US Army Corps of Engineers
Baltimore District

Baltimore Harbor and Channels

Dredged Material Management Plan Update

FINAL REPORT

October 2017

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EXECUTIVE SUMMARY

In December 2005, the Dredged Material Management Plan (DMMP) for the Baltimore Harbor and Channels project was released as a final document. Since that time, it has been the foundation on which the US Army Corps of Engineers, Baltimore District (USACE) has relied to plan dredged material placement for maintenance of the federal channels servicing the Port of Baltimore. The 2005 DMMP determined the federal standard placement options that are used to calculate cost sharing between the Federal Government and the State of Maryland, and directed further study into the expansion of the Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island (PIERP), and a new project for the beneficial use of dredged material in the mid-Chesapeake Bay region.

In 2005, it was documented that the then currently used placement sites would run out of capacity or close within the 20-year planning horizon, and new options would be required to assure efficient maintenance of the channels through 2025. Since conditions and needs change, it was envisioned that the DMMP would be revisited every five years, or as needed, to determine if adequate capacity for the 20-year planning horizon existed. In 2010, the Baltimore District began planning a revision to the DMMP to account for changed conditions, specifically in the Baltimore Harbor area, where 20 years of capacity does not exist, to document a newly-approved federal standard for the Baltimore Harbor, and to account for implementation of the recommendations that had been made since 2005 for the Maryland Bay Channels and the Chesapeake and Delaware (C&D) Canal Lower Approach Channels.

In June 2011, Baltimore District received a memorandum from the Assistant Secretary of the Army for Civil Works (ASA(CW)), Ms. JoEllen Darcy, in reference to the Mid-Chesapeake Bay Island Ecosystem Restoration Project Chief's Report, August 24, 2009 that was under review by ASA(CW) and the Office of Management and Budget (OMB). Concerns raised in the ASA(CW)'s memorandum included the need and justification for the Mid-Bay project and the timing of when the project would need to be available to accept dredged material. A Preliminary Assessment (PA) was completed in December 2011 in response to Ms. Darcy's memo. The PA recommended an update to the 2005 DMMP for the Maryland Bay and C&D Canal Lower Approach Channels, as well as updating the plan for the Harbor Channels. While the DMMP was being revised to address these concerns, the notice of intent for the Baltimore Harbor and Channels 50-ft Project Limited Reevaluation Report was issued in 2014. In response, the Virginia Marine Resources Commission expressed concern with potential impacts to overwintering female blue crabs from the continued use of the Wolf Trap Alternate Open Water site in Virginia. As a result, the dredged material management needs for the Virginia Channels are also addressed in this update. No new feasible placement alternatives were proposed that were not already evaluated in the 2005 DMMP; therefore, no formal environmental consultation was undertaken for this update.

The DMMP Update has examined material placement needs for the Harbor Channels, which include the channels in the Patapsco River, inside the North Point-Rock Point Line; the Chesapeake Bay Approach Channels in Maryland, which extend from the North Point-Rock Point Line south and east to include the Craighill Entrance, Craighill Angle, Craighill Upper Range, Cutoff Angle, Brewerton Channel Eastern Extension, Tolchester Channel, and Swan Point Channel; the C&D Canal Lower Approach Channels, which extend from the mouth of the Sassafras River south to the Tolchester Channel, south of Pooles Island; and the Chesapeake Bay Approach Channels in Virginia, which extend from the Maryland-Virginia state line south to the Atlantic Ocean and include the Rappahannock Shoal, York Spit, and Cape Henry Channels.

Over the 20-year planning period, there is an estimated total need of 27 million cubic yards (mcy) of dredged material capacity for the Harbor Channels, 40 mcy for the Chesapeake Bay Channels (MD), 24 mcy for the C&D Canal Lower Approach Channels, and 13 mcy for the Chesapeake Bay Channels (VA). This includes maintenance and new work dredging for the Harbor and Bay Channels and maintenance dredging for the C&D Canal Lower Approach Channels. The Cox Creek Dredged Material Containment Facility (DMCF) accepts Harbor material and has 2 mcy capacity remaining while the Masonville DMCF, which currently accepts non-federal Harbor material, has 13 mcy capacity remaining. PIERP has 10 mcy of remaining capacity, allocated between the Chesapeake Bay Approach Channels (MD) and C&D Canal Lower Approach Channels. The open water disposal sites in Virginia have sufficient capacity for the planning window.

Alternative material placement sites identified for the 2005 DMMP for receiving Maryland material were reviewed for inclusion in the DMMP Update. Engineering assumptions, alternative locations, channels serviced, and costs were updated. Alternatives identified during the state dredged material management plan process were also included, as well as new alternatives identified by the project team. All of the alternatives considered in the DMMP Update are legally implementable from a federal perspective, though numerous alternatives in Maryland are considered inconsistent with or have constraints placed upon their use by state law. These constraints include geographic restrictions on the location of new upland confined disposal areas and a prohibition on overboard placement. Thirty-four alternatives were considered, which correspond to 65 total alternatives for the 4 geographic sub-areas; Harbor Channels, Chesapeake Bay Approach Channels in Maryland, C&D Canal Lower Approach Channels, and Chesapeake Bay Approach Channels in Virginia.

Four criteria were updated or generated for each alternative: capacity of the placement alternative; cost to dredge, construct, operate, and maintain each placement alternative; the environmental impact (positive or negative) caused by each placement alternative; and the risk, both technical/logistical and acceptability associated with the alternative. The environmental impacts of the alternative sites were evaluated by the Bay Enhancement Workgroup (BEWG), a standing committee of state and federal resource management and regulatory agencies and stakeholder groups, including USACE, U.S. Fish and Wildlife Service, National Marine Fisheries Service, Maryland Department of the Environment, Maryland Department of Natural Resources, and others.

Alternatives were assembled into suites of projects for the geographic sub-areas that would meet the required capacity over the 20-year planning period. Alternatives that did not meet minimum requirements for risk were eliminated from consideration. Because material from the Harbor

Channels generally cannot be used beneficially, the recommended Harbor Channel suite was selected based on the least cost environmentally acceptable alternative suite. Material from the Chesapeake Bay Approach Channels (MD) and C&D Canal Lower Approach Channels are typically available for beneficial use. Suites of alternatives were selected after cost effective-incremental cost analysis in which cost per cubic yard was compared to habitat benefit. Chesapeake Bay Approach Channels (VA) alternatives are the least cost environmentally acceptable alternatives available, have sufficient capacity for the planning period, and remain available for use until such time that their use is prohibited.

After screening and analysis, the recommended plan for Harbor Channel material placement includes: continued use of Cox Creek DMCF, continued non-federal use and authorization for federal placement at Masonville DMCF, expansion of Cox Creek DMCF, and study of the feasibility of a confined aquatic disposal pit in the Patapsco River. The federal standard for the Harbor Channels is Cox Creek DMCF. It is recommended that the federal standard include Masonville DMCF during years in which material is placed there (alternating placement with Cox Creek DMCF) and after capacity is exhausted at Cox Creek DMCF.

The recommended plan for the Chesapeake Bay Approach Channels (MD) is continued use of PIERP, expansion of PIERP, and development of the Mid-Chesapeake Bay Island Ecosystem Restoration Project (Mid-Bay Island). This is the least-cost, cost-effective plan and provides sufficient placement capacity without overloading the site as well as significant habitat benefits beyond the 20-year planning horizon. PIERP expansion and Mid-Bay Island have been formulated to receive material from the C&D Canal Lower Approach Channels as well as the Chesapeake Bay Approach Channels (MD). The least-cost, cost-effective plan with significant habitat benefits for C&D Canal Lower Approach Channels is PIERP Expansion and Mid-Bay Island with the use of the Philadelphia District owned and operated Pearce Creek dredged material placement facility. The federal standard for Chesapeake Bay Approach Channels (MD) is overboard placement in Deep Trough and the federal standard for C&D Canal Lower Approach Channels is overboard placement at Pooles Island, both of which are contrary to Maryland state law.

The recommended plan for the Chesapeake Bay Approach Channels (VA) is continued use of the Rappahannock Shoal Deep Alternate Open Water site, Wolf Trap Alternate Open Water site, and Dam Neck Ocean Open Water site. Capacity is more than adequate at these sites to accommodate dredging needs over the planning window. The Virginia Marine Resources Commission has expressed concern about the impacts of dredged material placement on overwintering female crabs at the Wolf Trap Alternate Open Water site. Expansion of the Wolf Trap site to the north, as suggested by the Virginia Institute of Marine Science, should be studied for its feasibility in the event that continued placement at Wolf Trap is prohibited by Virginia or determined to not be environmentally acceptable by a federal agency.

Implementation of the recommended plan will result in substantial beneficial impacts to important natural and socioeconomic resources at the project sites and throughout the region. Although the construction of the new alternatives and subsequent placement of dredged material will result in a permanent change in land use and loss of shallow water habitat (analyzed by separate NEPA documents), which will be offset by the restoration of remote island habitat, which includes associated uplands, wetlands, and shallow water coves. The overall benefit of restoring remote island habitat outweighs short-term or permanent adverse impacts. Providing sufficient long-term dredged material placement capacity will allow continued maintenance dredging of the federal channels, thereby contributing to the economic vitality of the Port of Baltimore, the region, and the nation.

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1. INTRODUCTION

A key and longstanding mission of the U.S. Army Corps of Engineers (USACE) is to provide safe, reliable, and efficient waterborne transportation systems (channels, harbors, and waterways) for movement of commerce, national security needs, and recreation. Since 1824, the USACE Baltimore District (CENAB) has been actively involved in constructing and maintaining a system of channels to allow large, deep-draft commercial shipping vessels to call on the Port of Baltimore for the transportation of a wide variety of products. In addition to shipping channels, a number of anchorage areas were established within the Port of Baltimore for vessels requiring layover. Accomplishing this mission successfully requires dredging of channels and associated navigation features and placement and/or management of dredged material.

The USACE Engineer Regulation (ER) 1105-2-100, Planning Guidance Notebook, dated April 22, 2000, mandates that the USACE Districts develop a Dredged Material Management Plan (DMMP) for all federally maintained navigation harbor projects where there is an indication of insufficient dredged material placement capacity to accommodate maintenance dredging over a 20 year planning horizon. The DMMP framework is a consistent and logical procedure by which dredged material management alternatives can be identified, evaluated, screened, and recommended so that dredged material placement operations are conducted in a timely, environmentally sensitive, and cost-effective manner. This updated programmatic DMMP addresses a full range of placement alternatives, ultimately leading to the selection of a final plan that ensures sufficient placement capacity is available for at least the next 20 years. ER 1105-2-100 further dictates that DMMPs should be updated periodically to maintain a plan for dredged material placement over a 20-year planning horizon. This updated programmatic DMMP is an update to the Baltimore Harbor and Channels DMMP originally approved in 2005 (Appendix A). The 2005 DMMP programmatically evaluated dredged material placement options and included an integrated tiered Environmental Impact Statement (EIS). A Preliminary Assessment (PA) for this updated DMMP was completed in 2011 (Appendix E).

Dredging is necessary to ensure safe navigation that minimizes delays and allows for the most energy efficient transport of cargo. Dredged material management options can be implemented pursuant to several existing authorities. The federal standard for navigation purposes is defined as the placement option for dredged material associated with the construction or maintenance of navigation projects in the least costly manner that is consistent with sound engineering practice and that meets all applicable federal environmental laws. This plan is also referred to as the "base plan" and is currently funded through the Operations and Maintenance (O&M) Program. The term "Federal Standard" recognizes that the plan is selected from the federal perspective and may or may not be locally supported. When options other than the federal standard are selected, other non-federal cost sharing requirements govern. Cost-share exceeding the cost of the federal standard may either be a shared federal and non-federal responsibility, or entirely a non-federal responsibility. A base plan is selected in this DMMP which contains disposal options that are least cost, consistent with sound engineering practices, and meet federal environmental laws. A recommended plan is also analyzed that differs from the base plan and which would include cost-sharing for the incremental cost over the base plan under the Environmental business line at a different cost share than the base plan. Section 204 of the Water Resources Development Act (WRDA) of 1992, later amended by Section 207 of WRDA 1996, and amended again in the Water Resources Reform and Development Act (WRRDA) of 2014, provides authority for the Corps of Engineers to implement projects for the protection, restoration, and creation of aquatic and ecologically related habitats, including wetlands, in connection with construction, operation, or maintenance dredging of an authorized federal navigation project. Section 201 of WRDA 1996 provides for U.S. Army Corps of Engineers cost sharing in the construction of new disposal sites and the improvement/expansion of existing disposal sites.

The Port of Baltimore consists of numerous channels; the 2005 DMMP divided the Baltimore Harbor and Channels project into four separate subsets; the Chesapeake Bay Approach Channels in Virginia (Virginia Bay Channels), the Chesapeake Bay Approach Channels in Maryland (Maryland Bay Channels), the Chesapeake and Delaware (C&D) Approach Channels, and the Harbor Channels. The Baltimore Harbor and Channels project is also connected to the Chesapeake and Delaware (C&D) Canal Project. The C&D Canal proper (excluding Chesapeake Bay Approach Channels), which is maintained by USACE Philadelphia District, will not be discussed in this document. The existing project for the Baltimore Harbor and Channels was authorized by the River and Harbor Act of August 8, 1917 and was modified by the River and Harbor Acts of January 1927, July 1930, October 1940, March 1945, July 1958, and December 1970, as well as WRDA 1996, and WRDA 1999.

The key products that the Port of Baltimore handles include, but are not limited to, coal, automobiles, Roll On /Roll Off (commonly referred to as Ro/Ro), containers, forest products, and project cargo. In 2013 the Port of Baltimore ranked fourteenth in the nation in foreign cargo tonnage, and ninth in terms of dollar value. The Port of Baltimore is ranked as the top port among all U.S. ports for handling autos and light trucks, farm and construction machinery, imported forest products, imported sugar, imported aluminum and imported gypsum. Baltimore ranks second in the U.S. for exported coal.

1.1 PURPOSE AND NEED

The Baltimore Harbor and Channels (MD and VA) Dredged Material Management Plan and Final Tiered Environmental Impact Statement was approved in December 2005. This DMMP was undertaken in response to a Preliminary Assessment completed in 2001 that found that continued maintenance dredging of the authorized Baltimore Harbor and Channels project was justified and found that there was a shortfall of placement capacity over a 20-year planning horizon. Furthermore, the Philadelphia District’s Dredged Material Management Plan Preliminary Assessment for the Inland Waterway from the Delaware River to Chesapeake Bay, Delaware and Maryland, September 1995, concluded that there was a shortage in dredged material capacity for the channel reach from the Sassafras River to Pooles Island and recommended a dredged material management study to identify suitable placement sites.

The 2005 DMMP has subsequently guided the placement of dredged material and the development of dredged material placement facilities for the Baltimore Harbor and Channels Project.

In June 2011, the Assistant Secretary of the Army for Civil Works, Ms. Jo-Ellen Darcy, requested a supplement to the 2005 DMMP by December 30, 2011. The request covered several specific issues, but was largely focused on the anticipated need for the Mid-Chesapeake Bay Island Ecosystem Restoration Project (Mid-Bay), which has a signed Chief of Engineers Report dated August 2009 and was a recommended alternative in the 2005 DMMP. A Preliminary Assessment was prepared in response to Ms. Darcy's request, which recommends a full update to the 2005 DMMP, covering the Maryland Bay and C&D Canal Approach Channels (Appendix E). The need to update the 2005 DMMP to account for changes in Harbor placement alternatives was already known. In 2015, in response to the notice of intent for the Baltimore Harbor and Channels 50-ft Project Limited Reevaluation Report and supplemental Environmental Impact Statement (EIS), the Virginia Marine Resources Commission expressed concern with potential impacts to overwintering female blue crabs from the continued use of the Wolf Trap Alternate Open Water site in Virginia. Therefore, in Section 2.6 of this document, the impacts to blue crabs are addressed and an update to the Baltimore Harbor and Channels DMMP, covers the Virginia Bay Channels, Maryland Bay Channels, Harbor Channels and Anchorages, and C&D Canal Approach Channels. The geographic scope will be discussed in a subsequent section.

The specific objectives of this update to the Baltimore Harbor and Channels DMMP are to:

- Develop a plan to maintain, in an economically and environmentally sound manner, channels necessary for navigation to the Port of Baltimore.
- Maximize the use of dredged material as a beneficial resource.
- Ensure that there is a minimum of 20 years of dredged material capacity for the project.

The specific goals for the update to the Baltimore Harbor and Channels DMMP are to:

- Reconsider all dredging and dredged material management alternatives, or combinations of alternatives examined in the 2005 DMMP. Consider all additional management alternatives that have become available in subsequent years.
- Utilize and incorporate appropriate data and information from other relevant USACE studies and projects, as well as, information and results from the State of Maryland's Dredged Material Management Program.
- Include an economic analysis of the viability of maintaining the existing channels.

Opportunities may exist to:

- Consider the use of innovative techniques, partnering policies, and nontraditional placement options to maximize the use of dredged material that may include, but is not limited to: wetland restoration, shoreline restoration, island restoration, landfill cover, building products, agricultural application, and abandoned mine land reclamation. Several efforts have been made to advance the state-of-the-art for innovative use of dredged material since the completion of the 2005 DMMP. Several pilot projects were undertaken by the Maryland Port Administration at the Cox Creek Dredged Material Containment Facility that investigated the feasibility of innovative reuse of dredged material for construction materials.

1.2 STUDY AUTHORITY

This DMMP update is being conducted pursuant to existing authorities for individual project operation and maintenance, as provided in the public laws that authorized the specific Baltimore Harbor and Channels projects and the Inland Waterway from the Delaware River to Chesapeake Bay (C&D Canal). The individual project authorizations are as follows:

1. River and Harbor Acts of 1927, 1930, 1940, and 1945.
2. The Baltimore Harbor and Channels 42-ft Project (authorized in Section 101 of the River and Harbor Act of 1958).
3. The Baltimore Harbor and Channels 50-ft Project (authorized in Section 101 of the River and Harbor Act of 1970).
4. The Baltimore Harbor and Anchorages and Channels Project (authorized in Section 101a(22) of Water Resources Development Act (WRDA) 1999).
5. The Chesapeake and Delaware (C&D) Canal Project was adopted as House Document 63-196 in 1919 and modified by Section 3 of the River and Harbor Act of 1927, by River and Harbor Committee Document 71-41 and Senate Document 71-151 in 1930, by House Document 72-201, House Document 73-18, and House Document 73-24 in 1935, and by Senate Document 83-123 in 1954.

General authorities relating primarily to beneficial uses of dredged material supplement these specific project authorities. Beneficial uses, which are not part of the federal standard for the navigation purpose, will be considered separable elements of the management plan and will be pursued under relevant authorities and separate funding sources. However, although it is funded from different sources and under separate authorities, the proposed beneficial use planning efforts must be pursued in conjunction with the overall management plan effort to ensure acceptability and ability to be implemented for a recommended plan to meet maintenance dredging needs for at least the next 20 years. Where management plan studies disclose the need to consider expanding or enlarging existing projects, such studies may only be pursued under specific study authority or under Section 216 of the Flood Control Act of 1970.

1.3 STUDY LIMITATIONS

This update to the 2005 DMMP has not been prepared as a feasibility study for specific sites, but as a broader planning document to recommend follow-on, site-specific analysis of the recommended suite of alternatives. Furthermore, this update reconsiders dredged material management alternatives examined in the 2005 DMMP and considers additional management alternatives not considered at that time. The 2005 DMMP included an integrated programmatic Environmental Impact Statement (EIS). This update does not revisit the conclusions of the EIS. The following is a brief summary of the issues considered outside the scope of this study.

Although potential impacts from expanding existing, permitted sites are evaluated, evaluation of site-specific impacts from implementing new generalized placement alternatives is outside the scope of this study. The assumptions for alternatives examined in 2005 have been reconsidered, updated, and changed as needed, in order to reflect current technologies, methods, and understandings. The locations of previous alternatives have also been reconsidered and refined as appropriate. For the purposes of preparing the cost estimates a representative location has been selected for each placement alternative that is not currently in use or in advanced planning stages. These locations are representative because the final designated site may not be precisely at that location. The impact analysis in this study corresponds with a broader level of planning, evaluating potential impacts for a particular type of alternative in a general area. Designation of any new placement site will normally require a site-specific feasibility study that includes the appropriate environmental review required by the National Environmental Policy Act, the Clean Water Act, and other applicable environmental laws. The Phase I cultural resources study that was undertaken for the 2005 DMMP addresses the geographic locations of placement alternatives, therefore no new cultural investigations were undertaken.

The following completed NEPA documents are pertinent to the DMMP. For sites that are still being evaluated stand-alone NEPA documentation will be prepared at the appropriate time.

- Baltimore Harbor and Channels 50-Foot Deepening General Design Memorandum and EIS (1981). Record of Decision (ROD) signed in 1981.
- Poplar Island Maryland Environmental Restoration Project Feasibility Report and EIS (1996). ROD signed in 1996.
- Mitigated Environmental Assessment for the Renovation of the Proposed CSX/Cox Creek Dredged Material Containment Facility by the Maryland Port Administration and Use of the Facility by the U.S Army Corps of Engineers. (May 2000). A Department of the Army Individual Permit was issued by Baltimore District Regulatory Branch in December 2001 and amended in December 2003.
- Final General Reevaluation Report (GRR) and Supplemental EIS for Poplar Island Environmental Restoration Project (September 2005). ROD signed in 2006.
- Mid-Bay Island (MD) Feasibility Report and EIS (2008). Chiefs Report signed in 2009. A ROD has not been signed.

- Masonville Dredged Material Containment Facility Final EIS (2007). ROD signed in 2007. Section 404 permit issued by Baltimore District Regulatory Branch in September 2007, and amended in 2008, 2009, and 2010.
- Pearce Creek Dredged Material Containment Area Modification, Cecil County, Maryland, Draft Environmental Assessment. March 2015.

The DMMP update was prepared in accordance with the guidance obtained in Engineering Regulation 1105-2-100. The 2005 DMMP contained four components defined by the channels authorized for maintenance dredging: Harbor Channels, C&D Canal Approach Channels, Chesapeake Bay Approach Channels (VA), and Chesapeake Bay Approach Channels (MD). As outlined in a memo from the USACE North Atlantic Division Regional Integration Team (CECW-NAD-RIT) dated March 23, 2015, the evaluation and comparison of updated alternatives as well as new alternatives for the DMMP occurred at a conceptual level, taking advantage of detailed information available from component-related studies. The following information/analyses are not necessary for the purposes of the DMMP update:

- Detailed costs;
- Real estate plan;
- NEPA review;
- Items of local responsibility;
- Draft PPA and financing plan; and,
- Cost sharing analysis.

The bulleted information above, although not necessary for this DMMP update, will be included for any site-specific feasibility study, post-authorization change report, or other study that is conducted for any project recommended by the DMMP update.

1.4 GEOGRAPHIC EXTENT OF THE DMMP

The area evaluated in this update is limited to the Chesapeake Bay and potential dredged material placement sites in Pennsylvania, Maryland, and Virginia required for maintaining the federal channels serving the Port of Baltimore.

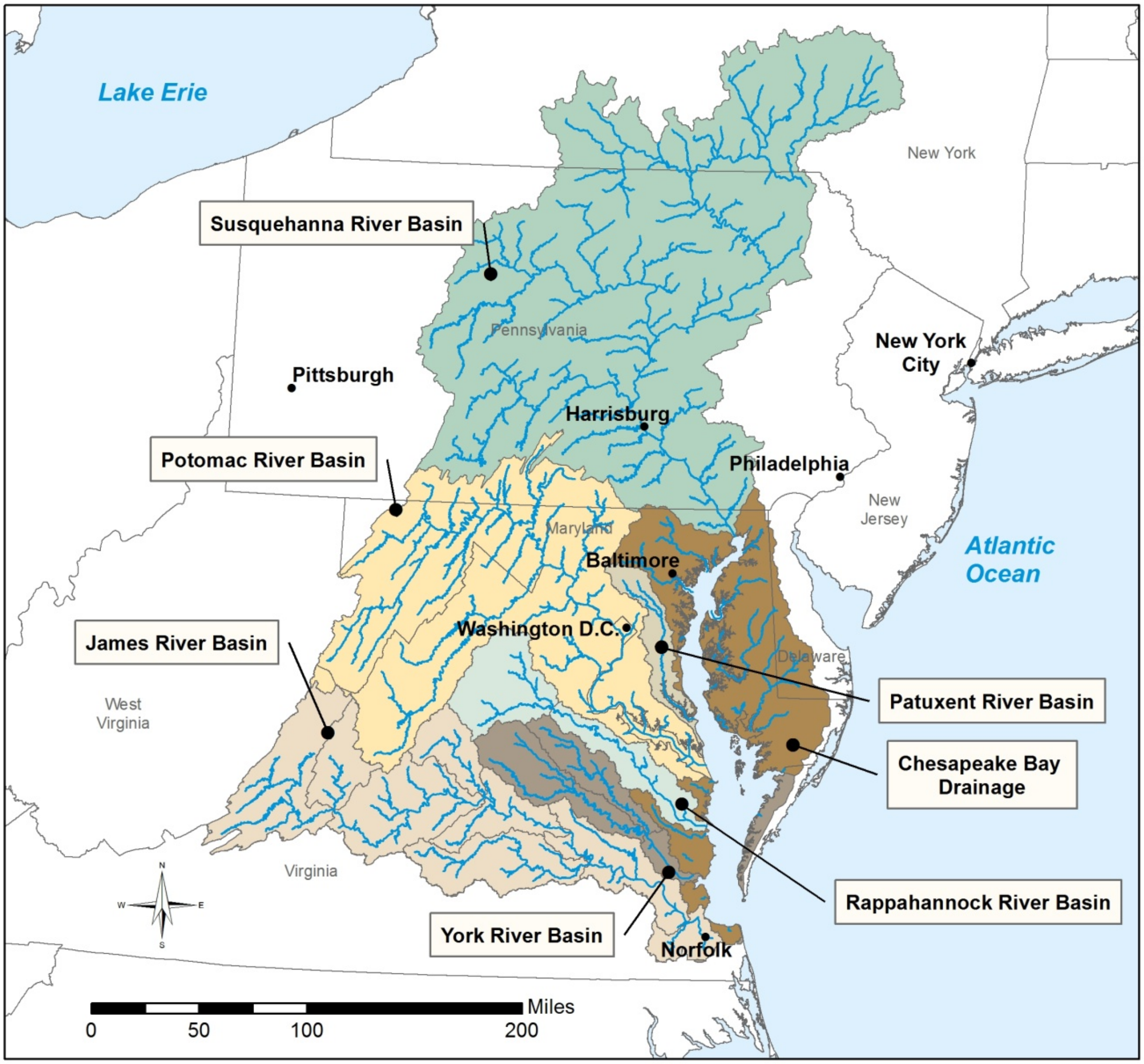


Figure 1-1. Chesapeake Bay Watershed and major river basins

The Bay drainage basin contains a number of major river basins pertinent to understanding shipping and dredged material management (Figure 1-1). The Port of Baltimore is located on the Patapsco River Basin on the west side of the upper Chesapeake Bay and has 45 miles of waterfront, 25 miles of which are industrially developed.

In order to effectively evaluate the entire navigation system, the federal channels for the Port of Baltimore are divided into four geographic subareas (Figure 1-2): C&D Canal Approach Channels, Chesapeake Bay Approach Channels (MD), Harbor Channels, and Chesapeake Bay Approach Channels (VA) (Figures 1-2 through 1-6).

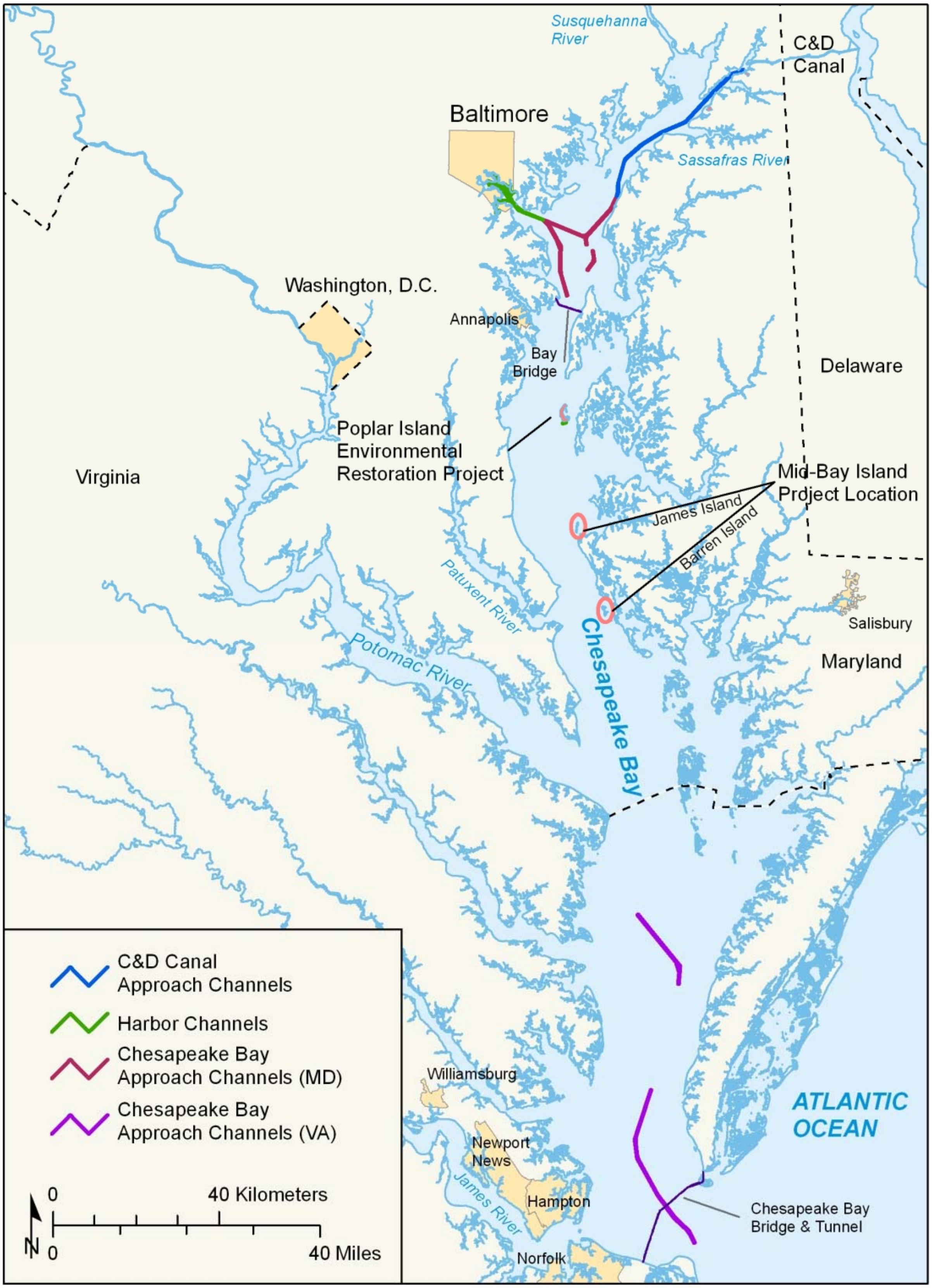


Figure 1-2. Baltimore Harbor and Channels Project geographic subareas

1.4.1 Chesapeake and Delaware (C&D) Canal Approach Channels

The C&D Canal Approach Channels extend approximately 30 miles from Town Point, near the western end of the C&D Canal, southwest to the vicinity of Pooles Island (Figure 1-3). The project provides a channel 35 feet deep and 450 feet wide from the Delaware River through Elk River and the Chesapeake Bay, to water of natural 35-foot depth in the Chesapeake Bay. The approach channels have been previously defined as Upper and Lower channels. The Upper Approach Channels extend approximately 15 nautical miles (nm) from the mouth of the Sassafras River at Howell Point to the C&D Canal at Town Point. Dredged material from this section of the approach channel has historically been placed in upland sites owned and operated by the Philadelphia District, including sites adjacent to the C&D Canal proper.

The Lower Approach reaches of the C&D Canal Approach Channels extend approximately 11 nm from the mouth of the Sassafras River southwest to the natural 35 foot deep contour of the Chesapeake Bay. Dredged material from the Lower Approach reaches was placed in open water placement sites in the Chesapeake Bay at Pooles Island (Figure 1-3) until December 2010 when the site was closed by Maryland state law. Section 3087 of WRDA 2007 authorized material dredged from the C&D Canal Lower Approach Channels to be placed at Poplar Island. In 2012 the Project Cooperation Agreement for Poplar Island was amended to add these channels to those approved for placement at Poplar Island. Only the Lower Approach reaches (south of the Sassafras River) of the C&D Canal Approach Channels are included in the scope of this study, and unless otherwise noted, all references to C&D Canal Approach Channels refer to the Lower Approach Channels.

Maintenance dredging of the Approach Channels must be performed yearly because of the heavy commercial usage of the C&D Canal Approach Channels and rapid shoaling rates. Dredging is mainly performed by a clamshell bucket dredge. This region of the Bay is naturally vulnerable to high shoaling rates because it is the area of the main Chesapeake Bay estuarine turbidity maximum. Therefore, sediment conveyed up the Bay in saltwater or down the Bay in freshwater settles in the region.

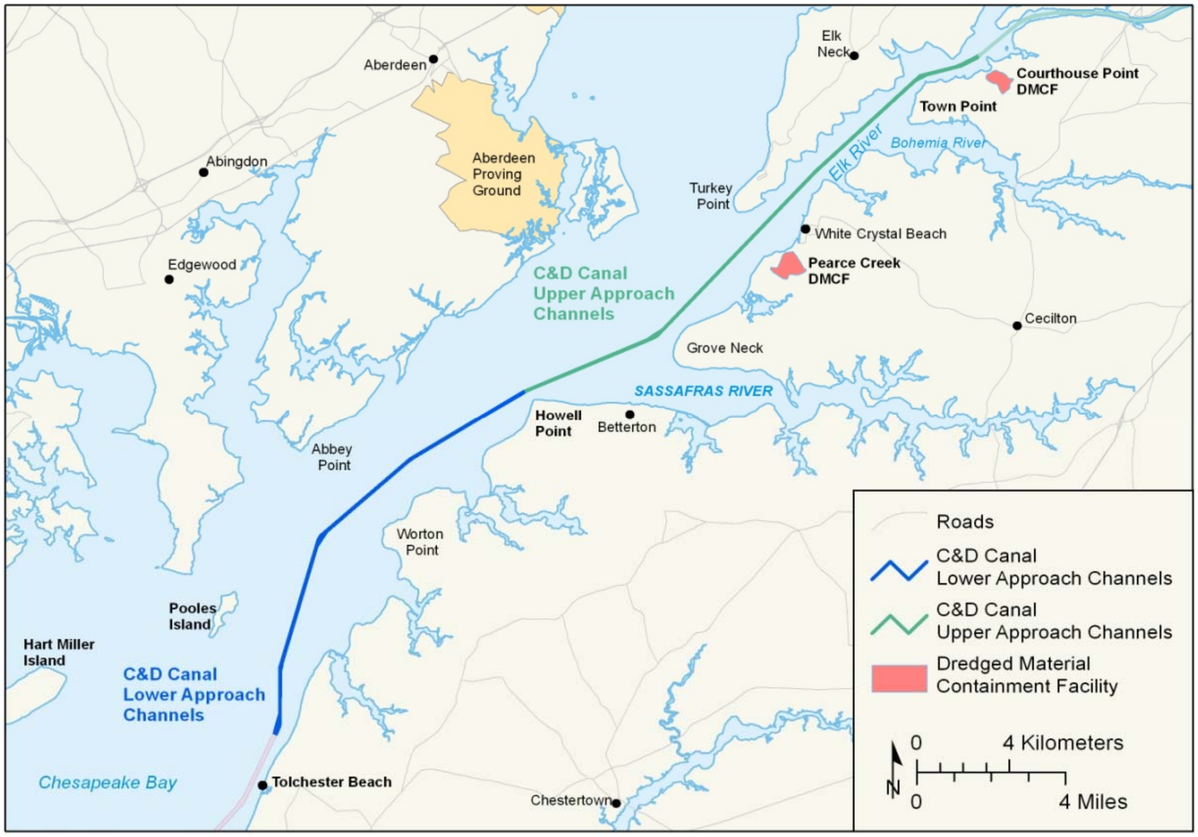


Figure 1-3. C&D Canal Approach Channels

1.4.2 Chesapeake Bay Approach Channels (MD)

The Chesapeake Bay Approach Channels (MD) are located north of the Bay Bridge at Kent Island and just south of Hart-Miller Island, and lead into the Patapsco River (Figure 1-4). The following channels are considered the approach channels in Maryland that service the Port of Baltimore:

Craighill Entrance – The Craighill Entrance Channel begins north of the Bay Bridge, which connects Sandy Point to Kent Island. The channel is 3.1 nautical miles (nm) long, 50 ft deep mean lower low water (MLLW), and 700 ft wide. The authorized dimensions are 50 ft deep and 800 ft wide (USACE, 1981).

Craighill Channel – This channel lies between the Sillery Bay and Belvidere Shoal connecting Craighill Entrance and Craighill Angle. It is approximately 2.8 nm long, 50 ft deep MLLW, and 700 ft wide. The authorized dimensions are 50 ft deep and 800 ft wide (USACE, 1981).

Craighill Angle – The Craighill Angle is approximately 1.6 nm long, 50 ft deep MLLW, with an average width of 1,258 ft. The authorized dimensions are 50 ft deep and 800 ft wide and widened in the angle (USACE, 1981).

Craighill Upper Range – This channel connects the Craighill Angle with the Cutoff Angle and is approximately 2.1 nm long, 50 ft deep MLLW, and 700 ft wide. The authorized dimensions are 50 ft deep and 800 ft wide (USACE, 1981).

Cutoff Angle – This channel connects the Craighill Channel Upper Range with the Brewerton Channel. It is approximately 0.9 nm long, 50 ft deep MLLW, with an average width of 1,220 ft. The authorized dimensions are 50 ft deep and 800 ft wide and widened in the angle (USACE, 1981).

Brewerton Eastern Extension – This channel extension connects the Tolchester Channel to the Brewerton Channel. It is approximately 5.0 nm long, 35 ft deep MLLW, and 600 ft wide, it's authorized dimensions (USACE, 1981).

Swan Point Channel – The Swan Point Channel is located west of Eastern Neck and is approximately 1.7 nm long, 35 ft deep MLLW, and 600 ft wide, it's authorized dimensions (USACE, 1981). Swan Point Channel allows barges and other vessels traversing the Chesapeake Bay to bypass the Baltimore Harbor entrance channels and connects deep-water areas.

Tolchester Channel – This channel is west of Tolchester Beach and connects to the Brewerton Channel Eastern Extension. It is approximately 6.5 nm long, 35 ft deep MLLW, and 600 ft wide, it's authorized dimensions (USACE, 1981).

In the mid-1980s modifications to the Baltimore Harbor and Channels project were undertaken which deepened and widened several channels. Due to financial and dredged material placement capacity constraints at the time, several channel components of the 50-foot project were not constructed to the authorized widths during Phase I of implementation (completed in 1990). In August 2014, a reevaluation of the Baltimore Harbors and Channels project was begun to determine if there is economic justification for modifying the remaining channels.

The expected new work material from widening has been incorporated into the expected total dredged material placement need. Expected changes in maintenance dredging quantities have been calculated and are incorporated into projected dredging volumes. Dredging is normally conducted with a mechanical clamshell dredge.

Figure 1-4. Chesapeake Bay Approach Channels (MD)

1.4.3 Baltimore Harbor Channels

Baltimore Harbor comprises various branch channels that provide access to the public and private terminals serving the Port of Baltimore (Figure 1-5). The harbor channels are defined as those west of the Rock Point and North Point Line (Maryland Port Administration (MPA), 1990). The Maryland Dredged Material Management Act of 2001 (The Act) placed several constraints on the placement of dredged material, including material originating from Baltimore Harbor. Material dredged from within Baltimore Harbor (Harbor Channels) is considered unsuitable for open water disposal based on periodic testing and must be placed in contained placement sites.

The harbor channels require periodic maintenance dredging, approximately every 2 to 5 years, because of sedimentation to allow for the passage of deep-draft ships. Dredging is usually done mechanically by clamshell dredge. Sediment in the harbor primarily originates from runoff and shoreline erosion. Prior to its closure in 2009, as mandated by state law, dredged material was placed at the Hart-Miller Island Dredged Material Containment Facility (HMI DMCF). HMI was used from 1984 through 2009 and was divided into an 800-acre North Cell and a 300-acre South Cell. In 2012 federal material began to be placed at the smaller Cox Creek DMCF.

The following channels are Baltimore Harbor channels:

Curtis Bay Channel – This channel is approximately 2.2 nm long, north of Marley Neck, extending from the Fort McHenry Channel to Curtis Bay with an approximate width of 400 ft and a dredged depth of 50 ft MLLW. The authorized dimensions are 600 ft wide and 50 ft deep.

Curtis Creek Channel – Curtis Creek lies in the more industrialized section of the Baltimore Harbor and flows north into Curtis Bay. The entire Curtis Creek Channel is approximately 2.2 nm long and comprises an upper, middle, and lower reach. The approximate channel depths are 22, 22, and 35 ft MLLW, respectively. The average respective channel widths are 150, 290, and 200 ft. The authorized dimensions for the upper and middle reaches are generally 200 ft wide and 22 ft deep. The authorized dimensions for the lower reach are 200 ft wide and 35 ft deep.

Middle Branch Channel Ferry Bar East Section – This channel is 42 ft deep and 600 ft wide, from the main channel at Fort McHenry to Ferry Bar, a distance of 1.4 nm. The authorized dimensions are 600 ft wide and 42 ft deep.

Northwest Branch – East and West Channels – The East Channel, which connects to the Fort McHenry Channel, is approximately 1.3 nm long, 600 ft wide, and 49 ft deep MLLW. The West Channel branches from the East Channel into the Northwest Harbor and is approximately 1.3 nm long, 40 ft deep MLLW, and 600 ft wide. Both channels have turning basins to allow large cargo ships to change course within the channels. The authorized dimensions of the East Channel are 600 ft wide and 49 ft deep. The authorized dimensions of the West Channel are 600 ft wide and 40 ft deep.

East and West Dundalk Marine Channels – These branch channels work together to serve the Seagirt and Dundalk Marine Terminals. The Dundalk Marine Terminal, a 570-acre cargo terminal, is the largest general cargo facility at the Port of Baltimore. This terminal handles containers, automobiles, farm, construction and other Roll-on/Roll-off (Ro/Ro) equipment, wood pulp, steel, breakbulk, and project cargo on a daily basis. The East Dundalk Channel is 400 ft wide by 1.1 nm long and West Dundalk Channel is 500 ft wide by 0.67 nm long. Both Channels have a dredged depth of 42 ft.

Dundalk/Seagirt Connecting Channel – This channel provides access to both the Dundalk and Seagirt Marine Terminals. The Seagirt Marine Terminal is a state-of-the-art, 284-acre container terminal, capable of handling 450,000 containers a year. The terminal has 4 ship berths, including a 50 ft berth with a total of 11 cranes, 4 of which are super post-Panamax size, thus providing the capability of unloading and loading new-Panamax ships with an outreach of 22 containers wide. In addition to containers, the terminal handles automobiles, farm, construction, and other Roll-on/Roll-off (Ro/Ro) equipment, wood pulp, steel, break bulk, and project cargo. The channel is 500 ft wide by 0.42 nm long and is dredged to a depth of 42 ft MLLW.

South Locust Point Marine Channel – This channel is 400 ft wide by 0.83 nm long and dredged to a depth of 36 ft MLLW and provides access to the 79-acre South Locust Marine Terminal and Cruise Maryland Terminal. The South Locust Marine Terminal is designed to handle medium-sized sea vessels and conveniently borders Interstate 95, making it ideal for cargo that requires timely delivery. The Cruise Maryland Terminal serves several passenger ship lines, with over 250,000 passengers passing through the facility a year.

Brewerton Channel – From the Cutoff Angle, the Brewerton Channel runs into the Patapsco River and connects to the Fort McHenry Channel via the Brewerton Angle. This channel is approximately 3 nm long, 50 ft deep MLLW, and 700 ft wide. The authorized dimensions are 800 ft wide and 50 ft deep.

Brewerton Angle – This channel is the connecting point between the Brewerton Channel and the Fort McHenry Channel. It is approximately 0.8 nm long and 50 ft deep MLLW with an average width of 1,075 ft. The authorized depth is 50 ft.

Fort McHenry Channel – The Fort McHenry Channel is the main channel within the Patapsco River. It runs from the Brewerton Angle to the East Dundalk Marine Channel and is approximately 3.8 nm long, 50 ft deep MLLW, and 700 ft wide. The authorized dimensions are 800 ft wide and 50 ft deep.

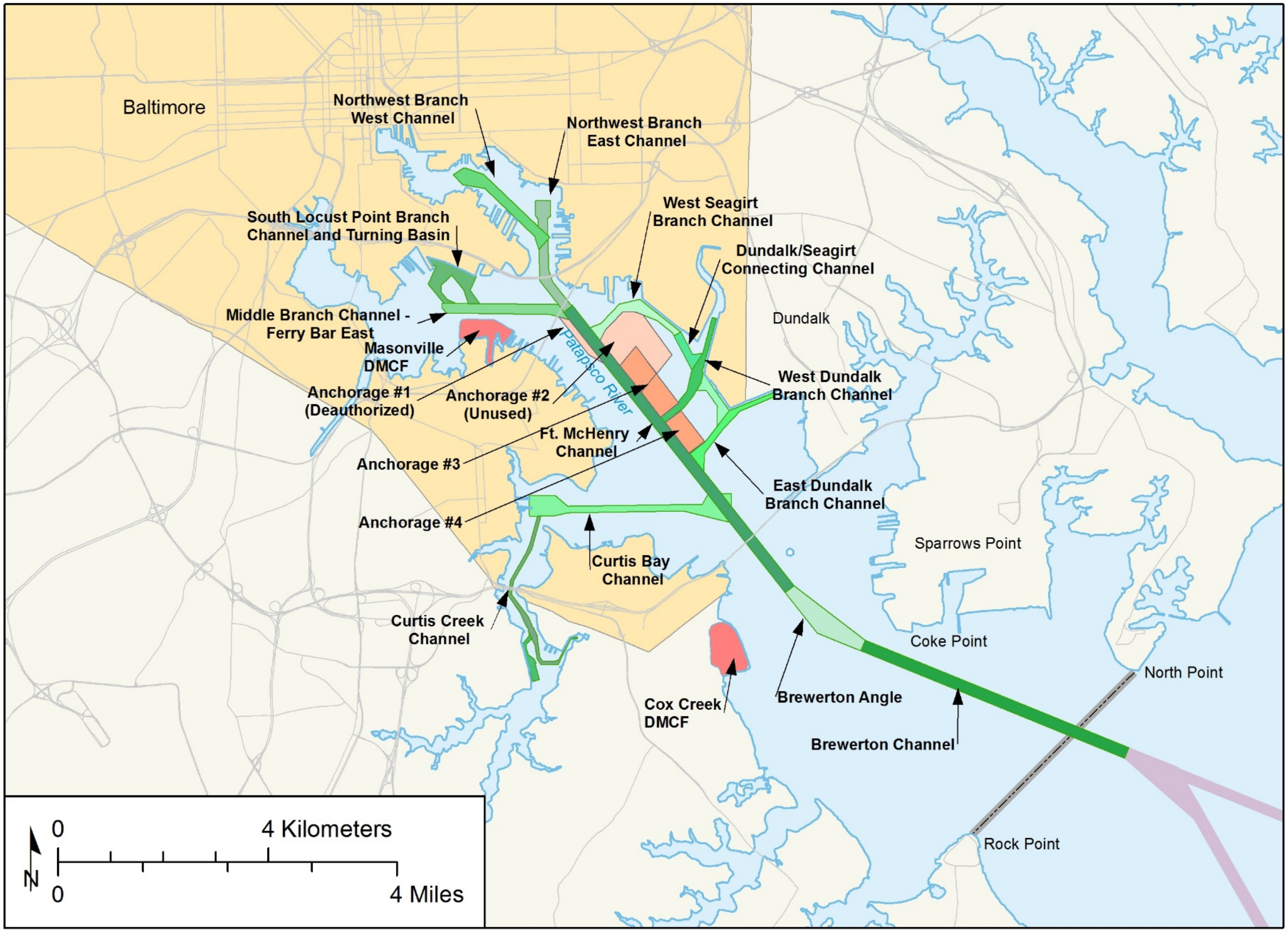


Figure 1-5. Baltimore Harbor Channels and Anchorages

1.4.4 Baltimore Harbor Anchorages

Baltimore Harbor Anchorages are used mainly by smaller bulk cargo vessels waiting for a berth to clear, cargo to arrive, or safe weather conditions (USACE, 1997). There are currently three anchorages authorized under the existing Baltimore Harbor and Channels project, two of which are used. The anchorages in use are maintained by the Federal Government and are regulated by the U.S. Coast Guard (USACE, 2001) (Figure 1-5). Anchorage #1 (Fort McHenry Anchorage) has been deauthorized and Anchorage #2 is no longer used.

The shoaling rate for the federally maintained anchorages is minimal and they are usually maintained on a 10-year dredging cycle. Sediment sources are the same as for Baltimore Harbor Channels.

Anchorage #3 (Riverview Anchorage #1) – Located in the Patapsco River, along the northeast side of the Fort McHenry Channel, southwest of Seagirt Marine Terminal. Anchorage #3 has three sections. The dimensions of #3A are authorized at 2,200 ft wide by 0.4 nm long, #3B at 1,800 ft wide by 0.3 nm long, and #3C at 1,500 ft wide by 0.1 nm long. Anchorage #3A and #3B are 42 ft MLLW deep while #3C is 35 ft MLLW deep.

Anchorage #4 (Riverview Anchorage #2) – This anchorage is located in the Patapsco River, along the northeast side of the Fort McHenry Channel, 3,000 ft southwest of the Dundalk Marine Terminal. It is approximately 0.4 nm long, 35 ft deep and 1,200 ft wide.

1.4.5 Chesapeake Bay Approach Channels (VA)

The three main Chesapeake Bay Approach Channels (VA): Cape Henry, York Spit, and Rappahannock Shoal, are maintained by USACE, Norfolk District (Figure 1-6). However, the budget for maintenance dredging of these channels located in the Commonwealth of Virginia is the responsibility of CENAB.

The Virginia channels undergo periodic maintenance dredging to aid in vessel navigation throughout the Chesapeake Bay. Dredged material from these channels has traditionally been placed at open water sites within the Virginia boundaries of the Chesapeake Bay as well as ocean placement sites. Dredging is typically conducted with hopper dredges. There are four main open water placement sites for Virginia dredged material: Dam Neck Ocean, Norfolk Ocean, Wolf Trap Alternate, and Rappahannock Shoal Deep Alternate.

The following channels are considered the approach channels in Virginia that service the Port of Baltimore:

Cape Henry Channel – 50 ft deep and 1,000 ft wide, approximately 4.7 nm long; located north of Cape Henry.

York Spit Channel – 50 ft deep and 800 ft wide, approximately 18.4 nm long; located east of the York River Entrance Channel and north of the Chesapeake Bay Bridge Tunnel. This channel was authorized to 1,000 ft wide.

Rappahannock Shoal Channel – 50 ft deep and 800 ft wide, approximately 10.3 nm long; located east of the Rappahannock River. This channel was authorized to 1,000 ft wide.

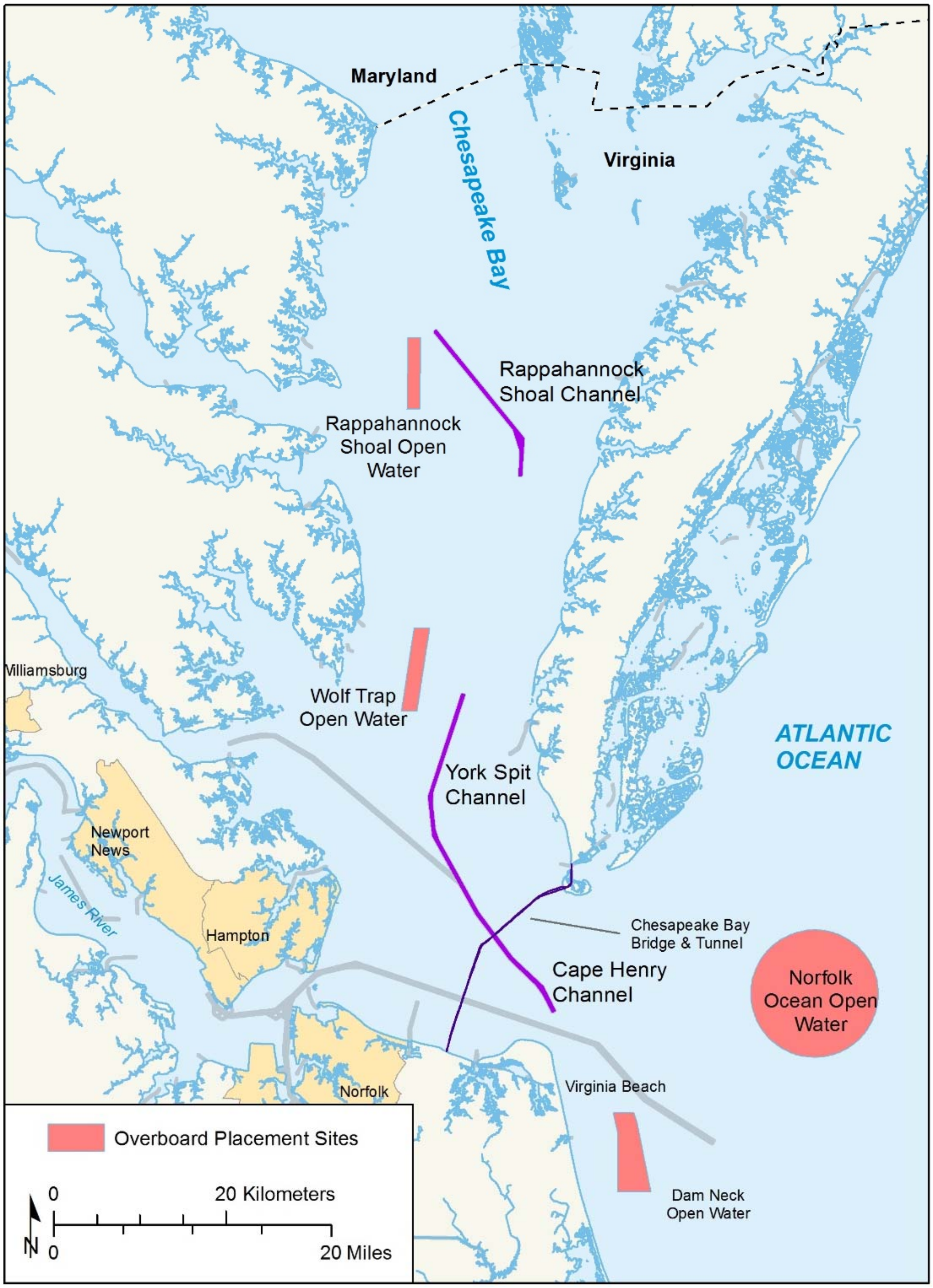


Figure 1-6. Chesapeake Bay Approach Channels (VA)

1.5 LOCAL SPONSORS

Successful dredged material management planning is a collaborative process. The planning should be conducted by a partnership that includes the Federal Government, the Port authorities, state and local governments, public interest groups, the scientific community, and private citizens.

The local sponsor for the Baltimore Harbor and Channels Project is the State of Maryland through the Maryland Port Administration (MPA). The MPA works to promote and increase waterborne commerce in Maryland, particularly at the Port of Baltimore. The MPA maintains and improves facilities and strengthens the workings of the private sector. Through the Administration's efforts, the Port of Baltimore is one of the world's leading commercial ports. In comparison to other U.S. ports, the Port of Baltimore was 9th in the nation in 2015 for dollar value ($51.1B) of foreign waterborne commerce and 13th in foreign cargo tonnage (32.4M tons). Among individual commodities, the Port of Baltimore leads the nation in farm and construction machinery, autos and light trucks, imported gypsum, imported sugar, and imported aluminum. The Port is second in the nation for exported coal and imported iron ore.

Approximately 13,650 direct jobs are generated through Port of Baltimore cargo and vessel activities while about 127,000 jobs in Maryland are linked to port activities. This results in $3 billion in personal wages and salary and more than $310 million in state and local taxes (MPA, 2016).

1.6 CONSTRAINTS AND RESTRICTIONS

During the formulation of the 2005 DMMP, the study team, in consultation with the MPA and the interested local, state and federal agencies and non-governmental organization (NGO), determined many constraints and restrictions dealing with dredged material that needed to be considered in the development of any plan. These constraints were in addition to the assumption that all placement options would be appropriate for the material in question. For example, material unsuitable for open water placement would not be considered for uses where clean material is required. Some of these constraints were based on Maryland state law or executive order, which impacts the analysis of and planning for placement sites, but does not change the determination of the federal standard. Some constraints were based on the insistence of the interested agencies that would be involved in the approval of a NEPA document. Some constraints were based on established environmental considerations. Finally, socio-political risk was established as it pertained to the likelihood that a project could be implemented. These various restrictions and constraints are presented below and remain restrictions and constraints for this update.

State Restrictions

Prior to the 2005 DMMP effort, material from the Baltimore Harbor was placed at Hart-Miller Island, material from the Maryland Approach Channels went to Poplar Island, and material from the C&D Lower Approach Channels was placed at Pooles Island in an overboard site. One of the main reasons that the DMMP was necessary was that certain state laws were passed through The Maryland Dredged Material Management Act of 2001 (The Act) that put constraints on the placement of dredged material. The constraints include a prohibition on overboard placement of dredged material in the open waters of the Chesapeake Bay, except continued use of open water placement at Pooles Island up to December 31, 2010.

The Act also contained restrictions that are more germane to dredged material placement in the Harbor Channels. Material dredged from within the Patapsco River, that is, from the Harbor Channels, is considered unsuitable for open water placement and must be placed in contained placement sites. Maryland Environment Code Annotated Section 5-1103 (based on The Act) does not allow any new dredged material placement facilities for federal channels anywhere within a 5-mile radius of the Hart-Miller/Pleasure Island chain. It restricts any further expansion, laterally or vertically of HMI, and mandates no placement at HMI on January 1, 2010 or thereafter. In addition, new dredged material containment facilities or other water-dependent facilities need to comply with Maryland's Critical Area laws, which are implemented by local jurisdictions and guide development of land within 1,000 feet of the mean high water line.

HMI was owned and operated by the State of Maryland and they have retained ownership subsequent to its closure. Prior to closure in 2009, HMI's capacity was exhausted. Since closure, the use and management of HMI has been transitioned to the Maryland Department of Natural Resources for use as a state park. The south cell of the island was opened to public use in 2016 while the north cell remains closed to the public. In the time since this DMMP update was initiated, development of the state park has progressed, with additional campsites, interpretive programs, trail construction, and additional public accessibility to much of the island. Also, all dredged material management activities, such as dewatering activities, have been progressively shut down as their need is no longer required. Therefore, this site's land use and purpose has changed and expansion of HMI can no longer be considered as a viable material placement alternative.

These constraints were all in place prior to the 2005 DMMP and remain in place today. They greatly impact the analysis of and planning for placement sites, but do not impact the determination of the federal standard.

The most recent analysis for overboard placement of dredged material in Maryland waters was completed in 1999/2000 for Site 104, a previously studied overboard placement site north of the Bay Bridge. More recent analysis for Maryland open water placement sites has not been conducted since the passage of the Maryland Dredged Material Management Act of 2001.

Section 401 of the Clean Water Act requires that a Water Quality Certification (WQC) be obtained for any Section 404 fill or placement activity in waters of the U.S. The WQC certifies that the activity or action will not adversely affect the water quality standards of the receiving waterway as defined in COMAR 26.08.02. If the proposed dredged material is determined to meet the state water quality standards and does not adversely affect the water use designation of that waterway, it would be expected that a WQC would be issued for its placement. Furthermore, The U.S. Environmental Protection Agency has provided concurrence for ocean disposal of Chesapeake Bay Approach Channel material from Maryland at the Norfolk Ocean Disposal Site (see Appendix F). Therefore, it is expected that this material would also be suitable for disposal at the historically utilized sites and would receive a WQC.

Agency Restrictions

In August 2011, as the 2011 Preliminary Assessment was prepared, federal and state resource agencies were contacted to update and reaffirm the restrictions they place on dredged material disposal and agency views on general disposal alternatives. Responses were solicited and received from four agencies: National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), Maryland Department of the Environment (MDE), and Maryland Department of Natural Resources (DNR). MDE and DNR had a combined response. These responses are included with the 2011 Preliminary Assessment (Appendix E).

Upper Bay Open Water Placement

Placement of material in the Upper Bay, the area north of the Bay Bridge, has been opposed by agencies because the area is a critically important area for migratory fish spawning. Essential Fish Habitat (EFH) has been designated for several species for juvenile and adult life stages in the Chesapeake Bay mainstem, but these species are not generally found in the low salinity conditions of the Upper Bay. No EFH for spawning adults has been designated in the Chesapeake Bay mainstem. Furthermore, the open water placement of dredged material is prohibited in the Chesapeake Bay and tidal tributaries by Maryland state law except when it is used for beneficial uses. These beneficial uses are 1) the restoration of underwater grasses; 2) the restoration of islands; 3) the stabilization of eroding shorelines; 4) the creation or restoration of wetlands; and 5) the creation, restoration, or enhancement of fish or shellfish habitats.

NMFS agrees with not placing material in the Upper Bay above the Bay Bridge except to use coarse-grain material, which is not typically dredged from the navigation channels, to enhance benthic habitat. This includes capping contaminated sediments (particularly in the tidal Patapsco River and Back River) and for enhancing oyster bar habitat. USFWS has no comparable position restricting material placement above the Bay Bridge, though there are significant natural resource concerns associated with such placement, such as increased turbidity and impacts to benthic habitat.

Island Creation

As outlined in state law, MDE and DNR support the beneficial use of dredged material for island restoration. USFWS also supports island restoration and would prioritize island restoration over other means of material disposal. Additionally, USFWS is not opposed to artificial island creation. Artificial island creation refers to the creation of an island where no remnant currently exists.

NMFS does not support artificial island creation for several reasons. Created islands would occur in high-energy areas and thus require hardening of the constructed island shoreline to prevent erosion and the escape of placed material. Shoreline hardening limits the number and type of finfish that use interior marsh cells. Marsh islands provide no ability for landward migration of created wetlands during subsequent sea level rise. While wetlands cannot migrate landward, USACE restored wetlands are designed and managed for anticipated sea level rise. Islands displace open water and benthic habitat of existing value that will not be recouped in-kind in the new island habitat, although no island project could be justified and built where the newly created habitat didn't exceed the existing habitat in value. Furthermore, NMFS regards island restoration as a nebulous term since what is being restored may not resemble what was lost to erosion (see Appendix B of the Preliminary Assessment included as Appendix E to this document).

Highly-Valued Habitat Impact Avoidance

In addition to general resource agency concerns about dredged material placement sites, specific ecological impacts must be considered in the management of dredged material.

Oyster Bars

The eastern oyster (*Crassotrea virginica*) is a commercially and ecologically important species to the Chesapeake Bay and has long been considered one of the Bay's keystone species. Oysters perform valuable ecosystem benefits by consuming algae and water-borne nutrients by filtering water at a rate of up to 5 liters per hour per individual oyster. Oyster reefs historically provided the principal Bay hard bottom habitat for numerous species, such as worms, snails, sea squirts, sponges, small crabs, and fishes. The oyster usually lives in water depths of between 8 and 25 feet. Seasonal deficiencies in dissolved oxygen in Bay water prevent their establishment in most waters deeper than 35 feet (USACE et al., 2009).

The oyster population of the Bay is at 1-percent of its historic levels due to diseases/parasites and overfishing. The 2010 strategy for implementing the Chesapeake Bay Executive Order (E.O. 13508) sets a goal of restoring native oyster habitat and populations in 20 out of 35 to 40 candidate tributaries by 2025 (FLC, 2010). Currently, no tributaries have fully restored oyster populations though several tributaries have successful living oyster reef habitats. Maryland DNR has designated Natural Oyster Bars (NOBs) as a resource of special significance, and activities that occur on or near NOBs are regulated to minimize adverse impacts to oyster populations. Generally, direct placement of dredged material may not occur on NOBs, though the use of coarse grained sediment for enhancing oyster bar habitat could be considered in some circumstances. For all sediment disposal options the location and design of dredged disposal areas must consider oyster bars and oyster habitat and avoid damaging impacts.

Submerged Aquatic Vegetation

Submerged Aquatic Vegetation (SAV) is a diverse assembly of rooted vascular plants found in shoal areas of Chesapeake Bay, in geographic locations that extend from its mouth to the headwaters of its tributaries (Figure 17). SAV can occur in water depths to 10 feet, the depth to which light penetration generally permits the growth of rooted aquatic plants; however, because of increased turbidity, most SAV is currently found in water depths of 3 to 5 feet or less in the Bay. The term submerged aquatic vegetation is used for both marine rooted vascular plants and freshwater rooted vascular plants that have colonized Chesapeake Bay and its tributaries.

Annual SAV surveys conducted since the 1980s track the recovery of SAV in Chesapeake Bay, and guide protection and restoration efforts. SAV beds in Chesapeake Bay are mapped and measured annually by the Virginia Institute of Marine Science (VIMS) using aerial photography. These surveys are summarized by three zones: Upper Bay, Middle Bay, and Lower Bay.

The Upper Bay Zone extends south from the Susquehanna River to the Chester and Magothy Rivers and is delineated by the Bay Bridge to the south. The Middle Bay Zone extends south from the Bay Bridge to the Rappahannock River and Pocomoke Sound, including the Potomac River. The Lower Bay Zone extends south from the Rappahannock River and Pocomoke Sound to the mouth of the Chesapeake Bay. Long term SAV abundance Bay-wide has increased from 38,228 acres in 1984 to 79,675 acres in 2010. Short-term and year-to-year trends are more variable. This may be compared to estimates of historical coverage of SAV in 1937 of about 200,000 acres bay-wide. In 2003, the Chesapeake Bay Program set a goal to plant 1,000 acres of SAV by 2008. Through 2010, 169.5 acres of SAV have been planted (CBP, 2011).

Several species of SAV that occur in Chesapeake Bay are considered invasive, including water chestnut (*Trapa natans*), which is found in the Potomac, Bird, and Sassafras rivers, and hydrilla (*Hydrilla verticillata)*, which grows in freshwater portions of the Chesapeake Bay and most of its tributaries.

2. AFFECTED ENVIRONMENT

The Chesapeake Bay is the nation's largest estuary, encompassing approximately 2,500 square miles of water. The watershed discharging into the Bay is approximately 64,000 square miles and includes parts of six states (Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia) and the District of Columbia.

The Bay is approximately 200 miles long from Havre de Grace, MD to Norfolk, VA. The width of the Bay ranges from 3.4 miles near Aberdeen, MD, to 35 miles near the mouth of the Potomac River (CBP Web site). The average water depth of the Bay is approximately 21 feet with some deep troughs, which traverse much of the Bay's length, at depths of up to 175 feet.

The Chesapeake Bay watershed is an incredibly complex ecosystem, with more than 3,600 species of flora and fauna and a human population exceeding 17 million. The Bay is a major resting ground along the Atlantic Migratory Bird Flyway. The diversity of habitats supports economic, recreational, and educational resources. Important commercial and recreational species include blue crab, oyster, striped bass, and numerous species of waterfowl.

The protection and restoration of the Bay's resources is considered vital to its future and the impacts from dredging and the placement of dredged material is a concern.

In the 2005 Dredged Material Management Plan (DMMP), the Chesapeake Bay was divided into four regions; Upper Bay, Baltimore Harbor, Middle Bay, and Lower Bay. This division is also the conventional way the Chesapeake Bay Program divide the Bay and roughly correlates to salinity regions. The affected environment chapter of the 2005 DMMP presented a variety of environmental categories that could be impacted from these dredging activities such as:

- Physical conditions of the Chesapeake Bay
- Geology and soils
- Surface water quality
- Hazardous, toxic, and radioactive waste
- Air quality
- Aquatic resources
- Wetlands
- Terrestrial resources
- Rare, threatened, and endangered species
- Recreation
- Cultural resources
- Socio-Economics
- Transportation
- Noise
- Dredging needs

Since the completion of the 2005 Baltimore Harbor and Channels (MD and VA) DMMP and final tiered environmental impact statement (EIS), the goal of the updated plan is to reconsider all dredging and dredged material management alternatives, or combinations of alternatives examined in the 2005 DMMP and to consider all additional management alternatives that have become available in subsequent years. For the purposes of the DMMP update, the sections of the affected environment chapter have been reviewed to determine where changes may or may not have occurred since the 2005 analysis. Much of the environmental information presented in the 2005 DMMP document regarding the various regions within the Chesapeake Bay has not changed and as such the DMMP update, which is not a NEPA document, will not revisit the conclusions of the EIS.

2.1 SURFACE WATER QUALITY/ TOTAL MAXIMUM DAILY LOAD (TMDL)

The Chesapeake Bay is the largest estuarine system in the contiguous United States having a watershed of almost 64,000 square miles. The Bay contains a range of salinity conditions from nearly marine at the mouth to freshwater in headwater tidal tributaries. This unique ecosystem also contains more than 1,500 square miles of wetlands that provide critical habitat for fish, shellfish, and wildlife; filter and process residential, agricultural, and industrial wastes; and buffer coastal areas against storm and wave damage. Surface water quality conditions in the Chesapeake Bay are dependent on numerous factors, such as land usage in the watershed, wind and tidal effects, air deposition, and physical and chemical characteristics of freshwater stream flow.

Since the completion of the 2005 DMMP, the U.S. Environmental Protection Agency (EPA) has established the Chesapeake Bay Total Maximum Daily Load (TMDL), which is a comprehensive program with rigorous accountability measures to initiate sweeping actions to restore clean water in the Chesapeake Bay and the region's streams, creeks, and rivers. The TMDL program is designed to ensure that all pollution control measures needed to fully restore the Bay and its tidal rivers are in place by 2025, with at least 60 percent of the actions completed by 2017. The TMDL program is also supported by rigorous accountability measures to ensure cleanup commitments are met, including short- and long-term benchmarks, a tracking and accountability system for jurisdiction activities, and federal contingency actions that can be employed if necessary to spur progress.

In coordination with the EPA and the Chesapeake Bay Program, the State of Maryland has developed and is implementing Maryland's Chesapeake Bay tributary strategy and TMDL Watershed Implementation Plan to achieve reductions from point and nonpoint sources necessary to meet Maryland's TMDL sediment and nutrient allocations. The TMDLs that have been developed for the Chesapeake Bay will have an effect on existing dredged material containment facilities and may have an effect on restoration sites and other dredged material containment facilities proposed for future beneficial use. Currently, the Cox Creek and Masonville DMCFs are operating under nutrient load allocations set forth by the Baltimore Harbor TMDL. The Cox Creek discharge permit requires implementation of BMPs to reduce and/or offset any nutrient inputs. The current Masonville discharge permit requires the implementation of BMPs to reduce and/or offset all net nutrient inputs to the Patapsco River by May 1, 2015. The Masonville permit also requires an annual assessment of monitoring data to define actual operating conditions and the associated nutrient loads, and to determine the opportunity for reductions and offsets to meet the final permit limits. The new Baltimore Harbor waste load allocation for total nitrogen and total phosphorus has been reduced by 50 percent effective May 3, 2015. This means that Cox Creek, Masonville, and any future DMCFs (after showing to localized water quality impacts) within the Baltimore Harbor must operate within the 50 percent reduction in accordance with the Overlay Permit dated May 1, 2015.

The Masonville permit requires MPA to attain compliance with the final permit limits for total nitrogen and total phosphorus through any combination of trading or offset purchases, treatment, recirculation, and land application. Both the Cox Creek and Masonville permits required that MPA apply for major modifications to the permits to ensure compliance with the TMDLs within 48 months (November 2, 2014) of the effective date of the permit (November 3, 2010). The MPA has had one wetland permit modifications since they received their initial permit on September 12, 2007.

Members from the Nutrient Discharge Management Working Group (a group comprised of experienced MES staff and MES subcontractors) continue to identify solutions to reduce, eliminate, or offset nutrient loads to the Chesapeake Bay from the Cox Creek DMCF, Masonville DMCF, and Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island.

Currently, the most effective technologies used at Baltimore Harbor and Channels dredged material placement sites to meet Chesapeake Bay TMDLs include inflow and discharge in the winter, which is a less sensitive time for aquatic species in and around the project site, and to practice recirculation during inflow events to limit the amount of nutrients discharged after inflow. Recirculation delays consolidation of the material at the site but does not affect the total suspended solids per gallon of water discharged because this is limited by state law. Another practice currently done at the placement sites is to hold water until it meets the state water quality standards. Other technologies have been studied such as floating wetlands within the containment facilities, package water treatment plants, and off-site mitigation such as stream restoration, and forest buffers.

Maryland state law prohibits the overboard placement of dredged material. There is, at present, no data regarding potential placement at the Deep Trough overboard placement site with which to engage EPA in discussions regarding TMDLs and it is unlikely that any will be forthcoming to investigate the use of this site due to circumstances and costs. The most recent analysis was completed in 1999/2000 for Site 104, a previously studied overboard placement site north of the Bay Bridge. The Governor withdrew consideration of Site 104 before USACE could complete a revised Draft EIS. Site 104 is the same geological feature as the Deep Trough but less deep.

Previous studies have indicated that there is little movement of material out of the placement sites and little release of phosphorous which was bound to the sediment. The release of nitrogen was less than 0.05 percent in the northern part of the Chesapeake Bay. A more recent analysis for the open water sites has not been conducted since the passage of the Maryland Dredged Material Management Act of 2001.

Section 401 of the Clean Water Act requires that a Water Quality Certification (WQC) be obtained for any Section 404 fill or placement activity in waters of the U.S. The WQC certifies that the activity or action will not adversely affect the water quality standards of the receiving waterway as defined in COMAR 26.08.02. If the proposed placement of dredged material (overboard or in CDF) is determined to meet the state water quality standards and does not adversely affect the water use designation of that waterway, it would be expected that a WQC would be issued for this activity. Furthermore, EPA has provided concurrence for ocean disposal of Chesapeake Bay Approach Channel material from Maryland at the Norfolk Ocean Disposal Site (see Appendix F). Therefore, it is expected that this material would also be suitable for disposal at the historically utilized sites and would receive a WQC.

2.2 DREDGED SEDIMENT QUALITY IN BALTIMORE HARBOR

Sediments in Baltimore Harbor/Patapsco River contain contaminants from industrial and municipal sources as well as from non-point sources as would be expected in an urbanized/industrialized region. Studies indicate that sediments in some areas of Baltimore Harbor presently exhibit toxic characteristics, and sediment toxicity in tributary creeks and bays is patchy.

Several studies in the late 1960s and 1970s characterized the sediment quality, existing conditions, and need for further testing and evaluation of dredged material in the Chesapeake Bay (SDCC, 1975). The Spoil Disposal Criteria Committee was composed of representatives of Baltimore, Philadelphia, and Norfolk USACE Districts, USEPA, US Fish and Wildlife Service (USFWS), and Maryland state agencies. Bioassays and other studies were subsequently carried out by academic institutions (Tsai et al., 1979; Mason and Lawrence, 1998; McGee et al., 1999). USACE conducted sediment testing and monitoring in the 1980s (PAS, 1985) and periodically since 1995 showing that sediment chemistry in the Harbor channels have not changed substantially.

Some priority pollutants, including several heavy metals, are present in dredged material in Baltimore Harbor (EA, 2013). These pollutants occur in concentrations, in some locations, that are known to cause either or both acute and chronic toxicological effects in some sensitive marine organisms. In addition, the combination of multiple priority pollutants probably causes some synergistic toxicological effects (USACE, 1997). A clear indicator of this likely toxicity is the depauperate benthic community in many areas of the Harbor.

USEPA Region 3 has recommended reevaluation of maintenance sediments approximately once every 3 years. USACE sampled sediments in 1995, 1998, 2002, 2005, and 2012 (EA, 1996, 2000, 2006, 2007, and 2013). Samples have been collected in each of the Baltimore Harbor channel reaches. The next sampling period is scheduled for 2017. The testing program included bulk sediment analysis, effluent elutriate analytical testing, and toxicity characteristics leaching procedure testing (TCLP) with recent sampling following guidance in:

- USEPA/USACE, 1998 (EPA-823-B-98-004). Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual (Inland Testing Manual)
- USACE, 2003. (ERDC/EL TR-03-1). Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual (Upland Testing Manual).
- USEPA/USACE, 1995 (EPA-823-B-95-001). QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations.
- USEPA, 2001 (EPA-823-B-01-002). Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual.

Several metals (arsenic, chromium, copper, lead, mercury, nickel, silver, and zinc) were found to exceed Probable Effects Levels (PELs) for a number of resident species. Zinc exceeded the PEL value most frequently. PELs represent contaminant concentrations above which adverse biological effects frequently occur. A comparison between the results of 2012 sediment samples and previous studies showed that the mean concentrations of tested analytes from 2012 fell within the range of previous studies, indicating that the overall conditions influencing the distribution of target analytes in the Baltimore Harbor navigation channels have not changed substantially since sampling began in 1995.

Copper was the only tested constituent (out of 18 metals) in the effluent elutriate analytical testing that exceeded the USEPA saltwater criteria. Copper concentrations exceeded acute estuarine copper criterion in 2 of 12 effluent elutriates in 2012.

2.3 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

Toxic chemicals are a major stressor for the Chesapeake Bay. Chemical contaminants harm plants, animals, fish, and humans, affecting reproduction, development, and the survival of organisms. The nature, extent, and severity of toxic effects varies widely throughout the Chesapeake systems. Some toxic chemicals such as zinc, nickel, copper, and other metals occur naturally in soils and sediments.

Chemical contaminants enter the Bay and its tributaries from point sources (for example, industrial and municipal wastewater treatment plants), and nonpoint sources (for example, urban and suburban storm water runoff and agricultural runoff). Domestic activities such as home and lawn maintenance, driving, and discarding unused household chemicals add airborne and waterborne contaminants to the Bay. Chemicals typically travel through the watershed and deposit in the Bay and its tributaries. Persistent chemicals may reach harmful levels when they continue to accumulate in the sediment at the bottom of the Bay. As population continues to grow in the Chesapeake Bay watershed, the nonpoint sources become increasingly difficult to track and control.

A second issue with respect to toxics in the Bay area is the potential presence of contaminated sites in or near the Bay that may affect dredging or placement options. USACE regulations typically require documentation and evidence of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and federal Superfund (NPL) sites within boundaries of a proposed project that can impact or be impacted by hazardous, toxic, or radioactive waste (HTRW) contamination. USACE Engineer Regulation 1165-2-132 states that dredged material and sediments beneath navigable waters proposed for dredging qualify for HTRW only if they are within the boundaries of a site designated by EPA or a state for a response action, like removal or remediation under CERCLA. However, dredged sediments that exhibit one or more Resource Conservation and Recovery Act (RCRA) hazardous waste characteristics are subject to RCRA Subtitle C Requirements for management and disposal.

Dredged material management regulations prohibit placement of HTRW in the dredged area. It is therefore required that none of the originating locations for the material to be placed in a site are listed as CERCLA or NPL sites or considered to be potential sources of hazardous, toxic, or radioactive substances. For both the Maryland area and the Virginia area, a link to the hazardous and toxic waste sites or the NPL sites can be found through EPA's EnviroMapper at this link: http://www.epa.gov/enviro/html/em.

In addition to NPL sites, other contaminated sites, including those under various state oversight and cleanup programs (i.e., state Superfund, underground storage tank (UST), or voluntary cleanup programs, among others) may, by virtue of their contaminants and their proximity to the Bay, affect dredged material management options. A large number of sites may fall under one of these categories and site-specific studies should identify and evaluate those that might affect a proposed action. Sites listed by the State of Maryland can be identified through the Maryland Internet Mapping Center at: http://www.mde.state.md.us/mappingsite/index.asp. This gives information about Hazardous sites on the NPL, Voluntary Cleanup Program, State Master List, and Federal Facilities. Information on sites addressed under Virginia's Hazardous Waste, Brownfields, and Voluntary Remediation Programs, as well as federal Superfund sites in Virginia, can be accessed at: http://www.deq.state.va.us/waste.

The potential exists for the presence of unexploded ordnance buried in the Harbor sediment. Unexploded ordnance recovered during dredging operations would have to be handled and disposed of in an appropriate manner to prevent safety threats or detrimental impacts to the environment.

2.4 AIR QUALITY

The Chesapeake Bay's air shed is 570,000 square miles, stretching west to Ohio and north to Canada. An air shed is an area of land over which airborne pollutants can travel to enter a specific body of water (CBP, 2014). Airborne pollution originates from a variety of sources, including automobile and small engine emissions, power-generating facilities, industry, agriculture, and construction.

At more than 17 million people, there are more people in the Chesapeake Bay watershed today than ever before. It is estimated an additional 157,000 people move into the region every year, bringing with them more vehicles and more demands for energy from power plants. And as a result, more air and nitrogen pollution will damage the Bay (CBF, 2014).

According to Maryland Department of the Environment's 2012 Clean Air Progress in Maryland publication, for over 40 years Maryland has worked to improve its air quality. Reductions in emissions from utilities, motor vehicles and other sources as diverse as manufacturing and consumer products have reduced the number of days in which Marylanders breathe unhealthy air while also improving visibility (MDE, 2012). These improvements are the direct result of effective controls on local sources of air pollution. By requiring installation of state of the art control technologies and aggressive policies, progress continues toward cleaner air. The Clean Air Act requires the Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. EPA must designate areas as meeting (attainment) or not meeting (nonattainment) the NAAQS. Currently, parts of Maryland are designated as nonattainment including several areas in Baltimore, Philadelphia-Wilmington-Atlantic City, and Washington, DC-MD-VA. The entire Upper Bay and the Baltimore Harbor area are in nonattainment for ozone, while only portions of the Middle and Lower Bay are in nonattainment for ozone. The majority of the areas that are in a nonattainment zone, are near or located in urban/industrial areas which have the highest population and number of pollutant sources.

Overall, it is important to note that states throughout the Chesapeake Bay watershed have effective air pollution controls in place to address the pollution generated. Vehicles and fuels are cleaner, and utilities have invested billions of dollars in pollution controls. States have also worked to reduce toxics emissions from fuels, paints and industrial processes. The MPA also has an ongoing commitment to improve air quality and helping the Baltimore area meet national health-based air quality standards. According to the Port of Baltimore green port website (http://www.mpa.maryland.gov/greenport/air-quality.php), they have several air quality programs and policies designed to help improve air quality and reduce air emissions at the Port of Baltimore. One of these programs include the dray truck replacement program which helps replace older dray trucks with newer models that meets or exceeds the specified emission certified engine standards of the EPA. The vehicle being replaced must be scrapped so that it will not remain in service and create pollution. Since the launch of this program in February 2012 through May 2014, 82 dray trucks have been replaced and have already shown a reduction in emissions for nitrous oxide, particulate matter, hydrocarbons, and carbon monoxide.

2.5 ESSENTIAL FISH HABITAT

The Magnuson-Stevens Act of 1996 calls for direct action to stop or reverse the continued loss of fish habitats, and mandates the identification of Essential Fish Habitat (EFH) for managed species of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. Essential Fish Habitat is broadly defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."

In 2005, the project team had determined that EFH has been identified within some parts of the Chesapeake Bay and its tributaries for 16 species:

- *Atlantic sea herring (*Clupea harengus*)
- Atlantic sharpnose shark (*Rhizoprionodon terraenovae)*
- *Black sea bass (*Centropristis striata*)
- *Bluefish (*Pomatomus saltatrix*)
- *Cobia (*Rachycentron canadum*)
- Dusky shark (*Carcharhinus obscurus*)
- *King mackerel (*Scomberomorus cava*lla)
- *Red drum (*Sciaenops ocellatus*)
- *Red hake (*Urophycis chuss*)
- Sandbar shark (*Carcharhinus plumbeus*)
- Sand tiger shark (*Carcharias taurus*)
- Scup (*Stenotomus chrysops*)
- *Spanish mackerel (*Scomberomorus maculatus*)
- *Summer flounder (*Paralichthys dentatus*)
- *Windowpane flounder (*Scopthalmus aquosus*)

* indicates species that were identified with EFH for the mainstem of the Chesapeake Bay for both Maryland and Virginia in 2005.

Updated coordination in 2014 with NOAA fisheries, Virginia Field Office and research on the mid-Atlantic EFH designations webpage (http://www.nero.noaa.gov/hcd/webintro.html), resulted in the reduction of the number of EFH designations identified to be germane to the DMMP. Species of concern to the DMMP for the mainstem of the Chesapeake Bay (Maryland / Virginia) are presented in Table 2-1.

There are also three skate species in the mid-Atlantic region that are within the project area for which EFH was designated after preparation of the 2005 DMMP. These additional species are:

- Clearnose Skate (*Raja eglanteria*)
- Winter Skate (*Leucoraja ocellata*)
- Little Skate (*Leucoraja erinacea*)

For all the three skate species, there are now EFH designations for both juvenile and adult life stages within the DMMP project areas. For the clearnose skate, for both juvenile and adult stages, habitats with soft bottom, rocky or gravelly substrates are designated as EFH. For the little skate, for both juvenile and adult stages, habitats with sandy, gravelly, or mud substrates are designated as EFH. Finally, for the winter skate, for both juvenile and adult stages, habitats with a substrate of sand and gravel or mud are designated as EFH.

Table 2-1. EFH designations for the mainstem of the Chesapeake Bay (Maryland and Virginia)

Species	**Eggs**	**Larvae**	**Juveniles**	**Adults**
Red hake (*Urophycis chuss*)			S	S
Windowpane flounder (*Scopthalmus aquosus*)			M,S	M,S
Atlantic sea herring *(Clupea harengus)*				S
Bluefish (*Pomatomus saltatrix*)			M,S	M,S
Atlantic butterfish (*Peprilus triacanthus*)	M,S	M,S	M,S	M,S
Summer flounder (*Paralichthys dentatus*)		M,S	M,S	M,S
Scup (*Stenotomus chrysops*)			S	S
Black sea bass (*Centropristis striata*)			M,S	M,S
King mackerel (*Scomberomorus cavalla*)	X	X	X	X
Spanish mackerel (*Scomberomorus maculatus*)	X	X	X	X
Cobia (*Rachycentron canadum*)	X	X	X	X
Red drum (*Sciaenops ocellatus*)	X	X	X	X

X = EFH has been designated for a given species and lifestage.
M = The EFH designation for this species includes the mixing water/brackish salinity zone of this estuary (0.5% < salinity < 25%).
S = The EFH designation for this species includes the seawater salinity zone of this estuary (salinity ≥ 25%).

In consideration of the ecology and salinity tolerances of the species within the Chesapeake Bay, only juvenile bluefish (*Pomatomus saltatrix*), and juvenile summer flounder (*Paralichthys dentatus*) are likely to occur within the North Point/Rock Point line.

Maintenance dredging occurs during the winter months when summer flounder and bluefish are absent from the Chesapeake Bay. Juvenile bluefish generally concentrate in shoal waters in the upper Bay and are uncommon in the areas where maintenance activities would occur upstream of the North Point/Rock Point line. Although EFH is designated in this area, no impact is anticipated from the dredging activities as mitigative measures, such as time of year restrictions, are implemented to avoid the resource. There are little to no direct impacts on juvenile summer flounder and bluefish from the dredging activities.

Some regions within the Bay have also been designated Habitat Areas of Particular Concern (HAPC). HAPC are those areas of special importance within EFH that may require additional protection from adverse effects. HAPC is defined on the basis of its ecological importance, sensitivity, exposure, and rarity of the habitat. NOAA/NMFS has designated HAPC in the Chesapeake Bay for the larvae, juvenile, and adult stages for the highly migratory sandbar shark *(Carcharhinus plumbeus)*, but not for any other Atlantic highly migratory species (Guide to Essential Fish Habitat Designations in the Northeastern United States; http://www.nero.noaa.gov/hcd/STATES4/VirgMary.htm)

There are now 15 species for which EFH has been designated within the Bay of potential concern to the DMMP. Additionally, HAPC for sandbar shark could be of potential concern. It is important to note that these EFH summaries serve only as a guide for EFH designations. If a specific project site is selected, additional consultation with NMFS is required.

2.6 BLUE CRAB

The blue crab (*Callinectes sapidus*) is one of the most ecologically, commercially, and symbolically important species present in the Chesapeake Bay. The blue crab is an important recreational and commercial fishery in the State of Maryland and Commonwealth of Virginia, and the highest valued fishery in the Chesapeake Bay. The Chesapeake Bay is the largest producer of blue crabs in the country, with an estimated one-third of the nation's blue crab catch coming from Bay waters. Since the year 2000, Bay-wide commercial harvest of blue crabs has averaged an estimated 51.3 million pounds annually (CBSAC, 2015).

Blue crabs are found throughout the entirety of the Chesapeake Bay, from the mouth of the Bay to the Upper Bay's tidal freshwater areas. Blue crabs utilize nearly every habitat type throughout their life cycle. During early larval stages blue crabs inhabit high salinity offshore waters. As larvae mature they migrate from high salinity waters into estuarine waters, making use of intertidal marshes, seagrass beds, and soft-sediment shorelines as they grow. Juvenile and molting adult blue crabs depend heavily on SAV beds for protection and shelter. Blue crabs are classified as opportunistic benthic omnivores, feeding on various crustaceans, mollusks, fish, and organic debris (Perry and McIlwain, 1986). Blue crabs also serve as important prey items for a number of species. As larvae, they are preyed upon by fish, jellyfish, shrimp, and planktivores. Predators of juvenile and adult blue crabs include fish, aquatic turtles, herons, egrets, diving ducks, raccoons, and humans.

Female crabs are most abundant in the higher salinity waters of the Lower Bay while males are more widely distributed, inhabiting areas of lower salinity in the Middle and Upper Bay (Figure 2-1). Mating occurs from May to October in the shallow waters of the Middle and Upper Bay areas. After mating, female crabs migrate back to the Lower Chesapeake Bay to release their eggs. After spawning, both male and female blue crabs will bury themselves under the substrate, typically in October, until they re-emerge the following March. Males overwinter in deep water areas of the Upper Bay while females remain where they released their eggs in the higher salinity waters of the Lower Bay throughout the winter.

Since blue crabs burrow in the substrate while overwintering and overwintering habitat includes bottom habitat in the federal navigation channels, a small percentage of blue crabs are permanently lost when maintenance dredging occurs during the winter months when they are inactive and unable to escape the disturbance of dredging in the channels.

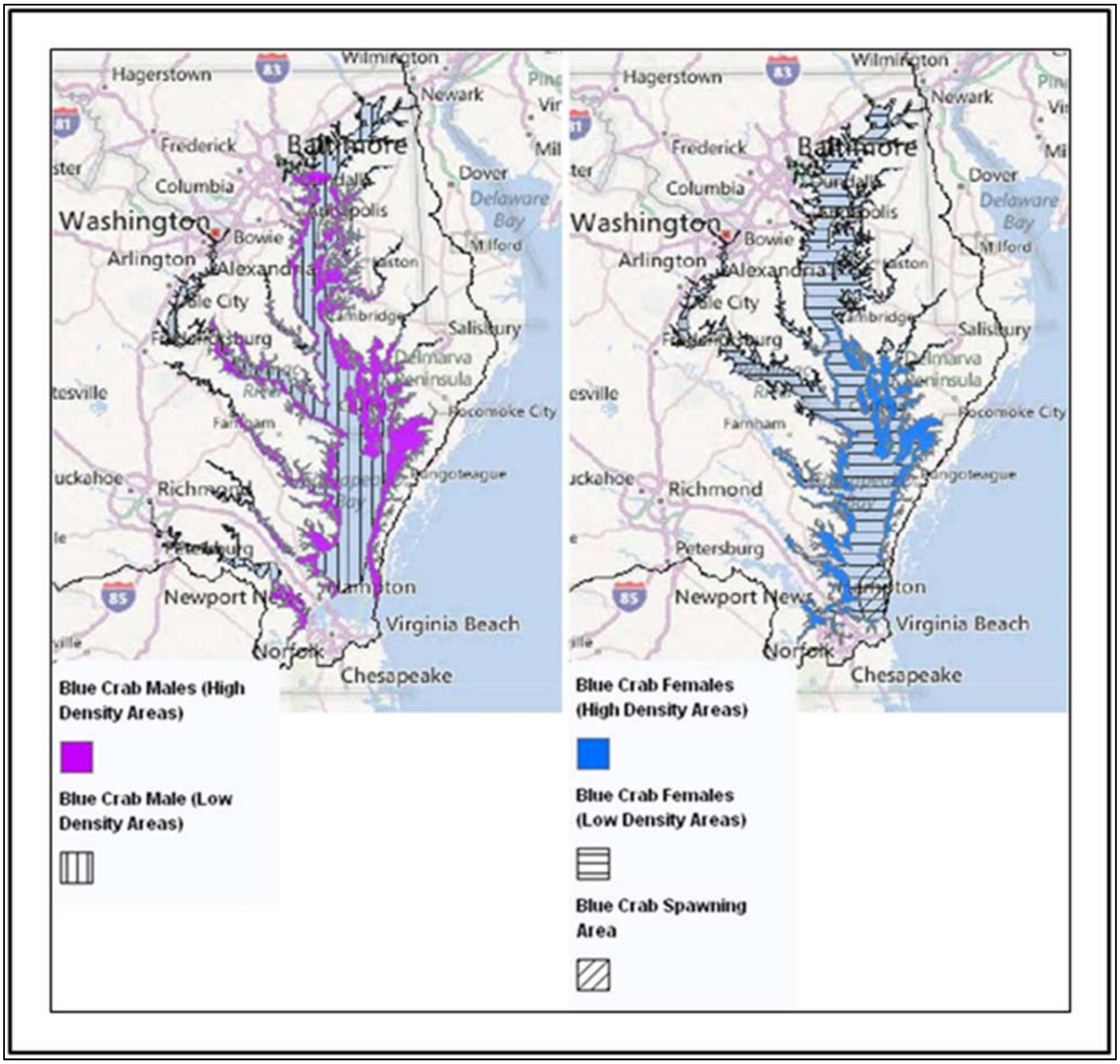
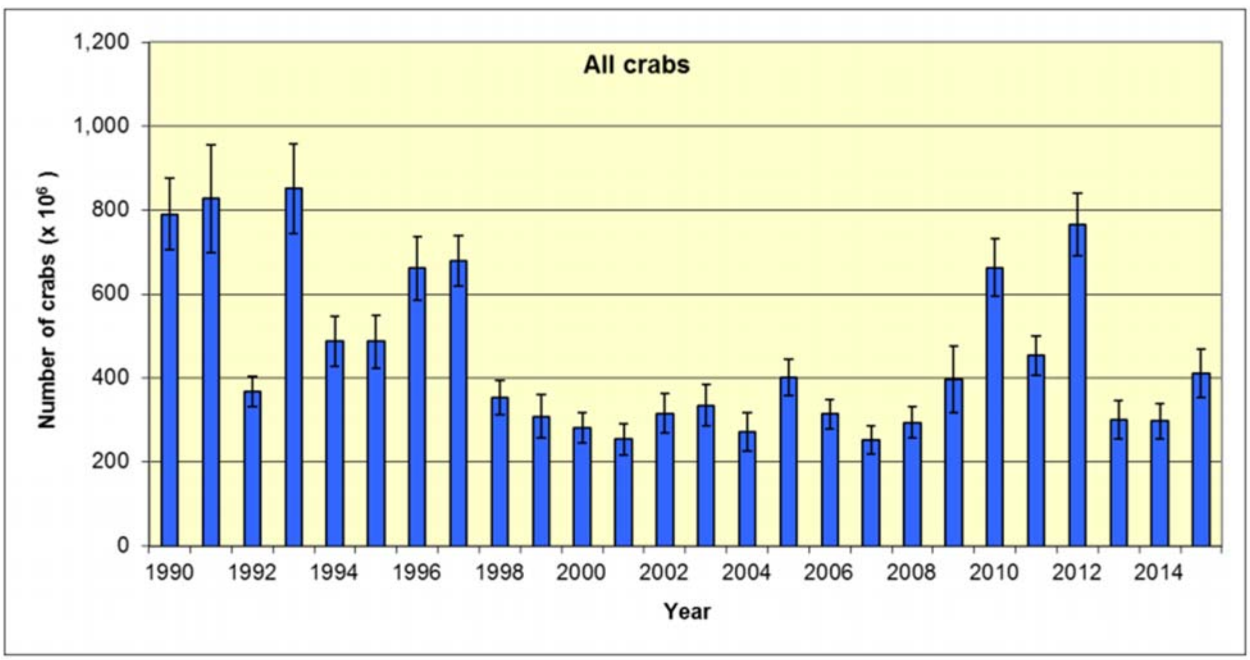


Figure 2-1. Distribution and densities of male and female blue crabs in the Chesapeake Bay during the summer months (http://www.virginiaplaces.org/natural/crabs.html)

There are four major sources of information concerning Chesapeake Bay blue crab population: Maryland Trawl and Commercial Landings Surveys, Virginia Trawl and Commercial Landings Surveys, Maryland DNR Winter Dredge Surveys, and the Chesapeake Bay Stock Assessment Committee's (CBSAC) Annual Blue Crab Advisory Report. Trawl and Commercial Landings Surveys provide Bay-wide abundance and distribution data for fisheries species. Mandatory reporting of commercial landings replaced voluntary reporting for Maryland in 1981 and for Virginia in 1993. Maryland DNR, in a cooperative effort with VIMS, conducts the Chesapeake Bay Winter Dredge Surveys, which produce indices of recruitment and spawning potential in addition to estimates of abundance and commercial exploitation. A total of 1,500 randomly selected and 125 fixed sites are sampled each year (MDDNR, 2015). The CBSAC Blue Crab Advisory Report is based on data from trawl surveys, Calvert Cliff's peeler pot survey, and the Bay-wide winter dredge survey. The 2015 Winter Dredge Survey indicated that total abundance of all blue crabs grew from 297 million crabs in 2014 to 411 million crabs in 2015, an increase of 38 percent (Figure 2-2). Trawl and Commercial Landings Surveys show that total Bay-wide commercial catch decreased from 36.8 million pounds in 2013 to 35 million pounds in 2014. The 2014 Bay-wide commercial harvest was the lowest harvest recorded in the last 25 years (Figure 2-3).



Note: Error bars represent 95 percent confidence intervals

Figure 2-2. Winter dredge survey estimate of abundance of blue crabs in Chesapeake Bay (CBP, 2015)

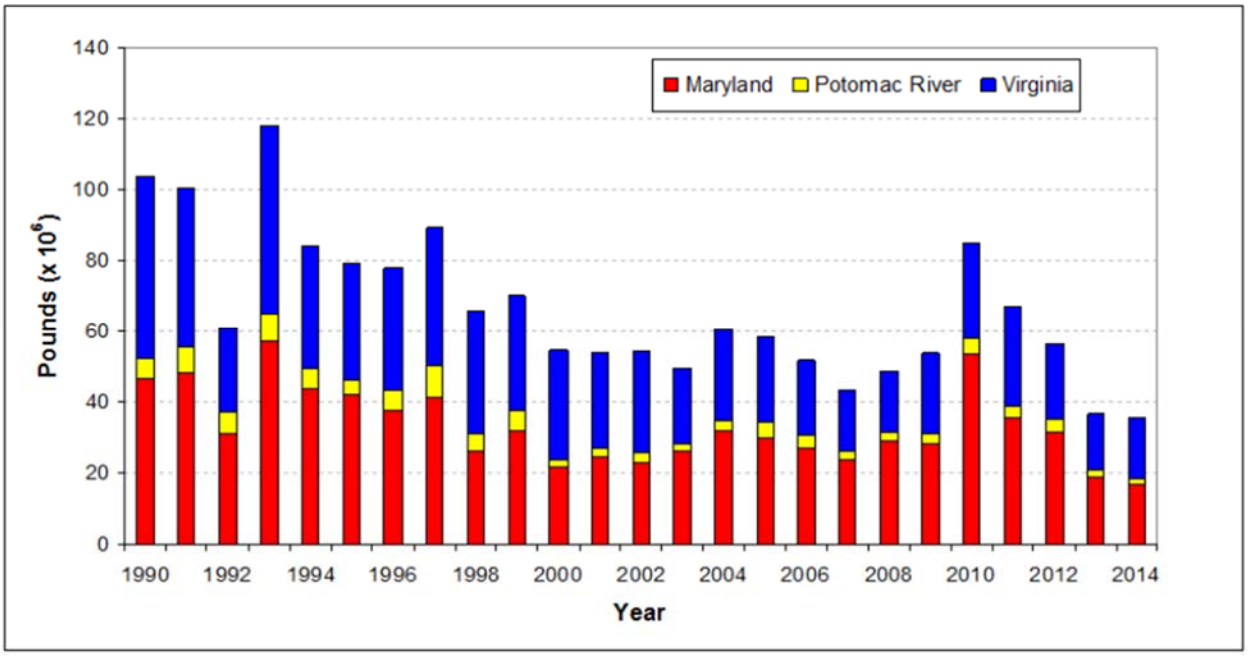


Figure 2-3. Total Chesapeake Bay commercial blue crab landings for Maryland, Virginia, and Potomac River, 1990–2014 (CBP, 2015)

In 1981 Virginia Marine Resources Commission (VMRC) entered into an agreement with the USACE to allow for the continued placement of dredged material from the Virginia Approach Channels without a VMRC permit for disposal of the material under certain conditions. The agreement conditions require that the USACE complete baseline monitoring before placement of material at the sites in order to document existing conditions prior to placement. USACE is also required to consider placement operations that minimize impacts to blue crabs and other species and to consider alternatives for placement recommended by VMRC. Although USACE is not required to apply for a VMRC permit, they must request a 401 Water Quality Certification to maintain the Virginia Approach Channel with dredged material placement in the Wolf Trap Alternate and Rappahannock Deep Shoal Alternate Open Water Sites.

Both the Wolf Trap Deep Alternate and the Rappahannock Shoal Alternate Open Water Sites are located within a designated blue crab sanctuary and especially high densities of overwintering female blue crabs are known to be present within the vicinity of the Wolf Trap Alternate Open Water Site as shown in Figure 2-4. VMRC has been working extensively with both the USACE Norfolk and the USACE Baltimore Districts relative to concerns for overwintering blue crabs present at Wolf Trap Alternate Open Water Site, and the monitoring program requirements of the aforementioned agreement, and has recommended that USACE explore alternative placement areas for the Baltimore Harbor and Channels 50-Foot Project which minimize impacts to and/or avoid overboard placement in the commission's Blue Crab Sanctuary Area 1 (Figure 2-5).

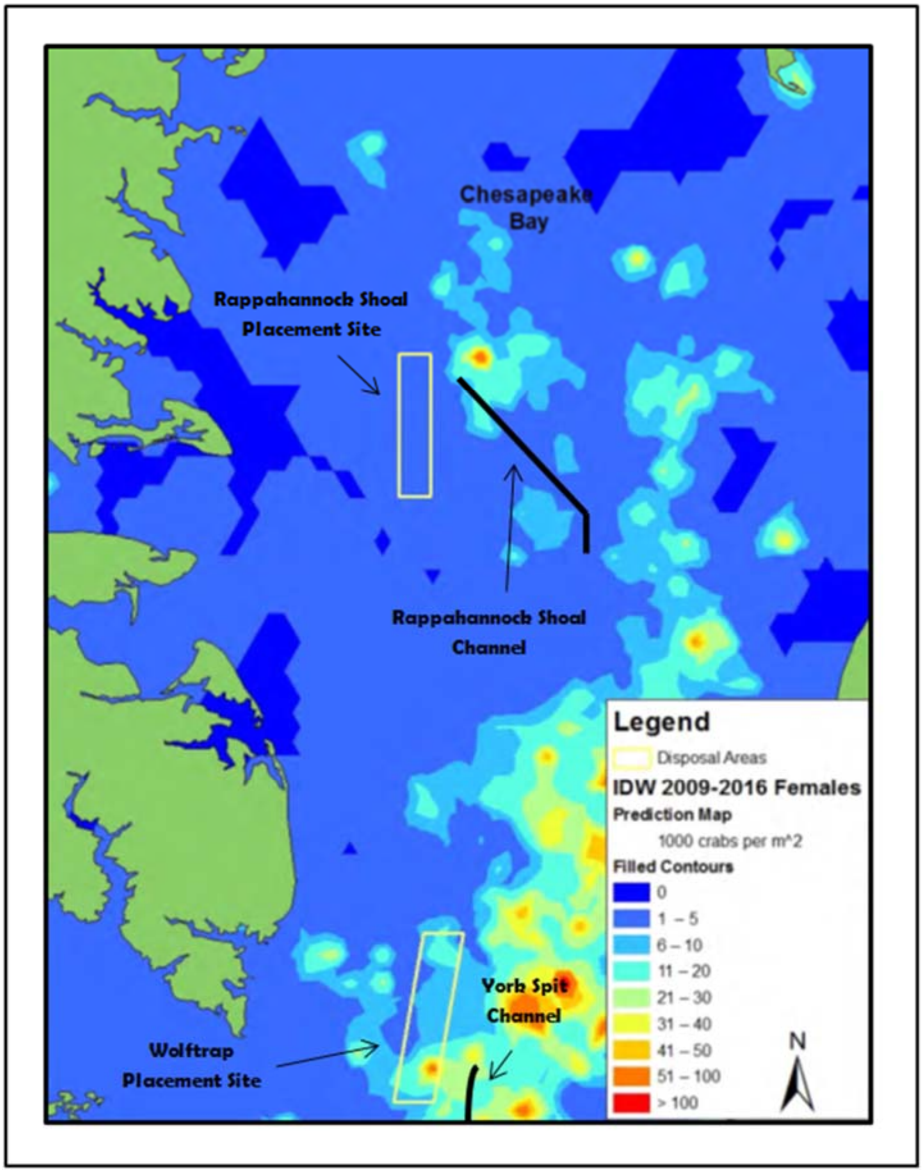


Figure 2-4. Density of blue crab females as a composite in relation to federal navigation channels and dredged material disposal sites from 2009-2016 (Lipcius & Knick, 2016)

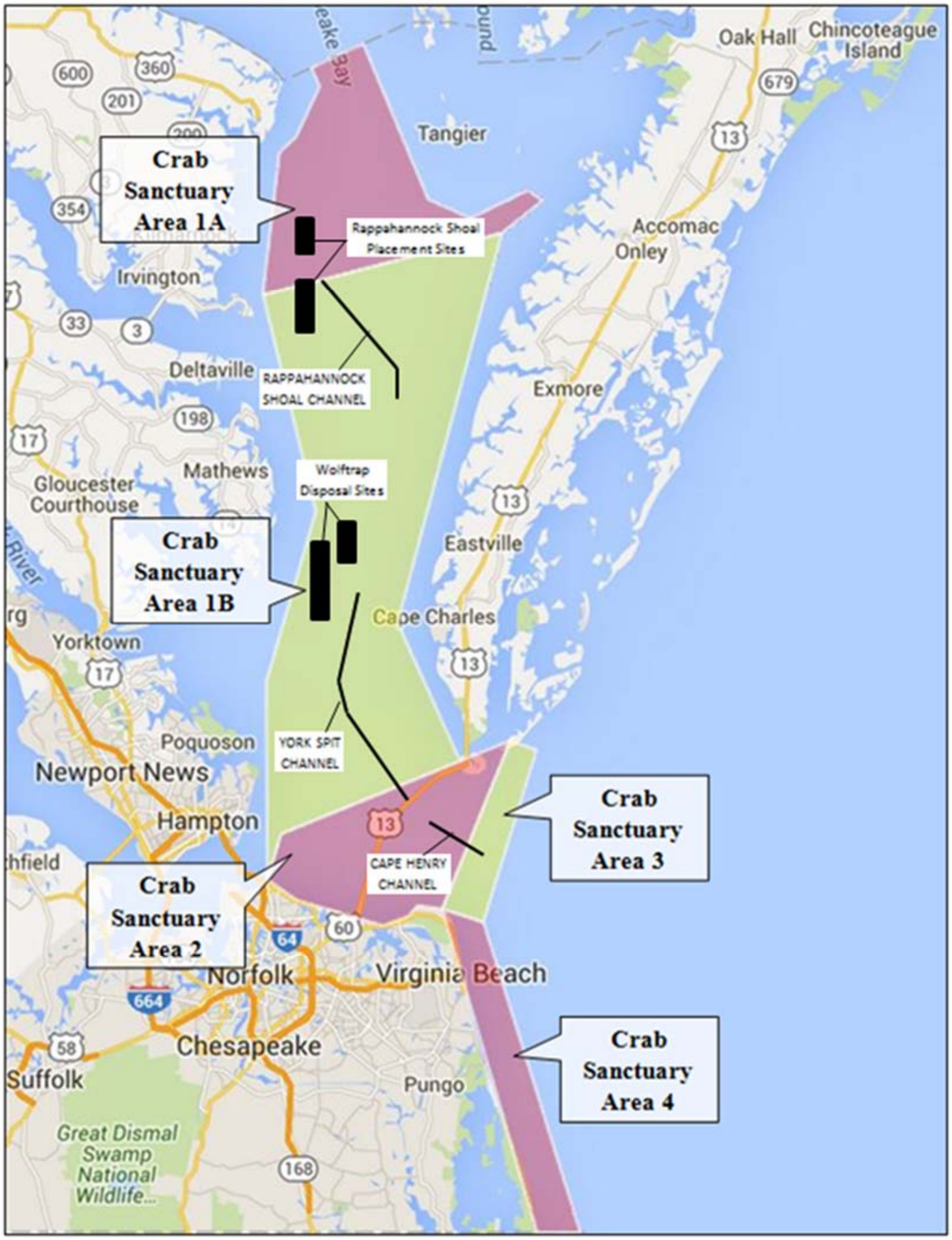


Figure 2-5. Blue Crab Sanctuary Areas - Source: VMRC, Virginia Blue Crab Sanctuary (October 2012)

2.7 WATERFOWL HABITAT

Millions of migratory birds pass through and stop-over in the Chesapeake Bay every year. Species of concern which use Chesapeake Bay marshes as breeding grounds include the saltmarsh sharp-tailed sparrow (*Ammodramus caudacutus*) and the seaside sparrow (*Ammodramus maritimus*). Wading birds such as the great blue heron (*Ardea Herodias)* and snowy egret (*Egretta thula*) use the Chesapeake Bay for nesting, along with other marsh-nesting species which includes the clapper rail (*Rallus longirostris*), black rail (*Laterallus jamaicensis*), least bittern (*Ixobrychus exilis*), Foster's tern (*Sterna forsteri*) , and laughing gull (*Leucophaeus atricilla*). The Chesapeake Bay is a prime habitat for waterfowl species to breed, overwinter, and to stop on their migratory journey. Waterfowl which use the Bay for nesting include the mallard (*Anas platyrhynchos*) and American black duck (*Anas rubripes*). Other migratory waterfowl species which use the Bay in the winter include redhead (*Aythya americana*), northern pintail (*Anas acuta*), American wigeon (*Anas americana*), ruddy duck (*Oxyura jamaicensis*), and canvasback (*Aythya valisineria*).

Loss of habitat along waterways poses the biggest threat to many bird species in the Bay watershed. Deforestation, shoreline development, and shoreline erosion disrupt nesting activities, and chemical contaminants in the water damage the food source of many Bay birds. The Bay's vast tidal marshlands are important nesting nursery, and wintering areas for colonial waterbirds, wading birds, and several federally listed and state-listed endangered species. Rare, threatened, and endangered species found in the Chesapeake Bay are listed in Section 2.6.

In the Upper Bay, several colonial waterbird nesting sites have been documented, particularly along the Chester and Eastern rivers. Several waterfowl staging and concentration areas are located in the Upper Bay, particularly to the south of Havre de Grace, and off the shore of much of the eastern Upper Bay shoreline. In Baltimore Harbor, much of the Patapsco River is designated by Maryland DNR as waterfowl staging and concentration areas. There is also a designated area to the west of Hart-Miller Island. In the Middle Bay region, many Bay islands have designated waterfowl staging and concentration areas. Tidal influences create extensive networks of salt marshes and tidal flats in the Middle Bay that support diverse communities of bird species. James and Barren Islands support waterfowl habitat with numerous bird species frequenting both islands. Vase salt marshes and the low numbers of mammalian predators provide ideal habitats for a variety of bird species in the Lower Bay. Tidal flats, with their abundant invertebrate communities of worms, crabs, and clams, serve as a primary food source for Bay shorebirds.

2.8 RARE, THREATENED, AND ENDANGERED SPECIES

The Endangered Species Act (ESA) of 1973 (16 USC 1531-1543) regulates activities affecting plants and animals classified as endangered or threatened, as well as the designated critical habitat of such species.

In 2005, in fulfillment of federal and state requirements, consultation via letter was conducted with the USFWS Ecological Services Office in Annapolis, Maryland; the Habitat and Protected Resources

Division of the NMFS in Oxford, MD; MD DNR's Heritage and Wildlife Service in Annapolis, MD; and the Virginia Department of Conservation and Recreation (VDCR), Division of Natural Heritage in Richmond, VA. Information requested from these agencies included federal and state listed rare, threatened, and endangered species; designated proposed critical habitat; and candidate taxa occurring in the project area. Because the DMMP is programmatic, rather than site-specific, the Maryland and Virginia portions of the Chesapeake Bay watershed were considered to be the project area.

Communication with fishery biologists from NOAA in early 2014 indicated that since 2005, they have listed 5 Distinct Population Segments (DPSs) of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), one of which is in the Chesapeake Bay. This species along with shortnose sturgeon (*Acipenser brevirostrum*), green sea turtle (*Chelonia mydas*), leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*), and Kemp's ridley turtle (*Lepidochelys kempii*), are several federally listed endangered species of great concern for the DMMP project area.

In addition, in February 2014, consultation with UFWS Annapolis Field Office and research on the Information, Planning, and Conservation System (IPAC) website (http://ecos.fws.gov/ipac/) identified additional federally listed species within the project area that could potentially be of concern at placement sites:

- Delmarva fox squirrel (*Sciurus niger cinereus*)
- Puritan Tiger beetle (*Cicindela puritana*)
- Bog Turtle (*Glyptemys muhlenbergii*)
- Northeastern beach Tiger beetle (*Cicindela dorsalis dorsalis*)
- Dwarf wedge mussel (*Alasmidonta heterodon*)
- Sensitive joint vetch (*Aeschynomene virginica*)
- Swamp pink (*Helonias bullata*)
- Sandplain gerardia (*Agalinis acuta*)
- Canby's dropwort (*Oxypolis canbyi*)

Table 2-2 includes all of the federally listed rare, threatened, and endangered species in the mainstem of the Chesapeake Bay.

Table 2-2. USFWS Rare, Threatened, and Endangered Species for the Chesapeake Bay area (Maryland and Virginia)

Species	**Status**	**Critical Habitat**
Birds		
Piping Plover (*Charadrius melodus*)	Threatened	Yes
Red Knot (*Calidris canutus rufa*)	Threatened	No
Red-Cockaded woodpecker (*Picoides borealis*)	Endangered	No
Roseate tern (*Sterna dougallii dougallii*)	Endangered	No
Clams		
Dwarf wedge mussel (*Alasmidonta heterodon*)	Endangered	No
Tar River spinymussel (*Elliptio steinstansana*)	Endangered	No
Crustaceans		
Hay's Spring amphipod (*Stygobromus hayi*)	Endangered	No
Fish		
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)*	Endangered	No
Shortnose sturgeon (*Acipenser brevirostrum)*	Endangered	No
Roanoke logperch (*Percina rex*)	Endangered	No
Plants		
Canby's dropwort (*Oxypolis canbyi*)	Endangered	No
Sandplain gerardia (*Agalinis acuta*)	Endangered	No
American chaffseed (*Schwalbea americana*)	Endangered	No
Seabeach amaranth (*Amaranthus pumilus*)	Threatened	No
Sensitive joint-vetch (*Aeschynomene virginica*)	Threatened	No
Small Whorled pogonia (*Isotria medeoloides*)	Threatened	No
Swamp pink (*Helonias bullata*)	Threatened	No

Table 2-2 cont. USFWS Rare, Threatened, and Endangered Species for the Chesapeake Bay area (Maryland and Virginia)

Species	Status	Critical Habitat
Insects		
Northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*)	Threatened	No
Puritan tiger beetle (*Cicindela puritana*)	Threatened	No
Mammals		
Delmarva Peninsula fox squirrel (*Sciurus niger cinereus*)	Endangered	No
Northern Long-eared Bat (*Myotis septentrionalis*)	Threatened	No
Reptiles		
Bog Turtle (*Glyptemys muhlenbergii*)	Threatened	No
Green sea turtle (*Chelonia mydas*)	Threatened	Yes
Hawksbill sea turtle (*Eretmochelys imbricata*)	Endangered	Yes
Loggerhead turtle (*Caretta caretta*)	Endangered	No
Kemp's Ridley sea turtle (*Lepidochelys kempii*)	Endangered	No
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered	Yes

Of all of the federally listed species identified by USFSW and NOAA, the species that could possibly be impacted by dredging activities are the shortnose and Atlantic sturgeon along with the species of sea turtles previously mentioned.

In May 2013, the USACE Baltimore District prepared a Biological Assessment on the potential impacts of dredging and dredged material placement operations on Atlantic sturgeon, shortnose sturgeon, and the various sea turtles. The overall conclusion of the biological assessment was that dredging or dredged material placement activities are not likely to adversely affect these species within the Chesapeake Bay or its tributaries. In August 2013, NOAA issued a Biological Opinion covering a 12 year period stating that they concur with the USACE determination and that no further consultation pursuant to Section 7 of the Endangered Species Act was required.

It was agreed between the USACE-Baltimore District and NOAA, that dredging in the deep draft navigation channels would occur from June 1 through November 30 of any given calendar year, to be protective of adult shortnose and Atlantic sturgeon. Dredging was then further restricted in the Baltimore Harbor Approach Channels to August 1 to November 30, with observers used from December through March if dredging is proposed during this time frame. Atlantic sturgeon is present in the Maryland waters of the Chesapeake Bay but is much more common in the Virginia waters of the Bay. Atlantic surgeon is also known to spawn within the James River in Virginia but they do not presently spawn in Maryland. With shortnose sturgeon, there are no known spawning areas in the Chesapeake Bay and the species is transient in presence.

NOAA concurred that any effect to Endangered Species Act-listed (ESA) species by the mechanical dredging will be insignificant or discountable and that the dredging is not likely to adversely affect any listed species under its jurisdiction. No incidental take statement (ITS) was required. NOAA concurred that any effects during placement would be insignificant. NOAA stated that the effects to water quality are minimal and that all effects of turbidity, benthic resources removal and potential alterations of water quality are insignificant/discountable.

There is no documentable spawning of sturgeon or nesting by sea turtles in the Maryland part of the Chesapeake Bay. Marine mammal presence is rare and is usually a sighting of a seal although a Florida manatee ("Chessie") was sighted a few times starting in 1994 and then ten years later. NOAA states that the effects from vessels used during dredging and placement would be insignificant in Maryland.

2.9 CULTURAL RESOURCES

From April 3 through May 10, 2004, Panamerican Consultants, Inc., a subcontractor to Weston Solutions, conducted a reconnaissance-level cultural resources survey for the CENAB DMMP. The purpose of the survey was to identify known cultural resources within proposed and existing dredge material placement sites. Cultural resources include archaeological sites, buildings, structures, objects, or districts. Based on the prehistory, history, and topography of each DMMP site, a determination of the potential for additional cultural resources within each site was formulated. The reconnaissance-level cultural resource survey identified known cultural resources within the proposed and existing dredged material placement areas within and near the Chesapeake Bay. Further site specific testing and assessment of project effects will need to be addressed on a site-by-site basis if and when specific sites are selected for dredged material placement. A full report of the cultural resources is included for reference under Appendix E of the 2005 DMMP report (Appendix A).

The updated DMMP document is for the most part looking at the same sites evaluated in 2005, but there a few new sites/revisions DMMP placement alternatives being looked at. The new/revised placement sites include a vertical expansion of Courthouse Point and Pearce Creek, northward lateral expansion of Cox Creek (Cristal site), westward lateral expansion of Cox Creek on MPA-owned property, vertical expansion of Cox Creek, overall expansion of Cox Creek utilizing the previously listed options, island creation in Susquehanna Flats, and an increase in size of both Parsons and Sharps Island small island restoration sites. Regarding the cultural resources, the existing Cox Creek site that is being used for dredged material placement has received concurrence from the State Historic Preservation Office (SHPO). However, the MPA, who owns this site, is currently gathering information regarding the cultural resources of the western part of this exiting site, and will be coordinating with the SHPO and if and when the MPA considers purchasing the site adjacent to Cox Creek called Cristal (the northward lateral expansion of Cox Creek) coordination with the SHPO office will occur. Courthouse Point has been owned and operated by the USACE Philadelphia District since the 1930s. If, and when, a vertical expansion is needed, their DMMP will cover whatever NEPA is necessary including examination of cultural resources. Finally, in regards to Parsons and Sharps Island, if those sites are selected as dredged material placement sites, the USACE would complete a full NEPA analysis and coordination with the SHPO.

2.10 RELATIVE SEA LEVEL CHANGE

The global sea level is changing and projections over the years have varied widely. Over the period 1901 to 2010, global mean sea level rose by 0.19 [0.17 to 0.21] meters (IPCC, 2014). The rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia. Assessments conducted in the U.S. and internationally show that global average sea level rose approximately 1.7 millimeters per year through the 20th century, after a period of little change during the previous two thousand years (EPA, 2009).

The Chesapeake Bay region is susceptible to sea level rise impacts, but is also greatly impacted by gradual subsidence of the land due to geological shifts, as well as groundwater extraction (Eggleston and Pope, 2013). The mean sea level trend at the mouth of the Chesapeake Bay (measured at the Chesapeake Bay Bridge Tunnel, Virginia NOAA tide gauge) is 5.93 millimeters (mm) per year based on monthly mean sea level data from 1975 to 2015 (Figure 2-6). This is equivalent to a change of 1.94 feet in 100 years. The trend at the Baltimore, Maryland gauge is 3.14 mm per year measured from 1902 to 2015, which is equivalent to a change of 1.03 feet in 100 years (Figure 2-7).

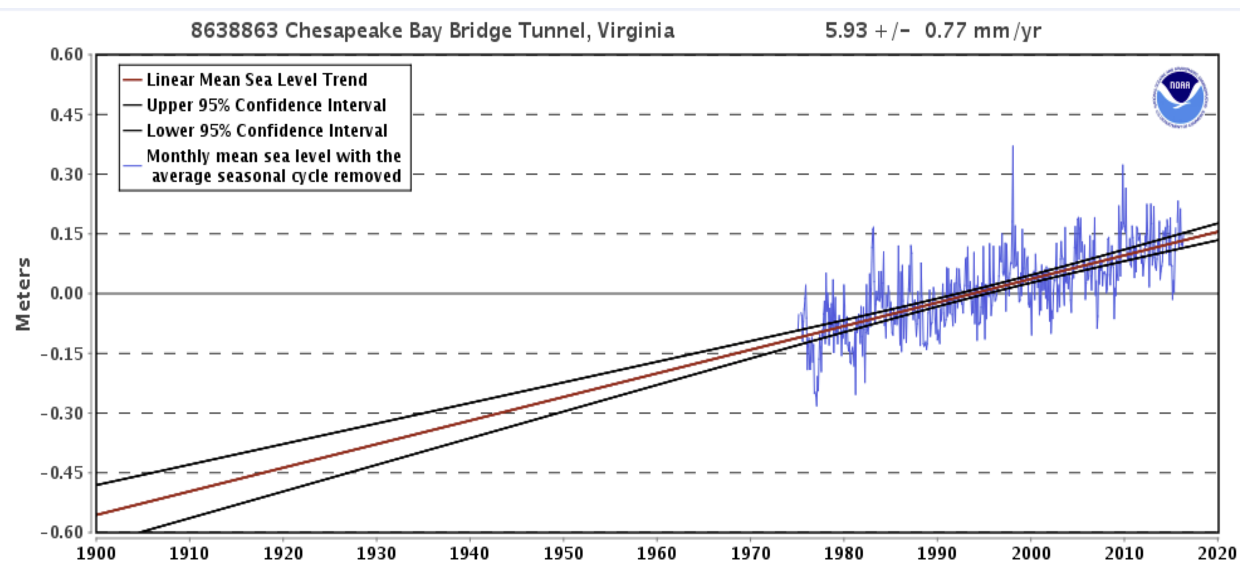


Figure 2-6. Sea level trend at Chesapeake Bay Bridge Tunnel, Virginia (NOAA Tidal Gauge)

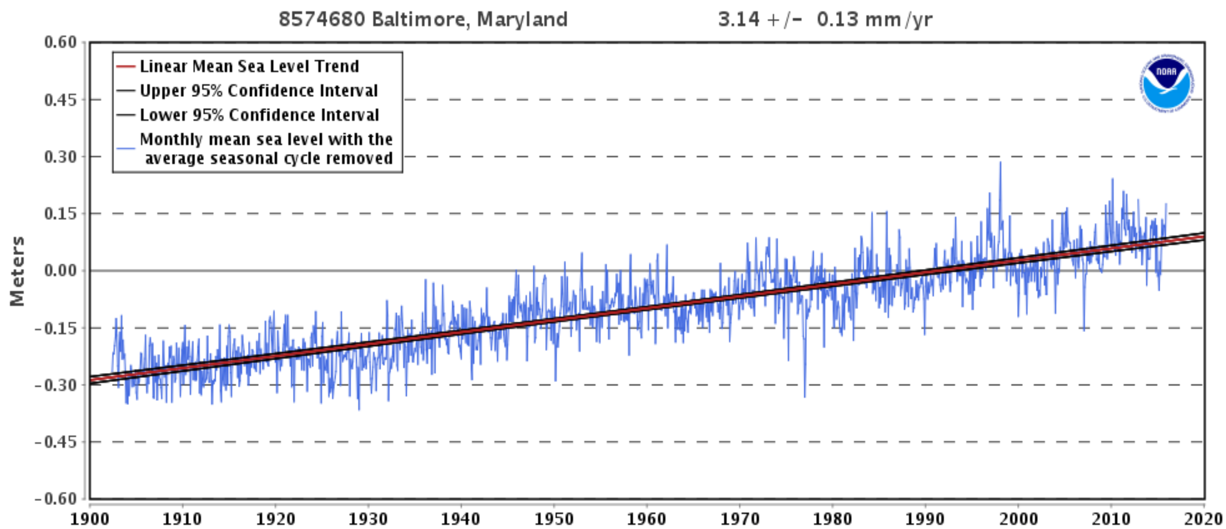


Figure 2-7. Mean sea level trend at Baltimore, Maryland (NOAA Tidal Gauge)

Recent climate research by the Intergovernmental Panel on Climate Change (IPCC) predicts continued or accelerated global warming for the 21st Century and possibly beyond, which would cause a continued or accelerated rise in global mean sea level. USACE Engineering Regulation ER 1110-2-8162 "Incorporating Sea Level Change into Civil Works Programs" was developed with the assistance of coastal scientists from the NOAA National Ocean Service and the US Geological Survey and guides how the evaluation of sea level change is applied to USACE projects.

Planning studies and engineering designs are used to evaluate the entire range of possible future rates of sea-level change (SLC), represented by three scenarios of "low", "intermediate' and "high" sea-level change. Using these sea level change scenarios as opposed to an individual scenario probability underscores the uncertainty in how local relative sea levels will actually play out into the future. At any location, changes in local relative sea level (LRSL) reflect the integrated effects of global mean sea level (GMSL) change plus local or regional changes of geologic, oceanographic, or atmospheric origin.

- "Low" rate of sea-level change is equal to the historic rate of SLC, which can be viewed at each gage.
- "Intermediate" rate of sea-level (ISL) change is based on the modified NRC curve I and Using the current estimate of 1.7 mm/year for GMSL change, the following equations

$$E(t) = 0.0017t + bt^2$$

in which t represents years, starting in 1986, b is a constant, and E(t) is the eustatic sea level change, in meters, as a function of t.

Manipulating the above equation to account for the fact that it was developed for eustatic sea level change starting in 1992 (which corresponds to the midpoint of the current National Tidal Datum

Epoch of 1983-2001), while projects will actually be constructed at some date after 1992, results in equation

$$E(t_2) - E(t_1) = 0.0017(t_2 - t_1) + b(t_2^2 - t_1^2)$$

where (t_1) is the time between the project's construction date and 1992 and (t_{12}) is the time between a future date at which one wants an estimate for sea level change and 1992 (or t_2=t_1+number of years after construction).

- "High" rate of sea-level change (HSL) is based on the modified NRC curve III and the above equations.

The trend for Sea Level Charge at Baltimore gauge is estimated to be 3.08 mm/year according to USACE Institute of Water resources Sea Level Change calculator, based on data provided by the CO-OPS gage 8574680. There is a slight difference in the reported SLC rate between the USACE IWR Sea Level Change calculator and the historic SLC reported on the NOAA gage's website. This can be attributed to rounding, unit conversion and confidence intervals. The 2014 tidal data is used for the analysis of existing conditions. Projecting out 70 years from 2017, which was analyzed for the Baltimore Harbor and Channels 50-ft Project LRR, the rates of change relative to Baltimore gage in 2087 are as follows: "low" rate of change is 0.93 feet, the "intermediate" rate of change is 1.76 feet, and the "high" rate of change is 4.34 feet (Figure 2-8; Table 2-3).

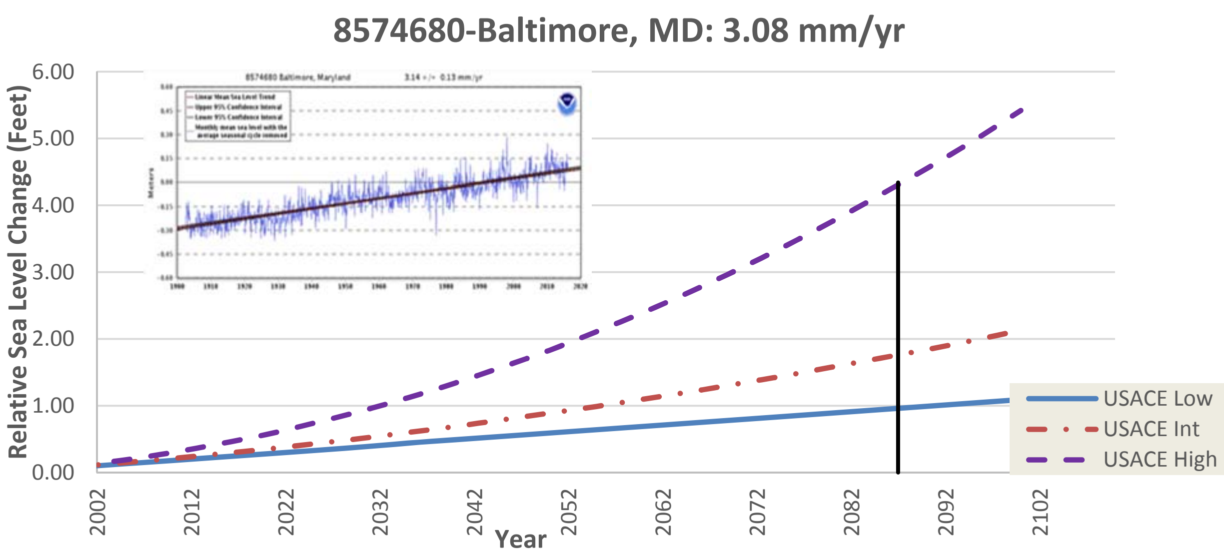


Figure 2-8. Comparison of the three sea level rise curves at Baltimore, MD using USACE Sea Level Change Curve Calculator (curves computed using criteria in EC1165-2-212). Per NOAA the mean sea level trend is 3.14 mm/year for this gage with a 95% confidence interval of +/- 0.13 mm/yr based on monthly mean sea level data from 1902 to 2015, which is equivalent to a change of 1.03 feet in 100 years.

Table 2-3. Calculated Sea Level Charge Rates using IWR USACE Sea Level Change calculator

Sea Level Change Rates in 2087 (ft)											
Baltimore (8574680)			**Lewisetta (8635750)**			**Gloucester Pt (8637624)**			**Ch Bay Br Tunnel (8638863)**		
Low	Int	High	Low	Int	High	Low	Int	High	Low	Int	High
0.93	1.76	4.34	1.56	2.35	4.9	1.21	2	4.58	1.84	2.71	5.2

The trend for Sea Level Charge at Chesapeake Bay Bridge Tunnel gauge is estimated to be 6.05 mm/year according to USACE Institute of Water Resources Sea Level Change calculator, based on data provided by the CO-OPS gage 8638863. There is a slight difference in the reported SLC rate between the USACE IWR Sea Level Change calculator and the historic SLC reported on the NOAA gage's website. This can be attributed to rounding, unit conversion and confidence intervals. 2014 tidal data is used for the analysis of existing conditions. The rates of change relative to Chesapeake Bay Bridge Tunnel gage in 2087 are as follows: "low" rate of change is 1.84 feet, the "intermediate" rate of change is 2.71 feet, and the "high" rate of change is 5.2 feet (Figure 2-9; Table 2-3).

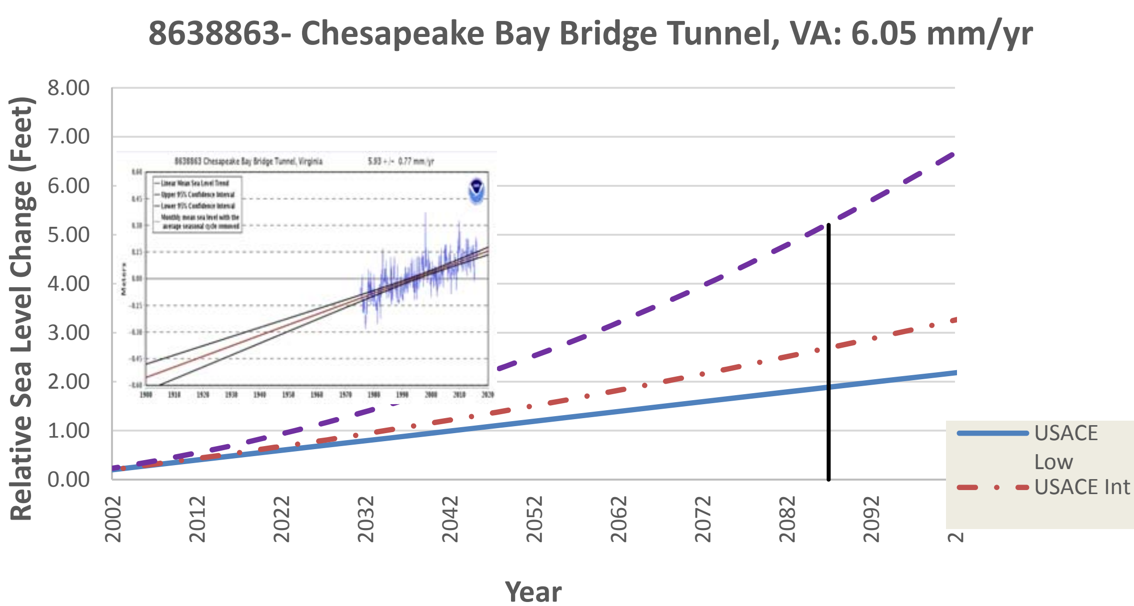


Figure 2-9. Comparison of the three sea level rise curves at Chesapeake Bay Bridge Tunnel, VA using USACE Sea Level Change Curve Calculator (curves computed using criteria in EC1165-2-212). Per NOAA the mean sea level trend is 5.93 mm/year with a 95% confidence interval of +/- 0.77 mm/yr based on monthly mean sea level data from 1975 to 2015, which is equivalent to a change of 1.94 feet in 100 years.

In Norfolk, sea level rise may increase through 2087 by 0.86 feet in the low scenario, 1.39 feet in the intermediate scenario, and 3.06 feet in the high scenario. In Baltimore, sea level rise may increase through 2087 by 0.78 feet in the low scenario, 1.31 feet in the intermediate scenario, and 2.98 feet in the high scenario.

Sea level rise can be linked to future issues in the Chesapeake Bay such as damage to infrastructure like ports, channels, or bridges from shoaling or scouring or lead to loss of shoreline or other habitats. MPA, as the owner and operator of Maryland's public marine terminals, has developed a policy to respond to the risk that sea level rise poses to infrastructure. Increased shoreline recession and flooding of low lying areas has been identified as a major concern. Although MPA does not expect major impacts to terminals within the planning period, major impacts to managed low lying properties, such as Poplar Island, have been identified as a major concern by MPA. Planted vegetation at the restored Island may not be able to survive increased water depths due to sea level rise, which may in turn lead to shoreline erosion. Sea level rise could also affect access to the island by inundating the mainland operations center (land base; MPA, 2010). The State of Maryland also has a 2012 executive order that dictates how the state will invest funds to address sea level rise; the executive order is at: http://www.governor.maryland.gov/executiveorders/01.01.2012.29.pdf.

2.11 DREDGING NEEDS

The MPA and CENAB continually assess the dredging needs of the Port of Baltimore, with dredged material resulting from both new non-federal construction and maintenance dredging, and the available placement capacity. Table 2-4 shows the anticipated dredging needs for federal and non-federal navigation projects for the next 20 years. The period of analysis is 20 years, from 2017 to 2036. However, alternatives that provide dredged material capacity for more than 20 years were evaluated. As a matter of regular business, Baltimore District continually reevaluates if there are 20 years of dredged material capacity available, therefore, it is anticipated that a future DMMP will be completed when it is apparent that insufficient capacity is available.

The feasibility report for the Baltimore Harbor and Channels 50-Foot project was completed in 1969 and the recommendations of that report were subsequently authorized. The project was constructed in the mid-1980s, with construction completed in 1990. At that time, changes to cost-share were rumored, which were borne out in WRDA 1986. These cost share changes greatly added to the cost, for which the non-federal sponsor was responsible. There was also concern about the capacity of disposal sites to receive the amounts of material to be dredged. Due to these concerns, various alternatives were developed and it was determined that widths narrower than authorized in some channels would provide adequate safety for the vessel fleet at the time. This was documented in the October 1985 supplement to the 1981 General Design Memorandum and constructed as "Phase I" of the project. "Phase II" was envisioned to construct the channels to their full authorized dimensions.

The anticipated dredging need in this DMMP update includes new work dredging volumes associated with widening the Maryland Bay Approach Channels to their authorized width of 800 feet at a depth of 50 feet and widening the York Spit and Rappahannock Shoal Channels in Virginia to their authorized width of 1,000 feet at a depth of 50 feet. These alternatives are being studies studied in the Baltimore

Harbor and Channels 50-Foot Project, Limited Reevaluation Report. A variety of measures were considered to alleviate vessel delays within the channel system, including constructing the channels to various widths and no action. Economic analysis, performed with the HarborSym Suite demonstrated that widening the Maryland Approach Channels as well as constructing the Virginia Channels to their authorized dimensions resulted in the greatest net benefits. Net benefits were negative when widening the Inner Harbor Channels were considered, due to material disposal costs. In the Inner Harbor Channels area all new work material is allocated to projected projects from state and private sources. Increased O&M volumes are assumed for the widened channels after construction. O&M material projections are based the channel shoaling rates and anticipated dredging cycles. There is no anticipated new work dredging in the C&D Canal Approach Channels.

Because historical pay quantities were used for the projections of future dredging needs, 10 percent was added for non-pay overdepth. This accounts for the imprecision associated with dredging to a specified depth. Since 2005, placed quantities of dredged material at Poplar Island are, on average, about 9.5 percent higher than pay quantities.

Dredging needs were estimated based on past dredging events, with an adjustment in the future for increased sediment volumes due to widened channels. It has been assumed that natural wind and wave conditions, as well as tidal range and tidal currents in the area will generally remain the same. Climate change modeling predicts more severe and more frequent storms in the future along with rising sea levels. Increased sedimentation from more frequent storms may require changes in dredging in the future, but these changes cannot currently be quantified.

Past dredging volumes were budget constrained such that the total volume of material removed in a given year was less than the total needs for the year. Thus, if more funding were available, more sediment would be removed until the backlog of dredging needs was completed. The historical dredging volumes were averaged over time and that amount projected into the future based on past dredging frequency. Future potential changes in already constrained funding were not considered when estimating dredging needs.

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Table 2-4. Baltimore Harbor and Channels projected dredging quantities (cy) by channel and fiscal year

CHANNEL SECTION	Total Estimated Dredging Quantity/Cycle	Total Estimated Dredging Quantity/Cycle w/ 50-ft	2017 Estimated Quantities	2018 Estimated Quantities	2019 Estimated Quantities	2020 Estimated Quantities	2021 Estimated Quantities	2022 Estimated Quantities	2023 Estimated Quantities	2024 Estimated Quantities	2025 Estimated Quantities	2026 Estimated Quantities	2027 Estimated Quantities	2028 Estimated Quantities	2029 Estimated Quantities	2030 Estimated Quantities	2031 Estimated Quantities	2032 Estimated Quantities	2033 Estimated Quantities	2034 Estimated Quantities	2035 Estimated Quantities	2036 Estimated Quantities	TOTAL	AVERAGE ANNUAL
VIRGINIA CHANNELS																								
CAPE HENRY CHANNEL	500,000					500,000						500,000						500,000					1,500,000	
YORK SPIT CHANNEL	375,000		375,000			375,000			375,000			375,000			375,000			375,000			375,000		2,625,000	
RAPPAHANNOCK SHOAL	600,000							600,000										600,000					1,200,000	
New Work							1,800,000	1,800,000	1,700,000														5,300,000	
SUB-TOTAL	1,475,000		375,000	-	-	875,000	1,800,000	2,400,000	2,075,000	-	-	875,000	-	-	375,000	-	-	1,475,000	-	-	375,000	-	10,625,000	
10% Contingency			37,500	-	-	87,500	180,000	240,000	207,500	-	-	87,500	-	-	37,500	-	-	147,500	-	-	37,500	-	1,062,500	
TOTAL			412,500	-	-	962,500	1,980,000	2,640,000	2,282,500	-	-	962,500	-	-	412,500	-	-	1,622,500	-	-	412,500	-	11,687,500	
10% Non-pay overdepth			41,250	-	-	96,250	198,000	264,000	228,250	-	-	96,250	-	-	41,250	-	-	162,250	-	-	41,250	-	1,168,750	
TOTAL VIRGINIA CHANNELS			453,750	-	-	1,058,750	2,178,000	2,904,000	2,510,750	-	-	1,058,750	-	-	453,750	-	-	1,784,750	-	-	453,750	-	12,856,250	642,813
C&D CANAL APPROACH CHANNELS (CENAP)																								
C&D CANAL APPROACH CHANNELS - CENAP			1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	20,000,000	
SUB-TOTAL			1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	20,000,000	
10% Contingency			100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	2,000,000	
TOTAL			1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	22,000,000	
10% Non-pay Overdepth			110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	2,200,000	
TOTAL C&D CANAL APPROACH CHANNELS			1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	1,210,000	24,200,000	1,210,000
MARYLAND BAY APPROACH CHANNELS																								
CRAIGHILL ENTRANCE	300,000	315,000		300,000		300,000		315,000		315,000		315,000		315,000		315,000		315,000		315,000		315,000	3,120,000	
CRAIGHILL CHANNEL	250,000	260,000	250,000				250,000				260,000				260,000				260,000				1,280,000	
CRAIGHILL ANGLE	800,000	882,000		800,000			800,000			882,000			882,000		882,000	882,000			882,000			882,000	6,892,000	
CRAIGHILL UPPER RANGE	125,000	130,000	125,000			125,000			130,000			130,000			130,000			130,000			130,000		900,000	
CUTOFF ANGLE	400,000	414,000		400,000		400,000		414,000		414,000		414,000		414,000		414,000		414,000		414,000		414,000	4,112,000	
BREWERTON EXTENSION	800,000		800,000		800,000		800,000		800,000		800,000		800,000		800,000		800,000		800,000		800,000		8,000,000	
TOLCHESTER CHANNEL	700,000				700,000			700,000			700,000			700,000			700,000			700,000			4,200,000	
SWAN POINT CHANNEL	500,000				500,000							500,000							500,000				1,500,000	
TOLCHESTER S-TURN	-														850,000								850,000	
New Work						1,400,000	900,000																2,300,000	
SUB-TOTAL			1,175,000	1,500,000	2,000,000	2,225,000	2,750,000	1,429,000	930,000	1,611,000	1,760,000	1,359,000	1,682,000	1,429,000	2,922,000	1,611,000	1,500,000	859,000	2,442,000	1,429,000	930,000	1,611,000	33,154,000	
10% Contingency			117,500	150,000	200,000	222,500	275,000	142,900	93,000	161,100	176,000	135,900	168,200	142,900	292,200	161,100	150,000	85,900	244,200	142,900	93,000	161,100	3,315,400	
TOTAL			1,292,500	1,650,000	2,200,000	2,447,500	3,025,000	1,571,900	1,023,000	1,772,100	1,936,000	1,494,900	1,850,200	1,571,900	3,214,200	1,772,100	1,650,000	944,900	2,686,200	1,571,900	1,023,000	1,772,100	36,469,400	
10% Non-pay Overdepth			129,250	165,000	220,000	244,750	302,500	157,190	102,300	177,210	193,600	149,490	185,020	157,190	321,420	177,210	165,000	94,490	268,620	157,190	102,300	177,210	3,646,940	
TOTAL MARYLAND BAY APPROACH CHANNELS			1,421,750	1,815,000	2,420,000	2,692,250	3,327,500	1,729,090	1,125,300	1,949,310	2,129,600	1,644,390	2,035,220	1,729,090	3,535,620	1,949,310	1,815,000	1,039,390	2,954,820	1,729,090	1,125,300	1,949,310	40,116,340	2,005,817
HARBOR APPROACH CHANNELS																								
BREWERTON CHANNEL	500,000				500,000			500,000			500,000			500,000			500,000			500,000			3,000,000	
BREWERTON ANGLE	400,000			400,000			400,000			400,000			400,000			400,000			400,000			400,000	2,800,000	
FT. McHENRY CHANNEL	400,000		400,000			400,000			400,000			400,000			400,000			400,000			400,000		2,800,000	
FERRY BAR CHANNEL	232,000		232,000								232,000								232,000				696,000	
CURTIS BAY CHANNEL	525,000					525,000					525,000					525,000					525,000		2,100,000	
NON-FEDERAL MAINTENANCE			90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000		1,710,000	
TOTAL HARBOR CHANNELS MAINTENANCE			722,000	490,000	590,000	1,015,000	490,000	590,000	490,000	490,000	1,347,000	490,000	490,000	590,000	490,000	1,015,000	590,000	490,000	722,000	590,000	1,015,000	400,000	13,106,000	655,300
New Work																								
FEDERAL NEW WORK																							-	
STATE AND PRIVATE NEW WORK			150,000	150,000	1,250,000	150,000	150,000	150,000	1,150,000	150,000	150,000	150,000	150,000	150,000	2,150,000	150,000	2,150,000	150,000	150,000	150,000	150,000	150,000	9,100,000	
TOTAL NEW WORK			150,000	150,000	1,250,000	150,000	150,000	150,000	1,150,000	150,000	150,000	150,000	150,000	150,000	2,150,000	150,000	2,150,000	150,000	150,000	150,000	150,000	150,000	9,100,000	455,000
SUB-TOTAL			872,000	640,000	1,840,000	1,165,000	640,000	740,000	1,640,000	640,000	1,497,000	640,000	640,000	740,000	2,640,000	1,165,000	2,740,000	640,000	872,000	740,000	1,165,000	550,000	22,206,000	
10% Contingency			87,200	64,000	184,000	116,500	64,000	74,000	164,000	64,000	149,700	64,000	64,000	74,000	264,000	116,500	274,000	64,000	87,200	74,000	116,500	55,000	2,220,600	
TOTAL			959,200	704,000	2,024,000	1,281,500	704,000	814,000	1,804,000	704,000	1,646,700	704,000	704,000	814,000	2,904,000	1,281,500	3,014,000	704,000	959,200	814,000	1,281,500	605,000	24,426,600	
10% Non-Pay Overdepth			95,920	70,400	202,400	128,150	70,400	81,400	180,400	70,400	164,670	70,400	70,400	81,400	290,400	128,150	301,400	70,400	95,920	81,400	128,150	60,500	2,442,660	
TOTAL HARBOR CHANNELS			1,055,120	774,400	2,226,400	1,409,650	774,400	895,400	1,984,400	774,400	1,811,370	774,400	774,400	895,400	3,194,400	1,409,650	3,315,400	774,400	1,055,120	895,400	1,409,650	665,500	26,869,260	1,343,463

The data in this table is based on compiled historical dredged amounts and average frequency in which they are dredged. This data is intended for long range planning only, it is not a schedule for when a given channel will be dredged. That decision will be based on project condition surveys, funding, and coordination with the Maryland Pilots Association and the Maryland Port Administration.

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3. ALTERNATIVES

This chapter presents the descriptions of placement and beneficial use alternatives, the screening of these alternatives, and the trade-off analysis that leads to the recommendation of alternative suites that will be carried forward for detailed study.

For the purpose of this updated programmatic DMMP, the new sites and innovative use alternatives have been developed on a programmatic basis, rather than on a site-specific basis. Although several new site options are in various stages of evaluation, the purpose of this DMMP is to conduct a programmatic level evaluation of the alternatives. The result of this programmatic level evaluation is the recommendation of alternatives that should undergo further evaluation (i.e., reconnaissance and feasibility studies) in order to select the best specific site and design. The selection of new specific sites will be performed following the completion of this programmatic DMMP through site-specific reconnaissance and feasibility studies and in compliance with NEPA and other laws and regulations. They may include already completed, ongoing, or planned studies. Additional study authority and/or funding may be required to conduct these follow-on studies.

3.1 "NO ACTION" ALTERNATIVE

The "No Action" alternative is used as a basis for comparison to the recommended plan. Because the proposed action is to develop a plan to improve the existing conditions, the consequences of no action (i.e., lack of sufficient placement capacity) are particularly important because they define the need for the DMMP. This alternative consists of a continuation of the current maintenance dredging at the constructed channel dimensions and placing the dredged material at the existing placement sites without modification (sites and capacities are summarized in Table 3-1). The existing placement sites for each of the channel approaches are as follows:

- Harbor Channels and Anchorages
  - Cox Creek Dredged Material Containment Facility (DMCF)

    The Cox Creek Dredged Material Containment Facility is located in Anne Arundel County, Maryland, just south of the Baltimore City line, along the western shoreline of the Patapsco River. In February 2010, Cox Creek was approved by USACE North Atlantic Division as the federal standard for Baltimore Harbor placement. Material dredged from the Baltimore Harbor that is within the Patapsco River is legally considered to be unsuitable for open water placement by state law, 90 percent of Harbor material has been found to be unsuitable for open water placement in accordance with local EPA regulations, and thus must be placed in upland contained facilities. Cox Creek is owned and operated by MPA. The site has 6 mcy total capacity (about 133 acres) and is scheduled to receive federal maintenance material over its approximately 12 year operational life. As of 2016, approximately 2 mcy of capacity remains. The Baltimore

District will use the site and pay a tipping fee to the state under the auspices of Section 217 of WRDA 1996, as amended. A Memorandum of Agreement was signed in 2013 and over 1.5 mcy of federal material has been placed. O&M funding is used to reimburse the state for the federal share of the placement costs based on a tipping fee formula calculated each year based on the location from which the material is dredged and the depth of the project from which it came.

- Masonville DMCF

  The Masonville Dredged Material Containment Facility is in Baltimore City and covers 141 acres. It will ultimately contain 14 mcy of material. As of 2017 it is expected that Masonville will have approximately 13 mcy of capacity remaining. Similar to Cox Creek, the site was constructed by the State of Maryland. The state is pursuing a partnership with the USACE under Section 217, similar to Cox Creek. The analysis for this agreement is scheduled to be completed in 2017. The approved federal standard for the Harbor Channels states that future upland placement sites beyond Cox Creek will likely be included in the federal standard due to the limited life of the Cox Creek site. Once approved for use, Masonville will be recommended to be part of the federal standard, which is consistent with the analysis of this DMMP update. This is also in accordance with the February 2010, North Atlantic Division approval of the Baltimore District's inner harbor base plan white paper.

  State law (Md. Env. Code § 5-1102) prohibits the placement of dredged material from Baltimore Harbor in an unconfined manner in the Bay or its tributaries. As noted in Table 2-3, the total projected dredging need of Harbor channels and anchorages for the planning period is estimated at 27 mcy. As such, continued maintenance dredging of the Harbor Channels, without other additional placement alternatives (e.g., the construction of new or expanded containment facilities) will result in a 12-mcy capacity shortfall for the 20-year planning period.

▪ Chesapeake Bay Approach Channels (MD) and C&D Canal Lower Approach Channels

  - Poplar Island Environmental Restoration Project (PIERP) and Beneficial Use

    Officially named the Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island, the unexpanded Poplar Island project will restore 1,140 acres of remote island habitat in Chesapeake Bay through the beneficial use of dredged material (Figure 3-1). The island is being restored as 50-percent upland habitat and 50-percent wetlands habitat and is located approximately 34 miles south of Baltimore in Talbot County, Maryland. Placement of dredged material began in 2001. Since that time, it has been the primary placement site for the Maryland Approach Channels, which produce an average of 2 mcy per year in maintenance material. The Poplar Island project is designed to efficiently handle this rate of material inflow.

The capacity of the Poplar Island site was originally designed to be 38 mcy, but has since been increased to 40 mcy based on analyses that show a better rate of consolidation than was originally anticipated (see Section 3.3.3 for a discussion of consolidation). At a rate of 2 mcy per year, the project has a projected 20-year life, though this assumption is idealized since in-flow rates are not perfectly consistent and since over the last few years of placement the site will not be able to accommodate the full 2 mcy volume. Rather, stepped down quantities will be placed so that precise final elevations can be attained. The unexpanded project is anticipated to have about 10.0 mcy capacity remaining after 2016 inflows. Due to the statutory closing of the Pooles Island open water placement site in 2010, the 2005 DMMP concluded that the 1.2 mcy of material removed from the C&D Lower Approach Channels annually would be placed at Poplar Island. This amount of material, in addition to the 2 mcy per year of Maryland Bay Approach Channels material, would cause an overloading condition that slows the rate of consolidation and delays the availability of the full site capacity.

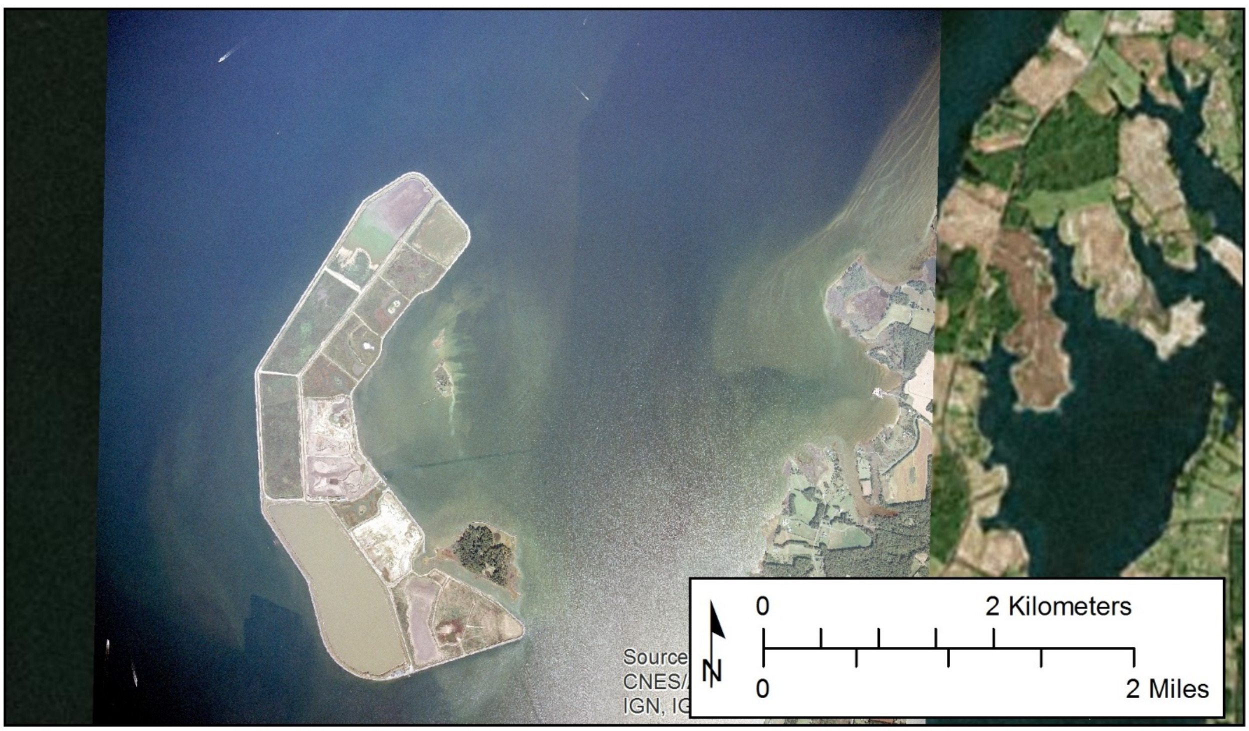

Figure 3-1. Dredged material placement alternative, PIERP (corresponding Map #20, in Table 3-2). Image from 2014.

- PIERP Expansion

Island expansion is the vertical and/or horizontal expansion of an existing island through the placement of dredged material within a constructed perimeter dike. In most cases, the dike encloses the placement area and isolates the dredged material from the surrounding environment. The perimeter dike is constructed of sand and requires heavy, protective armoring on the seaward side to prevent erosion from waves and currents. Interior dikes are constructed to separate the expanded area of the Island into several smaller cells. The smaller cells enhance the overall management and dewatering of the dredged material, and allow the creation of distinct upland and wetland habitats.

Dredged material would be transported to the Island expansion site by scow, pumped through a hydraulic unloader, and deposited behind the perimeter dike. Material pumped into designated wetland cells would be placed at a low elevation that would allow tidal inundation. In upland cells, dredged material may be filled to an elevation close to that of the perimeter dike (minus any designed freeboard).

As discussed previously, PIEPR was originally designed to be 1,140 acres in size. In order to provide additional capacity, the existing dikes will be raised and a 575-acre lateral expansion to the northeast constructed. The lateral expansion will create additional habitat, consisting of 29 percent wetlands, 47 percent uplands, and 24 percent open water. An embayment of 110 acres is included in these wetland habitats. No additional habitat will be created by vertical expansion of the existing upland dike. This vertical expansion of the existing upland placement capacity results in a significant increase in contingency to deal with the many uncertainties of the new wetland cell development, increasing the potential for successfully completing the wetland development. Expansion of Poplar Island was authorized by WRRDA 14. Lateral Expansion Contract #1 for $28.6M was awarded in 2016 and the notice to proceed issued on October 25, 2016.

For the vertical expansion, the existing exterior upland dikes are 35,000 ft in length and set at an elevation of +25 ft MLLW. The vertical expansion will increase the crest elevation to +30 ft MLLW (crest width 15 ft and slope 3:1). The in-place volume of the vertically expanded dike is 0.43 mcy. The in-place volume of the site due to vertical expansion is 4.2 mcy, which excludes the material required for dike construction. It is assumed that suitable borrow material for dike construction is available from within the footprint of the lateral expansion.

The lateral expansion of PIERP includes the creation of 575 acres to the northeast of the existing site (Figure 3-2). The new exterior upland dike will have an elevation of +25 ft MLLW (20-ft crest width and slope 3:1), and an in-place dike volume of 2.9 mcy. To ensure efficient dewatering for habitat creation and management, the expanded site is divided into five smaller interior cells. The interior dikes subdividing the wetland portion is set at an elevation of +8 ft MLLW (crest width 20 ft and slope of 3:1), and has a length of 3,200 ft. The upland dike may eventually be subdivided by temporary cross dikes, but initially, no interior upland dike is anticipated. The dike separating the upland and wetland areas has the same dimensions as the exterior upland dike and is included in the length associated with the upland cell. With fill heights to +20 ft MLLW and +1.6 ft MLLW in the upland and wetland areas, respectively, the lateral expansion of PIERP will create an increased in-place volume of 19.6 mcy, which excludes the material required for dike construction. The site capacity (cut volume) for vertical and lateral expansion of PIERP is equal to the total in-place volume divided by a consolidation factor of 0.7, or 28 mcy. This will bring the total volume of PIERP to 68 mcy.

PIERP expansion was evaluated separately in this DMMP from the unexpanded PIERP. Costs and capacity are apportioned to the expanded project separately from the unexpanded project and this portion of the project is referred to as PIERP expansion. For all purposes other than this DMMP, PIERP is a single project as budgeted in recent years.

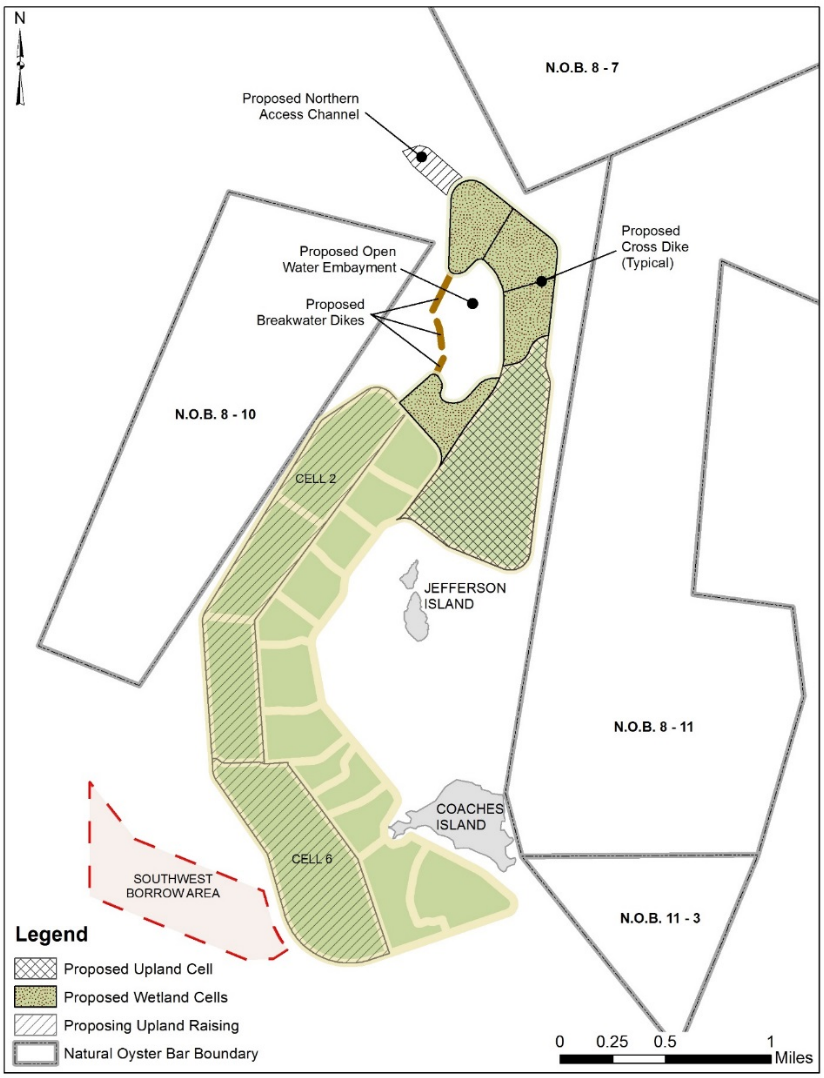

Figure 3-2. PIERP Expansion site layout.

With anticipated new work dredging of about 2.3 mcy over the 20-year planning horizon and ongoing maintenance dredging, there is a 33.8 mcy capacity shortfall for the Maryland Bay Approach Channels over the 20-year planning period without the construction of PIERP expansion. This assumes an allocation of remaining capacity of about 63-percent (6.3 mcy) to Maryland Bay Channels and 37-percent (3.7 mcy) to C&D Canal Lower Approach Channels.

- Pearce Creek

  Pearce Creek is a previously-used material placement site in Cecil County, Maryland on the eastern shoreline of the Chesapeake Bay, owned by Philadelphia District and currently not in use. It is a 230-acre site with 9.5 mcy of current capacity. It has been inactive since 1992 and is currently used as a wildlife management area. Groundwater contamination in the area was identified in the mid-1990s and has since been studied by U.S. Geological Survey and USACE. MDE issued a Water Quality Certification (#14-WQC-02) to USACE on December 19, 2014, which expires March 31, 2018. The WQC allows USACE to conduct maintenance dredging activities in the C&D Canal and associated approach channels, with subsequent material placement in the Pearce Creek Dredged Material Containment Facility. The WQC was issued conditionally upon the construction of an impervious liner and connection of the local community to the municipal water supply.

  USACE, Philadelphia District (NAP) has committed approximately $23M to the installation of a liner at Pearce Creek to address groundwater contamination concerns. Construction of the liner was completed in 2017.

  The CDF will be ready to receive dredged material by October 2017. NAP is making deliberate progress towards completion of the liner and in meeting MDE WQC requirements (monitoring wells, ground water analysis) for a FY17 contract award.

  The Maryland Port Administration is proving $12M in funding for the construction of a new municipal water line to the communities adjacent to the Pearce Creek Placement Site to alleviate any water quality concerns and issues. Pearce Creek and PIERP capacity for C&D Canal Lower Approach Channel material leaves an 11 mcy capacity shortfall.

▪ Chesapeake Bay Approach Channels (MD)

- Norfolk Ocean Open Water Site

  The Norfolk Ocean Open Water Site is located in the Atlantic Ocean, approximately 15 miles southeast of Cape Charles, VA, as shown in Figure 3-3. At about 41,500 acres in size, it has sufficient capacity for the projected quantity (see Table 2-5) of dredged material to be removed from the Virginia Bay Channels, Maryland Bay Channels, and C&D Canal Lower Approach Channels during the 20-year planning period.

This site has not been used previously for Maryland material, and due to the distance that the material would have to travel from the Maryland Bay Channels or C&D Lower Approach Channels to the Norfolk Ocean placement site (over 176 miles on average) a large number of scows and tugs would be required for efficient use of a dredge. That is, to be efficient, a dredge must operate continuously, or as close to continuously as possible. The scows must be emptied and brought back to the dredge site in a timely fashion such that there is always an empty scow ready as soon as a full scow is towed away.

The MPA has conducted studies in recent years that indicate that the use of placement sites in the Atlantic Ocean would likely be permissible. Due to the high cost, it is unlikely that this would ever be a preferred alternative for the Maryland Approach Channels or the C&D Lower Approach Channels, but it may provide an option of last resort for them. The other primary issue of interest to MPA about this option is that, since it is not the federal standard for channels in Maryland waters, and since there is no beneficial component to ocean placement, all costs for this option above the federal standard would be borne by the State of Maryland.

While the Norfolk Ocean Open Water site would have sufficient capacity to meet the needs of the C&D Canal Lower Approach Channels and Chesapeake Bay Approach Channels (MD) over the 20-year planning period, its use would likely be cost-prohibitive. Therefore, the most recent Maryland state and CENAB data suggest that there will be a capacity shortfall for the C&D Canal Lower Approach Channels, Chesapeake Bay Approach Channels (MD), and Harbor Channels within the next 10 years.

- Rappahannock Shoal Deep Alternate Open Water Site

The Rappahannock Shoal Deep Alternate Open Water site is located approximately 1 mile west of the Rappahannock Shoal Channel in the Virginia waters of the Chesapeake Bay as shown in Figure 3-3 (Map #22). The site has an area of approximately 3,100 acres and has been used for the placement of material from the periodic maintenance dredging of the Rappahannock Shoal Channel. It is estimated that the site has sufficient capacity for the dredge material that is projected to be removed from the Rappahannock Shoal Channel during the planning period.

- Wolf Trap Alternate Open Water Site

The Wolf Trap Alternate site is located in the Virginia waters of the Bay near Matthews County, Virginia as shown in Figure 3-3 (Map #30). The site has an area of approximately 4,400 acres and is currently used for the placement of material from the periodic maintenance dredging of the York Spit Channel. It is also occasionally used for small amounts of material from other federal dredging projects in Virginia. It is estimated that the site has sufficient capacity for the dredged material that is projected to be removed from the York Spit Channel during the planning period.

- Dam Neck Ocean Open Water Site

  The Dam Neck Ocean Open Water site is a 1,600-acre site located in the Atlantic Ocean, approximately 3 miles off the coastline of Virginia Beach, VA, as shown in Figure 3-3 (Map #32). Currently, only suitable material dredged from the Cape Henry Channel is allowed to be placed at the Dam Neck site. The site has sufficient capacity for the projected quantity of dredged material to be removed from the Cape Henry Channel during the planning period.

Table 3-1. Existing dredged material management facilities and their capacity

Existing Dredged Material Management Placement Facility	2017 Projected Remaining Capacity (cy)	Total Capacity (cy)
Cox Creek Dredged Material Containment Facility	2,000,000	6,000,000
Masonville Dredged Material Containment Facility	13,000,000	14,000,000
PIERP	3,700,000 C&D/ 6,300,000 MD	40,000,000
PIERP Expansion	28,000,000	28,000,000
Pearce Creek	9,500,000	9,500,000
Norfolk Ocean Open Water	>65,000,000	>65,000,000
Rappahannock Shoal Deep Alternate	>50,000,000	>50,000,000
Wolf Trap Alternate Open Water	33,000,000	>33,000,000
Dam Neck Ocean Open Water	>50,000,000	>50,000,000

3.1.1 Dredging Methodology

Mechanical dredging is the preferred dredging methodology for the Baltimore Harbor and Channels project due to capacity constraints at all placement sites and long transport distances to many placement sites. Hydraulic dredging introduces larger quantities of water to upland placement sites and results in less efficient long-term use of the placement site capacity. For the Baltimore Harbor area channels, which have a short distance to placement sites, mechanical dredging is specified explicitly in contract specifications. This is due to capacity concerns at the containment facilities. For material from Maryland Bay channels, the transport distance to Poplar Island is considered too far to pump with pipeline and efficient use of placement capacity is also a top priority. For overboard placement at Deep Trough, the federal standard, mechanical dredging is assumed because of high turbidity levels introduced with a pumped slurry into deep water areas. Historically, placement of material at Deep Trough and Poole’s Island was performed using mechanical dredging and bottom dump scows because jetting a pumped slurry into these deep water areas would cause very high turbidity levels.

3.2 DREDGED MATERIAL PLACEMENT ALTERNATIVES CONSIDERED

This section presents a description of the alternatives that have been developed for evaluation in this DMMP update. A general description of the alternative is presented, followed by the specific components that apply to each of the applicable channel approaches. The alternatives are presented first for the existing sites, then expansion of existing sites, then new sites, and finally innovative uses of dredged material. The existing sites represent currently permitted and active placement sites. Expansion of existing sites includes closed open water sites, currently open containment facilities, and island restoration sites. New sites include a number of new open water, containment, and restoration sites. Innovative use alternatives include agricultural placement and wetlands restoration, and the reuse of dredged material that has been placed in containment facilities for construction materials, capping, and mine reclamation.

The dredged material placement alternatives considered here include all options that are legally implementable from a federal perspective. All placement alternatives have been developed under an assumption that suitable dredged material would be used for a given alternative type and location. Suitable material is defined as having physical and chemical characteristics compatible with the placement location and compliant with all applicable federal regulations. Numerous alternatives are considered contrary to state law or have constraints placed upon their use by Maryland state law (Senate Bill 830), which was passed in 2001. The constraints include a prohibition on open water placement of dredged material in the waters of the Maryland portion of the Chesapeake Bay. Other dredged material placement prohibitions include placing dredged material from Baltimore Harbor in an unconfined manner in the Bay or its tributaries, the prohibition of raising the dikes at HMI or laterally expanding HMI, and the prohibition of placing dredged material in the Bay or its tributaries within 5 miles of the Hart-Miller-Pleasure Island chain in Baltimore County. In addition, new dredged material containment facilities or other water-dependent facilities need to comply with Maryland's Critical Area law.

The descriptions of the alternatives include technical assumptions regarding the size, configuration, material requirements, in-place volume, and other parameters used to estimate quantities for cost estimating and site capacity determinations. As previously discussed, the DMMP evaluates the alternatives on a programmatic level. Therefore, the assumptions presented often do not represent a specific site, but a programmatic site with a general location. Selection of specific sites, configurations, and other design parameters would be determined for selected alternatives as part of follow-on detailed studies (e.g., feasibility studies).

Table 3-2 lists the alternatives presented in this section and the approach channels that are applicable to each. Figures 3-1 through 3-3 provide general locations for all of the alternatives listed in Table 3-2.

Table 3-2. Dredged material management placement alternatives

Dredged Material Management Placement Alternative	Map #	Map	Harbor Channels	C&D Approach	Ches Bay Approach (MD)	Ches Bay Approach (VA)
Agricultural Placement- Maryland	1	3-1		✓	✓	
Artificial Island Creation- Upper Bay	2	3-1		✓	✓	
Building Products – Lightweight Aggregate	3	3-2/3	✓	✓		
C&D Canal Pearce Creek Upland Sites Expansion	4	3-3	✓	✓	✓	
Capping- Landfill	5	3-2	✓	✓		
Capping- Brownfields	6	3-2	✓	✓		
Confined Aquatic Disposal Pit (CAD) - Patapsco River, MD	7	3-2	✓			
Coke Point - DMCF	8	3-2	✓			
Courthouse Point Vertical Expansion	9	3-3	✓	✓	✓	
Cox Creek Vertical Expansion	10	3-2	✓			
Cox Creek Northward Lateral Expansion - Cristal Site	11	3-2	✓			
Cox Creek Westward Lateral Expansion	12	3-2	✓			
Cox Creek Combined Expansion	10,11,12	3-2	✓			
Dam Neck Ocean Open Water	32	3-1				✓
Large Island Restoration- Mid Bay	15	3-1		✓	✓	
Mine Placement - Western Maryland	16	3-1	✓	✓		
New Open Water (Deep Trough)	17	3-1		✓	✓	
Norfolk Ocean Open Water Placement	18	3-1		✓	✓	✓
Pooles Island Open Water Site Expansion	19	3-3		✓	✓	
PIERP Expansion	20	3-1		✓	✓	
Quarry Placement - Cecil County, MD	21	3-1	✓	✓		
Rappahannock Shoal Deep Alternate Open Water Site	22	3-1				✓
Rappahannock Shoal Deep Alternate Open Water Site Expansion	22	3-1		✓	✓	
Shoreline Restoration - Mid Bay	23	3-1		✓	✓	
Shoreline Restoration - Upper Bay	24	3-1		✓	✓	
Small Island Restoration- Mid Bay - Parsons Island	25	3-1		✓	✓	
Small Island Restoration – Mid Bay - Sharps Island	26	3-1		✓	✓	
Subaqueous Capping – Patapsco River, MD	27	3-2		✓	✓	

Table 3-2 cont. Dredged material management placement alternatives

Dredged Material Management Placement Alternative	Map #	Map	Harbor Channels	C&D Approach	Ches Bay Approach (MD)	Ches Bay Approach (VA)
Susquehanna Flats- Upper Bay Island Restoration	28	3-1/3		✓	✓	
Wetland Restoration- Dorchester County, MD	29	3-1		✓	✓	
Wolf Trap Alternate Open Water Placement	30	3-1		✓	✓	✓
Wolf Trap Alternate Open Water Placement Northern Expansion	31	3-1				✓

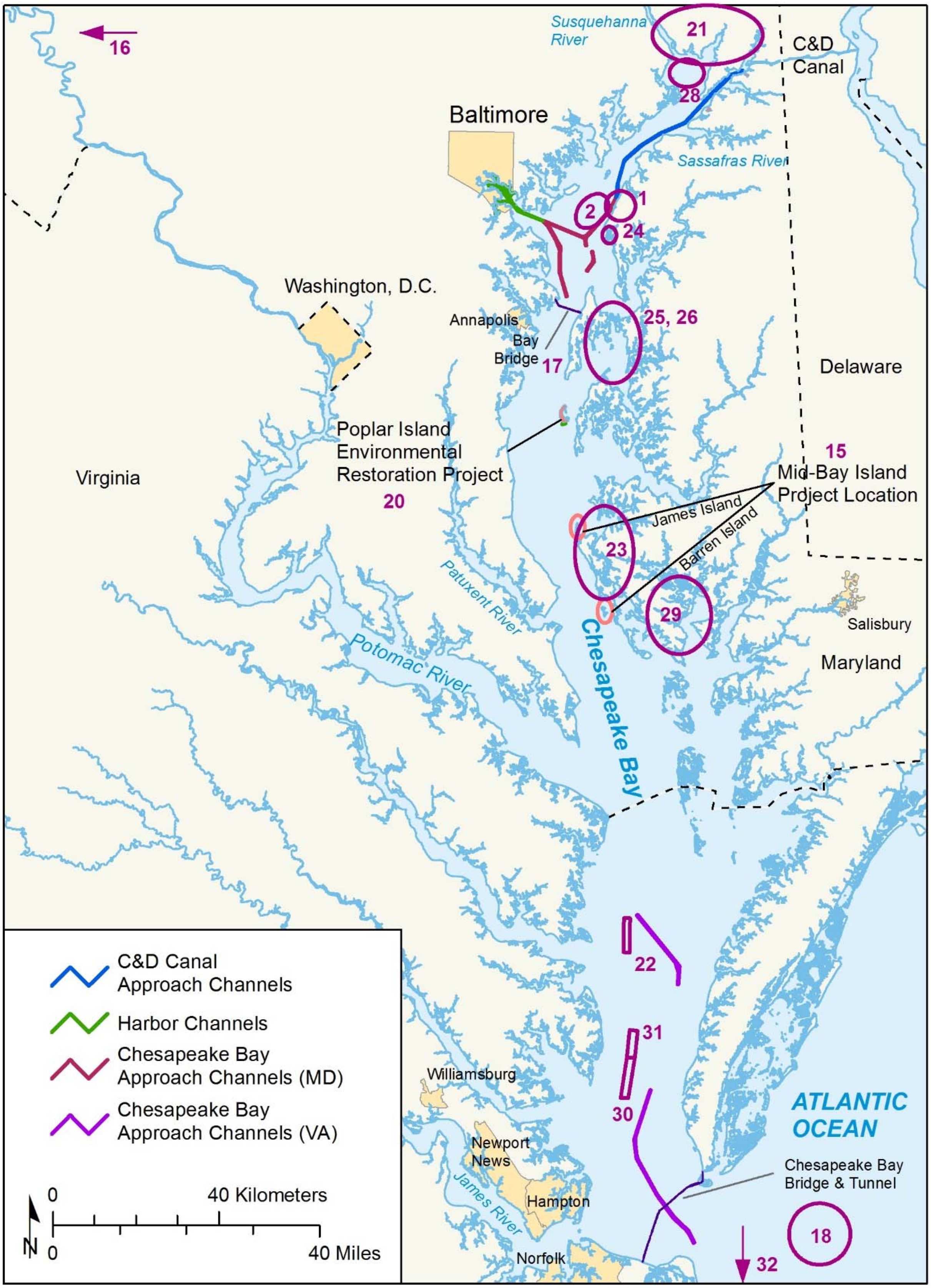

Figure 3-3. Dredged material management placement alternatives, Chesapeake Bay and outlying areas (numbers correspond to Map # in Table 3-2).

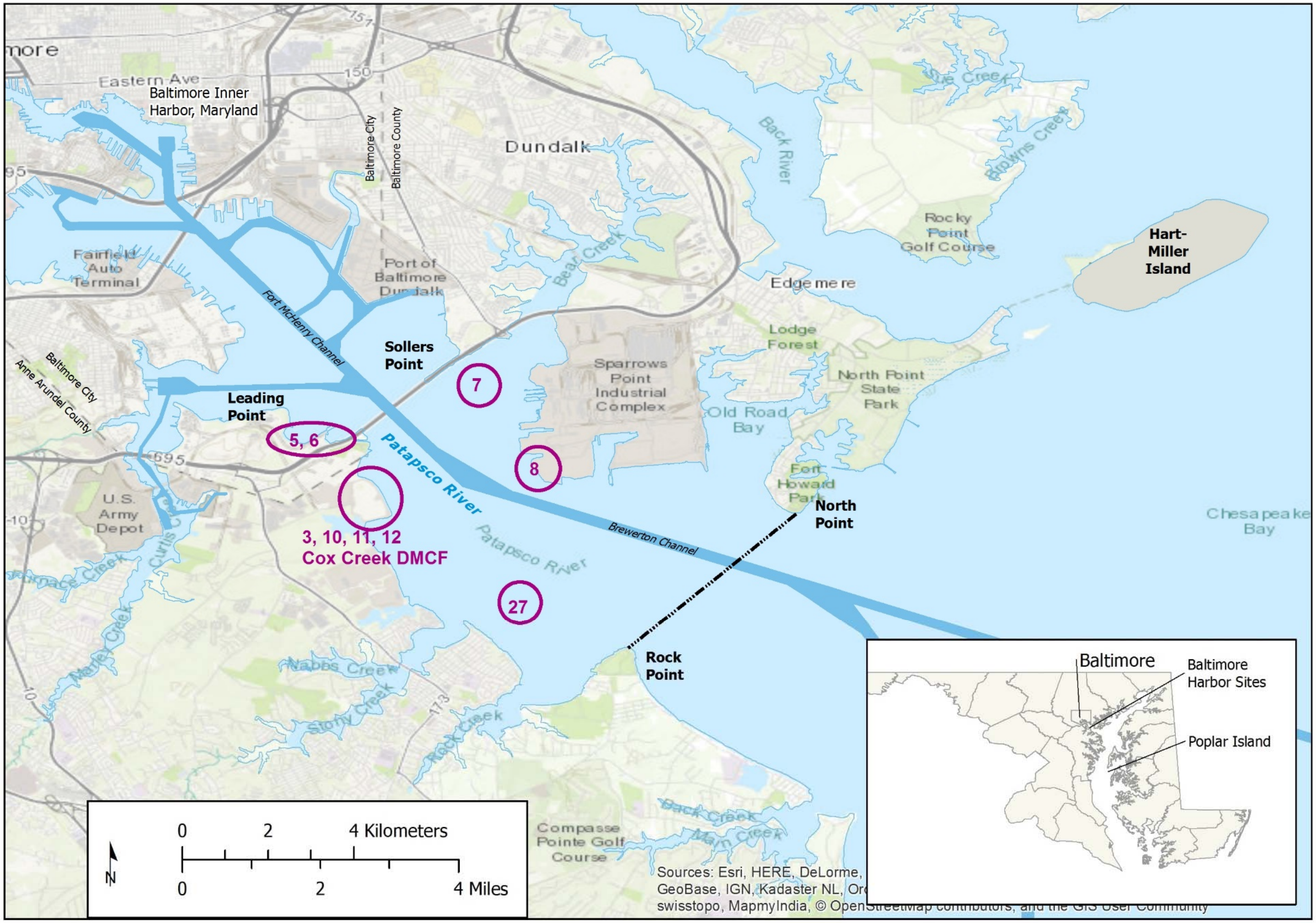

Figure 3-4. Dredged material management placement alternatives, Baltimore Harbor area (numbers correspond to Map # in Table 3-2).

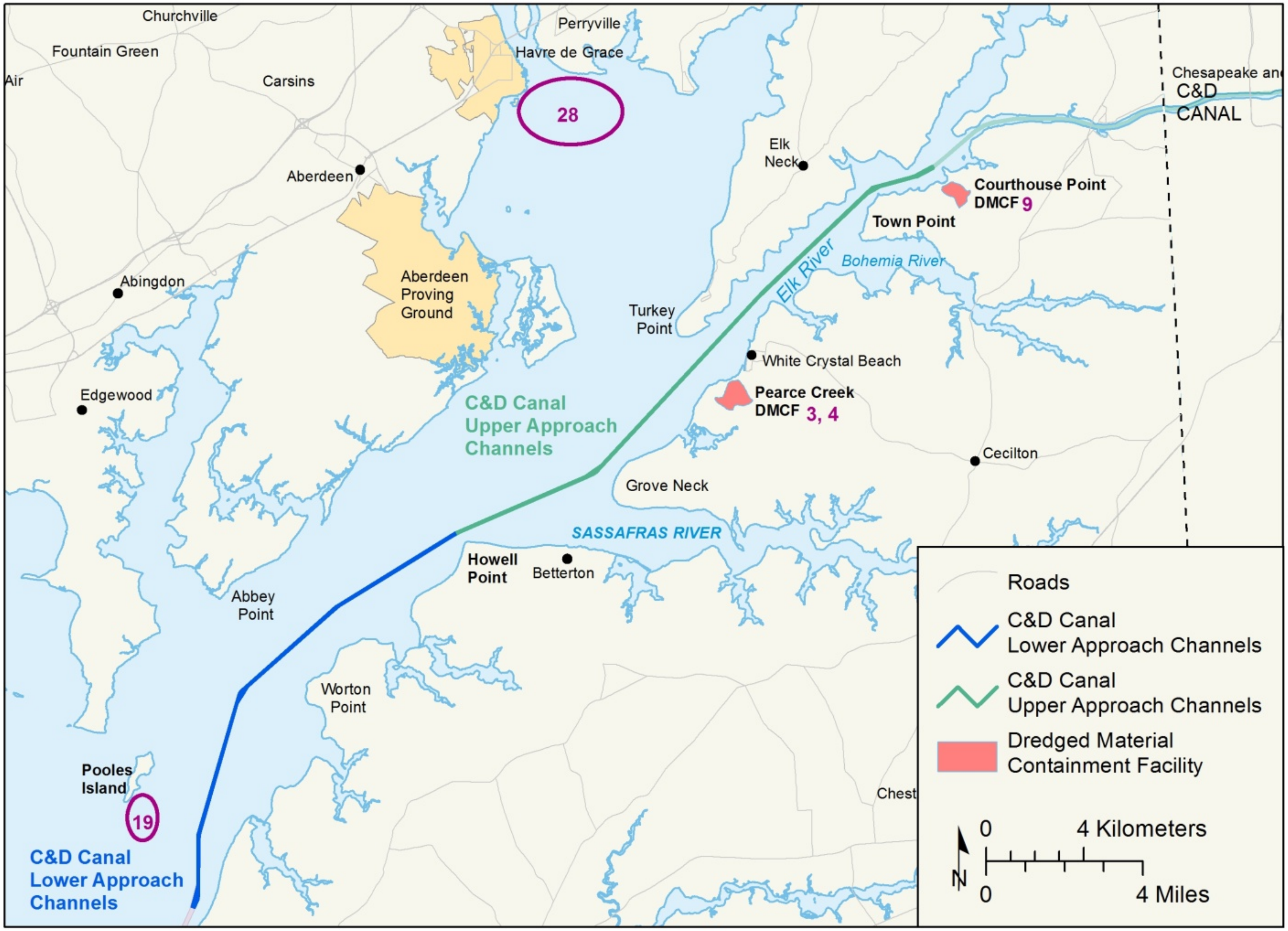

Figure 3-5. Dredged material management placement alternatives, Upper Bay area (number correspond to Map # in Table 3-2).

3.2.1 Existing Sites

3.2.1.1 *Open Water Placement*

Open water placement is the discharge of dredged material in oceans, rivers, lakes, or estuaries by means of a pipeline or release from a hopper dredge or barge. The discharged material settles through the water column and deposits on the bottom of the placement site. Dredged material may be placed in an open water placement site hydraulically or mechanically. The most common open water placement methods are illustrated in Figure 3-6. Hydraulically dredged material is discharged through a pipeline a short distance from the intake pipe or transported to the placement site and deposited from a hopper. Mechanically dredged material is placed in a bottom-dump barge or scow and towed to the placement site for discharge. In Maryland, dredging is done mechanically by clamshell and placed into barges or scows.

Several existing open water placement sites are evaluated for the DMMP. These sites include the Norfolk Ocean Open Water Placement site, Pooles Island Open Water Placement site, Rappahannock Shoal Deep Alternate Open Water Placement site, and Wolf Trap Alternate Open Water Placement site. Technical assumptions used for the estimation of costs and capacity for each site are described in the following sections.

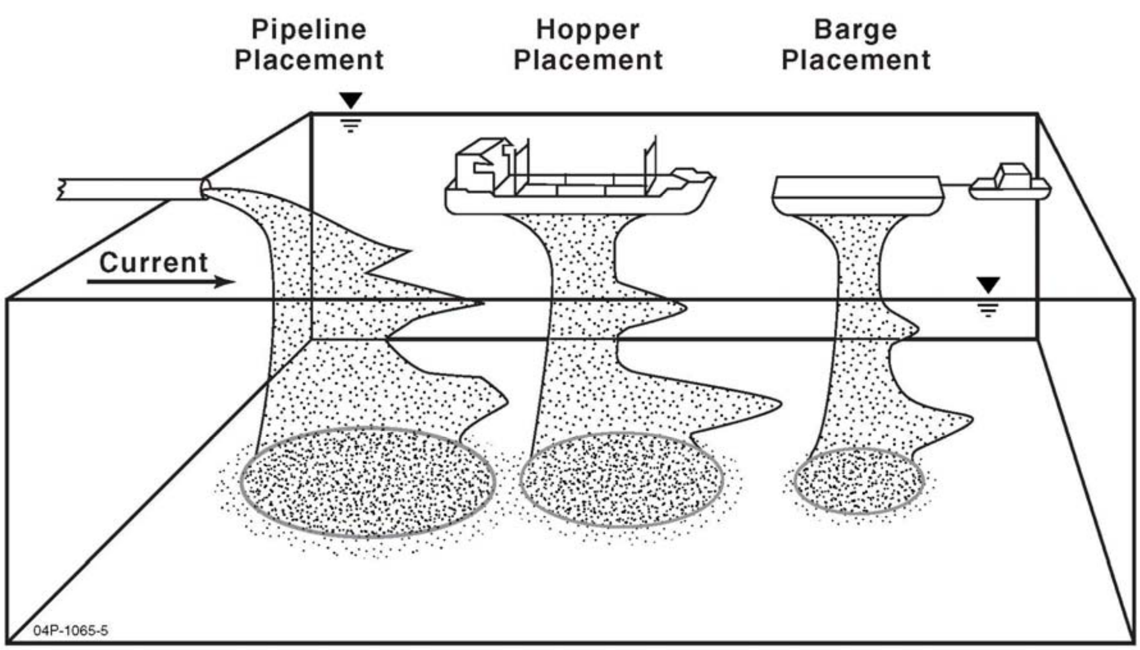

Figure 3-6. Open water placement methods (EPA, USACE, 1992, rev. 2004)

3.2.1.1.1 **Norfolk Ocean Open Water Placement Site**

The Norfolk Ocean Open Water Placement site is an existing site located in the Atlantic Ocean, approximately 17 miles off the Virginia coastline as shown in Figure 3-3 (Map #18). Because of the large capacity of this placement site, this alternative could be considered for use for the C&D Canal Lower Approach Channels and Chesapeake Bay Approach Channels (MD).

The Norfolk Ocean Open Water Placement site is circular in shape, with a radius of approximately 4 nm and an area of approximately 41,500 acres. The water depth ranges from 43 to 85 feet (MPA, n.d.) with varying grade elevations of the bottom. The remaining in-place volume of the site in 1990 was estimated at 1.34 billion cubic yards (bcy), as cited in the *Port of Baltimore Dredged Material Management Master Plan* (MPA, 1990). Relatively little material has been placed in the site since that time and it is assumed that remaining capacity has not changed significantly. This alternative is capable of meeting the dredging needs for the C&D Canal Approach Channels (24 mcy at 1.2 mcy/year), Chesapeake Bay Approach Channels (MD) (40 mcy at 2.0 mcy/year), and the Chesapeake Bay Approach Channels (VA) (13 mcy at 0.65 mcy/year) over the 20-year period.

For this alternative, it is assumed material would be mechanically dredged from the C&D Canal Approach or Chesapeake Bay Approach (MD), or dredged from Chesapeake Bay Approach Channels (VA) with a hopper dredge. Material would be placed within a barge or hopper and transported to the Norfolk Ocean Open Water Placement site, where it would be released. One-way transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels, 191 nm; Chesapeake Bay Approach Channels (MD), 172 nm; and Chesapeake Bay Approach Channels (VA), 39 nm.

Placement of dredged material is restricted to clean sediments. Use of this site is subject to the approval by U.S. EPA under the authority of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended (USACE, 1981). EPA has provided concurrence on the suitability for ocean placement of selected Maryland dredged material at the Norfolk Ocean Disposal Site provided that the material meets certain criteria. Individual concurrence letters for channel reaches are provided in Appendix F.

3.2.1.1.2 **Pooles Island Open Water Site**

The Pooles Island Open Water Site refers to a group of existing open water placement sites located near Pooles Island. Specifically, the open water placement sites are located on the northwest side of the Upper Chesapeake Bay at the mouth of the Gunpowder and Bush Rivers in Harford County, Maryland as shown in Figure 3-5 (Map #19). The site is in the Upper Bay region and serves as the federal standard for the C&D Canal Lower Approach Channels. It is also considered an alternative for the Chesapeake Bay Approach (MD) channels.

The placement sites associated with Pooles Island are Areas G-North, G-East, G-West, G-Central, G-South, and Site 92, as well as sites D, E, F, and H to the north of Pooles Island (Halka and Pangeotou, 1992). It is uncertain, however, whether any of these sites could be approved for use. According to the information from the Maryland Geological Survey, only Site 92, G-East, and G-West can accept more material. It is estimated that Site 92 can accept an additional 5 mcy prior to closure.

For this alternative, it is assumed material would be dredged from the center of the C&D Canal Approach Channels—Lower Approach with a clamshell dredge. Material would be placed into dump scows and transported to the Pooles Island Open Water Placement site. Transport distance from the center of the C&D Canal Approach Channels—Lower Approach to the placement site is 13 nm. Transport distance from the center of the Chesapeake Bay Approach (MD) channels to the placement site is 11 nm.

3.2.1.1.3 Rappahannock Shoal Deep Alternate Open Water Site

The Rappahannock Shoal Deep Alternate Open Water Placement site is an existing site located approximately 1 mile west of the Rappahannock Shoal Channel, as shown in Figure 3-3 (Map #22). The site is in the Lower Bay region and serves as the federal standard for the Rappahannock Shoal Channel of the Chesapeake Bay Approach Channels (VA). It is estimated that the site has sufficient capacity for the dredged material that is projected to be removed from the Rappahannock Shoal Channel during the 20-year planning period.

The Rappahannock Shoal Deep Alternate Open Water Placement site is approximately 4.5 nm by 0.8 nm in dimension and has an area of 3,100 acres. The average water depth is 39 feet. The remaining capacity of the site is estimated to be sufficient for material from the Rappahannock Shoal Channel. No additional dredged material has been placed at the site since 1989.

For this alternative, it is assumed material would be hydraulically dredged from the Chesapeake Bay Approach Channels (VA) with a hopper dredge. Material would be transported to the Rappahannock Shoal Deep Alternate Open Water Placement site, where it would be released from the hopper. Transport distance from the respective channels to the placement site is 25 nm.

3.2.1.1.4 Wolf Trap Alternate Open Water Site

The Wolf Trap Alternate Open Water Placement site is an existing site located in the Virginia waters of the Chesapeake Bay, east of Mathews County, VA as shown in Figure 3-3 (Map #30). The site is in the Lower Bay region and serves as the federal standard for the York Spit Channel of the Chesapeake Bay Approach Channels (VA). It is estimated that the site has sufficient capacity for the dredged material that is projected to be removed from the York Spit Channel during the 20-year planning period. It is also considered as an alternative for the C&D Canal Channels and the Chesapeake Bay Approach Channels (MD).

The northern half of the Wolf Trap Alternate Open Water Placement site is approximately 3.0 nm by 1.0 nm in dimension with an area of 2,500 acres. This area is deeper than the southern portion and generally has less overwintering crab density. The average water depth is 39 feet. The remaining in-place volume of the site is 33 mcy, as calculated by subtracting the allowable water depth of 29.5 feet (9 m; Anderson, 2004) from the average water depth and multiplying by the area. The allowable water depth is based on the bathymetry surrounding the site to allow material placement to those depths. The site possesses sufficient capacity and further expansion is not required for reasons of material accommodation. It is assumed that this alternative is capable of meeting the 20-year dredging needs of York Spit Channel and, with the Commonwealth of Virginia's approval, it would be capable of meeting the needs of a portion of the C&D Canal Approach Channels and the Chesapeake Bay Approach Channels (MD).

The VMRC has expressed concern with continued dredged material placement at Wolf Trap as they have indicated that it is utilized by female blue crabs to overwinter in Virginia waters. Female crabs burrow into the sediment during the cooler water temperatures (October to March). This is the time of year when dredging and placement usually occurs.

The VMRC has indicated that 1 inch or more of placed dredged material may result in crab mortality during this time. However, to date there is no experimental or field data that indicates dredged material placement causes mortality or other impacts to overwintering blue crabs. A 2005 report written by the Virginia Institute of Marine Science (VIMS) and The College of William & Mary "found no evidence of dead or injured blue crabs, whether mature or immature, male or female" following dredged material placement in Wolf Trap Alternate placement area.

Baltimore and Norfolk Districts are working collaboratively with VMRC and VIMS to assess evidence of potential impacts to overwintering blue crabs from disposal of dredged material. Therefore, the Baltimore District (NAB) and Norfolk District (NAO) are recommending to expand collaboration efforts with the VMRC to include conducting adaptive monitoring and additional research of the potential impacts of dredged material placement on overwintering blue crabs.

For this alternative, it is assumed material would be dredged from the York Spit Channel with a hopper dredge and the C&D Canal Approach or Chesapeake Bay Approach (MD) Channels with a clamshell dredge. The dredged material would be transported to the Wolf Trap Alternate Open Water Placement site, where it would be released from the hopper or the scow. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels, 130 nm, Chesapeake Bay Approach Channels (MD), 112 nm, and Chesapeake Bay Approach Channels (VA) 34 nm.

3.2.1.1.5 **Dam Neck Ocean Open Water Site**

The Dam Neck Ocean Open Water Site is an existing U.S. EPA-designated 1,600-acre site located in the Atlantic Ocean, approximately 3 miles off the coastline of Virginia Beach, VA, as shown in Figure 3-3 (Map #32). Currently, the only Baltimore Harbor and Channels Project material allowed to be placed at the Dam Neck Site is suitable dredged material from the Cape Henry Channel. The site has sufficient capacity for the projected quantity of dredged material to be removed from the Cape Henry Channel during the 20-year planning period. The site serves as the federal standard for the Cape Henry Channel of the Chesapeake Bay Approach Channels (VA).

The Dam Neck Ocean Open Water Placement site is approximately 2.1 nm by 0.9 nm in dimension, with an area of approximately 9 square nm (40 CFR 228.15). The water depth ranges from 30 feet to 50 feet. The remaining capacity as of the February 2009 Site Management and Monitoring Plan for the Dam Neck Ocean Dredged Material Disposal Site was estimated at 50 mcy (Anninos and Wisniewski 2009). Therefore, the site possesses sufficient capacity for the projected 1.5 mcy of dredging from the Cape Henry Channel, and further expansion is not required to meet the dredging needs of the Chesapeake Bay Approach Channels (VA).

For this alternative, it is assumed material would be dredged from the Chesapeake Bay Approach Channels (VA) with a hopper dredge. Material would be placed within the hopper and transported to the Dam Neck Open Water placement site, where it would be released through the hopper's split-hull or bottom doors. The transport distance from the midpoint of the Chesapeake Bay Approach Channels (VA) to the placement site is 39 nm.

3.2.2 New Sites or Expanded Existing Sites

3.2.2.1 *Artificial Island Creation (AIC)*

An artificial island is created or formed by the placement of dredged material within a constructed perimeter dike in a location where an island did not previously exist. AIC is different from island restoration, which involves recreating remote island habitat where it once existed. State and federal agencies are generally supportive of island restoration. However, AIC is inconsistent with the Coastal Zone Management Act (CZMA) and not supported by NMFS. NMFS does not support AIC for several reasons. Created island would occur in high-energy areas and thus require hardening of the constructed island shoreline to prevent erosion and the escape of placed material. Shoreline hardening limits the number and type of finfish that use interior marsh cells. Created island habitat displaces subtidal habitat of existing value that will not be recouped in-kind in the new island habitat, although no island project could be justified and built where the newly created habitat didn't exceed the existing habitat in value.

In most cases, the dike encloses the placement area and isolates the dredged material from the surrounding environment. The perimeter dike is constructed of sand and requires heavy, protective armoring on the seaward side to prevent erosion from waves and currents. Interior dikes are constructed to separate the island into several smaller cells. The smaller cells enhance the overall management and dewatering of the dredged material, and allow the creation of distinct upland and wetland habitats.

Dredged material would be transported to the AIC site by scow, pumped through a hydraulic unloader, and deposited behind the perimeter dike. Material pumped into designated wetland cells are placed at a low elevation that would allow tidal inundation. In upland cells, dredged material may be filled to an elevation close to that of the perimeter dike (minus any designed freeboard).

The representative area for AIC within the Upper Bay Region is west of Tolchester Channel (Gales Lump Reef) as shown in Figure 3-3 (Map #2). The site is considered as a placement alternative for the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD).

The representative AIC consists of 1,000 acres with a rectangular shape 8,000 ft long by 5,500 ft wide for a perimeter length of 27,000 lin ft; 50 percent upland and 50 percent wetland. The upland area is divided into two 250-acre subcells, and the wetland area is subdivided into 6 smaller cells to facilitate placement and incremental site development. The dikes are constructed using sand assumed to be obtained from within the upland cell footprint supplemented by suitable access channel material. It is assumed that 25 percent of the dike footprint requires replacement of unsuitable soft soils to an average depth of 12 feet.

The exterior dike for the upland area has a crest width of 20 ft set at elevation +20 ft MLLW, and side slopes of 3H:1V. The exterior upland dike length is 21,500 ft and, with an average water depth of 12 ft, will require 3.0 mcy of borrow sand. The crest of the perimeter upland dike will have a crushed stone road surface and exterior slopes will be protected from wave energy with armor stone.

An interior dike will separate the upland into 2 cells. The dike has a crest width of 20 ft set at elevation +18 ft MLLW, and side slopes of 2.5H:1V. The interior upland dike length is 2,250 ft and, with an average water depth of 12 ft, will require 0.24 mcy of borrow sand. The crest of the separator dike has a crushed stone road surface and exterior slopes seeded above the water line to provide erosion resistance.

To ensure efficient dewatering for habitat creation and management, the wetland area is divided into six smaller interior cells. The interior dikes for the wetland subdivision have a crest width of 15 ft set at elevation +6 ft MLLW, and side slopes of 2.5H:1V. The total length of the interior wetland dikes is 13,500 ft and require 0.80 mcy of borrow sand.

An access channel connecting the site to the -25 MLLW depth in the bay is assumed to be 2,500 ft long with an average width of 500 ft and an average dredging depth of 8 ft resulting in 0.37 mcy of dredging. It is assumed that approximately 50 percent of the access dredged material is sand suitable for dike construction.

Based on the assumed final dredged material to elevation +16.0 ft MLLW, the volume of the upland area is 14.8 mcy. Based on the assumed final dredged material elevation of +1.6 ft MLLW, the volume of the wetland area is 4.9 mcy. Therefore, the total volume of the site is approximately 20.5 mcy. The site capacity, obtained by dividing the site volume by the consolidation factor of 0.7, yields a site capacity of 29.3 mcy.

For this alternative, it is assumed suitable material would be dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed within a scow and transported to the site where it would be pumped from the scow using a hydraulic unloader. Transport distances from the respective channels to the placement site are as follows: C&D Canal Approach Channels, 15 nm; and Chesapeake Bay Approach Channels (MD), 13 nm.

3.2.2.2 *Subaqueous Capping*

Subaqueous capping is the controlled, accurate placement of suitable dredged material over contaminated sediments at the bottom of a water body. Suitable dredged material can be used to cover either existing contaminated sediments or previously placed contaminated dredged material. Typically, contaminated material is placed in a mounded configuration and covered with a mound of clean material, perhaps 3 feet or more in thickness. The cap prevents the migration of contaminated material and isolates it from benthic organisms. Conventional dredging equipment and techniques are frequently used for a subaqueous capping project, but these practices must be controlled more precisely than for conventional open water placement. Previous studies have shown that both fine-grained and sandy material can be effective subaqueous materials; however, the physical characteristics of the subaqueous capping sediment should be compatible with the contaminated sediment and of sufficient grain size to remain in place.

The areas that are feasible for this alternative are limited to those areas of the river that are deep enough that the cap system will not alter habitat and significantly impact river currents. Additionally, capping sites cannot be in the vicinity of the navigation channels.

The representative area for subaqueous capping is a contaminated site within the Upper Bay region in the Patapsco River, Maryland, as shown in Figure 3-4 (Map #27). The site is considered a placement alternative for the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD). The alternative involves the use of clean dredged sediments as a subaqueous cap over contaminated sediments. Design assumptions associated with this alternative are detailed in the following paragraphs.

The Patapsco River subaqueous capping site is located between Rock Point and Leading Point and is approximately 250 acres in size. It is assumed that 4 feet (2 feet of dredged material and 2 feet of sand) of material would be spread over 250 acres of existing harbor sediments that would not be dredged. This would raise the existing bottom by 4 feet and the amount of dredged material used for this example provides a capacity of 0.81 mcy. For completely submerged sites, the final density of dredged material placed as a subaqueous cap will be similar to the density of the maintenance dredged material in-situ in the channel and will experience little to no change in void ratio in this buoyant state, resulting in minimal consolidation. Therefore the site capacity (cut volume) is approximately equal to or slightly greater than the in-place volume. The final mounded configuration may, however, experience erosional losses. It is assumed that the granular material would be transported from a sand borrow source near Sparrows Point, and this volume is not included in the site capacity for dredged material.

For this alternative, it is assumed that clean material necessary to provide the intended containment for contaminated sediment in the harbor would be mechanically dredged from the

C&D Canal Approach Channels-Lower Approach or the Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed within a dump scow and transported to the Patapsco River subaqueous capping site. The scow would be accurately positioned before placement of the material. The dredged material would then be released from the hull of the scow. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels-Lower Approach, 29 nm; Chesapeake Bay Approach Channels (MD), 11 nm.

3.2.2.3 ***Confined Aquatic Disposal (CAD)***

Confined aquatic disposal (CAD) is a process where dredged material is disposed of at the bottom of a body of water, within a natural depression, a depression constructed specifically for the placement, or within a depression created during sand mining. The difference between CAD and open water placement is that the deposited material is confined to the designated area, preventing lateral or vertical movement. Typical configurations for facilities for contaminated sediments is shown in Figure 3-7, As shown in Figure 3-7, the CAD would be constructed within an existing depression if available or by constructing subsurface lateral containment dikes (using clean material) to form the containment cells. The capacity of a CAD facility depends on the quantity of the dredged material, the volume of the depression or the constructed facility, and the availability of suitable locations to site the facility.

Costs associated with CAD facilities vary widely depending on many parameters, including the physical and chemical characteristics of the dredged material to be deposited, the type of CAD facility construction, and distance between the dredging location and the CAD facility. Because CAD does not involve land transport, it can be cost-effective alternative compared to upland placement alternatives. Furthermore, dewatering is not required, which reduces costs compared to land-based alternatives.

The proposed CAD site for the DMMP is near Sollers Point in the Patapsco River, MD, as shown in Figure 3-4 (Map #7). The site is in the Upper Bay region and is considered a placement alternative for the Harbor Channels.

The CAD site near Sollers Point is 100 acres in size. The average water depth is approximately 25 feet. The bottom 20 feet of the disposal site would be used for dredged material placement. Dredged material will be placed into the pit using open water placement methods in 4 inflow cycles, adding 800,000 cy of dredged material annually for 4 years. Each inflow would place approximately 5 feet of material in the confined disposal site.

The in-place volume of the site will therefore include the volume of dredged material from the Harbor Channels at a total thickness of 20 feet (5 feet annually for 4 years. The in-place volume of the site is 3.2 mcy. Because this alternative is placed below the water level, it is assumed the material would exhibit minimal consolidation. There may also be minor losses due to erosion. Therefore, the site capacity (cut volume) is approximately equal to or slightly greater than the in-place volume.

For this alternative, it is assumed material would be dredged from the Harbor Channels by a clamshell dredge and placed in a scow. Based on dispersion model data, the scow would be accurately positioned over the CAD site before the dredged material was released from the scow. Transport distance from the center of the respective channels to the placement site is 1.5 nm.

For this alternative hydraulic dredging with pipeline delivery could be considered and may result in a lower cost for placement. However, it is reasonable to believe that dredging activities that would utilize this placement site would also utilize placement sites, such as CDFs, that are incompatible with hydraulic dredging. Such a dredging scenario would likely increase contract costs and therefore is unlikely to be awarded, resulting in mechanical dredging remaining the preferred dredging methodology.

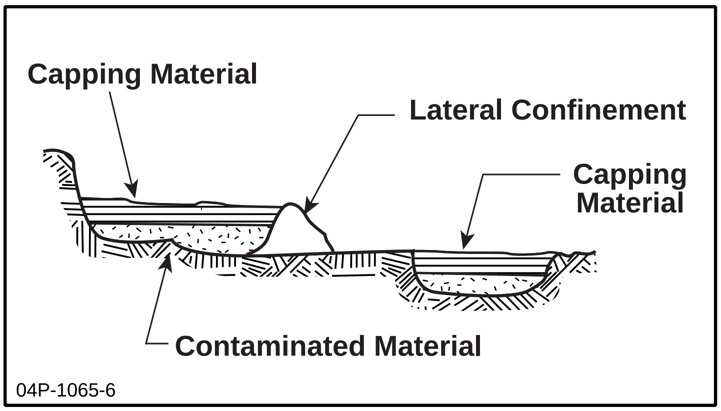

Figure 3-7. Confined aquatic disposal (for unsuitable material)

3.2.2.4 *Confined Disposal Facility (CDF)*

A CDF is an engineered structure for the containment of dredged material. CDFs are bound by confinement dikes or structures to enclose the placement area, thereby isolating the dredged material from its surrounding environment. The three types of CDFs examined for the DMMP are upland, nearshore, and island as shown in Figure 3-8. An upland CDF consists of a fully diked facility located above the water line and out of wetland areas. A nearshore CDF has at least one or more sides adjacent to the shoreline. Island CDFs are completely surrounded by water.

CDFs may be used for coarse and fine-grained material. The material is placed into the CDF either hydraulically or mechanically. Placing the material directly into the CDF from the dredging site through pipelines is the most economical method. If the dredging site is at a great distance from the CDF, material may be transferred to the CDF via barge or truck and then placed into the facility. In any case, the dredged material consists of a certain percentage of slurry when it is pumped into the facility. Depending on the placement method, slurry material initially deposited in the CDF may occupy several times its original volume because of water content. Mechanical placement results in a lower volume of slurry than hydraulic placement. Design of the CDF must account for this additional volume during the drying phase. Following placement, the dredged material is allowed to consolidate, settle, and dewater. Dewatering is through evaporation, or percolation through the dike walls or into the ground. CDFs that use weirs to enable surface water to exit the facility must be designed with sufficient retention times to ensure adequate sediment settling occurs. Effective crust management techniques can be used to improve dewatering and thereby maximize placement capacity. Crust management techniques include the use of pontoon excavators and low ground pressure equipment (depending on the stage of dewatering involved) to create a preferential drainage channel to allow the water to drain more quickly (Wikar, 2000).

Dredged material placement within a CDF has several benefits. CDFs can prevent or substantially reduce the amount of sediment material re-entering the environment when properly designed, operated, and maintained. CDFs can provide a permanent storage location for dredged material and would naturally vegetate when left undisturbed. Finally, CDFs can be used as processing and/or blending areas for beneficial use activities.

The size, design, and cost of a CDF are site-specific. Factors include location; physical nature of sediments to be placed (e.g., grain size, organic content, etc.); physical nature of project footprint; chemical nature of sediments (contaminated versus clean); volume of sediments to be stored; pumping/transport distance placement method; and the design life of the facility. Additional costs are incurred through the operation and maintenance (O&M) of the CDF.

It is assumed that dredging of Harbor channels is done by clamshell dredge. While pipeline dredging could be used for some Harbor channels, it has not been used in the past, and is unlikely to be used in the near future. Clamshell dredging is utilized to minimize the amount of water introduced to CDFs and ultimately the amount of water that must be removed from the CDF. This is a concern because of nutrient discharge limits contained in the sites' water quality permits. Furthermore, dredging contracts for Baltimore Harbor channels are generally awarded to one contractor who will work both "inner" and "outer" channels. This means that one contractor will mobilize to dredge material that will be used beneficially and placed at Poplar Island ("outer" channel material) and they will also dredge "inner" channels, which is unsuitable for open water placement and placed at a CDF. The same equipment is mobilized to dredge both channel locations, which results in clamshell dredging utilized within both channel areas.

Four CDF alternatives are evaluated in the DMMP, including the construction of a new CDF along the Patapsco River and the expansion of three existing CDFs - Pearce Creek, Cox Creek, and Courthouse Point. Design assumptions for each site are described in the following sections.

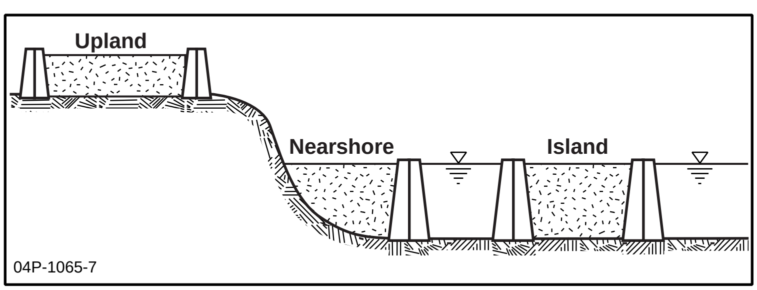

Figure 3-8. Types of confined disposal facilities

3.2.2.4.1 New Confined Disposal Facility – Coke Point

Construction of a new CDF along the Patapsco River in Maryland at Coke Point adjacent to the Sparrows Point Industrial site, as shown in Figure 3-9 (Map #8), is considered a placement alternative for the Harbor Channels.

The initial containment dike for the facility will be approximately 20 ft high (base elevation +12 ft to dike crest elevation +32 ft) except for a reach where it spills into the river to estimated depths of 25 to 30 ft. The initial dike will include the construction of an earth dike base fill, upon which the first dike raising section will be constructed. The initial dike will be raised in two 10-ft vertical increments to crest elevations +42 ft and +52 ft. The increase in dike height will be achieved by raising the dikes toward the interior of the facility and not increasing the overall footprint of the existing CDF.

A 3:1 slope and 20 ft wide crest is assumed. Both the exterior and interior slopes of the initial dike section will be stabilized with vegetation and the crest will have a crushed stone roadway surface. The proposed CDF covers an area of approximately 270 acres, with an effective dredged material placement area of approximately 221 acres after accounting for the dike footprint. The perimeter dike length is estimated at 12,800 lin ft.

The dike fill will consist of suitable fill (high strength, low permeability and low compressibility) imported from an off-site borrow source within 15 miles of the site. Construction will use conservative earthwork practices controlling lift thickness, moisture content, and density. Based on the likely permeable nature of the man-made site, an impervious cutoff wall and impervious cell liner are proposed to provide suitable containment of the dredged material and effluent, and to assure satisfactory control of seepage through and beneath the containment dikes.

The final 10-ft dike raising increment will require construction of the dike on dredged materials. To provide adequate foundation support, further consolidation and strength gain of the dredged material will be required. It is assumed that a high strength geotextile will first be installed over the dredged materials across the footprint of the raised dike section. The new dike footprint will then be surcharged with a 10 ft high soil surcharge load that will be used to consolidate and strengthen the underlying dredged materials. After the dredged material has gained sufficient strength, the raising section will be constructed to final dike crest elevation +52 ft. The raising section may be constructed in several vertical increments to accommodate any additional settlement of the dredged material. In order to accelerate the consolidation, wick drains were assumed as vertical drainage beneath the raised dike section.

The in-place volume of the site is based on filling the facility from an average base elevation of +14 ft to a final maximum elevation of +49 ft (3 ft below the final crest elevation. The estimated in-place volume of 12.5 mcy provides a total site capacity of approximately 17.9 mcy based on a consolidation factor (final site volume/cut volume) of 0.7. It is assumed that the annual dredged material placement rate will be approximately 1 mcy yielding a site life of approximately 18 years.

For this alternative, it is assumed material would be mechanically dredged from the Harbor Channels using a clamshell dredge and placed into a barge. The barge would be transported to the site where the dredged material would be pumped directly into the CDF using a hydraulic unloader. Transport distance from the center of the respective channels to the placement site is 4 nm.

Figure 3-9. Dredged material placement alternative, Coke Point DMCF area map (corresponding Map #8 in Table 3-2)

3.2.2.4.2 C&D Canal Upland Sites Expansion (Pearce Creek)

The existing nearshore Pearce Creek CDF is located along the Elk River, as shown in Figure 3-10 (Map #4). The Pearce Creek site has been inactive since 1992 and is currently used as a wildlife management area. Modifications to the site are currently being made, including the installation of a liner, and it is expected to resume operations in 2017. The site is considered a placement alternative for the Harbor Channels, C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD).

Pearce Creek CDF is 260 acres in size. In order to increase capacity, this alternative proposes the vertical expansion of the exterior dike. The exterior dike is 13,500 ft in length and set at an elevation of 50 ft above grade. The vertical expansion would increase the crest elevation to 60 ft above grade and would be achieved by adding to the interior slope so as not to increase the overall footprint of the existing CDF. The new dimensions of the exterior dike consist of a 20-ft crest width and 3:1 side slopes. A crushed stone roadway would be constructed on the 20 foot wide dike crest. The exterior and interior dike slopes of the vertical extension would be stabilized with vegetation. Assuming that approximately 240 acres of the Pearce Creek CDF was available for dredged material placement, the vertical expansion would increase the site's in-place volume by 3.9 mcy. The site capacity (cut volume) is equal to the in-place volume divided by 0.7, or 5.6 mcy.

The expanded dike would be constructed from clean local borrow materials. The expansion of the dike vertically without changing the outside toe of slope of the existing dike would require construction of the dike on existing dredged materials. In order to provide adequate foundation support for the dike, further consolidation and strength gain of the dredged material would be required. For this alternative, it is assumed that a high-strength geotextile would first be installed on the interior dike slope and across the footprint of the new dike extension over the dredged materials. The new dike footprint would then be surcharged with a 20-ft-high soil load that would be used to further consolidate and provide strength gain of the underlying dredged materials. It is assumed that the initial 20-ft surcharge block would settle (or displace soft dredged material) approximately 10 feet before creating a stable surface capable of supporting the raised dike section. The time required for sufficient consolidation of the dredged material may be many years. In order to accelerate the consolidation, wick drains may be used with a horizontal drainage layer between the surcharge pile and the dredged materials. Additionally, groundwater contamination is a concern at Pearce Creek, and installation of an impervious liner was begun in March 2016. The cost of this liner was included in the cost estimate.

For this alternative, it is assumed material would be mechanically dredged from the Harbor Channels, C&D Canal Approach Channels, or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed within a barge and transported to the Pearce Creek CDF, where it would be pumped directly into the CDF using a hydraulic unloader. Transport distances from the center of the respective channels to the placement site are as follows: Harbor Channels, 35 nm; C&D Canal Approach Channels, 6 nm; and Chesapeake Bay Approach Channels (MD), 25 nm.

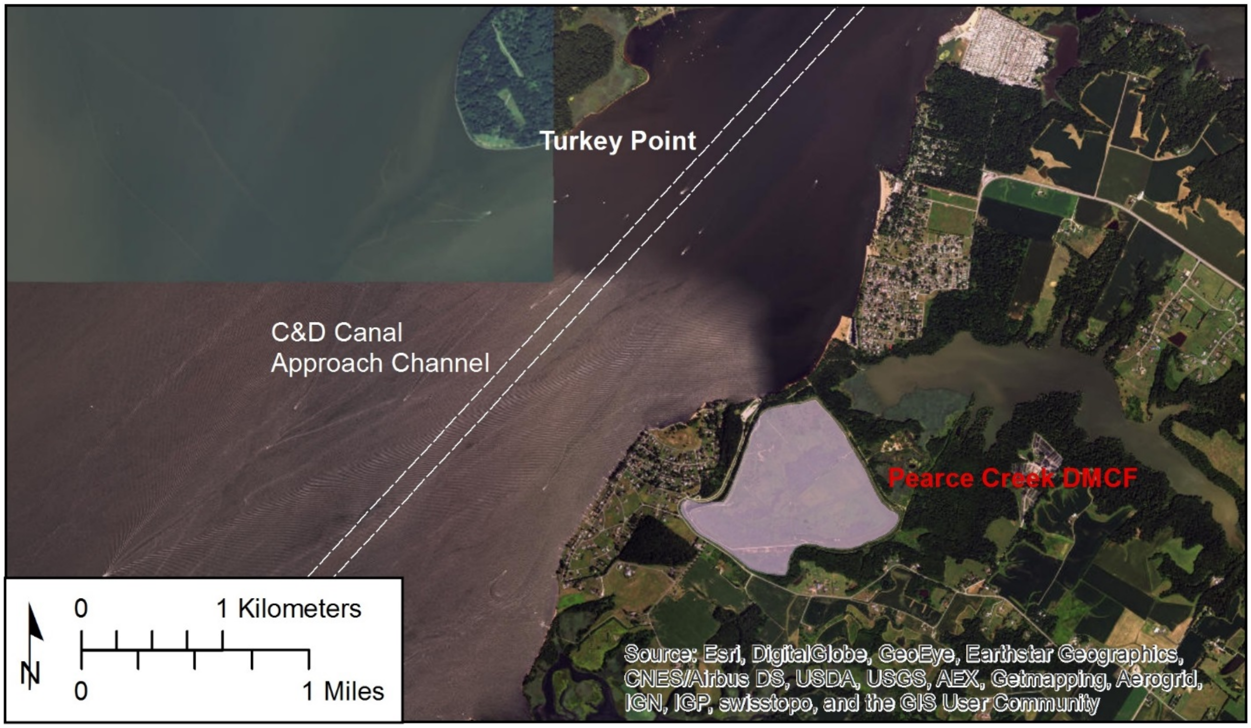

Figure 3-10. Dredged material placement alternatives, Pearce Creek area map (corresponding Map #4 in Table 3-2)

3.2.2.4.3 Courthouse Point Vertical Expansion

The Courthouse Point Dredged Material Containment Facility is located in Cecil County, Maryland, along the Elk River, north of the Pearce Creek DMCF (Figure 3-11; Map #9). The existing facility, which is owned by Philadelphia District, is approximately 140 acres, and was operated as a placement site for material dredged from the northern approach channels to C&D Canal for over forty-years. However, due to water quality concerns, the site has not been recently used. The site is considered a placement alternative for the Harbor Channels, C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD).

The proposed vertical expansion will raise the existing perimeter dikes 20 ft from elevation 50 ft to elevation 70 ft above grade. The increase in dike height will be achieved by adding to the interior slope and not increasing the overall footprint of the existing DMCF. A 3:1 slope and 20 ft wide crest is assumed. Both the exterior and interior raised dike sections will be stabilized with vegetation. The crest will support a crushed stone roadway surface. The raising will increase the volume of the site by approximately 4.5 mcy and add approximately 6.5 mcy of additional dredged material placement capacity. The existing DMCF has a perimeter length of 11,000 lin ft.

The expansion of the dike vertically without changing the outside toe of slope of the existing dike will require construction of the dike on existing dredged materials. In order to provide adequate foundation support for the dike, further consolidation and strength gain of the dredged material will be required. It is assumed that a high strength geotextile will first be installed across the footprint of the new dike extension over the dredged materials. The new dike footprint fill then be surcharged with a 16 foot high soil surcharged load constructed approximately 25 ft beyond the inside toe of the raised dike section. The surcharge fill will consolidate the underlying dredged material and provide strength gain to support the raised dike. After the dredged material has gained sufficient strength, the raised dike can be constructed. The time for sufficient consolidation of the dredged material may be several years. In order to accelerate the consolidation, wick drains can be used as vertical drainage beneath the raised dike section. Alternatively, the dike raising can be constructed in stages as the dredged material gains strength through consolidation. It is assumed that borrow materials will be obtained from local (off-site) sources. Additionally, groundwater contamination is a concern at Courthouse Point, and it was assumed that reopening of the facility will require the installation of a groundwater containment system such as an impervious liner and cutoff walls.

The one-way hauling distance for this alternative is approximately 7 miles longer than the distances to the Pearce Creek DMCF. For this alternative, it is assumed material would be mechanically dredged from the Harbor Channels, C&D Canal Approach Channels, or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed within a barge and transported to the Pearce Creek CDF, where it would be pumped directly into the CDF using a hydraulic unloader. Transport distances from the center of the respective channels to the placement site are as follows: Harbor Channels, 42 nm; C&D Canal Approach Channels, 13 nm; and Chesapeake Bay Approach Channels (MD), 32 nm.

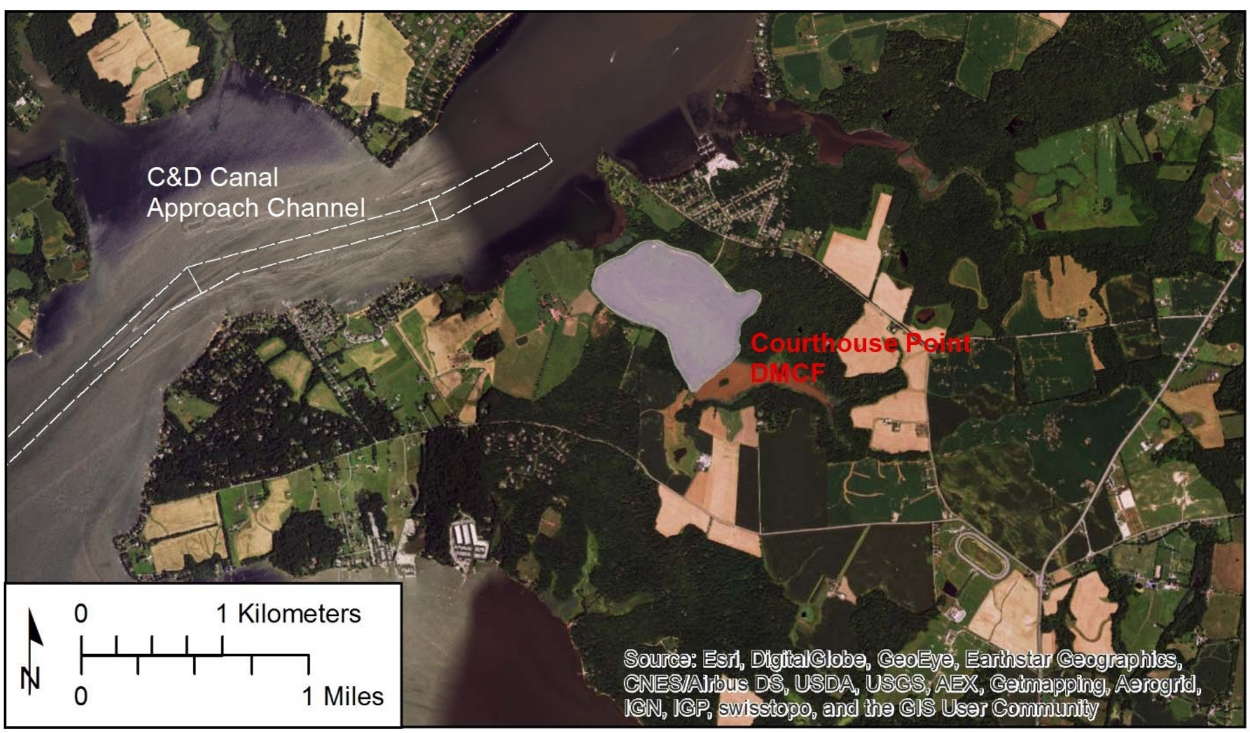

Figure 3-11. Dredged material placement alternatives, Courthouse Point area map (corresponding Map #9 in Table 3-2)

3.2.2.4.4 Cox Creek Vertical Expansion

Cox Creek is an existing 133-acre CDF located along the Patapsco River near the Francis Scott Key Bridge as shown in Figure 3-12 (Map #10). The site is located in the Upper Bay region and is considered a placement alternative for the Harbor Channels.

The Cox Creek CDF comprises a total area of 133 acres with approximately 102 acres available for dredged material placement. In order to increase capacity, this alternative proposes the vertical expansion of the exterior dike. The exterior dike is 8,900 ft in length and set at an elevation of 36 ft above grade. For this alternative, vertical expansion would further increase the crest elevation by 10 ft to 46 ft above grade, and would be achieved by adding to the interior slope so as not to increase the overall footprint of the existing CDF. The new dimensions of the exterior dike consist of a 20-ft crest width and 3:1 side slopes. Both the exterior and interior dike slopes of the vertical extension would be stabilized with vegetation. The increased capacity due to vertical expansion of the exterior dike is based on placement of dredged material within the CDF to a height 4 ft below the crest elevation. The proposed vertical expansion of the Cox Creek CDF would increase the site's in-place volume by 1.5 mcy. The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.7, or 2.1 mcy.

The expanded dike would be constructed from clean local borrow materials. The expansion of the dike vertically without changing the outside toe of the existing dike would require construction of the dike on existing dredged materials. In order to provide adequate foundation support for the dike expansion, further consolidation and strength gain of the dredged material would be required. For this cost estimate, it is assumed that a high-strength geotextile would first be installed across the footprint of the new dike extension over the dredged materials. The new dike footprint would then be surcharged with a 20-ft-high soil load that would be used to further consolidate and provide strength gain of the underlying dredged materials. After the dredged material has gained sufficient strength, the outer wedge of the surcharge pile would be removed, and the remaining wedge would be the interior dike slope. The time for sufficient consolidation of the dredged material may be many years. In order to accelerate the consolidation, wick drains may be used with a horizontal drainage layer between the surcharge pile and the dredged materials.

For this alternative, it is assumed material would be dredged from the Harbor Channels with a clamshell dredge. Material would be placed with a barge and transported to the Cox Creek CDF, where it would be pumped into the site using a hydraulic unloader. Transport distance from the center of the respective channels to the placement site is 3 nm.

3.2.2.4.5 Cox Creek Northward Lateral Expansion

This alternative would expand the Cox Creek DMCF laterally northward, onto property owned by Cristal USA, Inc., a chemical manufacturer (Figure 3-12; Map #11). The existing Cristal property is largely idle at this time. There is a 10-acre parcel within the site, not owned by

Cristal, which is being actively used. The majority of the site consists of impervious surface of either warehouse or pavement.

This alternative consists of the addition of a new upland CDF immediately adjacent to the north of the existing Cox Creek DMCF. The expansion would consist of approximately 100 acres with perimeter containment dikes averaging 25 ft in height capable of containing an average depth of dredged material of 20 ft. A 3:1 slope and 20 foot wide crest is assumed for the 25 foot high dike. Both the exterior and interior slopes of the raised dike section will be stabilized with vegetation. The available placement acreage is estimated to be approximately 90 acres after accounting for the dike footprint. The perimeter dike length is estimated at 10,000 lin ft.

The in-place volume of the expanded portion of the DMCF is based on filling the facility to within 5 ft of the top of the dike allowing for freeboard and typical consolidation of the dredged material to a final surface. The estimated containment volume of the expanded portion of the facility is 2.9 mcy. The site capacity for this alternative is based on dividing the site volume by 0.7 due to consolidation of the dredged material for an estimated capacity of 4.1 mcy.

The site is occupied by approximately 90 industrial buildings that will need to be removed before development as a DMCF. The presence of hazardous waste, underground and above ground storage tanks, and other infrastructure features is yet to be evaluated and will likely have some impact on the cost of site preparation. The site is listed as a Toxic Release Inventory Site with a record of air emissions of carbonyl sulfide, manganese compounds, and hydrochloric acid.

In order to accelerate material consolidation, wick drains were assumed to be used as vertical drainage beneath the dike section. Additionally, groundwater contamination is a significant concern, and it was assumed that an impervious liner would be necessary.

For this alternative, it is assumed material would be dredged from the Harbor Channels with a clamshell dredge. Material would be placed with a barge and transported to the Cox Creek CDF, where it would be pumped into the site using a hydraulic unloader. Transport distance from the center of the respective channels to the placement site is 3 nm.

3.2.2.4.6 **Cox Creek Westward Expansion**

This alternative would expand the Cox Creek DMCF westward onto property owned by MPA. Westward expansion would occur on a 100-acre parcel that is a former copper refinery (Figure 3-12; Map #12). The property includes numerous abandoned warehouses, pavement, and facilities which support dredged material innovative ruse pilot projects. MPA is currently in the process of removing the warehouses. The area to the south of the property is under a conservation easement, held by the North County Land Trust and includes the Swan Creek wetland, which was mitigation for the construction of the existing DMCF.

The alternative consists of an expansion of approximately 100 acres with perimeter containment dikes averaging 25 ft in height capable of containing an average depth of dredged material of 20 ft. A 3:1 slope and 20 foot wide crest is assumed for the 25 foot high dike. Both the exterior and interior slopes of the raised dike section will be stabilized with vegetation. The available placement acreage is estimated to be approximately 90 acres after accounting for the dike footprint. The perimeter dike length is estimated at 8,000 lin ft.

The in-place volume of the expanded portion of the DMCF is based on filling the facility to within 5 ft of the top of the dike allowing for freeboard and typical consolidation of the dredged material to a final surface. The estimated containment volume of the expanded portion of the facility is 2.9 mcy. The site capacity for this alternative is based on dividing the site volume by 0.7 due to consolidation of the dredged material for an estimated capacity of 4.1 mcy.

The site is occupied by approximately 30 industrial buildings that will need to be removed before development as a DMCF. The presence of hazardous waste, underground and above ground storage tanks, and other infrastructure features is yet to be evaluated and will likely have some impact on the cost of site preparation. It has been assumed that the site will require an impervious interior liner. Additionally, wick drains have been assumed in order to accelerate the drainage and consolidation of the dredged material.

For this alternative, it is assumed material would be dredged from the Harbor Channels with a clamshell dredge. Material would be placed with a barge and transported to the Cox Creek CDF, where it would be pumped into the site using a hydraulic unloader. Transport distance from the center of the respective channels to the placement site is 3 nm.

3.2.2.4.7 **Cox Creek Combined Expansion**

This alternative would incorporate the previous separate alternatives for expansion of the Cox Creek DMCF (Figure 3-12; Map #10,11,12). The expansion will be a combination of: 1) a vertical expansion of the existing DMCF by raising the existing perimeter dikes 24 ft from existing elevation 36 ft to 60 ft in total height; 2) lateral expansions to the west and north with new 20 foot high dikes also constructed to elevation 60 ft and connected to the existing DMCF. The raising of the existing DMCF will be accomplished in two stages (36 to 46 ft and 46 to 64 ft) with a support base constructed for each raising increment. It is assumed that the dike base and embankment fill material will be obtained from nearby off-site sources. Raising the existing DMCF will be achieved by adding to the interior slope and not increasing the overall footprint of the existing facility. All dikes will have 3:1 slopes and 20 foot crest widths. Both the exterior and interior slopes of all new dike sections will be stabilized with vegetation.

The three components of the expanded Cox Creek will have a total placement area of approximately 200 acres and an added volume of 6.2 mcy providing an added placement capacity of 8.9 mcy based on an average volume occupied ratio of 0.7. This accounts for anticipated consolidation of the dredged material compared to the average density in-situ.

To provide adequate foundation support for the existing DMCF dike raising on the contained dredged material, consolidation and strength gain of the dredged material will be required. It is assumed that a high strength geotextile will first be installed across the footprint of the dike raising base. The existing dredged material will be surcharged with a 10 foot thick load of borrow fill that will displace and consolidate the underlying dredged material providing a base supporting the raised dike section. In order to accelerate the consolidation, wick drains have been assumed as vertical drainage beneath the raised dike section. Additionally, groundwater contamination is a concern, and it was assumed that the expansion will require the installation of an impervious liner.

For this alternative, it is assumed material would be dredged from the Harbor Channels with a clamshell dredge. Material would be placed with a barge and transported to the Cox Creek CDF, where it would be pumped into the site using a hydraulic unloader. Transport distance from the center of the respective channels to the placement site is 3 nm.

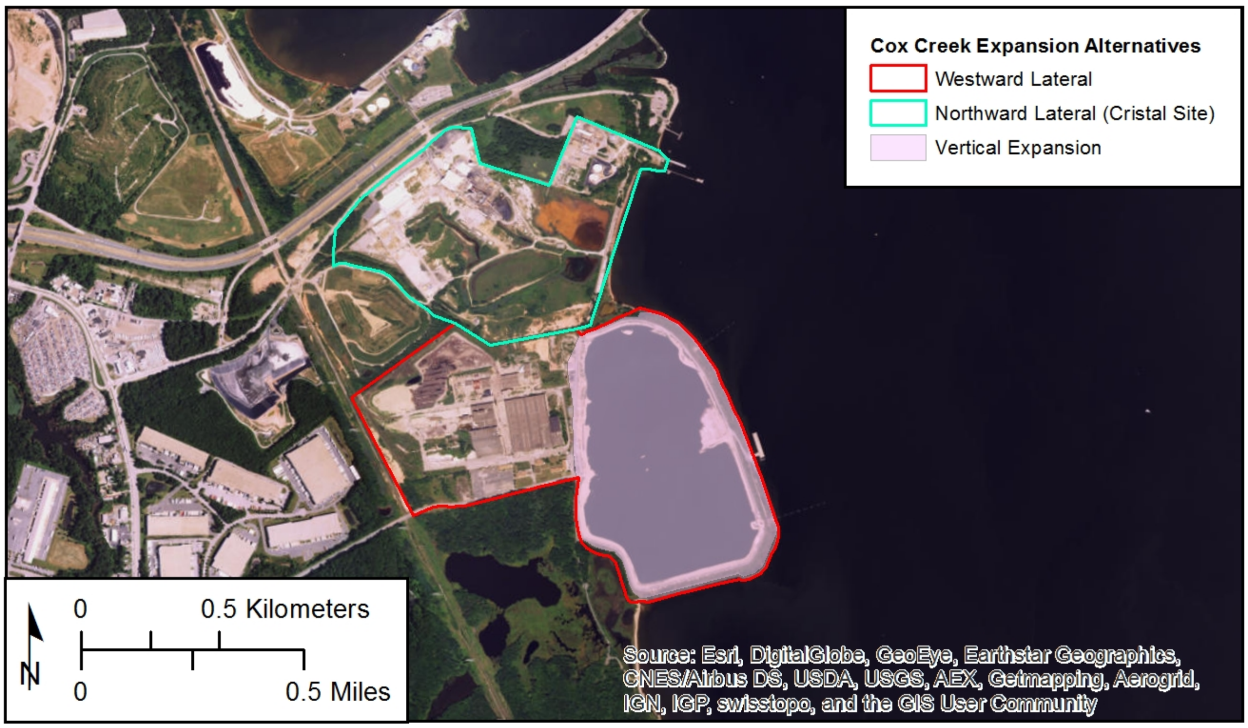

Figure 3-12. Dredged material placement alternatives, Cox Creek area map (corresponding Map #'s 3, 10, 11, and 12 in Table 3-2)

3.2.2.5 *Large Island Restoration*

Large Island Restoration (LIR) is the restoration of a historic island footprint through the construction of perimeter dikes and the placement of dredged material. This is distinct from artificial island creation, which refers to the creation of an island where no remnant currently exists. Island restoration is supported by MDE, DNR, and USFWS. For the purposes of this study, LIR refers to the restoration of islands whose historic area is more than 1,000 acres.

LIR is performed by the placement of dredged material within a constructed perimeter dike in a location where an island has suffered land loss due to erosion, sea-level rise, or subsidence. In most cases, the dike encloses the placement area and isolates the dredged material from the surrounding environment. The perimeter dike is constructed of sand and requires heavy, protective armoring on the seaward side to prevent erosion from waves and currents. Interior dikes are constructed to separate the island into several smaller cells. The smaller cells enhance the overall management and dewatering of the dredged material, and allow the creation of distinct upland and wetland habitats.

Dredged material would be transported to the LIR site by scow, pumped through a hydraulic unloader, and deposited behind the perimeter dike. Material pumped into designated wetland cells are placed at a low elevation that would allow tidal inundation. In upland cells, dredged material may be filled to an elevation close to that of the perimeter dike (minus any designed freeboard).

LIR is evaluated as an alternative for the Middle Bay region of the DMMP, and each island consists of approximately 50 percent uplands and 50 percent wetlands. The PDT could not identify any opportunities for LIR in the Upper Bay as there are no appropriate remnant islands. Design assumptions associated with this alternative for each region are detailed in the following paragraphs.

The representative area for LIR is in Dorchester County, Maryland, as shown in Figure 3-13 (Map #15). The site is considered a placement alternative for the C&D Canal Lower Approach Channels and Chesapeake Bay Approach Channels (MD).

The proposed LIR site is the recommended plan presented by the Corps of Engineers in the September 2008 Final Mid-Chesapeake Bay Island Ecosystem Restoration Integrated Feasibility Report & Environmental Impact Statement and authorized by the Water Resources Reform and Development Act of 2014 (WRRDA 14). The recommended plan, referred to as Mid-Bay Island, consists of two parts: 2,072 acres of island restoration at James Island and 72 acres of island restoration/protection at Barren Island. Detailed descriptions of the 2 components of this alternative follow below.

The proposed James Island site has a dog-leg shape and is approximately 16,500 ft by 9,000 ft by 4,000 ft (Figure 3-14). The 2,072 acre area will be subdivided into 45 percent upland (932 acres) and 55 percent wetland (1,043 acres). Specifically for the wetlands, the following habitat acreages are targeted: 202 acres of high marsh, 728 acres of low marsh, and 113 acres of mudflat and intertidal areas. In the vicinity of James Island, the average water depth is 6 ft as determined from NOAA charts in the proposed Dorchester County area.

The James Island exterior perimeter dike is 45,000 ft in length and is set at an elevation of +20 ft MLLW (crest width 20 ft and slope 2.5:1). The in-place volume of the exterior dike is 3.8 mcy. To better facilitate dewatering of the dredged material, the site is divided into smaller interior cells (4 upland and 22 wetland). Wetland interior cross dikes are 75,000 ft in length and will be built to approximately +6 ft MLLW (crest width 15 ft and slope 2.5:1). Upland interior dikes are 12,000 ft in length and will be built to approximately +20 ft MLLW (crest width 20 ft and 2.5:1

slope). The dike separating the upland and wetland areas has the same dimensions as the exterior and a length of 6,300 ft. The total interior dike volume is 4.75 mcy.

The Barren Island restoration/protection component of the plan totals 72 acres and will include modification of the existing sill, and construction of a near-shore sill and breakwaters (Figure 3-15). The average water depth around Barren Island is greater than 6 ft. The existing sill is approximately 4,900 ft in length and will require the addition of stone to create a 6 ft crest width and height of +4 ft MLLW. The near-shore sill will have a crest width of 6 ft, and elevation of +4 ft MLLW, and a total length of 9,760 ft. The breakwater section will be approximately 8,200 ft in length, with a crest width of 6 ft, and an elevation of +6 MLLW. Note that all dredged material needed for the Barren Island restoration will come from local maintenance dredging projects and will not come from any of the channels that are evaluated in this analysis. After placement of sand, the area will be graded and planted to restore wetlands.

The total in-place volume of the Mid Bay Island site is 67 mcy, which does not include the 8.6 mcy required for dike construction. It is assumed that the interior/exterior dike construction utilizes existing material located inside the footprint of the facility. The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.7, or 95.7 mcy.

For this alternative, it is assumed material would be mechanically dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Dredged material would be placed into an adjacent scow and transported to the site. Material would be offloaded from the scow and pumped through a hydraulic unloader to a location behind the exterior dike. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels, 58 nm; and Chesapeake Bay Approach Channels (MD), 40 nm.

Figure 3-13. Dredged material placement alternatives, Mid-Bay large island restoration, James and Barren Islands (corresponding Map #15 in Table 3-2)

Figure 3-14. James Island plan

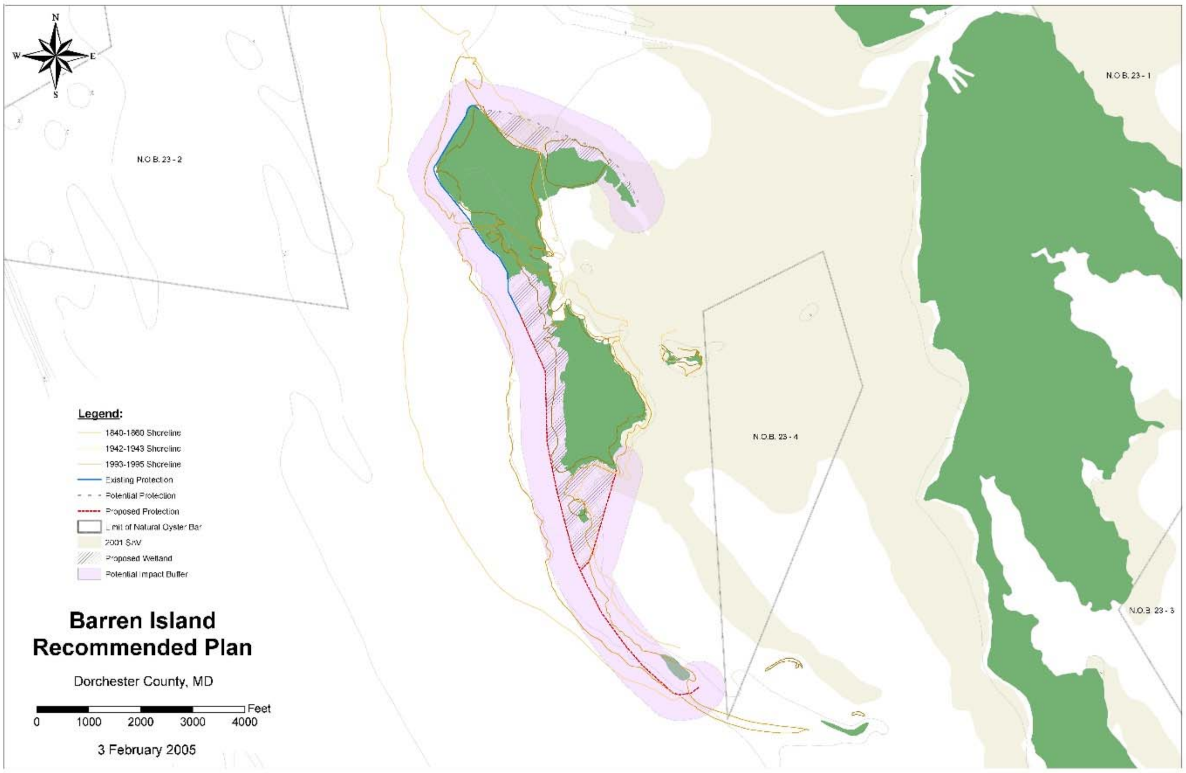

Figure 3-15. Barren Island plan

3.2.2.6 *New Open Water Site – Deep Trough*

The Deep Trough is an area of very deep water, up to 160 feet in depth that is generally aligned along a north-south axis in the eastern center of the mainstem of the Chesapeake Bay (Figure 3-3; Map #17). This trench is a remnant of the ancient Susquehanna River channel when this portion of the Bay was a riverine environment. The trench extends approximately 20 miles, beginning offshore of Kent Island, in the vicinity of the Bay Bridge, south to the mouth of the Little Choptank River. It is an area encompassed by the -60 foot MLLW depth contour, which extends 20 miles south from the Bay Bridge to a shallower sill of a depth of -60 ft to -70 ft MLLW opposite the mouth of the Little Choptank River (Versar 1990). Placement capacity is estimated to exceed 100 mcy.

For this alternative, it is assumed material would be dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed into dump scows and transported to the Deep Trough site where it would be released from the scow. Transport distances from the center of the respective channels to the placement site are as follows (in miles): C&D Canal Approach Channels, 34 nm; and Chesapeake Bay Approach Channels (MD), 15 nm.

3.2.2.7 *Pooles Island Open Water Site Expansion*

The Pooles Island Open Water Site refers to a group of existing open water placement sites located near Pooles Island in the Upper Bay region as shown in Figure 3-5 (Map #19). Specifically, the open water placement sites are located on the northwest side of Upper Chesapeake Bay at the mouth of the Gunpowder and Bush Rivers in Harford County, Maryland. Expansion of this site is considered a placement alternative for the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD). It should be noted that state law (MD Senate Bill 830; Maryland Environmental Code (5), Subtitle 11) closed the Pooles Island sites to placement in 2010. These restrictions would have to be addressed in expanding Pooles Island.

As described in Section 3.1, all placement sites, with the exception of Site 92, G-West, and G-East associated with Pooles Island, have reached capacity, can no longer retain additional sediments, or have minimal remaining capacity. Therefore, this alternative consists of a 350-acre expansion of the Pooles Island Open Water site between G-West and Site 92. Assuming an 8.5-ft lift to approximately -11 ft MLLW, the expansion would provide an additional site capacity of 5 mcy.

For this alternative, it is assumed material would be dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed into dump scows and transported to the expanded portion of the Pooles Island Open Water Placement site where it would be released from the scow. Transport distances from the center of the respective channels to the placement site are as follows (in miles): C&D Canal Approach Channels, 5 nm; and Chesapeake Bay Approach Channels (MD), 15 nm.

3.2.2.8 *Rappahannock Shoal Deep Alternate Open Water Site Expansion*

The Rappahannock Shoal Deep Alternate Open Water Placement site is located approximately 1 mile west of the Rappahannock Shoal Channel as shown in Figure 3-3 (Map #22). The site is in the Lower Bay region and expansion of the site serves as a placement alternative for the C&D Canal Approach and Chesapeake Bay Approach Channels (MD). However, a 1981 agreement between the Virginia Secretary of Commerce and Resources and the Maryland Secretary of Transportation designated this site and the Wolf Trap site for the placement of dredged material "…for that part of Baltimore's 50-foot channel project located in Virginia waters." This agreement would have to be changed to allow for disposal of Maryland material in Virginia waters.

The existing Rappahannock Shoal Deep Alternate Open Water Placement site is approximately 27,000 ft by 5,000 ft in dimension and has an area of 3,100 acres. The average water depth is 39 ft. The remaining site capacity is sufficient for the dredged material from the Rappahannock Shoal Channel. Expansion of the site by 1,000 acres to the northwest would provide an additional 5 mcy of site capacity at an average placement thickness of approximately 3 feet over the planning horizon.

For this alternative, it is assumed material would be mechanically dredged from the C&D Canal Approach or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed in a dump scow and transported to the expanded portion of the Rappahannock Shoal Deep Alternate Open Water Placement site where it would be released from the scow. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels, 104 nm; Chesapeake Bay Approach Channels (MD), 85 nm.

3.2.2.9 ***Shoreline Restoration***

Shoreline erosion is persistent throughout Chesapeake Bay because of wave action, sea-level rise, and subsidence. Shoreline restoration is the process of restoring and mitigating a shoreline to its original or desired position prior to any natural or man-made disturbance. Clean dredged material may be used in shoreline restoration and can provide environmental and economic benefits. Material placed at a particular site would need to be compatible with existing sediment and site characteristics (e.g., coarse-grained material would be used to restore sandy locations). Shoreline restoration has the potential to create habitat and improve water quality while reducing the loss of valuable waterfront property and protecting sensitive habitats. The material may be placed at the site mechanically from a truck or barge, or it may be transported into the site as a slurry by a hydraulic pipeline.

One methodology for shoreline restoration is the use of living shoreline treatments. Living shorelines are the result of applying erosion control measures that include a suite of techniques which can be used to minimize coastal erosion and maintain coastal processes. Techniques may include the use of fiber coir logs, sills, groins, breakwaters, or other natural components used in combination with sand, other natural materials, and/or marsh plantings. While living shorelines may provide substantial habitat benefits, avoidance or minimization of channelward encroachment into subtidal habitat should be avoided. Thus, the use of living shorelines where there is no recent evidence of shoreline erosion or documentation of loss of wetlands habitat, the fill or creation channelward of the recent shoreline extent is generally not supported by resource agencies. Suitable dredged material is required for living shoreline creation, with consideration given to grain size and other characteristics. Material from the Baltimore Harbor and Channels project is generally fine grained, therefore shoreline restoration through living shorelines would require engineered structures for containment. Living shoreline creation may be an option for small amounts suitable dredged material but would need to be evaluated on a case-by-case basis.

Shoreline restoration is evaluated as an alternative for the Middle Bay and Upper Bay regions of the DMMP. Design assumptions associated with this alternative for each region are detailed in the following paragraphs.

Middle Bay

The representative area for shoreline restoration within the Middle Bay region is northwest Dorchester County, Maryland, as shown in Figure 3-16 (Map #23). The site is considered a placement alternative for the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD).

The shoreline restoration alternative for the DMMP update in northwest Dorchester County, Maryland, involves the restoration of a peninsula using dredged material. Dredged material would be placed behind a newly constructed exterior dike to create low-marsh and high-marsh habitats. The proposed site is three-sided (two dikes extending perpendicular from the shoreline and one longer dike parallel to the shoreline, thereby restoring the eroded peninsula) with dimensions of 5,100 ft by 1,500 ft. The area is 175 acres and the restored wetlands will consist of 50 percent low marsh and 50 percent high marsh. The average water depth is 4 feet, as determined from NOAA charts of the Dorchester County vicinity. No grade change was assumed for this alternative.

The exterior dike is 8,100 ft in length and constructed to an elevation of +6 ft MLLW. The crest width is 15 ft and side slopes are 3:1. The volume of the exterior dike is 0.14 mcy. The seaward side of the dike would be armored to provide protection against waves and currents. 50 percent of the site will be low marsh, with dredged material filled to an elevation of +1.3 ft MLLW, and 50 percent of the site will be high marsh, with dredged material filled to an elevation of +2.3 ft MLLW. Material would be added in three dredging cycles. The total in-place volume of the site is 1.6 mcy and includes the 0.14 mcy required for dike construction. It is assumed that the dike construction utilizes existing material located inside the footprint of the facility. The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.7, or 2.3 mcy. Two spillways would be constructed to allow for dewatering of the dredged material during the development process. After dewatering, minor grading would be necessary to create the wetland habitat, including the cutting of at least one large channel. After site grading is completed, the spillway structures and the adjacent dike sections would be removed to create tidal openings for the wetland.

For this alternative, it is assumed suitable material would be dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed within a barge and transported to the NW Dorchester County, Maryland shoreline restoration site where it would be placed within the dike by a hydraulic unloader. It is assumed the dredged material will be placed over a 3 year period and that the project will take 5 years to allow for settlement. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels, 60 nm; and Chesapeake Bay Approach Channels (MD), 40 nm.

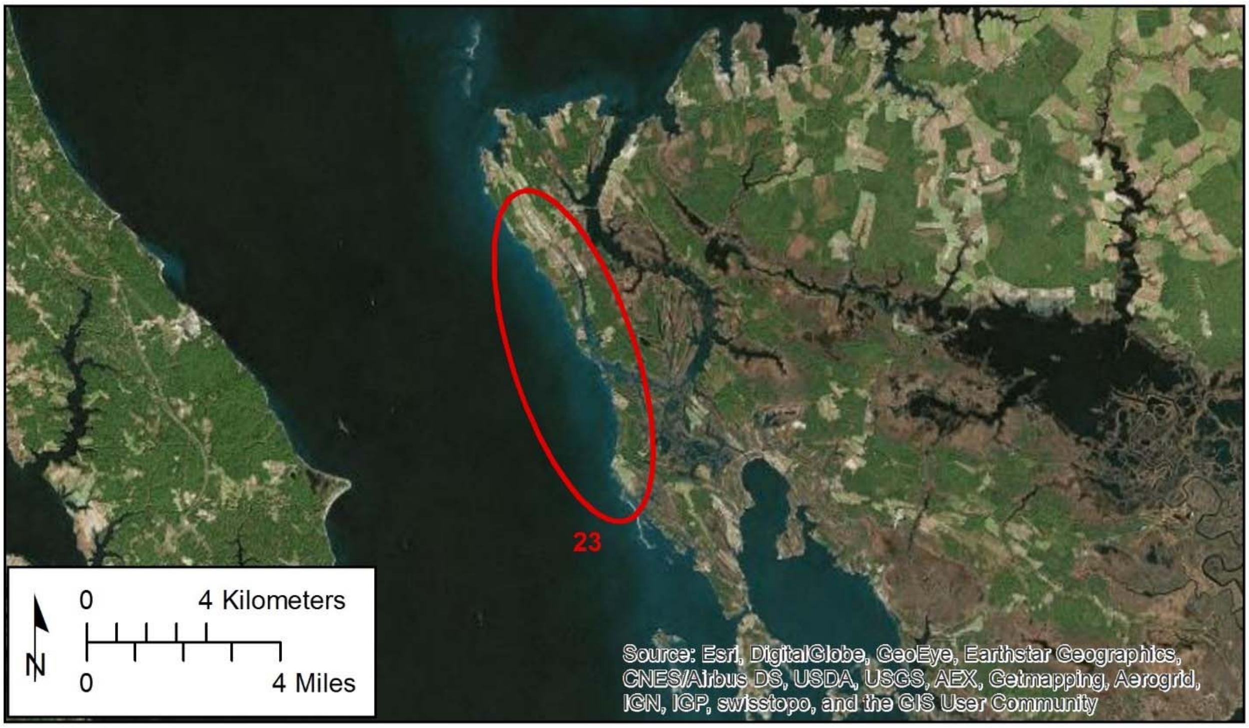

Figure 3-16. Dredged material placement alternatives, Mid-Bay shoreline restoration (corresponding Map #23 in Table 3-2)

Upper Bay

The representative area for shoreline restoration within the Upper Bay region is west of Rock Hall, Maryland, as shown in Figure 3-3 (Map #24). The site is considered a placement alternative for the C&D Canal Lower Approach Channels and Chesapeake Bay Approach Channels (MD).

The shoreline restoration alternative for the DMMP update west of Rock Hall, MD, involves the restoration of a peninsula using dredged material. Dredged material would be placed behind a newly constructed exterior dike to create low-marsh and high-marsh habitats. The proposed shoreline restoration site is three-sided (two dikes extending perpendicular from the shoreline and one longer dike parallel to the shoreline, thereby restoring the eroded peninsula) with dimensions of 3,200 ft by 1,500 ft. The area is 110 acres and the restored wetlands will consist of 50 percent low marsh and 50 percent high marsh. The average water depth is 4 ft, as determined from NOAA maps of the Rock Hall vicinity. No grade change was assumed for this alternative.

The exterior dike is 6,200 ft in length and constructed to an elevation of +6 ft MLLW. The crest width is 15 ft and side slopes are 3:1. The volume of the exterior dike is 0.1 mcy. The seaward side of the dike would be armored to provide protection against waves and currents. 50 percent of the site will be low marsh, with dredged material filled to an elevation of +1.3 ft MLLW, and 50 percent of the site will be high marsh, with dredged material filled to an elevation of +2.3 ft MLLW. Material would be added in three dredging cycles. The in-place volume of the site is 1.0 mcy, which includes the 0.1 mcy required for dike construction. It is assumed that the dike construction utilizes existing material located inside the footprint of the facility. The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.7, or 1.5 mcy.

Two spillways would be constructed to allow for dewatering of the dredged material during the development process. After dewatering, minor grading would be necessary to create the wetland habitat, including the cutting of at least one large channel. After site grading is completed, the spillway structures and the adjacent dike sections would be removed to create tidal openings for the wetland. For this alternative, it is assumed suitable material would be dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed within a barge and transported to the shoreline restoration site west of Rock Hall, MD, where it would be placed within the dike by a hydraulic unloader. It is assumed the dredged material will be placed over a 3 year period and that the project will take 5 years to allow for settlement. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels, 17 nm; and Chesapeake Bay Approach Channels (MD), 3.5 nm.

For this alternative hydraulic dredging with pipeline delivery could be considered and may result in a lower cost for placement. However, it is reasonable to believe that dredging activities that would utilize this placement site would also utilize placement sites, such as CDFs, that are incompatible with hydraulic dredging. Such a dredging scenario would likely increase contract costs and therefore is unlikely to be awarded, resulting in mechanical dredging remaining the preferred dredging methodology.

3.2.2.10 ***Small Island Restoration***

Small Island Restoration (SIR) is the restoration of a historic island footprint through the construction of perimeter dikes and the placement of dredged material. This is distinct from artificial island creation, which refers to the creation of an island where no remnant currently exists. For the purposes of this study, SIR refers to the restoration of an island whose historic area is less than 1,000 acres. Based on experience with Poplar Island, it has been determined that efficient placement of dredged material into a site that is 50 percent upland and 50 percent wetland requires a minimum size of about 500 acres (250 acres wetlands, 250 acres uplands). This size allows for appropriate material handling and consolidation while allowing for wetland cell development. The proportion of upland to wetlands for island restoration was determined in consultation with resource agencies. Therefore, this area provides the dividing line between large and small island restoration projects. The example sites developed below consist of 500 acre sites and two different locations.

SIR is performed by the placement of dredged material within a constructed perimeter dike in a location where an island has experienced land loss because of erosion, sea-level rise, or subsidence. In most cases, the dike encloses the placement area and isolates the dredged material from the surrounding environment. The perimeter dike is constructed of sand and requires heavy, protective armoring on the seaward side to prevent erosion from waves and currents. Interior dikes are constructed to separate the island into several smaller cells. The smaller cells enhance the overall management and dewatering of the dredged material, and allow the creation of distinct upland and wetland habitats.

Dredged material would be transported to the SIR site by scow, pumped through a hydraulic unloader, and deposited behind the perimeter dike. Material pumped into designated wetland cells are placed at a low elevation that would allow tidal inundation. A typical surface elevation of +1.6 MLLW has been assumed for the low marsh in the SIR examples following. In upland cells, dredged material may be filled to an elevation close to that of the perimeter dike. In the following examples, the final upland elevation has been assumed to be 4 feet below the dike crest elevation allowing 2 feet of freeboard plus 2 feet for consolidation of dredged material to the final upland surface.

SIR is evaluated as an alternative for the Middle Bay and Upper Bay regions of the DMMP, and consists of 50 percent uplands and 50 percent wetlands. Design assumptions associated with this alternative are detailed in the following paragraphs.

Middle Bay

Two representative locations were evaluated for SIR within the Middle Bay region. Included was a sheltered location represented by Parsons Island, Maryland, and an exposed location represented by Sharps Island, Maryland, as shown in Figure 3-17 (Map #25,26). The sites are considered as placement alternatives for the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD).

Parsons Island. The proposed 500-acre SIR site is square in shape and has dimensions of approximately 4,667 ft by 4,667 ft. The exterior dike length is 18,668 ft. The average water depth is 6 feet, as determined by NOAA charts. The island would be divided into 50 percent upland at a final dredged material elevation of +6.0 MLLW and 50 percent wetland at a final dredged material elevation of +1.6 MLLW. Sand to construct all dikes will be obtained from borrow sources within the footprint of the site or from the access channel leading to the site.

The exterior dike has a crest width of 20 ft set at elevation +10 ft MLLW, and side slopes of 3H:1V. The exterior dike length is 18,668 ft and, with an average water depth of 6 ft, will require 0.75 mcy of borrow sand. The crest of the perimeter dike will have a crushed stone road surface and exterior slopes will be protected from wave energy with armor stone. The exterior armor consists of a 3-foot layer of armor stone on a 1.5-foot stone underlayer on a 6-inch bedding stone layer founded on a geotextile filter material.

A primary interior dike will separate the upland and wetlands. The dike has a crest width of 20 ft set at elevation +8 ft MLLW, and side slopes of 3H:1V. The separator dike length is 6,600 ft and, with an average water depth of 6 ft, will require 0.27 mcy of borrow sand. The crest of the separator dike will have a crushed stone road surface and exterior slopes will be seeded above the water line to provide erosion resistance.

To ensure efficient dewatering for habitat creation and management, the wetland area is divided into four smaller interior cells. Three interior dikes for the wetland subdivision have a crest width of 15 ft set at elevation +6 ft MLLW, and side slopes of 2.5H:1V. The total length of the interior wetland dikes is 7,967 ft and will require 0.25 mcy of borrow sand.

Based on the assumed final dredged material to elevation +6.0 MLLW, the volume of the upland area is 5.8 mcy. Based on the assumed final dredged material elevation of +1.6 MLLW, the volume of the wetland area is 3.1 mcy. Therefore, the total volume of the site is approximately 8.9 mcy. The site capacity, obtained by dividing the site volume by the consolidation factor of 0.7, yields a site capacity of 12.7 mcy. For this alternative, it is assumed suitable material would be mechanically dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Dredged material would be placed into an adjacent scow and transported to the site. Material would be pumped through a hydraulic unloader to a location behind the exterior dike. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels, 48 nm; and Chesapeake Bay Approach Channels (MD), 29 nm.

Sharps Island. The proposed 500-acre SIR site is square in shape and has dimensions of approximately 4,667 ft by 4,667 ft. The exterior dike length is 18,668 ft. The average water depth is 10 ft, as determined by NOAA charts. The island would be divided into 50 percent upland at a final dredged material elevation of +6.0 MLLW and 50 percent wetland at a final dredged material elevation of +1.6 MLLW. Sand to construct all dikes will be obtained from borrow sources within the footprint of the site or from the access channel leading to the site.

The exterior dike has a crest width of 20 ft set at elevation +10 ft MLLW, and side slopes of 3H:1V. The exterior dike length is 18,668 ft and, with an average water depth of 10 ft, will require 1.11 mcy of borrow sand. The crest of the perimeter dike will have a crushed stone road surface and exterior slopes will be protected from wave energy with armor stone. The exterior armor consists of a 5-foot thickness of armor stone on a 2.5-foot stone underlayer on a 6-inch bedding stone layer founded on a geotextile filter material.

A primary interior dike will separate the upland and wetlands. The dike has a crest width of 20 ft set at elevation +10 ft MLLW, and side slopes of 3H:1V. The separator dike length is 6,600 ft and, with an average water depth of 10 ft, will require 0.39 mcy of borrow sand. The crest of the separator dike will have a crushed stone road surface and exterior slopes will be seeded above the water line to provide erosion resistance.

To ensure efficient dewatering for habitat creation and management, the wetland area is divided into four smaller interior cells. Three interior dikes for the wetland subdivision have a total length of 7,967 ft, a crest width of 15 ft set at elevation +6 ft MLLW, and side slopes of 2.5H:1V. The upland area will also be subdivided by a similar 3,300 foot dike with a crest elevation of +8 MLLW. The interior cell dikes will require 0.45 mcy of borrow sand.

An access channel would be required between the -25.0 foot elevation within the bay and the containment site. It is assumed that the channel would be 2,000 ft long, have an average width of 500 ft, and a bottom elevation of -25 MLLW generating approximately 0.56 mcy of dredged material. It is assumed that approximately half of the channel material would consist of usable sand and the remainder would be spoiled within the site.

Based on the assumed final dredged material to elevation +6.0 MLLW, the volume of the upland area is 6.5 mcy. Based on the assumed final dredged material elevation of +1.6 MLLW, the volume of the wetland area is 4.7 mcy. Therefore, the total volume of the site is approximately 11.2 mcy. The site capacity, obtained by dividing the site volume by the consolidation factor of 0.7, yields a site capacity of 15.9 mcy. Additional capacity of approximately 2.8 mcy would be realized by the volume of borrow excavation located within the proposed upland cells raising the total site capacity to 18.7 mcy.

For this alternative, it is assumed suitable material would be mechanically dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Dredged material would be placed into an adjacent scow and transported to the site. Material would be pumped through a hydraulic unloader to a location behind the exterior dike. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels, 50 nm; and Chesapeake Bay Approach Channels (MD), 31 nm.

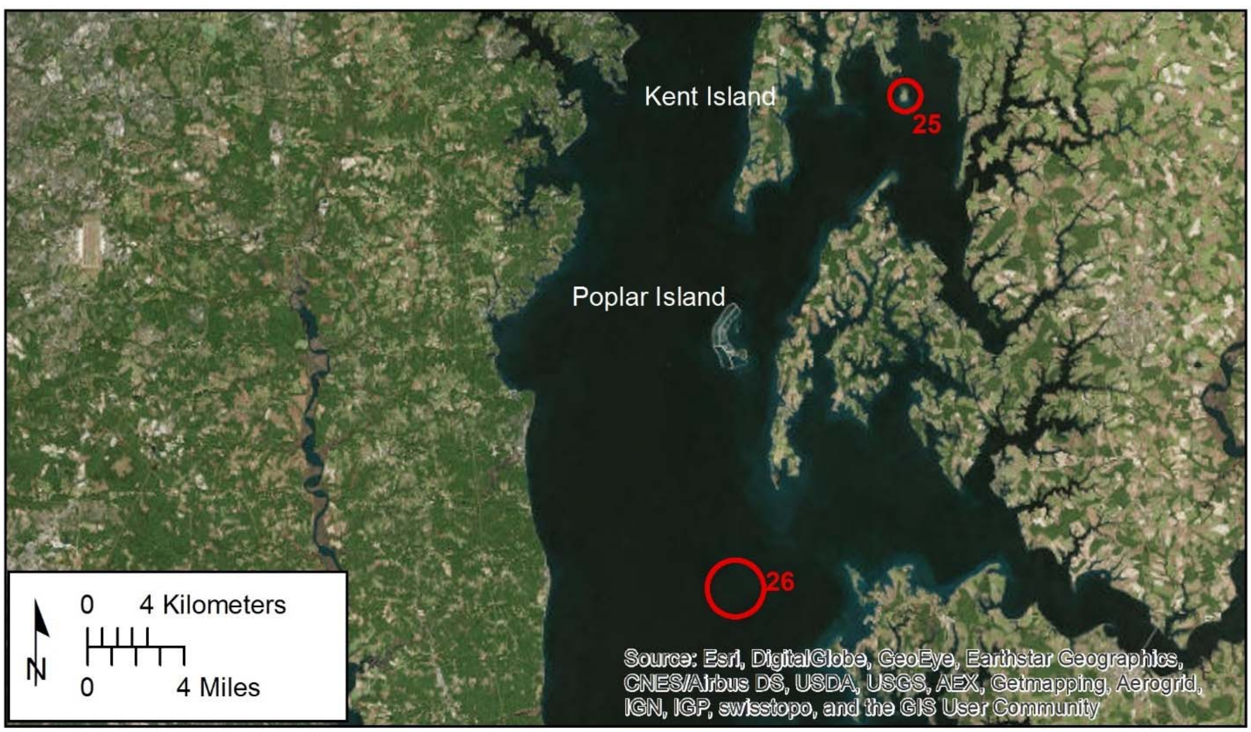

Figure 3-17. Dredged material placement alternatives, Mid-Bay small island restoration, Parsons Island and Sharps Island (corresponding Map #'s 25 and 26 in Table 3-2)

Upper Bay

Susquehanna Flats. The proposed 500-acre SIR site is within the Susquehanna Flats near the mouth of the Susquehanna River (Figure 3-18; Map #28). This alternative would be unacceptable to state and federal resource agencies because of submerged aquatic vegetation (SAV) beds and waterfowl habitat. The displacement of subtidal habitat of existing value would not be recouped in restored island habitat. The opposition of state and federal resource agencies to island restoration at Susquehanna Flats has been expressed in general via email and orally during BEWG discussion. Water depth at the representative site is approximately -3 to -6 ft MLLW. The perimeter dike length is approximately 18,700 lin ft. The exterior dike height is at +10 ft MLLW. The dike dimensions include a crest width of 20 ft and 3:1 slopes. The exterior dike volume for these dimensions is approximately 0.55 mcy. It is assumed that the sand dike material is available from within the site area. There is no subsurface information; it is assumed that unsuitable foundation materials will be encountered along 50 percent of the perimeter dike requiring removal and replacement to an average depth of 8 ft and removal width of 140 ft.

An access channel is assumed to be 3,300 ft long by 500 ft wide by an average 15 foot depth for a total excavation quantity of 0.92 mcy. It is assumed that one-third of this amount (0.31 mcy) will be usable sand, and two-thirds (0.62 mcy) will be placed in the upland cell, thereby reducing site capacity to 4.7 mcy.

Interior dike length for the 500 acres island assumes four cells with the wetland cells separated by the uplands by a diagonal dike of the same cross sectional dimensions as the perimeter dike (0.13 mcy). Another interior dike that divides the upland area into 2 cells has a height of +8 ft MLLW, crest width of 15 ft, and a 2.5:1 slope (0.04 mcy). The dike in the wetland portion is +6 ft MLLW, with a 15 foot wide crest and a 2.5:1 slope (0.07 mcy). The interior dike volume is 0.24 mcy. The total dike volume is 0.79 mcy offset by approximately 0.25 mcy obtained from access channel excavation for a net required volume of 0.54 mcy.

Assuming 50 percent wetland filled to a height of +1.6 ft MLLW, and 50 percent uplands filled to a height of +6 ft MLLW (top of dike minus 2 ft of freeboard), the in-place volume of the site is 4.7 mcy. It is assumed that interior/exterior dike construction utilizes existing material inside the footprint of the facility, and adds additional volume to the upland cell. The site capacity is equal to the in-place volume divided by a factor of 0.7, yielding a total site capacity of approximately 6.7 mcy.

For this alternative, it is assumed suitable material would be mechanically dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Dredged material would be placed into an adjacent scow and transported to the site. Material would be pumped through a hydraulic unloader to a location behind the exterior dike. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels, 9 nm; and Chesapeake Bay Approach Channels (MD), 30 nm.

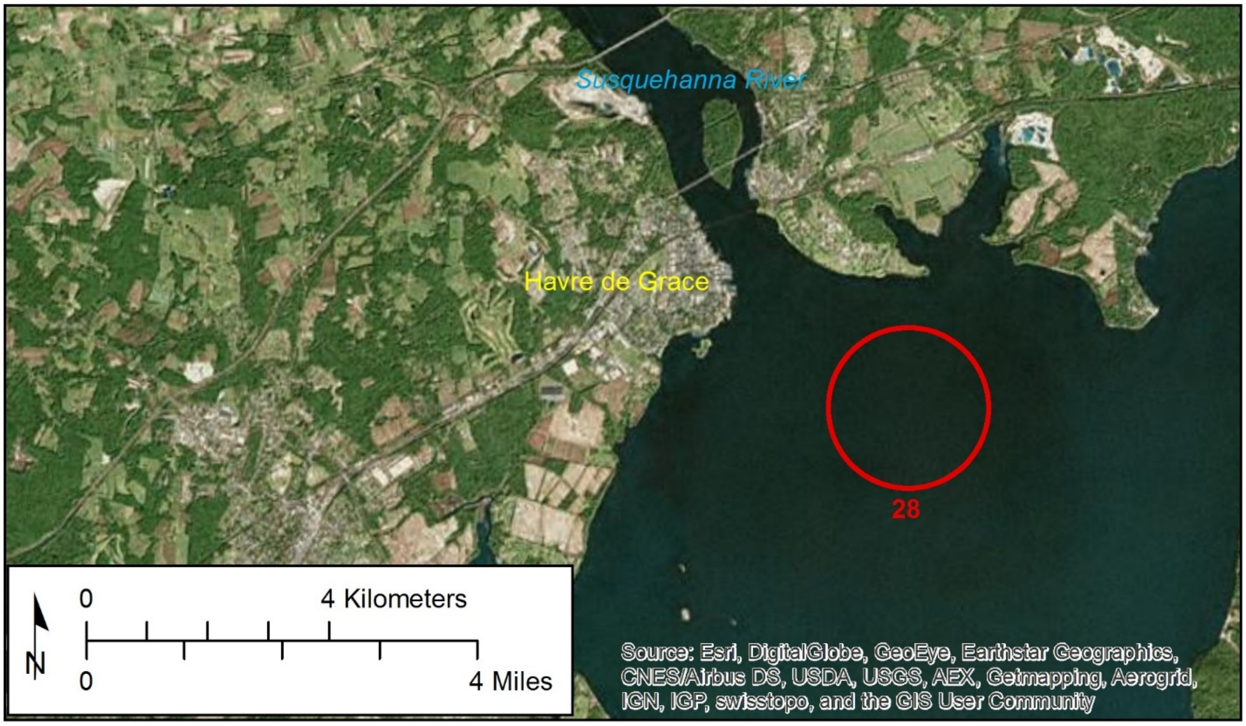

Figure 3-18. Dredged material placement alternatives, Mid-Bay small island restoration, Susquehanna Flats (corresponding Map #28 in Table 3-2)

3.2.2.11 *Wolf Trap Alternate Open Water Placement Northern Expansion*

The expanded Wolf Trap Alternate Open Water Placement site is immediately adjacent to the north of the existing Wolf Trap Alternate Open Water Placement site in the Virginia waters of the Chesapeake Bay, east of Matthews County, VA as shown in Figure 3-19. (Map #31). The site is in the Lower Bay region and was provided as a suggested alternate disposal site for investigation by VIMS. If found to be a feasible disposal site, it is estimated that the site has sufficient capacity for the dredged material that is projected to be removed from the York Spit Channel during the 20-year planning period.

With a similar 1.0 nm width of the current Wolf Trap site and encompassing the entire deep water area (about 4.25 nm north to south), the site is approximately 3,500 acres. Based on bathymetric surveys conducted by Baltimore District Navigation Division in April, July, and August 2017 and processed in late September 2017, the average water depth in this northern area is about 39 feet MLLW. The in-place volume of the site was calculated to be over 30 mcy, using an allowable water depth of 30 ft (9.1 m) which generally matches the bathymetry surrounding the site and would allow placement to surrounding depths.

Use of this site will require studies of its suitability for material disposal including an archaeological survey and biological surveys of the benthic environment. This new site will need to be approved by resource and regulatory agencies. A funding source for these investigations has not been identified at this time.

For this alternative, it is assumed material would be dredged from the York Spit channel with a hopper dredge. Material would be transported to the expanded portion of the Wolf Trap Alternate Open Water site where it would be released from the hopper. The transport distance from the center of the York Spit Channel to the placement site is 15 nm.

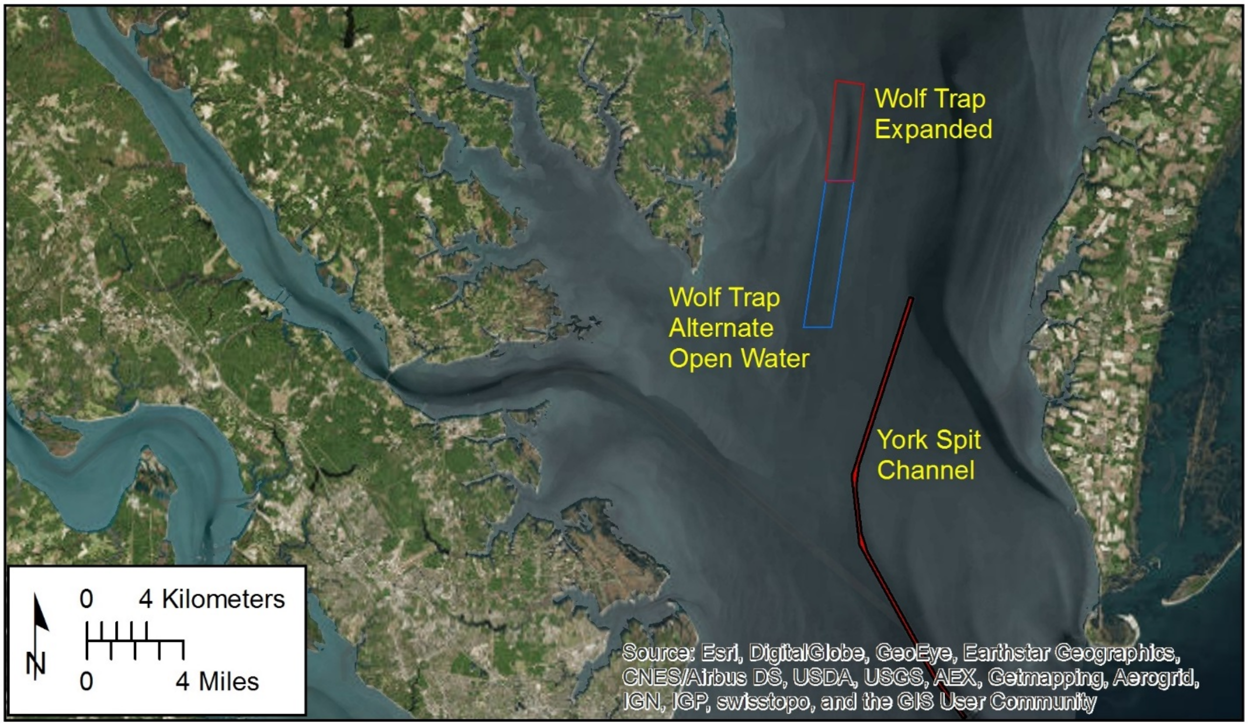

Figure 3-19. Dredged material placement alternatives, Wolf Trap Alternate Open Water Placement Northern Expansion (corresponding Map #31 in Table 3-2)

3.2.3 Innovative Uses

3.2.3.1 *Agricultural Placement*

Agricultural placement is the application of dredged materials to agricultural (farm) land for the purpose of sediment management and rehabilitation or improvement of the land. Wet placement is a method in which fine-grained dredged sediments are applied directly onto the agricultural land application site to amend excessively drained cropland, thereby improving water retention and crop yield. Wet placement does not require prior dewatering of dredged material before application. Instead, material is dredged and placed in a barge that is towed as close as possible to the agricultural land application site. A temporary dike is constructed around the site and a hydraulic unloader pumps the material into the confined area using adjacent water. Following dewatering and consolidation, the dredged material is tilled into the existing soil.

Agricultural placement is evaluated as a beneficial use alternative for the Middle Bay region of the DMMP. Design assumptions associated with this alternative for each region are detailed in the following paragraphs.

The representative area for agricultural placement within the Middle Bay region is in Kent County, Maryland, between Rock Hall and Worton (Figure 3-20; Map #1). The site is considered a placement alternative for the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD).

The agricultural placement alternative for the DMMP is in Kent County, Maryland, and involves the application of dredged material across 233 acres of land. The application would consist of two 16-inch lifts across three approximately 80-acre sites over a period of 3 years. The material will be dewatered in place, and then tilled into the soil with any necessary amendments. Over the 3 year period, material will be placed on each 80-acre site during years 1 and 3 (250,000 cy per year).

Temporary erosion, sediment, and stormwater controls are needed until dredged material is tilled into the soil. Controls would include the installation of temporary containment dikes as well as interior dikes to sub-divide the site into 10-acre cells. The exterior dikes will be 3 feet high, with 3:1 side slopes and a 1 foot crest width, and the total volume of exterior dike material is 7480 cy per site. The interior dikes will be 2.5 feet high, with 3:1 side slopes and a 1 foot crest width, and the total volume of interior dikes will be 2040 cy per site. Two total placements of approximately 233 acres of treated area equates to approximately 0.5 mcy cut volume from the channels.

For this alternative, it is assumed suitable material would be mechanically dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) by a clamshell dredge. Dredged material would be placed into an adjacent barge and transported to a moored barge close to the application site. The moored barge would be used to stage the material during the relatively slow agricultural placement operation rather than tying up the transport barges waiting for offloading. The moored barge could be moved into and out of place at high tide, allowing it to be moored in relatively shallow water. Material would be transferred hydraulically from the transport barge into the moored barge. Dredged material would then be hydraulically pumped via pipeline from the moored barge onto the agricultural placement site. The length of the pipeline would be adjusted as needed in order to place material evenly within each cell. It is assumed that the typical distance from the unloader to the placement site will be approximately 5 miles. Transport distances from the center of the respective channels to the unloader near the placement site are as follows: C&D Canal Approach Channels, 10 nm; and Chesapeake Bay Approach Channels (MD), 10 nm.

Figure 3-20. Dredged material placement alternatives, Upper-Bay agricultural placement, artificial island and shoreline restoration area map (corresponding Map #'s 1, 2, and 24 in Table 3-2)

3.2.3.2 *Building Products*

Technologies have been developed over the years to use dredged material to manufacture construction products, although full-scale commercial production is not yet available for most products. Depending on the sediment characteristics and processing requirements, dewatered dredged material may be used in the following applications: concrete aggregates (sand or gravel); backfill material or in the production of bituminous mixtures and mortar (sand); raw material for brick manufacturing (clay with less than 30 percent sand); ceramics, such as tile (clay); pellets for insulation or lightweight backfill or aggregate (clay); and raw material for the production of riprap or blocks for the protection of dikes and slopes against erosion (rock).

Dredged material may also be used as construction fill for site grading and structural fill. Techniques may be used to improve the structural properties of dredged material for use as construction fill, such as amendments to reduce the moisture content and improve the strength of the material. Amendments can include lime, cement, and fly ash. The type, combination, and amount of amendment material depends on the moisture content, the amount of fines (clays and silts), and organic content of the dredged material. Greater amounts of amendment are typically required if the dredged material has a high water clay and/or organic content. The amount and type of amendment would also be dictated by the required physical properties of the finished product.

Beneficial use of dredged material in building products, specifically the Harbor Rock concept of using dredged material to create lightweight aggregate (LWA), is the representative process for the DMMP. This process is evaluated as an alternative for material dredged from the Harbor Channels and C&D Canal Approach Channels. Design assumptions associated with this alternative are detailed in the following paragraphs.

Harbor Rock lightweight aggregate can be used in commercial construction applications. This beneficial use alternative begins with the excavation of dewatered dredged material from an existing CDF, which would in turn provide additional capacity for projected maintenance dredging. An existing CDF has been designated for each area channel as follows: Harbor Channels-Cox Creek CDF (Figure 3-4; Map #3); C&D Canal Approach Channels-Pearce Creek CDF (Figure 3-5; Map #3). It is assumed that the Harbor Rock processing facility is setup within 3 miles of the CDF and that the dredged material is trucked from the CDF to the Harbor Rock Processing facility. Based on information generated through a pilot project at the Cox Creek DMCF, the estimated cost for processing dredged material to lightweight aggregate is approximately 30 dollars per ton. Note that the profits from the sale of the LWA have already been bundled into this 30 dollars per ton processing cost. It is assumed that the dredged material contains approximately 0.25 tons per cy. It was also assumed that the total amount of dredged material to be used is 0.5 mcy, to be processed in one year.

For this alternative, dewatered dredged material would be excavated from each channel's respective CDF for use in lightweight aggregate production. The excavated material would provide 0.5 mcy of additional total storage at an existing CDF. It is assumed suitable material would be mechanically dredged from the Harbor Channels, or C&D Canal Approach Channels, by a clamshell dredge. Material would be placed within a barge and transported to the respective CDF where it would be pumped within the CDF by a hydraulic unloader. Transport distances from the center of the respective channels to the existing CDF are as follows: Harbor Channels, 3 nm; C&D Canal Approach Channels, 6 nm.

3.2.3.3 *Capping – Landfills and Brownfields*

Capping is a relatively new beneficial use concept and consists of the covering of solid waste landfills or abandoned contaminated industrial sites, known as "brownfields," with large quantities of dewatered dredged material. Dredged material often possesses important cover material characteristics such as workability, moderate cohesion, and low permeability. In addition, all forms of dredged material from silts to gravel make excellent cover, with the exception of peat and highly organic material. Although fine-grained sediments do not have the physical properties needed for a final cap that requires high strength and stability, the material can be amended so that it is a suitable foundation for many types of redevelopment, such as parks, golf courses, parking lots, or light industrial use. Amendments would be similar to those discussed in Section 3.2.3.2, Building Products.

Beneficial use of dredged material in landfill or brownfield capping is evaluated as an alternative for suitable material dredged from the Harbor Channels and C&D Canal Approach Channels. Design assumptions associated with this alternative are detailed in the following paragraphs.

This beneficial use alternative begins with the excavation of dewatered dredged material from an existing CDF, which would in turn provide additional capacity for projected dredging. The capacity would be filled by other suitable material. An existing CDF has been designated for each channel area as follows: Harbor Approach Channels - Cox Creek CDF; C&D Canal Approach Channels - Pearce Creek CDF (Map #5 & 6). It is assumed for the purpose of this cost estimate that the landfill or brownfield facility is located approximately 30 miles from the respective CDF.

It is further assumed that the dewatered dredged material would require blending with sandy material to improve structural properties for use as a final cap. Specifically, for use as a landfill cap, a mixture of 75 percent dewatered dredged material and 25 percent sand would be blended in place with a tiller. For use as a brownfield cap, a mixture of 50 percent dewatered dredged material and 50 percent sand would be blended using a pug mill operation prior to placement.

Both the landfill and the brownfield capping alternatives result in 0.5 mcy (per channel) of dredged material capacity over the life of the project.

Since this alternative utilizes dewatered dredged material, it is estimated approximately 0.35 mcy of material would be excavated from each channel's respective CDF for use as final cover at a landfill or brownfield site. The excavated material would provide 0.5 mcy of additional storage at each existing CDF. It is further assumed that this alternative will result in an annual available capacity of 100,000 cy due to the removal of dewatered dredged material from each CDF.

Material would be mechanically dredged from the Harbor Channels or C&D Canal Approach Channels, by a clamshell dredge. Material would be placed within a barge and transported to the respective CDF where it would be pumped into the CDF using a hydraulic unloader. Transport distances from the center of the respective channels to the existing CDF are as follows: Harbor Channels, 3 nm; C&D Canal Approach Channels, 6 nm.

3.2.3.4 *Mine Placement*

Mine reclamation is the use of clean, dewatered dredged material to reclaim land that has been damaged by surface mining or used to fill subsurface mines. For evaluation under the DMMP, mine reclamation is defined as large-scale use of dredged material to either fill deep-depth mines or use as surface cover, either alone or blended with other materials. The history of mining in the Appalachian region presents opportunities for beneficial use of dredged material through mine reclamation; however, potential sites are a considerable distance from the Bay.

The representative area for mine placement is a 300 acre site located in western Maryland (Figure 3-3; Map #16). Beneficial use of dredged material for mine reclamation is evaluated as a placement alternative for material dredged from the Harbor Channels and C&D Canal Approach Channels. Design assumptions associated with this alternative are detailed in the following paragraphs.

This beneficial use alternative begins with the excavation of dewatered dredged material from an existing CDF, which would in turn provide additional capacity for projected maintenance dredging. The capacity would be filled by other suitable material. An existing CDF has been designated for each channel as follows: Harbor Channels - Cox Creek CDF; and C&D Canal Approach Channels - Pearce Creek CDF.

It is assumed for the purpose of this cost estimate that the mine placement site is located in western Maryland. Once transported to the mine site by truck, the dewatered dredged material would require blending with available coal fly ash (depending upon its characteristics) before placement and compaction. Specifically, a mechanical mixing operation (pug mill plant) would be used to create a mixture of 90 percent dewatered dredged material and 10 percent fly ash. Once the dredged material mixture is placed and compacted, the site is seeded, fertilized, and mulched.

For this alternative, it is assumed dewatered dredged material would be excavated from each channel's respective CDF and transported by truck to the abandoned mine. Transport by rail was not considered for transport from a CDF to Western Maryland mine sites because of expected costs associated with double handling of dredged material. From a Bay adjacent CDF, material would need to be excavated, loaded to a truck, which would then be loaded to a train car. We assume approximately 1.4 mcy of dewatered dredged material would be excavated from each CDF, opening up 2 mcy of additional capacity at each existing CDF over the course of 20 years. This capacity would be reused by placement of newly dredged materials, and we assume 100,000 cy per year for 20 years. The new material could be mechanically dredged from the Harbor Channels or C&D Canal Approach Channels by a clamshell dredge. Material would be placed within a barge and transported to the respective CDF where it would be pumped directly into the CDF using a hydraulic unloader. Transport distances from the respective channels to the existing CDF are as follows: Harbor Channels, 3 nm; and C&D Canal Approach Channels, 6 nm. Transport distances from the respective CDF to the mine site are as follows (in miles): Harbor Channels, 115 mi; and C&D Canal Approach Channels, 140 mi.

3.2.3.5 *Quarry Placement*

Quarry reclamation is the use of clean, dewatered dredged material to reclaim land that has been damaged by quarry excavation or used to fill abandoned quarries. For evaluation under the DMMP, quarry reclamation is defined as large-scale use of dredged material to either fill deep-depth quarries or use as surface cover, either alone or blended with other materials.

The representative area for quarry placement is in Cecil County, Maryland (Furnace Bay) (Figure 3-21; Map #21)). Beneficial use of dredged material for reclamation at an abandoned sand quarry is evaluated as a placement alternative for material dredged from the Harbor

Channels and C&D Canal Approach Channels. Design assumptions associated with this alternative are detailed in the following paragraphs.

This beneficial use alternative begins with the excavation of dewatered dredged material from an existing CDF, which would in turn provide additional capacity for projected maintenance dredging. An existing CDF has been designated for each channel as follows: Harbor Channels - Cox Creek CDF; and C&D Canal Approach Channels - Pearce Creek CDF. It is assumed for the purpose of this cost estimate that the quarry placement is located in Cecil County, on the Eastern Shore of Maryland (Furnace Bay). It is assumed that the quarry is below grade on all sides and that no additional containment berms are necessary. Once transported to the quarry site by truck, the dewatered dredged material would be unloaded, stockpiled for mixing and drying treatment, and then placed and compacted. It is further assumed that all dredged material will be mixed with 15 percent fly ash for drying except for the last five feet of fill material which would be blended with 50 percent sand to add structural strength for site redevelopment. This alternative uses approximately 7.5 mcy of dewatered dredged material over a period of 30 years.

For this alternative, dewatered dredged material would be excavated from each channel's respective CDF and transported by truck to the abandoned mine. Transport by barge was not considered for transport from a CDF to a quarry because of expected costs associated with double handling of dredged material. From a Bay adjacent CDF, material would need to be excavated and loaded to a barge. The barge would then need to be unloaded onto a truck and transported to a quarry. No quarries are currently available or would be available in the foreseeable future with marine access. The excavated material would provide approximately 10.7 mcy of additional storage (cut volume) amongst the existing CDFs over the 30 year period. Material would be mechanically dredged from the Harbor Channels and C&D Canal Approach Channels by a clamshell dredge. Material would be placed within a barge and transported to the respective CDF where it would be pumped directly into the CDF using a hydraulic unloader. Transport distances from the respective channels to the existing CDF are as follows: Harbor Channels, 3 nm; and C&D Canal Approach Channels, 6 nm. Transport distances from the respective CDF to the quarry site are as follows: Harbor Channels, 40 mi; and C&D Canal Approach Channels, 23 mi.

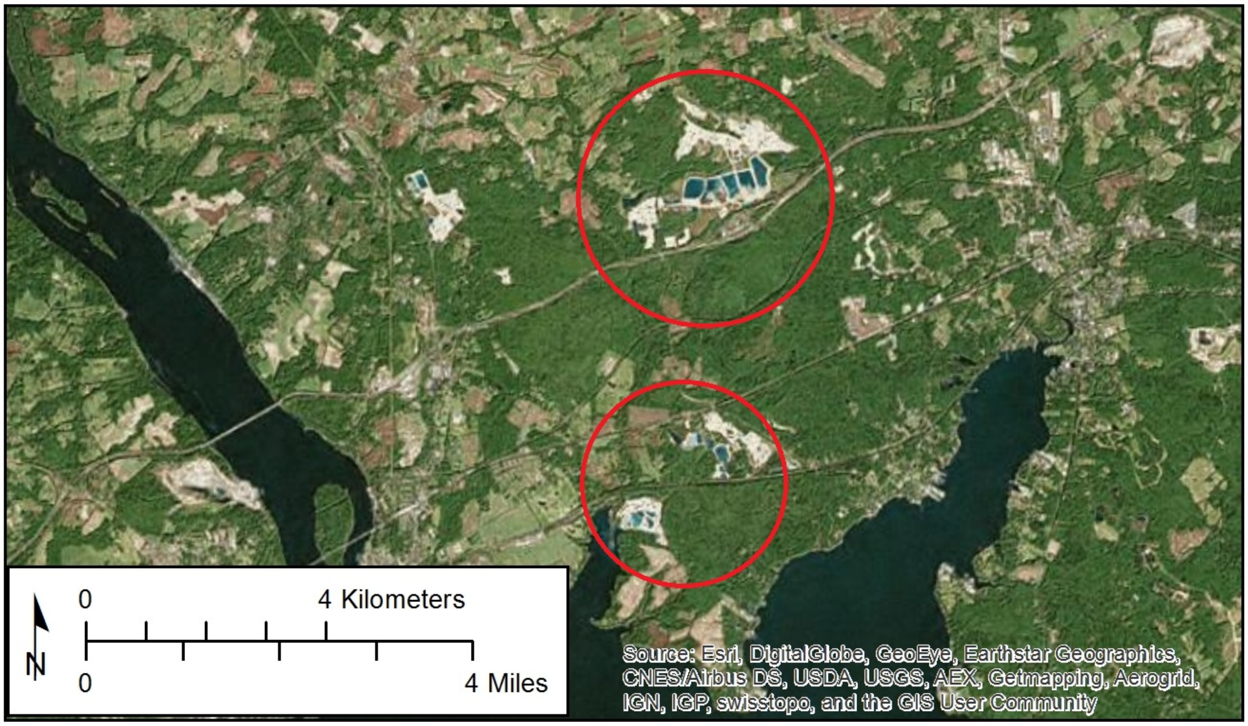

Figure 3-21. Dredged material placement alternatives, Upper-Bay quarry placement, Cecil County, MD (corresponding Map #21 in Table 3-2)

3.2.3.6 *Wetland Restoration*

Wetlands restoration is the use of dredged material to reclaim wetlands that have already been lost to open water as a result of erosion, subsidence, sea-level rise, and other factors. Dredged material is placed at depths of 2 to 5 feet in open water depressions that were once wetlands. These areas are usually surrounded by wetlands that are at risk of being lost because of subsidence and the erosive effects of currents and wave energy within these open water depressions. Research also suggests that introducing iron-rich dredged material from the upper part of the bay to these open water depressions, by buffering sulfide production, would significantly improve water quality and fish habitat in these depressions during wetland reclamation.

The amount and distribution of dredged material on wetlands is site-specific, and factors influencing its use include wetland proximity to dredging operations, physical and chemical nature of sediments, and volume of sediments. Actual application depths differ from one wetland to another, but it must be thick enough to raise the wetland elevation to the desired wetland type and allow natural revegetation. Multiple lifts over a long period of time may be required to prevent sea level rise from converting the wetland area back to open water.

The representative area for wetland restoration is the Blackwater National Wildlife Refuge (Refuge) in Dorchester County, Maryland, as shown in Figure 3-22 (Map #29). The Refuge is located along the eastern shore of Maryland, approximately 55 miles south of Baltimore and directly south of the Choptank River. Beneficial use of dredged material for wetland restoration at the Refuge is evaluated as a placement alternative for the C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD). Design assumptions associated with this alternative are detailed in the following paragraphs.

Historically, the marshes at Blackwater NWR have suffered severe damage by nutria, erosion along its shoreline, and loss due to sea-level rise and subsidence. Similarly, direct and indirect human impact such as marsh burning, road construction, and wildlife management practices have accelerated marsh loss. The alternative consists of the placement of 2 foot lifts of dredged material over 1,000 acres of degraded wetlands at the Refuge. The total containment volume to be filled with dredged material is approximately 6.5 mcy and would require approximately 9.2 mcy of dredged material assuming a consolidation factor of 0.7 and would result in a consolidated dredged material layer approximately 4 feet in thickness. Placement would be accomplished over a period of approximately 9 years with the placement of approximately 1/3 of the total volume of material during 3 events occurring at 3-year intervals to allow for consolidation of each lift before placement of the subsequent lift.

For this alternative, it is assumed material would be mechanically dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) by a clamshell dredge and placed into a barge. The barge would travel to an offshore location close to the Refuge and be moored to a buoy. Temporary containment, such as an earthen berm or sand-filled geotextile tubes, would be constructed around the area of application. Material to construct containment features would be transported to the site from nearby sand borrow sources estimated to be available within 5 miles of the placement site. Material would be pumped from the barge using a hydraulic unloader through a network of pipelines, using booster pumps as required. It is estimated that the pumping distance from the dredged material barge to the placement site would be approximately 10 miles. A shallow-barge or other floating platform would move the inflow pipe along the edge of the application area during the process. Transport distances from the center of the respective channels to the unloader location are as follows: C&D Canal Approach Channels, 65 nm; and Chesapeake Bay Approach Channels (MD), 45 nm.

Figure 3-22. Dredged material placement alternatives, wetland restoration, Dorchester County (corresponding Map #29 in Table 3-2)

3.3 SCREENING PROCESS

3.3.1 Methodology

Fifty-nine dredged material placement alternatives were investigated for dredged material from the Chesapeake Bay Approach Channels (MD), C&D Canal Approach Channels, and Harbor Channels (Table 3-1). In order to determine the most feasible means to manage 20 years of dredged material, the alternatives must be compared. In the development of the 2005 DMMP three quantitative criteria and two qualitative criteria were developed. These criteria were also used for comparison in this update.

The quantitative criteria include environmental impact, capacity, and cost. Environmental impact is described in terms of a habitat index and reflects the net amount and quality of habitat that would be created by an alternative. Capacity is the amount of dredged material that a particular alternative would accommodate during its facility life and is measured in terms of cy. Cost is the total cost, in dollars, and cubic yard cost, in dollars/cy, of an alternative. Cost includes initial study; permitting and design; site development and closeout; dredging, transport, and placement; habitat development; and operation and maintenance.

The qualitative criteria used to compare alternatives are technical/logistical risk and acceptability risk. Technical/logistical risk is defined as the likelihood that an alternative would not provide the expected capacity or environmental benefit during the 20-year planning window of the DMMP due to implementation factors. Acceptability risk is defined as the likelihood that an alternative would be significantly delayed or would not proceed because of prohibition by law or by significant regulatory or public opposition. Both technical/logistical risk and acceptability risk are measured on a relative scale of 1 (low risk) to 5 (high risk).

The following sections provide further detail about the quantitative and qualitative criteria and the comparison of alternatives.

3.3.2 Environmental Impact Evaluation

USACE Guidance

Many of the dredged material placement alternatives under consideration are expected to generate environmental benefits. Levels and types of environmental benefits vary significantly from one alternative to another, and, like most environmental benefits, cannot be compared using dollar-based measures of value.

In situations where dollar measures of value cannot be used to compare the benefits of environmental projects, USACE guidance compels comparing expected environmental outcomes using biophysical indicators of environmental gains and losses (for example, habitat acres created multiplied by habitat suitability units per acre). Because of the challenge of dealing with non-monetized benefits, the concept of significance of outputs plays an important role in ecosystem restoration evaluation. Along with information from cost effectiveness and incremental cost analyses, and information about risks and acceptability, information about the significance of ecosystem outputs that would be generated by various projects helps to determine which projects should be recommended. The significance of project outputs should be reflected in various measures of institutional, public, and/or technical importance. As a practical matter, unless specific estimates of the market or nonmarket values associated with an output are available, this means that some stakeholder group, law, policy, regulation, or scientific finding indicates that a particular resource or output is important.

Environmental Benefit Indicators

The 2005 DMMP compared 28 different types of environmental indicator systems for use in comparing the environmental benefits of material placement alternatives. None of the systems were suitable for comparing alternatives with different environmental goals or for use in a programmatic context where general types of alternatives are compared without reference to specific sites. However, the State of Maryland had developed a system to quantify differences in expected environmental benefits associated material disposal alternatives. This system was used in the 2005 DMMP, was used by the State of Maryland in evaluating alternatives for placement of Harbor material in 2011, and was used for this update.

Unexploded Ordnance and Hazardous, Toxic, and Radioactive Waste

As part of its mission, the military currently tests, and has historically tested, weapons in portions of the Chesapeake Bay near Aberdeen Proving Ground, at Bloodsworth Island (immediately north of Holland Island) in the central Bay (Navy firing/bombing range), and several other locations. This includes the firing of live rounds and stray shells are known to have landed outside the designated restricted areas. Several areas of the Bay (Figure 3-23) are believed to contain shells that did not explode during testing. The presence of or potential for unexploded ordinance (UXO) could significantly complicate the construction of a dredged material placement area. Also, any option that is known to have the potential for existing pollutants (HTRW) or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) liabilities would be a poor choice for a dredged material placement area if construction would potentially remobilize contaminants into the environment. With respect to UXO, there is no approved remediation policy. There is also no specific federal policy regarding the liability of potential responsible parties. These are institutional issues, which would need to be addressed in addition to the potential environmental and safety implications associated with UXO, and in relationship to technical difficulties associated with cleanup. These issues were examined and included in the "Bay Enhancement Working Group" (BEWG) indicators.

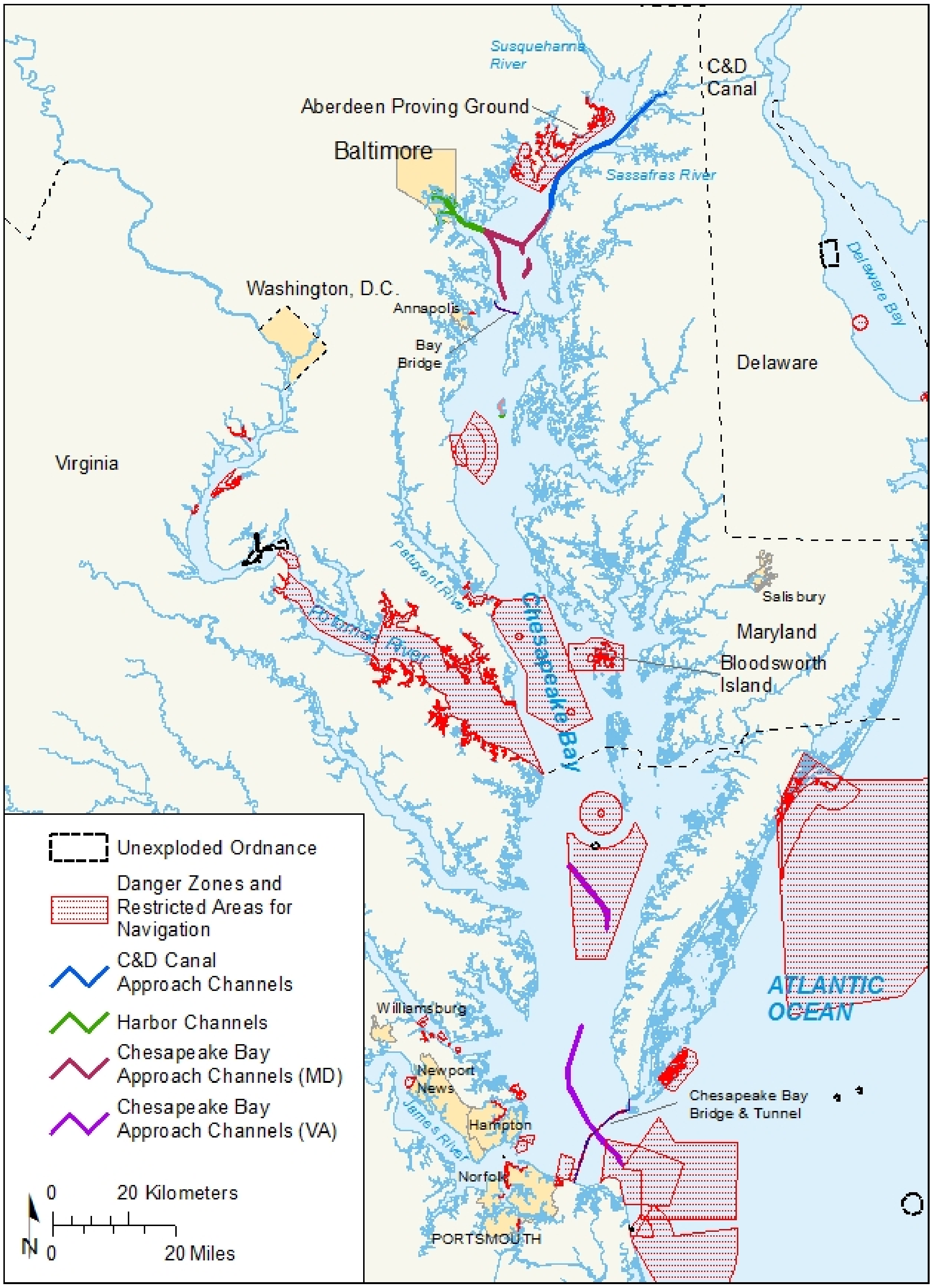

Figure 3-23. Areas of the Chesapeake Bay that may contain unexploded ordnance or are danger zones and restricted areas for navigation.

BEWG Indicators

The "Bay Enhancement Working Group" (BEWG), is a group consisting of environmental scientists from state and federal agencies and representatives of environmental and citizens groups who meet periodically as needed to assess and compare the environmental aspects of dredged material placement options (Table 3-3). During 2002 through 2004, the BEWG met nearly every month to assess and compare potential environmental benefits associated with the 27 dredged material placement alternatives being considered by the state.

Table 3-3. Agencies and organizations participating in the Bay Enhancement Working Group (BEWG)

US Army Corps of Engineers, Baltimore District
US Army Corps of Engineers, Philadelphia District
US Environmental Protection Agency, Region III
US Fish and Wildlife Service
NOAA National Marine Fisheries Service
NOAA Chesapeake Bay Office
Maryland Port Administration
Maryland Geological Survey
Maryland Department of Natural Resources
Maryland Department of the Environment
Maryland Environmental Service
Citizens' Advisory Committee
Chesapeake Bay Foundation

To facilitate these comparisons, the BEWG developed a set of 52 parameters related to the environmental suitability of proposed placement options. The parameters were divided into 10 categories based upon similar attributes, including water quality, wetlands, human use attributes, and others (Table 3-4). A brief description of each resource parameter is presented in Appendix B.1, Alternative Resource Scoring Indices. The BEWG then assigned each parameter a weighting factor based upon the consensus of the group. Next, each parameter was assigned a raw score of +1, -1, or 0 for each alternative under consideration based upon existing data and historical information, as well as the collective experience and knowledge of the BEWG and the technical study team. A "+1" was assigned to a given parameter if the option is expected to protect or enhance *existing* resources of that type in or immediately adjacent to the option footprint. A "–1" was assigned if the resource is present and long-term negative impacts (or further degradation) are expected as a result of option development. A "0" was assigned when no negative impacts are expected to existing resources at or immediately adjacent to an option. It was also used in cases where there was not enough conclusive evidence to make a definitive evaluation, or evidence was ambiguous. Additional caveats were made to some scores as described in Appendix B.2, Environmental Parameters to be Considered for the Site Ranking. Appendix B provides a full description of the BEWG process, the BEWG environmental indicator system, and the alternative assumptions. To generate environmental benefits, for the purpose of the federal DMMP, an alternative must create, restore, or enhance some type of habitat. Four BEWG categories inconsistent with USACE policy were removed for evaluation of federal placement sites and BEWG scores recalculated: Infrastructure, Existing Land Use, Commercial Socioeconomics, and Community Socioeconomics.

Table 3-4. BEWG categories and parameters used in the DMMP evaluation

Category	Parameter	Weight
Water Quality	Dissolved Oxygen	3
	Nutrient Enrichment	3
	Turbidity	3
	Salinity	4
	Ground Water	5
Aquatic Habitat	Shallow Water Habitat (Tier II & Tier III)	4
	SAV	5
Wetlands	Tidal Wetlands	5
	Nontidal Wetlands	5
Aquatic Biology – Finfish/Shellfish	Benthic Community	3
	Finfish Spawning Habitat	4
	Finfish Rearing Habitat	4
	Larval Transport	6
	Habitat of Particular Concern	5
	Essential Fish Habitat	3
	Commercially Harvested Species and Habitat	4
	Thermal Refuge	4
	Recreational Fishery	4
Special	Protected Species (RTE) (SSPRA)	5
Waterbirds	Waterfowl Use	4
	Wading and Shorebird Use	4
Terrestrial	Wildlife Habitat	2
	Forests	3
	Streams	4
	Lakes & Ponds	2
	Other Natural Avian Habitat	2
	Prime or Unique Agricultural Land	3
Physical Parameters	Substrate/Soil Characteristics	3
	Hydro-dynamics effects	4
	Toxic Contaminants	4
	CERCLA/UXO Potential	5
	Fossil Shell Mining	3
	Floodplains	2

Table 3-4 cont. BEWG categories and parameters used in the DMMP evaluation

Category	Parameter	Weight
Human Use Attributes	Recreational Value	2
	Aesthetics	2
	Noise	2
	Cultural Resources	3
	Air Quality	3
	Infrastructure	3
	Existing Land Use	3
	Environmental Justice	4
	Public Health	5
	Public Safety	5
	Navigation	3
Beneficial Attributes	Beneficial Use Wetlands	4
	Beneficial Use Uplands	2
	Beneficial Use - Adjacent Habitat Enhancement	2
	Beneficial Use - Faunal	2
	Beneficial Use - Recreational Enhancement	2
	Shoreline Protection	2

Score alternatives

In 2004, the placement alternatives and federal standards identified during the federal DMMP process were presented to BEWG and those alternatives scored. For alternatives that had previously been scored by BEWG during the state DMMP process, scores were slightly adjusted where needed, otherwise the scores were accepted. Similarly, BEWG was presented with updated and new alternatives in September 2013 as part of the DMMP Update process. These updated and new alternatives were scored using the same criteria as had been used in the 2005 DMMP. The scores for alternatives that did not see substantial changes remained unchanged from 2005.

Scale to eliminate negative scores

Many of the alternatives are expected to generate positive environmental benefits. Because of how BEWG indicators were developed and weighted however, the cumulative BEWG score for over half of the alternatives being considered were negative. For purposes of comparing the relative environmental rankings of alternatives, the absolute values of overall BEWG scores and whether they were positive or negative were not important. However, having negative overall BEWG scores for many alternatives that are actually expected to result in positive net environmental benefits causes problems when these scores are used in any kind of quantitative analysis.

Therefore, the overall BEWG score for each alternative was scaled so that the least environmentally beneficial alternative received a score of zero and all other alternatives received positive scores. Adjusting BEWG scores in this way involved adding the value of the lowest negative score to the unadjusted BEWG score for all alternatives and has no effect on the relative environmental ranking of alternatives. The unadjusted (normalized BEWG scores) and adjusted (normalized +1.9091) BEWG scores for each of the federal DMMP alternatives are presented in Table 3-5. The methodology used to normalize and adjust the BEWG scores is presented in detail in Appendix B.

Account for project magnitude

BEWG's use of only +1, 0, or -1 for scoring each environmental parameter limited the ability to account for differences in the expected magnitudes of impacts in the scoring of alternatives. The use of dredged material to restore wetlands, for example, was assigned a –1, 0, or +1 for various indicator values without regard to whether the project design resulted in 100, 1,000, or 10,000 acres of restored wetlands. While the size of an alternative was usually expected to affect its environmental impacts, the limitation in the BEWG environmental scoring system meant that BEWG scores did not allow the magnitude of these expected impacts to be quantified. For example, the acreage of Small Island Restoration – Middle Bay was 100 acres and the acreage of Large Island Restoration – Middle Bay was 1,000 acres. Yet, both alternatives received the same +1 scores for Wildlife Habitat, and, based on BEWG indicators, would appear to generate the same environmental benefits, even though a Large Island Restoration would provide up to 10 times more wildlife habitat.

The BEWG scoring of specific size projects within a project type is not suitable for comparing projects of different sizes within that project type. Also, ignoring the magnitude of environmental outcomes biases results against highly favorable environmental restoration projects. An option that included 3,000 acres of wetland restoration, for example, could be expected to have costs approximately three times higher than an option that involved 1,000 acres of wetland restoration, but would receive the same environmental score. This would always make larger environmental restoration projects appear less cost-effective than smaller projects in terms of achieving environmental benefits, even though the opposite may be true.

Therefore, the BEWG scores for a particular alternative are multiplied by the acreage of habitat created by that alternative to generate an overall "habitat benefit index" that is proportional to the size of each project. Using this approach, those alternatives that do not create, restore, or enhance habitat (e.g., Agricultural Placement) do not create habitat benefits. Therefore, while these alternatives still retain their BEWG scores, these scores would be multiplied by zero acres of habitat created, resulting in an overall habitat benefit index of zero (see Table 3-5).

Table 3-5. BEWG scores, habitat created, and habitat benefit index for each alternative

Dredged Material Management Placement Alternative	Normalized BEWG Score	Normalized Score +1.9091	Acres Habitat Created	Habitat Benefit Index
Agricultural Placement- Maryland	0.3462	2.2553	0	0
Artificial Island Creation- Upper Bay	-0.9474	0.9617	1000	961.7
Building Products – Lightweight Aggregate	1.0909	3.0000	0	0
C&D Canal Pearce Creek Upland Sites Expansion	-0.3548	1.5543	0	0
Capping- Landfill	1.0435	2.9526	0	0
Capping- Brownfields	1.0435	2.9526	0	0
Confined Aquatic Disposal Pit (CAD) - Patapsco River, MD	0	1.9091	0	0
Coke Point - DMCF	-0.3429	1.5662	0	0
Courthouse Point Vertical Expansion	-0.35	1.5591	0	0
Cox Creek Vertical Expansion	-0.25	1.6591	0	0
Cox Creek Northward Lateral Expansion - Cristal Site	-0.1786	1.7305	0	0
Cox Creek Westward Lateral Expansion	-0.2963	1.6128	0	0
Cox Creek Combined Expansion[1]	-0.2963	1.6128	0	0
Dam Neck Ocean Open Water	0	1.909	0	0
Large Island Restoration- Mid Bay	0.3788	2.2879	2144	4905.25
Mine Placement - Western Maryland	1.5833	3.4924	300	1047.72
New Open Water (Deep Trough)	-0.8438	1.0653	0	0
Norfolk Ocean Open Water Placement	0	1.9091	0	0
Pooles Island Open Water Site Expansion	-1	0.9091	0	0
PIERP Expansion	-0.7143	1.1948	575	687.01
Quarry Placement - Cecil County, MD	1.2222	3.1313	0	0
Rappahannock Shoal Alternate Open Water Site	-1.0341	0.875	0	0
Rappahannock Shoal Deep Alternate Open Water Site Expansion	-1.9091	0	0	0
Shoreline Restoration - Mid Bay	-0.3810	1.5281	175	267.418
Shoreline Restoration - Upper Bay	-0.0698	1.8393	110	202.323
Small Island Restoration- Mid Bay - Parsons Island	-0.2708	1.6383	500	819.15
Small Island Restoration – Mid Bay - Sharps Island	-0.5897	1.3194	500	659.7
Subaqueous Capping – Patapsco River, MD	0.7895	2.6986	0	0
Susquehanna Flats- Upper Bay Island Rest.	-0.22	1.6891	500	844.55
Wetland Restoration- Dorchester County, MD	1.7381	3.6472	1000	3718.6
Wolf Trap Alternate Open Water Placement	-1.2667	0.6424	0	0
Wolf Trap Alternate Open Water Placement Northern Expansion	NA	NA	0	0

[1] Lowest BEWG score of all Cox Creek Options

3.3.3 Capacity Evaluation

Site volumes and capacities were developed for each of the DMMP alternatives. A summary of site capacities is presented in Table 3-6. Site capacity was a criterion used in the evaluation of the DMMP alternatives in order to develop a suite of alternatives that would meet the 20-year capacity goal of the project.

Site volume and capacity are dependent upon the specific type of alternative, and the assumptions developed in their calculation are described in Section 3.2. Site capacity consists of the placement volume adjusted by a factor that accounts for the actual volume occupied by the dredged material after it reaches its final density. That adjustment factor is commonly referred to as the consolidation factor, or more accurately the volume-occupied ratio or VOR. For completely submerged sites, the final density of the dredged material after consolidation will be similar to the density of the maintenance dredged material in-situ in the channel and the consolidation factor will be close to 1. For sites where a portion of the confined dredged material is substantially above normal water levels, the effect of consolidation is significant and the consolidation factor is typically about 0.65 to 0.7. For each alternative, a conceptual engineering approach was developed using a site-specific estimate of the appropriate consolidation factor to account for the anticipated volume occupied.

Figure 3-24 demonstrates the relationship between the volume of material dredged (in-situ volume) and the impact of that volume on placement capacity. The figure points out several important concepts that are necessary to understand and account for when dealing with dredged material management. First, the capacity of the scows (that is, the barges that transport recently dredged material to the ultimate placement site) must be larger than the volume of material dredged. This is because the material bulks by approximately 50-percent during dredging as more water is introduced. The material is pumped from the scow to the placement site, or handling facility. This requires the further addition of water to the point where the slurry is only on the order of 10-percent solids. Some of this water is quickly removed as the material decants, but for the purposes of determining capacity needs the material volume is approximately double its in-situ volume. Over time, the material will consolidate and de-water. A properly managed site can actually consolidate the material such that it occupies even less volume than it did before dredging. This highlights how important it is to allow for optimum drying and consolidation before adding more material. If material is added too quickly, or if insufficient time is allowed for dewatering, then more capacity volume will be used in the site than the actual volume of dredging. This is referred to as over-loading and highlights the importance of proper scheduling to account for adequate de-watering. If placement sites that offer adequate capacity are not available in a timely fashion, the existing sites will be over-loaded and the ultimate potential capacity of those sites will be reduced. Experience shows that the material should be placed in a three-foot lift (based on in-situ volume) to facilitate dewatering and crust development and to optimize capacity. So, if 3 million cubic yards of material is being placed, it would require 3 million square yards of area, or approximately 620 acres. The existing Poplar Island placement site, which has been very well managed since it began to accept material, is experiencing consolidation of the material such that it ultimately occupies approximately 70-percent or less of its in-situ volume.

The consolidation factor applied by CENAB was alternative-specific. For alternatives involving placement of dredged material on land, such as CDFs or Artificial Islands, a total consolidation factor of 0.7 was generally used to account for gravity drainage from the material and natural compaction under the weight of the material. For alternatives with substantial or complete submergence of the confined dredged material where drainage and compaction forces would be lower a consolidation factor of 0.9 to 1.0 was used.

Table 3-6. Unit cost and capacity for DMMP Update alternatives

Dredged Material Management Placement Alternative	App. C Cost Estimate Page #'s	Harbor ($/cy)	C&D ($/cy)	MD Bay ($/cy)	VA Bay ($/cy)	Capacity (cy)
Agricultural Placement- Maryland	2-6		$ 165	$ 178		500,000
Artificial Island Creation- Upper Bay	7-14		$ 28	$ 25		29,300,000
Building Products – Lightweight Aggregate	15-17	$ 74	$ 76			500,000
C&D Canal Pearce Creek Upland Sites Expansion	18-21	$ 38	$ 28	$ 30		5,600,000
Capping- Landfill	22-24	$ 124	$ 125			500,000
Capping- Brownfields	25-27	$ 124	$ 126			500,000
Confined Aquatic Disposal Pit (CAD) - Patapsco River, MD	28-30	$ 19				3,200,000
Coke Point - DMCF	31-33	$ 29				17,900,000
Courthouse Point Vertical Expansion	34-39	$ 42	$ 31	$ 37		6,500,000
Cox Creek Vertical Expansion	42-45	$ 35				5,300,000
Cox Creek Northward Lateral Expansion - Cristal Site	46-48	$ 54				2,100,000
Cox Creek Westward Lateral Expansion	49-51	$ 67				1,600,000
Cox Creek Combined Expansion	52-55	$ 33				8,900,000
Dam Neck Ocean Open Water	*				$ 5.5	50,000,000
Large Island Restoration- Mid Bay	56-62		$ 37	$ 29		35,700,000 C&D/ 60,000,000 MD
Mine Placement - Western Maryland	65-69	$ 132	$ 133			2,000,000
New Open Water (Deep Trough)	70-72		$ 16	$ 10		24,000,000 C&D/ 40,000,000 MD

* Contract W91236-13-B-0009

Table 3-6 cont. Unit cost and capacity for DMMP Update alternatives

Dredged Material Management Placement Alternative	App. C Cost Estimate Page #'s	Harbor ($/cy)	C&D ($/cy)	MD Bay ($/cy)	VA Bay ($/cy)	Capacity (cy)
Norfolk Ocean Open Water Placement	73-75		$ 56	$ 49		24,000,000 C&D/ 40,000,000 MD
Pooles Island Open Water Site Expansion	76-78		$ 9	$ 8		5,000,000
PIERP Expansion	79-86		$ 31	$ 23		10,500,000 C&D/ 17,500,000 MD
Quarry Placement - Cecil County, MD	87-91	$ 110	$ 109			10,700,000
Rappahannock Shoal Alternate Open Water Site	*				$ 4	50,000,000
Rappahannock Shoal Deep Alternate Open Water Site Expansion	92-94		$ 37	$ 31		5,000,000
Shoreline Restoration - Mid Bay	95-102		$ 82	$ 71		2,300,000
Shoreline Restoration - Upper Bay	103-106		$ 71	$ 62		1,500,000
Small Island Restoration- Mid Bay - Parsons Island	107-110		$ 39	$ 33		12,700,000
Small Island Restoration – Mid Bay - Sharps Island	111-116		$ 39	$ 33		18,700,000
Subaqueous Capping – Patapsco River, MD	117-119		$ 34	$ 28		810,000
Susquehanna Flats- Upper Bay Island Restoration	120-128		$ 32	$ 39		6,700,000
Wetland Restoration- Dorchester County, MD	129-132		$ 98	$ 91		9,200,000
Wolf Trap Alternate Open Water Placement	133-135		$ 39	$ 36	$ 7	24,000,000 C&D/ 20,000,000 MD
Wolf Trap Alternate Open Water Placement Northern Expansion	136-137				$ 18	31,500,000

* Contract W91236-13-B-0009

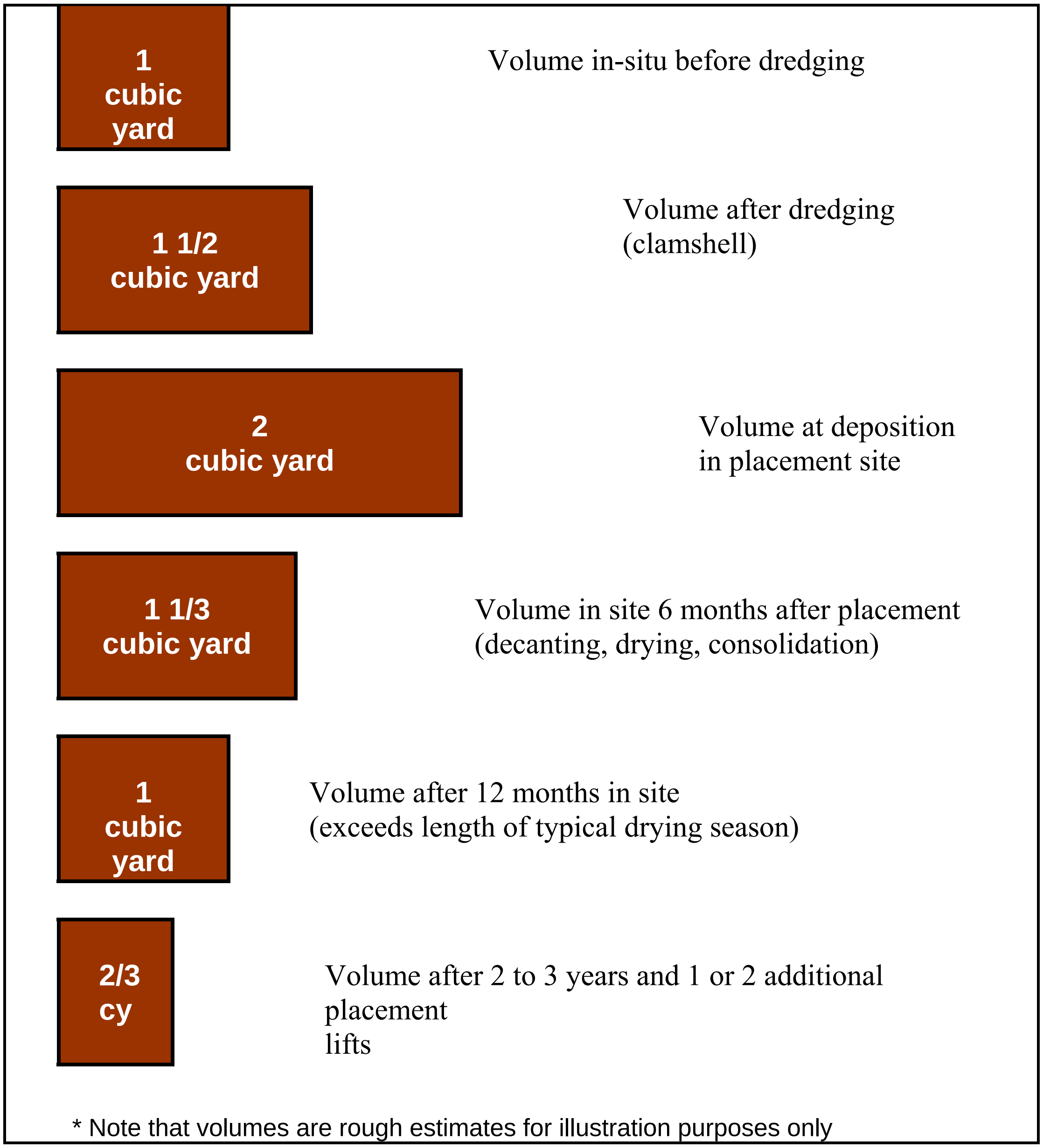

Figure 3-24. Material volume during dredging and placement

3.3.4 Cost Evaluation

Detailed cost estimates were developed for each of the DMMP alternatives. A summary of the cost/cubic yard for each alternative is presented in Table 3-6. Alternative cost was a criterion used in the evaluation of the DMMP alternatives in order to develop a suite of alternatives that would meet the 20-year capacity goal of the project.

Cost estimates were originally derived for the 2005 DMMP. Those estimates were reevaluated, assumptions and engineering updated where appropriate, and updated costs generated. Cost estimates were calculated on an alternative-specific basis using the detailed engineering assumptions described in Section 3.2. Concept-level cost spreadsheets for each alternative and its respective channel(s) are located in Appendix C (page numbers are listed in Table 3-6). Each spreadsheet provides a comprehensive overview of factors affecting project cost, including assumptions/basis for estimate, project capacity and site volume, operating life, and average one-way haul distance for dredged material.

Individual cost components of the estimate include, where applicable, initial costs (preliminary study and design, permitting), site development costs (mobilization/demobilization, containment dike construction), dredging costs (mobilization/demobilization, dredging, transportation, placement), habitat development costs (planning and design, grading, planting), and O&M costs (O&M monitoring and reporting, dredged material management). The individual contingency factors reflect the relative uncertainty in the application of each alternative, which affects the uncertainty in the resulting cost estimate. For example, well-proven and conventional placement alternatives such as open water placement have relatively little uncertainty in their implementation as well as a reasonable body of actual data cost. Therefore, the uncertainty associated with their relative cost is low (20 percent). For innovative approaches that may not have yet been implemented at field scale, there is significantly more uncertainty in their methods, production rates, etc., and relatively little reliable cost data for individual operations, resulting in a high uncertainty (e.g., 50 percent) for their overall cost. Contingency factors for each alternative take into consideration unknowns, such as engineering and constructability issues. A contingency factor was developed by experienced CENAB engineering personnel for each alternative, and is included on individual spreadsheets in Appendix C. Contingency factors were originally developed for the 2005 DMMP and were unchanged unless experience or conditions have demonstrated the need for change. The contingency factors were applied to the subtotal cost to calculate the total project cost. The unit cost ($/cy) for each alternative was determined by dividing the total project cost by the site capacity.

3.3.5 Technical and Logistical Risk Evaluation

The BEWG indicators of environmental benefits are "outcome-based"; they reflect BEWG's assessment of the environmental benefits that would accrue if environmentally beneficial projects could be designed and carried out successfully and performed as intended. BEWG did not address technical and logistical questions about the "implementability" of various beneficial use options, made no judgments about whether the environmental benefits associated with one alternative are more or less likely to be realized than those associated with another alternative, and did not weight indicators of environmental benefit on the basis of expected (risk-adjusted) environmental outcomes.

Alternatives need to be compared based on realistic expectations about environmental benefits, and this required that differences in risks associated with the "implementability" of alternatives be taken into account. Large island restoration with wetlands, for example, is an alternative that has been undertaken successfully in the Bay, while the use of dredged material in near-shore large-scale wetland restoration in the Bay is relatively rare and poses significant logistical and engineering challenges.

The evaluation of technical and logistical risk utilized the same parameters as the 2005 DMMP. A joint state/federal team of dredged material placement experts met in 2004 to review the logistical and technical factors that affect the likelihood that each alternative would perform as expected, in terms of placement capacity and/or environmental benefits. For this DMMP Update, technical members of the project delivery team reviewed and adjusted the rankings of risk several alternatives based on increased engineering expertise and project experience at current material placement facilities.

Alternatives were ranked on a scale of 1 (low risk) to 5 (high risk) on the basis of the stage of development of the underlying material placement and site development technology using the following criteria:

1. Alternative is routine and/or cost-effective (e.g., beach nourishment).
2. Alternative requires development of specialized techniques and material.
3. Alternative requires standardization of methods.
4. Alternative is in the initial implementation stage (e.g., building products).
5. Alternative is in the basic science, engineering, and experimentation stage.

Alternatives being routinely carried out in this region or elsewhere were considered low risk and assigned a 1. Alternatives that have barely passed the proof of concept stage or are only in the initial stages of experimentation were considered high risk and were assigned a 4 or 5 (Table 3-7). In the 2005 DMMP alternatives with a technical/logistical risk ranking of 4 or 5 were considered too risky to be implementable within the 20-year planning horizon being used for this DMMP. This consideration was also used in this update. Therefore, these alternatives were screened out before suites of alternatives (combinations of alternatives that meet the 20-year-minimum dredged material placement need) were developed for further analyses.

Alternatives that were eliminated based on technical/logistical risk included Agricultural Placement, Mine Placement in western Maryland, and Wetland Restoration in Dorchester County, MD. With technological advances, some of these alternatives may become less risky in the future, and therefore may be reconsidered and included in suites that would be evaluated as part of a future DMMP review. Building Products was an alternative screened out in 2005, but it has been shown at a small scale to be a feasible alternative through a pilot demonstration project at the Cox Creek DMCF. Therefore, its technical/logistical risk score was lowered and it was included in alternative suite development. The technical/logistical risk score increased for Wetland Restoration in Dorchester County, MD from 2005 to 2014. This was due to the reevaluation of the alternative and the physical characteristics of the area. This alternative was not included in alternative suite development in the DMMP Update.

3.3.6 Acceptability Risk Evaluation

The implementation risks associated with some alternatives involves primarily technical and logistical factors described above, but the implementation risks associated with other alternatives involve primarily legal and political constraints. For example, Maryland law prohibits the placement of dredged material in an unconfined manner in the Chesapeake Bay and its tributaries. This constitutes a state ban on some alternatives, including New Open Water (Deep Trough) and Pooles Island Site Expansion. Another alternative, Artificial Island Creation – Upper Bay, faces significant public opposition that may be reflected in legal and political challenges that could prohibit or significantly delay implementation.

Acceptability risk, which is the likelihood that legal and political challenges would adversely affect project implementation, may appear to be considered more manageable and less important than technical and logistical risks, which are the likelihood that physical constraints would inhibit a project. However, laws and public opinion can be much slower to change than technology, and within the context of a DMMP that covers at least 20 years, acceptability risk may be more of an impediment than technical and logistical risk. For example, the number of years required to overcome engineering and logistical challenges and reduce the technological risks associated with innovative wetland restoration projects could be much fewer than the number of years required to reevaluate open water placement and receive agency concurrence as well as change the Maryland state law banning open water placement of dredged materials.

The acceptability risk assigned to alternatives in the 2005 DMMP was reviewed and updated by USACE, as appropriate, and a risk score was assigned to new alternatives, based on scores for similar alternatives and the constraints of law and public opinion. Acceptability was scored using the following criteria:

1. No law to prohibit alternative/minor public or regulatory issues.
2. No law to prohibit alternative/moderate public or regulatory issues.
3. No law to prohibit alternative/significant public or regulatory issues.
4. Law prohibiting alternative/minor public or regulatory issues.
5. Law prohibiting alternative/significant public or regulatory issues.

Alternatives that were contrary to law or faced significant public opposition (scored 3, 4, or 5) were not included in final suites of alternatives considered to meet 20-year placement needs. This screening was also used in this DMMP update (Table 3-7). These alternatives were, however, used to generate alternatives to determine the federal standard for material placement as these alternatives may be the least cost environmentally acceptable alternative.

Acceptability scores changed for several alternatives due to shifts in public opinion and ongoing outreach to local communities by the Maryland Port Administration. CAD-Patapsco River was eliminated from consideration in the 2005 DMMP, but public opposition to this alternative is likely less today. MPA is currently pursuing a pilot CAD placement cell with minimal regulatory or public opposition. Cox Creek expansion was eliminated from consideration in the 2005 DMMP, but public opposition to this alternative is likely less today due to extensive and ongoing public outreach by MPA.

Alternatives that were eliminated based on acceptability risk included Artificial Island Creation, Mine Placement – Cecil County & Western Maryland, Pooles Island Open Water Site

Expansion, and New Open Water (Deep Trough). Susquehanna Flats was an alternative introduced with this DMMP update but received a score of three and was not included in suites of alternatives.

Table 3-7. Qualitative risk rankings: technical/logistical and acceptability

Dredged Material Management Placement Alternative	**Technical/Logistical Risk**		**Acceptability Risk**	
Agricultural Placement- Maryland	4	Studies have been done in this and other areas; specific constraints of project (size of farm field, type of soils, distance from barge to field) make it challenging	2	Likely regulatory issues with groundwater, putting salt on land; may be difficulties with public opposition at the site.
Artificial Island Creation- Upper Bay	2	Would be similar to PIERP, so many techniques now standard; development of wetlands and habitat still being worked out, so not yet into routine applications	3	No law against it, but significant public opposition exists. NMFS also opposes the creation of islands.
Building Products – Lightweight Aggregate	3	Several successful pilot projects completed; however, the interest in lightweight aggregate and the logistics of large-scale manufacture are highly uncertain	2	Could inundate associated industries; potential regulatory issues with emissions and outflow, although assumed to convey to manufacturer.
C&D Canal Pearce Creek Upland Sites Expansion	2	Assuming there is foundation material to support dike raising, this type of project has successfully been done before	2	Groundwater concerns will be alleviated with installation of liner and water system.
Capping- Landfill	2	Smaller, similar projects have been done before; may be more logistically challenging given larger quantities (more trucks, etc).	2	May be regulatory issues; likely public opposition associated with trucking necessary to move material out of CDF to capping site.
Capping- Brownfields	2	Same rationale as Capping - Landfill; assumes more amendments than landfill capping and does not consider remediation	2	Same rationale as Capping - Landfill
Confined Aquatic Disposal Pit (CAD) - Patapsco River, MD	3	Has been done on a large scale off NY Harbor; some uncertainty as to whether cap stays in place. Pilot project beginning in 2014 should provide technical and logistical information for further alternative consideration.	2	May be against state prohibition on open water placement; certainly other regulatory and public issues associated with potential for resuspending toxics.
Coke Point - DMCF	3	Similar projects have been completed elsewhere; similar to islands, but no habitat development assumed, therefore more confidence in successful outcome; Real estate acquisition relatively high risk.	2	Concerns about toxic sediments and other environmental contaminants at site.

Table 3-7 cont. Qualitative risk rankings: technical/logistical and acceptability

Alternative	Technical/Logistical Risk		Acceptability Risk	
Courthouse Point Vertical Expansion	2	Assuming there is foundation material to support dike raising, this type of project has successfully been done before	2	Likely public concerns with dike raising and placement of harbor material. Groundwater concern would be alleviated with liner and water system
Cox Creek Vertical Expansion	1	Assuming there is foundation material to support dike raising, this type of project has successfully been done before	2	Likely public concerns with dike raising.
Cox Creek Northward Lateral Expansion - Cristal Site	2	Assumes all upland, no habitat development; similar projects have been successfully done before. Real estate acquisition will take time.	2	May be public opposition to site expansion and likely regulatory issues with site contamination
Cox Creek Westward Lateral Expansion	1	Assumes all upland, no habitat development; similar projects have been successfully done before	2	May be public opposition to site expansion and likely regulatory issues with site contamination
Cox Creek Combined Expansion	2	Real estate acquisition for entire site will take time.	2	May be public opposition to site expansion and likely regulatory issues with site contamination
Dam Neck Ocean Open Water	1	Routinely done	1	Few public or regulatory challenges because it is an existing site
Large Island Restoration- Mid Bay	2	Would be similar to PIERP, so many techniques now standard; development of wetlands and habitat still being worked out, so not yet into routine applications	1	Minor public and regulatory issues - through NEPA process.
Mine Placement - Western Maryland	4	Large logistical constraints – potential difficulty in maintaining efficiency of placement given need to move material over land, need for rail infrastructure	3	Significant public opposition at placement sites and some regulatory issues
New Open Water (Deep Trough)	1	Routinely done	5	Against state law and would have significant public opposition
Norfolk Ocean Open Water Placement	1	Routinely done	2	Some moderate regulatory issues
Pooles Island Open Water Site Expansion	1	Routinely done	5	Against state law, and would have significant public opposition
PIERP Expansion	2	Would be similar to PIERP, so many techniques now standard; development of wetlands and habitat still being worked out, so not yet into routine applications	1	Minor public and regulatory issues - through NEPA process.
Quarry Placement - Cecil County, MD	3	Large logistical constraints – many trucks needed, potential difficulty in maintaining efficiency of placement given need to move material over land	3	Significant public opposition at placement sites and some regulatory issues
Rappahannock Shoal Deep Alternate Open Water Site	1	Routinely done	1	Few public or regulatory challenges because it is an existing site.

Table 3-7 cont. Qualitative risk rankings: technical/logistical and acceptability

Alternative	Technical/Logistical Risk		Acceptability Risk	
Rappahannock Shoal Deep Alternate Open Water Site Expansion	1	Routinely done	2	Regulatory issues associated with sandbar shark EFH and sturgeon. A 1981 agreement between the State of Maryland and Commonwealth of Virginia only allows the placement of dredged material from Virginia
Shoreline Restoration - Mid Bay	2	Uncertainties associated with wetland creation similar to island restoration projects	2	Some regulatory and community issues
Shoreline Restoration - Upper Bay	2	Uncertainties associated with wetland creation similar to island restoration projects	2	Some regulatory and community issues
Small Island Restoration- Mid Bay - Parsons Island	2	Uncertainties associated with wetland creation similar to island restoration projects; some discussion of scoring a 1 – may be somewhat easier because of land access and more predictable hydrology; consensus score is 2	2	Some regulatory and public acceptance issues
Small Island Restoration – Mid Bay - Sharps Island	2	Would be similar to PIERP, so many techniques now standard; development of wetlands and habitat still being worked out, so not yet into routine applications	2	Some regulatory and public acceptance issues
Subaqueous Capping – Patapsco River, MD	3	Would be similar to PIERP, so many techniques now standard; development of wetlands and habitat still being worked out, so not yet into routine applications	2	Public prefers material removed completely; would be okay with capping; likely not against prohibition on open water placement because beneficial use.
Susquehanna Flats- Upper Bay Island Restoration	2	Would be similar to PIERP, so many techniques now standard; development of wetlands and habitat still being worked out, so not yet into routine applications	3	Significant regulatory issues with building in large SAV beds. Regulatory agencies have stated their total opposition.
Wetland Restoration- Dorchester County, MD	4	Long pumping distances over water and overland with road crossings. Limited ability to stockpile material for efficient placement.	1	Few public or regulatory challenges
Wolf Trap Alternate Open Water Placement	1	Routinely done	2	A 1981 agreement between the State of Maryland and the Commonwealth of Virginia only allows the placement of dredged material from Virginia waters. VMRC has expressed concern about impacts to blue crabs.
Wolf Trap Alternate Open Water Placement Northern Expansion	1	Routinely done	2	Within VA crab sanctuary but recommended for study by VIMS as alternate to current Wolf Trap Open Water Placement Site.

3.3.7 Screening Summary

In summary, five criteria were developed during the formulation of the 2005 DMMP. These criteria were reviewed and their application to individual alternatives modified when warranted in this DMMP update. These updates to screening criteria resulted in a trade-off analysis that differed in both application and result from that conducted for the 2005 DMMP, and is detailed in the next section.

3.4 TRADE-OFF ANALYSIS

3.4.1 Alternative Suite Formulation

The primary goal of the DMMP is to provide sufficient material placement capacity to meet the 20-year-minimum dredging needs in each of the four geographic subareas. Few of the dredged material placement alternatives listed in Table 3-8 can meet material placement requirements by themselves. The rest need to be combined into “suites” of alternatives that together meet the placement needs of one or more subareas.

The following sections describe the process that was used to identify all possible suites for each subarea, and narrow the focus of analysis to a limited number of suites for each subarea. The process that was used to reduce the many thousands of possible suites to the several hundred that became the focus of the tradeoff analysis was carried out separately for each geographic subarea. For each geographic subarea, the first step was to enter all technically/logistically feasible placement alternatives into the computer program IWR Planning Suite to identify all possible combinations of alternatives. Those combinations of alternatives that met the subarea’s 20-year placement capacity requirements were then identified as “suites” and were evaluated further. Because all suites met the placement capacity requirements, the next step was to compare suites on the basis of three other factors: costs, environmental benefits, and risks. A preliminary screening of suites eliminated those that were clearly inferior to other suites in terms of costs, environmental benefits, or both. Suites with high acceptability risk (see Section 3.3.6) were then screened out to generate the final set of suites that became the focus of the tradeoff analysis. The following sections detail how this process was carried out for each subarea.

Table 3-8. Quantitative and qualitative criteria summary table. Cost estimates can be found in Appendix C.

Dredged Material Management Placement Alternative	Harbor ($/cy)	C&D ($/cy)	MD Bay ($/cy)	VA Bay ($/cy)	Capacity (cy)	Habitat Benefit Index	Technical/ Logistical Risk	Acceptability Risk
Agricultural Placement- Maryland		$ 165	$ 178		500,000	0	4	2
Artificial Island Creation- Upper Bay		$ 28	$ 25		29,300,000	961.7	2	3
Building Products – Lightweight Aggregate	$ 74	$ 76			500,000	0	3	2
C&D Canal Pearce Creek Upland Sites Expansion	$ 38	$ 28	$ 30		5,600,000	0	2	2
Capping- Landfill	$ 124	$ 125			500,000	0	2	2
Capping- Brownfields	$ 124	$ 126			500,000	0	2	2
Confined Aquatic Disposal Pit (CAD) - Patapsco River, MD	$ 19				3,200,000	0	3	2
Coke Point - DMCF	$ 29				17,900,000	0	3	2
Courthouse Point Vertical Expansion	$ 42	$ 31	$ 37		6,500,000	0	2	2
Cox Creek Vertical Expansion	$ 35				5,300,000	0	1	2
Cox Creek Northward Lateral Expansion - Cristal Site	$ 54				2,100,000	0	2	2
Cox Creek Westward Lateral Expansion	$ 67				1,600,000	0	1	2
Cox Creek Combined Expansion	$ 33				8,900,000	0	2	2
Dam Neck Ocean Open Water				$ 5.5	50,000,000	0	1	1
Large Island Restoration- Mid Bay		$ 37	$ 29		35,700,000 C&D/ 60,000,000 MD	1,839.47 C&D/ 3,065.79 MD/ 4,905.26 Total	2	1
Mine Placement - Western Maryland	$ 132	$ 133			2,000,000	1047.72	4	3
New Open Water (Deep Trough)		$ 16	$ 10		24,000,000 C&D/ 40,000,000 MD	0	1	5

Table 3-8 cont. Quantitative and qualitative criteria summary table. Cost estimates can be found in Appendix C.

Dredged Material Management Placement Alternative	Harbor ($/cy)	C&D ($/cy)	MD Bay ($/cy)	VA Bay ($/cy)	Capacity (cy)	Habitat Benefit Index	Technical/ Logistical Risk	Acceptability Risk
Norfolk Ocean Open Water Placement		$ 56	$ 49		24,000,000 C&D/ 40,000,000 MD	0	1	2
Pooles Island Open Water Site Expansion		$ 9	$ 8		5,000,000	0	1	5
PIERP Expansion		$ 31	$ 23		10,500,000 C&D/ 17,500,000 MD	257.63 C&D/ 429.38 MD/ 687.01 Total	2	1
Quarry Placement - Cecil County, MD	$ 110	$ 109			10,700,000	0	3	3
Rappahannock Shoal Deep Alternate Open Water Site				$ 4	50,000,000	0	1	1
Rappahannock Shoal Deep Alternate Open Water Site Expansion		$ 37	$ 31		5,000,000	0	1	2
Shoreline Restoration - Mid Bay		$ 82	$ 71		2,300,000	267.418	2	2
Shoreline Restoration - Upper Bay		$ 71	$ 62		1,500,000	202.323	2	2
Small Island Restoration- Mid Bay - Parsons Island		$ 39	$ 33		12,700,000	819.15	2	2
Small Island Restoration – Mid Bay - Sharps Island		$ 39	$ 33		18,700,000	659.7	2	2
Subaqueous Capping – Patapsco River, MD		$ 34	$ 28		810,000	0	3	2
Susquehanna Flats- Upper Bay Island Restoration		$ 32	$ 39		6,700,000	844.55	2	3
Wetland Restoration- Dorchester County, MD		$ 98	$ 91		9,200,000	3,718.6	4	1
Wolf Trap Alternate Open Water Placement		$ 39	$ 36	$7	24,000,000 C&D/ 20,000,000 MD	0	1	1
Wolf Trap Alternate Open Water Placement Northern Expansion				$ 18	31,500,000	0	1	2

3.4.1.1 *Harbor Channels*

The total projected need for Harbor Channels is 27 mcy over 20 years. Suites of alternatives for Harbor Channels must include alternatives that are designed to accommodate dredged material unsuitable for open water placement. Ninety percent (24.3 mcy) of Harbor material is presumed to be unsuitable for open water placement in accordance with local EPA regulations, thus 2.7 mcy are presumed to be clean (suitable) and have no placement restrictions. Note that for the purposes of building suites of alternatives for the Harbor Channels, the federal perspective on clean versus unsuitable material in Baltimore Harbor was used. Although some material from the Harbor Channels may be considered "clean" by federal standards, according to Maryland state law, any material inside the North Point/Rock Point line is legislatively defined as unsuitable, and 90 percent does not meet local EPA regulations.

Existing capacity for Harbor Channel dredged material is 15 mcy. This includes 2 mcy of remaining capacity at Cox Creek DMCF and 13 mcy of remaining capacity at Masonville DMCF. Both of these existing sites can accommodate unsuitable material. For the purpose of this analysis, therefore, it was assumed that of the 12 mcy net capacity need, at least 10.8 mcy would need to be placed in facilities designed to contain unsuitable material. Alternatives considered that could accept unsuitable material are: Building Products – Lightweight Aggregate; Confined Aquatic Disposal Pit (CAD) – Patapsco River, MD; Coke Point – DMCF; and Cox Creek Expansion (4 alternatives).

To create suites for the Harbor Channels, all possible combinations of technically/logistically acceptable (see Section 3.3.5) alternatives were separately identified for unsuitable and clean material alternatives. In total, 449 combinations of alternatives suitable for unsuitable and clean material and 61 combinations of alternatives suitable for clean material only were considered.

The unsuitable and clean material combinations were again combined. These resulting combinations were then screened for appropriate total capacity. Net need is 12 mcy, so combinations of alternatives were selected if they met this need or exceeded it by the amount of the next largest acceptable capacity alternative. Thus, appropriate capacity could be as low as 12 mcy or as high as 26.8 mcy (Coke Point and next largest acceptable option – Cox Creek Combination Expansion). Acceptable alternatives also must have at least 10.8 mcy of capacity for unsuitable material.

The suites were then screened for acceptability (see Section 3.3.6); any suite containing an alternative with an acceptability risk greater than 2 was eliminated. After this screening, 48 suites of alternatives remained, with capacity between 12 and 26.8 mcy. All remaining plans can accommodate 10.8 mcy of unsuitable material.

The same analysis was also conducted including the existing Masonville DMCF. This analysis confirmed that Masonville DMCF should be included in a suite of least cost placement alternatives for Harbor material as it is a component of all least cost suites.

Because material disposal needs will continue after the 20 year planning horizon, and only one alternative includes sufficient capacity over the planning window, it was important to build suites that would contain alternatives that could be implemented in a sequence over the planning window. Additionally, due to real estate and environmental challenges, the likelihood of Coke Point becoming available has decreased since 2013.

3.4.1.2 *C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD)*

The C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD) are located close to each other. The C&D Canal Approach Channels extend approximately 30 miles from Town Point, near the western end of the C&D Canal, southwest to the vicinity of Pooles Island, and the Chesapeake Bay Approach Channels (MD) are located north of the Bay Bridge at Kent Island, and just south of Hart-Miller Island, and lead into the Patapsco River. These channels are similar in terms of the type of material dredged and the alternatives available for dredged material placement. The distinction between the channels is largely administrative in that the Philadelphia District of the U.S. Army Corps of Engineers (CENAP) manages the C&D Canal Approach while CENAB manages the Chesapeake Bay Approach Channels (MD). These areas were combined in the 2005 DMMP to generate suites of placement site alternatives. In this DMMP Update, assumptions about which sites could accommodate material were altered, and therefore suites for the channels were generated separately. The resulting suites were, however, analyzed holistically.

While the conditions that initially originated the combination of these areas has not changed much from the 2005 DMMP, the alternatives for disposal did change slightly such that not all alternatives are available for both areas. Furthermore, PIERP Expansion and Mid-Bay Island were formulated to accept material from both channels but their capacities, costs, and benefits were prorated to each area. Thus, suite development was conducted separately for the two areas and several assumptions were made: If PIERP Expansion or Mid-Bay was part of the recommended suite for Chesapeake Bay Approach Channels material they must be included in the recommended suite for C&D Canal Approach Channels because their formulated benefits cannot be realized within the planning horizon without receiving material from both areas. Also, if a recommended suite contained an alternative for the Chesapeake Bay Approach Channels in MD, the recommended C&D Approach Channels suite could not also contain this alternative except for PIERP expansion and Mid-Bay.

The projected need for the combined C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD) is 64.3 mcy over the next 20 years. Existing capacity is 23.0 mcy. 10.0 mcy is at PIERP: 6.3 mcy is allocated to Chesapeake Bay Approach Channels (MD) materials and 3.7 mcy is allocated to C&D Canal Lower Approach Channels materials. 9.5 mcy will be available at Pearce Creek beginning in 2017. The projected 20-year capacity need for Chesapeake Bay Approach Channels (MD) is 40.1 mcy. This includes 30.8 mcy of maintenance dredging, 2.3 mcy of new work dredging, and 7 mcy of contingency and non-pay overdepth material. Net need for Chesapeake Bay Approach Channels (MD) is 33.8 mcy. No new work dredging in the C&D Canal Lower Approach Channels is expected and it is assumed that there will be 24.2 mcy of maintenance dredging (1.2 mcy/year), which includes contingency and non-pay overdepth. Net need for C&D Canal Lower Approach Channels is 11 mcy.

Alternative Suite Generation

Technically/logistically acceptable (see Section 3.3.5) alternatives for the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD) ranged in placement capacity from 500,000-cy capacity (e.g., Capping - Landfills) to nearly infinite and inexhaustible capacity (e.g., New Open Water (Deep Trough)), and one large alternative meets placement needs on its own (e.g., Large Island Restoration-Mid Bay). An initial review of alternatives indicated that, as in the 2005 DMMP, alternatives needed to be combined into suites that could accommodate appropriate dredged material volumes. In the 2005 DMMP, an "anchor-based" approach was employed, whereby large alternatives could accommodate large amounts of dredged material since each suite included at least one large capacity alternative ("anchor") supplemented by various combinations of smaller technically/logistically feasible alternatives to meet the total placement capacity need. For this update, suites were created combinatorially in IWR Planning Suite and then screened based on volume of dredged material that could be accommodated. This update utilized an approach whereby all combinations of suites were constructed and analyzed. This was done for ease of analysis and because it was quickly apparent that the large alternatives utilized as anchors in the 2005 DMMP are necessary to reach capacity needs.

Several alternatives were also allowed to be added to suites multiple times. Up to five shoreline restoration (mid bay or upper bay) projects, three small island restoration – Parsons Island, and two small island restoration – Sharps Island could be used in suite generation. Because these projects are representative of these types of projects, this allowed for the generation of suites that could utilize multiple small island projects, for example. Cost, habitat benefit, and capacity was assumed to be the same for each additional project.

To create the complete set of suites for the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD), all technically/logistically feasible alternatives for each area were entered into IWR Planning Suite, which generated all possible combinations of these alternatives. Alternatives with with an acceptability risk (Section 3.3.6) greater than 2 were not allowed in suite generation. The resulting combinations of alternatives were ordered according to capacity, and those which provided less than a minimum of 20 years of capacity were eliminated. Suites with capacity less than 34 mcy for Chesapeake Bay Approach Channels (MD) and less than 7.5 mcy for C&D Canal Approach Channels were eliminated.

The total number of suites identified for C&D Canal Approach Channels was 165,694 and for Chesapeake Bay Approach Channels (MD) was 109,022.

Screening Suites for Cost-effectiveness

The tradeoff analysis compares suites of alternatives using quantitative criteria: environmental impacts (benefit or impact of placement alternative – Habitat Benefit Index), capacity of the placement alternative (number of cubic yards), and cost of the alternative ($ per cy - dredge, construct, operate and maintain the alternative). Qualitative criteria were also considered: technical/logistical risk, and acceptability risk. These criteria were used to compare alternatives against one another, develop various suites of alternatives that would meet that capacity needs over the planning horizon, and result in the federal standard for Baltimore Harbor Channel components.

The first step in performing the tradeoff analysis was to reduce the number of suites under consideration by eliminating those suites that were clearly inferior to other possible suites.

Because all suites meet overall placement capacity, the following three decision rules were used to make this determination:

- Rule 1: If Suite A has lower costs and higher environmental benefits than Suite B, eliminate Suite B.
- Rule 2: If Suite A has lower costs and the same environmental benefits as Suite B, eliminate Suite B.
- Rule 3: If Suite A has higher environmental benefits and the same costs as Suite B, eliminate Suite B.

These decision rules were applied to the 109,022 suites associated with the Chesapeake Bay Approach (MD), and resulted in cost-effective suites that included the lowest cost combinations of alternatives that could achieve various levels of environmental benefits. Applying all three decision rules to eliminate suites that were inferior in terms of cost, environmental benefit, or both reduced the number of suites to be considered in the tradeoff analysis for Chesapeake Bay Approach Channels (MD) from 109,022 to 36. The five least costly alternative suites that meet the minimum capacity requirements are shown in Table 3-9.

Table 3-9. Chesapeake Bay Approach Channels (MD) cost effective suites. Recommended alternative shaded. There were no cost effective suites with sufficient capacity at a cost less than the recommended alternative. Total cost for alternatives can be found in Appendix C.

Alternative	Cost	Capacity (cy)	Habitat Benefit Index	Cost/cy
Mid-Bay/PIERP Expansion	$ 2,164,113,604	77,500,000	3,495.17	$ 27.92
Mid-Bay/ PIERP Expansion/Shore. Rest. Upper Bay/Subaqueous Capping	$ 2,250,833,554	79,810,000	3,697.49	$ 28.20
Mid-Bay/ PIERP Expansion/Shore. Rest. Upper Bay (x2)/Subaqueous Capping	$ 2,315,105,402	81,310,000	3,899.81	$ 28.47
Mid-Bay PIERP Expansion/Parsons Island/Subaqueous Capping	$ 2,602,932,385	91,010,000	4,314.31	$ 28.60
Mid-Bay PIERP Expansion/Parsons Island (x2)/Subaqueous Capping	$ 3,019,303,064	103,710,000	5,133.46	$ 29.11

For the C&D Canal Approach Channels, the decision rules were applied to 165,694 suites and screened for acceptability risk, which resulted in 24 suites remaining for consideration (Table 3-10, five least cost suites shown). The recommended alternative was selected after the final suite analysis described in the following Section 3.4.2.

Table 3-10. C&D Canal Lower Approach Channels cost effective suites, five least cost suites shown. Recommended alternative shaded. There were no cost effective suites with sufficient capacity at a cost less than the recommended alternative. Total cost for alternatives can be found in Appendix C.

Alternative	Cost	Capacity (cy)	Habitat Benefit Index	Cost/cy
Mid-Bay/PIERP Expansion	$ 1,657,260,687	46,200,000	2,097.10	$ 35.87
Mid-Bay/PIERP Expansion/Shore. Rest. Upper Bay	$ 1,730,119,204	47,700,000	2,299.42	$ 36.27
Mid-Bay/PIERP Expansion/Parsons Island	$ 2,152,920,767	58,900,000	2,916.25	$ 36.55
Mid-Bay/PIERP Expansion/Shore. Rest. Upper Bay/Parsons Island	$ 2,225,779,284	60,400,000	3,118.57	$ 36.85
Mid-Bay/PIERP Expansion/Parsons Island (x2)	$ 2,648,580,847	71,600,000	3,735.40	$ 36.99

3.4.2 Suite Analysis

The final step in the DMMP update process is the evaluation of suites of alternatives that meet the net dredged material capacity requirements for each of the three geographic areas to select a recommended plan.

Harbor Channels

Harbor channel suites were evaluated based on least cost alternatives, along with reasonable assumptions about implementation schedules and real estate acquisition potential. After screening for capacity, the least cost (by cost/cy) suite of the remaining Harbor Channel suites is

Masonville, DMCF, Confined Aquatic Disposal Pit (CAD) – Patapsco River MD, and Coke Point – DMCF (Table 3-11). The latter two placement sites involve significant risk in their implementation and timing of availability due to real estate and environmental challenges. MPA has discussed acquisition of Coke Point for many years with a succession of its owners. Multiple studies of contaminants at the site and feasibility the construction of the DMCF have occurred. Coke Point is now owned by Tradepoint Atlantic and the likelihood of acquisition by MPA for use as a DMCF is highly unlikely. In May 2017 the owners of Sparrow's Point, Tradepoint Atlantic, released their long-term development plans for Sparrow's Point, and a CDF is not included (Figure 3-25). Therefore, alternatives that meet capacity needs that do not include Coke Point have been selected over alternatives including Coke Point. A pilot project for CAD began in 2016 by MPA, but the availability of sites in Patapsco River that could accommodate federal material is unknown at this time. Due to their ownership of most of the Cox Creek site, MPA is currently pursuing expansion of Cox Creek. Therefore, it is likely that an expanded Cox Creek DMCF will be the next available to receive Harbor Channel material.

The next least cost suite that avoids the risk of Coke Point includes utilizing the existing Masonville DMCF, expanding Cox Creek DMCF vertically and laterally, and implementing CAD. This is the recommended plan for implementation. In April 2015 MPA received approval from the state Board of Public Works for a project to begin raising the existing dikes at Cox Creek as well as expand the facility westward. This plan is 75 cents per cubic yard more expensive than the least cost alternative, but reduces the risk of real estate acquisition by utilizing sites that are already owned and operated by MPA. CAD will require further study for implementation, either for federal or other dredged material.

Table 3-11. Harbor Channels suites. Recommended alternative shaded. Total cost for alternatives can be found in Appendix C.

Alternative	Cost[2]	Capacity (cy)	Cost/cy
Masonville/CAD/Coke Point	$ 926,411,452	34,100,000	$ 27.17
Masonville/Building Products/CAD/Coke Point	$ 963,628,978	34,600,000	$ 27.85
Masonville/Coke Point	$ 864,178,804	30,900,000	$ 27.97
Masonville/Cox Creek Combined Expansion/CAD	$ 706,425,443	25,100,000	$ 28.14
Masonville/CAD/Coke Point/Cox Creek Vertical Expansion	$ 1,110,375,196	39,350,000	$ 28.22
Masonville/Cox Creek Combined Expansion/CAD/Coke Point	$ 1,215,941,443	43,000,000	$ 28.28
Building Products/CAD/Coke Point/Cox Creek Combined	$ 898,496,165	30,500,000	$ 29.46

[2] Masonville DMCF costs have been prorated for the 1 mcy of material already placed at the facility.

Figure 3-25. Tradepoint Atlantic's long-term plan for Sparrow's Point

C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD)

Cost-effectiveness (CE) analysis and incremental cost analysis (ICA) was used to develop a recommended plan for the Chesapeake Bay Approach Channels (MD) and C&D Canal Lower Approach Channels suites. Based on CE analysis, the suite of Mid-Bay and PIERP expansion was the least cost/cy plan and the least cost plan overall for Chesapeake Bay Approach Channels (MD). Using ICA analysis, adding the next most environmentally beneficial placement sites (for example, Shoreline Restoration-Upper Bay, or Small Island Restoration – Middle Bay (Parsons Island)) to this suite slightly increased environmental benefits but had relatively high costs per cubic yard of placement capacity. Therefore, for the alternative suite with least cost and relatively high habitat benefit is PIERP Expansion and Large Island Restoration – Middle Bay. This is similar to what was recommended in 2005; however, Wetland Restoration – Dorchester County was not included in this update because of the reexamination and ultimate high score for technical and logistical risk. Both alternatives, PIERP expansion and Large Island Restoration – Middle Bay, were authorized in WRRDA 2014 and together provide a reasonable amount of remaining capacity beyond a 20-year window, thus reducing risk and capacity development costs in out-years.

Because PIERP Expansion and Large Island Restoration – Middle Bay are formulated to receive material from both Chesapeake Bay Approach Channels (MD) and C&D Canal Lower Approach

Channels, suites for C&D Canal Lower Approach Channels should contain these sites. The least cost, cost effective plan for C&D Canal Lower Approach channels is also PIERP Expansion and Large Island Restoration – Middle Bay. This alternative allows for enough capacity over the 20-year planning window, and provides reasonable capacity beyond the 20-year window.

3.4.3 Chesapeake Bay Approach Channels (VA)

The projected need for the Chesapeake Bay Approach Channels in Virginia is 12.9 mcy over the planning window. Current placement sites for Virginia Bay Approach Channels are Dam Neck Ocean Open Water Placement, Rappahannock Shoal Deep Alternate Open Water Placement, and Wolf Trap Alternate Open Water Placement. Capacity at these existing sites is more than adequate to meet the need for these channels of the planning window. This means that the net need for the Virginia Bay Approach Channels is zero.

The VMRC has expressed concern with continued dredged material placement at Wolf Trap as they have indicated that it is utilized by female blue crabs to overwinter in Virginia waters. Female crabs burrow into the sediment during the cooler water temperatures (October to March). This is the time of year when dredging and placement usually occurs.

A review of past dredged material placement monitoring at Wolf Trap Alternate Open Water Placement site and literature review done as part of the Baltimore Harbor and Channels 50-ft Project Limited Reevaluation Report has not demonstrated that there are negative impacts from material placement at Wolf Trap. The site remains environmentally acceptable from a federal perspective. Therefore, Wolf Trap Alternate Open water Placement site remains the federal standard for material placement from the York Spit Channel.

3.5 FEDERAL STANDARD

The federal standard is defined in 33 C.F.R. § 335.7. The federal standard is the dredged material placement alternative(s) identified by USACE that represents the least costly alternative(s) consistent with sound engineering practices and compliant with federal environmental laws, which include the environmental standards established by Section 404(b)(1) of the Clean Water Act evaluation process or ocean dumping criteria. The federal standard may therefore include alternatives that fully comply with federal law, but may be restricted by state laws. For example, the State of Maryland has passed laws that severely restrict the placement of material in the open waters of the Bay, and limit placement of material from the Harbor to existing containment sites that have defined closure and capacity restraints. The federal standard includes options that, in the absence of these state laws, can provide potential capacity for anticipated federal maintenance needs, comply with federal laws, and are based on sound engineering practices.

There are three economic purposes for establishment of the federal standard. First, the federal standard limits the federal investment to a justified level of costs. Second, it serves as a basis for cost-sharing purposes. Finally, the federal standard establishes baseline costs to be used for any economic analyses. Any cost in excess of the federal standard is either borne by the non-federal sponsor (the State of Maryland, in this case) or shared with USACE under other authorities if the ultimate placement site is in the federal interest. For example, Section 204 of the WRDA of 1992, and later amended by Section 207 of WRDA 1996, provides authority for USACE to implement projects for the protection, restoration, and creation of aquatic and ecologically related habitats in connection with construction, operation, or maintenance dredging of an authorized federal navigation project. Section 201 of WRDA 1996 provides for USACE cost sharing in the construction of new placement sites and the improvement/expansion of existing placement sites. The cost sharing is limited to the federal standard with the only federal interests in the incremental cost being ecosystem restoration or placing suitable material on beaches. Therefore, the incremental cost of the increased costs over the federal standard for the Harbor CDFs would be non-federal.

Currently, the federal standard for the Port of Baltimore Approach Channels to be addressed in the DMMP update has four components, as defined by the channels that are authorized for maintenance dredging. These channels, as described in Section 1.5, include the C&D Canal Lower Approach Channels, Harbor Channels, Chesapeake Bay Approach Channels (MD), and Chesapeake Bay Approach Channels (VA). Details of the federal standard are presented in the following sections, along with economic justification of continued maintenance dredging.

Section 401 of the Clean Water Act requires that a Water Quality Certification (WQC) be obtained for any Section 404 fill or placement activity in waters of the U.S. In Maryland, the WQC certifies that the activity or action will not adversely affect the water quality standards of the receiving waterway as defined in COMAR 26.08.02. If the proposed placement of dredged material is determined to meet the state water quality standards and does not adversely affect the water use designation of that waterway, it would be expected that a WQC would be issued for its placement. Furthermore, EPA has provided concurrence for ocean disposal of Chesapeake Bay Approach Channel material from Maryland at the Norfolk Ocean Disposal Site (see Appendix F). Therefore, because approval for ocean placement is more onerous than for placement in the Bay, it is expected that this material would also be suitable for disposal at the historically utilized sites in the Bay and would receive a WQC. Without the Maryland Dredged Material Management Act of 2001 disposal at overboard placement sites would also be consistent with the state's CZMA.

Studies have indicated that there is little movement of material out of overboard placement sites in the Middle and Upper Chesapeake Bay and little release of phosphorous, which is bound to the sediment. The release of nitrogen was less than 0.05 percent in the northern part of the Chesapeake Bay. A more recent analysis for open water sites has not been conducted since the passage of the Maryland Dredged Material Management Act of 2001.

3.5.1 C&D Canal Approach Channels—Pooles Island Expansion

The first component of the DMMP federal standard is the open water placement of sediment from the C&D Canal Approach Channels south of the Sassafras River. Overboard placement at

Pooles Island is the federal standard identified in the 2005 DMMP for this material. While Pooles Island was filled to capacity in 2009 and closed by state law, Pooles Island Expansion has dredged material placement capacity available and is the least costly alternative consistent with sound engineering practice and compliant with federal environmental laws. Pooles Island Expansion is the federal standard for the dredged material for the C&D Canal Approach Channels identified in this DMMP update.

3.5.2 Chesapeake Bay Approach Channels (MD)—Deep Trough

The second component of the DMMP federal standard is open water placement of dredged material from the 50- and 35-ft channels in the Maryland portion of the Chesapeake Bay into the "Deep Trough." The Deep Trough is part of a deep water trench, about 20 miles long, and up to 160 feet in depth as shown in Figure 3-26. However, placement of material in the Deep Trough is not permitted under state law. Absent this state law, there is sufficient capacity to accommodate 20 years of maintenance material from the Chesapeake Bay Approach Channels (MD). Deep Trough is the federal standard for the dredged material for the Chesapeake Bay Approach Channels (MD) identified in this DMMP update.

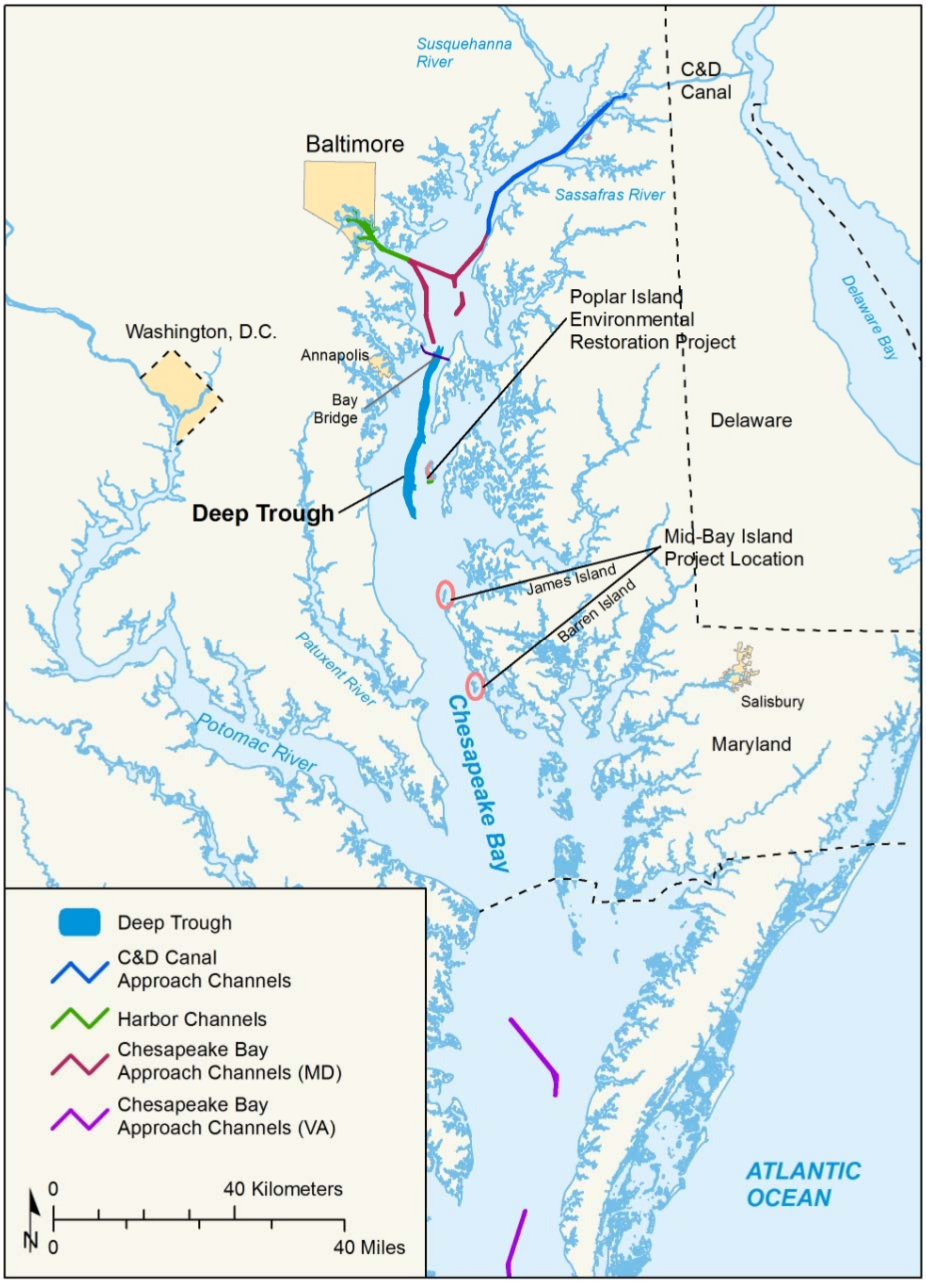

Figure 3-26. "Deep trough" is a naturally deep area in the mainstem of the Chesapeake Bay

3.5.3 Harbor Channels—Cox Creek DMCF

The third component of the DMMP federal standard is the placement of material from the Harbor Channels (that is, areas upstream of the North Point to Rock Point line at the mouth of the Patapsco River) at Cox Creek DMCF. Under state law, material from the Harbor Channels is unsuitable for open water placement and most beneficial use projects that require clean dredged material. Furthermore, about 90 percent of the Harbor material has been found to be unsuitable for open water placement and is environmentally unacceptable. The upland Cox Creek site is permitted to accept Harbor dredged material, and has an estimated current capacity of 2 mcy. Cox Creek DMCF is the federal standard for the dredged material for the Harbor Channels identified in this DMMP update. Additionally, due to limited capacity at Cox Creek, it is anticipated that the federal standard beyond 2018 for the Harbor material would be Masonville DMCF, which has 13 mcy of remaining capacity. While Masonville DMCF will be operational throughout the 20-year planning horizon, yearly placement needs will exceed the facility's annual capacity. Thus, it is anticipated that the federal standard after 2020 will be Masonville DMCF or, if it is at its annual capacity due to federal material placement, the next least costly DMCF that has available capacity for a dredging cycle. This is anticipated to be Cox Creek Expansion.

3.5.4 Chesapeake Bay Approach Channels (VA)

The fourth component of the DMMP federal standard is the open water placement of dredged material from the Virginia Channels into the existing placement sites in the Chesapeake Bay and Atlantic Ocean. There are currently no issues with continued use of three of these sites within the planning period of the DMMP, including the EPA/USACE designated Dam Neck and Norfolk Ocean Sites, and the Rappahannock Shoal Deep Alternate Site. As previously discussed, there is concern about the continued use of the Wolf Trap Alternate Open Water Placement Site. No deleterious impacts to overwintering female blue crabs have been observed. Continued use of the site is recommended.

It is also recommended that placement at the Wolf Trap Alternate Open Water Placement Site be monitored for potential negative impacts to crabs. It is also recommended that research be conducted on placement impacts to crabs. Finally, the Wolf Trap Alternate Open Water Placement Site Northern Expansion should be studied for its suitability to receive dredged material from the York Spit Channel.

3.5.5 Economic Justification of Continued Maintenance

As discussed in Section 1.9, the DMMP update process began with the Preliminary Assessment (see Appendix E), which CENAB finalized in December 2011. Since a Preliminary Assessment establishes whether more detailed study is required to prepare a management plan, a required component of the Preliminary Assessment is an economic analysis to determine whether continuing O&M costs (including maintenance dredging) of the overall project and separable increments are warranted. The Preliminary Assessment concluded that continued maintenance of the Baltimore Harbor and Channels Projects is warranted. Although this analysis did not provide separate justifications for the 42-ft and 50-ft projects, a more-detailed analysis using updated information was completed in July 2014, which further examined the economic justification of continued maintenance of the 50-ft project, the 42-ft project, and the C&D Canal and its approach channels maintained by the Philadelphia District. This economic analysis is provided as Appendix D and concludes that continued maintenance dredging of the Baltimore Harbor and Channels project to their currently maintained depths is justified.

Continued vitality of the harbor is demonstrated through an assessment of the volumes of cargo transiting the harbor on an annual basis, growth in commodities imported and exported in the harbor, and infrastructure available to receive and convey cargo to end markets. Continued investment in harbor infrastructure and transportation networks support growth in volumes of traditional commodities as well as recent trends in cargo systems and niche markets.

Justification for continued maintenance of the harbor is demonstrated through the number and draft of vessels regularly transiting the harbor and its channels. The assessment is based on the past and present use of the navigation channel, total cargo movement, and vessel trips by draft.

Based on the continued use of Baltimore Harbor by deep draft vessels, it is evident that maintenance dredging of the channel should continue. Although iron volumes have decreased as a result of the closure of the RG Steel plant at Sparrows Point, commodity tonnage and vessel traffic have increased over the last two years, as the United States economy returns to sustained economic growth. The large commodity groups of Petroleum and Petroleum Products and Coal Products have been relatively stable over the past 10 years and should remain stable in the future. The vessels associated with these commodity groups and the emerging niche market traffic will continue to utilize the deep draft channel in the future.

A Limited Reevaluation Report (LRR) and supplemental environmental impact statement to reevaluate the justification for widening the 50 foot project in Baltimore Harbor as authorized but unconstructed in the 1980s is currently underway. The scope of the LRR includes an in-depth assessment of vessels calling the harbor presently, projections of the future fleet of vessels, and a calculation of savings through the application of HarborSym, a planning-level simulation model. Justification for continued maintenance of the harbor is demonstrated through the number and draft of vessels regularly transiting the harbor and its channels. The assessment is based on the past and present use of the navigation channel, total cargo movement and vessel trips by sailing draft. A long-term forecast for the Harbor, which combined a trade forecast for Baltimore Harbor, and empirical data obtained from the Port further confirms that imports and exports within the Harbor will grow on average of 2.3 percent and 1.8 percent, respectively, into the future.

3.6 RECOMMENDED PLAN

The overall goal of the DMMP is to develop a plan to maintain, in an economically and environmentally sound manner, channels necessary for navigation in the Port of Baltimore, conduct dredged material placement in the most environmentally sound manner, and maximize the use of dredged material as a beneficial resource. Using both quantitative and qualitative analyses, the CENAB DMMP Team proposes implementation or follow-on study and optimization of the following alternatives, shown in Figures 3-27 and 3-28, which provide a minimum of 20 years of dredged material management for the Port of Baltimore:

- Continued maintenance dredging of the Virginia Channels and use of open water sites in VA with monitoring of placement at the Wolf Trap Alternate Open Water Placement site;
- Research the impact of dredged material placement on overwintering female blue crabs;

- Study the feasibility of expanding the Wolf Trap Alternate Open Water Placement site to the north;
- Continued maintenance dredging of the Maryland Channels and use of existing placement sites in Maryland (Poplar Island Environmental Restoration Project, Cox Creek DMCF, Pearce Creek);
- Authorization of federal use of Masonville DMCF;
- PIERP Expansion;
- Mid-Bay Island Implementation;
- Expansion of Cox Creek DMCF (all options combined);
- Confined Aquatic Disposal Pit in Patapsco River.

The total cost associated with the recommended plan, providing dredged material placement capacity for greater than 20 years of federal O&M and new work material, is $4,732,350,000 and the associated environmental benefit, as described by a habitat index score, is 5,592, equivalent to a total of 2,719 acres of habitat. This habitat score is based on the restoration of upland and wetland habitat as part of the PIERP Expansion with 575 acres of habitat restored (habitat score of 687) and the Large Island Restoration-Middle Bay project with 2,144 acres of habitat restored (habitat score of 4,905). In contrast, the total cost of the federal standard is $992,650,000, with no anticipated environmental benefits. Included in Tables 3-12 and 3-13 are a breakdown of the total cost and habitat restoration for each element of the recommended plan and federal standard. The recommended plan cost is greater than the federal standard due to the cost differential between open water placement at Deep Trough and construction of the environmental restoration projects at Poplar Island and Mid-Bay Islands. These projects are justified on ecosystem restoration benefits with an authorized cost-share of 75 percent federal and 25 percent non-federal. The non-federal sponsor, the Maryland Port Administration, has continued to demonstrate their willingness to participate in these projects though the signing of Project Partnership Agreements, Memoranda of Agreements, and other similar documents.

Total habitat restoration of 2,719 acres will have primary positive impacts to wetlands and habitat for water birds through the implementation of the Mid-Bay project and PIERP Expansion. A review of environmental impacts for each alternative as evaluated through the BEWG scoring process can be found in Appendix B.

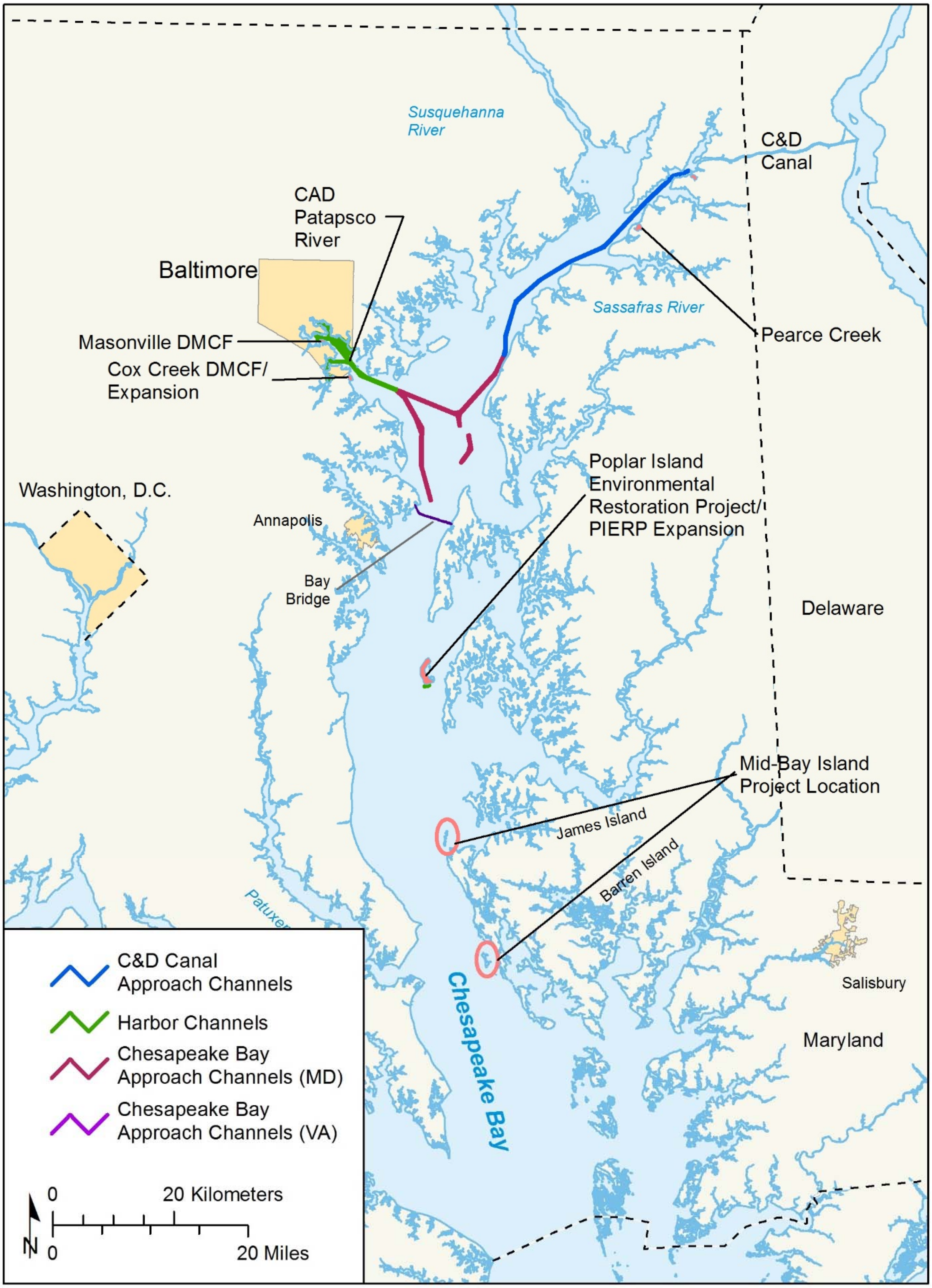

Figure 3-27. Recommended plan in Maryland for dredged material management

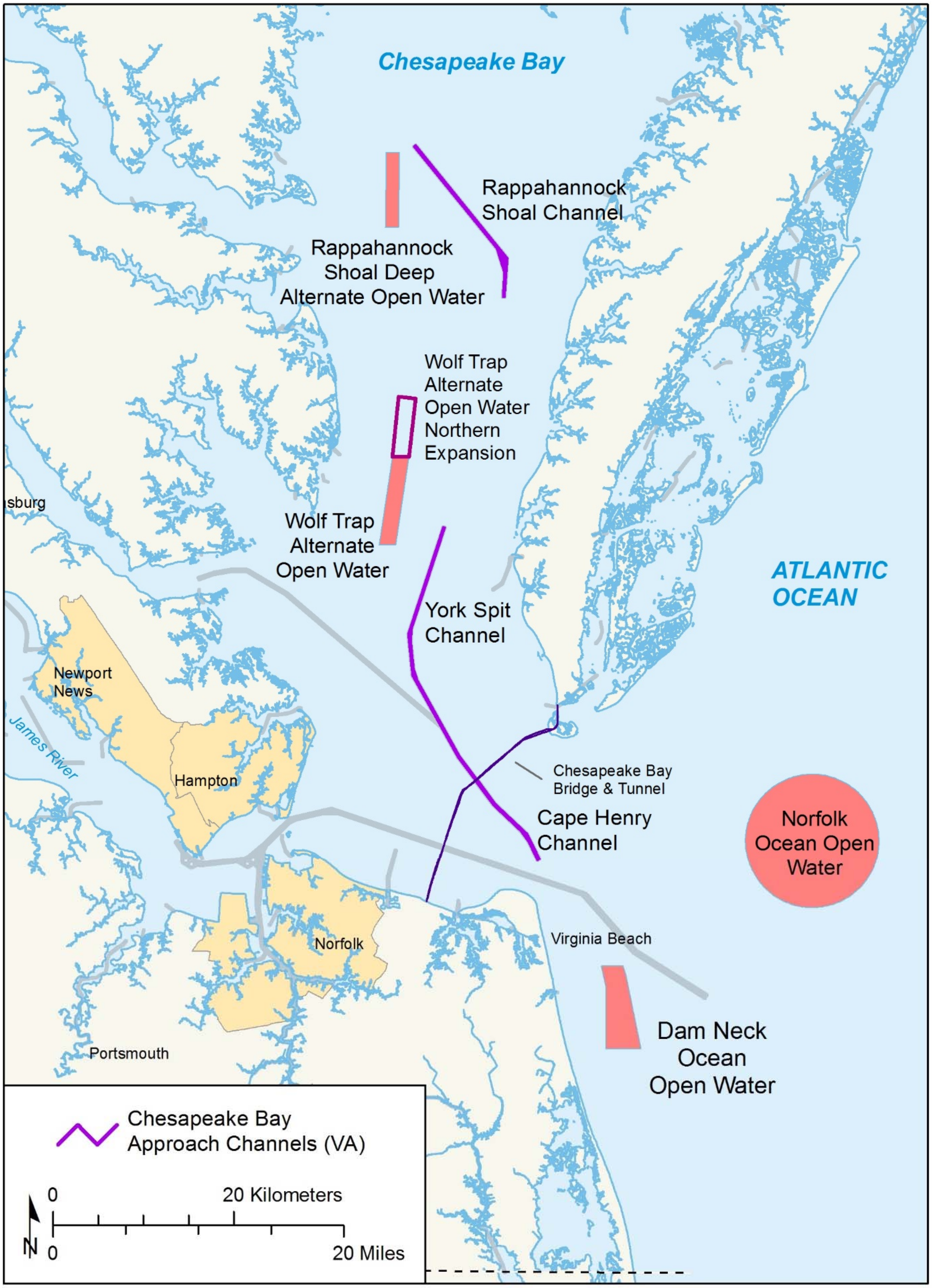

Figure 3-28. Recommended plan in Virginia for dredged material management

Table 3-12. Total cost and habitat index score for the recommended plan.

Geographic Channel Area	Total Projected Dredging Need (mcy)	Dredged Material Placement Site	Net capacity need met by site (mcy)	Unit cost for placement[1]	Total Cost for placement site[1]	Acres of Habitat Restored
Harbor Channels	27	Cox Creek DMCF	2 (6 total)	$ 24	$ 141,400,000	0
		Masonville DMCF	13 (14 total)	$ 25	$ 354,700,000	0
		Cox Creek DMCF Expansion	8.9	$ 33	$289,500,000	0
		CAD Patapsco River	3.2	$ 19	$ 62,200,000	0
Chesapeake Bay Approach Channels (MD)	40.1	PIERP Expansion	17.5	$ 23	$ 409,800,000	359
		Mid-Bay Island	16.3 (60 total)	$ 29	$ 1,754,300,000	1,340
Chesapeake Bay Approach Channels (VA)	12.9	Wolf Trap Alternate	7.9 (33 total)	$ 7	$ 55,300,000	0
		Rappahannock Shoal	3.2 (50 total)	$ 4	$ 12,800,000	0
		Dam Neck	1.8 (50 total)	$ 5.5	$ 9,900,000	0
C&D Canal Lower Approach Channels	24.2	PIERP Expansion	10.5	$ 31	$ 328,600,000	216
		Mid-Bay Island	0.5 (35.7 total)	$ 37	$ 1,328,600,000	804
TOTAL	**104.2**		**82.5[2] (161.4 total)**		**$ 4,747,100,000**	**2,719**

[1]See Appendix C; [2]Does not include 19.5 mcy at Poplar Island and Pearce Creek.

Table 3-13. Total cost and habitat index score for the federal standard.

Geographic Channel Area	Dredged Material Placement Site	Net capacity need met by site (mcy)	Unit cost for placement*	Total Cost for placement site*	Acres of Habitat Restored
Harbor Channels	Cox Creek DMCF	2 (6 total)	$ 24	$ 141,400,000	0
	Masonville DMCF	13 (14 total)	$ 25	$ 354,700,000	0
Chesapeake Bay Approach Channels (MD)	Deep Trough	40	$ 10	$ 388,500,000	0
Chesapeake Bay Approach Channels (VA)	Wolf Trap Alternate	6.2 (33 total)	$ 7	$ 43,400,000	0
	Rappahannock Shoal	2.9 (50 total)	$ 4	$ 11,600,000	0
	Dam Neck	1.5 (50 total)	$ 5.5	$ 8,250,000	0
C&D Canal Lower Approach Channels	Pooles Island Expansion	5	$ 9	$ 44,800,000	0
TOTAL		**70.6**		**$ 992,650,000**	**0**

**See Appendix C*

4. ENVIRONMENTAL CONSEQUENCES OF THE RECOMMENDED PLAN

Dredged material management alternatives for the Baltimore Harbor, Chesapeake Bay Approach Channels (MD), and Chesapeake and Delaware (C&D) Canal Approach Channels were subject to a comprehensive screening process as described in Chapter 3. Its purpose was to identify the preferred alternative, or recommended plan, to accommodate maintenance and new work dredging for the Baltimore Harbor and Channels project for at least the next 20 years. The recommended plan for dredged material placement as presented in Section 3-6 is described below and shown in Figures 3-27 and 3-28.

- Continued maintenance dredging of the Virginia Channels and use of open water sites in VA;
- Research the impact of dredged material placement on overwintering female blue crabs;
- Study the feasibility of expanding the Wolf Trap Alternate Open Water Placement site to the north;
- Continued maintenance dredging of the Maryland Channels and use of existing placement sites in Maryland (Poplar Island Environmental Restoration Project, Cox Creek DMCF, Pearce Creek);
- Authorization of federal use of Masonville DMCF;
- PIERP Expansion;
- Mid-Bay Island Implementation;
- Expansion of Cox Creek DMCF (all options combined);
- Confined Aquatic Disposal Pit in Patapsco River.

This chapter summarizes evaluations, conducted in a programmatic manner, of the environmental impacts of preferred alternatives that were not previously evaluated in the 2005 DMMP. If conditions have changed for preferred alternatives that were evaluated in 2005, their impacts have been reevaluated. Environmental impacts include direct impacts, which are caused by the action and occur at the same time and place, and indirect impacts, which are caused by the action and are later in time or farther removed in distance but still reasonably foreseeable.

Existing dredged material management facilities that will continue to be used as placement sites have been previously assessed and permitted. Site specific assessments have been completed on several alternatives that were recommended in 2005 and evaluated programmatically at that time. Therefore, these sites are not considered in detail here except for an overview of the site and environmental consequences. Those facilities include PIERP, PIERP Expansion, Mid-Bay Island, Cox Creek DMCF, Masonville DMCF, and Pearce Creek. Electronic copies of assessments of these sites (other than Masonville DMCF) are available in Appendix G.

Compliance with federal regulations ensures that maintenance dredging of navigation channels and dredged material placement is environmentally acceptable. The following is a list of federal regulations and executive orders that, depending on location, could be applicable to a project. The applicable regulatory and policy requirements should be considered during the planning process for any project.

Federal Statutes

The American Indian Religious Freedom Act (AIRFA) (42 U.S.C.A. 1996)
Anadromous Fish Conservation Act (16 U.S.C. 757a to 757g)
Antiquities Act (16 U.S.C. 431).
Archaeological and Historic Preservation Act (16 U.S.C. 469a-1)
Archaeological Resources Protection Act (16 U.S.C. 470aa-470ll)
Clean Air Act (CAA) (42 U.S.C. 7401 et seq.)
Clean Water Act (33 U.S.C. 1251 et seq.)
Coastal Barrier Resources Act (16 U.S.C. 3501 et seq.)
Coastal Zone Management Act (16 U.S.C. 1451-1564)
Endangered Species Act (ESA) (16 U.S.C. 1531-1544)
Estuary Protection Act (16 U.S.C. 1221 et seq.)
Farmland Protection Policy Act (7 U.S.C. 4201 et seq.)
Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661 et seq.)
Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801-1882; 90 Stat. 331; as amended)
Historic Sites Act of 1935 (16 U.S.C. 461)
Land and Water Conservation Fund Act (LWCFA) (16 U.S.C.A. 4601-11)
Marine Mammal Protection Act (16 U.S.C. 1374)
Marine Protection, Research and Sanctuaries Act (a.k.a. Ocean Dumping Act) (33 U.S.C. 1401 et seq.)
Migratory Bird Conservation Act (16 U.S.C. 715 et seq.)
National Environment Policy Act (42 U.S.C. 4321 et seq.)
National Historic Preservation Act (NHPA) (16 U.S.C. 470)
Native American Graves Protection and Repatriation Act (NAGPRA) (25 U.S.C.A. 3001)
Noise Control Act (42 U.S.C. 4901 et seq.)
North American Wetlands Conservation Act (16 U.S.C. 4401 et seq.)
Occupational Health and Safety Act (29 U.S.C. 651 et seq.)
Rivers & Harbors Act (33 U.S.C. 401-418)
Safe Drinking Water Act (42 U.S.C. 300F et seq.)
Solid Waste Disposal Act (42 U.S.C. 6901 et seq.)
Water Resources Development Acts (33 U.S.C. and 42 U.S.C.)
Water Resources Planning Act (42 U.S.C. 1962 et seq.)
Watershed Protection and Flood Prevention Act and the River and Harbor Flood Control Act (16 U.S.C. 1001)
Wild and Scenic Rivers Act River and Harbor Flood Control (16 U.S.C. 1278 et seq.)
Wilderness Act (16 U.S.C.A. 1131 et seq.)

Executive Orders, Memoranda, etc.

Chesapeake Bay Protection and Restoration (E.O. 13508)
Protection and Enhancement of Environmental Quality (E.O.11514)

Protection and Enhancement of Cultural Environment (E.O. 11593)
Floodplain Management (E.O.11988)
Protection of Wetlands (E.O.11990)
Prime and Unique Farmlands (CEQ Memorandum, 11 Aug. 80)
Environmental Justice (E.O.12898)
Recreational Fisheries (E.O.12962)

4.1 EXISTING OR AUTHORIZED PLACEMENT SITES

4.1.1 Cox Creek Dredged Material Containment Facility

The Cox Creek DMCF is an existing near-shore, confined placement facility located in Anne Arundel County, Maryland and owned by the MPA (Figure 3-27). The Cox Creek DMCF was a previously used facility that was acquired and modified by MPA to accept additional material. It began accepting new material in 2008 and was first used by the Federal Government under a Memorandum of Agreement (MOA) in 2013.

Modifications to Cox Creek to enable its current capacity impacted 4.87 acres of shallow tidal waters of the Patapsco River (MPA, 2002). These impacts were mitigated through the creation of a tidal wetland project consisting of a mixture of open water and vegetated tidal marsh. Various mammals, amphibians, and reptiles have been observed at or may be expected to inhabit or use the DMCF, but due to their high mobility, impacts are minimal. Birds utilizing the DMCFR are temporarily displaced during the placement of dredged material.

The Cox Creek dredged material containment facility receives dredged material from the Baltimore Harbor channels west of the North Point-Rock Point line. The sediments from the Baltimore Harbor are considered unsuitable for open water placement by Maryland law (The Maryland Dredged Material Management Act of 2001), and must be placed in a containment facility like Cox Creek DMCF. Processing or treating dredged material to produce environmentally safe material or beneficial use products may achieve renewable capacity for the facility. This material would be marketed, utilized, or otherwise placed off-site.

The Chesapeake Bay TMDL was established in December 2010 by the U.S. EPA and is administered in Maryland by the Maryland Department of the Environment through the National Pollutant Discharge Elimination System (NPDES). Cox Creek DMCF operates under a nutrient waste load allocation (WLA) that is written into the Individual Discharge Permit for the site (Permit # 09DP3424) and implemented through a nutrient reduction plan. The Cox Creek discharge permit requires implementation of best management practices (BMPs) to reduce and/or offset any nutrient inputs. Several BMPs are currently being considered that will offset the total nitrogen load from Cox Creek including hydraulic placement with recirculation and off-site offsets such as stream restoration.

4.1.2 Masonville Dredged Material Containment Facility

The Masonville DMCF is located within the Baltimore Harbor, northwest of the Baltimore Harbor Tunnel toll plaza (I-895), in the Fairfield area of South Baltimore. Masonville DMCF is owned, operated, and maintained by MPA. Initial construction of the facility was completed in 2010 and began receiving material that year. The first planned dike raising is scheduled to begin in 2015.

The USACE completed a Final Environmental Impact Statement Environmental Assessment (FEIS) to support a joint federal and state permit application submitted by the Maryland Port Administration (MPA) to the U.S. Army Corps of Engineers (USACE) for the proposed Masonville DMCF. The Record of Decision (ROD) was signed on August 23, 2007. In accordance with the Council on Environmental Quality's "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (NEPA) of 1969" (40 CFR 1500-1508) and Engineer Regulation 200-2-2 (Procedures for Implementing NEPA), the USACE assessed the potential environmental impacts and site development issues of the proposed Masonville DMCF in the EIS. Implementation of NEPA requires that federal agencies initiate "an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to the proposed action."

Various public meetings were held between March 2003 and December 2006 during which Masonville or Harbor Options were discussed. The Notice of Intent (NOI) was published in the Federal Register on May 26, 2005 and went out to the USACE agency distribution list as well as the Harbor Team and DMMP distribution lists. The public scoping meeting was conducted at the Harbor Hospital in Baltimore Maryland on June 15, 2005. This meeting was the result of the publication of the NOI. Notices were sent to interested parties and advertisements were placed in the newspaper. The public comment period closed on July 15, 2005.

Masonville covers 141 acres, including land and water. The area had been used for over a century by heavy industry, including shipbreaking. The land area falls within the Baltimore City limits, next to 55-acres of protected shoreline habitat known as Masonville Cove. A dike encloses 127 acres of open water that will be filled with dredged material. Over time, the enclosed area will be dried and compacted into solid land. The new land will have a temporary height of 42 feet above water level and settle into a final height of 36 feet. When Masonville is eventually closed to dredged material, the land within the dike will become a marine terminal.

Environmental cleanup and mitigation efforts related to the construction of Masonville include the removal of 25 derelict and sunken vessels, removal of an abandoned pier, removal of 60,000 tons of debris and waste. Tidal and nontidal wetlands have been created and restored and over 100 reef balls have been placed in nearby waters. Masonville Cove has been restored and the Masonville Cove Environmental Education Center, opened in April 2009, provides environmental education programs for the community.

Additional mitigation measures include: stream restoration in Western Run and Biddison Run, which are tributaries to Baltimore Harbor; eel population enhancement; fish stocking in upstream reaches of the Patapsco River; and design, construction, and installation of five trash interceptors near Baltimore Harbor.

Like Cox Creek DMCF, Masonville operates under a nutrient WLA in its individual discharge permit (Permit # 09DP3650) and implemented through a nutrient reduction plan. To meet Chesapeake Bay TMDLs, Masonville's discharge permit loading limits for total nitrogen and total phosphorus changed to zero pounds net in 2015. BMP alternatives are being considered to reach zero pound net discharge including off-site treatment at the nearby Patapsco waste water treatment plant.

4.1.3 Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island (PIERP) and PIERP Expansion

PIERP is an ongoing project of the beneficial use of dredged material for environmental restoration. The impacts from this project are associated with operations and restoration activities. The dikes and project footprints have already been constructed and the impacts previously assessed. USACE prepared an Integrated Feasibility Report and EIS for Poplar Island in February 1996. The Record of Decision (ROD) was signed on September 4, 1998. In 2005, the Baltimore District prepared a General Reevaluation Report and Supplemental EIS (SEIS) for the project, which evaluated project expansion. A ROD was signed on October 11, 2006.

During operations, minor changes in sediment quality and composition are expected within the placement sites, but no significant changes are expected outside placement areas. There are no impacts to cultural resources, SAV, vegetation, and terrestrial, wetland, or aquatic resources from the operations of the site (USACE, 2001). Increased turbidity and sedimentation from dredged material placement cause short-term impacts that temporarily affect the water quality in the project area (EA, 2005). No significant impacts to the benthic community or to benthic populations, due to dredged material placement, are expected since the placement sites are already diked and partially filled. Coordination with NMFS on EFH in the placement areas indicated that Poplar Island lies within the general reach of EFH for bluefish, winter flounder, and summer flounder. However, the placement site is fully contained and ongoing activities would not affect EFH. Some waterfowl and other birds are displaced from the Poplar Island area during placement operations. This disturbance has been characterized as insignificant and temporary, since the birds return after placement operations cease (USACE, 2013).

Impact assessments for the site indicated that placement activities would not negatively impact air quality in the area due to the relatively small outputs of the construction equipment and the intermittent nature of the placement activities. Dredging and placement activities have minimal impact on recreational boating activities as most work occurs primarily during the late fall and winter, when recreational boating on the Bay is at a minimum.

PIERP is restoring remote island habitat, a scarce and rapidly vanishing ecosystem component within the Chesapeake Bay region. Loss of remote island habitat within the middle-eastern Chesapeake Bay has been estimated at approximately 10,500 acres in the last 150 years, a trend that will continue because of erosive forces and sea level rise. Remote islands in the Chesapeake Bay serve as an important stop-over point for migratory avian species, providing forage and protected resting habitat during spring and fall migration along the Atlantic Flyway for many shorebird and waterbird species.

The project provides an environmental benefit of restoring remote island habitat, 1,715 acres of wetlands, uplands, and near-shore and shoal habitats (USACE, 2013). Poplar Island provides direct environmental benefits of improved health, richness, and sustainability to aquatic and wildlife species including the American black duck. It supports the USACE commitment of restoring and recovering remote island habitats under the Chesapeake Bay Protection and Restoration Executive Order (E.O. 13508).

4.1.4 Mid-Chesapeake Bay Island Ecosystem Restoration

The proposed Mid-Chesapeake Bay Island Ecosystem Restoration Project (Mid-Bay Island) consists of two parts: 2,072 acres of island restoration at James Island and 72 acres of island restoration/protection at Barren Island, in the Chesapeake Bay off the coast of Dorchester County, Maryland. The final recommended configuration and its environmental consequences was presented in the September 2008 Final Mid-Chesapeake Bay Island Ecosystem Restoration Integrated Feasibility Report and Environmental Impact Statement. The project was authorized for construction in WRRDA 14.

The proposed James Island site has a dog-leg shape and is approximately 16,500 ft by 9,000 ft by 4,000 ft. The 2,072 acre area will be subdivided into 45 percent upland (932 acres) and 55 percent wetland (1,043 acres). Specifically for the wetlands, the following habitat acreages are targeted: 202 acres of high marsh, 728 acres of low marsh, and 113 acres of mudflat and intertidal areas. The Barren Island restoration/protection component of the plan totals 72 acres and will include modification of the existing sill, and construction of a near-shore sill and breakwaters.

Coordination with agencies and technical experts from academic institutions was an integral and continuous part of the Mid-Bay Island study. The PDT was directed by the USACE-Baltimore District (lead agency) and by the MPA (non-Federal sponsor), and included personnel from agencies including MDE, MDNR, Maryland Environmental Services (MES), NMFS, NOAA Chesapeake Bay Field Office, USEPA Region 3, USFWS Chesapeake Bay Field Office, and USFWS Blackwater National Wildlife Refuge. In addition, various other private-interest groups and organizations that are stakeholders in the Bay, such as the Dorchester County Shoreline Erosion Group, Dorchester County Commissioner and County Council, MPA’s Citizen’s

Advisory Committee (CAC), conservation groups, sportsmen, boaters, and watermen were also involved in the development of the recommended plan.

A Notice of Intent was published in the Federal Register on January 17, 2003, and two public scoping meetings were held in February and March 2003. Between March 2004 and May 2005, several additional informal meetings were held with interest groups and civic organizations with particular interest in the project and local watermen were specifically targeted for involvement in the process and significant efforts were made to accommodate their concerns. The Notice of Availability for the Draft Integrated Feasibility Study/EIS was published in the Federal Register on September 8, 2006, and the draft report was issued to almost 850 participants, including federal, state and local agencies, local libraries, and private citizens. Two public meetings for the Draft Integrated Feasibility Study/EIS were held in October 2006.

Agency and public comments received during the public comment period generally expressed strong support for the project. The Draft EIS received a rating of 'LO' (lack of objections) from USEPA, and the USFWS, MDNR and NMFS service expressed general support of the project. At the public meetings, the project received support from Maryland state delegates and county representatives (Dorchester County Council), in addition to the Dorchester County Shoreline Erosion Group, the Dorchester Citizens for Planned Growth, and the Dorchester County Seafood Harvesters Association. These groups expressed support for the project because of the potential for shoreline protection, reduction in local erosion and water turbidity, and potential economic boom to both the local economy and to the Port of Baltimore, a vital economic component to the State of Maryland.

The Mid-Bay Island project will restore remote island habitat, a scarce and rapidly vanishing ecosystem component within the Chesapeake Bay region. Loss of remote island habitat within the middle-eastern Chesapeake Bay has been extensive, a trend that will continue because of erosive forces and sea level rise. Remote islands in the Chesapeake Bay serve as an important stop-over point for migratory avian species, providing forage and protected resting habitat during spring and fall migration along the Atlantic Flyway for many shorebird and waterbird species. Additionally, the remote island habitat restored at James and Barren Islands will provide valuable wetlands and a vital connection between open-water and mainland terrestrial habitats within the region and provide valuable nesting habitat for a variety of colonial nesting and wading bird species. For aquatic species, remote islands such as James and Barren Island may increase the potential for commercially important large predator finfish species (such as bluefish, striped bass, and Atlantic croaker) to utilize the habitat because of the island's proximity to deep open water as opposed to the shallows adjacent to mainland marshes. Protection of the extensive SAV beds east of Barren Island will provide nursery habitat for blue crabs and many species of fish, while also providing foraging habitat for waterfowl.

The Mid-Bay project will result in a loss of approximately 2,172 acres of Chesapeake Bay bottom within the project footprint, including open-water habitat, shallow water habitat, and benthic habitat. An additional 101 acres of shallow water habitat will be disturbed and deepened to construct the access channel at James Island. The recommended plan was specifically chosen to minimize shallow water impacts by reducing the size of the footprint at Barren Island. Finfish, blue crabs, and avian species that utilize the area within the footprint will be displaced, but comparable habitat is located adjacent to the project area. Non-mobile benthic communities within the footprint will eventually be buried. The benthic community is anticipated to recolonize the access channel area after dredging, but increased water depths and the exposure of a different bottom substrate may result in the recolonization of a different type of benthic community. Benthic organisms in the dredged channel will be destroyed during dredging and pioneer species from outside the channel area would start to recolonize within a year or two after dredging the channel area. Recreational and commercial fisheries within the project footprint will be displaced. The project will result in the hardening of approximately 43,350 lin ft of armored shoreline, which are anticipated to be off-set in the long term by the protection afforded to the adjacent existing SAV beds and the use of the perimeter dikes as epibenthic habitat and food source for juvenile finfish. The recommended plan will create a permanent viewshed change from the adjacent Eastern Shore of Maryland; and increases in noise and light levels will impact residents, primarily during the initial construction seasons when the exterior dikes are constructed and during subsequent dredged material inflow operations.

Construction for the Mid-Bay project is expected to begin in 2023. The nearest residents are approximately 1.5 miles away from the James Island site where the dike construction would occur. According to the Mid-Bay Chesapeake Bay Island Ecosystem Restoration Integrated Feasibility Report and Environmental Impact Statement (EIS) noise associated with the Mid-Bay project are broken down into two sections, impacts associated with James Island and impacts associated with Barren Island. At James Island the highest sustained noise levels generated by construction and dredged material placement are likely to be around 90 A-Weighted Decibel (dBA) (very loud) at 50 feet but would decrease to typical daytime neighborhood background levels (55 dBA) within 3,200 feet of the noise source. The 55 dBA standard is typical threshold level for noise regulation in rural areas. Barren Island is a much smaller project than the restoration at James Island, which would take 3 years. The project is expected to be constructed in less than 2 years and the construction activities are likely to take place only during the day, so noise levels associated with the project would not conflict with local noise ordinances. According to the feasibility report, noise levels are likely to be noticeable to most residents and visitors of the western waterfront area of Upper Hoopers Island during rock placement. As with James Island, any recreational boaters choosing to fish within 10,000 feet of the Island are likely to experience noticeable noises periodically. The Barren Island remnants are likely to experience periodic noise levels that would be perceived as moderately loud.

4.1.5 Pearce Creek

Pearce Creek is owned by USACE, Philadelphia District and is located in Cecil County, Maryland, along the Elk River and Pearce Creek shorelines to the northwest and northeast, respectively. Elk River is a tidal tributary of the Chesapeake Bay. Pearce Creek is non-tidal. The site is located near Cecilton, Maryland. The area enclosed by dikes is 260 acres. The dikes are 35 to 40 feet NAVD 88. The natural adjacent topography of the Chesapeake Bay coast is lower-lying than the DMCF.

The site was originally used as a sand and gravel quarry. The entire basin area (approximately 1,000 acres) is USACE owned. Pearce Creek was used for placement of dredged material from the C&D canal southern approach channels from 1937 to 1992. It is currently unused because of concerns over groundwater contamination in surrounding communities. Installation of an impervious liner began in March 2016 and the site is expected to be operational again in 2017. Access to the site is by water and there are no major roads or railroads bordering the site.

The area around Pearce Creek to the north, east, and south consists of wetlands and forests. Agricultural fields are located across Pond Neck Road to the southwest. The west side of the site faces a residential area named West View Shores. To the southwest about a quarter mile from the DMCF lies the residential community of Bay View Estates. To the north of the site across Pearce Creek about a quarter mile from the facility lies the Crystal Beach community. These communities rely on groundwater as their water supply.

A study completed by USGS in 2012 found that the DMCF is a source of elevated concentrations of dissolved solids and a driver of processes that mobilize and transport metals and nutrients in groundwater. This affects groundwater utilized by West View Shores and Bay View Estates. The dredged bay sediments placed in the DMCF contained brackish Elk River. Because of its elevation, the DMCF is a recharge area for the underlying aquifers. When this recharged underlying aquifers were recharged groundwater quality was degraded. The groundwater contains concentrations of some chemical constituents at levels greater than maximum allowable or recommended levels established by the USEPA.

The tidal waters and sediments of the Elk River in the vicinity of the DMCF are likely impaired somewhat by background levels of PCBs from regional sources consistent with patterns in the Chesapeake Bay.

The Cecilton area air quality meets attainment standards for ground level ozone and small particulate matter (PM2.5), major regulated pollutants. The area infrequently (about 1 percent of the time) violates the carbon monoxide, NOx, SOx, and large particulate matter (PM10) standards.

The tidal waters of the Elk River in the vicinity of the DMCF are typical of the Upper Bay and are impaired by excess turbidity caused by regional nutrient loading. However, they are generally well-oxygenated. Over the 10 year period from 2004 through 2013, VIMS has mapped SAV beds along the Elk River shoreline immediately west of the DMCF in all years but 2011 and 2012. However, operation of the DMCF is not expected to have any significant impact on these beds.

The interior of the DMCF itself, other than the vicinity of the dike, is mapped as a palustrine emergent wetland (PEM) by the NWI. The NWI maps PEM and palustrine forested (PFO) wetlands occurring exterior to the DMCF to the southeast. The shoreline of Pearce Creek to the northeast of the DMCF is mapped as PEM wetland by the NWI. Placement of dredged material at Pearce Creek would effectively remove the PEM wetland within the interior of the site. Before the DMCF was constructed, the site was a wetland that drained to the tidal Elk River or adjacent Pearce Creek.

The Elk River supports aquatic insects, snails, and clams comparable to freshwater non-tidal habitats. Benthic health in the Elk River is generally better than in adjacent tidal rivers of the upper Bay. Water of the Elk River are important spawning and nursery areas for a variety of anadromous fish species. It is possible that Atlantic sturgeon and or shortnose sturgeon could occur in the Elk River. No spawning populations are known to occur there at this time, but it is likely that they did historically spawn in the vicinity. These waters of the Elk River are a state-designated waterfowl staging area in winter.

The Stemmers Run boat ramp and parking lot lie adjacent to the DMCF on its northwestern side. Crystal Beach has a marina and boat ramp on the Elk River shoreline to the north of the DMCF. The waters of the upper Bay support a notable sport fishery for a number of fish species, including striped bass and largemouth bass. The waters of the Elk River are utilized by recreational boaters. Recreational boats utilizing the C&D Canal transit the Elk River in the vicinity of the DMCF.

4.1.6 Dam Neck Ocean Open Water

There is little evidence of long-term adverse environmental impacts; however, there would be short-term impacts during dredged material placement. Dredged material to be placed at Dam Neck will be dredged from the Cape Henry Channel with a hopper dredge. Placement of this material will be via the hopper's hull. Upon dumping, dredged material will partition into a main cloud, which will descend vertically, and a turbidity cloud. The main cloud will descend to the bottom at a high velocity, leaving behind a small turbidity cloud, which will contain a small amount of total solids and settle within a few hours. This temporary increase in turbidity in the water column when dredged material is released will cause short-term degradation of water quality, affecting habitat for fish, free-swimming invertebrates, and benthos.

Impacts to the area receiving dredged material can include smothering/suffocation of bottom organisms by clogging gill surfaces/membranes, physical abrasion and ingestion of excess solids; destruction of demersal fish eggs and/or spawning habitat; as well as the resulting potential increase of disease. The similarity of sediment type between the material to be dredged and the sediments already in the placement area, and the frequency of use, will speed up benthic reestablishment. To minimize environmental effects of ocean water placement, the Dam Neck site is limited to placement of sandier materials. If dredged material is placed in minor thicknesses over a short amount of time, few benthic organisms would be killed (Spaur, 2005).

The placement of dredged material at the Dam Neck open water placement site may have an indirect impact to the breeding, spawning, nursery, and passage activities of commercially important finfish and shellfish in and out of the Chesapeake Bay. Most of these activities do not occur within the placement site but in offshore waters or in the adjacent Chesapeake Bay estuarine waters that are offshore or inshore of the site. Increased turbidity and sedimentation will cause short-term impacts that will directly affect the water quality in the project area. The migration of sea turtles near the site during the spring may also be disrupted due to the placement of dredged material. Minimal impacts on blue crab, bay anchovy, and sand shrimp larvae are expected. The placement of dredged material will result in the permanent loss of benthic organisms in the project area (CENAO, 1990). Possible impacts can be minimized by adhering to time-of-year restrictions on dredging and material placement.

4.1.7 Rappahannock Shoal Deep Alternate Open Water

Open water placement of dredged material at the Rappahannock Shoal Deep Alternate placement site is not likely to have significant adverse impacts on the water column or benthic communities (Diaz and Cutter, 1997). Dredged material to be placed at Rappahannock Shoal Deep will be dredged from the Chesapeake Bay Approach Channels (VA) with a hopper dredge. Placement of this material will be via the hopper's hull. Upon dumping, dredged material will partition into a main cloud, which will descend vertically, and a turbidity cloud. The main cloud will descend to the bottom at a high velocity, leaving behind a small turbidity cloud, which will contain a small amount of total solids and settle within a few hours. This temporary increase in turbidity in the water column when dredged material is released will cause short-term impacts, including lower levels of dissolved oxygen for a few hours following material placement at the immediate site.

The existing benthic community will be buried under a layer of dredged material. This will affect the short-term vertical distribution of benthic biomass by direct burial and, therefore, its availability to predators. However, in the long term, there is no evidence that deposited material affects the vertical distribution of organisms (Wilber, 1996). If organisms are buried, repopulation should start to occur after placement activities have ceased and recover within a season (Diaz and Cutter, 1997). The similarity of sediment type between the material to be dredged and the sediments already in the placement area will speed up benthic reestablishment. To minimize possible impacts to blue crabs, dredging and material placement should not be performed from 1 June through 31 December (VIMS, 2005). If dredged material is placed in minor thicknesses over a short amount of time, few benthic organisms would be killed (Spaur, 2005).

Although the Rappahannock Shoal Deep Alternate placement site is an important area for commercially important fishery resources, the placement of dredged material is not expected to have an adverse effect on these resources.

4.1.8 Wolf Trap Alternate Open Water

Open water placement of dredged material at the Wolf Trap placement site is not likely to have significant impacts of the water column or benthic communities, including crabs as discussed below. Dredged material to be placed at Wolf Trap will be dredged from the York Spit Channel with a hopper dredge. Placement of this material will be via the hopper's hull. Upon dumping, dredged material will partition into a main cloud, which will descend vertically, and a turbidity cloud. The main cloud will descend to the bottom at a high velocity, leaving behind a small turbidity cloud, which will contain a small amount of total solids and settle within a few hours. This temporary increase in turbidity in the water column when dredged material is released will cause short-term impacts, including lower levels of dissolved oxygen for a few hours following material placement at the immediate site.

The existing benthic community will be buried under a layer of dredged material. This will affect the short-term vertical distribution of benthic biomass by direct burial and, therefore, its availability to predators. However, in the long-term, there is no evidence that deposited material affects the vertical distribution of organisms (Wilber, 1996). If organisms are buried, repopulation should start to occur after placement activities have ceased and recover within a season (Diaz and Cutter, 1997). The similarity of sediment type between the material to be dredged and sediments already in the placement area, and the frequency of use will speed up benthic reestablishment.

The Wolf Trap Alternate Open Water site lies within an area where large numbers of female blue crabs congregate to spawn in the fall and then overwinter in the bottom sediments. Placement of material at Wolf Trap Alternate Open Water site during the winter months would result in the burial of overwintering crabs. According to the U.S. Fish and Wildlife Service (USFWS) scoping letter, received in response to the study initiation notice associated with the Baltimore Harbor and Channels 50-ft Project Limited Reevaluation Report (Appendix H), in order to minimize impacts to overwintering blue crabs, dredging and placement would need to be restricted during the period 15 November to 15 March in the two channel sections in Virginia.

In the past, efforts to minimize the impacts to overwintering blue crabs from the placement of dredged material in the Wolf Trap Alternate Open Water Site have included the placement of material in a thin layer no greater than one inch in thickness and to allow placement in the early spring ideally after bottom waters are above 50 degrees Fahrenheit. Environmental monitoring of the Wolf Trap Alternate Open Water Site was conducted in late winter and early spring 2015 by the Engineer Research and Development Center (ERDC) for the USACE, Norfolk Division. Findings from this study indicated that the 2015 dredged material placement at Wolf Trap

Alternate Open Water Site, which was not started until May 2015, affected few crabs. This is likely because water temperatures were warmer in May (over 50 degrees Fahrenheit) and fewer mature female crabs were in the area. The crabs that were still in the area could avoid placement activities since they are more active in warmer water. This study also reported that a post placement dredge survey that was conducted in December 2003 found no evidence of dead or injured blue crabs. This suggested that lethal stress did not occur as a result of the placement activity that occurred in early winter 2003; however, sublethal impacts to crabs from this placement event are still unknown and uncertain (CENAO, 2016).

A study of the impacts of dredged material placement on Dungeness crabs in the Pacific Northwest has shown zero mortality and suggests that the crab's habitat conditions are improved with dredged material disposal (CENWP, 2016). While blue crabs and Dungeness crabs differ in their life history, the results of this study are suggestive that the impacts of dredged material disposal on blue crabs are not significant.

Use of the open water placement sites, Wolf Trap Alternate and Rappahannock Shoal Deep Alternate, as material placement sites for the proposed project is permitted by a 1981 agreement between the Commonwealth of Virginia and the State of Maryland. Wolf Trap Alternate Open Water Site is projected to receive 50,000 cy from the U.S. Coast Guard's (USCG) Wormley Creek project in 2016. However, VMRC has expressed special concern regarding overwintering female blue crabs at the Wolf Trap Alternate Open Water Site, which is located within the Commission's Blue Crab Sanctuary as discussed in Section 2.6. As stated by VMRC in a letter to USACE, the majority of overwintering female crabs will spawn from May through August each year, and any additional loss of female crabs due to overboard placement of dredged material will affect commercial crab harvests of all Bay jurisdictions. The use of Wolf Trap Alternate Open Water Site for new work York Spit Channel and Wormley Creek material would result in an estimated six inches of overburden over the entire site. VIMS has indicated that one inch of overburden is detrimental to blue crab population and would result in a direct impact to blue crabs. VMRC has stated that placement at Wolf Trap Alternate Open Water Site for the Wormley Creek project and other dredging projects is inconsistent with the Coastal Zone Management (CZM) program and is recommending this to the Virginia Secretary of Natural Resources. VMRC has advocated for re-evaluation of the use of the Wolf Trap Alternate Open Water Site as well as an evaluation and possible reconsideration of the 1981 agreement between the Commonwealth of Virginia and Maryland for the use of both of the open water placement sites. NMFS have recommended use of other sites (NODS) for disposal based on the impacts to blue crabs and have also recommended beneficial use based on the suitability of material (personal communication, VIMS, VMRC, NMFS, March 25, 2016).

The VIMS has proposed an area to the north of Wolf Trap Alternate as a viable placement site that would not have overwintering crab impacts, but it will require study to determine its suitability and whether it is environmentally acceptable. The proposed area is further away from the federal navigation channel, which would likely result in additional costs due to increased fuel consumption and transit time between the dredging and placement areas. Per U.S. Army Corps of Engineers Headquarters (CECW-CO) Memorandum dated October 21, 2015, "a state's desired dredging methods, placement locations, or other requirements that exceed the federal standard can usually be accommodated to 'the maximum extent practicable,' so long as the state or non-federal sponsor agrees to pay any difference between the cost of implementing the federal standard and the cost of implementing the state's requirements."   A new overboard placement site will need to be approved by resource and regulatory agencies, which could take a very long time.

In addition to environmental impacts associated with open water placement, the Wolf Trap site is susceptible to wave-induced velocity that may cause sediments to become resuspended in the water column. This site is relatively shallow, with a depth of 39 feet, and the area can experience wind speeds of 35 miles per hour or greater. The combination of water depth and high wind speeds cause wave-induced velocities that could resuspend deposited materials. This generally occurs less than 48 hours per year. Material eroded out of this placement site would be expected to move northward in the Bay or locally to deeper parts of the Bay floor (USACE, 1981).

4.2 PROPOSED PLACEMENT SITES

4.2.1 Cox Creek Expansion

MPA has initiated a feasibility study that will address the possibility of expanding the existing Cox Creek DMCF (Figure 3-2). The expansion alternatives that are being evaluated include westward expansion onto MPA owned property (the recommended plan in this DMMP Update), raising the dikes on the existing Cox Creek DMCF, acquiring and expanding the DMCF to the north onto the Cristal USA property, and combinations of these alternatives. This alternative was discussed in general terms in the 2005 DMMP as both Cox Creek DMCF and as part of the general additional Patapsco River containment facilities alternative.

Cox Creek is located in Anne Arundel County, Maryland on the western shore of the Patapsco River, one mile south of the Francis Scott Key Bridge (I-695). The site is underlain by a layer of clay (the Arundel Clay) that acts as a barrier, and a bentonite liner was also installed at the site, preventing anything in the DMCF from reaching groundwater.

USACE originally constructed Cox Creek in the mid-1960s for dredged material placement from the Baltimore Harbor channels. Placement was completed in 1966. Kennecott Refining Corporation purchased the upland portion in 1959 and operated it as a copper refinery until 1986, at which time the Cox Creek Refining Corporation operated the copper refinery until 1996. The dredged material containment facility portion of the property was transferred to the Kennecott Refining Corporation and the B&O Railroad Company (now CSX) in 1966. MPA purchased the area in 1993 and in 1994 received renovation approval from the Anne Arundel County Council. Renovations at the site strengthened and raised the dike walls. Renovations were completed in

2005. The reopened Cox Creek received its first material inflow in December 2005 and its first USACE inflow in October 2012. Dredged material is transported by scow to the site and would continue to be transported by scow with expansion. To date 3 mcy has been placed. A currently non-operational CSX rail line is located on the western corner of the site.

The area surrounding Cox Creek is mostly industrial. To the south of the facility are the Herbert A. Wagner and Brandon Shores Generating Stations. A warehouse and distribution area, which also contains the Under Armour factory outlet is to the west. Adjacent to the existing Cox Creek DMCF is the Swan Creek Mitigated Wetland (SCMW), which was completed in 2003 and is comprised of about 11.13 acres of tidal wetland habitat. This was built to mitigate for 4.87 acres of open water lost during DMCF renovation. Immediately west of the SCMW is a 115 acre area of the Swan Creek watershed that was granted by MPA to the Maryland Environmental Trust and North County Land Trust as a forest conservation easement. The Swan Creek watershed consists of open water and forested habitat. The Swan Creek watershed is connected to the SCMW through a cobble riffle allowing tidal influence into Swan Creek. There are non-tidal wetlands located in the upland portion of the site where vegetation consists mainly of Phragmites, cattails, weeping willows, sweet gum, wool grass, switchgrass, and poison ivy. Expansion of Cox Creek will be designed and constructed so that these wetland areas are not disturbed.

Exterior monitoring of sediments and benthic populations has been done in 2006-2010 and 2013. Ten locations are sampled each year, including a reference location. Baseline monitoring was conducted in 2006. The 2013 exterior monitoring findings showed virtually no change from the baseline monitoring year, which indicated that several analytes were present in the sediment in concentrations that could potentially cause adverse effects to aquatic organisms. Air quality is poor in the area. The BGE Brandon Shores Generating plant introduces the greatest amount of air pollutants in the area and is located south of Cox Creek.

MES conducts daily, weekly, monthly, quarterly, and annual monitoring associated with NPDES permit required water sampling. All sampled parameters are reported to MDE quarterly. During exterior monitoring in-situ water quality monitoring is conducted that includes temperature, dissolved oxygen, pH, salinity, conductivity, turbidity, and secchi depth at each sampling site. There are no beds of submerged aquatic vegetation (SAV) noted on the Virginia Institute of Marine Science (VIMS) 2013 Interactive SAV Map.

In the 2013 Exterior Monitoring Benthic Community Assessment 18 unique benthic taxa were collected. Benthic mean abundance ranged from 224 to 6.596 individuals/square meter with bivalves as the numerically dominant taxon at four of the exterior monitoring locations and the reference site. Oligochaetes were dominant at four locations, and polychaetes and bivalves were numerically equivalent one of the monitoring locations. Seven exterior monitoring locations in 2013 met the Chesapeake Bay Restoration Goal Index with Benthic Index of Biotic Integrity (B-

IBI) scores of 3.0. The B-IBI for estuarine Chesapeake Bay was published in 1997 by Weisberg et al. and demonstrates that the index can distinguish stressed sites from reference sites.

Located just off the beach of Cox Creek are 325 reef balls that have created habitat for fish. Fish surveys are conducted every other month from April to October. In 2013 the most abundant fish captured adjacent to the reef balls were Atlantic silverside, bay anchovy, and white perch. Fish species that were once found in great numbers include shad and herring species, along with American eels. The SCMW and cobble riffle allow passage for carp to spawn within the Swan Creek watershed. Multiple carp spawning occurred in 2014. An extensive terrestrial and avian species list is available from MES. When mudflats are exposed in the SCMW and the existing DMCF several migratory shorebirds utilize the site.

The Baybrook Area is adjacent to Cox Creek and is made up of the Curtis Bay and Brooklyn neighborhoods, and Hawkins Point and Fairfield industrial areas. In 2010, the Baybrook population was 14,243. 52.1 percent of residents were white, 36.5 percent were black or African American, 9.8 percent were Latino or Hispanic, and 1.9 percent were Asian. The median household income was $32,192 in 2010. This is significantly lower than the U.S. median income of $51,914.

Use of the adjacent waters is mostly industrial. However, the Patapsco River is used for boating and fishing. The Swan Creek area is used for passive recreation such as birding and environmental education purposes. No hunting or fishing is permitted at Cox Creek and would not be permitted at an expanded site.

4.2.2 Confined Aquatic Disposal

Bottom sediment of a suitable grain size (sand and gravel) for use in construction would be excavated for use from the Bay bottom, leaving a depression used to laterally contain placed dredged material from maintenance dredging of federal channels and anchorages. Dredged material would be placed in the mined area using open water placement techniques and capped with sand on a periodic basis, with the final surface being a sand cap.

The representative site for CAD is off Sollers Point in the Patapsco River (Figure 3-2). Adjacent water depths in the area is about 25 feet. The size of a CAD site could be 100 acres of bottom. Preliminary estimation of capacity is 3.2 mcy. The site would be constructed and accessed from the water. Material could also be pumped to the site from an offloading point elsewhere in the Patapsco River.

The adjacent land areas have a long history of industrial and commercial activity. Currently, the land along the river is primarily urban, with commercial, industrial, and transportation activities. The river bottom locally contains utilities crossing the river. Interstate 695 (Baltimore Beltway) crosses the Patapsco River at Sollers Point on the Key Bridge. An urban wildlife refuge has been established at Masonville Cove adjacent to and southwest of Masonville DMCF.

The river bottom consists of unconsolidated sediment, and the river bottom adjacent to the navigation channels may have pilings, shipwrecks, and various materials intentionally or unintentionally disposed of from adjacent urban lands. The river bottom has received contaminants from historic industrial and commercial activities for several centuries and sediments are legally presumed to be unsuitable for open water disposal. However, clean sediments can be found in the river and sediment would be tested to ensure its suitability for use in construction during future feasibility studies.

The Baltimore region is in non-attainment for ozone and particulate matter 2.5 (pm 2.5). The region is in attainment with federal and state air quality standards for other regulated major air pollutants.

The waters of the Patapsco River typically have poor clarity and excess nutrient content. Waters deeper than about 6 feet deep are prone to hypoxic/anoxic conditions in wet years. Shallow water above about 6 foot depth is rarely prone to hypoxic/anoxic conditions. No SAV beds are mapped to occur off Sollers Point in annual surveys conducted by VIMS between 1995 and 2013.

River bottom at Sollers Point is mapped by the NWI as estuarine subtidal unconsolidated bottom. No vegetated wetlands are mapped to occur in open river waters at these locations. West of Sollers Point, vegetated tidal marsh is mapped to occur along the shoreline. The shorelines are largely stabilized with only limited areas of unstabilized shoreline occurring.

Landscaped and remnant natural and successional vegetation occurs locally along the shoreline in adjacent areas (e.g., lawns, successional old field and woodland vegetation). The sites have a long history of vegetation disturbance, so no mature forest is present. Southwest of Masonville Cove DMCF, the USFWS is working with the MPA and local interests to restore native trees, shrubs and wetland plants in Masonville Cove.

The Patapsco River supports commercial and recreational finfish typical of lower salinity water of the Chesapeake Bay. Species common in the vicinity of the potential project areas include white perch, bay anchovy, silversides, striped bass, largemouth bass, mummichogs, Atlantic menhaden, and bluefish. Although limited anadromous fish spawn in further upstream waters of the Patapsco River, the potential project areas do not appear to be nursery areas for anadromous fish. The Patapsco River provides habitat for blue crab. A variety of waterfowl and waterbirds associated with shoreline and open water habitats utilize the potential CAD open water areas including a variety of herons, geese, and ducks. Wildlife typical of Baltimore City and tolerant of urban land use occur on terrestrial habitats in proximity to these waters.

It is possible that shortnose or Atlantic sturgeon could occur in project waters, although poor benthic forage and degraded water quality limit the utility of area waters for sturgeon. Sea turtles and whales are absent from the Patapsco River.

There are no human populations in immediate proximity to the Sollers Point site under consideration. Because of fish consumption advisories, poor habitat conditions, and navigation conflicts, commercial fishing is limited. Subsistence fishing does occur in areas east of I-695 in the Patapsco River.

The open waters have recreational use for boating and fishing. Access to waters off Masonville DMCF for canoes and kayaks are provided by a dock at the Masonville Cove urban wildlife refuge. Fish consumption advisories recommend limited or no consumption of several finfish species because of contaminants.

4.3 CONTINUED MAINTENANCE DREDGING IMPACTS

Continued maintenance dredging of the C&D Canal Lower Approach Channels, Harbor Channels, and Chesapeake Bay Approach Channels (MD) would have minimal effects on the physical conditions of the estuary such as tidal range, current velocities, and circulation. The change in cross-sectional area of the Bay resulting from an increase in channel depth (removing shoaled material) would be insignificant relative to the overall cross section of the existing bay. Dredging the channel would slightly alter the hydraulic conductivity of the Bay, increasing flow in the channel and reducing currents at the margins. This could, in turn, slightly alter sediment transport patterns within the Bay. Although sediment transport effects are also thought to be minimal, an extensive sediment transport model would be required to confirm this assumption.

Continued maintenance dredging of the channels is not expected to affect the geology and soils in the study area. Maintenance dredging would, of course, disrupt the sediment within the dredged area, and some transport of suspended sediment during dredging could occur.

Adverse water quality impacts from continued maintenance dredging develop mainly through resuspension of sediments into the water column. Salinity generally increases with depth in Chesapeake Bay waters. However, maintenance dredging is not expected to create a significant change in salinity that would impact aquatic resources. Channel dredging would also result in a slight increase in turbidity and siltation with no significant environmental impact expected (USACE, 1997).

Natural turbidity is low and any impact associated with clamshell dredging is expected to be temporary and minor. Increases in turbidity, water contamination, and nutrient release are potential impacts of sediment resuspension. Dissolved oxygen levels in the channel are naturally lower in warmer months and any effects on dissolved oxygen during dredging events would be minimal.

The dredging process is not expected to release concentrations of dissolved constituents that will impact water column organisms or affect human health. Release of nitrogen compounds and other contaminants occurs during dredging activities and subsequently from newly exposed sediment surfaces. Studies of nitrogen flux rates from Bay sediments have indicated that an average rate of 0.03 pounds per square meter (USACE, 2001) can be expected over a short time period of days or weeks after dredging. Other experiments indicated that phosphorus is not released from Bay sediments at the temperatures and oxygen levels that occur in the Upper Bay during fall, winter, and spring dredging season. The severity of these impacts depends on the characteristics of sediments removed, the amount of dredging required, and on the dredging methods used. Appropriate management practices such as proper filling of barges to avoid overflow and a routine inspection program can minimize the incidental release of sediment to the water column (USACE, 2001).

Within the Harbor Channels, research indicates that long-term impacts of dredged material on water quality have generally been slight (USACE, 1981). Salinity generally increases with depth in waters of the Baltimore Harbor. Continued maintenance dredging is not expected to create a significant change in salinity that would impact aquatic resources (USACE, 1997). Natural turbidity in the Harbor Channels is greater than in the Bay as a result of ship traffic. Turbidity associated with dredging is expected to be a temporary and minor addition to natural turbidity. Release of nitrogen and other nutrients would have minor short-term impacts on the water column in these areas.

Testing of Harbor sediments shows that portions of the sediments are unsuitable for open water disposal, with the most polluted material in the Inner Harbor. The resuspension of polluted sediments may result in the temporary release of toxic chemicals into the water column. However, there is generally little net mass release of heavy metals and long-term impacts are expected to be negligible (USACE, 1997). Dredging activity closer to the open Bay would release suspended sediments into the open Bay but these are expected to contain fewer contaminants (USACE, 1981). Dredging has the potential to exacerbate the problem of low dissolved oxygen, which is common in Baltimore Harbor. Immediately after dredging, the duration, extent, or frequency of low dissolved oxygen would temporarily increase but return to normal shortly thereafter (USACE, 1997).

Periodic sediment sampling and testing of the sediments in the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD) has not detected levels of HTRW that would preclude unconfined upland or aquatic placement. No impacts are expected from HTRW during continued maintenance dredging and subsequent placement of the dredged material. If dredged sediments exhibit any RCRA characteristics, their handling and disposal is subject to RCRA Subtitle C requirements (and corresponding state regulations).

Historically, Baltimore has been home to a wide array of heavy manufacturing and industrial companies. While environmental laws implemented in the 1970s have halted chemical releases by these industries into Baltimore Harbor, residual HTRW chemical contamination still remains in the sediments. By law, the State of Maryland has mandated that all dredged material taken from the Harbor (within the North Point-Rock Point Line; Figures 1-4 and 1-5) be considered unsuitable for open water disposal, and thereby places limits on its use and placement. The

Federal Government is not bound by the state law; however, there is evidence that some material dredged within the Harbor area would be considered unsuitable for open water placement by federal standards. There is the potential for short-term releases of pollutants into the water column during dredging operations. These impacts have been shown to be short term and no long-term effects have been identified. If dredged sediments exhibit any RCRA characteristics, their handling and disposal is subject to RCRA Subtitle C requirements (and corresponding state regulations).

Use of a clamshell dredge and transport of dredged material by barges powered by towboats is common to all of the alternatives, as is some type of hydraulic placement of the dredged material. Therefore, emissions from the dredge and hydraulic system would be roughly the same for the same amount of material handled. Thus, the major variable affecting emissions and resulting air quality of the alternatives would be the distance the material is transported, which would determine the time the towboat is operated for each barge load. Although a study for the Port Authority of New York & New Jersey shows that NOx emissions from dredging are generally larger (by a factor of 2 to 10) than those from transporting, the transporting emissions are still substantial (Starcrest Consulting Group, LLC, 2002). Therefore, maintenance dredging has the potential for low- to moderate- short-term impact but activities remain below annual thresholds. Preliminary results of air quality analyses for the Baltimore Harbor and Channels 50-Foot LRR indicate that air pollutants from new work dredging activities in Maryland would remain below annual thresholds. In Virginia, new work activities would occur in areas currently in attainment status for air quality.

Continued maintenance dredging is conducted using a mechanical clamshell bucket dredge in the C&D Canal Lower Approach Channels, the Chesapeake Bay Approach Channels (MD), and the Harbor Channels. This type of dredging uses the clamshell bucket to grab sediment from the channel bottom and hoists the sediment through the water column so that the contents can be offloaded to a barge for placement or beneficial reuse.

Although all aquatic resources are in some manner affected, mechanical dredging is more disruptive to the benthic environment than it is to the water column. Although benthic populations are already low due to frequent dredging and hypoxic/anoxic conditions, any remaining benthic invertebrates, oysters, soft-shell clams, over-wintering blue crabs, and some bottom feeder finfish that exist within the channel would be permanently lost as a result of the dredging. However, shoals dredged from these channels are a small percentage of the total bottom area.

Dredging has the potential to be especially detrimental to blue crabs and the commercial blue crab fishery because blue crabs burrow in the substrate while overwintering in the deeper waters. Therefore, a small percentage of blue crabs may be permanently lost if dredging is to occur during the winter months.

Because of their high mobility, most finfish are expected to be able to avoid contact with the clamshell bucket and to be temporarily displaced during the dredging operation. Therefore, it is highly unlikely that finfish would suffer significant impacts as a result of mechanical dredging. Lastly, mechanical dredging would, in the vicinity of the dredging operation, temporarily increase the level of turbidity and suspended solids (USACE, 1997).

An Essential Fish Habitat (EFH) impact (see Chapter 2) assessment done by USACE for the Upper Bay area suggested that only juvenile and adult summer flounder and juvenile bluefish likely occur in the area of the C&D Canal Approach Channels (USACE, 2002). Continued maintenance dredging would occur during winter months, when summer flounder and bluefish are absent. Therefore, continued maintenance dredging should have no direct impacts on summer flounder and bluefish or other EFH (USACE, 2002).

Because the Harbor Channels and the Chesapeake Bay Approach Channels (MD) tend to be more hypoxic/anoxic than the C&D Canal Lower Approach Channels and contain a greater amount of contaminants, the environmental impacts will be similar or less.

Continued maintenance dredging in the C&D Canal Lower Approach Channels could potentially cause short-term impacts on terrestrial resources (mammals, marsupials, birds, and herpetiles). The only terrestrial species potentially impacted by maintenance dredging are waterfowl and the diamondback terrapin. Mechanical clamshell bucket dredging used in this region produces turbid plumes by releasing sediment into the water column. Waterfowl and diamondback terrapin can avoid the immediate impacts of channel dredging, but turbidity plumes caused by dredging may indirectly affect them through adverse impacts to benthic and aquatic food sources (USACE, 1996). These impacts would be minimal because most species of wildlife feed over relatively large areas.

Because of the relative absence of terrestrial species in the dredging area, no substantial impacts are expected from maintenance dredging activities. Navigable channels are also distant enough from island and mainland shores to avoid significantly impacting terrestrial wildlife inhabiting Upper Bay shorelines. Continued maintenance dredging of the Chesapeake Bay Approach Channels (MD) is also expected to have no substantial impacts to terrestrial resources.

Waterfowl and diamondback terrapin can avoid the immediate impacts of continued maintenance channel dredging in the Baltimore Harbor, and no significant noise-related impacts are expected assuming that resident wildlife is accustomed to industrial operations. Predatory birds could be exposed to contaminants by consuming aquatic organisms that accumulate contaminants released to the water column following dredging activity. However, observations indicate that even during open water placement operations, essentially no uptake of metals or PCBs by fish or most invertebrates occurs (USACE, 1981). Therefore, the potential risk to predatory birds is minimal.

Continued maintenance dredging operations are not expected to significantly impact federal or state-listed RTE species in the Upper Bay. The shortnose and Atlantic sturgeons, peregrine falcon, least tern, and bald eagle are state or federally listed rare, threatened, or endangered species expected to occur in the Upper Bay. Most sensitive species can avoid the direct impacts of channel dredging, but turbidity plumes caused by dredging may indirectly affect them through adverse impacts to finfish, benthic, and submerged vegetative food sources (USACE, 1996).

Although few studies have been conducted on the subject, there are potential impacts to the shortnose sturgeon that could occur from dredging activity. Potential impacts include (1) physical injury or death to sturgeon due to entrainment by the draghead of hopper dredges; (2) injury to larvae or juveniles from dredging operations; (3) the disruption of migrations due to physical disturbances and noise; (4) the settling of suspended material on the spawning ground or foraging locations; and (5) if the material is contaminated, toxin uptake by sturgeon.

Short-nose sturgeon typically prefer deeper waters and are benthic foragers, which would magnify the potential for dredging interactions (NOAA, 2003). Dredging has the potential to destroy benthic feeding areas, disrupt spawning migrations, and deposit fine sediments in spawning habitats. Fish capture and/or mortality, either incidental or intentional, would result in the removal of sturgeon individuals from an already small fish population unless appropriate measures are taken to return the sturgeon to the water without harm. Any decrease in sturgeon population size is problematic because fewer adults are available for reproduction, resulting in smaller future populations and potentially lower levels of genetic variation in the population (WESTON, 2002b). These impacts from dredging operations may be avoided by imposing work restrictions during spawning and migration periods and through the use of alternative dredge types (CENWW, 2002). Continuing consultations with MDNR, USFWS, and NMFS are recommended to ensure regulatory compliance and mitigation of impacts to rare species.

The least tern, peregrine falcon, northern harrier, black skimmer, shortnose sturgeon, and Atlantic sturgeon are state or federally listed species expected to occur in the Middle Bay. Most sensitive species can avoid the direct impacts of channel dredging, but turbidity plumes caused by dredging may indirectly affect them through adverse impacts to benthic and submerged vegetative food sources (USACE, 1996). Because dredging methods used in the Middle Bay are like those used in the C&D Canal Approach Channels, impacts to the shortnose sturgeon would be similar to those described for the Upper Bay.

The shortnose sturgeon, peregrine falcon, and the bald eagle are state or federally listed species that are potentially present in Baltimore Harbor. Peregrine falcons (Maryland endangered) have been consistently observed nesting in downtown Baltimore at the Inner Harbor and on the Francis Scott Key Bridge. Their diet generally consists of pigeons, but they occasionally prey on waterbirds. Falcons could potentially be exposed to contaminants by consuming birds that have accumulated contaminants released to the water column. However, prey species are migratory and are not likely to bioaccumulate toxins at a level that would harm the falcons or reduce their reproductive success (USACE, 1997).

Continued maintenance dredging of the navigable channels would have short-term impacts on recreation. This would primarily be a temporary increase in turbidity, which has the potential to impact recreational and commercial fishing. Notification to mariners would minimize disturbance because commercial and recreational fishermen would likely avoid fishing in the vicinity of ongoing dredging. The proposed channel dredging is not expected to conflict with boating in the C&D Canal Lower Approach Channels or Chesapeake Bay Approach Channels (MD) because recreation boaters have the ability to navigate around the ongoing dredging operations. Within the Harbor, short-term impacts may result in increased boat traffic and congestion. Recreational impacts would also be limited if dredging is performed during the winter months. All recreational activities are projected to resume normal practice following project completion (USACE, 1997).

Continued maintenance dredging requires the use of both natural and socioeconomic resources. Although dredging activities would remove benthic organisms, potentially including commercially important species, recolonization of the benthic community would eventually occur, preventing an irreversible impact.

Socioeconomic resources include capital resources, labor resources, fuels, and construction material. Continued maintenance dredging requires capital and a labor force that is dedicated during the life of the project. The energy that is required to operate dredges, move barges and equipment, and transport workers would cause an irretrievable consumption of fuels and lubricants.

Continued maintenance dredging of the C&D Canal Approach Channels to the authorized depth of 35 feet would have a long-term beneficial impact on Bay navigation. Regular maintenance dredging would allow deep-draft vessels to safely navigate the upper region of the Bay and the approach to the C&D Canal. The C&D Canal Approach Channels provide a waterway for deep-draft commercial shipping to travel westerly through the C&D Canal and visit the Port of Baltimore. Maintenance dredging of the channels ensures safe transportation.

Continued maintenance dredging of the Chesapeake Bay Approach Channels (MD) to their respective authorized depths would have a long-term beneficial impact on Bay navigation. Regular maintenance dredging would allow deep-draft vessels to safely navigate this region of the Bay. The Chesapeake Bay Approach Channels (MD) provide passage for commercial ships to and from the Harbor Channels and the upper region of the Bay. Deep-draft ships that call on the Port of Baltimore must use these channels to enter the Patapsco River.

Continued maintenance dredging of the existing authorized Harbor projects, including the approach channels, branch channels, and anchorages within the Harbor, would have a long-term beneficial impact on navigation within the Port of Baltimore. These projects provide access to various public and private terminals serving the Port. The Port is considered an economic engine for the entire region and continued maintenance of the Harbor projects would allow safe passage and berthing for the commercial vessels that call on the Port.

The movement of dredges, barges, and associated support craft does have the potential to negatively impact the passage of commercial ships in the tighter confines of the Harbor. These impacts would be short term and disruption during operations would be minimized through notification to mariners. If hydraulic cutterhead dredges are used, submerging the pipeline as much as practicable would also minimize disruption.

Although dredges and the associated support craft could a have temporary, short-term negative impact on navigation, disruption during operations would be minimized through notification to mariners.

There is expected to be no impact on highways and/or railroads due to continued maintenance dredging.

Noise impacts are expected to be similar at all of the channel sites. Noise impacts to the natural and human environment are expected to be localized and short-term, occurring during maintenance dredging.

Dredging could potentially occur 24 hours a day, 7 days a week. While dredging activities would generate noise from a variety of equipment, the primary sources of equipment noise would include the dredges, the associated pumps and generators, and tugboats used to position the dredges and scows. Other equipment, such as tending boats and survey boats, do not contribute substantially to the noise associated with dredging activities. Scows would be associated with the dredging operation and tugboats would be used to move them to the reuse and placement site. Noise also builds up from commercial and recreational boat traffic, truck engines, tugs, dredging equipment, crew boats, and backup warning signals.

Noise associated with dredging activities includes the operation of dredges. These activities can intermittently generate noise levels as high as 85 to 88 dBA (California Department of Water Resources, 2000). The loudest expected sounds of 88 dBA from dredging operations can be expected to be attenuated to levels approaching 55 dBA (with levels exceeding 65 dBA considered unacceptable according to the Department of Housing and Urban Development Policy 24 CFR Part 51) approximately 2,000 feet from the source. This distance can vary depending on environmental criteria identified above. Most noise-sensitive areas (e.g., residences, schools, hospitals) do not fall within the noise impact zone.

Besides noise impacts to the residents living around the Bay area, there are also consequences for underwater noise as this can impact fish and other marine animal behavior. Sound is important to them when they are hunting for prey, avoiding predators, or engaging in social interaction. They can also suffer from acoustically induced stress in their own habitat. Changes in vocalization behavior, breathing and diving patterns, and active avoidance of noise sources by marine life have all been observed in response to anthropogenic noise.

Continued maintenance dredging as authorized under the Baltimore Harbor and Channels project would cause a number of short-term impacts to the environment. Such disturbances during dredging activities would consist of noise and visual impacts, water quality and air quality impacts, a temporary loss of benthic communities, and minor disturbances to navigation.

The negative short-term effects stated above are not significant when compared with the positive effects of maintaining the channels to their authorized depths. Based on the economic justification in Appendix D, the continued maintenance of the Baltimore Harbor and Channels project is warranted. The benefits of maintaining a safe navigable waterway into the Port of Baltimore more than offset the temporary impacts to the environment during dredging operations.

4.4 CUMULATIVE EFFECTS

The likely cumulative effects of the resource areas examined in this DMMP Update, within the context of the 20-year timeframe of the plan and other past, present, and reasonably foreseeable future actions, are summarized below. The cumulative effects of each of the alternatives are expected to be similar except as noted.

Activities warranting greatest attention in the cumulative effects subsection are those activities that in combination with recommended alternatives would potentially magnify what are perceived as the most significant impacts in the study area. The activities meriting particularly scrutiny include: 1) conversion of significant areas of open water and Chesapeake Bay bottom habitat, including shallow water habitat, to island habitat, 2) impacts on Chesapeake Bay TMDLs, 3) effects to endangered species, and 4) containing the spread of invasive species. All alternatives have had an analysis of their cumulative impacts or will have an analysis, as part of their compliance with federal regulations. Please see individual project documentation for a discussion of cumulative impacts specific to those projects.

4.4.1 Sources of Cumulative Effects

The recommended plan includes continuation of dredging, open water placement of dredged material, restoration of remote island habitat, and use of dredged material containment facilities. Recent and reasonably foreseeable human actions that have converted or would convert open water habitat to island upland and tidal wetland habitat include the existing and expanded PIERP, and the Mid-Bay Island project. Dredging activities include ongoing maintenance of the Baltimore Harbor Channels and construction of the channels in the Chesapeake Bay mainstem to their authorized width. Recent and reasonably foreseeable human actions to place dredged material in open water include placement of less than 100,000 cy of material from the Wormley Creek Coast Guard Station in the Wolf Trap Alternate Open Water Placement Site.

Federal and State laws generally restrict filling of open water to protect the Chesapeake Bay ecosystem, other than for some reclamation of lands lost to recent erosion. Consequently, there are no other public or private actions foreseeable at this time that would contribute substantially to the cumulative open water impacts of the USACE projects described above. Historically, more than 10,000 acres of large island habitat have been converted to open water in the Mid-Bay region since European settlement (Kearney and Stevenson, 1991; Leatherman, 1992; Wray et al., 1995).

On December 29, 2010 the USEPA established the Chesapeake Bay TMDL, prompted by insufficient progress in restoration efforts and poor water quality in the Bay and its tidal tributaries. The TMDL set Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus, and 6.45 billion pounds of sediment per year; equating to a reduction of 25 percent in nitrogen, 24 percent in phosphorus, and 20 percent in sediment. Bay jurisdictions are engaged in cleanup activities designed to meet the pollution reduction targets, both cumulatively and within 92 sub-segments with individual TMDLs.

Dredging may be considered to have some cumulative effect on certain endangered species, particularly sea turtles and sturgeon. Habitat loss has resulted in historic declines of the population of these endangered species and recovery plans are in place to ameliorate these effects and increase population numbers.

Invasive SAV species have been found in the Chesapeake Bay and tidal tributaries, including water chestnut (*Trapa natans*) and hydrilla (*Hydrilla verticillata*). Hydrilla is generally treated similarly to native species because it generally co-occurs with native species. Where it occurs, SAV beds are usually a compilation of native species and hydrilla, thus it is difficult to separate out specific plants, so the entire bed is protected. Only water chestnut is actively managed and reported as part of the SAV Management Strategies adopted by the Chesapeake Bay Program. Water Chestnut can form dense mats blocking sunlight from reaching other SAV species. Water chestnut can also disrupt boat traffic. Mechanical harvesting of water chestnut has been successful in removing it from areas where it has spread and active management is working to keep it in check.

4.4.2 Adverse and Beneficial Effects

The recommended alternatives would permanently convert a total of 2,747 acres (2,172 acres at the Mid-Bay project and 575 additional acres at PIERP) of open Bay bottom to wetlands and upland habitat; bottom substrates along with any existing benthic community or SAV resources and waterfowl foraging habitat would be buried. Any transient aquatic species and commercial fishing activity in the area would also be displaced.

The dredging and placement of dredged material in designated open water placement areas would have no impact to shallow water habitat and SAV habitats because designated open water placement areas are not considered shallow water habitat and SAV are not located there due to deep depths. Placement options that include filling shallow water areas would result in the loss of this aquatic habitat. However, the Bay is naturally growing by several hundred acres per year. Although the net impacts to shallow water habitat acreage are unknown, it is likely that increasing Bay size would offset cumulative losses of shallow water habitat to dredged material placement projects within a several-year to decade's period. Placement sites are designed to minimize the loss of SAV habitat. The wave shadow created from island restoration projects may benefit HAPCs and SAV beds critical to early life stages of many finfish species (WESTON, 2002a).

Continued maintenance dredging, proposed new work dredging, and dredged material management activities, as well as proposed placement alternatives identified in the DMMP Update would have negative impacts on shallow water habitat, but these impacts would not be considered cumulatively significant when compared to the benefits gained from tidal wetland restoration and construction as well as from protection of existing shallow water habitat and SAV.

The recommended alternative is expected to have cumulative beneficial impacts in the long term by restoring and protecting Chesapeake Bay island ecosystems from further shoreline erosion, adding a total of approximately 2,747 acres of remote island habitat in the Chesapeake Bay, including Sensitive Species Project Review Areas (SSPRA). Many of the cumulative benefits of protecting and creating additional island habitat are associated with the ecological services provided by restoring wetland habitats, protection of existing habitats, and habitat diversification.

Altering the bathymetry of existing dredged material placement sites (open water and island restoration) and proposed elevations may impact currents and sediment transportation pathways. The construction of the PIERP project and the Mid-Bay project will provide some protection from wave erosion to existing remnant islands and the shoreline of the mainland. Natural processes that produce a net growth of the Bay by several hundred acres per year would effectively compensate aerially for open water converted to the newly restored islands.

Dredging, dredged material placement at open water sites, the construction of dredged material placement facilities, and the management of dredged materials result in minimal short-term adverse cumulative impacts on Chesapeake Bay Total Maximum Daily Loads (TMDLs). The impacts include resuspension of sediments and nutrients (including nitrogen compounds). Previous studies have indicated that there is little movement of material out of overboard placement sites and little release of phosphorous which was bound to sediment. Release of nitrogen was also minimal. Dredged material placement facility alternatives and island restoration alternatives in this DMMP Update can be operated to minimize nutrient releases, therefore there are no anticipated short- or long-term adverse effects to TMDLs.

Ongoing and future maintenance dredging and open water placement would result in minimal impact to aquatic endangered species. Time of year restrictions, gear best management practices, and dredging methods are expected to prevent or minimize the incidental take of sea turtles. Measures must be undertaken to reduce impacts to sea turtles and other endangered species. Sea turtle deflectors must be used on hopper dredges and endangered/threatened species observers must be present. Given precautionary measures used during dredging and placement activities, impacts would not be cumulatively significant.

The movements of shortnose and Atlantic sturgeon appear to depend on the season, fish size, and the specific river system. Spawning and early life stages only occur in freshwater habitats. Therefore, no life stages besides salinity-tolerant adults should occur in dredging or placement sites. Occurrence of sturgeon in the areas identified in the DMMP Update is expected to be limited to rare transients. Given precautionary measures used during dredging and placement activities, impacts would not be cumulatively significant.

Cumulative impacts from the preservation of the existing island in the Mid-Bay Island project, and the existing and expanded PIERP site would benefit habitat for some rare, threatened, or endangered species. The islands provide habitat for several State or Federal rare, threatened, or endangered species, such as bald eagle, royal tern, and least tern. The recommended alternative would preserve the existing James and Barren Islands that are currently utilized by the documented endangered species, and also create 2,144 acres of additional habitat for nesting and foraging of these species. PIERP has demonstrated the ability to attract endangered species such as least tern for nesting, and habitat restoration at James Island and restoration/protection at Barren Island are expected to attract similar species. The recommended alternative, in combination with the existing habitat at the PIERP facility, would protect existing rare, threatened, and endangered species habitat along the eastern shore of the Chesapeake Bay, and create additional nesting, resting, and foraging habitat.

Past, present, and foreseeable future dredging and dredged material placement would have minimal, if any, impacts on native species as a consequence of spreading invasive species. There is little risk of spread of invasive SAV from dredging activities because dredging occurs at depths beyond which any SAV occurs in the Chesapeake Bay. Therefore there is little chance that invasive SAV could be spread from placement of dredged material. The ongoing beneficial use of dredged material to restore eroding islands and shorelines, as well as proposed future use of dredged material, would have no significant adverse effects from invasive species due to planting plans that only utilize native species.

5. IMPLEMENTATION

As described in Chapter 3, the federal standard is defined as the dredged material placement option identified by USACE that represents the least costly option consistent with sound engineering practices and which meets all federal environmental standards, including those established by Section 404 of the Clean Water Act (CWA) of 1972 and Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, as amended.

5.1 RECOMMENDED PLAN

As described in Section 3.6, the recommended plan is comprised of continued maintenance dredging of the Baltimore Harbor and Channels project, continued dredging of the C&D Canal Approach Channels project, continued use of existing placement sites (including those not yet authorized for use), and development of new dredged material placement alternatives. In developing the schedule for implementation of each component of the recommended plan, consideration has been given to the authorization process, real estate acquisition process, planning and design, construction, dredging needs by channel reach, and both the projected annual and total dredged material capacity at each site. Figures 5-1 and 5-2 are projected timelines for the implementation of the updated recommended plan.

The updated recommended plan is similar to the plan recommended in the 2005 DMMP, with several important changes (Table 5-1).

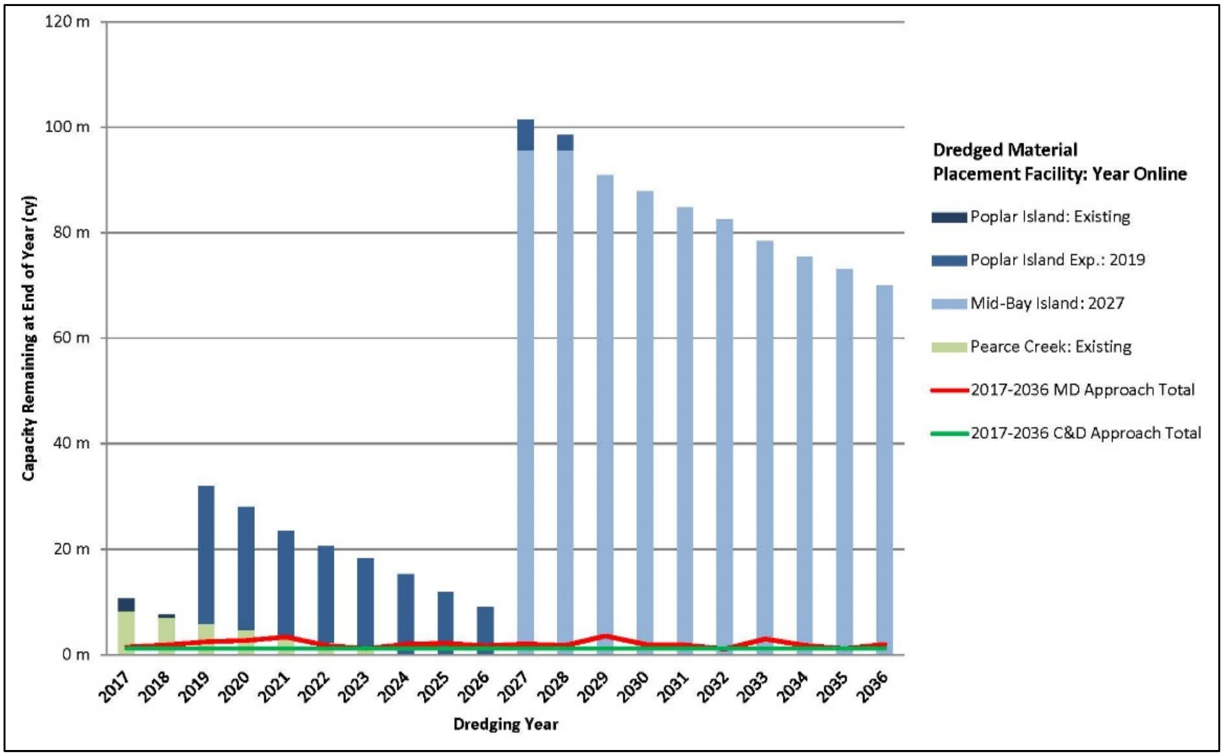

Figure 5-1. Projected dredging volumes and dredged material placement capacity for Approach Channels (MD) and C&D Canal Approach Channels – maintenance and new work dredging

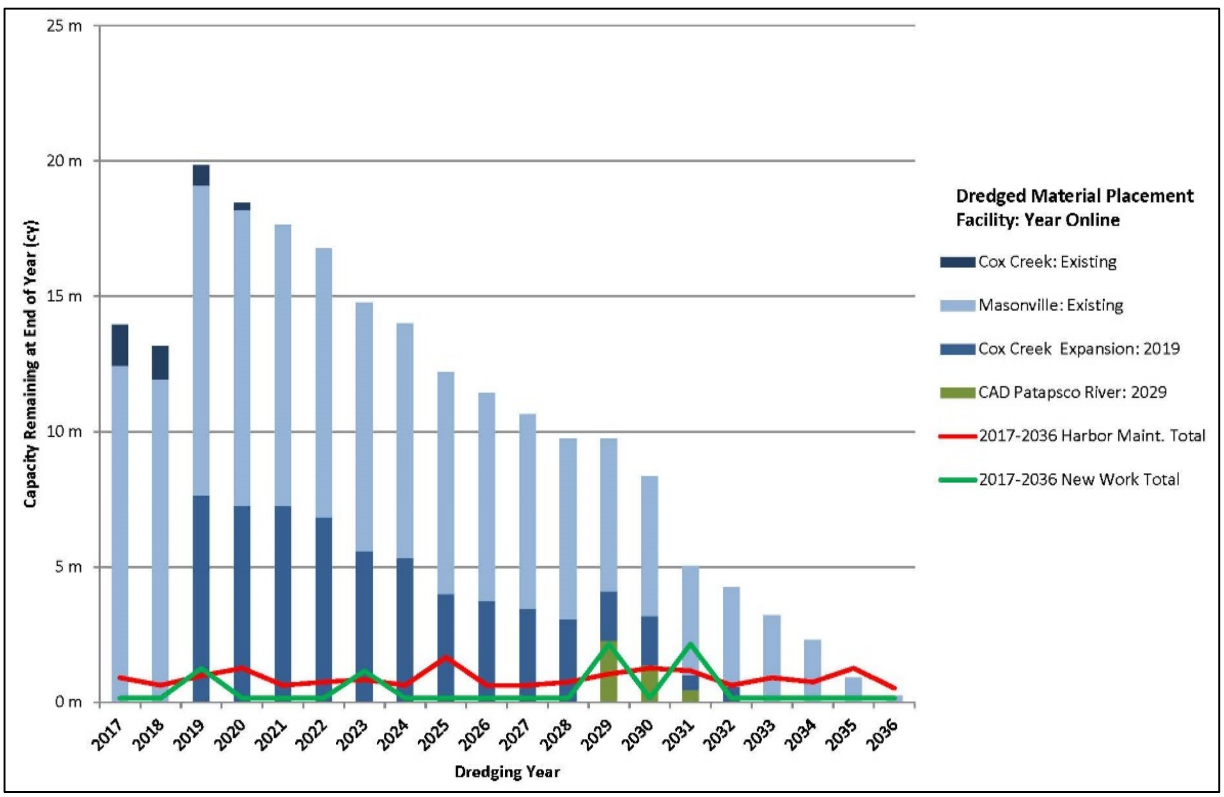

Figure 5-2. Projected dredging volumes and dredged material placement capacity for Baltimore Harbor and Anchorages – maintenance and new work dredging

Table 5-1. Comparison of recommended plans from 2005 and 2017

Geographic Channel Area	DMMP Recommendation		Status
	2005	2017	
Harbor Channels	Continued use of HMI DMCF		No capacity, closed by state law, now a state park
	Cox Creek DMCF	Continued use of Cox Creek DMCF	In use, present capacity projected to be exhausted in 2020
	Multiple Confined Disposal Facilities – Patapsco River	Masonville DMCF	Constructed, Authorization for federal use needed, recommended as part of base plan
		Cox Creek Expansion	Site development by MPA begun, authorization for federal use needed
		Confined Aquatic Disposal Pit (CAD) – Patapsco River, MD	Pilot CAD in design by MPA, feasibility and authority needed.
	Innovative use		Pilot studies conducted at Cox Creek, MPA reexamining options for large scale feasibility
Chesapeake Bay Approach Channels (MD)	Continued use of Poplar Island	Continued use of Poplar Island	In use, capacity projected to be exhausted in 2019
	PIERP Expansion	PIERP Expansion	Authorized WRRDA 2014; Initial contract awarded 2016
	Mid-Bay	Mid-Bay	Authorized WRRDA 2014
	Wetland Restoration-Dorchester County		Not cost effective
Chesapeake Bay Approach Channels (VA)	Wolf Trap Alternate	Wolf Trap Alternate	In use but continued use questioned by VMRC
	Rappahannock Shoal	Rappahannock Shoal	In use
	Dam Neck	Dam Neck	In use
C&D Canal Lower Approach Channels	Continued use of Pooles Island Open Water Site		Closed by state law and capacity exhausted
	Continued use of Poplar Island	Continued use of Poplar Island	In use, capacity projected to be exhausted in 2019
	PIERP Expansion	PIERP Expansion	Authorized WRRDA 2014
	Mid-Bay	Mid-Bay	Authorized WRRDA 2014
		Pearce Creek	Implementation by NAP, expected to receive material in 2017

Chesapeake Bay Approach Channels (MD) and C&D Canal Lower Approach Channels

- **Continued maintenance dredging and use of Poplar Island** – The existing PIERP has an estimated remaining capacity of 6.3 mcy for Baltimore Harbor and Channels Maryland Approach Channels material and 3.7 mcy for C&D Canal Lower Approach Channels (10.0 mcy total estimated remaining capacity). The capacity of Poplar Island should continue to be used and optimized until its capacity is exhausted.

- **PIERP Expansion** – The expansion of PIERP is necessary to meet the projected capacity needs of the material to be dredged from the C&D Canal Approach Channels (Lower Approach) and the Chesapeake Bay Approach Channels (MD). The expanded sections of Poplar Island must be available to accept material in 2019 to avoid excessively overloading the existing cells at PIERP.

  A General Reevaluation Report (GRR) and Supplemental Environmental Impact Statement (SEIS) was completed for PIERP Expansion in 2006. On July 22, 2013 a Limited Reevaluation Report (LRR) for PIERP Expansion was approved by HQUSACE. The LRR examined project cost increases for both PIERP and PIERP Expansion. The Assistant Secretary of the Army for Civil Work (ASA(CW)) presented a letter of recommendation for the project to Congress on February 26, 2014. The Water Resources Reform and Development Act of 2014 (WRRDA 2014) provides authorization for inclusion of PIERP Expansion in the original project with updated project costs and cost-shared 75 percent federal and 25 percent non-federal. The expansion of PIERP is justified on environmental outputs.

- **Large Island Restoration - Mid-Bay –** PIERP expansion will provide additional capacity for dredged material, but will not provide the annual or total dredged material capacity required for the 20-year planning period. Restoring James and Barren Islands in the Chesapeake Bay is the preferred alternative to meet the additional capacity needs. Mid-Bay Island needs to be operational by 2027 to avoid overloading the expansion area of PIERP. While providing needed dredged material placement capacity for the current planning window, Mid-Bay is projected to have nearly 70 million cy of capacity beyond 2036.

  The Chief of Engineer's Report for Mid-Chesapeake Bay Island was approved on August 24, 2009. The project was authorized by Section 7002 of WRRDA 2014. Cost-share for the project is 65 percent federal and 35 percent non-federal.

- **Use of Pearce Creek** –The use of Pearce Creek DMCF after the installation of a new impervious liner will provide cost-effective capacity for material originating in the C&D Approach Channels (Lower Approaches). This capacity may allow for a longer project life at PIERP or Mid-Bay Island, which could result in lower costs per cubic yard of material long-term. The use of Pearce Creek for C&D Canal Lower Approach Channel material is preferred along with placement at PIERP or Mid-Bay Island.

Chesapeake Bay Approach Channels (VA)

- **Continued maintenance dredging and use of Rappahannock Shoal Deep Alternate Open Water Site, Wolf Trap Alternate Open Water Site, and Dam Neck Ocean Open Water Site** – The projected need for the Chesapeake Bay Approach Channels in Virginia is 12.9 mcy over the planning window. Current placement sites for Virginia Bay Approach Channels are Dam Neck Ocean Open Water Placement, Rappahannock Shoal Deep Alternate Open Water Placement, and Wolf Trap Alternate Open Water Placement. Capacity at these existing sites is more than adequate to meet the need for these channels of the planning window.

- **Wolf Trap Alternate Open Water Site Northern Expansion** – Wolf Trap Alternate Open Water Placement Site Northern Expansion should be studied for its suitability to receive dredged material from the York Spit Channel. If continued placement at Wolf Trap Alternate Open Water Site is prohibited by Virginia or determined to not be environmentally acceptable by a federal agency, placement to the immediate north of the existing Wolf Trap site may afford long term disposal capability.

Harbor Channels

- **Continued maintenance dredging and use of Cox Creek DMCF and Masonville DMCF** – The existing and authorized Cox Creek DMCF has an estimated remaining capacity of 2 mcy. The capacity of Cox Creek should continue to be used and optimized until its capacity is exhausted. The Masonville DMCF has an estimated remaining capacity of 13 mcy and should also be used and optimized until its capacity is exhausted. Like Cox Creek, approval for use of Masonville DMCF will be sought under Section 217 of WRDA 1996, as amended. A decision document for use of Masonville is expected to be completed in 2017. Cox Creek DMCF is the federal standard for Harbor Material and it is recommended that Masonville DMCF be recognized as the federal standard in conjunction with Cox Creek such that material placement may be optimized.

- **Cox Creek Expansion –** In order to meet the annual placement needs of the Harbor material and provide options for the optimization of material placement, additional dredged material placement alternatives must be constructed. The existing Cox Creek facility provides several different potential alternatives for expansion. Utilizing all expansion alternatives provides the least cost for disposal at the site. MPA is in the preliminary stages of preparing its property for expansion of Cox Creek by removing existing buildings and beginning the preparation of designs for construction.

- **Confined Aquatic Disposal Pit (CAD) – Patapsco River, MD** – CAD does not provide the capacity needed for long-term disposal and its use for Harbor Material is unproven and untried. MPA is undertaking a limited trial of CAD near the Masonville DMCF. CAD may provide an additional cost-effective disposal alternative and could be used to alleviate overloading situations at other disposal alternatives. This could occur if TMDL regulations don't allow for efficient dewatering at DMCFs or if there are unexpected delays in construction of Cox Creek Expansion or Coke Point DMCF. It is recommended that further investigation of this alternative be conducted to determine its feasibility.

- **Placement schedules -** While Cox Creek DMCF and Masonville DMCF will be accepting dredged material concurrently, an analysis conducted by MPA concludes that alternating federal material placement between Cox Creek DMCF and Masonville DMCF should not occur until at least 2018, to allow for anticipated non-federal placement at Masonville and dike raising. MPA has recommended that all federal maintenance material be placed at Cox Creek through at least 2018, which will maximize available capacity in Masonville. When a third material placement site can be brought online within the harbor, placement activities may be adjusted so that material consolidation is maximized, thus maximizing site capacity.

5.2 DMMP REVIEWS

The DMMP will be reviewed and updated, as with this update, as necessary to reflect significant changes in statutory, regulatory, scientific, or environmental conditions.

6. RECOMMENDATIONS

Within the next 20 years, there will be a shortage of dredged material placement capacity for continued maintenance dredging of the Baltimore Harbor and Channels in Maryland. Feasible alternatives for managing dredged material have been carefully considered, including use of dredged material as a beneficial resource. Through a rigorous and systematic process, dredged material alternatives have been compared for capacity, cost, environmental benefit and/or impact, and implementation risk. This process resulted in the recommendations of the 2005 DMMP, which have subsequently been studied and implemented where feasible. This DMMP update has followed the same process and reevaluated the alternatives presented in 2005, resulting in the selection of an updated recommended plan. The recommended plan consists of dredged material management alternatives that together will provide sufficient dredged material placement capacity for continued maintenance dredging through the next 20 years, with capacity remaining beyond that time. These management alternatives are continued maintenance dredging of the Virginia Channels and continued use of the existing open water placement sites Rappahannock Shoal Deep Alternate, Wolf Trap Alternate, and Dam Neck Ocean; continued maintenance dredging of the Maryland Channels and continued use of Poplar Island Environmental Restoration Project, Cox Creek DMCF, and Masonville DMCF (when approved); construction of the authorized PIERP Expansion and Mid-Bay Islands projects which will restore a combined 2,719 acres of habitat; use of Pearce Creek; expansion of the Cox Creek DMCF; and investigation of Confined Aquatic Disposal (CAD) in Baltimore Harbor. The recommended alternatives continue to develop the recommendations contained in the 2005 DMMP and provide specific alternatives for the disposal of Harbor material.

A number of innovative dredged material placement alternatives were eliminated prior to the development of the recommended plan because of their high cost, high technical uncertainty, and high implementation risk. This includes beneficial use alternatives such as the use of abandoned mines as placement sites and agricultural soil improvement with dredged material, and use of dredged material to produce building products. The continued technical development of innovative uses of dredged material in partnership with the State of Maryland was recommended in the 2005 DMMP and remains a recommendation. At such time as these alternatives can be refined for full-scale use, they should be considered for inclusion in the recommended plan.

The recommended plan is anticipated to have little adverse impact on the quality of the environment and the restoration alternatives will have the potential to provide environmental benefit by restoring critical habitat and protecting the environment from further degradation. It is recommended that the alternatives included in the recommended plan continue into the feasibility study phase, as appropriate, to further refine the placement options, maximize capacity and environmental benefits, and limit adverse impacts.

The recommendations contained herein reflect the information available at this time and current Department of the Army policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction and operations and maintenance program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to Congress as proposals for authorization and implementation funding. However, prior to transmittal to Congress, the non-federal project partner (the State of Maryland), interested federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Edward P. Chamberlayne, P.E.
Colonel, U.S. Army
Commander and District Engineer

7. LIST OF PREPARERS

Included in Table 7-1 is a list of people from the project delivery team, U.S. Army Corps of Engineers Baltimore District, the Maryland Port Administration, and Maryland Environmental Services who were involved in developing this DMMP update.

Table 7-1. List of preparers

Name	Organization	Title – Role in DMMP Update
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8. REFERENCES

Anderson, M. 2004. Personal communication with Michael Anderson.

Anninos, D. and W. Wisniewski. 2009. Site Management and Monitoring Plan for the Dam Neck Ocean Disposal Site (DNODS). February.

CENAB (U.S. Army Corps of Engineers, Baltimore District). 1999. Draft Environmental Impact Statement for Proposed Open-Water Placement of Dredged Material at Site 104, Queen Anne's County, Maryland.

CENAO (U.S. Army Corps of Engineers, Norfolk District). 1990. Norfolk Harbor and Channels, Virginia: Long Term Disposal (inner harbor), Draft Information Report. June 1990.

CENAO. 2002. Essential Fish Habitat Assessment: Coan River Dredging and Jetty Project at Walnut Point, Northumberland County, Virginia.

CENAO. 2016. A Characterization of Finfish, Blue Crabs and Benthic Invertebrates Before, During, and After Dredged Material Placement. April 2016.

Chesapeake Bay Program (CBP). 2011. Restoring Underwater Bay Grasses. Retrieved November 2011, from http://www.chesapeakebay.net/baygrassrestoration.aspx?menuitem=15804.

CBP. 2014. Air Pollution within the Chesapeake Bay. Retrieved February 11, 2014, from http://www.chesapeakebay.net/issues/issue/air_pollution#inline

CBP. 2015. Chesapeake Bay Grasses. Web. 30 Nov. 2015. http://www.chesapeakebay.net/visualization/baygrasses/#10/37.1882/-76.1833?year=2013&compare=2013&chart=temp.

CBSAC. 2015. Chesapeake Bay Blue Crab Advisory Report. Retrieved from: http://chesapeakebay.noaa.gov/images/stories/fisheries/cbsac2015bluecrabadvisoryreport.pdf

CENWW (U.S. Army Corps of Engineers, Walla Walla District). 2002. *Final Dredged Material Management Plan and Environmental Impact Statement (DMMP/EIS) - McNary Reservoir and Lower Snake River Reservoirs*. Walla Walla, WA. Available at: http://www.nww.usace.army.mil/dmmp/MAINRPT.pdf

Danger from the Air (2014) Retrieved February 11, 2014, from http://www.cbf.org/how-we-save-the-bay/issues/air-pollution

Diaz, R.J. and G.R. Cutter, Jr. 1997. Baltimore Harbor and Channels Aquatic Benthos Investigations: Rappahannock Shoals Disposal Site. Prepared for U.S. Army Corps of Engineers Baltimore District.

EA Engineering, Science, and Technology, Inc. (EA), 1996. *FY1995 Sediment Sampling and Chemical Analysis for Baltimore Harbor and Chesapeake Bay, Maryland*. Prepared for USACE-Baltimore District. October.

EA Engineering, Science, and Technology, Inc. (EA), 2000. *FY1998 Sediment Sampling and Chemical Analysis for Baltimore Harbor and Chesapeake Bay, Maryland*. Prepared for USACE-Baltimore District. April.

EA Engineering, Science, and Technology (EA). 2005. *Poplar Island Expansion Study – Final Supplemental Studies to Evaluate Existing Conditions of Aquatic Resources, Spring 2004 through Fall 2004. Chesapeake Bay, Maryland.* Prepared for USACE, Baltimore District. May 2005.

EA Engineering, Science, and Technology, Inc. (EA), 2006. *FY02 Evaluation of Dredged Material: Upper Chesapeake Bay Approach Channels to the Port of Baltimore and Baltimore Harbor Channels*. Prepared for USACE Baltimore District. June.

EA Engineering, Science, and Technology, Inc. (EA), 2007. *FY05 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*. Prepared for USACE Baltimore District. November.

EA Engineering, Science, and Technology, Inc. (EA), 2009. *FY08 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*. Prepared for USACE Baltimore District. July.

EA Engineering, Science, and Technology, Inc. (EA), 2013. *FY12 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*. Prepared for USACE Baltimore District. December.

Eggleston, Jack, and Pope, Jason, 2013, Land subsidence and relative sea-level rise in the southern Chesapeake Bay region: U.S. Geological Survey Circular 1392, 30 p., http://dx.doi.org/10.3133/cir1392.

Environmental Protection Agency (EPA). 2009. Coastal sensitivity to sea-level rise: a focus on the mid-Atlantic region. Vol. 4. [Titus, James G., and K. Eric Anderson]. Government Printing Office, 2009.

Federal Leadership Committee for the Chesapeake Bay (FLC). 2010. Executive Order 13508 Strategy for Protecting and Restoring the Chesapeake Bay Watershed. May 2010.

Halka, J. and W. Panageotou. 1992. “Capacity Determination for Overboard Disposal Areas in the Pooles Island Vicinity,” Maryland Geological Survey, Department of Natural Resources, Coastal and Estuarine Geology, Open File Report No. 11.

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II, and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Lipcius, R.N. and K.E. Knick. 2016. Dredge disposal effects on blue crab. Prepared for U.S. Army Corps of Engineers, Baltimore District.

Maryland Department of the Environment (MDE). 2012. Clean Air Progress in Maryland. Retrieved September 10, 2014, from http://www.mde.state.md.us/programs/Air/Documents/GoodNewsReport2012/GoodNews2012finalinteractive.pdf

Maryland Department of Natural Resources (MDNR). 2015. 2015 Blue Crab Winter Dredge Survey. Web. <http://dnr2.maryland.gov/fisheries/Pages/blue-crab/dredge.aspx>

Maryland Port Administration (MPA). 1990. *Port of Baltimore Dredged Material Management Master Plan*. May 1990.

MPA, 2011. The Economic Impacts of the Port of Baltimore 2010. December 16, 2011. http://mpa.maryland.gov/_media/client/planning/2012/EconomicImpact.pdf

MPA, 2016. Port Scores With Best Ever First Quarter Performance. June 2, 2016. http://www.mpa.maryland.gov/_media/client/News-Publications/2016/060216.pdf

Mason, R.P. and Lawrence, A.L., 1999. Concentration, distribution, and bioavailability of mercury and methylmercury in sediments of Baltimore Harbor and Chesapeake Bay, Maryland, USA. Environmental Toxicology and Chemistry, 18(11), pp.2438-2447.

McGee, B.L., Fisher, D.J., Yonkos, L.T., Ziegler, G.P. and Turley, S., 1999. Assessment of sediment contamination, acute toxicity, and population viability of the estuarine amphipod Leptocheirus plumulosus in Baltimore Harbor, Maryland, USA. Environmental Toxicology and Chemistry, 18(10), pp.2151-2160.

National Oceanic and Atmospheric Administration (NOAA). 2003. National Marine Fisheries Service (NOAA Fisheries) Endangered Species Act Section 7 Consultation, Biological Opinion. July 24, 2003.

NOAA. 2014. Guide to Essential Fish Habitat Designations in the Northeastern United States. Retrieved February 24, 2014, from http://www.nero.noaa.gov/hcd/webintro.html

NOAA. 2014. Greater Atlantic Regional Fisheries Office's Protected Resources Division Website. Retrieved February 26, 2014, from https://www.nero.noaa.gov/protected/index.html

Perry, Harriet M. and McIlwain, Thomas D. 1986. Species Profiles: Life Hi stories and Environmental Requirementsof Coastal Fishes and Invertebrates (Gulf of Mexico) Blue Crab. http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-055.pdf

Princeton Aqua Science (PAS), 1985. Baltimore Harbor, Maryland Sediment Sampling and Analysis. Prepared for the Baltimore ACOE. June.

Spaur, C. CENAB. Personal Communication with Christopher Spaur, 2005.

Spoil Disposal Criteria Committee (SDCC), 1975. Spoil Disposal Criteria for Maryland Waters.

Starcrest Consulting Group, LLC for the Port Authority of New York & New Jersey. 2002. Marine and Land-Based Mobile Source Emission Estimates for 50-Foot Deepening Project, Rev. 3 Jan 2002.

Tsai, C.F., Welch, J., Chang, K.Y., Shaeffer, J. and Cronin, L.E., 1979. Bioassay of Baltimore harbor sediments. Estuaries, 2(3), pp.141-153.

United States Army Corps of Engineers, Baltimore District (USACE). 1981. *Main Report and Environmental Statement, Baltimore Harbor and Channels, Maryland and Virginia: Final Combined Phase I and II General Design Memorandum.* August 1981.

USACE. 1997. Baltimore Harbor Anchorages and Channels, Maryland and Virginia: Integrated Feasibility Report and Environmental Impact Statement. March 1997.

USACE. 2001. Baltimore Harbor Anchorages and Channels, Maryland and Virginia: Final Supplemental Environmental Assessment and Finding of No Significant Impact. November 2001.

USACE. 2002. Essential Fish Habitat Assessment: Baltimore Harbor and Channels Federal Project Maintenance Dredging of 42- and 50-foot Navigation Channels for Calendar Years 2002 and 2003. August 2002.

USACE. 2005. Appendix E: Cultural Resources Survey for the Dredged Material Management Plan (DMMP) and Environmental Impact Statement (EIS) Baltimore Harbors and Channels. U.S. Army Corps of Engineers, Baltimore District.

USACE. 2009. Final Mid-Chesapeake Bay Island Ecosystem Restoration Integrated Feasibility Report and Environmental Impact Statement (EIS). U.S. Army Corps of Engineers, Baltimore District. April 2009.

USACE. 2013. Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island, Talbot County, Maryland: Limited Reevaluation Report. September 2013.

U.S. Army Corps of Engineers, Philadelphia District. 1996. *Chesapeake and Delaware Canal-Baltimore Harbor Connecting Channels (Deepening) Delaware and Maryland: Final Feasibility Report and Final Environmental Impact Statement (EIS).* August 1996.

USACE, Maryland Department of Natural Resources, and the Virginia Marine Resources Commission. 2009. Final programmatic environmental impact statement for oyster restoration in Chesapeake Bay including the use of a native and/or nonnative oyster. 386 pages, plus Appendices. http://www.nao.usace.army.mil/OysterEIS/

United States Fish and Wildlife Service, Information, Planning, and Conservation System (2014) Retrieved February 26, 2014, from http://ecos.fws.gov/ipac/

Versar. 1990. *Assessment of the Feasibility of Utilizing the Deep Trough as a Dredge Disposal Site.* Contract report prepared for the Power Plant and Environmental Review Division, Maryland Department of Natural Resources, in response to a request from the Maryland Port Administration. Columbia, Maryland.

VIMS (Virginia Institute of Marine Science). 2005. Impact of York River Entrance Channel Dredge Material at the Wolf Trap Alternate Dredge Material Placement Area on the Blue Crab Spawning Stock.

VMRC (Virginia Marine Resources Commission). 2012. Virginia Blue Crab Sanctuary: Blue Crabs in Virginia. Virginia Places. Web. 4 Feb. 2016. http://www.virginiaplaces.org/natural/crabs.html.

Weisberg, S.B., Ranasinghe, J.A., Dauer, D.M. Schaffner, L.C., Diaz, R.J., and Frithsen, J.B. 1997. An estuarine benthic index of biotic integrity (B-IBI) for Chesapeake Bay. *Estuaries*, 20, 149-158.

WESTON (Weston Solutions, Inc.). 2002a. Final Report: Preliminary Assessment of Environmental Conditions on Barren Island, Dorchester County, Maryland. West Chester, PA. Prepared for Maryland Environmental Service. Annapolis, MD.

WESTON. 2002b. Biological Assessment for the Shortnose Sturgeon in the Waters Surrounding the U.S. Army Garrison Aberdeen Proving Ground, Maryland. West Chester, PA. Prepared for Aberdeen Proving Ground, The Directorate of Safety Health and the Environment. Aberdeen Proving Ground, MD.

Wikar, K. "Crust Management Benefits Provide Higher Placement Capacity at Maryland Port Administration Containment Facility." Massachusetts Institute of Technology Sea Grant Center for Coastal Resources, Conference on Dredged Material Management: Options and Environmental Considerations, December 3-5, 2000.