
Anthracene	µg/kg	< 0.20	< 0.21	< 0.20	< 0.20	< 0.20	< 0.21	< 0.21	< 0.21	< 0.20	< 0.20	85.30	1100	1,000,000	5,000,000
Benzo(a)anthracene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38	261	1600	880	7,800
Benzo(a)pyrene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38	430	1600	90	780

Table 3-5. (Continued)

Analysis Name	Units	FVC-9		FVC-10		FVC-11		FVC-12		FVC-13		ERL	ERM	URS Non Critical Water	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom			Restricted	Unrestricted
Benzo(b)fluoranthene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			880	7,800
Benzo(g,h,i)perylene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38				
Benzo(k)fluoranthene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			8,800	78,000
Beta BHC	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			350	3,200
bis(2-Chloroethoxy)methane	µg/kg	< 0.20	< 0.21	< 0.20	< 0.20	< 0.20	< 0.21	< 0.21	< 0.21	< 0.20	< 0.20				
bis(2-Chloroethyl)ether	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			200	5,200
bis(2-Ethylhexyl)phthalate	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			46,000	410,000
Butylbenzylphthalate	µg/kg	< 190	< 210	< 190	< 190	< 190	< 200	< 200	< 200	< 190	< 190			930,000	5,000,000
Carbazole	µg/kg	< 77	< 82	< 77	< 77	< 78	< 82	< 81	< 81	< 77	< 77			32,000	290,000
Chrysene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38	384	2800	87,000	780,000
Delta BHC	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38				
Dibenz(a,h)anthracene	µg/kg	< 0.20	< 0.21	< 0.20	< 0.20	< 0.20	< 0.21	< 0.21	< 0.21	< 0.20	< 0.20	63.40	260	90	780
Dibenzofuran	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			31,000	820,000
Dieldrin	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			40	360
Diethylphthalate	µg/kg	< 0.38	< 0.41	< 0.38	< 0.38	< 0.39	< 0.40	< 0.40	< 0.40	< 0.38	< 0.38			1,000,000	5,000,000
Dimethylphthalate	µg/kg	< 77	< 82	< 77	< 77	< 78	< 82	< 81	< 81	< 77	< 77			1,000,000	5,000,000
Di-n-butylphthalate	µg /kg	< 77	< 82	< 77	< 77	< 78	< 82	< 81	< 81	< 77	< 77				
Di-n-octylphthalate	µg/kg	< 77	< 82	< 77	< 77	< 78	< 82	< 81	< 81	< 77	< 77			160,000	4,100,000
Endosulfan I	µg/kg	< 77	< 82	< 77	< 77	< 78	< 82	< 81	< 81	< 77	< 77			47,000	1,200,000
Endosulfan II	µg/kg	< 0.51	< 0.54	< 0.51	< 0.51	< 0.51	< 0.54	< 0.53	< 0.53	< 0.51	< 0.51			47,000	1,200,000
Endosulfan Sulfate	µg/kg	< 0.38	< 0.41	< 0.38	< 0.38	< 0.39	< 0.40	< 0.40	< 0.40	< 0.38	< 0.38				
Endrin	µg/kg	< 0.38	< 0.41	< 0.38	< 0.38	< 0.39	< 0.40	< 0.40	< 0.40	< 0.38	< 0.38			2,300	61,000
Endrin Aldehyde	µg/kg	< 1.20	< 1.20	< 1.20	< 1.20	< 1.20	< 1.20	< 1.20	< 1.20	< 1.20	< 1.20				
Endrin Ketone	µg/kg	< 0.38	< 0.41	< 0.38	< 0.38	< 0.39	< 0.40	< 0.40	< 0.40	< 0.38	< 0.38				
Fluoranthene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38	600	5100	310,000	5,000,000
Fluorene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38	19	540	310,000	5,000,000
Gamma BHC - Lindane	µg /kg	< 0.20	< 0.21	< 0.20	< 0.20	< 0.20	< 0.21	< 0.21	< 0.21	< 0.20	< 0.20			490	4,400
Gamma Chlordane	µg /kg	< 0.35	< 0.37	< 0.35	< 0.35	< 0.35	< 0.37	< 0.36	< 0.36	< 0.35	< 0.35				
Heptachlor	µg/kg	< 0.20	< 0.21	< 0.20	< 0.20	< 0.20	< 0.21	< 0.21	< 0.21	< 0.20	< 0.20			140	1,300
Heptachlor Epoxide	µg/kg	< 0.20	< 0.21	< 0.20	< 0.20	< 0.20	< 0.21	< 0.21	< 0.21	< 0.20	< 0.20			70	630
Hexachlorobenzene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			400	3,600
Hexachlorobutadiene	µg/kg	< 77	< 82	< 77	< 77	< 78	< 82	< 81	< 81	< 77	< 77			8,200	73,000
Hexachlorocyclopentadiene	µg/kg	< 190	< 210	< 190	< 190	< 190	< 200	< 200	< 200	< 190	< 190			10,000	1,400,000
Hexachloroethane	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			46,000	410,000
Indeno(1,2,3-cd)pyrene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			870	7,800
Isophorone	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			670,000	5,000,000

Table 3-5. (Continued)

Analysis Name	Units	FVC-9		FVC-10		FVC-11		FVC-12		FVC-13		ERL	ERM	URS Non Critical Water	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom			Restricted	Unrestricted
Methoxychlor	µg /kg	< 4.60	< 4.90	< 4.60	< 4.60	< 4.70	< 4.90	< 4.80	< 4.80	< 4.60	< 4.60			39,000	1,000,000
Naphthalene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38	160	2100	160,000	4,100,000
Nitrobenzene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			3,900	100,000
N-Nitroso-di-n-propylamine	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			90	820
N-Nitrosodiphenylamine	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			130,000	1,200,000
p,p-DDD	µg/kg	< 0.67	< 0.72	< 0.67	< 0.67	< 0.68	< 0.71	< 0.70	< 0.70	< 0.67	< 0.67	2.20	27	2,700	24,000
p,p-DDE	µg/kg	< 0.38	< 0.41	< 0.38	< 0.38	< 0.39	< 0.40	< 0.40	< 0.40	< 0.38	< 0.38			1,900	17,000
p,p-DDT	µg/kg	< 0.38	< 0.41	< 0.38	< 0.38	< 0.39	< 0.40	< 0.40	< 0.40	< 0.38	< 0.38			1,900	17,000
PCB-1016	µg/kg	< 3.80	< 4.10	< 3.80	< 3.80	< 3.90	< 4.00	< 4.00	< 4.00	< 3.80	< 3.80			82000	5000
PCB-1221	µg/kg	< 12	< 12	< 12	< 12	< 12	< 12	< 12	< 12	< 12	< 12			3000	300
PCB-1232	µg/kg	< 5.00	< 5.30	< 5.00	< 5.00	< 5.00	< 5.30	< 5.20	< 5.20	< 5.00	< 4.90			3000	300
PCB-1242	µg/kg	< 4.60	< 4.90	< 4.60	< 4.60	< 4.70	< 4.90	< 4.80	< 4.80	< 4.60	< 4.60			3000	300
PCB-1248	µg/kg	< 6.90	< 7.40	< 6.90	< 7.00	< 7.00	< 7.40	< 7.30	< 7.20	< 6.90	< 6.90			3000	300
PCB-1254	µg /kg	< 3.80	< 4.10	< 3.80	< 3.80	< 3.90	< 4.00	< 4.00	< 4.00	< 3.80	< 3.80			3000	300
PCB-1260	µg/kg	J 4.70	< 4.10	< 3.80	< 3.80	J 4.90	< 4.00	< 4.00	< 4.00	< 3.80	< 3.80			3000	300
Pentachlorophenol	µg/kg	< 190	< 210	< 190	< 190	< 190	< 200	< 200	< 200	< 190	< 190			5,300	48,000
Phenanthrene	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38	240	1500	1,000,000	5,000,000
Phenol	µg/kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38			1,000,000	5,000,000
Pyrene	µg /kg	< 38	< 41	< 39	< 39	< 39	< 41	< 40	< 40	< 39	< 38	665	2600	230,000	5,000,000
Toxaphene	µg/kg	< 13	< 14	< 13	< 13	< 13	< 13	< 13	< 13	< 13	< 13			580	5,200

Table 3-6. Results of organic sediment testing at the Fenwick South borrow site in February 2004											
Analysis Name	**Units**	**FVC-1**		**FVC-2**		**FVC-3**		**FVC-4**		**FVC-5**	
		Top	**Bottom**	**Top**	**Bottom**	**Top**	**Bottom**	**Top**	**Bottom**	**Top**	**Bottom**
1,2,4-Trichlorobenzene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
1,2-Dichlorobenzene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
1,3-Dichlorobenzene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
1,4-Dichlorobenzene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
2,2'-oxybis(1-Chloropropane)	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
2,4,5-Trichlorophenol	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
2,4,6-Trichlorophenol	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
2,4-Dichlorophenol	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
2,4-Dimethylphenol	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
2,4-Dinitrophenol	µg/kg	< 790	< 790	< 780	< 800	< 760	< 810	< 770	< 770	< 740	< 790
2,4-Dinitrotoluene	µg/kg	< 79	< 79	< 78	< 80	< 76	< 81	< 77	< 77	< 74	< 79
2,6-Dinitrotoluene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
2-Chloronaphthalene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
2-Chlorophenol	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
2-Methylnaphthalene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
2-Methylphenol	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
2-Nitroaniline	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
2-Nitrophenol	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
3,3'-Dichlorobenzidine	µg/kg	< 79	< 79	< 78	< 80	< 76	< 81	< 77	< 77	< 74	< 79
3-Nitroaniline	µg/kg	< 79	< 79	< 78	< 80	< 76	< 81	< 77	< 77	< 74	< 79
4,6-Dinitro-2-methylphenol	µg/kg	< 200	< 200	< 190	< 200	< 190	< 200	< 190	< 190	< 190	< 200
4-Bromophenyl-phenylether	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
4-Chloro-3-methylphenol	µg/kg	< 79	< 79	< 78	< 80	< 76	< 81	< 77	< 77	< 74	< 79
4-Chloroaniline	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
4-Chlorophenyl-phenylether	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
4-Methylphenol	µg/kg	< 79	< 79	< 78	< 80	< 76	< 81	< 77	< 77	< 74	< 79
4-Nitroaniline	µg/kg	< 79	< 79	< 78	< 80	< 76	< 81	< 77	< 77	< 74	< 79
4-Nitrophenol	µg/kg	< 200	< 200	< 190	< 200	< 190	< 200	< 190	< 190	< 190	< 200
Acenaphthene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Acenaphthylene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Aldrin	µg/kg	< 0.61	< 0.61	< 0.59	< 0.61	< 0.58	< 0.62	< 0.59	< 0.59	< 0.57	< 0.60

Table 3-6a. (Continued)

Analysis Name	Units	FVC-6		FVC-7		FVC-8		ERL	ERM	URL Non Critical Water	
		Top	Bottom	Top	Bottom	Top	Bottom			Restricted	Unrestricted
1,2,4-Trichlorobenzene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			78,000	2,000,000
1,2-Dichlorobenzene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			560,000	5,000,000
1,3-Dichlorobenzene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			230,000	5,000,000
1,4-Dichlorobenzene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			27,000	240,000
2,2'-oxybis(1-Chloropropane)	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39				
2,4,5-Trichlorophenol	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			780,000	5,000,000
2,4,6-Trichlorophenol	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			58,000	520,000
2,4-Dichlorophenol	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			23,000	610,000
2,4-Dimethylphenol	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			160,000	4,100,000
2,4-Dinitrophenol	µg/kg	< 810	< 820	< 800	< 800	< 780	< 770			16,000	410,000
2,4-Dinitrotoluene	µg/kg	< 81	< 82	< 80	< 80	< 78	< 77			16,000	410,000
2,6-Dinitrotoluene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			7,800	200,000
2-Chloronaphthalene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39				
2-Chlorophenol	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			39,000	1,000,000
2-Methylnaphthalene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			160,000	4,100,000
2-Methylphenol	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39	70	670	390,000	5,000,000
2-Nitroaniline	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			470	12,000
2-Nitrophenol	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39				
3,3'-Dichlorobenzidine	µg/kg	< 81	< 82	< 80	< 80	< 78	< 77			1,400	13,000
3-Nitroaniline	µg/kg	< 81	< 82	< 80	< 80	< 78	< 77				
4,6-Dinitro-2-methylphenol	µg/kg	< 200	< 200	< 200	< 200	< 200	< 190			80	2,000
4-Bromophenyl-phenylether	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39				
4-Chloro-3-methylphenol	µg/kg	< 81	< 82	< 80	< 80	< 78	< 77				
4-Chloroaniline	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			31,000	820,000
4-Chlorophenyl-phenylether	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39				
4-Methylphenol	µg/kg	< 81	< 82	< 80	< 80	< 78	< 77			39,000	5,000,000
4-Nitroaniline	µg/kg	< 81	< 82	< 80	< 80	< 78	< 77				
4-Nitrophenol	µg/kg	< 200	< 200	< 200	< 200	< 200	< 190			63,000	1,600,000
Acenaphthene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39	16	500	470,000	5,000,000
Acenaphthylene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39				
Aldrin	µg/kg	< 0.62	< 0.62	< 0.61	< 0.61	< 0.60	< 0.59				

Table 3-6b. (Continued)

Analysis Name	Units	FVC-1		FVC-2		FVC-3		FVC-4		FVC-5	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Alpha BHC	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.19	< 0.21	< 0.20	< 0.20	< 0.19	< 0.20
Alpha Chlordane	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.19	< 0.21	< 0.20	< 0.20	< 0.19	< 0.20
Anthracene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Benzo(a)anthracene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Benzo(a)pyrene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Benzo(b)fluoranthene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Benzo(g,h,i)perylene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Benzo(k)fluoranthene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Beta BHC	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.19	< 0.21	< 0.20	< 0.20	< 0.19	< 0.20
bis(2-Chloroethoxy)methane	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
bis(2-Chloroethyl)ether	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
bis(2-Ethylhexyl)phthalate	µg/kg	J 350	< 200	< 190	< 200	< 190	< 200	< 190	< 190	< 190	< 200
Butylbenzylphthalate	µg/kg	< 79	< 79	< 78	< 80	< 76	< 81	< 77	< 77	< 74	< 79
Carbazole	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Chrysene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Delta BHC	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.19	< 0.21	< 0.20	< 0.20	< 0.19	< 0.20
Dibenz(a,h)anthracene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Dibenzofuran	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Dieldrin	µg/kg	< 0.39	< 0.39	< 0.38	< 0.39	< 0.38	< 0.40	< 0.38	< 0.38	< 0.37	< 0.39
Diethylphthalate	µg/kg	< 79	< 79	< 78	< 80	< 76	< 81	< 77	< 77	< 74	< 79
Dimethylphthalate	µg/kg	< 79	< 79	< 78	< 80	< 76	< 81	< 77	< 77	< 74	< 79
Di-n-butylphthalate	µg/kg	< 79	< 79	< 78	< 80	< 76	< 81	< 77	< 77	< 74	< 79
Di-n-octylphthalate	µg/kg	< 79	< 79	< 78	< 80	< 76	< 81	< 77	< 77	< 74	< 79
Endosulfan I	µg/kg	< 0.52	< 0.52	< 0.51	< 0.53	< 0.50	< 0.53	< 0.51	< 0.51	< 0.49	< 0.52
Endosulfan II	µg/kg	< 0.39	< 0.39	< 0.38	< 0.39	< 0.38	< 0.40	< 0.38	< 0.38	< 0.37	< 0.39
Endosulfan Sulfate	µg/kg	< 0.39	< 0.39	< 0.38	< 0.39	< 0.38	< 0.40	< 0.38	< 0.38	< 0.37	< 0.39
Endrin	µg/kg	< 0.59	< 0.60	< 0.58	< 0.60	< 0.57	< 0.61	< 0.58	< 0.58	< 0.56	< 0.59
Endrin Aldehyde	µg/kg	< 1.20	< 1.20	< 1.20	< 1.20	< 1.10	< 1.20	< 1.20	< 1.20	< 1.10	< 1.20
Endrin Ketone	µg/kg	< 0.39	< 0.39	< 0.38	< 0.39	< 0.38	< 0.40	< 0.38	< 0.38	< 0.37	< 0.39
Fluoranthene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Fluorene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39

Table 3-6c. (Continued)

Analysis Name	Units	FVC-6		FVC-7		FVC-8		ERL	ERM	URL Non Critical Water	
		Top	Bottom	Top	Bottom	Top	Bottom			Restricted	Unrestricted
Alpha BHC	µg/kg	< 0.21	< 0.21	< 0.20	< 0.20	< 0.20	< 0.20			100	910
Alpha Chlordane	µg/kg	< 0.21	< 0.21	< 0.20	< 0.20	3< 0.20	< 0.20				
Anthracene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39	85.30	1100	1,000,000	5,000,000
Benzo(a)anthracene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39	261	1600	880	7,800
Benzo(a)pyrene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39	430	1600	90	780
Benzo(b)fluoranthene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			880	7,800
Benzo(g,h,i)perylene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39				
Benzo(k)fluoranthene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			8,800	78,000
Beta BHC	µg/kg	< 0.21	< 0.21	< 0.20	< 0.20	< 0.20	< 0.20			350	3,200
bis(2-Chloroethoxy)methane	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39				
bis(2-Chloroethyl)ether	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			200	5,200
bis(2-Ethylhexyl)phthalate	µg/kg	< 200	< 200	< 200	< 200	< 200	< 190			46,000	410,000
Butylbenzylphthalate	µg/kg	< 81	< 82	< 80	< 80	< 78	< 77			930,000	5,000,000
Carbazole	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			32,000	290,000
Chrysene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39	384	2800	87,000	780,000
Delta BHC	µg/kg	< 0.21	< 0.21	< 0.20	< 0.20	< 0.20	< 0.20				
Dibenz(a,h)anthracene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39	63.40	260	90	780
Dibenzofuran	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			31,000	820,000
Dieldrin	µg/kg	< 0.40	< 0.40	< 0.40	< 0.40	< 0.39	< 0.38			40	360
Diethylphthalate	µg/kg	< 81	< 82	< 80	< 80	< 78	< 77			1,000,000	5,000,000
Dimethylphthalate	µg/kg	< 81	< 82	< 80	< 80	< 78	< 77			1,000,000	5,000,000
Di-n-butylphthalate	µg/kg	< 81	< 82	< 80	< 80	< 78	< 77				
Di-n-octylphthalate	µg/kg	< 81	< 82	< 80	< 80	< 78	< 77			160,000	4,100,000
Endosulfan I	µg/kg	< 0.53	< 0.54	< 0.53	< 0.53	< 0.52	< 0.51			47,000	1,200,000
Endosulfan II	µg/kg	< 0.40	< 0.40	< 0.40	< 0.40	< 0.39	< 0.38			47,000	1,200,000
Endosulfan Sulfate	µg/kg	< 0.40	< 0.40	< 0.40	< 0.40	< 0.39	< 0.38				
Endrin	µg/kg	< 0.61	< 0.61	< 0.60	< 0.60	< 0.59	< 0.58			2,300	61,000
Endrin Aldehyde	µg/kg	< 1.20	< 1.20	< 1.20	< 1.20	< 1.20	< 1.20				
Endrin Ketone	µg/kg	< 0.40	< 0.40	< 0.40	< 0.40	< 0.39	< 0.38				
Fluoranthene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39	600	5100	310,000	5,000,000
Fluorene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39	19	540	310,000	5,000,000

Table 3-6d. (Continued)

Analysis Name	Units	FVC-1		FVC-2		FVC-3		FVC-4		FVC-5	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Gamma BHC - Lindane	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.19	< 0.21	< 0.20	< 0.20	< 0.19	< 0.20
Gamma Chlordane	µg/kg	< 0.36	< 0.36	< 0.35	3.70	< 0.34	1.40	< 0.35	< 0.35	< 0.33	J 0.71
Heptachlor	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.19	< 0.21	< 0.20	< 0.20	< 0.19	< 0.20
Heptachlor Epoxide	µg/kg	< 0.20	< 0.20	< 0.20	< 0.20	< 0.19	< 0.21	< 0.20	< 0.20	< 0.19	< 0.20
Hexachlorobenzene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Hexachlorobutadiene	µg/kg	< 79	< 79	< 78	< 80	< 76	< 81	< 77	< 77	< 74	< 79
Hexachlorocyclopentadiene	µg/kg	< 200	< 200	< 190	< 200	< 190	< 200	< 190	< 190	< 190	< 200
Hexachloroethane	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Indeno(1,2,3-cd)pyrene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Isophorone	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Methoxychlor	µg/kg	< 4.80	< 4.80	< 4.70	< 4.80	< 4.60	< 4.80	< 4.60	< 4.60	< 4.50	< 4.70
Naphthalene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Nitrobenzene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
N-Nitroso-di-n-propylamine	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
N-Nitrosodiphenylamine	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
p,p-DDD	µg/kg	< 0.69	< 0.69	< 0.68	< 0.69	< 0.66	< 0.70	< 0.67	< 0.67	< 0.65	< 0.69
p,p-DDE	µg/kg	< 0.39	< 0.39	< 0.38	< 0.39	< 0.38	< 0.40	< 0.38	< 0.38	< 0.37	< 0.39
p,p-DDT	µg/kg	< 0.39	< 0.39	< 0.38	< 0.39	< 0.38	< 0.40	< 0.38	< 0.38	< 0.37	< 0.39
PCB-1016	µg/kg	< 3.90	< 3.90	< 3.80	< 3.90	< 3.80	< 4.00	< 3.80	< 3.80	< 3.70	< 3.90
PCB-1221	µg/kg	< 12	< 12	< 12	< 12	< 11	< 12	< 12	< 12	< 11	< 12
PCB-1232	µg/kg	< 5.10	< 5.10	< 5.00	< 5.10	< 4.90	< 5.20	< 4.90	< 5.00	< 4.80	< 5.10
PCB-1242	µg/kg	< 4.80	< 4.80	< 4.70	< 4.80	< 4.60	< 4.80	< 4.60	< 4.60	< 4.50	< 4.70
PCB-1248	µg/kg	< 7.10	< 7.10	< 7.00	< 7.20	< 6.80	< 7.30	< 6.90	< 6.90	< 6.70	< 7.10
PCB-1254	µg/kg	< 3.90	< 3.90	< 3.80	< 3.90	< 3.80	< 4.00	< 3.80	< 3.80	J 16.00	< 3.90
PCB-1260	µg/kg	< 3.90	< 3.90	< 3.80	< 3.90	< 3.80	J 7.30	< 3.80	< 3.80	J 13.00	< 3.90
Pentachlorophenol	µg/kg	< 200	< 200	< 190	< 200	< 190	< 200	< 190	< 190	< 190	< 200
Phenanthrene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Phenol	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Pyrene	µg/kg	< 40	< 40	< 39	< 40	< 38	< 40	< 38	< 39	< 37	< 39
Toxaphene	µg/kg	< 13	< 13	< 13	< 13	< 13	< 13	< 13	< 13	< 12	< 13

Table 3-6e. (Continued)

Analysis Name	Units	FVC-6		FVC-7		FVC-8		ERL	ERM	URL Non Critical Water	
		Top	Bottom	Top	Bottom	Top	Bottom			Restricted	Unrestricted
Gamma BHC - Lindane	µg/kg	< 0.21	< 0.21	< 0.20	< 0.20	< 0.20	< 0.20			490	4,400
Gamma Chlordane	µg/kg	< 0.36	< 0.37	< 0.36	< 0.36	< 0.35	< 0.35				
Heptachlor	µg/kg	< 0.21	< 0.21	< 0.20	< 0.20	< 0.20	< 0.20			140	1,300
Heptachlor Epoxide	µg/kg	< 0.21	< 0.21	< 0.20	< 0.20	< 0.20	< 0.20			70	630
Hexachlorobenzene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			400	3,600
Hexachlorobutadiene	µg/kg	< 81	< 82	< 80	< 80	< 78	< 77			8,200	73,000
Hexachlorocyclopentadiene	µg/kg	< 200	< 200	< 200	< 200	< 200	< 190			10,000	1,400,000
Hexachloroethane	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			46,000	410,000
Indeno(1,2,3-cd)pyrene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			870	7,800
Isophorone	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			670,000	5,000,000
Methoxychlor	µg/kg	< 4.80	< 4.90	< 4.80	< 4.80	< 4.70	< 4.60			39,000	1,000,000
Naphthalene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39	160	2100	160,000	4,100,000
Nitrobenzene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			3,900	100,000
N-Nitroso-di-n-propylamine	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			90	820
N-Nitrosodiphenylamine	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			130,000	1,200,000
p,p-DDD	µg/kg	< 0.70	< 0.71	< 0.70	< 0.70	< 0.68	< 0.67	2.20	27	2,700	24,000
p,p-DDE	µg/kg	< 0.40	< 0.40	< 0.40	< 0.40	< 0.39	< 0.38			1,900	17,000
p,p-DDT	µg/kg	< 0.40	< 0.40	< 0.40	< 0.40	< 0.39	< 0.38			1,900	17,000
PCB-1016	µg/kg	< 4.00	< 4.00	< 4.00	< 4.00	< 3.90	< 3.80			82000	5000
PCB-1221	µg/kg	< 12	< 12	< 12	< 12	< 12	< 12			3000	300
PCB-1232	µg/kg	< 5.20	< 5.30	< 5.20	< 5.20	< 5.00	< 5.00			3000	300
PCB-1242	µg/kg	< 4.80	< 4.90	< 4.80	< 4.80	< 4.70	< 4.60			3000	300
PCB-1248	µg/kg	< 7.30	< 7.30	< 7.20	< 7.20	< 7.00	< 7.00			3000	300
PCB-1254	µg/kg	< 4.00	< 4.00	< 4.00	< 4.00	J 19.00	< 3.80			3000	300
PCB-1260	µg/kg	< 4.00	< 4.00	< 4.00	< 4.00	J 19.00	< 3.80			3000	300
Pentachlorophenol	µg/kg	< 200	< 200	< 200	< 200	< 200	< 190			5,300	48,000
Phenanthrene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39	240	1500	1,000,000	5,000,000
Phenol	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39			1,000,000	5,000,000
Pyrene	µg/kg	< 40	< 41	< 40	< 40	< 39	< 39	665	2600	230,000	5,000,000
Toxaphene	µg/kg	< 13	< 13	< 13	< 13	< 13	< 13			580	5,200

Table 3-7. Results of inorganic water testing at the borrow sites sampled in February 2004

Parameter	Units	E	Fenwick North	Equipment Blank	DNREC Marine Acute	DNREC Marine Chronic
Aluminum	mg/l	0.115	< 0.0413	< 0.0413		
Antimony	mg/l	< 0.0085	< 0.0085	< 0.0085		
Arsenic	mg/l	< 0.0049	< 0.0049	< 0.0049	0.069	0.036
Barium	mg/l	0.0072	0.0067	< 0.00048		
Beryllium	mg/l	< 0.00034	< 0.00034	< 0.00034		
Cadmium	mg/l	< 0.00087	< 0.00087	< 0.00087	0.043	0.0093
Calcium	mg/l	389	386	< 0.0494		
Chromium	mg/l	< 0.0022	< 0.0022	< 0.0022	1.1	0.05
Cobalt	mg/l	< 0.0016	< 0.0016	< 0.0016		
Copper	mg/l	< 0.0021	< 0.0021	< 0.0021	0.0029	
Iron	mg/l	0.104	< 0.0453	< 0.0453		
Lead	mg/l	< 0.0093	< 0.0093	< 0.0093	0.14	0.0056
Magnesium	mg/l	1210	1180	< 0.0183		
Manganese	mg/l	< 0.00051	< 0.00051	0.0018		
Mercury	mg/l	< 0.00016	< 0.00016	< 0.00016	0.0021	0.000025
Nickel	mg/l	< 0.0038	< 0.0038	< 0.0038	0.075	0.0083
Potassium	mg/l	318	304	0.0703		
Selenium	mg/l	0.005	0.0047	< 0.0047	0.3	0.071
Silver	mg/l	0.105	0.104	< 0.0018	0.0023	
Sodium	mg/l	9000	8990	1.4		
Thallium	mg/l	< 0.0089	< 0.0089	< 0.0089		
Vanadium	mg/l	< 0.0017	< 0.0017	< 0.0017		
Zinc	mg/l	< 0.0041	< 0.0041	< 0.0041	0.095	0.086
pH	Std. Units	8	8.1			
Total Suspended Solids	mg/l	8	6.4	< 3		
Total Dissolved Solids	mg/l	32700	31500	< 9.7		

Table 3-8. Results of organic water testing at the Fenwick Island borrow sites sampled in February 2004

Parameter	Units	E	Fenwick North	Equipment Blank	Marine Acute	Marine Chronic
1,2,4-Trichlorobenzene	µg/	< 1	< 1	< 1		
1,2-Dichlorobenzene	µg/	< 1	< 1	< 1		
1,3-Dichlorobenzene	µg/	< 1	< 1	< 1		
1,4-Dichlorobenzene	µg/	< 1	< 1	< 1		
2,2'-oxybis(1-Chloropropane)	µg/	< 1	< 1	< 1		
2,4,5-Trichlorophenol	µg/	< 1	< 1	< 1		
2,4,6-Trichlorophenol	µg/	< 1	< 1	< 1		
2,4-Dichlorophenol	µg/	< 1	< 1	< 1		
2,4-Dimethylphenol	µg/	< 1	< 1	< 1		
2,4-Dinitrophenol	µg/	< 21	< 24	< 19		
2,4-Dinitrotoluene	µg/	< 1	< 1	< 1		
2,6-Dinitrotoluene	µg/	< 1	< 1	< 1		
2-Chloronaphthalene	µg/	< 1	< 1	< 1		
2-Chlorophenol	µg/	< 1	< 1	< 1		
2-Methylnaphthalene	µg/	< 1	< 1	< 1		
2-Methylphenol	µg/	< 1	< 1	< 1		
2-Nitroaniline	µg/	< 1	< 1	< 1		
2-Nitrophenol	µg/	< 1	< 1	< 1		
3,3'-Dichlorobenzidine	µg/	< 1	< 1	< 1		
3-Nitroaniline	µg/	< 1	< 1	< 1		
4,6-Dinitro-2-methylphenol	µg/	< 5	< 6	< 5		
4-Bromophenyl-phenylether	µg/	< 1	< 1	< 1		
4-Chloro-3-methylphenol	µg/	< 1	< 1	< 1		
4-Chloroaniline	µg/	< 1	< 1	< 1		
4-Chlorophenyl-phenylether	µg/	< 1	< 1	< 1		
4-Methylphenol	µg/	< 2	< 2	< 2		
4-Nitroaniline	µg/	< 1	< 1	< 1		
4-Nitrophenol	µg/	< 11	< 12	< 10		
Acenaphthene	µg/	< 1	< 1	< 1		
Acenaphthylene	µg/	< 1	< 1	< 1		
Aldrin	µg/	< 0.0022	< 0.0021	< 0.0023	1.3	
Alpha BHC	µg/	< 0.0022	< 0.0021	< 0.0023		
Alpha Chlordane	µg/	< 0.0022	< 0.0021	< 0.0023		
Anthracene	µg/	< 1	< 1	< 1		
Benzo(a)anthracene	µg/	< 1	< 1	< 1		
Benzo(a)pyrene	µg/	< 1	< 1	< 1		
Benzo(b)fluoranthene	µg/	< 1	< 1	< 1		

Table 3-8. (Continued)

Parameter	Units	E	Fenwick North	Equipment Blank	Marine Acute	Marine Chronic
Benzo(g,h,i)perylene	µg/	< 1	< 1	< 1		
Benzo(k)fluoranthene	µg/	< 1	< 1	< 1		
Beta BHC	µg/	< 0.013	< 0.013	< 0.014		
bis(2-Chloroethoxy)methane	µg/	< 1	< 1	< 1		
bis(2-Chloroethyl)ether	µg/	< 1	< 1	< 1		
bis(2-Ethylhexyl)phthalate	µg/	< 2	< 2	< 2		
Butylbenzylphthalate	µg/	< 2	< 2	< 2		
Carbazole	µg/	< 1	< 1	< 1		
Chrysene	µg/	< 1	< 1	< 1		
Delta BHC	µg/	0.0046	0.0094	< 0.0034		
Dibenz(a,h)anthracene	µg/	< 1	< 1	< 1		
Dibenzofuran	µg/	< 1	< 1	< 1		
Dieldrin	µg/	< 0.0054	< 0.0052	< 0.0057		
Diethylphthalate	µg/	< 2	< 2	< 2		
Dimethylphthalate	µg/	< 2	< 2	< 2		
Di-n-butylphthalate	µg/	< 2	< 2	< 2		
Di-n-octylphthalate	µg/	< 2	< 2	< 2		
Endosulfan I	µg/	< 0.0043	< 0.0042	< 0.0046		
Endosulfan II	µg/	< 0.0054	< 0.0052	< 0.0057		
Endosulfan Sulfate	µg/	< 0.0098	< 0.0094	< 0.01		
Endrin	µg/	< 0.0043	< 0.0042	< 0.0046		
Endrin Aldehyde	µg/	< 0.022	< 0.021	< 0.023		
Endrin Ketone	µg/	< 0.0043	< 0.0042	< 0.0046		
Fluoranthene	µg/	< 1	< 1	< 1		
Fluorene	µg/	< 1	< 1	< 1		
Gamma BHC - Lindane	µg/	< 0.0022	< 0.0021	< 0.0023		
Gamma Chlordane	µg/	< 0.0022	< 0.01	< 0.0023	0.09	0.004
Heptachlor	µg/	< 0.0022	< 0.0021	< 0.0023		
Heptachlor Epoxide	µg/	< 0.0022	< 0.0021	< 0.0023		
Hexachlorobenzene	µg/	< 1	< 1	< 1		
Hexachlorobutadiene	µg/	< 1	< 1	< 1		
Hexachlorocyclopentadiene	µg/	< 5	< 6	< 5		
Hexachloroethane	µg/	< 1	< 1	< 1		
Indeno(1,2,3-cd)pyrene	µg/	< 1	< 1	< 1		
Isophorone	µg/	< 1	< 1	< 1		
Methoxychlor	µg/	< 0.065	< 0.063	< 0.069		
Naphthalene	µg/	< 1	< 1	< 1		
Nitrobenzene	µg/	< 1	< 1	< 1		
N-Nitroso-di-n-propylamine	µg/	< 1	< 1	< 1		
N-Nitrosodiphenylamine	µg/	< 2	< 2	< 2		
Oil & Grease	mg/l	< 2.5	< 2.5	< 2.5		
p,p-DDD	µg/	< 0.0043	< 0.0042	< 0.0046	0.13	0.001

Table 3-8. (Continued)

Parameter	Units	E	Fenwick North	Equipment Blank	Marine Acute	Marine Chronic
p,p-DDE	µg/	< 0.0043	< 0.0042	< 0.0046	0.13	0.001
p,p-DDT	µg/	< 0.0043	< 0.0042	< 0.0046	0.13	0.001
PCB-1016	µg/	< 0.22	< 0.21	< 0.23		
PCB-1221	µg/	< 0.43	< 0.42	< 0.46		
PCB-1232	µg/	< 0.11	< 0.1	< 0.11		
PCB-1242	µg/	< 0.22	< 0.21	< 0.23		
PCB-1248	µg/	< 0.33	< 0.31	< 0.34		
PCB-1254	µg/	< 0.22	< 0.21	< 0.23		
PCB-1260	µg/	< 0.33	< 0.31	< 0.34		
Pentachlorophenol	µg/	< 3	< 4	< 3	13	7.9
Phenanthrene	µg/	< 1	< 1	< 1		
Phenol	µg/	< 1	< 1	< 1		
Pyrene	µg/	< 1	< 1	< 1		
Toxaphene	µg/	< 0.33	< 0.31	< 0.34	0.21	0.0002

Table 3-9. Percent TOC, Silt/Clay, Sand, and Gravel for surface layer cores (0-1 feet) and bottom layer cores (1-depth of penetration ft) analyzed for contaminant concentrations. Grain sizes for these samples were calculated using sieve sizes provided in Table 2-1.

Borrow Area	Station	Layer (feet)	TOC	Silt/Clay	Sand	Gravel
E	EVC-1	0-1	0.98	2.62	89.81	7.58
	EVC-1	1-2.7	0.83	2.67	96.84	0.50
	EVC-2	0-1	0.40	2.00	71.99	26.02
	EVC-2	1-4.2	0.88	4.54	91.78	3.68
	EVC-3	0-1	0.38	0.92	95.40	3.68
	EVC-3	1-1.7	0.35	1.04	97.86	1.11
	EVC-4	0-1	0.31	0.66	98.12	1.22
	EVC-4	1-4.6	0.32	2.39	96.47	1.14
	EVC-5	0-1	0.23	0.75	98.71	0.54
	EVC-5	1-2.2	0.30	1.40	91.88	6.72
Fenwick South	FVC-1	0-1	0.70	6.64	85.73	7.64
	FVC-1	1-5.7	1.51	5.47	88.83	5.69
	FVC-2	0-1	0.38	0.90	94.04	5.06
	FVC-2	1-5.0	0.99	6.27	89.82	3.91
	FVC-3	0-1	0.29	1.06	92.19	6.75
	FVC-3	1-4.0	0.71	4.62	88.42	6.96
	FVC-4	0-1	0.30	0.44	55.90	43.66
	FVC-4	1-4.0	0.87	11.23	73.30	15.47
	FVC-5	0-1	0.24	2.47	89.29	8.24
	FVC-5	1-3.3	1.10	7.86	84.74	7.40
	FVC-6	0-1	0.87	1.94	92.16	5.89
	FVC-6	1-3.8	0.74	3.86	93.10	3.04
	FVC-7	0-1	0.42	0.73	99.14	0.13
	FVC-7	1-4.3	0.71	4.30	93.96	1.74
	FVC-8	0-1	0.42	1.40	98.37	0.23
	FVC-8	1-2.8	0.41	1.15	97.37	1.48
Fenwick North	FVC-9	0-1	0.78	3.17	89.34	7.49
	FVC-9	1-5.0	2.60	7.37	92.24	0.39
	FVC-10	0-1	0.31	0.73	93.80	5.47
	FVC-10	1-4.3	0.50	1.98	92.73	5.29
	FVC-11	0-1	0.43	2.27	48.74	49.00
	FVC-11	1-4.5	0.63	4.59	89.84	5.57
	FVC-12	0-1	0.67	3.58	93.30	3.12
	FVC-12	1-4.0	0.81	4.73	85.13	10.14
	FVC-13	0-1	0.31	0.71	96.43	2.86
	FVC-13	1-4.5	0.53	2.35	90.01	7.64

4.0 CONCLUSIONS

The results of the chemical testing of the sediment cores collected from the Delaware Coast From Cape Henlopen To Fenwick Island Storm Damage Reduction Project sand borrow sites revealed that the with the exception of three parameters (aluminum, arsenic, and iron), the sediments are below the Delaware Uniform Risk-Based Remediation Standards for non-critical water resource areas. These parameters (except for Aluminum) fall within the lower ranges of "Typical Delaware Soil Concentrations" from the Delaware Remediation Standards Guidance Under the Delaware Hazardous Substance Clean-up Act (1999). Sediment contaminant concentrations for all of the inorganics, semivolatiles, pesticides and most of the Aroclor PCBs were below NOAA guidelines for the protection of aquatic organisms (ER-L and ER-M) indicating that, in-situ, the sediments are generally not toxic to marine organisms. However, some of the Aroclor PCB levels when summed together (and alone in one case) exceed the ER-L for total PCBs of 22 μg/kg and Delaware's Draft Sediment Guideline of 33 μg/kg for total PCBs. The presence and/or extent of total PCB concentrations can be conclusively verified by conducting additional tests utilizing a more sensitive high resolution congener specific methodology. The bottom water sampling over the borrow sites indicated that inorganic and organic contaminant concentrations were either non-detected or all below Delaware water quality criteria for marine waters.

Geotechnical analysis of the sediment core samples indicated that for the most part the borrow sites contained greater than 80% sands. These data will be evaluated further by the USACE geotechnical engineers and added to their current database on the suitability of the borrow sites for beach replenishment activities.

APPENDIX A

CHEMICAL ANALYSIS

Pg 1 of _3__

VERSAR, Inc. *CHAIN OF CUSTODY / SAMPLE INFORMATION FORM*

Versar, Inc. • 9290Rumsey Road • Columbia, MD 21045 • (410) 964-9200 • FAX (410) 964-5156

LOT # 7446 / 4216774-99 / 884826 / 4216818 / 884832

Contact name	Katherine Dillow	Sampler	Katherine Dillow
Contact phone	410-740-6116	Project Name	Fenwick Island
Invoice AdPTess	Same as above	Contract/P.O Number	110653-0048-001
		Sample Turnaround Time	Normal

LL USE LAB ID NO.	Grab/ Composite	Station Location	Matrix	Container Description/ Preservation Status	# of Containers	Date	Time	Analyses Required/Comments
	Composite	EVC-1	sed		1	2/11/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	EVC-2	sed		1	2/11/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	EVC-3	sed		1	2/11/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	EVC-4	sed		1	2/11/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	EVC-5	sed		1	2/11/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	EVC-1-0	sed		1	2/11/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	EVC-2-0	sed		1	2/11/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	EVC-3-0	sed		1	2/11/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	EVC-4-0	sed		1	2/11/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	EVC-5-0	sed		1	2/11/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH

Transferred by:	Received by:	Date	Time
Transferred by:	Received by:	Date	Time
Transferred by:	Received by: Denise Lynch	Date 2/14	Time 0 90

Cooler Receipt Information (LAB USE ONLY)

Sufficient ice? - Yes/No If No, temp.= _____

Sample containers pres'd? - Yes/No If No, explain

Custody Seal present/intact? - Yes/No

Initials: DMS Date: 2/14/04

Pg 2 of _3__

VERSAR, Inc. CHAIN OF CUSTODY / SAMPLE INFORMATION FORM 7446/4216774-95/884826

Versar, Inc. • 9200Rumsey Road • Columbia, MD 21045 • (410) 964-9200 • FAX (410) 964-5156

4216813/884832

LOT #		Sampler	Katherine Dillow
Contact name	Katherine Dillow	Project Name	Fenwick Island
Contact phone	410-740-6116	Contract/P.O Number	110653-0048-001
Invoice AdPTess	Same as above	Sample Turnaround Time	Normal

LL USE LAB ID NO:	Grab/ Composite	Station Location	Matrix	Container Description/ Preservation Status	# of Containers	Date	Time	Analyses Required/Comments
	Composite	FVC-1	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-2	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-3	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-4	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-5	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-6	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-7	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-8	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-9	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-10	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-11	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-12	sed		1	2/11/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-13	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH

Transferred by:	Received by:	Date	Time
Transferred by:	Received by:	Date	Time
Transferred by:	Received by:	Date 2/14	Time 0900

Cooler Receipt Information (LAB USE ONLY)

Sufficient Ice? Yes/No If No, temp.= _____

Sample containers pres'd? Yes/No If No, explain

Custody Seal present/intact? Yes/No

Initials: Date: 2/14/04

Pg 3 of 3

VERSAR, Inc. CHAIN OF CUSTODY / SAMPLE INFORMATION FORM

7446/42/6774-99/884826
42/6B/8/884832

Versar, Inc. • 9290Rumsey Road • Columbia, MD 21045 • (410) 964-9200 • FAX (410) 964-5156

LOT #		Sampler	Katherine Dillow
Contact name	Katherine Dillow	Project Name	Fenwick Island
Contact phone	410-740-6116	Contract/P.O Number	110653-0048-001
Invoice AdPTess	Same as above	Sample Turnaround Time	Normal

LL USE LAB ID NO:	Grab/ Composite	Station Location	Matrix	Container Description/ Preservation Status	# of Containers	Date	Time	Analyses Required/Comments
	Composite	FVC-1-0	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-2-0	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-3-0	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-4-0	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-5-0	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-6-0	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-7-0	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-8-0	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-9-0	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-10-0	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-11-0	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-12-0	sed		1	2/11/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH
	Composite	FVC-13-0	sed		1	2/12/04		TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease, pH

Transferred by:	Received by:	Date	Time
Transferred by:	Received by:	Date	Time
Transferred by:	Received by: [signature]	Date 2/14/04	Time 0900

Cooler Receipt Information (LAB USE ONLY)

Sufficient Ice? Yes/No If No, temp.= _____

Sample containers pres'd? Yes/No If No, explain

Custody Seal present/intact? Yes/No

Initials: [illegible] Date: 2/14/04

Pg 1 of _1_

VERSAR, Inc. CHAIN OF CUSTODY / SAMPLE INFORMATION FORM

7446/42/6774-99/884826
4216813/884832

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LOT #		Sampler	Katherine Dillow
Contact name	Katherine Dillow	Project Name	Fenwick Island
Contact phone	410-740-6116	Contract/P.O Number	110653-0048-001
Invoice AdP Tess	Same as above	Sample Turnaround Time	Normal

LL USE LAB ID NO:	Grab/ Composite	Station Location	Matrix	Container Description/ Preservation Status	# of Containers	Date	Time	Analyses Required/Comments
	Grab	EQUIPMENTBLANK	w		10	2/13/04	1400	TSS (prefilter), TDS, TAL Inorganics, TCL Semivolatile Organics, TCL Pesticides/PCBs, Oil and Grease

Transferred by:	Received by:	Date	Time
Transferred by:	Received by:	Date	Time
Transferred by:	Received by:	Date 2/14/04	Time 0900

Cooler Receipt Information (LAB USE ONLY)

Sufficient ice? Yes/No If No, temp.= _____

Sample containers pres'd? Yes/No If No, explain

Custody Seal present/intact? Yes/No

Initials: Date: 2/14/04

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216774

EVC-2 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 12:59
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EVC-2

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.		0.0033	mg/kg	1
01643	Aluminum	7429-90-5	6,630.		3.36	mg/kg	1
01650	Calcium	7440-70-2	241.		1.42	mg/kg	1
01654	Iron	7439-89-6	1,890.		5.55	mg/kg	1
01657	Magnesium	7439-95-4	618.		2.25	mg/kg	1
01662	Potassium	7440-09-7	427.		4.22	mg/kg	1
01667	Sodium	7440-23-5	2,140.		53.6	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.06	mg/kg	1
06935	Arsenic	7440-38-2	0.632	J	0.568	mg/kg	1
06936	Selenium	7782-49-2	0.593	J	0.534	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.749	mg/kg	1
06946	Barium	7440-39-3	6.80		0.0363	mg/kg	1
06947	Beryllium	7440-41-7	0.179	J	0.0670	mg/kg	1
06949	Cadmium	7440-43-9	N.D.		0.0613	mg/kg	1
06951	Chromium	7440-47-3	7.55		0.227	mg/kg	1
06952	Cobalt	7440-48-4	0.611		0.159	mg/kg	1
06953	Copper	7440-50-8	1.04	J	0.216	mg/kg	1
06955	Lead	7439-92-1	1.59	J	0.897	mg/kg	1
06958	Manganese	7439-96-5	11.4		0.0431	mg/kg	1
06961	Nickel	7440-02-0	2.81		0.227	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.170	mg/kg	1
06971	Vanadium	7440-62-2	7.22		0.182	mg/kg	1
06972	Zinc	7440-66-6	7.75		0.204	mg/kg	1
00111	Moisture	n.a.	15.3		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	N.D.		508.	mg/kg	1
00394	pH	n.a.	8.5		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.60	ug/kg	1

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216774

EVC-2 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 12:59
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EVC-2

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.39	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.39	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.72	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.7	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.39	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.68	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.52	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.39	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.39	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.4	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.9	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.1	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.7	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.1	ug/kg	1
01998	PCB-1254	11097-69-1	38.	3.9	ug/kg	1
01999	PCB-1260	11096-82-5	40.	3.9	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.39	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.35	ug/kg	1
	Due to interfering peaks on the chromatogram, the values reported represent the lowest reporting limits obtainable for endrin and endrin aldehyde. Despite numerous cleanup methods, we were unable to reach our usual reporting limits.					
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	39.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	39.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	39.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	39.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	39.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	79.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216774

EVC-2 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 12:59
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EVC-2

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03746	2-Nitrophenol	88-75-5	N.D.	39.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	39.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	39.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	39.	ug/kg	1
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	39.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	39.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	39.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	39.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	39.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	39.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	39.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	39.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	79.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	39.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	39.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	79.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	39.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	39.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	79.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	39.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	39.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	39.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	39.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	39.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	79.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	39.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	790.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	39.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	39.	ug/kg	1

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216774

EVC-2 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 12:59
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EVC-2

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	39.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	79.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	39.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine. The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	39.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	39.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	39.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	39.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	79.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	39.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	79.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	39.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	39.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	79.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	79.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	39.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	39.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	39.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	39.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	39.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	39.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	79.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	39.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	79.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	39.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:36	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1

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Lancaster Laboratories Sample No. SW 4216774

EVC-2 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 12:59
Discard: 03/27/2004

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Columbia MD 21045

EVC-2

01657	Magnesium	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06935	Arsenic	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 19:41	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 09:20	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 15:17	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/02/2004 11:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 20:00	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 10:24	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/20/2004 06:09	Linda M Hartenstine	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/20/2004 06:09	Linda M Hartenstine	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216775

EVC-4 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 12:59
Discard: 03/27/2004

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Columbia MD 21045

EVC-4

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.		0.0032	mg/kg	1
01643	Aluminum	7429-90-5	1,540.		3.44	mg/kg	1
01650	Calcium	7440-70-2	615.		1.45	mg/kg	1
01654	Iron	7439-89-6	1,800.		5.68	mg/kg	1
01657	Magnesium	7439-95-4	558.		2.30	mg/kg	1
01662	Potassium	7440-09-7	252.		4.32	mg/kg	1
01667	Sodium	7440-23-5	1,970.		54.8	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.08	mg/kg	1
06935	Arsenic	7440-38-2	1.08	J	0.581	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.546	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.767	mg/kg	1
06946	Barium	7440-39-3	2.16		0.0372	mg/kg	1
06947	Beryllium	7440-41-7	N.D.		0.0685	mg/kg	1
06949	Cadmium	7440-43-9	N.D.		0.0627	mg/kg	1
06951	Chromium	7440-47-3	3.27		0.232	mg/kg	1
06952	Cobalt	7440-48-4	0.850		0.163	mg/kg	1
06953	Copper	7440-50-8	0.634	J	0.221	mg/kg	1
06955	Lead	7439-92-1	1.57	J	0.918	mg/kg	1
06958	Manganese	7439-96-5	12.2		0.0441	mg/kg	1
06961	Nickel	7440-02-0	1.51		0.232	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.174	mg/kg	1
06971	Vanadium	7440-62-2	5.47		0.186	mg/kg	1
06972	Zinc	7440-66-6	6.41		0.209	mg/kg	1
00111	Moisture	n.a.	13.9		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	N.D.		499.	mg/kg	1
00394	pH	n.a.	8.6		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.59	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216775

EVC-4 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

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Discard: 03/27/2004

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EVC-4

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.		0.38	ug/kg	1
01222	Dieldrin	60-57-1	N.D.		0.38	ug/kg	1
01223	Endrin	72-20-8	N.D.		0.58	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.		4.6	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.		0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.		0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.		0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.		0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.		0.38	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.		0.67	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.		13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.		0.51	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.		0.38	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.		0.38	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.		1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.		3.8	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.		12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.		5.0	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.		4.6	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.		7.0	ug/kg	1
01998	PCB-1254	11097-69-1	8.3	J	3.8	ug/kg	1
01999	PCB-1260	11096-82-5	7.9	J	3.8	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.		0.38	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.		0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.		0.35	ug/kg	1
04688	TCL SW846 Semivolatiles Soil						
01185	Phenol	108-95-2	N.D.		39.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.		39.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.		39.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.		39.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.		39.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.		77.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.		39.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.		39.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.		39.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.		39.	ug/kg	1

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2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
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Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216775

EVC-4 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 12:59
Discard: 03/27/2004

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Columbia MD 21045

EVC-4

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	39.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	39.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	39.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	39.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	39.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	39.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	39.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	39.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	77.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	39.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	39.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	77.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	39.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	39.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	77.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	39.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	39.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	39.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	39.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	39.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	77.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	39.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	770.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	39.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	39.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	39.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	77.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	39.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

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2425 New Holland Pike
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Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216775

EVC-4 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

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Submitted: 02/14/2004 09:00
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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EVC-4

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	39.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	39.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	39.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	39.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	77.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	39.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	77.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	39.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	39.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	77.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	77.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	39.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	39.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	39.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	39.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	39.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	39.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	77.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	39.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	77.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	39.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Analysis Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:38	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1

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EVC-4 Composite Sediment Sample
Fenwick Island

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9200 Rumsey Road
Columbia MD 21045

EVC-4

06935	Arsenic	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 19:47	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 09:27	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 15:17	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/02/2004 11:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 20:00	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 10:44	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/20/2004 11:39	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/20/2004 11:39	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216776

EVC-2-0 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 12:59
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EVC20

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	0.0043 J	0.0032	mg/kg	1
01643	Aluminum	7429-90-5	1,630.	3.43	mg/kg	1
01650	Calcium	7440-70-2	397.	1.45	mg/kg	1
01654	Iron	7439-89-6	1,530.	5.67	mg/kg	1
01657	Magnesium	7439-95-4	514.	2.29	mg/kg	1
01662	Potassium	7440-09-7	253.	4.31	mg/kg	1
01667	Sodium	7440-23-5	2,080.	54.7	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.08	mg/kg	1
06935	Arsenic	7440-38-2	1.16	0.579	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.545	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.765	mg/kg	1
06946	Barium	7440-39-3	2.19	0.0371	mg/kg	1
06947	Beryllium	7440-41-7	N.D.	0.0684	mg/kg	1
06949	Cadmium	7440-43-9	N.D.	0.0626	mg/kg	1
06951	Chromium	7440-47-3	3.33	0.232	mg/kg	1
06952	Cobalt	7440-48-4	0.539 J	0.162	mg/kg	1
06953	Copper	7440-50-8	1.12 J	0.220	mg/kg	1
06955	Lead	7439-92-1	2.00 J	0.915	mg/kg	1
06958	Manganese	7439-96-5	12.0	0.0440	mg/kg	1
06961	Nickel	7440-02-0	1.35	0.232	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.174	mg/kg	1
06971	Vanadium	7440-62-2	5.20	0.185	mg/kg	1
06972	Zinc	7440-66-6	7.20	0.209	mg/kg	1
00111	Moisture	n.a.	15.4	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	N.D.	508.	mg/kg	1
00394	pH	n.a.	8.6	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.60	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216776

EVC-2-0 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 12:59
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EVC20

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.39	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.39	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.59	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.7	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.39	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.69	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.52	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.39	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.39	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.9	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.1	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.7	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.1	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	3.9	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	3.9	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.39	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.35	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	39.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	39.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	39.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	39.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	39.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	79.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	39.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	39.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	39.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	39.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216776

EVC-2-0 Composite Sediment Sample
Fenwick Island

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Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EVC20

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	39.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	39.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	39.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	39.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	39.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	39.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	39.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	39.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	79.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	39.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	39.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	79.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	39.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	39.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	79.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	39.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	39.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	39.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	39.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	39.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	79.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	39.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	790.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	39.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	39.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	39.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	79.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	39.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216776

EVC-2-0 Composite Sediment Sample
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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EVC20

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	39.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	39.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	39.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	39.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	79.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	39.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	79.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	39.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	39.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	79.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	79.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	39.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	39.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	39.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	39.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	39.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	39.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	79.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	39.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	79.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	39.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:39	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1

Lancaster Laboratories

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EVC-2-0 Composite Sediment Sample
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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EVC20

06935	Arsenic	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 20:03	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 09:46	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 15:17	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/02/2004 11:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 20:00	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 11:05	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/20/2004 12:37	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/20/2004 12:37	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216777

EVC-4-0 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:00
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EVC40

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.		0.0032	mg/kg	1
01643	Aluminum	7429-90-5	1,210.		3.46	mg/kg	1
01650	Calcium	7440-70-2	543.		1.46	mg/kg	1
01654	Iron	7439-89-6	2,100.		5.72	mg/kg	1
01657	Magnesium	7439-95-4	437.		2.32	mg/kg	1
01662	Potassium	7440-09-7	184.		4.35	mg/kg	1
01667	Sodium	7440-23-5	1,840.		55.2	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.09	mg/kg	1
06935	Arsenic	7440-38-2	2.25		0.585	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.550	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.772	mg/kg	1
06946	Barium	7440-39-3	1.49		0.0374	mg/kg	1
06947	Beryllium	7440-41-7	N.D.		0.0690	mg/kg	1
06949	Cadmium	7440-43-9	N.D.		0.0632	mg/kg	1
06951	Chromium	7440-47-3	2.63		0.234	mg/kg	1
06952	Cobalt	7440-48-4	0.903		0.164	mg/kg	1
06953	Copper	7440-50-8	0.494	J	0.222	mg/kg	1
06955	Lead	7439-92-1	1.76	J	0.924	mg/kg	1
06958	Manganese	7439-96-5	18.2		0.0444	mg/kg	1
06961	Nickel	7440-02-0	1.17		0.234	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.175	mg/kg	1
06971	Vanadium	7440-62-2	5.53		0.187	mg/kg	1
06972	Zinc	7440-66-6	6.93		0.211	mg/kg	1
00111	Moisture	n.a.	14.5		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	522.	J	503.	mg/kg	1
00394	pH	n.a.	8.5		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.60	ug/kg	1

MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216777

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EVC40

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.		0.39	ug/kg	1
01222	Dieldrin	60-57-1	N.D.		0.39	ug/kg	1
01223	Endrin	72-20-8	N.D.		0.58	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.		4.7	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.		0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.		0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.		0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.		0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.		0.39	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.		0.68	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.		13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.		0.51	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.		0.39	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.		0.39	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.		1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.		3.9	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.		12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.		5.0	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.		4.7	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.		7.0	ug/kg	1
01998	PCB-1254	11097-69-1	16.	J	3.9	ug/kg	1
01999	PCB-1260	11096-82-5	20.		3.9	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.		0.39	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.		0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.		0.35	ug/kg	1
04688	TCL SW846 Semivolatiles Soil						
01185	Phenol	108-95-2	N.D.		39.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.		39.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.		39.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.		39.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.		39.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.		78.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.		39.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.		39.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.		39.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.		39.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216777

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EVC40

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	39.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	39.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	39.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	39.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	39.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	39.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	39.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	39.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	78.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	39.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	39.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	78.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	39.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	39.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	78.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	39.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	39.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	39.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	39.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	39.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	78.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	39.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	780.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	39.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	39.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	39.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	78.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	39.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216777

EVC-4-0 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:00
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EVC40

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	39.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	39.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	39.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	39.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	78.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	39.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	78.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	39.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	39.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	78.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	78.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	39.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	39.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	39.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	39.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	39.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	39.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	78.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	39.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	78.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	39.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:41	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
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Lancaster Laboratories Sample No. SW 4216777

EVC-4-0 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

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9200 Rumsey Road
Columbia MD 21045

EVC40

06935	Arsenic	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 20:08	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 09:52	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 15:17	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/02/2004 11:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 20:00	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 11:26	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/20/2004 13:36	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/20/2004 13:36	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216778

FVC-1 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:00
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-1

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.	0.0032	mg/kg	1
01643	Aluminum	7429-90-5	11,400.	3.49	mg/kg	1
01650	Calcium	7440-70-2	181.	1.47	mg/kg	1
01654	Iron	7439-89-6	2,090.	5.76	mg/kg	1
01657	Magnesium	7439-95-4	490.	2.33	mg/kg	1
01662	Potassium	7440-09-7	324.	4.38	mg/kg	1
01667	Sodium	7440-23-5	1,880.	55.6	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.10	mg/kg	1
06935	Arsenic	7440-38-2	0.666 J	0.589	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.554	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.778	mg/kg	1
06946	Barium	7440-39-3	8.50	0.0377	mg/kg	1
06947	Beryllium	7440-41-7	0.158 J	0.0695	mg/kg	1
06949	Cadmium	7440-43-9	N.D.	0.0636	mg/kg	1
06951	Chromium	7440-47-3	7.62	0.236	mg/kg	1
06952	Cobalt	7440-48-4	3.678	0.165	mg/kg	1
06953	Copper	7440-50-8	1.30	0.224	mg/kg	1
06955	Lead	7439-92-1	2.70	0.931	mg/kg	1
06958	Manganese	7439-96-5	9.83	0.0448	mg/kg	1
06961	Nickel	7440-02-0	3.24	0.236	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.177	mg/kg	1
06971	Vanadium	7440-62-2	9.28	0.189	mg/kg	1
06972	Zinc	7440-66-6	7.56	0.212	mg/kg	1
00111	Moisture	n.a.	16.0	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	N.D.	512.	mg/kg	1
00394	pH	n.a.	8.2	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.61	ug/kg	1

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Lancaster Laboratories Sample No. SW 4216778

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Fenwick Island

Collected:02/12/2004 by KD

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9200 Rumsey Road
Columbia MD 21045

FVC-1

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.39	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.39	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.60	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.8	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.39	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.69	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.52	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.39	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.39	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.9	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.1	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.8	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.1	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	3.9	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	3.9	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.39	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.36	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	40.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	40.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	40.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	40.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	40.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	79.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	40.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	40.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	40.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	40.	ug/kg	1

Lancaster Laboratories

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-1

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	40.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	40.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	40.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	40.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	40.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	40.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	40.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	40.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	79.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	40.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	40.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	79.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	40.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	40.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	79.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	40.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	40.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	40.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	40.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	40.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	79.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	40.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	790.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	40.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	40.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	40.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	79.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	40.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

MEMBER ACIL
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2425 New Holland Pike
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FVC-1

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	40.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	40.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	40.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	40.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	79.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	40.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	79.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	40.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	40.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	79.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	79.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	40.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	40.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	40.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	40.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	40.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	40.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	79.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	40.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	79.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	40.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:42	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1

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Lancaster Laboratories Sample No. SW 4216778

FVC-1 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:00
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-1

06935	Arsenic	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 20:14	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 09:59	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 15:17	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/02/2004 11:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 20:00	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 11:46	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/19/2004 08:09	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/19/2004 08:09	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216779

FVC-2 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:00
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-2

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.	0.0033	mg/kg	1
01643	Aluminum	7429-90-5	12,500.	3.54	mg/kg	1
01650	Calcium	7440-70-2	295.	1.49	mg/kg	1
01654	Iron	7439-89-6	3,310.	5.84	mg/kg	1
01657	Magnesium	7439-95-4	949.	2.37	mg/kg	1
01662	Potassium	7440-09-7	571.	4.44	mg/kg	1
01667	Sodium	7440-23-5	2,240.	56.4	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.11	mg/kg	1
06935	Arsenic	7440-38-2	0.838 J	0.597	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.562	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.789	mg/kg	1
06946	Barium	7440-39-3	11.3	0.0382	mg/kg	1
06947	Beryllium	7440-41-7	0.283 J	0.0705	mg/kg	1
06949	Cadmium	7440-43-9	N.D.	0.0645	mg/kg	1
06951	Chromium	7440-47-3	10.6	0.239	mg/kg	1
06952	Cobalt	7440-48-4	1.33	0.167	mg/kg	1
06953	Copper	7440-50-8	2.31	0.227	mg/kg	1
06955	Lead	7439-92-1	3.22	0.944	mg/kg	1
06958	Manganese	7439-96-5	23.1	0.0454	mg/kg	1
06961	Nickel	7440-02-0	4.50	0.239	mg/kg	1
06966	Silver	7440-22-4	0.289 J	0.179	mg/kg	1
06971	Vanadium	7440-62-2	19.1	0.191	mg/kg	1
06972	Zinc	7440-66-6	13.2	0.215	mg/kg	1
00111	Moisture	n.a.	16.3	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	N.D.	514.	mg/kg	1
00394	pH	n.a.	8.2	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.61	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216779

FVC-2 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:00
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-2

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.39	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.39	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.60	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.8	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.39	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.69	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.53	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.39	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.39	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.9	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.1	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.8	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.2	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	3.9	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	3.9	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.39	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	3.7	0.36	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	40.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	40.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	40.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	40.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	40.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	80.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	40.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	40.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	40.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	40.	ug/kg	1

MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Lancaster Laboratories Sample No. SW 4216779

FVC-2 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-2

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	40.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	40.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	40.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	40.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	40.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	40.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	40.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	40.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	80.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	40.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	40.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	80.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	40.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	40.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	80.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	40.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	40.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	40.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	40.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	40.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	80.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	40.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	800.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	40.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	40.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	40.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	80.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	40.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

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2425 New Holland Pike
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Lancaster Laboratories Sample No. SW 4216779

FVC-2 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-2

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	40.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	40.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	40.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	40.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	80.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	40.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	80.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	40.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	40.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	80.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	80.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	40.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	40.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	40.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	40.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	40.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	40.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	80.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	40.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	80.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	40.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:44	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216779

FVC-2 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

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Columbia MD 21045

FVC-2

06935	Arsenic	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 20:19	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 10:05	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 15:17	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/02/2004 11:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 20:00	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 12:48	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/20/2004 14:35	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/20/2004 14:35	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216780

FVC-3 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:01
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-3

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.		0.0034	mg/kg	1
01643	Aluminum	7429-90-5	7,570.		3.55	mg/kg	1
01650	Calcium	7440-70-2	445.		1.50	mg/kg	1
01654	Iron	7439-89-6	3,230.		5.87	mg/kg	1
01657	Magnesium	7439-95-4	1,070.		2.38	mg/kg	1
01662	Potassium	7440-09-7	573.		4.46	mg/kg	1
01667	Sodium	7440-23-5	1,980.		56.6	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.12	mg/kg	1
06935	Arsenic	7440-38-2	0.950	J	0.600	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.564	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.792	mg/kg	1
06946	Barium	7440-39-3	31.8		0.0384	mg/kg	1
06947	Beryllium	7440-41-7	0.134	J	0.0708	mg/kg	1
06949	Cadmium	7440-43-9	0.0720	J	0.0648	mg/kg	1
06951	Chromium	7440-47-3	7.68		0.240	mg/kg	1
06952	Cobalt	7440-48-4	2.01		0.168	mg/kg	1
06953	Copper	7440-50-8	2.73		0.228	mg/kg	1
06955	Lead	7439-92-1	1.98	J	0.948	mg/kg	1
06958	Manganese	7439-96-5	27.5		0.0456	mg/kg	1
06961	Nickel	7440-02-0	4.81		0.240	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.180	mg/kg	1
06971	Vanadium	7440-62-2	10.4		0.192	mg/kg	1
06972	Zinc	7440-66-6	13.6		0.216	mg/kg	1
00111	Moisture	n.a.	17.5		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	1,670.		521.	mg/kg	1
00394	pH	n.a.	8.2		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.21	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.21	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.62	ug/kg	1

MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216780

FVC-3 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:01
Discard: 03/27/2004

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Columbia MD 21045

FVC-3

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.		0.40	ug/kg	1
01222	Dieldrin	60-57-1	N.D.		0.40	ug/kg	1
01223	Endrin	72-20-8	N.D.		0.61	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.		4.8	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.		0.21	ug/kg	1
01982	Beta BHC	319-85-7	N.D.		0.21	ug/kg	1
01983	Delta BHC	319-86-8	N.D.		0.21	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.		0.21	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.		0.40	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.		0.70	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.		13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.		0.53	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.		0.40	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.		0.40	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.		1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.		4.0	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.		12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.		5.2	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.		4.8	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.		7.3	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.		4.0	ug/kg	1
01999	PCB-1260	11096-82-5	7.3	J	4.0	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.		0.40	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.		0.21	ug/kg	1
03026	Gamma Chlordane	5103-74-2	1.4		0.36	ug/kg	1
04688	TCL SW846 Semivolatiles Soil						
01185	Phenol	108-95-2	N.D.		40.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.		40.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.		40.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.		40.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.		40.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.		81.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.		40.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.		40.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.		40.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.		40.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216780

FVC-3 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:01
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-3

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	40.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	40.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	40.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	40.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	40.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	40.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	40.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	40.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	81.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	40.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	40.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	81.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	40.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	40.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	81.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	40.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	40.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	40.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	40.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	40.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	81.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	40.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	810.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	40.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	40.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	40.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	81.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	40.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216780

FVC-3 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:01
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-3

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	40.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	40.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	40.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	40.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	81.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	40.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	81.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	40.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	40.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	81.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	81.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	40.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	40.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	40.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	40.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	40.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	40.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	81.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	40.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	81.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	40.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:45	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216780

FVC-3 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-3

06935	Arsenic	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 20:25	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 10:12	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/02/2004 11:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 20:00	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 13:09	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/20/2004 15:33	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/20/2004 15:33	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216781

FVC-4 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:01
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-4

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	0.0090 J	0.0032	mg/kg	1
01643	Aluminum	7429-90-5	8,340.	3.36	mg/kg	1
01650	Calcium	7440-70-2	564.	1.42	mg/kg	1
01654	Iron	7439-89-6	5,920.	5.55	mg/kg	1
01657	Magnesium	7439-95-4	1,930.	2.25	mg/kg	1
01662	Potassium	7440-09-7	1,210.	4.22	mg/kg	1
01667	Sodium	7440-23-5	2,220.	53.6	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.06	mg/kg	1
06935	Arsenic	7440-38-2	1.68	0.567	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.533	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.749	mg/kg	1
06946	Barium	7440-39-3	15.4	0.0363	mg/kg	1
06947	Beryllium	7440-41-7	0.261 J	0.0669	mg/kg	1
06949	Cadmium	7440-43-9	N.D.	0.0613	mg/kg	1
06951	Chromium	7440-47-3	12.7	0.227	mg/kg	1
06952	Cobalt	7440-48-4	3.04	0.159	mg/kg	1
06953	Copper	7440-50-8	4.65	0.216	mg/kg	1
06955	Lead	7439-92-1	3.59	0.896	mg/kg	1
06958	Manganese	7439-96-5	47.0	0.0431	mg/kg	1
06961	Nickel	7440-02-0	6.44	0.227	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.170	mg/kg	1
06971	Vanadium	7440-62-2	16.5	0.182	mg/kg	1
06972	Zinc	7440-66-6	22.3	0.204	mg/kg	1
00111	Moisture	n.a.	13.6	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	N.D.	498.	mg/kg	1
00394	pH	n.a.	8.5	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.59	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216781

FVC-4 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:01
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-4

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.38	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.38	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.58	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.6	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.38	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.67	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.51	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.38	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.38	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.8	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.0	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.6	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	6.9	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	3.8	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	3.8	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.38	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.35	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	39.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	39.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	39.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	39.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	39.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	77.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	39.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	39.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	39.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	39.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216781

FVC-4 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

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Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
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FVC-4

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	39.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	39.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	39.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	39.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	39.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	39.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	39.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	39.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	77.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	39.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	39.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	77.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	39.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	39.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	77.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	39.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	39.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	39.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	39.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	39.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	77.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	39.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	770.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	39.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	39.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	39.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	77.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	39.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

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2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Lancaster Laboratories Sample No. SW 4216781

FVC-4 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:01
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-4

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	39.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	39.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	39.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	39.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	77.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	39.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	77.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	39.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	39.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	77.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	77.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	39.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	39.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	39.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	39.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	39.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	39.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	77.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	39.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	77.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	39.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:46	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1

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Lancaster Laboratories Sample No. SW 4216781

FVC-4 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

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FVC-4

06935	Arsenic	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 20:30	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 10:18	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/02/2004 11:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 13:29	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/20/2004 16:32	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/20/2004 16:32	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216488

FVC-5 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/13/2004 16:25
Reported: 03/04/2004 at 12:48
Discard: 03/19/2004

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9200 Rumsey Road
Columbia MD 21045

FVC-5

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	0.0064 J	0.0033	mg/kg	1
01643	Aluminum	7429-90-5	7,270.	3.40	mg/kg	1
01650	Calcium	7440-70-2	820.	1.44	mg/kg	1
01654	Iron	7439-89-6	5,410.	5.63	mg/kg	1
01657	Magnesium	7439-95-4	1,720.	2.28	mg/kg	1
01662	Potassium	7440-09-7	983.	4.28	mg/kg	1
01667	Sodium	7440-23-5	2,260.	54.3	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.07	mg/kg	1
06935	Arsenic	7440-38-2	3.01	0.575	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.541	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.759	mg/kg	1
06946	Barium	7440-39-3	33.1	0.0368	mg/kg	1
06947	Beryllium	7440-41-7	0.373 J	0.0679	mg/kg	1
06949	Cadmium	7440-43-9	N.D.	0.0621	mg/kg	1
06951	Chromium	7440-47-3	13.5	0.230	mg/kg	1
06952	Cobalt	7440-48-4	6.83	0.161	mg/kg	1
06953	Copper	7440-50-8	3.65	0.219	mg/kg	1
06955	Lead	7439-92-1	2.72	0.909	mg/kg	1
06958	Manganese	7439-96-5	49.6	0.0437	mg/kg	1
06961	Nickel	7440-02-0	11.2	0.230	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.173	mg/kg	1
06971	Vanadium	7440-62-2	20.0	0.184	mg/kg	1
06972	Zinc	7440-66-6	27.6	0.207	mg/kg	1
00111	Moisture	n.a.	15.6	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	N.D.	509.	mg/kg	1
00394	pH	n.a.	8.5	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.60	ug/kg	1

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Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216488

FVC-5 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/13/2004 16:25
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Discard: 03/19/2004

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CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.		0.39	ug/kg	1
01222	Dieldrin	60-57-1	N.D.		0.39	ug/kg	1
01223	Endrin	72-20-8	N.D.		0.59	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.		4.7	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.		0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.		0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.		0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.		0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.		0.39	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.		0.69	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.		13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.		0.52	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.		0.39	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.		0.39	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.		1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.		3.9	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.		12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.		5.1	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.		4.7	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.		7.1	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.		3.9	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.		3.9	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.		0.39	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.		0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	0.71	J	0.36	ug/kg	1
04688	TCL SW846 Semivolatiles Soil						
01185	Phenol	108-95-2	N.D.		39.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.		39.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.		39.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.		39.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.		39.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.		79.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.		39.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.		39.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.		39.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.		39.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216488

FVC-5 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

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Submitted: 02/13/2004 16:25
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Discard: 03/19/2004

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Columbia MD 21045

FVC-5

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	39.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	39.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	39.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	39.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	39.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	39.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	39.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	39.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	79.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	39.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	39.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	79.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	39.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	39.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	79.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	39.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	39.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	39.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	39.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	39.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	79.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	39.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	790.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	39.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	39.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	39.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	79.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	39.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216488

FVC-5 Composite Sediment Sample
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FVC-5

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	39.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	39.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	39.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	39.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	79.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	39.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	79.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	39.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	39.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	79.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	79.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	39.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	39.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	39.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	39.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	39.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	39.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	79.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	39.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	79.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	39.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:28	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1

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FVC-5

06935	Arsenic	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 19:19	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 08:55	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:27	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	02/24/2004 10:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 20:00	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 07:59	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/20/2004 02:15	Linda M Hartenstine	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/20/2004 02:15	Linda M Hartenstine	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216782

FVC-6 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:02
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-6

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	0.0050	J	0.0034	mg/kg	1
01643	Aluminum	7429-90-5	4,200.		3.52	mg/kg	1
01650	Calcium	7440-70-2	662.		1.49	mg/kg	1
01654	Iron	7439-89-6	4,500.		5.81	mg/kg	1
01657	Magnesium	7439-95-4	1,310.		2.35	mg/kg	1
01662	Potassium	7440-09-7	695.		4.42	mg/kg	1
01667	Sodium	7440-23-5	2,300.		56.1	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.11	mg/kg	1
06935	Arsenic	7440-38-2	0.927	J	0.594	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.559	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.784	mg/kg	1
06946	Barium	7440-39-3	7.99		0.0380	mg/kg	1
06947	Beryllium	7440-41-7	0.374	J	0.0701	mg/kg	1
06949	Cadmium	7440-43-9	N.D.		0.0642	mg/kg	1
06951	Chromium	7440-47-3	7.50		0.238	mg/kg	1
06952	Cobalt	7440-48-4	3.14		0.166	mg/kg	1
06953	Copper	7440-50-8	2.08		0.226	mg/kg	1
06955	Lead	7439-92-1	2.50		0.939	mg/kg	1
06958	Manganese	7439-96-5	39.3		0.0452	mg/kg	1
06961	Nickel	7440-02-0	6.04		0.238	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.178	mg/kg	1
06971	Vanadium	7440-62-2	11.6		0.190	mg/kg	1
06972	Zinc	7440-66-6	26.5		0.214	mg/kg	1
00111	Moisture	n.a.	18.3		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	961.	J	526.	mg/kg	1
00394	pH	n.a.	8.4		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.21	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.21	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.62	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216782

FVC-6 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:02
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-6

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.40	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.40	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.61	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.9	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.21	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.21	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.21	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.21	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.40	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.71	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.54	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.40	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.40	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	4.0	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.3	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.9	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.3	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	4.0	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	4.0	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.40	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.21	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.37	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	41.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	41.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	41.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	41.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	41.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	82.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	41.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	41.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	41.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	41.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216782

FVC-6 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:02
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-6

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	41.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	41.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	41.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	41.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	41.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	41.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	41.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	41.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	82.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	41.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	41.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	82.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	41.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	41.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	82.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	41.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	41.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	41.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	41.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	41.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	82.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	41.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	820.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	41.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	41.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	41.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	82.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	41.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216782

FVC-6 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:02
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-6

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	41.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	41.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	41.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	41.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	82.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	41.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	82.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	41.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	41.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	82.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	82.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	41.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	41.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	41.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	41.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	41.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	41.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	82.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	41.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	82.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	41.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:50	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216782

FVC-6 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:02
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-6

06935	Arsenic	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 20:36	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 10:25	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/05/2004 11:45	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 13:50	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/22/2004 18:47	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/22/2004 18:47	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216818

FVC-7 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 12:55
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-7

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.		0.0034	mg/kg	1
01643	Aluminum	7429-90-5	5,870.		3.49	mg/kg	1
01650	Calcium	7440-70-2	923.		1.47	mg/kg	1
01654	Iron	7439-89-6	5,850.		5.76	mg/kg	1
01657	Magnesium	7439-95-4	1,780.		2.33	mg/kg	1
01662	Potassium	7440-09-7	398.		4.38	mg/kg	1
01667	Sodium	7440-23-5	2,280.		55.6	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.10	mg/kg	1
06935	Arsenic	7440-38-2	3.41		0.589	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.554	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.778	mg/kg	1
06946	Barium	7440-39-3	9.01		0.0377	mg/kg	1
06947	Beryllium	7440-41-7	0.342	J	0.0695	mg/kg	1
06949	Cadmium	7440-43-9	0.148	J	0.0636	mg/kg	1
06951	Chromium	7440-47-3	9.93		0.236	mg/kg	1
06952	Cobalt	7440-48-4	5.17		0.165	mg/kg	1
06953	Copper	7440-50-8	3.73		0.224	mg/kg	1
06955	Lead	7439-92-1	3.10		0.931	mg/kg	1
06958	Manganese	7439-96-5	68.2		0.0448	mg/kg	1
06961	Nickel	7440-02-0	8.97		0.236	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.177	mg/kg	1
06971	Vanadium	7440-62-2	14.8		0.189	mg/kg	1
06972	Zinc	7440-66-6	25.2		0.212	mg/kg	1
00111	Moisture	n.a.	16.8		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	N.D.		517.	mg/kg	1
00394	pH	n.a.	8.2		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.61	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216818

FVC-7 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 12:55
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-7

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.40	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.40	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.60	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.8	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.40	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.70	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.53	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.40	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.40	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	4.0	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.2	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.8	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.2	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	4.0	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	4.0	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.40	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.36	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	40.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	40.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	40.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	40.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	40.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	80.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	40.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	40.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	40.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	40.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216818

FVC-7 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 12:55
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-7

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	40.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	40.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	40.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	40.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	40.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	40.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	40.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	40.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	80.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	40.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	40.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	80.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	40.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	40.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	80.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	40.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	40.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	40.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	40.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	40.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	80.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	40.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	800.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	40.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	40.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	40.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	80.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	40.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216818

FVC-7 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 12:55
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-7

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	40.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	40.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	40.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	40.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	80.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	40.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	80.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	40.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	40.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	80.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	80.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	40.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	40.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	40.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	40.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	40.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	40.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	80.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	40.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	80.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	40.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Analysis Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:41	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216818

FVC-7 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

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Reported: 03/12/2004 at 12:55
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-7

06935	Arsenic	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 14:01	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 06:09	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/09/2004 10:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 04:54	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/23/2004 15:14	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/23/2004 15:14	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216489

FVC-8 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/13/2004 16:25
Reported: 03/04/2004 at 12:48
Discard: 03/19/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-8

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.		0.0033	mg/kg	1
01643	Aluminum	7429-90-5	1,970.		3.36	mg/kg	1
01650	Calcium	7440-70-2	719.		1.42	mg/kg	1
01654	Iron	7439-89-6	2,520.		5.56	mg/kg	1
01657	Magnesium	7439-95-4	667.		2.25	mg/kg	1
01662	Potassium	7440-09-7	317.		4.23	mg/kg	1
01667	Sodium	7440-23-5	1,980.		53.6	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.06	mg/kg	1
06935	Arsenic	7440-38-2	1.17		0.568	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.534	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.750	mg/kg	1
06946	Barium	7440-39-3	2.60		0.0364	mg/kg	1
06947	Beryllium	7440-41-7	N.D.		0.0670	mg/kg	1
06949	Cadmium	7440-43-9	N.D.		0.0613	mg/kg	1
06951	Chromium	7440-47-3	3.92		0.227	mg/kg	1
06952	Cobalt	7440-48-4	1.00		0.159	mg/kg	1
06953	Copper	7440-50-8	0.619	J	0.216	mg/kg	1
06955	Lead	7439-92-1	1.21	J	0.897	mg/kg	1
06958	Manganese	7439-96-5	13.8		0.0432	mg/kg	1
06961	Nickel	7440-02-0	1.71		0.227	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.170	mg/kg	1
06971	Vanadium	7440-62-2	6.71		0.182	mg/kg	1
06972	Zinc	7440-66-6	6.26		0.204	mg/kg	1
00111	Moisture	n.a.	13.7		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	N.D.		498.	mg/kg	1
00394	pH	n.a.	8.6		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.59	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216489

FVC-8 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

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Discard: 03/19/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-8

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.38	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.38	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.58	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.6	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.38	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.67	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.51	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.38	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.38	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.8	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.0	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.6	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.0	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	3.8	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	3.8	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.38	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.35	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	39.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	39.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	39.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	39.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	39.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	77.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	39.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	39.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	39.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	39.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216489

FVC-8 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

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Discard: 03/19/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-8

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	39.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	39.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	39.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	39.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	39.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	39.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	39.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	39.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	77.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	39.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	39.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	77.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	39.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	39.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	77.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	39.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	39.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	39.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	39.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	39.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	77.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	39.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	770.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	39.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	39.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	39.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	77.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	39.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216489

FVC-8 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/13/2004 16:25
Reported: 03/04/2004 at 12:48
Discard: 03/19/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-8

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	39.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	39.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	39.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	39.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	77.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	39.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	77.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	39.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	39.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	77.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	77.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	39.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	39.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	39.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	39.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	39.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	39.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	77.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	39.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	77.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	39.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:29	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216489

FVC-8 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/13/2004 16:25
Reported: 03/04/2004 at 12:48
Discard: 03/19/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-8

06935	Arsenic	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 19:25	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 09:01	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:27	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	02/24/2004 10:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 20:00	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 08:20	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/20/2004 03:14	Linda M Hartenstine	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/20/2004 03:14	Linda M Hartenstine	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216783

FVC-9 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:02
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-9

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.	0.0034	mg/kg	1
01643	Aluminum	7429-90-5	21,300.	3.62	mg/kg	1
01650	Calcium	7440-70-2	253.	1.53	mg/kg	1
01654	Iron	7439-89-6	3,740.	5.98	mg/kg	1
01657	Magnesium	7439-95-4	1,020.	2.42	mg/kg	1
01662	Potassium	7440-09-7	730.	4.55	mg/kg	1
01667	Sodium	7440-23-5	2,730.	57.7	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.14	mg/kg	1
06935	Arsenic	7440-38-2	0.919 J	0.611	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.575	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.807	mg/kg	1
06946	Barium	7440-39-3	15.4	0.0391	mg/kg	1
06947	Beryllium	7440-41-7	0.500 J	0.0721	mg/kg	1
06949	Cadmium	7440-43-9	N.D.	0.0660	mg/kg	1
06951	Chromium	7440-47-3	16.1	0.244	mg/kg	1
06952	Cobalt	7440-48-4	1.76	0.171	mg/kg	1
06953	Copper	7440-50-8	3.41	0.232	mg/kg	1
06955	Lead	7439-92-1	4.54	0.966	mg/kg	1
06958	Manganese	7439-96-5	17.3	0.0464	mg/kg	1
06961	Nickel	7440-02-0	6.01	0.244	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.183	mg/kg	1
06971	Vanadium	7440-62-2	16.6	0.196	mg/kg	1
06972	Zinc	7440-66-6	18.9	0.220	mg/kg	1
00111	Moisture	n.a.	19.0	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	N.D.	531.	mg/kg	1
00394	pH	n.a.	8.4	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.21	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.21	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.63	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216783

FVC-9 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:02
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-9

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.41	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.41	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.62	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.9	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.21	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.21	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.21	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.21	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.41	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.72	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	14.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.54	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.41	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.41	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	4.1	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.3	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.9	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.4	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	4.1	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	4.1	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.41	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.21	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.37	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	41.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	41.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	41.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	41.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	41.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	82.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	41.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	41.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	41.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	41.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216783

FVC-9 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:02
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-9

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	41.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	41.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	41.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	41.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	41.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	41.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	41.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	41.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	82.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	210.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	41.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	41.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	82.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	41.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	41.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	82.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	41.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	41.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	41.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	41.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	41.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	210.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	82.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	210.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	41.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	820.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	210.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	41.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	41.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	41.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	82.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	41.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216783

FVC-9 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:02
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-9

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	41.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	41.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	41.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	41.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	82.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	41.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	82.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	41.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	41.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	82.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	210.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	82.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	41.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	41.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	41.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	41.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	41.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	41.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	82.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	41.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	82.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	41.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:51	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216783

FVC-9 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:02
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC-9

06935	Arsenic	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 18:03	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	2	02/19/2004 18:03	John P Hook	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 07:24	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/05/2004 11:45	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 14:11	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/22/2004 21:24	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/22/2004 21:24	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216784

FVC-10 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:02
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC10

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.		0.0032	mg/kg	1
01643	Aluminum	7429-90-5	4,280.		3.34	mg/kg	1
01650	Calcium	7440-70-2	401.		1.41	mg/kg	1
01654	Iron	7439-89-6	2,620.		5.51	mg/kg	1
01657	Magnesium	7439-95-4	704.		2.23	mg/kg	1
01662	Potassium	7440-09-7	429.		4.19	mg/kg	1
01667	Sodium	7440-23-5	1,850.		53.2	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.05	mg/kg	1
06935	Arsenic	7440-38-2	1.27		0.564	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.530	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.744	mg/kg	1
06946	Barium	7440-39-3	5.92		0.0361	mg/kg	1
06947	Beryllium	7440-41-7	0.156	J	0.0665	mg/kg	1
06949	Cadmium	7440-43-9	N.D.		0.0609	mg/kg	1
06951	Chromium	7440-47-3	5.78		0.226	mg/kg	1
06952	Cobalt	7440-48-4	1.61		0.158	mg/kg	1
06953	Copper	7440-50-8	0.979	J	0.214	mg/kg	1
06955	Lead	7439-92-1	1.58	J	0.891	mg/kg	1
06958	Manganese	7439-96-5	20.1		0.0428	mg/kg	1
06961	Nickel	7440-02-0	2.77		0.226	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.169	mg/kg	1
06971	Vanadium	7440-62-2	9.68		0.180	mg/kg	1
06972	Zinc	7440-66-6	7.97		0.203	mg/kg	1
00111	Moisture	n.a.	13.9		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	N.D.		499.	mg/kg	1
00394	pH	n.a.	8.2		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.59	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216784

FVC-10 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:02
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC10

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.38	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.38	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.58	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.6	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.38	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.67	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.51	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.38	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.38	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.8	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.0	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.6	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.0	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	3.8	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	3.8	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.38	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.35	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	39.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	39.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	39.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	39.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	39.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	77.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	39.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	39.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	39.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	39.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216784

FVC-10 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC10

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	39.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	39.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	39.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	39.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	39.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	39.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	39.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	39.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	77.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	39.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	39.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	77.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	39.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	39.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	77.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	39.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	39.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	39.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	39.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	39.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	77.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	39.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	770.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	39.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	39.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	39.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	77.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	39.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216784

FVC-10 Composite Sediment Sample
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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC10

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	39.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	39.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	39.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	39.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	77.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	39.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	77.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	39.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	39.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	77.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	77.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	39.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	39.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	39.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	39.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	39.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	39.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	77.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	39.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	77.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	39.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:19	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1

Lancaster Laboratories

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FVC-10 Composite Sediment Sample
Fenwick Island

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC10

06935	Arsenic	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 14:17	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 06:48	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/05/2004 11:45	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/19/2004 22:01	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/22/2004 22:16	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/22/2004 22:16	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216785

FVC-11 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:03
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC11

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.	0.0034	mg/kg	1
01643	Aluminum	7429-90-5	15,600.	3.63	mg/kg	1
01650	Calcium	7440-70-2	1,600.	1.53	mg/kg	1
01654	Iron	7439-89-6	13,100.	6.00	mg/kg	1
01657	Magnesium	7439-95-4	4,480.	2.43	mg/kg	1
01662	Potassium	7440-09-7	2,450.	4.56	mg/kg	1
01667	Sodium	7440-23-5	3,150.	57.9	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.14	mg/kg	1
06935	Arsenic	7440-38-2	3.96	0.613	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.577	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.810	mg/kg	1
06946	Barium	7440-39-3	38.0	0.0393	mg/kg	1
06947	Beryllium	7440-41-7	0.697	0.0724	mg/kg	1
06949	Cadmium	7440-43-9	0.269 J	0.0663	mg/kg	1
06951	Chromium	7440-47-3	26.1	0.245	mg/kg	1
06952	Cobalt	7440-48-4	6.61	0.172	mg/kg	1
06953	Copper	7440-50-8	12.1	0.233	mg/kg	1
06955	Lead	7439-92-1	3.60	0.969	mg/kg	1
06958	Manganese	7439-96-5	126.	0.0466	mg/kg	1
06961	Nickel	7440-02-0	16.8	0.245	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.184	mg/kg	1
06971	Vanadium	7440-62-2	38.8	0.196	mg/kg	1
06972	Zinc	7440-66-6	39.4	0.221	mg/kg	1
00111	Moisture	n.a.	18.5	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	N.D.	528.	mg/kg	1
00394	pH	n.a.	8.4	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.21	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.21	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.63	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216785

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Fenwick Island

Collected:02/12/2004 by KD

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC11

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.40	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.40	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.61	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.9	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.21	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.21	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.21	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.21	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.40	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.71	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.54	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.40	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.40	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	4.0	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.3	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.9	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.4	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	4.0	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	4.0	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.40	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.21	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.37	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	41.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	41.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	41.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	41.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	41.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	82.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	41.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	41.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	41.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	41.	ug/kg	1

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Fenwick Island

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Versar Incorporated - MD
9200 Rumsey Road
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FVC11

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	41.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	41.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	41.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	41.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	41.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	41.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	41.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	41.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	82.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	41.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	41.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	82.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	41.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	41.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	82.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	41.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	41.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	41.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	41.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	41.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	82.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	41.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	820.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	41.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	41.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	41.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	82.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	41.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

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2425 New Holland Pike
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Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216785

FVC-11 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:03
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

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CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	41.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	41.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	41.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	41.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	82.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	41.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	82.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	41.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	41.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	82.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	82.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	41.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	41.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	41.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	41.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	41.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	41.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	82.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	41.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	82.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	41.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:21	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1

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06935	Arsenic	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 14:21	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 07:05	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/05/2004 11:45	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/19/2004 23:03	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/22/2004 23:08	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/22/2004 23:08	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216786

FVC-12 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

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Reported: 03/12/2004 at 13:03
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CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.	0.0034	mg/kg	1
01643	Aluminum	7429-90-5	12,500.	3.57	mg/kg	1
01650	Calcium	7440-70-2	929.	1.51	mg/kg	1
01654	Iron	7439-89-6	14,000.	5.91	mg/kg	1
01657	Magnesium	7439-95-4	4,140.	2.39	mg/kg	1
01662	Potassium	7440-09-7	2,260.	4.49	mg/kg	1
01667	Sodium	7440-23-5	3,080.	57.0	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.12	mg/kg	1
06935	Arsenic	7440-38-2	4.98	0.604	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.568	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.797	mg/kg	1
06946	Barium	7440-39-3	27.5	0.0386	mg/kg	1
06947	Beryllium	7440-41-7	0.819	0.0713	mg/kg	1
06949	Cadmium	7440-43-9	0.239 J	0.0652	mg/kg	1
06951	Chromium	7440-47-3	19.5	0.242	mg/kg	1
06952	Cobalt	7440-48-4	6.65	0.169	mg/kg	1
06953	Copper	7440-50-8	9.44	0.229	mg/kg	1
06955	Lead	7439-92-1	5.87	0.954	mg/kg	1
06958	Manganese	7439-96-5	129.	0.0459	mg/kg	1
06961	Nickel	7440-02-0	14.9	0.242	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.181	mg/kg	1
06971	Vanadium	7440-62-2	24.8	0.193	mg/kg	1
06972	Zinc	7440-66-6	39.9	0.217	mg/kg	1
00111	Moisture	n.a.	17.2	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	N.D.	519.	mg/kg	1
00394	pH	n.a.	8.3	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.21	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.21	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.62	ug/kg	1

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CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.40	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.40	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.60	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.8	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.21	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.21	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.21	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.21	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.40	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.70	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.53	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.40	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.40	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	4.0	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.2	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.8	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.2	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	4.0	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	4.0	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.40	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.21	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.36	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	40.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	40.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	40.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	40.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	40.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	81.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	40.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	40.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	40.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	40.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216786

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CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	40.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	40.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	40.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	40.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	40.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	40.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	40.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	40.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	81.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	40.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	40.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	81.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	40.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	40.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	81.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	40.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	40.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	40.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	40.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	40.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	81.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	40.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	810.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	40.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	40.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	40.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	81.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	40.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

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CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	40.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	40.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	40.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	40.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	81.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	40.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	81.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	40.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	40.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	81.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	81.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	40.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	40.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	40.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	40.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	40.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	40.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	81.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	40.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	81.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	40.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:22	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1

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Columbia MD 21045

FVC12

06935	Arsenic	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 14:25	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 07:11	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/05/2004 11:45	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/19/2004 23:23	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/20/2004 17:30	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/20/2004 17:30	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216787

FVC-13 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:03
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC13

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.	0.0031	mg/kg	1
01643	Aluminum	7429-90-5	3,910.	3.34	mg/kg	1
01650	Calcium	7440-70-2	949.	1.41	mg/kg	1
01654	Iron	7439-89-6	4,870.	5.52	mg/kg	1
01657	Magnesium	7439-95-4	1,170.	2.23	mg/kg	1
01662	Potassium	7440-09-7	633.	4.20	mg/kg	1
01667	Sodium	7440-23-5	2,070.	53.3	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.05	mg/kg	1
06935	Arsenic	7440-38-2	3.63	0.564	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.530	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.745	mg/kg	1
06946	Barium	7440-39-3	6.01	0.0361	mg/kg	1
06947	Beryllium	7440-41-7	0.194 J	0.0666	mg/kg	1
06949	Cadmium	7440-43-9	0.0835 J	0.0609	mg/kg	1
06951	Chromium	7440-47-3	7.14	0.226	mg/kg	1
06952	Cobalt	7440-48-4	2.27	0.158	mg/kg	1
06953	Copper	7440-50-8	1.86	0.214	mg/kg	1
06955	Lead	7439-92-1	2.43	0.891	mg/kg	1
06958	Manganese	7439-96-5	48.0	0.0429	mg/kg	1
06961	Nickel	7440-02-0	4.57	0.226	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.169	mg/kg	1
06971	Vanadium	7440-62-2	11.0	0.181	mg/kg	1
06972	Zinc	7440-66-6	13.7	0.203	mg/kg	1
00111	Moisture	n.a.	13.1	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	N.D.	495.	mg/kg	1
00394	pH	n.a.	8.4	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.59	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216787

FVC-13 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:03
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC13

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.38	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.38	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.58	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.6	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.38	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.67	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.51	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.38	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.38	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.8	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	4.9	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.6	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	6.9	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	3.8	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	3.8	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.38	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.35	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	38.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	38.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	38.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	38.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	38.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	77.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	38.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	38.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	38.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	38.	ug/kg	1

MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216787

FVC-13 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:03
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC13

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	38.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	38.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	38.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	38.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	38.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	38.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	38.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	38.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	77.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	38.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	38.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	77.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	38.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	38.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	77.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	38.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	38.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	38.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	38.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	38.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	77.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	38.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	770.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	38.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	38.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	38.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	77.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	38.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

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Lancaster Laboratories, Inc.
2425 New Holland Pike
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Lancaster Laboratories Sample No. SW 4216787

FVC-13 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:03
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC13

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	38.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	38.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	38.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	38.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	77.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	38.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	77.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	38.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	38.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	77.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	77.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	38.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	38.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	38.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	38.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	38.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	38.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	77.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	38.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	77.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	38.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Analysis Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:23	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216787

FVC-13 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
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Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC13

06935	Arsenic	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 14:28	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 07:16	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/05/2004 11:45	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/19/2004 23:44	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/23/2004 00:00	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/23/2004 00:00	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216788

FVC-1-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:04
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-10

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.		0.0033	mg/kg	1
01643	Aluminum	7429-90-5	3,520.		3.45	mg/kg	1
01650	Calcium	7440-70-2	396.		1.46	mg/kg	1
01654	Iron	7439-89-6	3,850.		5.69	mg/kg	1
01657	Magnesium	7439-95-4	1,010.		2.31	mg/kg	1
01662	Potassium	7440-09-7	624.		4.33	mg/kg	1
01667	Sodium	7440-23-5	2,250.		55.0	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.08	mg/kg	1
06935	Arsenic	7440-38-2	1.60		0.582	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.547	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.768	mg/kg	1
06946	Barium	7440-39-3	6.85		0.0373	mg/kg	1
06947	Beryllium	7440-41-7	0.137	J	0.0687	mg/kg	1
06949	Cadmium	7440-43-9	N.D.		0.0629	mg/kg	1
06951	Chromium	7440-47-3	6.79		0.233	mg/kg	1
06952	Cobalt	7440-48-4	1.49		0.163	mg/kg	1
06953	Copper	7440-50-8	2.05		0.221	mg/kg	1
06955	Lead	7439-92-1	2.32	J	0.920	mg/kg	1
06958	Manganese	7439-96-5	24.6		0.0442	mg/kg	1
06961	Nickel	7440-02-0	3.22		0.233	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.175	mg/kg	1
06971	Vanadium	7440-62-2	11.9		0.186	mg/kg	1
06972	Zinc	7440-66-6	11.5		0.210	mg/kg	1
00111	Moisture	n.a.	15.8		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	N.D.		511.	mg/kg	1
00394	pH	n.a.	8.4		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.61	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216788

FVC-1-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:04
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-10

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.39	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.39	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.59	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.8	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.39	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.69	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.52	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.39	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.39	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.9	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.1	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.8	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.1	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	3.9	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	3.9	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.39	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.36	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	40.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	40.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	40.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	40.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	40.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	79.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	40.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	40.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	40.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	40.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216788

FVC-1-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:04
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-10

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	40.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	40.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	40.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	40.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	40.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	40.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	40.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	40.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	79.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	40.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	40.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	79.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	40.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	40.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	79.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	40.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	40.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	40.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	40.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	40.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	79.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	40.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	790.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	40.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	40.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	40.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	79.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	40.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216788

FVC-1-0 Composite Sediment Sample
Fenwick Island

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-10

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.						
03773	4-Bromophenyl-phenylether	101-55-3	N.D.		40.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.		40.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.		40.	ug/kg	1
03776	Anthracene	120-12-7	N.D.		40.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.		79.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.		40.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.		79.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.		40.	ug/kg	1
03782	Chrysene	218-01-9	N.D.		40.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.		79.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	350.	J	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.		79.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.		40.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.		40.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.		40.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.		40.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.		40.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.		40.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.		79.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.		40.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.		79.	ug/kg	1
04702	Carbazole	86-74-8	N.D.		40.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:25	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1

Lancaster Laboratories

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9200 Rumsey Road
Columbia MD 21045

FV-10

06935	Arsenic	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 14:32	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 07:22	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/05/2004 11:45	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 00:05	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/23/2004 00:52	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/23/2004 00:52	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216789

FVC-2-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:04
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-20

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.	0.0032	mg/kg	1
01643	Aluminum	7429-90-5	1,960.	3.35	mg/kg	1
01650	Calcium	7440-70-2	266.	1.41	mg/kg	1
01654	Iron	7439-89-6	2,680.	5.53	mg/kg	1
01657	Magnesium	7439-95-4	445.	2.24	mg/kg	1
01662	Potassium	7440-09-7	215.	4.21	mg/kg	1
01667	Sodium	7440-23-5	1,880.	53.4	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.05	mg/kg	1
06935	Arsenic	7440-38-2	2.83	0.566	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.532	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.747	mg/kg	1
06946	Barium	7440-39-3	2.19	0.0362	mg/kg	1
06947	Beryllium	7440-41-7	0.0871 J	0.0668	mg/kg	1
06949	Cadmium	7440-43-9	0.0690 J	0.0611	mg/kg	1
06951	Chromium	7440-47-3	2.84	0.226	mg/kg	1
06952	Cobalt	7440-48-4	0.803	0.158	mg/kg	1
06953	Copper	7440-50-8	1.30	0.215	mg/kg	1
06955	Lead	7439-92-1	2.06 J	0.894	mg/kg	1
06958	Manganese	7439-96-5	25.1	0.0430	mg/kg	1
06961	Nickel	7440-02-0	1.43	0.226	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.170	mg/kg	1
06971	Vanadium	7440-62-2	7.46	0.181	mg/kg	1
06972	Zinc	7440-66-6	8.84	0.204	mg/kg	1
00111	Moisture	n.a.	14.2	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	N.D.	501.	mg/kg	1
00394	pH	n.a.	8.5	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.59	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216789

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-20

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.38	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.38	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.58	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.7	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.38	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.68	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.51	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.38	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.38	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.8	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.0	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.7	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.0	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	3.8	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	3.8	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.38	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.35	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	39.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	39.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	39.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	39.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	39.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	78.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	39.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	39.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	39.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	39.	ug/kg	1

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FV-20

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	39.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	39.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	39.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	39.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	39.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	39.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	39.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	39.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	78.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	39.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	39.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	78.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	39.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	39.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	78.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	39.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	39.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	39.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	39.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	39.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	78.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	39.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	780.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	39.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	39.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	39.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	78.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	39.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216789

FVC-2-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
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Versar Incorporated - MD
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FV-20

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	39.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	39.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	39.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	39.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	78.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	39.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	78.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	39.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	39.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	78.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	78.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	39.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	39.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	39.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	39.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	39.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	39.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	78.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	39.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	78.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	39.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:26	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216789

FVC-2-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:04
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-20

06935	Arsenic	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 14:44	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 07:28	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/05/2004 11:45	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 00:25	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/23/2004 01:44	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/23/2004 01:44	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

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2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216790

FVC-3-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:05
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-30

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.		0.0032	mg/kg	1
01643	Aluminum	7429-90-5	1,200.		3.28	mg/kg	1
01650	Calcium	7440-70-2	1,130.		1.38	mg/kg	1
01654	Iron	7439-89-6	1,240.		5.41	mg/kg	1
01657	Magnesium	7439-95-4	403.		2.19	mg/kg	1
01662	Potassium	7440-09-7	205.		4.12	mg/kg	1
01667	Sodium	7440-23-5	1,730.		52.3	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.03	mg/kg	1
06935	Arsenic	7440-38-2	N.D.		0.554	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.520	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.731	mg/kg	1
06946	Barium	7440-39-3	2.21		0.0354	mg/kg	1
06947	Beryllium	7440-41-7	N.D.		0.0653	mg/kg	1
06949	Cadmium	7440-43-9	N.D.		0.0598	mg/kg	1
06951	Chromium	7440-47-3	2.18		0.221	mg/kg	1
06952	Cobalt	7440-48-4	0.604		0.155	mg/kg	1
06953	Copper	7440-50-8	0.725	J	0.210	mg/kg	1
06955	Lead	7439-92-1	1.10	J	0.875	mg/kg	1
06958	Manganese	7439-96-5	9.72		0.0421	mg/kg	1
06961	Nickel	7440-02-0	1.39		0.221	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.166	mg/kg	1
06971	Vanadium	7440-62-2	4.24		0.177	mg/kg	1
06972	Zinc	7440-66-6	4.07		0.199	mg/kg	1
00111	Moisture	n.a.	12.3		0.50	%	1

"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.

00236	Oil & Grease	n.a.	N.D.		490.	mg/kg	1
00394	pH	n.a.	8.3		0.010	Std. Units	1

The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.

01225 TCL Pesticides in Solids

01218	Gamma BHC - Lindane	58-89-9	N.D.		0.19	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.19	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.58	ug/kg	1

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PO Box 12425
Lancaster, PA 17605-2425
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Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216790

FVC-3-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:05
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-30

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.38	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.38	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.57	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.6	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.19	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.19	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.19	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.19	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.38	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.66	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.50	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.38	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.38	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.1	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.8	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	11.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	4.9	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.6	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	6.8	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	3.8	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	3.8	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.38	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.19	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.34	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	38.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	38.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	38.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	38.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	38.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	76.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	38.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	38.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	38.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	38.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216790

FVC-3-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:05
Discard: 03/27/2004

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9200 Rumsey Road
Columbia MD 21045

FV-30

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	38.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	38.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	38.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	38.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	38.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	38.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	38.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	38.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	76.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	38.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	38.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	76.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	38.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	38.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	76.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	38.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	38.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	38.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	38.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	38.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	76.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	38.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	760.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	38.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	38.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	38.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	76.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	38.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

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2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
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Lancaster Laboratories Sample No. SW 4216790

FVC-3-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:05
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-30

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	38.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	38.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	38.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	38.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	76.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	38.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	76.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	38.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	38.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	76.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	76.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	38.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	38.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	38.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	38.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	38.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	38.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	76.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	38.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	76.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	38.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:27	Camary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216790

FVC-3-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-30

06935	Arsenic	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 14:48	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 07:33	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/05/2004 11:45	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 01:48	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/23/2004 08:26	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/23/2004 08:26	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216791

FVC-4-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:05
Discard: 03/27/2004

FV-40

Account Number: 07446

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.	0.0031	mg/kg	1
01643	Aluminum	7429-90-5	1,580.	3.34	mg/kg	1
01650	Calcium	7440-70-2	535.	1.41	mg/kg	1
01654	Iron	7439-89-6	2,410.	5.52	mg/kg	1
01657	Magnesium	7439-95-4	462.	2.23	mg/kg	1
01662	Potassium	7440-09-7	228.	4.20	mg/kg	1
01667	Sodium	7440-23-5	1,640.	53.3	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.05	mg/kg	1
06935	Arsenic	7440-38-2	1.35	0.564	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.530	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.745	mg/kg	1
06946	Barium	7440-39-3	12.1	0.0361	mg/kg	1
06947	Beryllium	7440-41-7	0.0778 J	0.0666	mg/kg	1
06949	Cadmium	7440-43-9	N.D.	0.0609	mg/kg	1
06951	Chromium	7440-47-3	2.84	0.226	mg/kg	1
06952	Cobalt	7440-48-4	0.748	0.158	mg/kg	1
06953	Copper	7440-50-8	0.759 J	0.214	mg/kg	1
06955	Lead	7439-92-1	1.14 J	0.891	mg/kg	1
06958	Manganese	7439-96-5	9.94	0.0429	mg/kg	1
06961	Nickel	7440-02-0	1.16	0.226	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.169	mg/kg	1
06971	Vanadium	7440-62-2	5.64	0.181	mg/kg	1
06972	Zinc	7440-66-6	4.92	0.203	mg/kg	1
00111	Moisture	n.a.	13.1	0.50	%	1

"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.

00236	Oil & Grease	n.a.	N.D.	495.	mg/kg	1
00394	pH	n.a.	8.5	0.010	Std. Units	1

The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.

01225 TCL Pesticides in Solids

01218	Gamma BHC - Lindane	58-89-9	N.D.	0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.59	ug/kg	1

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216791

FVC-4-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:05
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-40

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.38	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.38	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.58	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.6	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.38	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.67	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.51	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.38	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.38	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.8	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	4.9	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.6	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	6.9	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	3.8	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	3.8	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.38	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.35	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	38.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	38.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	38.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	38.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	38.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	77.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	38.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	38.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	38.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	38.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216791

FVC-4-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

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Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-40

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	38.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	38.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	38.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	38.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	38.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	38.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	38.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	38.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	77.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	38.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	38.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	77.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	38.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	38.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	77.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	38.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	38.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	38.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	38.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	38.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	77.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	38.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	770.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	38.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	38.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	38.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	77.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	38.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216791

FVC-4-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:05
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-40

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	38.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	38.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	38.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	38.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	77.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	38.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	77.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	38.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	38.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	77.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	77.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	38.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	38.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	38.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	38.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	38.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	38.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	77.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	38.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	77.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	38.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:28	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216791

FVC-4-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:05
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-40

06935	Arsenic	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 14:52	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 07:39	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/09/2004 10:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 02:08	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/23/2004 09:17	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/23/2004 09:17	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216490

FVC-5-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/13/2004 16:25
Reported: 03/04/2004 at 12:48
Discard: 03/19/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC50

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	0.0060	J	0.0030	mg/kg	1
01643	Aluminum	7429-90-5	1,310.		3.23	mg/kg	1
01650	Calcium	7440-70-2	565.		1.36	mg/kg	1
01654	Iron	7439-89-6	2,310.		5.34	mg/kg	1
01657	Magnesium	7439-95-4	405.		2.16	mg/kg	1
01662	Potassium	7440-09-7	186.		4.06	mg/kg	1
01667	Sodium	7440-23-5	1,620.		51.5	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.02	mg/kg	1
06935	Arsenic	7440-38-2	1.76		0.546	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.513	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.721	mg/kg	1
06946	Barium	7440-39-3	1.75		0.0349	mg/kg	1
06947	Beryllium	7440-41-7	N.D.		0.0644	mg/kg	1
06949	Cadmium	7440-43-9	N.D.		0.0590	mg/kg	1
06951	Chromium	7440-47-3	2.55		0.218	mg/kg	1
06952	Cobalt	7440-48-4	0.611		0.153	mg/kg	1
06953	Copper	7440-50-8	0.718	J	0.207	mg/kg	1
06955	Lead	7439-92-1	1.60	J	0.862	mg/kg	1
06958	Manganese	7439-96-5	16.2		0.0415	mg/kg	1
06961	Nickel	7440-02-0	1.07	J	0.218	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.164	mg/kg	1
06971	Vanadium	7440-62-2	6.40		0.175	mg/kg	1
06972	Zinc	7440-66-6	6.44		0.197	mg/kg	1
00111	Moisture	n.a.	10.2		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	N.D.		479.	mg/kg	1
00394	pH	n.a.	8.7		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.19	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.19	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.57	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216490

FVC-5-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/13/2004 16:25
Reported: 03/04/2004 at 12:48
Discard: 03/19/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC50

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.		0.37	ug/kg	1
01222	Dieldrin	60-57-1	N.D.		0.37	ug/kg	1
01223	Endrin	72-20-8	N.D.		0.56	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.		4.5	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.		0.19	ug/kg	1
01982	Beta BHC	319-85-7	N.D.		0.19	ug/kg	1
01983	Delta BHC	319-86-8	N.D.		0.19	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.		0.19	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.		0.37	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.		0.65	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.		12.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.		0.49	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.		0.37	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.		0.37	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.		1.1	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.		3.7	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.		11.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.		4.8	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.		4.5	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.		6.7	ug/kg	1
01998	PCB-1254	11097-69-1	16.	J	3.7	ug/kg	1
01999	PCB-1260	11096-82-5	13.	J	3.7	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.		0.37	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.		0.19	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.		0.33	ug/kg	1
04688	TCL SW846 Semivolatiles Soil						
01185	Phenol	108-95-2	N.D.		37.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.		37.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.		37.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.		37.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.		37.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.		74.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.		37.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.		37.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.		37.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.		37.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216490

FVC-5-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/13/2004 16:25
Reported: 03/04/2004 at 12:48
Discard: 03/19/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC50

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	37.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	37.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	37.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	37.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	37.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	37.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	37.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	37.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	74.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	37.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	37.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	74.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	37.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	37.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	74.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	37.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	37.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	37.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	37.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	37.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	74.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	37.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	740.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	37.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	37.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	37.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	74.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	37.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216490

FVC-5-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/13/2004 16:25
Reported: 03/04/2004 at 12:48
Discard: 03/19/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC50

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	37.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	37.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	37.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	37.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	74.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	37.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	74.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	37.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	37.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	74.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	74.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	37.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	37.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	37.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	37.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	37.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	37.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	74.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	37.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	74.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	37.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:34	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216490

FVC-5-0 Composite Sediment Sample
Fenwick Island

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC50

06935	Arsenic	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 19:30	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 09:07	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:27	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/02/2004 11:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 20:00	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 09:42	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/20/2004 04:12	Linda M Hartenstine	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/20/2004 04:12	Linda M Hartenstine	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216792

FVC-6-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:05
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-60

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	0.0105 J	0.0033	mg/kg	1
01643	Aluminum	7429-90-5	2,910.	3.52	mg/kg	1
01650	Calcium	7440-70-2	18,400.	1.49	mg/kg	1
01654	Iron	7439-89-6	4,830.	5.81	mg/kg	1
01657	Magnesium	7439-95-4	1,070.	2.35	mg/kg	1
01662	Potassium	7440-09-7	566.	4.42	mg/kg	1
01667	Sodium	7440-23-5	2,920.	56.1	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.11	mg/kg	1
06935	Arsenic	7440-38-2	2.43	0.594	mg/kg	1
06936	Selenium	7782-49-2	0.737 J	0.559	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.784	mg/kg	1
06946	Barium	7440-39-3	6.43	0.0380	mg/kg	1
06947	Beryllium	7440-41-7	0.159 J	0.0701	mg/kg	1
06949	Cadmium	7440-43-9	0.130 J	0.0642	mg/kg	1
06951	Chromium	7440-47-3	6.63	0.238	mg/kg	1
06952	Cobalt	7440-48-4	1.61	0.166	mg/kg	1
06953	Copper	7440-50-8	2.85	0.226	mg/kg	1
06955	Lead	7439-92-1	4.45	0.939	mg/kg	1
06958	Manganese	7439-96-5	38.0	0.0452	mg/kg	1
06961	Nickel	7440-02-0	3.69	0.238	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.178	mg/kg	1
06971	Vanadium	7440-62-2	12.6	0.190	mg/kg	1
06972	Zinc	7440-66-6	19.1	0.214	mg/kg	1
00111	Moisture	n.a.	17.5	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	N.D.	521.	mg/kg	1
00394	pH	n.a.	8.5	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.21	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.21	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.62	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216792

FVC-6-0 Composite Sediment Sample
Fenwick Island

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-60

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.40	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.40	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.61	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.8	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.21	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.21	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.21	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.21	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.40	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.70	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.53	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.40	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.40	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	4.0	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.2	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.8	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.3	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	4.0	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	4.0	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.40	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.21	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.36	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	40.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	40.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	40.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	40.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	40.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	81.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	40.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	40.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	40.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	40.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216792

FVC-6-0 Composite Sediment Sample
Fenwick Island

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FV-60

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03755	1,2-Dichlorobenzene	95-50-1	N.D.	40.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	40.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	40.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	40.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	40.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	40.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	81.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	40.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	40.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	81.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	40.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	40.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	81.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	40.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	40.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	40.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	40.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	40.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	81.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	40.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	810.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	40.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	40.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	40.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	81.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	40.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216792

FVC-6-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

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FV-60

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	40.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	40.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	40.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	40.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	81.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	40.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	81.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	40.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	40.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	81.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	81.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	40.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	40.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	40.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	40.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	40.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	40.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	81.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	40.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	81.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	40.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:33	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216792

FVC-6-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:05
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-60

06935	Arsenic	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 14:56	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 07:45	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/05/2004 11:45	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 02:29	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/23/2004 10:08	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/23/2004 10:08	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216793

FVC-7-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:06
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-70

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.		0.0034	mg/kg	1
01643	Aluminum	7429-90-5	2,510.		3.45	mg/kg	1
01650	Calcium	7440-70-2	3,670.		1.46	mg/kg	1
01654	Iron	7439-89-6	3,080.		5.69	mg/kg	1
01657	Magnesium	7439-95-4	1,110.		2.30	mg/kg	1
01662	Potassium	7440-09-7	506.		4.33	mg/kg	1
01667	Sodium	7440-23-5	2,440.		54.9	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.08	mg/kg	1
06935	Arsenic	7440-38-2	1.61		0.582	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.547	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.768	mg/kg	1
06946	Barium	7440-39-3	5.00		0.0373	mg/kg	1
06947	Beryllium	7440-41-7	0.132	J	0.0687	mg/kg	1
06949	Cadmium	7440-43-9	0.132	J	0.0629	mg/kg	1
06951	Chromium	7440-47-3	5.43		0.233	mg/kg	1
06952	Cobalt	7440-48-4	1.22		0.163	mg/kg	1
06953	Copper	7440-50-8	1.24		0.221	mg/kg	1
06955	Lead	7439-92-1	2.20	J	0.920	mg/kg	1
06958	Manganese	7439-96-5	25.8		0.0442	mg/kg	1
06961	Nickel	7440-02-0	2.72		0.233	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.175	mg/kg	1
06971	Vanadium	7440-62-2	7.90		0.186	mg/kg	1
06972	Zinc	7440-66-6	9.92		0.210	mg/kg	1
00111	Moisture	n.a.	16.6		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	N.D.		516.	mg/kg	1
00394	pH	n.a.	8.4		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.61	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216793

FVC-7-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:06
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-70

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.40	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.40	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.60	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.8	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.40	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.70	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.53	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.40	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.40	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	4.0	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.2	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.8	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.2	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	4.0	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	4.0	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.40	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.36	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	40.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	40.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	40.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	40.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	40.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	80.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	40.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	40.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	40.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	40.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216793

FVC-7-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:06
Discard: 03/27/2004

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FV-70

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	40.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	40.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	40.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	40.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	40.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	40.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	40.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	40.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	80.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	40.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	40.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	80.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	40.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	40.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	80.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	40.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	40.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	40.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	40.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	40.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	80.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	40.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	800.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	40.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	40.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	40.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	80.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	40.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216793

FVC-7-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:06
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-70

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	40.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	40.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	40.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	40.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	80.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	40.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	80.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	40.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	40.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	80.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	80.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	40.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	40.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	40.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	40.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	40.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	40.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	80.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	40.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	80.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	40.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:34	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216793

FVC-7-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:06
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-70

06935	Arsenic	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 14:59	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 07:50	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/09/2004 10:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 02:50	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/23/2004 10:59	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/23/2004 10:59	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216491

FVC-8-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/13/2004 16:25
Reported: 03/04/2004 at 12:49
Discard: 03/19/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC80

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.		0.0032	mg/kg	1
01643	Aluminum	7429-90-5	1,290.		3.41	mg/kg	1
01650	Calcium	7440-70-2	692.		1.44	mg/kg	1
01654	Iron	7439-89-6	1,880.		5.63	mg/kg	1
01657	Magnesium	7439-95-4	498.		2.28	mg/kg	1
01662	Potassium	7440-09-7	217.		4.28	mg/kg	1
01667	Sodium	7440-23-5	2,090.		54.3	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.07	mg/kg	1
06935	Arsenic	7440-38-2	1.15	J	0.575	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.541	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.759	mg/kg	1
06946	Barium	7440-39-3	1.66		0.0368	mg/kg	1
06947	Beryllium	7440-41-7	N.D.		0.0679	mg/kg	1
06949	Cadmium	7440-43-9	N.D.		0.0621	mg/kg	1
06951	Chromium	7440-47-3	3.06		0.230	mg/kg	1
06952	Cobalt	7440-48-4	0.751		0.161	mg/kg	1
06953	Copper	7440-50-8	0.555	J	0.219	mg/kg	1
06955	Lead	7439-92-1	1.64	J	0.909	mg/kg	1
06958	Manganese	7439-96-5	11.1		0.0437	mg/kg	1
06961	Nickel	7440-02-0	1.17		0.230	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.173	mg/kg	1
06971	Vanadium	7440-62-2	5.22		0.184	mg/kg	1
06972	Zinc	7440-66-6	6.32		0.207	mg/kg	1
00111	Moisture	n.a.	14.8		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	N.D.		505.	mg/kg	1
00394	pH	n.a.	8.6		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.60	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216491

FVC-8-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/13/2004 16:25
Reported: 03/04/2004 at 12:49
Discard: 03/19/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC80

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.		0.39	ug/kg	1
01222	Dieldrin	60-57-1	N.D.		0.39	ug/kg	1
01223	Endrin	72-20-8	N.D.		0.59	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.		4.7	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.		0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.		0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.		0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.		0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.		0.39	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.		0.68	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.		13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.		0.52	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.		0.39	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.		0.39	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.		1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.		3.9	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.		12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.		5.0	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.		4.7	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.		7.0	ug/kg	1
01998	PCB-1254	11097-69-1	19.	J	3.9	ug/kg	1
01999	PCB-1260	11096-82-5	19.	J	3.9	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.		0.39	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.		0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.		0.35	ug/kg	1
04688	TCL SW846 Semivolatiles Soil						
01185	Phenol	108-95-2	N.D.		39.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.		39.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.		39.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.		39.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.		39.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.		78.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.		39.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.		39.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.		39.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.		39.	ug/kg	1

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216491

FVC-8-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/13/2004 16:25
Reported: 03/04/2004 at 12:49
Discard: 03/19/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC80

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	39.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	39.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	39.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	39.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	39.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	39.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	39.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	39.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	78.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	39.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	39.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	78.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	39.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	39.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	78.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	39.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	39.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	39.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	39.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	39.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	78.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	39.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	780.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	39.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	39.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	39.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	78.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	39.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216491

FVC-8-0 Composite Sediment Sample
Fenwick Island

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC80

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	39.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	39.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	39.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	39.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	78.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	39.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	78.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	39.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	39.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	78.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	78.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	39.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	39.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	39.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	39.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	39.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	39.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	78.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	39.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	78.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	39.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 09:35	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216491

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Fenwick Island

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FVC80

06935	Arsenic	SW-846 6010B	1	02/19/2004 19:36	John P Hook	1
06936	Selenium	SW-846 6010B	1	02/19/2004 19:36	John P Hook	1
06944	Antimony	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 09:14	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:27	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/02/2004 11:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 20:00	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 10:03	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/20/2004 05:11	Linda M Hartenstine	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/20/2004 05:11	Linda M Hartenstine	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:00	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 03:30	David V Hershey Jr	1

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216794

FVC-9-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:06
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-90

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	0.0055 J	0.0032	mg/kg	1
01643	Aluminum	7429-90-5	12,700.	3.38	mg/kg	1
01650	Calcium	7440-70-2	474.	1.43	mg/kg	1
01654	Iron	7439-89-6	3,720.	5.58	mg/kg	1
01657	Magnesium	7439-95-4	903.	2.26	mg/kg	1
01662	Potassium	7440-09-7	627.	4.24	mg/kg	1
01667	Sodium	7440-23-5	2,090.	53.8	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.06	mg/kg	1
06935	Arsenic	7440-38-2	1.55	0.570	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.536	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.753	mg/kg	1
06946	Barium	7440-39-3	5.71	0.0365	mg/kg	1
06947	Beryllium	7440-41-7	0.228 J	0.0673	mg/kg	1
06949	Cadmium	7440-43-9	0.0901 J	0.0616	mg/kg	1
06951	Chromium	7440-47-3	11.1	0.228	mg/kg	1
06952	Cobalt	7440-48-4	1.16	0.160	mg/kg	1
06953	Copper	7440-50-8	2.31	0.217	mg/kg	1
06955	Lead	7439-92-1	3.68	0.901	mg/kg	1
06958	Manganese	7439-96-5	21.3	0.0433	mg/kg	1
06961	Nickel	7440-02-0	4.65	0.228	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.171	mg/kg	1
06971	Vanadium	7440-62-2	14.0	0.183	mg/kg	1
06972	Zinc	7440-66-6	15.4	0.205	mg/kg	1
00111	Moisture	n.a.	13.2	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	N.D.	495.	mg/kg	1
00394	pH	n.a.	8.6	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.59	ug/kg	1

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Lancaster Laboratories, Inc.
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Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216794

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Fenwick Island

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FV-90

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.		0.38	ug/kg	1
01222	Dieldrin	60-57-1	N.D.		0.38	ug/kg	1
01223	Endrin	72-20-8	N.D.		0.58	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.		4.6	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.		0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.		0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.		0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.		0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.		0.38	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.		0.67	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.		13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.		0.51	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.		0.38	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.		0.38	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.		1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.		3.8	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.		12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.		5.0	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.		4.6	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.		6.9	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.		3.8	ug/kg	1
01999	PCB-1260	11096-82-5	4.7	J	3.8	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.		0.38	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.		0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.		0.35	ug/kg	1
04688	TCL SW846 Semivolatiles Soil						
01185	Phenol	108-95-2	N.D.		38.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.		38.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.		38.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.		38.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.		38.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.		77.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.		38.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.		38.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.		38.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.		38.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216794

FVC-9-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

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Versar Incorporated - MD
9200 Rumsey Road
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FV-90

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	38.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	38.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	38.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	38.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	38.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	38.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	38.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	38.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	77.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	38.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	38.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	77.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	38.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	38.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	77.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	38.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	38.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	38.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	38.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	38.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	77.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	38.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	770.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	38.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	38.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	38.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	77.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	38.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216794

FVC-9-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:06
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV-90

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	38.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	38.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	38.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	38.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	77.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	38.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	77.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	38.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	38.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	77.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	77.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	38.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	38.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	38.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	38.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	38.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	38.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	77.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	38.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	77.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	38.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:35	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1

Lancaster Laboratories

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9200 Rumsey Road
Columbia MD 21045

FV-90

06935	Arsenic	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 15:03	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 07:56	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/09/2004 10:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 03:10	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/23/2004 11:50	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/23/2004 11:50	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216795

EVC-10-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:06
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV100

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	0.0047 J	0.0032	mg/kg	1
01643	Aluminum	7429-90-5	1,200.	3.35	mg/kg	1
01650	Calcium	7440-70-2	265.	1.42	mg/kg	1
01654	Iron	7439-89-6	1,710.	5.54	mg/kg	1
01657	Magnesium	7439-95-4	429.	2.24	mg/kg	1
01662	Potassium	7440-09-7	216.	4.22	mg/kg	1
01667	Sodium	7440-23-5	1,780.	53.5	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.05	mg/kg	1
06935	Arsenic	7440-38-2	1.05 J	0.567	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.533	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.748	mg/kg	1
06946	Barium	7440-39-3	1.97	0.0363	mg/kg	1
06947	Beryllium	7440-41-7	0.0714 J	0.0669	mg/kg	1
06949	Cadmium	7440-43-9	N.D.	0.0612	mg/kg	1
06951	Chromium	7440-47-3	2.58	0.227	mg/kg	1
06952	Cobalt	7440-48-4	0.538 J	0.159	mg/kg	1
06953	Copper	7440-50-8	0.921 J	0.215	mg/kg	1
06955	Lead	7439-92-1	1.62 J	0.895	mg/kg	1
06958	Manganese	7439-96-5	9.95	0.0431	mg/kg	1
06961	Nickel	7440-02-0	1.12 J	0.227	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.170	mg/kg	1
06971	Vanadium	7440-62-2	5.71	0.181	mg/kg	1
06972	Zinc	7440-66-6	5.43	0.204	mg/kg	1
00111	Moisture	n.a.	13.5	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	N.D.	497.	mg/kg	1
00394	pH	n.a.	8.6	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.59	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216795

EVC-10-0 Composite Sediment Sample
Fenwick Island

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Reported: 03/12/2004 at 13:06
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV100

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.38	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.38	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.58	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.6	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.38	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.67	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.51	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.38	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.38	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.8	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.0	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.6	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	6.9	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	3.8	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	3.8	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.38	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.35	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	39.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	39.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	39.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	39.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	39.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	77.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	39.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	39.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	39.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	39.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216795

EVC-10-0 Composite Sediment Sample
Fenwick Island

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9200 Rumsey Road
Columbia MD 21045

FV100

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	39.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	39.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	39.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	39.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	39.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	39.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	39.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	39.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	77.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	39.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	39.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	77.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	39.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	39.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	77.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	39.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	39.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	39.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	39.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	39.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	77.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	39.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	770.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	39.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	39.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	39.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	77.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	39.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

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FV100

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	39.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	39.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	39.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	39.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	77.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	39.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	77.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	39.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	39.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	77.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	77.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	39.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	39.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	39.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	39.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	39.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	39.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	77.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	39.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	77.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	39.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:36	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1

MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
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Columbia MD 21045

FV100

06935	Arsenic	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 15:07	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 08:13	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/09/2004 10:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 03:31	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/23/2004 12:41	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/23/2004 12:41	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216796

EVC-11-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:07
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV110

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.		0.0032	mg/kg	1
01643	Aluminum	7429-90-5	2,080.		3.36	mg/kg	1
01650	Calcium	7440-70-2	669.		1.42	mg/kg	1
01654	Iron	7439-89-6	2,360.		5.55	mg/kg	1
01657	Magnesium	7439-95-4	821.		2.25	mg/kg	1
01662	Potassium	7440-09-7	398.		4.22	mg/kg	1
01667	Sodium	7440-23-5	2,320.		53.6	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.06	mg/kg	1
06935	Arsenic	7440-38-2	1.05	J	0.568	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.534	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.749	mg/kg	1
06946	Barium	7440-39-3	3.72		0.0363	mg/kg	1
06947	Beryllium	7440-41-7	0.106	J	0.0670	mg/kg	1
06949	Cadmium	7440-43-9	N.D.		0.0613	mg/kg	1
06951	Chromium	7440-47-3	4.36		0.227	mg/kg	1
06952	Cobalt	7440-48-4	1.30		0.159	mg/kg	1
06953	Copper	7440-50-8	1.31		0.216	mg/kg	1
06955	Lead	7439-92-1	1.32	J	0.897	mg/kg	1
06958	Manganese	7439-96-5	21.0		0.0431	mg/kg	1
06961	Nickel	7440-02-0	2.74		0.227	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.170	mg/kg	1
06971	Vanadium	7440-62-2	6.86		0.182	mg/kg	1
06972	Zinc	7440-66-6	8.83		0.204	mg/kg	1
00111	Moisture	n.a.	14.5		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	889.	J	503.	mg/kg	1
00394	pH	n.a.	8.5		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.60	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216796

EVC-11-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:07
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV110

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.		0.39	ug/kg	1
01222	Dieldrin	60-57-1	N.D.		0.39	ug/kg	1
01223	Endrin	72-20-8	N.D.		0.58	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.		4.7	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.		0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.		0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.		0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.		0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.		0.39	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.		0.68	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.		13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.		0.51	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.		0.39	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.		0.39	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.		1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.		3.9	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.		12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.		5.0	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.		4.7	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.		7.0	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.		3.9	ug/kg	1
01999	PCB-1260	11096-82-5	4.9	J	3.9	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.		0.39	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.		0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.		0.35	ug/kg	1

The surrogate data is outside the QC limits. Results from the reextraction are within the limits. The hold time had expired prior to the reextraction so all results are reported from the original extract. Similar results were obtained in both extracts.

04688 TCL SW846 Semivolatiles Soil

01185	Phenol	108-95-2	N.D.		39.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.		39.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.		39.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.		39.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.		39.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.		78.	ug/kg	1

Lancaster Laboratories

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Discard: 03/27/2004

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9200 Rumsey Road
Columbia MD 21045

FV110

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03746	2-Nitrophenol	88-75-5	N.D.	39.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	39.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	39.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	39.	ug/kg	1
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	39.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	39.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	39.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	39.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	39.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	39.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	39.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	39.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	78.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	39.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	39.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	78.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	39.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	39.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	78.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	39.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	39.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	39.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	39.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	39.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	78.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	39.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	780.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	39.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	39.	ug/kg	1

Lancaster Laboratories

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Columbia MD 21045

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CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	39.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	78.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	39.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine. The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	39.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	39.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	39.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	39.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	78.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	39.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	78.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	39.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	39.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	78.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	78.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	39.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	39.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	39.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	39.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	39.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	39.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	78.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	39.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	78.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	39.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:38	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216796

EVC-11-0 Composite Sediment Sample
Fenwick Island

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Columbia MD 21045

FV110

01657	Magnesium	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06935	Arsenic	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 15:11	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 08:19	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/09/2004 10:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 03:52	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/23/2004 13:32	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/23/2004 13:32	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216797

EVC-12-0 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

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Versar Incorporated - MD
9200 Rumsey Road
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FV120

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	0.0321 J	0.0034	mg/kg	1
01643	Aluminum	7429-90-5	3,930.	3.55	mg/kg	1
01650	Calcium	7440-70-2	2,300.	1.50	mg/kg	1
01654	Iron	7439-89-6	5,250.	5.87	mg/kg	1
01657	Magnesium	7439-95-4	1,600.	2.38	mg/kg	1
01662	Potassium	7440-09-7	855.	4.46	mg/kg	1
01667	Sodium	7440-23-5	2,460.	56.6	mg/kg	1
06925	Thallium	7440-28-0	N.D.	1.12	mg/kg	1
06935	Arsenic	7440-38-2	2.94	0.600	mg/kg	1
06936	Selenium	7782-49-2	N.D.	0.564	mg/kg	1
06944	Antimony	7440-36-0	N.D.	0.792	mg/kg	1
06946	Barium	7440-39-3	8.46	0.0384	mg/kg	1
06947	Beryllium	7440-41-7	0.198 J	0.0708	mg/kg	1
06949	Cadmium	7440-43-9	0.221 J	0.0648	mg/kg	1
06951	Chromium	7440-47-3	9.92	0.240	mg/kg	1
06952	Cobalt	7440-48-4	2.35	0.168	mg/kg	1
06953	Copper	7440-50-8	3.97	0.228	mg/kg	1
06955	Lead	7439-92-1	5.68	0.948	mg/kg	1
06958	Manganese	7439-96-5	56.5	0.0456	mg/kg	1
06961	Nickel	7440-02-0	5.44	0.240	mg/kg	1
06966	Silver	7440-22-4	N.D.	0.180	mg/kg	1
06971	Vanadium	7440-62-2	11.9	0.192	mg/kg	1
06972	Zinc	7440-66-6	24.5	0.216	mg/kg	1
00111	Moisture	n.a.	17.5	0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.					
00236	Oil & Grease	n.a.	2,060.	521.	mg/kg	1
00394	pH	n.a.	8.4	0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 mL. of deionized water) after being tumbled for 30 min.					
01225	TCL Pesticides in Solids					
01218	Gamma BHC - Lindane	58-89-9	N.D.	0.21	ug/kg	1
01219	Heptachlor	76-44-8	N.D.	0.21	ug/kg	1
01220	Aldrin	309-00-2	N.D.	0.62	ug/kg	1

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Lancaster Laboratories, Inc.
2425 New Holland Pike
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717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

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EVC-12-0 Composite Sediment Sample
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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV120

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.40	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.40	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.61	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.8	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.21	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.21	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.21	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.21	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.40	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.70	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.53	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.40	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.40	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	4.0	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.2	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.8	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	7.3	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	4.0	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	4.0	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.40	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.21	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.36	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	40.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	40.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	40.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	40.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	40.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	81.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	40.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	40.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	40.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	40.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216797

EVC-12-0 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:07
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV120

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	40.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	40.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	40.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	40.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	40.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	40.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	40.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	40.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	81.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	200.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	40.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	40.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	81.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	40.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	40.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	81.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	40.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	40.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	40.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	40.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	40.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	200.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	81.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	200.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	40.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	810.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	200.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	40.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	40.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	40.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	81.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	40.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216797

EVC-12-0 Composite Sediment Sample
Fenwick Island

Collected:02/11/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:07
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV120

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	40.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	40.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	40.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	40.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	81.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	40.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	81.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	40.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	40.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	81.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	200.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	81.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	40.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	40.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	40.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	40.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	40.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	40.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	81.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	40.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	81.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	40.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Analysis Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:39	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216797

EVC-12-0 Composite Sediment Sample
Fenwick Island

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Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV120

06935	Arsenic	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 15:15	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 08:24	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/09/2004 10:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 04:12	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/20/2004 18:29	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/20/2004 18:29	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 11:00	Jennytza L Marcano	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Analysis Report

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216798

EVC-13-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:08
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV130

CAT No.	Analysis Name	CAS Number	Dry Result		Dry Method Detection Limit	Units	Dilution Factor
00159	Mercury	7439-97-6	N.D.		0.0032	mg/kg	1
01643	Aluminum	7429-90-5	930.		3.29	mg/kg	1
01650	Calcium	7440-70-2	331.		1.39	mg/kg	1
01654	Iron	7439-89-6	1,620.		5.44	mg/kg	1
01657	Magnesium	7439-95-4	419.		2.20	mg/kg	1
01662	Potassium	7440-09-7	189.		4.14	mg/kg	1
01667	Sodium	7440-23-5	1,820.		52.5	mg/kg	1
06925	Thallium	7440-28-0	N.D.		1.03	mg/kg	1
06935	Arsenic	7440-38-2	1.08	J	0.556	mg/kg	1
06936	Selenium	7782-49-2	N.D.		0.523	mg/kg	1
06944	Antimony	7440-36-0	N.D.		0.735	mg/kg	1
06946	Barium	7440-39-3	1.40		0.0356	mg/kg	1
06947	Beryllium	7440-41-7	N.D.		0.0657	mg/kg	1
06949	Cadmium	7440-43-9	N.D.		0.0601	mg/kg	1
06951	Chromium	7440-47-3	2.24		0.223	mg/kg	1
06952	Cobalt	7440-48-4	0.551	J	0.156	mg/kg	1
06953	Copper	7440-50-8	0.683	J	0.211	mg/kg	1
06955	Lead	7439-92-1	1.33	J	0.879	mg/kg	1
06958	Manganese	7439-96-5	8.33		0.0423	mg/kg	1
06961	Nickel	7440-02-0	1.08	J	0.223	mg/kg	1
06966	Silver	7440-22-4	N.D.		0.167	mg/kg	1
06971	Vanadium	7440-62-2	5.23		0.178	mg/kg	1
06972	Zinc	7440-66-6	5.02		0.200	mg/kg	1
00111	Moisture	n.a.	13.6		0.50	%	1
	"Moisture" represents the loss in weight of the sample after oven drying at 103 - 105 degrees Celsius. The moisture result reported above is on an as-received basis.						
00236	Oil & Grease	n.a.	N.D.		498.	mg/kg	1
00394	pH	n.a.	8.5		0.010	Std. Units	1
	The pH was performed on a 1:1 slurry (25 gms. of sample and 25 ml. of deionized water) after being tumbled for 30 min.						
01225	TCL Pesticides in Solids						
01218	Gamma BHC - Lindane	58-89-9	N.D.		0.20	ug/kg	1
01219	Heptachlor	76-44-8	N.D.		0.20	ug/kg	1
01220	Aldrin	309-00-2	N.D.		0.59	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216798

EVC-13-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:08
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV130

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
01221	p,p-DDT	50-29-3	N.D.	0.38	ug/kg	1
01222	Dieldrin	60-57-1	N.D.	0.38	ug/kg	1
01223	Endrin	72-20-8	N.D.	0.58	ug/kg	1
01859	Methoxychlor	72-43-5	N.D.	4.6	ug/kg	1
01981	Alpha BHC	319-84-6	N.D.	0.20	ug/kg	1
01982	Beta BHC	319-85-7	N.D.	0.20	ug/kg	1
01983	Delta BHC	319-86-8	N.D.	0.20	ug/kg	1
01984	Heptachlor Epoxide	1024-57-3	N.D.	0.20	ug/kg	1
01985	p,p-DDE	72-55-9	N.D.	0.38	ug/kg	1
01986	p,p-DDD	72-54-8	N.D.	0.67	ug/kg	1
01988	Toxaphene	8001-35-2	N.D.	13.	ug/kg	1
01989	Endosulfan I	959-98-8	N.D.	0.51	ug/kg	1
01990	Endosulfan II	33213-65-9	N.D.	0.38	ug/kg	1
01991	Endosulfan Sulfate	1031-07-8	N.D.	0.38	ug/kg	1
01992	Endrin Aldehyde	7421-93-4	N.D.	1.2	ug/kg	1
01993	PCB-1016	12674-11-2	N.D.	3.8	ug/kg	1
01994	PCB-1221	11104-28-2	N.D.	12.	ug/kg	1
01995	PCB-1232	11141-16-5	N.D.	5.0	ug/kg	1
01996	PCB-1242	53469-21-9	N.D.	4.6	ug/kg	1
01997	PCB-1248	12672-29-6	N.D.	6.9	ug/kg	1
01998	PCB-1254	11097-69-1	N.D.	3.8	ug/kg	1
01999	PCB-1260	11096-82-5	N.D.	3.8	ug/kg	1
03017	Endrin Ketone	53494-70-5	N.D.	0.38	ug/kg	1
03025	Alpha Chlordane	5103-71-9	N.D.	0.20	ug/kg	1
03026	Gamma Chlordane	5103-74-2	N.D.	0.35	ug/kg	1
04688	TCL SW846 Semivolatiles Soil					
01185	Phenol	108-95-2	N.D.	39.	ug/kg	1
01186	2-Chlorophenol	95-57-8	N.D.	39.	ug/kg	1
01187	1,4-Dichlorobenzene	106-46-7	N.D.	39.	ug/kg	1
01188	N-Nitroso-di-n-propylamine	621-64-7	N.D.	39.	ug/kg	1
01189	1,2,4-Trichlorobenzene	120-82-1	N.D.	39.	ug/kg	1
01190	4-Chloro-3-methylphenol	59-50-7	N.D.	77.	ug/kg	1
03746	2-Nitrophenol	88-75-5	N.D.	39.	ug/kg	1
03747	2,4-Dimethylphenol	105-67-9	N.D.	39.	ug/kg	1
03748	2,4-Dichlorophenol	120-83-2	N.D.	39.	ug/kg	1
03749	2,4,6-Trichlorophenol	88-06-2	N.D.	39.	ug/kg	1

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216798

EVC-13-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
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Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV130

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
03753	bis(2-Chloroethyl)ether	111-44-4	N.D.	39.	ug/kg	1
03754	1,3-Dichlorobenzene	541-73-1	N.D.	39.	ug/kg	1
03755	1,2-Dichlorobenzene	95-50-1	N.D.	39.	ug/kg	1
03757	Hexachloroethane	67-72-1	N.D.	39.	ug/kg	1
03758	Nitrobenzene	98-95-3	N.D.	39.	ug/kg	1
03759	Isophorone	78-59-1	N.D.	39.	ug/kg	1
03760	bis(2-Chloroethoxy)methane	111-91-1	N.D.	39.	ug/kg	1
03761	Naphthalene	91-20-3	N.D.	39.	ug/kg	1
03762	Hexachlorobutadiene	87-68-3	N.D.	77.	ug/kg	1
03763	Hexachlorocyclopentadiene	77-47-4	N.D.	190.	ug/kg	1
03764	2-Chloronaphthalene	91-58-7	N.D.	39.	ug/kg	1
03765	Acenaphthylene	208-96-8	N.D.	39.	ug/kg	1
03766	Dimethylphthalate	131-11-3	N.D.	77.	ug/kg	1
04690	2-Methylphenol	95-48-7	N.D.	39.	ug/kg	1
04691	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	39.	ug/kg	1
04692	4-Methylphenol	106-44-5	N.D.	77.	ug/kg	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04693	4-Chloroaniline	106-47-8	N.D.	39.	ug/kg	1
04694	2-Methylnaphthalene	91-57-6	N.D.	39.	ug/kg	1
04695	2,4,5-Trichlorophenol	95-95-4	N.D.	39.	ug/kg	1
04696	2-Nitroaniline	88-74-4	N.D.	39.	ug/kg	1
04689	TCL SW846 Semivolatiles/Soil					
01191	Acenaphthene	83-32-9	N.D.	39.	ug/kg	1
01192	4-Nitrophenol	100-02-7	N.D.	190.	ug/kg	1
01193	2,4-Dinitrotoluene	121-14-2	N.D.	77.	ug/kg	1
01194	Pentachlorophenol	87-86-5	N.D.	190.	ug/kg	1
01195	Pyrene	129-00-0	N.D.	39.	ug/kg	1
03750	2,4-Dinitrophenol	51-28-5	N.D.	770.	ug/kg	1
03751	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	190.	ug/kg	1
03767	2,6-Dinitrotoluene	606-20-2	N.D.	39.	ug/kg	1
03768	Fluorene	86-73-7	N.D.	39.	ug/kg	1
03769	4-Chlorophenyl-phenylether	7005-72-3	N.D.	39.	ug/kg	1
03770	Diethylphthalate	84-66-2	N.D.	77.	ug/kg	1
03772	N-Nitrosodiphenylamine	86-30-6	N.D.	39.	ug/kg	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine.					

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216798

EVC-13-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:08
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV130

CAT No.	Analysis Name	CAS Number	Dry Result	Dry Method Detection Limit	Units	Dilution Factor
	The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03773	4-Bromophenyl-phenylether	101-55-3	N.D.	39.	ug/kg	1
03774	Hexachlorobenzene	118-74-1	N.D.	39.	ug/kg	1
03775	Phenanthrene	85-01-8	N.D.	39.	ug/kg	1
03776	Anthracene	120-12-7	N.D.	39.	ug/kg	1
03777	Di-n-butylphthalate	84-74-2	N.D.	77.	ug/kg	1
03778	Fluoranthene	206-44-0	N.D.	39.	ug/kg	1
03780	Butylbenzylphthalate	85-68-7	N.D.	77.	ug/kg	1
03781	Benzo(a)anthracene	56-55-3	N.D.	39.	ug/kg	1
03782	Chrysene	218-01-9	N.D.	39.	ug/kg	1
03783	3,3'-Dichlorobenzidine	91-94-1	N.D.	77.	ug/kg	1
03784	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	190.	ug/kg	1
03785	Di-n-octylphthalate	117-84-0	N.D.	77.	ug/kg	1
03786	Benzo(b)fluoranthene	205-99-2	N.D.	39.	ug/kg	1
03787	Benzo(k)fluoranthene	207-08-9	N.D.	39.	ug/kg	1
03788	Benzo(a)pyrene	50-32-8	N.D.	39.	ug/kg	1
03789	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	39.	ug/kg	1
03790	Dibenz(a,h)anthracene	53-70-3	N.D.	39.	ug/kg	1
03791	Benzo(g,h,i)perylene	191-24-2	N.D.	39.	ug/kg	1
04697	3-Nitroaniline	99-09-2	N.D.	77.	ug/kg	1
04698	Dibenzofuran	132-64-9	N.D.	39.	ug/kg	1
04700	4-Nitroaniline	100-01-6	N.D.	77.	ug/kg	1
04702	Carbazole	86-74-8	N.D.	39.	ug/kg	1

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00159	Mercury	SW-846 7471A	1	02/17/2004 11:40	Damary Valentin	1
01643	Aluminum	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
01650	Calcium	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
01654	Iron	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
01657	Magnesium	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
01662	Potassium	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
01667	Sodium	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06925	Thallium	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Lancaster Laboratories Sample No. SW 4216798

EVC-13-0 Composite Sediment Sample
Fenwick Island

Collected:02/12/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:08
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

FV130

06935	Arsenic	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06936	Selenium	SW-846 6010B	1	02/19/2004 15:19	Jayme E Curet	1
06944	Antimony	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06946	Barium	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06947	Beryllium	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06949	Cadmium	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06951	Chromium	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06952	Cobalt	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06953	Copper	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06955	Lead	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06958	Manganese	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06961	Nickel	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06966	Silver	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06971	Vanadium	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
06972	Zinc	SW-846 6010B	1	02/17/2004 08:30	Joanne M Gates	1
00111	Moisture	EPA 160.3 modified	1	02/20/2004 16:48	Scott W Freisher	1
00236	Oil & Grease	SW-846 9071A	1	03/09/2004 10:00	Nichole L Underwood	1
00394	pH	SW-846 9045C (modified)	1	02/16/2004 21:30	Luz M Groff	1
01225	TCL Pesticides in Solids	SW-846 8081A/8082	1	02/20/2004 04:33	Andrea J Covey	1
04688	TCL SW846 Semivolatiles Soil	SW-846 8270C	1	02/23/2004 14:23	Jeffrey B Smith	1
04689	TCL SW846 Semivolatiles/Soil	SW-846 8270C	1	02/23/2004 14:23	Jeffrey B Smith	1
00381	BNA Soil Extraction	SW-846 3550B	1	02/17/2004 09:30	Jessica Agosto	1
05708	SW SW846 ICP Digest	SW-846 3050B	1	02/16/2004 20:20	Annamaria Stipkovits	1
05711	SW SW846 Hg Digest	SW-846 7471A modified	1	02/16/2004 23:40	Annamaria Stipkovits	1
06006	PPL Pesticide Solid Extraction	SW-846 3550B	1	02/17/2004 07:15	Ginelle L Haines	1

Lancaster Laboratories

Lancaster Laboratories Sample No. WW 4216799

Equipment Blank Grab Water Sample
Fenwick Island

Collected:02/13/2004 by KD

Account Number: 07446

Submitted: 02/14/2004 09:00
Reported: 03/12/2004 at 13:08
Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EQUIP

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit	Units	Dilution Factor
00259	Mercury	7439-97-6	N.D.	0.00016	mg/l	1
01743	Aluminum	7429-90-5	N.D.	0.0413	mg/l	1
01750	Calcium	7440-70-2	N.D.	0.0494	mg/l	1
01754	Iron	7439-89-6	N.D.	0.0453	mg/l	1
01757	Magnesium	7439-95-4	N.D.	0.0183	mg/l	1
01762	Potassium	7440-09-7	0.0703 J	0.0429	mg/l	1
01767	Sodium	7440-23-5	1.40	0.463	mg/l	1
07022	Thallium	7440-28-0	N.D.	0.0089	mg/l	1
07035	Arsenic	7440-38-2	N.D.	0.0049	mg/l	1
07036	Selenium	7782-49-2	N.D.	0.0047	mg/l	1
07044	Antimony	7440-36-0	N.D.	0.0085	mg/l	1
07046	Barium	7440-39-3	N.D.	0.00048	mg/l	1
07047	Beryllium	7440-41-7	N.D.	0.00034	mg/l	1
07049	Cadmium	7440-43-9	N.D.	0.00087	mg/l	1
07051	Chromium	7440-47-3	N.D.	0.0022	mg/l	1
07052	Cobalt	7440-48-4	N.D.	0.0016	mg/l	1
07053	Copper	7440-50-8	N.D.	0.0021	mg/l	1
07055	Lead	7439-92-1	N.D.	0.0093	mg/l	1
07058	Manganese	7439-96-5	0.0018 J	0.00051	mg/l	1
07061	Nickel	7440-02-0	N.D.	0.0038	mg/l	1
07066	Silver	7440-22-4	N.D.	0.0018	mg/l	1
07071	Vanadium	7440-62-2	N.D.	0.0017	mg/l	1
07072	Zinc	7440-66-6	N.D.	0.0041	mg/l	1
00206	Total Suspended Solids	n.a.	N.D.	3.0	mg/l	1
00212	Total Dissolved Solids	n.a.	N.D.	9.7	mg/l	1
00231	Oil & Grease	n.a.	N.D.	2.5	mg/l	1

The blank analyzed with this sample contained 1.2 mg/l of oil and grease. As directed in EPA method 413.1, the value of the blank was subtracted from the value of the sample to obtain the reported result.
Sufficient sample volume was not available to perform a MS/MSD for this analysis. Therefore, a LCS/LCSD was performed to demonstrate precision and accuracy at a batch level.

00937	TCL Pesticides in Waters					
00938	Endrin Ketone	53494-70-5	N.D.	0.0046	ug/l	1
01361	Alpha Chlordane	5103-71-9	N.D.	0.0023	ug/l	1
01362	Gamma Chlordane	5103-74-2	N.D.	0.0023	ug/l	1

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Lancaster Laboratories Sample No. WW 4216799

Equipment Blank Grab Water Sample
Fenwick Island

Collected:02/13/2004 by KD

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Discard: 03/27/2004

Versar Incorporated - MD
9200 Rumsey Road
Columbia MD 21045

EQUIP

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit	Units	Dilution Factor
01600	Alpha BHC	319-84-6	N.D.	0.0023	ug/l	1
01601	Beta BHC	319-85-7	N.D.	0.014	ug/l	1
01602	Gamma BHC - Lindane	58-89-9	N.D.	0.0023	ug/l	1
01603	Delta BHC	319-86-8	N.D.	0.0034	ug/l	1
01604	Heptachlor	76-44-8	N.D.	0.0023	ug/l	1
01605	Aldrin	309-00-2	N.D.	0.0023	ug/l	1
01606	Heptachlor Epoxide	1024-57-3	N.D.	0.0023	ug/l	1
01607	p,p-DDE	72-55-9	N.D.	0.0046	ug/l	1
01608	p,p-DDD	72-54-8	N.D.	0.0046	ug/l	1
01609	p,p-DDT	50-29-3	N.D.	0.0046	ug/l	1
01610	Dieldrin	60-57-1	N.D.	0.0057	ug/l	1
01611	Endrin	72-20-8	N.D.	0.0046	ug/l	1
01613	Toxaphene	8001-35-2	N.D.	0.34	ug/l	1
01615	Endosulfan II	33213-65-9	N.D.	0.0057	ug/l	1
01616	Endosulfan I	959-98-8	N.D.	0.0046	ug/l	1
01617	Endosulfan Sulfate	1031-07-8	N.D.	0.010	ug/l	1
01618	Endrin Aldehyde	7421-93-4	N.D.	0.023	ug/l	1
01619	PCB-1016	12674-11-2	N.D.	0.23	ug/l	1
01620	PCB-1221	11104-28-2	N.D.	0.46	ug/l	1
01621	PCB-1232	11141-16-5	N.D.	0.11	ug/l	1
01622	PCB-1242	53469-21-9	N.D.	0.23	ug/l	1
01623	PCB-1248	12672-29-6	N.D.	0.34	ug/l	1
01624	PCB-1254	11097-69-1	N.D.	0.23	ug/l	1
01626	PCB-1260	11096-82-5	N.D.	0.34	ug/l	1
01860	Methoxychlor	72-43-5	N.D.	0.069	ug/l	1
	Sufficient sample volume was not available to perform a MS/MSD for this analysis. Therefore, a LCS/LCSD was performed to demonstrate precision and accuracy at a batch level.					
04678	TCL SW846 Semivolatiles/Waters					
03871	4-Chloroaniline	106-47-8	N.D.	1.	ug/l	1
03905	2-Methylnaphthalene	91-57-6	N.D.	1.	ug/l	1
03907	2-Nitroaniline	88-74-4	N.D.	1.	ug/l	1
03922	2,4,5-Trichlorophenol	95-95-4	N.D.	1.	ug/l	1
03924	2-Chlorophenol	95-57-8	N.D.	1.	ug/l	1
03925	Phenol	108-95-2	N.D.	1.	ug/l	1
03926	2-Nitrophenol	88-75-5	N.D.	1.	ug/l	1

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EQUIP

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit	Units	Dilution Factor
03927	2,4-Dimethylphenol	105-67-9	N.D.	1.	ug/l	1
03928	2,4-Dichlorophenol	120-83-2	N.D.	1.	ug/l	1
03929	4-Chloro-3-methylphenol	59-50-7	N.D.	1.	ug/l	1
03930	2,4,6-Trichlorophenol	88-06-2	N.D.	1.	ug/l	1
03936	bis(2-Chloroethyl)ether	111-44-4	N.D.	1.	ug/l	1
03937	1,3-Dichlorobenzene	541-73-1	N.D.	1.	ug/l	1
03938	1,4-Dichlorobenzene	106-46-7	N.D.	1.	ug/l	1
03939	1,2-Dichlorobenzene	95-50-1	N.D.	1.	ug/l	1
03941	Hexachloroethane	67-72-1	N.D.	1.	ug/l	1
03942	N-Nitroso-di-n-propylamine	621-64-7	N.D.	1.	ug/l	1
03943	Nitrobenzene	98-95-3	N.D.	1.	ug/l	1
03944	Isophorone	78-59-1	N.D.	1.	ug/l	1
03945	bis(2-Chloroethoxy)methane	111-91-1	N.D.	1.	ug/l	1
03946	1,2,4-Trichlorobenzene	120-82-1	N.D.	1.	ug/l	1
03947	Naphthalene	91-20-3	N.D.	1.	ug/l	1
03948	Hexachlorobutadiene	87-68-3	N.D.	1.	ug/l	1
03949	Hexachlorocyclopentadiene	77-47-4	N.D.	5.	ug/l	1
03950	2-Chloronaphthalene	91-58-7	N.D.	1.	ug/l	1
03951	Acenaphthylene	208-96-8	N.D.	1.	ug/l	1
03952	Dimethylphthalate	131-11-3	N.D.	2.	ug/l	1
04680	2-Methylphenol	95-48-7	N.D.	1.	ug/l	1
04681	2,2'-oxybis(1-Chloropropane)	108-60-1	N.D.	1.	ug/l	1
04682	4-Methylphenol	106-44-5	N.D.	2.	ug/l	1
	3-Methylphenol and 4-methylphenol cannot be resolved under the chromatographic conditions used for sample analysis. The result reported for 4-methylphenol represents the combined total of both compounds.					
04679	TCL SW846 Semivolatiles/Waters					
03879	Dibenzofuran	132-64-9	N.D.	1.	ug/l	1
03908	3-Nitroaniline	99-09-2	N.D.	1.	ug/l	1
03909	4-Nitroaniline	100-01-6	N.D.	1.	ug/l	1
03931	2,4-Dinitrophenol	51-28-5	N.D.	19.	ug/l	1
03932	4-Nitrophenol	100-02-7	N.D.	10.	ug/l	1
03933	4,6-Dinitro-2-methylphenol	534-52-1	N.D.	5.	ug/l	1
03934	Pentachlorophenol	87-86-5	N.D.	3.	ug/l	1
03953	2,6-Dinitrotoluene	606-20-2	N.D.	1.	ug/l	1
03954	Acenaphthene	83-32-9	N.D.	1.	ug/l	1
03955	2,4-Dinitrotoluene	121-14-2	N.D.	1.	ug/l	1

Lancaster Laboratories

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Equipment Blank Grab Water Sample
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9200 Rumsey Road
Columbia MD 21045

EQUIP

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit	Units	Dilution Factor
03956	Fluorene	86-73-7	N.D.	1.	ug/l	1
03957	4-Chlorophenyl-phenylether	7005-72-3	N.D.	1.	ug/l	1
03958	Diethylphthalate	84-66-2	N.D.	2.	ug/l	1
03960	N-Nitrosodiphenylamine	86-30-6	N.D.	2.	ug/l	1
	N-nitrosodiphenylamine decomposes in the GC inlet forming diphenylamine. The result reported for N-nitrosodiphenylamine represents the combined total of both compounds.					
03961	4-Bromophenyl-phenylether	101-55-3	N.D.	1.	ug/l	1
03962	Hexachlorobenzene	118-74-1	N.D.	1.	ug/l	1
03963	Phenanthrene	85-01-8	N.D.	1.	ug/l	1
03964	Anthracene	120-12-7	N.D.	1.	ug/l	1
03965	Di-n-butylphthalate	84-74-2	N.D.	2.	ug/l	1
03966	Fluoranthene	206-44-0	N.D.	1.	ug/l	1
03967	Pyrene	129-00-0	N.D.	1.	ug/l	1
03969	Butylbenzylphthalate	85-68-7	N.D.	2.	ug/l	1
03970	Benzo(a)anthracene	56-55-3	N.D.	1.	ug/l	1
03971	Chrysene	218-01-9	N.D.	1.	ug/l	1
03972	3,3'-Dichlorobenzidine	91-94-1	N.D.	1.	ug/l	1
03973	bis(2-Ethylhexyl)phthalate	117-81-7	N.D.	2.	ug/l	1
03974	Di-n-octylphthalate	117-84-0	N.D.	2.	ug/l	1
03975	Benzo(b)fluoranthene	205-99-2	N.D.	1.	ug/l	1
03976	Benzo(k)fluoranthene	207-08-9	N.D.	1.	ug/l	1
03977	Benzo(a)pyrene	50-32-8	N.D.	1.	ug/l	1
03978	Indeno(1,2,3-cd)pyrene	193-39-5	N.D.	1.	ug/l	1
03979	Dibenz(a,h)anthracene	53-70-3	N.D.	1.	ug/l	1
03980	Benzo(g,h,i)perylene	191-24-2	N.D.	1.	ug/l	1
04684	Carbazole	86-74-8	N.D.	1.	ug/l	1

The recoveries of several compounds were outside of QC limits in the LCS. This sample was re-extracted outside of the method required holding time, and acceptable QC was observed. The data reported here is from the initial extraction of the sample.

Sufficient sample volume was not available to perform a MS/MSD for this analysis. Therefore, a LCS/LCSD was performed to demonstrate precision and accuracy at a batch level.

Lancaster Laboratories

Lancaster Laboratories Sample No. WW 4216799

Equipment Blank Grab Water Sample
Fenwick Island

Collected:02/13/2004 by KD

Account Number: 07446

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EQUIP

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00259	Mercury	SW-846 7470A	1	02/16/2004 21:03	Nelli S Markaryan	1
01743	Aluminum	SW-846 6010B	2	02/25/2004 12:41	Joanne M Gates	1
01750	Calcium	SW-846 6010B	1	02/24/2004 19:45	John P Hook	1
01754	Iron	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
01757	Magnesium	SW-846 6010B	1	02/24/2004 19:45	John P Hook	1
01762	Potassium	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
01767	Sodium	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07022	Thallium	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07035	Arsenic	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07036	Selenium	SW-846 6010B	1	02/20/2004 11:51	Jayme E Curet	1
07044	Antimony	SW-846 6010B	1	02/20/2004 11:51	Jayme E Curet	1
07046	Barium	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07047	Beryllium	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07049	Cadmium	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07051	Chromium	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07052	Cobalt	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07053	Copper	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07055	Lead	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07058	Manganese	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07061	Nickel	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07066	Silver	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07071	Vanadium	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
07072	Zinc	SW-846 6010B	1	02/18/2004 03:17	Donna R Sackett	1
00206	Total Suspended Solids	EPA 160.2	1	02/18/2004 15:23	Anne L Kuenzli	1
00212	Total Dissolved Solids	EPA 160.1	1	02/18/2004 11:54	Anne L Kuenzli	1
00231	Oil & Grease	EPA 413.1	1	02/23/2004 07:15	Yolunder Y Bunch	1
00937	TCL Pesticides in Waters	SW-846 8081A/8082	1	02/18/2004 20:19	Richard A Shober	1
04678	TCL SW846 Semivolatiles/Waters	SW-846 8270C	1	02/22/2004 22:01	Ian D Spotts	1
04679	TCL SW846 Semivolatiles/Waters	SW-846 8270C	1	02/22/2004 22:01	Ian D Spotts	1
00813	BNA Water Extraction	SW-846 3510C	1	02/17/2004 10:00	Zachary S Dennis	1
00817	Water Sample Pest. Extraction	SW-846 3510C	1	02/18/2004 08:20	Joseph S Feister	1
01848	WW SW846 ICP Digest (tot rec)	SW-846 3005A	1	02/17/2004 10:28	Megersa Deyessa	1
01848	WW SW846 ICP Digest (tot rec)	SW-846 3005A	2	02/24/2004 21:20	Annamaria Stipkovits	1
05713	WW SW846 Hg Digest	SW-846 7470A	1	02/16/2004 16:00	Nelli S Markaryan	1

Lancaster Laboratories

Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Matrix QC may not be reported if site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD was performed, unless otherwise specified in the method.

Laboratory Compliance Quality Control

Analysis Name	Blank Result	Blank MDL	Report Units	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
Batch number: 040470014A	Sample number(s): 4216774-4216783							
Gamma BHC - Lindane	N.D.	0.17	ug/kg	107		64-134		
Heptachlor	N.D.	0.17	ug/kg	106		64-142		
Aldrin	N.D.	0.51	ug/kg	108		58-138		
p,p-DDT	N.D.	0.33	ug/kg	103		67-152		
Dieldrin	N.D.	0.33	ug/kg	102		71-133		
Endrin	N.D.	0.50	ug/kg	99		68-133		
Methoxychlor	N.D.	4.0	ug/kg	95		56-168		
Alpha BHC	N.D.	0.17	ug/kg	107		56-126		
Beta BHC	N.D.	0.17	ug/kg	106		68-137		
Delta BHC	N.D.	0.17	ug/kg	115		42-144		
Heptachlor Epoxide	N.D.	0.17	ug/kg	100		72-132		
p,p-DDE	N.D.	0.33	ug/kg	106		71-143		
p,p-DDD	N.D.	0.58	ug/kg	97		60-153		
Toxaphene	N.D.	11.	ug/kg					
Endosulfan I	N.D.	0.44	ug/kg	101		71-130		
Endosulfan II	N.D.	0.33	ug/kg	104		73-134		
Endosulfan Sulfate	N.D.	0.33	ug/kg	98		58-133		
Endrin Aldehyde	N.D.	1.0	ug/kg	102		47-145		
PCB-1016	N.D.	3.3	ug/kg					
PCB-1221	N.D.	10.	ug/kg					
PCB-1232	N.D.	4.3	ug/kg					
PCB-1242	N.D.	4.0	ug/kg					
PCB-1248	N.D.	6.0	ug/kg					
PCB-1254	N.D.	3.3	ug/kg					
PCB-1260	N.D.	3.3	ug/kg					
Endrin Ketone	N.D.	0.33	ug/kg	106		70-143		
Alpha Chlordane	N.D.	0.17	ug/kg	102		76-133		
Gamma Chlordane	N.D.	0.30	ug/kg	104		63-145		
Batch number: 040470022A	Sample number(s): 4216784-4216798							
Gamma BHC - Lindane	N.D.	0.17	ug/kg	109		64-134		
Heptachlor	N.D.	0.17	ug/kg	106		64-142		
Aldrin	N.D.	0.51	ug/kg	111		58-138		
p,p-DDT	N.D.	0.33	ug/kg	103		67-152		
Dieldrin	N.D.	0.33	ug/kg	102		71-133		
Endrin	N.D.	0.50	ug/kg	99		68-133		
Methoxychlor	N.D.	4.0	ug/kg	96		56-168		

*- Outside of specification
(1) The result for one or both determinations was less than five times the LOQ.
(2) The background result was more than four times the spike added.

MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Laboratory Compliance Quality Control

Analysis Name	Blank Result	Blank MDL	Report Units	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
Alpha BHC	N.D.	0.17	ug/kg	107		56-126		
Beta BHC	N.D.	0.17	ug/kg	107		68-137		
Delta BHC	N.D.	0.17	ug/kg	111		42-144		
Heptachlor Epoxide	N.D.	0.17	ug/kg	103		72-132		
p,p-DDE	N.D.	0.33	ug/kg	106		71-143		
p,p-DDD	N.D.	0.58	ug/kg	98		60-153		
Toxaphene	N.D.	11.	ug/kg					
Endosulfan I	N.D.	0.44	ug/kg	103		71-130		
Endosulfan II	N.D.	0.330	ug/kg	104		73-134		
Endosulfan Sulfate	N.D.	0.33	ug/kg	102		58-133		
Endrin Aldehyde	N.D.	1.0	ug/kg	101		47-145		
PCB-1016	N.D.	3.3	ug/kg					
PCB-1221	N.D.	10.	ug/kg					
PCB-1232	N.D.	4.3	ug/kg					
PCB-1242	N.D.	4.0	ug/kg					
PCB-1248	N.D.	6.0	ug/kg					
PCB-1254	N.D.	3.3	ug/kg					
PCB-1260	N.D.	3.3	ug/kg					
Endrin Ketone	N.D.	0.33	ug/kg	105		70-143		
Alpha Chlordane	N.D.	0.17	ug/kg	103		76-133		
Gamma Chlordane	N.D.	0.30	ug/kg	106		63-145		
Batch number: 040470394018	Sample number(s): 4216774-4216780							
pH				100		99-101		
Batch number: 04047039402A	Sample number(s): 4216781-4216789							
pH				100		99-101		
Batch number: 04047039402B	Sample number(s): 4216790-4216798							
pH				100		99-101		
Batch number: 040475708002	Sample number(s): 4216774-4216783							
Aluminum	N.D.	3.00	mg/kg	132		78-192		
Calcium	10.3 J	1.25	mg/kg	108		97-119		
Iron	N.D.	4.89	mg/kg	120		51-219		
Magnesium	N.D.	1.98	mg/kg	110		93-128		
Potassium	7.24 J	3.72	mg/kg	112		89-142		
Sodium	N.D.	47.2	mg/kg	88		48-130		
Thallium	N.D.	0.930	mg/kg	100		96-112		
Arsenic	N.D.	0.500	mg/kg	95		90-110		
Selenium	N.D.	0.470	mg/kg	104		94-114		
Antimony	N.D.	0.660	mg/kg	63		7-186		
Barium	N.D.	0.0320	mg/kg	103		96-117		
Beryllium	N.D.	0.0590	mg/kg	101		89-111		
Cadmium	N.D.	0.0540	mg/kg	96		88-106		
Chromium	0.263 J	0.200	mg/kg	99		92-114		
Cobalt	N.D.	0.140	mg/kg	97		88-107		
Copper	N.D.	0.190	mg/kg	99		90-111		

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Laboratory Compliance Quality Control

Analysis Name	Blank Result	Blank MDL	Report Units	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
Lead	N.D.	0.790	mg/kg	97		86-109		
Manganese	N.D.	0.0380	mg/kg	100		91-119		
Nickel	N.D.	0.200	mg/kg	97		89-107		
Silver	N.D.	0.150	mg/kg	124		84-166		
Vanadium	N.D.	0.160	mg/kg	105		83-146		
Zinc	0.495 J	0.180	mg/kg	96		91-110		
Batch number: 040475708003	Sample number(s): 4216784-4216798							
Aluminum	N.D.	2.96	mg/kg	143		78-192		
Calcium	3.31 J	1.25	mg/kg	106		97-119		
Iron	N.D.	4.89	mg/kg	128		51-219		
Magnesium	N.D.	1.98	mg/kg	110		93-128		
Potassium	N.D.	3.72	mg/kg	117		89-142		
Sodium	N.D.	47.2	mg/kg	84		48-130		
Thallium	N.D.	0.930	mg/kg	98		96-112		
Arsenic	N.D.	0.500	mg/kg	93		90-110		
Selenium	N.D.	0.470	mg/kg	102		94-114		
Antimony	N.D.	0.660	mg/kg	76		7-186		
Barium	0.0480 J	0.0320	mg/kg	103		96-117		
Beryllium	N.D.	0.0590	mg/kg	98		89-111		
Cadmium	N.D.	0.0540	mg/kg	95		88-106		
Chromium	N.D.	0.200	mg/kg	98		92-114		
Cobalt	N.D.	0.140	mg/kg	96		88-107		
Copper	N.D.	0.190	mg/kg	98		90-111		
Lead	N.D.	0.790	mg/kg	94		86-109		
Manganese	N.D.	0.0380	mg/kg	102		91-119		
Nickel	N.D.	0.200	mg/kg	95		89-107		
Silver	N.D.	0.150	mg/kg	124		84-166		
Vanadium	N.D.	0.160	mg/kg	108		83-146		
Zinc	0.274 J	0.180	mg/kg	97		91-110		
Batch number: 040475711004	Sample number(s): 4216774-4216783							
Mercury	N.D.	0.0028	mg/kg	89		76-115		
Batch number: 040475711005	Sample number(s): 4216784-4216798							
Mercury	N.D.	0.0028	mg/kg	86		76-115		
Batch number: 040475713001	Sample number(s): 4216799							
Mercury	N.D.	0.00016	mg/l	101		80-120		
Batch number: 04047SLC026	Sample number(s): 4216782-4216785, 4216787-4216796, 4216798							
Phenol	N.D.	33.	ug/kg	78		67-108		
2-Chlorophenol	N.D.	33.	ug/kg	86		74-104		
1,4-Dichlorobenzene	N.D.	33.	ug/kg	75		62-104		
N-Nitroso-di-n-propylamine	N.D.	33.	ug/kg	70		62-109		
1,2,4-Trichlorobenzene	N.D.	33.	ug/kg	83		72-102		
4-Chloro-3-methylphenol	N.D.	67.	ug/kg	90		72-117		
Acenaphthene	N.D.	33.	ug/kg	85		76-109		

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Laboratory Compliance Quality Control

Analysis Name	Blank Result	Blank MDL	Report Units	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
4-Nitrophenol	N.D.	170.	ug/kg	83		55-133		
2,4-Dinitrotoluene	N.D.	67.	ug/kg	86		75-118		
Pentachlorophenol	N.D.	170.	ug/kg	59		47-110		
Pyrene	N.D.	33.	ug/kg	89		71-110		
2-Nitrophenol	N.D.	33.	ug/kg	93		76-111		
2,4-Dimethylphenol	N.D.	33.	ug/kg	82		68-103		
2,4-Dichlorophenol	N.D.	33.	ug/kg	86		76-104		
2,4,6-Trichlorophenol	N.D.	33.	ug/kg	80		75-106		
2,4-Dinitrophenol	N.D.	670.	ug/kg	63		21-120		
4,6-Dinitro-2-methylphenol	N.D.	170.	ug/kg	79		41-121		
bis(2-Chloroethyl)ether	N.D.	33.	ug/kg	79		66-104		
1,3-Dichlorobenzene	N.D.	33.	ug/kg	76		62-105		
1,2-Dichlorobenzene	N.D.	33.	ug/kg	76		64-101		
Hexachloroethane	N.D.	33.	ug/kg	80		62-105		
Nitrobenzene	N.D.	33.	ug/kg	80		70-106		
Isophorone	N.D.	33.	ug/kg	80		70-103		
bis(2-Chloroethoxy)methane	N.D.	33.	ug/kg	90		75-114		
Naphthalene	N.D.	33.	ug/kg	82		73-103		
Hexachlorobutadiene	N.D.	67.	ug/kg	85		69-108		
Hexachlorocyclopentadiene	N.D.	170.	ug/kg	72		9-154		
2-Chloronaphthalene	N.D.	33.	ug/kg	80		72-103		
Acenaphthylene	N.D.	33.	ug/kg	79		66-113		
Dimethylphthalate	N.D.	67.	ug/kg	81		76-108		
2,6-Dinitrotoluene	N.D.	33.	ug/kg	81		75-108		
Fluorene	N.D.	33.	ug/kg	76		66-115		
4-Chlorophenyl-phenylether	N.D.	33.	ug/kg	74		70-108		
Diethylphthalate	N.D.	67.	ug/kg	82		75-109		
N-Nitrosodiphenylamine	N.D.	33.	ug/kg	81		67-105		
4-Bromophenyl-phenylether	N.D.	33.	ug/kg	80		74-110		
Hexachlorobenzene	N.D.	33.	ug/kg	81		72-110		
Phenanthrene	N.D.	33.	ug/kg	80		70-107		
Anthracene	N.D.	33.	ug/kg	81		71-107		
Di-n-butylphthalate	N.D.	67.	ug/kg	84		73-109		
Fluoranthene	N.D.	33.	ug/kg	78		69-107		
Butylbenzylphthalate	N.D.	67.	ug/kg	92		75-117		
Benzo(a)anthracene	N.D.	33.	ug/kg	80		74-107		
Chrysene	N.D.	33.	ug/kg	82		72-109		
3,3'-Dichlorobenzidine	N.D.	67.	ug/kg	42		9-101		
bis(2-Ethylhexyl)phthalate	N.D.	170.	ug/kg	83		63-131		
Di-n-octylphthalate	N.D.	67.	ug/kg	76		67-115		
Benzo(b)fluoranthene	N.D.	33.	ug/kg	78		71-113		
Benzo(k)fluoranthene	N.D.	33.	ug/kg	82		75-112		
Benzo(a)pyrene	N.D.	33.	ug/kg	79		79-113		
Indeno(1,2,3-cd)pyrene	N.D.	33.	ug/kg	83		74-113		
Dibenz(a,h)anthracene	N.D.	33.	ug/kg	88		80-125		
Benzo(g,h,i)perylene	N.D.	33.	ug/kg	83		74-119		
2-Methylphenol	N.D.	33.	ug/kg	78		68-103		
2,2'-oxybis(1-Chloropropane)	N.D.	33.	ug/kg	85		66-138		

*- Outside of specification
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MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

Lancaster Laboratories

Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Laboratory Compliance Quality Control

Analysis Name	Blank Result	Blank MDL	Report Units	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
4-Methylphenol	N.D.	67.	ug/kg	73		65-113		
4-Chloroaniline	N.D.	33.	ug/kg	37		14-104		
2-Methylnaphthalene	N.D.	33.	ug/kg	86		70-102		
2,4,5-Trichlorophenol	N.D.	33.	ug/kg	81		76-110		
2-Nitroaniline	N.D.	33.	ug/kg	85		76-117		
3-Nitroaniline	N.D.	67.	ug/kg	66		53-107		
Dibenzofuran	N.D.	33.	ug/kg	80		72-107		
4-Nitroaniline	N.D.	67.	ug/kg	65		48-96		
Carbazole	N.D.	33.	ug/kg	85		73-107		
Batch number: 04047SLD026	Sample number(s): 4216774-4216781,4216786,4216797							
Phenol	N.D.	33.	ug/kg	84		67-108		
2-Chlorophenol	N.D.	33.	ug/kg	86		74-104		
1,4-Dichlorobenzene	N.D.	33.	ug/kg	79		62-104		
N-Nitroso-di-n-propylamine	N.D.	33.	ug/kg	85		62-109		
1,2,4-Trichlorobenzene	N.D.	33.	ug/kg	81		72-102		
4-Chloro-3-methylphenol	N.D.	67.	ug/kg	88		72-117		
Acenaphthene	N.D.	33.	ug/kg	90		76-109		
4-Nitrophenol	N.D.	170.	ug/kg	95		55-133		
2,4-Dinitrotoluene	N.D.	67.	ug/kg	93		75-118		
Pentachlorophenol	N.D.	170.	ug/kg	82		47-110		
Pyrene	N.D.	33.	ug/kg	87		71-110		
2-Nitrophenol	N.D.	33.	ug/kg	93		76-111		
2,4-Dimethylphenol	N.D.	33.	ug/kg	85		68-103		
2,4-Dichlorophenol	N.D.	33.	ug/kg	86		76-104		
2,4,6-Trichlorophenol	N.D.	33.	ug/kg	88		75-106		
2,4-Dinitrophenol	N.D.	670.	ug/kg	83		21-120		
4,6-Dinitro-2-methylphenol	N.D.	170.	ug/kg	80		41-121		
bis(2-Chloroethyl)ether	N.D.	33.	ug/kg	84		66-104		
1,3-Dichlorobenzene	N.D.	33.	ug/kg	79		62-105		
1,2-Dichlorobenzene	N.D.	33.	ug/kg	80		64-101		
Hexachloroethane	N.D.	33.	ug/kg	79		62-105		
Nitrobenzene	N.D.	33.	ug/kg	85		70-106		
Isophorone	N.D.	33.	ug/kg	81		70-103		
bis(2-Chloroethoxy)methane	N.D.	33.	ug/kg	92		75-114		
Naphthalene	N.D.	33.	ug/kg	83		73-103		
Hexachlorobutadiene	N.D.	67.	ug/kg	83		69-108		
Hexachlorocyclopentadiene	N.D.	170.	ug/kg	96		9-154		
2-Chloronaphthalene	N.D.	33.	ug/kg	85		72-103		
Acenaphthylene	N.D.	33.	ug/kg	86		66-113		
Dimethylphthalate	N.D.	67.	ug/kg	86		76-108		
2,6-Dinitrotoluene	N.D.	33.	ug/kg	87		75-108		
Fluorene	N.D.	33.	ug/kg	84		66-115		
4-Chlorophenyl-phenylether	N.D.	33.	ug/kg	86		70-108		
Diethylphthalate	N.D.	67.	ug/kg	87		75-109		
N-Nitrosodiphenylamine	N.D.	33.	ug/kg	85		67-105		
4-Bromophenyl-phenylether	N.D.	33.	ug/kg	85		74-110		
Hexachlorobenzene	N.D.	33.	ug/kg	85		72-110		

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MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Laboratory Compliance Quality Control

Analysis Name	Blank Result	Blank MDL	Report Units	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
Phenanthrene	N.D.	33.	ug/kg	84		70-107		
Anthracene	N.D.	33.	ug/kg	85		71-107		
Di-n-butylphthalate	N.D.	67.	ug/kg	83		73-109		
Fluoranthene	N.D.	33.	ug/kg	81		69-107		
Butylbenzylphthalate	N.D.	67.	ug/kg	88		75-117		
Benzo(a)anthracene	N.D.	33.	ug/kg	88		74-107		
Chrysene	N.D.	33.	ug/kg	86		72-109		
3,3'-Dichlorobenzidine	N.D.	67.	ug/kg	42		9-101		
bis(2-Ethylhexyl)phthalate	N.D.	170.	ug/kg	89		63-131		
Di-n-octylphthalate	N.D.	67.	ug/kg	84		67-115		
Benzo(b)fluoranthene	N.D.	33.	ug/kg	88		71-113		
Benzo(k)fluoranthene	N.D.	33.	ug/kg	87		75-112		
Benzo(a)pyrene	N.D.	33.	ug/kg	88		79-113		
Indeno(1,2,3-cd)pyrene	N.D.	33.	ug/kg	76		74-113		
Dibenz(a,h)anthracene	N.D.	33.	ug/kg	95		80-125		
Benzo(g,h,i)perylene	N.D.	33.	ug/kg	88		74-119		
2-Methylphenol	N.D.	33.	ug/kg	82		68-103		
2,2'-oxybis(1-Chloropropane)	N.D.	33.	ug/kg	97		66-138		
4-Methylphenol	N.D.	67.	ug/kg	86		65-113		
4-Chloroaniline	N.D.	33.	ug/kg	26		14-104		
2-Methylnaphthalene	N.D.	33.	ug/kg	83		70-102		
2,4,5-Trichlorophenol	N.D.	33.	ug/kg	89		76-110		
2-Nitroaniline	N.D.	33.	ug/kg	93		76-117		
3-Nitroaniline	N.D.	67.	ug/kg	69		53-107		
Dibenzofuran	N.D.	33.	ug/kg	86		72-107		
4-Nitroaniline	N.D.	67.	ug/kg	72		48-96		
Carbazole	N.D.	33.	ug/kg	84		73-107		
Batch number: 04047WAE026	Sample number(s): 4216799							
4-Chloroaniline	N.D.	1.	ug/l	62	72	32-120	15	30
Dibenzofuran	N.D.	1.	ug/l	70	81	66-107	15	30
2-Methylnaphthalene	N.D.	1.	ug/l	69	79	59-107	14	30
2-Nitroaniline	N.D.	1.	ug/l	77	84	74-114	9	30
3-Nitroaniline	N.D.	1.	ug/l	73	81	64-113	10	30
4-Nitroaniline	N.D.	1.	ug/l	64	71	56-107	11	30
2,4,5-Trichlorophenol	N.D.	1.	ug/l	74	85	70-115	13	30
2-Chlorophenol	N.D.	1.	ug/l	73	81	63-112	10	30
Phenol	N.D.	1.	ug/l	37	40	24-65	7	30
2-Nitrophenol	N.D.	1.	ug/l	80	94	71-113	17	30
2,4-Dimethylphenol	N.D.	1.	ug/l	68	76	60-107	11	30
2,4-Dichlorophenol	N.D.	1.	ug/l	76	84	70-107	10	30
4-Chloro-3-methylphenol	N.D.	1.	ug/l	79	87	71-113	9	30
2,4,6-Trichlorophenol	N.D.	1.	ug/l	76	86	71-109	13	30
2,4-Dinitrophenol	N.D.	20.	ug/l	71	79	46-121	10	30
4-Nitrophenol	N.D.	10.	ug/l	35	39	19-76	9	30
4,6-Dinitro-2-methylphenol	N.D.	5.	ug/l	74	86	56-130	14	30
Pentachlorophenol	N.D.	3.	ug/l	60	71	50-112	16	30
bis(2-Chloroethyl)ether	N.D.	1.	ug/l	69	77	59-109	12	30

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2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Laboratory Compliance Quality Control

Analysis Name	Blank Result	Blank MDL	Report Units	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
1,3-Dichlorobenzene	N.D.	1.	ug/l	53	63	39-103	16	30
1,4-Dichlorobenzene	N.D.	1.	ug/l	55	63	41-102	14	30
1,2-Dichlorobenzene	N.D.	1.	ug/l	57	67	45-103	16	30
Hexachloroethane	N.D.	1.	ug/l	37	47	22-102	23	30
N-Nitroso-di-n-propylamine	N.D.	1.	ug/l	69	76	59-107	9	30
Nitrobenzene	N.D.	1.	ug/l	71	81	63-112	13	30
Isophorone	N.D.	1.	ug/l	71	79	66-105	10	30
bis(2-Chloroethoxy)methane	N.D.	1.	ug/l	80	89	74-120	10	30
1,2,4-Trichlorobenzene	N.D.	1.	ug/l	61	72	49-107	17	30
Naphthalene	N.D.	1.	ug/l	69	81	58-108	16	30
Hexachlorobutadiene	N.D.	1.	ug/l	34	47	20-111	31*	30
Hexachlorocyclopentadiene	N.D.	5.	ug/l	42	56	12-119	29	30
2-Chloronaphthalene	N.D.	1.	ug/l	67	79	63-104	16	30
Acenaphthylene	N.D.	1.	ug/l	69	79	52-117	14	30
Dimethylphthalate	N.D.	2.	ug/l	65	62	34-114	5	30
2,6-Dinitrotoluene	N.D.	1.	ug/l	74	83	71-108	12	30
Acenaphthene	N.D.	1.	ug/l	71	83	69-112	15	30
2,4-Dinitrotoluene	N.D.	1.	ug/l	79	89	75-122	12	30
Fluorene	N.D.	1.	ug/l	66	77	61-116	15	30
4-Chlorophenyl-phenylether	N.D.	1.	ug/l	71	82	67-109	13	30
Diethylphthalate	N.D.	2.	ug/l	69	74	61-110	6	30
N-Nitrosodiphenylamine	N.D.	2.	ug/l	68	75	63-104	10	30
4-Bromophenyl-phenylether	N.D.	1.	ug/l	72	82	71-110	13	30
Hexachlorobenzene	N.D.	1.	ug/l	74	84	71-110	12	30
Phenanthrene	N.D.	1.	ug/l	68*	78	70-109	13	30
Anthracene	N.D.	1.	ug/l	67*	76	69-108	13	30
Di-n-butylphthalate	N.D.	2.	ug/l	67*	75	69-111	12	30
Fluoranthene	N.D.	1.	ug/l	66*	77	69-107	16	30
Pyrene	N.D.	1.	ug/l	77	84	69-116	9	30
Butylbenzylphthalate	N.D.	2.	ug/l	71	76	66-121	7	30
Benzo(a)anthracene	N.D.	1.	ug/l	73*	82	74-113	11	30
Chrysene	N.D.	1.	ug/l	71*	81	73-113	13	30
3,3'-Dichlorobenzidine	N.D.	1.	ug/l	56	66	30-108	17	30
bis(2-Ethylhexyl)phthalate	N.D.	2.	ug/l	73	81	62-126	11	30
Di-n-octylphthalate	N.D.	2.	ug/l	69	76	62-118	10	30
Benzo(b)fluoranthene	N.D.	1.	ug/l	73	81	71-116	11	30
Benzo(k)fluoranthene	N.D.	1.	ug/l	74	83	72-116	11	30
Benzo(a)pyrene	N.D.	1.	ug/l	72*	81	74-116	12	30
Indeno(1,2,3-cd)pyrene	N.D.	1.	ug/l	71	81	70-120	13	30
Dibenz(a,h)anthracene	N.D.	1.	ug/l	78	88	76-128	12	30
Benzo(g,h,i)perylene	N.D.	1.	ug/l	72	82	70-121	13	30
2-Methylphenol	N.D.	1.	ug/l	67	72	56-105	7	30
2,2'-oxybis(1-Chloropropane)	N.D.	1.	ug/l	75	85	65-130	12	30
4-Methylphenol	N.D.	2.	ug/l	65	68	52-97	4	30
Carbazole	N.D.	1.	ug/l	68*	79	70-108	14	30
Batch number: 040480015A	Sample number(s): 4216799							
Endrin Ketone	N.D.	0.0040	ug/l	95	95	61-139	0	30

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Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Laboratory Compliance Quality Control

Analysis Name	Blank Result	Blank MDL	Report Units	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
Alpha Chlordane	N.D.	0.0020	ug/l	101	101	62-135	0	30
Gamma Chlordane	N.D.	0.0020	ug/l	103	113	68-132	10	30
Alpha BHC	N.D.	0.0020	ug/l	98	100	56-122	2	20
Beta BHC	N.D.	0.012	ug/l	110	110	72-149	0	20
Gamma BHC - Lindane	N.D.	0.0020	ug/l	100	110	65-144	10	20
Delta BHC	N.D.	0.0030	ug/l	95	96	66-157	1	20
Heptachlor	N.D.	0.0020	ug/l	100	100	45-130	0	20
Aldrin	N.D.	0.0020	ug/l	84	86	47-122	2	20
Heptachlor Epoxide	N.D.	0.0020	ug/l	110	110	73-141	0	20
p,p-DDE	N.D.	0.0040	ug/l	95	95	57-131	0	20
p,p-DDD	N.D.	0.0040	ug/l	76	81	66-141	6	20
p,p-DDT	N.D.	0.0040	ug/l	100	100	59-137	0	20
Dieldrin	N.D.	0.0050	ug/l	100	105	71-129	5	20
Endrin	N.D.	0.0040	ug/l	100	100	62-135	0	20
Toxaphene	N.D.	0.30	ug/l					
Endosulfan II	N.D.	0.0050	ug/l	100	105	73-133	5	20
Endosulfan I	N.D.	0.0040	ug/l	110	110	66-131	0	20
Endosulfan Sulfate	N.D.	0.0090	ug/l	90	86	70-149	5	20
Endrin Aldehyde	N.D.	0.020	ug/l	95	95	36-158	0	20
PCB-1016	N.D.	0.20	ug/l					
PCB-1221	N.D.	0.40	ug/l					
PCB-1232	N.D.	0.10	ug/l					
PCB-1242	N.D.	0.20	ug/l					
PCB-1248	N.D.	0.30	ug/l					
PCB-1254	N.D.	0.20	ug/l					
PCB-1260	N.D.	0.30	ug/l					
Methoxychlor	N.D.	0.060	ug/l	90	91	49-155	1	20
Batch number: 040481848001	Sample number(s): 4216799							
Calcium	N.D.	0.0494	mg/l	101		93-113		
Iron	N.D.	0.0453	mg/l	102		91-114		
Magnesium	0.0280 J	0.0183	mg/l	99		93-110		
Potassium	N.D.	0.0429	mg/l	97		80-120		
Sodium	N.D.	0.463	mg/l	109		89-112		
Thallium	N.D.	0.0089	mg/l	99		92-107		
Arsenic	N.D.	0.0049	mg/l	97		92-109		
Selenium	N.D.	0.0047	mg/l	96		91-111		
Antimony	N.D.	0.0085	mg/l	99		94-112		
Barium	N.D.	0.00048	mg/l	101		93-109		
Beryllium	N.D.	0.00034	mg/l	102		96-111		
Cadmium	N.D.	0.00087	mg/l	101		97-111		
Chromium	N.D.	0.0022	mg/l	100		95-112		
Cobalt	N.D.	0.0016	mg/l	98		95-109		
Copper	N.D.	0.0021	mg/l	101		92-110		
Lead	N.D.	0.0093	mg/l	102		93-110		
Manganese	N.D.	0.00051	mg/l	101		93-110		
Nickel	N.D.	0.0038	mg/l	101		93-110		
Silver	N.D.	0.0018	mg/l	101		96-114		

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Quality Control Summary

Client Name: Versar Incorporated - MD Group Number: 884826
Reported: 03/12/04 at 01:08 PM

Laboratory Compliance Quality Control

Analysis Name	Blank Result	Blank MDL	Report Units	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
Vanadium	N.D.	0.0017	mg/l	101		96-109		
Zinc	N.D.	0.0041	mg/l	101		94-112		
Batch number: 04049020601A	Sample number(s): 4216799							
Total Suspended Solids	N.D.	3.0	mg/l	79		55-132		
Batch number: 04049021201A	Sample number(s): 4216799							
Total Dissolved Solids	N.D.	9.7	mg/l	101		80-120		
Batch number: 04051820005A	Sample number(s): 4216774-4216779							
Moisture				100		99-101		
Batch number: 04051820006A	Sample number(s): 4216780-4216789							
Moisture				100		99-101		
Batch number: 04051820006B	Sample number(s): 4216790-4216798							
Moisture				100		99-101		
Batch number: 04054023101A	Sample number(s): 4216799							
Oil & Grease	N.D.	2.5	mg/l	92	92	70-100	0	10
Batch number: 040551848003	Sample number(s): 4216799							
Aluminum	N.D.	0.0413	mg/l	104		93-112		
Batch number: 04062023601A	Sample number(s): 4216774-4216781							
Oil & Grease	N.D.	430.	mg/kg	97		89-107		
Batch number: 04065023601A	Sample number(s): 4216782-4216790,4216792							
Oil & Grease	N.D.	430.	mg/kg	98		89-107		
Batch number: 04069023601A	Sample number(s): 4216791,4216793-4216798							
Oil & Grease	N.D.	430.	mg/kg	98		89-107		

Sample Matrix Quality Control

Analysis Name	MS %REC	MSD %REC	MS/MSD Limits	RPD	RPD MAX	BKG Conc	DUP Conc	DUP RPD	Dup RPD Max
Batch number: 040470014A	Sample number(s): 4216774-4216783								
Gamma BHC - Lindane	106	105	43-154	1	35				
Heptachlor	105	103	70-138	2	35				
Aldrin	109	107	65-134	3	35				
p,p-DDT	94	95	62-166	1	35				
Dieldrin	95	96	68-139	1	35				
Endrin	87	88	48-188	1	35				

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Quality Control Summary

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Group Number: 884826

Sample Matrix Quality Control

Analysis Name	MS %REC	MSD %REC	MS/MSD Limits	RPD	RPD MAX	BKG Conc	DUP Conc	DUP RPD	Dup RPD Max
Methoxychlor	53*	70*	74-162	27	35				
Alpha BHC	107	105	64-134	1	35				
Beta BHC	77	90	31-176	15	35				
Delta BHC	87	98	68-158	12	35				
Heptachlor Epoxide	97	97	69-133	1	35				
p,p-DDE	104	102	48-175	2	35				
p,p-DDD	89	91	52-181	1	35				
Endosulfan I	96	97	62-133	1	35				
Endosulfan II	26*	46*	65-144	56*	35				
Endosulfan Sulfate	22*	34*	65-154	43*	35				
Endrin Aldehyde	53*	64	63-125	19	35				
Endrin Ketone	67	78	33-173	15	50				
Alpha Chlordane	100	99	65-147	1	50				
Gamma Chlordane	103	102	30-157	1	50				
Batch number: 040470022A	Sample number(s): 4216784-4216798								
Gamma BHC - Lindane	105	107	43-154	2	35				
Heptachlor	103	104	70-138	1	35				
Aldrin	107	108	65-134	1	35				
p,p-DDT	99	101	62-166	3	35				
Dieldrin	99	101	68-139	2	35				
Endrin	96	99	48-188	3	35				
Methoxychlor	94	94	74-162	0	35				
Alpha BHC	102	103	64-134	1	35				
Beta BHC	105	104	31-176	1	35				
Delta BHC	106	112	68-158	5	35				
Heptachlor Epoxide	99	100	69-133	1	35				
p,p-DDE	102	104	48-175	2	35				
p,p-DDD	94	96	52-181	2	35				
Endosulfan I	99	101	62-133	2	35				
Endosulfan II	99	103	65-144	4	35				
Endosulfan Sulfate	100	103	65-154	3	35				
Endrin Aldehyde	97	100	63-125	3	35				
Endrin Ketone	0*	104	33-173	200*	50				
Alpha Chlordane	98	100	65-147	2	50				
Gamma Chlordane	103	104	30-157	1	50				
Batch number: 040470394013	Sample number(s): 4216774-4216780								
pH						8.6	8.6	0	1
Batch number: 040470394024	Sample number(s): 4216781-4216789								
pH						8.2	8.2	0	1
Batch number: 040470394028	Sample number(s): 4216790-4216798								
pH						8.4	8.4	0	1
Batch number: 040475708002	Sample number(s): 4216774-4216783								

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Quality Control Summary

Client Name: Versar Incorporated - MD
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Group Number: 884826

Sample Matrix Quality Control

Analysis Name	MS %REC	MSD %REC	MS/MSD Limits	RPD	RPD MAX	BKG Conc	DUP Conc	DUP RPD	Dup RPD Max
Aluminum	(2)	(2)	75-125	1	20	17,300.	16,100.	7	20
Calcium	99	102	75-125	2	20	205.	210.	3	20
Iron	(2)	(2)	75-125	1	20	3,030.	2,960.	2	20
Magnesium	(2)	(2)	75-125	0	20	824.	847.	3	20
Potassium	123	121	75-125	1	20	591.	585.	1	20
Sodium	(2)	(2)	75-125	2	20	2,210.	2,300.	4	20
Thallium	96	97	78-109	2	20	N.D.	N.D.	0 (1)	20
Arsenic	94	96	75-112	2	20	0.745 J	0.914 J	20 (1)	20
Selenium	97	98	75-125	1	20	N.D.	N.D.	0 (1)	20
Antimony	67*	69*	75-125	3	20	N.D.	N.D.	0 (1)	20
Barium	97	101	75-125	4	20	12.5	5.03	85*	20
Beryllium	104	106	81-119	1	20	0.405 J	0.386 J	5 (1)	20
Cadmium	97	98	75-125	1	20	N.D.	N.D.	0 (1)	20
Chromium	107	111	75-125	2	20	13.0	12.7	2	20
Cobalt	96	98	75-125	2	20	1.43	1.43	0 (1)	20
Copper	106	107	75-125	1	20	2.76	2.68	3 (1)	20
Lead	99	100	75-125	1	20	3.68	3.52	4 (1)	20
Manganese	99	101	75-125	1	20	14.0	13.9	0	20
Nickel	99	100	75-125	1	20	4.86	4.77	2 (1)	20
Silver	102	102	75-125	1	20	N.D.	N.D.	0 (1)	20
Vanadium	103	104	75-125	1	20	13.4	12.8	4	20
Zinc	99	100	75-125	1	20	15.3	15.0	2	20
Batch number: 040475708003	Sample number(s): 4216784-4216798								
Aluminum	(2)	(2)	75-125	3	20	4,880.	5,460.	11	20
Calcium	132*	133*	75-125	0	20	768.	814.	6	20
Iron	(2)	(2)	75-125	0	20	4,870.	5,290.	8	20
Magnesium	(2)	(2)	75-125	1	20	1,490.	1,620.	9	20
Potassium	165*	170*	75-125	1	20	747.	824.	10	20
Sodium	(2)	(2)	75-125	3	20	1,890.	1,930.	2	20
Thallium	96	96	78-109	1	20	N.D.	N.D.	0 (1)	20
Arsenic	94	96	75-112	1	20	2.84	3.31	15 (1)	20
Selenium	96	97	75-125	1	20	N.D.	N.D.	0 (1)	20
Antimony	88	91	75-125	3	20	N.D.	N.D.	0 (1)	20
Barium	100	102	75-125	2	20	7.49	8.51	13	20
Beryllium	101	102	81-119	1	20	0.284 J	0.307 J	8 (1)	20
Cadmium	96	97	75-125	1	20	0.124 J	0.0627 J	65* (1)	20
Chromium	103	104	75-125	1	20	8.26	8.80	6	20
Cobalt	98	99	75-125	1	20	4.30	5.18	19	20
Copper	98	100	75-125	2	20	3.10	2.92	6 (1)	20
Lead	98	99	75-125	2	20	2.58	3.16	20 (1)	20
Manganese	111	114	75-125	1	20	56.7	60.3	6	20
Nickel	97	98	75-125	1	20	7.46	8.48	13	20
Silver	103	103	75-125	1	20	N.D.	N.D.	0 (1)	20
Vanadium	103	104	75-125	0	20	12.3	13.5	9	20
Zinc	99	100	75-125	1	20	21.0	22.0	5	20

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Quality Control Summary

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Group Number: 884826

Sample Matrix Quality Control

Analysis Name	MS %REC	MSD %REC	MS/MSD Limits	RPD	RPD MAX	BKG Conc	DUP Conc	DUP RPD	Dup RPD Max
Batch number: 040475711004	Sample number(s): 4216774-4216783								
Mercury	105	106	80-120	1	20	N.D.	N.D.	58* (1)	20
Batch number: 040475711005	Sample number(s): 4216784-4216798								
Mercury	103	102	80-120	1	20	N.D.	N.D.	0 (1)	20
Batch number: 040475713001	Sample number(s): 4216799								
Mercury	73*	66*	80-120	8	20	0.00031	0.00033	8 (1)	20
Batch number: 04047SLC026	Sample number(s): 4216782-4216785,4216787-4216796,4216798								
Phenol	81	79	30-137	2	30				
2-Chlorophenol	84	84	46-124	1	30				
1,4-Dichlorobenzene	77	73	38-116	5	30				
N-Nitroso-di-n-propylamine	76	75	46-127	2	30				
1,2,4-Trichlorobenzene	82	85	37-132	3	30				
4-Chloro-3-methylphenol	90	90	47-136	1	30				
Acenaphthene	87	87	48-132	0	30				
4-Nitrophenol	89	79	14-172	11	30				
2,4-Dinitrotoluene	86	85	47-138	1	30				
Pentachlorophenol	81	78	5-138	3	30				
Pyrene	88	87	28-144	1	30				
2-Nitrophenol	94	96	42-133	2	30				
2,4-Dimethylphenol	88	88	44-131	0	30				
2,4-Dichlorophenol	85	87	38-133	2	30				
2,4,6-Trichlorophenol	87	84	41-132	3	30				
2,4-Dinitrophenol	79	74	20-143	6	30				
4,6-Dinitro-2-methylphenol	78	75	5-150	5	30				
bis(2-Chloroethyl)ether	79	76	40-132	3	30				
1,3-Dichlorobenzene	77	76	37-118	2	30				
1,2-Dichlorobenzene	78	75	41-115	4	30				
Hexachloroethane	76	74	20-135	3	30				
Nitrobenzene	82	85	39-137	4	30				
Isophorone	82	83	47-128	2	30				
bis(2-Chloroethoxy)methane	91	95	50-136	4	30				
Naphthalene	83	84	38-132	1	30				
Hexachlorobutadiene	85	87	38-134	2	30				
Hexachlorocyclopentadiene	70	58	5-140	19	30				
2-Chloronaphthalene	84	83	45-127	2	30				
Acenaphthylene	82	81	46-128	1	30				
Dimethylphthalate	86	84	52-125	2	30				
2,6-Dinitrotoluene	84	83	52-124	0	30				
Fluorene	84	82	39-137	3	30				
4-Chlorophenyl-phenylether	86	83	52-122	4	30				
Diethylphthalate	85	83	53-128	3	30				
N-Nitrosodiphenylamine	82	82	46-131	0	30				
4-Bromophenyl-phenylether	83	84	49-133	1	30				
Hexachlorobenzene	84	84	44-133	0	30				

*- Outside of specification
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MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Sample Matrix Quality Control

Analysis Name	MS %REC	MSD %REC	MS/MSD Limits	RPD	RPD MAX	BKG Conc	DUP Conc	DUP RPD	Dup RPD Max
Phenanthrene	82	84	29-143	2	30				
Anthracene	84	83	35-138	1	30				
Di-n-butylphthalate	84	83	51-126	1	30				
Fluoranthene	81	80	19-145	1	30				
Butylbenzylphthalate	90	90	40-141	0	30				
Benzo(a)anthracene	89	88	26-144	1	30				
Chrysene	88	87	23-150	1	30				
3,3'-Dichlorobenzidine	88	83	2-129	6	30				
bis(2-Ethylhexyl)phthalate	84	84	48-137	1	30				
Di-n-octylphthalate	78	78	38-147	0	30				
Benzo(b)fluoranthene	85	84	32-140	1	30				
Benzo(k)fluoranthene	90	89	36-143	1	30				
Benzo(a)pyrene	87	87	23-154	1	30				
Indeno(1,2,3-cd)pyrene	86	89	36-141	3	30				
Dibenz(a,h)anthracene	91	92	19-163	1	30				
Benzo(g,h,i)perylene	84	86	17-152	2	30				
2-Methylphenol	81	77	42-125	5	30				
2,2'-oxybis(1-Chloropropane)	97	94	50-143	2	30				
4-Methylphenol	78	77	40-132	2	30				
4-Chloroaniline	60	76	6-126	24	30				
2-Methylnaphthalene	85	88	42-128	4	30				
2,4,5-Trichlorophenol	85	87	41-132	2	30				
2-Nitroaniline	87	86	47-137	1	30				
3-Nitroaniline	80	80	26-131	0	30				
Dibenzofuran	84	85	39-129	1	30				
4-Nitroaniline	78	76	27-133	3	30				
Carbazole	82	82	41-133	0	30				
Batch number: 04047SLD026	Sample number(s): 4216774-4216781,4216786,4216797								
Phenol	83	87	30-137	4	30				
2-Chlorophenol	83	88	46-124	6	30				
1,4-Dichlorobenzene	75	79	38-116	4	30				
N-Nitroso-di-n-propylamine	81	86	46-127	7	30				
1,2,4-Trichlorobenzene	80	82	37-132	3	30				
4-Chloro-3-methylphenol	86	90	47-136	4	30				
Acenaphthene	85	89	48-132	5	30				
4-Nitrophenol	90	95	14-172	6	30				
2,4-Dinitrotoluene	89	94	47-138	6	30				
Pentachlorophenol	87	92	5-138	5	30				
Pyrene	84	89	28-144	6	30				
2-Nitrophenol	92	95	42-133	3	30				
2,4-Dimethylphenol	83	84	44-131	1	30				
2,4-Dichlorophenol	84	86	38-133	2	30				
2,4,6-Trichlorophenol	83	89	41-132	6	30				
2,4-Dinitrophenol	83	86	20-143	3	30				
4,6-Dinitro-2-methylphenol	81	87	5-150	7	30				
bis(2-Chloroethyl)ether	82	85	40-132	3	30				

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Sample Matrix Quality Control

Analysis Name	MS %REC	MSD %REC	MS/MSD Limits	RPD	RPD MAX	BKG Conc	DUP Conc	DUP RPD	Dup RPD Max
1,3-Dichlorobenzene	76	79	37-118	4	30				
1,2-Dichlorobenzene	77	80	41-115	5	30				
Hexachloroethane	75	79	20-135	4	30				
Nitrobenzene	82	84	39-137	3	30				
Isophorone	80	83	47-128	4	30				
bis(2-Chloroethoxy)methane	89	92	50-136	3	30				
Naphthalene	81	83	38-132	2	30				
Hexachlorobutadiene	81	82	38-134	2	30				
Hexachlorocyclopentadiene	66	75	5-140	13	30				
2-Chloronaphthalene	79	84	45-127	7	30				
Acenaphthylene	81	87	46-128	7	30				
Dimethylphthalate	82	87	52-125	6	30				
2,6-Dinitrotoluene	82	90	52-124	9	30				
Fluorene	79	84	39-137	7	30				
4-Chlorophenyl-phenylether	82	88	52-122	7	30				
Diethylphthalate	83	90	53-128	7	30				
N-Nitrosodiphenylamine	82	88	46-131	7	30				
4-Bromophenyl-phenylether	82	89	49-133	8	30				
Hexachlorobenzene	81	88	44-133	9	30				
Phenanthrene	81	88	29-143	8	30				
Anthracene	81	89	35-138	9	30				
Di-n-butylphthalate	80	88	51-126	9	30				
Fluoranthene	79	85	19-145	8	30				
Butylbenzylphthalate	85	90	40-141	6	30				
Benzo(a)anthracene	84	89	26-144	6	30				
Chrysene	84	88	23-150	5	30				
3,3'-Dichlorobenzidine	65	65	2-129	0	30				
bis(2-Ethylhexyl)phthalate	83	90	48-137	7	30				
Di-n-octylphthalate	81	85	38-147	5	30				
Benzo(b)fluoranthene	84	87	32-140	4	30				
Benzo(k)fluoranthene	84	88	36-143	5	30				
Benzo(a)pyrene	86	90	23-154	4	30				
Indeno(1,2,3-cd)pyrene	84	87	36-141	4	30				
Dibenz(a,h)anthracene	90	96	19-163	7	30				
Benzo(g,h,i)perylene	83	88	17-152	6	30				
2-Methylphenol	80	84	42-125	5	30				
2,2'-oxybis(1-Chloropropane)	96	98	50-143	2	30				
4-Methylphenol	84	89	40-132	6	30				
4-Chloroaniline	49	69	6-126	35*	30				
2-Methylnaphthalene	81	84	42-128	4	30				
2,4,5-Trichlorophenol	85	93	41-132	10	30				
2-Nitroaniline	89	93	47-137	5	30				
3-Nitroaniline	80	90	26-131	12	30				
Dibenzofuran	82	87	39-129	6	30				
4-Nitroaniline	73	81	27-133	10	30				
Carbazole	81	88	41-133	8	30				

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MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Sample Matrix Quality Control

Analysis Name	MS %REC	MSD %REC	MS/MSD Limits	RPD	RPD MAX	BKG Conc	DUP Conc	DUP RPD	Dup RPD Max
Batch number: 040481848001	Sample number(s): 4216799								
Calcium	(2)	(2)	78-122	9	20	522.	534.	2	20
Iron	(2)	(2)	75-125	9	20	19.7	20.0	2	20
Magnesium	(2)	(2)	75-125	8	20	760.	831.	9	20
Potassium	(2)	(2)	75-125	6	20	106.	111.	5 (1)	20
Sodium	(2)	(2)	75-125	8	20	4,380.	4,720.	7	20
Thallium	112	113*	89-112	1	20	N.D.	N.D.	0 (1)	20
Arsenic	108	112	86-119	3	20	N.D.	N.D.	0 (1)	20
Selenium	104	106	75-125	2	20	N.D.	N.D.	0 (1)	20
Antimony	108	110	75-125	1	20	N.D.	N.D.	0 (1)	20
Barium	91	94	82-113	2	20	1.35	1.33	1	20
Beryllium	100	102	91-117	3	20	0.00039 J	N.D.	200* (1)	20
Cadmium	103	107	87-117	4	20	N.D.	N.D.	0 (1)	20
Chromium	101	103	86-118	2	20	N.D.	N.D.	0 (1)	20
Cobalt	101	105	91-112	4	20	0.0017 J	N.D.	200* (1)	20
Copper	111	112	89-119	1	20	N.D.	N.D.	0 (1)	20
Lead	111	113	87-118	2	20	N.D.	N.D.	0 (1)	20
Manganese	(2)	(2)	85-111	8	20	5.80	5.92	2	20
Nickel	101	104	91-111	2	20	N.D.	N.D.	0 (1)	20
Silver	106	117	75-125	4	20	0.0653	0.0646	1	20
Vanadium	102	103	95-112	1	20	N.D.	N.D.	0 (1)	20
Zinc	109	111	80-120	2	20	N.D.	N.D.	0 (1)	20
Batch number: 04049020601A	Sample number(s): 4216799								
Total Suspended Solids						163.	200.	21 (1)	24
Batch number: 04049021201A	Sample number(s): 4216799								
Total Dissolved Solids	97	98	60-140	0	5	1,900.	1,860.	2	5
Batch number: 04051820005A	Sample number(s): 4216774-4216779								
Moisture						13.9	13.6	2	15
Batch number: 04051820006A	Sample number(s): 4216780-4216789								
Moisture						13.9	14.0	0	15
Batch number: 04051820006B	Sample number(s): 4216790-4216798								
Moisture						16.8	17.5	4	15
Batch number: 04054023101A	Sample number(s): 4216799								
Oil & Grease						N.D.	N.D.	3 (1)	56
Batch number: 040551848003	Sample number(s): 4216799								
Aluminum	(2)	(2)	75-125	14	20	136.	124.	9	20
Batch number: 04062023601A	Sample number(s): 4216774-4216781								
Oil & Grease	88	98	65-126	11	20	N.D.	N.D.	37* (1)	20

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MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Sample Matrix Quality Control

Analysis Name	MS %REC	MSD %REC	MS/MSD Limits	RPD	RPD MAX	BKG Conc	DUP Conc	DUP RPD	Dup RPD Max
Batch number: 04065023601A	Sample number(s): 4216782-4216790,4216792								
Oil & Grease	90	79	65-126	12	20	785. J	465. J	51* (1)	20
Batch number: 04069023601A	Sample number(s): 4216791,4216793-4216798								
Oil & Grease	98	91	65-126	7	20	N.D.	N.D.	51* (1)	20

Surrogate Quality Control

Analysis Name: TCL Pesticides in Solids
Batch number: 040470014A

	Tetrachloro-m-xylene	Decachlorobiphenyl
4216774	101	99
4216775	104	101
4216776	95	93
4216777	92	92
4216778	103	100
4216779	100	99
4216780	98	101
4216781	99	97
4216782	99	105
4216783	92	92
Blank	102	102
LCS	102	103
MS	100	99
MSD	100	98
Limits:	58-149	62-159

Analysis Name: TCL Pesticides in Solids
Batch number: 040470022A

	Tetrachloro-m-xylene	Decachlorobiphenyl
4216784	101	104
4216785	98	106
4216786	95	101
4216787	94	99
4216788	99	105
4216789	98	100
4216790	103	102
4216791	99	100
4216792	98	103
4216793	99	102

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Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Quality Control Summary

Client Name: Versar Incorporated - MD
Group Number: 884826
Reported: 03/12/04 at 01:08 PM

Surrogate Quality Control

4216794	100	104
4216795	99	98
4216796	164*	158
4216797	102	103
4216798	102	101
Blank	100	101
LCS	101	102
MS	98	98
MSD	99	100
Limits:	58-149	62-159

Analysis Name: TCL SW846 Semivolatiles/Soil
Batch number: 04047SLC026

	Phenol-d6	2-Fluorophenol	2,4,6-Tribromophenol	Nitrobenzene-d5
4216782	75	75	85	80
4216783	77	75	87	83
4216784	77	76	84	86
4216785	76	75	81	81
4216787	74	72	75	76
4216788	77	76	83	82
4216789	75	75	79	80
4216790	73	73	81	78
4216791	74	72	84	80
4216792	74	73	87	80
4216793	71	70	81	77
4216794	61	59	66	65
4216795	77	77	81	81
4216796	77	75	86	82
4216798	75	73	83	79
Blank	77	77	83	84
LCS	81	80	85	85
MS	83	80	93	86
MSD	81	80	90	90
Limits:	45-120	41-119	46-136	47-128

	2-Fluorobiphenyl	Terphenyl-d14
4216782	83	77
4216783	87	78
4216784	85	81
4216785	85	78
4216787	81	74
4216788	86	81
4216789	86	79
4216790	82	76
4216791	84	79
4216792	85	83
4216793	79	78

*- Outside of specification
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MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Surrogate Quality Control

4216794	67	66
4216795	83	81
4216796	87	83
4216798	82	84
Blank	87	83
LCS	84	88
MS	88	94
MSD	88	95
Limits:	55-123	49-133

Analysis Name: TCL SW846 Semivolatiles/Soil
Batch number: 04047SLD026

	Phenol-d6	2-Fluorophenol	2,4,6-Tribromophenol	Nitrobenzene-d5
4216774	79	75	80	78
4216775	84	80	88	83
4216776	78	75	81	79
4216777	77	73	86	80
4216778	77	75	88	82
4216779	79	76	82	82
4216780	81	76	87	78
4216781	78	75	81	75
4216786	81	77	84	79
4216797	83	80	89	83
Blank	78	75	80	81
LCS	82	81	91	86
MS	80	78	89	85
MSD	84	82	93	87
Limits:	45-120	41-119	46-136	47-128

	2-Fluorobiphenyl	Terphenyl-d14
4216774	79	76
4216775	83	86
4216776	81	77
4216777	82	83
4216778	82	81
4216779	82	83
4216780	80	82
4216781	79	80
4216786	80	83
4216797	85	86
Blank	80	81
LCS	87	91
MS	83	88
MSD	88	92
Limits:	55-123	49-133

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MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

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Quality Control Summary

Client Name: Versar Incorporated - MD
Reported: 03/12/04 at 01:08 PM

Group Number: 884826

Surrogate Quality Control

Analysis Name: TCL SW846 Semivolatiles/Waters
Batch number: 04047WAE026

	2-Fluorophenol	Phenol-d6	2,4,6-Tribromophenol	Nitrobenzene-d5
4216799	51	33	89	86
Blank	56	37	91	89
LCS	58	39	92	86
LCSD	58	39	97	89
Limits:	23-94	10-80	45-142	54-124

	2-Fluorobiphenyl	Terphenyl-d14
4216799	84	80
Blank	83	87
LCS	86	90
LCSD	88	93
Limits:	64-112	53-124

Analysis Name: TCL Pesticides in Waters
Batch number: 040480015A

	Tetrachloro-m-xylene	Decachlorobiphenyl
4216799	87	91
Blank	89	96
LCS	93	64
LCSD	91	56
Limits:	45-125	47-155

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MEMBER ACIL
Lancaster Laboratories, Inc.
2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax: 717-656-2681

APPENDIX B

CORING LOGS

DRILLING LOG	DE State Plane (NAD 83 Ft) 189,469.5 N; 770,338.1 E	Date: February 11th, 2004	SHEET 1 OF 1 SHEETS

1. PROJECT: USACE-Bethany Beach/South Bethany Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”	
2. Station: EVC-1		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~	
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)	EVC-1	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE STARTED 2/11/04	COMPLETED 2/11/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -49 ft	
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 84%	
9. TOTAL DEPTH OF HOLE 4.4 ft		19. SIGNATURE OF INSPECTOR	

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-49			**10 YR 6/3 Pale brown medium to fine SAND**	**SP**		**Two pictures were taken.**
-50	1.0					
-51	2.0					
-52	3.0		**10 YR 5/6 Yellowish Brown medium to fine SAND with small inclusions of Gley 2.5/N Black medium to fine sand**	**SP**		
-53	4.0					
	5.0					
	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					

DRILLING LOG	DE State Plane (NAD 83 Ft) 189,351.2 N; 772,757.0 E	Date: February 11th, 2004	SHEET 1 OF 1 SHEETS

1. PROJECT: USACE- USACE-Bethany Beach/South Bethany Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”		
2. Station: EVC-2		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	EVC-2	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED 1	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/11/04	COMPLETED 2/11/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -47 ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 84%		
9. TOTAL DEPTH OF HOLE 6.2 ft.		19. SIGNATURE OF INSPECTOR		

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-48			**10 YR 3/1 Brown coarse SAND with pebbles to 1”**	**SP**		**Three pictures were taken.**
-49	1.0		**10 YR 5/1 Gray medium to fine SAND (no pebbles)**	**SP**		
-50	2.0		**10 YR 5/1 Gray very fine SAND with traces of silt**	**SP**		
-51	3.0					
	4.0					
-52	5.0					
-53	6.0					
-54	7.0					
	8.0					
	9.0					
	10.0					
	11.0					

DRILLING LOG	DE State Plane (NAD 83 Ft) 186,643.4 N; 770,685.0 E	Date: February 11th, 2004	SHEET 1 OF 1 SHEETS

1. PROJECT: USACE USACE-Bethany Beach/South Bethany Storm Damage Reduction Project -		10. SIZE AND TYPE OF BIT 4”		
2. Station: EVC-3		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	EVC-3	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/11/04	COMPLETED 2/11/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -41.5 ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 73%		
9. TOTAL DEPTH OF HOLE 3.7 ft.		19. SIGNATURE OF INSPECTOR		

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-41.5			**10 YR 5/2 Grayish brown medium SAND with minor traces of coarse sand**	**SP**		**Two pictures were taken.**
-42.5	1.0					
-43.5	2.0		**10 YR 3/1 Very dark gray medium to fine SAND with few coarse fragments**	**SP**		
-44.5	3.0					
	4.0					
	5.0					
	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					

DRILLING LOG	DE State Plane (NAD 83 Ft) 187,528.7 N; 776,176.0 E	Date: February 11th, 2004	SHEET 1 OF 1 SHEETS

1. PROJECT: USACE- USACE-Bethany Beach/South Bethany Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”		
2. Station: EVC-4		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	EVC-4	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED 1	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/11/04	COMPLETED 2/11/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -43.6ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 85%		
9. TOTAL DEPTH OF HOLE 6.6 ft.		19. SIGNATURE OF INSPECTOR		

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-14 -15 -16	1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0		**10 YR 5/2 Grayish brown fine and medium SAND with moderate amount of shell fragments**	**SP**		**Three pictures were taken.**

DRILLING LOG	DE State Plane (NAD 83 Ft) 186,004.1 N; 774,030.8 E	Date: February 11th, 2004	SHEET 1 OF 1 SHEETS

1. PROJECT: USACE- USACE-Bethany Beach/South Bethany Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”		
2. Station: EVC-5		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	EVC-5	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/11/04	COMPLETED 2/11/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -36 ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 76%		
9. TOTAL DEPTH OF HOLE 4.2 ft.		19. SIGNATURE OF INSPECTOR		

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-36			**10 YR 5/3 Brown medium SAND with many shell fragments**	**SP**		**Two pictures were taken.**
-37	1.0					
-38	2.0					
	3.0					
	4.0					
	5.0					
	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					

DRILLING LOG	DE State Plane (NAD 83 Ft) 171,775.0 N; 766,529.5 E	Date: February 12th, 2004	SHEET 1 OF 1 SHEETS

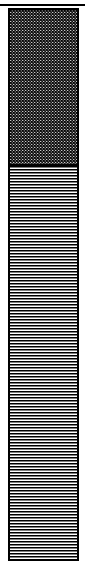
1. PROJECT: USACE- USACE-Fenwick Island Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”		
2. Station: FVC-1		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	FVC-1	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED 2	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/12/04	COMPLETED 2/12/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -41 ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 87%		
9. TOTAL DEPTH OF HOLE 7.7 ft.		19. SIGNATURE OF INSPECTOR		

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-42			**10 YR 3/1 Very dark gray medium to coarse SAND with pebbles to ¼”**	**SP**		**Three pictures were taken.**
-43	1.0		**10 YR 5/1 Gray medium SAND with small inclusions of 10 yr 5/6 yellowish brown medium sand**	**SP**		
-44	2.0					
-45	3.0					
	4.0					
-46	5.0		**10 YR 5/1 Gray fine SAND**	**SP**		
-47	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					

DRILLING LOG	**DE State Plane (NAD 83 Ft)** 170,296.2 N; 767,360.3 E	Date: February 12th, 2004	**SHEET 1 OF 1 SHEETS**

1. PROJECT: USACE-Fenwick Island Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”		
2. Station: FVC-2		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	FVC-2	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED 2	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/12/04	COMPLETED 2/12/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -47 ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 86%		
9. TOTAL DEPTH OF HOLE 7.0 ft.		19. SIGNATURE OF INSPECTOR		

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-48			**10 YR 5/3 Brown medium SAND with moderate shell fragments**	**SP**		**Two pictures were taken.**
-49	1.0					
-50	2.0		**10 YR 6/1 Gray fine SAND (no shells)**	**SP-SM**		
-51	3.0					
-52	4.0					
-53	5.0					
-54	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					



DRILLING LOG	DE State Plane (NAD 83 Ft) 168,814.7 N; 766,685.1 E	Date: February 12th, 2004	SHEET 1 OF 1 SHEETS
1. PROJECT: USACE-Fenwick Island Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”	
2. Station: FVC-3		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~	
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)	FVC-3	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED 1 / UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE STARTED 2/12/04	COMPLETED 2/12/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -38 ft	
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 83%	
9. TOTAL DEPTH OF HOLE 72 in		19. SIGNATURE OF INSPECTOR	

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-48			**10 YR 4/2 Dark grayish brown medium to fine SAND**	**SP-SM**		**Three pictures were taken.**
-49	1.0					
-50	2.0					
	3.0					
-51			**10 YR 5/6 Yellowish brown medium to coarse SAND with pebbles to ½ ”**	**SP-SM**		
	4.0					
-52			**10 YR 7/1 Light gray medium SAND**	**SP**		
	5.0					
-53	6.0					
-54	7.0					
	8.0					
	9.0					
	10.0					
	11.0					

DRILLING LOG	DE State Plane (NAD 83 Ft) 168,230.8 N; 768,113.6	Date: February 12th, 2004	SHEET 1 OF 1 SHEETS

1. PROJECT: USACE-Fenwick Island Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”		
2. Station: FVC-4		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	FVC-4	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED 1	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/12/04	COMPLETED 2/12/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -38 ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 83%		
9. TOTAL DEPTH OF HOLE 6.0 ft.		19. SIGNATURE OF INSPECTOR		

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-38			**10 YR 4/2 Grayish brown coarse SAND with pebbles to 1”**	**SP**		**Three pictures were taken.**
-39	1.0		**10 YR 3/1 Very dark gray medium to fine SAND**	**SP**		
-40	2.0					
			10 YR 5/1 Gray very fine SAND with moderate silt	**SP**		
-41	3.0					
	4.0			**CL**		
-42			**10 YR 6/1 Gray dense CLAY**			
	5.0					
-43	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					

DRILLING LOG	DE State Plane (NAD 83 Ft) 167,969.7 N; 769,228.6 E	Date: February 12th, 2004	SHEET 1 OF 1 SHEETS

1. PROJECT: USACE-Fenwick Island Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”		
2. Station: FVC-5		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	FVC-5	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/12/04	COMPLETED 2/12/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -49 ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 81%		
9. TOTAL DEPTH OF HOLE 5.3 ft.		19. SIGNATURE OF INSPECTOR		

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-49			**10 YR 4/3 Brown coarse SAND with many shell fragments and pebbles to 0.25”**	**SP**		**Three pictures were taken.**
-50	1.0		**10 YR 4/1 Dark gray medium SAND with few 0.25” pebbles, no shell fragments**	**SP**		
-51	2.0		**2.5 Y 5/1 Gray medium to fine SAND (no pebbles or shell)**	**SP**		
-52	3.0		**5 Y 5/0 Gray fine SAND with silt**	**SP-SM**		
-53	4.0					
	5.0					
	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					

DRILLING LOG	DE State Plane (NAD 83 Ft) 166,515.3 N, 773,132.4 E	Date: February 12th, 2004	SHEET 1 OF 1 SHEETS

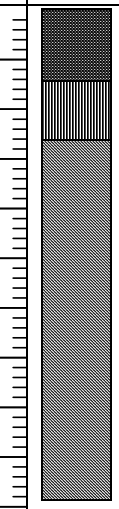
1. PROJECT: USACE-Fenwick Island Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”		
2. Station: FVC-6		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	FVC-6	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED 1	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/12/04	COMPLETED 2/12/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -48 ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 83%		
9. TOTAL DEPTH OF HOLE 5.8 ft.		19. SIGNATURE OF INSPECTOR		

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-48			**10 YR 2/1 Black silty fine SAND with shell fragments (anoxic-stinks)**	**SP**		**Three pictures were taken.**
-49	1.0		**10 YR 3/1 Very dark gray medium SAND with shell fragments**	**SP**		
-50	2.0		**10 YR 5/1 Gray very fine SAND with no shell fragments**	**SP**		
-51	3.0					
	4.0					
-52	5.0					
-53	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					

DRILLING LOG	DE State Plane (NAD 83 Ft) 165,732.6 N, 774,023.6 E	Date: February 12th, 2004	SHEET 1 OF 1 SHEETS

1. PROJECT: USACE-Fenwick Island Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”		
2. Station: FVC-7		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	FVC-7	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED 1	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/12/04	COMPLETED 2/12/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -45 ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 84%		
9. TOTAL DEPTH OF HOLE 6.3 ft.		19. SIGNATURE OF INSPECTOR		

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-45			**10 YR 5/3 Brown medium to fine SAND**	**SP-SM**		**Three pictures were taken.**
-46	1.0		**2.5 Y 3/1 Very dark gray fine SAND with few shell fragments**	**SP-SM**		
-47	2.0		**5 Y 4/1 Gray very fine SAND**	**SP-SM**		
-48	3.0					
	4.0					
-49	5.0					
	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					



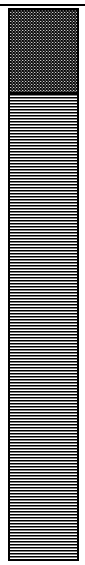
DRILLING LOG	**DE State Plane (NAD 83 Ft)** 165,356.0 N; 775,314.1 E	Date: February 12th, 2004	**SHEET 1 OF 1 SHEETS**
1. PROJECT: USACE-Fenwick Island Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”	
2. Station: FVC-8		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~	
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)	FVC-8	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/12/04 / COMPLETED 2/12/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -45 ft	
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 79%	
9. TOTAL DEPTH OF HOLE 4.8 ft.		19. SIGNATURE OF INSPECTOR	

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-45			**10 YR 5/2 Grayish brown medium SAND with intermittent shell fragments and trace coarse sand**	**SP**		**Two pictures were taken.**
-46	1.0					
-47	2.0					
-48	3.0		**10 YR 4/1 Dark gray medium to fine SAND (no shell fragments)**	**SP**		
-49	4.0					
	5.0					
	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					

DRILLING LOG	**DE State Plane (NAD 83 Ft)** 173,306.6 N; 766,989.8 E	Date: February 12th, 2004	**SHEET 1 OF 1 SHEETS**

1. PROJECT: USACE-Fenwick Island Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”		
2. Station: FVC-9		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	FVC-9	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED 2	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/12/04	COMPLETED 2/12/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -41.5 ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 86%		
9. TOTAL DEPTH OF HOLE 7.0 ft.		19. SIGNATURE OF INSPECTOR		

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-41.5			**2.5 Y 2.5/0 Black medium to coarse SAND**	**SP-SM**		**Two pictures were taken.**
-42.5	1.0		**2.5 Y 6/1 gray very fine silty SAND**	**SP-SM**		
-43.5	2.0					
-44.5	3.0					
-45.5	4.0					
-46.5	5.0					
-47.5	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					



DRILLING LOG	DE State Plane (NAD 83 Ft) 173,506.0 N, 771,037.2 E	Date: February 12th, 2004	SHEET 1 OF 1 SHEETS

1. PROJECT: USACE-Fenwick Island Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”		
2. Station: FVC-10		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	FVC-10	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED 1	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/12/04	COMPLETED 2/12/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -38 ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 84%		
9. TOTAL DEPTH OF HOLE 6.3 ft.		19. SIGNATURE OF INSPECTOR		

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-38			**10 YR 4/1 Dark gray medium to coarse SAND**	**SP**		**Three pictures were taken**.
-39	1.0		**10 YR 5/2 Grayish brown medium to fine SAND**	**SP**		
-40	2.0					
-41	3.0		**10 YR 4/1 Dark Gray fine SAND**	**SP**		
-42	4.0		**10 YR 7/1 Light Gray very fine SAND**	**SP**		
-43	5.0					
	6.0					
	7.0					
	8.0					
	9.0					
	10.0					

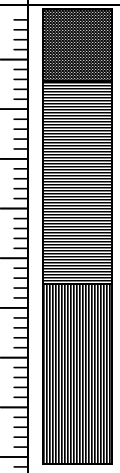
DRILLING LOG	DE State Plane (NAD 83 Ft) 172,816.1 N, 773,983.4 E	Date: February 12th, 2004	SHEET 1 OF 1 SHEETS

1. PROJECT: USACE-Fenwick Island Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”		
2. Station: FVC-11		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	FVC-11	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED 1	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/12/04	COMPLETED 2/12/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -49.6ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 83%		
9. TOTAL DEPTH OF HOLE 6.6 ft.		19. SIGNATURE OF INSPECTOR		

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-49.6			**2.5 YR 4/1 Gray medium to coarse SAND with moderate silt**	**SP-SM**		**Three pictures were taken.**
-50.6	1.0		**2.5 YR 3/1 Very dark gray sandy CLAY**	**CL**		
-51.6	2.0		**10 YR 6/1 Gray medium SAND**	**SP**		
-52.6	3.0					
-53.6	4.0					
-54.6	5.0					
	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					

DRILLING LOG	**DE State Plane (NAD 83 Ft)** 171,748.3 N, 778,626.5 E	Date: February 12th, 2004	**SHEET 1 OF 1 SHEETS**
1. PROJECT: USACE-Fenwick Island Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”	
2. Station: FVC-12		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~	
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)	FVC-12	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED 1 / UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE STARTED 2/12/04	COMPLETED 2/12/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -41.5 ft	
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 83%	
9. TOTAL DEPTH OF HOLE 6.0 ft.		19. SIGNATURE OF INSPECTOR	

Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-41.5			**Gley 2.5/N Black medium to fine SAND**	**SP-SM**		**Three pictures were taken.**
-42.5	1.0		**5Y 4/1 Dark grey fine SAND**	**SP-SM**		
-43.5	2.0					
-44.5	3.0		**5Y 4/1 Dark grey medium to coarse SAND with intermitent pockets of clay (same hue/chroma), also small pebbles <0.25 inches**	**SP-SM**		
-45.5	4.0					
-46.5	5.0					
-47.5	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					



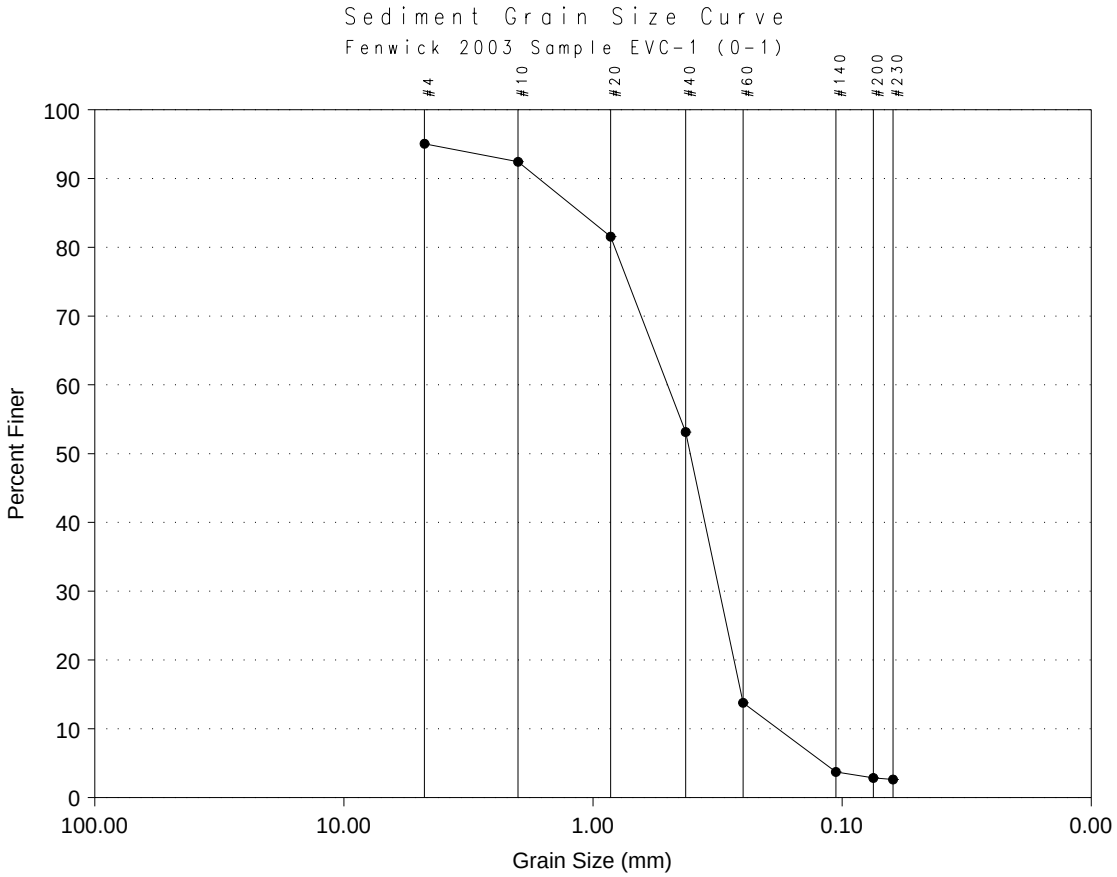
DRILLING LOG	DE State Plane (NAD 83 Ft) 167,443.8 N; 776,324.1 E	Date: February 12th, 2004	SHEET 1 OF 1 SHEETS

1. PROJECT: USACE-Fenwick Island Storm Damage Reduction Project		10. SIZE AND TYPE OF BIT 4”		
2. Station: FVC-13		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~		
3. DRILLING AGENCY: Aqua Survey		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number)	FVC-13	13. TOTAL NO. OF OVER-BURDEN SAMPLS TAKEN	DISTURBED 1	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NO. OF CORE BOXES ~	15. ELEVATION OF GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERTICAL		16. DATE HOLE	STARTED 2/12/04	COMPLETED 2/12/04
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -45 ft		
8. DEPTH DRILLED INTO ROCK		18. TOTAL % CORE RECOVERY FOR BORING ~ 85%		
9. TOTAL DEPTH OF HOLE 6.5 ft.		19. SIGNATURE OF INSPECTOR		

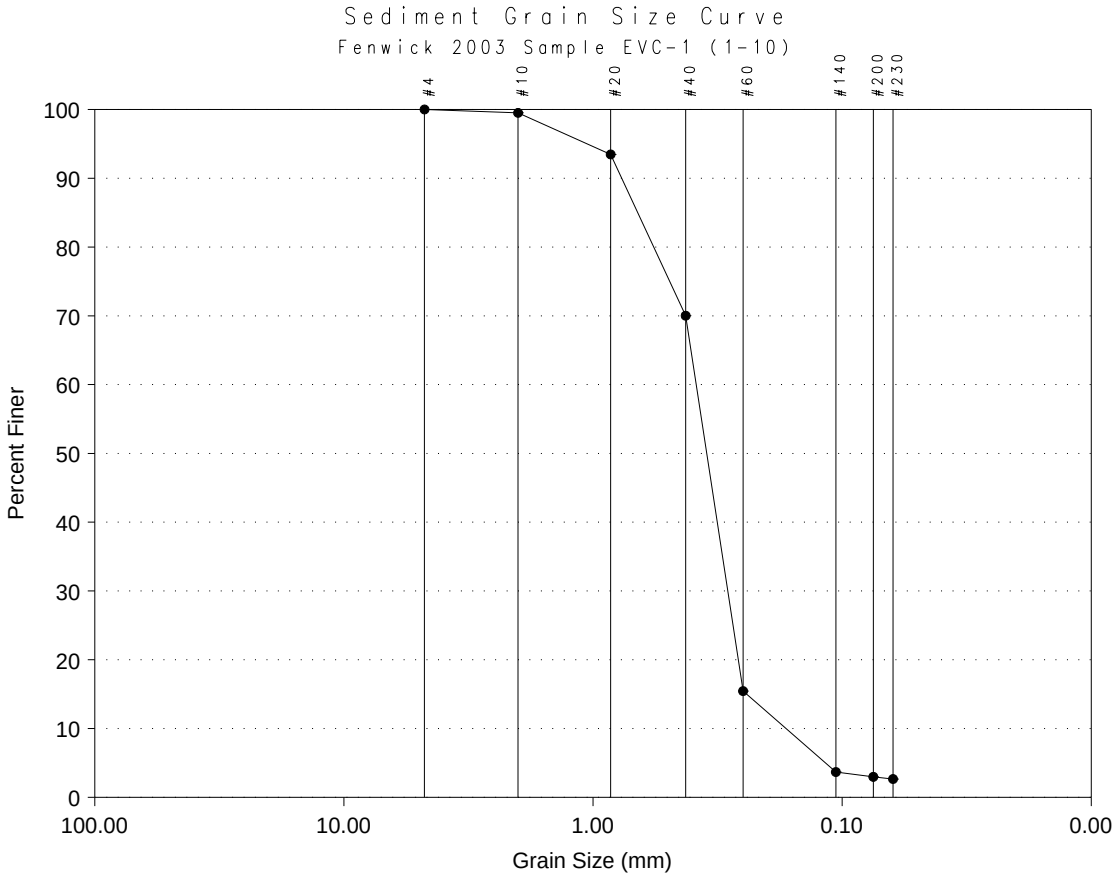
Sediment Surface Elevation a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	USCS e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-46			**10 YR 5/3 Brown medium SAND with a few shell fragments**	**SP**		**Three pictures were taken.**
-47	1.0					
-48	2.0					
-49	3.0		**2.5 Y 4/1 Dark gray medium SAND with few shell fragments**	**SP**		
-50	4.0		**2.5 Y 4/1 Dark gray very fine SAND**	**SP**		
-50	5.0					
-54	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					

APPENDIX C

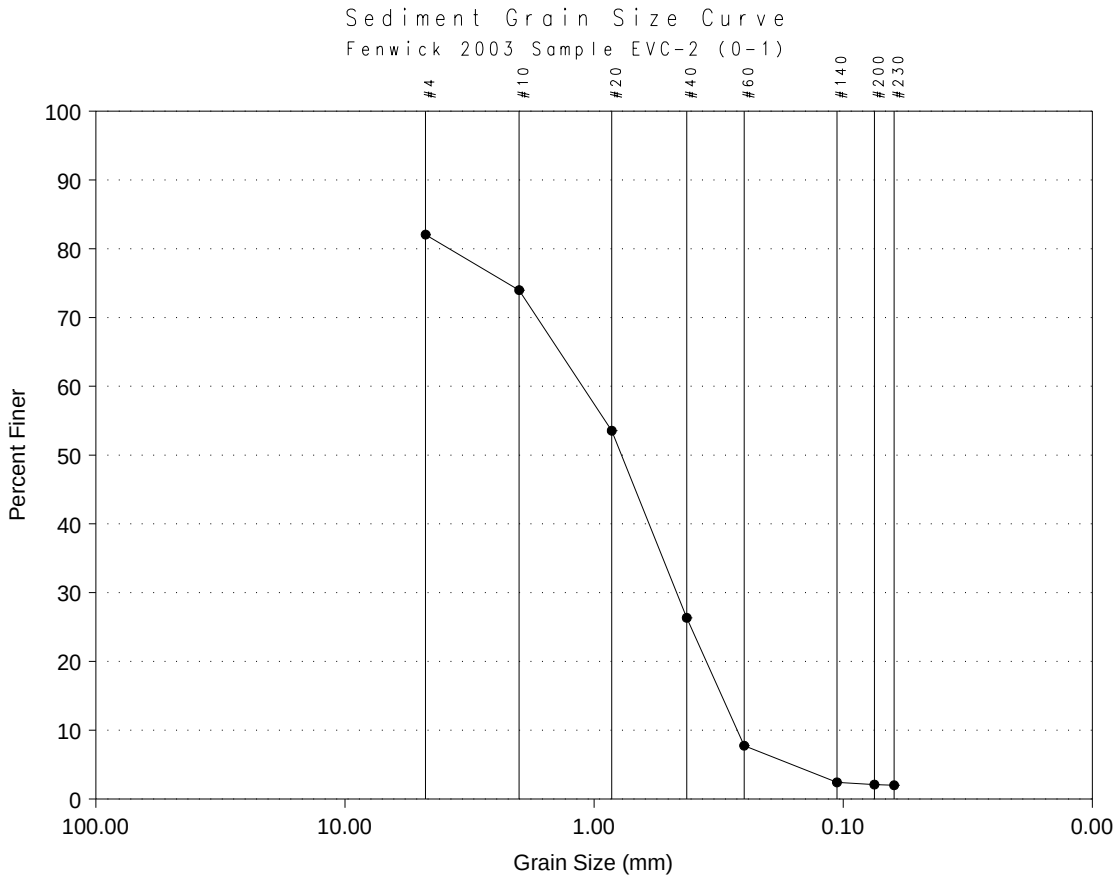
GRAIN SIZE ANALYSIS OF CONTAMINANT COMPOSITES



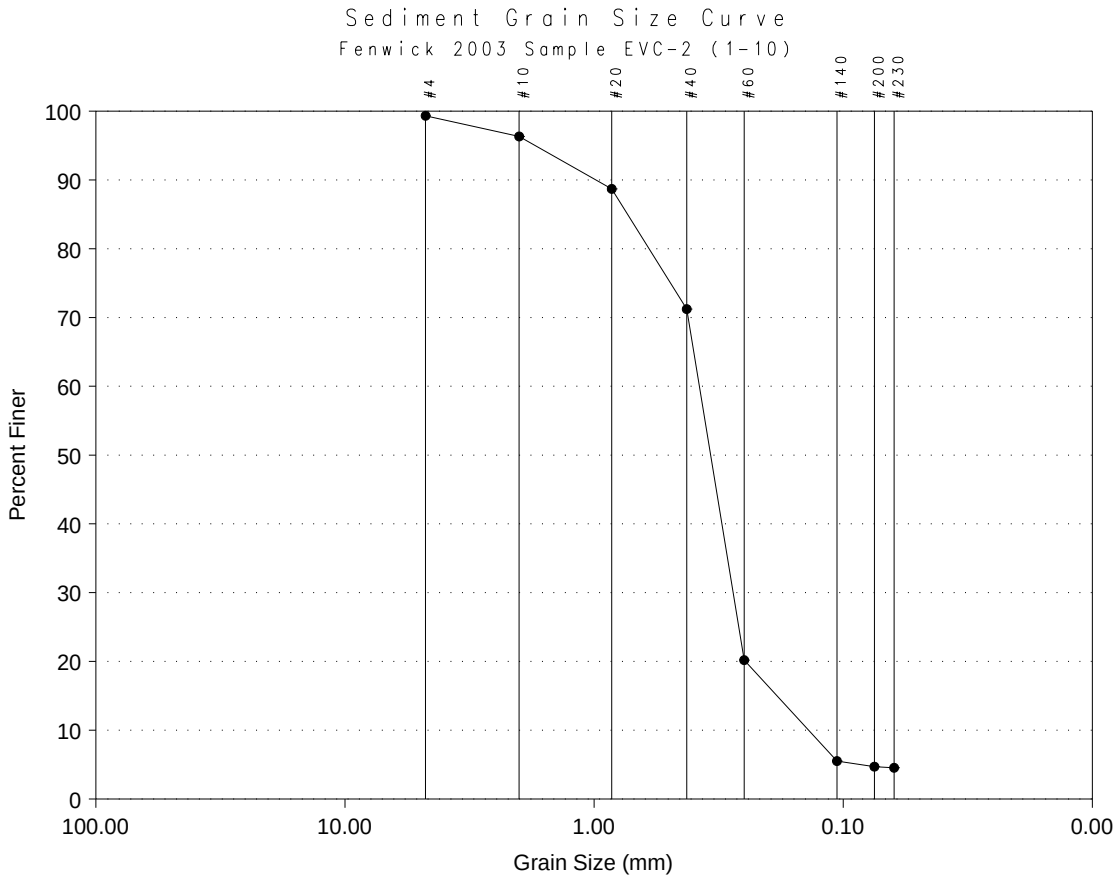
Sample composite of surface 0-1 ft.



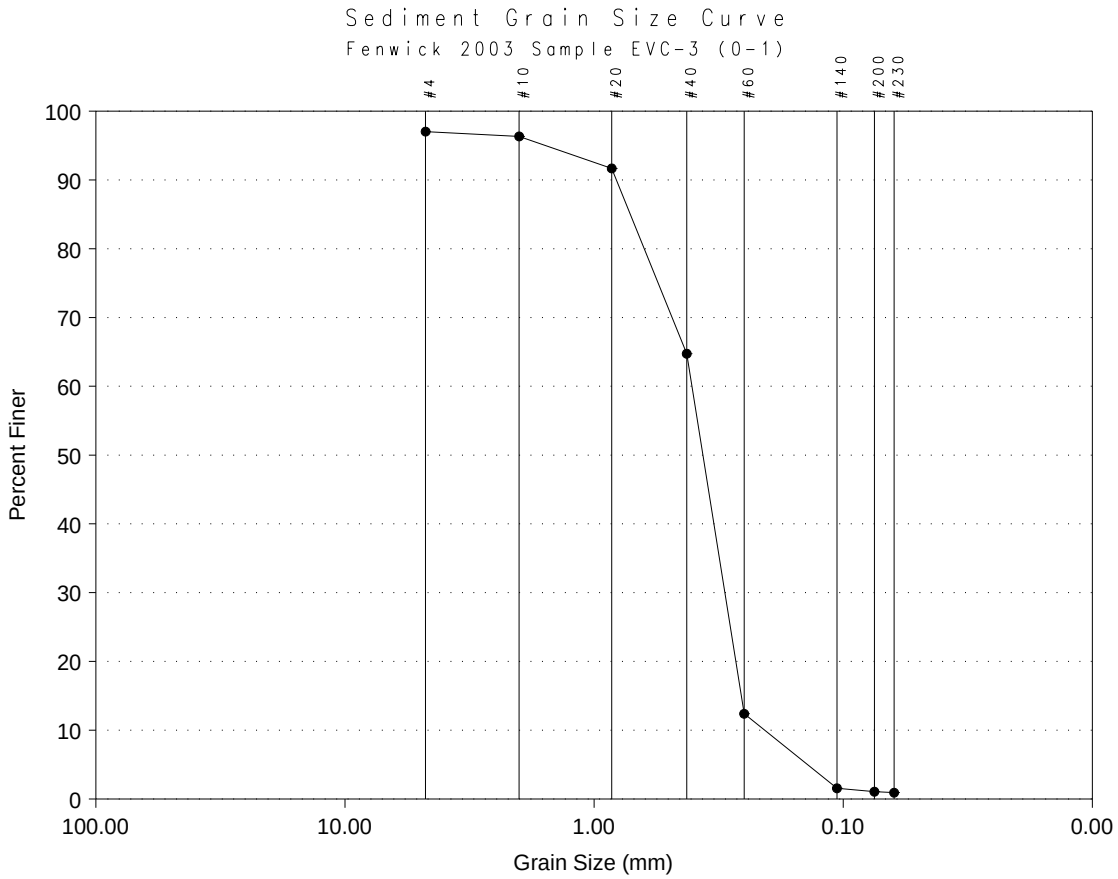
Sample composite of 1.0 – 2.7 ft.



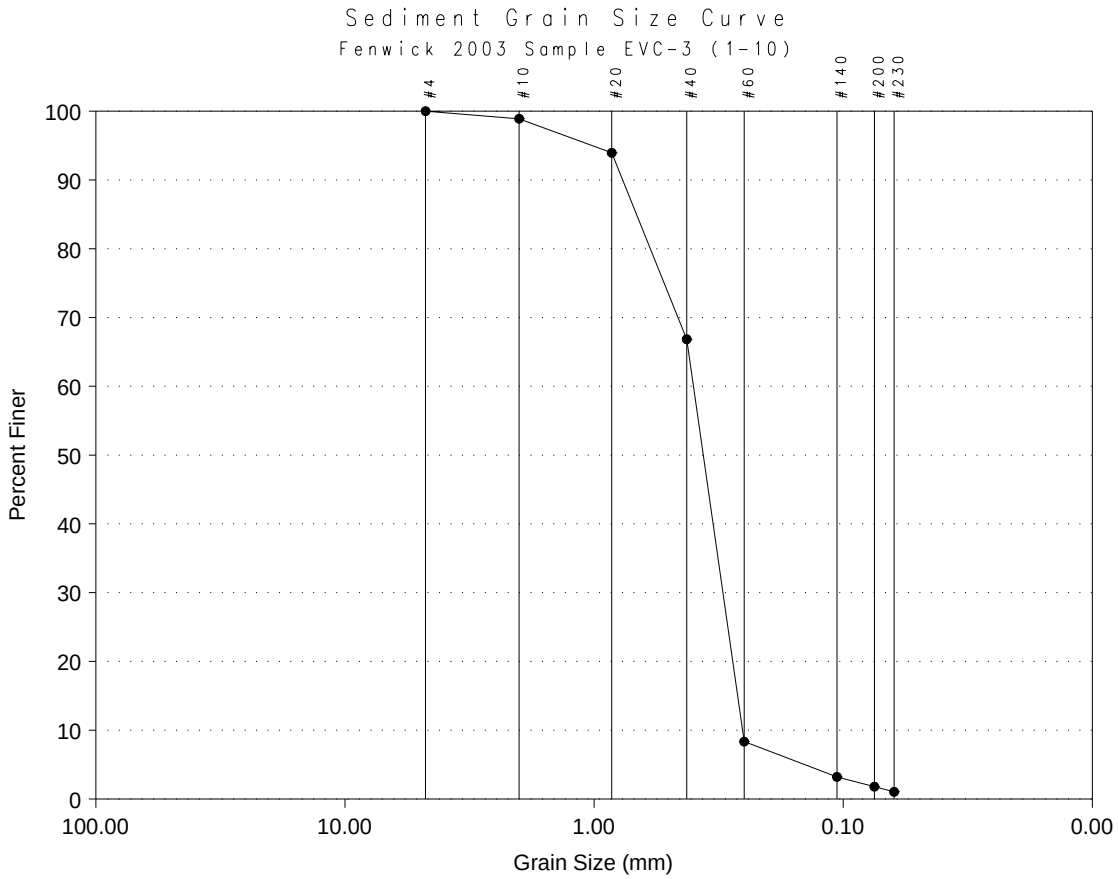
Sample composite of surface 0-1 ft.



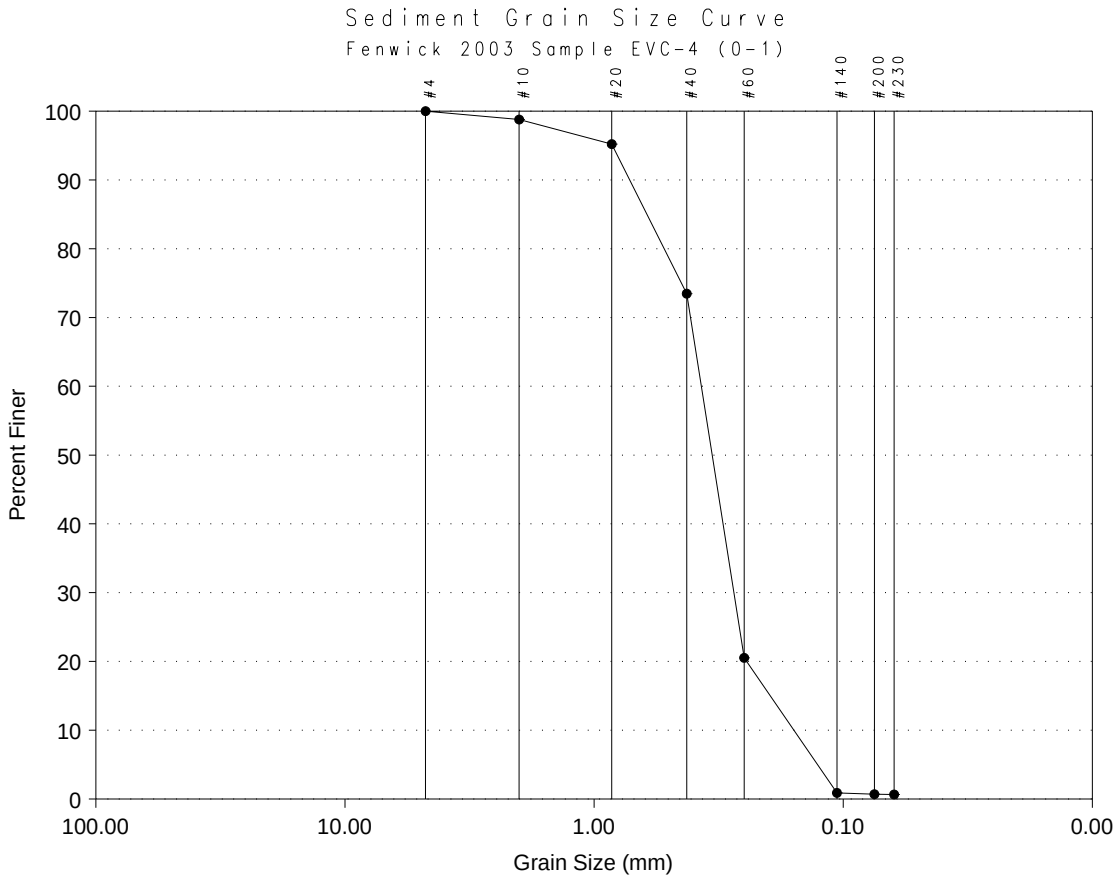
Sample composite of 1.0 – 4.2 ft.



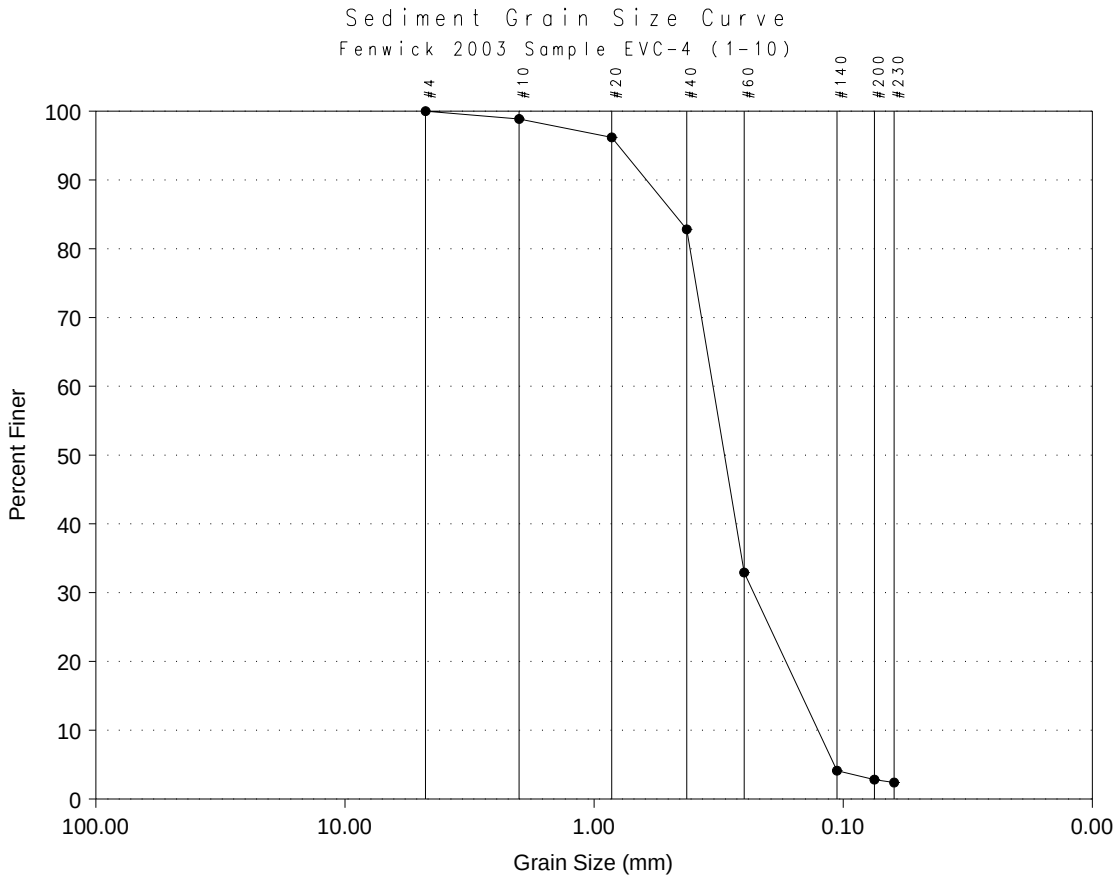
Sample composite of surface 0-1 ft.



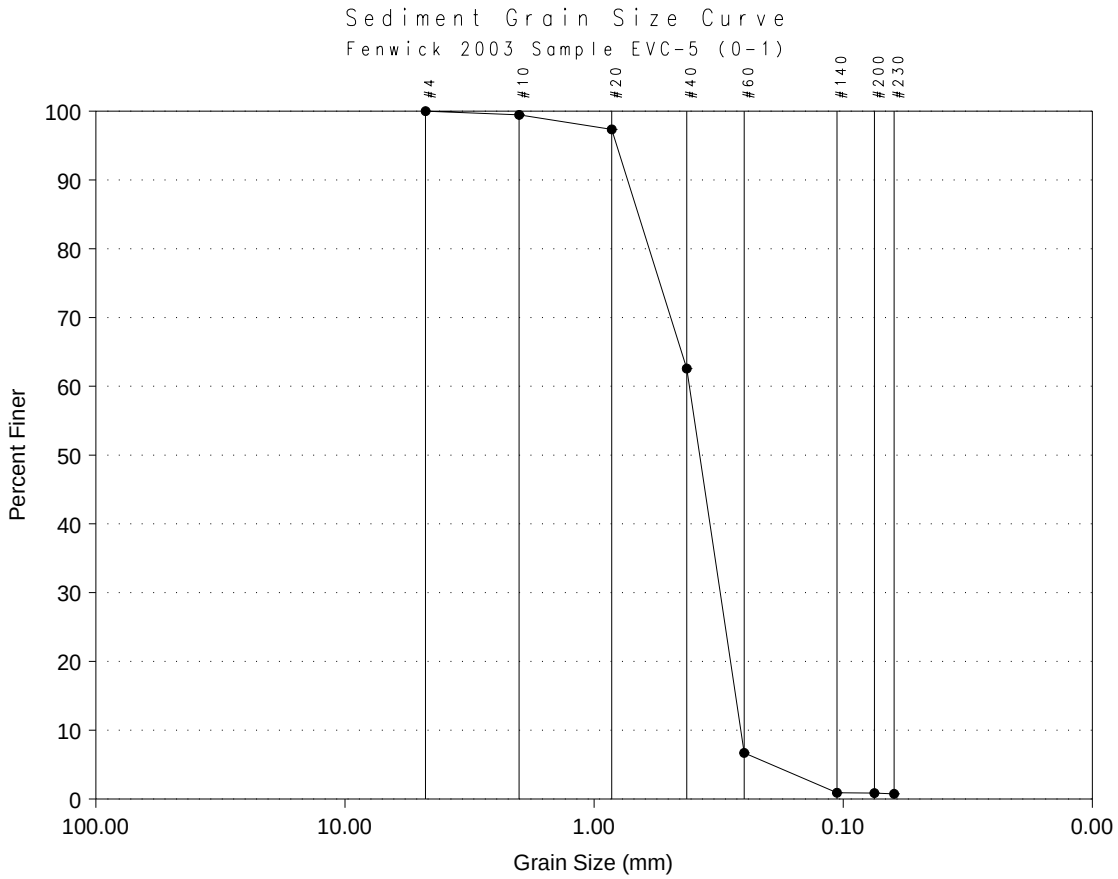
Sample composite of 1.0 – 1.7 ft.



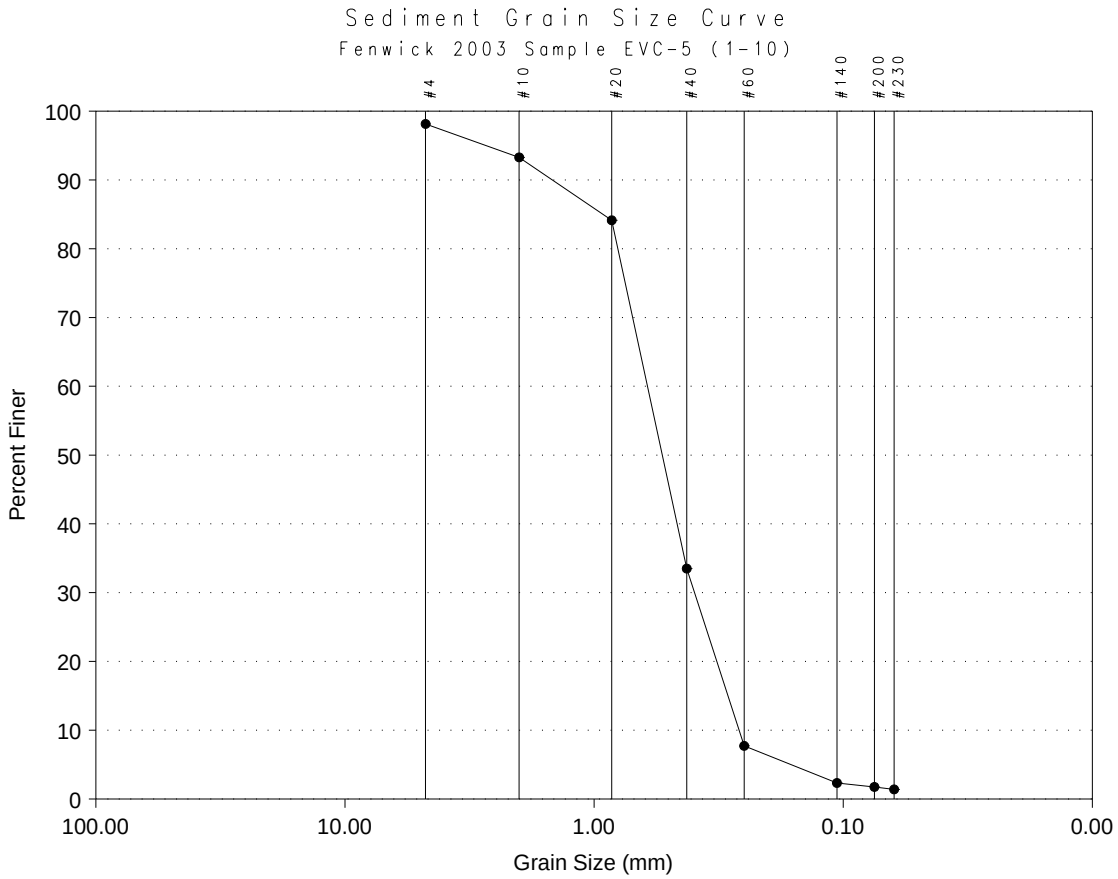
Sample composite of surface 0-1 ft.



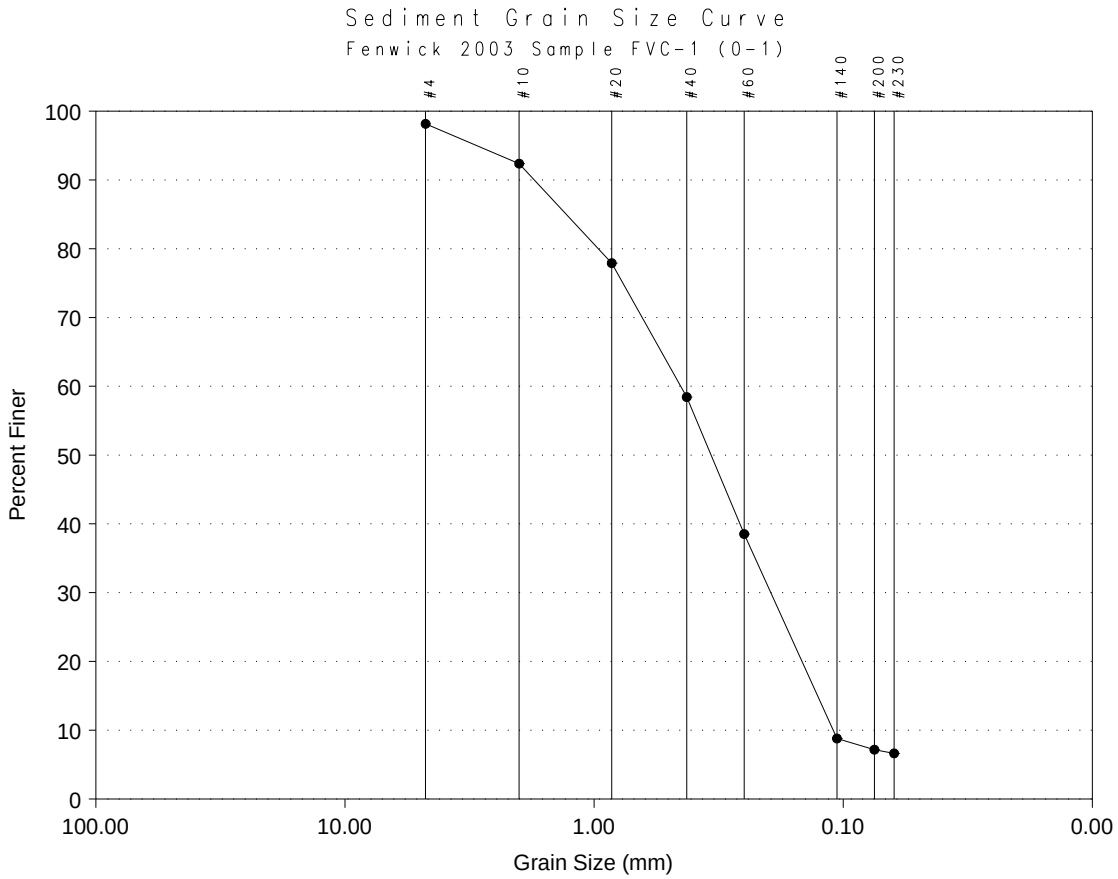
Sample composite of 1.0 – 4.6 ft.



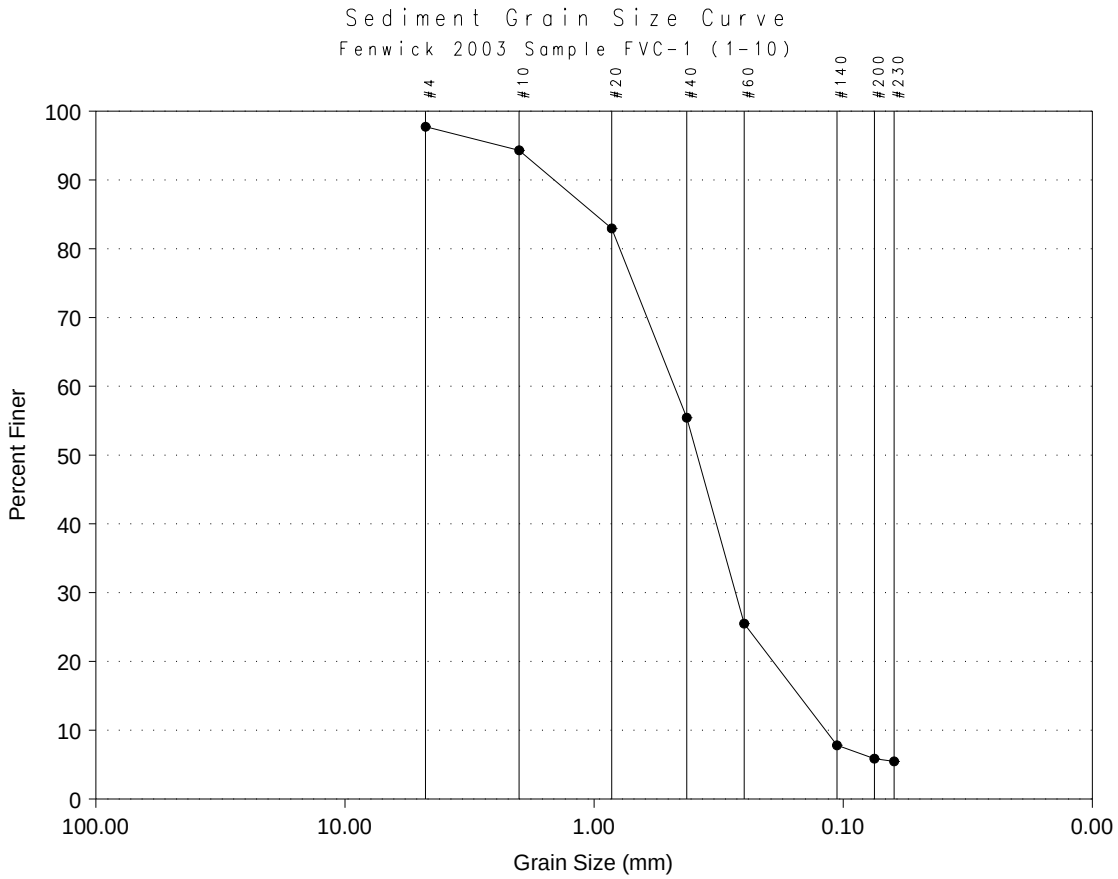
Sample composite of surface 0-1 ft.



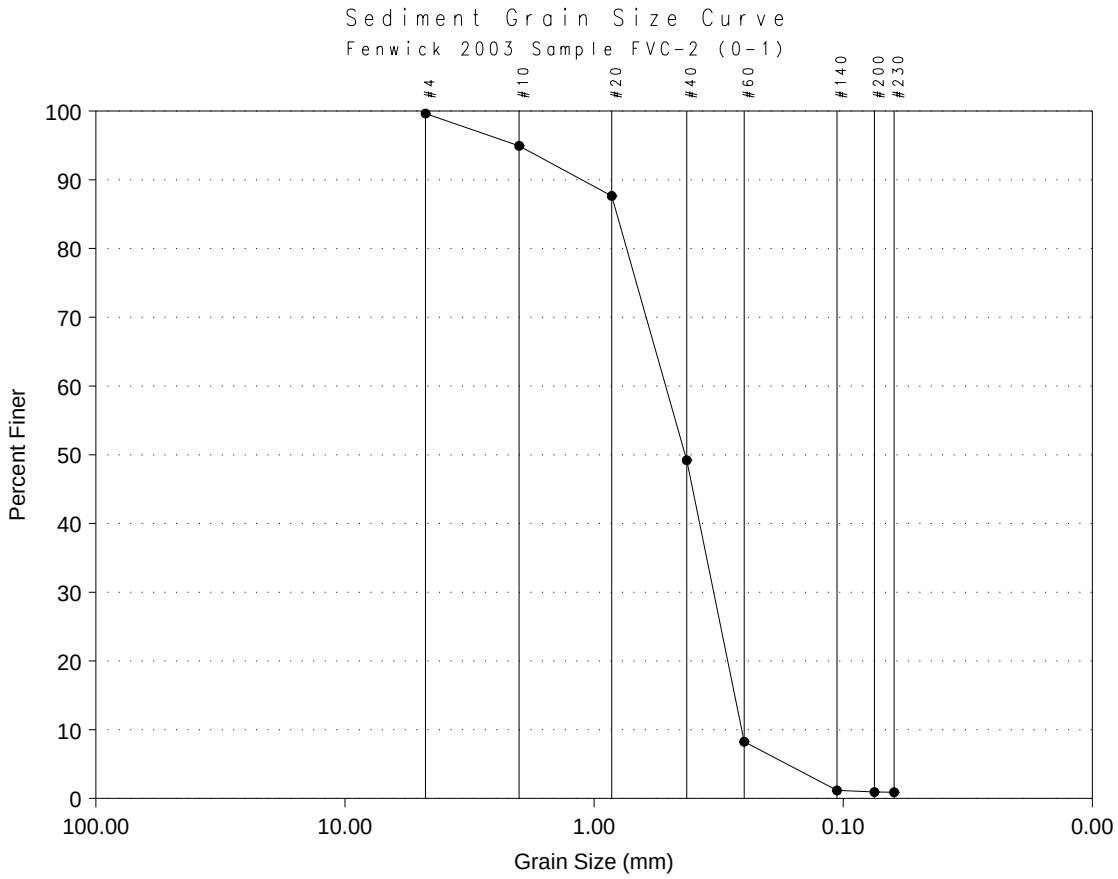
Sample composite of 1.0 – 2.2 ft.



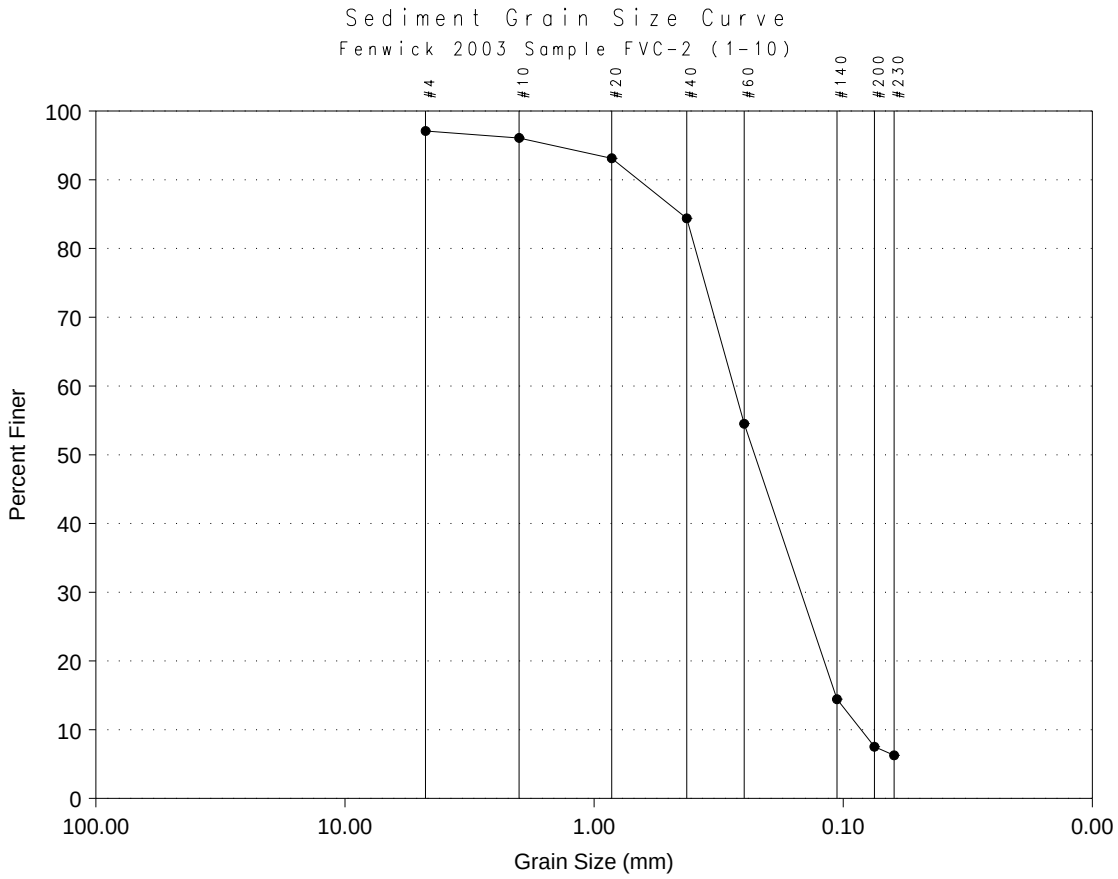
Sample composite of surface 0-1 ft.



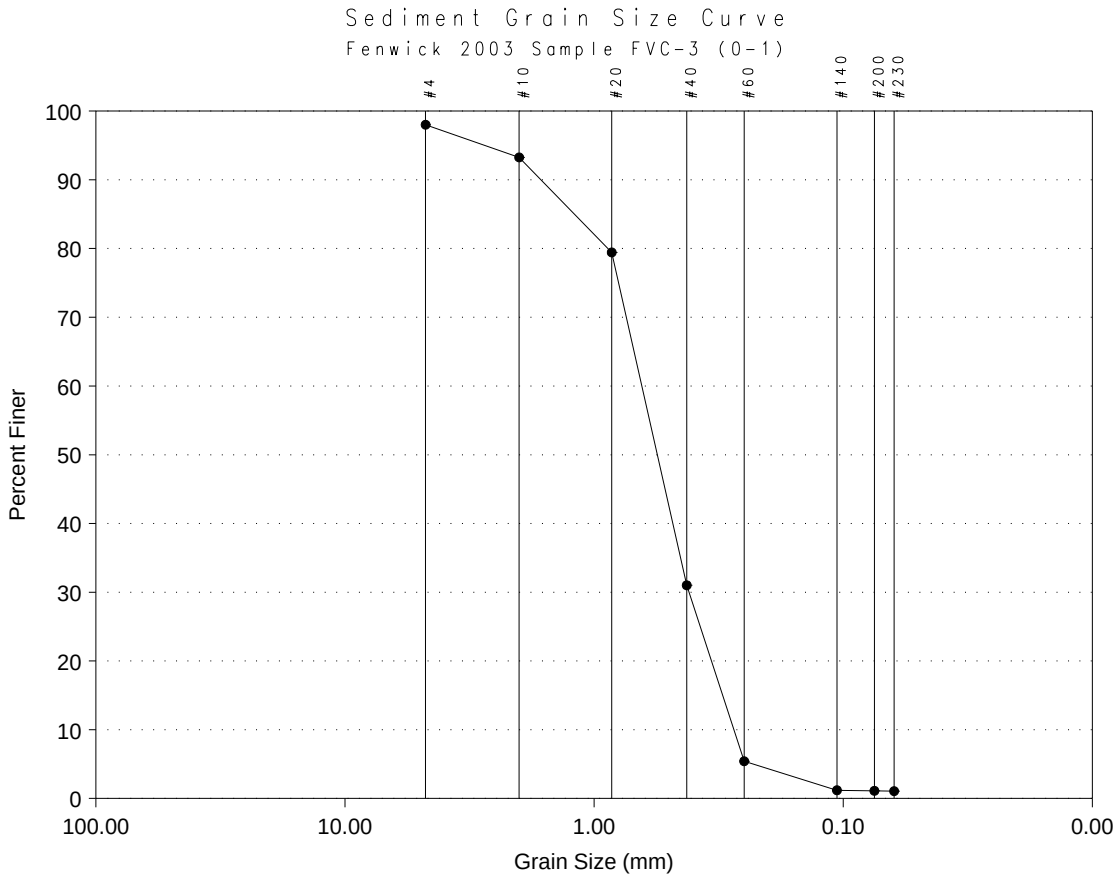
Sample composite of 1.0 – 5.7 ft.



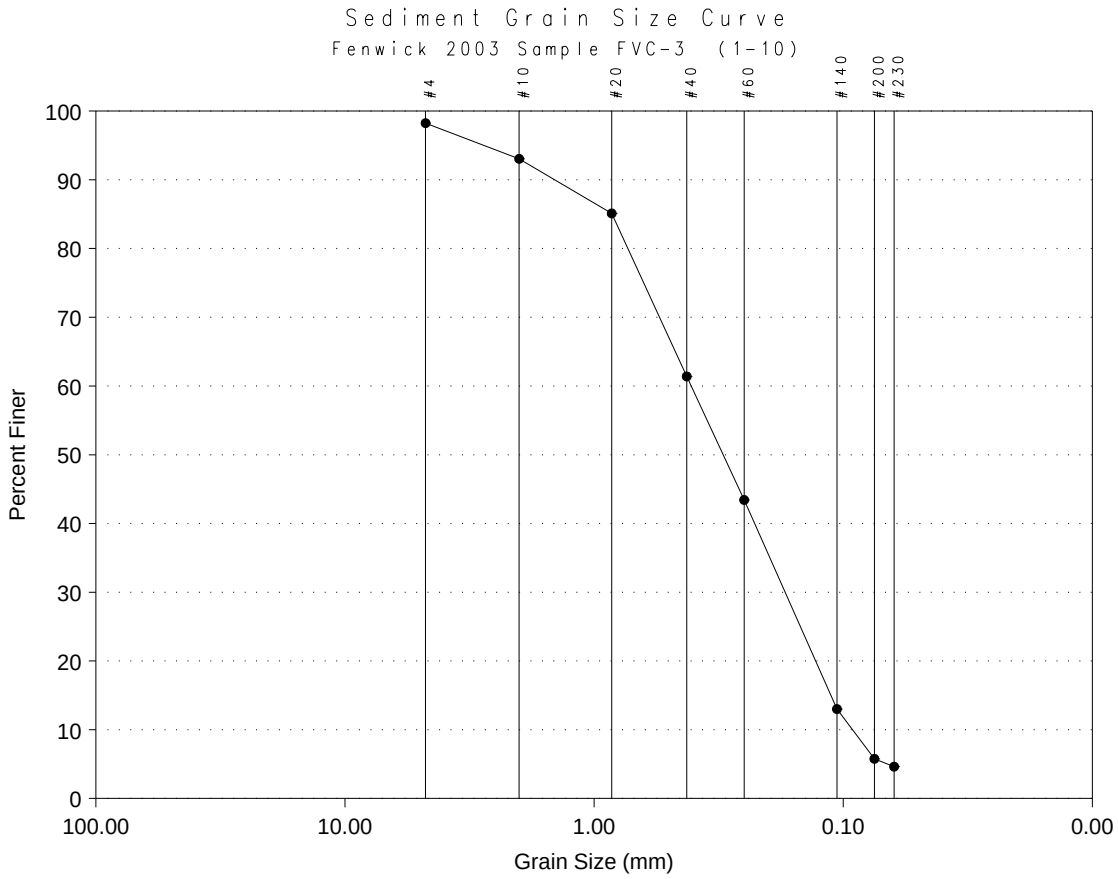
Sample composite of surface 0-1 ft.



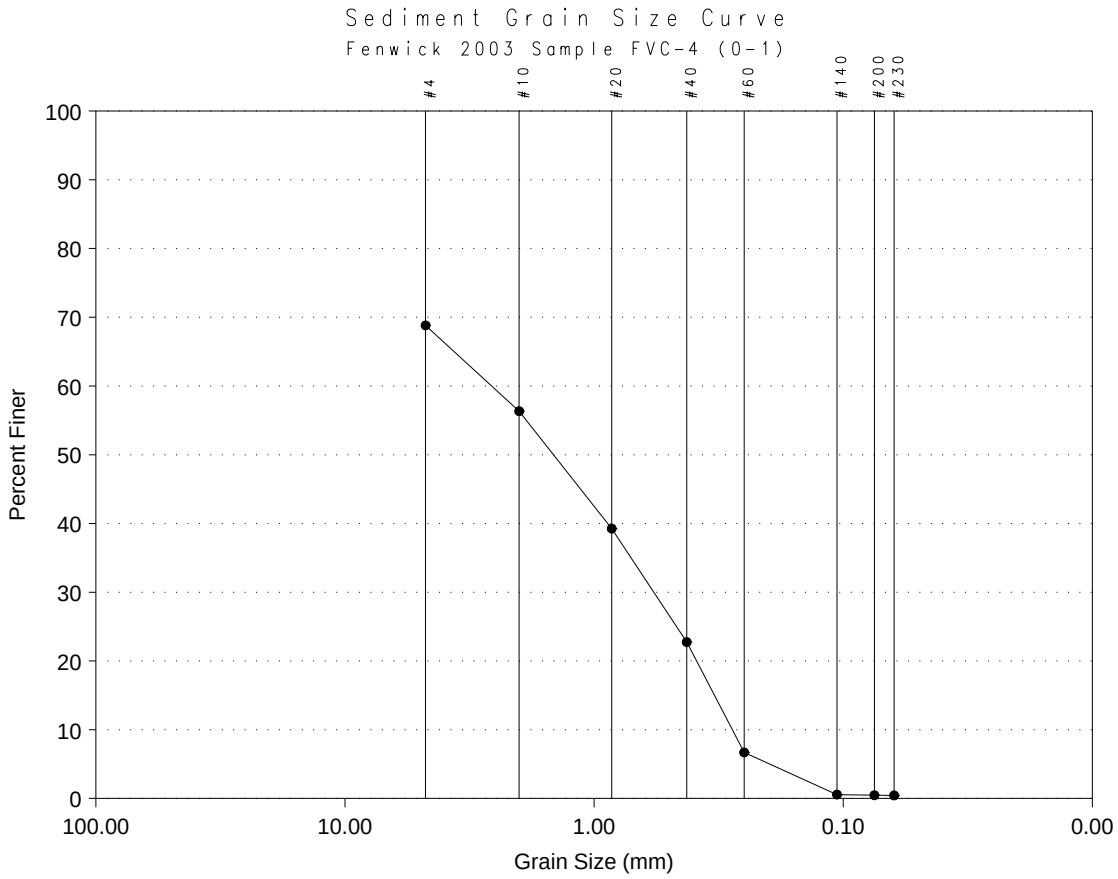
Sample composite of 1.0 – 5.0 ft.



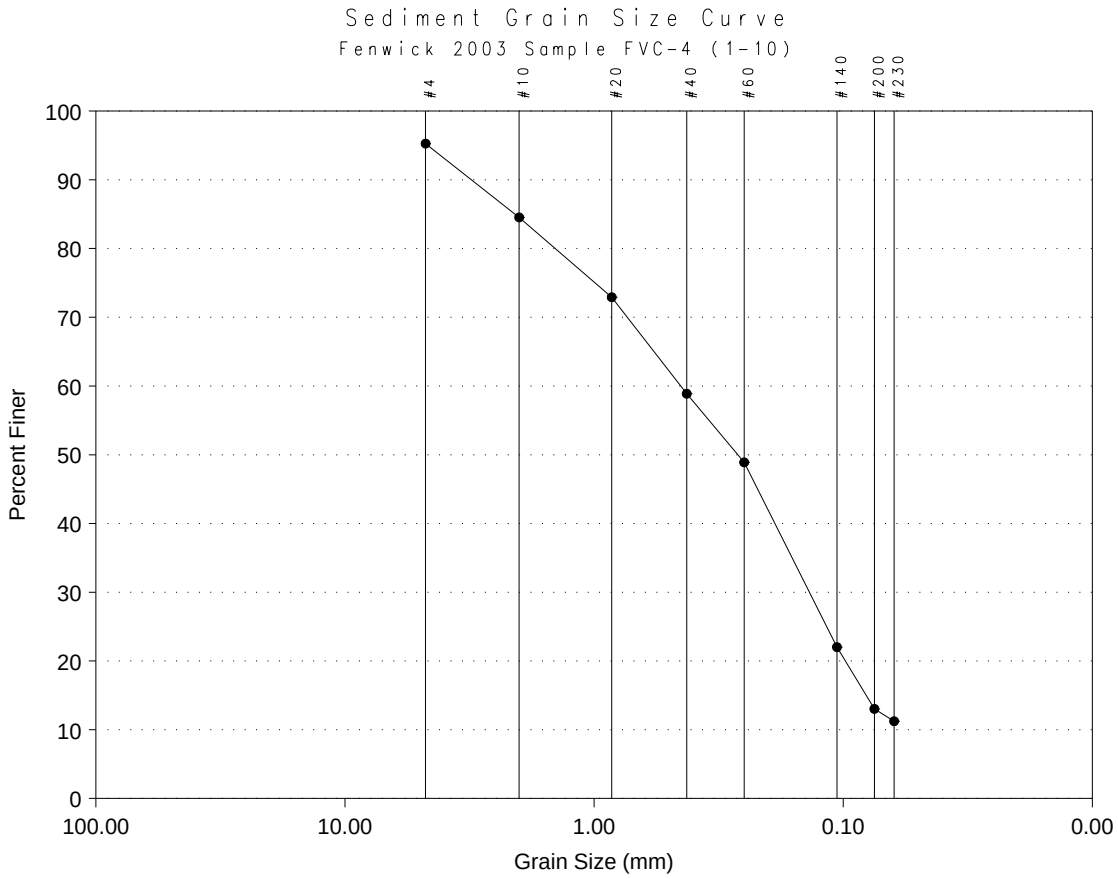
Sample composite of surface 0-1 ft.



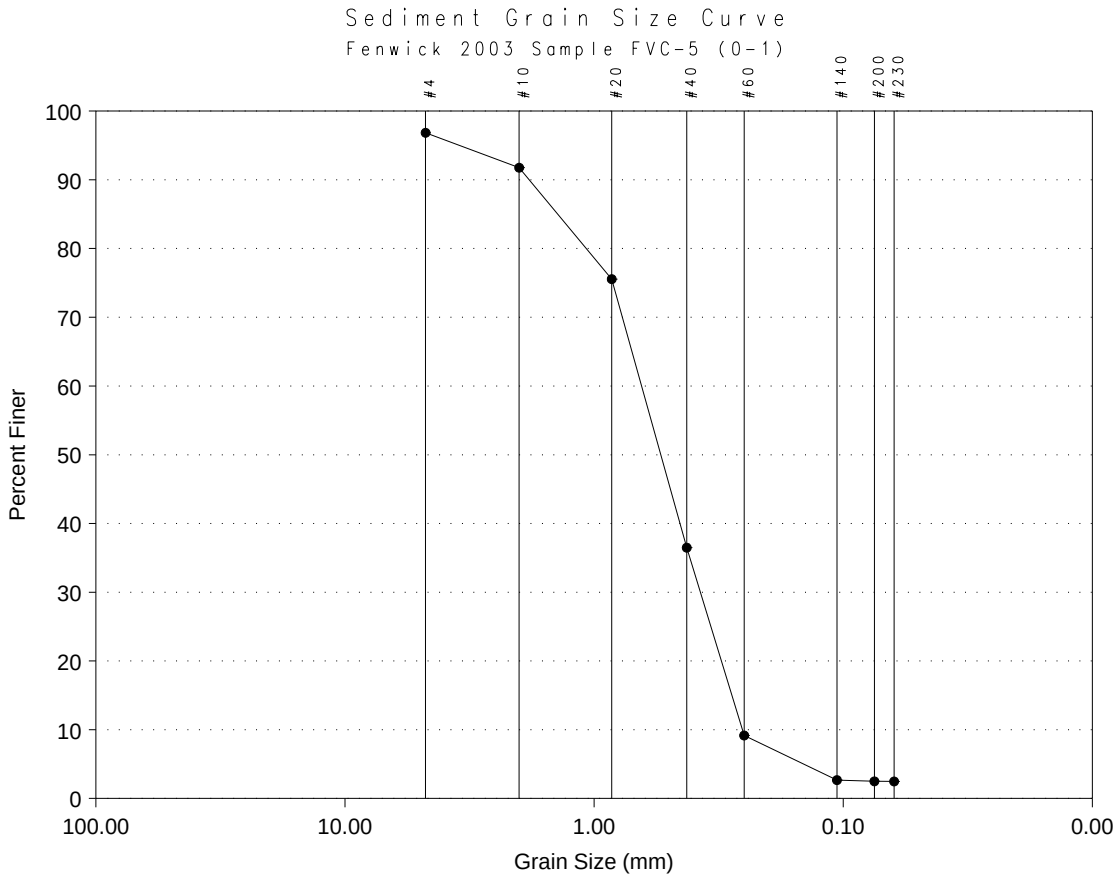
Sample composite of 1.0 – 4.0 ft.



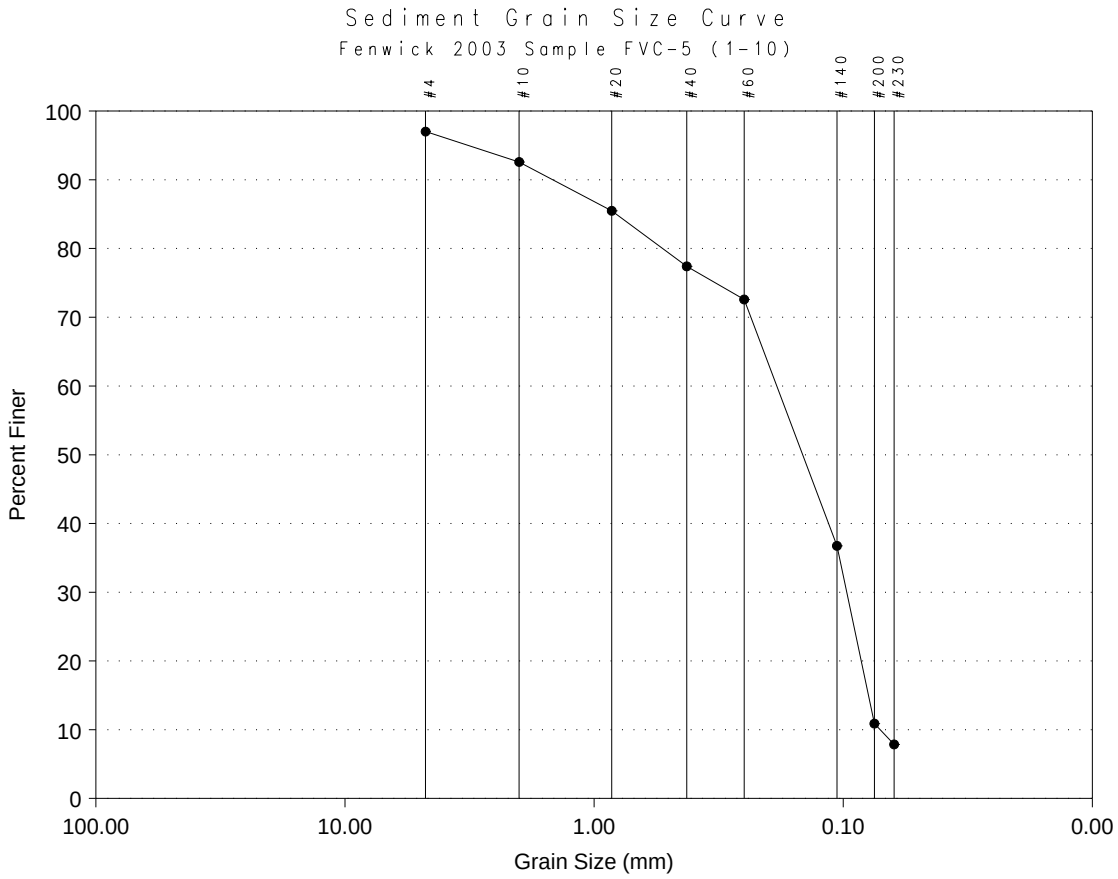
Sample composite of surface 0-1 ft.



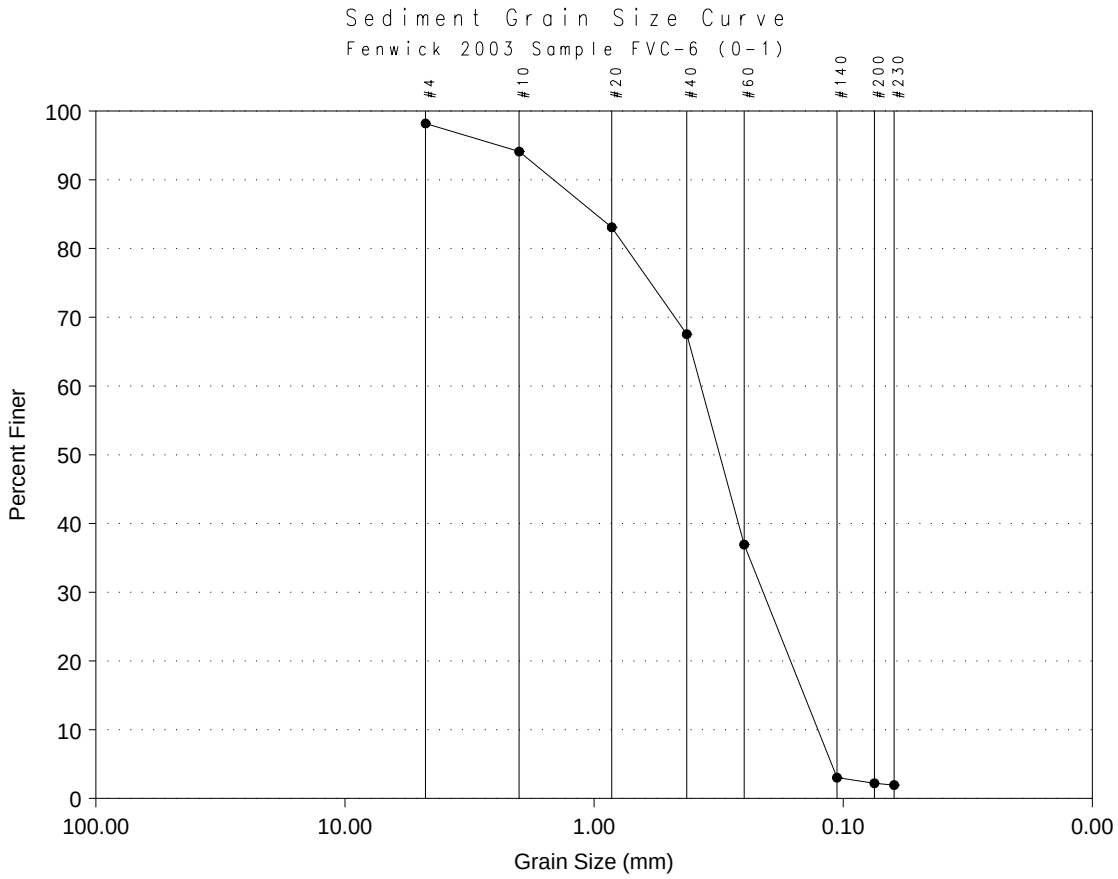
Sample composite of 1.0 – 4.0 ft.



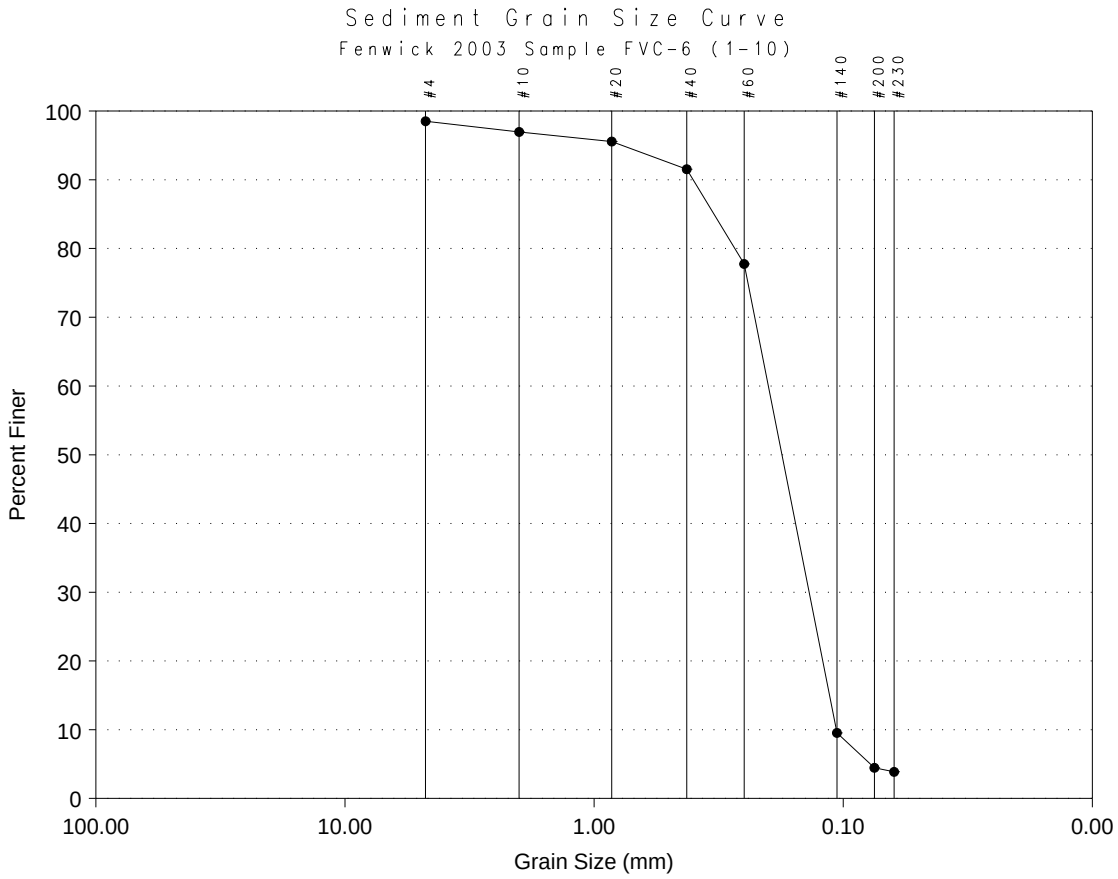
Sample composite of surface 0-1 ft.



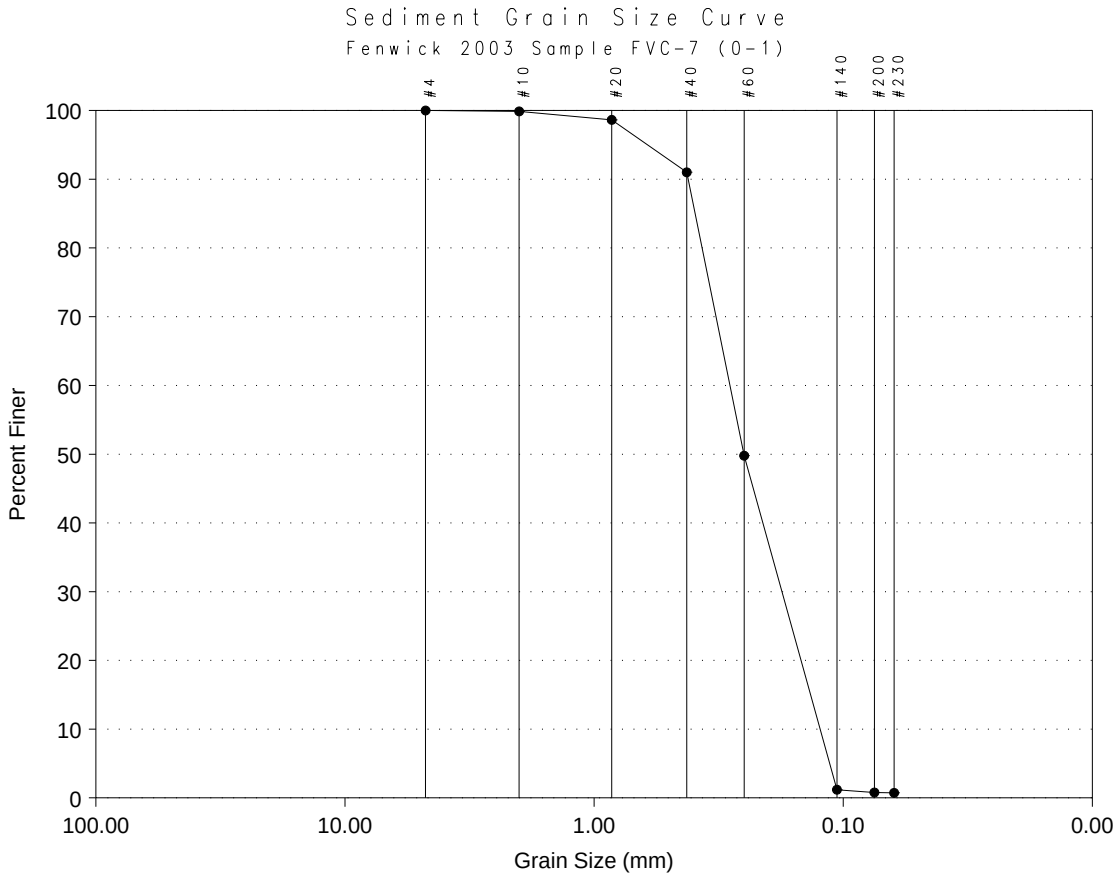
Sample composite of 1.0 – 3.3 ft.



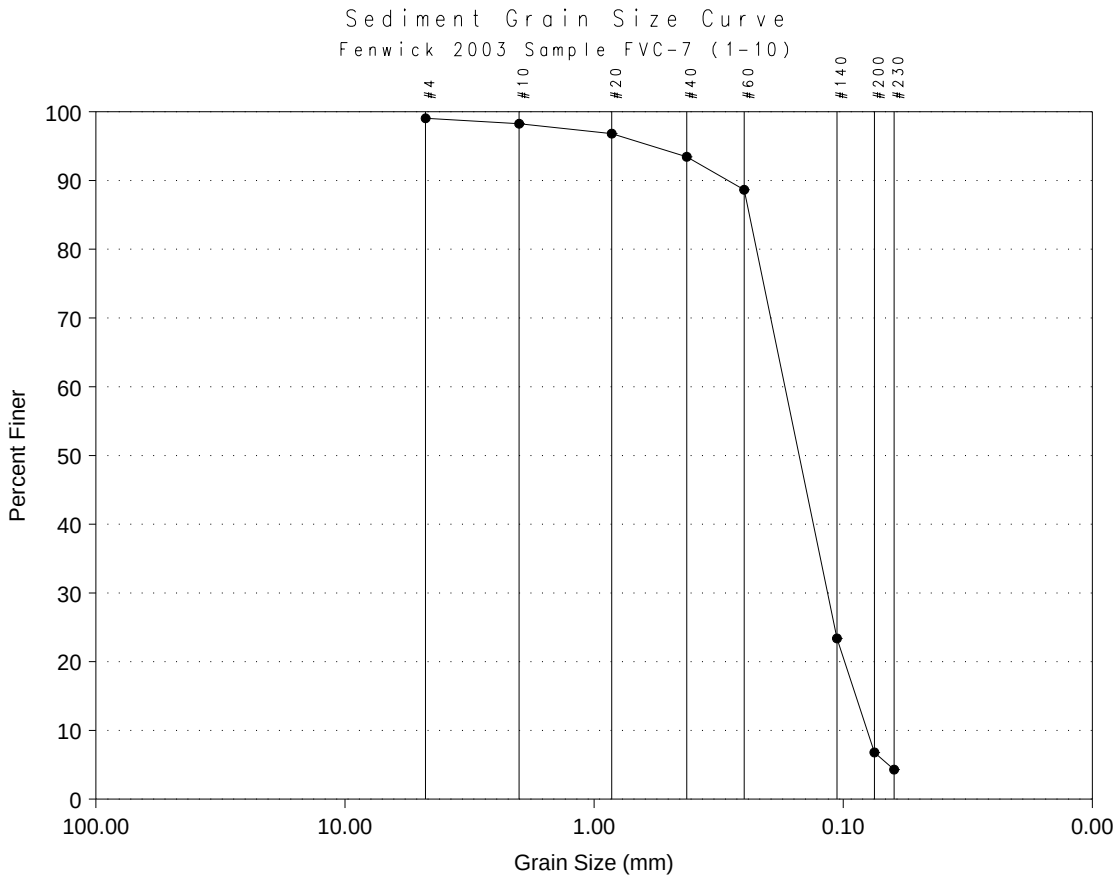
Sample composite of surface 0-1 ft.



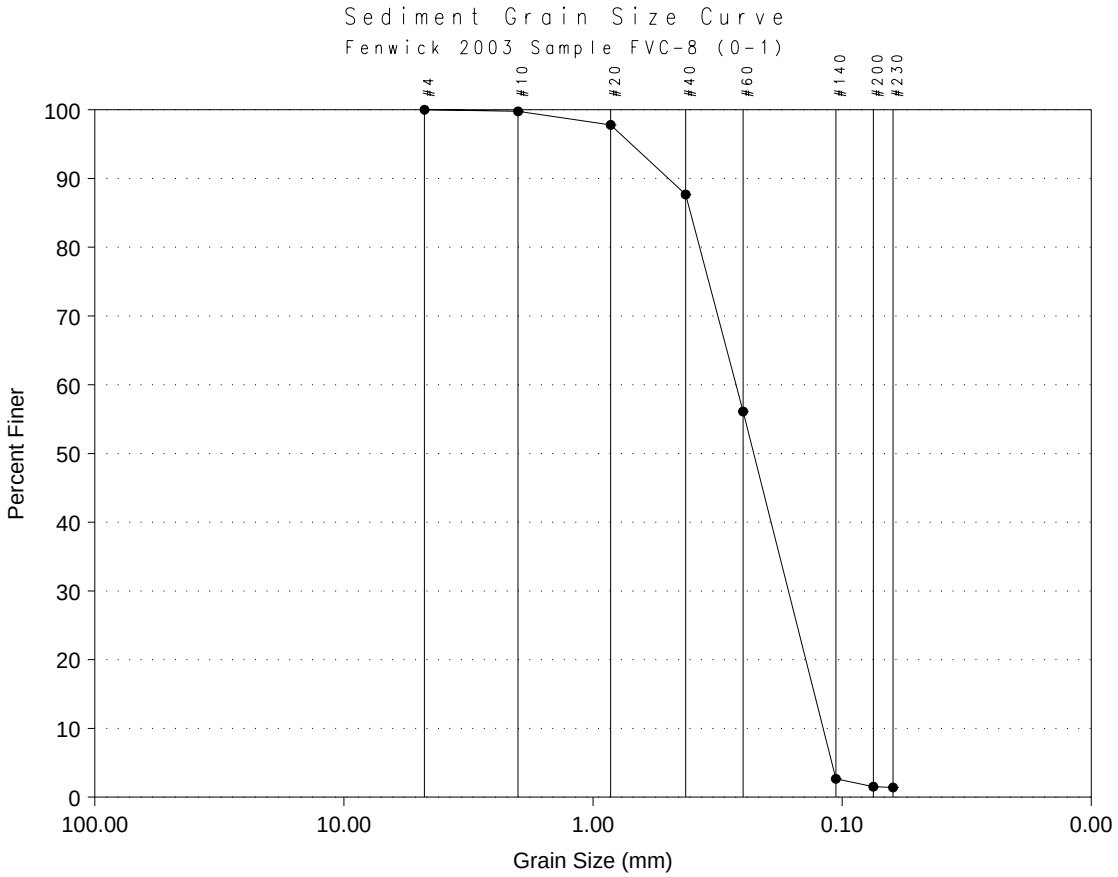
Sample composite of 1.0 – 3.8 ft.



Sample composite of surface 0-1 ft.



Sample composite of 1.0 – 4.3 ft.



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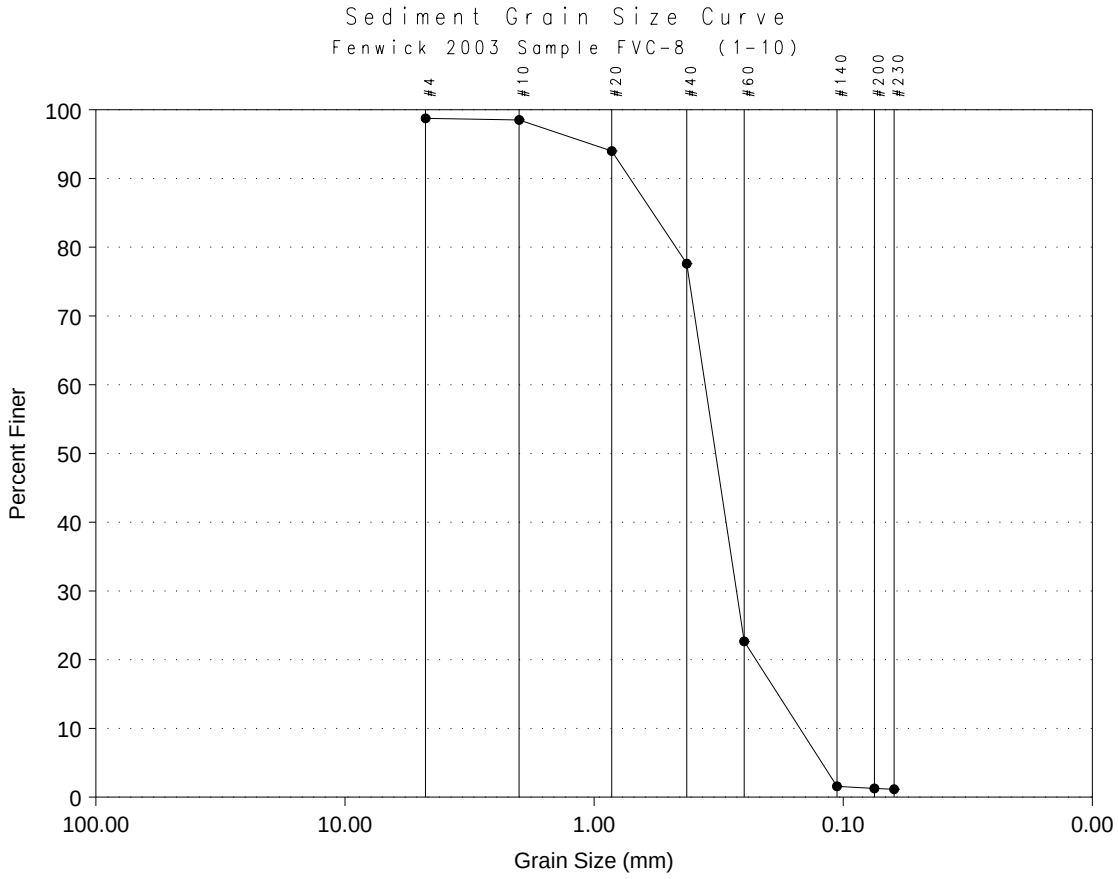
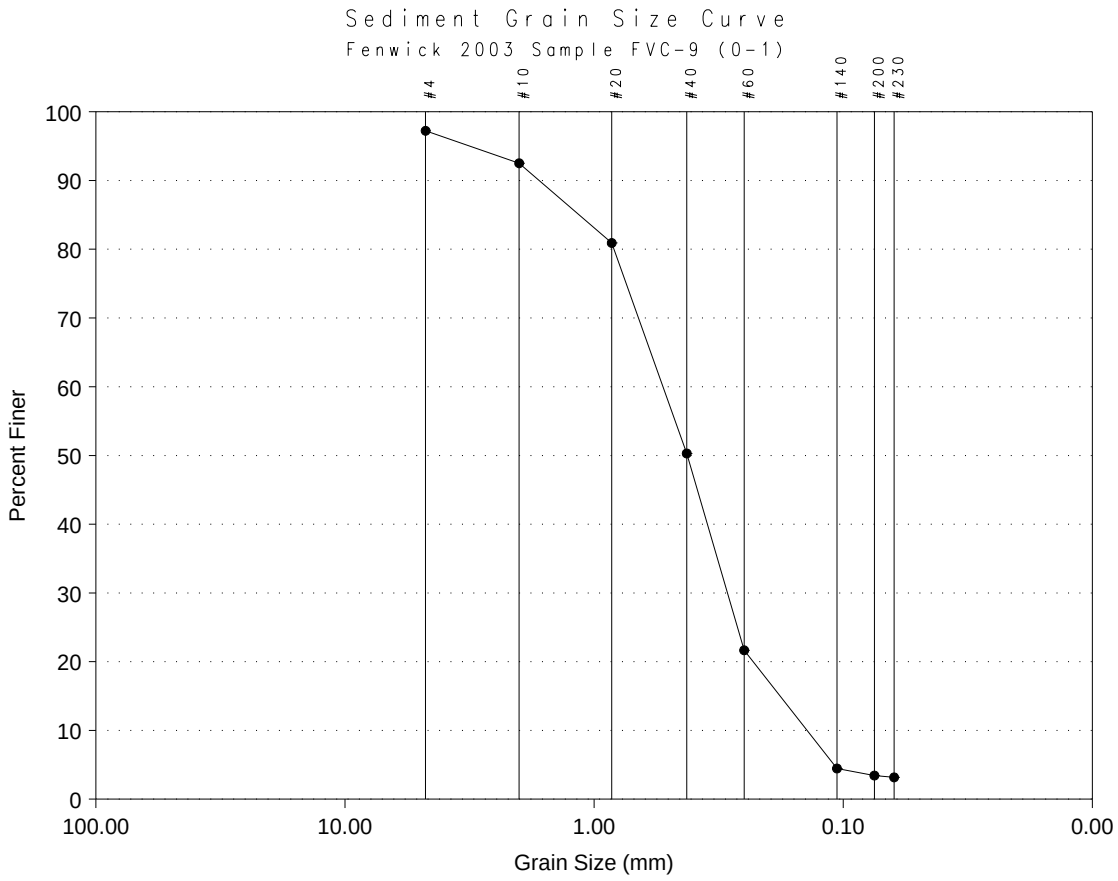
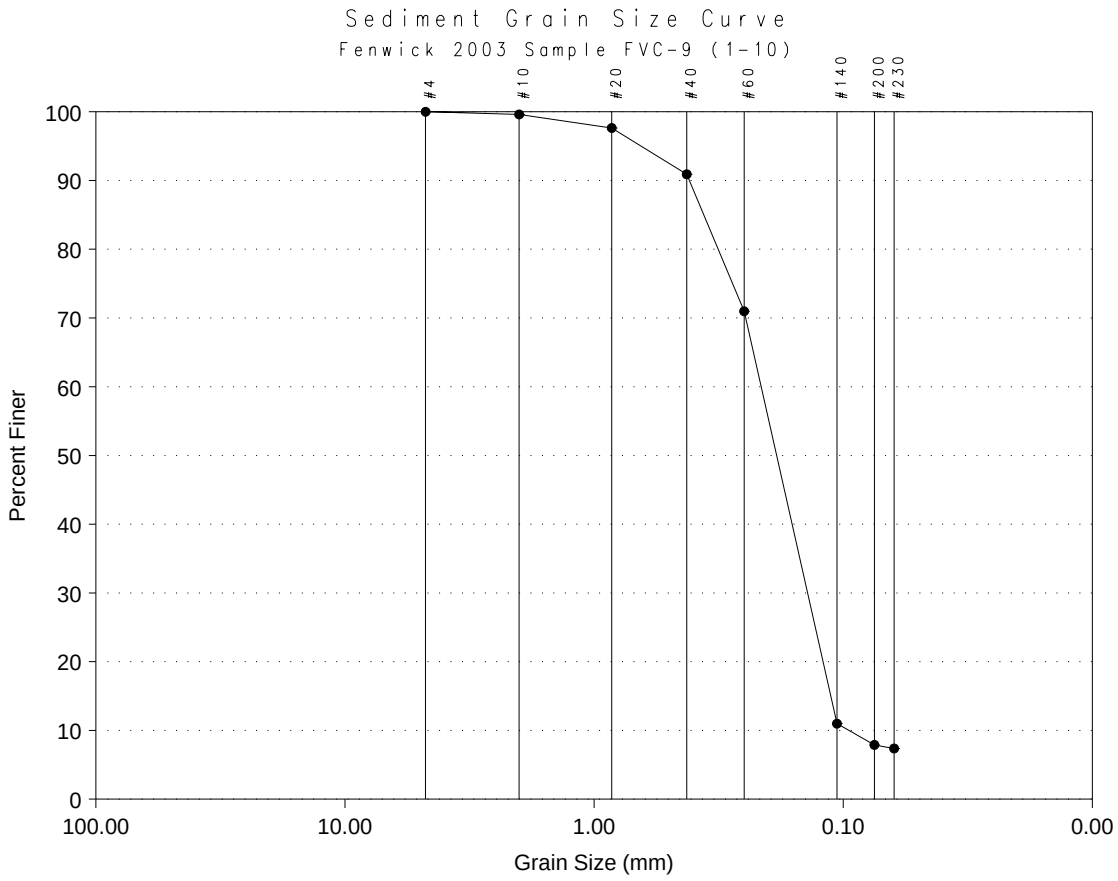


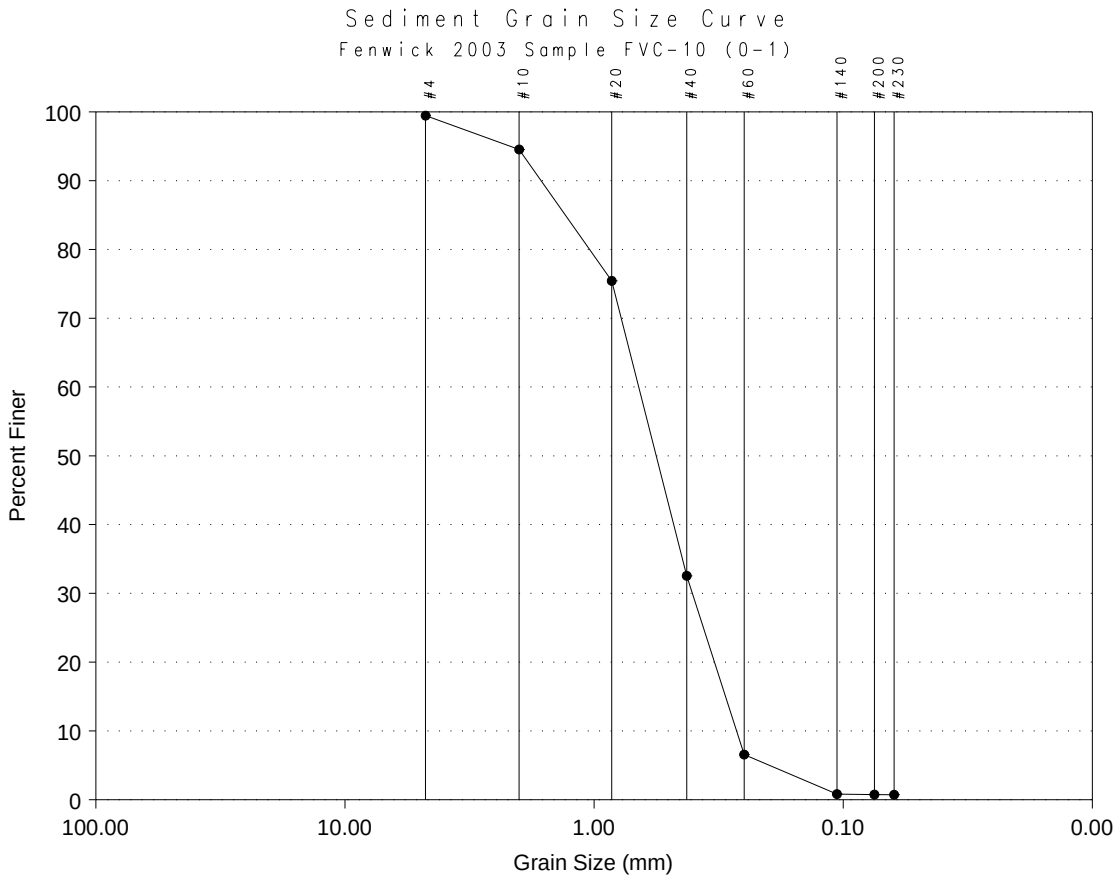
Sample composite of 1.0 – 2.8 ft.



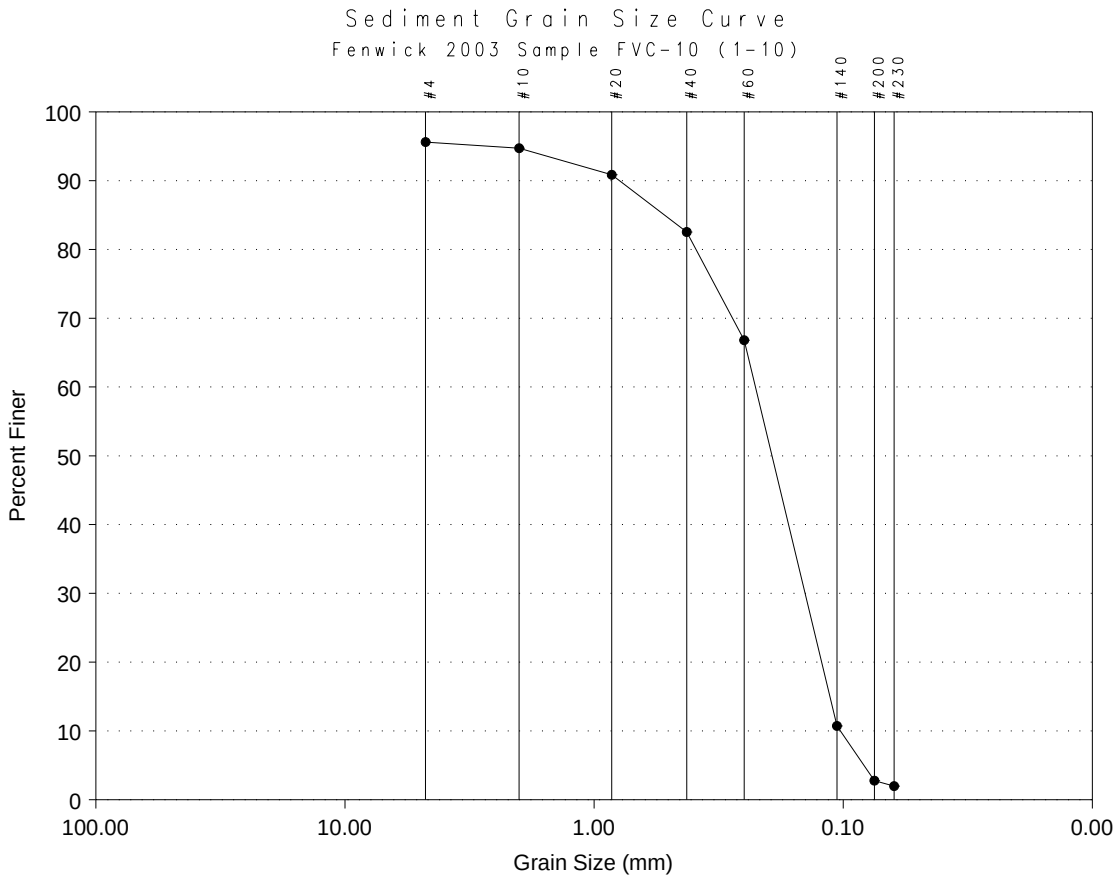
Sample composite of surface 0-1 ft.



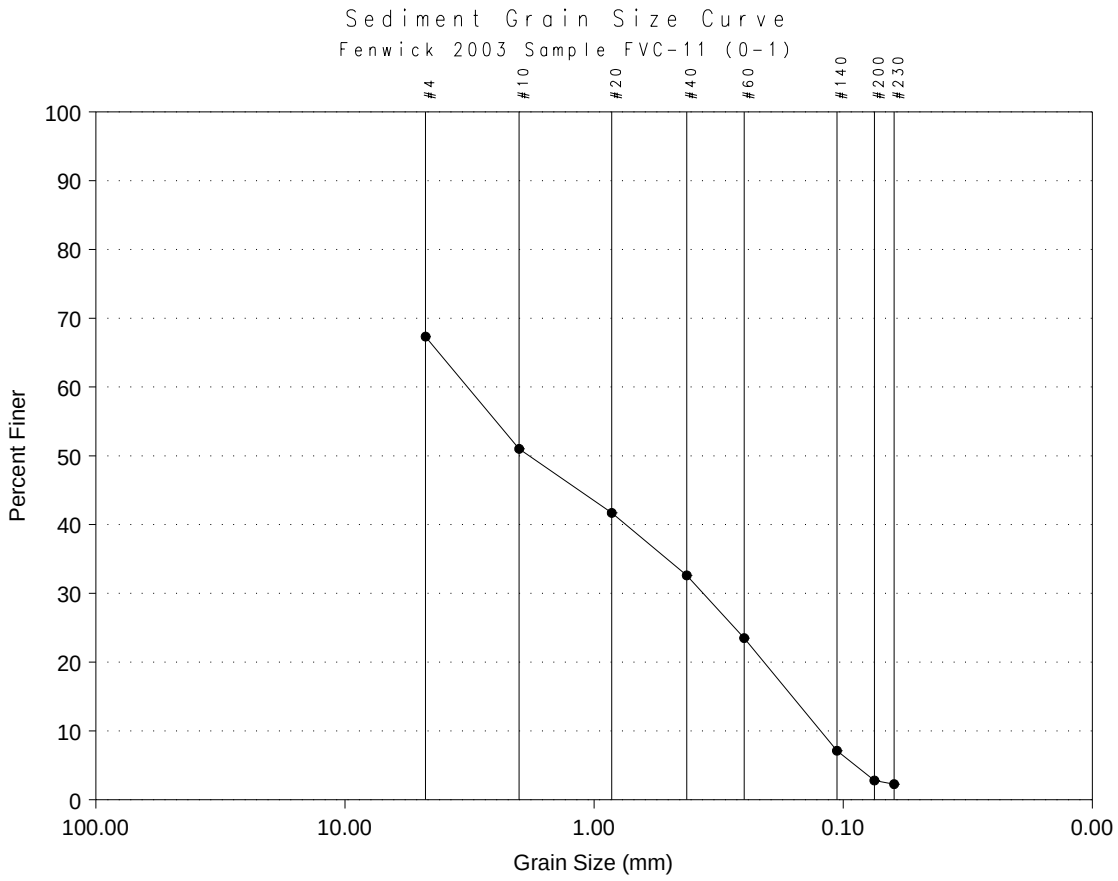
Sample composite of 1.0 – 5.0 ft.



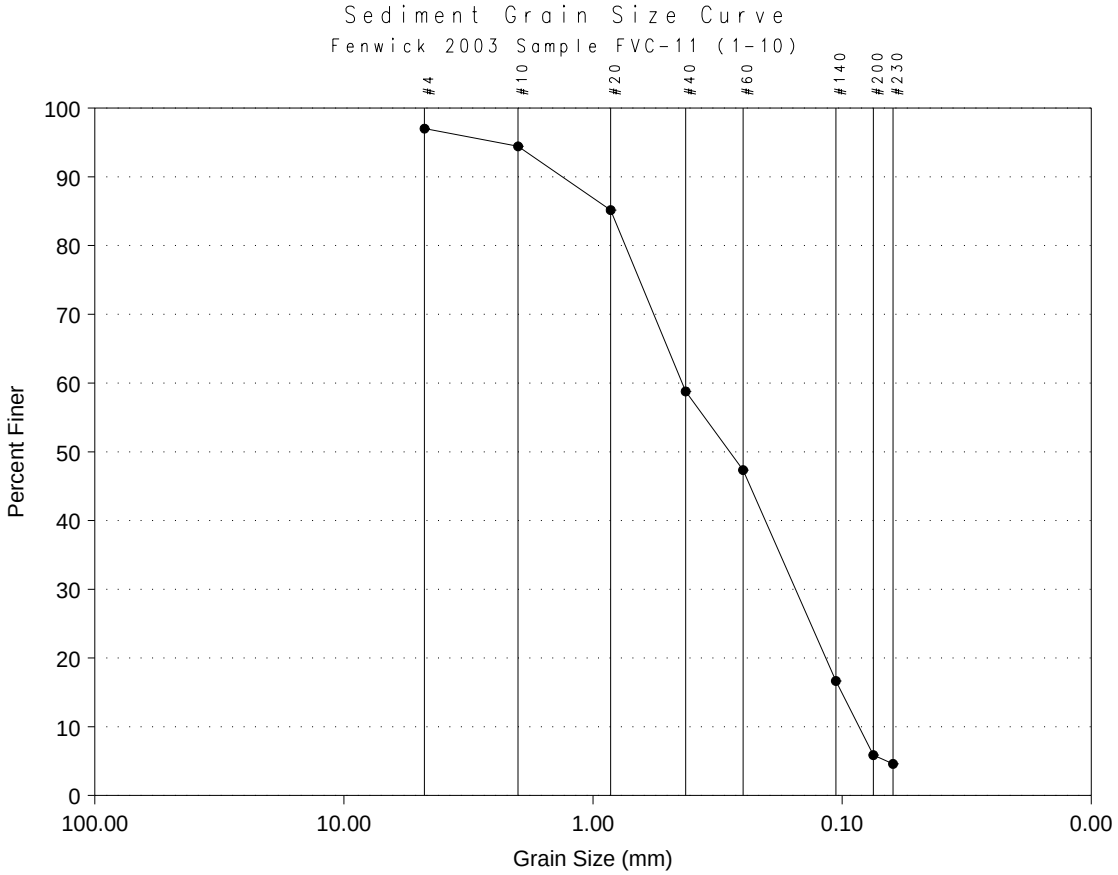
Sample composite of surface 0-1 ft.



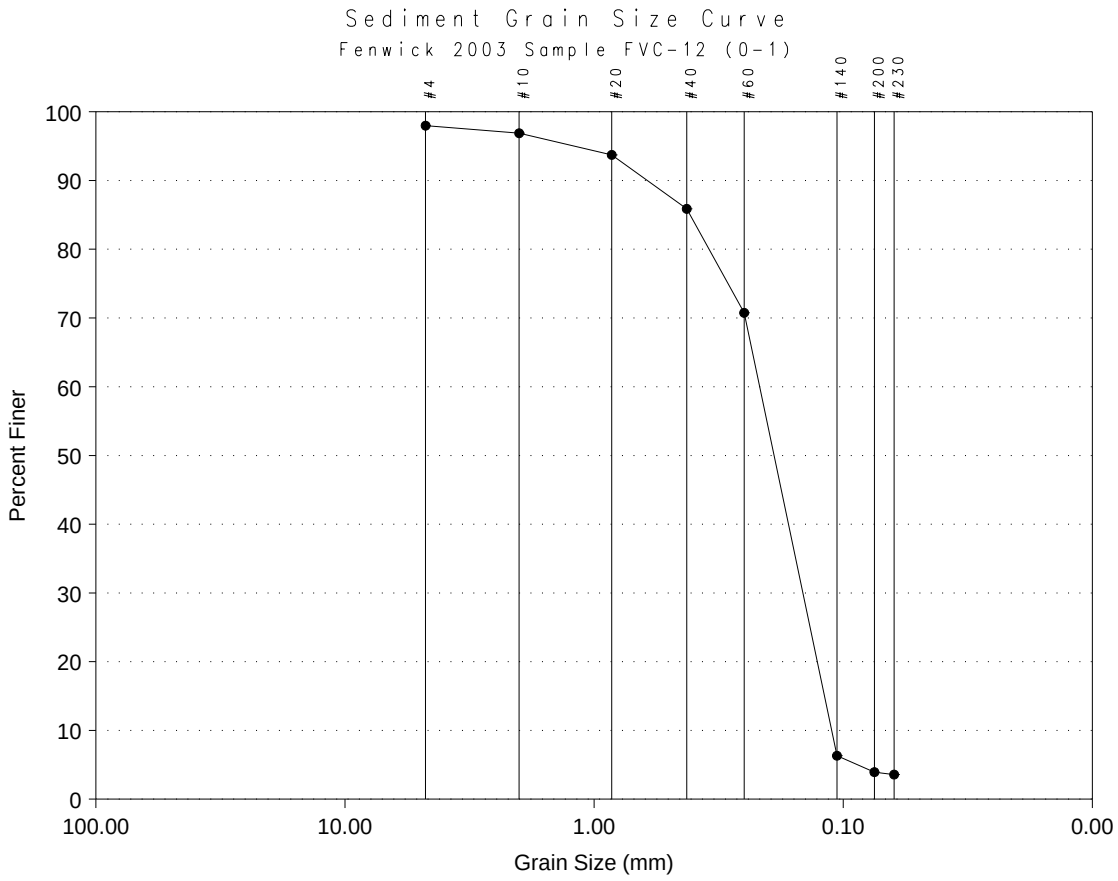
Sample composite of 1.0 – 4.3 ft.



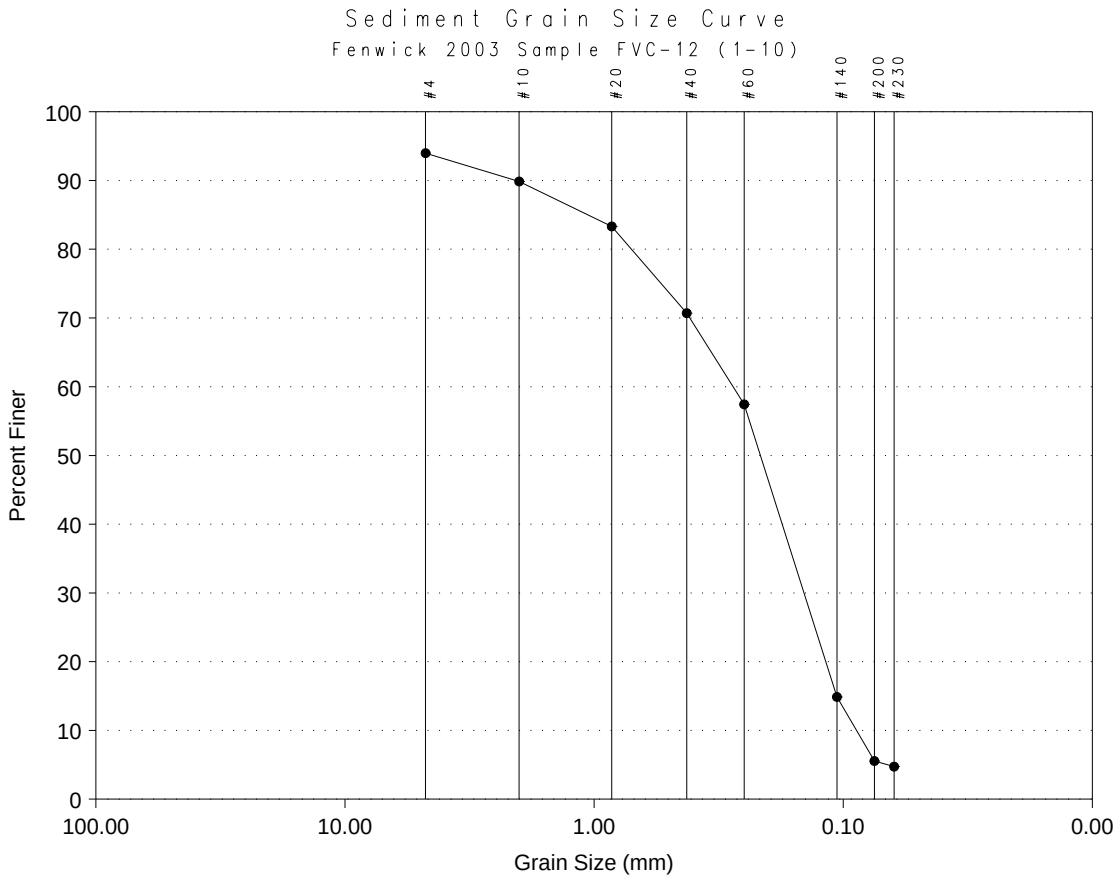
Sample composite of surface 0-1 ft.



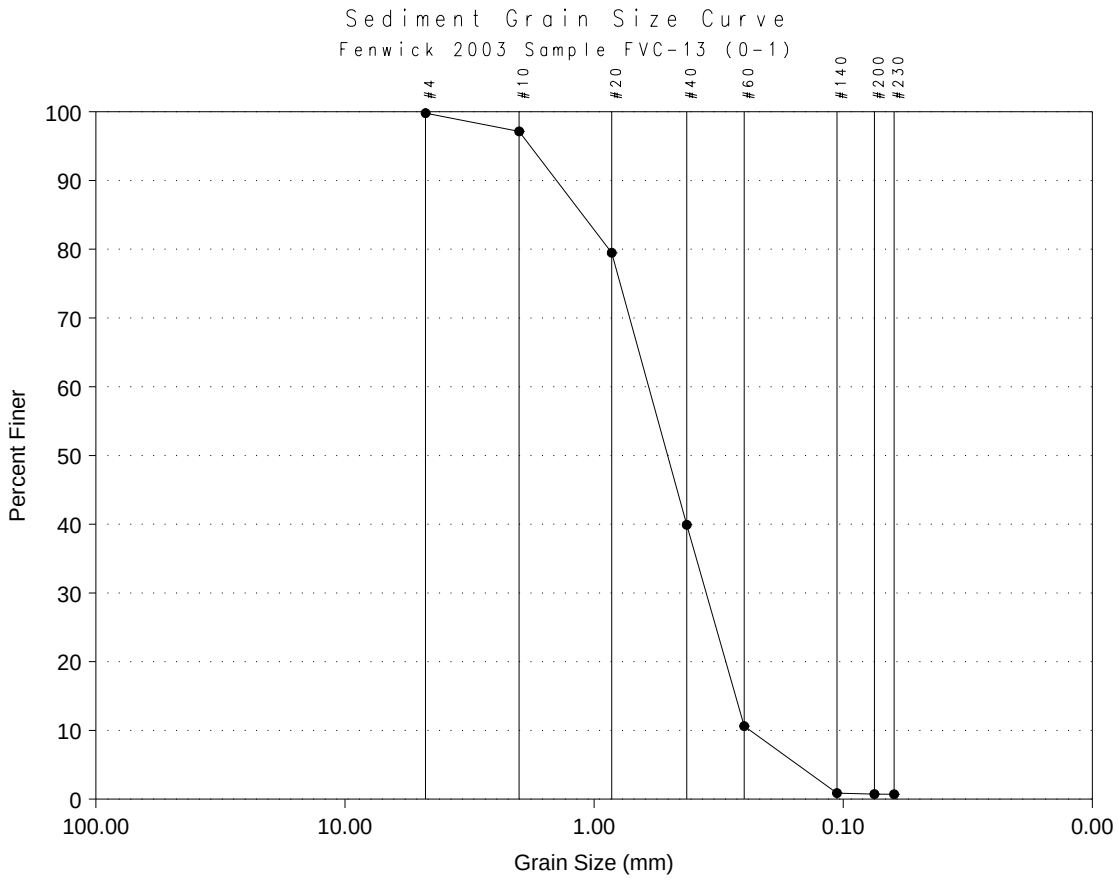
Sample composite of 1.0 – 4.5 ft.



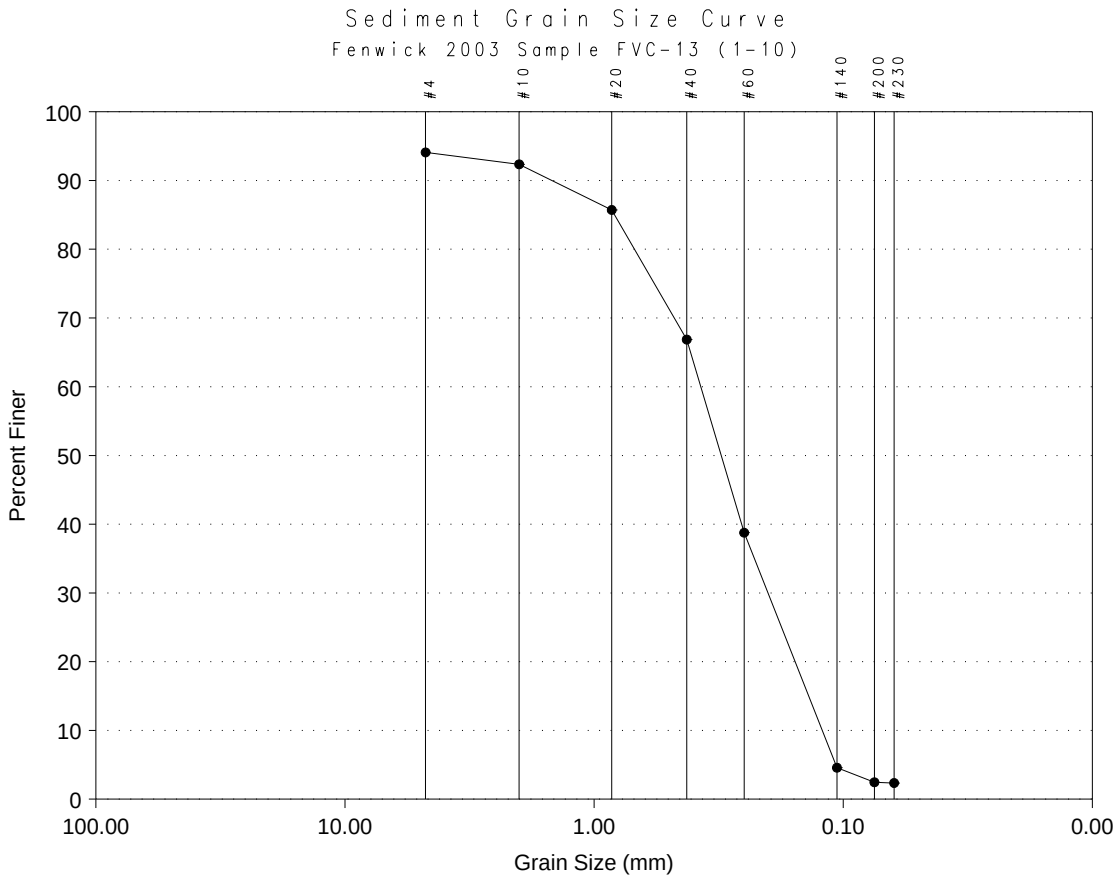
Sample composite of surface 0-1 ft.



Sample composite of 1.0 – 4.0 ft.



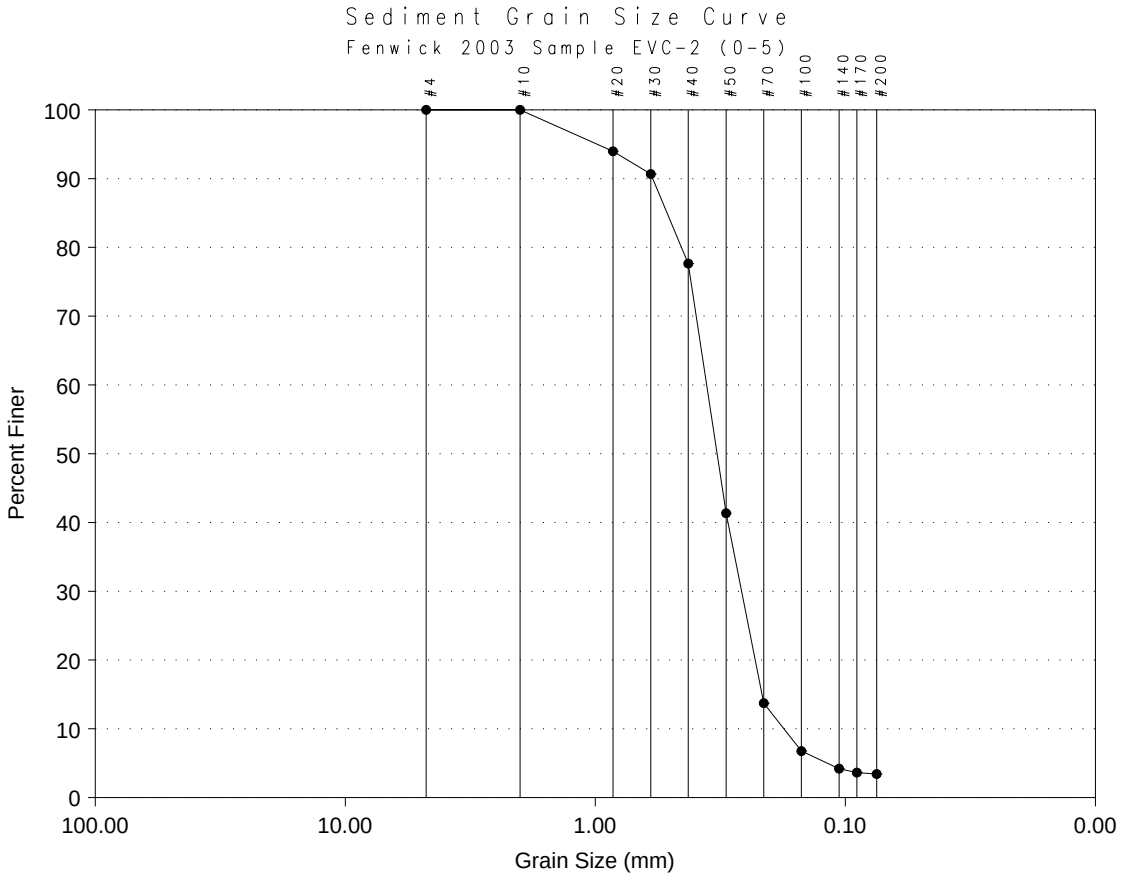
Sample composite of surface 0-1 ft.



Sample composite of 1.0 – 4.5 ft.

APPENDIX D

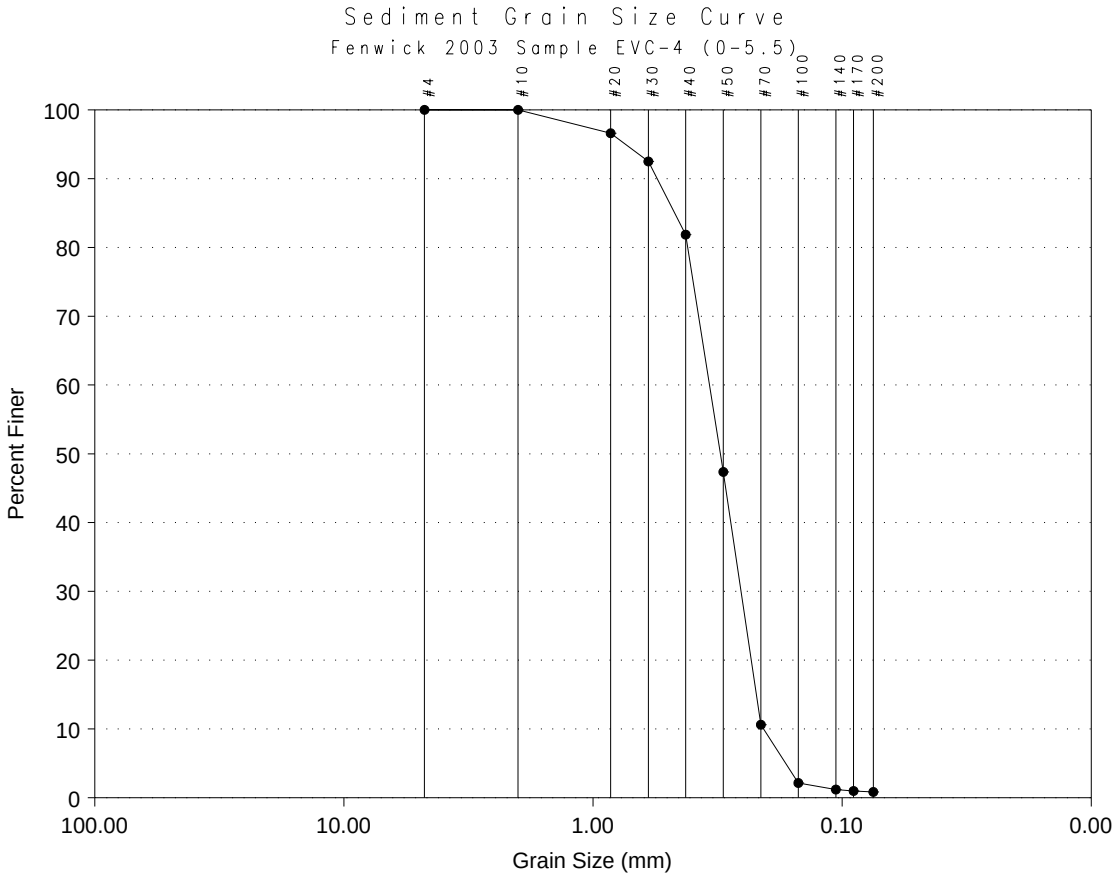
GRAIN SIZE GEOTECHNICAL SAMPLES



SIEVE NO.	SIEVE SIZE (MM)	Percent
4	4.75	100.00
10	2	100.00
20	0.85	93.97
30	0.6	90.66
40	0.425	77.65
50	0.3	41.35
70	0.212	13.73
100	0.15	6.76
140	0.106	4.20
170	0.09	3.64
200	0.075	3.42

GRAIN SIZE	
D60	0.497
D30	0.215
D10	0.123

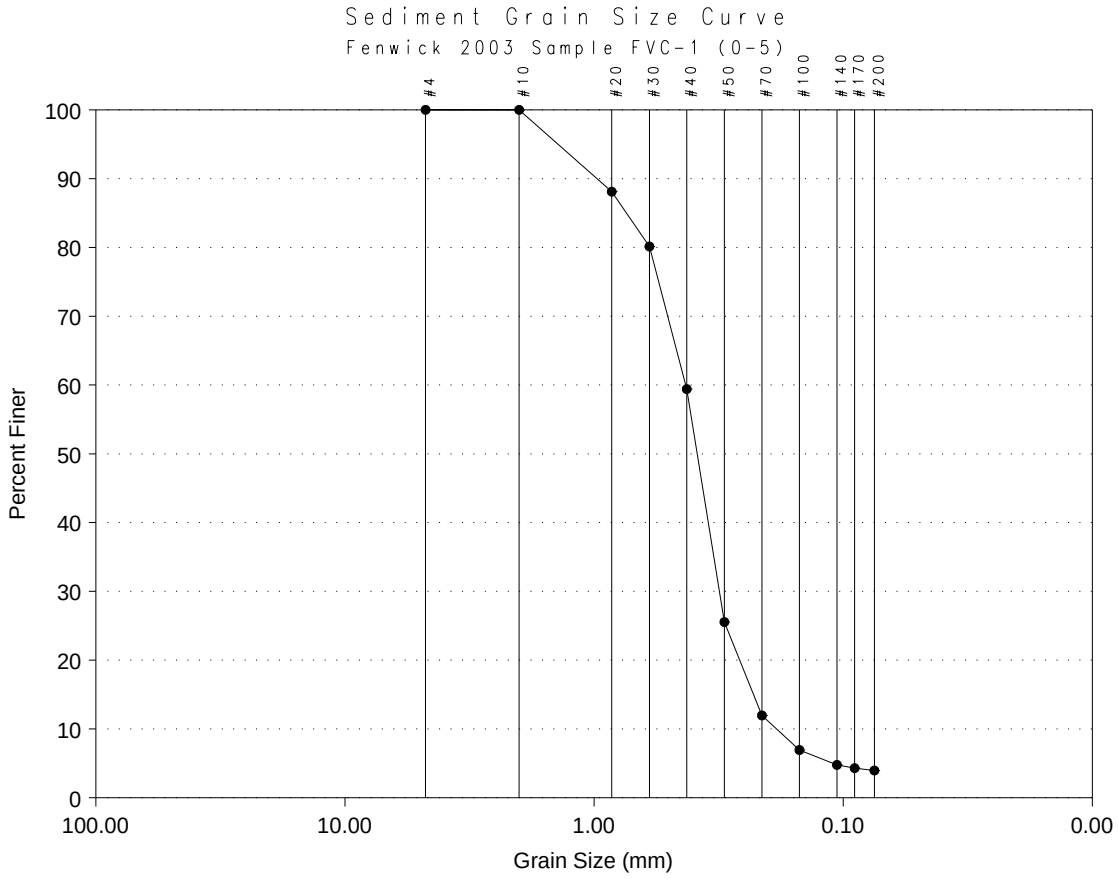
COEFFICIENTS	
CC =	0.757
CU =	4.035
POORLY GRADED SANDS	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	96.60
30	0.6	92.50
40	0.425	81.85
50	0.3	47.36
70	0.212	10.61
100	0.15	2.14
140	0.106	1.19
170	0.09	0.98
200	0.075	0.83

GRAIN SIZE	
D60	0.490
D30	0.223
D10	0.132

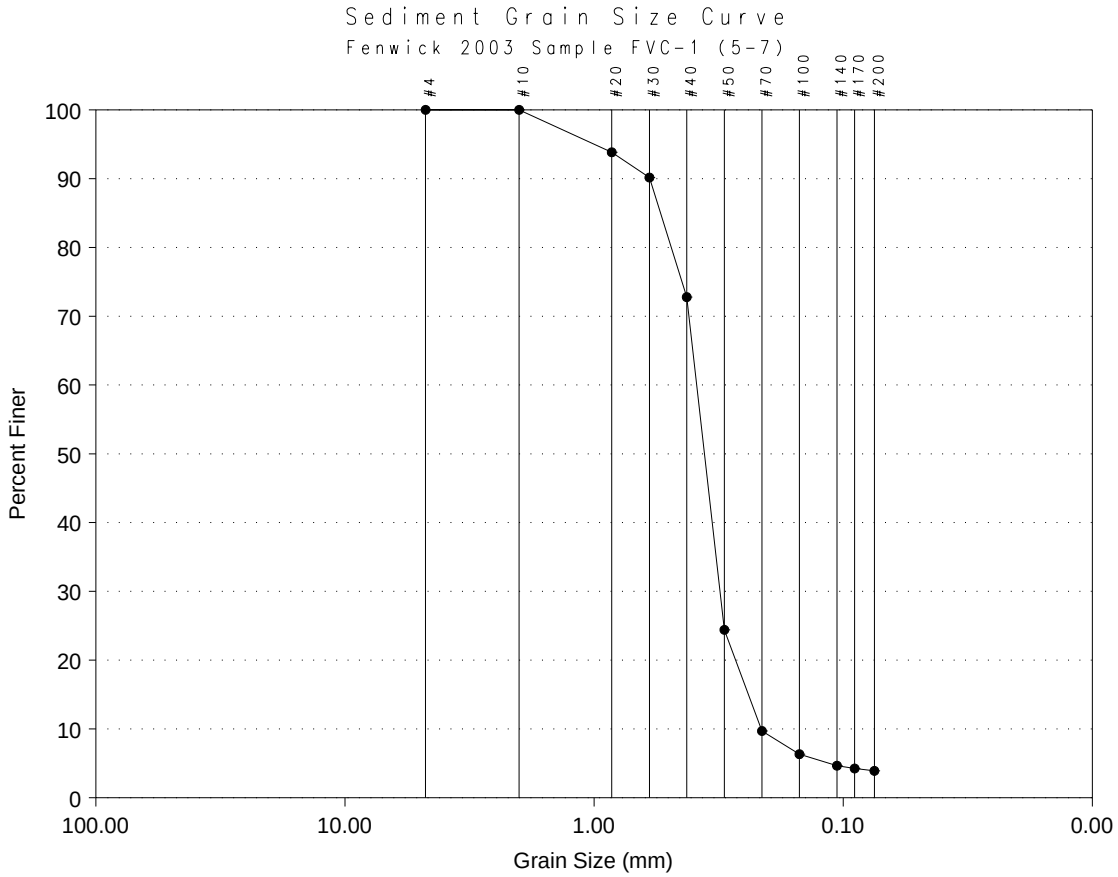
COEFFICIENTS	
CC =	0.770
CU =	3.706
POORLY GRADED SANDS	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	88.10
30	0.6	80.14
40	0.425	59.40
50	0.3	25.55
70	0.212	11.96
100	0.15	6.94
140	0.106	4.77
170	0.09	4.30
200	0.075	3.96

GRAIN SIZE	
D60	0.585
D30	0.237
D10	0.130

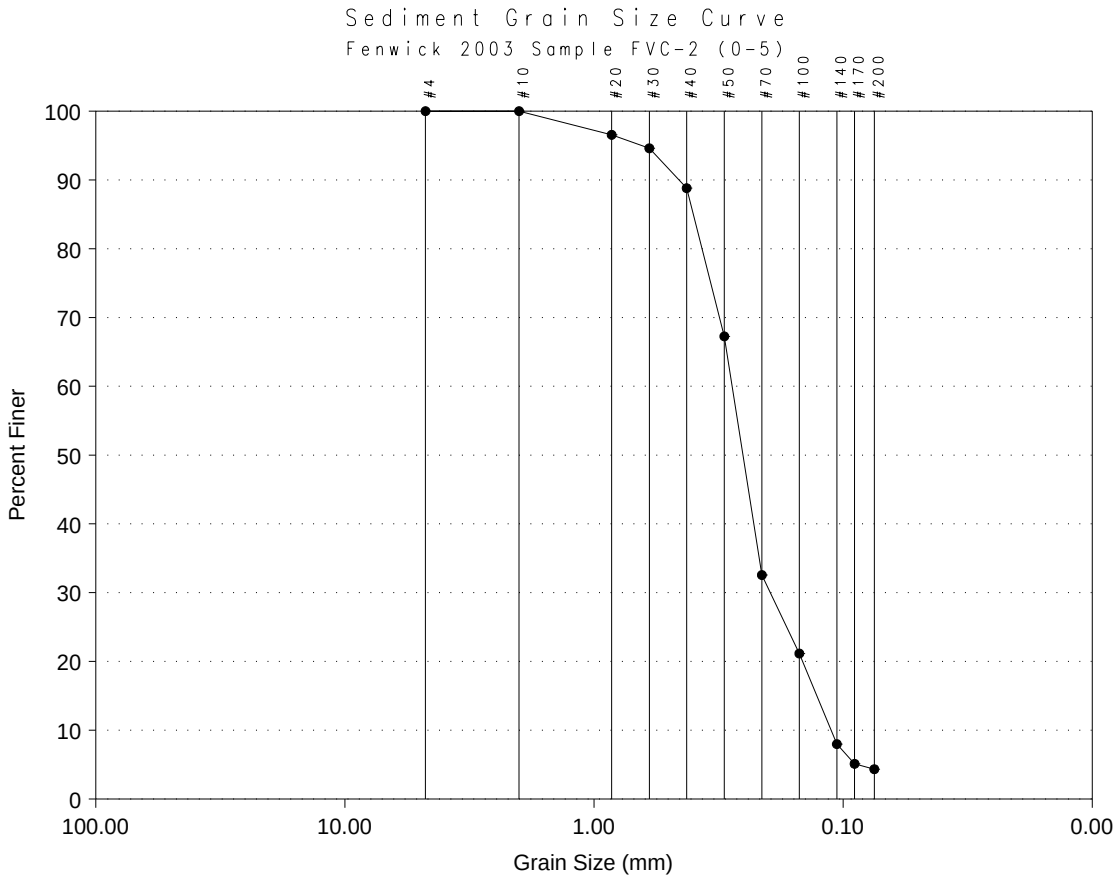
COEFFICIENTS	
CC =	0.740
CU =	4.504
POORLY GRADED SANDS	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	93.83
30	0.6	90.16
40	0.425	72.77
50	0.3	24.41
70	0.212	9.70
100	0.15	6.33
140	0.106	4.66
170	0.09	4.25
200	0.075	3.90

GRAIN SIZE	
D60	0.527
D30	0.231
D10	0.133

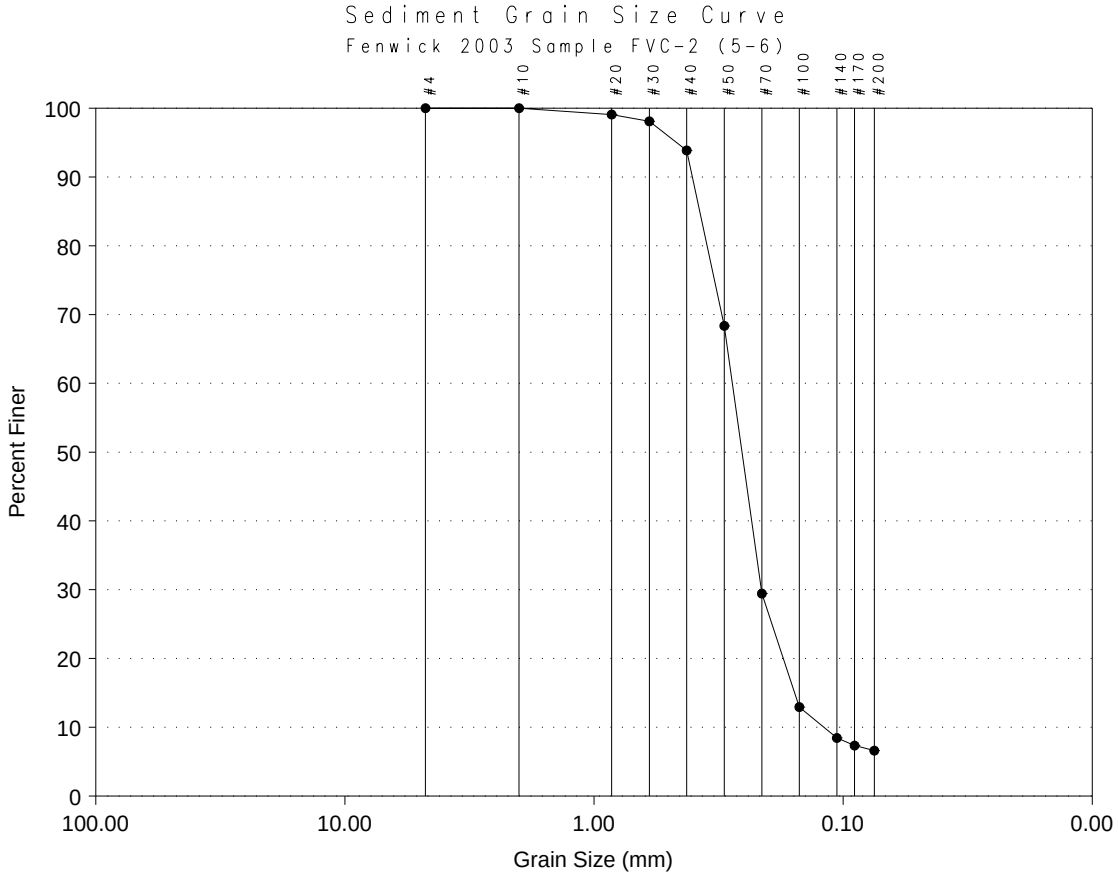
COEFFICIENTS	
CC =	0.760
CU =	3.955
POORLY GRADED SANDS	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	96.55
30	0.6	94.60
40	0.425	88.80
50	0.3	67.26
70	0.212	32.56
100	0.15	21.15
140	0.106	7.98
170	0.09	5.11
200	0.075	4.33

GRAIN SIZE	
D60	0.403
D30	0.171
D10	0.097

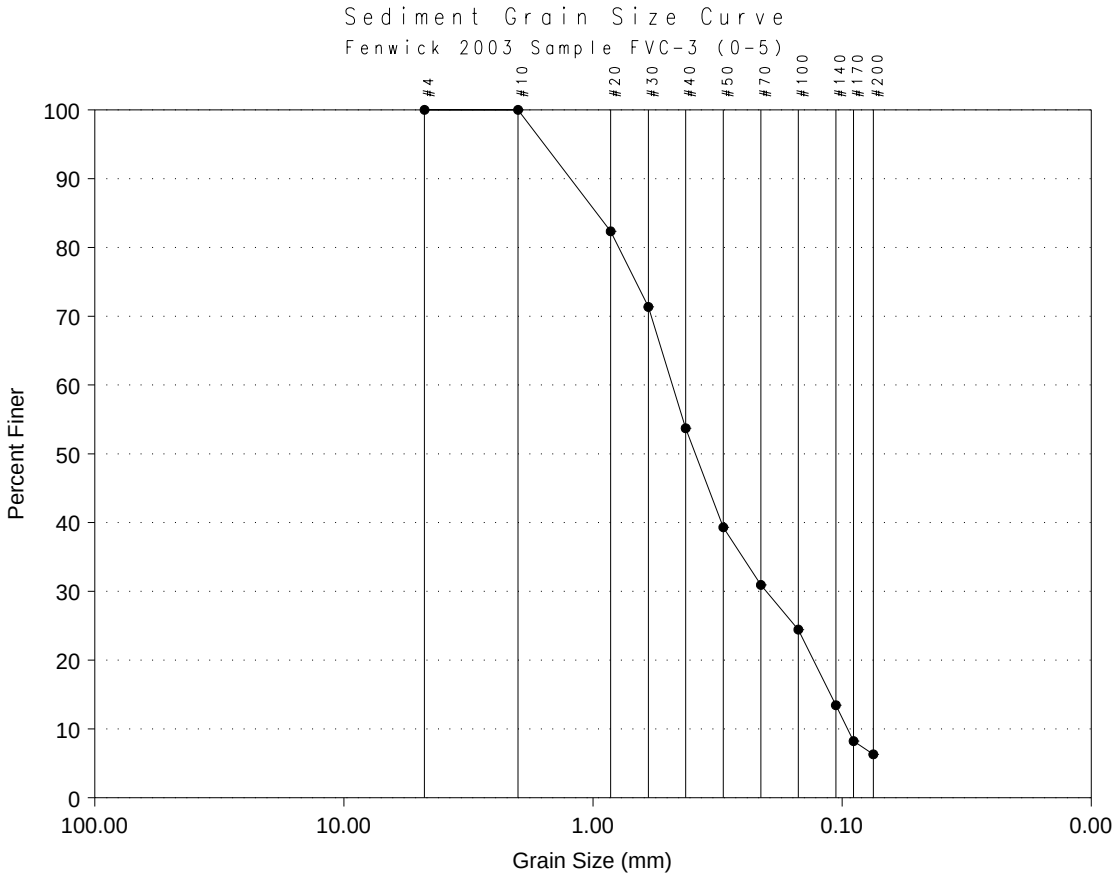
COEFFICIENTS	
CC =	0.752
CU =	4.158
POORLY GRADED SANDS	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	99.08
30	0.6	98.08
40	0.425	93.86
50	0.3	68.35
70	0.212	29.43
100	0.15	12.94
140	0.106	8.44
170	0.09	7.34
200	0.075	6.60

GRAIN SIZE	
D60	0.397
D30	0.176
D10	0.102

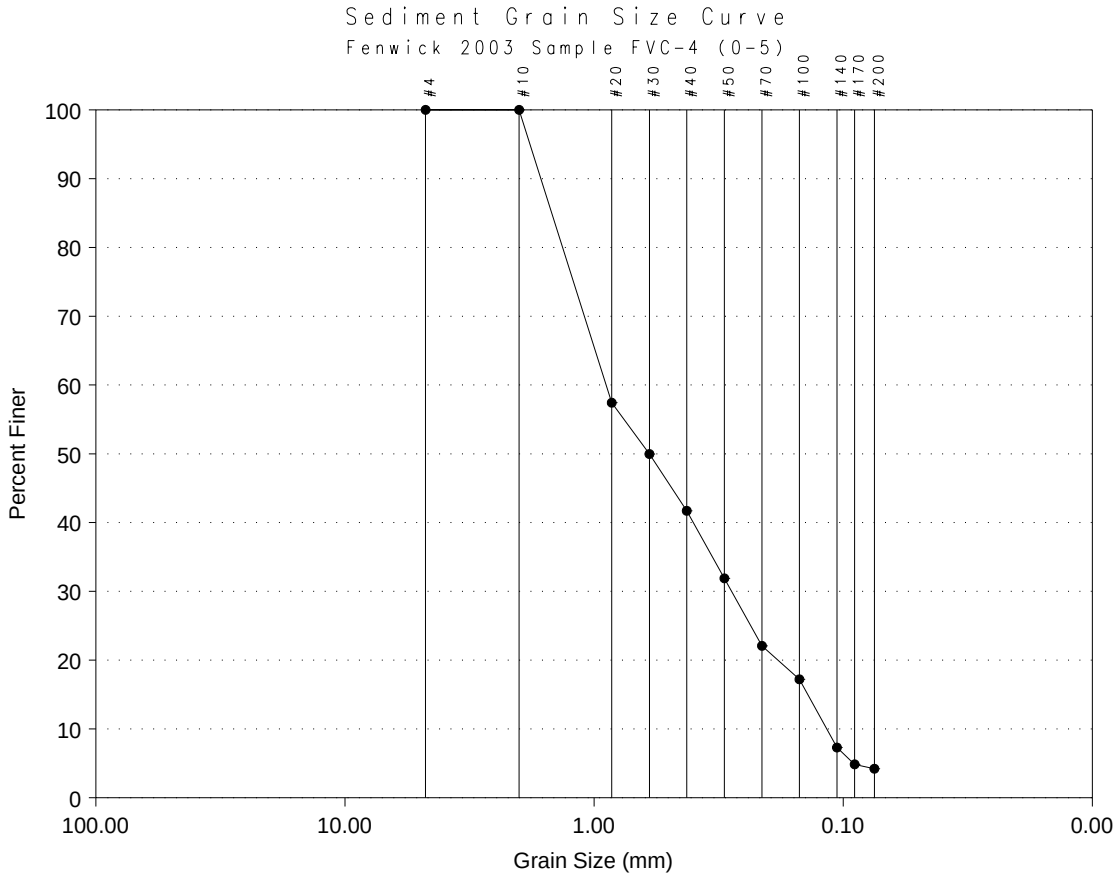
COEFFICIENTS	
CC =	0.763
CU =	3.877
POORLY GRADED SANDS WITH SILT	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	82.34
30	0.6	71.35
40	0.425	53.71
50	0.3	39.31
70	0.212	30.93
100	0.15	24.44
140	0.106	13.45
170	0.09	8.23
200	0.075	6.30

GRAIN SIZE	
D60	0.558
D30	0.187
D10	0.090

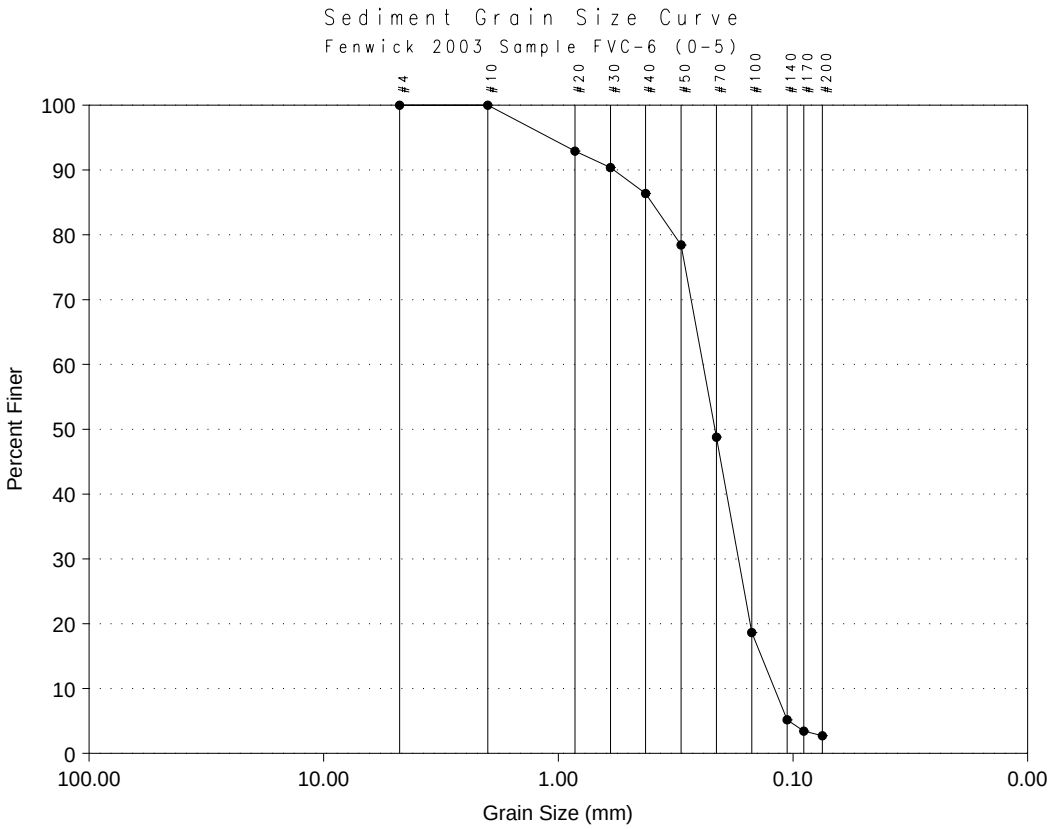
COEFFICIENTS	
CC =	0.694
CU =	6.203
POORLY GRADED SANDS WITH SILT	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	57.42
30	0.6	49.97
40	0.425	41.71
50	0.3	31.90
70	0.212	22.08
100	0.15	17.21
140	0.106	7.30
170	0.09	4.85
200	0.075	4.22

GRAIN SIZE	
D60	0.775
D30	0.252
D10	0.119

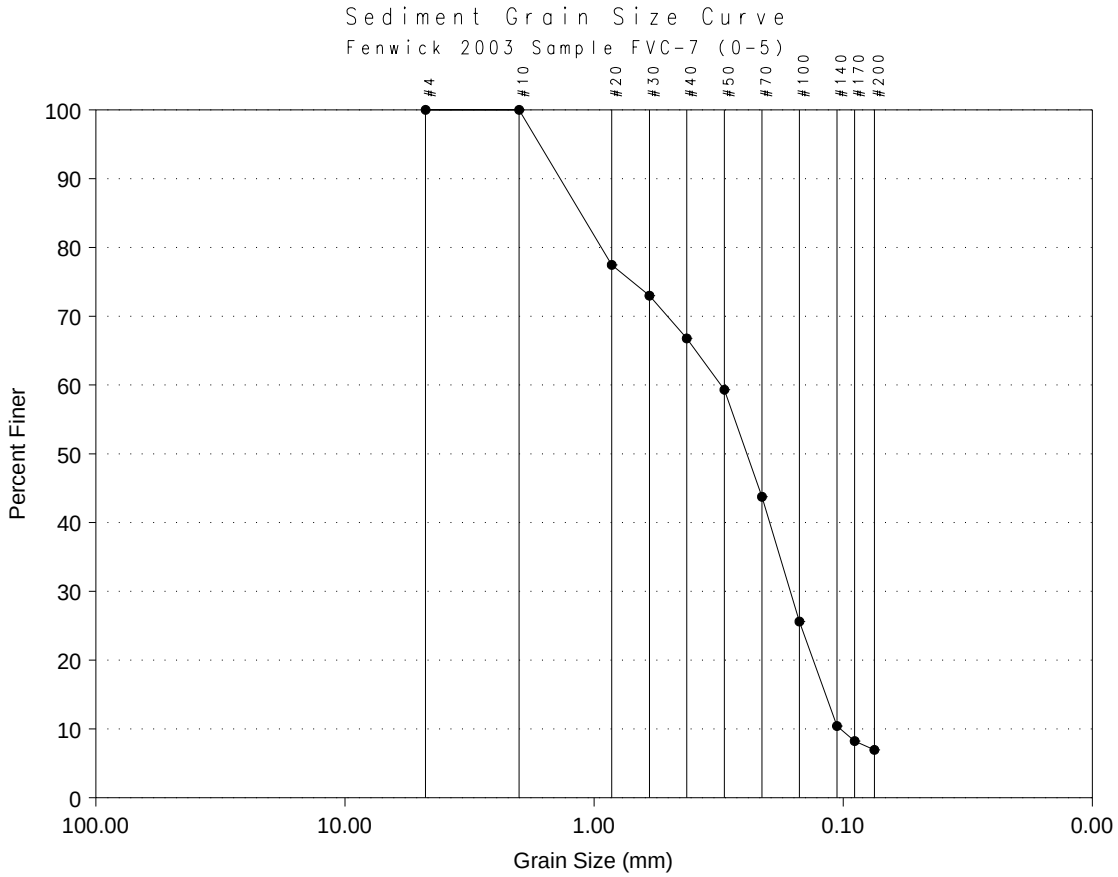
Coefficients	
CC =	0.687
CU =	6.521
POORLY GRADED SANDS	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	92.91
30	0.6	90.38
40	0.425	86.38
50	0.3	78.44
70	0.212	48.78
100	0.15	18.63
140	0.106	5.16
170	0.09	3.42
200	0.075	2.70

GRAIN SIZE	
D60	0.394
D30	0.169
D10	0.096

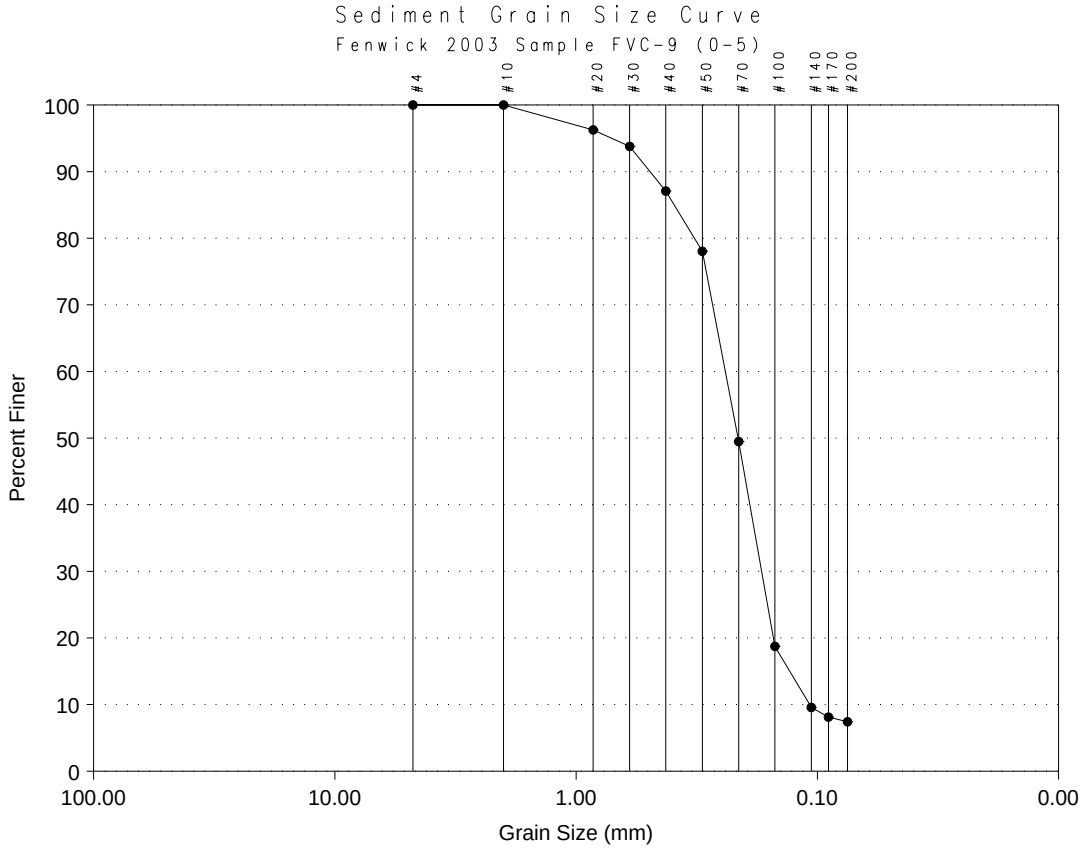
COEFFICIENTS	
CC =	0.754
CU =	4.116
POORLY GRADED SANDS	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	77.46
30	0.6	72.98
40	0.425	66.77
50	0.3	59.31
70	0.212	43.75
100	0.15	25.61
140	0.106	10.43
170	0.09	8.24
200	0.075	6.95

GRAIN SIZE	
D60	0.484
D30	0.163
D10	0.079

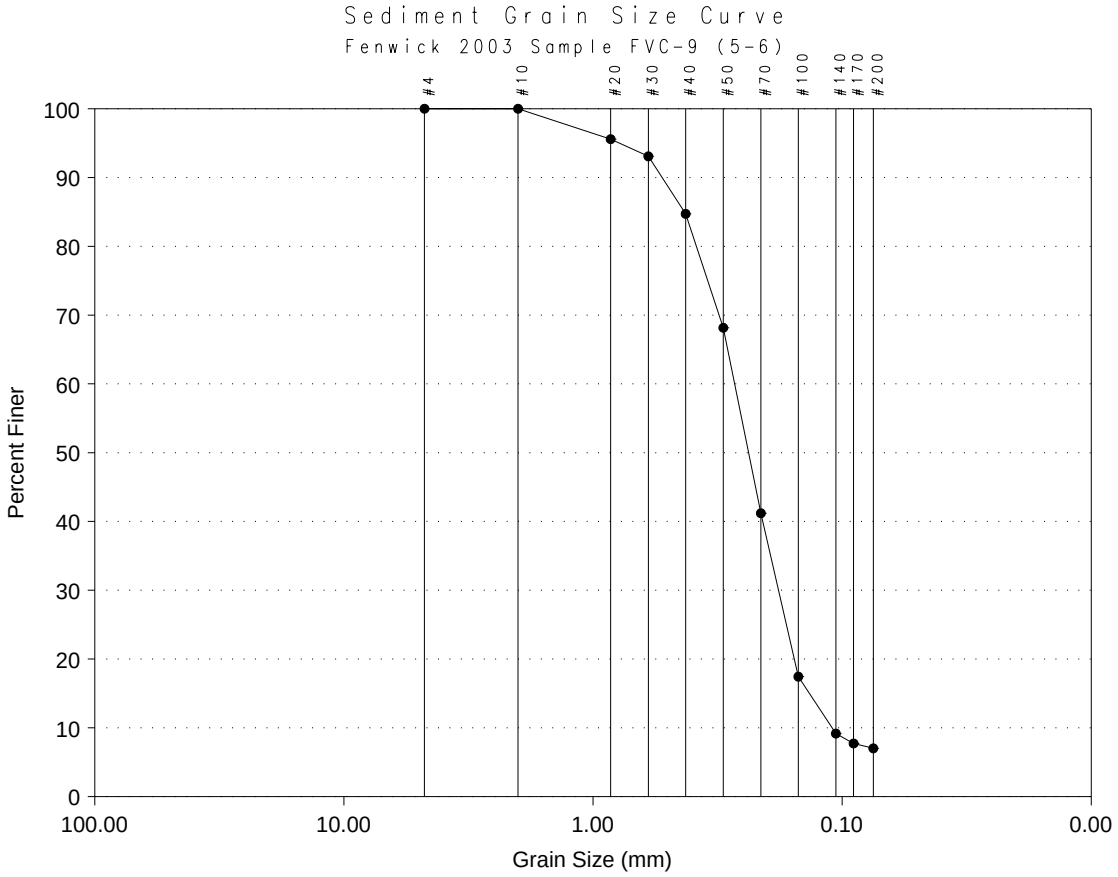
COEFFICIENTS	
CC =	0.696
CU =	6.110
POORLY GRADED SANDS WITH SILT	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	96.26
30	0.6	93.78
40	0.425	87.08
50	0.3	78.04
70	0.212	49.48
100	0.15	18.73
140	0.106	9.56
170	0.09	8.12
200	0.075	7.41

GRAIN SIZE	
D60	0.373
D30	0.156
D10	0.088

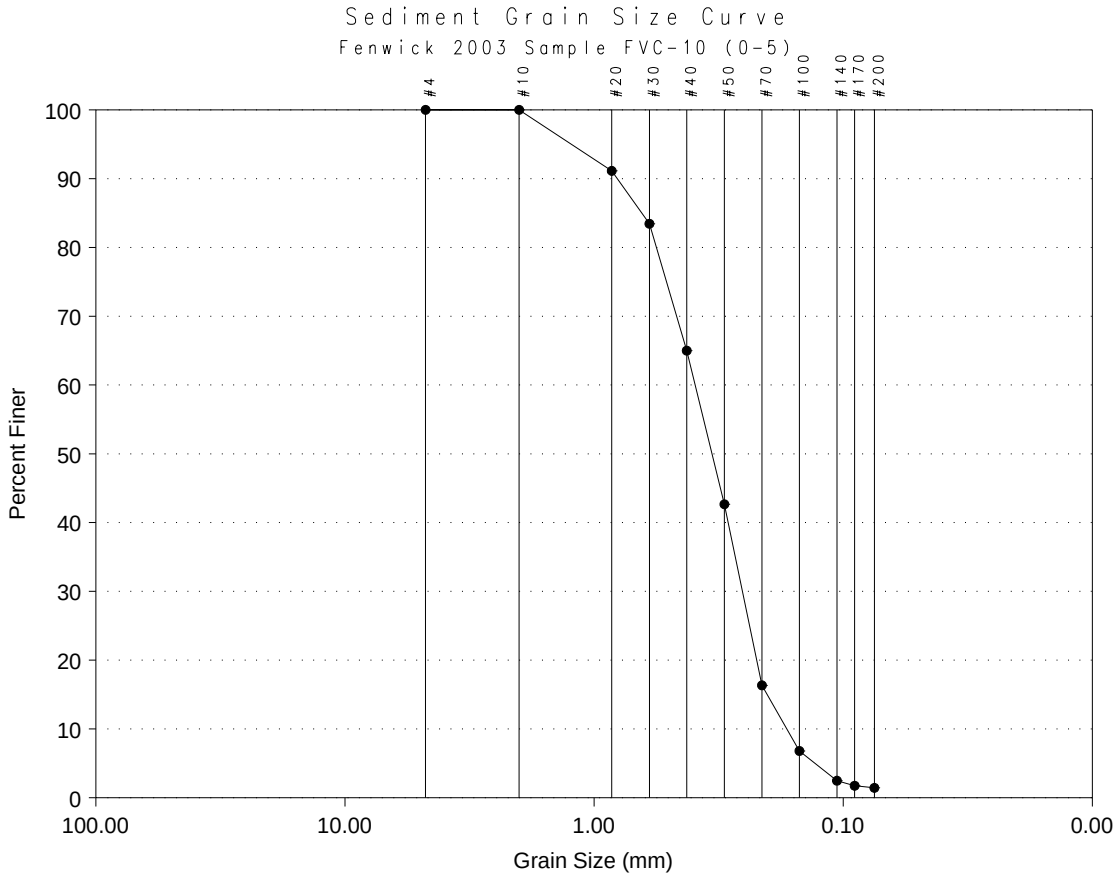
COEFFICIENTS	
CC =	0.748
CU =	4.263
POORLY GRADED SANDS WITH SILT	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	95.58
30	0.6	93.08
40	0.425	84.71
50	0.3	68.15
70	0.212	41.19
100	0.15	17.44
140	0.106	9.16
170	0.09	7.73
200	0.075	7.01

GRAIN SIZE	
D60	0.399
D30	0.164
D10	0.090

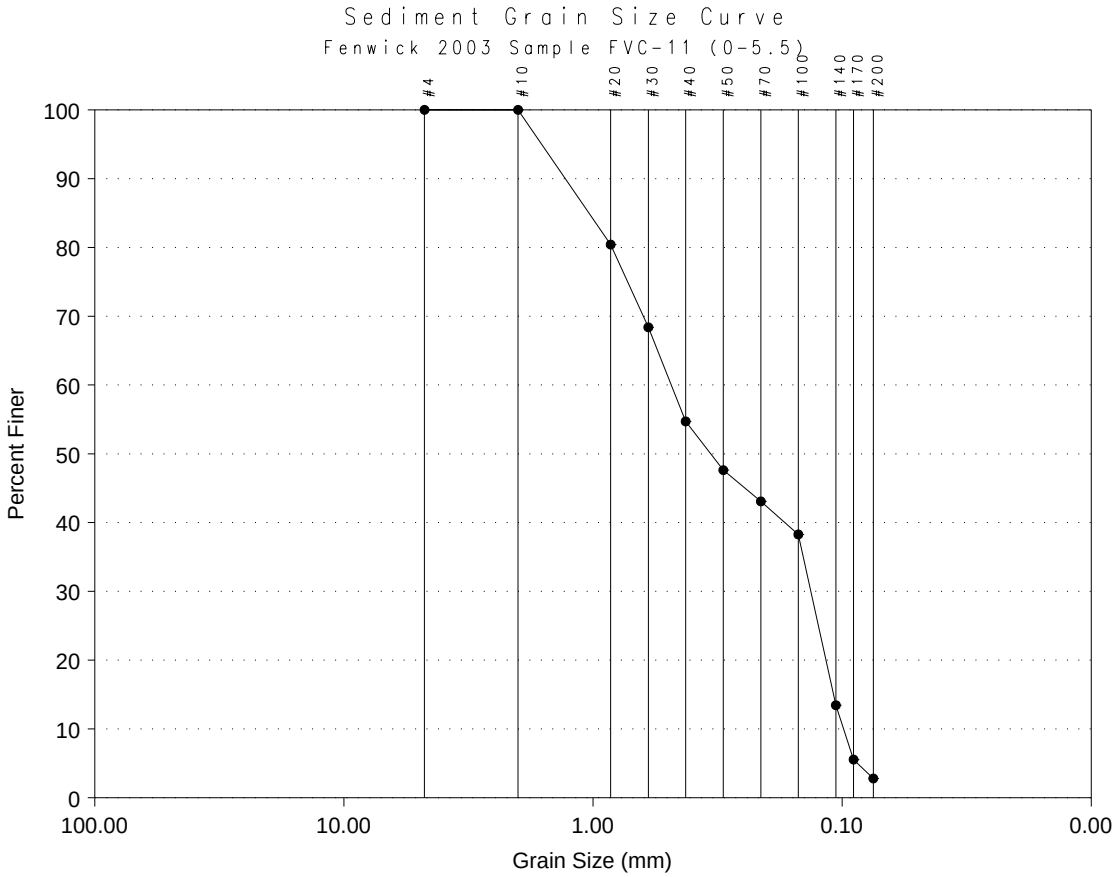
COEFFICIENTS	
CC =	0.743
CU =	4.415
POORLY GRADED SANDS WITH SILT	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	91.13
30	0.6	83.44
40	0.425	64.99
50	0.3	42.66
70	0.212	16.34
100	0.15	6.80
140	0.106	2.47
170	0.09	1.74
200	0.075	1.43

GRAIN SIZE	
D60	0.540
D30	0.223
D10	0.124

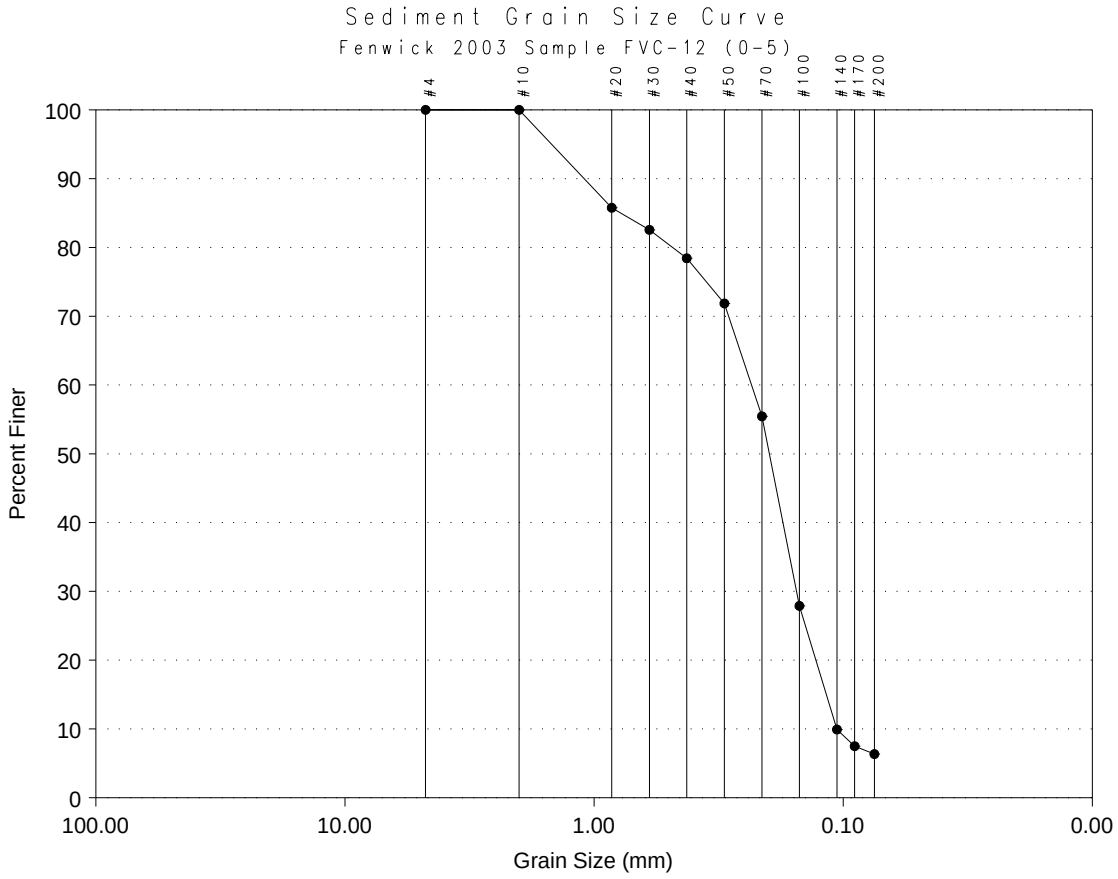
COEFFICIENTS	
CC =	0.745
CU =	4.371
POORLY GRADED SANDS	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	80.42
30	0.6	68.39
40	0.425	54.71
50	0.3	47.62
70	0.212	43.08
100	0.15	38.27
140	0.106	13.45
170	0.09	5.55
200	0.075	2.80

GRAIN SIZE	
D60	0.517
D30	0.170
D10	0.081

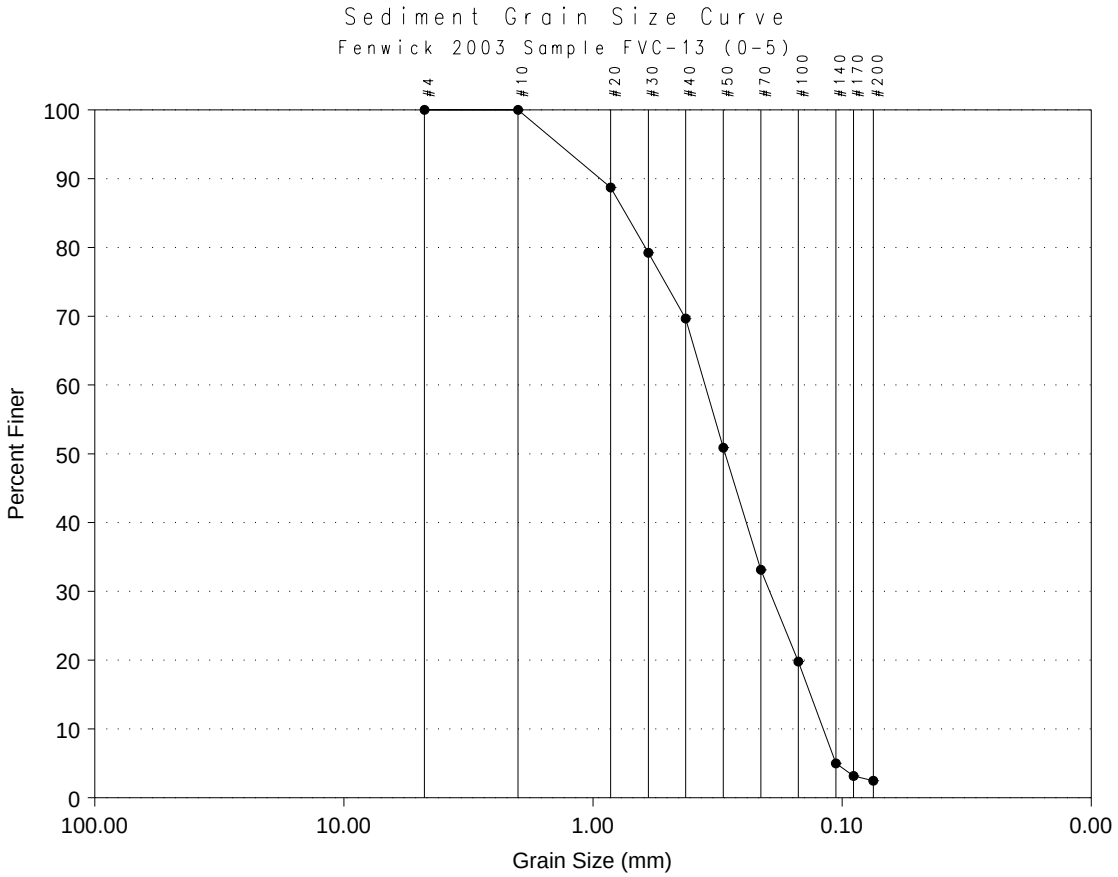
COEFFICIENTS	
CC =	0.690
CU =	6.392
POORLY GRADED SANDS	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	85.77
30	0.6	82.55
40	0.425	78.43
50	0.3	71.85
70	0.212	55.44
100	0.15	27.88
140	0.106	9.92
170	0.09	7.49
200	0.075	6.34

GRAIN SIZE	
D60	0.402
D30	0.151
D10	0.078

COEFFICIENTS	
CC =	0.721
CU =	5.129
POORLY GRADED SANDS WITH SILT	



SIEVE NO.	SIEVE SIZE (MM)	PERCENT
4	4.75	100.00
10	2	100.00
20	0.85	88.71
30	0.6	79.22
40	0.425	69.66
50	0.3	50.88
70	0.212	33.14
100	0.15	19.79
140	0.106	4.99
170	0.09	3.16
200	0.075	2.46

GRAIN SIZE	
D60	0.498
D30	0.189
D10	0.099

COEFFICIENTS	
CC =	0.725
CU =	5.003
POORLY GRADED SANDS	

APPENDIX E

FIELD DATA SHEETS

USACE - Fenwick Island
Sediment Coring Project

Sample #: EVC-1

Core #'s 1

Date: February 11, 2004

Tide: Flood

Start Time: 9:15

Weather: Sunny but cold
little wind but shifting

Composite Time: ____:____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	10:00	50ft			8ft		2 1/2ft	
2	11:30						3ft.	

Depths measured in feet

Comments\ Descriptions: (8 ft. cores)

Retrying first station - not enough seal fine sand
Nothing second try - try again
third try hook weights off - equipment prob

USACE - Fenwick Island
Sediment Coring Project

Sample #: EVC-2

Core #'s 2

Date: February 12, 2004

Tide: _____

Start Time: 11 : 52

Weather: Sunny

Composite Time: ____ : ____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	12:00	47					5ft.	
	:							

Depths measured in feet

Comments\ Descriptions: (8 ft. cores)

USACE - Fenwick Island
Sediment Coring Project

Sample #: EVC-3

Core #'s 5

Date: February 11 , 2004

Tide: _____

Start Time: 14 : 17

Weather: Sunny

Composite Time: ____ : ____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	14 : 20	41,5					2	
	:							

Depths measured in feet

Comments\ Descriptions:

(8 ft. cores)

Versar INC.

USACE - Fenwick Island
Sediment Coring Project

Sample #: EVC-4

Core #'s 3

Date: February 11 , 2004

Tide: _____

Start Time: 12:24

Weather: Sunny

Composite Time: ____:____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	12:30	43.6						
2	13:20						5'1/2ft.	

Depths measured in feet

(8 ft. cores)

Comments\ Descriptions:

Willy words get what you can
plastic shot up barrel try again
only about 3 tries

Versar INC.

USACE - Fenwick Island
Sediment Coring Project

Sample #: EVC-5

Core #'s 4

Date: February 11 , 2004

Tide: _____

Start Time: 13 23

Weather: Sunny

Composite Time: ____:____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	13:30	36					2 1/2	
2	14:50	32						

Depths measured in feet

(8 ft. cores)

Comments\ Descriptions:

Nothing 1st try
2nd got it

Versar INC.

1257 HT

USACE - Fenwick Island
Sediment Coring Project

Sample #: FVC-1

Date: February 12, 2004

Start Time: 11 : 36

Composite Time: ____ : ____

Core #'s 15

Tide: ~~High~~ Flood

Weather: Cloudy

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	11 : 40	41	38 28. 263	75 01. 8 72			7Ft.	
	:							

Depths measured in feet

(8 ft. cores)

Comments\ Descriptions:

Versar INC.

USACE - Fenwick Island
Sediment Coring Project

Sample #: FVC-2

Core #'s 14

Date: February 12, 2004

Tide: Flood

Start Time: 11 : 13

Weather: _____

Composite Time: ____:____

_____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	11:20	39	38 28.019	75 01 699			6	
	:							

Depths measured in feet

Comments\ Descriptions: (8 ft. cores)

right on the dot.

Versar INC.

USACE - Fenwick Island
Sediment Coring Project

Sample #: FVC-3

Core #'s 13

Date: February 12, 2004

Tide: _____

Start Time: 10 : 49

Weather: _____

Composite Time: ____ : ____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	11 : 00	38	38° 27.775	75° 01.842			5ft.	
	:							

Depths measured in feet

(8 ft. cores)

Comments\ Descriptions:

_____

_____

_____

Versar INC.

USACE - Fenwick Island
Sediment Coring Project

Sample #: FVC-4

Core #'s 12

Date: February 12, 2004

Tide: _____

Start Time: 10 :21

Weather: _____

Composite Time: ____:____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	10:30	38	3827.678	7501.543			5ft.	
	:							

Depths measured in feet

Comments\ Descriptions:

(8 ft. cores)

Versar INC.

USACE - Fenwick Island
Sediment Coring Project

Sample #: FVC-5

Core #'s 11

Date: February 12, 2004

Tide: _____

Start Time: 9 : 54

Weather: _____

Composite Time: ____ : ____

_____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	10:00	39	38° 27.634	75° 01.131			4/7	
	:							

Depths measured in feet

Comments\ Descriptions:

(8 ft. cores)

_____

_____

_____

Versar INC.

USACE - Fenwick Island
Sediment Coring Project

Sample #: FVC-6

Core #'s 10

Date: February 12, 2004

Tide: _____

Start Time: 9 : 20

Weather: _____

Composite Time: ____ : ____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	9:30	48	38 27.392	75 00.493			5ft.	
	:							

Depths measured in feet

(8 ft. cores)

Comments\ Descriptions:

try again 1st one only a foot and a half

Versar INC.

USACE - Fenwick Island
Sediment Coring Project

Sample #: FVC-7

Core #'s 9

Date: February 12, 2004

Tide: _____

Start Time: 8 : 58

Weather: Cloudy

Composite Time: ____ : ____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	9 : 05	49	39 27 262	75 00.307			~~4ft.~~	
	:						5.3	

Depths measured in feet

Comments\ Descriptions:

(8 ft. cores)

Versar INC.

USACE - Fenwick Island
Sediment Coring Project

Sample #: FVC-8

Core #'s 8

Date: February 12, 2004

Tide: _____

Start Time: 8 :39

Weather: Cloudy

Composite Time: ____:____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	8 :45	45	38.27.199	75.00.037			3.5ft	
	:							

Depths measured in feet

Comments\ Descriptions:

(8 ft. cores)

Versar INC.

USACE - Fenwick Island
Sediment Coring Project

Sample #: FVC-9

Core #'s 16

Date: February 12, 2004

Tide: _____

Start Time: 12:04

Weather: Cloudy

Composite Time: ____:____

a little windy but beautiful

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	12:15	41.5	3829575	7501 774			6.5	
	:							

Depths measured in feet

(8 ft. cores)

Comments\ Descriptions:

getting good at this

Versar INC.

USACE - Fenwick Island
Sediment Coring Project

Sample #: FK-10

Core #'s 17

Date: February 12, 2004

Tide: _____

Start Time: 12 : 24

Weather: _____

Composite Time: ____ : ____

_____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	12:30	40	38 28.545	75 09.926			5.5	
	:							

Depths measured in feet

Comments\ Descriptions: (8 ft. cores)

_____

_____

_____

Versar INC.

12/10

USACE - Fenwick Island
Sediment Coring Project

Sample #: FVC-11

Core #'s 18

Date: February 12, 2004

Tide: High Slack

Start Time: 12:46

Weather:

Composite Time: :

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	12:55	49.6	38 29.429	75 02.309			5.5	
	:							

Depths measured in feet

Comments\ Descriptions:

(8 ft. cores)

Versar INC.

USACE - Fenwick Island
Sediment Coring Project

Sample #: FVC-12

Core #'s 6

Date: February , 2004

Tide:

Start Time: 14 : 54

Weather: Sunny

Composite Time: ____:____

Core #	Time	Station Depth	Latitude	Longitude	Target Depth	Pen. Depth	Core Depth	Comments
1	15:00	24.6	39°20.250	74°59.337			5ft	
	:							

Depths measured in feet

Comments\ Descriptions: (8 ft. cores)

may have been on shoal want to avoid shoal
moving boat
drifting

Versar INC.

BASELINE BIOLOGICAL MONITORING OF TWO OFFSHORE SAND SOURCES ALONG THE DELAWARE ATLANTIC COAST (FENWICK ISLAND BORROW AREA AND AREA E)

Prepared for

U.S. Army Corps of Engineers
Philadelphia District
100 Penn Square East
Philadelphia, PA 19107

Prepared by

Lisa C. Scott and William H. Burton
Versar, Inc.
9200 Rumsey Road
Columbia, MD 21045

Contract No. DACW61-00-D-0009
Delivery Order No. 00046

Prepared Under the Supervision of

_____

William H. Burton
Principal Investigator

May 2005

FOREWORD

This report entitled “Baseline Biological Monitoring of Two Offshore Sand Sources Along the Delaware Atlantic Coast (Fenwick Island Borrow Area and Area E)” was prepared by Versar, Inc., for Mr. Steve Allen, Environmental Resources Branch, U.S. Army Corps of Engineers, Philadelphia District, under Contract No. DACW61-00-D-0009, Delivery Order No. 48.

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers, Philadelphia District (USACE) is conducting baseline biological investigations of two offshore sand source areas located along the southern Delaware Atlantic Coast that are proposed for use in two Federal beach replenishment projects. The two sand source areas, known as the "Fenwick Island Borrow Area" and "Area E", are intended to be used to restore the berm and dunes along the shoreline communities of Fenwick Island and Bethany Beach/South Bethany, respectively. Information collected as part of these borrow area evaluations can be used to develop dredging operation plans that will limit impacts to living resources within the area. The current study continues to expand and enhance the information known about the living resource communities living within the two proposed borrow areas. Water quality, fisheries resource, and benthic macroinvertebrate community data were collected to evaluate potential impacts from dredging operations and provide the information needed to continue to refine dredging plans to limit impacts.

Within Area E and the Fenwick Island Borrow Area, the fisheries study was conducted in all seasons (summer 2003 to spring 2004) using three different gears to sample all adult, juvenile, and pelagic species. Fish and mobile epi-benthic invertebrate communities were monitored at both sites and the data were used to assess the effects of a 10-foot deep 43-acre pit created in Area E. Replicate samples with a 25-foot trawl, an 80-foot commercial trawl, and experimental gillnets were taken in and around the pit and in the undisturbed Fenwick Island Borrow Area. Analysis of variance testing using standardized catch, number of species, and diversity indices indicated that no statistically significant differences in the fish community composition and abundance existed between the borrow site impacted by the sand mining (Area E) and the reference borrow area (Fenwick Island Borrow Area). Differences in fisheries resources within the pit and Area E in general, did not appear different from the resources of the Fenwick Island Borrow Area

Continuous water quality monitoring equipment was deployed in Area E in August 2004 to record parameters inside and outside the dredge pit. Water quality monitoring within Area E suggested that the creation of the pit changed water quality conditions in the bottom waters of the pit, particularly in regard to dissolved oxygen and chlorophyll concentrations. Both dissolved oxygen (DO) and chlorophyll concentrations in the bottom waters of the pit were less than outside the pit. Additionally, surface sediment samples collected along with the benthic samples suggested a higher amount of silt/clay content within the pit compared to outside the pit. Both the lower DO and higher amounts of silt/clay suggest that circulation patterns within the pit may be different than outside the pit allowing for a sediment sink for silt/clay particles.

A benthic video sled was towed along track lines within both potential borrow areas to characterize the bottom habitat types. Benthic community resources were sampled in Area E to determine if the creation of the dredge pit caused a shift in the benthic assemblage. Benthic resources were sampled at stations within the Fenwick Island Borrow Area based on the sediment habitat types identified from the video sled results. The benthic community within the pit was distinctly different from the one outside the pit. Differences appeared to be due mainly to an increase in two recognized tolerant species, *Nucula proxima* and *Acteocina canaliculata*.

Within the Fenwick Island Borrow Area, the benthic video sled identified three distinct sediment habitats, fine sand, coarse sand, and gravel habitat. Benthic sampling conducted within these three habitat types suggested that the benthic community is more vibrant and diverse in and near areas containing larger sediment particles such as gravel and pebbles. Differences between the fine and coarse habitats were minimal and of little ecological importance in terms of dredging impacts.

Information from both borrow areas can be used to design or improve dredging operation plans within potential sand borrow areas. Developing dredging plans for beach replenishment activities to limit the creation of dredge pits over at least 10 feet depth could reduce the chances of causing changes in benthic community, bottom sediment and water quality parameters detected in this study. However, since the fish community did not display an impact, the change in water quality and the benthic community observed in this study may have little impact on higher living resources. Limiting sand dredging to less of a depth change but spread out over a larger area, would cause immediate impacts to the benthic community over the larger dredged area, but the benthic community would be more likely to recover to pre-dredge conditions then if a deeper pit were created.

The combined use of video sled data and benthic sampling in this study provided a more detailed examination of a potential borrow area than either method alone. Data from the benthic sled can be used to map the sediment habitats within the borrow area so that dredging plans can be designed to avoid areas with large sediment particles if so desired.

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1.0 INTRODUCTION

The U.S. Army Corps of Engineers, Philadelphia District (USACE), is planning and constructing two beach replenishment projects along the southern Delaware Atlantic coastline for the communities of Fenwick Island and Bethany Beach/South Bethany, Delaware (USACE, 1998; USACE, 2000). These projects involve an initial placement of sand to restore the berm and dunes along the beaches to a predetermined height and width in order to minimize storm associated damages to these communities. The berms and dunes would be maintained through periodic nourishments done on a cyclical basis over a 50-year project life. The initial construction and periodic nourishments require the use of offshore borrow areas as sand sources. During the feasibility studies for these projects, two offshore sand borrow areas were identified offshore of each project area. The "Fenwick Island Borrow Area" (approximately 2,850 acres in size) was designated for the community of Fenwick Island, and "Area E" (approximately 775 acres in size) was designated for the communities of Bethany Beach and South Bethany (Figure 1-1).

A critical component of pre-construction studies is the evaluation of potential short- and long-term impacts on the living resources that would occur as a result of sand dredging in the designated borrow areas. Environmental concerns with sand dredging include the removal of existing communities and food resources and the potential disruption of commercial and recreational fisheries. Other possible effects of dredging include borrow area habitat modification, disruption of natural recruitment patterns of macroinvertebrate fauna, and changing the community mix from an older, established community with large, deep dwelling organisms to one with high abundances of small, surface dwelling, opportunist taxa.

A thorough evaluation of the living resources can provide USACE with the guidance necessary to select the most appropriate area from which to mine sand as a means of limiting impacts on living resource communities. As part of the current study, Area E and the Fenwick Island Borrow Area were investigated both biologically and chemically to identify the suitability of each site as a sand source for the beach replenishment project. Findings of the sediment chemistry analyses conducted within the two borrow areas were provided in (Versar 2004).

The purpose of this report was to summarize and present the baseline biological and water quality data collected from within the two borrow areas. Two separate biological studies were conducted to examine the living resources within the borrow areas. A finfish study and a benthic monitoring study were conducted within both Area E and the Fenwick Island Borrow Area. These studies will provide USACE with an inventory of recent biological data that can be used as baseline data to define any immediate or long-range impacts of dredging on the biota and its habitat. The data can be statistically compared to post-dredge data to assess the recovery of the habitat after a dredging event and can be used to establish future monitoring needs. In addition, Area E was previously sampled for benthic macroinvertebrates in December 1997 (Scott and Bruce 1998). Data obtained from that study were compared to the current benthic

data to assess temporal and spatial differences in the benthic community to further assist in quantifying dredging impacts should they occur.

One of the environmental concerns regarding the mining of sand at offshore borrow sites for beach replenishment projects is whether the creation of ocean bottom pits could create localized pockets of poor water quality. Different water quality conditions could arise if the pit reduced bottom water circulation or if higher density ocean water settled into the pit creating a gradient that could inhibit the exchange of water within the pit into the upper water column. Ocean bottom pits could also create a sink trapping organic particles and other material that could result in a higher biological oxygen demand reducing dissolved oxygen levels within the bottom waters of the pit.

At Area E, an approximate 10-12 foot deep, 43-acre pit was created in the northwest corner during a beach replenishment operation conducted in August and September 1998 (Figure 1-1). The project was conducted by the state of Delaware where sand was hydraulically dredged from Area E and pumped via a pipeline to eroding beaches in Bethany Beach, South Bethany, Sea Colony, Middlesex Beach and Sussex Shores, Delaware. The creation of the 10-12 foot deep pit provided an opportunity to empirically measure whether water quality conditions within the bottom waters of the pit were different from ambient conditions outside the Area E pit. Habitat differences resulting from the pit creation could also impact living resources within the pit. For the current study, benthic and finfish samples were collected from within and near the pit and compared to samples outside the pit and a reference borrow area (Fenwick Island Borrow Area).

A benthic video sled investigation was also conducted in both Area E and the Fenwick Island Borrow Area to help quantify the physical habitat within both borrow areas. Data collected within and outside the Area E pit were compared to determine if physical and biological differences could be detected. Data collected from the Fenwick Island Borrow Area were evaluated to determine if different and distinct habitats existed within the borrow area. Benthic grab samples were collected from the distinct habitats and data evaluated to determine if a relationship exists between the physical habitat distinguished by the camera sled data and the natural benthic community existing within the areas. Use of benthic video sled data with ground truthing from benthic surveys could potentially increase the area scientifically examined yet keep costs manageable for future borrow area investigations.

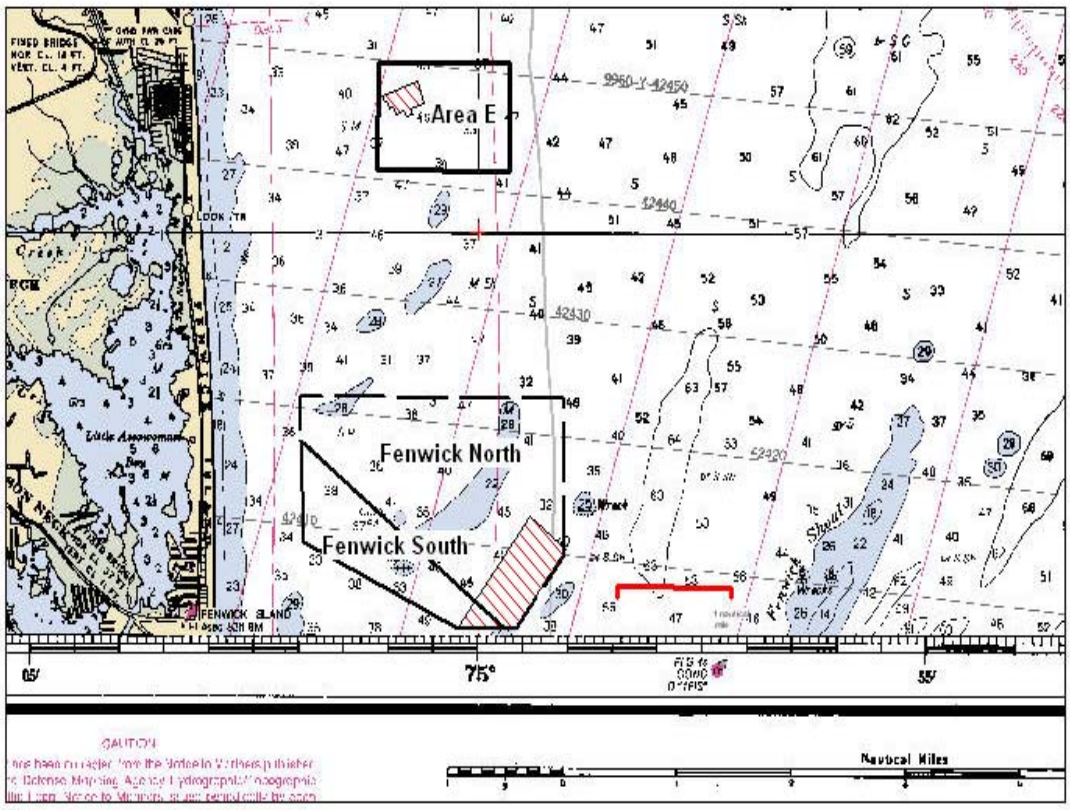

Figure 1-1. General location of Area E (775 acres) and the Fenwick Island Borrow Area (2,850 acres) off the Delaware coast

2.0 METHODS

2.1 WATER QUALITY MONITORING

The creation of the 10-12 foot deep pit in Area E for the replenishment project constructed in 1998 provided an opportunity to empirically measure whether water quality conditions within the bottom waters of the pit were different from ambient conditions outside the pit. From August 10, 2004 through August 26, 2004, two data logging YSI water quality meters were moored 1-meter from the bottom in the center of the Area E pit and programmed to collect data at 15-minute intervals. Water depths where these meters were deployed averaged about 58 feet. Parameters measured by the meters included dissolved oxygen (mg/l), chlorophyll (µg/l), turbidity (NTUs), and salinity (PPT). For comparative purposes a third meter was moored in waters approximately 0.25 miles to the south of the pit in approximately 46 feet of water that represented the average depth of the Area E borrow site surrounding the pit. The month of August was selected to provide a worse case scenario as summertime water temperatures and higher phytoplankton production would provide the greatest oxygen demand within the bottom waters of the pit. Each meter was calibrated before deployment and the data were post-processed to remove any out-of-range values, data anomalies, probe failures, and other data issues that typically occur during long-term deployments with in-situ instrumentation.

2.2 FINFISH COLLECTION METHODS

Surveys of the fish and mobile epi-benthic invertebrate communities were conducted in four seasons from summer 2003 through spring 2004 at the two borrow areas (Area E and Fenwick Island Borrow Area, Figure 1-1). The borrow areas are within 3 nautical miles of the Delaware coastline and have depth ranges of 30 – 50 feet. Except for the Fenwick North Area, these sites are relatively flat in bathymetry. The Fenwick North Area contains several small shoals that were designated to be off-limits to dredging (USACE, 2000). Dates during which the sampling occurred and the associated seasons for each of the four cruises are provided in Table 2-1. All seasons were sampled for this survey because the fish community in the mid-Atlantic region changes over the course of a year primarily due to changing water temperatures. Sampling cruises generally started later than planned and occurred over a longer time-period because of frequent days with bad weather conditions and rough seas in the area.

Sampling gears with different species and size selectivity were used to obtain samples with a species and size composition that are representative of the fish and nekton communities in the areas. During each season three fish sampling gears were used:

- Experimental Trawl - Sampling with a 7.6-m (25-foot) experimental semi-balloon otter trawl with 44.5-mm stretch mesh body fitted with a 3.2-mm stretch mesh liner in the codend was conducted from a 6.4-m research vessel.

- Commercial Trawl - Sampling with a 24.4-m (80-foot) Yankee net with a mesh of 146-mm stretch mesh was conducted from a 16.5-m wooden stern trawler based in Ocean City, Maryland.

- Gillnets - Sampling by gillnets was conducted from a commercial gillnet boat based in Ocean City, Maryland. The gillnets were 91.4-m in length and 3-m deep and were composed of six 15.2-m panels of varying mesh size. Of the six panels in each net, two panels were 50.8-mm stretch mesh, 2 panels were 101.6-mm stretch mesh and two panels were 152.4-mm stretch mesh.

During each survey, four replicate 10-min trawls using the commercial trawl and the experimental trawl were conducted and four gillnet sets were collected within each borrow area.

Table 2-1. Summary of survey start date within each season for the Area E and the Fenwick Island Borrow Area fisheries survey work

	Summer 2003	**Fall 2003**	**Winter 2004**	**Spring 2004**
25-foot Trawls	09/24/2003	12/04/2003	02/11/2004	05/25/2004
Commercial Trawls	10/01/2003	11/18/2003	02/04/2004	05/26/2004
Experimental Gillnets	08/12/2003	11/17/2003	02/23/2004	05/27/2004

The trawls were typically towed in a south or north direction at each site, at a standard speed of 1-2 knots and a target tow duration of 10 min. On several collections, wave conditions, currents, navigation difficulties or other boats prevented the collections from occurring entirely in the pre-selected areas or for a total of 10 min. The actual towing distance was determined by a differential GPS. High abundance of horseshoe crabs and other organisms in the towpath also dictated a reduced tow to ensure that the trawl could be retrieved safely during certain seasons. Using the towing start and end positions, the effort for each haul was standardized to distance traveled by the trawl. For the commercial trawl, catches were reported in numbers caught per 1,000-foot while the catches for the 25-foot trawl were reported in numbers per 500-foot of tow length. In the Fenwick Borrow Area commercial trawling was restricted to the eastern portion of the area because snags and hang downs in the western end of the borrow site precluded sampling this area.

The gillnets were set on the bottom parallel to the coast because of the high currents in the area. Gillnets sets were limited to daytime, with a minimum soaking time of one hour. All gill net catches were standardized to numbers caught per soak hour. The specific location of the commercial trawls, 25-foot trawls, and the gill net sets within each borrow area is presented in Figures 2-1 and 2-2.

All fish and epi-benthic shellfish taken in each collection were identified to the species level (if species identification was uncertain, they were identified to the lowest taxonomic level

practical), counted, and total length was recorded. When a collection contained more than 25 individuals of a species, 25 specimens were randomly selected for length measurement.

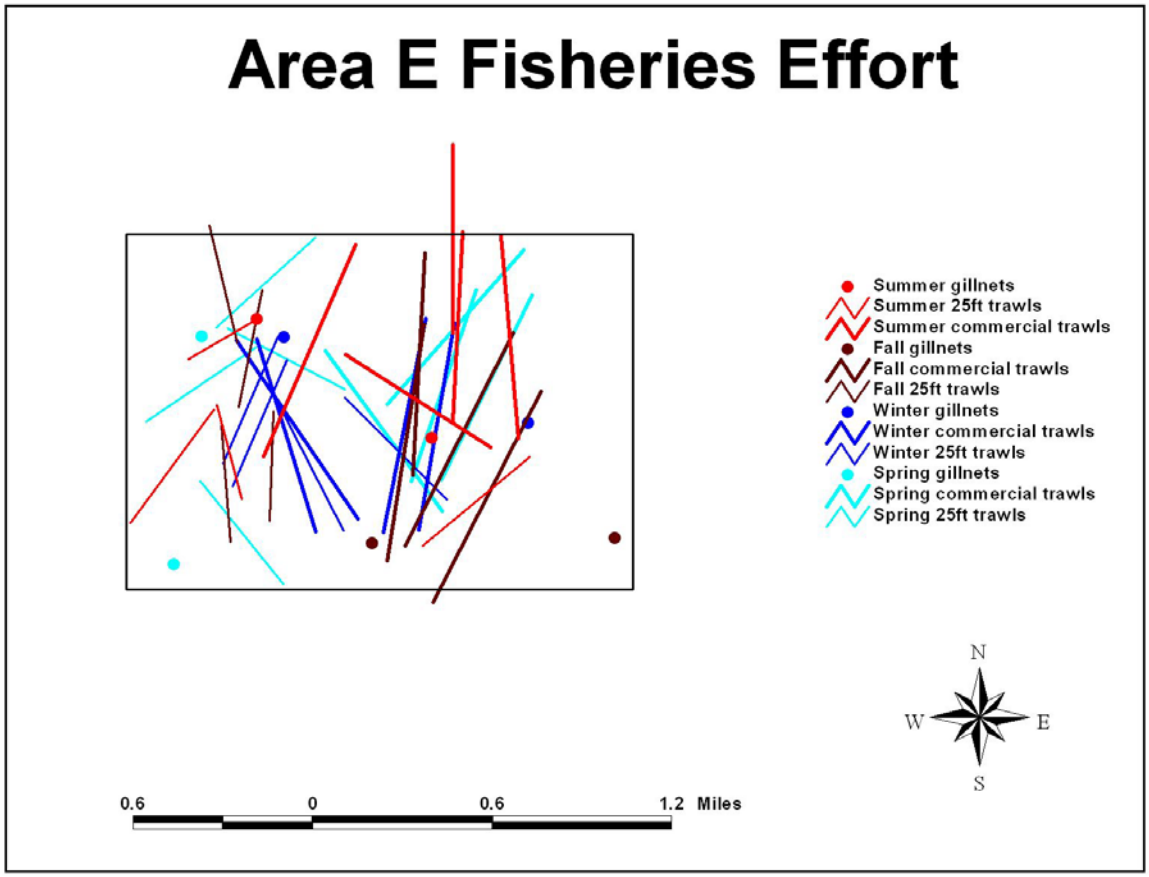

Figure 2-1. Locations of trawl and gillnet sets among the various seasons sampled within Area E

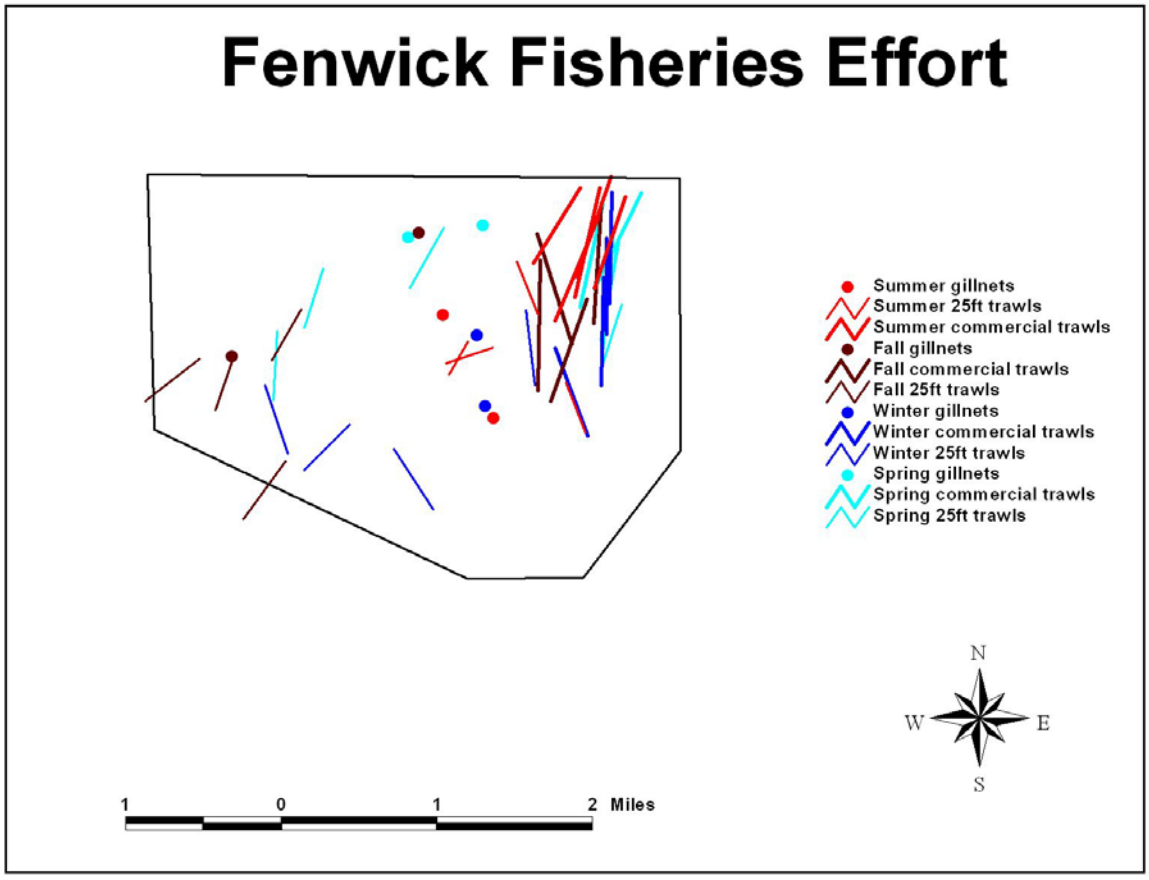

Figure 2-2. Locations of trawl and gillnet sets among the various seasons sampled within the Fenwick Island Borrow Area

2.3 BENTHIC VIDEO SLED COLLECTION METHODS

On April 12 and 13, 2004, the Virginia Institute of Marine Science towed a benthic video sled over Area E and the Fenwick Island Borrow Area to provide data on the biological and physical features associated with these two areas. The survey was conducted using a North Star Marine sea tow vessel with a Versar scientist on-board to direct the fieldwork. In coordination with the USACE, target track lines were created in GIS to provide a vessel-maneuvering plan to follow in the field during a two-day survey effort (Figures 2-3 and 2-4). Track lines crossing the pit in Area E was included in the sampling plan.

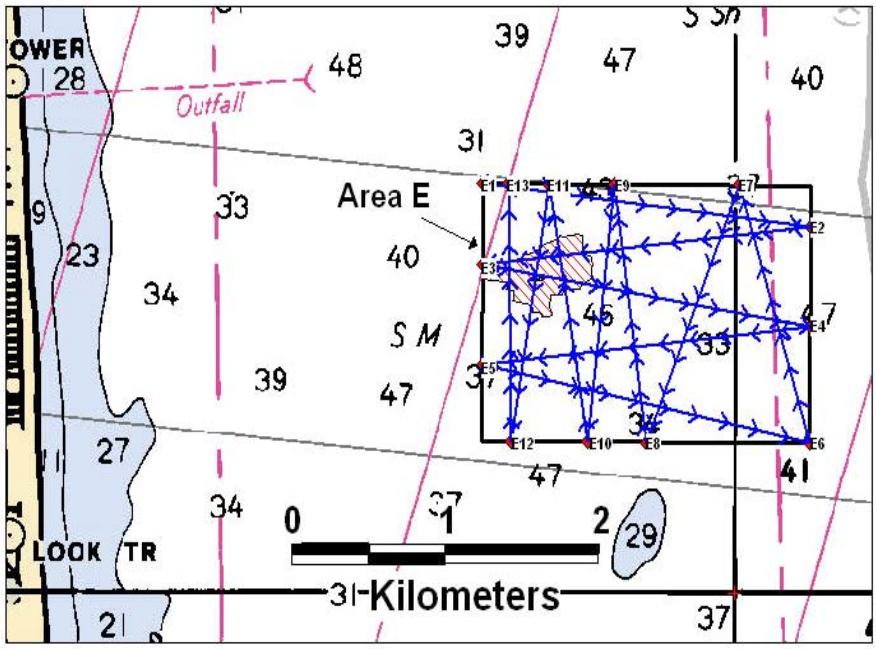

Figure 2-3. Planned track lines for the Area E video survey

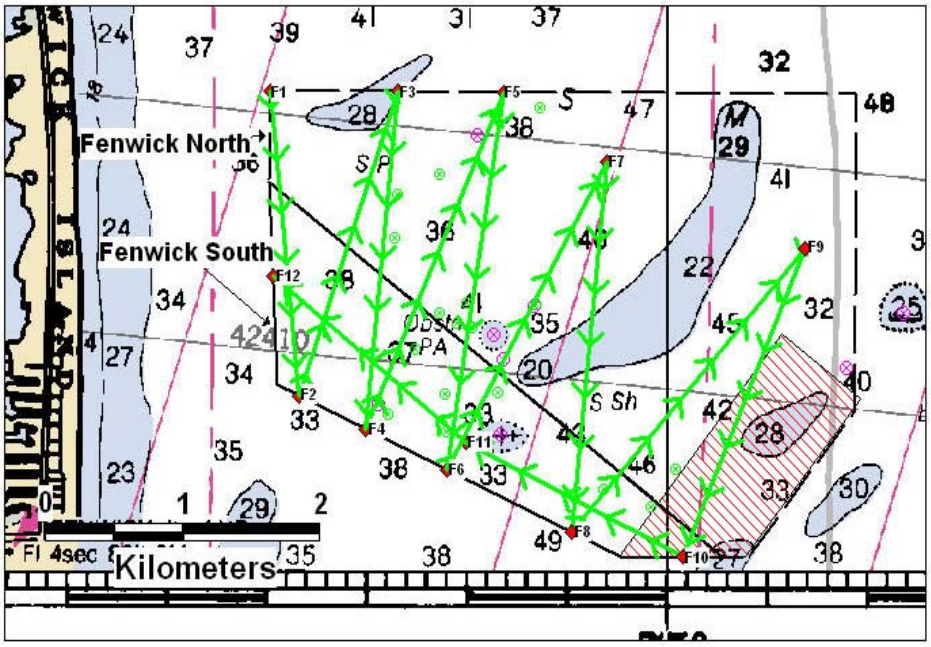

Figure 2-4. Planned track lines for the Fenwick Island Borrow Area video survey

2.3.1 Video Sled Description

The towed sled (Figure 2-5) had three video cameras mounted in three different configurations to provide: 1) a broad overview of the bottom and cables leading to the surface, 2) near bottom horizontal view to see fish over the bottom and bed form types, and 3) a vertical high resolution view for sediment type and biogenic features. The broad overview camera was mounted about 0.5 m off the bottom and angled to view the bottom out in front of the sled from 2 to 10 m. The near bottom horizontal camera was mounted 0.2 m off the bottom at an oblique angle of 20^{o} to provide a close-up view of bottom morphology and the presence of juvenile fish and other mobile fauna from 0.2 to 1.0 m in front of the sled. Its field of view was a trapezoid with an area of approximately 0.9 to 1.0 m^2 being about 0.25 m near the sled and about 1.5 m at a distance of about 1.0 m from the sled. The vertical camera was mounted perpendicular to the bottom at a distance of 0.3 m from the sediment surface and had a field of view of 28 cm x 21 cm or 588 cm^2 (0.06 m^2). Illumination for the vertical and horizontal cameras was provided by electronic video strobes.

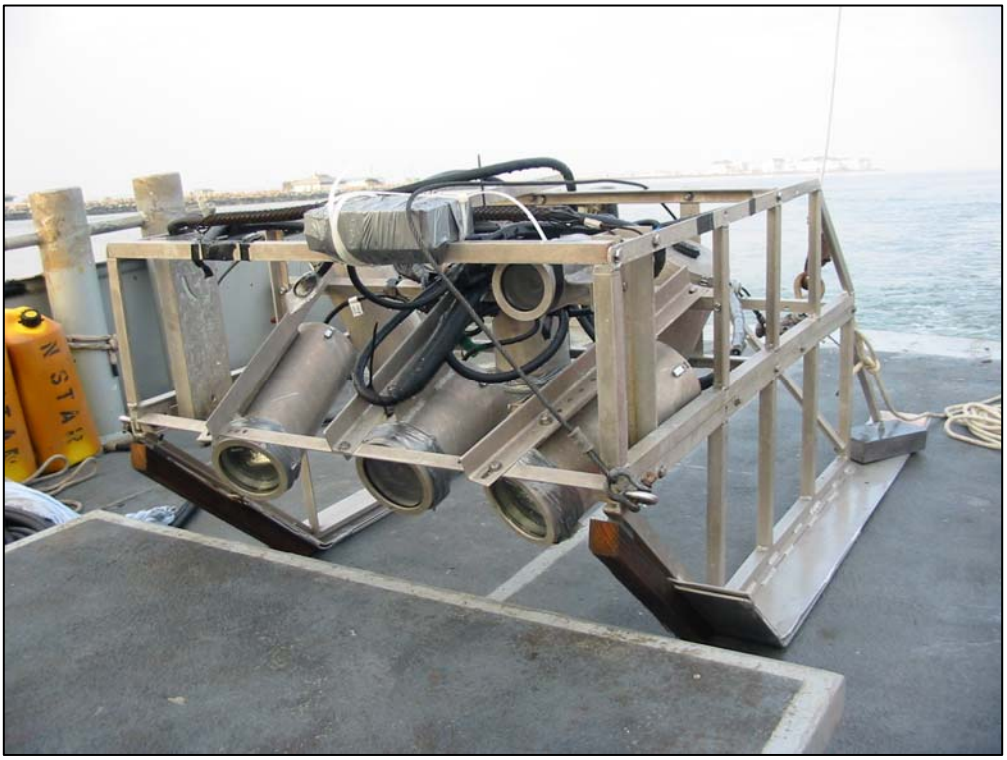

Figure 2-5. Video sled used to characterize benthic habitats. Overview camera is at the top right corner of the sled, horizontal camera is in the front center and flanked by two electronic video strobes, close-up vertical camera is in the center of the sled, behind the horizontal camera. Sled runners are 0.8 m apart.

The video sled was linked to the surface via two cables that provided power to the cameras and strobes. The video signals were transmitted to the surface where sled performance

and bottom features could be viewed in real-time. The video signal from each camera was multiplexed and recorded on to a single master tape that was used for aligning the video from the horizontal and vertical cameras. Video signals from the horizontal and vertical cameras were also recorded on higher resolution digital recorders for later analysis.

2.3.2 Video Analysis

Benthic habitats were classified by analyzing videotapes recorded from the horizontal and vertical cameras. Physical and biological features were sampled from the recorded videotape at 2.5-minute intervals. If video images were not visible because of poor near-bottom visibility, the last instance the bottom was visible and the first moment the bottom reappeared were analyzed. All fish visible from the forward or downward cameras were identified to the lowest possible taxon and physical and biological features of the benthic habitats at the instance the fish was noted and recorded. Analysis of the videotape was conducted using a Sony editing deck and high-resolution video monitor. Data on bed roughness, sediment type, shell hash, biogenic structures, epi-faunal and infaunal organisms, and fishes and rays were collected and entered into an excel spreadsheet. The features recorded and used in this analysis are listed in Table 2-2.

Table 2-2. Physical and biological features sampled from horizontal camera videotapes

Physical	Biological
Silt & Clay: 0 = absent 1 = present	Count of: Sessile epifauna
Fine-Medium Sand: 0 = absent 1 = present	Count of: Fishes
Coarse Sand & Gravel: 0 = absent 1 = present	Count of: Skates/Rays
Bedforms: 0 = absent 1 = present	Count of: Burrow opening
Size of bedforms 0 = <30 cm wavelength 1 = >30 cm wavelength	Count of: Biogenic mounds or pits
Waveform of bedforms 0 = smooth rounded crest 1 = sharp peaked crest	Count of: Tubes
Shape of bedforms 0 = straight 1 = asymmetric	Count of: Mobile epifauna
Secondary ripples: 0 = absent 1 = present	
Shell fragments 0 = 0-5% coverage of bottom 1 = 5-10% coverage of bottom 2 = 10-25% coverage of bottom 3 = >25% coverage of bottom	
Whole shell: 0 = absent 1 = present	

Video data files for each borrow area were combined with the DGPS positions by aligning timing mark placed in the DGPS files, the time code recorded with the multiplex video, and the time code generated by the digital video recorders used with the horizontal and vertical cameras. Bottom habitats were then classified based on both physical and biological characteristics.

Bottom habitats were then classified based on both physical and biological characteristics. Physical characteristics included variables for bedforms type and size, which were primarily wavelength and form, and sediment grain size. Biological characteristics included variables for shell fragment cover, mobile fauna, sedentary fauna, and other biogenic structures (Table 2-2).

2.4 MACROBENTHIC COLLECTION METHODS

2.4.1 Field Collection Methods

Benthic sampling within the two borrow areas was conducted between November 10 and 11, 2004. In Area E, The sampling regime varied from the Scope of Work (Appendix A). In Area E, 5 samples were collected from within the pit created from past dredging operations and 5 samples were collected from outside the pit but within the boundaries of the borrow area (Figure 2-6). Sampling within the Fenwick Island Borrow Area deviated somewhat from the Scope of Work (Appendix A). Since one of the goals of the study was to provide ground truthing for the benthic video sled results, as well as provide benthic community information for the area in general, stations were allocated to three sediment habitats identified from the video sled results. Three relatively distinct sediment habitats, fine sands, coarse sands, and pebble/rock, were sampled for benthic macroinvertebrates. Six samples were allocated to each of these three habitats for a total of 18 samples collected within the Fenwick Island Borrow Area (Figure 2-7). Stations F1 to F6 were collected in the fine sand habitat, Stations F7 to F12 were collected from the coarse sediment habitat, and Stations F13 to F18 were collected from the gravel sediment habitat.

Stations were located in the field using a Trimble NT200D Differential Global Positioning System (DGPS), which is accurate to within 10 ft. After positioning the vessel on station, the exact position coordinates were obtained from the DGPS and were recorded on a field data sheet. Exact station coordinates are listed in Table 2-3.

Benthic and sediment samples were collected with a 0.044-m^2 stainless steel, Young grab sampler. Sediments from the benthic grab were sieved through a 0.5-mm screen and preserved in a 10% solution of buffered formaldehyde stained with rose bengal. For the grain-size and total organic content (TOC) sample, surface sediments were scooped from the top 2 cm of the sediment grab sample, placed in a prelabled collection container, and was frozen until laboratory processing.

Bottom water quality measurements were taken at four sites one in Area E and three in the Fenwick Island Borrow Area. A Hydrolab Surveyor II was used to measure dissolved oxygen concentration (DO), salinity, conductivity, temperature, pH and turbidity. Depth measurements were recorded at each station in both borrow areas using the vessel's electronic depth meter.

The SOW (Appendix A) called for a commercial surf clam survey, however, due to boat subcontracting problems, a clam survey could not be performed. Clams collected in the benthic grab samples were used to estimate the number of juvenile clams in the areas.

Table 2-3. Benthic station coordinates (in decimal minutes) within Area E (Stations beginning with E) and the Fenwick Island Borrow Area (Stations beginning with F).

	Latitude		Longitude	
Station	**Degrees**	**Decimal Minutes**	**Degrees**	**Decimal Minutes**
E-1	38	31.0740	75	0.6973
E-2	38	31.0762	75	0.7773
E-3	38	31.0481	75	0.7358
E-4	38	31.0154	75	0.7690
E-5	38	31.0144	75	0.6958
E-6	38	31.0806	75	0.0845
E-7	38	31.6294	75	0.8740
E-8	38	31.6077	75	0.2446
E-9	38	31.5034	74	59.9302
E-10	38	31.7898	75	1.0728
F-1	38	28.0718	75	1.7666
F-2	38	27.8522	75	1.7379
F-3	38	27.7027	75	1.7298
F-4	38	27.7358	75	1.6881
F-5	38	27.9849	75	1.6011
F-6	38	28.0686	75	1.5640
F-7	38	27.7574	75	1.2947
F-8	38	27.6138	75	1.3123
F-9	38	27.5107	75	1.2985
F-10	38	27.5828	75	1.2122
F-11	38	27.7067	75	1.1588
F-12	38	27.7994	75	1.1042
F-13	38	28.4797	75	0.3459
F-14	38	28.5279	75	0.3183
F-15	38	28.5713	75	0.3012
F-16	38	28.5692	75	0.2545
F-17	38	28.5609	75	0.2257
F-18	38	28.5537	75	0.2017

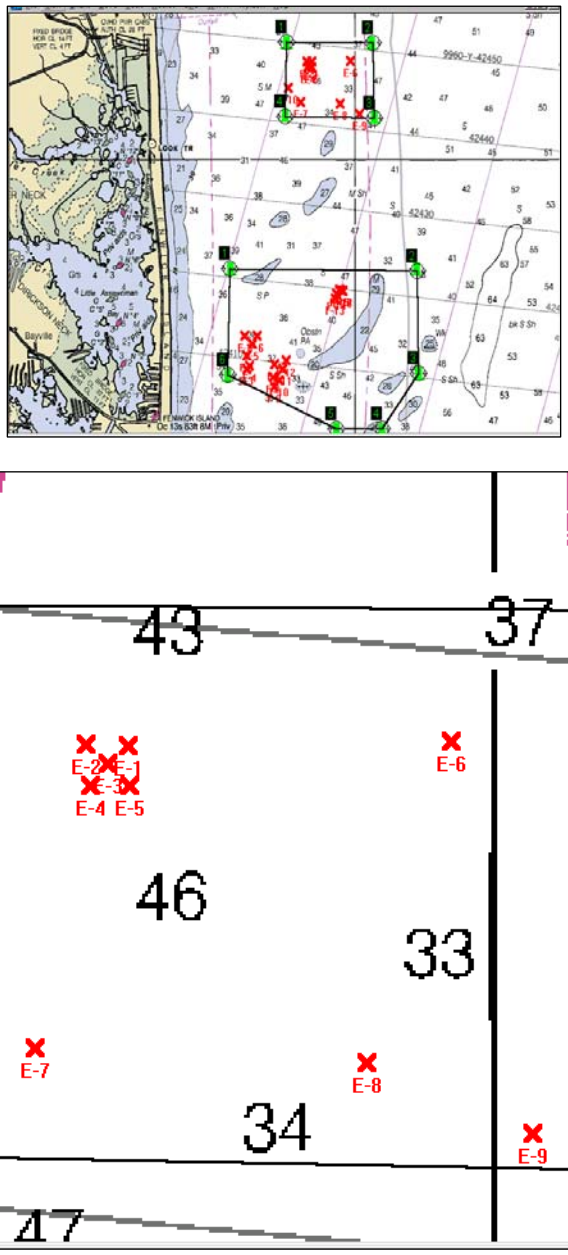

Figure 2-6. Benthic sampling stations within Area E along the Delaware coastline. Station names are labeled in red.

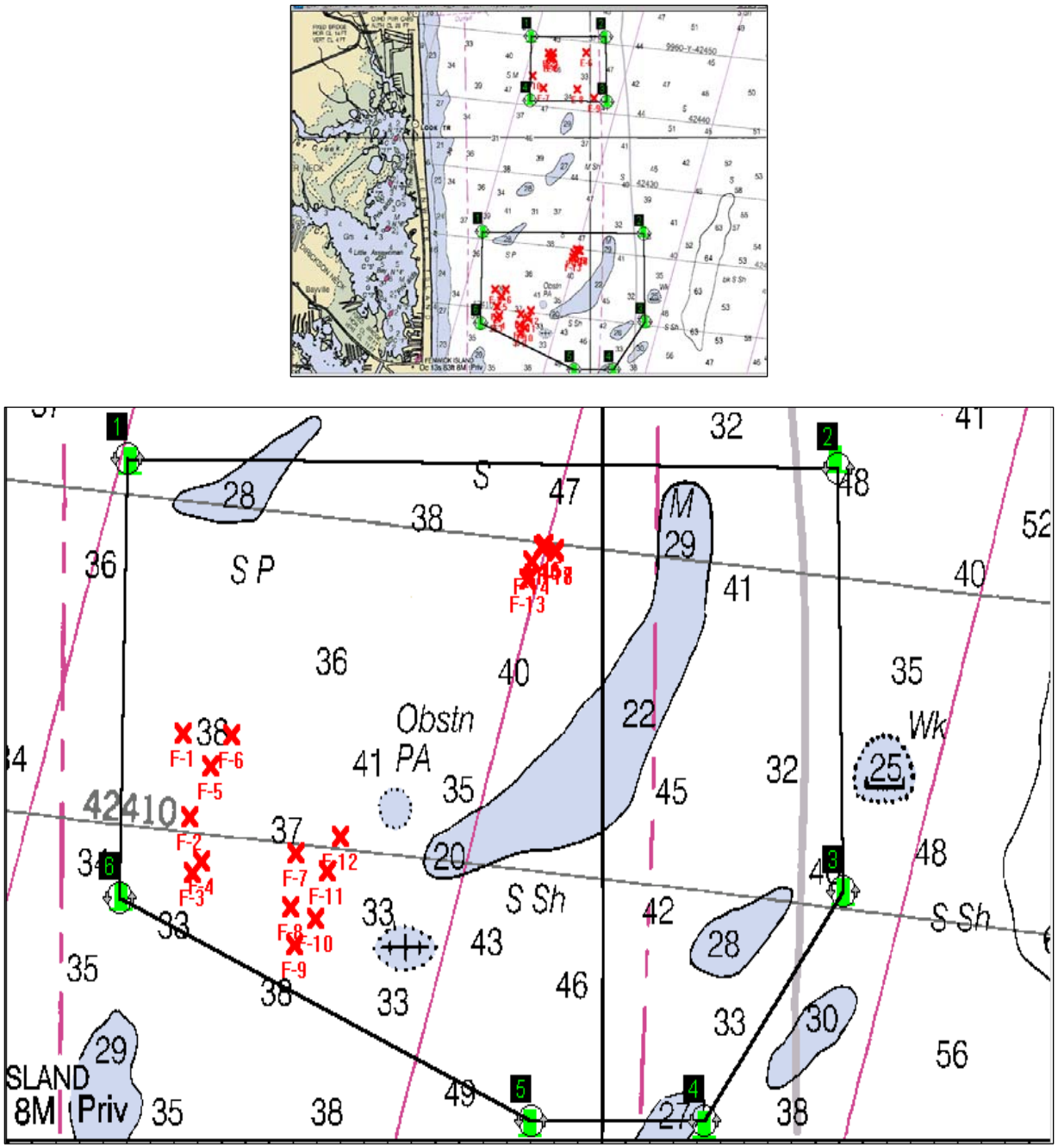

Figure 2-7. Benthic sampling stations within the Fenwick Island Borrow Area along the Delaware coastline. Station names are labeled in red.

2.4.2 Laboratory Methods

Benthic samples were sieved in the laboratory using a 0.5-mm standard laboratory sieve to remove the field preservative. All benthic organisms in each sample were sorted from the remaining debris using a dissecting microscope. All infaunal and epi-faunal organisms present in the sample were identified to the lowest practical taxonomic category, and counted. The number of organisms longer than 2 cm was recorded for each taxon. After identification, organisms were grouped according to the lowest taxonomic level to determine taxon specific ash-free dry weight (AFDW) biomass. AFDW biomass was determined by drying each taxon to a constant weight at 60 °C, ashing in a muffle furnace at 500 °C for 4 hours, and weighing the remains.

When completing taxonomic identifications in the laboratory, some organisms cannot be completely identified to the species level, particularly if they are immature/juveniles or in poor shape. The taxonomist made a note in the database when it was the opinion of the taxonomist that such an organism should not be considered a separate taxon when tallying total number of taxa. All of the statistical analyses and calculation of diversity indices accounted for these taxonomic identification notations.

Grain-size analysis was performed according to ASTM Method D422-63. Sieve sizes ranged from 4.75 mm (U.S. Standard Sieve No. 4) to 63 µm (U.S. Standard Sieve No. 230). Sediments were categorized by Wentworth's classifications (Table 2-4). Total organic content (TOC) was measured by weight loss upon ignition at 500 °C for 4 hours.

Table 2-4. Sieve sizes used for sediment particle distribution and the Wentworth sediment size categories (Buchanan 1984)

Sieve Number	Sieve Size	Wentworth Size Category
4	4.75-mm	Pebble
10	2.00-mm	Granule
20	850-µm	Very Coarse Sand
40	425-µm	Coarse Sand
60	250-µm	Medium Sand
140	106-µm	Fine Sand
200	75-µm	Undefined
230	63-µm	Very Fine Sand
	< 63-µm	Silt-Clay

2.4.3 Data Analysis

2.4.3.1 Finfish

One of the objectives of this study was to evaluate whether recent sand mining which created a 10-foot deep, 43 acre pit in Area E altered the fish community composition and abundance relative to an un-impacted reference site (Fenwick Island Borrow Area). Sampling for finfish in Area E was conducted within the boundaries of Area E and were often in or adjacent to the pit that was dredged for the Bethany Beach sand mining operation in September 1998 (Figure 2-1). To assess potential pit effects on fish community composition and abundance seasonal comparisons of catch differences between Area E and the reference area, Fenwick Island Borrow Area, were made by gear type. Analysis of variance tests (ANOVA) for significant differences ($p < 0.05$) in total catch, number of species, and the Shannon-Wiener Diversity Index among gears, sampling season, and borrow area were conducted.

A two-way ANOVA for each sampling gear was run to test for significant differences between seasons and borrow area. Data were log transformation to standardize catch per tow and soak hour data to allow for a normal distribution because fisheries abundance data are typically skewed by large hauls. Differences in number of species found in the collections and the Shannon-Wiener Diversity Index, which measures species richness and evenness were also tested. ANOVA testing was performed on the entire collections (e.g., all species collected by the gears) then subsets including only the invertebrate species, fish (including sharks/rays), and only free-swimming invertebrates (shrimps and squid).

The fisheries collections at Area E and the Fenwick Island Borrow Area were conducted concurrently with a two-year Minerals Management Service (MMS) study. Versar conducted this study for MMS using the same gear, vessels, crews and study design to evaluate the importance of offshore shoals beyond the three-mile federal waters limit. The MMS study included replicate 25-foot trawls, 80-foot commercial trawls, and experimental gillnets sets at four shoals (Fenwick, Weaver, Shoal B and Shoal D; Figure 2-8) plus four flat bottom reference areas. The MMS sampling was conducted seasonally for two consecutive years starting in the fall of 2002 and ending in the summer of 2004. Yearly and seasonal MMS data that coincided with the USACE data were visually and graphically compared to the borrow area data to evaluate differences in fish communities between inshore and offshore study areas.

2.4.3.2 Macroinvertebrate Grab Samples

The benthic macroinvertebrate community sampled with using a benthic grab were described and statistically compared in several ways. In Area E, data from stations within the pit and outside the pit were pooled and means were compared to each other using an analysis of variance tests (ANOVA). Means were considered statistically different at the $p < 0.05$ level. An ANOVA was conducted using means from within and outside the pit and the data collected from

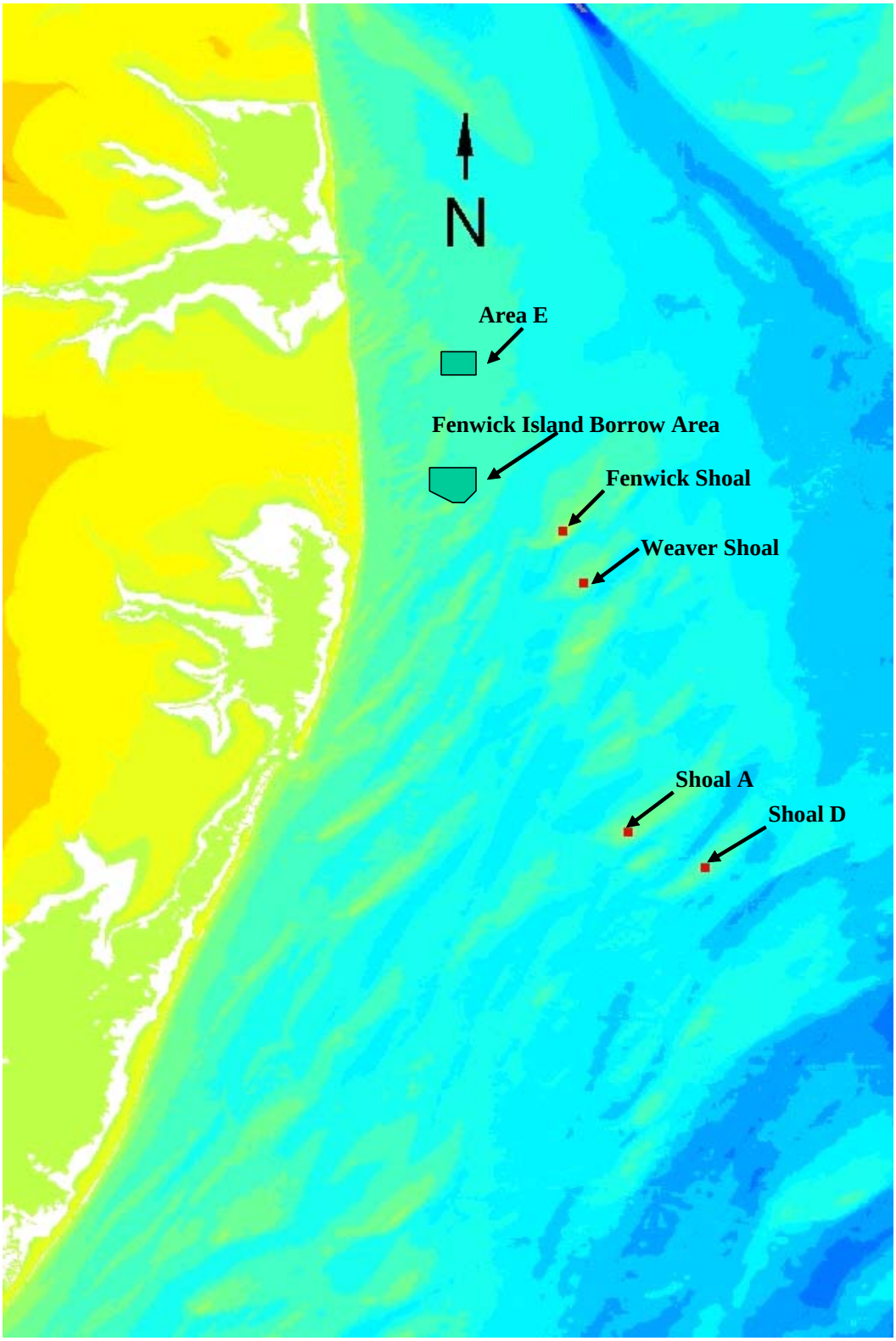

Figure 2-8. Location of the MMS shoal field finfish sampling that was conducted concurrently with the Area E and the Fenwick Island Borrow Area sampling

Area E in 1997. For the Fenwick Island Borrow Area, stations were pooled to obtain means for each of the three predetermined sediment habitats sampled based on the benthic video sled results.

Several measures of diversity, abundance, and biomass were statistically examined for the benthic community. Four measures of diversity were calculated (1) number of infauna taxa (i.e., taxa richness); (2) number of epifauna taxa; (3) number of taxa with organisms greater than 2 cm, (4) Shannon-Wiener Diversity Index for infauna taxa, which includes measures of taxa richness and evenness (the higher the number the greater the diversity); and (5) Simpson's Dominance Index for infauna taxa (scaled from 0 to 1, with 1 being the highest possible diversity), which calculates the probability of randomly selecting two organisms that are different taxa (Shannon and Weaver 1949; Krebs 1978).

The formula for the calculation of the Shannon-Wiener Index is:

$$H = -\sum_{i=1}^{s} \left(p_i\right)\left(\log_2 p_i\right)$$

where

H = index of species diversity
S = number of species
p_i = proportion of total sample belonging to ith species

The formula for the calculation of the Simpson's Dominance Index is:

$$D = 1 - \sum_{i-1}^{2} \left(p_i\right)^2$$

where

D = Simpson's index of diversity
p_i = proportion of individuals of species i in the community

Several measures of benthic abundance and biomass were calculated and statistically compared. These included total epifauna, total infauna, infauna amphipods, infauna bivalves, and infauna polychaetes. All abundance and biomass data were log-transformed before analysis to meet requirements for normality.

A cluster analysis was performed separately on the benthic samples collected in Area E and the Fenwick Island Borrow Area based on the results of the ANOVAs. The aim of the analysis was to differentiate between groupings of stations (inside or outside the pit) for Area E and for the Fenwick Island Borrow Area based on the three sediment habitats defined by the video sled analysis (fine sand, coarse sand, and gravel). The cluster analysis used for this study started with the calculation of a similarity matrix using the Bray-Curtis coefficient. A hierarchical clustering method using the similarity matrix created a dendrogram of station

groupings based on the coefficient. The resulting dendrogram attempts to group samples into "natural groupings" of similar samples. The Primer-E Ltd. statistical package was used for the cluster analysis (Clark and Warwick, 2001).

3.0 RESULTS

3.1 CONTINUOUS WATER QUALITY MONITORING IN AREA E

Salinities inside and outside the Area E pit ranged from a high of 39 ppt during August 13, 2004 to a low of 35 ppt at the end of the deployment period (Figure 3-1). Salinities inside and outside the pit mirrored each other within a 3 ppt range over most the 16 day time series. During a two-day period between August 22 and 24, salinities at the control site were 2-3 ppt lower then those observed in the pit. Salinities measured by the two meters inside the pit during this two-day time period varied by one part per thousand but by August 25 all three readings converged to within 0.5 ppt of each other.

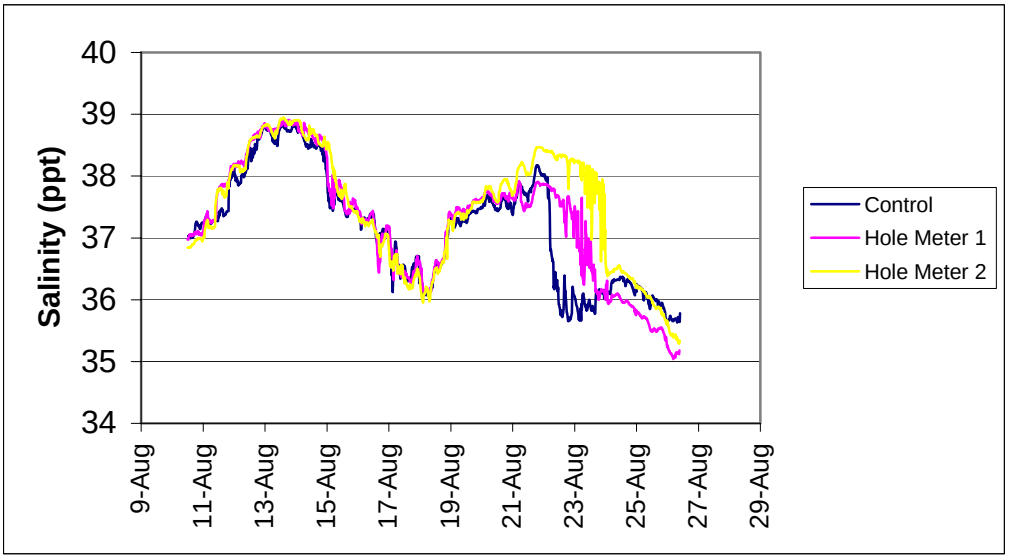

Figure 3-1. Salinity differences within and outside of the dredged hole in Area E monitored with in-situ YSI probes during August 2004

Turbidity measurements were highly variable ranging from <1 NTU to over 120 NTUs at the control site (Figure 3-2). After August 17 the probe on the second meter inside the pit failed, but the probe on the other meter kept functioning throughout the 16-day deployment. Turbidities measured by the pit meter #1 varied less than those recorded by pit meter #2 (when it was functioning) and the control meter outside the pit. Three days before the control turbidity probe failed on August 22, turbidities at this site varied greatly between 3 and 120 NTUs. Similarly, large changes in turbidity were observed at the end of the 16-day deployment from the pit meter #1 records.

Dramatic differences between the chlorophyll levels inside and outside the Area E pit were apparent in the time series (Figure 3-3). Control site chlorophyll levels were consistently

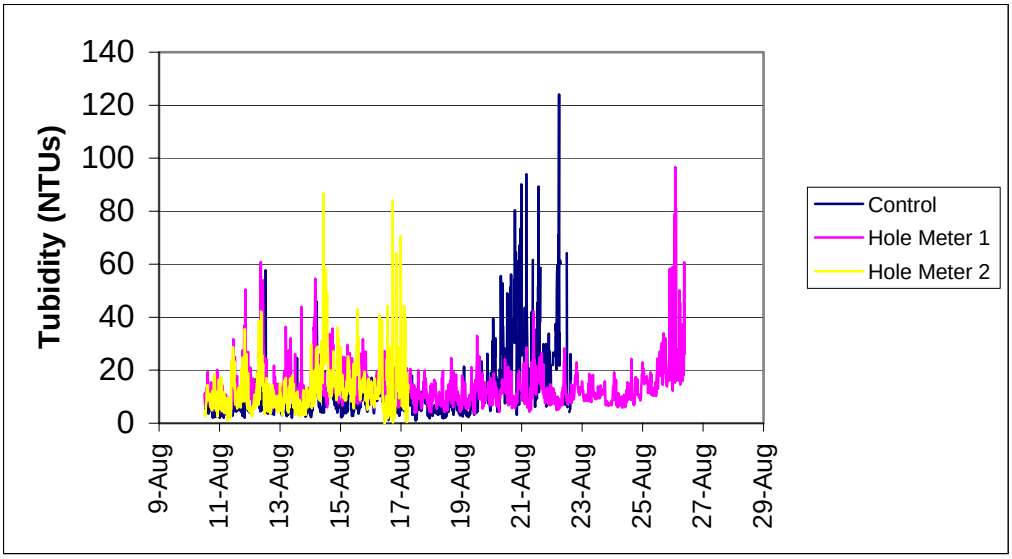

Figure 3-2. Turbidity differences within and outside of the dredged hole in Area E monitored with in-situ YSI probes during August 2004

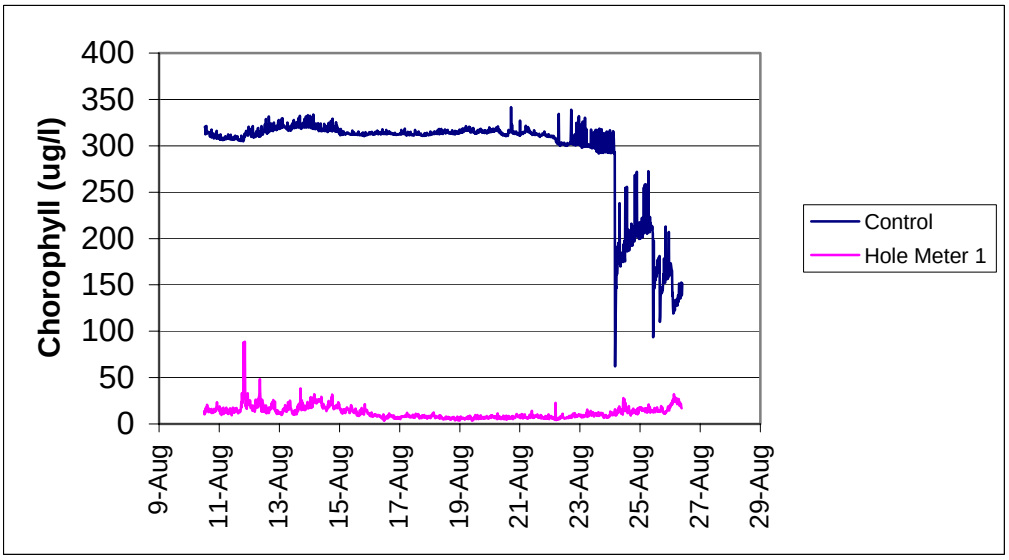

Figure 3-3. Chlorophyll differences within and outside of the dredged hole in Area E monitored with in-situ YSI probes during August 2004

over 300 µg/l until the numbers began to fall during the last two days of the 16-day deployment (possibly due to fouling of the probe). Chlorophyll concentrations inside the Area E pit generally hovered around 20 µg/l with the exception of one spike to 88µg/l on August 11, 2004. The chlorophyll probe on pit meter #2 did not function properly during the entire deployment.

Dissolved oxygen (DO) levels were consistently lower inside the Area E pit relative to the control site by about 4 mg/l, but converged to a difference of less than 1 mg/l during the last 3 days of the deployment (Figure 3-4). For all three meters, daily fluctuations in DO mirrored each other and the two meters inside the pit had nearly identical readings throughout the time series.

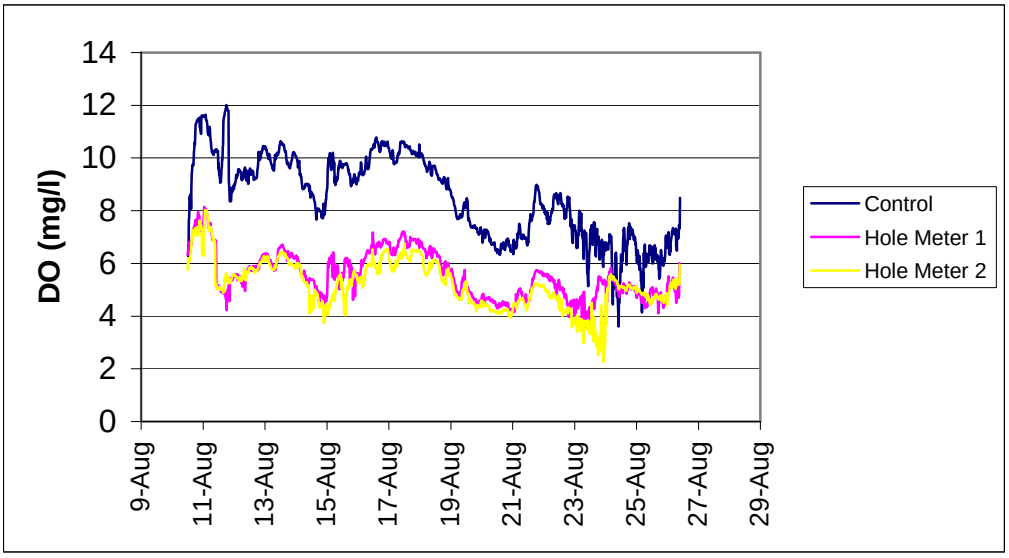

Figure 3-4. Dissolved oxygen differences within and outside of the dredged hole in Area E monitored with in-situ YSI probes during August 2004

3.2 FINFISH

3.2.1 Overall Catch Composition Among Gear Types

A total of 71 species of finfish, invertebrates, and sharks/rays were collected with the 25-foot trawl, commercial trawl, and experimental gill nets used for the Area E and Fenwick Island Borrow Area sampling conducted between summer 2003 and the spring 2004. Among these species, 44 were finfish, 16 were invertebrates and 11 different species of cartilaginous fish (sharks/rays). Seasonal catches varied greatly among gears but less so between borrow area. Finfish annual catches in the 25-foot otter trawl were dominated by bay anchovies, Atlantic croakers, and spotted hake. Invertebrate catches with this gear contained mostly right-handed hermit crabs, sand shrimp, and squids (Table 3-1). Among the cartilaginous fishes collected by

the small trawls, clearnose skate and winter skate were the most common rays taken on an annual basis.

The commercial trawl took greater numbers of organisms and more species than the small trawl and experimental gill nets (Table 3-2). The most common finfish taken in the commercial trawls over four seasons of sampling where butterfish, scup, and spotted hake. Collections with the commercial trawl also took large numbers of macroinvertebrates including squids, lady crabs, starfish, and knobbed whelks. Sharks/rays were generally more susceptible to capture by the commercial gear and were dominated by clearnose skates, winter skates, little skates, and spiny dogfish.

Lower numbers of species and catches were observed in the gill net collections where Atlantic menhaden, croaker, and hickory shad were the dominant finfish taken in the collections over the four seasons included in study (Table 3-3). Three shark species dominated the annual catches for the experimental gill nets including smooth dogfish, dusky shark, and spiny dogfish. Fewer species of invertebrates were collected with the gillnets, which was expected since most invertebrate species live on the bottom and would not be captured in the water column nets.

3.2.2 Gear Specific Catches

Twenty-five Foot Trawl

Standardized catch per unit of effort and the number of fish and macroinvertebrate species collected within Area E where the dredged pit was created were either equal to or higher than those observed within undisturbed habitats at the Fenwick Island Borrow Area. In the summer of 2003, a total of 27 species of finfish, shellfish, and cartilaginous species were collected in Area E while only 17 were taken in the Fenwick Island Borrow Area (Table 3-1). Higher catch rates were also observed in Area E where the total catch among the replicate samples in summer 2003 averaged 174 organisms per standardized tow relative to the 63 organisms per tow recorded for the Fenwick Island Borrow Area. Summer 2003 finfish catches in Area E were dominated by weakfish, bay anchovy, and Atlantic croaker, while the right-handed hermit crab was the most prevalent invertebrate species in the collections (Table 3-1). A similar species dominance pattern was seen at the Fenwick Island Borrow Area, but in lesser numbers.

The fall 2003 collection with the 25-foot otter trawl resulted in a higher number of species at Area E than at the Fenwick Island Borrow Area (27 and 20, respectively, Table 3-1). The standardized catch rates per tow, however, were nearly identical at 791 per tow for Area E and 773 organisms per tow for the Fenwick Island Borrow Area. Atlantic croakers and bay anchovies were the dominant finfish catch in both areas followed by spotted hake. However, bay anchovy was the dominant species caught at Area E (376 per tow) while the Atlantic croaker dominated the fall 2003 collections at the Fenwick Island Borrow Area (373 per tow). Sand shrimp, right-handed hermit crabs, and Atlantic rock crab were the dominant invertebrate species in the fall 2003 collections. Winter skates were consistently collected at both borrow areas in average catch rates ranging from 3-4 individuals per tow (Table 3-1).

Table 3-1. Summary of seasonal fish and mobile benthic invertebrate catches at Area E and Fenwick Island Borrow Area taken with the 25-foot otter trawl

	Summer 2003		Fall 2003		Winter 2004		Spring 2004		Total
Common Name	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	
Alewife									
American Eel							0.22		0.22
American Sand Lance					0.21				0.21
American Shad									
Atlantic Croaker	9.97	5.85	104.88	373.47					494.16
Atlantic Herring			0.25			0.22			0.46
Atlantic Mackerel									
Atlantic Menhaden			4.87	27.79					32.65
Atlantic Moonfish	0.21								0.21
Atlantic Silverside			0.52	2.83	8.73	5.12			17.19
Atlantic Sturgeon									
Bay Anchovy	34.75	14.56	375.95	89.41	0.21	0.24	0.22		515.34
Black Sea Bass							0.89	0.47	1.37
Blueback Herring									
Bluefish	0.21	0.32							0.53
Butterfish	0.31	0.32					13.43	1.55	15.61
Chub Mackerel									
Feather Blenny			0.25						0.25
Fourspot Flounder	0.42								0.42
Hickory Shad				0.71					0.71
Jacks							0.22	0.25	0.47
Lined Seahorse				0.21					0.21
Northern Kingfish	0.63	2.39							3.03
Northern Pipefish			0.54	0.70					1.24
Northern Puffer	1.53	2.17							3.70

Table 3-1. (Continued)

	Summer 2003		Fall 2003		Winter 2004		Spring 2004		Total
Common Name	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	
Northern Searobin			0.27				8.47	6.97	15.70
Northern Stargazer									
Red Hake			1.81	0.82					2.63
Scup							2.89	29.22	32.11
Shortnose Sturgeon									
Silver Hake			2.06				7.15	1.11	10.32
Silver Perch	2.25								2.25
Smallmouth Flounder	0.42	0.27	0.27	0.23			4.47	4.31	9.97
Spot									
Spotted Hake	0.97	0.69	17.23	56.73			84.37	145.48	305.48
Spotted Seatrout	0.21								0.21
Striped Anchovy	1.32	2.86							4.18
Striped Bass									
Striped Cusk Eel	9.65	3.13	0.78	0.96					14.52
Striped Searobin	0.42	0.41	1.80						2.63
Summer Flounder	0.21		0.25						0.46
Weakfish	58.96	4.37	5.31	0.79					69.44
Windowpane Flounder	0.63	1.12	4.30	3.02		0.21	0.22	4.54	14.05
Winter Flounder			0.25			0.20			0.45
Atlantic Rock Crab	0.21	0.28	23.89	6.67			0.22	0.47	31.76
Atlantic Surfclam		0.82							0.82
Blue Crab									
Channeled Whelk	0.59							0.22	0.81
Coarsehand Lady Crab									
Heart Urchins		0.82	2.03	1.54	0.21		0.90		5.51

Table 3-1. (Continued)

	Summer 2003		Fall 2003		Winter 2004		Spring 2004		Total
Common Name	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	
Horseshoe Crab									
Knobbed Whelk	1.25						1.11	1.41	3.77
Lady Crab	0.73		2.30	1.99					5.01
Moon Snails					0.61	0.20			0.81
Portly Spider Crab	2.19								2.19
Purple Spined Sea Urchin			0.25		0.42				0.67
Right Handed Hermit Crabs	40.46	22.20	77.42	16.09	7.68	12.12	32.19	14.40	222.56
Sand Shrimp			153.55	185.67	44.33	42.85	32.93	15.11	474.44
Squids	0.21						44.37	44.99	89.57
Starfishes	5.58		6.61	0.26	1.66	3.17	0.22	4.48	22.00
Atlantic Angel Shark									
Atlantic Sharpose Shark									
Atlantic Stingray									
Bullnose Ray									
Clearnose Skate	0.59						3.58	2.53	6.69
Dusky Shark									
Little Skate							0.22	0.22	0.44
Smooth Dogfish									
Spiny Dogfish			0.27						0.27
Thresher Shark									
Winter Skate			3.32	4.07	0.20	0.44	0.67	0.47	9.17
Total Catch	**174.89**	**62.59**	**791.19**	**773.97**	**64.25**	**64.78**	**238.98**	**278.21**	
Number of species	**27**	**17**	**27**	**20**	**10**	**10**	**21**	**19**	

Table 3-2. Summary of seasonal fish and mobile benthic invertebrate catches at Area E and Fenwick Island Borrow Area taken with the 80-foot commercial trawl

	Summer 2003		Fall 2003		Winter 2004		Spring 2004		Total
Common Name	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	
Alewife								1.26	1.26
American Eel									
American Sand Lance									
American Shad						0.17		0.14	0.31
Atlantic Croaker	0.22	0.37							0.59
Atlantic Herring									0.00
Atlantic Mackerel		38.80							38.80
Atlantic Menhaden									
Atlantic Moonfish									0.00
Atlantic Silverside					0.70				0.70
Atlantic Sturgeon			0.13						0.13
Bay Anchovy			0.40	13.45					13.85
Black Sea Bass								0.16	0.16
Blueback Herring								0.16	0.16
Bluefish	0.26		0.13	0.24					0.63
Butterfish	800.22	58.05	35.90	4.96			42.26	325.30	1266.69
Chub Mackerel	1.37								1.37
Feather Blenny									
Fourspot Flounder									
Hickory Shad			0.12		0.28	0.33			0.73
Jacks								0.15	0.15
Lined Seahorse									0.00
Northern Kingfish	2.38	0.81					1.74	1.74	6.67
Northern Pipefish									

Table 3-2. (Continued)

	Summer 2003		Fall 2003		Winter 2004		Spring 2004		Total
Common Name	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	
Northern Puffer	0.13	0.12						0.16	0.40
Northern Searobin	10.15	1.03	1.66				0.29	0.45	13.58
Northern Stargazer	0.24	0.34						0.14	0.72
Red Hake									0.00
Scup	74.32	0.56	3.81	0.41			868.47	110.43	1058.00
Shortnose Sturgeon							0.15	0.00	0.15
Silver Hake							3.52	7.77	11.29
Silver Perch									
Smallmouth Flounder								0.16	0.16
Spot									
Spotted Hake	21.75	24.95	2.18	0.94			1.17	61.64	112.64
Spotted Seatrout									
Striped Anchovy									
Striped Bass			0.51						0.51
Striped Cusk Eel									
Striped Searobin	0.32	1.97	1.38	0.29				0.58	4.53
Summer Flounder	0.24	0.48	3.31	4.31			0.88	1.23	10.44
Weakfish	2.81		7.30	0.13			2.50	0.71	13.45
Windowpane Flounder	0.70	0.76	12.31	12.31	0.56	2.36	0.30	0.63	29.92
Winter Flounder					0.28				0.28
Atlantic Rock Crab	0.12		0.13	0.13	0.28	0.17		0.16	0.99
Atlantic Surfclam									
Blue Crab	1.34	0.47	0.13		0.14				2.07
Channeled Whelk		0.13	0.64	0.12				0.32	1.20
Coarsehand Lady Crab	0.38			0.13					0.51

Table 3-2. (Continued)

	Summer 2003		Fall 2003		Winter 2004		Spring 2004		Total
Common Name	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	
Heart Urchins									
Horseshoe Crab	1.97	0.60	0.50	0.14	0.14		0.59		3.93
Knobbed Whelk	1.06	2.65	2.86	1.70			2.77	3.28	14.32
Lady Crab	1.97	6.74	5.29	18.45					32.44
Moon Snails	0.64	0.12							0.76
Portly Spider Crab	0.48	0.59							1.07
Purple Spined Sea Urchin									
Right Handed Hermit Crabs		0.12	0.63						0.74
Sand Shrimp									
Squids	9.47	9.24	2.66	2.44			65.97	29.70	119.49
Starfishes	10.30	6.07	0.53	2.88	0.28			0.79	20.86
Atlantic Angel Shark	0.63	1.22							1.86
Atlantic Sharpose Shark	0.10								0.10
Atlantic Stingray	0.19	0.11							0.31
Bullnose Ray	0.64	0.33							0.97
Clearnose Skate	40.12	30.08	2.53	1.59			49.03	27.06	150.41
Dusky Shark							0.15		0.15
Little Skate			1.39	4.56	0.28	0.73	1.03	2.55	10.54
Smooth Dogfish	0.13	0.11		0.39			2.48	1.49	4.60
Spiny Dogfish			2.27	3.15					5.42
Thresher Shark		0.14							0.14
Winter Skate	1.59	0.38	16.87	27.15	3.37	10.67	6.00	16.79	82.82
Total Catch	**986.20**	**187.36**	**105.55**	**99.88**	**6.31**	**14.42**	**1049.30**	**594.92**	
Number of species	**31**	**29**	**26**	**22**	**10**	**6**	**18**	**27**	

Table 3-3. Summary of seasonal fish and mobile benthic invertebrate catches at Area E and Fenwick Island Borrow Area taken with the experimental gillnets

	Summer 2003		Fall 2003		Winter 2004		Spring 2004		Total
Common Name	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	
Alewife									
American Eel									
American Sand Lance									
American Shad									
Atlantic Croaker	12.86	1.71	0.24	0.18					15.00
Atlantic Herring									
Atlantic Mackerel									
Atlantic Menhaden	13.84	11.53		0.30			0.10		25.77
Atlantic Moonfish									
Atlantic Silverside									
Atlantic Sturgeon									
Bay Anchovy									
Black Sea Bass									
Blueback Herring									
Bluefish	0.84	1.89	0.99	2.28					6.00
Butterfish	3.59	3.06	0.73	1.80					9.19
Chub Mackerel									
Feather Blenny									
Fourspot Flounder									
Hickory Shad			1.74	9.18					10.92
Jacks									
Lined Seahorse									
Northern Kingfish			0.25	0.15				0.09	0.49
Northern Pipefish									

Table 3-3. (Continued)

	Summer 2003		Fall 2003		Winter 2004		Spring 2004		Total
Common Name	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	
Northern Puffer									
Northern Searobin									
Northern Stargazer			0.25						0.25
Red Hake									
Scup		0.22							0.22
Shortnose Sturgeon									
Silver Hake									
Silver Perch									
Smallmouth Flounder									
Spot	0.63	0.90							1.53
Spotted Hake									
Spotted Seatrout									
Striped Anchovy									
Striped Bass									
Striped Cusk Eel									
Striped Searobin		0.18							0.18
Summer Flounder	0.21								0.21
Weakfish	0.21		1.25	6.50					7.96
Windowpane Flounder									
Winter Flounder									
Atlantic Rock Crab									
Atlantic Surfclam									
Blue Crab									
Channeled Whelk									
Coarsehand Lady Crab									

Table 3-3. (Continued)

	Summer 2003		Fall 2003		Winter 2004		Spring 2004		Total
Common Name	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	**Area E**	**Fenwick Borrow**	
Heart Urchins									
Horseshoe Crab									
Knobbed Whelk								0.08	0.08
Lady Crab									
Moon Snails									
Portly Spider Crab							0.10	0.26	0.36
Purple Spined Sea Urchin									
Right Handed Hermit Crabs									
Sand Shrimp									
Squids									
Starfishes									
Atlantic Angel Shark									
Atlantic Sharpose Shark	0.42								0.42
Atlantic Stingray									
Bullnose Ray		0.18							0.18
Clearnose Skate		0.00					0.59	0.35	0.94
Dusky Shark	3.15	3.68							6.82
Little Skate									
Smooth Dogfish	2.51	3.51		0.35			4.37	4.48	15.23
Spiny Dogfish			1.73	3.67					5.40
Thresher Shark									
Winter Skate				0.15			0.10	0.61	0.87
Total Catch	**38.27**	**26.87**	**7.19**	**24.56**	**0.00**	**0.00**	**5.26**	**5.87**	
Number of species	**10**	**10**	**8**	**10**	**0**	**0**	**5**	**6**	

The total number of species and catch rates were the lowest in the winter 2004 collections relative to the other three seasons. Collections in both borrow areas produced 10 species each with comparable catch rates of about 64 individuals per standardized tow (Table 3-1). The winter collections were primarily dominated by invertebrates (sand shrimps and right-handed hermit crabs) with one species, Atlantic silversides, making up the bulk of the finfish catches. Atlantic silversides are typically found closer to shore (in the surf zone) but may have moved into offshore waters to over-winter.

Spring 2004 sampling in Area E and the Fenwick Island Borrow Area with the small trawl again resulted similar species numbers and average catch rates between both sampling areas. Catches in Area E contained 21 species and a total catch rate of 239 per standardized tow (Table 3-1). Catches in the Fenwick Island Borrow Area were similar with 19 species and a catch rate of 278. Large numbers of spotted hake, scup and butterfish were found in both borrow areas in varying proportions as were smallmouth flounder (4 per tow) and silver hake. The invertebrate catches ranged between 15 to 45 individuals per tow among the borrow areas for the right-handed hermit crabs, sand shrimps, and squid were in densities similar to those observed in the winter collections. Somewhat higher catches of the clearnose skate were taken in the spring 2004 (2-3 per tow), this species was absent in the fall 2003 and winter 2004 collections and rarely taken in the summer 2003 with the small trawl.

Commercial 80-foot Trawl

Relative to the small trawl, very different catch rates were observed in commercial trawl collections (Table 3-2). For example, butterfish, which was a minor component in the small trawl, were the major summer 2003 catch in the commercial trawls. Area E catches of butterfish were extremely high (800 per standardized commercial trawl) while lesser catches were recorded of the undisturbed Fenwick Island Borrow Area (58 per tow). Summer commercial trawling in Area E also produced high numbers of scup (74 per tow) relative to less than 1 per tow at the Fenwick Island Borrow Area and none in the small trawl summer 2003 collections. High catches of spotted hake were taken in both borrow areas (between 22 and 25 per tow) as were clearnose skates (between 30 and 40 per tow). The commercial trawls produced a higher diversity of invertebrate species relative to the small trawl probably because the trawl's heavier doors and tickler chain provide for better contact with the ocean bottom.

In fall 2003 commercial trawl collections, butterfish (36 per tow) remained the dominant fish species at Area E followed by windowpane flounder (12 per tow), weakfish (7 per tow) and scup (4 per tow, Table 3-2). Similar catches of windowpane flounder were taken at the Fenwick Island Borrow Area (12 per tow) but much fewer butterfish, weakfish, and scup were captured. Fall 2003 collections with the commercial gear produced high numbers of winter skate in both borrow areas (17 to 27 individuals per tow) as well as other species of sharks/rays. In general, the commercial trawl was much more effective at collecting cartilaginous fish than the small trawl and gillnet in all seasons. Despite some obvious differences in catch rates among species, both the total number of organisms collected (105 and 100) and the number of species

found (26 and 22) were remarkably similar between Area E and the Fenwick Island Borrow Area during the fall 2003 sampling events (Table 3-2).

As was seen with the small trawl sampling, total catch rates and species numbers were much reduced in the winter 2004 collections (Table 3-2). No one finfish or invertebrate species dominated the winter collections that produced 10 species in Area E and only 6 in the Fenwick Island Borrow Area. Winter skate was the primary species collected at both sites.

Total catches greatly increased during the spring 2004 sampling where over 1,000 organisms per tow among 18 different species were observed at Area E, while nearly 600 per tow among 27 species was taken at the Fenwick Island Borrow Area (Table 3-2). Scup and butterfish dominated the finfish catches at both sites (ranging form 42 to 868 per tow) while clearnose skates comprised most of the cartilaginous fish species in the collections (27 to 49 per tow).

Experimental Gillnets

Relative to the small trawl and commercial trawl collections, the experimental gillnet samples collected much fewer species and lower numbers of specimens (Table 3-3). During the summer 2003-gill net set, 10 species were collected by the gear in both borrow areas. Catch rates per hour of gill net soak time was higher at Area E (38 fish per hour) relative to the Fenwick Island Borrow Area (27 fish per hour). Summer 2003 catch composition was primarily Atlantic croaker, Atlantic menhaden, and butterfish although few numbers of Atlantic croaker were taken in the Fenwick Island Borrow Area gill net sets. Approximately equal numbers of smooth dogfish were taken at both areas during the summer 2003 gillnet collections (2-3 per hour of soak time).

Gillnet catches in the fall 2003 were much reduced at Area E (7 fish per hour) while catches in the Fenwick Island Borrow Area remained at levels observed in the summer sets (25 fish per hour, Table 3-3). Hickory shad, weakfish, and bluefish were the major finfish species collected at the Fenwick Island Borrow Area in fall 2003. These species were also observed at Area E but in lower abundance. Among the cartilaginous fishes collected during the fall sampling, spiny dogfish was the primary species taken by the gill nets.

Winter 2004 gill net sets produced no fish in either borrow site reflecting the low numbers observed in the small trawls and commercial trawls which are more active (mobile) sampling gears (Table 3-3).

The spring 2004 gill net sets produced between 5 and 6 species between the borrow sites at catch rates of only about 6 fish per hour of soak time (Table 3-3). Two of the six species found in the Fenwick Island Borrow Area sets were invertebrates (horseshoe crabs and portly spider crabs) tangled in the gear. Smooth dogfish comprised the major portion of the spring 2004 collection at both borrow area where approximately four specimens per soak hour was taken by the gear.

3.2.3 Statistical Tests Within Gear Type, Season, and Borrow Area

If sand dredging and the creation of the pit in 1998 had a long-term impact on the fish community, then differences between communities in Area E and the undisturbed Fenwick Island Borrow Area would be apparent. The results of the statistical testing on the fisheries data collected at Area E and the Fenwick Island Borrow Area suggest that no significant differences in either fish community composition or abundance exist (Table 3-4). Statistical tests with the entire database indicated that the standardized catch rates were significantly different between seasons as would be expected but not between borrow areas. With one exception, no significant difference in number of species was observed between the affected (Area E) and reference (Fenwick Island) borrow areas. Significantly higher numbers of species were taken in the Area E with the 25-foot trawl compared to the Fenwick Island Borrow Area (Table 3-4). Differences in the Shannon-Wiener Diversity Index were significant between seasons for all gears, but not borrow area (Table 3-4).

Analysis of variance testing on total catch, number of species and the Shannon-Wiener Diversity Index on data subsets (e.g., invertebrates only, fish only, pelagic invertebrates) all resulted in the same conclusion that no significant borrow site difference was detected despite the fact that a 10 deep, 43 acre pit was created in 1998.

Table 3-4. ANOVA results testing for differences between total catch, number of species, and the Shannon-Wiener Index of diversity for the three gear types used. Significant differences are shaded (p=0.05).

Gear	Dependent Variable	Source	DF	SS	MS	F Value	Prob >F
25-ft trawl	Log Total Catch	Season	3	5.069	1.690	23.66	<.0001
		Borrow Area	1	0.117	0.117	1.63	0.212
	Number of Species	Season	3	443.344	147.781	12.62	<.0001
		Borrow Area	1	52.531	52.531	4.49	0.044
	Shannon-Wiener	Season	3	14.179	4.726	7.02	<.0001
		Borrow Area	1	0.012	0.012	0.02	0.895
Commercial trawl	Log Total Catch	Season	3	16.057	5.352	59.04	<.0001
		Borrow Area	1	0.355	0.355	3.92	0.057
	Number of Species	Season	3	853.371	284.457	32.85	<.0001
		Borrow Area	1	34.000	34.000	3.93	0.057
	Shannon-Wiener	Season	3	23.580	7.860	10.44	<.0001
		Borrow Area	1	0.002	0.002	0	0.956

Table 3-4. (Continued)

Gear	Dependent Variable	Source	DF	SS	MS	F Value	Prob >F
Gillnet	Log Total Catch	Season	3	9.736	3.245	75.17	<.0001
		Borrow Area	1	0.122	0.122	2.82	0.104
	Number of Species	Season	2	64.333	32.167	15.02	<.0001
		Borrow Area	1	4.167	4.167	1.95	0.178
	Shannon-Wiener	Season	2	9.019	4.509	22.13	<.0001
		Borrow Area	1	0.340	0.340	1.67	0.211

3.2.4 Comparisons with Fisheries Data Collected from an Offshore Minerals Management Service Study

Because few differences in catch rates and species composition where observed between shoal and reference sampling, all data were combined for comparison to the Area E and Fenwick Island Borrow Area samples for the seasons and years that overlapped with the concurrent MMS study. Because no statistically significant differences were detected between Area E and the Fenwick Island Borrow Area fish communities, these data were combined as well to contrast inshore (USACE data) versus offshore (MMS data; Versar 2005) differences in fish community composition and abundance.

25-Foot Trawls

Comparison of the mean total catch per unit effort (CPUE) of all fish, sharks/rays, and invertebrates taken by the 25-foot trawls taken inshore (Area E and Fenwick Island Borrow Area) indicated that catches were dramatically higher in most seasons compared to the offshore MMS study (Figure 3-5). Summer 2003 inshore catches averaged 238 organisms per standardized tow while the offshore samples averaged only 36 per tow. Weakfish, right-handed hermit crabs, bay anchovies, and Atlantic croakers dominated summer 2003 inshore collections for the 25-foot trawl (Appendix B, Table B-1). In offshore waters bay anchovies, starfish, right-handed hermit crabs, and scup were the primary species taken by the gear.

In the fall of 2003, catches in the inshore area were over ten times higher than offshore collections. Atlantic croakers, bay anchovies, and sand shrimp were the dominant inshore species while the offshore trawls were comprised of mostly invertebrates such as starfish, hermit crabs, and squids. Winter 2004 catches were low in both the inshore and offshore areas with slightly more organisms taken from the inshore waters (Figure 3-5). Sand shrimps, hermit crabs, and starfish were the primary invertebrates taken while the Atlantic silverside was the dominant

fish. Silversides are commonly found in the surf zone in warmer months and may use inshore waters as over-wintering habitat. Only 20 organisms per tow were taken in the offshore waters in winter 2004 comprising mostly sand shrimp, gastropods, starfishes, and hermit crabs. Very few fish were collected in the offshore small trawls in winter 2004 (Appendix B, Table B-1).

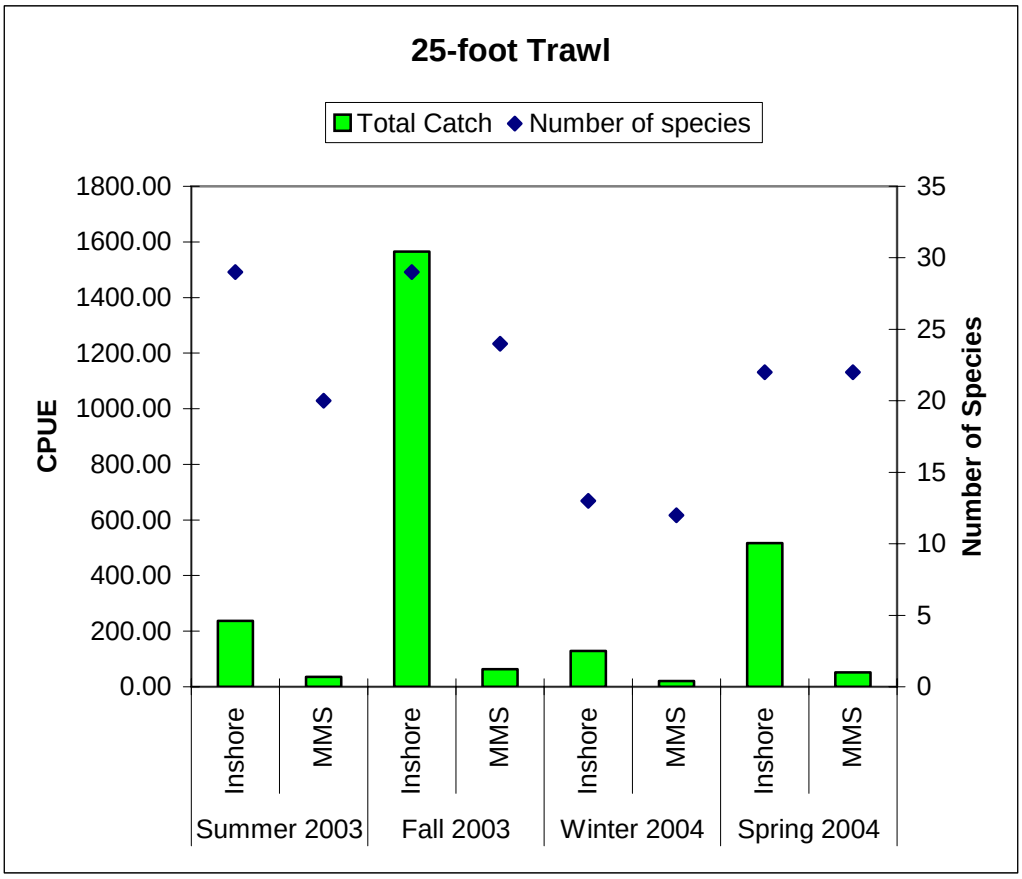

Figure 3-5. Comparison of mean CPUE and number of species collected between the inshore (USACE data) and offshore (MMS data) 25-foot trawl collections among seasons

Spring 2004 inshore trawling produced higher catches (517/tow) than offshore trawling (51/tow). Higher catches in the inshore area was spread out among more species than in other seasons. Although high numbers of spotted hake (230/tow) were collected in the inshore areas, high catches of squid (89/tow), sand shrimp (48/tow), hermit crabs (47/tow), scup (32/tow), northern searobins (15/tow), and butterfish (15/tow) were also collected in the spring 2004 collection (Appendix B, Table B-1). The offshore catches were dominated by squids (15/tow), hermit crabs (9/tow), starfish (8/tow), and gastropods (5/tow).

Commercial trawls

Inshore summer 2003 catch rates with the commercial trawler produced dramatically higher catches (1,173 organisms/tow) relative to the offshore collections at the MMS study sites (371/tow; Figure 3-6). The inshore commercial trawls produced large numbers of butterfish, scup, clearnose skate, and spotted hake. In the offshore commercial trawls, scup was the dominant fish species in the collections followed by the northern searobin, and American sand lance (Appendix B, Table B-2). While the mean catches in the fall 2003 commercial trawls were similar between the inshore (205/tow) and offshore (355/tow) collections, the species dominance patterns were different. Inshore commercial trawls collected primarily winter skate, butterfish, windowpane flounder, and lady crabs; offshore trawls collected primarily spiny dogfish, striped bass, and winter skates. The high occurrence of striped bass in the offshore waters was largely a function of an extremely high catch (1,225 in one tow) of 24-inch adults taken at Fenwick Shoals in the fall of 2003. Winter 2004 commercial trawl catches were low in both the inshore and offshore collections (Figure 3-6) with winter skate, windowpane, and little skates being the dominant catch in both areas (Appendix B, Table B-2). Spring 2004 commercial trawl catches increased dramatically to over 1,100 organisms taken per tow in both the inshore and offshore areas and both inshore and offshore trawls contained large numbers of scup, butterfish, and squid.

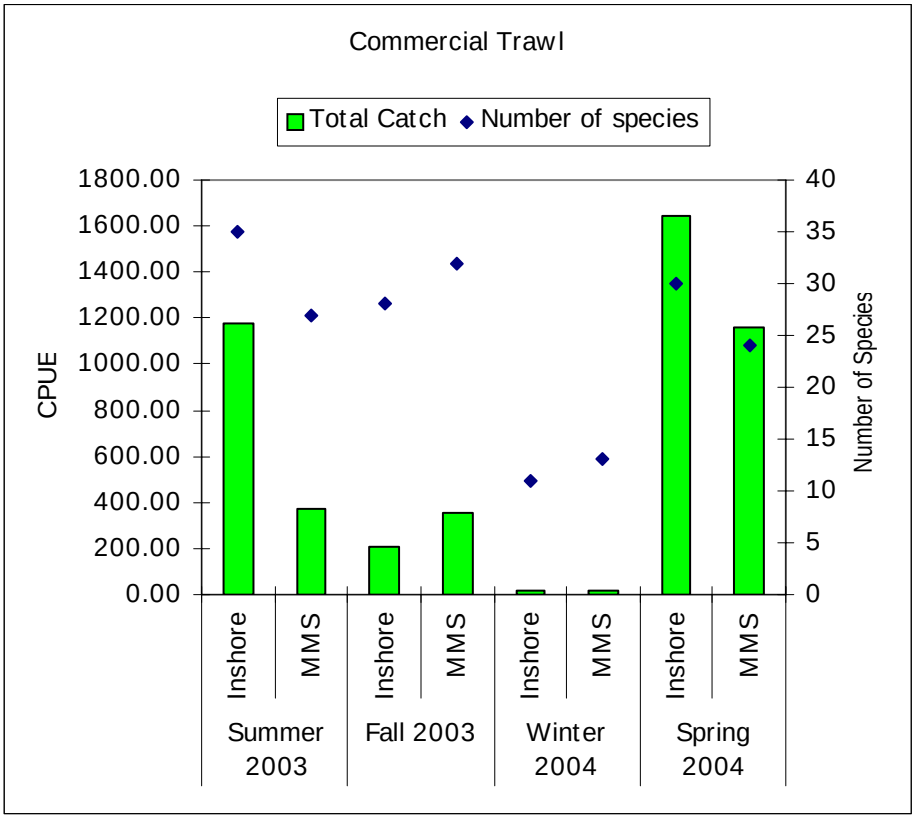

Figure 3-6. Comparison of mean CPUE and number of species collected between the inshore (USACE data) and offshore (MMS data) commercial trawl collections among seasons

Experimental Gill Nets

Gillnet catch rates in the inshore samples at Area E and Fenwick Island Borrow Area was generally higher in all seasons than the offshore collections except in winter 2004 (Figure 3-7). Atlantic menhaden, Atlantic croaker, and smooth dogfish were the dominant species captured in both areas in the summer 2004 gillnet collections (Appendix B, Table B-3). Dusky sharks were also collected in relatively high proportions in the inshore sets. Inshore catches averaged 65 fish per hour of soak time, while only 10 fish per hour were taken in the offshore gillnets (Figure 3-7). In the fall of 2003 hickory shad, weakfish, and spiny dogfish dominated the inshore gillnet catches in contrast to the offshore sets that took primarily spiny dogfish (20/per hour, Appendix B, Table B-3). Winter 2004 gillnets sets produced zero catches in the inshore collections and extremely low numbers of a few species in the offshore sets. Inshore gillnet collections in the spring 2004 season produced about 11 fish per hour of soak time and only 3 fish per hour in the offshore waters. Smooth dogfish was the dominant species to both areas. A few specimens of adult American shad were taken (5) in the offshore sets, potential stragglers from the eastern seaboard anadromous spawning run.

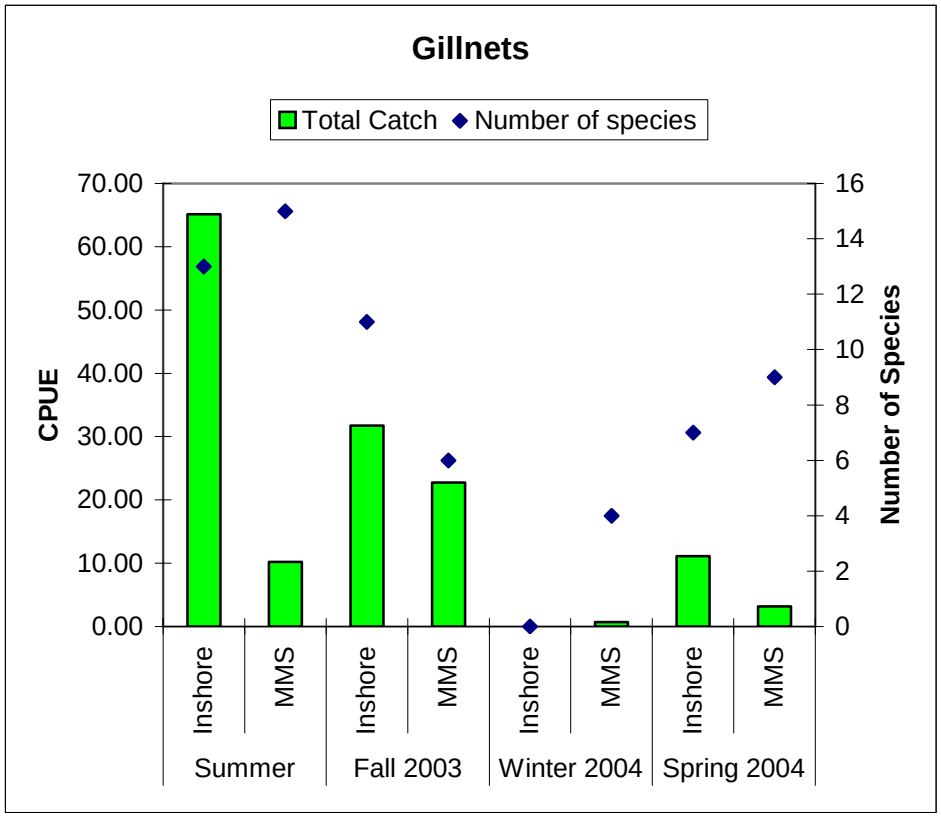

Figure 3-7. Comparison of mean CPUE and number of species collected between the inshore (USACE data) and offshore (MMS data) experimental gillnet collections among seasons

3.3 BENTHIC VIDEO SLED

3.3.1 Habitat characterization

The summarized data sampled from the horizontal and vertical cameras are presented in Appendix C. The 2.5-minute sampling interval produced a total of 481 data points between Area E and the Fenwick Island Borrow Area. Of the total number of points, 269 were collected in Area E and 212 were collected in the Fenwick Island Borrow Area (Appendix C). Individual habitat classifications were combined for each data point to arrive at a final benthic habitat classification for the video track lines.

Of the 60 total possible combinations of habitat classification, 34 occurred within the two survey areas (Table 3-5). Overall, the most commonly occurring habitat type (habitat code 3000) was small, sharp crested bedforms, with fine-medium-sand sediments, less than 10% shell cover, and no biogenic activity (87 out of 481 samples). Sixty-nine of the 87 occurrences of habitat code 3000 occurred in Area E (Figure 3-8, Appendix C). The majority of these 69 habitat classifications were located in the lower half of Area E (Figure 3-8). The second most common habitat type within both survey areas had the same features except the bedforms were smooth and large (habitat code 2000: 65 samples). Thirty-nine of the 65 data points of this habitat classification occurred in the Fenwick Island Borrow Area (Figure 3-8, Appendix C). Maps depicting the various physical and biological features measured from the survey are presented in Appendix D.

Table 3-5. Frequency of final habitat classifications observed between Area E and the Fenwick Island Borrow Area during the April 2004 benthic video sled survey conducted by VIMS.

Habitat Code	Bedform Size	Bedform Shape	Grain-size	Shell Cover	Biogenic	Total Frequency
1000	Large	Sharp	Fine-Medium sand	<10% Shell	Not Biogenic	26
1001	Large	Sharp	Fine-Medium sand	<10% Shell	Biogenic	2
1010	Large	Sharp	Fine-Medium sand	>10% Shell	Not Biogenic	5
1011	Large	Sharp	Fine-Medium sand	>10% Shell	Biogenic	1
1100	Large	Sharp	Coarse sand-Granules	<10% Shell	Not Biogenic	6
1110	Large	Sharp	Coarse sand-Granules	>10% Shell	Not Biogenic	1
1200	Large	Sharp	Pebble-Cobble-Rock	<10% Shell	Not Biogenic	11
2000	Large	Smooth	Fine-Medium sand	<10% Shell	Not Biogenic	65
2001	Large	Smooth	Fine-Medium sand	<10% Shell	Biogenic	1
2010	Large	Smooth	Fine-Medium sand	>10% Shell	Not Biogenic	6
2100	Large	Smooth	Coarse sand-Granules	<10% Shell	Not Biogenic	4
2110	Large	Smooth	Coarse sand-Granules	>10% Shell	Not Biogenic	2

Table 3-5. (Continued)

Habitat Code	Bedform Size	Bedform Shape	Grain-size	Shell Cover	Biogenic	Total Frequency
2200	Large	Smooth	Pebble-Cobble-Rock	<10% Shell	Not Biogenic	21
2201	Large	Smooth	Pebble-Cobble-Rock	<10% Shell	Biogenic	3
2210	Large	Smooth	Pebble-Cobble-Rock	>10% Shell	Not Biogenic	3
3000	Small	Sharp	Fine-Medium sand	<10% Shell	Not Biogenic	87
3001	Small	Sharp	Fine-Medium sand	<10% Shell	Biogenic	4
3010	Small	Sharp	Fine-Medium sand	>10% Shell	Not Biogenic	13
3011	Small	Sharp	Fine-Medium sand	>10% Shell	Biogenic	1
3100	Small	Sharp	Coarse sand-Granules	<10% Shell	Not Biogenic	49
3101	Small	Sharp	Coarse sand-Granules	<10% Shell	Biogenic	1
3110	Small	Sharp	Coarse sand-Granules	>10% Shell	Not Biogenic	9
3200	Small	Sharp	Pebble-Cobble-Rock	<10% Shell	Not Biogenic	43
3210	Small	Sharp	Pebble-Cobble-Rock	>10% Shell	Not Biogenic	6
4000	Small	Smooth	Fine-Medium sand	<10% Shell	Not Biogenic	59
4001	Small	Smooth	Fine-Medium sand	<10% Shell	Biogenic	5
4010	Small	Smooth	Fine-Medium sand	>10% Shell	Not Biogenic	11
4011	Small	Smooth	Fine-Medium sand	>10% Shell	Biogenic	2
4100	Small	Smooth	Coarse sand-Granules	<10% Shell	Not Biogenic	7
4200	Small	Smooth	Pebble-Cobble-Rock	<10% Shell	Not Biogenic	10
4201	Small	Smooth	Pebble-Cobble-Rock	<10% Shell	Biogenic	1
4210	Small	Smooth	Pebble-Cobble-Rock	>10% Shell	Not Biogenic	3
5100	None	.	Coarse sand-Granules	<10% Shell	Not Biogenic	2
5210	None	.	Pebble-Cobble-Rock	>10% Shell	Not Biogenic	11
Total						**481**

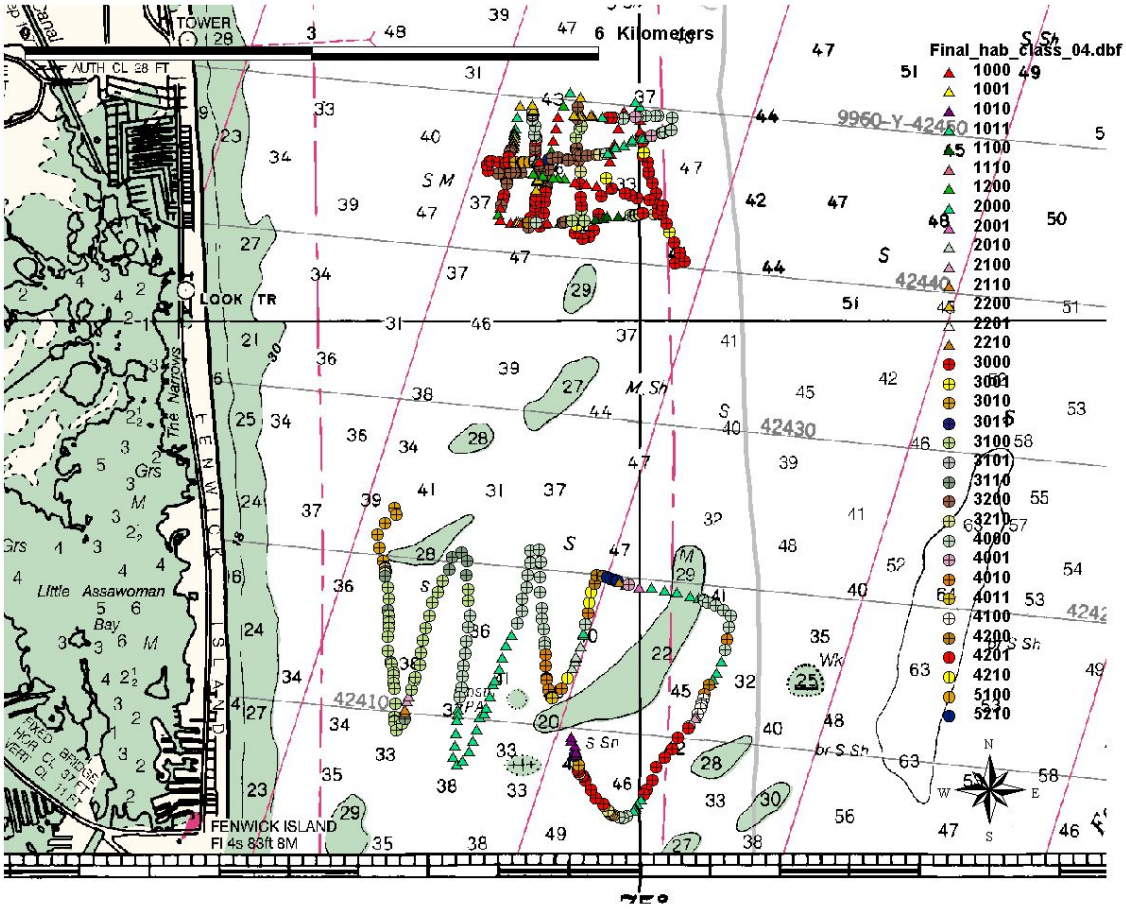

Figure 3-8. Final habitat classifications based on data from the video sled track lines within Area E and the Fenwick Island Borrow Area

3.3.2 Comparisons Between Area E and Fenwick Island Borrow Area

The biological features counted in the forward and downward facing cameras were very similar between the two borrow areas and in most cases slightly more features were observed in Area E relative to the Fenwick Island Borrow Area (Table 3-6). The biology parameter (i.e., live invertebrates captured in the digital images) averaged 3.7 organisms in Area E and 2.5 in the Fenwick Island Borrow Area. The number of biogenic parameters (i.e., physical features created by organisms) in Area E (0.8) was similar to the Fenwick Island Borrow Area (0.4) with high variability. Fish and skate/ray counts were higher in Area E compared to the Fenwick Island Borrow Area but again the variability was high (Table 3-6).

Table 3-6. Summary of biological features counted in the vertical and horizontal camera images collected at Area E and the Fenwick Island Borrow Area during the April 2004 bottom survey.

Borrow Area		Biology	Biogenic Biology	Fishes	Ray/Skate
Area E	Average	3.71	0.80	0.50	0.14
(N=269)	SD	4.08	2.14	0.74	0.39
Fenwick Borrow	Average	2.53	0.44	0.30	0.08
(N=212)	SD	4.90	1.48	0.58	0.33

The habitat codes created by the visual observations from the downward facing camera were compared to evaluate what differences existed between Area E and the Fenwick Island Borrow Area (Table 3-7). The four most common habitat codes observed in Area E were 3000, 3200, 1000 and 2000. Habitats classified as 2000 and 3000 were also two of the most common at the Fenwick Island Borrow Area but the other two, 4000 and 3100, were different than at Area E (Table 3-7). Although the frequencies of habitat codes were different between Area E and the Fenwick Island Borrow area, the biological significance of these differences is not apparent from this data.

Table 3-7. Frequency of final habitat classifications observed between Area E and the Fenwick Island Borrow Area during the April 2004 benthic video sled survey conducted by VIMS. See Table 3-5 for description of codes.

Habitat Code	Area E	Fenwick Borrow	Habitat Code	Area E	Fenwick Borrow
1000	26	0	3010	1	12
1001	2	0	3011	0	1
1010	0	5	3100	17	32
1011	0	1	3101	1	0
1100	6	0	3110	0	9
1110	0	1	3200	38	5
1200	11	0	3210	2	4
2000	26	39	4000	22	37
2001	0	1	4001	4	1
2010	0	6	4010	0	11
2100	0	4	4011	0	2
2110	0	2	4100	0	7
2200	21	0	4200	6	4
2201	3	0	4201	1	0
2210	2	1	4210	0	3
3000	69	18	5100	2	0
3001	4	0	5210	5	6
			Total	**269**	**212**

3.3.3 Area E

To evaluate whether a different distribution of benthic habitat codes existed within the dredged hole in Area E, data collected within the hole (N=25) were compared to (1) images taken from a 200 foot buffer (Figure 3-9) around the rim of the pit (N=22) and (2) images taken from the rest of Area E outside the pit (N=244; Table 3-8). The most frequent benthic habitat classifications within the Area E pit were 2200 (20%), 2000, 3200 and 4000 (all at 16%, Table 3-8). The most frequent habitat distribution around the rim of the pit was 3000 (32%). Benthic habitat classifications for the rest of Area E outside the pit were much more diverse and habitat classes 3000 (27%) and 3200 (14%) were dominant (Table 3-8). Average counts of the biological features recorded on the video images inside and outside the pit in Area E were similar suggesting similar biological activity within both areas (Figure 3-10).

3.3.4 Fenwick Island Borrow Area

The video sled survey conducted in the Fenwick Island Borrow Area was used to determine the sediment habitat types within the borrow. Of the 212 data points generated in the borrow area, 24 habitats were identified (Table 3-7). Within these 24 habitat classifications, three sediment habitat types were identified; sediments containing silt/clay and fine sands, sediments containing predominantly medium to coarse sand with some gravel, and sediments containing higher amounts of large pebbles/cobble sized rocks (Appendix C).

When the video sled track line sediment results were mapped, distinct patches of the three sediment habitats could be identified within the Fenwick Island Borrow Area (Figure 3-11). The first loop of the sled track within the borrow area contained mostly medium to coarse sand habitat (Figure 3-11). The second loop of the track line contained mainly sediments with fine particle sizes. Areas with pebble/cobble, or larger sized particles, were not as prominent but were clustered in a fashion so that areas containing these larger particles could be identified.

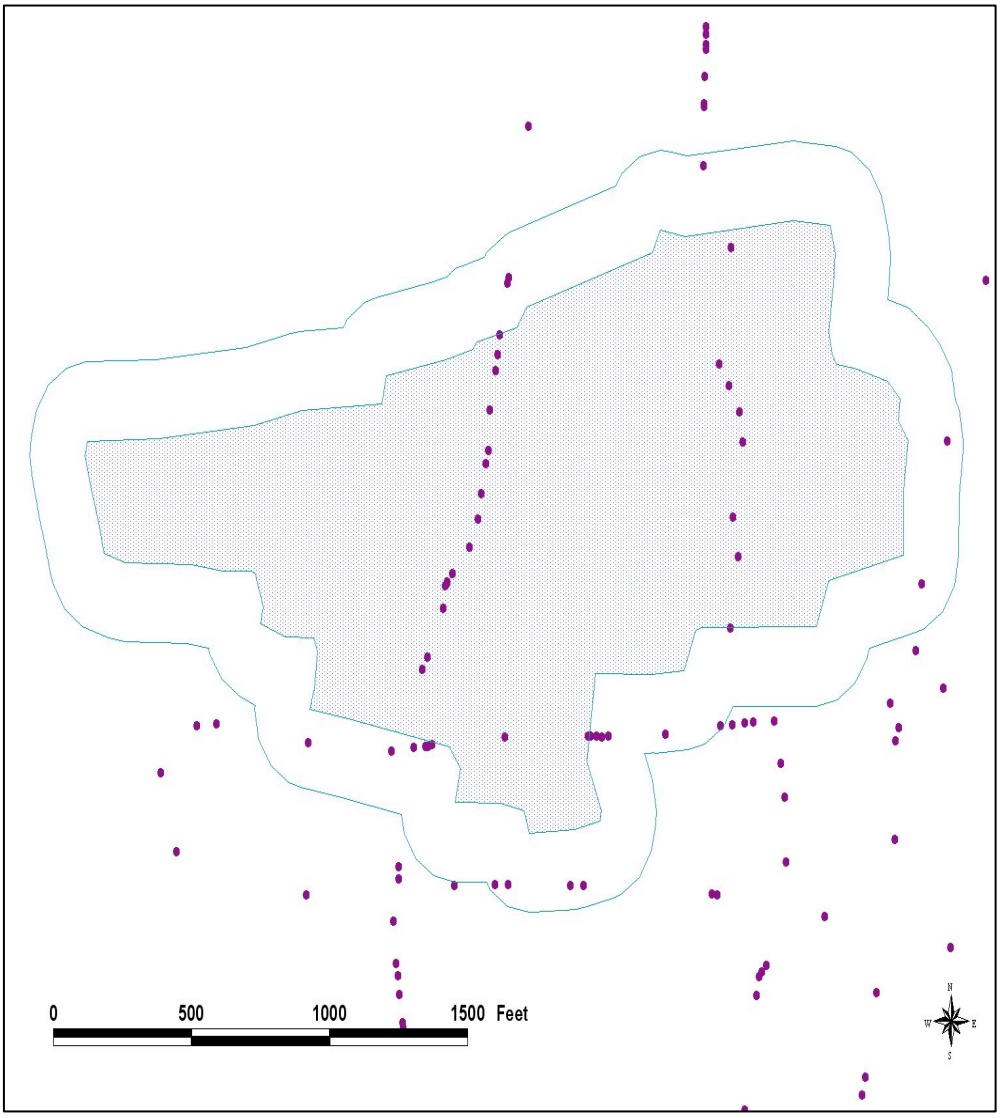

Figure 3-9. Video sled sampling points within the Area E pit and a 200-ft buffer around the rim of the pit.

Table 3-8. Frequency of final habitat classifications observed between Area E pit, at a 200-foot buffer around the rim of the pit, and all other Area E bottom habitats during the April 2004 benthic video sled survey conducted by VIMS. See Table 3-5 for description of codes.

Habitat Code	**Frequency in Pit**		**Frequency 200' from Pit**		**Frequency Outside Pit**	
	Count	%	Count	%	Count	%
1000	0	0	1	5	26	11
1001	0	0	0	0	2	1
1100	0	0	0	0	6	2
1200	0	0	2	9	11	5
2000	4	16	2	9	22	9
2200	5	20	0	0	16	7
2201	0	0	0	0	3	1
2210	0	0	0	0	2	1
3000	3	12	7	32	66	27
3001	0	0	0	0	4	2
3010	1	4	0	0	0	0
3100	0	0	1	5	17	7
3101	0	0	0	0	1	0
3200	4	16	3	14	34	14
3210	0	0	0	0	2	1
4000	4	16	1	5	18	7
4001	0	0	0	0	4	2
4200	2	8	0	0	4	2
4201	1	4	0	0	0	0
5100	0	0	2	9	2	1
5210	1	4	3	14	4	2
Total	**25**	**100**	**22**	**100**	**244**	**100**

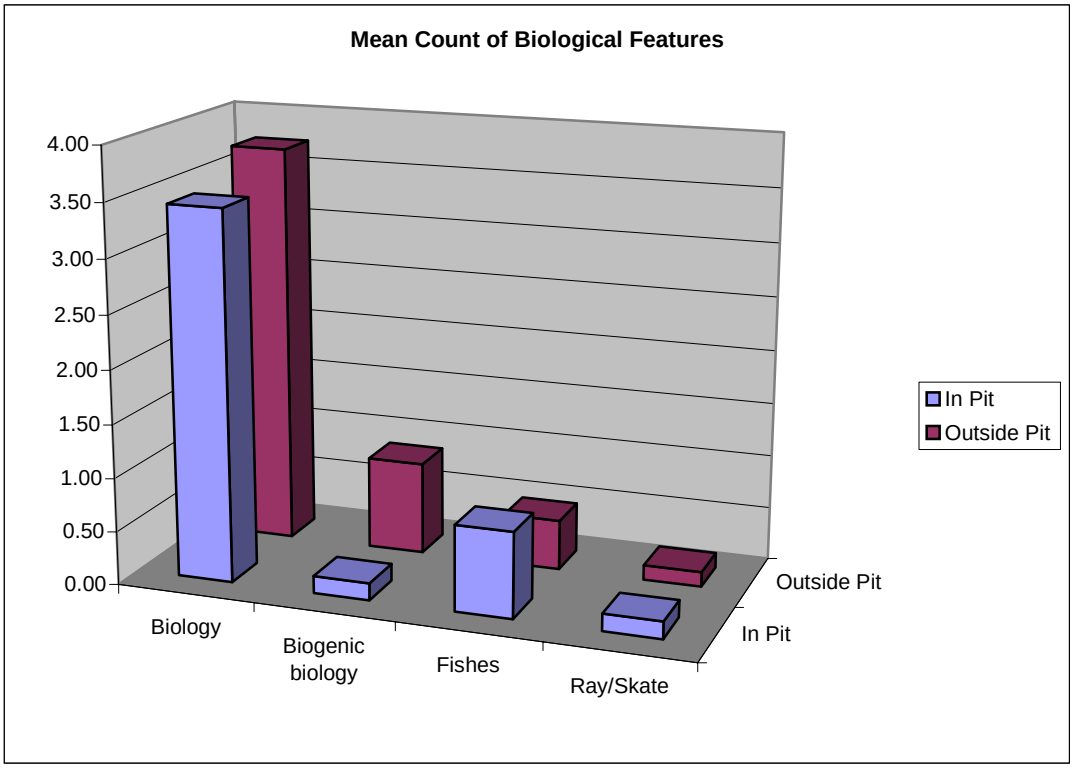

Figure 3-10. Mean count of biological features observed in the video images taken within and outside the Area E pit during the April 2004 VIMS survey.

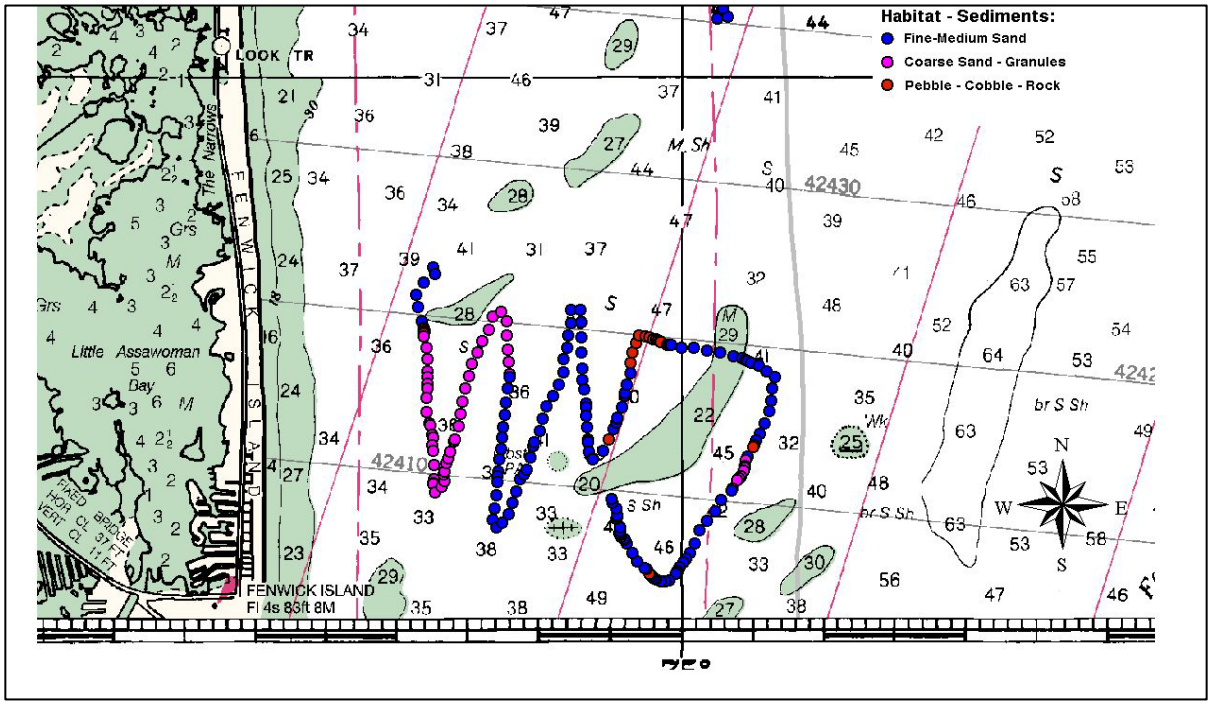

Figure 3-11. Video track lines within the Fenwick Island Borrow Area depicting the location of the three sediment habitats identified from the video images

3.4 MACROINVERTEBRATE GRAB SAMPLING

All information collected for each station including benthic species counts is presented in Appendix E. Benthic station specific sediment characteristics and sediment curves are presented in Appendix F.

3.4.1 Area E

Samples collected from within the pit created by previous dredging operations in Area E were compared to samples collected from undisturbed regions of the borrow area. Depth differences were significant inside and outside the pit. Inside the pit the mean depth was about 17 meters and outside the pit it was about 12 meters (Table 3-9).

Surface sediments inside the pit contained significantly higher levels of silt/clay particles than outside the pit (Table 3-9). The total organic carbon (TOC) in the surface sediments inside the pit (4.03%) was higher than outside the pit (0.30), which is not surprising because silt/clay particles have a higher organic content than sand particles, but the difference was not significant due to high variability (Table 3-9). The sediment curves for surface sediment analysis clearly shows that Stations E3, E4, and E5 contained the highest amounts of silt/clay particles (Appendix F). The rest of the stations contained mixtures of fine, medium, and coarse sands. The surface sediment samples did not contain any pebbles or larger sized gravel particles although the video sled results indicated areas with these particles existed within Area E (Figure 3-12). This was not surprising since the objective of sampling in Area E did not include ground truthing of the video camera results. Randomly selected benthic sampling sites do not appear to correspond to the location of the gravel sized particles indicated by the video sled (Figures 2-6 and 3-12).

Table 3-9. Means of sediment and station depth characteristics recorded during benthic macroinvertebrate sampling inside and outside the dredged pit created in Area E

Parameter	Inside Pit	Outside Pit	Anova
Depth (m)	16.78 (0.41)	11.94 (1.43)	*
Silt/Clay Content (% < 63 μm)	40.23 (36.42)	0.84 (0.19)	*
Total Organic Content (%)	4.03 (3.46)	0.30 (0.20)	NS

Water quality was measured at one station (E4) located inside the previously created pit during the benthic macroinvertebrate sampling. Some differences in surface and bottom measurements were detected at this 17 m deep station but the differences were small and most likely inconsequential to the benthic community at the station (Table 3-10). The small differences detected in dissolved oxygen concentrations (DO) and turbidity were not large enough to cause an impact on the benthic community.

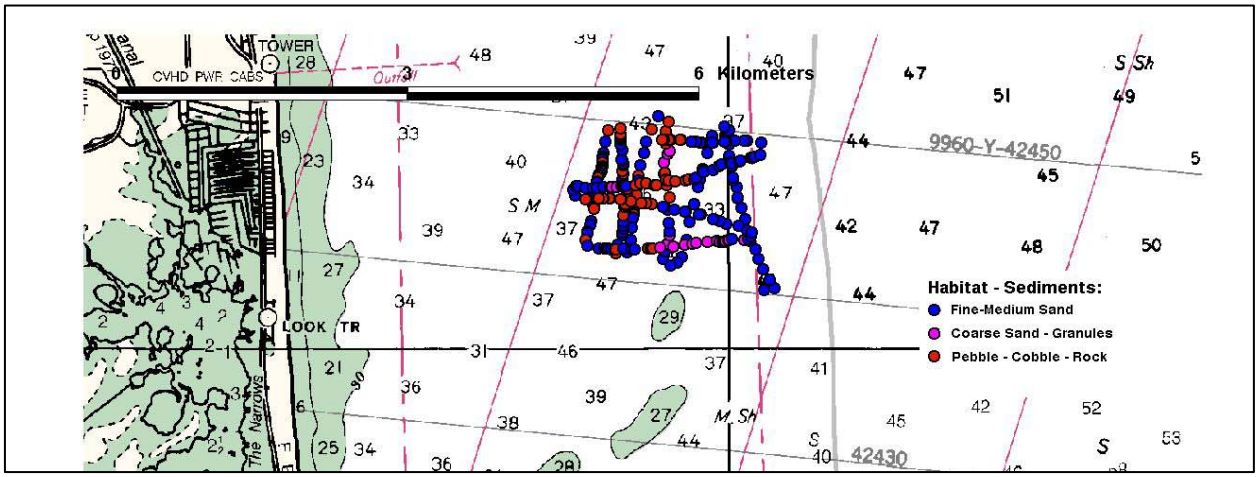

Figure 3-12. Surface sediment habitats as classified by the benthic video sled results in Area E.

Table 3-10. Water quality measurements recorded at various stations within Area E and the Fenwick Island Borrow Area during benthic macroinvertebrate sampling conducted in November 2004

Parameter	Station E4		Station F3		Station F9		Station F13	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
Depth (m)	0.5	17.1	.05	10.5	0.5	12.7	0.5	14.0
Temperature (°C)	13.47	13.45	13.42	13.36	13.46	13.49	13.41	13.36
Salinity (ppt)	31.19	31.19	31.16	31.12	31.08	31.07	31.11	31.16
DO (mg/l)	8.68	8.31	8.74	8.39	8.94	8.88	9.22	8.77
Conductivity (mS/cm)	47.77	47.78	47.73	47.68	47.63	47.62	47.67	47.74
pH	7.18	7.18	7.26	7.27	7.43	7.40	7.18	7.15
Turbidity (NTU)	20.9	22.1	30.8	31.4	28.6	31.0	19.9	37.4

Benthic community differences were detected between the samples collected within and outside the pit in Area E. For the infauna community, a higher percentage of the benthic composition was comprised of molluscs inside the pit and arthropods made up a much higher percentage of the benthic composition outside the pit (Figure 3-13). The percentage of polychaetes and oligochaetes were similar inside and outside the pit.

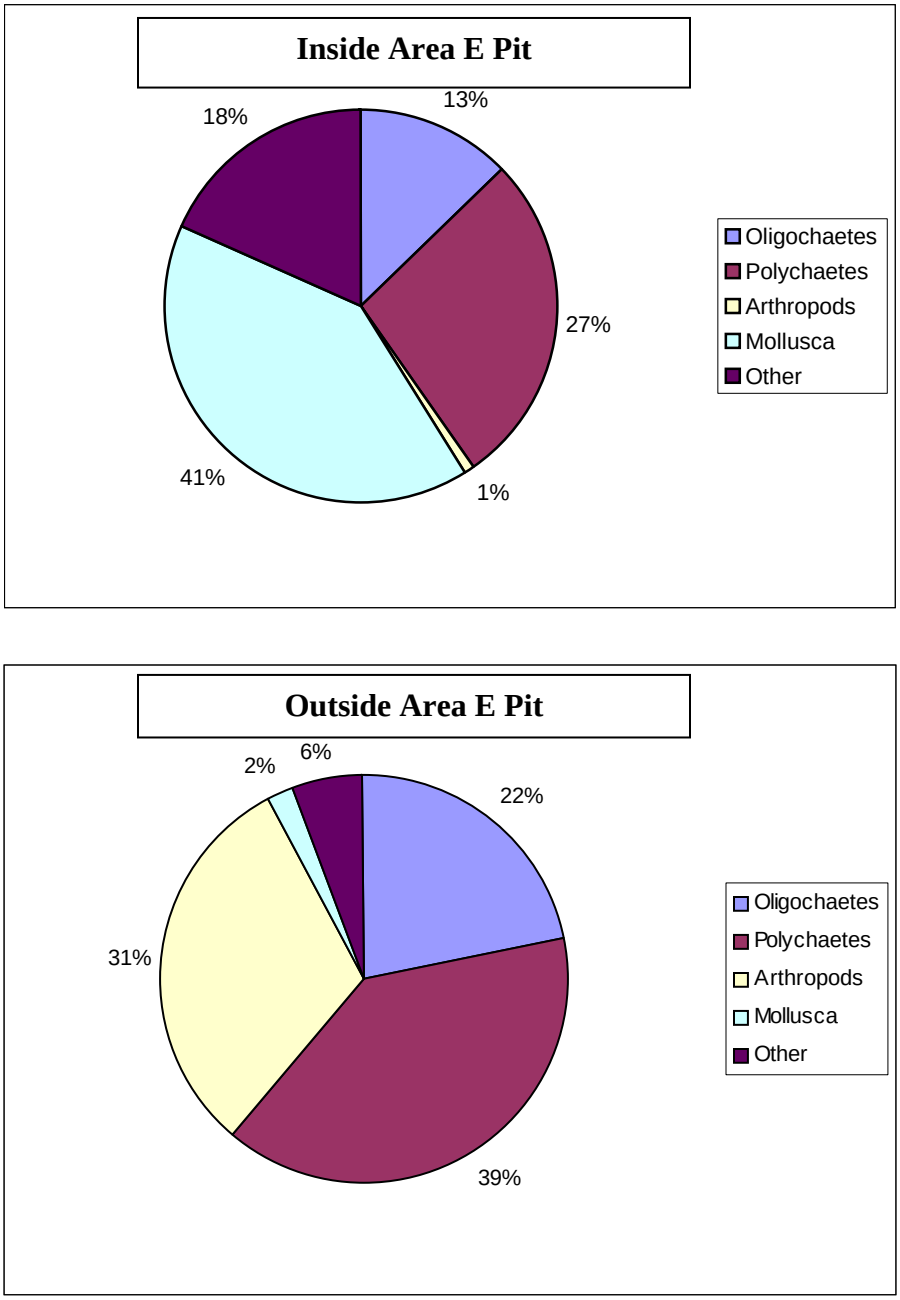

Figure 3-13. Benthic community composition inside and outside the pit previously created in Area E

Differences in the benthic composition detected between the two sampling areas in Area E were apparent in the dominant taxa of the two areas. Many of the dominant taxa within the pit were different than outside the pit. The snail *Acteocina canaliculata* and the clam *Nucula proxima* were the two most dominant taxa within the pit whereas neither of these two taxa were

collected in the samples outside the pit (Table 3-11). Outside the dredge pit the tanaid crustacean, *Tanaissus psammophilus*, was the most abundant taxa, yet was not collected at all inside the dredge pit (Table 3-11). Even though little difference in the percentage of polychaetes to the total community composition existed between the two sampling areas, many differences in the dominant polychaete taxa were apparent. Inside the pit, *Mediomastus ambiseta* and *Paraprionospio pinnata* were the two most dominant polychaetes but outside the pit they were either collected in very small numbers or not at all (Table 3-11). Outside the pit, the polychaetes *Aricidea cerrutii*, *Hesionura coineaui*, and *Streptosyllis pettiboneae*, were among the top dominant taxa but were not collected at all inside the pit (Table 3-11).

Table 3-11. Mean abundance of the top ten taxa collected from inside and outside Area E along the Delaware coast

Taxonomic Group	Taxon	Inside (#/m^2)	Outside (#/m^2)
Nemertina	Nemertina	881.82	181.82
Annelida : Polychaeta	*Aricidea catherinae*	81.82	190.91
	Aricidea cerrutii	0.00	118.18
	Hesionura coineaui	0.00	100.00
	Mediomastus ambiseta	545.45	18.18
	Paraprionospio pinnata	350.00	0.00
	Polygordius spp.	9.09	100.00
	Scoloplos rubra	4.55	77.27
	Streptosyllis pettiboneae	0.00	209.09
	Tharyx sp. A Morris	104.55	113.64
Annelida : Oligochaeta	Oligochaeta	904.54	790.91
Mollusca : Gastropoda	*Acteocina canaliculata*	1022.72	0.00
	Nassarius trivittatus	131.82	9.09
Mollusca : Bivalvia	*Nucula proxima*	3036.35	0.00
	Tellina agilis	177.27	36.36
Arthropoda : Tanaidacea	*Tanaissus psammophilus*	0.00	827.27

Anova tests run on various benthic community parameters further illustrate the differences detected in the benthic communities residing inside and outside the pit of Area E. Although the total infauna abundance inside the pit was over double that outside the pit, the difference was not significant due to a high standard error (Table 3-12). However, the large number of bivalves detected inside the pit led to a significant difference in both abundance and biomass between the two areas examined (Table 3-12). More epifauna taxa were collected inside the pit but the overall abundance of epifauna taxa was low.

Table 3-12. Mean and standard error (in parentheses) of various benthic community parameters measured at stations sampled within Area E in November 2004. ANOVA results are presented in the last column (*= significant at the 0.05 level).

Parameter	Inside Pit	Outside Pit	ANOVA Results
Number of taxa	24.20 (5.54)	23.40 (4.46)	NS
Shannon-Wiener Index	2.85 (0.31)	3.16 (0.23)	NS
Simpson's Dominance Index	0.77 (0.05)	0.80 (0.05)	NS
Number taxa > 2cm	1.60 (0.51)	1.00 (0.55)	NS
Total Abundance (#/m^2)	7809.07 (2640.18)	3331.81 (447.36)	NS
Amphipod Abundance (#/m^2)	36.36 (9.09)	31.82 (13.64)	NS
Bivalve Abundance (#/m^2)	3249.99 (1729.99)	59.09 (5.57)	*
Polychaete Abundance (#/m^2)	1445.45 (259.79)	1395.45 (284.10)	NS
Abundance organisms > 2cm (#/m^2)	59.09 (24.48)	22.73 (12.45)	NS
Total Biomass AFDW (g/m^2)	3.40 (1.01)	2.85 (2.43)	NS
Amphipod Biomass AFDW (g/m^2)	0.01 (0.01)	0.03 (0.01)	NS
Bivalve Biomass AFDW (g/m^2)	1.74 (0.58)	0.06 (0.02)	*
Polychaete Biomass AFDW (g/m^2)	0.61 (0.24)	0.15 (0.07)	NS
Number of Epifauna Taxa	1.80 (0.20)	0.60 (0.24)	*
Epifauna Abundance (#/m^2)	100.00 (42.28)	54.55 (43.48)	NS
Epifauna Biomass (g/m^2)	0.02 (0.01)	0.02 (0.02)	NS

Significant differences in some of the benthic parameters examined were also detected within the pit, outside the pit, and in data from December1997. The samples collected in 1997 had a significantly lower mean total infauna abundance than both inside and outside the pit (Table 3-13). The much higher abundances of *A. canaliculata* and *N. proxima* led to a significantly higher total mollusc abundance and biomass inside the pit compared to outside the pit and to 1997 data (Table 3-13). Significantly more epifauna species were collected inside the pit but overall, epifauna abundance was low in both areas in 2004 and in 1997. The number of taxa collected in 1997 and 2004 were not significantly different but diversity, as measured by the

Shannon-Wiener and Simpson's Dominance Indices, were significant. Duncan's results indicated that both indices were significantly lower inside the pit compared to 1997 but that outside the pit was not significantly different then either inside the pit or to 1997 data (Table 3-13).

Table 3-13. Mean and standard error (in parentheses) of various infauna (unless labeled as epifauna) benthic community parameters measured at stations sampled inside and outside the dredged pit of Area E in 2004 and in 1997. ANOVA results testing for differences between the three areas are presented in the last column (*= significant at the 0.05 level).

Parameter	Inside Pit	Outside Pit	1997	ANOVA Results
Number of taxa	24.20 (5.54)	23.40 (4.46)	19.80 (1.20)	NS
Shannon-Wiener Index	2.85 (0.31)	3.16 (0.23)	3.54 (0.06)	*Inside pit and 1997 significantly different
Simpson's Dominance Index	0.77 (0.05)	0.80 (0.05)	0.87 (0.01)	*Inside pit and 1997 significantly different
Number taxa > 2cm	1.60 (0.51)	1.00 (0.55)	1.28 (0.30)	NS
Total Abundance (#/m^2)	7809.07 (2640.18)	3331.81 (447.36)	1904.54 (244.33)	*1997 significantly lower
Amphipod Abundance (#/m^2)	36.36 (9.09)	31.82 (13.64)	199.09 (70.92)	NS
Bivalve Abundance (#/m^2)	3249.99 (1729.99)	59.09 (5.57)	119.09 (19.34)	*Inside pit significantly higher
Polychaete Abundance (#/m^2)	1445.45 (259.79)	1395.45 (284.10)	985.45 (156.53)	NS
Abundance organisms > 2cm (#/m^2)	59.09 (24.48)	22.73 (12.45)	32.73 (6.44)	NS
Total Biomass AFDW (g/m^2)	3.40 (1.01)	2.85 (2.43)	5.49 (4.48)	NS
Amphipod Biomass AFDW (g/m^2)	0.01 (0.01)	0.03 (0.01)	0.10 (0.02)	NS
Bivalve Biomass AFDW (g/m^2)	1.74 (0.58)	0.06 (0.02)	0.11 (0.02)	*Inside pit significantly higher
Polychaete Biomass AFDW (g/m^2)	0.61 (0.24)	0.15 (0.07)	0.31 (0.07)	NS
Number of Epifauna Taxa	1.80 (0.20)	0.60 (0.24)	0.76 (0.17)	*Inside pit significantly higher
Epifauna Abundance (#/m^2)	100.00 (42.28)	54.55 (43.48)	34.55 (10.17)	NS
Epifauna Biomass (g/m^2)	0.02 (0.01)	0.02 (0.02)	0.02 (0.01)	NS

An examination of the frequency of occurrence of taxa collected within the five samples from both areas helps to further explain the differences detected by the cluster analysis. Inside the pit, the polychaete worms, *P. pinnata* and *M. ambiseta*, and the bivalve, *N. proxima* were collected in all five samples but not in any of the samples outside the pit (except one sample, E6, had a low abundance of *M. ambiseta* outside the pit, Appendix E). Outside the pit, the polychaetes, *S. pettiboneae* and *Sigalion arenicola*, and the tanaid shrimp *T. psammophilus*, were collected from most of the samples yet none were collected in any of the pit samples (Appendix E).

Differences detected in the benthic community inside and outside the pit of Area E were definitive in the cluster analysis. All five pit samples clustered separately from the five samples outside the pit (Figure 3-14). The abundance cluster analyses uses all the benthic community information contained within each sample to identify similar stations. Differences detected in the benthic infauna community composition and dominance inside and outside the pit described above explain many of the differences detected by the cluster analysis. Within the cluster of pit samples, the three stations with high silt/clay percentages (i.e., E3, E4, and E5) clustered more similarly than E2 and E1 (Figure 3-14).

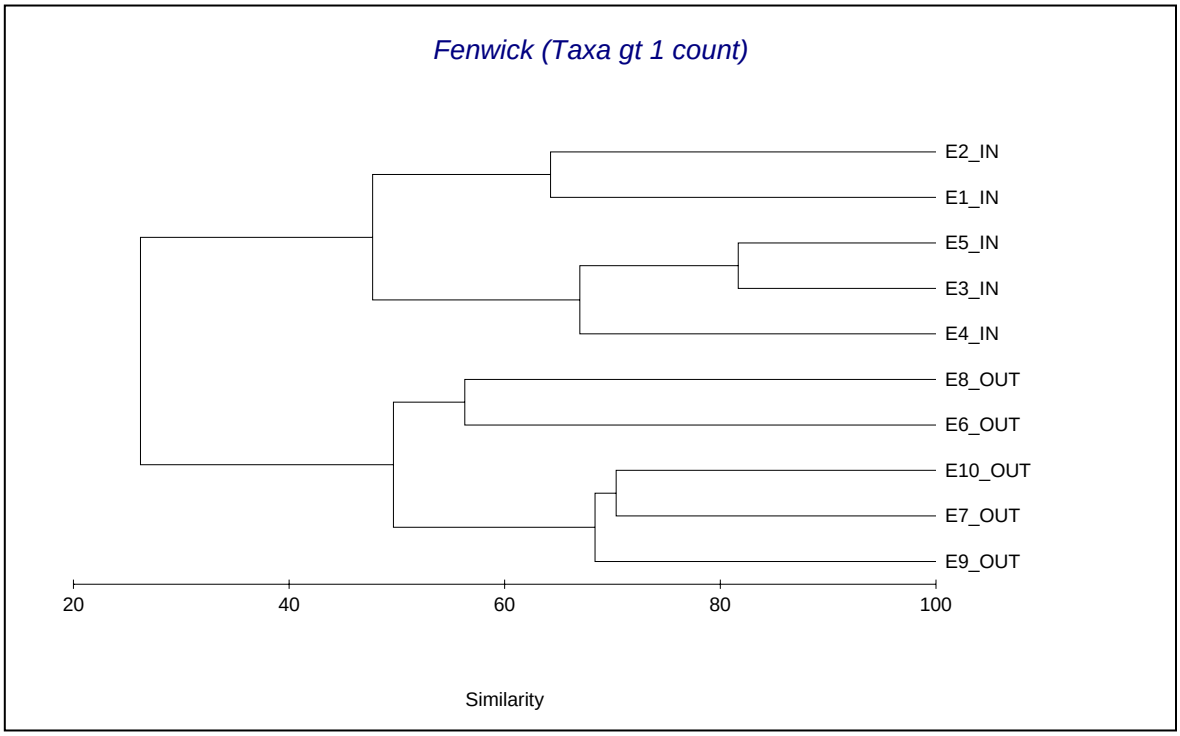

Figure 3-14. Dendrogram depicting the cluster analysis results showing similarities among Area E stations.

Although no surf clam survey was completed in 2004 in Area E, one was conducted in 1997. Of the 15 sampling sites randomly selected throughout Area E in 1997, only one adult

clam was found in the 1997 survey (Scott and Bruce 1998). In the ten grab samples taken in Area E in 2004, no juvenile surf clams were collected (Appendix E). In 1997, 12 of the 25 stations had no more than 2 juvenile clams per sample for a low average number of clams per square meter of 14.5.

3.4.2 Fenwick Island Borrow Area

As stated in Section 3.3.4, three distinct sediment habitats were identified from the video sled analysis. When mapped, distinct patches of the three sediment habitats could be identified within the Fenwick Island Borrow Area and benthic sampling stations were selected to correspond to these three habitat types. The mean depth at the gravel stations was about 2.5 meters deeper than at the fine and coarse sand stations (Table 3-14). The difference was significant but no effect on the benthic community due to depth is expected.

Although three different sediment habitats were targeted for sampling, the sediment analysis did not detect a significant difference between the percent silt/clay or TOC content of the surface grab samples collected at the time of benthic sampling (Table 3-14). Grab samples did not contain any gravel-sized particles even at the gravel habitat identified by the video camera sled. Sediment grain curves of the surface grab samples showed slight differences in the percentages of the grain size particles (Appendix F). Stations F13-F18, gravel habitat stations, contained higher amounts of coarse sand particles than the other stations. No differences in the grain sized curves of the fine and coarse sand habitat were apparent (Appendix F).

Differences in water quality measurements both between stations in the Fenwick Island Borrow Area and from surface to bottom were minimal (Table 3-10). The only difference worth noting was the higher turbidity at the bottom of Station F13 compared to the surface, but the difference would not have an effect on the benthic community since bottom turbidities between the three area stations was similar (Table 3-10).

Table 3-14. Means of sediment and station depth characteristics recorded during benthic macroinvertebrate sampling at the three sediment habitats sampled in the Fenwick Island Borrow Area.

Parameter	Fine Sand	Coarse Sand	Gravel	Anova
Depth (m)	11.98 (0.91)	11.88 (0.62)	14.47 (0.30)	* Gravel habitat significantly deeper
Silt/Clay Content (% < 63 µm)	0.83 (0.24)	0.50 (0.15)	1.47 (0.49)	NS
Gravel Content (% > 2 mm)	0	0	0	NS
Total Organic Content (%)	0.33 (0.07)	0.33 (0.06)	0.38 (0.06)	NS

The benthic infauna community composition at the three sediment habitats (fine sand, coarse sand, and gravel) was very similar in terms of percentage contribution of the major taxonomic groups (Figure 3-15). In all three sediment habitats, polychaete worms were the dominant group, followed closely by oligochaete worms. Molluscs and arthropod crustaceans contributed little to the overall community composition in all sediment habitats.

Although differences in the benthic community composition between the three habitats were minimal, differences in the dominant taxa within the taxonomic groups were apparent. In general, most of the differences in dominant infauna taxa were seen between the gravel habitat and the two sand habitats. For example, although the percentage of polychaetes collected were similar, in the gravel habitat several polychaetes were much more abundant than in the two sand habitats. These included *Aricidea catherinae, Mediomastus ambiseta*, and *Prionospio perkensi* (Table 3-15). In the two sand habitats, polychaete worms such as *Hemipodus roseus* and *Levinsenia gracilis*, were present in much higher numbers than in the gravel habitat. An examination of the dominant polychaete taxa within the two sand habitats revealed some differences as well. In the fine sand habitat, *A. cerrutii, Tharyx* sp. A, and *Levinsenia gracilis* were present in higher abundances than in the coarse sand habitat (Table 3-15). In the coarse sand areas, *Caulleriella* sp. B and *Polygordius* spp. were more abundant.

In the gravel habitat, the amphipod crustacean, *Unciola serrata* was much more abundant in the gravel habitat, whereas *Parahaustorius* cf. *deichmannae* was the dominant amphipod in the two sand habitats but in lower numbers than *Unciola* (Table 3-15). *Unciola*, though not specifically classified as an epifauna taxa by taxonomists, builds tubes on larger sized particles so their presence in large numbers would indicate the presence of larger gravel sized particles. In the all-inclusive "other" taxonomic category, differences in the dominant taxa were evident. In the gravel habitat, many more nemertian worms were collected and in the sand habitats, the chordate *Branchiostoma caribaeum* was more abundant in the sand habitats (Table 3-15).

Anova results suggest that the gravel habitat supports a benthic community different from the two sand habitats. The gravel habitat had significantly higher total infauna abundance and polychaete abundance and biomass than both the fine and coarse sand habitats (Table 3-16). Total mean infauna abundance was over an order of magnitude higher in the gravel habitat (14,462/m^2) compared to the fine sand (3,163/m^2) and coarse sand (3,799/m^2) habitats. The same pattern in mean total infauna abundance was seen in the mean polychaete abundance (Table 3-16). The mean number of epifauna taxa, abundance, and biomass were all significantly higher in the gravel habitat than in both sand habitats (Table 3-16). As with the infauna abundance, the mean epifauna abundance in the gravel habitat was over an order of magnitude higher than in both sand habitats (Table 3-16). The mean number of infauna taxa collected in the gravel habitat was higher than in the sand habitats, but due to the large variance the difference was not significant (Table 3-16).

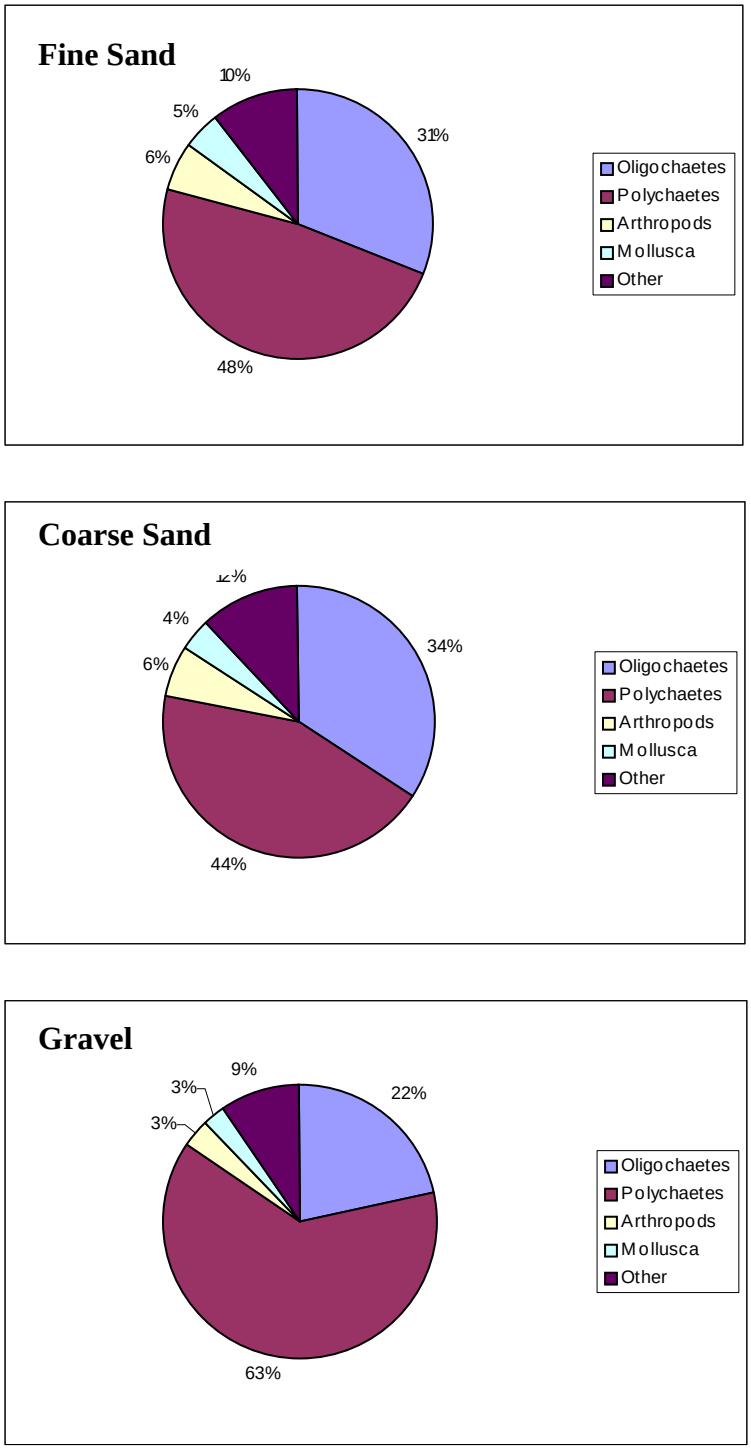

Figure 3-15. Benthic community composition at the three sediment habitats sampled within the Fenwick Island Borrow Area.

Table 3-15. Mean abundance of the top ten taxa collected from the three targeted sediment habitats within the Fenwick Island Borrow Area along the Delaware coast

Taxonomic Group	**Taxon**	**Fine Sand** (#/m^2)	**Coarse Sand** (#/m^2)	**Gravel** (#/m^2)
Nemertina	Nemertina	219.7	193.2	1003.8
Annelida : Polychaeta	*Aricidea catherinae*	208.3	204.5	4231.0
	Aricidea cerrutii	208.3	22.7	257.6
	Caulleriella sp. B (Blake)	90.9	227.3	223.5
	Hemipodus roseus	178.0	94.7	3.8
	Hesionura coineaui	15.2	72.0	3.8
	Mediomastus ambiseta	0.0	3.8	1000.0
	Levinsenia gracilis	151.5	37.9	0.0
	Polygordius spp.	72.0	295.5	223.5
	Prionospio perkinsi	0.0	0.0	125.0
	Scoloplos rubra	98.5	34.1	3.8
	Spiophanes bombyx	7.6	45.5	117.4
	Tharyx sp. A (Morris)	162.9	37.9	318.2
Annelida : Oligochaeta	Oligochaeta	1034.1	1659.1	3200.7
Arthropoda : Amphipoda	*Protohaustorius* cf. *deichmannae*	49.2	83.3	0.0
	Unciola serrata	7.6	11.4	238.6
Chordata : Cephalochordata	*Branchiostoma caribaeum*	79.5	147.7	3.8

Table 3-16. Mean and standard error (in parentheses) of various infauna (unless labeled as epifauna) benthic community parameters measured at stations sampled within the three sediment habitats targeted within the Fenwick Island Borrow Area. ANOVA results testing for differences between the three areas are presented in the last column (*= significant at the 0.05 level).

Parameter	Fine Sand	Coarse Sand	Gravel	ANOVA Results
Number of taxa	23.67 (0.67)	27.00 (3.97)	41.00 (10.49)	NS due to large variance
Shannon-Wiener Index	3.58 (0.21)	3.12 (0.28)	2.73 (0.19)	NS
Simpson's Dominance Index	0.85 (0.03)	0.77 (0.06)	0.74 (0.05)	NS
Number taxa > 2cm	0.67 (0.33)	1.00 (0.37)	2.17 (0.70)	NS
Total Abundance (#/m^2)	3162.87 (339.21)	3799.23 (1052.92)	14462.07 (2544.72)	* Gravel is significantly higher
Amphipod Abundance (#/m^2)	136.36 (50.14)	162.88 (55.49)	416.67 (157.64)	NS
Bivalve Abundance (#/m^2)	136.36 (43.52)	102.27 (30.91)	132.58 (59.68)	NS
Polychaete Abundance (#/m^2)	1465.90 (131.44)	1409.09 (295.45)	9314.36 (1299.97)	* Gravel is significantly higher
Abundance organisms > 2cm (#/m^2)	15.15 (7.58)	30.30 (11.24)	64.39 (24.49)	NS
Total Biomass AFDW (g/m^2)	2.15 (1.35)	2.53 (1.42)	2.82 (0.70)	NS
Amphipod Biomass AFDW (g/m^2)	0.07 (0.03)	0.05 (0.02)	0.06 (0.02)	NS
Bivalve Biomass AFDW (g/m^2)	0.31 (0.18)	0.49 (0.34)	0.56 (0.38)	NS
Polychaete Biomass AFDW (g/m^2)	0.22 (0.04)	0.26 (0.06)	1.07 (0.14)	* Gravel is significantly higher
Number of Epifauna Taxa	0.50 (0.22)	1.83 (0.40)	4.83 (1.40)	* Gravel is significantly higher
Epifauna Abundance (#/m^2)	11.36 (5.08)	125.00 (80.19)	2734.84 (784.33)	* All three habitats are significantly different
Epifauna Biomass (g/m^2)	0.02 (0.02)	0.05 (0.03)	0.82 (0.27)	* Gravel is significantly higher

As with the dominant taxa comparisons, differences between the sand habitats were not as evident. The only significant difference detected between the fine and coarse sand habitats was in the epifauna abundance, which was an order of magnitude greater in the coarse habitat (Table 3-16).

The cluster analysis performed on the macrobenthic data collected from the three sediment habitat types was again definitive, at least for the gravel habitat. All of the samples collected from the gravel habitat defined by the video sled camera results, clustered separately

from the fine and coarse sand habitat samples (Figure 3-16). Results for the two sand habitats were not as definitive. At a similarity index of about 65 % (100% is highest similarity), four fine sand stations (F11, F9, F7, and F10) clustered together with F1 (a coarse sample site). At a similarity index of about 55%, all of the fine sand samples clustered together along with Stations F1 and F3 (two coarse samples, Figure 3-16). These results indicate that the benthic communities at the fine sand stations are more similar to each other than to the coarse sand stations but this same similarity among the coarse sand samples was not as evident.

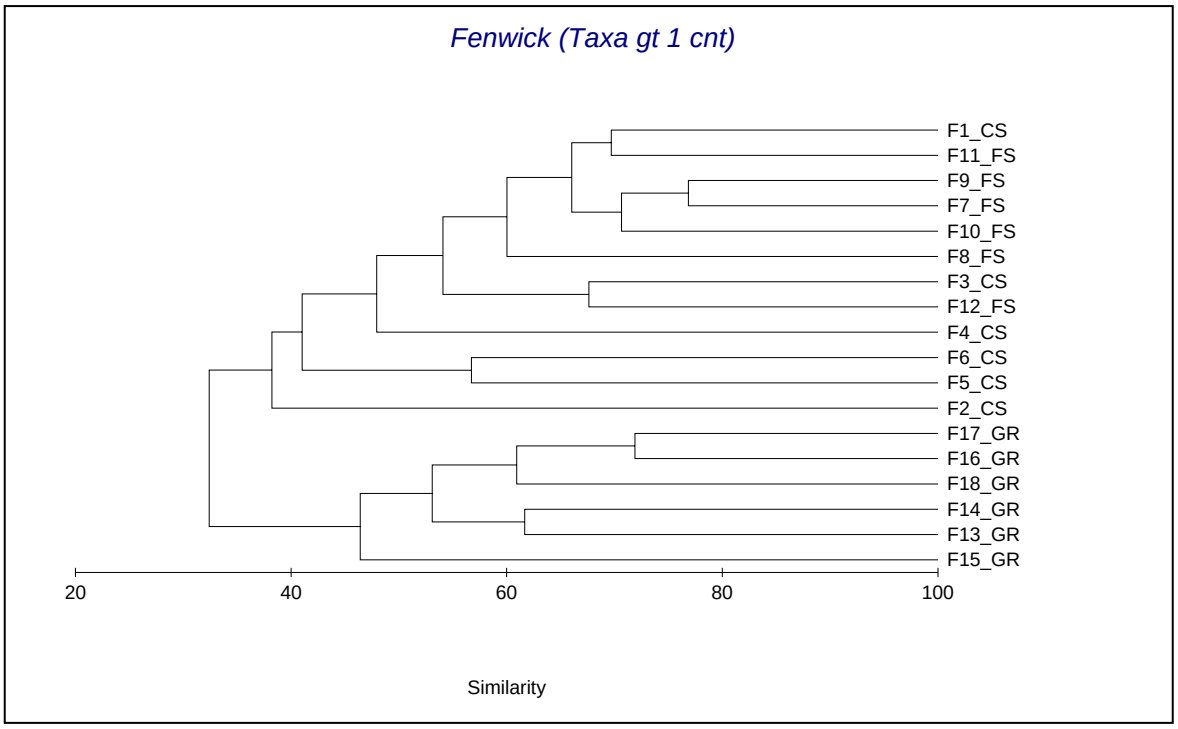

Figure 3-16. Dendrogram depicting the cluster analysis results showing similarities among the Fenwick Island Borrow Area stations. GR = Gravel, CS = Coarse Sand, FS = Fine Sand.

Juvenile surf clams, *Spisula solidissima*, were collected in both the fine sand and coarse sand habitats of the Fenwick Island Borrow Area but were not collected in any of the samples from the gravel habitat (Appendix E). In the fine sand habitat, clams were found in five of the six samples collected but no more than 2 were collected per sample for a mean of 26.5/m^2. In the coarse sand habitat, all six samples had one clam apiece (Appendix E). All of the juvenile clams collected in the two sand habitats were smaller than 2 cm in length. Commercial vessel subcontracting problems precluded conducting an adult surf clam survey. Only a few surf clams (0.82/standardized catch) were collected with the small 25 ft trawl during the finfish surveys (Table 3-1). No clams were collected in the large commercial finfish trawls (Table 3-2).

4.0 DISCUSSION

4.1 WATER QUALITY MONITORING

In-situ monitoring within Area E suggested that the creation of the pit changed water quality conditions in the bottom waters of the pit, particularly in regard to dissolved oxygen and chlorophyll concentrations. Lower chlorophyll levels were observed in the Area E pit that may have been caused by lower algal production due to the light attenuation caused by the 10-12 foot increase in depth relative to the control site. While no water column measurements were taken to quantify light levels in the pit relative to ambient depths, light attenuation increases exponentially with depth and the entire area is within the euphotic zone of Atlantic coastal waters.

Approximately 4 mg/l lower DO concentrations were measured inside the pit during the August time frame when seasonal water temperatures were among the highest and ambient dissolved oxygen concentrations would be at its lowest. The reduced levels observed in the pit could be a due to several reasons. Inside the pit, water circulation may be less than outside the pit which could be the cause of the higher silt/clay content in the surface sediments within the pit (see Table 3-9). Depletion of oxygen from the aerobic activity associated with silty sediment would lead to lower DO in the bottom waters. If circulation within the pit is lower than outside the pit, these lower DO bottom waters would not be flushed out or mixed as often as outside the pit. Lower DO levels could also be a direct result of the lower chlorophyll levels, which would limit the production of oxygen by phytoplankton. While lower DO levels were observed within the pit during the August time frame (when a worst case scenario would be expected), concentrations were typically above 4 mg/l and never reached levels where effects on biota would be expected (2 mg/l). During the November 2004 benthic sampling point measurements taken within the pit did not detect a difference between surface and bottom DO (see Table 3-10).

4.2 FISHERIES MONITORING

One objective of the finfish survey was to document the existing living resource communities within the two borrow areas so that potential impacts due to future dredging operations can be examined. Three different sampling gears were used to document the finfish community within the borrow areas. While water quality and benthic invertebrate differences within the pit relative to outside the pit were documented by the study, the finfish surveys did not detect significant differences between the two borrow areas. The fisheries survey was designed to characterize the fish community composition and abundance within both Area E and the Fenwick Island Borrow Area. Thus sampling was conduced more or less randomly within each borrow area. While some trawl samples were conducted within the Area E pit, most of the seasonal collection points fell outside the pit. In addition, the tow length for any particular trawl sample conducted in the pit was typically longer than the footprint of the pit. Commercial trawling was restricted to the eastern side of the Fenwick Borrow area due to snags and hang

downs in the western side of the borrow but small trawls were successfully conducted throughout the area. Although the sampling design limited our power to detect fish community differences directly inside the pit to pared samples conducted adjacent to the pit, the borrow site comparisons suggest that the presence of the pit did not create an area-wide change in community composition or abundance in Area E.

The summer 2003, winter 2004, and spring 2004 sampling events had pared gill net sets in Area E providing two replicate sets within the pit and two outside the pit for direct comparison. The two summer 2003 gill net collections in the Area E pit took more fish (119) than the two gill net sets taken outside the pit (63; Table 4-1). High numbers of Atlantic croaker and butterfish were taken within the pit while similar numbers of Atlantic menhaden were collected both inside and outside the pit. No fish were collected in any of the gill nets sets in Area E in the winter 2004 collections suggesting that the pit does not create an over-wintering area for resident fish species. The spring 2004 gill net sets produced fewer species and lower total numbers consisting of primarily smooth dogfish. Gill net catches in spring 2004 were higher outside the pit in Area E (Table 4-1).

Video images taken within the Area E pit did not indicate lower biological activity relative to bottom habitats outside the pit (see Figure 3-9). Based on the biological features counted on the video images inside the pit to those taken outside the pit in Area E, similar average counts were observed in both areas suggesting that the biological activity within the pit was not reduced relative to undisturbed bottom habitats.

Table 4-1. Comparison of fish catches in pared gill net sets within and outside the Area E pit during the summer 2003 and spring 2004 sampling events

	Summer 2003		**Spring 2004**	
	Inside	**Outside**	**Inside**	**Outside**
Atlantic Croaker	53	8		
Atlantic Menhaden	30	36		1
Atlantic Sharpnose Shark	2			
Bluefish	3	1		
Butterfish	16	1		
Clearnose Skate				6
Dusky Shark	7	8		
Portly Spider Crab				1
Smooth Dogfish	5	7	10	34
Spot	2	1		
Summer Flounder		1		
Weakfish	1			
Winter Skate			1	
TOTAL	**119**	**63**	**11**	**42**

4.3 BENTHIC COMMUNITY AND VIDEO SLED

Both Area E and the Fenwick Island Borrow Area contained benthic communities similar to other mid Atlantic coastline areas. None of the species collected were particularly unique or environmentally sensitive to preclude dredging operations in either area. Neither of the areas contained a large proportion of large infauna species, which could take longer to recover from dredging. Additionally, few juvenile surf clams were collected with the grab in either borrow area and the adult surf clam survey conducted in Area E in 1997 collected only one adult clam.

4.3.1 Area E

An examination of the benthic community within Area E provided a means to examine potential impacts from habitat modifications in the form of pit creation. Based on Anova results, the benthic community inhabiting the borrow pit, created in 1998, was significantly different than the community surveyed in 1997 and to the community outside the pit for various parameters examined. Total abundance, total bivalve abundance and biomass, and both diversity indices indicated a different benthic community was present inside the pit compared to the one outside the pit and the 1997 community.

The benthic community within the pit contained many more nut clams, *Nucula proxima* and the carnivorous snails, *Acteocina canaliculata.* These two species accounted for most of the significant differences detected in the benthic community in Area E. *Nucula* clams are considered indicators of poor habitat quality (Chang et al. 1992). *Acteocina* snails feed on clams such as *Nucula* so their large abundance is linked to the large abundance of *Nucula*. Additionally, both *Nucula* and *Acteocina* were collected in the largest numbers at the three pit stations with high silt/clay content (F3, F4, and F6). The presence of muddier sites within the pit could indicate that the pit has become a sediment sink for silt/clay sized particles due to changes in circulation patterns. The large abundances of *Nucula* and *Acteocina* in the pit most likely indicate a change in community composition because of the pit creation and associated sediment changes.

Cluster analysis conducted on samples collected inside and outside the pit also strongly support the conclusion that the benthic community within the pit changed as a result of the pit creation. All of the samples taken inside the pit clustered separately from the samples taken outside the pit.

4.3.2 Fenwick Island Borrow Area

A benthic video camera survey can be used to diagram the bottom habitat of a potential borrow area by collecting high numbers of data points relatively cheaply. For the survey of the Fenwick Island Borrow Area, the video results documented 3 distinct sediment habitats within the borrow. Benthic and sediment samples collected with a benthic grab at the three habitats were somewhat successful at documenting differences within the habitats.

Though surface sediment grain curves results did not match the video camera results, benthic community differences were detected. Surface sediments taken at gravel habitats distinguished by the video camera did not contain any gravel sized particles. This could be a function of sampling bias. Since the benthic grab does not work effectively in hard substrate habitat, the field crew will move slightly until they get an acceptable grab. As a result, the samples taken in gravel habitat were most likely taken in areas containing higher amounts of sand since the grab works most effectively in these areas. However, the benthic community Anova and cluster analyses differentiated between the gravel habitat and the two sand habitats indicating that benthic community differences between the habitats exist even if the hard substrate is not sampled directly. Significantly more epifauna taxa, abundance, and biomass were collected in the gravel habitat samples, which led to all of these samples clustering together.

Benthic community differences between the two sand habitats were not as apparent, indicating that either the sampling regime was not sufficient to detect differences, or differences between the two sand habitats are minimal and undetectable. Some differences in the dominant taxa within the two sand habitats were detected but these did not lead to significant Anova results, and only in some similarity of samples based on the cluster results.

Use of the video sled can be valuable when evaluating the benthic community within a borrow area. Since the sled can be used in areas where benthic samples cannot be taken, a more detailed depiction of the bottom habitat can be documented within a potential borrow area. By correlating the benthic community with bottom habitats identified by a video sled survey, a broader and more accurate picture of the benthic living resources within a potential borrow area is possible, than just by benthic sampling alone. For example, simple random selection of benthic sampling sites could not be used to estimate the percentage of habitat associated with the benthic assemblage results. However, using camera results, it can be estimated that approximately 23% (see Table 3-7) of the bottom habitat of the Fenwick Island Borrow Area is gravel habitat, and would therefore, contain a higher amount of the associated epi-faunal and infaunal taxa.

4.4 CONCLUSION

Based on the benthic community inhabiting the two potential borrow areas, recovery after dredging operations to pre-dredge conditions should occur relatively rapidly provided the bottom habitat is not significantly modified. Additionally, fisheries data collected within the two potential borrow areas do not suggest a particularly unique community that could be threatened by dredging operations. However, data collected using three different gear types and over all four seasons suggest that direct impacts on these higher living resources would be more limited if dredging occurred in winter and spring seasons.

Results from Area E suggest that creation of a borrow pit 10 to 12 feet in depth can cause a shift in the benthic community composition within the pit. The data suggest that the benthic community currently inhabiting the pit contain many more tolerant organisms, such as *Nucula*

proxima and *Acteocina canaliculata*. The change could have been a result of the increase in amount of silt/clay particles detected inside the pit. Continuous water quality measurements taken inside the pit during August 2004 indicated that at least during summer, certain water quality parameters measured inside the pit were different than outside the pit. Bottom dissolved oxygen and chlorophyll levels were somewhat reduced inside the pit.

The differences detected in water quality and the benthic community within the pit appeared to have no impact on the fish community. Few differences in the number of fish or the species composition were apparent between Area E (including the pit area) and Fenwick Island Borrow Area (no pit). Additionally, gill net sets compared within Area E both inside and outside the pit did not indicate a difference. Video sled images indicated similar biological activity inside and outside the pit.

Developing dredging plans for beach replenishment activities to limit the creation of dredge pits over a 10-foot depth could reduce the chances of causing the changes in benthic community, bottom sediment, and water quality parameters detected in this study. However, since sampling of the fish community did not display an impact, a shift of this magnitude in water quality and the benthic community may have little impact on higher living resources. With the limited information at this point, it is still uncertain which factors of the pit dimensions are responsible for the observed changes in water quality, sediment habitat, and benthic community. It is expected that implementing limits in dredging depth (<10 ft.) would result in causing immediate impacts to the benthic community over a wider area but, the benthic community should recover to pre-dredge conditions more readily than if a deeper pit were created.

The combined use of video sled data and benthic sampling in this study provided a more detailed examination of a potential borrow area than either method alone. The results from the survey suggest that the benthic community is more vibrant and diverse in and near areas containing larger sediment particles such as gravel and pebbles. The same conclusions were found in another study conducted at a potential borrow site, Area G, located just offshore of the Indian River Inlet (Versar 2003). Data from the benthic sled can be used to map the sediment habitats within a potential borrow so that dredging plans can be designed to avoid areas with large sediment particles if so desired.

5.0 REFERENCES

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APPENDIX A

SCOPE OF WORK

SCOPE OF WORK

DELAWARE COAST FROM CAPE HENLOPEN TO FENWICK ISLAND
FENWICK ISLAND STORM DAMAGE REDUCTION PROJECT

BIOLOGICAL MONITORING OF FENWICK ISLAND SAND BORROW AREAS

Project Name: Biological Monitoring Of Fenwick Island Sand Borrow Area and Area E

Corps District and Contact: Philadelphia District Corps of Engineers, Wanamaker Building, and 100 Penn Square East, Philadelphia, PA 19107-3390. Project Biologist: Steve Allen, Environmental Resources Branch, by phone at (215) 656-6559 or by E-mail at Steven.D.Allen@usace.army.mil .

Contractor: Versar, Inc. Principal Investigator: Mr. William Burton (410) 740-6086.

INTRODUCTION

The U.S. Army Corps of Engineers (USACE), Philadelphia District, is currently developing detailed plans for a beach replenishment project along the coast of Delaware at Fenwick Island to provide storm damage reduction for this community. This project requires the use of an offshore sand source to provide suitable sand for beach replenishment, which includes initial construction and periodic nourishment. During the feasibility study, an offshore sand source was identified offshore of Fenwick Island. In addition, a sand source located offshore South Bethany (Area E) will also be investigated. This scope of work details the biological and chemical investigations to provide baseline information that would be used to monitor the effects that dredging in the borrow site would have on biological resources. The borrow areas are within 3 nautical miles of the Delaware Coastline and have depth ranges of 30 – 50 feet. Except for the Fenwick North Area, these sites are relatively flat in bathymetry. The Fenwick North site contains several small shoals that are designated to be off-limits to dredging. The NOAA Chart 1441 lists two possible obstructions (one in the Fenwick North Area and one in the Fenwick South Area). Other unknown obstructions may be present in these areas. The proposed sand borrow areas include two areas (Area E and Fenwick North) within a historic anti-aircraft artillery target range, and one that is outside of this range (Fenwick South). The target range fans out from south of South Bethany (York Beach and Fenwick Island State Park) and extends offshore as far north as Indian River Inlet area to the offshore Delaware-Maryland State Line. The areas inside of the target range are likely to include unexploded ordnance such as 40 mm to 90 mm projectiles.

PRODUCTS: Three separate publishable reports shall be submitted covering the following tasks: A.) Benthic Environment and Water Quality (Tasks 1 and 2), B.) Finfish Baseline Monitoring (Task 3), and C.) Sediment and Water Chemistry Testing (Task 4).

SAFETY: In accordance with Corps of Engineers Safety Requirements and Versar's Safety Policy, the contractor shall be responsible for ensuring that safety measures are implemented at all appropriate times on the work boat that include, but are not limited to: the use of appropriate U.S. Coast Guard approved Personal Flotation Devices and/or survival suits while working on deck, the use of hardhats, work gloves, and steel-toed boots. This includes a pre-trip briefing and identification/orientation of important safety features on the boat.

COLLECTION PERMITS: The contractor shall obtain all appropriate collection permits from the State of Delaware to complete the field sampling tasks outlined in this scope of work.

TASK 1 BENTHIC SLED CAMERA INVESTIGATION

1.1 Transect Locations: The contractor shall develop transect locations based on providing at least 46 km of track line within the Fenwick Borrow Area and Area E (see Figure 1). Development of transects/track lines shall consider obtaining maximum representative bottom coverage in the borrow areas. The transects may be conducted in straight or in "zig-zag" fashion to provide maximum coverage of these sites. The borrow area locations and coordinates are provided in Figure 1.

1.2 Equipment and Sampling Methods: VIMS Standard Bottom Imaging Sled shall be deployed with video cameras, and water quality sensors. The sled shall be towed at <1 knot when possible. Sled still images shall have the following dimensions, based upon the camera lens angles and depth above the bottom. The length of the image shall be about 43 cm, the width of the image shall be 30 cm, the area shall be about 1300 cm^2, or 0.13 m^2. The sled shall be towed at 2 to 3 knots when the vessel is under power and as low as 0.8 knots when adrift in order to acquire close-up bottom video and water quality data. The video camera shall be set obliquely and about 15 cm from the bottom in order to resolve the smaller details of the surface and biological structures. The area viewed by the video camera shall be trapezoid about 10 cm along the base line closest to the camera and 40 cm along the other baseline. The field of view shall be about 0.2 to 0.4 m^2 depending on sled orientation. The camera shall be mounted so that the focal plane will be 40 cm above the plane of the sled runners, meaning that each image will represent an area of 0.13 m^2.

1.2.1 Image Analysis: Sled video images shall be transferred from analog to digital video format. The digital video shall be played back at 1/3 speed, and feature determinations, counts, and classifications shall be done by an observer every 3 seconds, providing 1 second real-speed interval data. Substrate configuration, biological feature occurrence, quantity and type shall be recorded for each record. Video times shall be translated to position using DGPS logs recorded onboard. If position data are missing due to slowed DGPS data-logging, positions may be estimated using an average of the two nearest neighbors. If position data between two images or video analysis sequences are too imprecise to detect a difference, latitude and longitude may be adjusted between the two closest reliable points. Adjusted latitude and longitude for

the sled and plow transects may be estimated using one or two functions. If latitude and longitude values do not change between time intervals, then latitude may be adjusted by a cosine function of heading that incorporated velocity, and longitude may be adjusted by a sine function of heading that incorporated velocity. If one or more successive positions are missing, latitude and longitude values from the previous time step may be used with a random value added (on the order of 0.000001 degrees).

1.3 Documentation and Analysis

1.3.1 Documentation

The following sets of parameters shall be documented:

Set 1 - Sediment Type. Presence/Absence of:
Silt (SI)
Very Fine Sand to Fine Sand (VFSFS)
Medium Sand to Coarse Sand (MSCS)
Gravel (GR)
Shell Fragments (SHFR)
Large Shell Parts or Whole Shells (SHLG)
Cobbles
Boulders

Set 2 - Bed Type. Presence/Absence or Predominance of:
Bedforms; Wave or Current Ripples (Bedf)
Burrowed
Tracked
Small Tubes
Large Tubes (LgTubes)
Tube Bed or Mat (TubeBed)

Set 3 - Surface Variance. Image brightness pattern properties induced by primary bottom features:
Uniform
Graded
Split
Periodic
Heterogeneous (HETERO)

Set 4 - Roughness. Primary origins of roughness (equivalent contribution by more than one feature led to some cases where more than one parameter would be attributed responsibility):
Small Ripples (SMALLRIPP)
Large Ripples (LARGERIPP)
Biogenic Structures, e.g. tubes (BIOSTRUCT)

Evidence of Biogenic Activity, e.g. tracks (BIOACTIV)
Sediment Grains or Shells (GRAINorSH)
Unstructured; perhaps heterogeneous, or a surface in transition (UNSTRUCTURED)

Set 5 - Live Biology (LiveBiol); epifauna or structures attributable to certain infauna. Presence or Absence of:
Asabellides oculata tubes (Asabellides)
Diopatra cuprea tubes (Diopatra)
Other Polychaete tubes (OtherPoly)
Crustaceans, typically Cancer crabs (Crust)
Hermit Crabs or Gastropods; shell inhabitants indiscernible (HermCrabORGast)
Gastropods; discernible (Gast)
Bivalves (Biv)
Echinoderms; sea stars or sand dollars (Echin)
Ascidaceans; tunicates (Ascidacean)
Fish
Other

Set 6 – Human or Cultural Resource Features; Presence or Absence of potential:
Shipwrecks
Debris piles or scatter
Potential Unexploded Ordnance (40 mm artillery shells or other)
Or any other apparent man-made objects

1.3.2 Analysis

Video acquired from sled tows shall be visually analyzed at one-second intervals. Substrate, invertebrate fauna/biological features, and fish shall be classified into categories for each second of video, played at one-third speed. Substrates shall be classified in terms of visible physical characteristics:

Set 1 - Physical Characteristic Classes (SediHabi)
1 – Sediment surface with no ripples or bedforms, sediments are fine to medium sands without coarser sediments. Basically, flat featureless finer sediment bottom
2 – Small asymmetric bedforms, wave length <30 cm, sediments are fine to medium sands without coarser sediments.
3 – Large straight or asymmetric bedforms, wave length > 30 cm, sediments are medium to coarse sands on the crest, with gravel and pebble in the troughs.
4 – Large straight or asymmetric bedforms, wave length > 30 cm, sediments are medium to coarse sands on the crest, with gravel and pebble in the troughs.
5 – Gravel bed, sediment surface with no ripples or bedforms, sediments are predominantly coarser gravel and pebble with some finer sediments (silts and clays) mixed in.
6 – Pebble bed, sediment surface with no ripples or bedforms, sediments are predominantly pebbles with some cobble size grains, coarser gravel sediments may also be mixed-in.

Set 2 - Biogenic Structure Classes (BiogHabi)

1 - No biology apparent.
2 – Biogenic hard bottom, blue mussel (*Mytilus edulis*) bed, shell with few live mussels cover >50% of the bottom, sediments range from fines (silts and clays) to very coarse (pebbles and cobbles).
3 – Biogenic hard bottom, shell bed, mostly surfclam (*Spisula solidissima*) valves, shell covers >75% of the bottom, sediments range from fine-sand to coarse-sand and gravel.
4 – Biogenic hard bottom, encrusting bryozoans and relic coral pieces, usually associated with other coarse sediment fractions such as pebbles and cobbles.

In addition to habitat classifications, each fish observed in the video shall be reviewed at slow speed until species, or lowest practical taxonomic level is identified

1.4 Results Reporting

(see section 2.9)

1.5 Schedule and Submittals

(see Section 2.10)

TASK 2 BENTHIC INFAUNA GRAB SAMPLES, SURFCLAM SURVEY, AND WATER QUALITY MONITORING

2.1 Benthic Sampling: After the video camera survey is completed and preliminary data are received and reviewed, benthic samples shall be taken in the areas that correspond with the benthic sled track line. Sample stations shall be selected randomly within a physical habitat grouping along the benthic sled transect line. At each sampling station, one sample shall be collected using a 0.04 m^2, stainless steel, Young Grab Sampler. Each "grab" will be at least 75% full and show no evidence of surface washout. A total of 17 sample stations shall be established to represent the Fenwick borrow area with proportionate sample representation in the Southern and Northern Portions of the site. In addition, 5 samples shall be obtained from within the previously impacted portion of Area E, and 5 samples shall be taken outside of the impacted portion for comparison.

Benthic macroinvertebrates will be sieved in the field using 500 um mesh and preserved (isopropyl, ethanol or 5% buffered formalin) for laboratory processing. No samples will be composited; all will be handled individually.

2.2 Grain Size Analysis: A sediment grab sample for substrate particle size and organic content analysis will be collected at each sample station using the same equipment. This sample will be subsampled, frozen, and then transported to the laboratory for analysis. In the laboratory, sediment samples will be analyzed for grain size using ASTM D2487. Classification will be taken down to the U.S. standard sieve No. 200; the hydrometer portion of the ASTM test will not be run. A grain size curve will be generated for each sample tested. Samples will be measured for total organic carbon (TOC) as measured by loss on ignition.

2.3 Laboratory Analysis: Macroinvertebrates will be sorted from sample residue, identified, enumerated, and weighed. All taxa as measured by numerical count and/or biomass shall be identified to species or lowest possible taxonomic group. Length of all specimens relative to 2 cm (i.e., < or > 2 cm) will be recorded. All surfclams (*Spisula solidissima*) shall be **measured to the nearest millimeter** and weighed separately from other mollusks.

Noting that benthic macroinvertebrate community composition is strongly correlated with the nature of substrate conditions, the substrate particle size and organic content, these data will be examined for each sampling station. If, in the opinion of the contractor, these data are similar for all measurements made at all borrow area sample stations, then the biological data will be grouped for the purpose of data analysis. If two or more distinctive groups of substrate condition data are recognized, the biological data will be grouped similarly. In effect, this is data stratification on the basis of substrate conditions.

Each of the top ten species (as measured by numerical count and/or biomass) shall

be counted and dry-weighed separately. Each group shall be weighed to within 0.001 grams. Biomass determination shall be completed on each sample within the same day to avoid sample degradation.

2.4 Physical Data Collection: The following information shall be recorded for each station: date, time of day, depth (meters), weather conditions (height of sea, overcast/sunny), and latitude and longitude coordinates (differential global positioning system). The time of high and low tide for that geographic location shall be recorded.

2.5 Water Quality: Water quality parameters will be continuously monitored for a ten-day period between August 1 and September 15 at three locations: (1) a benthic station in the southern sector of the Fenwick Island Borrow Area, (2) within a previously dredged portion of Area E, (3) adjacent to the dredged portion of Area E

The following parameters will be obtained from the three permanent instrument mooring stations: salinity (ppt), chlorophyll *a*, dissolved oxygen concentration (ppm), pH, conductivity, water temperature (^{o}C), and turbidity (NTUs). To support collection of these data, a mooring system consisting of a well-marked float, chain, and heavy-duty anchor will be deployed near each of the sampling areas. A data logging water quality meter will be attached to each mooring station so that bottom conditions are measured every 15 minutes over the deployment period. The water quality meters will be serviced and data downloaded after ten days of deployment. These data will be reviewed to assess whether the deeper previously dredged area contains water quality conditions that are different from non-dredged areas.

2.6 Surf Clam Sampling: A total of 15 -five minute tows using a conventional hydraulic surf clam dredge with a 72-inch knife and with the cage "closed up" (to retain clams as small as 3 inches) shall be conducted in the Fenwick Borrow Area with equal representation in both the north sector and southern sector. The sample tow locations shall be established by stratified random samples to give adequate coverage and representation of the entire site. This survey will be conducted after the video and benthic invertebrate sampling is completed to avoid excessive disturbance of the study area. Station position shall be identified by position coordinates at the beginning and at the end of each 5-minute tow. GPS navigation systems shall be utilized on the boat for accurate verification of sample locations (position accuracy shall be within 100 ft. or less).

2.6.1 Mudbags: In the event of muddy sediments clogging the gear to the extent that the dredge cannot be safely hauled on deck, the cod end will be opened at the surface, and the tow would be recorded as a "mud bag". If “mud bags” are encountered during sampling, at least ten (five at each borrow area location) of the 15 sample tows shall be completed and free of “mudbags”. Station positions of “mudbag” tows shall be noted as such.

2.6.2 Health and Safety Plan/UXO Monitor: Based on the findings that the subject sites are within the confines of a former artillery firing range, the contractor shall develop a health and safety plan to address the potential for encountering unexploded ordnance

(UXO), and to insure that workers are adequately protected from potential hazards from encountering UXO's. The Contractor is required to obtain the services of a qualified Unexploded Ordnance (UXO) Health and Safety Technician to be responsible for conducting adequate health and safety practices related to the potential for encountering unexploded ordnance during surfclam sampling. This technician would be responsible for enforcing safety practices outlined in the health and safety plan, inspecting each surfclam dredge tow for UXO, safety certification of each dredge tow brought onboard the boat for other non-UXO trained personnel to process surfclam samples, document and photograph any UXO's encountered, and perform onsite or offsite (depending on appropriate circumstances) disposal of UXO's.

A qualified UXO technician meets the minimum qualifications of a UXO Technician III, which is outlined in the form DD FORM 1664 (ID# OE-025). A resume of qualifications of the dedicated UXO technician is subject to review and approval by the U.S. Army Engineering and Support Center, Huntsville Mandatory Center of Expertise for Ordnance and Explosives (CEHNC-OE).

The UXO technician shall assume 12 hours onboard a commercial surfclam vessel operating within 3 miles of the Delaware Atlantic Coastline. The UXO technician shall assume an additional 12 hours as an option cost, if services are required for an additional day. This option can only be exercised upon approval from the contracting officer.

2.6.3 Collection Gear and Sample Methods: At each station, a 5-minute tow shall be taken with a conventional hydraulic surf clam dredge with at least a 72-inch knife. The cage shall be "closed-up" to retain clams as small as 3 inches. For each 5-minute tow, the total volume of the haul (in U.S. Standard Bushels supplied by contractor) shall be either estimated or measured, live surf clams shall be sorted out and measured, and volumes of shell and other invertebrates shall be recorded. If a tow results in a catch exceeding 1 bushel of surf clams or greater, a bushel sample of live surf clams shall be measured for length to the nearest millimeter. If catches are less than one bushel, all live clams shall be measured to the nearest millimeter. Individual major invertebrates such as horseshoe crabs (Limulus), lady crabs (Ovalipes), spider crabs (Libinia), starfish, sand dollars (Echinodermata) and whelks (Busycon) shall be counted and recorded. Readily identifiable finfish incidentally collected shall also be counted and recorded.

*total numbers may be estimated if more than one bushel is collected per tow; if numbers are $\leq$ to one bushel, then all surf clams must be counted and measured per tow

2.6.4 Field Records: The following information shall be recorded for each surf clam collection:

- date
- time of day
- depth(s) shall be recorded continuously along tow track
- beginning and end coordinates for each tow or drag in Latitude/Longitude

- a print-out of each tow track shall be provided.

2.7 Benthic Invertebrate Data Analysis: A publishable report shall be prepared presenting the data, analysis, and discussions of the benthic sampling and surfclam survey. The report will describe, in detail, all methods that were used and the data obtained. Maps will be included to show the project area and sample locations. Data will be compiled and stored in SAS data sets (Windows Version 6.12). Separate files will be maintained for benthic invertebrate abundance, benthic invertebrate biomass, sediment grain size, and clam survey results. The horizontal grid will be based on a standard latitude and longitude coordinate system. Data will be delivered on a high-density 3.5 inch disk.

For benthic macroinvertebrate data, the identity and number of individuals for the species will be reported in terms of mean numbers per square meter of benthos. The identity and numbers of all individuals with length > 2 cm will be reported by species. Biomass data will be reported by taxon as mean value per square meter of benthos. The number of surfclams (*Spisula solidissima*) will be reported in terms of mean numbers per square meter of benthos calculated separately for the grabs and tows as well as by size classes (recruits, juveniles, and adults). Data collected by the Young Grab Sampler and surfclam tows will be reported on tables and/or graphs and fully summarized. Data collected from this study will be compared to data that has been collected in other similar studies in the area.

Biological data will be discussed in terms of species composition and population density that may be adversely impacted by turbidity or excavation by dredging. The report should also include a discussion of re-colonization potential. Taxonomic groups will be described in terms of their accessibility and desirability as a food source for water and shorebirds, fish, blue crabs, horseshoe crabs, surfclams and other commercial, recreational, or ecological important species, as well as whether the benthic communities found indicate a healthy or stressed environment. This information shall be presented in a typewritten scientific report, including sections describing the objective, methods, results, discussion, and conclusions. The results and analyses shall include but not be limited to graphical, tabular, and chart presentations of the data and findings. The conclusions section shall evaluate the potential for recovery of the benthic community based on the species found, as well as comparison of the results of this study with other similar benthic studies done in the area. Original data sheets shall be provided in the appendices of the report.

The following information shall be presented in the report:

-Maps showing locations of sample stations.
-Latitude/longitude coordinates of sample stations.
-All stations shall have recorded depth measurements.
-Dry weight biomass of major taxonomic groups per sample (as summed from individual taxa measured).

-Taxonomic distribution per sample.
-Abundance and sizes of important commercial and recreational species (surfclams) per sample.
-Abundance of opportunistic species per sample.
-Physical/chemical parameters at each station.
-Sediment grain sizes of each station.

2.8 Data and Statistical Analysis: The data and statistical analysis shall compare the benthic community, defined by species abundance, biomass, and diversity at a minimum, with respect to the water depth, habitat type and grain size distribution at that station to that of other stations. Data and statistical analysis shall include, but not be limited to abundance and/or densities (i.e., biomass/unit area, numbers of organisms/unit area, etc.), benthic community structure and diversity (i.e., Shannon-Weiner Index, Simpson's Dominance, species richness, evenness, and station similarity/dissimilarity). Data analysis shall be presented in graphical or tabular form to provide easy comparisons between stations.

2.9 Report Text: The contractor shall provide a type-written interim report discussing apparent preliminary findings on habitat characteristics of the borrow sites within 10 days from completion of field work for the benthic sled.

The contractor shall prepare a formal report that presents detailed finding of the work performed including a discussion on identifying habitat types that would have the least impact on benthic resources. This report shall be publishable and present the data, analysis, and discussions of this study. The report shall summarize that data in graphical or tabular form to provide easy comparisons between sampling sites. In addition, a table and map identifying sampling locations, geographic coordinates (obtained from differential global positioning system (DGPS)), and corresponding data collection results will be included. This report shall be publishable and present the data, analysis, and discussions of this study. Draft and final reports must be polished products, clean-typed, complete with all figures, tables, and appendices and reflect and report the analyses outlined in this scope of work. The recommended content and format should follow quality assurance and quality control guidelines and shall be structured as follows:

(1) TITLE PAGE - bearing the appropriate title, date, author, and contract number.

(2) EXECUTIVE SUMMARY - a brief description of the study's purpose, findings, and conclusions.

(3) TABLE OF CONTENTS - including a list of all figures and tables presented in the report.

(4) INTRODUCTION - stating the purpose of the study with background information on the project and area.

(5) METHODOLOGY - describes the sampling and analysis equipment and methodologies used.

(6) RESULTS - presents the collected data in tabular and graphic form and details any applicable statistical analyses used. A detailed map illustrating the project area and the sample locations by identification number shall be included.

(7) DISCUSSION - The discussion and/or conclusions shall include information resulting from a survey of appropriate applicable literature/reports to 1) evaluate the benthic community with regard to various qualifying characteristics including depth, sediment and energy regimes, 2) compare with other similar coastal benthic studies, 3) assess potential short-term and long-term effects on the benthic community and commercial fishery resources in the borrow areas and placement area resulting from dredging and fill activities, 4) assess the ability of the borrow and placement sites to become recolonized or recover from dredging disturbance, 5) provide a discussion on means (e.g. type of dredge, restriction of dredging operation according to specific depth, etc.) to avoid or minimize adverse impacts to the benthic community and associated shellfish resources from dredging within the proposed sand borrow sites.

(8) A LIST OF REFERENCES - includes literature cited and agencies or individuals consulted. The bibliography must be in a format used by professional scientific journals.

(9) APPENDICES - for personnel qualifications, a copy of this scope of work, raw data sheets, record logs, and other pertinent information.

Each report page will be produced on 8 1/2" x 11" paper, single spaced, with double spacing between paragraphs. Figures should not exceed 11" in height nor 12" in length under most circumstances. All text pages, including Appendices, must be consecutively numbered. Text print quality must be at least letter quality.

2.10 Submittal and Schedules:

A. All benthic field sampling (including camera work) shall be completed no later than September 30, 2003.

B. A draft interim report with preliminary results from the benthic sled camera work shall be submitted within 10 days of the field work.

C. The Contractor shall provide 5 copies of the draft report to the Philadelphia District U.S. Army Corps of Engineers within 80 calendar days from the completion of the sample collection.

D. The Corps will provide comments to the Contractor within 20 calendar days of receipt of the draft report. The contractor is responsible for incorporating any changes to the draft document.

E. The Contractor shall provide 5 bound copies, 1 unbound, reproducible, and 1 digital (MS Word format) original copy on CD-ROM of the final report to the Philadelphia District Corps of Engineers within 21 calendar days of the receipt of the review comments on the draft report.

TASK 3 FINFISH MONITORING

3.0 Finfish Field Investigation

3.1 Sample Locations: The contractor will conduct a fisheries survey in the Fenwick Island and Area E borrow areas that can be used as a baseline for future comparable monitoring efforts. Sample design shall consider depth, bottom habitat/substrate, previous anthropogenic impacts, stratification, etc. The study will also inventory Federally managed species where EFH is identified. Seasonal sampling will be conducted over a one-year period such that fall, winter, spring, and summer fish communities are characterized by the survey. Trawl beginning and end-points and the location of the gill net sets will be positioned using a Differential Global Positioning System. This finfish survey will be similar to the recently completed USACE sponsored Hen and Chicken Shoal study and the current seasonal study being conducted for the Mineral Management Service (MMS) at Fenwick, Weaver, and Shoals A and B. The data collected at the Fenwick Island sand borrow sites will be compared to MMS collection data to provide a broad overview of fish community abundances and composition at the study site to similar habitats in the region.

3.2 Equipment and Sampling Methods: Sampling will be conducted using commercial fish trawlers, small boat trawling, and experimental gill nets. Four to five replicate trawls will be taken in each borrow site. The data acquired will be used to characterize the fish community within these areas. To develop information on large faster moving pelagic fish, two experimental gill nets (w/ variable mesh size panels) will be set and fished in both areas for all seasons. The contractor shall employ the crew and vessel of a commercial fisherman to conduct the field sampling for this project. Gill nets will be set and anchored for a period before retrieval corresponding to ambient densities and will be partially based on the commercial gill netters experience and advice. Trawls shall be conducted using commercial fishing gear and will be towed for at least 10 minutes before retrieval (actual tow and gill net set times may be adjusted according to local conditions and the experience of the commercial fishing crew). The commercial trawler will use an 80-foot Yankee net. Small boat trawling will be conducted with a 40-foot experimental trawl to target smaller juvenile fish. Small boat trawling will be conducted for approximately 10 minutes depending on seasonal fish densities. The contractor shall obtain all necessary collection permits.

3.4 Data Analysis

3.4.1 Statistical Analysis: The analysis of the field data will be geared toward determining statistically significant differences between the total numbers caught, species composition, or fish size between sample stations and seasons. These analyses should include but not be limited to ANOVA tests, t-tests for size differences, or any non-parametric statistical techniques that the contractor believes necessary to discern differences between habitat types. A separate analysis will be conducted for each of the four seasons sampled and an evaluation of changes in community composition among

seasons will be provided.

3.5 Reporting Requirements

The contractor shall provide an assessment of the demersal and pelagic finfish within the study areas. The formal report shall summarize that data in graphical or tabular form to provide easy comparisons between sampling sites. In addition, a table and map identifying sampling locations, geographic coordinates (obtained from differential global positioning system (DGPS)), and corresponding data collection results will be included. This report shall be publishable and present the data, analysis, and discussions of this study.

Draft and final reports must be polished products, clean-typed, complete with all figures, tables, and appendices and reflect and report the analyses outlined in this scope of work. The recommended content and format should follow quality assurance and quality control guidelines and shall be structured as follows:

(1) TITLE PAGE - bearing the appropriate title, date, author, and contract number.

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(5) METHODOLOGY - describes the sampling and analysis equipment and methodologies used.

(6) RESULTS - presents the collected data in tabular and graphic form and details any applicable statistical analyses used. A detailed map illustrating the project area and the sample locations by identification number shall be included.

(7) DISCUSSION – The discussion shall draw inferences from the results in describing and comparing the catch per unit data spatially and temporally as they relate to the sand borrow sites and the habitat(s) present.

(8) A LIST OF REFERENCES - includes literature cited and agencies or individuals consulted. The bibliography must be in a format used by professional scientific journals.

(9) APPENDICES - for personnel qualifications, a copy of this scope of work, raw data sheets, record logs, and other pertinent information. .

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3.6 Schedule and Submittals

- Fall sampling will be conducted in the last week of October or the first week in November 2003.

- Winter Sampling will be conducted in end of December 2003 or in January 2004.

- Spring sampling will be conducted in April or May of 2004.

- Summer sampling will be conducted in July 2004 (or 2003 if mobilized in time).

  *Seasonal sampling events shall be at least 2 months from prior sampling date

- Trip reports summarizing the species found in the field survey, problems encountered, and preliminary observations will be submitted one week after each season's sampling event.

- One month after the last sampling event, five copies of a draft report will be submitted to the USACE.

- Two weeks after receiving the collective comments of the USACE and other reviewers 10 copies of a final report shall be submitted.

TASK 4 SEDIMENT AND WATER QUALITY ANALYSIS

4.0 Sediment and Water Sampling

A. **Sediment Samples** – Sediment samples shall be obtained from 9 inert plastic-lined vibrocores in accordance with the document: "The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters" Appendix A (NJDEP, 1997). **Sufficient sediment shall be obtained for both bulk sediment analyses and grain size analyses.**

B. **Sediment Sample Preparation:** Sediments shall be extracted from the 9 cores in the following ways:

- **Composite Samples:** The Fenwick Borrow Area shall have a total of 6 vibrocores, and Borrow Area E shall have 3 vibrocores (excluding the previously dredged area indicated in Figure A-1) . Each core shall be inspected prior to disturbing for stratification. Any significant sediment stratifications (ie. gravel, sand, mud, clay, peat, etc.) shall be measured and logged with their depth prior to disturbing. Sediment from the interior portion of the core shall be removed with stainless steel knives and spoons, thoroughly homogenized in a stainless steel container, and subsampled to provide sufficient sediment for later chemical analysis. Each vibrocore shall be separated by the surface 0.0 – 1.0 foot depth composite and the subsurface 1.0 - 10.0 foot depth (or maximum penetration depth) composite. This results in a total of 9 vibrocores to be collected yielding 18 composited bulk sediment samples to be analyzed (see Table 4.1).

- **Subsample Handling:** The subsamples shall be placed into appropriate glass storage containers. Sediment from the exterior portion of the core, which has been in contact with the core tube, shall not be used for chemical analysis. However, sediment from the exterior portion of the core may be utilized for grain size analysis.

- **Decontamination of Sampling Tools**: After a subsample is obtained, the knives and spoons that were in contact with the sediment shall be wiped and rinsed with deionized water. After sampling of an entire core is completed, the knives and spoons shall be cleaned in the following sequence: non-phosphate detergent and tap water rinse, tap water rinse, deionized water rinse, 10 percent nitric acid rinse (for metals), deionized water rinse, hexane rinse (for organics), deionized water rinse, acetone rinse (for organics) and a final deionized water rinse.

- **Sample Storage:** All sediment samples obtained for chemical analyses shall be immediately stored in the dark at temperatures $\leq$ 4 degrees Celcius. Storage temperature and light is not a factor for the sediment samples that will undergo grain size analysis.

C. **Water Samples** – Water samples shall be obtained from one predetermined vibrocore location within each borrow area for a total of 2 water sample locations (Table 1). A Q/C

field blank will also be used. Water samples shall be obtained in accordance with the document: "The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters" Appendix A (NJDEP, 1997).

- **Water Sampling Equipment and Method:** Water samples shall be obtained approximately 1 meter above the bottom with either a non-contaminating pump (peristaltic or magnetically coupled impeller design pump) or a discrete water sampler prior to obtaining vibrocore sample (to avoid suspension of bottom sediments). A sufficient quantity of seawater shall be obtained to run TAL metals, TCL Semivolatile Organics, TCL PCBs and Pesticides, and other miscellaneous parameters (See Table 4.2). The discrete water sampler should be made of stainless steel or acrylic plastic and be of the closed/opened/closed type. Seals should be Teflon-coated. Care shall be exercised during sampling to avoid stirring up bottom sediments.

- **Decontamination of Sampling Tools**: After a subsample is obtained, the water sampling equipment shall be wiped and rinsed with deionized water. After sampling of an entire core is completed, the knives and spoons shall be cleaned in the following sequence: non-phosphate detergent and tap water rinse, tap water rinse, deionized water rinse, 10 percent nitric acid rinse (for metals), deionized water rinse, hexane rinse (for organics), deionized water rinse, acetone rinse (for organics) and a final deionized water rinse.

- **Core and Sample Labeling** – The vibrocore identifications shall correspond with the borrow area names and separated by surface or subsurface sample id's.

TABLE 4.1 NUMBER OF VIBROCORES, SEDIMENT SAMPLES, AND WATER SAMPLES

LOCATION	# OF VIBROCORES	# OF SURFACE (0.0 – 1.0 FT.) COMPOSITED SUBSAMPLES	# OF SUB-SURFACE (1.0 – 10.0 FT) COMPOSITED SUBSAMPLES	TOTAL BULK SEDIMENT SAMPLES TO BE ANALYZED	# OF WATER SAMPLES TO BE ANALYZED
Fenwick Island Area (south)	3	3	3	6	1
Fenwick Island Area (north)	3	3	3	6	0
Area E	3	3	3	6	1
Q/C Field Blanks					1
TOTAL	**9**	**9**	**9**	**18**	**3**

IMPORTANT: The above sample methodology assumes that composites will be composed of uniform similar materials. If vibrocores reveal distinct stratification (significant distinct layers of fine grained materials of thickness 2 feet or greater) within each core, the contractor shall segregate the fine strata from the overlying strata and underlying strata until a determination is made to modify the composite subsample procedure. (It may be necessary then to subsample individual strata).

4.1 PRESERVATION OF SAMPLES

4.1.1 Chemical Analysis of Sediment and Water Samples- Sediment and water samples shall be analyzed in accordance with the document: "The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters" (NJDEP, 1997).

1. Order of Work

   The order in which the sediment samples are analyzed shall be at the Contractor's discretion.

2. Sample Preservation

   a. **Bulk Sediment Samples**– Sediment samples for bulk analysis shall be stored in the dark and at $\leq$ 4 degrees Celcius until sample analyses are initiated. Sample preservation shall utilize techniques as presented in Attachment 1 of NJDEP, 1997.

   b. **Water Samples** -Water samples obtained for background analyses shall be stored in the dark and at $\leq$ 4 degrees Celcius until sample analyses are initiated. Sample preservation shall utilize techniques as presented in Attachment 1 of NJDEP, 1997.

   c. **Sample Holding Times** – Chemical analyses shall be conducted based on the following maximum sample holding times.

      - Bulk sediment analysis for metals: analysis within **28 days** of sample collection.

      - Bulk sediment analysis for pesticides, PCBs, and semi-volatile organics, cyanide, sulfide, oil and grease, TOC, pH: analysis within **14 days** of sample collection.

      - Water samples for metals: analysis within **14 days** of sample collection.

- Water samples for semi-volatiles: **7 days** extract, 40 days extract to analysis.

- Water samples for pesticides and PCBs: analysis within **14 days** of sample collection

- All remaining sampled materials (water and sediment) shall be labeled and held in cold ($\leq$ 4 degrees Celcius) and dark storage for a period of 7 months from the sample date, and shall be available to the Contract Officer upon request.

4.2 CHEMICAL ANALYSIS

A. **Sediment Samples** - The sediment samples for bulk analysis shall be obtained from the sediment cores collected within the sand borrow site locations.

B. **Bulk Sediment** - the 18 sediment composites shall be analyzed for TAL metals, TCL Semivolatile Organics, TCL PCBs and Pesticides (Tables 4.3, 4.4 and 4.5), oil and grease, pH, total organic carbon (TOC) as measured by loss on ignition, and grain size analysis/distribution.

C. **Water Sample Analysis** –Two background water samples shall be taken from the water column at one of the vibrocore stations representative of each borrow area and one Q/C field blank (total of 3 samples) shall be analyzed for the same parameters as required for the bulk sediment samples. Samples shall be obtained prior to bottom disturbance from the vibrocore operation. In addition, a sufficient quantity of water shall be collected to run all chemical tests. Quantities of water required per sample for the background sample are presented in Appendix A of NJDEP, 1997. Water samples shall be stored at appropriate temperatures in containers with airtight seals that are clearly labeled with the sample location. In the laboratory, samples will be kept at 4 degrees C until laboratory analysis is conducted. Detection levels for water sample parameters for background water analyses shall not exceed levels listed for water in Tables 4.3, 4.4, and 4.5.

***Because these samples represent marine water and sediments, the concentration of salt may be much greater than the analyte of interest and may cause unacceptable interferences in certain analytical techniques. In such cases, the freshwater approach of acid digestion followed by inductively coupled plasma or graphite furnace atomic absorption spectroscopy (GFAAS) needs to be coupled with appropriate techniques for controlling this interference. The QA program shall document the ability of the selected methods to cope with high salt content of sediments (USEPA and USACE, 1991).**

TABLE 4.2 TESTS TO BE PERFORMED FOR SEDIMENT AND WATER SAMPLES		
TEST PROCEDURE	**TEST PARAMETERS**	**# SAMPLES TO BE ANALYZED**
Bulk Analysis	• TAL Inorganics, • TCL Semivolatile Organics • TCL Pesticides/PCB • TOC • Oil & Grease • pH • % moisture • grain size analysis/distribution.	18
Background Water	• TSS (prefilter) • TDS • TAL Inorganics • TCL Semivolatile Organics • TCL Pesticides/PCBs • Oil & Grease • pH	3

4.3 QUALITY ASSURANCE/QUALITY CONTROL

The Contractor shall maintain accurate quality control records including at least daily analytical instrument calibration data and appropriate preservation and storage of all excess sediment and water for a period of 7 months subsequent to the initial analyses. Laboratory QA/QC shall include at a minimum: documentation of ongoing instrument calibration, method blanks, control spikes, duplicate matrix spikes and percent recoveries for C-13 internal quantitation standards and surrogate standards. One equipment field blank shall be used as QC. The equipment blank will be created by pouring laboratory grade water over all sampling equipment that comes in contact with the sediments (e.g., stainless steel spoons and bowls) collected into appropriate samples jars and analyzed for the suite of parameters included in the study. The laboratory shall at a minimum be USEPA, and New Jersey State certified. The QA program shall document the ability of the selected methods to cope with high salt content of sediments (USEPA and USACE, 1991).

4.4 REPORTING REQUIREMENTS

An initial data collection report will consist of a brief discussion drawing inferences regarding the water and sediment test results and any potential impact to human or natural resources. Laboratory data sheets shall include: test method, appropriate holding time, date sample was collected, date of analysis, test result, detection levels, and an explanation of any data qualifiers. In addition, a table and map identifying sampling locations, geographic coordinates (obtained from differential global positioning system (DGPS)), and corresponding data collection results will be included.

Draft and final reports must be polished products, clean-typed, complete with all figures, tables, and appendices and reflect and report the analyses outlined in this scope of work. The recommended content and format should follow quality assurance and quality control guidelines and shall be structured as follows:

(1) TITLE PAGE - bearing the appropriate title, date, author, and contract number.

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(5) METHODOLOGY - describes the sampling and analysis equipment and methodologies used.

(6) RESULTS - presents the collected data in tabular and graphic form and details any applicable statistical analyses used. The resulting sediment data shall be summarized. Sediment sampling data will be compared to the State and US EPA Criteria and Long et al. 1995. A detailed map illustrating the project area and the sample locations by identification number shall be included.

(7) DISCUSSION - draws inferences regarding the existing water and sediment quality and the potential for impact to natural resources by the dredging operation.

(8) A LIST OF REFERENCES - includes literature cited and agencies or individuals consulted. The bibliography must be in a format used by professional scientific journals.

(9) APPENDICES - for personnel qualifications, a copy of this scope of work, raw data sheets, record logs, and other pertinent information. All QA/QC documentations shall be provided in the appendices (in a separate book if necessary).

Each report page will be produced on 8 1/2" x 11" paper, single spaced, with double spacing between paragraphs. Figures should not exceed 11" in height nor 12" in length under most circumstances. All text pages, including Appendices, must be consecutively numbered. Text print quality must be at least letter quality.

4.5 PERIOD OF PERFORMANCE

Three copies of the initial data collection report shall be submitted to the Corps Point of Contact within 30 days of sampling. Three copies of the draft report shall be submitted to the Corps Point of Contact within 60 days of sampling. The draft report will be reviewed and returned to the contractor for revision, if necessary, within 15 working days of receipt of the draft. Following the review period, the draft report will be amended, if necessary, and a final report (4 copies) submitted to the Corps Point of Contact within 15 working days. This schedule is subject to adjustment by the Corps Point of Contact for delays on the part of the Government, and for conditions beyond the control of the parties hereto.

Table 4.3 Target Analyte List and Corresponding Contract Required Quantitation Limits for Inorganics (Metals). Detection levels from NJDEP, 1997.

Parameter	Method (water)	Method (soil)	Limits of Detection	
			Water (ug/L)	Soil (mg/Kg)
Aluminum	200.7	SW-846 6010A	200	40
Antimony	200.7	SW-846 6010A	60	12
Arsenic	200.7	SW-846 6010A	10	0.4
Barium	200.7	SW-846 6010A	200	40
Beryllium	200.7	SW-846 6010A	5	1
Cadmium	200.7	SW-846 6010A	5	1
Calcium	200.7	SW-846 6010A	5000	1000
Chromium	200.7	SW-846 6010A	10	2
Cobalt	200.7	SW-846 6010A	50	10
Copper	200.7	SW-846 6010A	25	5
Iron	200.7	SW-846 6010A	100	20
Lead	200.7	SW-846 6010A	3	0.6
Magnesium	200.7	SW-846 6010A	5000	1000
Manganese	200.7	SW-846 6010A	15	3
Mercury	245.1	SW-846 7471	0.2	0.1

Nickel	200.7	SW-846 6010A	40	8
Potassium	200.7	SW-846 6010A	5000	1000
Selenium	200.7	SW-846 6010A	5	1
Silver	200.7	SW-846 6010A	10	1
Sodium	NA	SW-846 6010A	5000	1000
Thallium	200.7	SW-846 6010A	10	2
Vanadium	200.7	SW-846 6010A	50	10
Zinc	200.7	SW-846 6010A	20	4
Cyanide	335.2	SW-846 9010A	10	0.5

Table 4.4 Target Compound List and Corresponding Contract Required Quantitation Limits for Semivolatile Organics. Detection levels from NJDEP, 1997.

Parameter	Method	Limits of Detection	
		Water (ug/L)	Soil (ug/Kg)
Benzaldehyde*	SW-846 2870	10	660
Phenol	SW-846 2870	10	660
bis(2-Chloroethyl) ether	SW-846 2870	10	660
2-Chlorophenol	SW-846 2870	10	660
1,3-Dichlorobenzene**	SW-846 2870	10	660
1,4-Dichlorobenzene**	SW-846 2870	10	660
1,2-Dichlorobenzene**	SW-846 2870	10	660
2-Methylphenol	SW-846 2870	10	660
2,2'-oxybis(1-Chloropropane)	SW-846 2870	10	660
Acetaphenone*	SW-846 2870	10	660
4-Methylphenol	SW-846 2870	10	660
N-Nitroso-di-n-propylamine	SW-846 2870	10	660
Hexachloroethane	SW-846 2870	10	660
Nitrobenzene	SW-846 2870	10	660
Isophorone	SW-846 2870	10	660
2-Nitrophenol	SW-846 2870	10	660
2,4-Dimethylphenol	SW-846 2870	10	660
bis(2-Chloroethoxy)	SW-846 2870	10	660

Table 4.4 Target Compound List and Corresponding Contract Required Quantitation Limits for Semivolatile Organics. Detection levels from NJDEP, 1997.			
		Limits of Detection	
methane			
2,4-Dichlorophenol	SW-846 2870	10	660
1,2,4-Trichlorobenzene**	SW-846 2870	10	660
Naphthalene	SW-846 2870	10	660
4-Chloroaniline	SW-846 2870	20	1300
Hexachlorobutadiene	SW-846 2870	10	660
Caprolactam*	SW-846 2870	10	660
4-Chloro-3-methylphenol	SW-846 2870	20	1300
2-Methylnaphthalene	SW-846 2870	10	660
Hexachlorocyclopentadiene	SW-846 2870	10	660
2,4,6-Trichlorophenol	SW-846 2870	10	660
2,4,5-Trichlorophenol	SW-846 2870	10	660
1,1'-Biphenyl*	SW-846 2870	10	660
2-Chloronapthalene	SW-846 2870	10	660
2-Nitroaniline	SW-846 2870	50	3300
Dimethylphthalate	SW-846 2870	10	660
Acenaphthylene	SW-846 2870	10	660
2,6-Dinitrotoluene	SW-846 2870	10	660
3-Nitroaniline	SW-846 2870	50	3300
Acenaphthene	SW-846 2870	10	660
2,4-Dinitrophenol	SW-846 2870	50	3300
4-Nitrophenol	SW-846 2870	50	3300
Dibenzofuran	SW-846 2870	10	660
2,4-Dinitrotoluene	SW-846 2870	10	660
Diethylphthalate	SW-846 2870	10	660
4-Chlorophenyl-phenylether	SW-846 2870	10	660
Fluorene	SW-846 2870	10	660
4-Nitroaniline	SW-846 2870	20	830
4,6-Dinitro-2-methylphenol	SW-846 2870	50	3300
N-Nitrosodiphenylamine	SW-846 2870	10	660
4-Bromophenyl-phenylether	SW-846 2870	10	660
Hexachlorobenzene	SW-846 2870	10	660
Atrazine*	SW-846 2870	10	660
Pentachlorophenol	SW-846 2870	50	3300
Phenanthrene	SW-846 2870	10	660
Anthracene	SW-846 2870	10	660
Carbazole	SW-846 2870	10	330
Di-n-butylphthalate	SW-846 2870	10	330
Fluoranthene	SW-846 2870	10	660
Pyrene	SW-846 2870	10	660

Table 4.4 Target Compound List and Corresponding Contract Required Quantitation Limits for Semivolatile Organics. Detection levels from NJDEP, 1997.			
		Limits of Detection	
Butylbenzylphthalate	SW-846 2870	10	660
3,3'-Dichlorobenzidine	SW-846 2870	20	1300
Benzo(a)anthracene	SW-846 2870	10	660
Chrysene	SW-846 2870	10	660
bis-(2-Ethylhexyl)phthalate	SW-846 2870	10	660
Di-n-octylphthalate	SW-846 2870	10	660
Benzo(b)fluoranthene	SW-846 2870	10	660
Benzo(k)fluoranthene	SW-846 2870	10	660
Benzo(a)pyrene	SW-846 2870	10	660
Indeno(1,2,3-cd)pyrene	SW-846 2870	10	660
Dibenzo(a,h)anthracene	SW-846 2870	10	660
Benzo(g,h,i)perylene	SW-846 2870	10	660
1,2,4,5-Tetrachlorobenzene*	SW-846 2870	10	660
* This compound is not listed in NJDEP, 1997 **Compound is also listed on Volatile Organic Compound List in NJDEP, 1997			

Table 4.5 Target Compound List and Corresponding Contract Required Quantitation Limits for Pesticides and PCBs. Detection levels from NJDEP, 1997.			
Parameter	Method	Limits of Detection	
		Water (ug/L)	Soil (ug/Kg)
alpha-BHC	SW-846 8081A	0.05	1.9
beta-BHC	SW-846 8081A	0.05	3.3
delta-BHC	SW-846 8081A	0.05	1.7
gamma-BHC (Lindane)	SW-846 8081A	0.05	2
Heptachlor	SW-846 8081A	0.05	2.1
Aldrin	SW-846 8081A	0.05	2
Heptachlor epoxide	SW-846 8081A	0.05	2.1
Endosulfan I	SW-846 8081A	0.05	2.1
Dieldrin	SW-846 8081A	0.10	3.3
4,4'-DDE	SW-846 8081A	0.10	4.2
Endrin	SW-846 8081A	0.10	3.6
Endosulfan II	SW-846 8081A	0.10	3.3
4,4'-DDD	SW-846 8081A	0.10	4.2
Endosulfan sulfate	SW-846 8081A	0.10	3.6
4,4'-DDT	SW-846 8081A	0.10	3.6
Methoxychlor	SW-846 8081A	0.50	17
Endrin ketone	SW-846 8081A	0.10	3.3
Endrin aldehyde	SW-846 8081A	0.10	3.3

Table 4.5 Target Compound List and Corresponding Contract Required Quantitation Limits for Pesticides and PCBs. Detection levels from NJDEP, 1997.			
Parameter	**Method**	**Limits of Detection**	
		Water (ug/L)	**Soil (ug/Kg)**
alpha-Chlordane	SW-846 8081A	0.05	1.7
gamma-Chlordane	SW-846 8081A	0.05	1.7
Toxaphene	SW-846 8081A	5.0	170
Aroclor-1016	SW-846 8082	1.0	33
Aroclor-1221	SW-846 8082	2.0	67
Aroclor-1232	SW-846 8082	1.0	33
Aroclor-1242	SW-846 8082	1.0	33
Aroclor-1248	SW-846 8082	1.0	33
Aroclor-1254	SW-846 8082	1.0	33
Aroclor-1260	SW-846 8082	1.0	33

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Attachment 1

SUMMARY OF RECOMMENDED PROCEDURES FOR SAMPLE COLLECTION, PRESERVATION, AND STORAGE

Analyses	Collection Method[a]	Sample Volume[b]	Container[c]	Preservation Technique	Storage Conditions	Holding Times[d]
Sediment						
Chemical/Physical Analyses						
Metals	Grab/corer	100 g	Precleaned polyethylene jar[e]	Dry ice[e] or freezer storage for extended storages; otherwise refrigerate	≤ 4°C	Hg - 28 days Others - 6 months[f]
Organic compounds (e.g., PCBs, pesticides, polycyclic aromatic hydrocarbons)	Grab/corer	250 g	Solvent-rinsed glass jar with Teflon® lid[e]	Dry ice[e] or freezer storage for extended storage; otherwise refrigerate	≤ 4°C[e]/dark[f]	14 days[g]
Particle size	Grab/corer	100 g	Whirl-pac bag[e]	Refrigerate	< 4°C	Undetermined
Total organic carbon	Grab/corer	50 g	Heat treated glass vial with Teflon®-lined lid[e]	Dry ice[e] or freezer storage for extended storages; otherwise refrigerate	≤ 4°C[e]	14 days
Total solids/specific gravity	Grab/corer	50 g	Whirl-pac bag	Refrigerate	< 4°C	Undetermined
Miscellaneous	Grab/corer	≥ 50 g	Whirl-pac bag	Refrigerate	< 4°C	Undetermined
Sediment from which elutriate is prepared	Grab/corer	Depends on tests being performed	Glass with Teflon®-lined lid	Completely fill and refrigerate	4°C/dark/airtight	14 days
Biological Tests						
Dredged material	Grab/corer	12–15 L per sample	Plastic bag or container[h]	Completely fill and refrigerate; sieve	4°C/dark/airtight	14 days[i]
Reference sediment	Grab/corer	45–50 L per test	Plastic bag or container[h]	Completely fill and refrigerate; sieve	4°C/dark/airtight	14 days[i]
Control sediment	Grab/corer	21–25 L per test	Plastic bag or container[h]	Completely fill and refrigerate; sieve	4°C/dark/airtight	14 days[i]

Analyses	Collection Method[a]	Sample Volume[b]	Container[c]	Preservation Technique	Storage Conditions	Holding Times[d]
Water and Elutriate						
Chemical/Physical Analyses						
Particulate analysis	Discrete sampler or pump	500–2,000 mL	Plastic or glass	Lugols solution and refrigerate	4°C	Undetermined
Metals	Discrete sampler or pump	1 L	Acid-rinsed polyethylene or glass jar[j]	pH < 2 with HNO_3; refrigerate[j]	4°C 2°C[j]	Hg - 14 days Others - 6 months[k]
Total Kjeldahl nitrogen	Discrete sampler or pump	100–200 mL	Plastic or glass[k]	H_2SO_4 to pH < 2; refrigerate	4°C[k]	24 h[k]
Chemical oxygen demand	Discrete sampler or pump	200 mL	Plastic or glass[k]	H_2SO_4 to pH < 2; refrigerate	4°C[k]	7 days[k]
Total organic carbon	Discrete sampler or pump	100 mL	Plastic or glass[k]	H_2SO_4 to pH < 2; refrigerate	4°C[k]	<48 hours[k]
Total inorganic carbon	Discrete sampler or pump	100 mL	Plastic or glass[k]	Airtight seal; refrigerate[k]	4°C[k]	6 months[k]
Phenolic compounds	Discrete sampler or pump	1 L	Glass[k]	0.1–1.0 g $CuSO_4$; H_2SO_4 to pH < 2; refrigerate	4°C[k]	24 hours[k]
Soluble reactive phosphates	Discrete sampler or pump	--	Plastic or glass[k]	Filter; refrigerate[k]	4°C[k]	24 hours[k]
Extractable organic compounds (e.g., semivolatile compounds)	Discrete sampler or pump	4 L	Amber glass bottle[j]	pH < 2, 6N HCl; airtight seal; refrigerate	4°C[j]	7 days for extraction; 40 days for sample extract analyses[j]
Volatile organic compounds	Discrete sampler or pump	80 mL	Glass vial[j]	pH < 2 with 1:1 HCL; refrigerate in airtight, completely filled container[j]	4°C[j]	14 days for sample analysis, if preserved[j]
Total phosphorus	Discrete sampler or pump	--	Plastic or glass[h]	H_2SO_4 to pH < 2; refrigerate	4°C[k]	7 days[k]

PCB - polychlorinated biphenyl

[a] Collection method should include appropriate liners.

[b] Amount of sample required by the laboratory to perform the analysis (wet weight or volume provided, as appropriate). Miscellaneous sample size for sediment should be increased if auxiliary analytes that cannot be included as part of the organic or metal analyses are added to the list. The amounts shown are not intended as firm values; more or less tissue may be required depending on the analytes, matrices, detection limits, and particular analytical laboratory.

[c] All containers should be certified as clean according to U.S. EPA (1990c).

[d] These holding times are for sediment, water, and tissue based on guidance that is sometimes administrative rather than technical in nature. There are no promulgated, scientifically based holding time criteria for sediments, tissues, or elutriates. References should be consulted if holding times for sample extracts are desired. Holding times are from the time of sample collection.

[e] NOAA (1989).

[f] Tetra Tech (1986a).

[g] Sample may be held for up to 1 year if ≤ –20°C.

[h] Polypropylene should be used if phthalate bioaccumulation is of concern.

[i] Two weeks is recommended; sediments must not be held for longer than 8 weeks prior to biological testing.

[j] U.S. EPA (1987a); 40 CFR Part 136, Table III.

[k] Plumb (1981).

[l] If samples are not preserved to pH < 2, then aromatic compounds must be analyzed within 7 days.

[m] Tetra Tech (1986b).

Excerpted from pp. 54-57 of the USEPA "QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations", Office of Water (EPA 823-B-95-0001, April 1995).

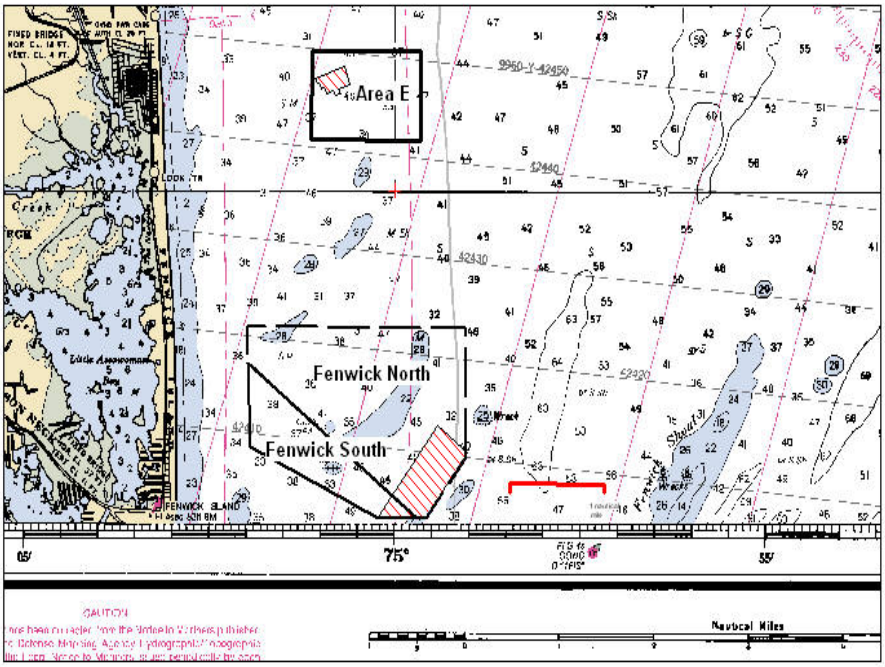
New Jersey Department of Environmental Protection (NJDEP). 1997. The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters.

APPENDIX A – BORROW AREA LOCATIONS AND COORDINATES

Table A-1. Geographic Coordinates of Borrow Area Corner Points

Point	Geographic Coordinates (NAD83)		Delaware State Plane in Feet (NAD83)	
	Latitude	**Longitude**	**Northing**	**Easting**
Fenwick North (Inside Firing Range Fan)				
F1	38.479912	-75.033124	175,000.2	765,965.2
F2	38.479741	-74.984099	175,000.1	780,000.2
F3	38.460364	-74.984216	167,943.0	779,999.8
F4	38.451291	-74.993184	164,626.8	777,447.0
F8	38.474335	-75.033255	172,968.9	765,936.2
Fenwick South (Outside Firing Range Fan)				
F5	38.451298	-74.995184	164,626.7	776,874.2
F6	38.451329	-75.003767	164,626.9	774,416.1
F7	38.461847	-75.032533	168,421.8	766,161.8
F8	38.474335	-75.033255	172,968.9	765,936.2
Area E (Inside Firing Range Fan)				
E1	38.521051	-75.018804	190,000.10	769,999.90
E2	38.520965	-74.994339	190,000.00	776,999.80
E3	38.507722	-74.994416	185,176.80	776,999.90
E4	38.507808	-75.018877	185,177.00	769,999.90

FENWICK ISLAND AND BETHANY BEACH PROPOSED SAND BORROW AREAS



Areas Previously Dredged By Delaware DNREC

*Note: Area E and Fenwick North Lie Within A Historic Anti-Aircraft Artillery Target Range

Figure A-1. Borrow Area Locations

APPENDIX B

FISHERIES RESOURCE DATA COLLECTED INSHORE (AREA E AND FENWICK ISLAND BORROW AREA) AND OFFSHORE (MMS)

Appendix B Table B-1 25 ft trawls								
	Summer 2003		Fall 2003		Winter 2004		Spring 2004	
Species	Inshore	MMS	Inshore	MMS	Inshore	MMS	Inshore	MMS
AMERICAN_EEL	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00
AMERICAN_SAND_LANCE	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00
ATLANTIC_CROAKER	15.82	0.11	478.34	6.63	0.00	0.00	0.00	0.00
ATLANTIC_HERRING	0.00	0.00	0.25	0.00	0.22	0.00	0.00	0.00
ATLANTIC_MENHADEN	0.00	0.00	32.65	0.00	0.00	0.00	0.00	0.00
ATLANTIC_MOONFISH	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC_ROCK_CRAB	0.50	0.05	30.57	0.40	0.00	0.11	0.69	0.76
ATLANTIC_SILVERSIDE	0.00	0.00	3.35	0.00	13.85	0.56	0.00	0.00
ATLANTIC_SURFCLAM	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BAY_ANCHOVY	49.30	14.61	465.37	1.90	0.45	0.00	0.22	0.00
BLACK_SEA_BASS	0.00	0.00	0.00	0.00	0.00	0.00	1.37	0.00
BLUEFISH	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BUTTERFISH	0.62	0.61	0.00	0.11	0.00	0.00	14.98	0.11
CHANNELED_WHELK	0.59	0.00	0.00	0.39	0.00	0.00	0.22	0.05
CHUB_MACKEREL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CLEARNOSE_SKATE	0.59	0.53	0.00	0.54	0.00	0.00	6.10	0.17
FEATHER_BLENNY	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00
FOURSPOT_FLOUNDER	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GASTROPODS	0.00	0.00	0.00	0.00	0.00	4.17	0.00	5.39
HEART_URCHINS	0.82	0.48	3.58	0.00	0.21	0.00	0.90	0.22
HICKORY_SHAD	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.00
JACKS	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00
KNOBBED_WHELK	1.25	0.05	0.00	0.00	0.00	0.00	2.52	0.00
LADY_CRAB	0.73	0.00	4.28	0.60	0.00	0.00	0.00	0.00
LINED_SEAHORSE	0.00	0.05	0.21	0.00	0.00	0.00	0.00	0.00
LITTLE_SKATE	0.00	0.00	0.00	0.05	0.00	0.05	0.44	0.28
MOON_SNAILS	0.00	0.00	0.00	0.17	0.81	1.46	0.00	2.10
NORTHERN_KINGFISH	3.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NORTHERN_PIPEFISH	0.00	0.00	1.24	0.06	0.00	0.00	0.00	0.00
NORTHERN_PUFFER	3.70	0.05	0.00	0.11	0.00	0.00	0.00	0.00
NORTHERN_SEAROBIN	0.00	1.54	0.27	0.60	0.00	0.00	15.44	2.75
NUDIBRANCHS	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.16

PORTLY_SPIDER_CRAB	2.19	0.05	0.00	0.05	0.00	0.00	0.00	0.00
PURPLE_SPINED_SEA_URCHIN	0.00	0.00	0.25	0.00	0.42	0.00	0.00	0.00
RED_HAKE	0.00	0.00	2.63	0.00	0.00	0.05	0.00	0.00
RIGHT_HANDED_HERMIT_CRABS	62.66	4.82	93.51	12.16	19.80	2.60	46.59	9.15
SAND_SHRIMP	0.00	0.00	339.21	0.21	87.18	7.96	48.04	2.66
SCUP	0.00	4.21	0.00	0.62	0.00	0.00	32.11	0.35
SILVER_HAKE	0.00	0.00	2.06	0.82	0.00	0.00	8.26	0.11
SILVER_PERCH	2.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SMALLMOUTH_FLOUNDER	0.70	0.22	0.49	1.79	0.00	0.00	8.78	1.46
SPINY_DOGFISH	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00
SPOTTED_HAKE	1.66	0.27	73.96	3.25	0.00	0.00	229.86	2.02
SPOTTED_SEATROUT	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SQUIDS	0.21	0.68	0.00	11.04	0.00	0.00	89.36	14.49
STARFISHES	5.58	6.09	6.88	18.70	4.84	3.20	4.70	8.01
STRIPED_ANCHOVY	4.18	0.99	0.00	0.05	0.00	0.00	0.00	0.00
STRIPED_CUSK_EEL	12.78	0.27	1.74	0.00	0.00	0.00	0.00	0.00
STRIPED_SEAROBIN	0.83	0.00	1.80	0.00	0.00	0.00	0.00	0.06
SUMMER_FLOUNDER	0.21	0.10	0.25	0.00	0.00	0.00	0.00	0.11
WEAKFISH	63.33	0.00	6.10	0.00	0.00	0.00	0.00	0.00
WINDOWPANE	1.75	0.00	7.32	1.31	0.21	0.22	4.76	0.66
WINTER_FLOUNDER	0.00	0.00	0.25	0.00	0.20	0.00	0.00	0.00
WINTER_SKATE	0.00	0.00	7.39	1.45	0.64	0.06	1.14	0.66
Total Catch	**237.48**	**35.78**	**1565.16**	**63.00**	**129.03**	**20.60**	**517.19**	**51.73**
Number of species	**29**	**20**	**29**	**24**	**13**	**12**	**22**	**22**

Appendix B Table B-2 Commercial Trawls								
	Summer 2003		Fall 2003		Winter 2004		Spring 2004	
NAME	Inshore	MMS	Inshore	MMS	Inshore	MMS	Inshore	MMS
ALEWIFE	0.00	0.00	0.00	0.00	0.00	0.08	1.26	0.55
AMERICAN_SAND_LANCE	0.00	43.34	0.00	0.07	0.00	0.00	0.00	0.08
AMERICAN_SHAD	0.00	0.00	0.00	0.00	0.17	0.00	0.14	0.00
ATLANTIC_ANGEL_SHARK	1.86	0.08	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC_CROAKER	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC_HERRING	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00
ATLANTIC_MACKEREL	38.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC_MENHADEN	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.00
ATLANTIC_ROCK_CRAB	0.12	0.21	0.26	0.13	0.45	0.06	0.16	0.00
ATLANTIC_SHARPNOSE_SHARK	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC_SILVERSIDE	0.00	0.00	0.00	0.00	0.70	0.21	0.00	0.00
ATLANTIC_STINGRAY	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC_STURGEON	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00
BAY_ANCHOVY	0.00	0.00	13.85	7.92	0.00	0.00	0.00	0.00
BLACK_SEA_BASS	0.00	0.07	0.00	0.49	0.00	0.00	0.16	0.22
BLUEBACK_HERRING	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00
BLUEFISH	0.26	0.00	0.37	1.93	0.00	0.00	0.00	0.00
BLUE_CRAB	1.81	0.00	0.13	0.00	0.14	0.00	0.00	0.00
BULLNOSE_RAY	0.97	0.23	0.00	0.00	0.00	0.00	0.00	0.00
BUTTERFISH	858.27	3.44	40.85	1.76	0.00	0.00	367.56	471.39
CHANNELED_WHELK	0.13	0.00	0.76	0.62	0.00	0.00	0.32	0.07
CHUB_MACKEREL	1.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CLEARNOSE_SKATE	70.20	9.21	4.12	6.65	0.00	0.00	76.09	0.71
COARSEHAND_LADY_CRAB	0.38	10.26	0.13	1.21	0.00	0.00	0.00	0.00
DUSKY_SHARK	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00
GOOSEFISH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
HARVESTFISH	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00
HICKORY_SHAD	0.00	0.00	0.12	0.00	0.60	0.16	0.00	0.00
HORSESHOE_CRAB	2.57	0.29	0.64	0.57	0.14	0.00	0.59	0.08
JACKS	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00
KNOBBED_WHELK	3.71	0.16	4.56	0.14	0.00	0.00	6.05	0.00
LADY_CRAB	8.70	25.06	23.74	8.29	0.00	0.00	0.00	0.00

LITTLE_SKATE	0.00	0.00	5.95	2.69	1.01	1.11	3.58	6.50
MOON_SNAILS	0.76	0.06	0.00	0.07	0.00	0.00	0.00	0.08
NORTHERN_KINGFISH	3.19	0.14	0.00	0.07	0.00	0.00	3.48	0.45
NORTHERN_PUFFER	0.24	0.00	0.00	0.00	0.00	0.00	0.16	0.09
NORTHERN_SEAROBIN	11.18	57.01	1.66	1.86	0.00	0.00	0.74	34.86
NORTHERN_STARGAZER	0.58	0.35	0.00	0.00	0.00	0.00	0.14	0.00
PORTLY_SPIDER_CRAB	1.07	0.00	0.00	0.07	0.00	0.00	0.00	0.14
RED_HAKE	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00
RIGHT_HANDED_HERMIT_CRABS	0.12	0.19	0.63	0.14	0.00	0.00	0.00	0.00
SCUP	74.89	189.77	4.22	3.28	0.00	0.00	978.89	480.27
SHORTNOSE_STURGEON	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00
SILVER_HAKE	0.00	0.00	0.00	0.00	0.00	0.00	11.29	0.00
SMALLMOUTH_FLOUNDER	0.00	0.07	0.00	0.07	0.00	0.00	0.16	0.00
SMOOTH_DOGFISH	0.24	0.00	0.39	0.14	0.00	0.00	3.97	18.22
SPANISH_MACKEREL	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
SPINY_DOGFISH	0.00	0.00	5.42	126.48	0.00	0.00	0.00	0.00
SPOTTED_HAKE	46.70	2.46	3.12	0.42	0.00	0.00	62.82	0.46
SQUIDS	18.71	21.43	5.10	5.90	0.00	0.00	95.67	115.30
STARFISHES	16.37	3.67	3.42	21.22	0.28	0.37	0.79	2.33
STRIPED_BASS	0.00	0.00	0.51	75.34	0.00	0.15	0.00	0.00
STRIPED_SEAROBIN	2.29	0.07	1.66	5.24	0.00	0.00	0.58	1.49
SUMMER_FLOUNDER	0.72	0.29	7.62	8.08	0.00	0.07	2.11	1.24
THRESHER_SHARK	0.14	0.07	0.00	0.00	0.00	0.00	0.00	0.00
WEAKFISH	2.81	0.00	7.43	0.00	0.00	0.00	3.21	0.00
WINDOWPANE	1.46	0.66	24.62	8.71	2.91	3.90	0.93	3.13
WINTER_FLOUNDER	0.00	0.00	0.00	0.00	0.28	0.09	0.00	0.08
WINTER_SKATE	1.97	2.92	44.02	66.18	14.04	6.83	22.79	23.10
Total Catch	**1173.56**	**371.69**	**205.43**	**355.94**	**20.73**	**13.78**	**1644.22**	**1160.92**
Number of species	**35**	**27**	**28**	**32**	**11**	**13**	**30**	**24**

Appendix B Table B-3 Gillnets								
	Summer 2003		**Fall 2003**		**Winter 2004**		**Spring 2004**	
NAME	**Inshore**	**MMS**	**Inshore**	**MMS**	**Inshore**	**MMS**	**Inshore**	**MMS**
ALEWIFE	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
AMERICAN_SHAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
ATLANTIC_CROAKER	14.58	1.96	0.42	0.00	0.00	0.00	0.00	0.00
ATLANTIC_MENHADEN	25.37	2.49	0.30	0.00	0.00	0.00	0.10	0.87
ATLANTIC_ROCK_CRAB	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00
ATLANTIC_SHARPNOSE_SHARK	0.42	0.72	0.00	0.00	0.00	0.00	0.00	0.00
BLUEFISH	2.73	1.39	3.27	1.31	0.00	0.00	0.00	0.00
BULLNOSE_RAY	0.18	0.11	0.00	0.00	0.00	0.00	0.00	0.00
BUTTERFISH	6.65	0.50	2.53	0.00	0.00	0.00	0.00	0.02
CLEARNOSE_SKATE	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.03
COBIA	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
DUSKY_SHARK	6.82	0.38	0.00	0.00	0.00	0.00	0.00	0.03
HICKORY_SHAD	0.00	0.00	10.92	0.00	0.00	0.00	0.00	0.00
KNOBBED_WHELK	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00
NORTHERN_KINGFISH	0.00	0.00	0.40	0.00	0.00	0.00	0.09	0.00
NORTHERN_PIPEFISH	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
NORTHERN_SEAROBIN	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00
NORTHERN_STARGAZER	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00
PORTLY_SPIDER_CRAB	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.13
SCUP	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SMOOTH_DOGFISH	6.03	1.77	0.35	0.18	0.00	0.00	8.85	1.34
SPANISH_MACKEREL	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00
SPINY_DOGFISH	0.00	0.00	5.40	20.33	0.00	0.61	0.00	0.00
SPOT	1.53	0.07	0.00	0.00	0.00	0.00	0.00	0.00
STARFISHES	0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.00
STRIPED_BASS	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.00
STRIPED_SEAROBIN	0.18	0.08	0.00	0.04	0.00	0.00	0.00	0.02
SUMMER_FLOUNDER	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WEAKFISH	0.21	0.07	7.75	0.00	0.00	0.00	0.00	0.00
WINTER_SKATE	0.00	0.00	0.15	0.42	0.00	0.00	0.72	0.61
Total Catch	**65.13**	**10.23**	**31.74**	**22.73**	**0.00**	**0.71**	**11.13**	**3.18**
Number of species	**13**	**15**	**11**	**6**	**0**	**4**	**7**	**9**

APPENDIX C

VIDEO CAMERA IMAGE DATA

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
		start															
F	1	38.482473	75.029043	0	0	0	0	10110	10000	2	3	0	1	0	3010		
F	2	38.481877	75.028855	0	0	0	0	10110	10000	2	3	0	1	0	3010		
F	3	38.481073	75.030195	0	0	0	0	10110	10000	2	3	0	1	0	3010		
F	4	38.480000	75.031077	0	0	0	0	10110	10000	2	3	0	1	0	3010		
F	5	38.478787	75.030845	1	0	0	0	10110	10000	2	3	0	1	0	3010		
F	6	38.477535	75.030435	1	0	0	0	10110	10000	2	3	0	1	0	3010		
F	7	38.476903	75.030193	1	0	0	2	10110	10	2	3	2	1	0	3210		
F	8	38.476802	75.030173	5	0	0	0	10110	10	2	3	2	1	0	3210		
F	9	38.476607	75.030125	0	0	0	0	10110	10	1	3	2	0	0	3200		
F	10	38.476590	75.030123	1	0	1	0	10110	10	1	3	2	0	0	3200		
F	11	38.476560	75.030128	0	1	1	0	10110	10	1	3	2	0	0	3200		
F	12	38.476557	75.030135	2	1	0	0	10110	10	1	3	2	0	0	3200		
F	13	38.476563	75.030180	1	0	0	0	10110	10	1	3	2	0	0	3200		
F	14	38.476373	75.030190	4	0	1	0	10110	10	2	3	2	1	0	3210		
F	15	38.476090	75.030198	0	0	0	0	10110	1000	2	3	1	1	0	3110		
F	16	38.475097	75.029887	0	0	0	0	10110	1000	1	3	1	0	0	3100		
F	17	38.474030	75.029758	0	0	0	0	10110	1000	1	3	1	0	0	3100		
F	18	38.472920	75.029807	0	0	0	0	10110	1000	2	3	1	1	0	3110		

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
F	19	38.472393	75.029742	0	2	1	0	10110	1000	1	3	1	0	0	3100		
F	20	38.471778	75.029717	0	0	0	0	10110	1000	1	3	1	0	0	3100		
F	21	38.471300	75.029740	0	0	1	1	10110	1000	1	3	1	0	0	3100		
F	22	38.470427	75.029860	4	0	0	0	10110	1000	1	3	1	0	0	3100		
F	23	38.469125	75.029818	0	0	0	0	10110	1000	1	3	1	0	0	3100		
F	24	38.468085	75.029523	7	0	0	1	10110	1000	2	3	1	1	0	3110		
F	25	38.467863	75.029443	2	5	0	1	10110	1000	1	3	1	0	0	3100	x	
F	26	38.467060	75.029153	5	0	1	0	10110	1000	1	3	1	0	0	3100		
F	27	38.466795	75.029133	1	0	0	0	10110	1000	1	3	1	0	0	3100		
F	28	38.466082	75.029153	4	2	0	0	10110	1000	1	3	1	0	0	3100		
F	29	38.465575	75.029110	3	0	1	0	10110	1000	1	3	1	0	0	3100		
F	30	38.464203	75.028965	6	0	0	0	10110	1000	1	3	1	0	0	3100	x	
F	31	38.462887	75.029023	2	0	0	0	10110	1000	1	3	1	0	0	3100		
F	32	38.462587	75.029073	1	0	0	0	10110	1000	1	3	1	0	0	3100		
F	33	38.462452	75.029080	5	0	1	0	10110	1000	1	3	1	0	0	3100		
F	34	38.461712	75.028830	6	0	0	0	10110	1000	1	3	1	0	0	3100	x	
		first turn															
F	35	38.462263	75.028135	4	0	0	0	10110	1000	1	3	1	0	0	3100	x	
F	36	38.462780	75.027808	7	0	1	0	10110	1000	2	3	1	1	0	3110		
F	37	38.463350	75.027833	4	0	0	0	11001	1000	2	2	1	1	0	2110		

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
F	38	38.463625	75.027803	3	0	0	1	11001	1000	2	2	1	1	0	2110		
F	39	38.464442	75.027587	2	0	0	0	11001	1000	1	2	1	0	0	2100		
F	40	38.464882	75.027345	3	0	2	0	11001	1000	1	2	1	0	0	2100		
F	41	38.465492	75.027057	2	0	1	0	10110	1000	1	3	1	0	0	3100		
F	42	38.466415	75.026685	7	0	1	1	10110	1000	1	3	1	0	0	3100	x	
F	43	38.466623	75.026543	5	0	0	0	10110	1000	1	3	1	0	0	3100		
F	44	38.467810	75.026067	2	0	0	0	10110	1000	1	3	1	0	0	3100	x	
F	45	38.468972	75.025865	4	0	0	0	10110	1000	1	3	1	0	0	3100		
F	46	38.470125	75.025670	3	0	0	0	10110	1000	1	3	1	0	0	3100		
F	47	38.471273	75.025300	5	0	0	0	10110	1000	1	3	1	0	0	3100		
F	48	38.472420	75.024910	5	0	0	0	10110	1000	1	3	1	0	0	3100		
F	49	38.473608	75.024580	0	0	0	0	10110	1000	1	3	1	0	0	3100		
F	50	38.474637	75.023892	0	0	0	0	10110	1000	1	3	1	0	0	3100		
F	51	38.475690	75.023277	1	0	0	0	10110	1000	1	3	1	0	0	3100		
F	52	38.476748	75.022547	0	0	0	0	10110	1000	2	3	1	1	0	3110		
F	53	38.477927	75.022138	0	0	0	0	10110	1000	2	3	1	1	0	3110		
F	54	38.478377	75.021047	0	0	0	0	10110	1000	2	3	1	1	0	3110		
		second turn															
F	55	38.477550	75.020413	0	0	1	0	10110	1000	2	3	1	1	0	3110		
F	56	38.476212	75.020448	0	0	0	0	10110	1000	2	3	1	1	0	3110		

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
F	57	38.474858	75.020325	3	0	0	0	10110	1000	1	3	1	0	0	3100		
F	58	38.473802	75.020253	2	0	0	0	10110	1000	1	3	1	0	0	3100		
F	59	38.472652	75.020092	3	0	1	0	11101	1000	2	1	1	1	0	1110		
F	60	38.472383	75.020087	2	0	0	0	10010	110000	1	4	0	0	0	4000		
F	61	38.471310	75.020317	1	0	0	0	10010	110000	1	4	0	0	0	4000		
F	62	38.470042	75.020493	1	0	0	0	10010	110000	1	4	0	0	0	4000		
F	63	38.468880	75.020658	3	0	0	0	10010	110000	1	4	0	0	0	4000		
F	64	38.467720	75.020823	4	2	0	0	10010	110000	1	4	0	0	0	4000		
F	65	38.466745	75.020952	1	0	0	0	10010	110000	1	4	0	0	0	4000		
F	66	38.465717	75.021072	1	0	0	0	10010	110000	1	4	0	0	0	4000		
F	67	38.465678	75.021078	0	1	0	0	10010	110000	1	4	0	0	0	4000		
F	68	38.464798	75.021268	4	0	0	0	10010	110000	1	4	0	0	0	4000		
F	69	38.463647	75.021462	0	0	0	0	11010	110000	1	2	0	0	0	2000		
F	70	38.463217	75.021535	3	0	0	0	11010	110000	1	2	0	0	0	2000		
F	71	38.462623	75.021578	2	0	0	0	11010	110000	1	2	0	0	0	2000	x	
F	72	38.461435	75.021692	2	0	0	0	11010	110000	1	2	0	0	0	2000		
F	73	38.460230	75.021872	2	0	0	0	11010	110000	1	2	0	0	0	2000	x	
F	74	38.459190	75.022053	0	0	0	0	11010	110000	1	2	0	0	0	2000		
F	75	38.458512	75.021642	2	0	0	0	11010	110000	1	2	0	0	0	2000	x	
		third turn															

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
F	76	38.458890	75.020977	1	0	0	0	11010	110000	1	2	0	0	0	2000		
F	77	38.459713	75.020203	0	0	0	0	11010	110000	1	2	0	0	0	2000	x	
F	78	38.460702	75.019742	0	0	0	0	11010	110000	1	2	0	0	0	2000		
F	79	38.461778	75.019313	0	0	0	0	11010	110000	1	2	0	0	0	2000	x	
F	80	38.462882	75.018877	0	0	0	0	11010	110000	1	2	0	0	0	2000		
F	81	38.463323	75.018403	1	1	0	0	11010	110000	1	2	0	0	0	2000	x	
F	82	38.463797	75.018102	2	0	1	0	11010	110000	1	2	0	0	0	2000		
F	83	38.464917	75.017695	1	0	0	0	11010	110000	1	2	0	0	0	2000		
F	84	38.466018	75.017332	0	0	0	0	11010	110000	0	2	0	0	0	2000		
F	85	38.466358	75.017153	0	0	0	0	11010	110000	1	2	0	0	0	2000		
F	86	38.467415	75.016505	0	0	0	0	11010	110000	1	2	0	0	0	2000		
F	87	38.468538	75.016202	0	0	0	0	11010	110000	1	2	0	0	0	2000		
F	88	38.469637	75.015787	0	0	0	0	11010	110000	1	2	0	0	0	2000		
F	89	38.470642	75.015073	0	0	0	0	11010	110000	1	2	0	0	0	2000		
F	90	38.471698	75.014412	0	0	1	0	10010	110000	1	4	0	0	0	4000		
F	91	38.472810	75.013902	0	0	0	0	10010	110000	1	4	0	0	0	4000		
F	92	38.473997	75.013845	0	0	0	0	10010	110000	1	4	0	0	0	4000		
F	93	38.475082	75.013430	0	0	0	0	10010	110000	1	4	0	0	0	4000		
F	94	38.476235	75.013317	0	0	0	0	10010	110000	1	4	0	0	0	4000		
F	95	38.477368	75.012997	2	0	0	0	10010	110000	1	4	0	0	0	4000		

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
F	96	38.478533	75.012947	0	0	0	0	10010	110000	1	4	0	0	0	4000		
F	97	38.478585	75.011913	0	0	0	0	10010	110000	1	4	0	0	0	4000		
		fourth turn															
F	98	38.477443	75.011722	0	0	0	0	10010	110000	1	4	0	0	0	4000		
F	99	38.476000	75.011763	0	0	0	0	10010	110000	1	4	0	0	0	4000		
F	100	38.474595	75.011763	0	0	0	0	10010	110000	1	4	0	0	0	4000		
F	101	38.473160	75.011593	0	0	0	0	10010	110000	1	4	0	0	0	4000		
F	102	38.472105	75.011607	0	0	0	0	10010	110000	1	4	0	0	0	4000		
F	103	38.471200	75.011422	0	0	0	0	10010	110000	1	4	0	0	0	4000		
F	104	38.469920	75.011243	2	0	0	0	10010	110000	1	4	0	0	0	4000		
F	105	38.469535	75.011245	0	0	1	0	10010	110000	1	4	0	0	0	4000		
F	106	38.468792	75.011165	3	0	0	0	10010	110000	2	4	0	1	0	4010		
F	107	38.467743	75.011120	3	0	0	0	10010	110000	2	4	0	1	0	4010		
F	108	38.466572	75.011013	3	2	1	0	10010	110000	2	4	0	1	0	4010		
F	109	38.466467	75.011010	2	0	0	0	10010	110000	2	4	0	1	0	4010		
F	110	38.466347	75.011030	4	0	0	2	10010	110000	2	4	0	1	0	4010		
F	111	38.465493	75.010850	3	0	0	0	10010	110000	2	4	0	1	0	4010		
F	112	38.464810	75.010442	1	9	0	0	10010	110000	2	4	0	1	1	4011		
F	113	38.464747	75.010405	5	4	0	0	10010	110000	2	4	0	1	0	4010		
F	114	38.464722	75.010387	53	3	0	0	10010	110000	2	4	0	1	1	4011		

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
		fifth turn															
F	115	38.465580	75.009207	4	1	0	0	10010	110000	2	4	0	1	0	4010		
F	116	38.466567	75.008557	3	0	0	0	10010	110010	2	4	2	1	0	4210		
F	117	38.467550	75.008018	4	0	0	0	11011	110000	2	2	0	1	0	2010		
F	118	38.468193	75.007635	2	0	0	1	11011	110000	2	2	0	1	0	2010		
F	119	38.468545	75.007510	1	0	0	0	11011	110000	2	2	0	1	0	2010		
F	120	38.468592	75.007478	6	0	0	0	11011	110000	2	2	0	1	0	2010		
F	121	38.469545	75.007020	2	0	0	0	11010	110000	2	2	0	1	0	2010		
F	122	38.470593	75.006635	0	0	1	0	11010	110000	1	2	0	0	0	2000		
F	123	38.470838	75.006672	2	0	1	0	11010	110000	1	2	0	0	0	2000		
F	124	38.471638	75.006385	0	0	4	0	10010	110000	1	4	0	0	0	4000		
F	125	38.472678	75.006023	0	0	0	0	10010	100000	2	4	0	1	0	4010		
F	126	38.473662	75.005928	0	0	0	0	10010	100010	3	4	2	1	0	4210		
F	127	38.474662	75.005765	5	0	0	0	10010	100010	2	4	2	1	0	4210	x	
F	128	38.475465	75.005305	0	0	1	0	10010	100010	1	4	2	0	0	4200	x	
F	129	38.476188	75.005020	0	0	0	0	10010	100010	1	4	2	0	0	4200	x	
		sixth turn															
F	130	38.476153	75.004242	6	0	1	0	10010	100010	1	4	2	0	0	4200	x	
F	131	38.476015	75.003762	1	0	1	0		10010	2	5	2	1	0	5210	x	
F	132	38.475895	75.003362	5	0	0	1		10010	2	5	2	1	0	5210	x	

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
F	133	38.475893	75.003335	1	0	1	0		10010	2	5	2	1	0	5210		
F	134	38.475818	75.002935	4	0	2	0		10010	2	5	2	1	0	5210		
F	135	38.475733	75.002715	5	0	1	0		10010	2	5	2	1	0	5210		
F	136	38.475682	75.002567	5	0	0	0		10010	2	5	2	1	0	5210		
F	137	38.475610	75.002380	2	0	0	0	11000	10010	2	2	2	1	0	2210		
F	138	38.475360	75.001613	1	0	0	1	11000	10000	2	2	0	1	0	2010		
F	139	38.475332	75.001433	2	9	1	0	11000	10000	1	2	0	0	0	2000		
F	140	38.475295	75.001242	3	10	0	0	10000	10000	1	4	0	0	1	4001		
F	141	38.475093	74.999970	1	9	0	0	11001	10000	0	2	0	0	1	2001		
F	142	38.475040	74.998532	0	0	0	0	11010	110000	1	2	0	0	0	2000		
F	143	38.474822	74.996970	0	0	0	0	11010	110000	1	2	0	0	0	2000		
F	144	38.474595	74.995463	3	0	0	0	11010	110000	1	2	0	0	0	2000		
F	145	38.474287	74.993902	2	3	0	0	11010	110000	1	2	0	0	0	2000		
F	146	38.474108	74.992903	0	0	0	1	11010	110000	1	2	0	0	0	2000		
F	147	38.473918	74.992368	3	0	0	0	10010	110000	1	4	0	0	0	4000		
F	148	38.473843	74.992210	0	0	1	0	10010	110000	1	4	0	0	0	4000		
F	149	38.473693	74.991697	1	0	1	0	10010	110000	1	4	0	0	0	4000		
F	150	38.473425	74.990883	0	0	0	0	10010	110000	0	4	0	0	0	4000		
F	151	38.472903	74.989937	1	0	0	0	10010	110000	1	4	0	0	0	4000		
F	152	38.472397	74.988988	0	0	1	0	10010	110000	1	4	0	0	0	4000		

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
		seventh turn															
F	153	38.471345	74.989297	0	0	0	0	10010	110000	1	4	0	0	0	4000		
F	154	38.470190	74.989440	0	0	0	0	10010	110000	2	4	0	1	0	4010		
F	155	38.469225	74.989693	0	0	0	0	10010	110000	1	4	0	0	0	4000		
F	156	38.468123	74.990197	0	0	0	0	11010	110000	1	2	0	0	0	2000		
F	157	38.467110	74.990717	0	0	0	0	11010	110000	1	2	0	0	0	2000		
F	158	38.466487	74.991237	3	0	0	0	11010	110000	1	2	0	0	0	2000		
F	159	38.466082	74.991460	5	2	0	0	11010	110000	1	2	0	0	0	2000		
F	160	38.465897	74.991585	5	0	1	0	10010	110010	1	4	2	0	0	4200		
F	161	38.465063	74.992205	0	0	0	0	10010	110000	2	4	0	1	0	4010		
F	162	38.464650	74.992367	4	1	1	0	10010	11000	1	4	1	0	0	4100		
F	163	38.464170	74.992507	2	0	0	0	10010	11000	1	4	1	0	0	4100		
F	164	38.464017	74.992550	2	0	0	0	10010	11000	0	4	1	0	0	4100		
F	165	38.463967	74.992567	2	2	0	0	10010	11000	0	4	1	0	0	4100		
F	166	38.463692	74.992673	3	4	1	0	10010	11000	0	4	1	0	0	4100		
F	167	38.463175	74.992995	4	0	1	0	10010	11000	1	4	1	0	0	4100		
F	168	38.462980	74.993215	7	2	0	0	11010	11000	1	2	1	0	0	2100		
F	169	38.462865	74.993383	3	0	1	2	11010	11000	1	2	1	0	0	2100		
F	170	38.462070	74.993998	5	4	0	0	10010	11000	0	4	1	0	0	4100		
F	171	38.461870	74.994130	0	0	0	0	10110	100000	1	3	0	0	0	3000		

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
F	172	38.461005	74.995343	3	0	0	0	10110	100000	1	3	0	0	0	3000		
F	173	38.459930	74.996030	0	0	0	0	10110	100000	1	3	0	0	0	3000		
F	174	38.459070	74.996940	2	0	1	0	10110	100000	1	3	0	0	0	3000		
F	175	38.458230	74.997910	4	0	0	0	10110	100000	1	3	0	0	0	3000		
F	176	38.456950	74.998440	1	0	0	0	10110	100000	1	3	0	0	0	3000		
F	177	38.456130	74.999022	1	0	0	0	10110	100000	1	3	0	0	0	3000		
F	178	38.455623	74.999412	0	0	1	0	10110	100000	1	3	0	0	0	3000		
F	179	38.455230	74.999782	11	0	0	0	11010	100000	1	2	0	0	0	2000		
F	180	38.454765	75.000180	4	0	0	0	11010	100000	1	2	0	0	0	2000		
F	181	38.454487	75.000377	1	0	0	0	11000	100000	0	2	0	0	0	2000		
F	182	38.454360	75.000465	4	0	0	1	11000	100000	0	2	0	0	0	2000		
F	183	38.454318	75.000502	2	0	0	0	11000	100000	0	2	0	0	0	2000		
F	184	38.454193	75.000607	5	0	0	0	11000	100000	0	2	0	0	0	2000		
F	185	38.453610	75.001475	1	1	0	0	10010	100000	0	4	0	0	0	4000		
F	186	38.453460	75.001920	0	4	1	0	10010	100000	0	4	0	0	0	4000		
		eight turn															
F	187	38.453517	75.002373	0	0	0	0	10010	100000	0	4	0	0	0	4000		
F	188	38.453687	75.002977	7	3	2	0	10110	100000	2	3	0	1	0	3010		
F	189	38.453752	75.003252	4	0	2	0	10110	100000	2	3	0	1	0	3010		
F	190	38.453905	75.003430	6	1	0	0	10110	100000	2	3	0	1	0	3010		

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
F	191	38.454077	75.003593	0	0	1	0	10110	100000	2	3	0	1	0	3010		
F	192	38.454183	75.003747	2	0	1	0	10110	100010	2	3	2	1	0	3210		
F	193	38.454617	75.004142	5	1	1	0	10110	100000	2	3	0	1	0	3010		
F	194	38.454727	75.004257	3	0	0	0	10110	100000	1	3	0	0	0	3000		
F	195	38.455320	75.005217	2	0	0	0	10110	100000	1	3	0	0	0	3000		
F	196	38.456107	75.005737	0	0	0	0	10110	100000	1	3	0	0	0	3000		
F	197	38.456947	75.006382	0	2	0	0	10110	100000	1	3	0	0	0	3000		
F	198	38.457300	75.006610	3	0	1	0	10110	100000	1	3	0	0	0	3000		
F	199	38.457412	75.006758	1	0	1	0	10110	100000	1	3	0	0	0	3000		
F	200	38.457617	75.007042	0	0	1	0	10110	100100	1	3	1	0	0	3100		
F	201	38.457748	75.007185	4	0	1	0	10110	10000	1	3	0	0	0	3000		
F	202	38.457808	75.007237	0	0	1	1	10110	10000	1	3	0	0	0	3000		
F	203	38.457968	75.007357	4	0	0	0	10110	10000	1	3	0	0	0	3000		
F	204	38.458162	75.007245	3	0	2	0	10110	10000	1	3	0	0	0	3000		
F	205	38.458443	75.007250	6	0	2	0	10110	10000	2	3	0	1	0	3010		
F	206	38.459283	75.007593	22	0	2	0	10110	10000	2	3	0	1	1	3011		
F	207	38.459413	75.007553	7	0	0	1	11110	10000	4	1	0	1	0	1010		
F	208	38.459525	75.007525	35	0	0	0	11110	10000	4	1	0	1	1	1011		
F	209	38.459638	75.007515	10	1	1	0	11110	10000	2	1	0	1	0	1010		
F	210	38.460230	75.007683	9	0	0	0	11110	100000	2	1	0	1	0	1010		

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
F	211	38.460735	75.008063	0	0	1	0	11110	100000	2	1	0	1	0	1010		
F	212	38.461055	75.008148	4	0	0	0	11110	100000	2	1	0	1	0	1010		
		end of Area F															
		Averages		2.53	0.44	0.30	0.08										
		SD		4.90	1.48	0.58	0.33										
E	213	38.505385	74.995712	0	0	0	0	10110	100000	1	3	0	0	0	3000		N
E	214	38.505538	74.994572	5	0	0	0	10110	100000	1	3	0	0	0	3000		N
E	215	38.506373	74.995138	6	0	0	0	10110	100000	1	3	0	0	0	3000		N
E	216	38.507295	74.995860	0	0	0	0	10110	100000	1	3	0	0	0	3000		N
E	217	38.508267	74.996373	0	8	0	0	10110	100000	1	3	0	0	1	3001		N
E	218	38.509093	74.996743	2	2	1	0	10110	100000	1	3	0	0	0	3000		N
E	219	38.509940	74.997365	0	0	0	0	10110	100000	1	3	0	0	0	3000		N
E	220	38.510900	74.997700	2	0	0	0	10110	100000	1	3	0	0	0	3000		N
E	221	38.511928	74.997960	2	0	0	0	10110	100000	1	3	0	0	0	3000		N
E	222	38.512937	74.998375	0	0	1	0	10110	100000	1	3	0	0	0	3000		N
E	223	38.513807	74.998875	6	2	1	0	10110	100000	1	3	0	0	0	3000		N
E	224	38.513928	74.998878	1	0	0	0	10110	100000	1	3	0	0	0	3000		N
E	225	38.513943	74.998877	0	0	0	1	10110	100000	1	3	0	0	0	3000		N
E	226	38.514877	74.998935	6	0	0	0	10110	100000	1	3	0	0	0	3000		N
E	227	38.515508	74.999475	3	0	0	1	10110	100000	1	3	0	0	0	3000		N

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
E	228	38.515773	74.999460	0	7	0	0	10110	100000	1	3	0	0	1	3001		N
E	229	38.516805	74.999493	6	1	0	0	10110	100000	1	3	0	0	0	3000		N
E	230	38.517217	74.999698	0	0	1	0	10110	100000	1	3	0	0	0	3000		N
E	231	38.517807	74.999908	4	3	0	0	11110	100000	1	1	0	0	0	1000		N
E	232	38.518830	74.999917	2	1	0	0	11110	100000	1	1	0	0	0	1000		N
E	233	38.519643	75.000323	5	4	0	1	11000	100000	1	2	0	0	0	2000		N
E	234	38.519675	75.000283	14	0	1	0	11000	100000	1	2	0	0	0	2000		N
E	235	38.519717	75.000222	5	0	0	0	11000	100000	1	2	0	0	0	2000		N
E	236	38.519833	74.999993	7	2	0	2	11000	100000	1	2	0	0	0	2000		N
E	237	38.520093	74.999863	4	2	0	2	11000	100000	1	2	0	0	0	2000		N
E	238	38.520523	75.000390	3	1	0	0	11000	100000	1	2	0	0	0	2000		N
E	239	38.519615	75.001822	0	0	0	0	11100	100000	1	1	0	0	0	1000		N
E	240	38.518057	75.002417	0	1	0	0	11100	100000	1	1	0	0	0	1000		N
E	241	38.516533	75.002963	3	0	0	0	11100	100000	1	1	0	0	0	1000		N
E	242	38.516457	75.002998	1	0	0	1	11100	100000	1	1	0	0	0	1000		N
E	243	38.515607	75.003347	0	0	0	1	11100	100000	1	1	0	0	0	1000		N
E	244	38.514922	75.003490	2	0	0	0	11100	100000	1	1	0	0	0	1000		N
E	245	38.513323	75.003980	0	9	0	0	10110	100000	0	3	0	0	1	3001		N
E	246	38.511678	75.004492	1	2	0	0	10110	100000	0	3	0	0	0	3000		N
E	247	38.510003	75.004833	4	1	0	0	10110	100000	0	3	0	0	0	3000		N

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
E	248	38.508432	75.005403	4	1	0	0	10110	100000	0	3	0	0	0	3000		N
E	249	38.507877	75.006010	2	0	0	2	10110	100000	0	3	0	0	0	3000		N
E	250	38.507688	75.006732	3	3	0	0	10110	100000	0	3	0	0	0	3000		N
E	251	38.508233	75.007610	0	0	0	0	10110	100000	0	3	0	0	0	3000		N
E	252	38.508922	75.007455	0	8	0	0	10110	100000	0	3	0	0	1	3001		N
E	253	38.509577	75.007197	7	0	0	1	10110	100100	0	3	1	0	0	3100		N
E	254	38.509643	75.007137	4	3	0	0	10110	100100	1	3	1	0	0	3100		N
E	255	38.510467	75.006913	5	4	0	0	10110	100100	1	3	1	0	0	3100		N
E	256	38.510788	75.006892	4	2	0	0	10110	100000	1	3	0	0	0	3000		N
E	257	38.511618	75.006970	2	0	0	0	10110	100000	1	3	0	0	0	3000		N
E	258	38.512812	75.007055	2	0	0	0	10110	110000	1	3	0	0	0	3000		N
E	259	38.513942	75.006917	2	0	0	0	10110	110010	2	3	2	1	0	3210		N
E	260	38.515043	75.007232	6	0	0	0	10110	111110	1	3	2	0	0	3200		N
E	261	38.515502	75.007327	4	0	1	0	10110	111110	1	3	2	0	0	3200		N
E	262	38.516090	75.007502	1	0	0	0	10110	111110	1	3	2	0	0	3200		N
E	263	38.516220	75.007473	1	0	0	2	10110	111110	1	3	2	0	0	3200		N
E	264	38.517142	75.007583	0	0	0	0	10110	101100	1	3	1	0	0	3100		N
E	265	38.517937	75.007035	0	0	0	0	10110	101100	1	3	1	0	0	3100		N
E	266	38.518177	75.006887	0	1	2	0	10110	101100	1	3	1	0	0	3100		N
E	267	38.518892	75.007312	2	0	0	0	10110	111110	1	3	2	0	0	3200		N

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
E	268	38.520005	75.007363	1	0	0	0	10110	111110	1	3	2	0	0	3200		N
E	269	38.520948	75.007013	8	0	0	0	11011	111110	1	2	2	0	0	2200		N
E	270	38.521408	75.008180	0	0	0	0	11011	100000	1	2	0	0	0	2000		N
E	271	38.520208	75.009032	7	0	1	0	11110	111010	1	1	2	0	0	1200		N
E	272	38.519085	75.009638	4	0	0	0	11110	100000	1	1	0	0	0	1000		N
E	273	38.518028	75.009878	6	1	0	0	11110	100000	1	1	0	0	0	1000		N
E	274	38.516922	75.010265	7	0	0	0	11110	100000	1	1	0	0	0	1000		N
E	275	38.515933	75.010517	12	0	0	0	11110	110010	1	1	2	0	0	1200		N
E	276	38.515467	75.010572	6	0	2	0	11110	110000	1	1	0	0	0	1000		N
E	277	38.514935	75.010747	8	0	1	0	10010	110010	1	4	2	0	0	4200		N
E	278	38.514843	75.010773	8	0	1	0	10010	110010	1	4	2	0	0	4200		N
E	279	38.514162	75.010783	4	0	0	0	10110	110010	1	3	2	0	0	3200		N
E	280	38.513105	75.010962	3	0	0	0	10110	110010	1	3	2	0	0	3200		N
E	281	38.512518	75.011073	4	0	1	0	10110	110010	1	3	2	0	0	3200		N
E	282	38.512397	75.011105	0	2	1	0	10110	110010	1	3	2	0	0	3200		N
E	283	38.512090	75.011157	8	0	0	0	10110	110010	1	3	2	0	0	3200		N
E	284	38.512033	75.011163	0	3	1	0	10110	110000	1	3	0	0	0	3000		N
E	285	38.511127	75.011280	0	3	1	0	10110	110000	1	3	0	0	0	3000		N
E	286	38.510032	75.011377	4	0	0	0	10110	110000	1	3	0	0	0	3000		N
E	287	38.508863	75.011830	1	0	0	0	10110	100000	1	3	0	0	0	3000		N

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
E	288	38.508777	75.013167	2	0	0	0	10110	110010	1	3	2	0	0	3200		N
E	289	38.509162	75.013228	3	1	2	0	10110	110000	1	3	0	0	0	3000		N
E	290	38.509600	75.012947	2	0	0	0	10110	110000	1	3	0	0	0	3000		N
E	291	38.510415	75.012418	2	0	0	0	10110	110000	1	3	0	0	0	3000		N
E	292	38.510670	75.012408	7	0	1	0	10110	110000	1	3	0	0	0	3000		N
E	293	38.511025	75.012313	2	2	1	0	10110	110000	1	3	0	0	0	3000		N
E	294	38.511300	75.012342	5	0	0	0	10110	110000	1	3	0	0	0	3000		N
E	295	38.511662	75.012288	2	0	2	0	10110	110000	1	3	0	0	0	3000		N
E	296	38.512290	75.012268	4	0	0	0	11010	110001	1	2	2	0	0	2200		N
E	297	38.513082	75.012157	5	0	2	0	11010	110011	1	2	2	0	0	2200		N
E	298	38.513212	75.012127	2	0	2	0	11010	110011	1	2	2	0	0	2200		N
E	299	38.513245	75.012100	4	0	0	0	11010	110001	1	2	2	0	0	2200		N
E	300	38.513292	75.012058	7	2	0	1	11010	110001	1	2	2	0	0	2200		N
E	301	38.514003	75.011863	4	0	2	0	10110	110011	1	3	2	0	0	3200		N
E	302	38.514455	75.011875	3	0	1	0	10110	110010	0	3	2	0	0	3200		N
E	303	38.514687	75.011912	0	0	0	0	10110	110010	1	3	2	0	0	3200		N
E	304	38.515627	75.012412	3	0	1	0	10110	110000	0	3	0	0	0	3000		N
E	305	38.516122	75.012333	2	0	2	0	10110	10010	1	3	2	0	0	3200		Y
E	306	38.516392	75.012392	1	0	0	0	10110	1011	0	3	2	0	0	3200		Y
E	307	38.516915	75.012290	2	0	2	0	10110	110000	1	3	0	0	0	3000		Y

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
E	308	38.517118	75.012322	5	1	1	0	10010	110000	0	4	0	0	0	4000		Y
E	309	38.517303	75.012428	2	0	0	0	10010	110000	1	4	0	0	0	4000		Y
E	310	38.517455	75.012523	1	0	1	1	10010	10000	0	4	0	0	0	4000		Y
E	311	38.518260	75.012408	0	0	0	0	10010	100000	0	4	0	0	0	4000		Y
E	312	38.518823	75.012678	3	0	1	0	10010	110000	0	4	0	0	0	4000		N
E	313	38.519237	75.012673	38	1	0	0	10010	110000	0	4	0	0	1	4001		N
E	314	38.519252	75.012673	21	0	2	0	10010	110000	0	4	0	0	1	4001		N
E	315	38.519443	75.012665	4	0	1	0	10010	110000	1	4	0	0	0	4000		N
E	316	38.519628	75.012655	7	16	1	0	11010	110010	1	2	2	0	1	2201		N
E	317	38.519662	75.012655	8	8	1	0	11010	110010	1	2	2	0	1	2201		N
E	318	38.519733	75.012653	6	8	1	0	11010	110010	1	2	2	0	1	2201		N
E	319	38.519787	75.012653	9	0	1	0	11010	110010	1	2	2	0	0	2200		N
E	320	38.520285	75.012682	3	0	1	0	11010	110010	1	2	2	0	0	2200		N
E	321	38.520138	75.014117	7	0	0	0	11010	110010	1	2	2	0	0	2200		N
E	322	38.519095	75.014417	3	2	0	0	11010	110000	1	2	0	0	0	2000		N
E	323	38.518053	75.014610	1	0	2	0	11010	110000	1	2	0	0	0	2000		N
E	324	38.518010	75.014623	1	1	0	0	11010	110000	0	2	0	0	0	2000		N
E	325	38.517655	75.014702	1	0	1	0	11010	110000	0	2	0	0	0	2000		Y
E	326	38.517515	75.014720	3	0	1	0	11010	110000	1	2	0	0	0	2000		Y
E	327	38.517405	75.014742	4	0	0	1	11010	110000	1	2	0	0	0	2000		Y

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
E	328	38.517133	75.014802	1	0	0	0	11010	110010	1	2	2	0	0	2200		Y
E	329	38.516852	75.014812	3	0	1	0	11010	110010	1	2	2	0	0	2200		Y
E	330	38.516762	75.014842	5	0	1	1	11010	110011	1	2	2	0	0	2200		Y
E	331	38.516557	75.014888	0	0	2	0	11010	110011	1	2	2	0	0	2200		Y
E	332	38.516380	75.014915	2	1	1	0	11010	110011	1	2	2	0	0	2200		Y
E	333	38.516183	75.015000	3	0	1	0	11010	110000	1	2	0	0	0	2000		Y
E	334	38.516005	75.015170	15	2	0	0	10010	110011	1	4	2	0	1	4201		Y
E	335	38.515943	75.015222	11	0	0	0	10010	110011	1	4	2	0	0	4200		Y
E	336	38.515928	75.015227	9	0	2	0	10010	10011	1	4	2	0	0	4200		Y
E	337	38.515915	75.015242	3	0	1	0	10110	100011	1	3	2	0	0	3200		Y
E	338	38.515765	75.015265	4	0	0	0	10110	110011	1	3	2	0	0	3200		Y
E	339	38.515425	75.015422	3	0	1	0	10110	110000	0	3	0	0	0	3000		Y
E	340	38.515337	75.015472	2	0	2	0	10110	110000	0	3	0	0	0	3000		Y
E	341	38.514797	75.015553	0	0	0	0	10110	110000	0	3	0	0	0	3000		N
E	342	38.513977	75.015702	1	0	0	0	10110	110000	1	3	0	0	0	3000		N
E	343	38.513888	75.015703	2	0	0	0	10110	110000	1	3	0	0	0	3000		N
E	344	38.513595	75.015753	4	1	0	1	10110	110000	1	3	0	0	0	3000		N
E	345	38.513307	75.015733	2	0	1	0	10110	110000	1	3	0	0	0	3000		N
E	346	38.513217	75.015713	1	0	1	0	10110	100000	1	3	0	0	0	3000		N
E	347	38.513088	75.015698	0	0	1	0	10110	100000	1	3	0	0	0	3000		N

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
E	348	38.512892	75.015667	2	0	0	0	10110	110010	1	3	2	0	0	3200		N
E	349	38.512853	75.015662	4	0	1	0	10110	110010	1	3	2	0	0	3200		N
E	350	38.511725	75.015973	0	0	0	1	10110	110000	1	3	0	0	0	3000		N
E	351	38.511442	75.016107	1	0	1	0	10110	110000	0	3	0	0	0	3000		N
E	352	38.510822	75.016383	7	0	0	0	10110	110011	0	3	2	0	0	3200		N
E	353	38.510580	75.016472	4	0	0	0	11101	110000	1	1	0	0	0	1000		N
E	354	38.509963	75.016672	7	0	1	0	11101	110010	1	1	2	0	0	1200		N
E	355	38.509463	75.016448	0	0	0	0	11101	110000	1	1	0	0	0	1000		N
E	356	38.509217	75.015175	3	0	0	0	11100	110000	1	1	0	0	0	1000		N
E	357	38.509245	75.014498	2	3	2	0	11100	110000	0	1	0	0	0	1000		N
E	358	38.509252	75.014347	0	18	2	0	11100	110000	1	1	0	0	1	1001		N
E	359	38.509190	75.014062	0	6	1	0	11100	110000	0	1	0	0	1	1001		N
E	360	38.509150	75.013800	3	0	1	0	11100	110000	0	1	0	0	0	1000		N
E	361	38.509148	75.013302	1	3	1	0	10010	110011	1	4	2	0	0	4200		N
E	362	38.509145	75.013197	2	1	2	0	10010	110011	0	4	2	0	0	4200		N
E	363	38.509195	75.012278	1	0	0	0	10010	110000	0	4	0	0	0	4000		N
E	364	38.509127	75.011278	0	0	0	1	11100	110000	0	1	0	0	0	1000		N
E	365	38.509155	75.010923	5	0	0	0	11100	110000	1	1	0	0	0	1000		N
E	366	38.509178	75.009440	2	0	0	0	11100	11010	1	1	2	0	0	1200		N
E	367	38.509218	75.009088	7	1	0	0	10100	11010	1	3	2	0	0	3200		N

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
E	368	38.509225	75.009012	9	0	0	0	10100	11010	1	3	2	0	0	3200		N
E	369	38.509243	75.008812	16	0	0	0	10100	11011	1	3	2	0	0	3200		N
E	370	38.509330	75.007968	2	0	0	0	10110	11000	1	3	1	0	0	3100		N
E	371	38.509402	75.006470	5	2	0	0	10110	11000	1	3	1	0	0	3100		N
E	372	38.509582	75.005128	3	4	0	0	11110	11000	1	1	1	0	0	1100		N
E	373	38.509663	75.004208	7	0	1	0	11110	11000	0	1	1	0	0	1100		N
E	374	38.509783	75.003777	4	2	0	1	11110	11000	1	1	1	0	0	1100		N
E	375	38.509823	75.002407	2	1	0	0	11110	11000	0	1	1	0	0	1100		N
E	376	38.509877	75.001287	5	0	0	0	11110	11000	0	1	1	0	0	1100		N
E	377	38.509863	75.001030	0	0	1	0	11110	11000	1	1	1	0	0	1100		N
E	378	38.509848	75.000985	3	0	0	0	10110	11000	0	3	1	0	0	3100		N
E	379	38.509812	75.000667	4	10	1	0	10110	11000	1	3	1	0	1	3101		N
E	380	38.509852	75.000403	1	0	1	1	10110	11000	1	3	1	0	0	3100		N
E	381	38.509897	75.000270	4	0	2	0	10110	11000	1	3	1	0	0	3100		N
E	382	38.509965	74.999965	3	0	2	0	10110	11000	1	3	1	0	0	3100		N
E	383	38.509992	74.999875	1	0	1	0	10110	11000	0	3	1	0	0	3100		N
E	384	38.510005	74.999828	4	0	1	0	10110	11000	1	3	1	0	0	3100		N
E	385	38.510095	74.999558	3	0	0	0	10110	11000	1	3	1	0	0	3100		N
E	386	38.510107	74.999515	3	0	1	0	10110	100000	1	3	0	0	0	3000		N
E	387	38.509963	74.998132	4	0	0	0	10110	11000	1	3	1	0	0	3100		N

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
E	388	38.510110	74.997690	2	0	1	0	10110	10000	0	3	0	0	0	3000		N
E	389	38.510382	74.997293	4	0	2	0	10110	10000	1	3	0	0	0	3000		N
E	390	38.510743	74.997193	3	0	0	0	10110	10000	1	3	0	0	0	3000		N
E	391	38.511328	74.998723	3	0	0	0	10110	10000	1	3	0	0	0	3000		N
E	392	38.511528	75.000245	2	0	0	0	10110	10000	1	3	0	0	0	3000		N
E	393	38.511737	75.000943	3	0	0	0	10110	10000	1	3	0	0	0	3000		N
E	394	38.511928	75.001708	14	0	0	0	10110	10000	1	3	0	0	0	3000		N
E	395	38.512337	75.003217	0	0	0	0	10110	10000	1	3	0	0	0	3000		N
E	396	38.512405	75.003462	2	3	0	1	11100	10000	0	1	0	0	0	1000		N
E	397	38.512640	75.005007	1	1	0	0	11100	10000	0	1	0	0	0	1000		N
E	398	38.512648	75.005092	3	0	0	1	11101	10000	1	1	0	0	0	1000		N
E	399	38.512795	75.006295	7	0	0	0	11100	10000	1	1	0	0	0	1000		N
E	400	38.513028	75.007650	8	0	0	0	11100	10000	1	1	0	0	0	1000		N
E	401	38.513030	75.007672	5	0	1	0	11100	10000	1	1	0	0	0	1000		N
E	402	38.513335	75.008928	1	0	0	0	11100	11010	1	1	2	0	0	1200		N
E	403	38.513428	75.009677	4	2	1	1	11100	11010	1	1	2	0	0	1200		N
E	404	38.513415	75.010230	1	4	0	0	11100	111010	1	1	2	0	0	1200		N
E	405	38.513628	75.011477	5	0	0	0	11100	11010	1	1	2	0	0	1200		N
E	406	38.513782	75.012542	2	0	0	0	11100	10010	1	1	2	0	0	1200		N
E	407	38.513785	75.012597	6	0	1	0	11100	10010	1	1	2	0	0	1200		N

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
E	408	38.513843	75.013868	2	1	1	0	11100	10110	1	1	2	0	0	1200		N
E	409	38.513845	75.013998	4	0	0	1	10100	10010	1	3	2	0	0	3200		N
E	410	38.513852	75.014617	3	4	1	0	10110	10010	1	3	2	0	0	3200		N
E	411	38.513850	75.014752	5	1	0	0	10110	10010	1	3	2	0	0	3200		N
E	412	38.513842	75.015153	2	0	1	0	10110	10010	1	3	2	0	0	3200		N
E	413	38.513778	75.016620	7	0	0	0	10110	10010	1	3	2	0	0	3200		N
E	414	38.514075	75.017910	1	1	0	0	10110	10000	1	3	0	0	0	3000		N
E	415	38.514627	75.018062	0	0	0	1	10110	10000	1	3	0	0	0	3000		N
E	416	38.514952	75.017705	1	0	0	0	10110	100000	1	3	0	0	0	3000		N
E	417	38.514963	75.017510	0	1	1	0	10110	10000	0	3	0	0	0	3000		N
E	418	38.514835	75.016605	0	0	1	1	10110	10000	0	3	0	0	0	3000		N
E	419	38.514773	75.015778	4	0	2	0	10110	10000	0	3	0	0	0	3000		N
E	420	38.514807	75.015435	3	0	0	0	10110	10000	0	3	0	0	0	3000		N
E	421	38.514808	75.015415	0	0	2	0	10110	10000	0	3	0	0	0	3000		N
E	422	38.514817	75.015375	1	0	2	0	10110	10000	0	3	0	0	0	3000		N
E	423	38.514873	75.014652	0	0	0	1	10110	10000	2	3	0	1	0	3010		Y
E	424	38.514880	75.013823	4	0	0	0	0	11011	2	5	2	1	0	5210		Y
E	425	38.514877	75.013802	0	0	0	0	0	1011	2	5	2	1	0	5210		N
E	426	38.514875	75.013742	3	0	0	0	0	1011	2	5	2	1	0	5210		N
E	427	38.514873	75.013692	2	0	1	0	0	1011	2	5	2	1	0	5210		N

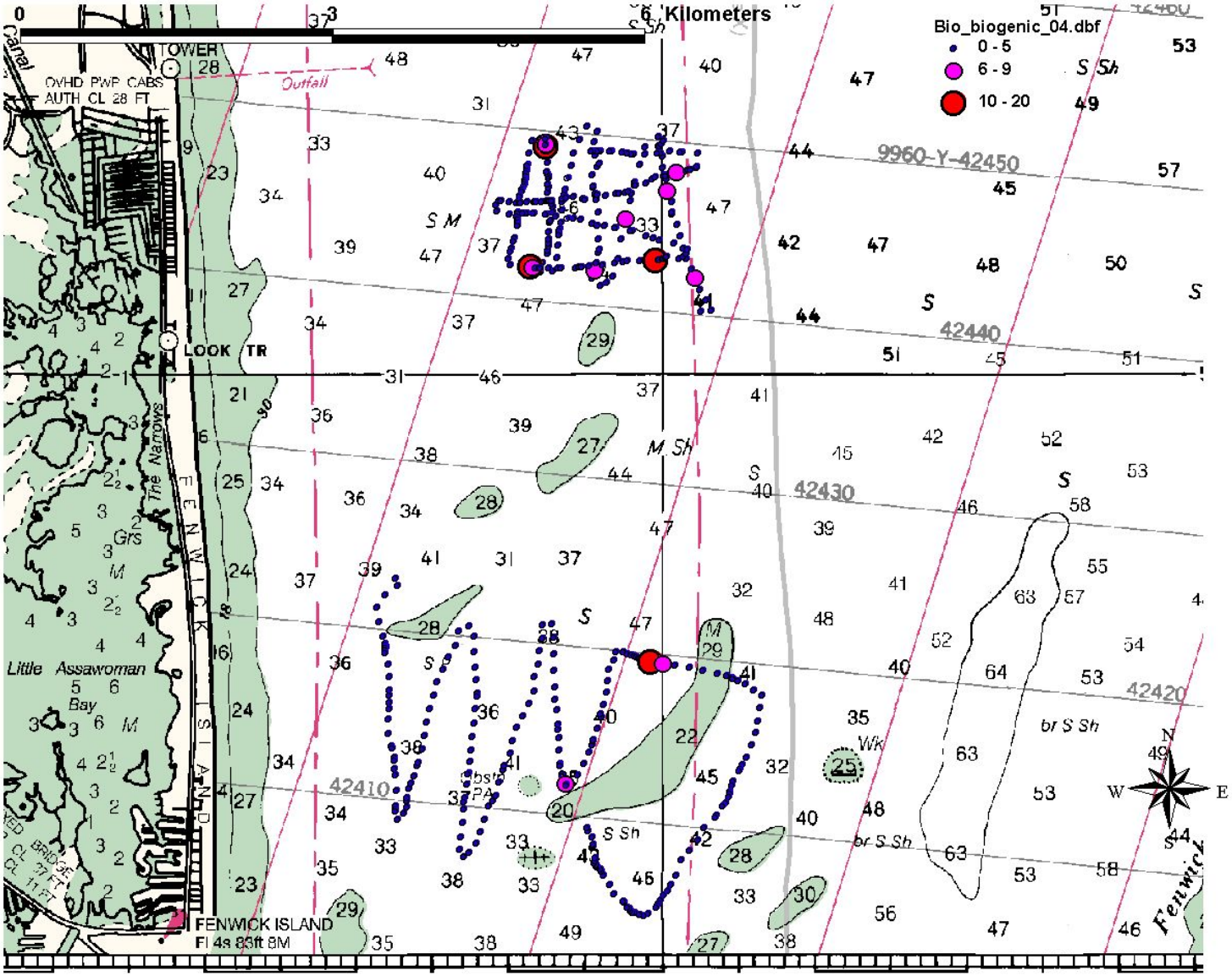
Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
E	428	38.514875	75.013625	9	0	1	0	0	11000	1	5	1	0	0	5100		N
E	429	38.514892	75.013058	2	1	0	0	0	11000	0	5	1	0	0	5100		N
E	430	38.514947	75.012515	0	1	2	0	10110	11000	1	3	1	0	0	3100		N
E	431	38.514955	75.012397	2	0	3	0	10010	10000	0	4	0	0	0	4000		N
E	432	38.514968	75.012270	4	1	5	0	11000	10000	1	2	0	0	0	2000		N
E	433	38.514973	75.012188	4	2	1	0	11000	10000	0	2	0	0	0	2000		N
E	434	38.514983	75.011982	4	0	2	0	11100	10000	1	1	0	0	0	1000		N
E	435	38.515108	75.010827	3	0	0	0	0	1010	2	5	2	1	0	5210		N
E	436	38.515208	75.010302	2	0	1	0	10110	10010	1	3	2	0	0	3200		N
E	437	38.515280	75.009638	0	0	0	0	10110	10010	0	3	2	0	0	3200		N
E	438	38.515102	75.008603	0	0	0	1	10110	10010	1	3	2	0	0	3200		N
E	439	38.515072	75.008435	3	0	0	0	10110	10010	1	3	2	0	0	3200		N
E	440	38.515557	75.007347	1	0	0	0	10110	10010	1	3	2	0	0	3200		N
E	441	38.515468	75.007023	4	0	0	0	10110	10010	1	3	2	0	0	3200		N
E	442	38.515430	75.006192	7	0	0	0	10110	10010	1	3	2	0	0	3200		N
E	443	38.515538	75.005018	0	0	0	0	10110	11010	1	3	2	0	0	3200		N
E	444	38.515558	75.004687	4	0	1	0	10110	11010	2	3	2	1	0	3210		N
E	445	38.515637	75.003963	1	0	0	1	10010	10000	1	4	0	0	0	4000		N
E	446	38.515733	75.003713	7	0	0	0	11000	10000	1	2	0	0	0	2000		N
E	447	38.516312	75.002935	0	0	0	0	11000	10000	1	2	0	0	0	2000		N

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
E	448	38.516295	75.002835	1	0	1	0	11000	10000	1	2	0	0	0	2000		N
E	449	38.516442	75.001775	4	3	1	0	11000	10000	1	2	0	0	0	2000		N
E	450	38.516788	75.001050	9	1	1	0	11000	10000	0	2	0	0	0	2000		N
E	451	38.516978	75.000762	8	3	0	0	11000	10000	0	2	0	0	0	2000		N
E	452	38.517130	74.999780	10	2	1	0	11000	10000	1	2	0	0	0	2000		N
E	453	38.517077	74.999557	8	0	0	1	11000	10000	1	2	0	0	0	2000		N
E	454	38.517258	74.998690	11	0	1	0	11000	10000	0	2	0	0	0	2000		N
E	455	38.517330	74.998492	4	6	0	0	10010	10000	0	4	0	0	1	4001		N
E	456	38.517573	74.997267	3	0	0	0	10010	10000	1	4	0	0	0	4000		N
E	457	38.517603	74.997132	7	0	1	0	10010	10000	1	4	0	0	0	4000		N
E	458	38.517657	74.996890	5	0	0	1	10010	10000	1	4	0	0	0	4000		N
E	459	38.517847	74.996223	4	1	1	0	10010	10000	1	4	0	0	0	4000		N
E	460	38.517877	74.996153	6	0	0	0	10010	10000	1	4	0	0	0	4000		N
E	461	38.519023	74.996052	1	0	0	0	10010	10000	0	4	0	0	0	4000		N
E	462	38.519157	74.997725	12	0	0	0	10010	10000	1	4	0	0	0	4000		N
E	463	38.519172	74.998042	9	0	2	0	10010	10000	1	4	0	0	0	4000		N
E	464	38.519212	74.999145	6	0	0	0	10010	10000	1	4	0	0	0	4000		N
E	465	38.519095	75.000187	8	0	1	1	10010	10000	1	4	0	0	0	4000		N
E	466	38.519093	75.000448	24	0	0	0	10010	10000	1	4	0	0	1	4001		N
E	467	38.518977	75.001798	15	0	0	0	10010	10000	1	4	0	0	0	4000		N

Area	chronological order	Lat	Long	Biology	Biogenic biology	Fishes	Ray/Skate	Surface	Sediment	Shell	Hab Surface	Hab Sediment	Hab Shell	Hab Biogenic	Final Hab Class	Benthic sample	In or out of Area E pit
E	468	38.518968	75.001840	11	1	1	0	10010	10000	1	4	0	0	0	4000		N
E	469	38.518973	75.003068	2	0	0	0	10010	10000	1	4	0	0	0	4000		N
E	470	38.518997	75.003268	3	0	1	0	10110	10000	1	3	0	0	0	3000		N
E	471	38.519052	75.003743	0	1	0	1	10110	10000	1	3	0	0	0	3000		N
E	472	38.519107	75.004323	2	0	0	0	11000	10000	1	2	0	0	0	2000		N
E	473	38.519220	75.005518	2	0	0	0	11000	10010	1	2	2	0	0	2200		N
E	474	38.519225	75.005552	1	0	0	1	11000	11010	2	2	2	1	0	2210		N
E	475	38.519248	75.005680	2	0	0	0	11000	11010	2	2	2	1	0	2210		N
E	476	38.519228	75.006718	2	0	0	0	11000	11010	1	2	2	0	0	2200		N
E	477	38.519228	75.006818	3	0	0	0	11000	11010	1	2	2	0	0	2200		N
E	478	38.519225	75.007028	7	0	0	0	11000	11010	1	2	2	0	0	2200		N
E	479	38.519225	75.007500	2	0	0	1	11000	11010	1	2	2	0	0	2200		N
E	480	38.519227	75.007508	3	0	0	0	11000	11010	1	2	2	0	0	2200		N
E	481	38.519257	75.007717	0	0	0	0	11000	11010	1	2	2	0	0	2200		N
		Averages		3.71	0.80	0.50	0.14										
		SD		4.08	2.14	0.74	0.39										

APPENDIX D

MAPS DEPICTING THE VARIOUS HABITAT CATEGORIES IDENTIFIED FROM THE VIDEO CAMERA IMAGE DATA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6 - 9
10 - 20
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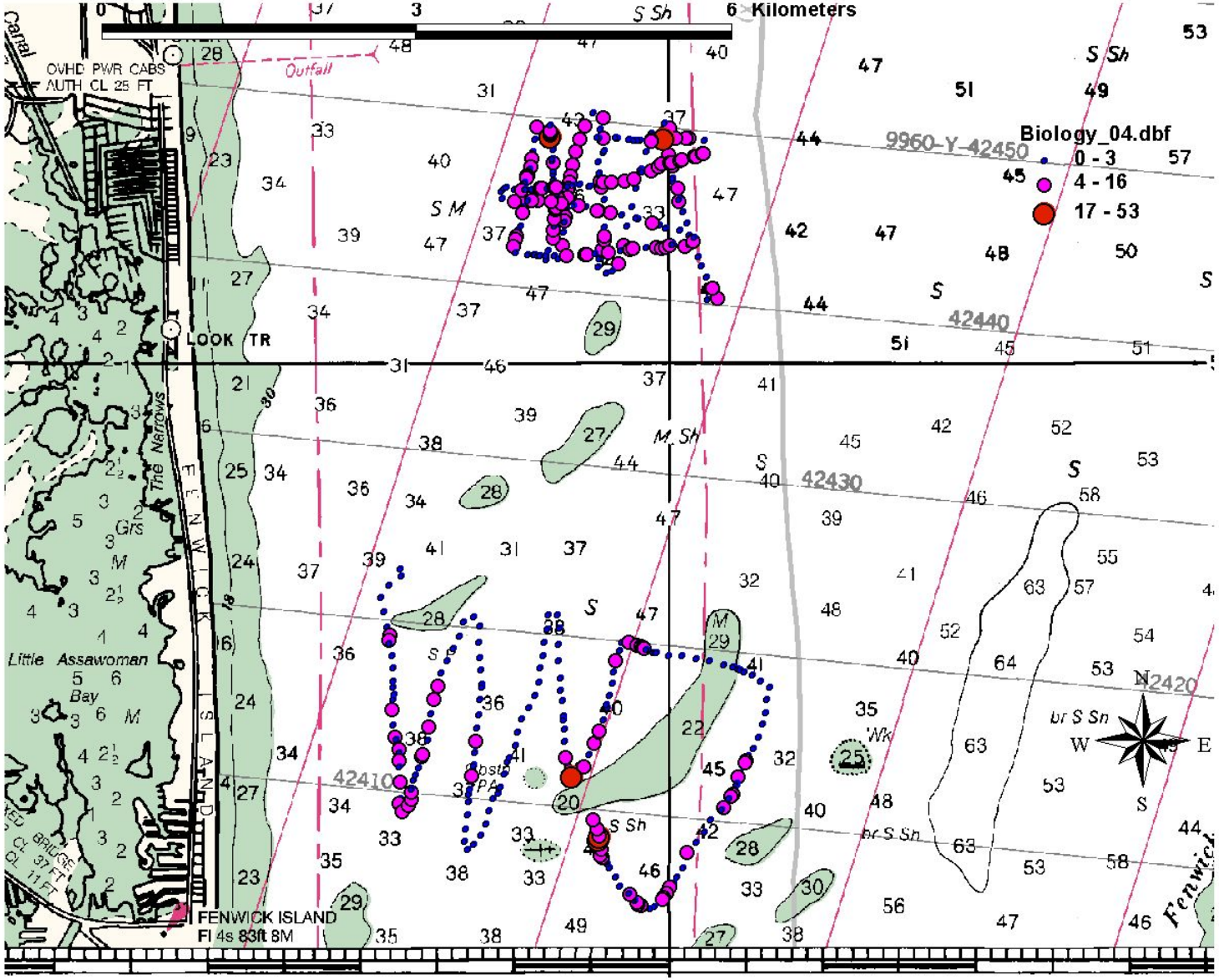
42440
42430
42420
42410
LOOK TR
TOWER
OVHD PWR CABS
AUTH CL 28 FT
Outfall
The Narrows
FENWICK ISLAND
FENWICK ISLAND
Fl 4s 83ft 8M
Little Assawoman
Bay
Grs
M
S M
M Sh
S
S Sh
br S Sh
Wk
Obstn
PA
N
W
E
S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4 - 16
17 - 53
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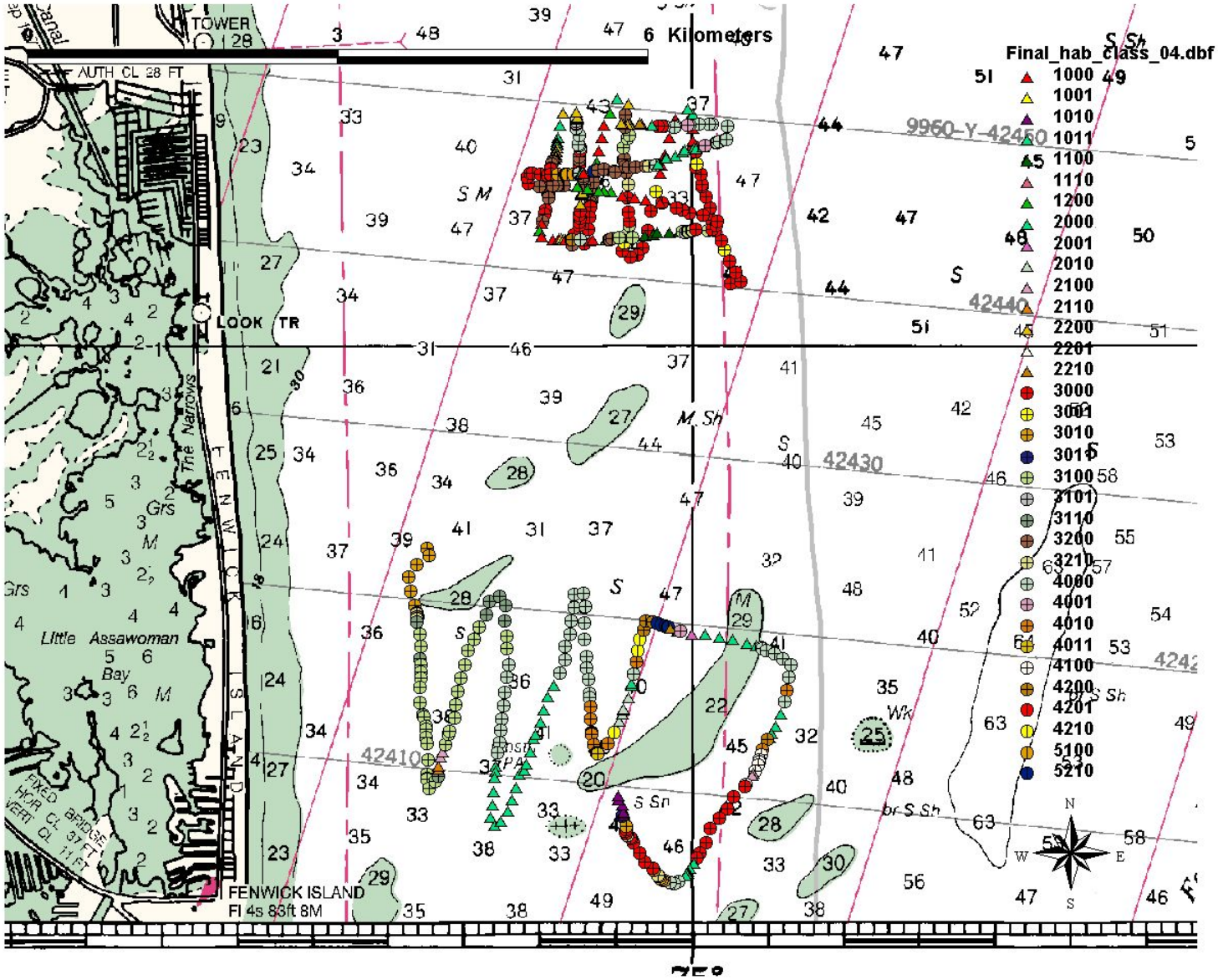
6 Kilometers
OVHD PWR CABS
AUTH CL 25 FT
Outfall
LOOK TR
The Narrows
FENWICK ISLAND
Little Assawoman Bay
FENWICK ISLAND
Fl 4s 83ft 8M
Fenwick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2001
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2100
2110
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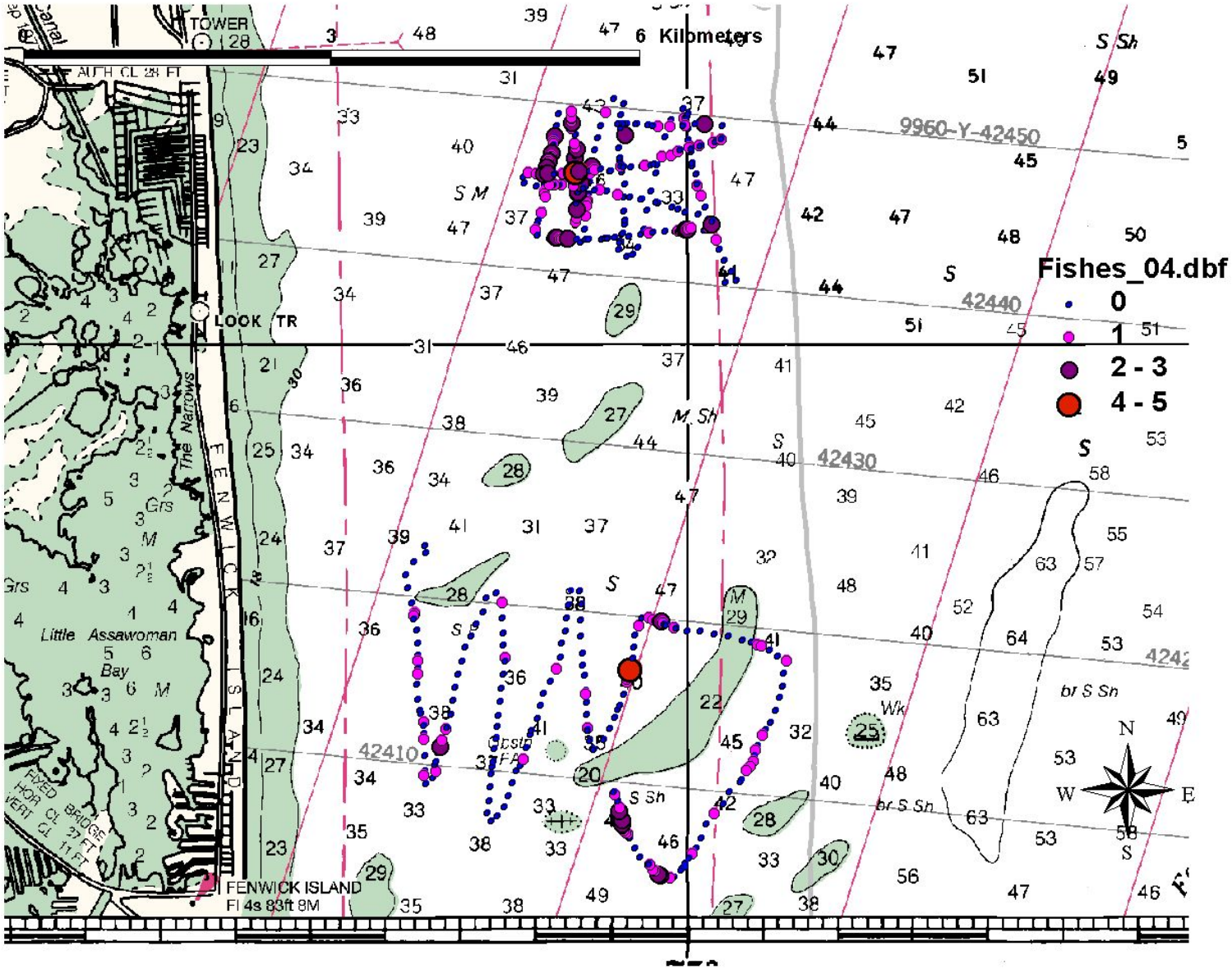
3100
3101
3110
3200
3210
4000
4001
4010
4011
4100
4200
4201
4210
5100
5210
9960-Y-42460
42440
42430
42410
TOWER
AUTH CL 28 FT
LOOK TR
The Narrows
FENWICK ISLAND
Fl 4s 88ft 8M
Little Assawoman Bay
FIXED HOR CL 37 FT
VERT CL 11 FT
N
S
E
W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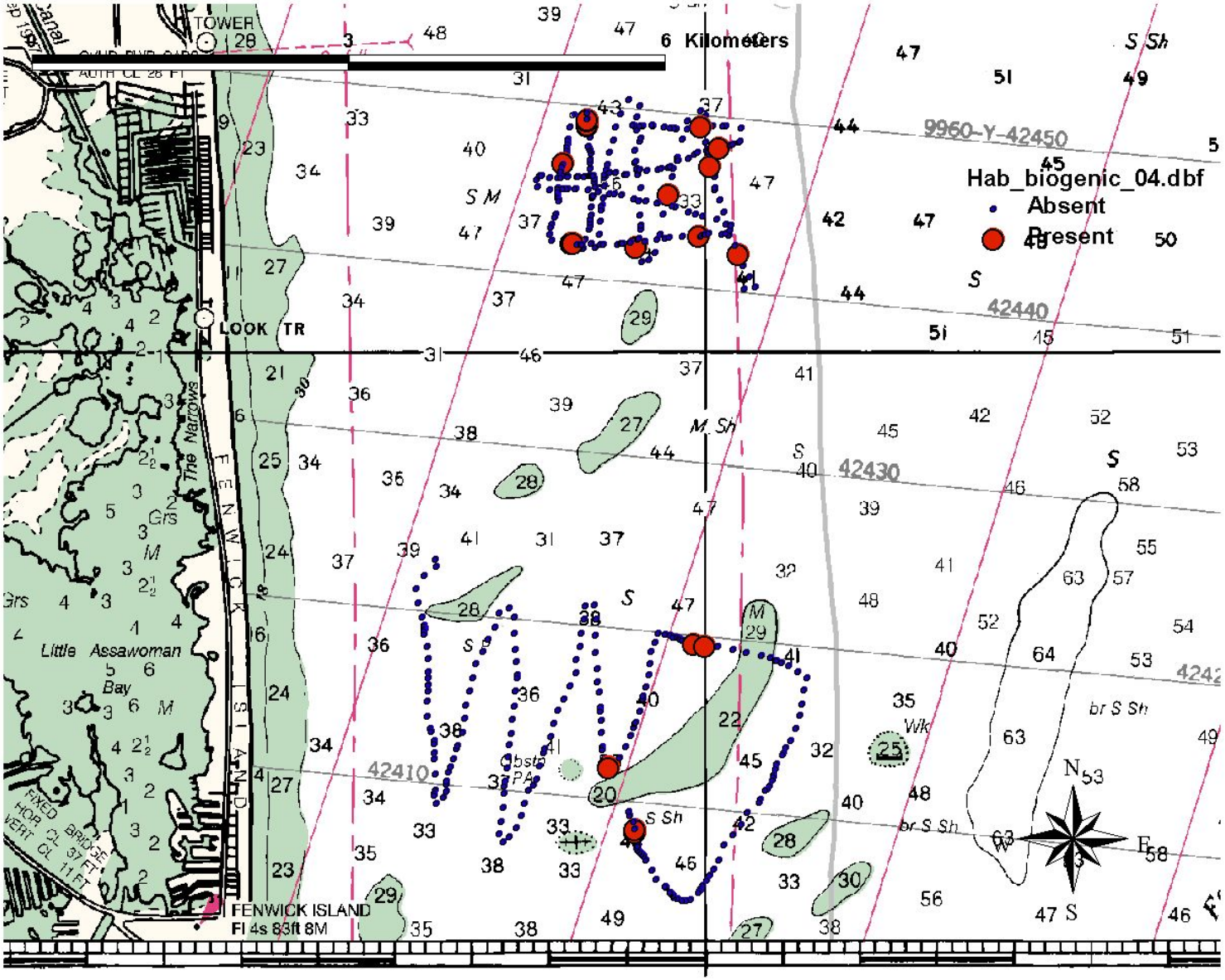
Fishes_04.dbf
0
1
2 - 3
4 - 5
9960-Y-42450
42440
42430
42410
LOOK TR
TOWER
FENWICK ISLAND
Fl 4s 83ft 8M
Little Assawoman Bay
The Narrows
FENWICK ISLAND
FIXED HOR CL 27 FT
VERT CL 11 FT
BRIDGE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Present
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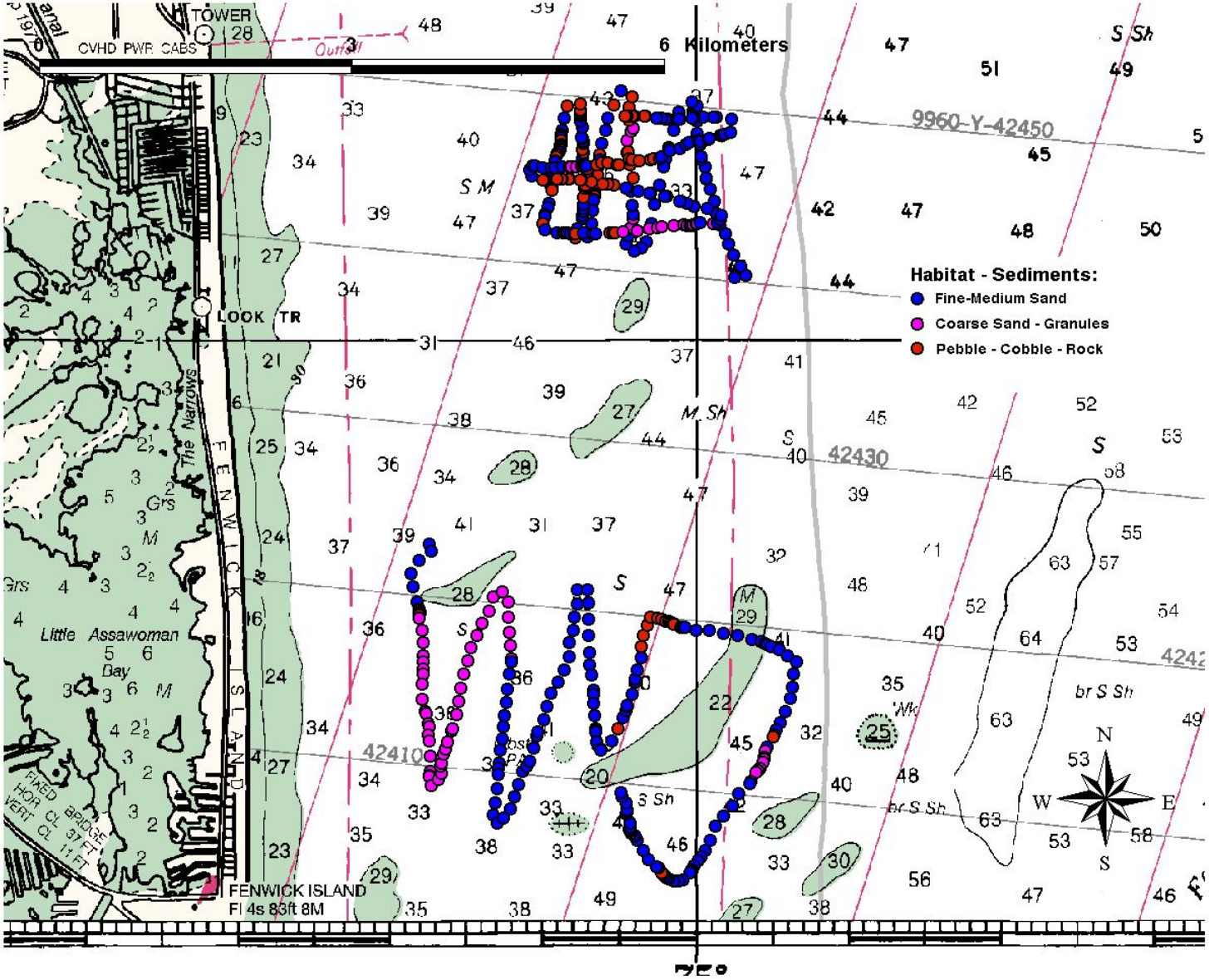
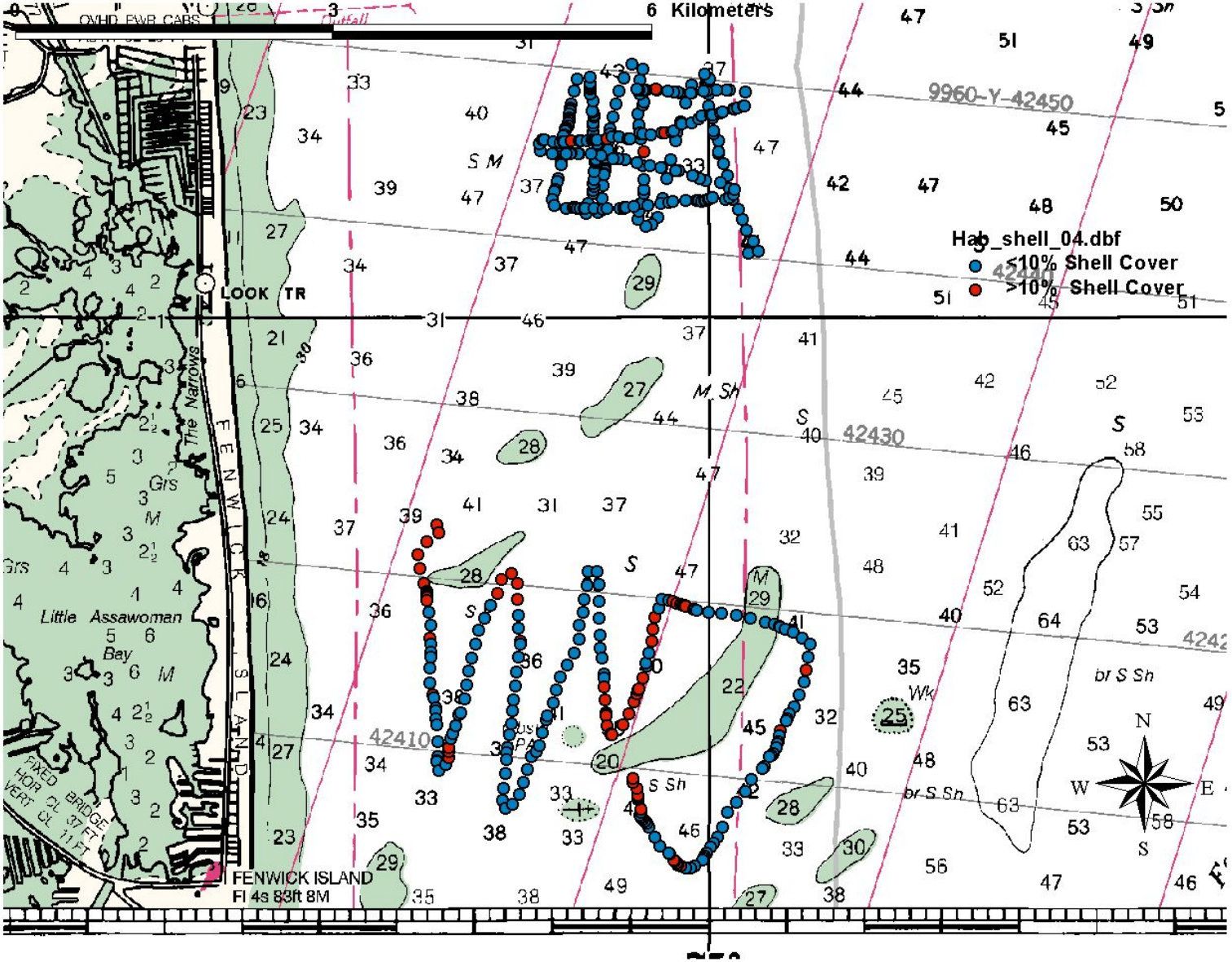
42440
42430
42410
LOOK TR
The Narrows
FENWICK ISLAND
Fl 4s 83ft 8M
Little Assawoman Bay
FIXED HOR CL 97 FT VERT CL 11 FT BRIDGE
TOWER 28
AUTH CL 28 FT
Obstn PA
M Sh
S Sh
br S Sh
Wk
Grs
N
E
S


6 Kilometers
Habitat - Sediments:
Fine-Medium Sand
Coarse Sand - Granules
Pebble - Cobble - Rock
9960-Y-42450
42430
42410
LOOK TR
FENWICK ISLAND
Fl 4s 83ft 8M
Little Assawoman Bay
The Narrows
FENWICK ISLAND
CVHD PWR CABS
TOWER
FIXED BRIDGE
HOR CL 37 FT
VERT CL 11 FT
N
S
E
W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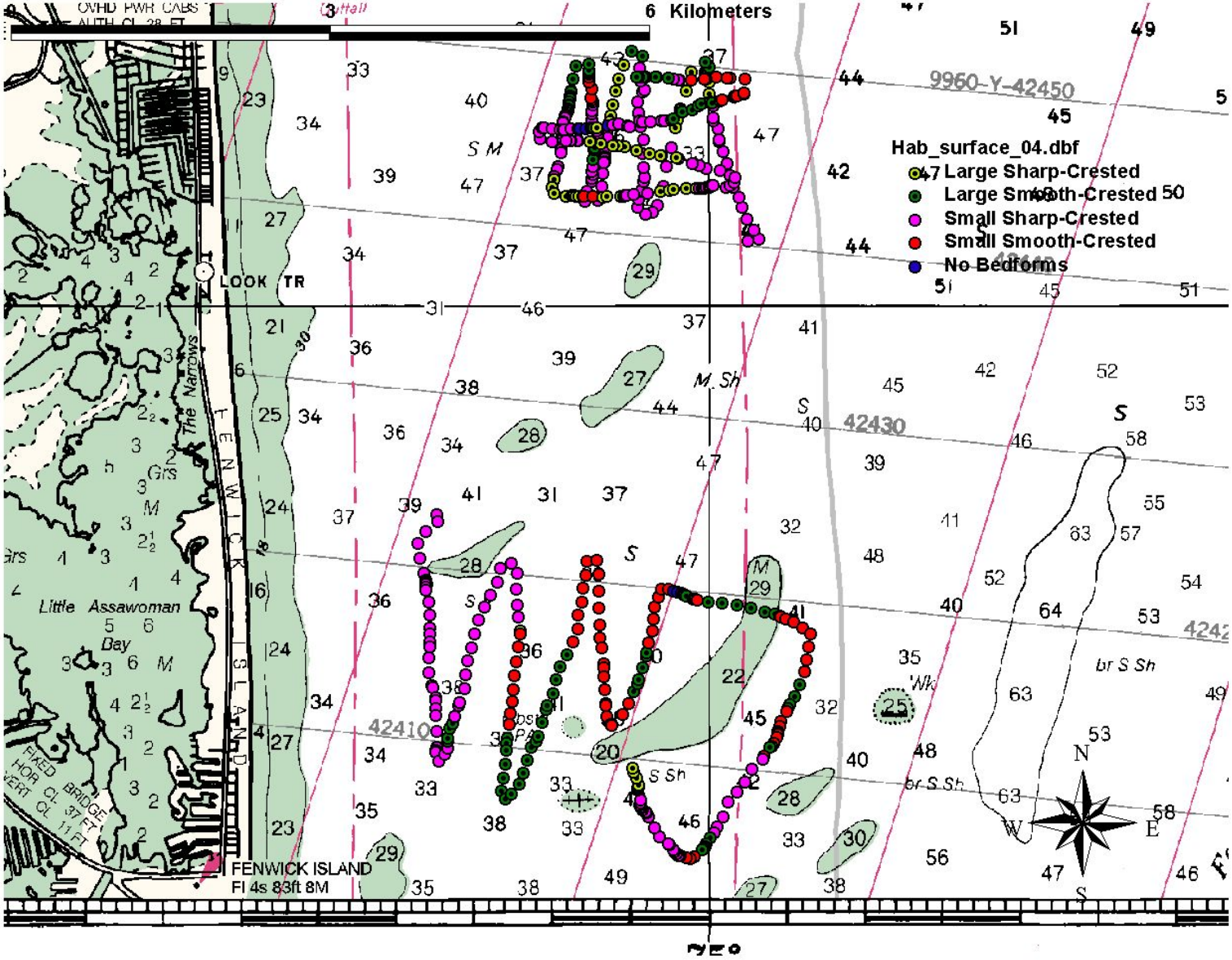
<10% Shell Cover
>10% Shell Cover
9960-Y-42450
42430
42410
LOOK TR
The Narrows
FENWICK ISLAND
Fl 4s 83ft 8M
Little Assawoman Bay
OVHD PWR CABS
FIXED HOR CL 37 FT
VERT CL 11 FT
BRIDGE
N
S
E
W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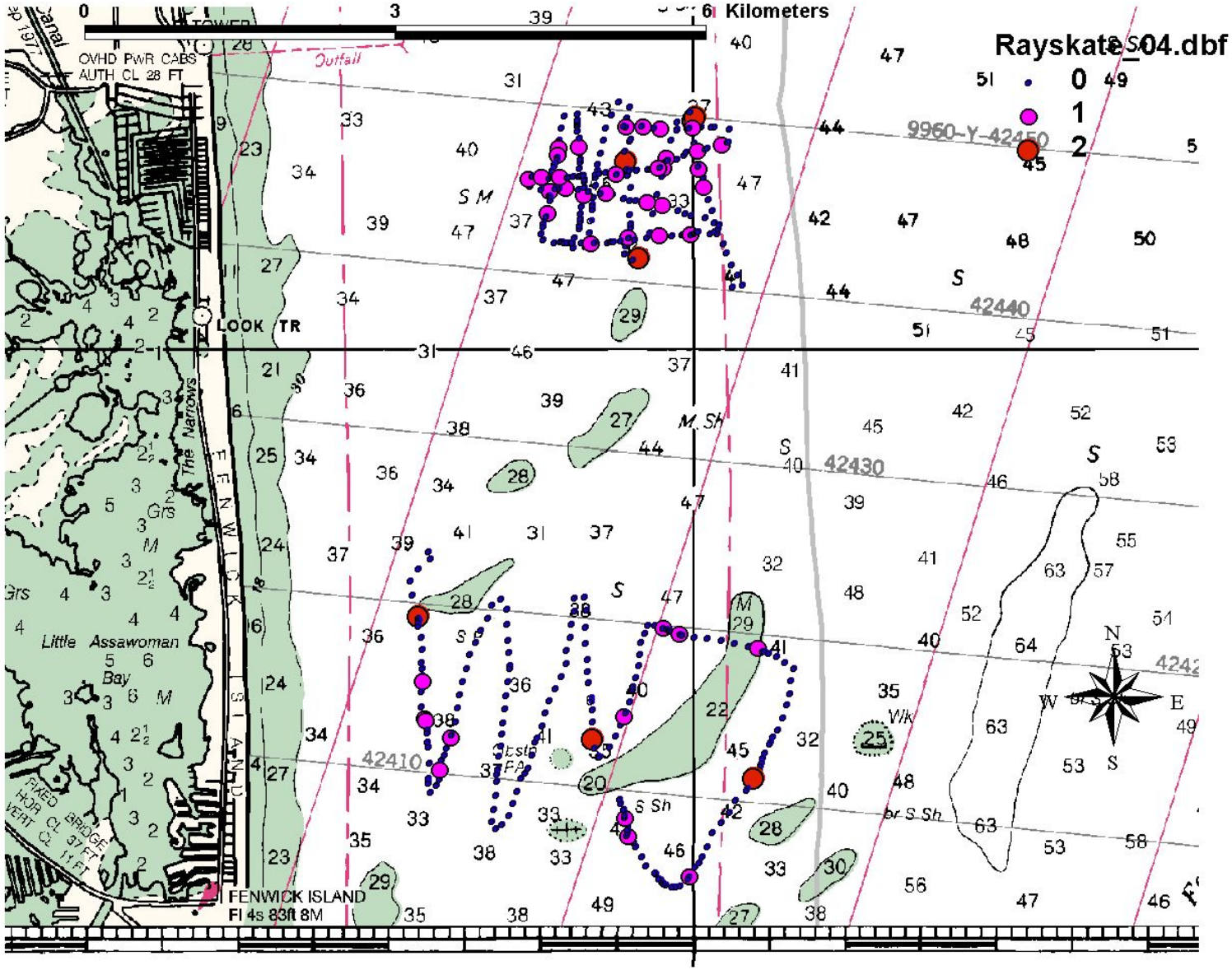
Large Smooth-Crested
Small Sharp-Crested
Small Smooth-Crested
No Bedforms
9960-Y-42450
42430
42410
LOOK TR
FENWICK ISLAND
Fl 4s 83ft 8M
Little Assawoman Bay
The Narrows
FENWICK ISLAND
FIXED HOR CL 37 FT
VERT CL 11 FT
BRIDGE
OVHD PWR CABS
AUTH CL 28 FT
N
S
E
W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Kilometers
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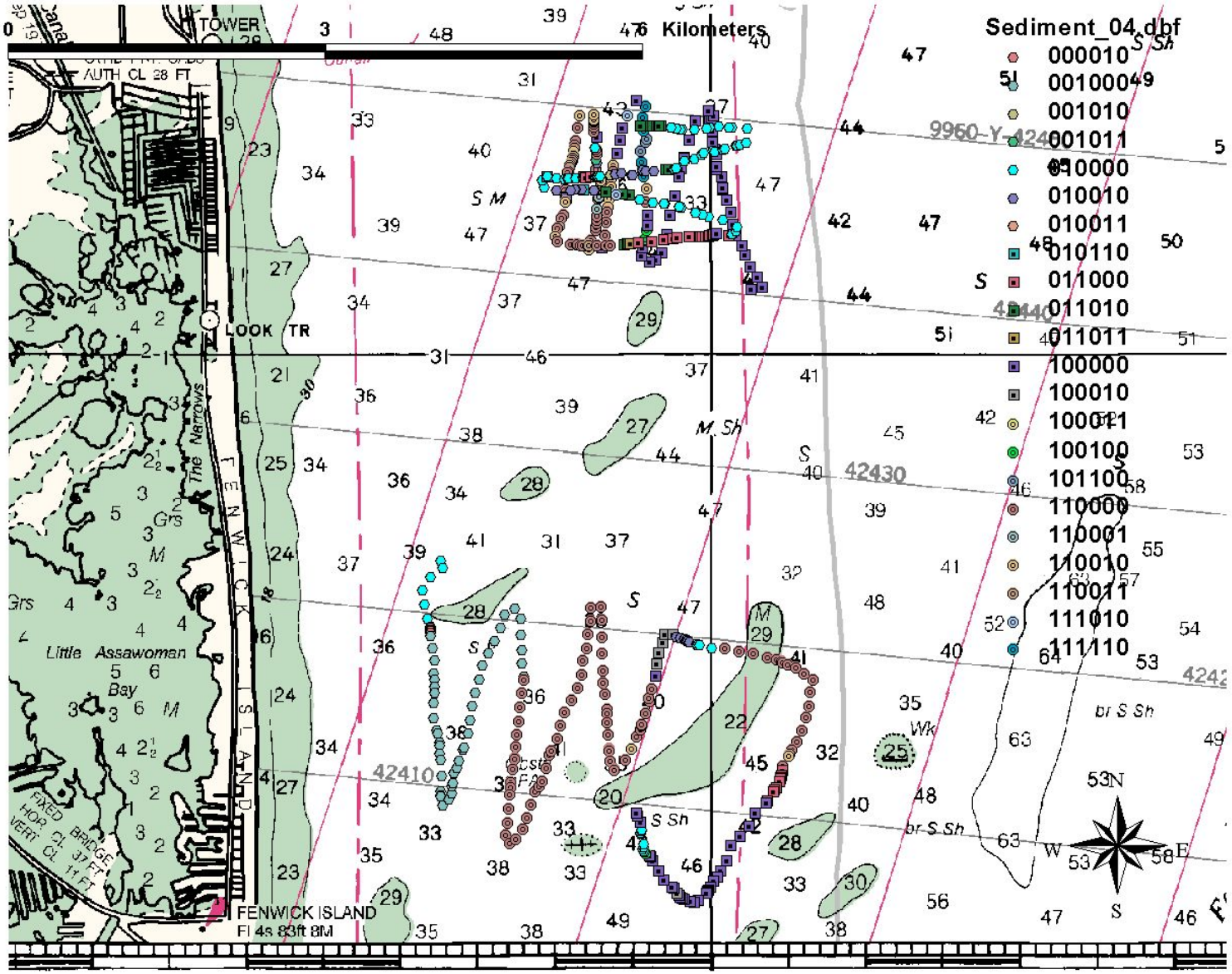
3
6
OVHD PWR CABS
AUTH CL 28 FT
Outfall
LOOK TR
The Narrows
FENWICK
Little Assawoman Bay
FIXED HOR CL 37 FT
VERT CL 11 FT
BRIDGE
FENWICK ISLAND
Fl 4s 83ft 8M
9960-Y-42450
42440
42430
42410
S Sh
br S Sh
Wk
N
S
E
W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010010
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010110
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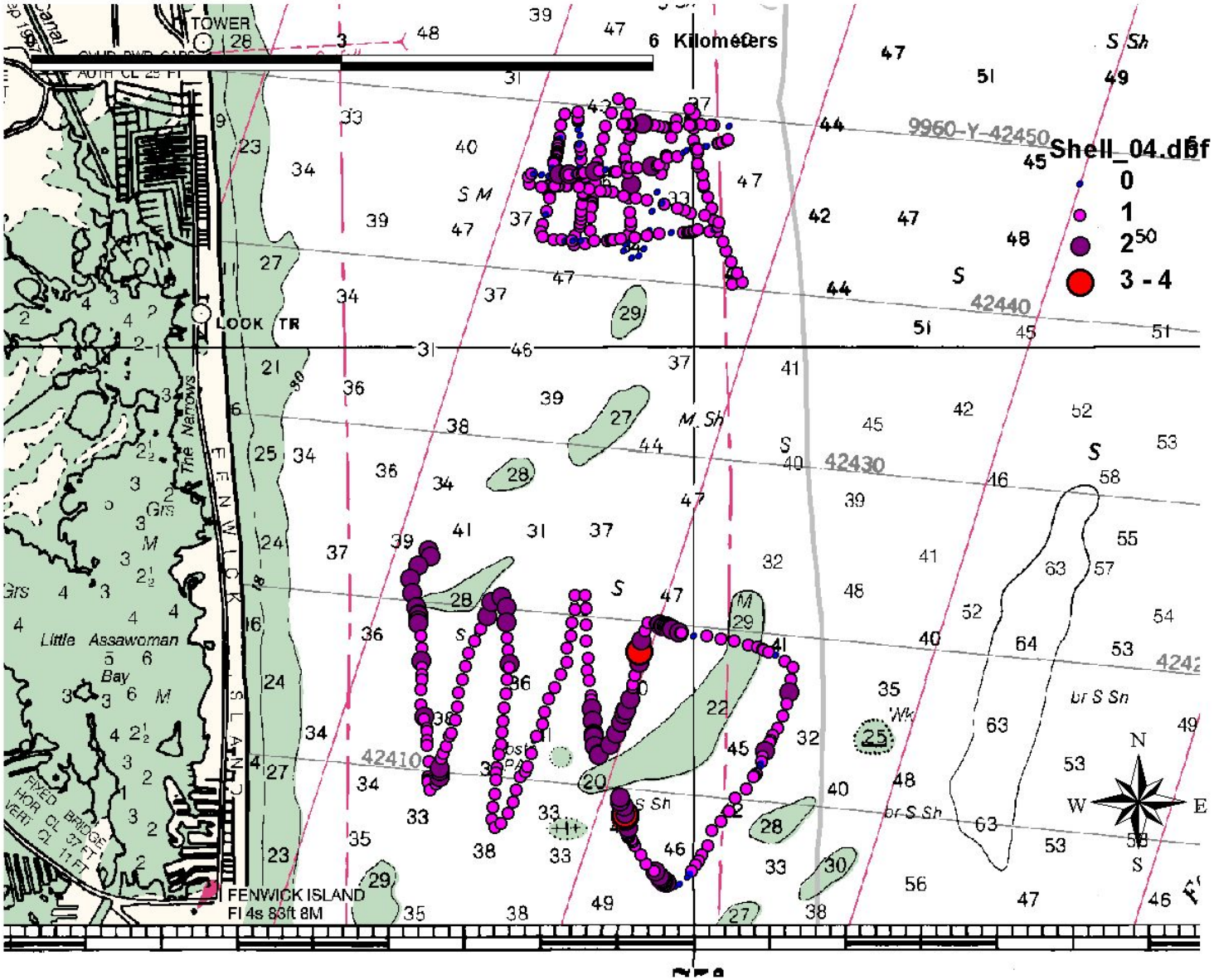
011010
011011
100000
100010
100011
100100
101100
110000
110001
110010
110011
111010
111110
TOWER
AUTH CL 28 FT
LOOK TR
The Narrows
FENWICK ISLAND
Little Assawoman Bay
FIXED BRIDGE
HOR CL 37 FT
VERT CL 11 FT
FENWICK ISLAND
Fl 4s 83ft 8M
42410
42430
9960-Y-42440
53N


6 Kilometers
Shell_04.dbf
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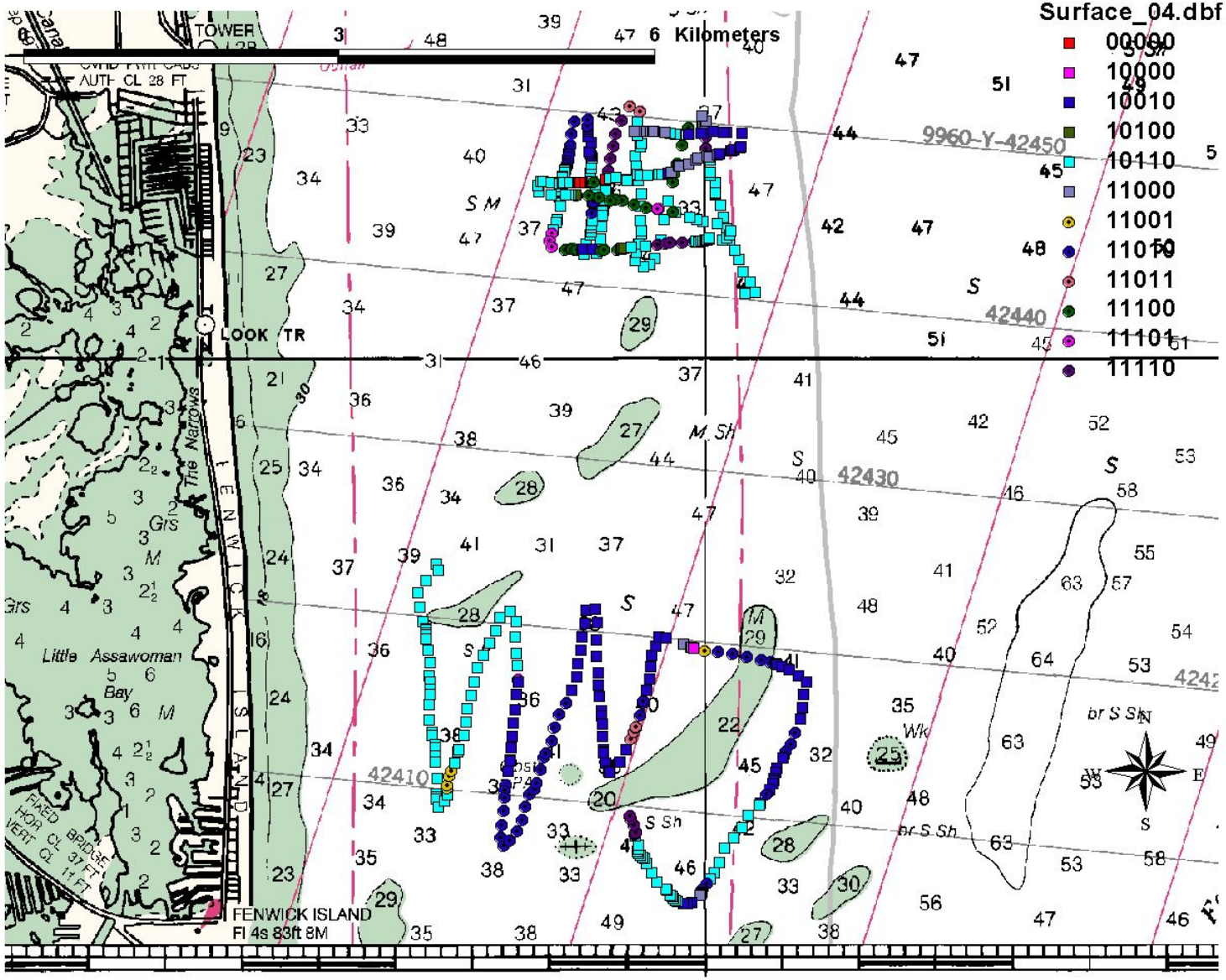
1
2
3 - 4
9960-Y-42450
42440
42430
42410
LOOK TR
TOWER
FENWICK ISLAND
Fl 4s 83ft 8M
Little Assawoman Bay
The Narrows
FENWICK ISLAND
FIXED HOR CL 37 FT
VERT CL 11 FT
BRIDGE
N
S
E
W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6 Kilometers
9960-Y-42450
42440
42430
42410
LOOK TR
FENWICK ISLAND
Fl 4s 83ft 8M
Little Assawoman Bay
The Narrows
FENWICK ISLAND
AUTH CL 28 FT
FIXED HOR CL 37 FT VERT CL 11 FT BRIDGE

APPENDIX E

STATION-SPECIFIC BENTHIC ABUNDANCE AND BIOMASS DATA

Fenwick Benthos 2004: E1

Station: E1	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	2.525	Simpson Index	.6908
Amphipod Abundance (#/m2)	23	Amphipod Biomass (g/m2)	.0011
Bivalve Abundance (#/m2)	136	Bivalve Biomass (g/m2)	.1341
Polychaete Abundance (#/m2)	545	Polychaete Biomass (g/m2)	.0568

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Apoprionospio pygmaea	68	0.00455
Aricidea catherinae	114	0.00227
Edotea triloba (Epi)	23	0.00227
Mediomastus ambiseta	250	0.00455
Nassarius trivittatus	45	0.03182
Nemertina	1159	0.06136
Nucula proxima	68	0.02727
Oligochaeta	250	0.00455
Pagurus spp. (Epi)	23	0.01591
Paraprionospio pinnata	23	0.01818
Phyllodoce arenae	23	0.01818
Spiophanes bombyx	45	0.00227
Tellina agilis	68	0.10682
Tharyx sp. A Morris	23	0.00682
Unciola serrata	23	0.00114
Total Abundance w/o Epi.	2205	
Total Abundance of Epi.	45	
Number of Taxa w/o Epi.	15	
Number of Epi Taxa	2	
Total Biomass w/o Epi.		0.30795
Total Biomass of Epi.		0.01818

Fenwick Benthos 2004: E2

Station: E2	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.929	Simpson Index	.9157
Amphipod Abundance (#/m2)	23	Amphipod Biomass (g/m2)	.0523
Bivalve Abundance (#/m2)	614	Bivalve Biomass (g/m2)	.7932
Polychaete Abundance (#/m2)	2114	Polychaete Biomass (g/m2)	.4375

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Apoprionospio pygmaea	136	0.00682
Aricidea catherinae	295	0.00682
Caulleriella sp. B (Blake)	227	0.00682
Drilonereis longa	45	0.03636
Glycera americana	23	0.01591
Mediomastus ambiseta	364	0.00227
Microphthalmus sczelkowii	23	0.00114
Nassarius trivittatus	114	1.02727
Nemertina	386	0.01591
Nephtyidae	68	0.01364
Nephtys picta	68	0.10682
Nucula proxima	159	0.16818
Oligochaeta	68	0.00114
Pagurus spp. (Epi)	23	0.00227
Paraprionospio pinnata	45	0.00682
Phyllodoce arenae	45	0.05227
Polygordius spp.	45	0.00114
Scoloplos rubra	23	0.00114
Spiochaetopterus costarum	68	0.04773
Spiophanes bombyx	182	0.01364
Tellina agilis	455	0.62500
Tharyx sp. A Morris	455	0.11818
Turbellaria (Epi)	23	0.00114
Unciola serrata	23	0.05227
Total Abundance w/o Epi.	3364	
Total Abundance of Epi.	45	
Number of Taxa w/o Epi.	46	
Number of Epi Taxa	2	
Total Biomass w/o Epi.		2.33067
Total Biomass of Epi.		0.00341

Fenwick Benthos 2004: E3

Station: E3	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.021	Simpson Index	.8273
Amphipod Abundance (#/m2)	68	Amphipod Biomass (g/m2)	.0011
Bivalve Abundance (#/m2)	2182	Bivalve Biomass (g/m2)	2.314
Polychaete Abundance (#/m2)	1545	Polychaete Biomass (g/m2)	.2159

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Acteocina canaliculata	750	0.23182
Ampelisca spp.	68	0.00114
Anthozoa	23	0.00114
Apoprionospio pygmaea	23	0.00114
Asabellides oculata	23	0.00455
Gastropoda (Epi)	227	0.00114
Glycinde solitaria	91	0.00909
Maldanidae	23	0.01591
Mediomastus ambiseta	750	0.01818
Nassarius trivittatus	159	0.33636
Nemertina	773	0.04091
Nucula proxima	2045	1.94545
Oligochaeta	2114	0.04318
Paranaitis speciosa	23	0.00114
Paraprionospio pinnata	409	0.14091
Polycirrus spp.	23	0.01591
Sigambra tentaculata	182	0.00909
Tellina agilis	91	0.10682
Turbellaria (Epi)	23	0.03409
Yoldia limatula	45	0.26136
Total Abundance w/o Epi.	7864	
Total Abundance of Epi.	250	
Number of Taxa w/o Epi.	20	
Number of Epi Taxa	2	
Total Biomass w/o Epi.		3.21931
Total Biomass of Epi.		0.03523

Fenwick Benthos 2004: E4

Station: E4	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	2.063	Simpson Index	.6328
Amphipod Abundance (#/m2)	23	Amphipod Biomass (g/m2)	.0011
Bivalve Abundance (#/m2)	9727	Bivalve Biomass (g/m2)	2.027
Polychaete Abundance (#/m2)	1318	Polychaete Biomass (g/m2)	1.355

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Acteocina canaliculata	3955	1.69999
Ampelisca spp.	23	0.00114
Anthozoa	23	0.01364
Bivalvia	23	0.00682
Glycinde solitaria	23	0.00682
Leitoscoloplos spp.	45	0.00114
Leucon americanus	68	0.00114
Mediomastus ambiseta	636	0.01591
Mysidae (Epi)	23	0.00114
Nassarius trivittatus	227	0.69091
Nemertina	1432	0.08636
Nephtys incisa	45	1.05454
Nucula proxima	9477	1.90908
Oligochaeta	341	0.00227
Paraprionospio pinnata	500	0.25682
Pectinaria gouldii	23	0.01591
Rictaxis punctostriatus	45	0.00114
Sigambra tentaculata	23	0.00227
Tellina agilis	227	0.11136
Tharyx sp. A Morris	23	0.00114
Total Abundance w/o Epi.	17182	
Total Abundance of Epi.	23	
Number of Taxa w/o Epi.	20	
Number of Epi Taxa	1	
Total Biomass w/o Epi.		5.87953
Total Biomass of Epi.		0.00114

Fenwick Benthos 2004: E5

Station: E5	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	2.699	Simpson Index	.7663
Amphipod Abundance (#/m2)	45	Amphipod Biomass (g/m2)	.0068
Bivalve Abundance (#/m2)	3591	Bivalve Biomass (g/m2)	3.431
Polychaete Abundance (#/m2)	1705	Polychaete Biomass (g/m2)	1.001

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Acteocina canaliculata	409	0.09545
Ampelisca vadorum	45	0.00682
Asabellides oculata	23	0.00227
Edotea triloba (Epi)	114	0.01818
Glycinde solitaria	68	0.00455
Maldanidae	23	0.00114
Mediomastus ambiseta	727	0.01591
Mulinia lateralis	45	0.07727
Nassarius trivittatus	114	0.59545
Natica pusilla	23	0.02273
Nemertina	659	0.03182
Nephtyidae	23	0.75682
Nucula proxima	3432	3.32953
Odostomia engonia (Epi)	23	0.00227
Oligochaeta	1750	0.03864
Paraprionospio pinnata	773	0.21818
Petricola pholadiformis	68	0.00114
Sigambra tentaculata	45	0.00114
Tellina agilis	45	0.02273
Tharyx sp. A Morris	23	0.00114
Total Abundance w/o Epi.	8432	
Total Abundance of Epi.	136	
Number of Taxa w/o Epi.	20	
Number of Epi Taxa	2	
Total Biomass w/o Epi.		5.24317
Total Biomass of Epi.		0.02045

Fenwick Benthos 2004: E6

Station: E6	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.393	Simpson Index	.8666
Amphipod Abundance (#/m2)	45	Amphipod Biomass (g/m2)	.0455
Bivalve Abundance (#/m2)	45	Bivalve Biomass (g/m2)	.0080
Polychaete Abundance (#/m2)	1477	Polychaete Biomass (g/m2)	.0511

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Ancinus depressus	23	0.03182
Aricidea catherinae	159	0.00682
Cardiidae	23	0.00114
Exogone hebes	23	0.00114
Hemipodus roseus	68	0.00114
Hesionura coineaui	182	0.00114
Magelona spp.	23	0.01818
Mediomastus ambiseta	91	0.00114
Nemertina	205	0.00682
Oligochaeta	568	0.00227
Opheliidae	23	0.00114
Protodrilus spp. *	227	0.00114
Protohaustorius cf. deichmannae	45	0.04545
Scolelepis spp.	23	0.00114
Scoloplos rubra	23	0.00455
Sigalion arenicola	23	0.00114
Streptosyllis pettiboneae	523	0.00909
Syllides spp.	23	0.00114
Tanaissus psammophilus	682	0.00909
Tharyx sp. A Morris	68	0.00227
Yoldia limatula	23	0.00682
Total Abundance w/o Epi.	3045	
Total Abundance of Epi.	227	
Number of Taxa w/o Epi.	21	
Number of Epi Taxa	1	
Total Biomass w/o Epi.		0.15454
Total Biomass of Epi.		0.00114

Fenwick Benthos 2004: E7

Station: E7	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.232	Simpson Index	.8167
Amphipod Abundance (#/m2)	45	Amphipod Biomass (g/m2)	.0261
Bivalve Abundance (#/m2)	45	Bivalve Biomass (g/m2)	.0239
Polychaete Abundance (#/m2)	1523	Polychaete Biomass (g/m2)	.1080

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Aricidea catherinae	205	0.01136
Aricidea cerrutii	318	0.01818
Byblis serrata	23	0.02500
Cardiidae	23	0.02273
Caulleriella sp. B (Blake)	91	0.00227
Cymothoidae *	23	0.08636
Hemipodus roseus	114	0.00455
Levinsenia gracilis	273	0.00455
Mellita quinquiesperforata	23	12.23178
Nemertina	205	0.06364
Oligochaeta	1455	0.02273
Opheliidae	23	0.00114
Parapionosyllis longicirrata	114	0.00114
Polygordius spp.	91	0.01364
Scoloplos rubra	68	0.00227
Spiophanes bombyx	68	0.02955
Streptosyllis pettiboneae	45	0.00114
Tanaissus psammophilus	568	0.01364
Tellina agilis	23	0.00114
Tharyx sp. A Morris	114	0.01818
Unciola spp.	23	0.00114
Total Abundance w/o Epi.	3886	
Total Abundance of Epi.	23	
Number of Taxa w/o Epi.	21	
Number of Epi Taxa	1	
Total Biomass w/o Epi.		12.57610
Total Biomass of Epi.		0.08636

Fenwick Benthos 2004: E8

Station: E8	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	2.264	Simpson Index	.6084
Amphipod Abundance (#/m2)	68	Amphipod Biomass (g/m2)	.0591
Bivalve Abundance (#/m2)	68	Bivalve Biomass (g/m2)	.1250
Polychaete Abundance (#/m2)	364	Polychaete Biomass (g/m2)	.0261

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Ancinus depressus	23	0.04545
Aricidea wassi	23	0.00114
Glyceridae	45	0.00114
Hesionura coineaui	91	0.00114
Nassarius trivittatus	23	0.25000
Nemertina	45	0.00114
Oligochaeta	114	0.00114
Protohaustorius cf. deichmannae	68	0.05909
Sigalion arenicola	114	0.00682
Spiophanes bombyx	23	0.01364
Streptosyllis pettiboneae	68	0.00227
Tanaissus psammophilus	1114	0.01364
Tellina agilis	68	0.12500
Total Abundance w/o Epi.	1818	
Total Abundance of Epi.	0	
Number of Taxa w/o Epi.	13	
Number of Epi Taxa	0	
Total Biomass w/o Epi.		0.52159
Total Biomass of Epi.		0.00000

Fenwick Benthos 2004: E9

Station: E9	Gear: VV-YM		Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.427	Simpson Index	.8509
Amphipod Abundance (#/m2)	0	Amphipod Biomass (g/m2)	.0000
Bivalve Abundance (#/m2)	68	Bivalve Biomass (g/m2)	.0727
Polychaete Abundance (#/m2)	1500	Polychaete Biomass (g/m2)	.4273

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Aricidea catherinae	114	0.00114
Aricidea cerrutii	45	0.00114
Aricidea wassi	136	0.01136
Caulleriella sp. B (Blake)	45	0.00455
Exogone dispar	114	0.00455
Magelona spp.	91	0.04318
Nassarius trivittatus	23	0.05909
Nemertina	114	0.00227
Nephtys bucera	23	0.09545
Notomastus spp.	23	0.00682
Oligochaeta	705	0.00682
Orbinia spp.	23	0.14318
Pagurus spp. (Epi)	23	0.00455
Polygordius spp.	295	0.01136
Scoloplos rubra	227	0.04545
Sigalion arenicola	91	0.01136
Spiophanes bombyx	45	0.01818
Streptosyllis pettiboneae	182	0.00227
Tanaissus psammophilus	1000	0.01136
Tellina agilis	45	0.06818
Tharyx sp. A Morris	45	0.02727
Yoldia limatula	23	0.00455
Total Abundance w/o Epi.	3432	
Total Abundance of Epi.	23	
Number of Taxa w/o Epi.	22	
Number of Epi Taxa	1	
Total Biomass w/o Epi.		0.58409
Total Biomass of Epi.		0.00455

Fenwick Benthos 2004: E10

Station: E10	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.504	Simpson Index	.8745
Amphipod Abundance (#/m2)	0	Amphipod Biomass (g/m2)	.0000
Bivalve Abundance (#/m2)	68	Bivalve Biomass (g/m2)	.0648
Polychaete Abundance (#/m2)	2114	Polychaete Biomass (g/m2)	.1602

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Ancinus depressus	23	0.13182
Aricidea catherinae	477	0.07273
Aricidea cerrutii	227	0.00909
Branchiostoma caribaeum	45	0.00909
Cardiidae	23	0.00114
Caulleriella sp. B (Blake)	23	0.00114
Dorvilleidae	23	0.00114
Glyceridae	159	0.00455
Hemipodus roseus	91	0.00682
Hesionura coineaui	227	0.00114
Levinsenia gracilis	45	0.00114
Magelona spp.	45	0.00909
Nemertina	341	0.00455
Oligochaeta	1114	0.02273
Polygordius spp.	114	0.00227
Scoloplos rubra	68	0.00455
Sigalion arenicola	45	0.00114
Streptosyllis pettiboneae	227	0.00227
Tanaissus psammophilus	773	0.00909
Tellina agilis	45	0.06364
Tharyx sp. A Morris	341	0.04318
Total Abundance w/o Epi.	4477	
Total Abundance of Epi.	0	
Number of Taxa w/o Epi.	40	
Number of Epi Taxa	0	
Total Biomass w/o Epi.		0.40227
Total Biomass of Epi.		0.00000

Fenwick Benthos 2004: F1

Station: F1	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.364	Simpson Index	.7973
Amphipod Abundance (#/m2)	227	Amphipod Biomass (g/m2)	.0750
Bivalve Abundance (#/m2)	68	Bivalve Biomass (g/m2)	.0091
Polychaete Abundance (#/m2)	1159	Polychaete Biomass (g/m2)	.2557

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Acanthohaustorius millsi	23	0.00114
Americhelidium americanum	23	0.00114
Anthozoa	91	0.02045
Aricidea catherinae	227	0.01591
Branchiostoma caribaeum	91	0.06364
Caulleriella sp. B (Blake)	45	0.00114
Cymothoidae *	23	0.09091
Dorvilleidae	45	0.00114
Edotea triloba (Epi)	23	0.00114
Hemipodus roseus	409	0.04091
Levinsenia gracilis	68	0.00455
Nemertina	136	0.00114
Oligochaeta	1341	0.03182
Oxyurostylis smithi	23	0.00227
Parapionosyllis longicirrata	23	0.00114
Pisione remota	23	0.00455
Polygordius spp.	114	0.00909
Protohaustorius cf. deichmannae	68	0.02045
Rhepoxynius hudsoni	114	0.05227
Sabellaria vulgaris (Epi)	45	0.00455
Scoletoma tenuis	23	0.06364
Scoloplos rubra	23	0.00682
Sigalion arenicola	23	0.04318
Spisula solidissima	23	0.00227
Tanaissus psammophilus	45	0.00227
Tellina tenella	45	0.00682
Tharyx sp. A Morris	91	0.05909
Total Abundance w/o Epi.	3227	
Total Abundance of Epi.	91	
Number of Taxa w/o Epi.	27	
Number of Epi Taxa	3	
Total Biomass w/o Epi.		0.55341
Total Biomass of Epi.		0.09659

Fenwick Benthos 2004: F2

Station: F2	Gear: VV-YM		Sampled Area: 0.044 sq.m
BENTHIC METRICS			
	Score		Score
Shannon-Wiener Index	3.226	Simpson Index	.8546
Amphipod Abundance (#/m2)	0	Amphipod Biomass (g/m2)	.0000
Bivalve Abundance (#/m2)	45	Bivalve Biomass (g/m2)	.0034
Polychaete Abundance (#/m2)	614	Polychaete Biomass (g/m2)	.1466

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)		
TAXA	Abundance (#/m2)	Biomass (g/m2)
Aricidea catherinae	159	0.01818
Branchiostoma caribaeum	23	0.02500
Cardiidae	23	0.00227
Decapoda (Epi)	45	0.00455
Dorvilleidae	23	0.00227
Glycera spp.	159	0.09773
Hemipodus roseus	91	0.00909
Mediomastus ambiseta	23	0.00114
Nemertina	159	0.02727
Nephtys picta	23	0.01591
Oligochaeta	364	0.00682
Oxyurostylis smithi	23	0.00114
Parapionosyllis longicirrata	114	0.00114
Spisula solidissima	23	0.00114
Tharyx sp. A Morris	23	0.00114
Total Abundance w/o Epi.	1273	
Total Abundance of Epi.	45	
Number of Taxa w/o Epi.	15	
Number of Epi Taxa	1	
Total Biomass w/o Epi.		0.21477
Total Biomass of Epi.		0.00455

Fenwick Benthos 2004: F3

Station: F3	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	1.768	Simpson Index	.4577
Amphipod Abundance (#/m2)	0	Amphipod Biomass (g/m2)	.0000
Bivalve Abundance (#/m2)	68	Bivalve Biomass (g/m2)	.7364
Polychaete Abundance (#/m2)	1250	Polychaete Biomass (g/m2)	.0977

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Amakusanthura magnifica	23	0.00227
Anthozoa	68	0.01818
Apoprionospio pygmaea	23	0.00455
Aricidea catherinae	295	0.04773
Aricidea cerrutii	68	0.00455
Branchiostoma caribaeum	364	0.31136
Cardiidae	23	0.04318
Dorvilleidae	45	0.00227
Glycera spp.	45	0.01136
Hesionura coineaui	432	0.00682
Levinsenia gracilis	114	0.00114
Nemertina	545	0.03864
Oligochaeta	6318	0.17045
Opheliidae	23	0.00227
Ophelina acuminata	23	0.00909
Parapionosyllis longicirrata	91	0.00114
Pisione remota	23	0.00227
Protodrilus spp. *	23	0.00114
Scoloplos rubra	23	0.00114
Sigalion arenicola	23	0.00227
Spisula solidissima	23	0.49091
Tanaissus psammophilus	23	0.00114
Tellina tenella	23	0.20227
Total Abundance w/o Epi.	8659	
Total Abundance of Epi.	23	
Number of Taxa w/o Epi.	44	
Number of Epi Taxa	1	
Total Biomass w/o Epi.		1.37613
Total Biomass of Epi.		0.00114

Fenwick Benthos 2004: F4

Station: F4	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.798	Simpson Index	.8795
Amphipod Abundance (#/m2)	159	Amphipod Biomass (g/m2)	.0193
Bivalve Abundance (#/m2)	250	Bivalve Biomass (g/m2)	2.100
Polychaete Abundance (#/m2)	977	Polychaete Biomass (g/m2)	.3114

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Anthozoa	114	0.03409
Aricidea catherinae	68	0.00114
Aricidea cerrutii	23	0.00227
Batea catharinensis (Epi)	68	0.00455
Branchiostoma caribaeum	409	0.64773
Cardiidae	23	0.00227
Dipolydora socialis	23	0.00114
Dorvilleidae	23	0.00114
Hemipodus roseus	68	0.00682
Levinsenia gracilis	45	0.00114
Lyonsia hyalina	114	0.01136
Magelona spp.	23	0.03409
Nemertina	227	0.01591
Nudibranchia (Epi)	23	0.00114
Oligochaeta	750	0.01364
Ophelina acuminata	45	0.00909
Pisione remota	23	0.00227
Polygordius spp.	68	0.03182
Rhepoxynius hudsoni	23	0.00114
Sabellaria vulgaris (Epi)	432	0.17727
Scoloplos rubra	23	0.00227
Spiophanes bombyx	45	0.03864
Spisula solidissima	45	2.05681
Streptosyllis pettiboneae	23	0.00114
Tanaissus psammophilus	23	0.00227
Tellina agilis	45	0.01591
Tharyx sp. A Morris	45	0.00114
Unciola serrata	68	0.01364
Yoldia limatula	23	0.01364
Total Abundance w/o Epi.	2932	
Total Abundance of Epi.	523	
Number of Taxa w/o Epi.	29	
Number of Epi Taxa	3	
Total Biomass w/o Epi.		3.14544
Total Biomass of Epi.		0.18295

Fenwick Benthos 2004: F5

Station: F5	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.198	Simpson Index	.8244
Amphipod Abundance (#/m2)	295	Amphipod Biomass (g/m2)	.1466
Bivalve Abundance (#/m2)	114	Bivalve Biomass (g/m2)	.0239
Polychaete Abundance (#/m2)	2659	Polychaete Biomass (g/m2)	.2295

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Acanthohaustorius millsi	45	0.07273
Amastigos caperatus	23	0.00114
Americhelidium americanum	23	0.00114
Aricidea catherinae	273	0.02273
Aricidea cerrutii	45	0.00114
Caulleriella sp. B (Blake)	1205	0.07500
Glycera spp.	23	0.00114
Hargeria rapax	45	0.00227
Lyonsia hyalina	45	0.00114
Magelona spp.	45	0.00909
Nassarius trivittatus	23	0.15000
Nemertina	45	0.00114
Oligochaeta	1068	0.01364
Opheliidae	23	0.00455
Pagurus spp. (Epi)	23	0.03182
Polygordius spp.	705	0.03409
Protohaustorius cf. deichmannae	159	0.04773
Rhepoxynius hudsoni	68	0.02500
Scoloplos rubra	114	0.02273
Sigalion arenicola	23	0.03409
Sphaerodoridae	45	0.00682
Spiophanes bombyx	114	0.01591
Spisula solidissima	45	0.02045
Streptosyllis pettiboneae	23	0.00114
Tellina agilis	23	0.00227
Turbellaria (Epi)	23	0.00114
Total Abundance w/o Epi.	4295	
Total Abundance of Epi.	45	
Number of Taxa w/o Epi.	26	
Number of Epi Taxa	2	
Total Biomass w/o Epi.		0.60000
Total Biomass of Epi.		0.03295

Fenwick Benthos 2004: F6

Station: F6	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.358	Simpson Index	.8279
Amphipod Abundance (#/m2)	295	Amphipod Biomass (g/m2)	.0830
Bivalve Abundance (#/m2)	68	Bivalve Biomass (g/m2)	.0432
Polychaete Abundance (#/m2)	1795	Polychaete Biomass (g/m2)	.4977

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Acanthohaustorius millsi	23	0.00114
Amastigos caperatus	91	0.00682
Aricidea catherinae	205	0.01136
Cardiidae	45	0.00455
Caulleriella sp. B (Blake)	114	0.00455
Dissodactylus mellitae (Epi)	23	0.00114
Magelona spp.	182	0.10227
Mellita quinquiesperforata	23	8.63634
Nemertina	45	0.00227
Nephtyidae	23	0.00227
Oligochaeta	114	0.00114
Opheliidae	23	0.00114
Parapionosyllis longicirrata	23	0.00114
Polygordius spp.	886	0.04545
Protohaustorius cf. deichmannae	273	0.08182
Scoloplos rubra	23	0.00227
Sigalion arenicola	45	0.30227
Spiophanes bombyx	114	0.00909
Tanaissus psammophilus	45	0.00114
Tellina agilis	23	0.03864
Tharyx sp. A Morris	68	0.00909
Total Abundance w/o Epi.	2409	
Total Abundance of Epi.	23	
Number of Taxa w/o Epi.	21	
Number of Epi Taxa	1	
Total Biomass w/o Epi.		9.26588
Total Biomass of Epi.		0.00114

Fenwick Benthos 2004: F7

Station: F7	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	4.085	Simpson Index	.9228
Amphipod Abundance (#/m2)	341	Amphipod Biomass (g/m2)	.1739
Bivalve Abundance (#/m2)	182	Bivalve Biomass (g/m2)	.0909
Polychaete Abundance (#/m2)	1864	Polychaete Biomass (g/m2)	.3034

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Ampelisca spp.	23	0.00114
Anthozoa	23	0.00114
Aricidea catherinae	182	0.01136
Aricidea cerrutii	386	0.02273
Branchiostoma caribaeum	68	0.02045
Cardiidae	68	0.00455
Caulleriella sp. B (Blake)	45	0.02727
Echinoidea	23	0.00682
Hemipodus roseus	273	0.04773
Levinsenia gracilis	136	0.00114
Nemertina	295	0.05000
Oligochaeta	591	0.01591
Parapionosyllis longicirrata	159	0.00227
Polycirrus spp.	23	0.04318
Polygordius spp.	136	0.01364
Protohaustorius cf. deichmannae	91	0.05682
Rhepoxynius hudsoni	227	0.11591
Scoletoma hebes	68	0.06364
Scoloplos rubra	114	0.04545
Spiophanes bombyx	23	0.00114
Spisula solidissima	23	0.08182
Streptosyllis pettiboneae	182	0.00114
Tanaissus psammophilus	45	0.00114
Tellina tenella	91	0.00455
Tharyx sp. A Morris	136	0.02273
Total Abundance w/o Epi.	3432	
Total Abundance of Epi.	0	
Number of Taxa w/o Epi.	25	
Number of Epi Taxa	0	
Total Biomass w/o Epi.		0.66363
Total Biomass of Epi.		0.00000

Fenwick Benthos 2004: F8

Station: F8	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.971	Simpson Index	.9124
Amphipod Abundance (#/m2)	227	Amphipod Biomass (g/m2)	.1375
Bivalve Abundance (#/m2)	45	Bivalve Biomass (g/m2)	.0034
Polychaete Abundance (#/m2)	1273	Polychaete Biomass (g/m2)	.2182

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Acanthohaustorius millsi	45	0.05682
Amakusanthura magnifica	23	0.00227
Ancinus depressus	23	0.02955
Aoprionospio pygmaea	23	0.00114
Aricidea catherinae	23	0.00227
Aricidea cerrutii	159	0.01136
Caulleriella sp. B (Blake)	364	0.03182
Echinoidea	23	0.00114
Hemipodus roseus	91	0.00455
Levinsenia gracilis	91	0.00114
Lumbrineridae	23	0.04091
Nemertina	159	0.00455
Nephtys picta	23	0.01818
Oligochaeta	341	0.00682
Orbinia spp.	23	0.07955
Parapionosyllis longicirrata	159	0.00227
Polygordius spp.	159	0.00909
Protohaustorius cf. deichmannae	114	0.07500
Rhepoxynius hudsoni	23	0.00455
Scoloplos rubra	45	0.00455
Spisula solidissima	23	0.00114
Tellina tenella	23	0.00227
Tharyx sp. A Morris	91	0.01136
Turbellaria (Epi)	23	0.00114
Unciola spp.	45	0.00114
Total Abundance w/o Epi.	2136	
Total Abundance of Epi.	23	
Number of Taxa w/o Epi.	25	
Number of Epi Taxa	1	
Total Biomass w/o Epi.		0.40454
Total Biomass of Epi.		0.00114

Fenwick Benthos 2004: F9

Station: F9	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.711	Simpson Index	.8736
Amphipod Abundance (#/m2)	91	Amphipod Biomass (g/m2)	.0341
Bivalve Abundance (#/m2)	318	Bivalve Biomass (g/m2)	.7830
Polychaete Abundance (#/m2)	1818	Polychaete Biomass (g/m2)	.2125

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Acanthohaustorius millsi	23	0.00227
Amakusanthura magnifica	23	0.00682
Anthozoa	23	0.00114
Aricidea catherinae	182	0.01136
Aricidea cerrutii	318	0.01591
Branchiostoma caribaeum	68	0.02500
Cardiidae	114	0.00227
Caulleriella sp. B (Blake)	68	0.00114
Dorvilleidae	68	0.00114
Hemipodus roseus	386	0.03182
Levinsenia gracilis	250	0.00682
Lyonsia hyalina	23	0.00114
Nemertina	250	0.07500
Oligochaeta	1091	0.03409
Parapionosyllis longicirrata	68	0.00227
Polygordius spp.	136	0.00114
Protohaustorius cf. deichmannae	45	0.02500
Rhepoxynius hudsoni	23	0.00682
Scoletoma tenuis	45	0.08864
Scoloplos rubra	159	0.04318
Sigalionidae	23	0.00227
Spisula solidissima	23	0.74545
Tellina agilis	136	0.02955
Tharyx sp. A Morris	114	0.00682
Yoldia limatula	23	0.00455
Total Abundance w/o Epi.	3682	
Total Abundance of Epi.	0	
Number of Taxa w/o Epi.	25	
Number of Epi Taxa	0	
Total Biomass w/o Epi.		1.17159
Total Biomass of Epi.		0.00000

Fenwick Benthos 2004: F10

Station: F10	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.744	Simpson Index	.8801
Amphipod Abundance (#/m2)	23	Amphipod Biomass (g/m2)	.0386
Bivalve Abundance (#/m2)	159	Bivalve Biomass (g/m2)	.9682
Polychaete Abundance (#/m2)	1318	Polychaete Biomass (g/m2)	.3614

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Anthozoa	91	0.00682
Aricidea catherinae	91	0.00682
Aricidea cerrutii	136	0.00909
Branchiostoma caribaeum	45	0.01818
Brania wellfleetensis	68	0.00227
Byblis serrata	23	0.03864
Cardiidae	68	0.00455
Caulleriella sp. B (Blake)	68	0.00682
Exogone dispar	23	0.00682
Goniadella gracilis	23	0.00682
Hemipodus roseus	114	0.00455
Levinsenia gracilis	182	0.00455
Mysidae (Epi)	23	0.00909
Nemertina	114	0.00227
Oligochaeta	705	0.01818
Orbinia spp.	23	0.12727
Scoloplos rubra	205	0.09545
Spiophanes bombyx	23	0.00227
Spisula solidissima	23	0.89772
Streptosyllis pettiboneae	68	0.00114
Syllides spp.	23	0.00114
Tellina tenella	68	0.06591
Tharyx sp. A Morris	273	0.08636
Total Abundance w/o Epi.	2477	
Total Abundance of Epi.	23	
Number of Taxa w/o Epi.	23	
Number of Epi Taxa	1	
Total Biomass w/o Epi.		1.42272
Total Biomass of Epi.		0.00909

Fenwick Benthos 2004: F11

Station: F11	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.171	Simpson Index	.7766
Amphipod Abundance (#/m2)	91	Amphipod Biomass (g/m2)	.0409
Bivalve Abundance (#/m2)	45	Bivalve Biomass (g/m2)	.0182
Polychaete Abundance (#/m2)	1045	Polychaete Biomass (g/m2)	.1114

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Amakusanthura magnifica	23	0.00455
Anthozoa	45	0.00227
Aricidea catherinae	205	0.02955
Aricidea cerrutii	205	0.01136
Branchiostoma caribaeum	91	0.05000
Brania wellfleetensis	45	0.00114
Cymothoidae *	23	0.09318
Dorvilleidae	23	0.00114
Hemipodus roseus	182	0.01591
Hesionura coineaui	23	0.00682
Levinsenia gracilis	114	0.00227
Maldanidae	23	0.00682
Natica pusilla	45	0.01591
Nemertina	159	0.03182
Oligochaeta	1273	0.03864
Opheliidae	23	0.00455
Protohaustorius cf. deichmannae	45	0.02727
Rhepoxynius hudsoni	45	0.01364
Scoloplos rubra	23	0.00682
Spisula solidissima	23	0.01136
Tanaissus psammophilus	23	0.00455
Tellina tenella	23	0.00682
Tharyx sp. A Morris	182	0.02500
Total Abundance w/o Epi.	2864	
Total Abundance of Epi.	23	
Number of Taxa w/o Epi.	23	
Number of Epi Taxa	1	
Total Biomass w/o Epi.		0.41136
Total Biomass of Epi.		0.09318

Fenwick Benthos 2004: F12

Station: F12	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	2.768	Simpson Index	.7166
Amphipod Abundance (#/m2)	45	Amphipod Biomass (g/m2)	.0250
Bivalve Abundance (#/m2)	68	Bivalve Biomass (g/m2)	.0205
Polychaete Abundance (#/m2)	1477	Polychaete Biomass (g/m2)	.1159

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Aricidea catherinae	568	0.04318
Aricidea cerrutii	45	0.00114
Branchiostoma caribaeum	205	0.06364
Cardiidae	45	0.00455
Dorvilleidae	182	0.00455
Hemipodus roseus	23	0.00455
Hesionura coineaui	68	0.00114
Levinsenia gracilis	136	0.00455
Microphthalmus spp.	23	0.00114
Nemertina	341	0.02500
Oligochaeta	2205	0.06136
Opheliidae	23	0.00227
Parapionosyllis longicirrata	68	0.00114
Polinices duplicatus	23	8.51134
Rhepoxynius hudsoni	45	0.02500
Scoletoma spp.	45	0.01136
Scoloplos rubra	45	0.01591
Spisula solidissima	23	0.01591
Streptosyllis pettiboneae	68	0.00455
Tanaissus psammophilus	23	0.00114
Tharyx sp. A Morris	182	0.02045
Total Abundance w/o Epi.	4386	
Total Abundance of Epi.	0	
Number of Taxa w/o Epi.	21	
Number of Epi Taxa	0	
Total Biomass w/o Epi.		8.82384
Total Biomass of Epi.		0.00000

Fenwick Benthos 2004: F13

Station: F13	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	2.665	Simpson Index	.7758
Amphipod Abundance (#/m2)	68	Amphipod Biomass (g/m2)	.0068
Bivalve Abundance (#/m2)	68	Bivalve Biomass (g/m2)	.0023
Polychaete Abundance (#/m2)	7909	Polychaete Biomass (g/m2)	1.273

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Ampelisca spp.	45	0.00227
Aricidea catherinae	2227	0.15682
Asterias forbesi (Epi)	23	0.95227
Caulleriella sp. B (Blake)	23	0.00114
Dorvilleidae	23	0.00114
Drilonereis longa	68	0.58636
Eumida sanguinea	23	0.00114
Glycera americana	45	0.12500
Mediomastus ambiseta	2045	0.04773
Nassarius trivittatus	68	0.15227
Nemertina	250	0.00909
Nucula proxima	23	0.00114
Oligochaeta	591	0.00455
Pagurus longicarpus (Epi)	45	0.43182
Phyllodoce arenae	23	0.01818
Prionospio perkinsi	23	0.00114
Sabellaria vulgaris (Epi)	2932	0.28864
Sigambra tentaculata	23	0.00114
Spiochaetopterus costarum	23	0.03409
Spiophanes bombyx	68	0.00455
Streblospio benedicti	114	0.00455
Tellina spp.	45	0.00114
Tharyx sp. A Morris	250	0.00114
Unciola spp.	23	0.00455
Total Abundance w/o Epi.	9023	
Total Abundance of Epi.	3000	
Number of Taxa w/o Epi.	24	
Number of Epi Taxa	3	
Total Biomass w/o Epi.		2.83181
Total Biomass of Epi.		1.67272

Fenwick Benthos 2004: F14

Station: F14	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	1.871	Simpson Index	.4843
Amphipod Abundance (#/m2)	91	Amphipod Biomass (g/m2)	.0239
Bivalve Abundance (#/m2)	182	Bivalve Biomass (g/m2)	.0989
Polychaete Abundance (#/m2)	12318	Polychaete Biomass (g/m2)	.9966

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Ampharete arctica	23	0.00114
Anthozoa	23	0.05000
Aricidea catherinae	9864	0.55000
Branchiostoma caribaeum	23	0.00682
Byblis serrata	23	0.00114
Caulleriella sp. B (Blake)	477	0.02045
Dorvilleidae	23	0.00114
Drilonereis longa	23	0.00455
Glycera spp.	68	0.02955
Lyonsia hyalina	23	0.00114
Magelona spp.	23	0.02500
Maldanidae	23	0.00114
Mediomastus ambiseta	386	0.00909
Nassarius trivittatus	45	0.08636
Nemertina	455	0.05909
Nephtys picta	68	0.03409
Oligochaeta	727	0.01364
Rhepoxynius hudsoni	45	0.01591
Sabellaria vulgaris (Epi)	455	0.03409
Spiophanes bombyx	250	0.02955
Tellina agilis	159	0.09773
Tharyx sp. A Morris	636	0.25682
Unciola serrata	23	0.00682
Total Abundance w/o Epi.	13864	
Total Abundance of Epi.	455	
Number of Taxa w/o Epi.	23	
Number of Epi Taxa	1	
Total Biomass w/o Epi.		1.33522
Total Biomass of Epi.		0.03409

Fenwick Benthos 2004: F15

Station: F15	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	3.265	Simpson Index	.8426
Amphipod Abundance (#/m2)	159	Amphipod Biomass (g/m2)	.0250
Bivalve Abundance (#/m2)	409	Bivalve Biomass (g/m2)	.5114
Polychaete Abundance (#/m2)	4386	Polychaete Biomass (g/m2)	.6000

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Acanthohaustorius millsi	23	0.00455
Amastigos caperatus	159	0.00455
Ancistrosyllis hartmanae	23	0.00227
Aricidea cerrutii	1545	0.07727
Caulleriella sp. B (Blake)	568	0.04545
Crepidula plana (Epi)	182	0.05909
Dispio uncinata	45	0.22500
Glycera americana	23	0.00909
Hemipodus roseus	23	0.00114
Mediomastus ambiseta	68	0.00227
Nassarius trivittatus	23	0.03182
Nemertina	432	0.04091
Oligochaeta	182	0.00455
Polygordius spp.	91	0.00114
Rhepoxynius hudsoni	91	0.01591
Sabellaria vulgaris (Epi)	1409	0.14773
Scoloplos rubra	23	0.00114
Spiochaetopterus costarum	23	0.06591
Spiophanes bombyx	205	0.01591
Tellina agilis	409	0.51136
Tharyx sp. A Morris	182	0.00114
Unciola spp.	45	0.00455
Total Abundance w/o Epi.	5773	
Total Abundance of Epi.	1591	
Number of Taxa w/o Epi.	22	
Number of Epi Taxa	2	
Total Biomass w/o Epi.		1.27272
Total Biomass of Epi.		0.20682

Station: F16	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	2.979	Simpson Index	.8031
Amphipod Abundance (#/m2)	705	Amphipod Biomass (g/m2)	.1136
Bivalve Abundance (#/m2)	45	Bivalve Biomass (g/m2)	2.393
Polychaete Abundance (#/m2)	12864	Polychaete Biomass (g/m2)	1.137

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Acteocina canaliculata	23	0.00227
Ampelisca spp.	227	0.02045
Ampelisca vadorum	23	0.03182
Ampharete arctica	23	0.00114
Aricidea catherinae	6864	0.44773
Astyris lunata (Epi)	91	0.02500
Caulleriella sp. B (Blake)	159	0.01364
Crepidula plana (Epi)	159	0.00227
Dorvilleidae	45	0.00114
Drilonereis longa	23	0.00455
Echinoidea	23	0.04091
Ensis directus	23	2.35908
Euceramus praelongus	45	0.65454
Euclymene zonalis	45	0.03636
Gastropoda (Epi)	45	0.00909
Glycera americana	136	0.10227
Hesionura coineaui	23	0.00114
Holothuroidea	23	0.15000
Leitoscoloplos spp.	23	0.00455
Libinia dubia *	114	0.46818
Mediomastus ambiseta	1295	0.02727
Nassarius trivittatus	68	0.47500
Nemertina	2114	0.18182
Nephtys picta	23	0.01591
Oligochaeta	3409	0.05682
Oxyurostylis smithi	23	0.00227
Pagurus spp. (Epi)	227	0.23636
Parapionosyllis longicirrata	91	0.00114
Phyllodoce arenae	23	0.00114
Pinnotheridae	23	0.03864
Polygordius spp.	45	0.00114
Prionospio perkinsi	250	0.00909
Sabellaria vulgaris (Epi)	3682	0.42727
Spiochaetopterus costarum	45	0.02955
Spiophanes bombyx	45	0.00114
Tellina spp.	23	0.03409
Tharyx sp. A Morris	23	0.01136
Unciola serrata	455	0.06136
Xanthidae (Epi)	23	0.01136
Total Abundance w/o Epi.	20023	
Total Abundance of Epi.	4341	
Number of Taxa w/o Epi.	76	
Number of Epi Taxa	7	
Total Biomass w/o Epi.		5.99884
Total Biomass of Epi.		1.17954

Fenwick Benthos 2004: F17

Station: F17	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

	Score		Score
Shannon-Wiener Index	2.882	Simpson Index	.8043
Amphipod Abundance (#/m2)	1023	Amphipod Biomass (g/m2)	.0841
Bivalve Abundance (#/m2)	68	Bivalve Biomass (g/m2)	.3284
Polychaete Abundance (#/m2)	8023	Polychaete Biomass (g/m2)	.8114

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Americhelidium americanum	68	0.00227
Ampelisca spp.	91	0.01136
Ancistrosyllis hartmanae	45	0.00114
Anthozoa	68	0.18864
Aricidea catherinae	1795	0.13409
Batea catharinensis (Epi)	205	0.02955
Caulleriella sp. B (Blake)	45	0.00227
Crepidula spp. (Epi)	23	0.00114
Dorvilleidae	45	0.00114
Drilonereis longa	23	0.00227
Ensis directus	23	0.30909
Eumida sanguinea	23	0.00114
Gastropoda (Epi)	45	0.05000
Glycera americana	23	0.01136
Leitoscoloplos spp.	23	0.00455
Lyonsia hyalina	23	0.00114
Maldanidae	23	0.01364
Mediomastus ambiseta	864	0.02045
Nassarius trivittatus	91	0.43636
Nemertina	2318	0.16591
Oligochaeta	4205	0.06136
Pagurus longicarpus (Epi)	295	0.62727
Parapionosyllis longicirrata	91	0.00114
Portunidae *	68	0.06818
Sabellaria vulgaris (Epi)	4886	0.51818
Spiochaetopterus costarum	91	0.09545
Spiophanes bombyx	45	0.00455
Tellina spp.	23	0.01818
Unciola serrata	659	0.04091
Total Abundance w/o Epi.	16227	
Total Abundance of Epi.	5523	
Number of Taxa w/o Epi.	29	
Number of Epi Taxa	6	
Total Biomass w/o Epi.		2.82272
Total Biomass of Epi.		1.29431

Station: F18	Gear: VV-YM	Sampled Area: 0.044 sq.m

BENTHIC METRICS

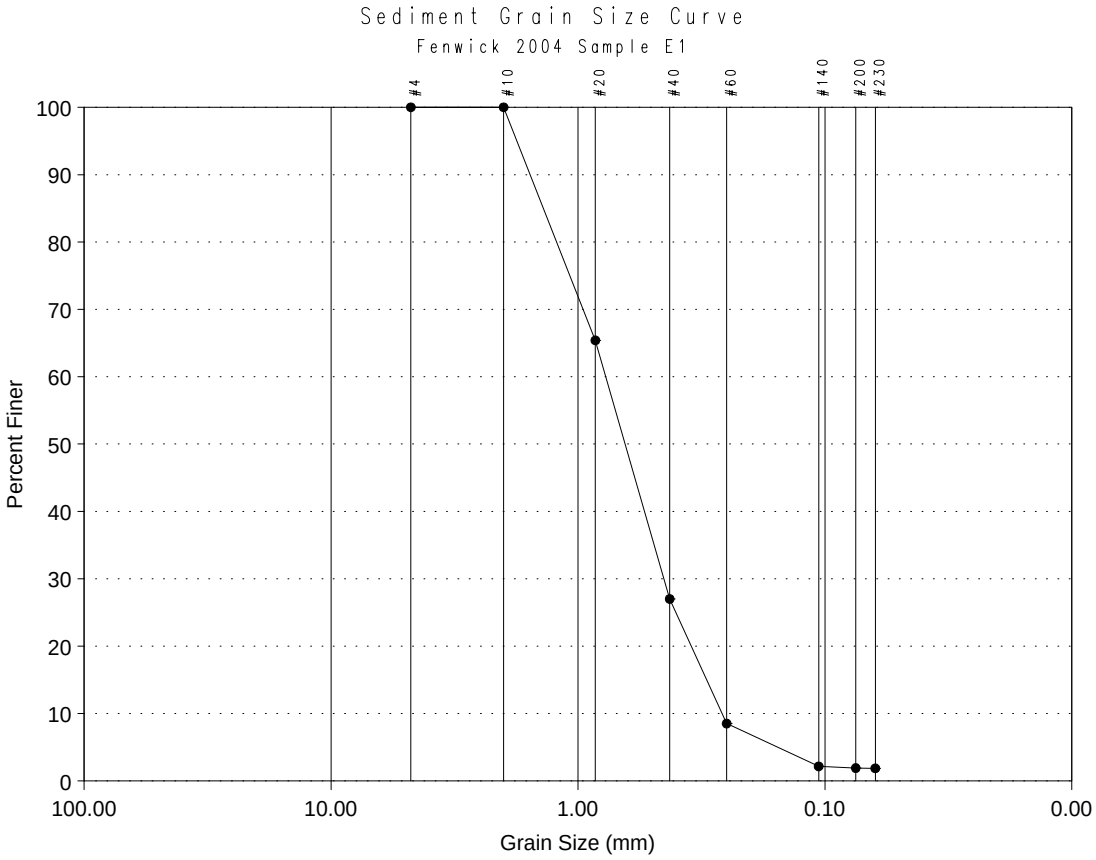
	Score		Score
Shannon-Wiener Index	2.739	Simpson Index	.7302
Amphipod Abundance (#/m2)	455	Amphipod Biomass (g/m2)	.0807
Bivalve Abundance (#/m2)	23	Bivalve Biomass (g/m2)	.0159
Polychaete Abundance (#/m2)	10386	Polychaete Biomass (g/m2)	1.593

BENTHIC ABUNDANCE AND BIOMASS (per sq. meter)

TAXA	Abundance (#/m2)	Biomass (g/m2)
Americhelidium americanum	45	0.00114
Ampelisca vadorum	114	0.06591
Aricidea catherinae	4636	0.51136
Batea catharinensis (Epi)	45	0.00114
Caulleriella sp. B (Blake)	68	0.00114
Corophiidae (Epi)	23	0.00114
Crepidula spp. (Epi)	45	0.00114
Drilonereis longa	227	0.10682
Euceramus praelongus	68	0.12500
Euclymene zonalis	23	0.04545
Gastropoda (Epi)	23	0.00455
Glycera americana	23	0.00455
Glycera dibranchiata	23	0.19091
Leitoscoloplos spp.	23	0.01818
Lepidonotus spp. (Epi)	23	0.01591
Mediomastus ambiseta	1341	0.03636
Nassarius trivittatus	23	0.17045
Nemertina	455	0.04773
Oligochaeta	10091	0.15227
Pagurus spp. (Epi)	159	0.38636
Podarke obscura	23	0.01136
Polydora spp.	23	0.01136
Polygordius spp.	1205	0.05682
Polynoidae (Epi)	23	0.00455
Polyplacophora (Epi)	45	0.02955
Portunidae *	23	0.01136
Prionospio perkinsi	477	0.01591
Sabellaria vulgaris (Epi)	1045	0.07273
Scoletoma tenuis	23	0.05227
Spiophanes bombyx	91	0.03182
Streblospio benedicti	68	0.00114
Syllidae	205	0.00227
Tanaissus psammophilus	23	0.00455
Tellina agilis	23	0.01591
Tharyx sp. A Morris	818	0.40227
Unciola spp.	227	0.01136
Xanthidae (Epi)	45	0.02045
Total Abundance w/o Epi.	21864	
Total Abundance of Epi.	1500	
Number of Taxa w/o Epi.	72	
Number of Epi Taxa	10	
Total Biomass w/o Epi.		2.64317
Total Biomass of Epi.		0.54886

APPENDIX F

STATION HABITAT DATA AND SEDIMENT CURVES


Sediment Grain Size Curve
Fenwick 2004 Sample E1
#4
#10
#20
#40
#60
#140
#200
#230
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80
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Percent Finer
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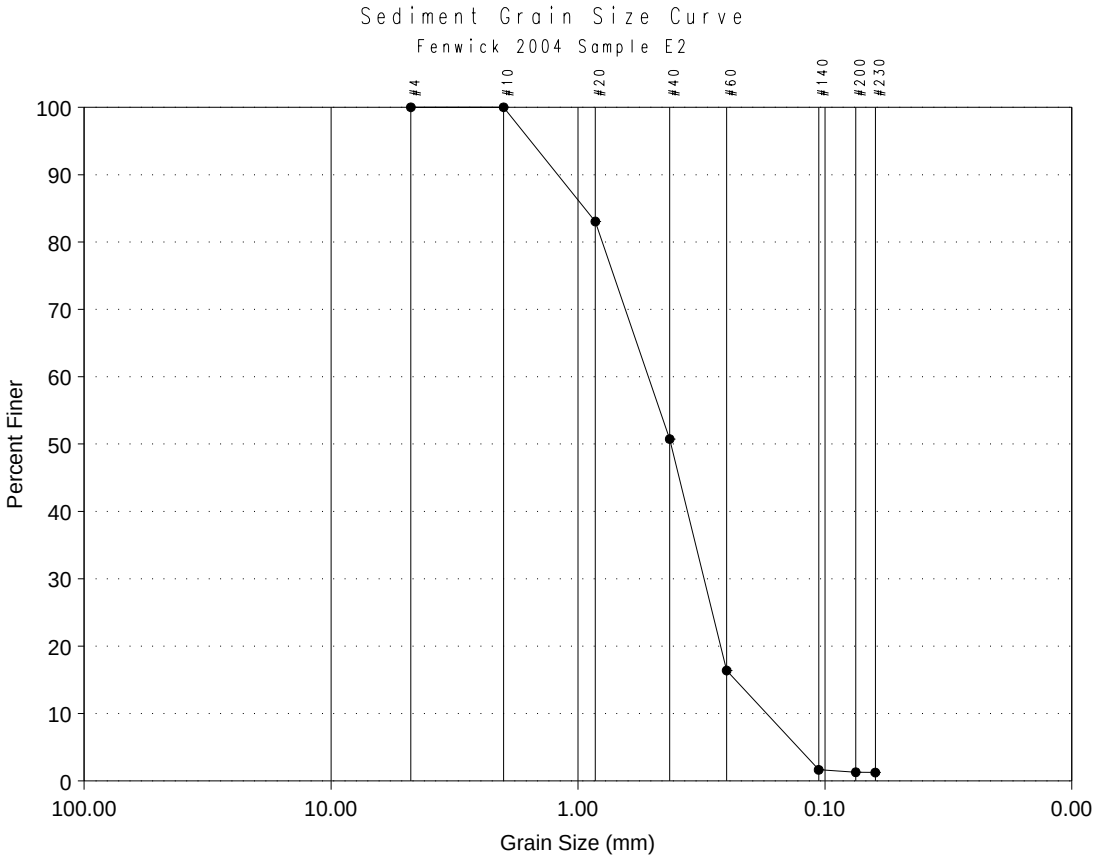
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample E2
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Percent Finer
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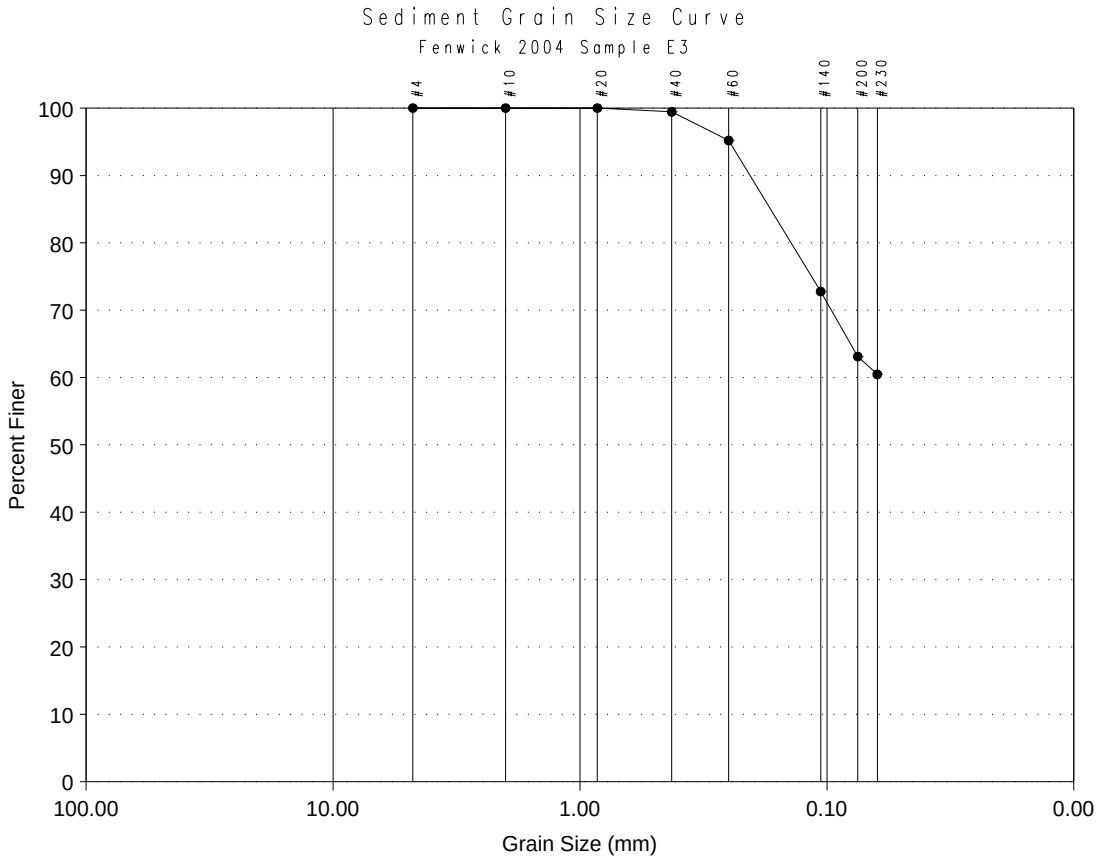
Grain Size (mm)


Sediment Grain Size Curve
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#200
#230
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80
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20
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Percent Finer
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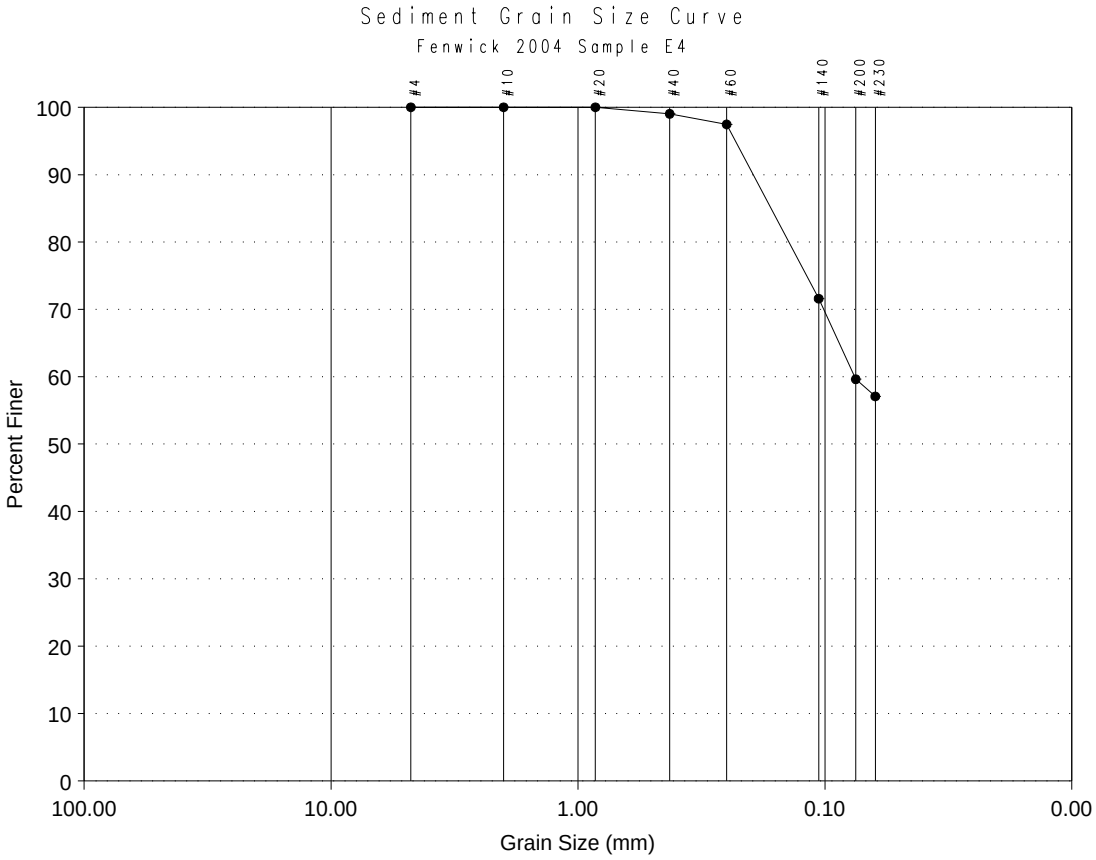
1.00
0.10
0.00
Grain Size (mm)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#140
#200
#230
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80
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20
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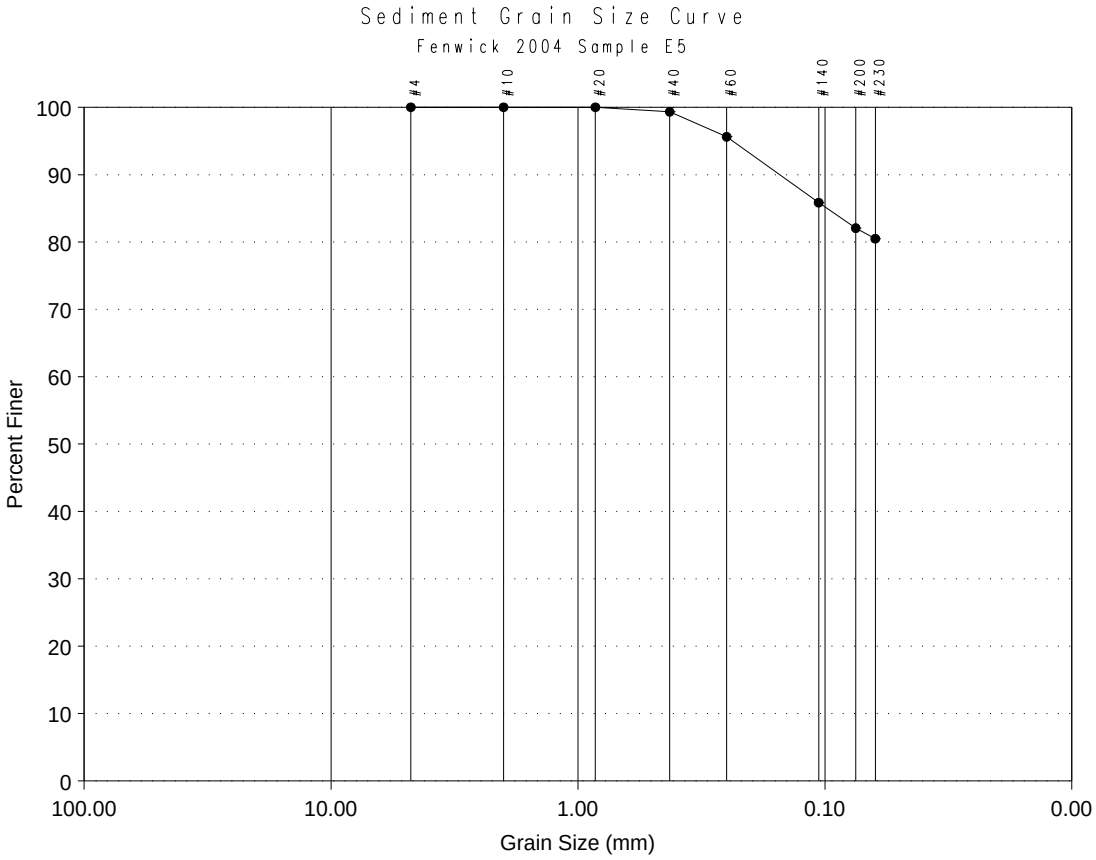
Percent Finer
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)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Fenwick 2004 Sample E5
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80
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20
10
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Percent Finer
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1.00
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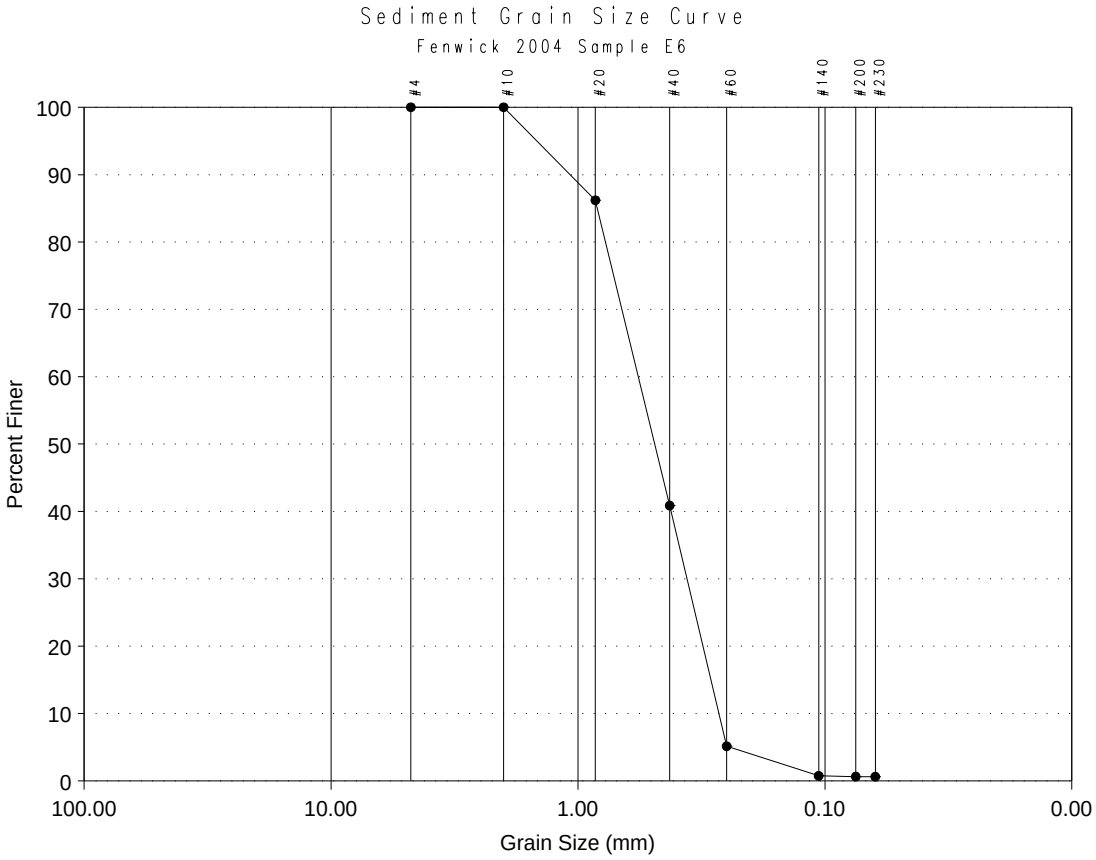
0.00
Grain Size (mm)


Sediment Grain Size Curve
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80
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20
10
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Percent Finer
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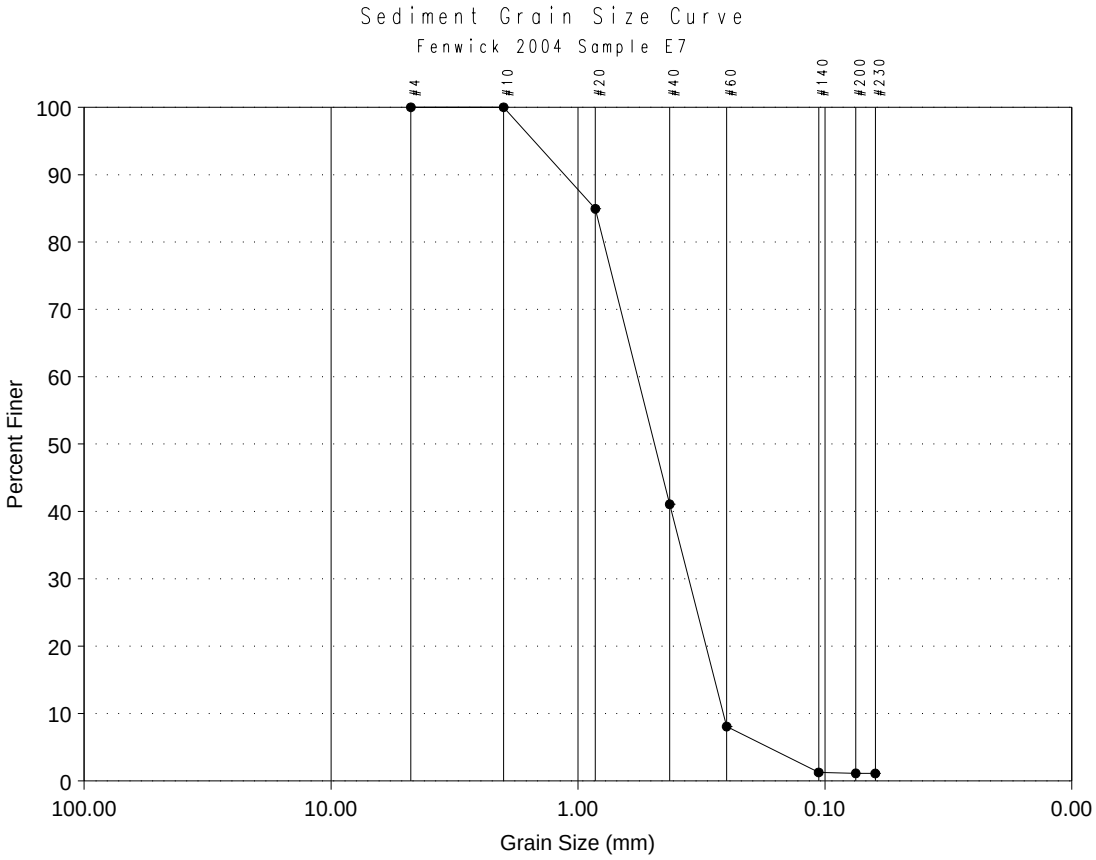
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
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80
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20
10
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Percent Finer
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1.00
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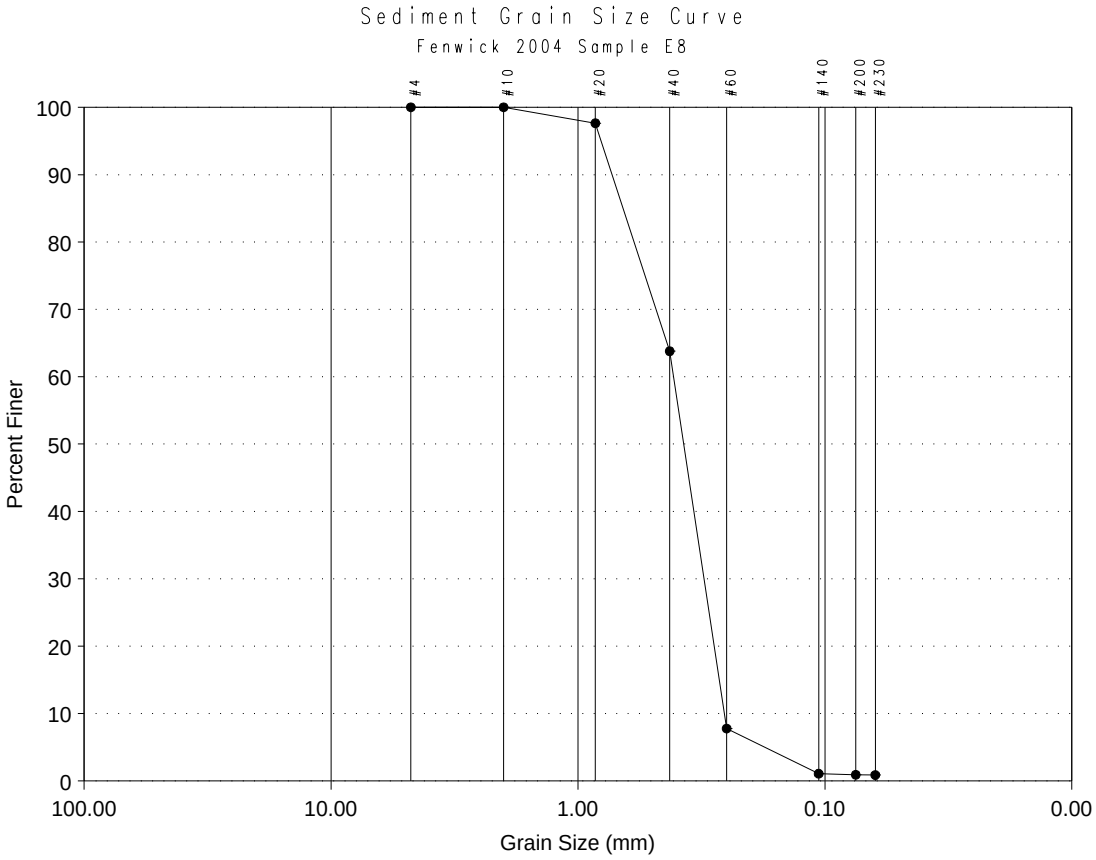
0.00
Grain Size (mm)


Sediment Grain Size Curve
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80
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10
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Percent Finer
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1.00
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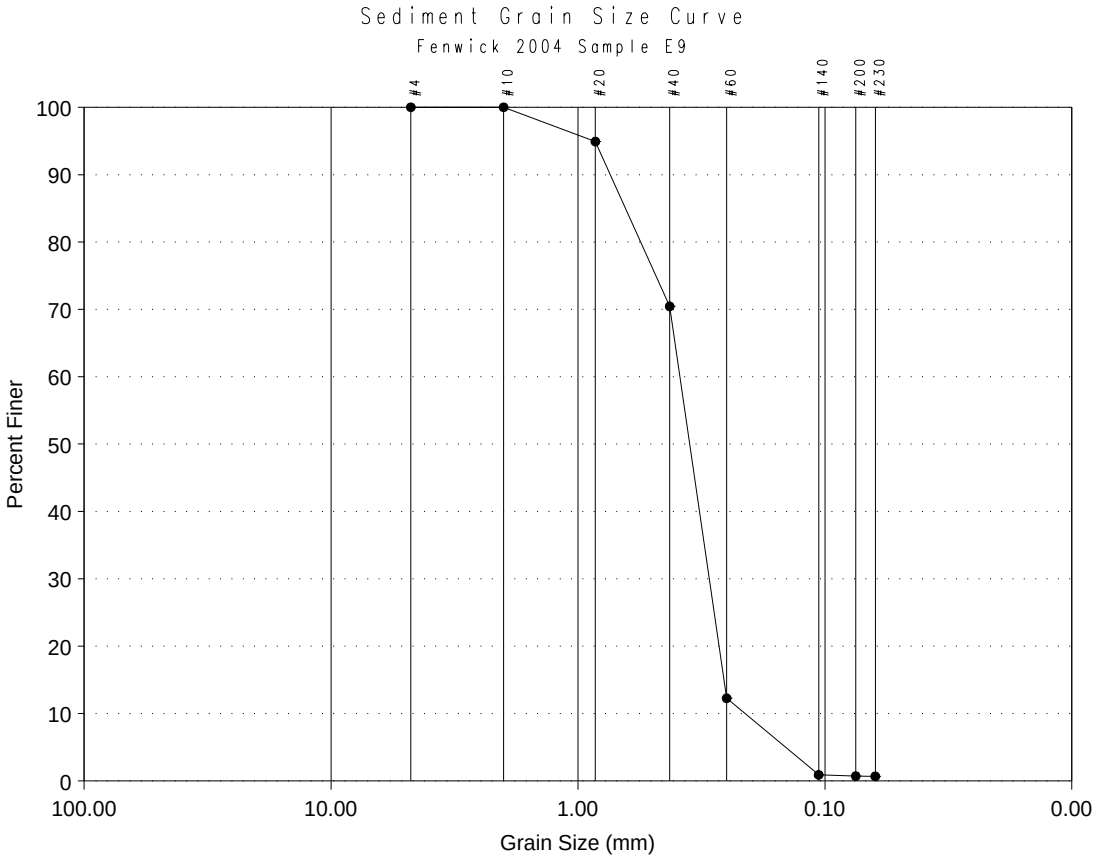
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample E9
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#200
#230
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90
80
70
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50
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30
20
10
0
Percent Finer
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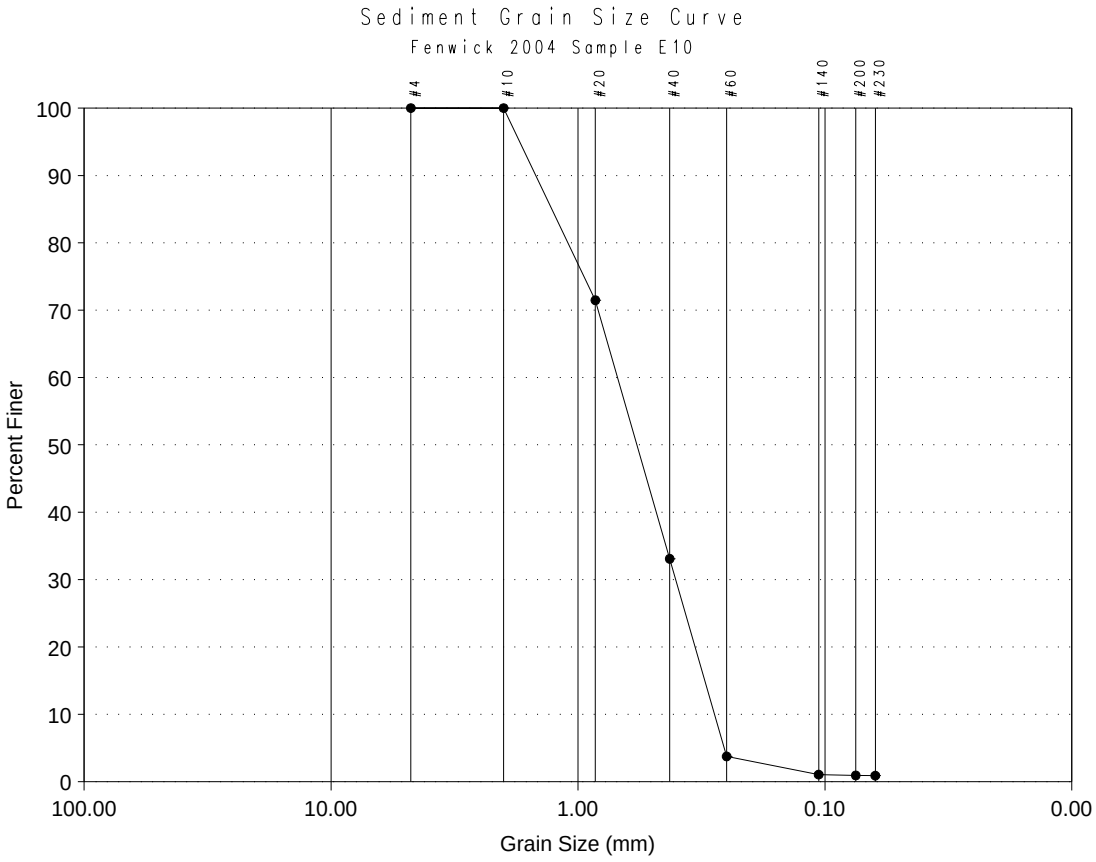
10.00
1.00
0.10
0.00
Grain Size (mm)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80
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20
10
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Percent Finer
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1.00
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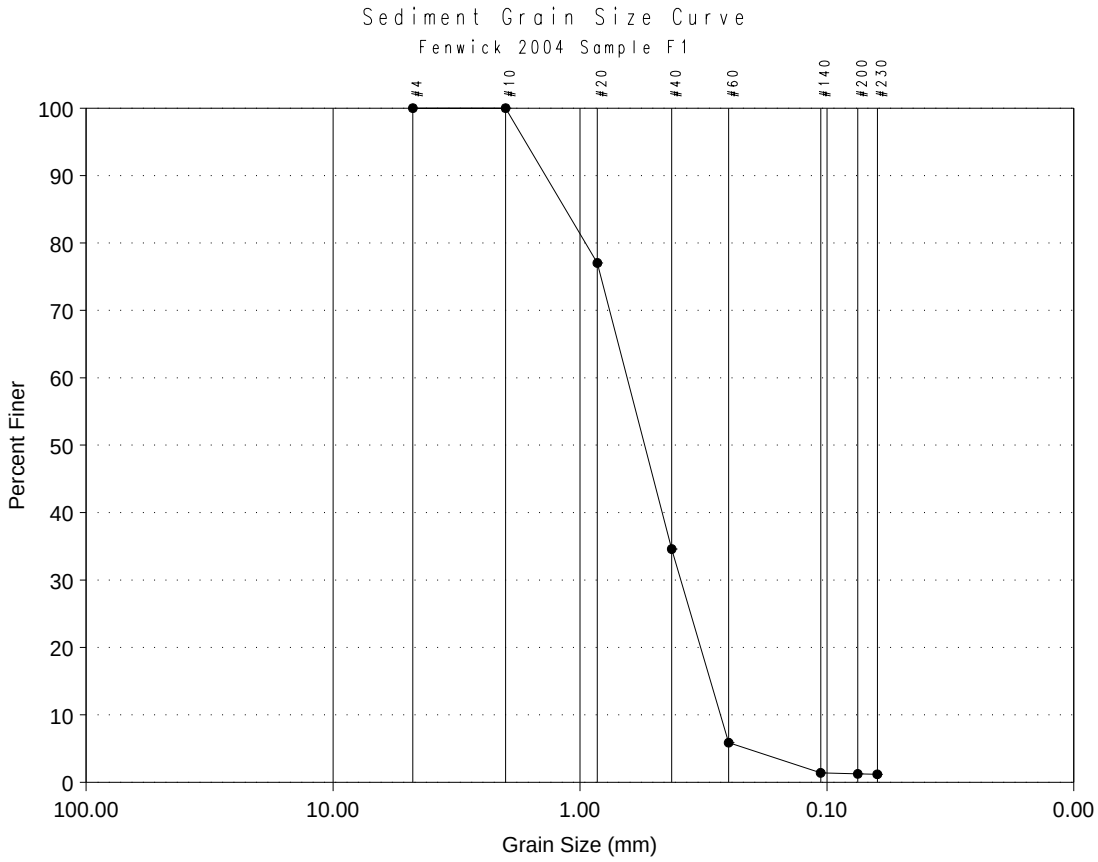
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F1
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#60
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#200
#230
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80
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50
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30
20
10
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Percent Finer
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1.00
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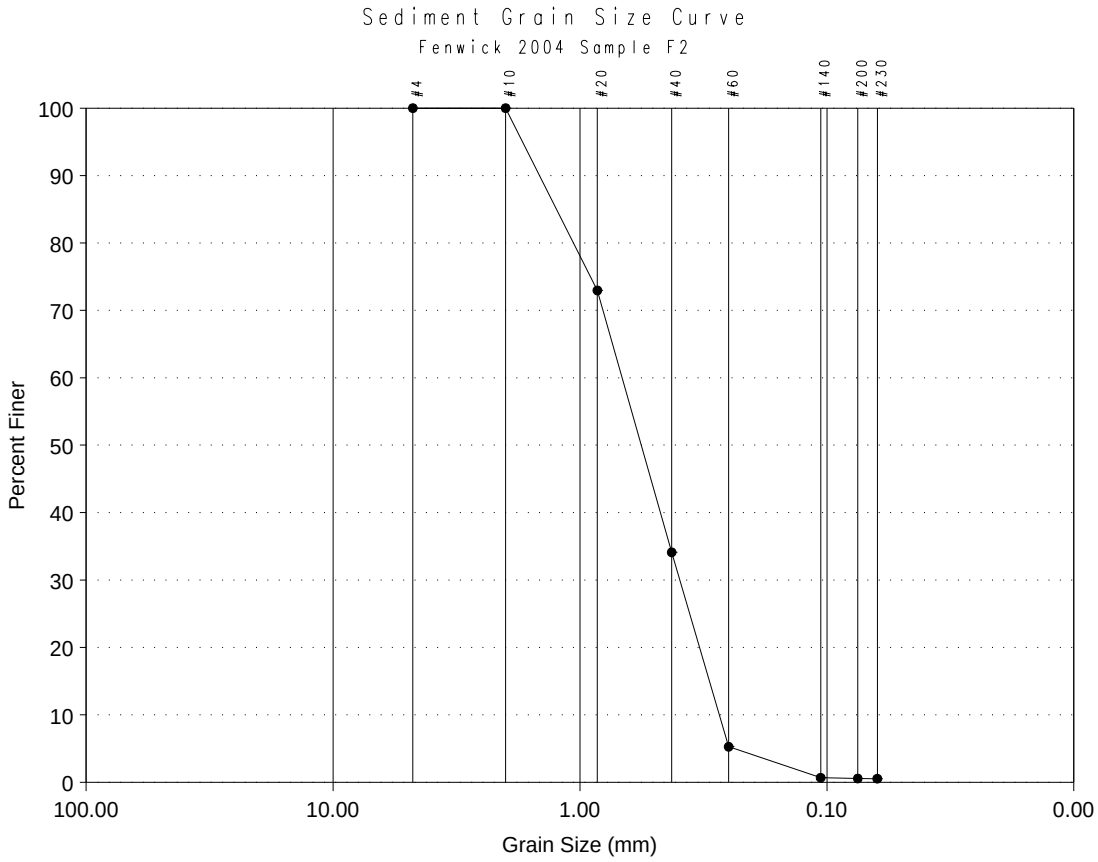
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F2
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#60
#140
#200
#230
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90
80
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50
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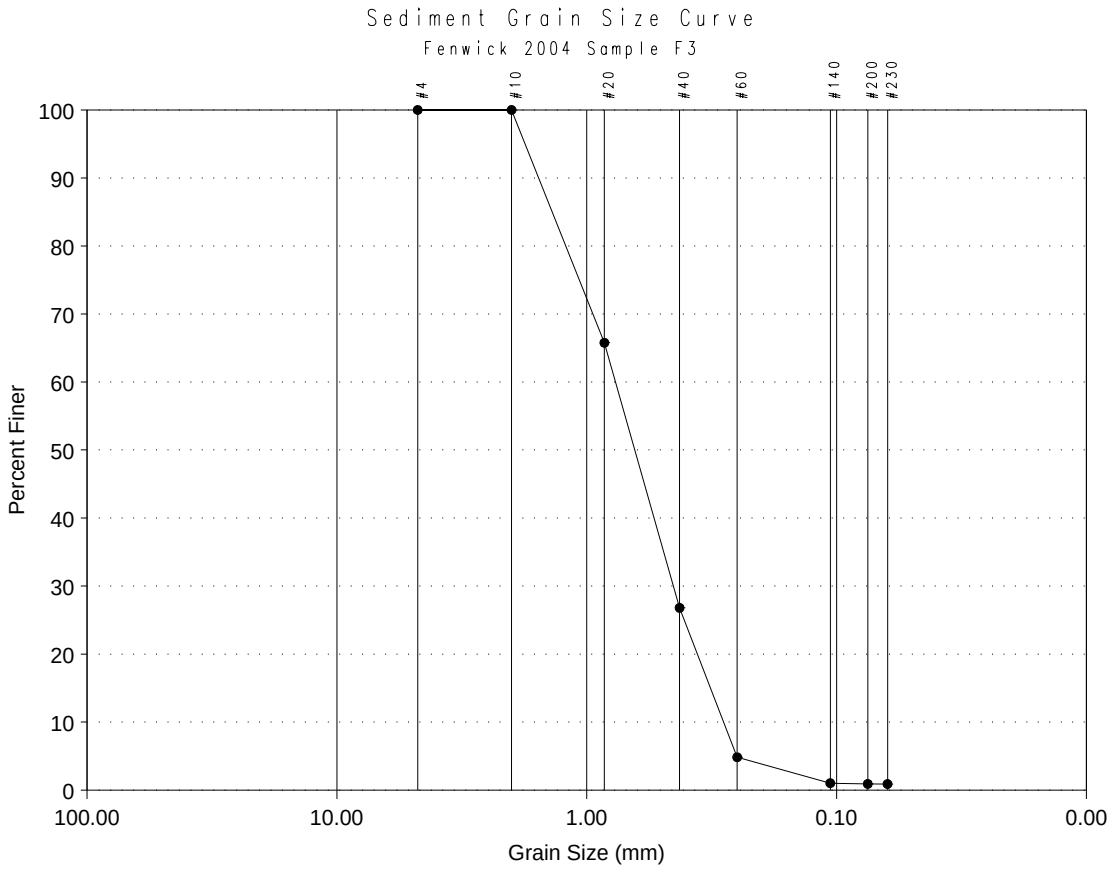
30
20
10
0
Percent Finer
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
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#60
#140
#200
#230
100
90
80
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50
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30
20
10
0
Percent Finer
100.00
10.00
1.00
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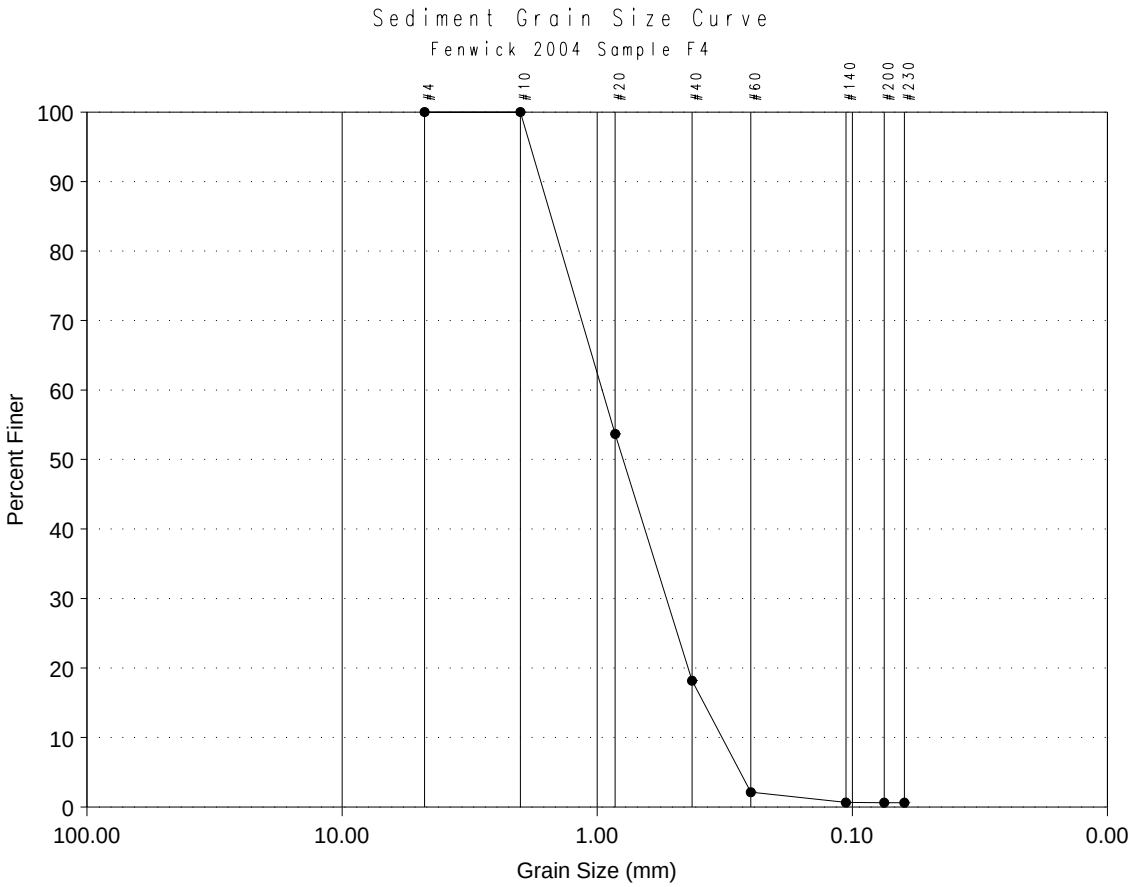
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F4
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#140
#200
#230
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80
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Percent Finer
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1.00
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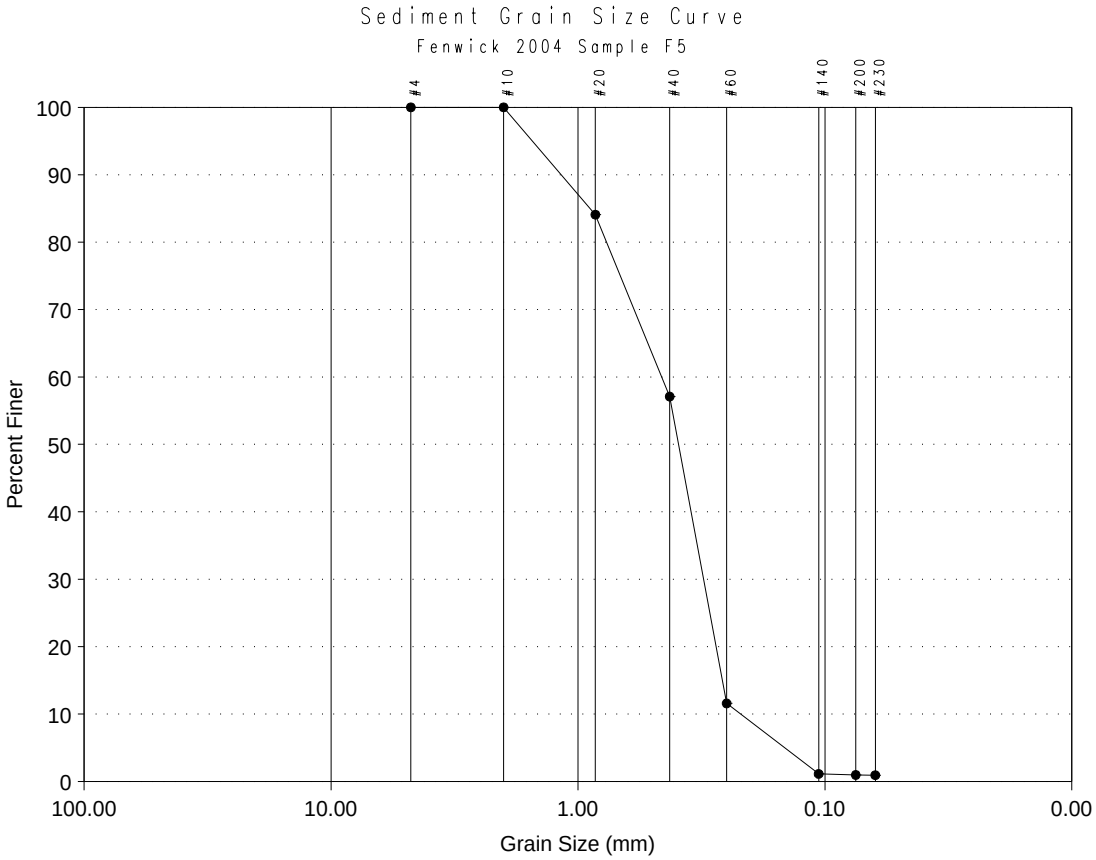
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F5
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#200
#230
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80
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20
10
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Percent Finer
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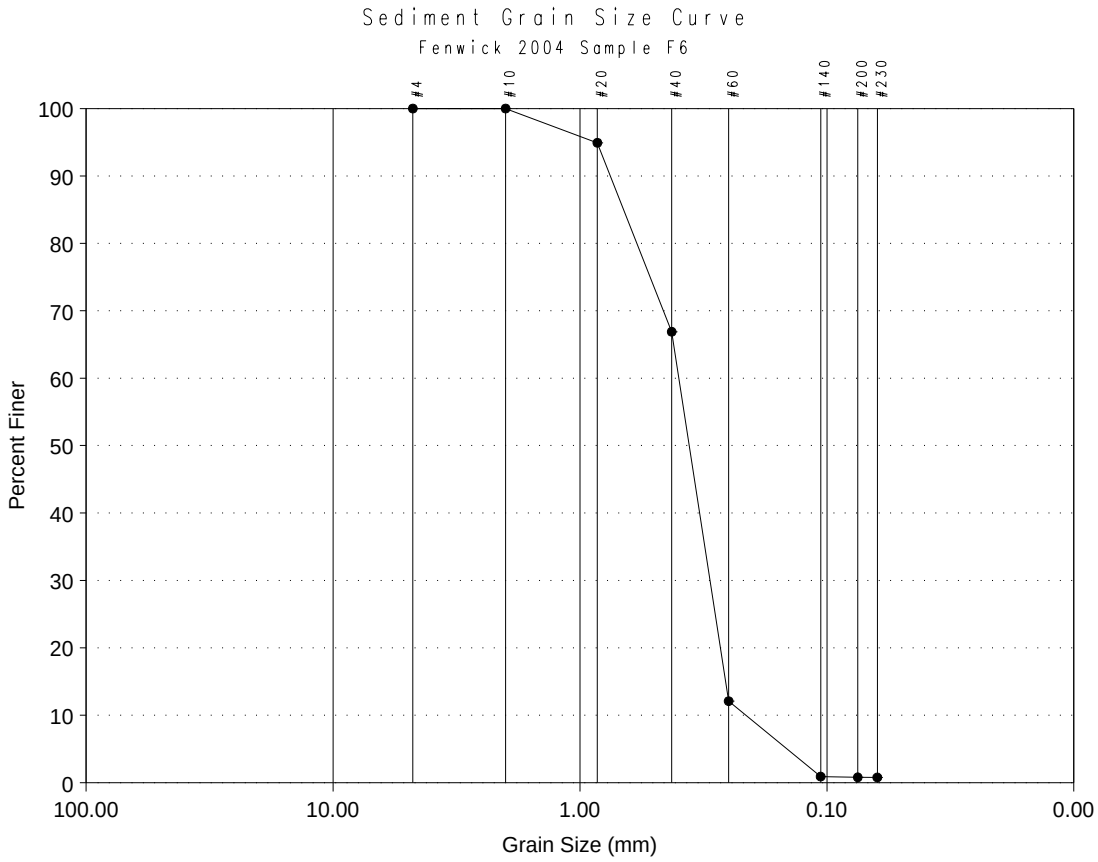
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F6
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#60
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90
80
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30
20
10
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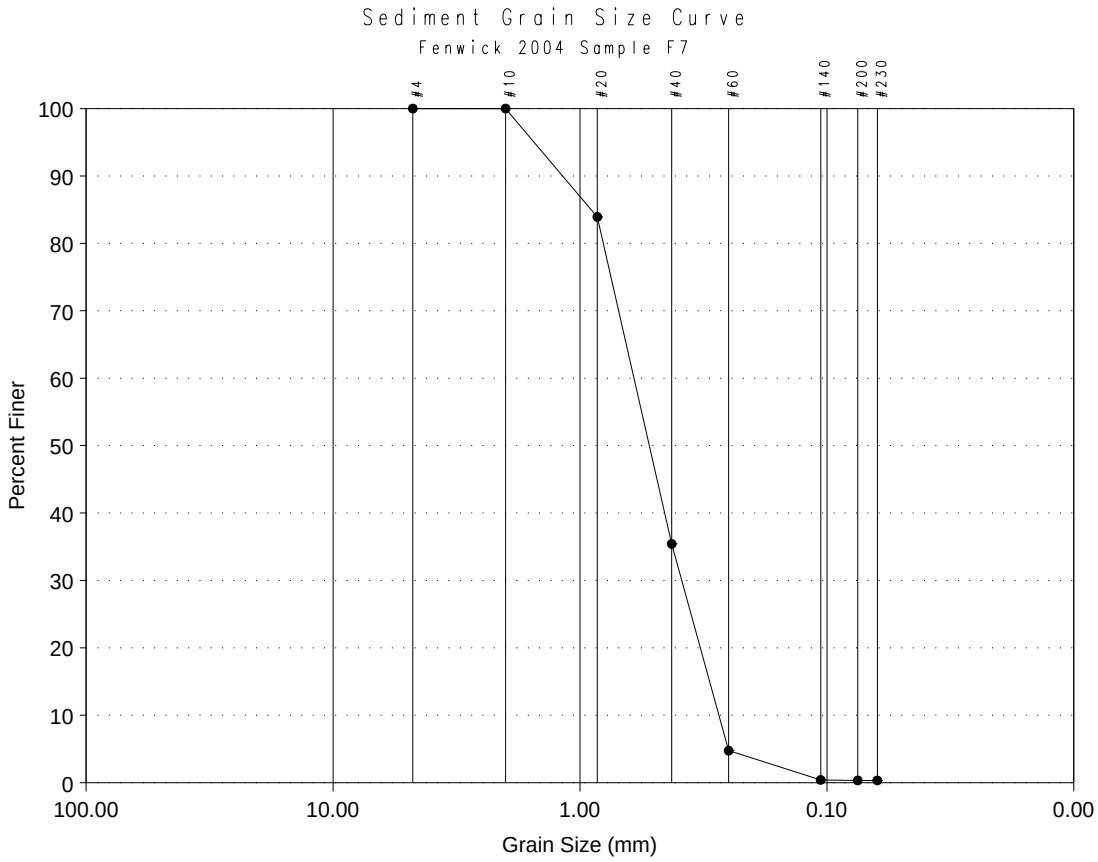
Percent Finer
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F7
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#40
#60
#140
#200
#230
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80
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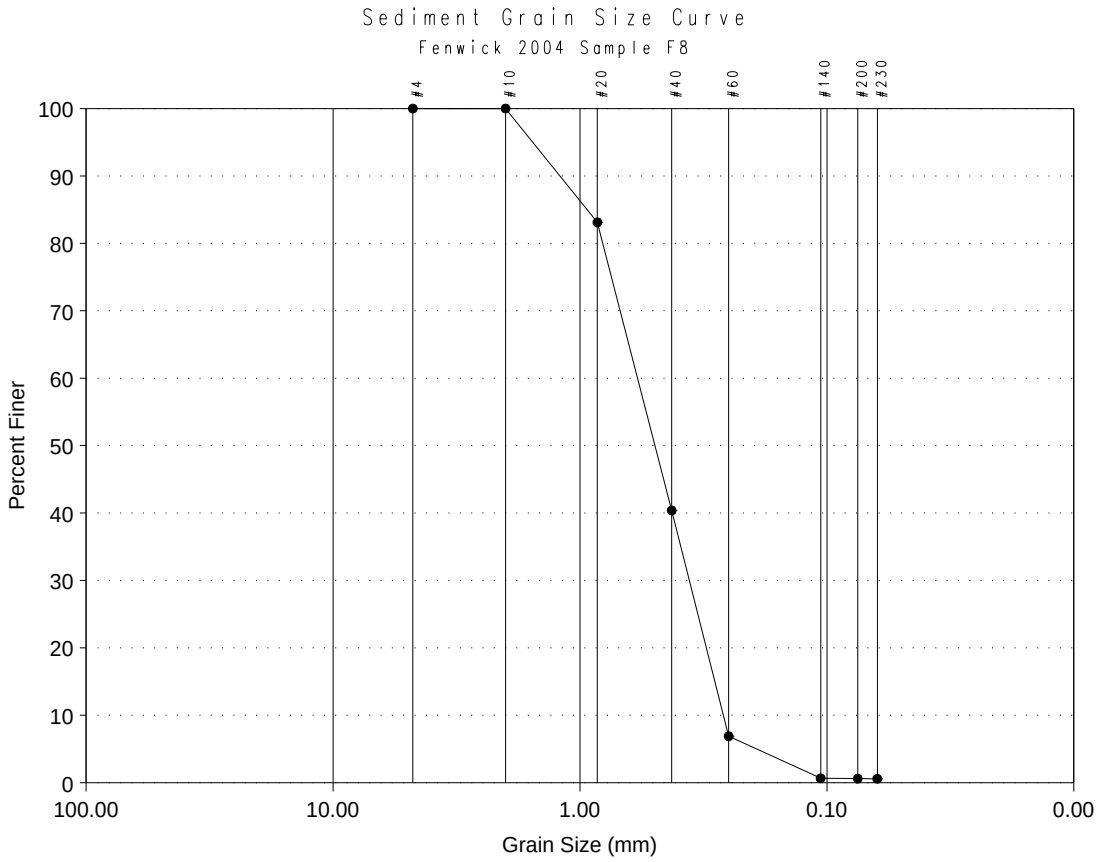
20
10
0
Percent Finer
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F8
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#60
#140
#200
#230
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80
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30
20
10
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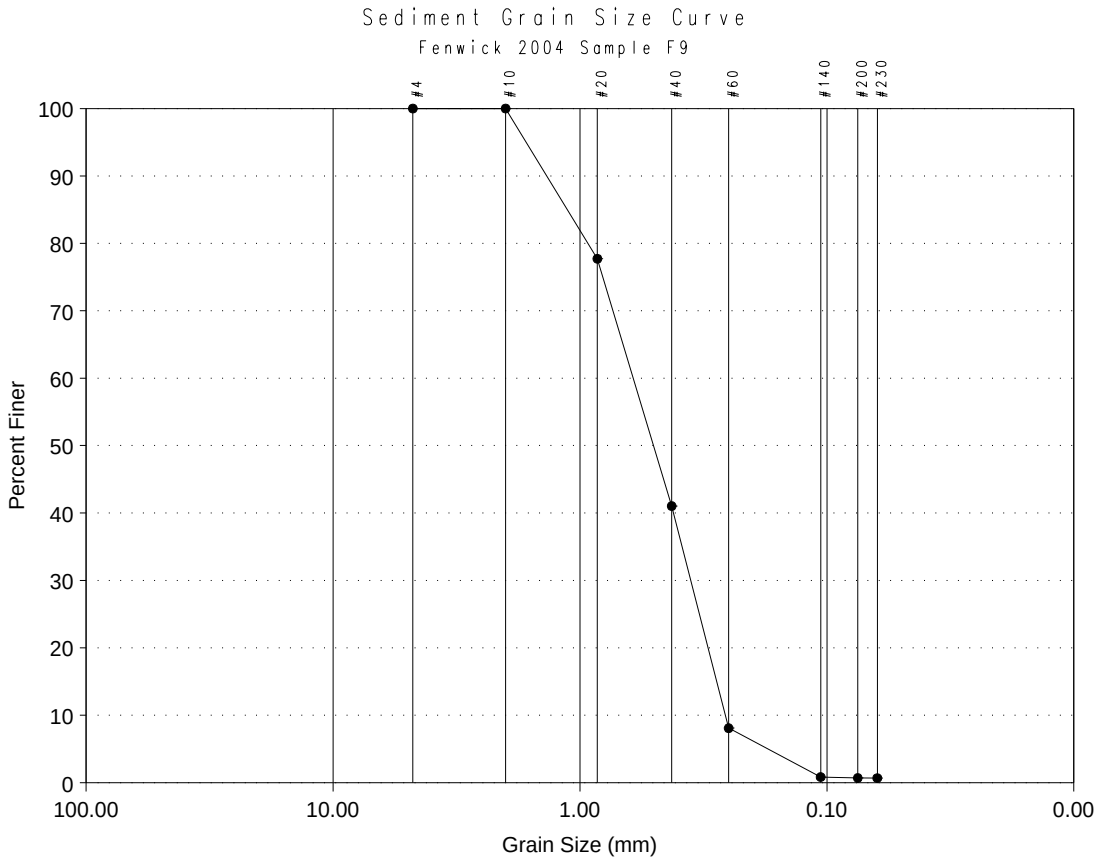
Percent Finer
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
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#230
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80
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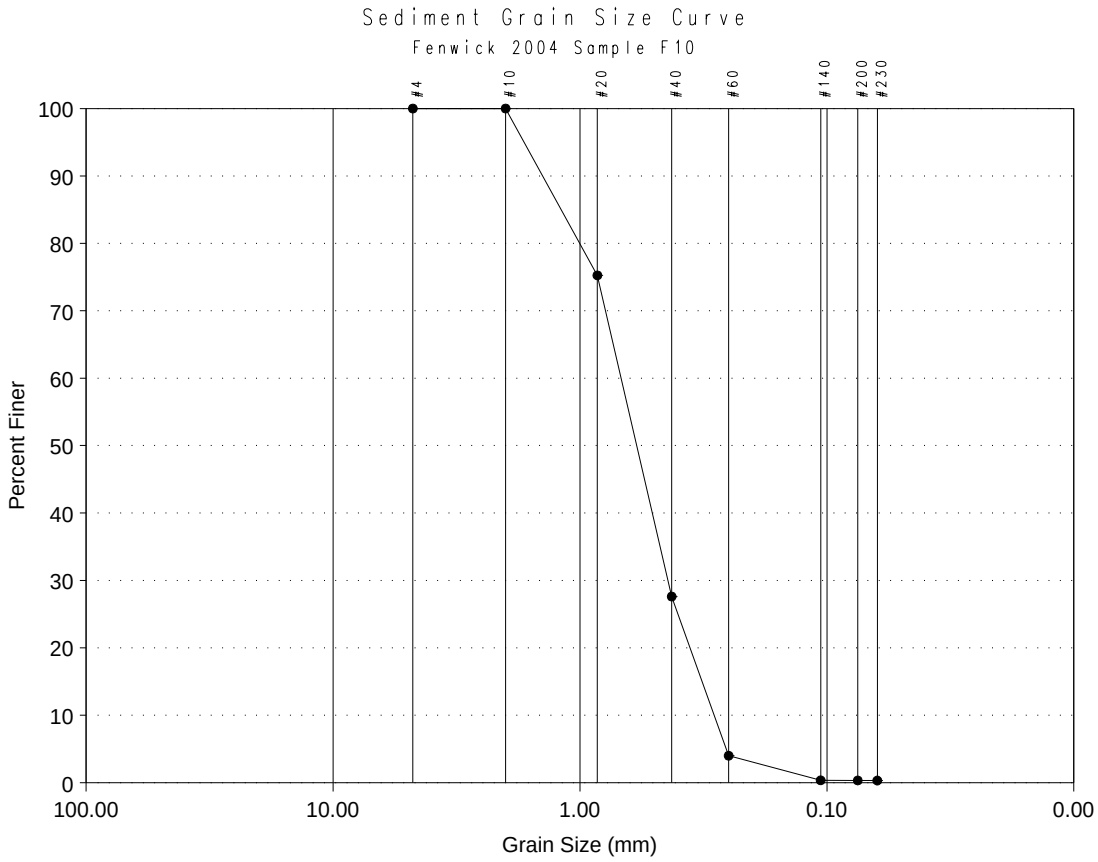
30
20
10
0
Percent Finer
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F10
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Percent Finer
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1.00
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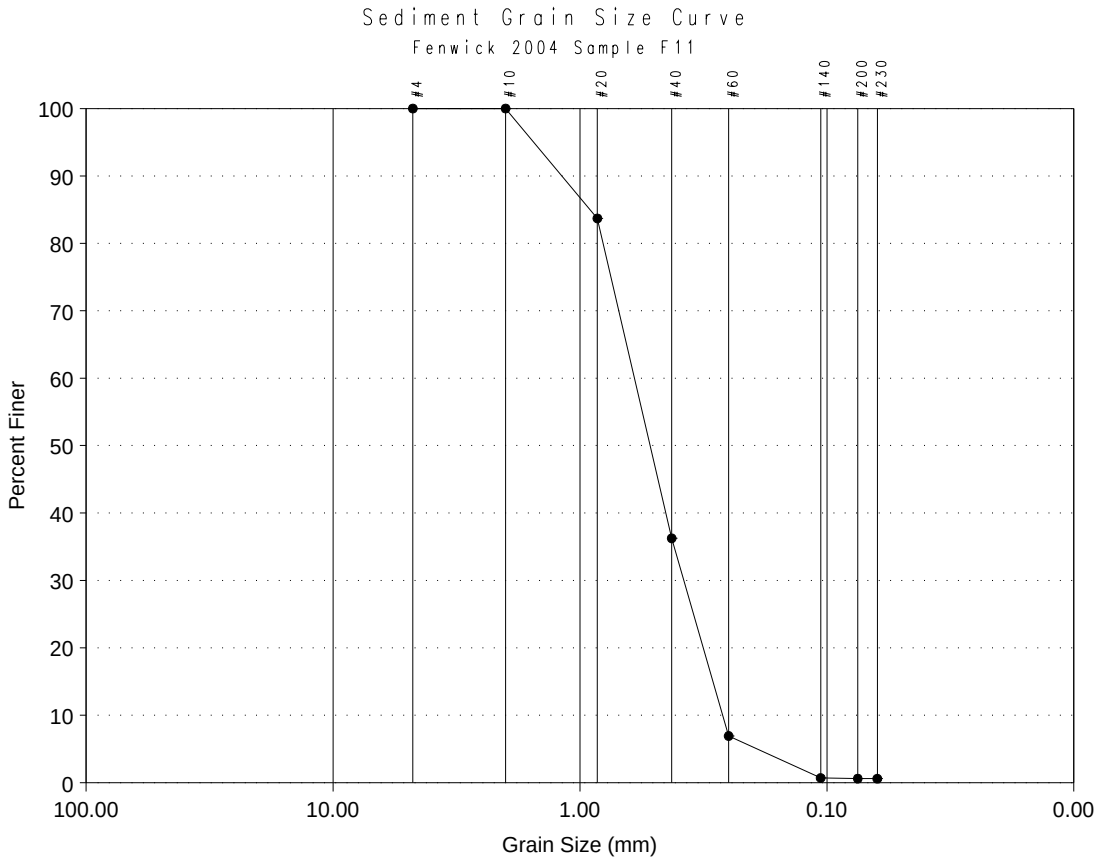
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F11
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80
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20
10
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Percent Finer
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1.00
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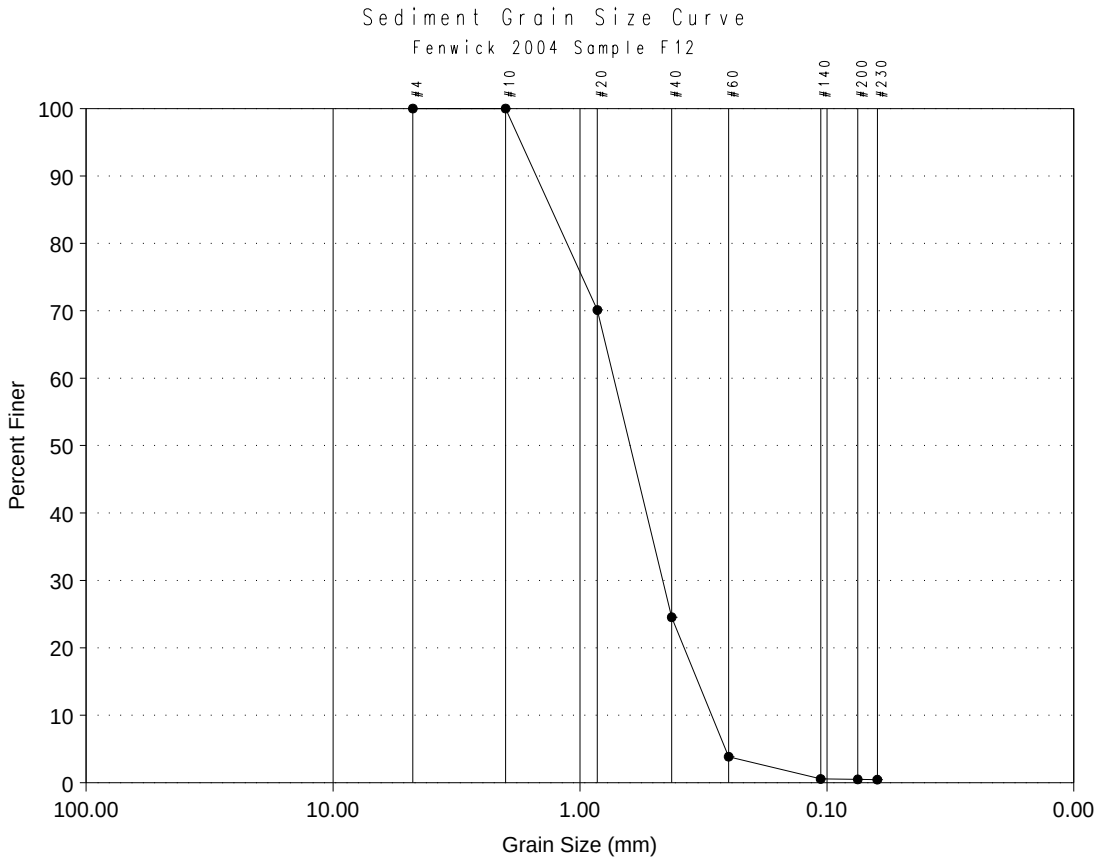
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F12
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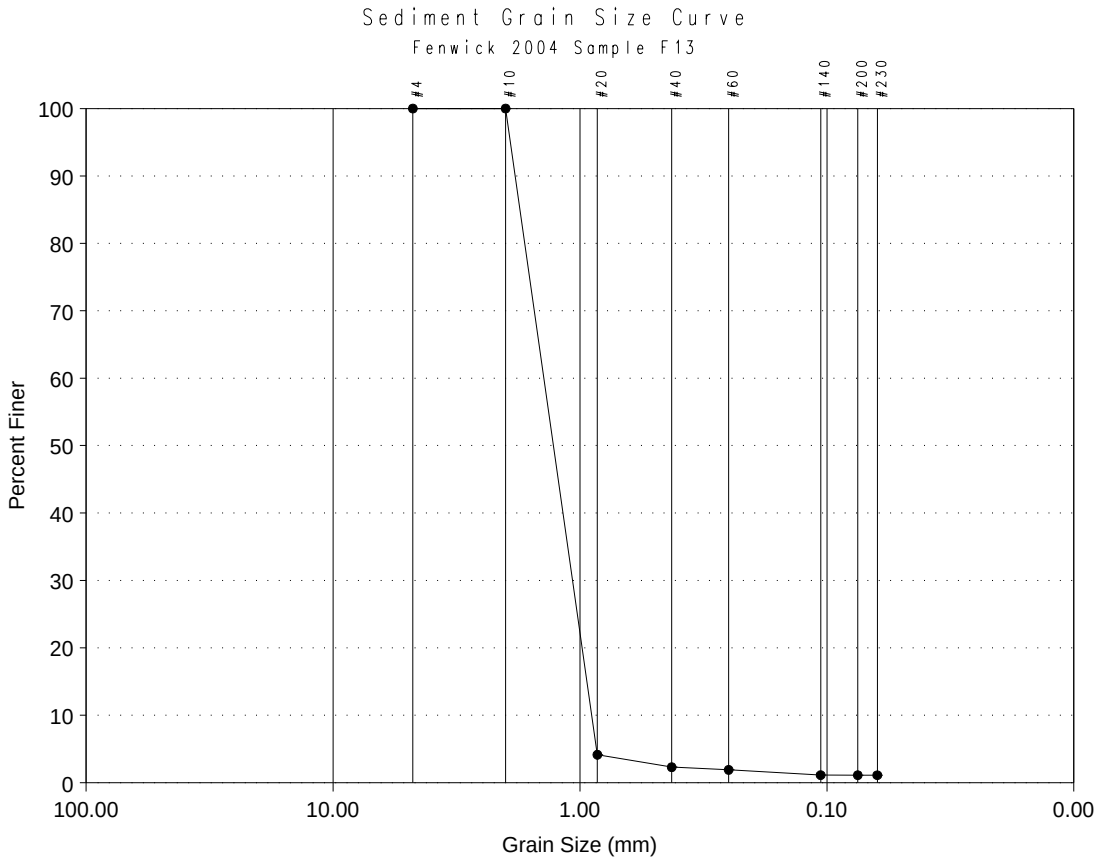
30
20
10
0
Percent Finer
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F13
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20
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Percent Finer
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1.00
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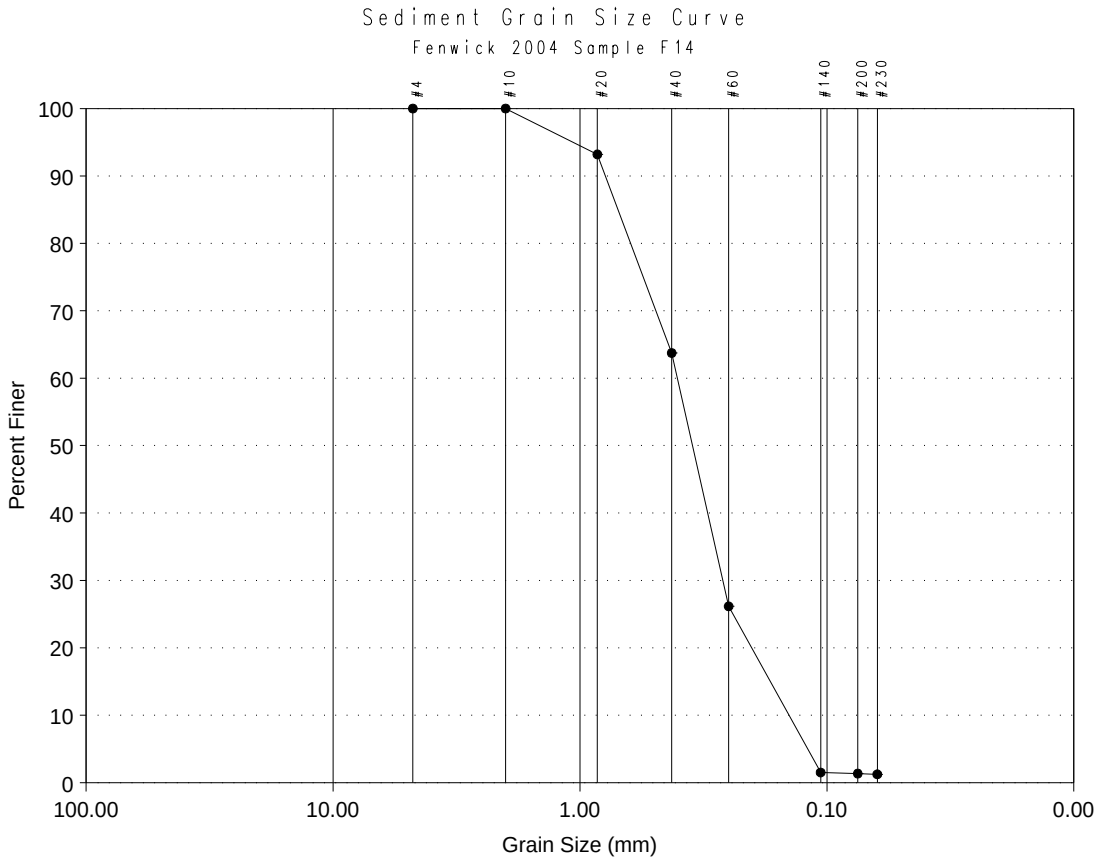
0.00
Grain Size (mm)


Sediment Grain Size Curve
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Percent Finer
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1.00
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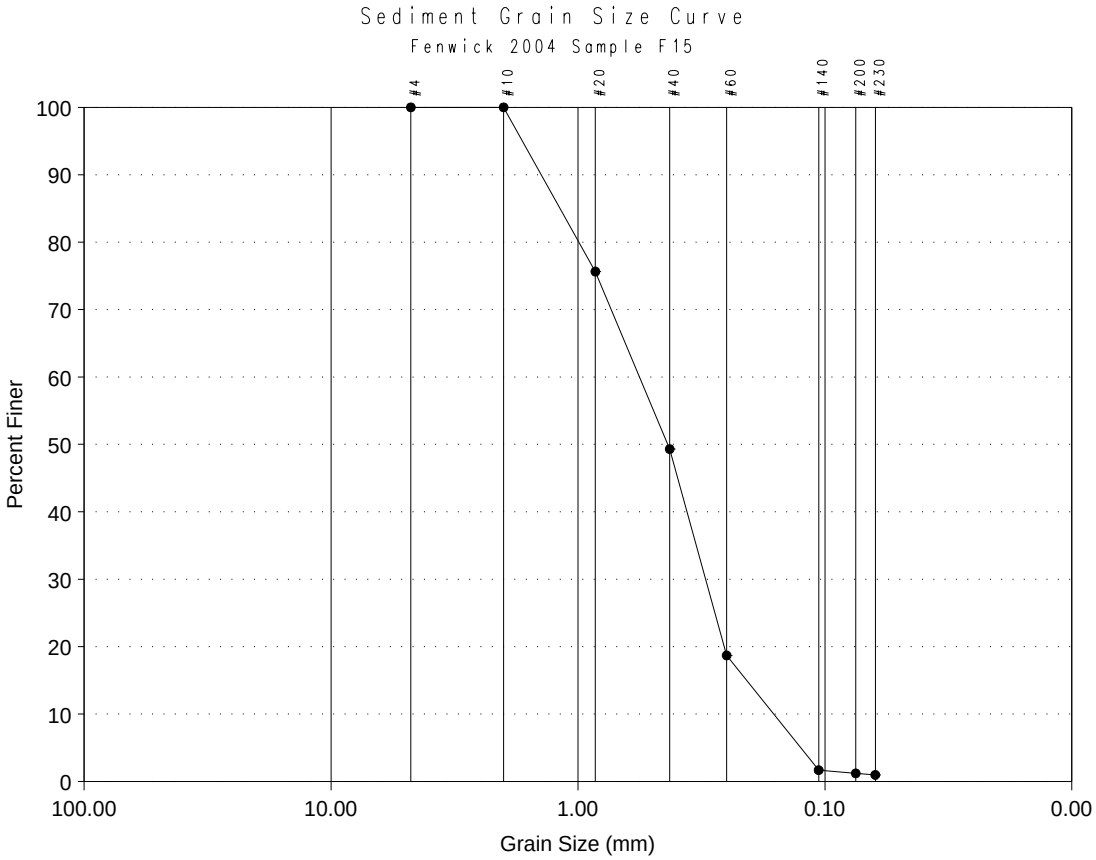
0.00
Grain Size (mm)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20
10
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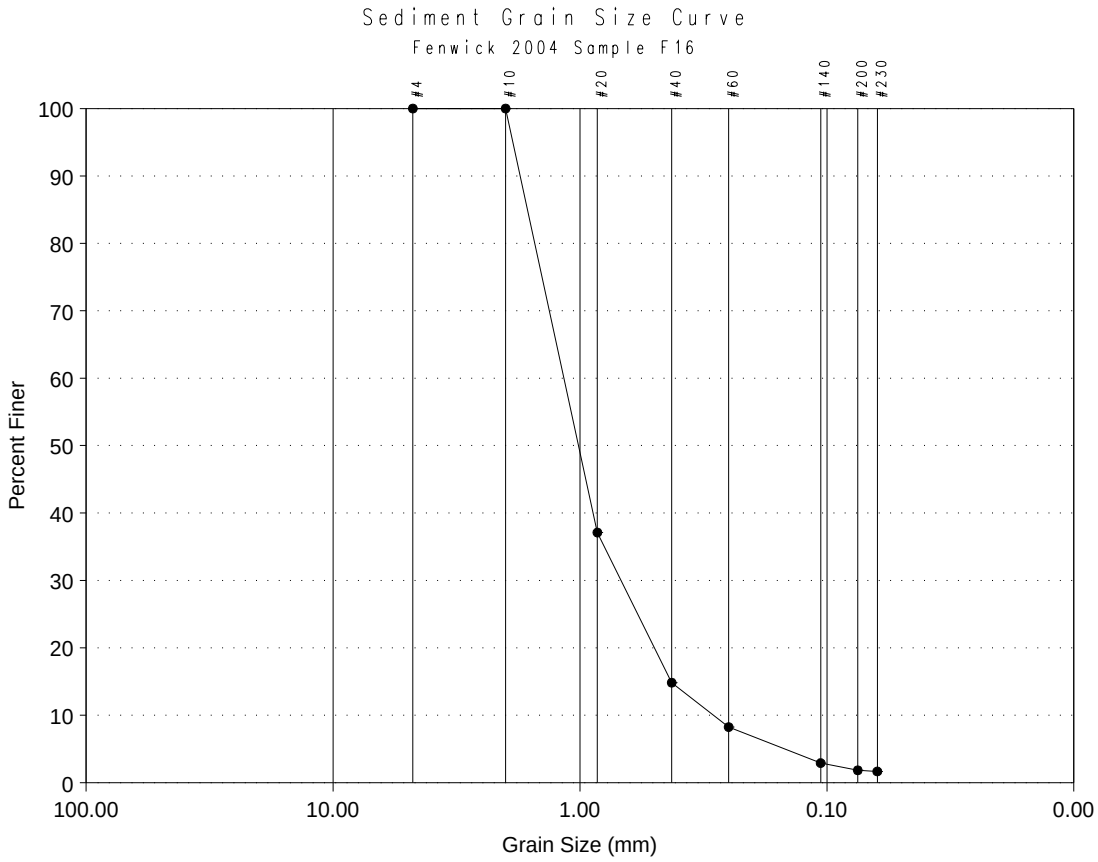
Percent Finer
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F16
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#200
#230
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80
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10
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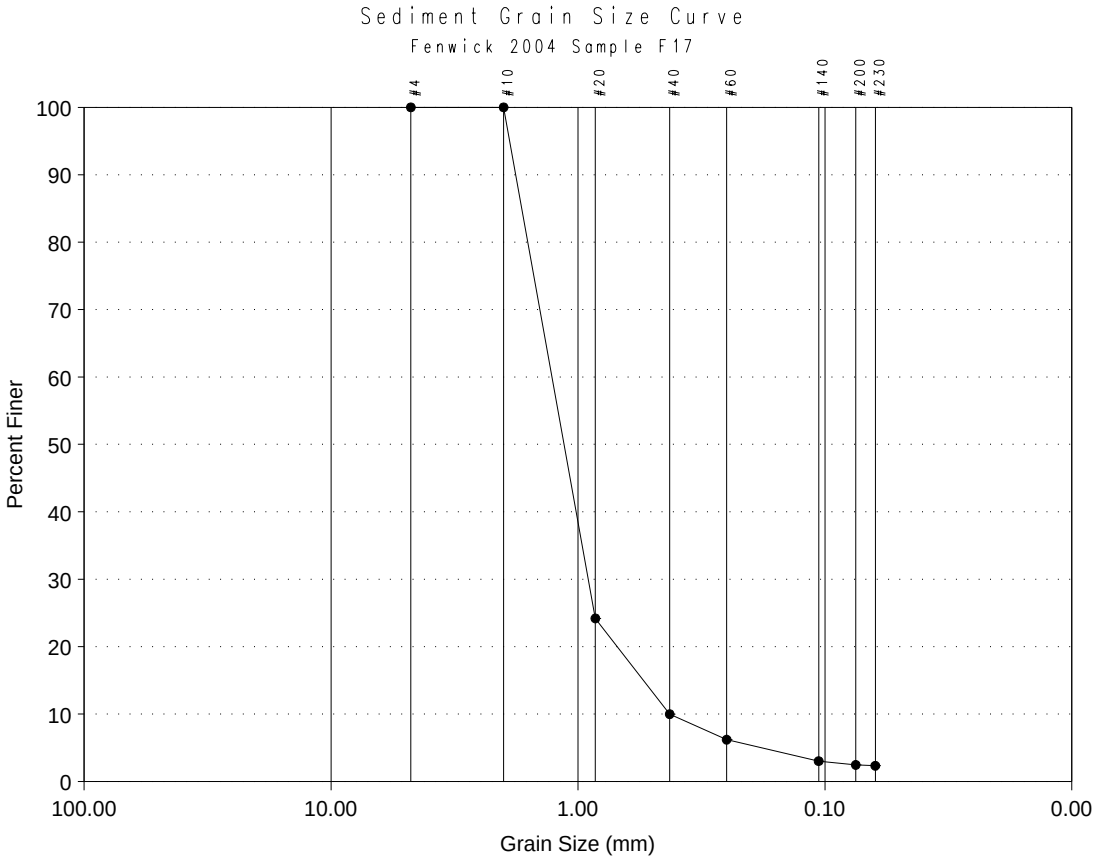
Percent Finer
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F17
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Percent Finer
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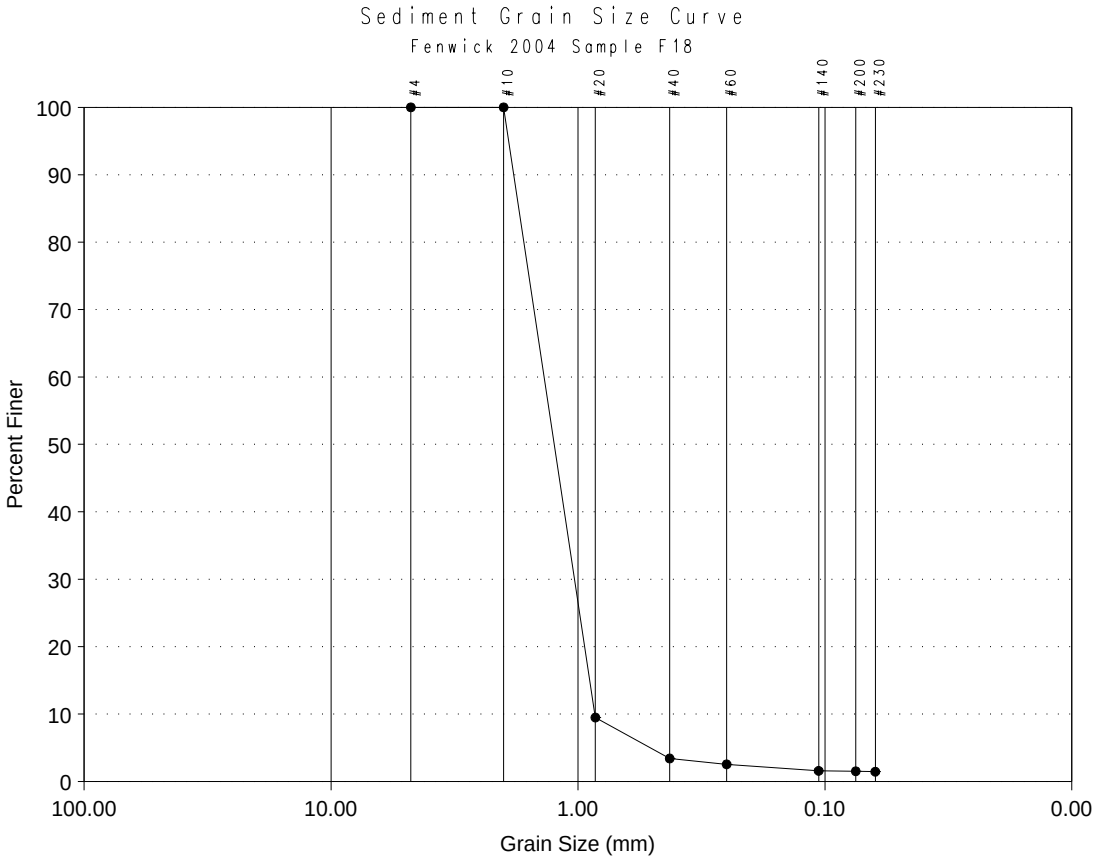
10.00
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
Fenwick 2004 Sample F18
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#230
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80
70
60
50
40
30
20
10
0
Percent Finer
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)