DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Channel Dredging
Appendix S

U.S. Army Corps of Engineers, Philadelphia District

APPENDIX S

NEW DREDGING PROJECTS

1. **CLASSIFICATION OF CREEK TO BE DREDGED**: Non applicable. The water body to be dredged is the existing Federal Navigation Channel in Delaware River/Bay that is maintained by the Corps of Engineers.

2. **SITE LOCATION OF DREDGING PROJECT: Locate the project site with respect to the county, creek, tributary.** Refer to Figure 3 in the attached Fact Sheet attached to the basic application. Also, see Plates 2, 3, 4, 24, and 25 of the SEIS (July 1997).

3. **DESCRIPTION OF DREDGING PROJECT: Describe the proposed project including the equipment to be used, quantity of material to be dredged, extent of the area to be dredged, place and method of disposal, etc. Detail is important.** Refer to Fact Sheet that is attached to the basic application for a description of the project and to Sections 3.0, 6.0, and 10.4.2.1 of the SEIS (July 1997).

4. **PURPOSE OF PROPOSED DREDGING PROJECT:**
   Define the purpose and need of the proposed dredging project. Who will benefit? See Section 2.0 of the SEIS (July 1997). Refer to attached Fact Sheet to the basic application.

   Submit color photos of site and bordering upland with explanation of the views shown (prints only). Using power point, color photos of traffic movements (oil tanker and barge) that use the existing 40-foot Delaware River Navigation Channel confined upland disposal areas (Reedy Point North and South, Killcohook, Artificial Island, Kelly Island Project Wetland Restoration and Beach Sites are attached.

   How often will maintenance dredging be required? Annual maintenance in the Delaware River portion and every two to four years in the Delaware Bay portion of the project.

5. **ENVIRONMENTAL CONSIDERATIONS OF THE DREDGING PROJECT**
   A sediment analysis must be performed in accordance with the attached sampling plan. A sediment analysis is included in Section 4.0 of the SEIS (July 1997).

6. **CHARACTERIZE THE SUBSTRATE TO BE DREDGED**

   A. **What is the chemical composition of the material to be dredged? Does the substrate contain organic or inorganic pollutants in relation to known clean bay sediments of similar composition?** See Section 4.0 of the SEIS (July 1997). A total of 86 sediment cores were collected within channel and bend widening locations that would be dredged during project construction. These cores were divided into 153 separate samples based on sediment stratification, or in some cases depth. All samples were tested using bulk analysis procedures. Heavy metals were found to be widely distributed throughout the project area. Organic contaminants including PCBs, pesticides, PAHs and phthalates were also detected in some samples. The complete data set has been provided to Mr. Richard Greene of the DNREC. In an independent technical review of the complete data set, Mr. Greene made the following general conclusions:

- Overall, the level of contamination in the main channel and bends is low to moderate, with much higher levels in the shallows.
- Concentrations of most contaminants are highest near the mouth of the Schuylkill River and just north of Pea Patch Island.
- Concentrations of metals are not likely to exceed their respective water quality criteria at 200 feet from the point of excavation provided that suspended sediment is kept below 250 mg/L.
- Reach E (Delaware Bay) sediments are suitable for "beneficial use".

Section 4.4 of the SEIS (July 1997) provides a discussion of the biological effects based testing that has been conducted. Testing includes water column and whole sediment bioassays, and bioaccumulation tests. Section 4.3 of the SEIS (July 1997) provides sediment data using the USEPA Toxicity Characteristic Leaching Procedure (TCLP).

B. **What is the physical composition of the substrate? State percent of sand, gravel, mud, silt. Does it contain shell fragments?** See Section 5.1.3 (Tables 5-22 and 5-23 of the EIS (February 1992). In the State of Delaware, the project includes a portion of the Delaware River (Station 127+000 to 350+000) and the entire Delaware Bay (Station 350+000 to 511+000). Refer to Figure 3 in the Fact Sheet attached to the basic application.

The following is the physical composition of the material to be dredged in the river and bay portion of the project by Station in the State of Delaware.

Delaware River Portion of Project

1. Station 127+000, to Station 210+000, the material is 100% silt.
2. Station 210+000 to 226+000, the material is 100% sand.
3. Station 226+000 to 249+000, the material is 94% sand and 6% silt.
4. Station 270+000 to 300+000 the material is 100% silt.
5. Station 300+000 to 325+000 the material is 80% sand and 20% silt.
6. There is no dredging from 325+000 to 350+000.

All of the material from the above dredged areas (Station 127+000 to Station 350+000 will be placed in confined upland disposal facilities).

Delaware Bay Portion of Project

In the Delaware Bay portion of the project, Stations 350+000 and 571+000, material to be dredged will be used for beneficial uses to construct the Kelly Island Wetland Restoration and for placement at eroding beaches.

1. Station 350+000 to Station 511+000, substrate to be dredged contains in excess of 95% sandy materials.

2. In one area between Station 360+000 and 381+000, there is approximately 240,000 cubic yards of fine-grained substrate. This material will be disposed of within the Kelly Island wetland restoration.

There are no measurable quantities of shells in the material. See Figure 3 in the Fact Sheet attached to the basic application and attached Bathymetry Maps for Station locations.

7. **CHARACTERIZE THE UNDERLYING SUBSTRATE TO BE EXPOSED BY THE PROJECT**

Is the underlying substrate (material at proposed dredging depth) of similar physical composition and chemical quality as material to be dredged? __X__ Yes _____ No

8. **Project the expected turbidity levels and area of effect (extent of plume) based o the percent of silt, sand, and gravel in the dredged material.**

The U.S. Army Corps of Engineers' Improvement of Operations and Maintenance Techniques Research Program has documented suspended sediment concentrations from cutterhead and hopper dredges without overflow to be in the range of 25-250 mg/L within 100 feet of the point of excavation. These turbidity levels are expected to occur within these limits during the dredging of deepening project.

9. **CHARACTERIZE THE BIOLOGICAL COMMUNITY**

A. **Is the area used as a nursery/spawning area for shellfish and/or finfish?** See attached document titled "Delaware River Main Channel Deepening Project Essential Fish Habitat Evaluation", dated 10 May 2000.

B. **What are the major benthic (bottom dwelling) species found at the area to be dredged?** See Section 4.3.4 of the EIS (February 1992) and Section 8.0 of the SEIS (July 1997). In addition, the Philadelphia District will conduct a study on the distribution of over-wintering female blue crabs in the Federal navigation channel in lower Delaware Bay and adjacent areas in the winter of 2000 -2001.

C. **Is there submerged aquatic vegetation present at or near the project site?** No.

10. **CHARACTERIZE THE EXISTING WATER QUALITY**

A. **Determine the classification of the stream according to state water quality criteria. Will the dredging project cause violations of the water quality criteria? Will designated water uses be affected?** See Sections 4.2.5 and 5.13 of the EIS (February, 1992) and Section 4.0 of the SEIS (July 1997). Using equilibrium partitioning equations, Mr. Richard Greene of the DNREC concluded that water quality criteria would not be violated within 200 feet of the point of dredging provided that suspended sediment concentrations are kept below 250 mg/L. The U.S. Army Corps of Engineers' Improvement of Operations and Maintenance Techniques Research Program has documented suspended sediment concentrations from cutterhead and hopper dredges without overflow to be in the range of 25-250 mg/L within 100 feet of the point of excavation. A distance of 200 feet was selected because it corresponds to the Delaware Basin Commission mixing zone criterion of five times the depth of water.

B. **Determine levels of dissolved oxygen (D.O.) in and around the project area. Measure D.O. at the water/substrate interface during worst-case conditions (i.e. summer morning).** Dissolved oxygen concentrations are variable within the project area (i.e. Philadelphia, PA to Delaware Bay). The following information is from: *Delaware River and Bay Water Quality Assessment 1996-1997 305(b) Report*. Delaware River Basin Commission, West Trenton, New Jersey. August 1998.

For Zone 3, dissolved oxygen levels recorded during all the boat-run sampling events exceeded 3.5 mg/L, which is the minimum standard based on a 24-hour average; however, the automatic monitor at the end of Pier 12 (Ben Franklin Bridge) recorded 16 days during the summer of 1996 when the daily mean was less than 3.5. Values as low as 2.9 mg/L (two occasions) were recorded as daily means. There were no violations of the oxygen standard recorded by the automatic monitor in 1997 (or in 1994 and 1995).

For Zone 5, individual values of dissolved oxygen from the boat-run collections were below 6.0 mg/L, which is the minimum dissolved oxygen standard based on a 24-hour average concentration, for 27 percent of the samples. The lowest value recorded was 2.9 mg/L at Pea Patch Island. At the USGS continuous monitor at Reedy Island, daily mean levels of dissolved oxygen were below 6.0 mg/L on 15 days in 1996 and 25 days in 1997. The lowest recorded daily mean levels were 5.4 mg/L and 5.1 mg/L, respectively. The lowest minimum daily level recorded was 4.5 mg/L.

For Zone 6, 21 percent of the samples at Port Mahon and 13 percent at Ship John Light were less than the minimum (at any time) 5.0 mg/L standard for this Zone. The lowest value recorded was 4.1 mg/L at Ship John Light. By comparison, in 1994-1995, only one sample was below 5.0, and that was 4.9 at Port Mahon.

11. IMPACT TO THE BOTTOM CONTOURS OF THE BAY OR CREEK

A. **What is proposed dredging depth in relation to surrounding bathymetry? Provide map showing surrounding depths.** Existing depths of the Delaware River in areas requiring new work dredging are in the range of 40 feet to 46 feet below MLLW. Adjacent areas beyond the channel limits are also in the depth range of 40 to 46 feet, subject to the dredging location considered. A series of bathymetry "maps" are included to facilitate the discussion of depth in and adjacent to the Delaware River Federal Channel.

B. Will the project change flow or circulation patterns in the bay or creek? Will shoalings patterns be altered? Three-dimensional numerical hydrodynamic/salinity modeling of the proposed channel deepening indicates that at some locations, and under some circumstances, flow distribution will change when compared to existing conditions. Detailed graphic and tabular results of this comparison are presented in Section 5.11 of the Supplemental Environmental Impact Statement (July, 1997). These data show that during normal to high flow periods with the deepened channel, oyster bed areas in the lower bay will experience small increases in salinity due to steeper longitudinal salinity gradients that accompany high flow conditions. During drought conditions, the predicted upstream movement in salinity due to deepening would be significantly less than the seasonal changes in salinity distribution resulting from normal variations in river flow. The highest salinities would occur in October and November when significant biological functions such as spawning and nursery activities and plant growth do not occur. The impact of those increases on oyster production is viewed as negligible. In the Supplemental Environmental Impact Statement for the project dated July 1997, the Corps concluded (based on modeling by its widely respected Waterways Experiment Station) that the maximum change in salinity over Delaware Bay oyster beds would be 0.3 parts per thousand. According to Dr. Eric Powell of Rutgers University, a nationally recognized expert on oyster ecology, any change up to 1 part per thousand will have no impact on oysters. Changes in the subtidal circulation over the oyster beds due to channel deepening will also be minimal, e.g., less than 1 cm/sec. Impacts that may occur to other environmental resources are also considered to be insignificant.

Although findings from the salinity model concluded that the range of salinity changes predicted by the model as well as changes in circulation, would pose no adverse impact on oyster resources, in an "Acknowledgement" with the New Jersey Department of Environmental Protection, the Philadelphia District agreed to further evaluate the effects of potential salinity changes on oyster populations due to the deepening project, as well as develop and implement a monitoring plan to assess the long term effects of the habitat development projects to the oyster beds. The purpose of the study is to examine the health and productivity of oyster populations on the natural seed beds in the Delaware Bay to attempt to determine if the project significantly impacted the oyster resources. The study, which began with the collection of pre-construction data in the spring of 2000 will continue during construction and following construction to ensure the Delaware Bay's oyster population is protected.

No significant changes in the distribution of shoaling are expected to accompany the deepening.

12. IMPACT TO SURROUNDING LANDS

What is the proximity of the dredging project to the nearest creek bank or banks? What are the existing land uses along this bank(s)? What is the primary vegetation? The dredging project covers the entire Federal Navigation Channel from Philadelphia to the mouth of the Delaware Bay, over 100 miles. From the Pennsylvania – Delaware line to Wilmington Harbor, the channel is from approximately 650 feet to approximately 2,600 feet from the Delaware shoreline. This portion of the river is highly developed and much of the shore has bank protection. From Wilmington to Pea Patch Island, the Federal Navigation Channel is from approximately 650 feet to over 1 mile from the shore. Between Wilmington Harbor and Pea Patch Island, the shoreline is less developed with some tidal flats and some channelized wetlands dominated by common reed *(Phragmites australis)*. Pea Patch Island is approximately 200 feet from the Federal Navigation Channel at the southern end. The shoreline of this portion of Pea Patch Island is in the process of being protected from further erosion with a stone breakwater, a portion of which was constructed in the winter of 1999 – 2000 (Delaware Wetlands Permits WE-075/99 and WE-278/00). Between Pea Patch Island and Cape Henlopen the shoreline of Delaware Bay is greater than one mile from the Federal Navigation Channel. The shore in this area is mostly undeveloped with tidal marsh dominated by marsh grass (*Spartina alternaflora)* some with narrow sandy beaches, much in State or Federal ownership. Much of this the shore is severely eroding (See Section 9.1.1 of the SEIS, July 1997).

13. **What measures will be taken during the dredging operation to minimize environmental impact?** The primary measure to avoid and minimize impacts during dredging on environmental resources is to observe windows for sensitive resources. These windows are attached to this application.

During dredging operations, water quality monitoring will take place at the point of excavation and at the Reedy Point confined disposal facilities to evaluate potential impacts to aquatic resources. Monitoring efforts include water quality of effluent discharged from the confined disposal facilities, water quality at the point of cutterhead dredging, and water quality in the vicinity of hopper dredging with overflow. Scopes of work for these monitoring efforts are attached to this application. The details of these scopes were discussed with Mr. Richard Greene of the DNREC during the 27 September 2000 project coordination meeting.

14. CONSIDERATIONS FOR DISPOSAL OF DREDGED MATERIALS
What are your plans for disposing of dredged material (i.e., upland disposal, wetland creation, island creation, etc.)? What alternatives have you considered?

The dredged material from the river portion of the project will be placed in existing, established, upland, confined dredged material sites that are located in State of Delaware. These sites include Reedy Point North, Reedy Point South and portions of Killcohook Areas 2 and 3, and Artificial Island Area 1 (See Figure 3 of the Fact Sheet and the attached engineering drawings of these confined upland disposal facilities). The dredged material from the Delaware Bay portion of the project will be used for beneficial uses for wetland creation and beach placement. For more detail refer to Section 3.4 of EIS (February 1992) and Sections 3.2 and 3.3 of the SEIS (July 1997). Extensive screening was conducted in selecting the upland and beneficial use placement areas. Refer to the attachment on screening of upland disposal areas. Also refer to the Fact Sheet attached to the basic application.

Since the preparation of the July 1997 SEIS, some portions of the Kelly Island Wetland Restoration project features have been refined and the sand stockpile placement sites (Broadkill and Slaughter) have been replaced with direct placement of sand to State of Delaware beaches.

a. The current Kelly Island Project design is attached in the Kelly Island Section of this permit application.

b. The sand stockpile placement sites will be replaced by 1 to 3 beach sites (constrained by availability of sand material and cost).

15. **When do you plan to conduct your dredging/disposal operation (approximate dates of operation)?** We plan to initiate in Spring/Summer of 2001

16. **Describe the characteristics and location of the proposed dredged material disposal site? What is the present use of the disposal site? Describe pipeline route if applicable.** At beach sites the material will be hopper dredged and transported to a point offshore of the beach. From that point the material will be pumped from the hopper through a pipeline, resting on the bottom, to the beach. The pipeline will land at a single point and be extended onshore over the length of the project as the fill progresses. Material will be spread on the beach by mechanical methods. The current sites are existing beaches in the State of Delaware. At Kelly Island, the sand material for construction and wetland filling will be delivered to the site in the same manner as the beaches. Once it reaches the site the pipeline will land on the shore and be extended offshore along the alignment of the containment beach. Once the containment structure has been closed, geotubes, the sluice or control structure, and groins will be installed. The area will be filled to grade with sand and silt materials and effluent controlled per requirements of water quality certificate as applicable to upland disposal of material. Presently the area is open water bordering marshland with a shoreline retreat of up to 30 feet per year.

The following established confined upland dredged material disposal sites that are located in Delaware will be used for this project: Killcohook, Areas 2 and 3 (See Plate 2 of the SEIS, July, 1997), Reedy Point North, Reedy Point South, and Artificial Island Area 1 (See Plate 3 of the SEIS, July, 1997). See Fact Sheet attached to the Basic Application for locations of these sites. Engineering drawings of these sites have been included as an attachment to this application.

In addition, dredged material will be used to restore a wetland at Kelly Island, at the mouth of the Mahon River. Kelly Island is a severely eroding shoreline that is part of the Bombay Hook National Wildlife Refuge. Details of this wetland restoration can be found in Section 3.3.3.2 of the SEIS (July, 1997). Since July 1997, minor refinements have been made to some of the features of the Kelly Island Wetland Restoration project. This refinement has been coordinated with Federal, and State regulatory agencies. See Figure 3 in the Fact Sheet that is attached to the basic application.

Dredged materials will also be placed at some of the eroding beaches listed in Item 7 of the basic application. The locations of these beaches are displayed in Figure 3 in the Fact Sheet.

17. **CHARACTERISTICS OF THE DREDGED MATERIAL**

A. **Based on sediment analysis required or other known factors, does the material contain any contaminants?** A sediment analysis is included in Section 4.0 of the SEIS (July, 1997). Also refer to item 6.A. above. A complete bulk sediment data set has been supplied to Richard Greene of the DNREC.

B. **What is the bulking factor of the material (e.g., how much will material increase in volume during dredging and disposal operation based on material composition, material water holding capacity and dredging method)?** The dredged material has been classified as either fined grained or silt and sand. The fine-grained material or silt materials have a bulking factor of 1.8 and the bulking factor for sand is 1.0. There is sufficient capacity to contain the materials to be dredged.

C. **What is the settling rate of the dredged material?** The sandy material will settle almost instantaneously. The rate of the fine-grained materials is unknown; however, the ponding of the confined upland disposal facilities will allow the material to settle out prior to returning to the Delaware River and Bay.

D. **What is the mounding ability of the material being disposed of?** The sandy materials will tend to mound, while the fine-grained materials will not.

18. CONSIDERATIONS FOR HABITAT DEVELOPMENT

Areas being considered for habitat development in the State of Delaware include Kelly Island Wetland restoration and Port Mahon beach placement site.

A. **Does similar habitat already exist in the area proposed for development?**
Wetland restoration (Kelly Island) and beach sand placement are proposed as habitat development. These are common, but eroding, habitats along the shore of Delaware Bay.

B. **What is the depth of water at mean low water?**
Existing depths over most of the Kelly Island wetland restoration site are less than 5 ft mllw. The exception is at the northern terminus of the sand containment dike, where existing depths attain 9 ft mllw. The depth at the Port Mahon sand placement site is less than 5 ft mllw.

C. **What is the salinity of water at the proposed site of development?**
The salinity varies depending on the location, tidal stage, and antecedent hydrologic conditions. Figure 5-9 of the SEIS (July, 1997) shows typical salinity ranges for Delaware Bay. The salinity ranges experienced at the proposed beneficial use sites are:
Kelly Island: 10 to 30 ppt
Port Mahon: 10 to 30 ppt
(Note that sand placement at Rehoboth/Dewey and Broadkill Beach are for storm damage reduction, not habitat restoration)

D. **What is the salinity of water from which material is being dredged?**

The salinity varies depending on the location, tidal stage, and antecedent hydrologic conditions. Figure 5-9 of the SEIS (July,1997) gives salinity ranges for Delaware Bay. Within State of Delaware waters, and depending on the conditions observed, salinity can range from 0 ppt (fresh water) to 34 ppt (sea water). Salinity of material used for habitat development should be from 10 to 30 ppt.

E. **Is the composition of the dredged material similar to the substrate at the site of habitat development?** Yes for beaches, No for Kelly Island. The substrate at Kelly is mainly silt and the dredged material is mostly sand.

F. **What are the biological characteristics of the site proposed for development? Are there oyster bars, spawning grounds, submerged aquatic vegetation, or other fragile ecosystems, which require temporary or permanent protection? These sites should be avoided for habitat development.**

Kelly Island: Biological resources for Kelly Island are described in Sections 3.3.2.7, 8.0 (Benthic sampling site L-9 is Kelly Island).

Port Mahon Beach Placement Site: 5,200 feet of this project has been described in the attached *Port Mahon, Delaware Interim Feasibility Study, Final Feasibility Report and Environmental Assessment* (September, 1997). Biological Resources are described in Sections 5.7, 5.8, 5.9, and 5.10 of this EA. Additional information can be found in Sections IV and V of the attached US Fish and Wildlife Service's *Planning Aid Report, Comprehensive Navigation Study, Main Channel Deepening Project, Delaware River From Philadelphia to the Sea, Beneficial Use of Dredged Material* (August, 1995).

G. **What are the wind and current conditions at the site? Do they change seasonally?**

WINDS. Prevailing wind direction reported from a variety of weather stations and from different time periods vary from southwest to northwest. Wind data for the period from 1924-1941 at the U.S. Weather Bureau Breakwater Harbor station shows that southwest is the prevailing wind direction, but winds from other directions occur nearly as often. Gale force winds, those over 30 miles per hour, originate most often from the northwest, and winds of more than 60 miles per hour originate from seven of the eight principal compass directions.

Wind data summarizing annual and seasonal wind speed and direction from the Dover Air Force Base station show that the most frequently occurring winds blow from the northwest. Monthly data show that the wind regime varies from season to season with stronger winter winds prevailing from the northwest and summer winds prevailing from the southwest. The dominant winds (highest velocity) are from the northeast.

CURRENTS. Tidal currents in the estuary are directly related to the astronomical tidal elevations and as such vary with the phase and amplitude of the various tidal constituents. Peak ebb and flood currents are largest along the axis of the bay and decrease toward either side. Based on results from a hydrodynamic model, the

National Ocean Service published a tidal circulation atlas for the Delaware River and Bay (NOAA, 1987). The charts show the speeds and directions of the tidal current in the Delaware River and Bay for each hour of an average tidal cycle. The current charts reflect the effects of channels, shoals, and other bathymetric features but do not include meteorological effects or river flow. River runoff can considerably modify the speed and direction of currents in the bay. Strong winds can cause nontidal currents.

From the entrance of the Delaware River and Bay to Artificial Island, the effects of wind generally dominate over river effects. However, increases in ebb currents in the lower bay have been observed when there is a large increase in the river flow. During periods of northerly or northwesterly winds, ebb currents increased and delayed times of weaker floods. Stronger ebbs were also observed after periods of increased water levels resulting from easterly or southeasterly winds. This effect can persist for up to 2 days. Northwesterly winds produced an opposite effect by temporarily lowering the water levels throughout the bay followed by a return to normal water levels.

H. **Will habitat development interfere with any existing commercial or recreational activities?** See the attached table "Delaware River Main Channel Deepening Project, Kelly Island Wetland Restoration/Protection", November 2000. This table shows the parameters that will be monitored to insure the success of the wetland restoration and protect adjacent resources such as oyster beds and insure that any commercial activity, such as boats using the Mahon River, will not be impacted. When complete, this project should increase horseshoe crabs spawning areas, which should benefit this fishery. The wetland restoration should also increase habitat for migratory waterfowl, which should benefit this recreational resource.

Habitat development at the Port Mahon Beach Placement Site should benefit the horseshoe crabs fishery by increasing the spawning areas. The beach will also protect the tidal marshes behind them from further erosion, which should maintain these areas for migratory waterfowl for hunting. Maintaining the tidal marshes will also benefit the recreational fishery, since many fish species use these areas for nursery habitat.

I. **Is there enough material to achieve desired elevations? Is the potential site of development large enough to accommodate the dredged material?** There is enough dredged material to build Kelly Island Wetland Restoration Site, as well as 1-3 beach sites. The plan and design for Kelly Island Wetland Restoration is included in the Kelly Island Wetland Restoration section of this permit application. Engineering drawings for beach restoration at Port Mahon, Delaware are attached to the basic application.

J. **Who is the owner of the site proposed for development? Who will maintain the new habitat?**

The Kelly Island site is owned by the US Fish and Wildlife Service. The site will be maintained by the Corps of Engineers. See Section 9.3.1.3 of the SEIS (July 1997).

Port Mahon: The ownership is described in the Basic Application.
The Corps will not maintain the beach areas. We do not know if the State of Delaware or county/township would maintain the beach.

K. What types of wildlife are to be attracted to the site? What is required in the way of habitat and food?

The Kelly Island wetland restoration will attract spawning horseshoe crabs on the large sand berm that will contain the dredged material. Migratory shorebirds will be attracted to the horseshoe crab eggs. The wetland behind the berm will attract migratory waterfowl and shorebirds, long-legged wading birds as well as other wildlife. This is described in Sections 3.3.2.7 and 9.1.5.1 of the SEIS (July, 1997). Additional information is provided in the attached table "Delaware River Main Channel Deepening Project, Kelly Island Wetland Restoration/Protection", November 2000.

Delaware Bay Beaches: The beaches will attract spawning horseshoe crabs and migratory shorebirds will be attracted to the horseshoe crab eggs.

L. What measures will be taken to reduce potential environmental impact?
Kelly Island Wetland Restoration: Based on environmental studies and coordination of the July 1997 SEIS, this project is not expected to have significant adverse impacts. A monitoring plan will be implemented. The plan is described in the attached table "Delaware River Main Channel Deepening Project, Kelly Island Wetland Restoration/Protection", November 2000.

Construction will be done at times of the year to minimize impact to sensitive resources both at Kelly Island Wetland Restoration site and the sand placement beach sites. Port Mahon beach site will be designed to accommodate spawning horseshoe crabs (See design in the attached Port Mahon Environmental Assessment). Tables of these "environmental windows" are attached for Kelly Island and the beach placement sites.

19. CONSIDERATIONS FOR UPLAND DISPOSAL

A. What is the distance from the dredging operation to the proposed site of disposal? Varies between ½ mile near Killcohook confined disposal facility in the River portion to 10 miles for some of the Bay disposal beaches.

B. What method of disposal is to be utilized (i.e., pipeline discharge, barge, hopper, etc.)? Hydraulic pipeline and hopper dredging.

C. Describe the proposed method of containment for the dredged material. The material will be contained in existing federally owned confined upland disposal facilities.

D. How much acreage is required for the quantity of material being disposed of?
The capacity of the confined disposal facilities is in excess of the required quantity to be disposed of, including bulking factors.

E. **Provide an engineering drawing of the proposed disposal facility.** Drawings for Reedy Point North, Reedy Point South, Killcohook areas 2 and 3, and Artificial Island area 1 confined upland disposal areas are attached.

F. **What measures will be taken to reduce potential environmental impact?** Effluent discharged from the confined disposal facilities during disposal operations will be monitored to insure Delaware surface water quality standards are met. A scope of work for this monitoring effort is included with this application. The concentration of suspended sediment discharged with the effluent will be controlled by raising the weir as necessary, which increases the retention time of water in the site prior to discharge. In addition, surface sediment samples of material will be collected from the facilities after the material has dried, and bulk sediment data will be evaluated for potential impacts to humans and wildlife resources using risk assessment procedures. A scope of work for this effort has also been included with this application.

G. **What is estimated life of the dredge spoil disposal site?** Note Reedy Point North and South will only be used for initial placement of dredged material. Killcohook and Artificial Island sites have 50 years of disposal capacity remaining.

20. **Has an Erosion and Sediment Control Plan been approved by the county conservation district for the project?* No__x__ Yes _____**
Dredging and use of dredged material for beach fill and wetland restoration/protection has not required an erosion and sedimentation plan and approval. However, if the dikes at the existing Federally-owned confined upland facility at Reedy Point North and South are to be raised, the Corps will require that the selected contractor prepare and obtain approval of the erosion and sedimentation plan from the appropriate county district.

***Approved plans must be received by this office prior to approval being issued.**

SAMPLING PLAN FOR NEW DREDGING PROJECTS

1. **Physical and Chemical Analysis of Sediment**

A. **Particle size distribution and percent solids analysis on core samples taken to depth of proposed dredging. Percentage sand, silt and clay should be given based on:** See response to Question #6, paragraph B.

sand:	**Greater than or equal to 0.0625mm**
silt:	**Less than 0.0635mm but greater then 0.0039mm**
clay:	**Less than 0.0039mm**

B. **Bulk sediment analysis (mg/lg) core samples taken to depth of proposed dredging for parameters on page 55 (list at end of this appendix) of this application.** This is discussed in Section 4.1 of the SEIS (July 1997).

C. **Elutriate analysis (mg/l) on core samples taken to depth of proposal dredging for parameters listed on page S-7 of this application. Dredge site water should be used for the dilution water.** This is discussed in Section 4.2 of the SEIS (July, 1997). Elutriate data for Delaware River Federal navigation channel sediment core samples is provided in Section 4.2 of the SEIS (July, 1997). In addition, actual data on the quality of effluent discharged from the existing Killcohook and Pedricktown confined disposal facilities has been collected during maintenance dredging operations in the Delaware River navigation channel. Study reports on these monitoring efforts have been provided to Mr. Richard Greene of the DNREC.

D. **Surface water analysis (mg/l) on one composite sample from dredging area for parameters listed on Chemical Parameters, for Analysis, page S-7 of this application.** The Killcohook and Pedricktown effluent monitoring studies include data from background locations outside the area of dredging influence.

2. **Biological Sampling**

A. **Benthic Invertebrate survey based on minimum of three surface grab samples or benthic dredge. Organisms should be identified to genus-level species where possible.** See Section 4.3.4 of the EIS (February, 1992) and Section 8.0 of the SEIS (July, 1997). In addition, the Philadelphia District will conduct a study on the distribution of over-wintering female blue crabs in the navigation channel in lower Delaware Bay and adjacent areas in the winter of 2000 - 2001. See attached scope of work.

B. **Description of emergent and submerged vegetation in or adjacent to the proposed dredging area.** There is no emergent or submerged vegetation in the vicinity of the proposed dredging area.

* **Data to be provided by applicant. Actual number of samples dependent on size of area to be dredged and suspected pollution level. As a general rule, a minimum of three sampling stations should be established.**

* **If sediment contaminants are shown to exist by the above analyses of a bioassay may be required. Suspected contaminated sediment proposed for upland disposal should be subjected to an EP Toxicity analysis.**

CHEMICAL PARAMETERS FOR ANALYSIS

Laboratory Analyses - Required

Total Phosphorus
Total Nitrogen
Total Organic Carbon
Oil and Grease
Cadmium
Chromium
Mercury
Lead
Nickel
Zinc
Copper

Laboratory Analyses - Recommended

Arsenic
DDT and Metabolites
Phenols
PCS's
Endrin
Lindane
Toxaphene
Methoxychlor
2-4-D
2, 4, 5-TP

Field Measurements of Water Column (Bottom and Surface) Required

Dissolved Oxygen
Temperature
Salinity
pH

* The state may modify the requested parameter list dependent on site conditions.

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Screening of Upland Disposal Areas

U.S. Army Corps of Engineers, Philadelphia District

DELAWARE MAIN STEM CHANNEL DEEPENING PROJECT
Summary
Screening of Upland Disposal Areas -River Portion of Project Area

1. AREA OF CONSIDERATION

- 5 mile band on either side of the Delaware River Navigation Channel(NJ, PA, DE).

2. SCREENING PROCESS

- Several iterations of engineering, economic, and environmental screening in coordination with the Federal, and State resource agencies.

3. INITIAL SCREENING

- Employed a computerized technique called Spatial Analysis Methodology (SAM) (forerunner of GIS layered approach).
- Perform an automated suitability screening using various kinds of (spatial) data to determine the relative attractiveness of land parcels for disposal activities.
- Archaeological Zones, Historic Sites, Recreational Areas, Groundwater Recharge Zones, Groundwater Protection Zones, Areas of importantance to fish and wildlife, Major (contiguous) wetlands, Development, Navigation features, Elevation and Distance from channel dredging areas.

4. MANUAL SCREENING

- Polygons were transferred to U.S. Geological Survey maps for manual screening to adjust for linear features such as roads, streams, and isolated structures that the model was unable to define.
- Consideration was also given to cost factors such as: minimum acreage requirements (100 acres), man-made improvements or navigational channel/access, reasonable disposal pipeline routes to reach the polygon, reasonable effluent water course to the river, and accessibility for construction and maintenance.
- Field visited the candidate upland disposal polygons.

5. INSTITUTIONAL/ENVIRONMENTAL SCREENING

- Institutional screening further eliminated sites that included public park land, designated wildlife areas, or adjacent to dense residential areas and communities.
- Environmental screening further eliminated sites that were not consistent with Federally approved Coastal Zone Management Plans.

Results

- Following this screening the number of potential sites for the Delaware River was further reduced.

6. DETAILED ANALYSIS

The remaining sites were subject to detailed costs analysis.

- Specific data with respect to site acquisition, initial. dike construction, annual maintenance, site capacity and mitigation requirements were developed and evaluated to generate a relative ranking of the costs associated with candidate sites.
- Environmental reviews were also conduced to rank the significant impacts associated with developing sites

for disposal purposes.

Results

- Based on this analysis, upland and aquatic sites were recommended for further consideration.
- Based on coordination with U.S. Fish and Wildlife Service and States of NJ and DE, aquatic sites were not permittable, if any upland sites were available.

7. FINAL SELECTION ANALYSIS

- More detailed cost analysis including incremental mitigation based on disposal requirements of the 45 foot project for initial dredging and maintenance.

- Various disposal schemes were costed out and evaluated.

Results

- Least cost option and environmentally viable disposal scheme was selected (Site 17G*, Raccoon Island, 15D and 15G).

*** Area no longer available as West Deptford Twp. purchased this site.**

US Army Corps
of Engineers

Philadelphia District

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

ESSENTIAL FISH HABITAT EVALUATION

PREPARED BY:
PHILADELPHIA DISTRICT
U.S. ARMY CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA 19107

May, 2000

Delaware River Main Channel Deepening Project
Essential Fish Habitat Evaluation

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DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

ESSENTIAL FISH HABITAT EVALUATION

Description of the Proposed Action.

The plan of construction modifies the depth of the existing navigation channel from 40 to 45 feet at mean low water, with an allowable dredging overdepth of one foot. The modified channel would follow the existing channel alignment from Delaware Bay to Philadelphia Harbor and Beckett Street Terminal, Camden, New Jersey, with no change in channel widths. The plan also includes channel bend widenings, as well as partial deepening of the Marcus Hook Anchorage to 45 feet. Approximately 33.4 million cubic yards of material would be dredged for initial project construction. In addition, 229,000 cubic yards of rock would be removed from the channel in the vicinity of Marcus Hook, Pennsylvania, including 70,000 cubic yards by blasting and the remainder by mechanical methods. Annual maintenance dredging for the 45-foot channel would increase to 6,007,000 cubic yards from the current 4,888,000 cubic yards for the 40-foot channel, for a net increase of 1,119,000 cubic yards. In the riverine portion of the project area, dredged material would be placed in nine active, Federally owned, upland dredged material disposal sites, and four new upland sites identified as 17G, 15D, 15G and Raccoon Island. In Delaware Bay, dredged material from initial project construction would be used for wetland restoration at Egg Island Point, New Jersey and Kelly Island, Delaware, and for beach nourishment at Rehoboth Beach and Dewey Beach on the Atlantic Ocean, and Broadkill Beach and other Delaware Bay beaches in Delaware. Except for the beach nourishment sites, this description summarizes the information presented in the *Final Supplemental Environmental Impact Statement for the Delaware River Main Channel Deepening Project* (Corps, 1997), which is attached for your information. The FSEIS included the stockpiling of sand at two offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to nearby beach sites in Delaware.

Essential Fish Habitat (EFH) of Species Located in Project Area

Under provisions of the reauthorized Magnuson-Stevens Fishery Conservation and Management Act of 1996, the Delaware River and Bay from New Castle, DE and Pennsville, NJ to the mouth of the Bay at the Atlantic Ocean including the navigation channel, wetland restoration sites, and beach nourishment sites were designated as Essential Fish Habitat (EFH) for species with Fishery Management Plans (FMP's), and their important prey species. The area near Marcus Hook, PA where rock blasting will be done is not designated as EFH. The National Marine Fisheries Service has identified EFH within 10 minute X 10 minute squares (Table 1 and Figure 1). The study area contains EFH for various life stages for 25 species of managed fish and shellfish. Table 2 presents the managed species and their life stage that EFH is identified for within the 10 x 10 minute squares that cover the study area. The habitat requirements for identified EFH species and their representative life stages are provided in Table 3.

TABLE 1. 10 MINUTE X 10 MINUTE SQUARES THAT CONTAIN ESSENTIAL FISH HABITAT FOR THE DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT (NOAA, 1999)

Square Number	Coordinates			
	North	East	South	West
31	39° 40,0' N	75° 30,0' W	39° 30.0' N	75° 40.0' W
38	39° 30.0' N	75° 30.0' W	39° 20.0' N	75° 40.0' W
39	39° 30.0'N	75° 20.0' W	39° 20.0' N	75° 30.0' W
48	39° 20.0' N	75° 20.0' W	39° 10.0' N	75° 30.0' W
49	39° 20/0' N	75° 10.0' W	39° 10.0' N	75° 20.0' W
50	39° 20.0' N	75° 00.0' W	39° 10.0' N	75° 10.0' W
59	39° 10.0' N	75° 20.0' W	39° 00.0' N	75° 30.0' W
60	39° 10.0' N	75° 10.0' W	39° 00.0' N	75° 20.0' W
61	39° 10.0' N	75° 00.0' W	39° 00.0' W	75° 10.0' W
70	39° 00.0' N	75° 10.0' W	38° 50.0' N	75° 20.0' W
71	39° 00.0' N	75° 00.0' W	38° 50.0' N	75° 10.0' W
80	38° 50.0' N	75° 10.0' W	38° 40.0' N	75° 20.0' W
81	38° 50.0' N	75° 00.0' W	38° 40.0' N	75° 10.0' W
90	38° 40.0' N	75° 00.0' W	38° 30.0' N	75° 10.0' W

Habitat Areas of Particular Concern (HAPC)

A review of EFH designations and the corresponding 10 x 10 minute squares, which encompasses numbers 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, and 90 contain areas designated as "Habitat Areas of Particular Concern" (HAPC) for the sandbar shark. HAPC are areas of EFH that are judged to be particularly important to the long-term productivity of populations of one or more managed species, or to be particularly vulnerable to degradation (NOAA, 1999).

Sandbar sharks use the shallows of Delaware Bay as an important seasonal nursery ground. The juvenile sharks (1 to 6 yr. old) return to the Bay from wintering grounds in the Carolinas, in mid May. Adult females visit the Bay to pup (deliver live-born young) in the first weeks of June. This has not been directly observed yet, many young caught in June bear fresh umbilical cord remnants and all have open umbilical scars indicating very recent birth. Newborns weigh about 1.5 pounds and are about 1.5 feet in length. Tag returns show that they stay in the bay feeding throughout the summer and depart for their winter (secondary) nurseries when the waters turn cool in mid October. Most newborns are found on the shallow flats in the Southwestern Bay although they seem to radiate out and use more of the Bay during the summer, as they get larger. Telemetry studies show

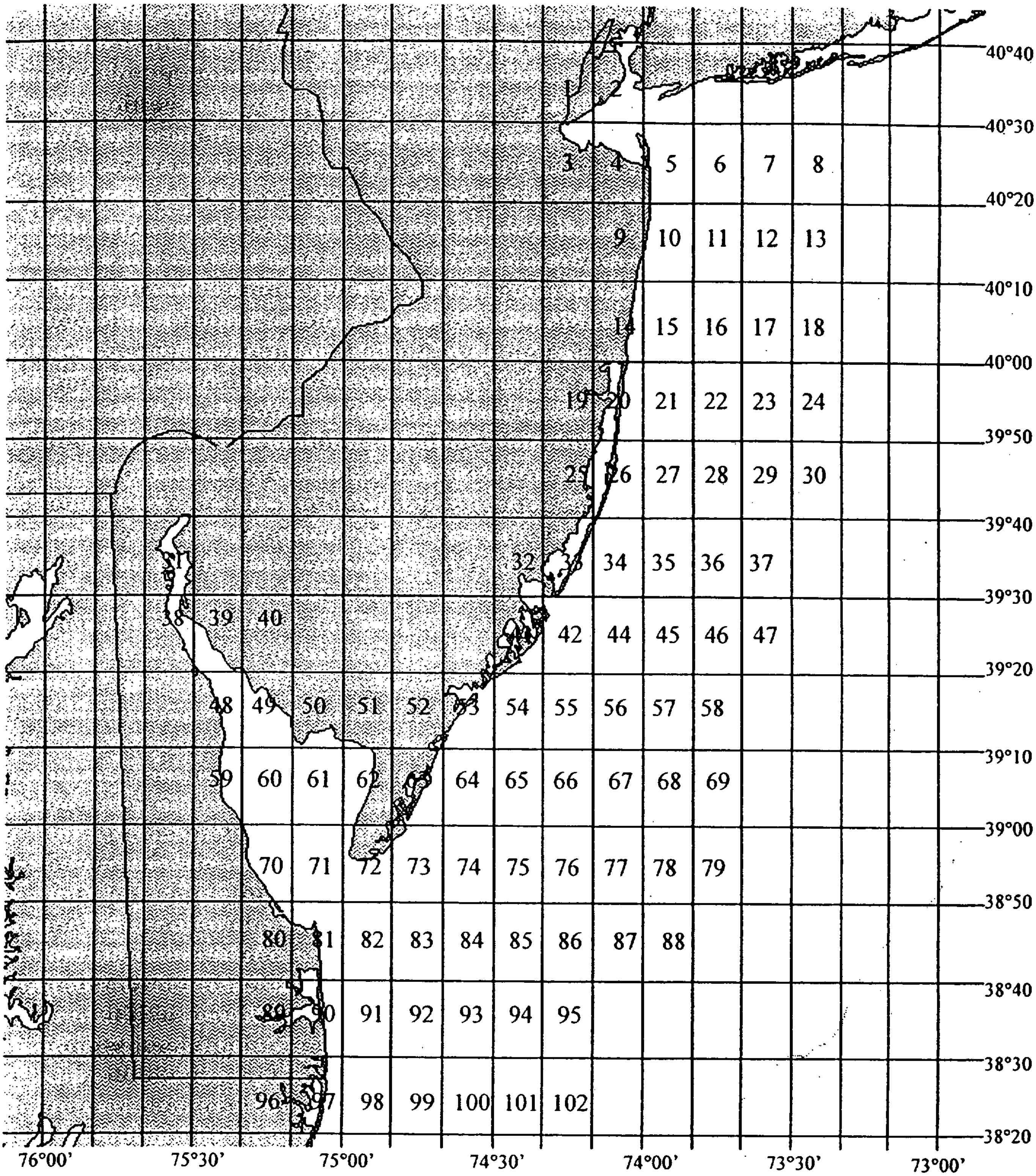

Figure 1: Map of summarized squares of EFH designation for the New Jersey and Delaware coast lines and selected Atlantic Ocean 10' x 10' latitude and longitude squares. The numbers within each square correspond to the page number within this document where the summary table of EFH designation can be located.

that juveniles cross the bay mainly on the bottom. They are bottom feeders, preying on fish, particularly flat fish, crabs (blue crabs and spider crabs) and other benthic organisms.

TABLE 2. SUMMARY OF SPECIES WITH EFH DESIGNATION IN THE 10 min. x 10 min. SQUARES OF 31, 38, 39, 48 49, 50, 59, 60, 61, 70, 71, 80, 81, and 90 (NOAA, 1999)				
MANAGED SPECIES	**EGGS**	**LARVAE**	**JUVENILES**	**ADULTS**
Atlantic cod *(Gadus morhua)*				
Red hake *(Urophycis chuss)*	31,71, 81	31, 71, 81	71, 81	81
Red fish *(Sebastes fasciatus)*	90			59,60,61,70, 71, 80, 81
Winter flounder *(Pleuronectes americanus)*	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38,39,48, 49, 50, 59, 60, 61, 70, 71,80, 81, 90	31, 38,39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31,38,39,48, 49,50,59,60,661, 70, 71,80,81, 90
Windowpane flounder *(Scopthalmus aquosus)*	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81,90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81,90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90
Atlantic sea herring *(Clupea harengus)*			48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90
Monkfish *(Lophius americanus)*	81, 90	81, 90		
Bluefish *(Pomatomus saltatrix)*			31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90
Long finned squid *(Loligo pealei)*	n/a	n/a		
Short finned squid *(Illex ilecebrosus)*	n/a	n/a		71
Atlantic butterfish *(Peprilus tricanthus)*		59, 60, 61, 70, 71, 80, 81	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	59, 60, 61, 70, 71, 80, 81, 90
Summer flounder *(Paralicthys dentatus)*		90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90
Scup *(Stenotomus chrysops)*	n/a	n/a	31, 38, 39, 48, 49, 50,59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 90
Black sea bass *(Centropristus striata)*	n/a	81	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	59, 60, 61, 70, 71, 80, 81, 90
Ocean quahog *(Artica islandica)*	n/a	n/a		
Spiny dogfish *(Squalus acanthias)*	n/a	n/a	71	81
King mackerel *(Scomberomorus cavalla)*	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90
Spanish mackerel *(Scomberomorus maculatus)*	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90
Cobia *(Rachycentron canadum)*	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90
Sand tiger shark *(Odontaspis taurus)*		50, 59, 60, 61, 70, 71, 80, 81, 90		59, 60, 61, 70, 71, 80, 81, 90
Atlantic angel shark *(Squatina dumerili)*		71, 81, 90	71, 81, 90	71, 81, 90
Dusky shark *(Charcharinus obscurus)*		48, 49, 50, 60, 61, 70, 71, 80, 81, 90		
Sandbar shark *(Charcharinus plumbeus)*		**HAPC** , 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	**HAPC** , 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	**HAPC** , 48, 49, 50, 59, 60; 61, 70, 71, 80, 81, 90
Scalloped hammerhead shark *(Sphyrna lewini)*			71, 81, 90	
Atl. Sharpnose shark *(Rhizopriondon terraenovae)*		71, 81, 90	71, 81	71, 81, 90

"n/a": species either have no data available on designated lifestages, or those lifestages are not present in the species reproductive cyle.

HAPC: (Habitat Areas of Particular Concern): EFH that is judged to be particularly important to the long-term productivity of populations of one or more managed species, or to be particularly vulnerable to degradation.

TABLE 3. HABITAT UTILIZATION OF IDENTIFIED EFH SPECIES AND THEIR SUMMARY OF SPECIES WITH EFH DESIGNATION IN THE 10 min. x 10 min. SQUARES OF 31, 38, 39, 48 49, 50, 59, 60, 61, 70, 71, 80, 81, and 90 (NOAA, 1999)

MANAGED SPECIES	EGGS	LARVAE	JUVENILES	ADULTS
Atlantic cod *(Gadus morhua)* (Fahay, 1998)				**Habitat:** Bottom (rocks, pebbles, or gravel) winter for Mid-Atlantic **Prey:** shellfish, crabs, and other crustaceans (amphipods) and polychaetes, squid and fish (capelin redfish, herring, plaice, haddock).
Red hake *(Urophycis chuss)* (Steimle et al. 1998)	**Habitat:** Surface waters, May – Nov.	**Habitat:** Surface waters, May –Dec. Abundant in mid- and outer continental shelf of Mid-Atl. Bight. **Prey:** copepods and other microcrustaceans under floating eelgrass or algae.	**Habitat:** Pelagic at 25-30 mm and bottom at 35-40 mm. Young inhabit depressions on open seabed. Older juveniles inhabit shelter provided by shells and shell fragments. **Prey:** small benthic and pelagic crustaceans (decapod shrimp, crabs, mysids, euphasiids, and amphipods) and polychaetes).	
Red fish (*Sebastes fasciatus*)	n/a			
Winter flounder (*Pleuronectes americanus)* (Pereira et al, 1998; McClane, 1978)	**Habitat:** Sandy bottom from Jan to May with peak from Mar to April in 1 to 40 fathams	**Habitat:** Planktonic, then bottom oriented; less than 6 m. **Prey:**nauplii, harpacticoids, calanoids, polychaetes, invertebrate eggs, phytoplankton.	**Habitat:** Shallow water. Winter in estuaries and outer continental shelf **Prey:** copepods, harpacticoids, amphipods, polychaetes	**Habitat:** Fined grained bottom habitats, 1-100 m **Prey:** omnivorous, polychaetes and crustaceans.
Windowpane flounder *(Scopthalmus aquosus)* (Chang, 1998)	**Habitat:** Surface waters, peaks in May and October.	**Habitat:** Pelagic waters.	**Habitat:** Bottom (fine sands) 5-125m in depth, in nearshore bays and estuaries less than 75 m **Prey**: small crustaceans (mysids and decapod shrimp) polychaetes and various fish larvae	**Habitat:** Bottom (fine sands), peak spawning in May , in nearshore bays and estuaries less than 75 m **Prey**: small crustaceans (mysids and decapod shrimp) polychaetes and various fish larvae
Atlantic sea herring *(Clupea harengus)* (Reid et al., 1998)			**Habitat:** Pelagic waters and bottom, < 10 C and 15-130 m depths **Prey:** zooplankton (copepods, decapod larvae, cirriped larvae, cladocerans, and pelecypod larvae)	**Habitat:** Pelagic waters and bottom habitats; **Prey:** chaetognath, euphausiids, pteropods and copepods.
Monkfish *(Lophius americanus)* (Steimle et al., 1998)	**Habitat:** Surface waters, Mar. – Sept. peak in June in upper water column of inner to mid continental shelf	**Habitat:** Pelagic waters in depths of 15 – 1000 m along mid-shelf also found in surf zone **Prey:** zooplankton (copepods,		

TABLE 3. HABITAT UTILIZATION OF IDENTIFIED EFH SPECIES AND THEIR SUMMARY OF SPECIES WITH EFH DESIGNATION IN THE 10 min. x 10 min. SQUARES OF 31, 38, 39, 48 49, 50, 59, 60, 61, 70, 71, 80, 81, and 90 (NOAA, 1999)

MANAGED SPECIES	EGGS	LARVAE	JUVENILES	ADULTS
		crustacean larvae, chaetognaths)		
Bluefish *(Pomatomus saltatrix)*			**Habitat:** Pelagic waters of continental shelf and in Mid Atlantic estuaries from May-Oct.	**Habitat:** Pelagic waters; found in Mid Atlantic estuaries April – Oct.
Long finned squid *(Loligo pealei)*	n/a	n/a		
Short finned squid *(Illex ilecebrosus)*	n/a	n/a		
Atlantic butterfish *(Peprilus tricanthus)*		**Habitat:** Pelagic waters, greater than 33 ft deep	**Habitat:** Pelagic waters in 10 – 360 m	**Habitat:** Pelagic waters
Summer flounder *(Paralicthys dentatus)*		**Habitat:** Pelagic waters, nearshore at depths of 10 – 70 m from Nov. – May	**Habitat:** Demersal waters (mud and sandy substrates)	**Habitat:** Demersal waters (mud and sandy substrates). Shallow coastal areas in warm months, offshore in cold months
Scup *(Stenotomus chrysops)*	n/a	n/a	**Habitat:** Demersal waters	**Habitat:** Demersal waters offshore from Nov – April
Black sea bass *(Centropristus striata)*	n/a	**Habitat:** Pelagic and estuarine.	**Habitat:** Demersal waters over rough bottom, shellfish and eelgrass beds, man-made structures in sandy-shelly areas	**Habitat:** Demersal waters over structured habitats (natural and man-made), and sand and shell areas
Ocean quahog *(Artica islandica)*	n/a	n/a		
Spiny dogfish *(Squalus acanthias)*	n/a	n/a		
King mackerel *(Scomberomorus cavalla)*	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone.	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone
Spanish mackerel *(Scomberomorus maculatus)*	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory
Cobia *(Rachycentron canadum)*	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory
Sand tiger shark *(Odontaspis taurus)*		**Habitat:** Shallow coastal waters, bottom or demersal		**Habitat:** Shallow coastal waters, bottom or demersal
Atlantic angel shark *(Squatina dumerili)*		**Habitat:** Shallow	**Habitat:** Shallow coastal	**Habitat:** Shallow coastal

TABLE 3. HABITAT UTILIZATION OF IDENTIFIED EFH SPECIES AND THEIR SUMMARY OF SPECIES WITH EFH DESIGNATION IN THE 10 min. x 10 min. SQUARES OF 31, 38, 39, 48 49, 50, 59, 60, 61, 70, 71, 80, 81, and 90 (NOAA, 1999)

MANAGED SPECIES	EGGS	LARVAE	JUVENILES	ADULTS
		coastal waters,	waters	waters, bottom (sand or mud near reefs)
Dusky shark *(Charcharinus obscurus)*		**Habitat:** Shallow coastal waters		
Sandbar shark *(Charcharinus plumbeus)* Pratt, 1999		**Habitat:** Shallow coastal waters; submerged flats (1-4 m). Important nursery area off Broadkill and Primehook beaches.	**Habitat:** Shallow coastal waters; submerged flats (1-4 m) Important nursery area off Broadkill and Primehook beaches.	**Habitat:** Shallow coastal waters; submerged flats (1-4 m)
Scalloped hammerhead shark *(Sphyrna lewini)*			**Habitat:** Shallow coastal waters	
Atl. sharpnose shark *(Rhizopriondon terraenovae)*		**Habitat:** Shallow coastal waters	**Habitat:** Shallow coastal waters	**Habitat:** Shallow coastal waters

The sharks main nursery areas on the East Coast are in Delaware and Chesapeake bays. They formerly used Great South Bay, Long Island, N. Y. but surveys show that they have not used it recently, possibly due to anthropogenic or geological (morphological) changes (Pratt, 1999).

Important Habitat in Delaware Bay

Pup and juvenile sharks use submerged flats for residence and feeding in water depths of from 1 to 4 meters. On the Delaware coast they extend from Roosevelt Inlet at the southern terminus of Broadkill Beach, to Port Mahon in the north. The greatest concentrations of young sharks occur off Broadkill and Primehook beaches, Delaware. They also are found in great numbers on submerged flats off the New Jersey shore (1-4 m) between Villas and Reed's Beach and shoal areas throughout the Bay such as Deadman and Hawksnest Shoal. They are limited by salinity to areas south of the latitude of Fortescue, NJ. Juveniles and pups may be caught almost anywhere in the bay, but the southwest coastal areas have the greatest consistent numbers as reflected in Catch per Unit Effort (CPUE) data (Pratt, 1999).

Effect Analysis

The following activities will be done within designated EFH to construct the Delaware River Main Channel Deepening Project: (1) dredging the navigation channel; (2) wetland restoration at Egg Island Point, NJ; (3) wetland restoration at Kelly Island, Delaware; and (4) beach nourishment at beaches in Delaware such as Rebohoth Beach and Dewey Beach on the Atlantic Ocean and Broadkill Beach on Delaware Bay. There are a number of Federally managed fish species where essential fish habitat (EFH) was identified for one or more life stages within the project impact areas. Fish occupation of waters within the project impact areas is highly variable spatially and temporally. Some of the species are strictly offshore, while others may occupy both nearshore and offshore waters. In addition, some species may be suited for the open ocean or pelagic waters, while others may be more oriented to bottom or demersal waters. This can also vary between life stages of Federally managed species. Also, seasonal abundances are highly variable, as many species are highly migratory. Impacts from dredging the navigation channel would include destruction of demersal or bottom dwelling life stages, if they occurred in the highly disturbed navigation channel. Wetland restorations at Egg Island Point and Kelly Island would change shallow water habitat to wetlands; however, these areas are eroding at up to 30 feet per year, destroying wetlands that are important nursery areas for many fish species. Many other areas of the Delaware Bay shoreline are eroding, creating more shallow water habitat in the process. Restoring and protecting wetlands has a net positive value on the aquatic environment. Beach restorations at Broadkill and other Delaware Bay beaches in Delaware will convert shallow water habitat to upland beach habitat. Broadkill Beach is eroding at a rate of an average of 10 feet per year and has been nourished numerous times in the last 50 years by the State of Delaware. Table 4 summarizes the potential impacts to those species that have EFH designated in the project area.

1. Channel Deepening/Maintenance Dredging: Dredging the navigation channel is expected to have minimal adverse impacts to the managed species. Most of the channel is presently disturbed from maintenance dredging and from prop wash from boat traffic. Adult and juveniles are mobile and many would be able to move away from the dredge, but, as stated in Table 3, some mortality of eggs, larvae and juveniles would be expected by entrainment into the dredge. This would be more likely to occur to some life stages of demersal species such as winter flounder, windowpane flounder, Atlantic sea herring, summer flounder, scup, black sea bass, sand tiger shark, Atlantic angel shark, sandbar shark, and Atlantic sharpnose shark.

TABLE 4. DIRECT AND INDIRECT IMPACTS ON FEDERALLY MANAGED SPECIES AND ESSENTIAL FISH HABITAT (EFH) IN THE 10' x 10' SQUARES OF 31, 38, 39, 48 49, 50, 59, 60, 61, 70, 71, 80, 81, and 90 (NOAA, 1999)

MANAGED SPECIES	EGGS	LARVAE	JUVENILES	ADULTS
Atlantic cod *(Gadus morhua)*				**Direct:** Possible disturbance during dredging. **Indirect:** Temporary disruption of benthic food prey organisms.
Red hake *(Urophycis chuss)*	Eggs occur in surface waters; therefore, no direct or indirect effects are expected.	Larvae occur in surface waters; therefore, no direct or indirect effects are expected.	**Direct:** Some mortality of juveniles could be expected from entrainment into the dredge. **Indirect:** Temporary disruption of benthic food prey organisms.	
Red fish (*Sebastes fasciatus)*	n/a			
Winter flounder (*Pleuronectes americanus*	Minimal adverse effects from dredging, wetland restoration and beach nourishment since eggs are demersal.	Minimal adverse effects from dredging, wetland restoration and beach nourishment since eggs are demersal.	**Direct:** Some mortality of juveniles could be expected from entrainment into the dredge. **Indirect:** Temporary disruption of benthic food prey organisms.	**Direct:** Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms.

TABLE 4. DIRECT AND INDIRECT IMPACTS ON FEDERALLY MANAGED SPECIES AND ESSENTIAL FISH HABITAT (EFH) IN THE 10' x 10' SQUARES OF 31, 38, 39, 48 49, 50, 59, 60, 61, 70, 71, 80, 81, and 90 (NOAA, 1999)

MANAGED SPECIES	EGGS	LARVAE	JUVENILES	ADULTS
Windowpane flounder *(Scopthalmus aquosus)*	Eggs occur in surface waters; therefore, no direct or indirect effects are expected	Larvae occur in pelagic waters; therefore, no direct or indirect effects are expected.	**Direct:** Some mortality of juveniles could be expected from entrainment into the dredge. **Indirect:** Temporary disruption of benthic food prey organisms.	**Direct:** Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms.
Atlantic sea herring *(Clupea harengus)*			**Direct:** Some mortality of juveniles could be expected from entrainment into the dredge. **Indirect:** None, prey items are planktonic	**Direct:** : Minor loss of shallow water habitat. **Indirect:** None, prey items are primarily planktonic
Monkfish *(Lophius americanus)*	Eggs occur in surface waters with depths greater than 25 m; therefore, no direct or indirect effects are expected.	Larvae occur in pelagic waters with depths greater than 25 m; therefore, no direct or indirect effects are expected.		
Bluefish *(Pomatomus saltatrix)*			**Direct:** Juvenile bluefish are pelagic species. No significant direct effects anticipated. **Indirect:** Temporary disruption of benthic food prey organisms.	**Direct:** Adult bluefish are pelagic species. No significant direct effects anticipated. **Indirect:** Temporary disruption of benthic food prey organisms.
Long finned squid *(Loligo pealei)*	n/a	n/a		
Short finned squid *(Illex ilecebrosus)*	n/a	n/a		
Atlantic butterfish *(Peprilus tricanthus)*		Larvae are pelagic; therefore, no direct or indirect impacts are expected.	**Direct:** Juvenile butterfish are pelagic species. No significant direct effects anticipated. **Indirect:** Temporary disruption of benthic food prey organisms.	**Direct:** Adult butterfish are pelagic species. No significant direct effects anticipated. **Indirect:** Temporary disruption of benthic food prey organisms.
Summer flounder *(Paralicthys dentatus)*		Larvae occur in pelagic waters with depths greater than 10 m; therefore, minor direct or indirect effects are expected	**Direct:** Some mortality of juveniles could be expected from entrainment into the dredge. Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms.	**Direct:** Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms.
Scup *(Stenotomus chrysops)*	n/a	n/a	**Direct:** Some mortality of juveniles could be expected from entrainment into the dredge. Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms.	**Direct:** Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms.
Black sea bass *(Centropristus striata)*	n/a		**Direct:** Some mortality of juveniles could be expected from entrainment into the dredge. Minor loss of shallow water habitat.	**Direct:** Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms.

TABLE 4. DIRECT AND INDIRECT IMPACTS ON FEDERALLY MANAGED SPECIES AND ESSENTIAL FISH HABITAT (EFH) IN THE 10' x 10' SQUARES OF 31, 38, 39, 48 49, 50, 59, 60, 61, 70, 71, 80, 81, and 90 (NOAA, 1999)

MANAGED SPECIES	EGGS	LARVAE	JUVENILES	ADULTS
			Indirect: Temporary disruption of benthic food prey organisms.	
Ocean quahog *(Artica islandica)*	n/a	n/a		
Spiny dogfish *(Squalus acanthias)*	n/a	n/a		
King mackerel *(Scomberomorus cavalla)*	**Direct Impacts:** Eggs are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** None anticipated.	**Direct Impacts:** Larvae are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** None anticipated.	**Direct Impacts:** Juveniles are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** Minor indirect adverse effects on food chain through disruption of benthic community, however, mackerel are highly migratory.	**Direct Impacts:** Adults are pelagic and highly migratory, therefore no adverse impacts are anticipated. **Indirect Impacts:** Minor indirect adverse effects on food chain through disruption of benthic community, however, mackerel are highly migratory.
Spanish mackerel *(Scomberomorus maculatus)*	**Direct Impacts:** Eggs are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** None anticipated.	**Direct Impacts:** Larvae are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** None anticipated.	**Direct Impacts:** Juveniles are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** Minor indirect adverse effects on food chain through disruption of benthic community, however, mackerel are highly migratory.	**Direct Impacts:** Adults are pelagic and highly migratory, therefore no adverse impacts are anticipated. **Indirect Impacts:** Minor indirect adverse effects on food chain through disruption of benthic community, however, mackerel are highly migratory.
Cobia *(Rachycentron canadum)*	**Direct Impacts:** Eggs are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** None anticipated.	**Direct Impacts:** Larvae are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** None anticipated.	**Direct:** Cobia are pelagic and migratory species. No significant direct effects anticipated. **Indirect:** Temporary disruption of benthic food prey organisms.	**Direct:** Cobia are pelagic and migratory species. No significant direct effects anticipated. **Indirect:** Temporary disruption of benthic food prey organisms.
Sand tiger shark *(Odontaspis taurus)**		**Direct:** Some mortality of larvae could be expected from entrainment into the dredge because they may be oriented with the bottom. Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within placement sites.		**Direct:** Adults are highly mobile and are capable of avoiding impact areas. Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within placement sites.
Atlantic angel shark *(Squatina dumerili)**		**Direct:** Some mortality of larvae could be expected from entrainment into the dredge because they may be oriented with the bottom. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within placement sites.	**Direct:** Some mortality of juveniles could be expected from entrainment into the dredge. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within placement sites.	**Direct:** Adults are mobile and are capable of avoiding impact areas. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within placement sites.
Dusky shark *(Charcharinus obscurus)**		**Direct:** Mortality from dredge unlikely because embryos are reported up to 3 feet in length (McClane,		

TABLE 4. DIRECT AND INDIRECT IMPACTS ON FEDERALLY MANAGED SPECIES AND ESSENTIAL FISH HABITAT (EFH) IN THE 10' x 10' SQUARES OF 31, 38, 39, 48 49, 50, 59, 60, 61, 70, 71, 80, 81, and 90 (NOAA, 1999)

MANAGED SPECIES	EGGS	LARVAE	JUVENILES	ADULTS
		1978). Therefore, the newborn may be mobile enough to avoid a dredge or placement areas. Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within placement sites.		
Sandbar shark *(Charcharinus plumbeus)**		**Direct:** If sand deposition is done between 1 May and 15 Sept. some mortality of larvae may be possible from entrainment into the dredge, burial in nearshore, and suffocation (Gorski, 2000) (pers. conv. between J. Brady-USACE and H.W. Pratt-NMFS. Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within placement sites.	**Direct:** Juveniles are mobile and are capable of avoiding impact areas, but may be vulnerable to suffocation (Gorski, 2000) if sand deposition is done between 1 May and 15 Sept. Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within placement sites.	**Direct:** Adults are highly mobile and are capable of avoiding impact areas. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within placement sites.
Scalloped hammerhead shark *(Sphyrna lewini)**			**Direct:** Juveniles may be mobile enough to avoid entrainment into the dredge or becoming buried/smothered at the placement site. Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.	
Atlantic. sharpnose shark *(Rhizopriondon terraenovae)**		**Direct:** Some mortality of larvae may be possible from entrainment into the dredge or burial in nearshore. Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within placement sites.	**Direct:** Juveniles are mobile and are capable of avoiding impact areas. Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within placement sites.	**Direct:** Adults are highly mobile and are capable of avoiding impact areas. Minor loss of shallow water habitat. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.

The notation "n/a" indicates that some of the species either have no data available on the designated lifestages, or those lifestages are not present in the species' reproductive cycle.
* Shark larvae are neonates and early juveniles; shark juveniles are late juveniles/subadults.

2. Wetland Restorations at Egg Island Point, NJ and Kelly Island, DE: Wetland restorations should not have significant adverse impacts to the EFH of the managed species. Egg Island Point wetland restoration will take place in Squares 50 and 61,

and Kelly Island wetland restoration will take place in Square 59 (See Table 1 and Figure 1). The same species are present at both sites (Table 2). Construction of the two wetland restorations will result in a change from shallow water habitat to wetlands. There will also be a temporary disruption of benthic food prey organisms during construction. However, Egg Island Point and Kelly Island are eroding at up to 30 feet per year, destroying wetlands that are important nursery areas for many fish species. Many other areas of the Delaware Bay shoreline are eroding, creating more shallow water habitat in the process. Restoring and protecting wetlands has a net positive value on the aquatic environment.

3. Beach Nourishment at Rehoboth Beach, Dewey Beach, Broadkill Beach and other Delaware Bay beaches in Delaware: The EFH Squares where construction could occur are 59, 70, 80, 81, and 90 (Table 1). All managed species listed in Table 2 occur in these squares. Beach nourishment at these beaches in Delaware will convert shallow water habitat to upland beach habitat. Broadkill Beach is eroding at a rate of an average of 10 feet per year (Corps, 1996 a). Rehoboth and Dewey Beaches are eroding up to 7 feet per year (Corps 1996 b). These beaches have been nourished numerous times in the last 50 years.

   Sandbar Shark: The habitat along the lower Delaware Bay coast in Delaware has been designated as "Habitat Areas of Particular Concern" (HAPC) (NOAA, 1999). Pratt (1999) believes that there will be a great potential to impact shark pups and their food source of benthic organisms in the nursery areas along the Delaware Bay Coast, especially offshore from Broadkill Beach to Slaughter Beach, if sand is deposited near the beach (in areas 1 – 4 m deep) in the nursery season. Potential impacts may include but not be limited to: changing the habitat characteristics, depth, profile, odor, turbidity and fauna of the area. Loss of forage would also occur. Prey species, principally crabs and fish of many species, may be disrupted directly by the presence of physical activity in the area and indirectly by the covering of vulnerable food web organisms with sand. In order to avoid potential impacts to the sandbar shark, no dredged material will be deposited from Broadkill Beach to Slaughter Beach (inclusive) from 1 May to 15 September. This window is recommended by the National Marine Fisheries Service (Gorski, 2000) and will prevent potential impacts to newborn and juvenile sharks such as suffocation. After this time period, the young sharks have reached a larger size where they would be more able to avoid the sand placement operations.

References

Corps of Engineers (Corps), 1997, *Delaware River Main Channel Deepening Project, Supplemental Environmental Impact Statement.* Philadelphia District, Philadelphia, PA

Corps of Engineers (Corps), 1996 a, *Broadkill Beach, DE Interim Feasibility Study, Final Feasibility Report and Environmental Impact Statement*, Philadelphia District, Philadelphia, PA

Corps of Engineers (Corps), 1996 b, *Rehoboth Beach/Dewey Beach, Interim Feasibility Study, Final Feasibility Report and Final Environmental Impact Statement*, Philadelphia District, Philadelphia, PA

Gorski, Stanley W., 2000, Letter to John T. Brady dated February 10, 2000, National Marine Fisheries Service, Highlands, NJ.

McClane, A.J., 1974, *McClane's Field Guide to Saltwater Fishes of North America*, Henry Holt and Company, LLC, New York, NY

NOAA, 1999, *Guide to Essential Fish Habitat Designations in the Northeastern United States*, NOAA/National Marine Fisheries Service, Habitat Conservation Division, Gloucester, MA

Pratt, Harold "Wes", 1999, Letter to John T. Brady dated October 4, 1999, National Marine Fisheries Service, Narragansett, RI.

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Scope of Work
Delaware Bay Winter Crab Survey

U.S. Army Corps of Engineers, Philadelphia District

Delaware River Main Channel Deepening Project
Scope of Work
Delaware Bay Winter Crab Survey

Introduction and Purpose

Resource agencies reviewing potential impacts of the proposed Delaware River Main Channel Deepening Project have suggested that the project may impact over-wintering female blue crab (*Callinectes sapidus*) populations if dredging were conducted in the winter season in lower Delaware Bay. With the on set of winter, female blue crabs migrate to the mouth of the estuary and burrow into deep-water sediments where they remain until spring whereas male crabs tend to burrow near their foraging habitat in shallow water. There is currently no adequate winter crab survey data for lower Delaware Bay to assess what portion of the over-wintering crab population resides in the navigation channel relative to other habitats. If a disproportionate number of hibernating crabs over-winter in the navigational channel, the dredging operation could have deleterious effects on the winter crab dredge fishery and blue crab recruitment in the following year. In contrast, if only a small percentage of the total blue crab population utilize this deepwater habitat, then the wintertime dredging restrictions being considered by the resource agency may not be necessary to protect the resource.

The purpose of this study is to: 1) determine the density distribution of over-wintering blue crabs with respect to the navigational channel, 2) assess the potential impacts of winter dredging on blue crab abundance by sex, and 3) provide an estimate of total blue crab standing stock in lower Delaware Bay for the winter 2000 season.

Study Plan

The contractor will conduct a dredge survey combined with gear efficiency studies to estimate absolute abundance of blue crabs in the lower Delaware Bay. Separate abundance estimates for males and females will be obtained for the channel, the channel bank, and the remaining areas with depths greater than 5 ft. The field study will be conducted in January/February, 2001. In Chesapeake Bay, blue crabs are generally inactive and bury themselves in the bottom sediment from November through March[1]; thus, they are less likely to escape the dredge by swimming. A similar behavior occurs for blue crabs in Delaware Bay, as supported by the existence of a winter dredge fishery. The contractor will lease a Delaware vessel with a captain experienced in the winter dredge fishery for blue crabs. The survey will be conducted using a standard 1.83 m wide sampling dredge lined with 12.7 mm nylon mesh, and similar field sampling protocol as for the yearly winter survey of the blue crab population in Chesapeake Bay[2].

[1] Van Engel, W. A. 1958. The blue crab and its fishery in Chesapeake Bay. Part I: Reproduction, early development, growth and migration. Comer. Fish. Rev. 20:6-17.

[2] Rothschild, B. J. and A. F. Sharov. 1997. Abundance estimation and population dynamics of the blue crab in the Chesapeake Bay. 81 p. University of Massachusetts Center for Marine Science and Technology. Final report to the Maryland Department of Natural Resources and Chesapeake Bay Stock Assessment Committee. Center for Marine Science and Technology, University of Massachusetts, North Dartmouth MA 02747-2300

The study area will extend from river mile 0 to approximately 32 in lower Delaware Bay (the lower portion of Section E of the Federal Navigation Channel where dredging will be done to deepen the channel). Stratified sampling will be conducted to ensure adequate sampling coverage of deep and shallow waters, and to support separate estimates of abundance for the dredged channel and transitional habitat along each side of the channel. The proposed stratification, sampling effort, and station allocation is summarized in Table 1 and the attached maps. As part of this study the contractor will conduct a field experiment to test if the density of blue crabs in the channel differs significantly from the density on the bank along the channel. This experiment will involve parallel hauls at 24 locations (transects) selected randomly or systematically (equal spacing with a random start) along the length of the channel to increase the power for detecting differences in abundance between the channel and the bank. The experimental sampling location within a strip along the channel will be allocated on the channel edge, as determined from accurate bathymetric maps to be provided by the Corps of Engineers. In the experimental design the contractor will take into account three distinct dredging categories in the navigational channel: (1) previously dredged; (2) slated to be dredged; and (3) never dredged. The number of transects will be allocated approximately even between the three dredge categories.

Table 1. Stratification, sampling effort, and sample selection.

Stratum	Sample size	Selection procedure for dredge stations
Channel – approximately 1000 ft wide, from river mile 0 to 32.	30	Random, or systematic (equal distance between stations, with random starting point), approximately 10 sites per dredge category.
Depth transitional area along each side of channel	30	Adjacent to hauls in channel, at random side of channel
Lower Delaware Deep waters	15	Simple Random
State of Delaware, Shallow lower	15	Simple Random
State of Delaware, Shallow upper	15	Simple Random
State of New Jersey, Shallow lower	15	Simple Random
State of New Jersey, Shallow upper	15	Simple Random
	Total: 135	

At each station, the dredge will be hauled for 1 min along the bottom at a speed of 3 knots. The towing distance will be measured by GPS. The number of blue crabs will be recorded, and information on carapace width, sex, maturity stage, and overall condition will be collected for each crab. Depth, salinity, and water temperature will be recorded at each station. In addition, a bottom sediment sample will be collected using a Young grab. Two surface-sediment sub-samples of approximately 120 ml each will be collected from the grab sample at each site for grain-size analysis. Sand and silt-clay particles will be separated in the laboratory by wet-sieving through a 63-μm, stainless sieve and weighed. Presence of blue mussels and sulfur sponge at each survey station and experimental site will be determined from the dredge samples. This information together with the sediment samples will be used to characterize and identify favorable habitat.

Estimating Density and Abundance

The mean number of crabs caught per standard area unit covered by a haul will be used to estimate the relative density of blue crabs in each stratum separately, and the stratified weighted mean for the total survey area. Standard estimators for stratified random sampling will be used to estimate a baywide mean density, and mean densities within strata[3,4]. The relative abundance for each stratum is obtained by extrapolating the mean density to the stratum area. The paired sample data from the channel and the transitional area along each side of the channel will also be analyzed using Analysis of Variance (ANOVA) to improve power of detecting differences in density.

The contractor will estimate the catching efficiency of the dredge to calibrate the relative estimates of abundance from the survey. Absolute density (i.e., number of crabs per square meter in each stratum) shall be estimated by adjusting the relative density for the catching efficiency of the sampling gear, and absolute abundance by stratum shall be estimated by extrapolating the mean absolute density to the stratum size. Based on estimates of absolute abundance, the contractor will quantify the fraction of the total winter population (for males and females) that resides in the channel.

Estimating Catching Efficiency

The average catching efficiency for the winter survey in Chesapeake Bay is around 15%[3]. That is, only 15% of the crabs residing in the path of the dredge are caught, on average. Catching efficiency may vary significantly between areas because of different bottom topography and sediment types. Hence, the average efficiency for the Chesapeake Bay surveys may not be representative for the different parts of Delaware Bay to be sampled in this study. The contractor will therefore conduct experiments to estimate the gear efficiency. The depletion experiments will be conducted at sites with various bottom sediment types (i.e., mud, sand, and hard bottom.)

The contractor will estimate the catching efficiency (i.e., the fraction of crabs present in the path of the dredge that is captured) by conducting removal experiments similar to those conducted as part of the yearly winter survey in Chesapeake Bay[5]. A total of nine experiments will be conducted, allocated to different sediment types. If possible, the contractor will also use information from the Chesapeake Bay survey to estimate sediment specific catching efficiencies.

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[3] Cochran, W. G. 1977. Sampling Techniques. 3rd ed. John Wiley & Sons. New York. 428pp.

[4] Vølstad, J. H., B. J. Rothschild, and T. Maurer. Abundance estimation and population dynamics of the blue crab in the Chesapeake Bay. Final Report to NOAA on contract F278-93-008, University of Maryland, CEES 07-4-30351.

[5] Vølstad, J. H., A. F. Sharov, G. Davis, and B. Davis. 2000. A method for estimating dredge catching efficiency for blue crabs, *Callinectes sapidus*, in Chesapeake Bay. Fish. Bull. 98: 410-420.

In the depletion experiments, a closed area will be sampled repeatedly over a relatively short time. An estimate of the catching efficiency is based on the trend in catch per unit effort (CPUE) as the population size in the study area declines. The removal experiments will be conducted after the stratified random survey is completed. Experimental locations will be chosen randomly from a subset of survey stations with positive catches for each of the three sediment types. Each removal experiment will be conducted within an area of approximately 100 m by 5.5 m marked with buoys. Each removal from the experimental area (coverage) will consist of 3 non-overlapping dredge tows conducted back and forth at a standard towing speed of 3 knots. A maximum of 10 removals will be completed for each depletion experiment. One unit of effort (coverage) is the combined 3 hauls required to sweep the experimental area, and catch is recorded as the total number of crabs caught per coverage. The carapace width and sex will be measured for each crab.

Data Analysis and Report

The contractor will prepare a report analyzing the winter blue crab population distribution and density in lower Delaware Bay. The report will describe all methods that were used and the data obtained. Maps will be included to show the study area and sample locations and will be delivered in ARCVIEW Shape File format (GIS). The horizontal grid will be based on the NAD 83, New Jersey State Plan Coordinate System in an appropriate electronic format (e.g., Windows version of Excel spreadsheet) to be determined by the Contracting Officer's Technical Representative. Data will also be reported in the Delaware State Plan Coordinate System and latitude and longitude.

Results shall be presented in graphical or tabular form to provide easy comparisons between sampling sites. The report shall be publishable and present the data, analysis, and discussions of this study. All data shall be presented in, but not be limited to, graphical and tabular forms. The report shall include written discussions of, but not be limited to, the following sections:

Purpose/objective of the study
Methods
Results
Discussion
Conclusions

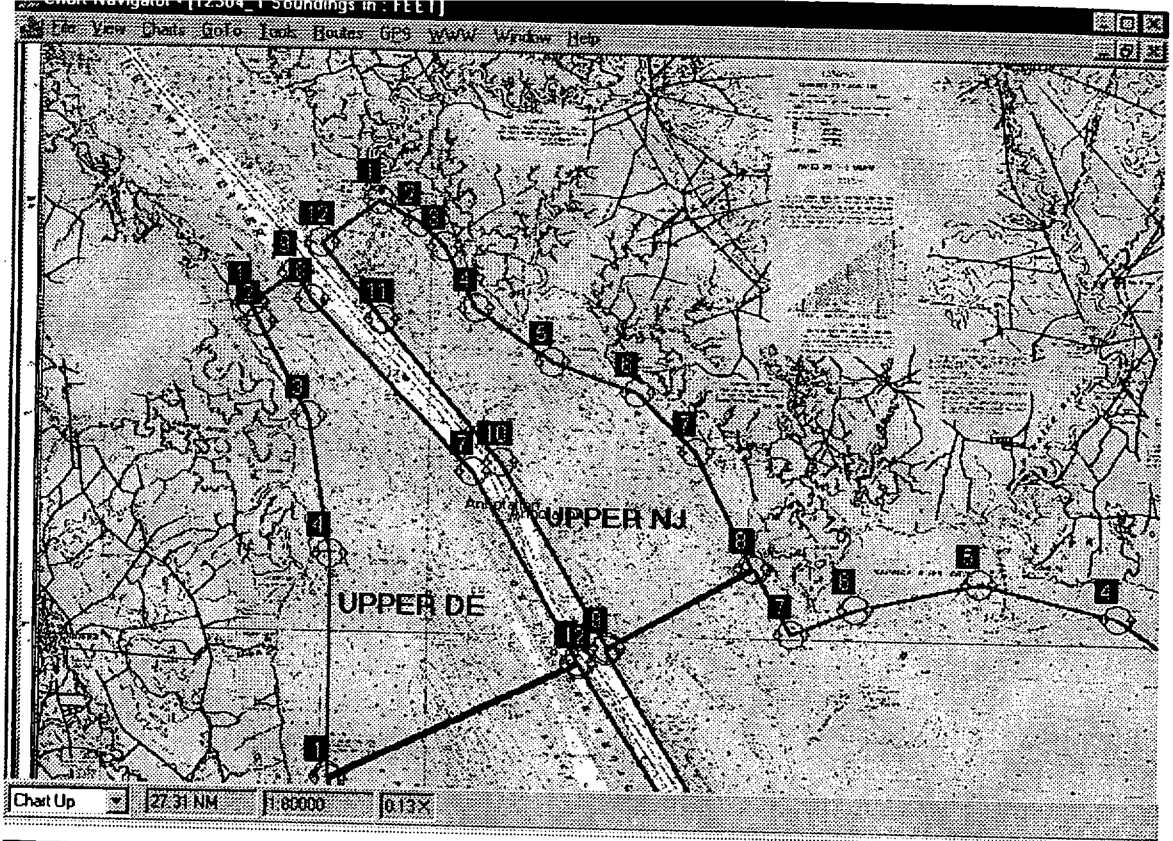
The conclusions sections shall evaluate the blue crab populations to determine the pre-construction baseline conditions. Original data sheets shall be provided in the appendices of the reports.

All figures, tables, maps, and charts shall be presented in the appendices, as appropriate. Appendices shall include original (dated) data sheets. The TITLE PAGE of each report shall include the date (month and year) the report was submitted, the project name, the author organization and/or client, and contract number. A TABLE OF CONTENTS, including a list of all Figures and Tables shall be presented in the report. The report shall be produced on 8 ½ X 11" paper, single-spaced, with double spacing between paragraphs. Figures shall be 8 ½ X 11" or folded 11 x 17" format sheet size. All text pages (including appendices) shall be

consecutively numbered. Text print quality will be letter quality in New Times Roman 12 point font. All references shall be properly cited in a bibliography at the end of the report text. In addition to the hard copies, each report will be submitted on a compact disk that is compatible with an IBM compatible PC using Microsoft Word 97.
The contractor will be available to make 1 presentation to coordinating agencies.

Submittals and Schedules:

A. Field sampling shall commence on or after January 1, 2001, and shall be completed within one month and no later than February 28, 2001.
B. The contractor shall provide 10 copies of a draft report to the Philadelphia District U.S. Army Corps of Engineers within two months after completing the field collections and no later than April 15, 2002.
C. The Corps will provide comments to the contractor within 45 calendar days of receipt of the draft report. The contractor is responsible for incorporating any changes to the draft documents.
D. The contractor shall provide 10 bound copies and 1 unbound, reproducible original copy of the final reports, as well as all electronic media, to the Philadelphia District Corps of Engineers within 30 days of receipt of comments. All tasks described under this scope shall be completed by 1 July 2001.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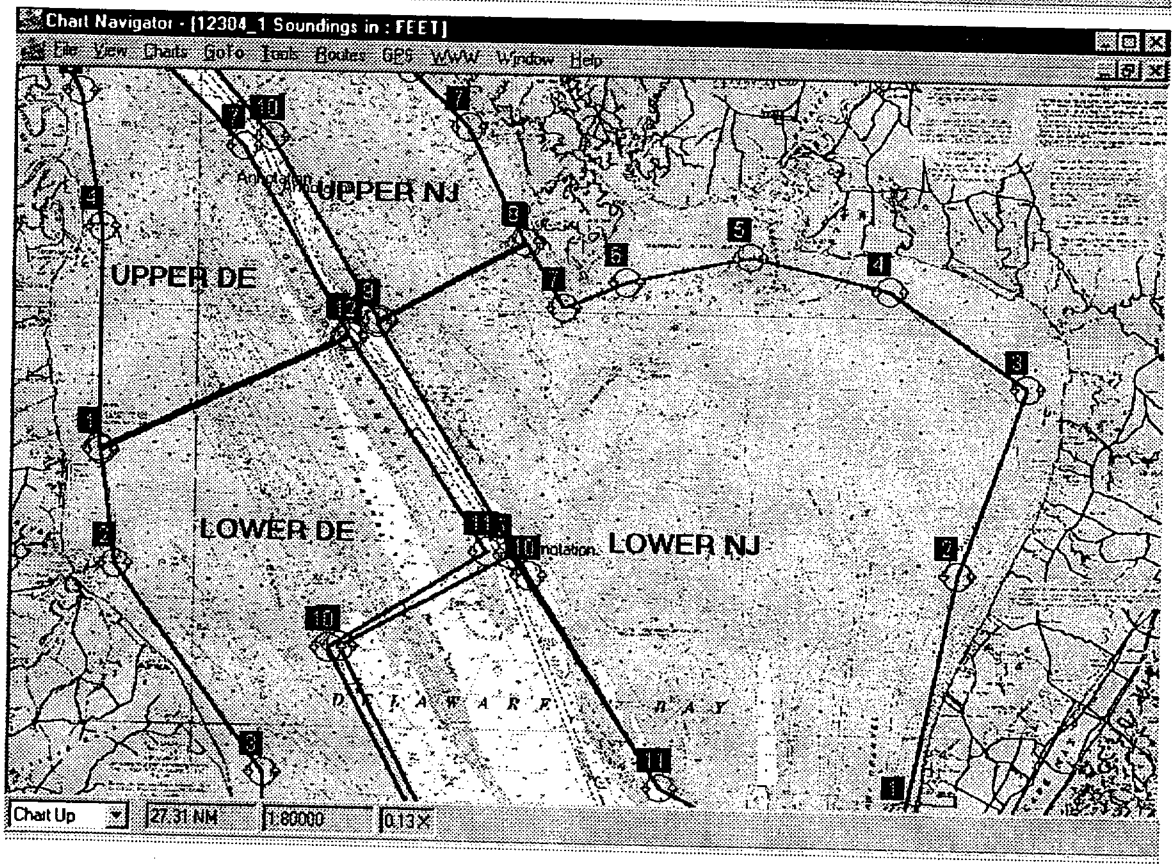
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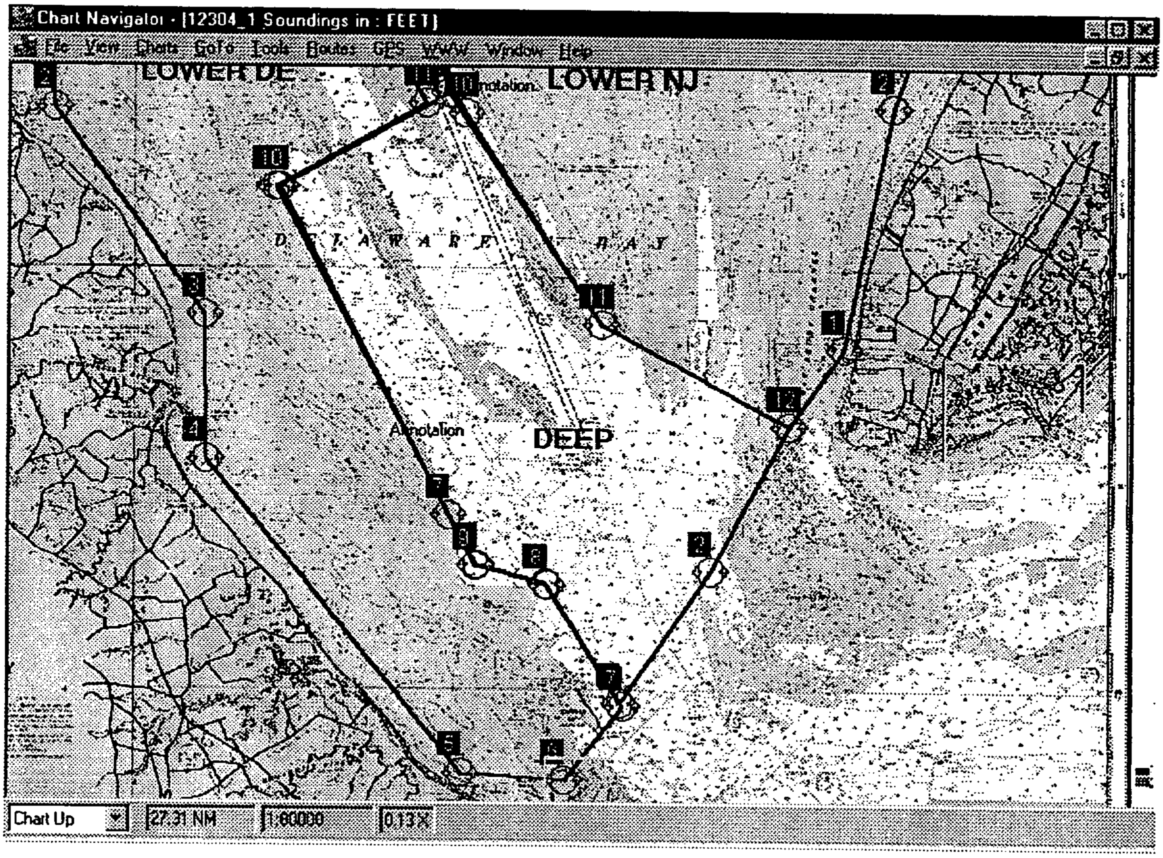
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DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

BIOLOGICAL ASSESSMENT:

EFFECTS OF ROCK BLASTING ON THE SHORTNOSE STURGEON (*Acipenser brevirostrum)*

PHILADELPHIA DISTRICT U.S. ARMY CORPS OF ENGINEERS

MAY 2000

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

BIOLOGICAL ASSESSMENT EFFECT OF ROCK BLASTING ON THE SHORTNOSE STURGEON (*Acipenser brevirostrum*)

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FIGURES

1.0 INTRODUCTION:

1.1 PURPOSE: Section 7 of the Endangered Species Act, as amended November 10, 1978, requires that a Biological Assessment be prepared on all major Federal actions involving construction when Federally listed or proposed endangered or threatened species may be affected. The purpose of this assessment is to examine the potential impacts associated with rock blasting on the endangered shortnose sturgeon (*Acipenser brevirostrum)* that will be under taken as part of the Delaware River Main Channel Deepening Project conducted by the Philadelphia District.

1.2 ENDANGERED SPECIES ACT: This "biological assessment" is part of the formal consultation process provided under Section 7 of the Endangered Species Act. Detailed procedures for this consultation process are defined in 50CFR402.

1.3 JEOPARDIZED SPECIES: The primary concern with the shortnose sturgeon is whether or not impacts associated with rock blasting will "jeopardize their continued existence." Federal regulation defines this term as "engaging in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of that species."

2.0 CHRONOLOGY OF EVENTS LEADING UP TO THIS ASSESSMENT:

In September 1995 the Philadelphia District initiated formal consultation under Section 7 of the Endangered Species Act of 1977 (16 U.S. C. 1531 et seq.), with regard to maintenance dredging of Delaware River Federal Navigation Projects from Trenton to the Sea, and potential impacts to the Federally endangered shortnose sturgeon. "A Biological Assessment of Federally Listed Threatened and Endangered Species of Sea Turtles, Whales, and the Shortnose Sturgeon within Philadelphia District Boundaries: Potential Impacts of Dredging Activities" was forwarded to NMFS for their review.

It was determined by the Corps that maintenance dredging activities in the southern reaches of the Delaware River, specifically from Philadelphia to the Sea, were not of concern with respect to impacting shortnose sturgeon. The area, between Philadelphia and Wilmington, was considered the "pollution zone" and was only utilized as a migratory route by adults during the early spring and late fall. This area is no longer considered a pollution zone and may be utilized by shortnose sturgeons (Green, 2000). South of Wilmington the shortnose sturgeon population is limited to adults due to increased salinity.

The Corps has followed certain recommended dredging windows established by the Delaware River Basin Fish and Wildlife Management Cooperative (Cooperative), and has conducted informal consultation for maintenance dredging activities. The Cooperatives' Fisheries Technical Committee (FTC) decided to implement the following restrictions as part of the Cooperatives Dredging Policy effective as of April 1997:

Hydraulic dredging, is prohibited from the Delaware Memorial Bridge to the Kinkora Range in non-Federal areas between April 15th and June 21st. No hydraulic dredging restrictions exist for the Federal channel or anchorages.

Overboard disposal and blasting are prohibited from the Delaware Memorial Bridge to the Betsy Ross bridge in all areas between March 15th and November 30. Bucket dredging is prohibited from March 15 to May 31 from the Delaware Memorial Bridge to the Kinkora Range. In all areas in the Delaware Bay to the Delaware Memorial Bridge, turtle monitors are required from June 1 to November 30 on hopper dredges.

A Biological Opinion was issued by the NMFS on November 26, 1996 (Montanio, 1996) for all dredging projects permitted, funded, or conducted by the District. The Opinion stated that dredging projects within the Philadelphia District may adversely affect sea turtles and shortnose sturgeon, but are not likely to jeopardize the continued existence of any threatened or endangered species under the jurisdiction of the NMFS. For projects within the Philadelphia District, the anticipated incidental take by injury or mortality is three (3) shortnose sturgeon.

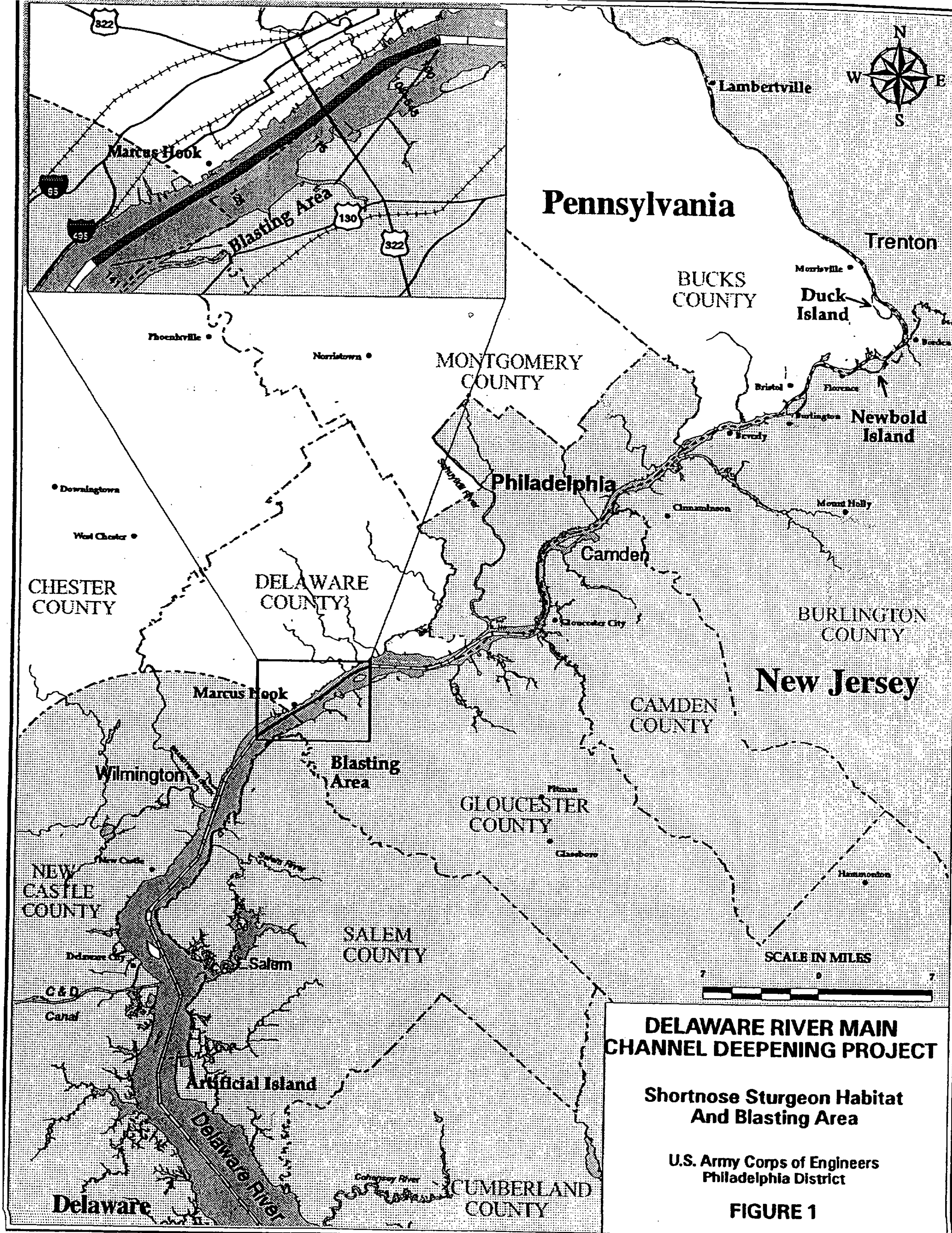
In letters dated 14 February 1997 and 29 December 1997, the United States Department of Commerce, the parent agency of the National Marine Fisheries Service (NMFS) stated that the Biological Opinion issued by the NMFS does not cover blasting. They further stated that sea turtles and marine mammals are not likely to be found in the Marcus Hook area where blasting will occur, but shortnose sturgeon may be found in the area. This is due in part to the fact that the Chester – Philadelphia "pollution zone no longer exists (Fruchter, 1997). They requested that the Corps continue to coordinate with the NMFS to ensure compliance with the requirements of the Endangered Species Act. This environmental assessment is in response to that request.

3.0 PROJECT DESCRIPTION AND LOCATION.

Approximately 70,000 cubic yards of bedrock from the Delaware River, covering 18 acres near Marcus Hook, Pennsylvania (River Mile 76.4 to River Mile 84.6) (see figure 1), would be removed to deepen the navigation channel to a depth of 47-ft mean low water. Blasting operations would occur up to five days a week between 1 December and 15 March, but the actual blasting would only occur for a brief period each day (Philadelphia District, 1997).

4.0 BIOLOGY DISTRIBUTION AND STATUS RELATED TO THE PROJECT.

4.1 Population Information: Shortnose sturgeon occur in the Delaware Estuary from the lower bay upstream to at least Lambertville, New Jersey (River Mile 148). Preliminary population estimates by Hastings (1987) indicate that the adult population of shortnose sturgeon in the upper tidal Delaware River is between 6,000 and 14,000



DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Shortnose Sturgeon Habitat And Blasting Area

U.S. Army Corps of Engineers
Philadelphia District

FIGURE 1

individuals. A draft recovery plan estimates the Delaware River population at 6,408 (adults only) (NMFS, 1996).

Tagging studies done by O'Herron et al. (1993) show that the most heavily used portion of the river appears to be between river mile 118 below Burlington Island and the Trenton Rapids at river mile 137.

Sturgeon overwinter from November to March in dense sedentary aggregations in the upper tidal reaches of the Delaware between river mile 118 and river mile 131, especially near Duck Island and Newbold Island. However, as opposed to shortnose sturgeon in Maine rivers, Delaware River shortnose sturgeon do not appear to remain as stationary during overwintering periods. Therefore, their use of the river is difficult to predict. Refer to figure 1 for the locations of important shortnose sturgeon habitat.

Spawning occurs in late March through April, between Trenton and at least the Scudders Falls area. During this period, males appear to stay on the spawning grounds for a longer time than do the females, a week or so as opposed to a few days, respectively (O'Herron and Hastings, 1985). In late spring and early summer, after spawning, shortnose sturgeon move rapidly downstream at least as far as Philadelphia. Additional information shows that improving water quality in the Philadelphia area has resulted in increase use of the lower river by shortnose sturgeon. Historically, they were rare in this area, possibly due to poor water quality. Many adult shortnose sturgeon return upriver to between river mile 127 and 134 within a few weeks, while others gradually move to the same area over the course of the summer (O'Herron, 1993). By November, adult shortnose sturgeon have returned to the overwintering grounds near Duck Island and Newbold Island.

Little is known about the movements of larvae and young-of-year shortnose sturgeon in the Delaware River, and nursery habitat has not been identified (Montanio, 1996; O'Herron, 2000). However Dadswell reports (1984) that post spawning adults and juvenile young of the year in other river systems move downstream to tidal areas and concentrate at, or just upstream of, the salt front during the summer months (June through August). The summer concentration zone in Winyah Bay estuary in South Carolina corresponds to the area with a salinity of 0.5 to1.0 ppt. Here the juveniles spend the next 2 to 8 years of life, moving up and down stream with the movements of the salt wedge until they reach a size of approximately 45 centimeters. O'Herron (2000) believes that the juveniles could range between Artificial Island (river mile 54) and the Schuylkill River (river mile 92) with the juveniles being closer to the downstream boundary during the winter when river freshwater input is normally greater.

4.2 Foraging: According to Dadswell (1984), shortnose sturgeon appear to be strictly benthic feeders. Adults eat mollusks, insects, crustaceans and small fish. Juveniles eat crustaceans and insects. In the Delaware River, Asiatic river clam (*Corbicula manilensis*) is considered to be the primary food source for the shortnose sturgeon (O'Herron and Hastings, 1985). *Corbicula* is widely distributed at all depths in the upper tidal Delaware River, although it is considerably more numerous in the shallows on both sides of the river than in the navigation channels.

Feeding in freshwater is largely confined to periods when water temperatures exceed 10 degrees C (Dadswell, 1979 and Marchette and Smiley, 1982). In general, feeding is heavy immediately after spawning in the spring and during the summer and fall, and lighter in the winter.

Juveniles feed primarily in 10 to 20 m deep river channels, over sandy-mud or gravel-mud bottoms (Pottle and Dadswell 1979). However, little is known about the specific feeding habits of juvenile shortnose sturgeon in the Delaware River because attempts to locate them in the upper tidal river have been unsuccessful (NMFS, 1996).

4.3 Overwintering: In the Delaware River, shortnose sturgeon form dense overwintering aggregates between river mile 118 and 131, especially in the Duck Island and Newbold Island area. One was found in the winter of 1985-1986 off Duck Island on the New Jersey side of the channel (O'Herron and Able, 1986). Tagging studies by Brundage (1986) also support this finding. According to O'Herron's study, the overwintering fish were generally active, appearing at the surface and even breaching through the skim ice. Tagging studies by O'Herron et al. (1993) found that the typical overwintering movements of the shortnose sturgeon are fairly localized. Based upon sonic survey data, they appear to remain within 1.24 river miles of the aggregation site (O'Herron and Able, 1986). This data applies to adult shortnose sturgeon; the location of the juvenile shortnose sturgeon is not known, but is believed to be on the fresh side of the oligohaline/fresh water interface (0.5 ppt) (O'Herron, 2000).

5.0 ASSESSMENT OF POTENTIAL IMPACTS

Blasting could impact the shortnose sturgeon in two ways: physical injury or mortality to individual fish, and damage to habitat.

5.1 Physical Injury

Several studies have demonstrated that underwater blasting can cause fish mortality (Teleki and Chamberlain 1978, Wiley et al. 1981, and Burton 1994). These studies have shown that size of charge and distance from detonation are the two most important factors in determining fish mortality from blasting. Depth of water, type of substrate, and the size and species of fish present also affect the number of fish killed by underwater explosions.

Teleki and Chamberlain (1978) conducted blasting mortality experiments in Long Point Bay, Lake Erie, at depths of 4 to 8 m. Fish were killed in radii ranging from 20 to 50 m for 22.7-kg charges and from 45 to 110 m for 272-kg charges during 28 monitored blasts. Explosives were packed into holes bored into the lake bottom. The kind of substrate determined the decay rate of the pressure wave, and mortality differed by species at identical pressure. Teleki and Chamberlain (1978) presented their results for several species in terms of 10% and 95% mortality radii (i.e., radii at which 10% and 95% of the caged fish were killed).

Wiley et al. (1981) measured the movement of fish swim bladders to estimate blast mortality for fish held in cages at varying depths during midwater detonations of 32-kg explosives in the Chesapeake Bay. Pressure gages were placed in cages that contained spot (*Leiostomus xanthurus)* and white perch (*Morone americana*). The study was conducted at the mouth of the Patuxent River in depths of about 46 m. Using data collected during 16 blasts, Wiley and colleagues predicted the distances at which 10%, 50%, and 90% mortality of white perch occurred. For 32-kg charges, the pressure wave was propagated horizontally most strongly at the depth at which the explosion occurred.

Burton (1994) conducted experiments on the Delaware River to estimate the effects of blasting to remove approximately 1,600 cubic yards of bedrock during construction of a gas pipeline. Charges of 112 and 957 kg of explosives were detonated in the river bed near Easton, Pennsylvania, during July 1993 in depths ranging between 0.5 and 2.0 m. Smallmouth bass (*Micropterus dolomieui)* were caged at a range of distances from the blasts. In the larger of the two blasts all fish in cages positioned farther than 24 meters (78 feet) from the blast survived

In Wilmington Harbor, Wilmington, North Carolina, studies were done to determine the impacts of blasting on shortnose sturgeon (Wilmington District, 2000). To determine the impacts of blasting on shortnose sturgeon and size of the LD1area (the lethal distance from the blast where 1 % of the fish died), test blasting was performed in Wilmington Harbor in the fall/winter of 1998/99. During test blasting, 50 hatchery reared shortnose sturgeon were placed in cages (2 feet diameter by 3 feet long plastic cylinders) 3 feet from the bottom (worst case survival scenario for blast pressure as confirmed by test blast pressure results) at 35, 70, 140, 280 and 560 feet up and downstream of the blast. Also, 200 caged sturgeon were held at a control location about 1/2mile from the blast location. The caged fish had a mean weight of 55 grams and were young of the year fish. Sturgeon cages were enclosed in a 0.6 inch nylon mesh sock to prevent any sturgeon from escaping if the cage was damaged. This was necessary for preservation of the genetic integrity of the resident fish population since the hatchery reared shortnose sturgeon were not the same subspecies as the shortnose sturgeon in the Cape Fear River. Stemming and an approximate 25 msec delay between holes were used with 52-62 pounds of explosives per hole. Stemming is the use of a selected material, usually angular gravel or crushed stone, to fill a drill hole above the explosive. Stemming is commonly used to contain the explosive force and increase the amount of work done on the surrounding strata. Large explosive charges can be broken into a series of smaller charges by use of timing delays (Keevin and Hempen, 1997).

There were 3 test blasts with an air curtain in operation and 4 without an air curtain in operation. An air curtain is a stream of air bubbles created by a manifold system on the river bottom surrounding the blast. In theory, when the blast occurs the air bubbles are compressed, and the blast pressure is reduced outside the air curtain. The air curtain when tested, was 50 feet from the blast.

The caged fish were visually inspected for survival just after the blast and after a 24hour holding period. The survival pattern just after the blast and after the 24 hour holding period were similar. Survival at the monitoring locations 140 feet and beyond just after the blast (with or without air curtain) was not significantly different. This 140 foot distance equals 2.1 acres and would be the edge of the LD1. Necropsies performed on the sturgeon also indicate that the impact area would not exceed 2.1 acres (Moser, 1999). A blast in the rock was calculated to be 0.014 of a blast in open water. In other words a 52 to 62 pound blast in rock is equivalent to a 0.73 to 0.87 pound blast in open water (Wilmington District, 2000).

5.2 Habitat.

Tagging studies done by O'Herron et al. (1993) show that the most heavily used portion of the river appears to be between river mile 118 below Burlington Island and the Trenton Rapids at river mile 137, which is about 33 river miles above the blasting project which is located below river mile 84.6. Spawning habitat has been located above Trenton, New Jersey (O'Herron and Hastings, 1985), about river mile 131. This is over 46 river miles above the blasting and should not be impacted. Overwintering concentrations of adult shortnose sturgeon have been found between river mile 118 and 131 (NMFS, 1996) which is also over 33 river miles from the blasting site which is located below river mile 84.6.

Shortnose sturgeon generally feed when the water temperature is greater than 10° C (Dadswell, 1979 and Marchette and Smiley, 1982) and in general, feeding is heavy immediately after spawning in the spring and during the summer and fall, and lighter in the winter (NMFS, 1996). Since this project is planned for the winter months, there should be no impact on sturgeon foraging. The Asiatic river clam (*Corbicula manilensis, or Corbicula fluminea*) is considered to be the primary food source for the shortnose sturgeon (O'Herron and Hastings, 1985). Fine clean sand, clay, and coarse sand are preferred substrates for this clam, although this species may be found in lower numbers on most any substrate (Gottfried, and Osborne, 1982; Belanger et al., 1985; Blalock and Herod, 1999). Gottfried and Osborne (1982) reported density as lowest on bottoms composed of silty organic sediments. Since the substrate is primarily rock, it is not considered prime habitat for the Asiatic clam; however, Scott (1992) found high numbers (2596.14 per square meter) of *Corbicula* below Conowingo Dam on gravel and bedrock substrates in the Susquehanna River. The high densities may be the result of the high oxygen concentrations immediately below the dam. Much lower concentration (512 clams per square meter) were found in Florida in its preferred sand habitat (Blalock, H.N., and J.J. Herod. 1999). Any benthic organisms that occur on the rock that is removed by blasting would be destroyed. The impact should not extend beyond the area of immediate impact since previous studies indicate that invertebrates are insensitive to pressure related damage from underwater explosions, which may be due to the fact that all the invertebrate species tested lack gas-containing organs which have been implicated in internal damage and mortality in vertebrates (Keevin and Hempen, 1997). Although there is no known information about invertebrate recovery time after blasting, data from other disturbances indicates that the benthic communities should become reestablished on the underlying rock within 2 years or less (New York District, 1999). It is unlikely that the blasting of rock to deepen the navigation channel will have a significant impact on the food source of shortnose sturgeons since the fish do light foraging during the time period when blasting would occur (winter) and since *Corbicula,* their favorite food source, is wide spread in the fresh water portion of the Delaware Estuary in more preferred habitats.

5.3 Juvenile Shortnose Sturgeon.

Very little data exists about the location of juvenile shortnose sturgeon. In other river systems, they are found upstream of the salt water – freshwater boundary (0.5 to 1.0 ppt) (Dadswell, et al., 1984). In the Delaware River, the location of the juvenile shortnose sturgeon is not known, but is believed to be on the fresh side of the oligohaline/fresh water interface (0.5 ppt). During the year, juvenile sturgeon could be found between Artificial Island (rm 54) and the Schuykill River (rm 92) (O'Herron, 2000). The locations of selected isohalines were modeled for monthly average inflows and for regulated drought conditions from August to November (Philadelphia District, 1997). The average location of the maximum intrusion of the 0.5 ppt isohaline during monthly average infows for November was river mile 73.9 under current dredging and at river mile 88.9 during regulated drought conditions. Although no information is available, the 0.5 ppt isohaline would likely be downstream of the November location during December through March since larger freshwater inflows enter the river during this period. Nevertheless, it is possible that juvenile shortnose sturgeon could be present in the vicinity of the blasting and could be impacted.

6.0 ALTERNATIVES CONSIDERED

A number of alternatives were evaluated by the Philadelphia District using economic, engineering and environmental criteria and are discussed in detail in the *Final Interim Feasibility Report and Environmental Impact Statement* (Philadelphia District, 1992).

7.0 REASONABLE AND PRUDENT MEASURES TO MINIMIZE IMPACTS:

Information presented above indicates that there may be a potential impact to overwintering juvenile shortnose sturgeon from rock blasting performed between 1 December and 15 March, although the location of juveniles is not known. The measures listed below focus on preventing physical injury to juveniles that may be near the blasting area, but would likely protect the larger adult fish if any were present since there is evidence that smaller fish are more vulnerable to injury than larger fish (Philadelphia District, 1997). Studies have shown that size of charge and distance from detonation are the two most important factors in determining fish mortality from blasting (Teleki and Chamberlain 1978, Wiley et al. 1981, and Burton 1994). In addition, the measures listed below were used in North Carolina to successfully minimize impacts to shortnose sturgeon:

- Before each blast, four (4) sinking gillnets (5.5 inch mesh, 100 meters long) will be set to surround the blast area as near as feasible. These nets will be in place for at least 3 hours and none of the nets will be removed any sooner than 1 hour before the blast. This may require overnight sets. Any sturgeon removed (shortnose or Atlantic) will be released at a location approved by the National Marine Fisheries Service.

- Channel nets will be set downcurrent of the blast area within 10 minutes of blast discharge in order to capture and document dead or injured fish.

- Scare charges will be used for each blast. A scare charge is a small charge of explosives detonated immediately prior to a blast for the purpose of scaring aquatic organisms away from the location of an impending blast Two scare charges will be used for each blast. The detonation of the first scare charge will be at 45 seconds prior to the blast, with the second scare charge detonated 30 seconds prior to the blast. Some marine mammals and fish may not locate the origin of the first scare charge. The second scare charge allows these creatures to better locate the source of the charge and maneuver away from the source.

- Blast pressures will be monitored and upper limits will be imposed on each series of 5 blasts.

- Average pressure shall not exceed 70 pounds per square inch (psi) at a distance of 140 feet.

- Maximum peak pressure shall not exceed 120 psi at a distance of 140 feet.

- Pressure will be monitored for each blast only at a distance of 140 feet.

- Surveillance for schools of fish will be conducted by vessels with sonar fish finders for a period of 20 minutes before each blast, and if fish schools are detected, blasting will be delayed until they leave. The surveillance zone will be approximately circular with a radius of about 500 feet extending outward from each blast set.

8.0 CONCLUSIONS

There should be no significant impacts to shortnose sturgeon provided the measures listed above are implemented.

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DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Environmental Windows

U.S. Army Corps of Engineers, Philadelphia District

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT: ENVIRONMENTAL WINDOWS IN STATE OF DELAWARE RIVER PORTION (ABOVE PEA PATCH ISLAND, RM 62)																										
ACTIVITY	**RIVER MILE**	**RESOURCE**	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
			1 - 15	16 - 31	1 - 15	16 - 28	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31
BLASTING	76.4 to 84.6	All Fish*																								
		Shortnose Sturgeon*																								
BUCKET DREDGING	69 to 100	Anadromous Fish, Shortnose Sturgeon																								
HYDRAULIC AND HOPPER DREDGING	0 to 69	Sea Turtle Monitoring																								
DREDGING WITHIN 2600' OF PEA PATCH ISLAND	62	Wading Bird Colony																								

*** Monitoring will be done in association with blasting. Techniques will be used to limit the impacts of blasting on fish.**

Dredging/placement Restriction
Monitoring Required

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT: ENVIRONMENTAL WINDOWS IN STATE OF DELAWARE BAY PORTION - WETLAND RESTORATION AT KELLY ISLAND																										
ACTIVITY	**LOCATION OF WORK**	**RESOURCE**	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
			1 - 15	16 - 31	1 - 15	16 - 28	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31
SAND PLACEMENT	Wetland Restoration at Kelly Island (RM 30)	Horseshoe Crabs/Shorebirds																								
DREDGING	RM 24 - 37	Winter Flounder (below RM 35)	**(Potential Restriction) ***																							
HYDRAULIC DREDGING	RM 24 - 37	Sea Turtles (RM 0 - 69)																								
PRE-CONSTR. MONITORING	RM 24 - 37	Oyster beds near Main Channel (RM 15 - 54)	April 2000 to April 2001																							
PRE-CONSTR. MONITORING	RM 24 - 37	Oyster beds near Kelly Island (RM 30)	One year prior to construction of Kelly Island																							

*** Coordination must be completed with National Marine Fisheries Service.**

LEGEND	
	Dredging/Placement Restriction
	Monitoring Required

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT: ENVIRONMENTAL WINDOWS IN STATE OF DELAWARE

BAY PORTION - SAND PLACEMENT, PORT MAHON

ACTIVITY	LOCATION OF WORK	RESOURCE	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
			1 - 15	16 - 31	1 - 15	16 - 28	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31
SAND PLACEMENT	Port Mahon to Pickering Beach (RM 27 - 29)	Horseshoe Crabs/Shorebirds																								
		Sandbar Shark	No known restrictions*																							
DREDGING	RM 19.5 -23.5	Female Blue Crabs (below RM 22)	Potential Restriction **																							
DREDGING	RM 19.5 -23.5	Winter Flounder (below RM 35)	Potential Restriction *																							
HYDRAULIC DREDGING	RM 19.5 -23.5	Sea Turtles (RM 0 - 69)																								
PRE-CONSTR. MONITORING	RM 19.5 -23.5	Oyster beds near Main Channel (RM 15 - 54)	April 2000 to April 2001																							
PRE-CONSTR. MONITORING	RM 19.5 -23.5	Oyster beds near Kelly Island (RM 30)	One year prior to construction of Kelly Island																							

*** Coordination must be completed with National Marine Fisheries Service.**

**** Coordination must be completed with DNREC.**

LEGEND	
	Dredging/Placement Restriction
	Monitoring Required

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT:
ENVIRONMENTAL WINDOWS IN STATE OF DELAWARE
BAY PORTION - SAND PLACEMENT AT BROADKILL BEACH

ACTIVITY	LOCATION OF WORK	RESOURCE	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
			1 - 15	16 - 31	1 - 15	16 - 28	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31
SAND PLACEMENT	Broadkill Beach (RM 3)	Horseshoe Crabs/Shorebirds																								
		Sandbar Shark																								
DREDGING	RM 12 - 15	Female Blue Crabs (below RM 22)	Potential Restriction **																							
DREDGING	RM 12 - 15	Winter Flounder (below RM 35)	(Potential Restriction) *																							
HYDRAULIC DREDGING	RM 12 - 15	Sea Turtles (RM 0 - 69)																								
PRE-CONSTR. MONITORING	RM 12 - 15	Oyster beds near Main Channel (RM 15 - 54)	April 2000 to April 2001																							

*** Coordination must be completed with National Marine Fisheries Service.**

**** Coordination must be completed with DNREC.**

LEGEND	
	Dredging/Placement Restriction
	Monitoring Required

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT: ENVIRONMENTAL WINDOWS IN STATE OF DELAWARE

BAY PORTION - SAND PLACEMENT AT REHOBOTH AND DEWEY BEACHES

ACTIVITY	LOCATION OF WORK	RESOURCE	Jan 1 - 15	Jan 16 - 31	Feb 1 - 15	Feb 16 - 28	Mar 1 - 15	Mar 16 - 31	Apr 1 - 15	Apr 16 - 30	May 1 - 15	May 16 - 31	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 - 31	Aug 1 - 15	Aug 16 - 31	Sep 1 - 15	Sep 16 - 30	Oct 1 - 15	Oct 16 - 31	Nov 1 - 15	Nov 16 - 30	Dec 1 - 15	Dec 16 - 31
SAND PLACEMENT	Rehoboth & Dewey Beaches (Atlantic Coast)	Horseshoe Crabs/Shorebirds	No known restrictions																							
		Sandbar Shark	No known restrictions																							
DREDGING	RM 6 - 9 and RM 11 - 12	Female Blue Crabs (below RM 22)	Potential Restriction **																							
DREDGING	RM 6 - 9 and RM 11 - 12	Winter Flounder (below RM 35)	(Potential Restriction) *																							
HYDRAULIC DREDGING	RM 6 - 9 and RM 11 - 12	Sea Turtles (RM 0 - 69)																								
PRE-CONSTR. MONITORING	RM 6 - 9 and RM 11 - 12	Oyster beds near Main Channel (RM 15 - 54)	April 2000 to April 2001																							

*** Coordination must be completed with National Marine Fisheries Service.**

**** Coordination must be completed with DNREC.**

LEGEND	
	Dredging/Placement Restriction
	Monitoring Required

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Bathymetry Maps

U.S. Army Corps of Engineers, Philadelphia District

BATHYMETRY MAPS

The maps are presented in two groups. The first group covers the Delaware River from the Pennsylvania-Delaware state line downstream to the vicinity of the entrance to the Chesapeake and Delaware (C&D) Canal (Figures 1 through 6.) The second group covers the Delaware River and Bay from the C&D Canal entrance to the bay mouth at Cape Henlopen-Cape May (Figures 7 through 15.) Within each group, there is an index map followed by a series of inset maps. Inset maps are identified by "range name," and include information on range length, project stationing, and River Miles (RM) as adopted by Delaware River Basin Commission.

The maps were created from a National Ocean Service (NOS) database of hydrographic soundings for the Delaware River and Bay. These survey data were obtained by NOS in the period between 1983 and 1993. Survey coverage extends from the Delaware shoreline across the river and bay to the New Jeresey shoreline, for the entire length of the Delaware Estuary. In this regard, the NOS hydrographic surveys, although not as current as Corps of Engineers channel surveys, provide the most comprehensive spatial coverage, especially for areas outside of the regularly surveyed navigation channel.

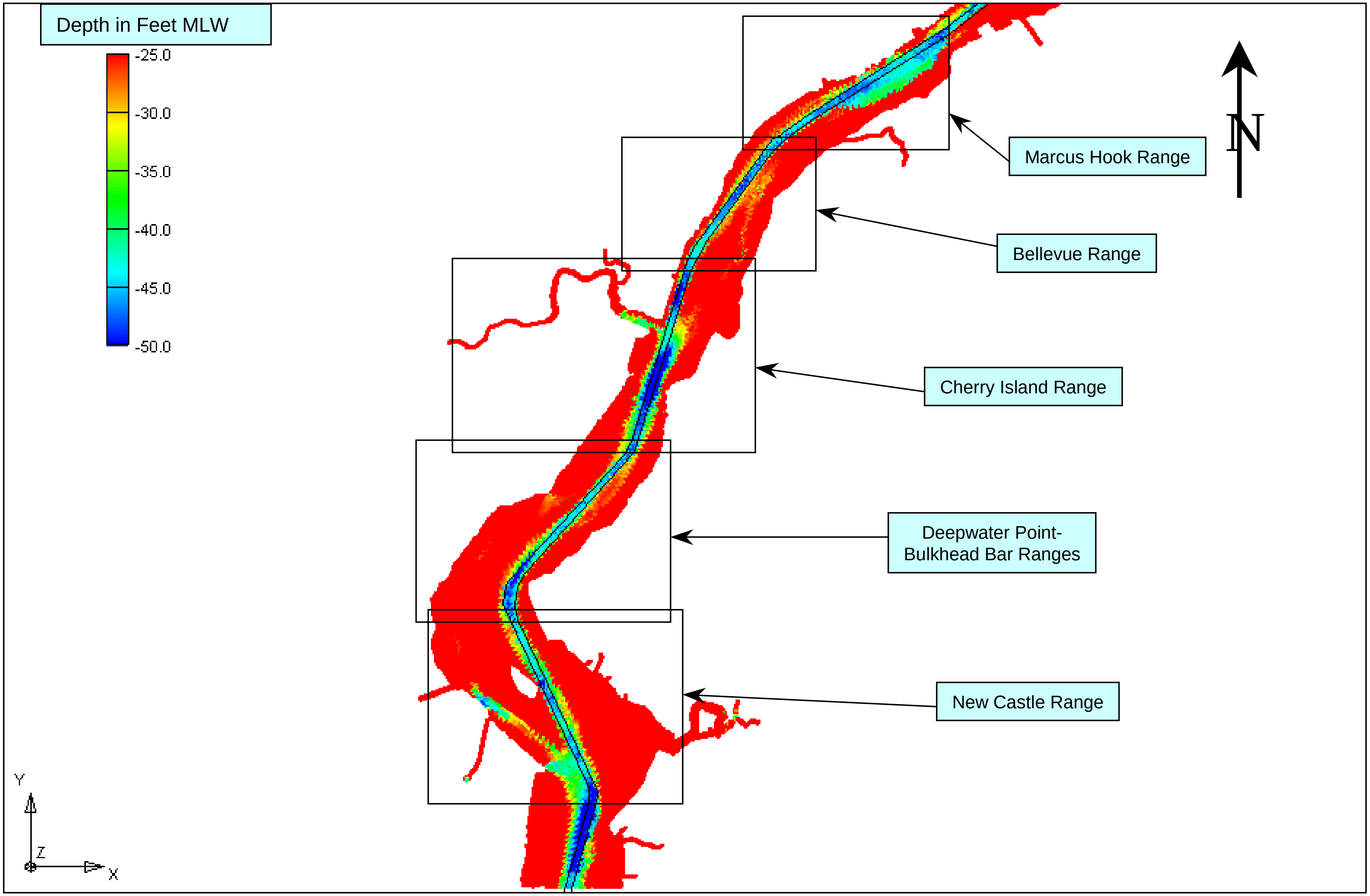
The sounding database used to create the Delaware River and Bay bathymetric maps included approximately 400,000 individual data points (i.e., soundings.) In order to create the graphical representations of the hydrographic survey data, the sounding data were first imported into a Corps of Engineers software package, the "Groundwater Modeling System" (GMS.) This software was used because of its ability to import, manipulate, and graphically display large geospatial data sets such as the river and bay bathymetry. Next, the east and west edges of the Delaware River navigation channel were imported into GMS, in order to show the channel in relation to adjacent areas of the estuary. Finally, a zone was defined extending several channel-widths on either side of the channel along its entire length, and an interpolated surface mesh was created within this zone. This step was performed in order to create a continuously color-contoured area in and adjacent to the channel, as opposed to simply displaying the scatter points.

Immediately below are three "sample" plots that illustrate the difference between scatter point data and meshed, contoured depth data. All three plots cover an identical portion of the Delaware River, in the general vicinity of the Christina River. Sample 1 displays scatter point data only, with the depth color-coded over the depth range of 25 to 50 feet below MLLW. Depths shallower than 25 feet MLLW are all red, and depths greater than 50 feet MLLW are all blue. Depths between 25 and 50 feet MLLW are coded by the range of colors between red through yellow, green, and cyan, to blue. Sample

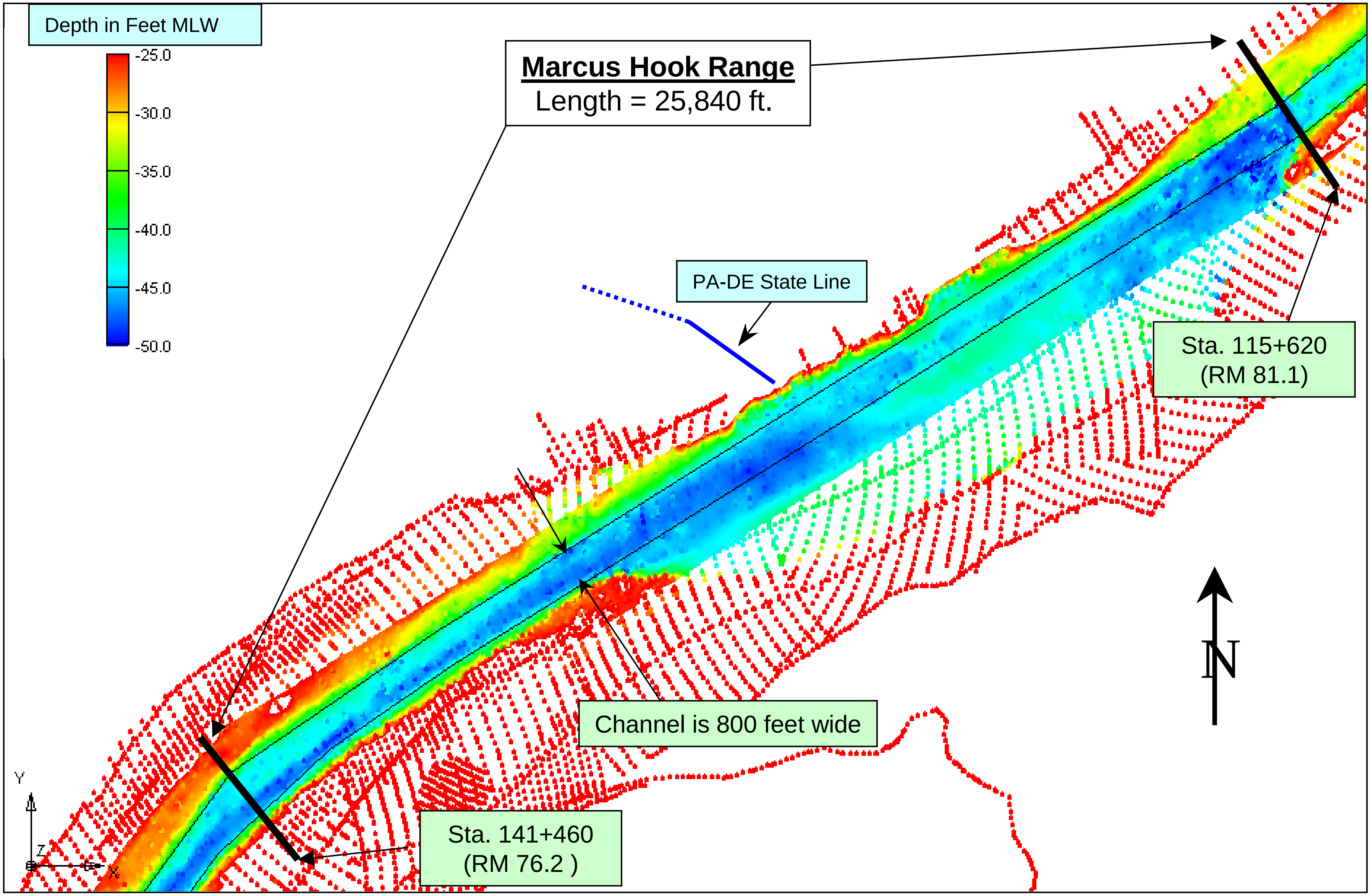
2 uses the same color scheme, but depicts only the zone on either side of the navigation channel for which the interpolated depth mesh was created. Open (clear) zones in the meshed area are either deeper than 50 feet MLLW (bounded by blue) or shallower than 25 feet MLLW (bounded by red). Sample 2 also shows the typical dimensions of mesh elements in the open areas. Sample 3 combines the scatter point and contoured, mesh data sets, and is the format for the index and inset maps included as Figures 1 through 15.

Each of the inset maps displays one navigation range, or a portion of a range, as in the case of Liston and Brandywine Ranges which are too long to display meaningfully on a single page. As explained above, the figures include both types of depth data – scatter points over the entire estuary, and contoured, meshed data in the zone adjacent to the navigation channel. Careful examination of the series of inset maps reveals that there is a wide range of depths adjacent to the navigation channel.

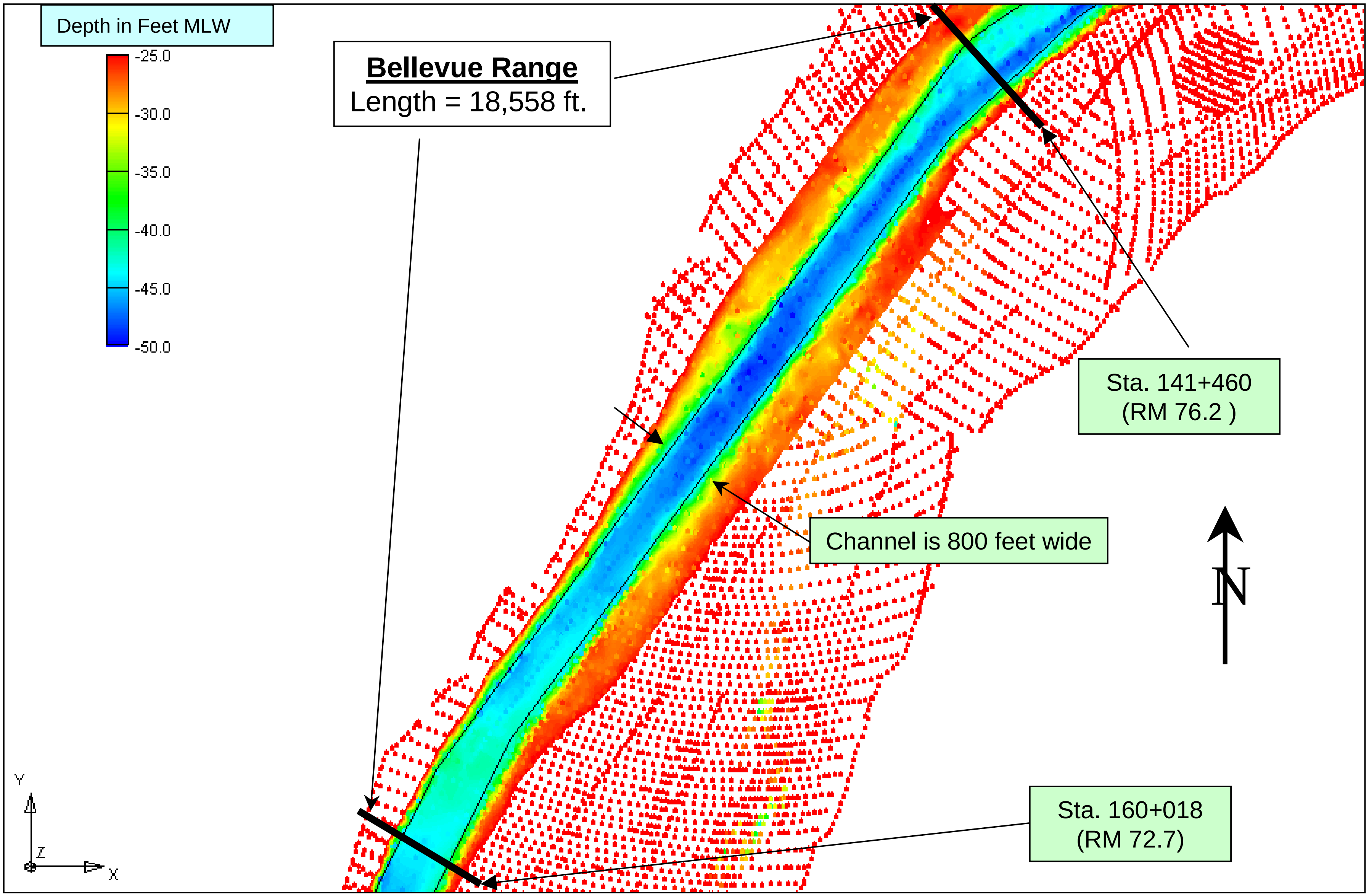
Delaware River, Philadelphia to the Sea Project:
Index Map: Existing Depths, PA-DE State Line to C&D Canal



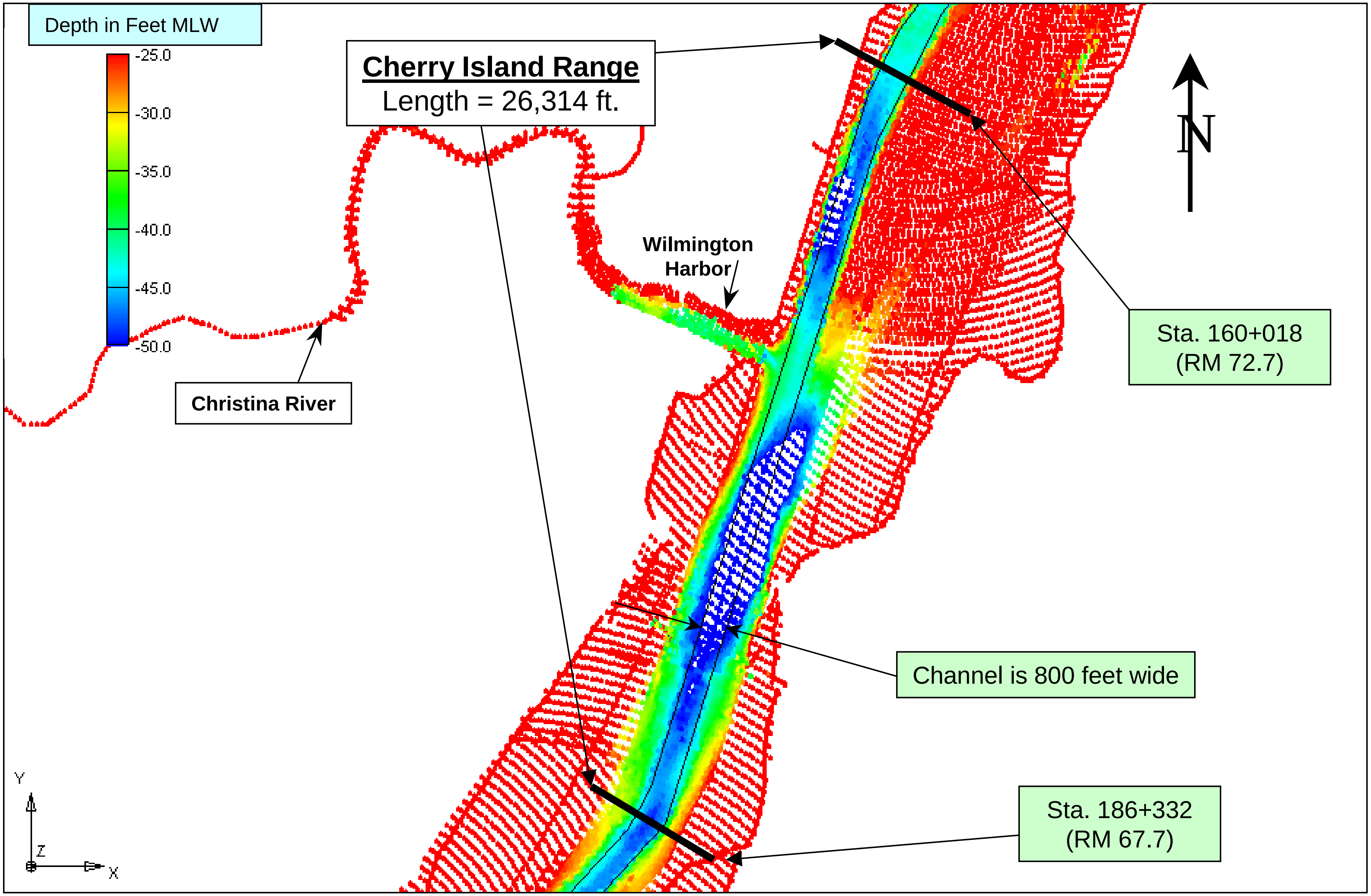
Delaware River, Philadelphia to the Sea Project:
Existing Depths, Marcus Hook Range



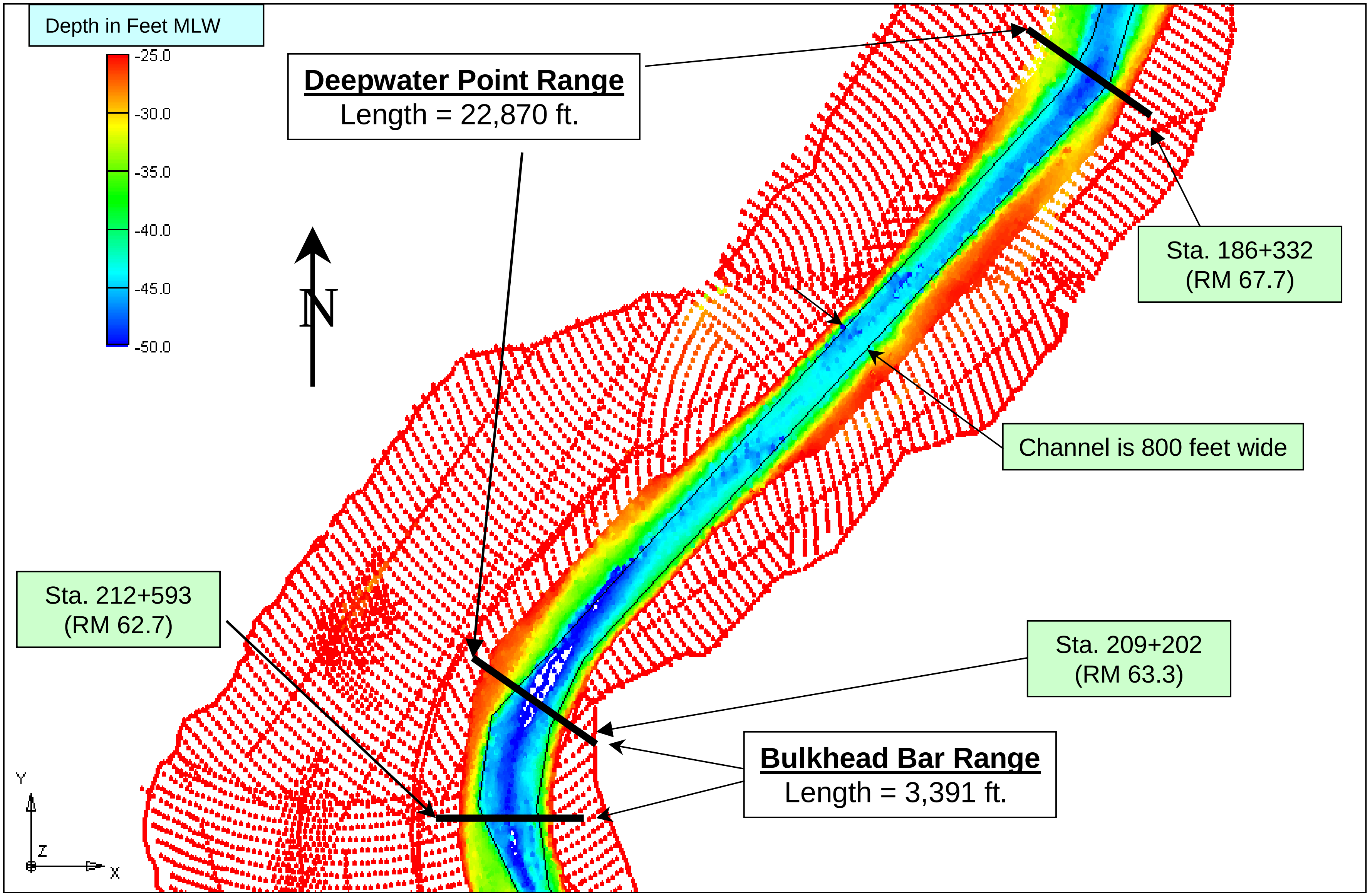
Delaware River, Philadelphia to the Sea Project:
Existing Depths, Bellevue Range



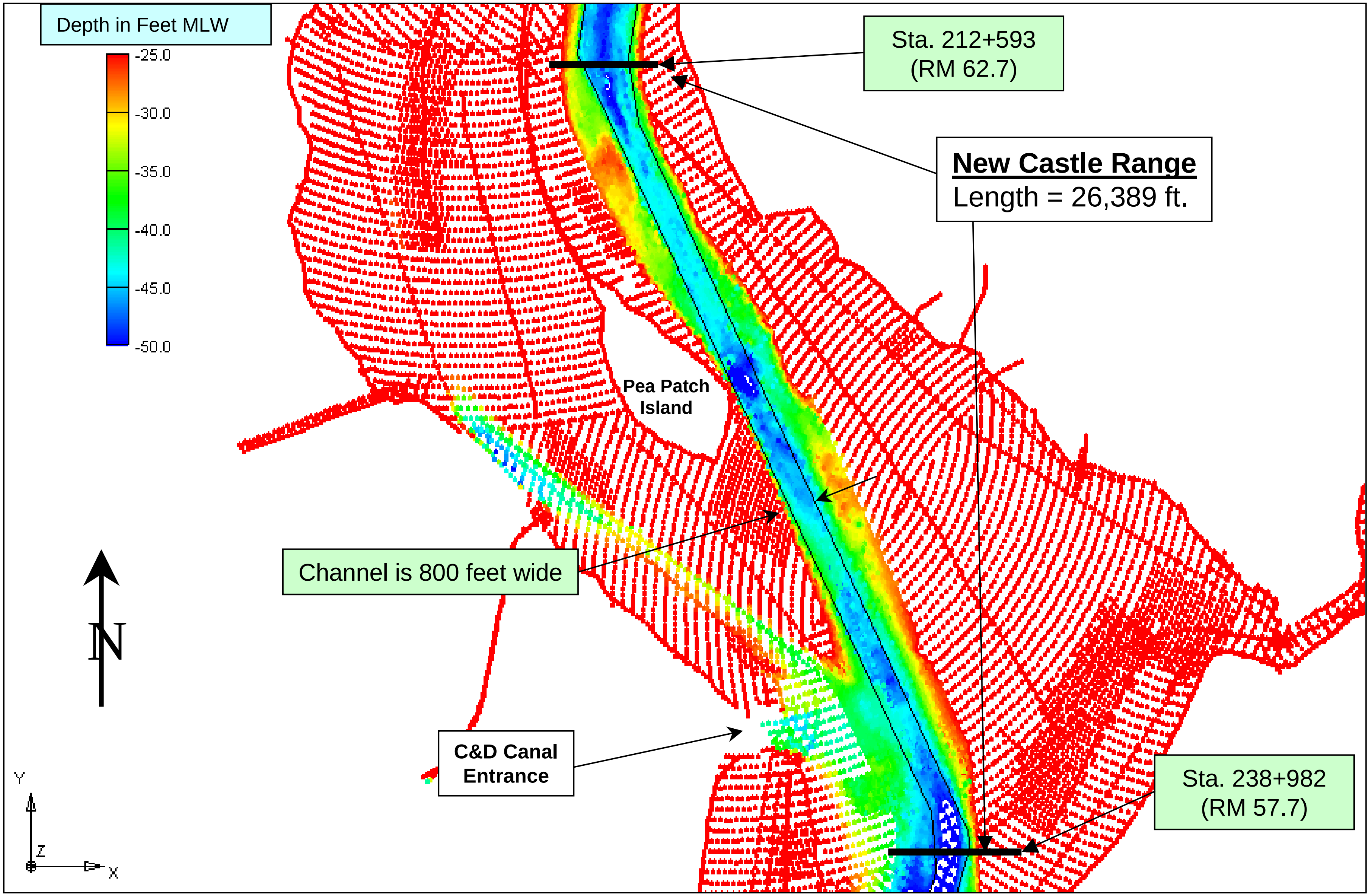
Delaware River, Philadelphia to the Sea Project:
Existing Depths, Cherry Island Range



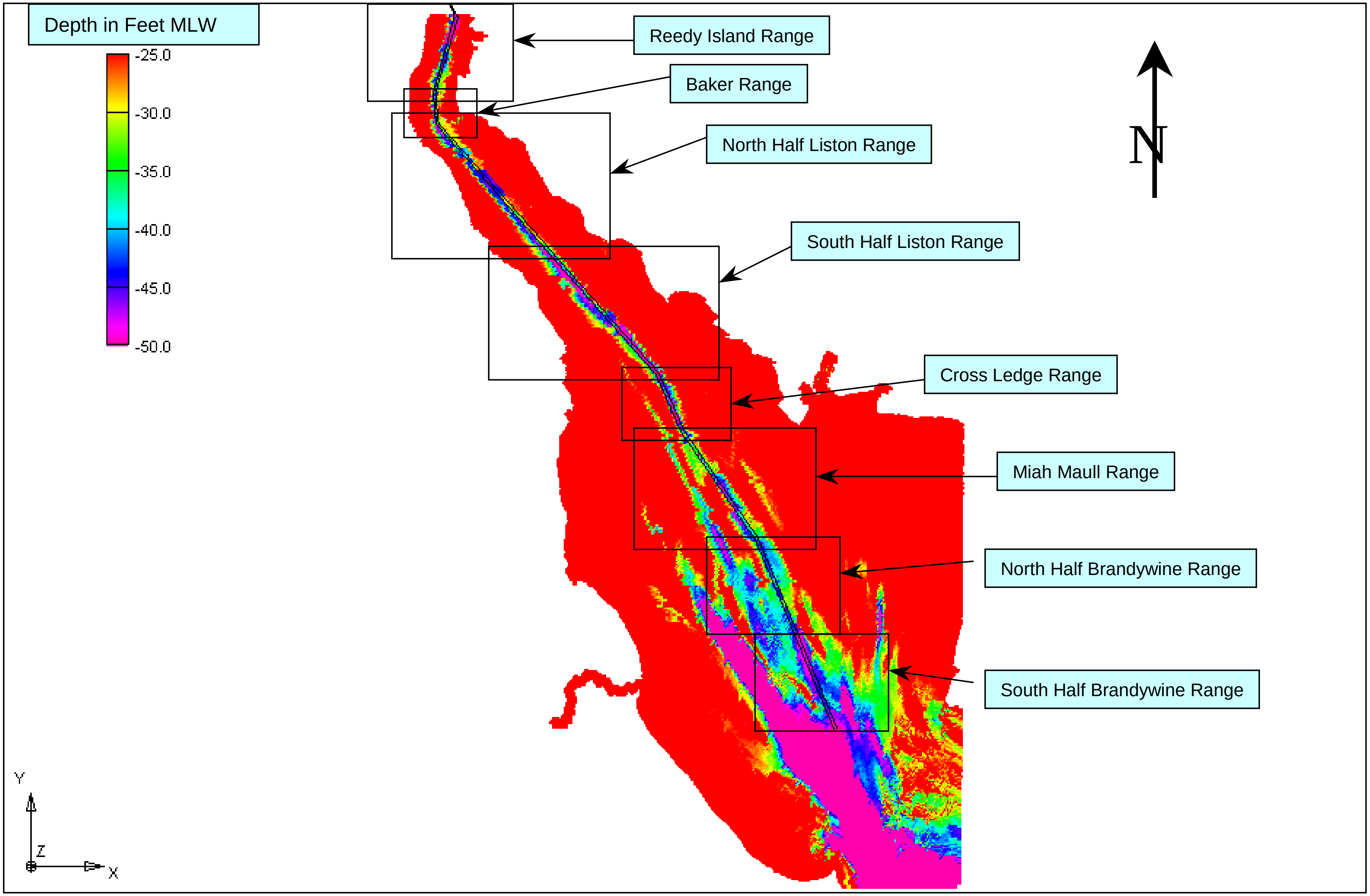
Delaware River, Philadelphia to the Sea Project:
Existing Depths, Deepwater Point & Bulkhead Bar Ranges



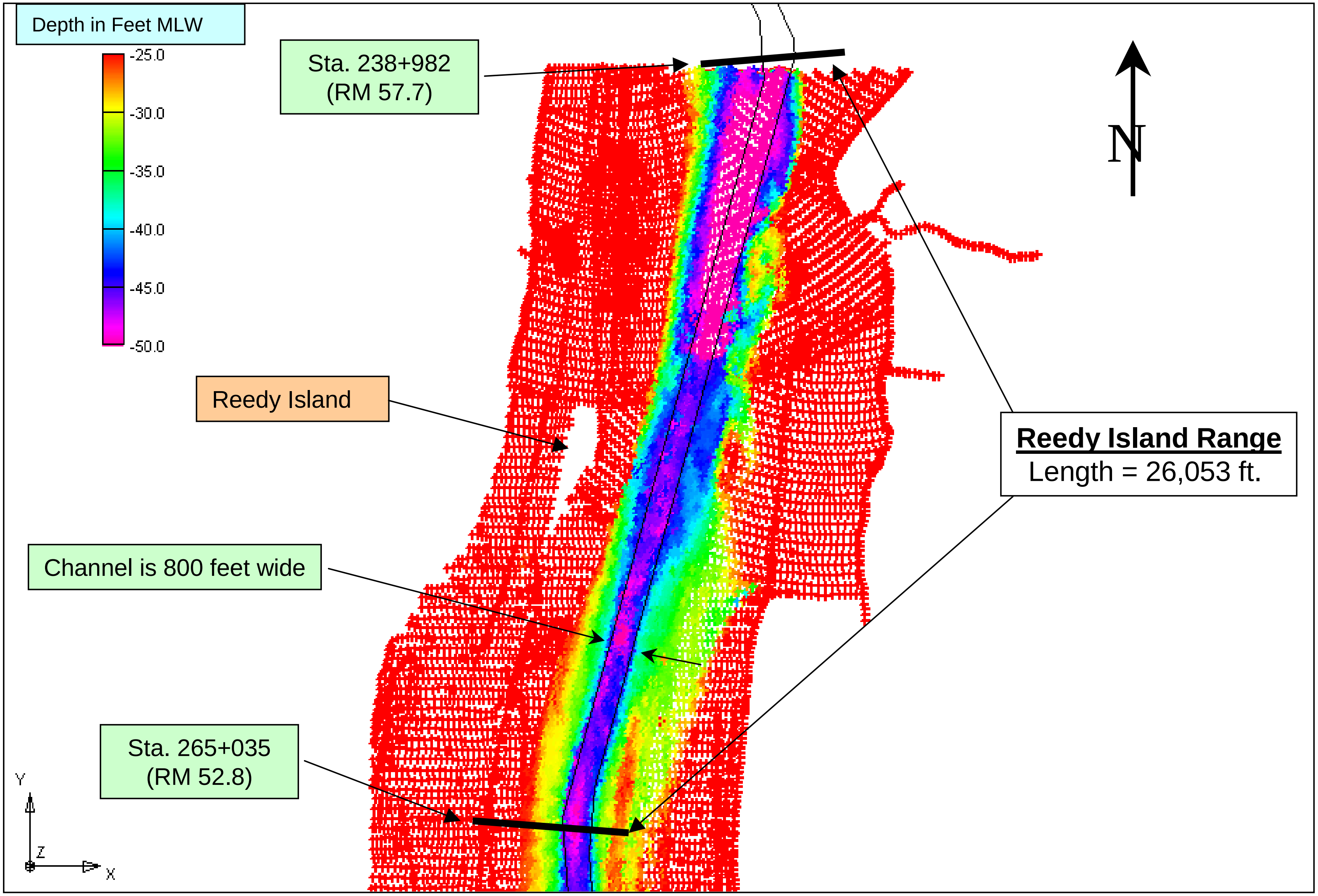
Delaware River, Philadelphia to the Sea Project:
Existing Depths, New Castle Range



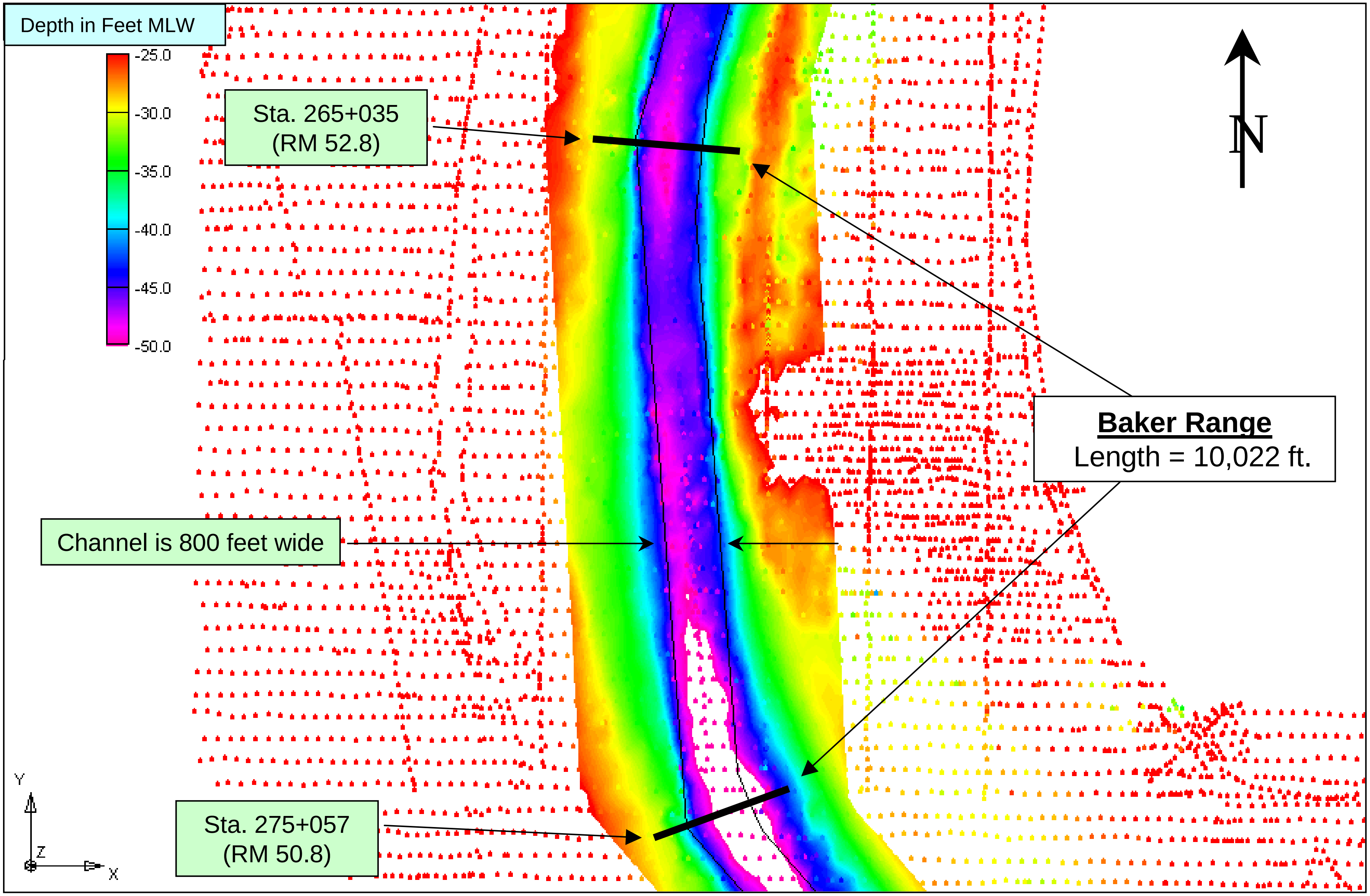
Delaware River, Philadelphia to the Sea Project:
Index Map: Existing Depths, C&D Canal to Bay Mouth



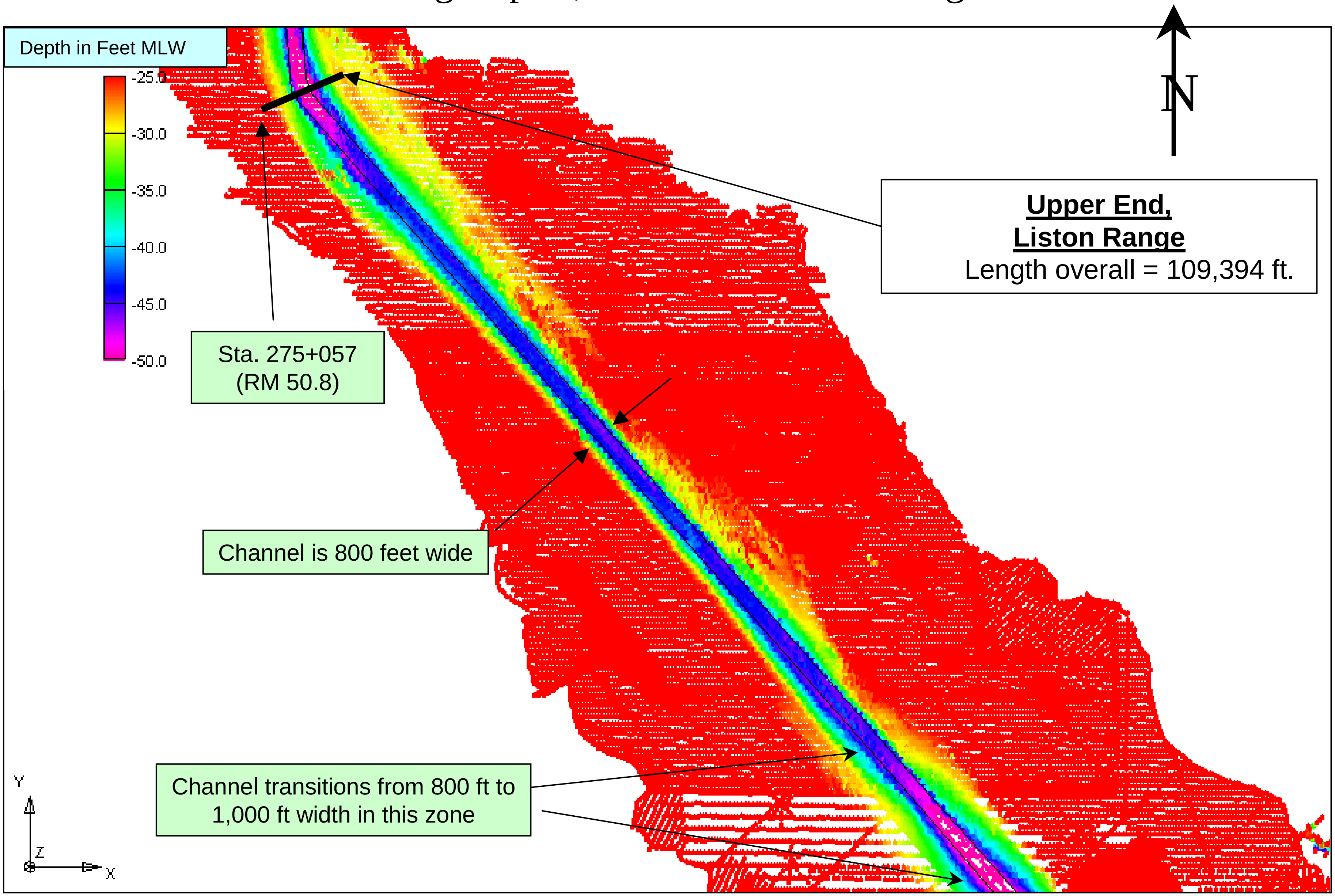
Delaware River, Philadelphia to the Sea Project:
Existing Depths, Reedy Island Range



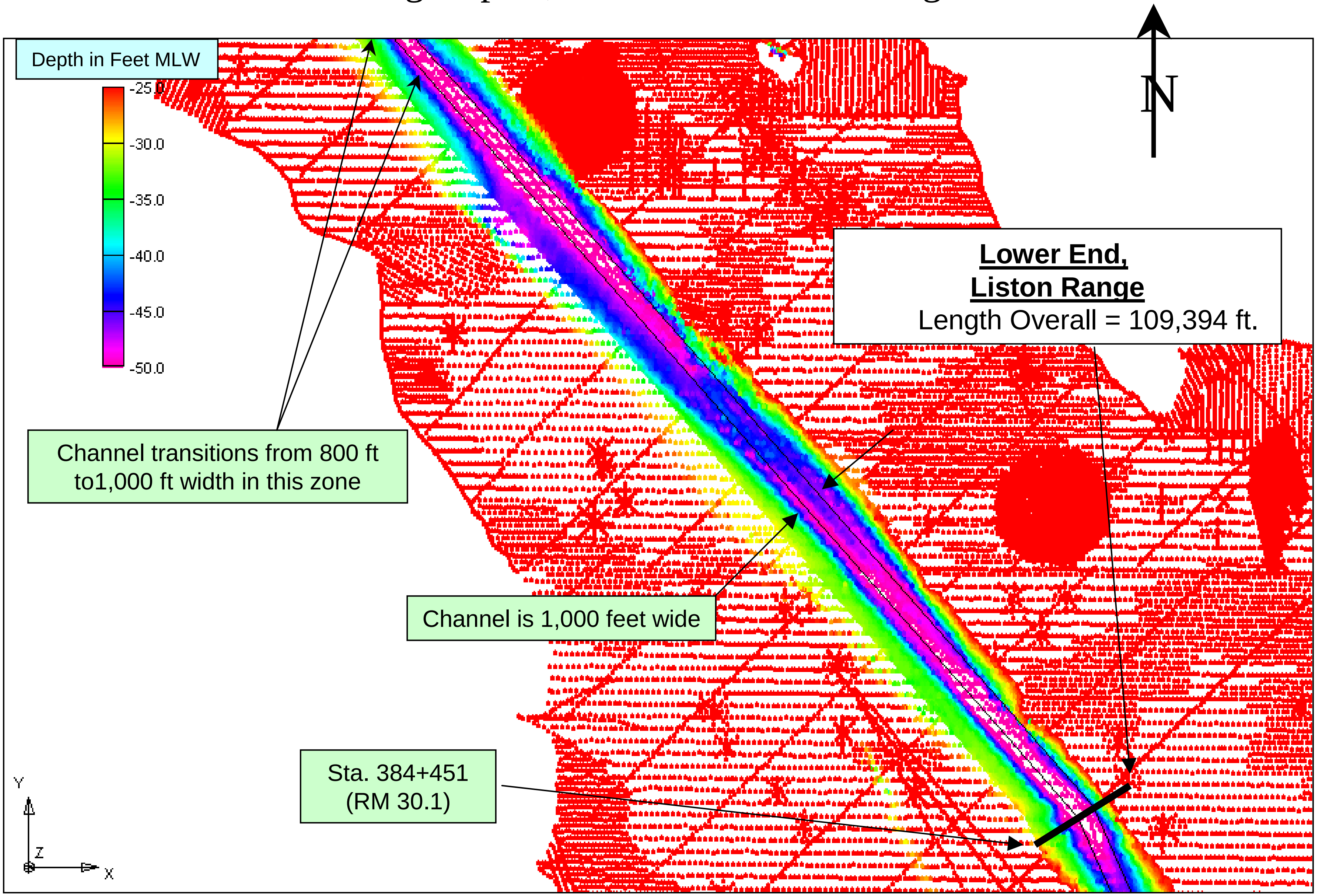
Delaware River, Philadelphia to the Sea Project:
Existing Depths, Baker Range



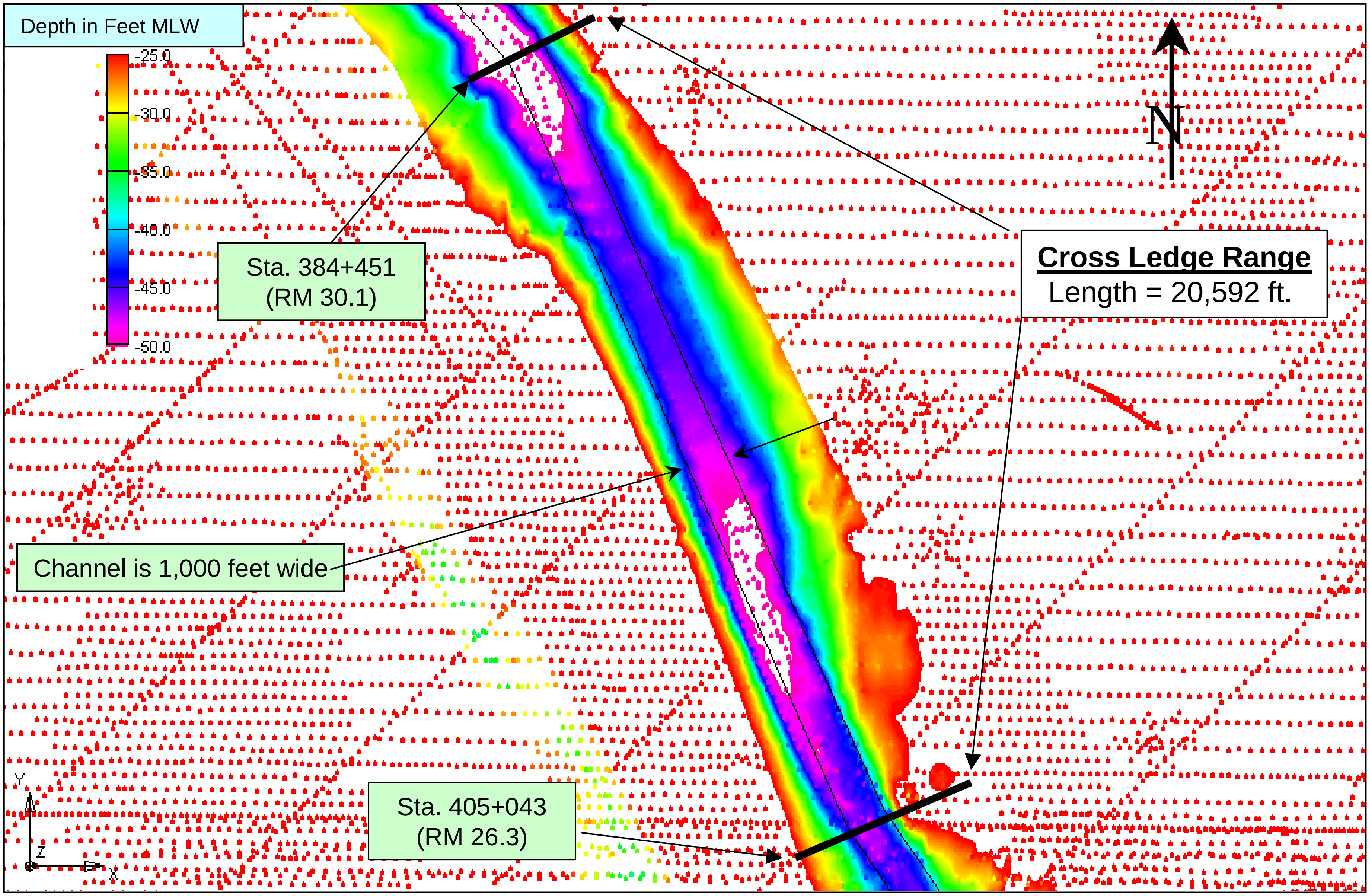
Delaware River, Philadelphia to the Sea Project:
Existing Depths, North Half Liston Range



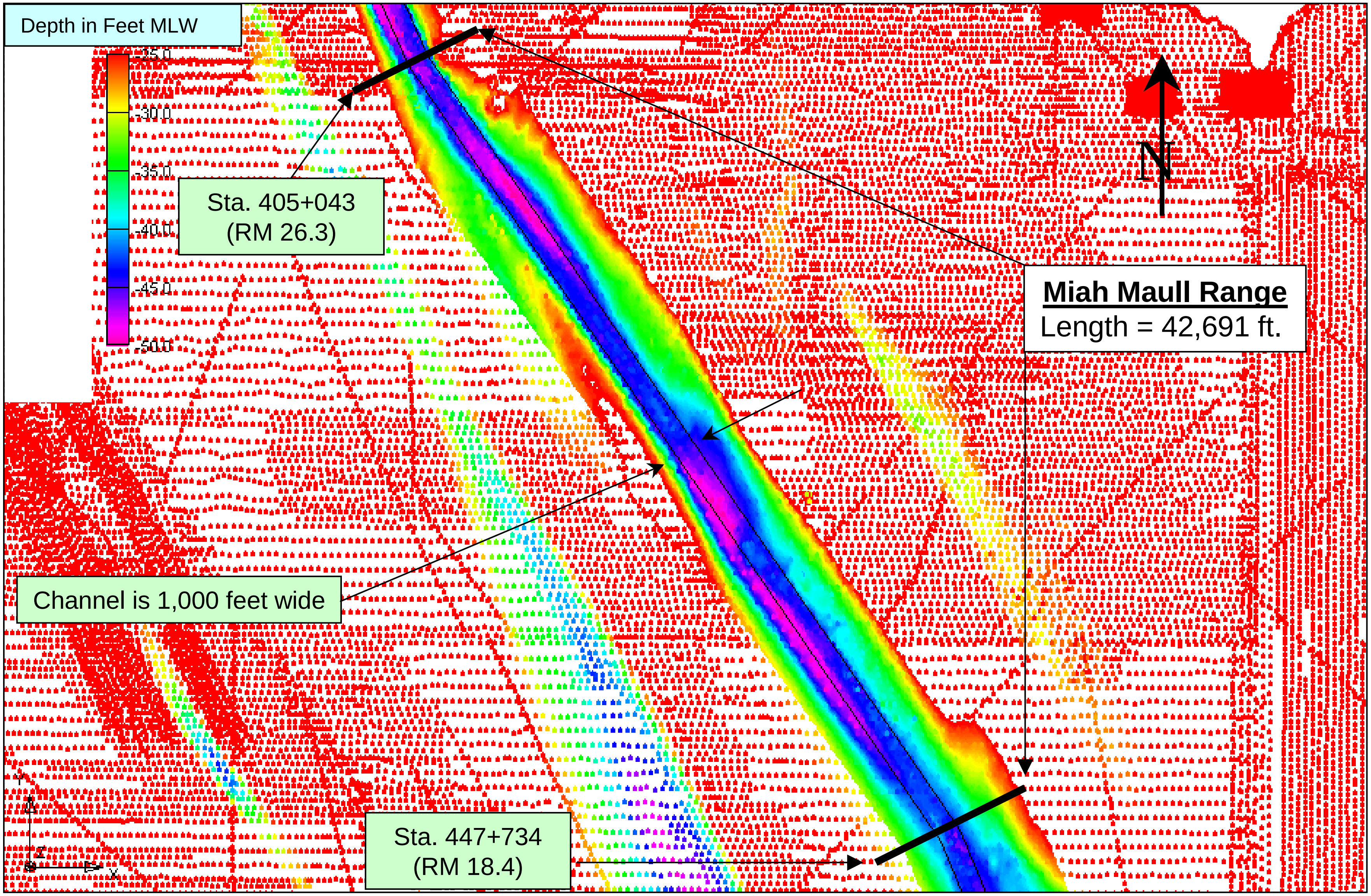
Delaware River, Philadelphia to the Sea Project: Existing Depths, South Half Liston Range



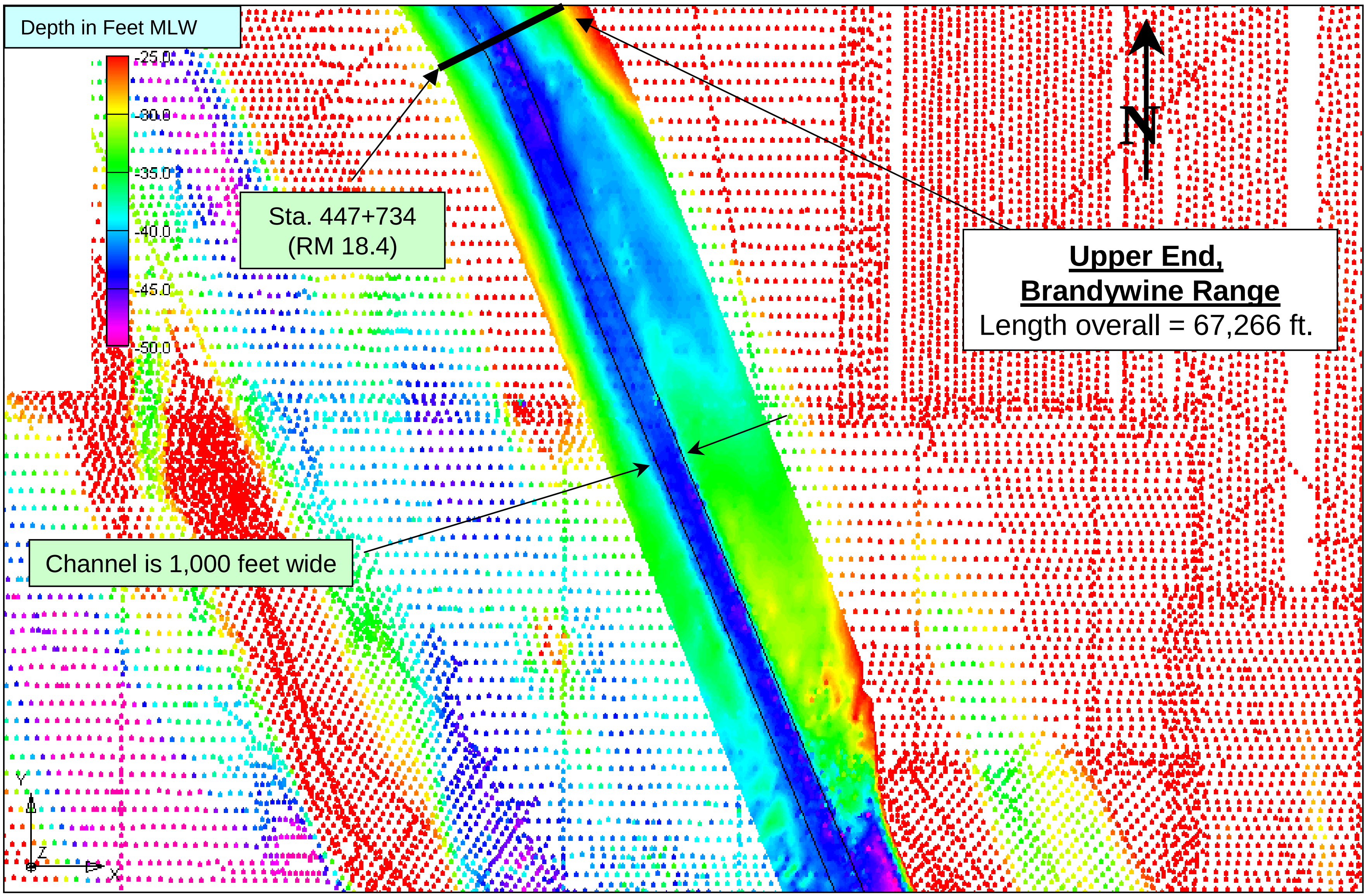
Delaware River, Philadelphia to the Sea Project:
Existing Depths, Cross Ledge Range



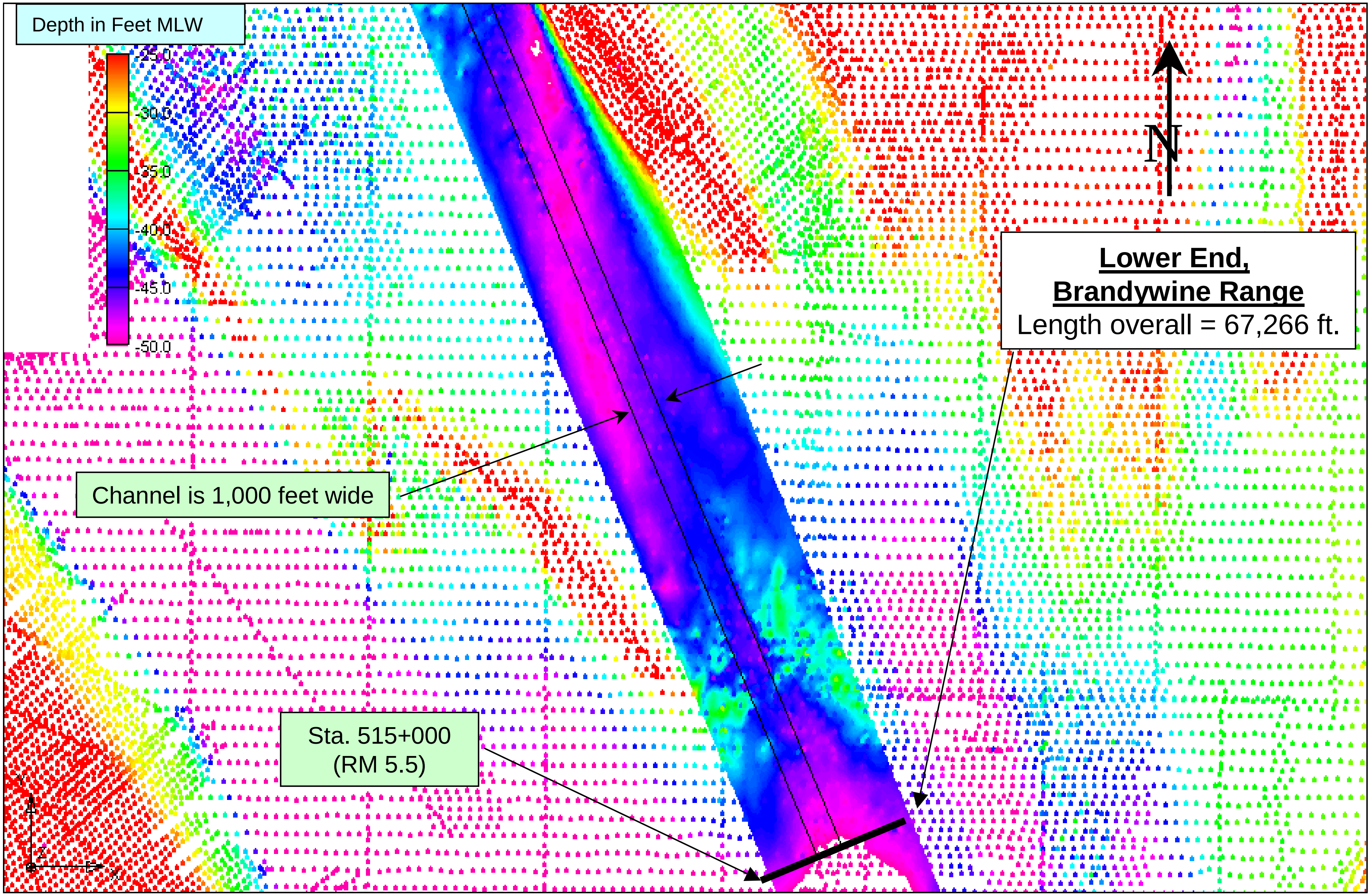
Delaware River, Philadelphia to the Sea Project: Existing Depths, Miah Maull Range



Delaware River, Philadelphia to the Sea Project:
Existing Depths, North Half Brandywine Range



Delaware River, Philadelphia to the Sea Project: Existing Depths, South Half Brandywine Range



APPLICANT'S REVIEW BEFORE MAILING

DID YOU COMPLETE THE FOLLOWING?

__X__	Yes	BASIC APPLICATION
__X__	Yes	APPENDICES
__X__	Yes	VICINITY MAP
__X__	Yes	PLAN VIEW
__X__	Yes	ELEVATION OR SECTION VIEW
__X__	Yes	SIGNATURE PAGE (Page 8) with Agent Authorization if appropriate
__*__	Yes	COPY OF PROPERTY DEED & SURVEY
__X__	Yes	THREE (3) COMPLETE COPIES
__*__	Yes	LIST OF ADJACENT PROPERTY OWNERS (as per item #11 of this basic application form)
__NA__	Yes	APPROPRIATE APPLICATION FEE (Checks should be made payable to the State of Delaware)

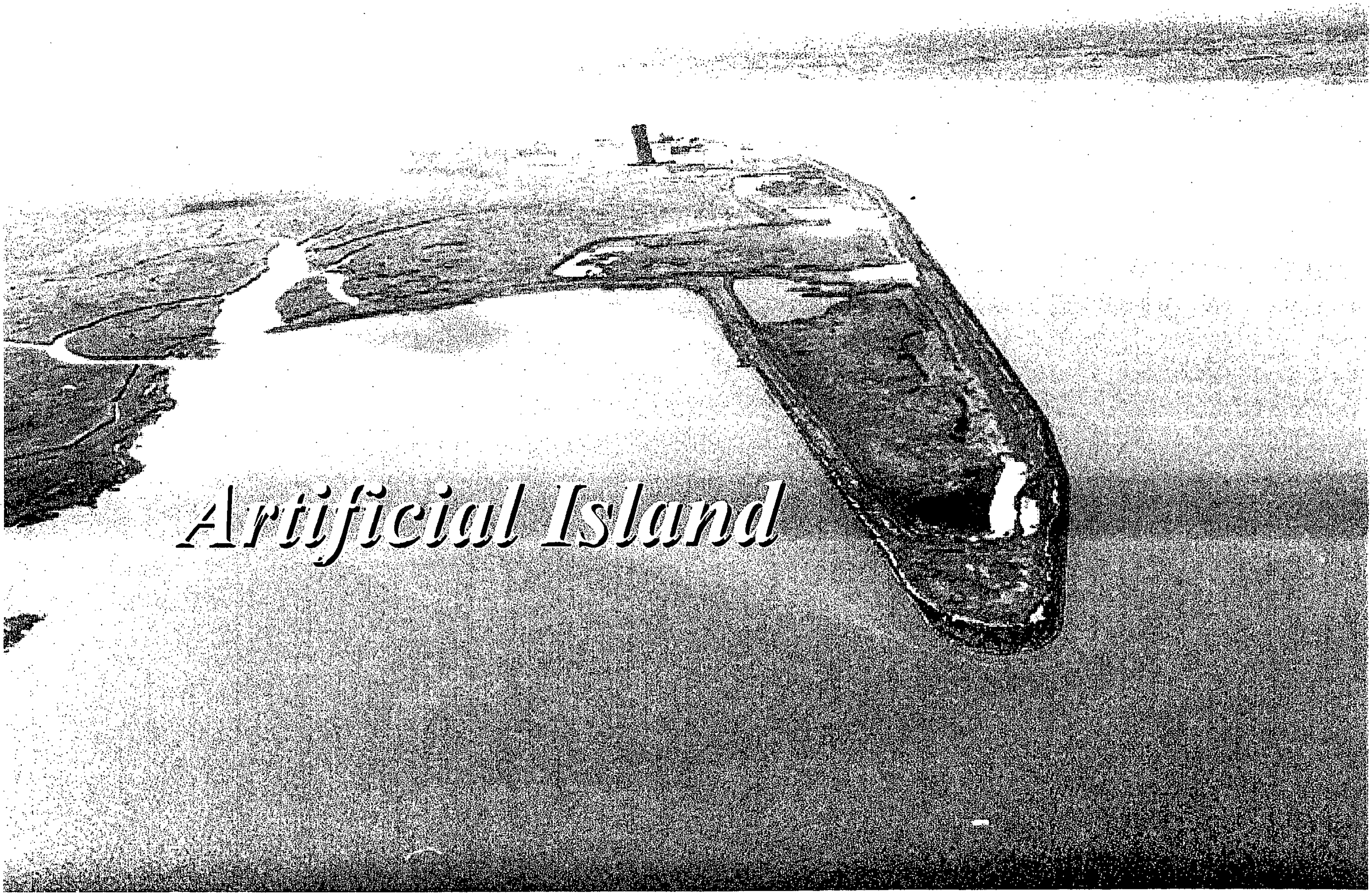
Mail 3 complete copies of the application, with drawing(s) to:

Department of Natural Resources and Environmental Control
Division of Water Resources
Wetlands and Subaqueous Lands Section
89 Kings Highway, P. O. Box 1401 Dover, DE 19903
(302) 739-4691

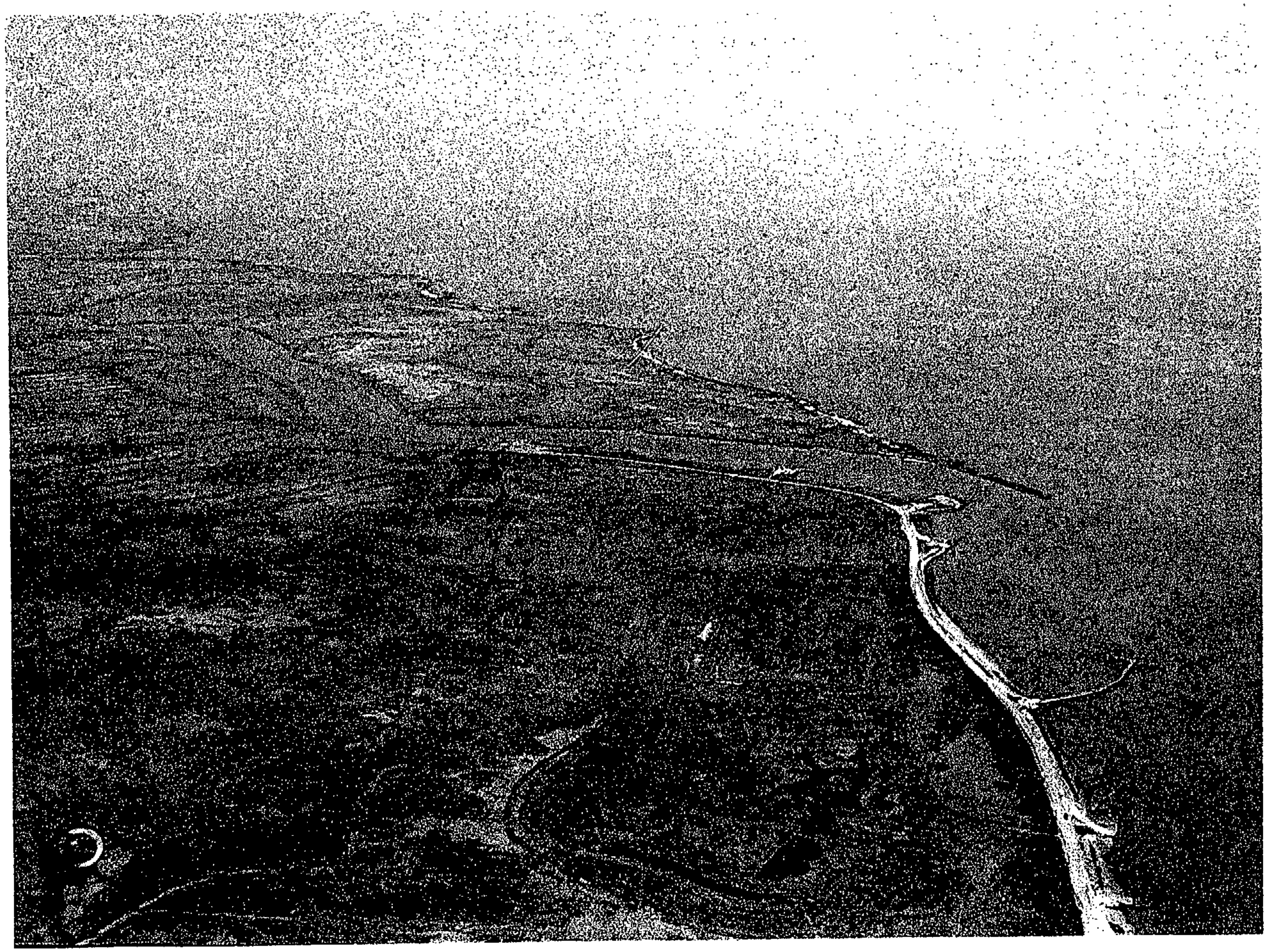
* Tax maps and lists of property owners will be supplied when the temporary easements are acquired for placement of sand material at the specific beach site (s).


Main Channel
Deepening
Project

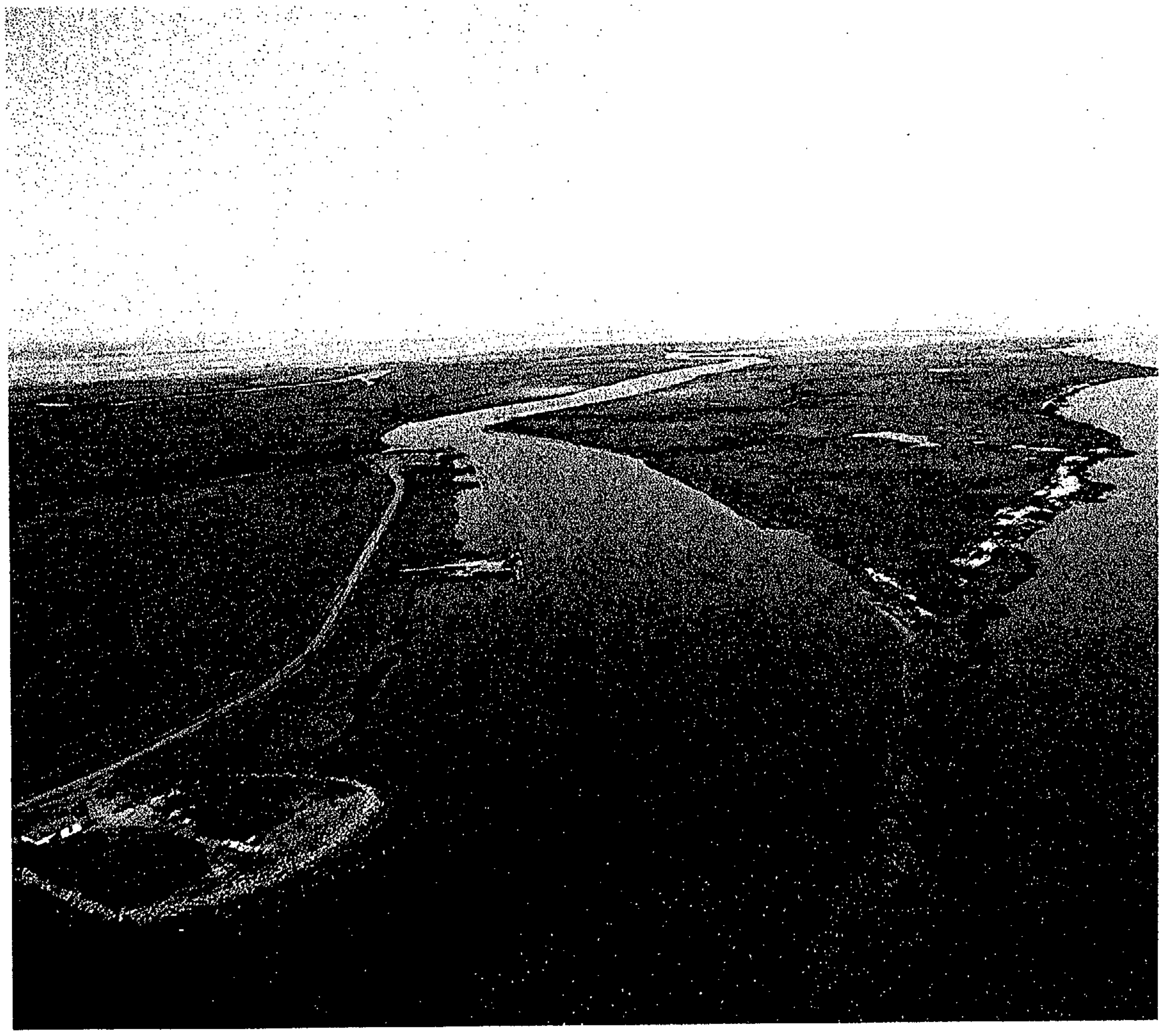

Pea Patch Island
Killcohook Existing Corps Upland Confined Disposal Facility


Artificial Island

Reedy Point North/South Confined Upland Disposal Facilities



Kelly Island, Delaware July 2000



Kelly Island, Delaware July 2000

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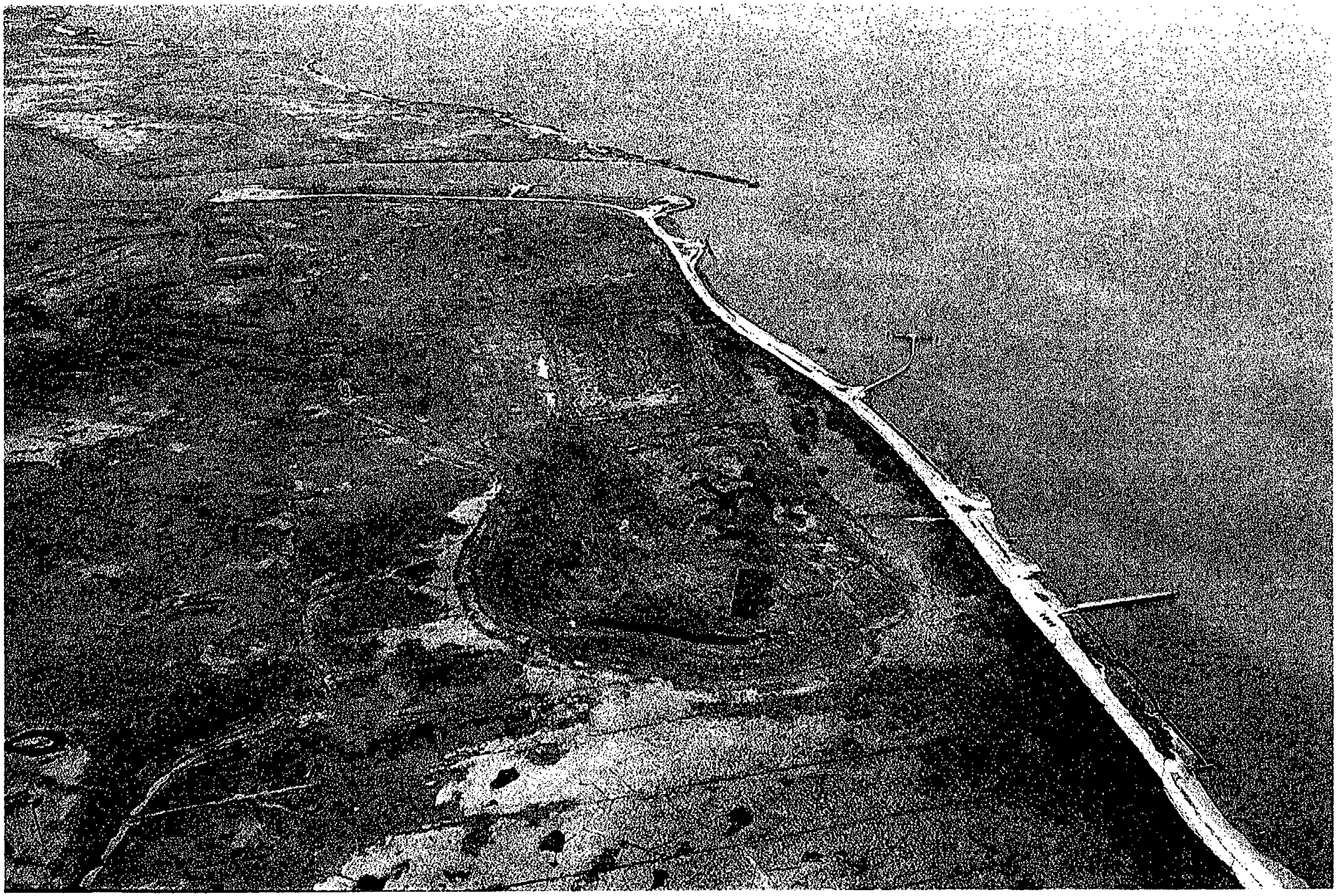

Port Mahon, Delaware July 2000

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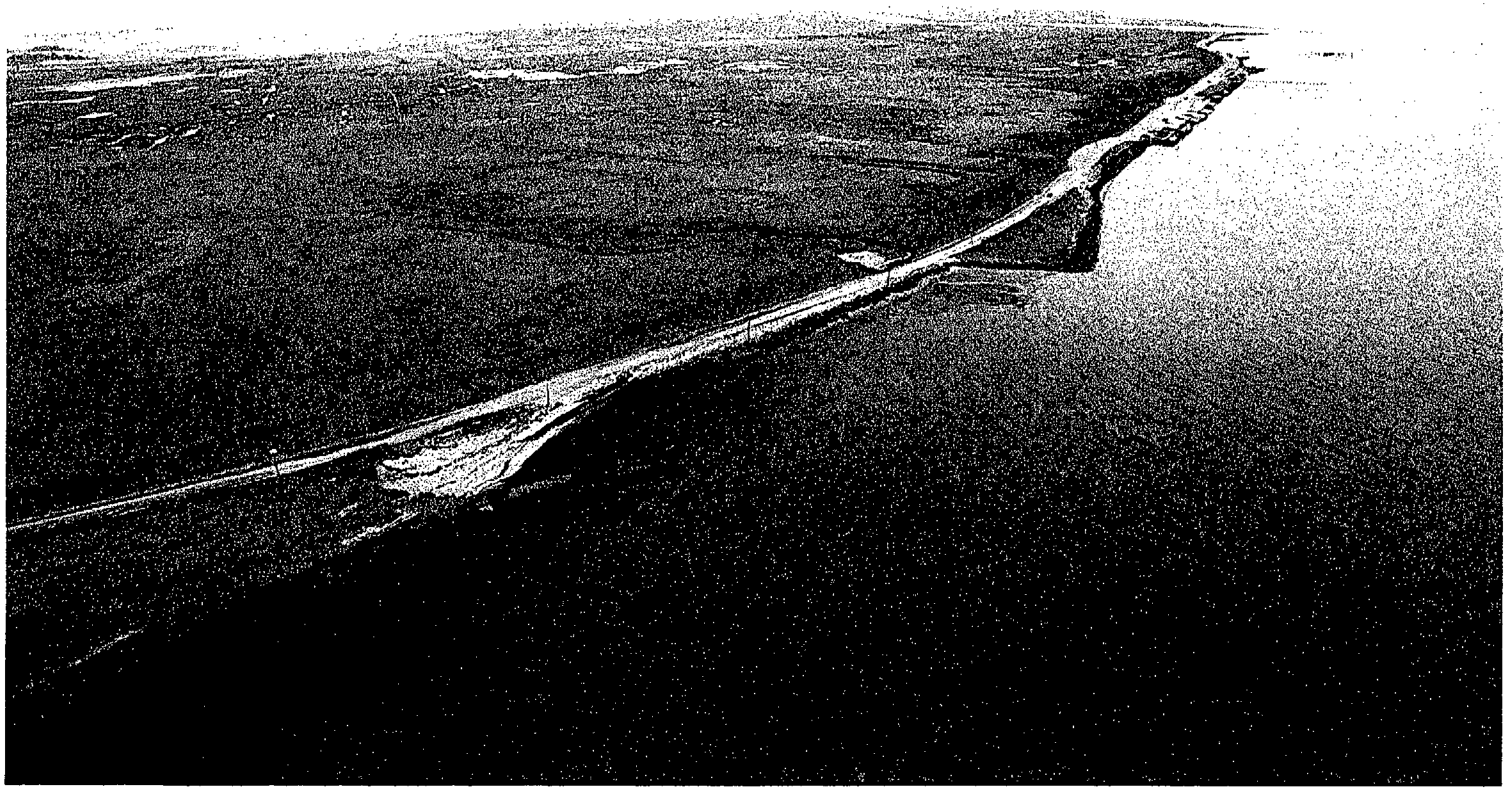

Port Mahon, Delaware July 2000