DRAFT SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT

and

FINDING OF NO SIGNIFICANT IMPACT

OYSTER RESTORATION IN THE TRED AVON RIVER OYSTER SANCTUARY, MARYLAND

U.S. ARMY CORPS OF ENGINEERS, BALTIMORE DISTRICT

July 2016

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EXECUTIVE SUMMARY

The Baltimore District of the U.S. Army Corps of Engineers (USACE-Baltimore) is proposing to expand oyster reef restoration efforts into water depths between 6.5 and 9 feet mean lower low water (MLLW) within the Tred Avon River Oyster Sanctuary, Talbot County, Maryland. The Tred Avon River Oyster Sanctuary encompasses all waters of the Tred Avon River upstream from Oxford, Maryland[1]. For the purposes of this environment assessment (EA), 'oyster reef restoration efforts' to be evaluated include 1) substrate reef restoration, 2) planting of spat-on-shell (seeding) on substrate reefs, and 3) planting of spat-on-shell on existing oyster reef habitat. The Tred Avon River Oyster Sanctuary Tributary Plan, developed by the Maryland Oyster Restoration Interagency Workgroup (MIW) identifies a restoration target of 146 acres.

The restoration of reef habitat using substrate, typically alternate substrates, is a USACE action. Maryland Department of Natural Resources (MD DNR), the non-federal sponsor for this project, produces the spat-on-shell at the state-owned Horn Point Hatchery, and provides for the planting of the spat-on-shell at restoration sites by the Oyster Recovery Partnership (ORP). The National Oceanic and Atmospheric Administration (NOAA provides funding for hatchery operation, planning expertise, and sonar surveys of bottom habitats.

This project is authorized under Section 704(b) of the Water Resources Development Act (WRDA) of 1986, as amended by Section 505 of WRDA 1996, Section 342 of WRDA 2000, Section 113 of the Energy and Water Development Appropriations Act (EWDA) of 2002, Section 126 of the EWDA of 2006, and Section 5021 of WRDA 2007, and Section 4010(b) of WRRDA 14. Section 704(b) is a Civil Works authority that authorizes USACE to construct alternative or beneficially modified habitats for indigenous fish and wildlife, including man-made reefs for fish habitat in the Chesapeake Bay. The non-Federal share of the cost for projects completed under Section 704(b) is 25 percent. MD DNR is the non-Federal sponsor for this project, and is contributing their share through in-kind services.

This EA is prepared in accordance with the National Environmental Policy Act (NEPA), 1969 as amended. Previous NEPA documentation completed in 1996, 1999, 2002, and 2009 evaluated the impacts of oyster reef restoration at water depths that maintained at least an 8 foot water column (navigational clearance) above restored reefs, including 26 acres in the Tred Avon River. In 1996, USACE-Baltimore produced a report entitled *Chesapeake Bay Oyster Recovery Project, Maryland* that identified six Oyster Recovery Areas (ORA's) including the Choptank River complex (which includes the Tred Avon River). Three years later, a 1999 supplemental EA was conducted to evaluate the impacts associated with constructing 18 acres of seed bar habitat in Eastern Bay located in Queen Anne's County, Maryland. In May 2002, the Baltimore District prepared the *Chesapeake Bay Oyster Recovery Project, Maryland Decision Document* to include project construction beyond 2000 and to increase the total project cost. This construction, known as Phase

[1] MD DNR has designated the Tred Avon River Oyster Sanctuary as all of the waters of the Tred Avon River north and east of a line beginning at a point on the shore on the east side of Town Creek, defined by Lat. 38^{o}41.835'N, Long. 76^{o}9.923'W; then running 255^{o} True to a point defined by Lat. 38^{o}41.823'N, Long. 76^{o}9.981'W; then running 0^{o} True to a point on the shore of the east side of Plaindealing Creek, defined by Lat. 38^{o}42.576'N, Long. 76^{o}9.978'W (MD DNR 2010).

II, continues today. In May 2009, the Baltimore District completed a separate stand-alone EA that evaluated the use of alternate substrate materials for constructing reef habitat due to the shortage of oyster shell entitled *Chesapeake Bay Oyster Restoration Using Alternate Substrate, Maryland*[2]. These documents are available at http://www.nab.usace.army.mil/Missions/Environmental/OysterRestoration.aspx.

Consistent with current NEPA documentation, up to 1 foot of material is placed on the bottom to restore reef habitat, which limits restoration for substrate reef construction to water depths deeper than 9 feet MLLW (depending on the amount of material placed) in order to maintain 8 feet of navigational water clearance. Prior to large-scale restoration efforts, maintaining a standard 8 foot navigational clearance for substrate reef placement was a straightforward way to address and avoid navigational conflicts, and there was sufficient habitat in deeper waters to satisfy the smaller restoration efforts. However, with the transition to large-scale oyster restoration to achieve system-wide impacts (USACE 2012), expanding restoration efforts into shallower water depths more fully represents the extent of historic reef habitat. Utilizing a broader range of the water column seeks to maximize habitat coverage and diversity.

With this supplemental EA, USACE is proposing to expand USACE-conducted oyster reef construction through substrate placement into water depths between 6.5 to 9 feet MLLW resulting in at least 6 feet of navigational water clearance across a maximum of 57 acres. Additionally, USACE is evaluating the MD DNR-led planting of spat-on-shell on constructed reefs and on existing oyster reef within the sanctuary on 71 acres. The spat-on-shell plantings on existing oyster reef can occur between 4 and 20 feet MLLW based on the natural location of the reef. Plantings on existing reefs are not subject to navigational clearance requirements as these sites are current reefs and a minor change in height will result from the project. The planting of spat-on-shell by MD DNR serves as the sponsor's in-kind contribution for the project, and therefore is evaluated in this EA as part of the 704(b) oyster restoration program.

A minimum 6 foot water column would be maintained above restored substrate reefs within the Tred Avon River oyster sanctuary following placement of up to 12 inches of substrate material and spat-on-shell. Planting of spat-on-shell on existing bars (i.e., seed only sites) in water depths between 4 to 20 feet MLLW and on newly constructed bars in water depths between 6.5 to 9 feet MLLW will result in a minor change in reef height (1 to 3 inches).

Although, native oyster shell is the preferred substrate by many stakeholders and will be used for reef restoration if it were to become available at a future time, the proposed reef restoration is expected to be accomplished using alternate substrates such as stone and non-oyster shell, because native oyster shell is currently unavailable. Stone to be used would be between 3 and 6 inches in size. The proposed actions evaluated in this supplemental EA are a significant part of a multi-

[2] These documents are incorporated by reference into this EA as *USACE, 1996. Chesapeake Bay Oyster Recovery Project Report, January 1996; USACE, 1999. Supplemental Environmental Assessment for the Construction of Seed Bars in Eastern Bay as Part of the Chesapeake Bay Oyster Recovery Project, Maryland, July 1999; USACE*2002. *Chesapeake Bay Oyster Recovery Project Maryland; May 2002;* and *USACE, 2009. Final Environmental Assessment and Finding of No Significant Impact: Chesapeake Bay Oyster Restoration Using Alternate Substrate Maryland.*

agency restoration effort outlined in the *Tred Avon River Oyster Restoration Tributary Plan: A blueprint for sanctuary restoration* (Maryland Oyster Restoration Interagency Workgroup 2015).

Based on the analysis conducted here, it is concluded that there would be no direct navigational impacts from the proposed project. Any proposed restoration sites that appeared to pose a navigational conflict were removed from the proposed plan or revised throughout the review process.

Recreational boaters, commercial watermen, and commercial barging operations are the primary users of the waterway. There are approximately 714 registered boats in the Tred Avon River. Drafts were available for 297 of the 714 registered boats. On average, these boats draw 3.2 feet, with a maximum of 11.8 feet. Of the registered boats with identified drafts, 26 boats have drafts greater than or equal to 6 feet. This equates to 8.75 percent of registered boats. USACE-Baltimore reached out to 500 residents along the Tred Avon River as well as to several marinas and the Tred Avon Yacht Club to determine where boat users traverse within the Tred Avon River and what common pathways are used. Further information on this outreach is discussed in the public involvement section of the report.

There are also two federally-maintained channels in the area, the Tred Avon River and Town Creek. No substrate placement is proposed within federally-maintained channels. At all substrate reef restoration locations, water clearance depths would continue to be at least 6 feet including the height of spat-on-shell. Substrate reef restoration sites cover a maximum of 57 acres across 33 sites. The water depth would be reduced between 7 to 15 inches following planting of spat-on-shell at reef restoration sites and between 1 to 3 inches at seed-only sites, thereby reducing the navigational clearance for boaters throughout the Tred Avon River in those areas.

Project impacts would be primarily positive. Oyster restoration efforts are expected to improve water quality through their filtering capability resulting in reduced sedimentation, enhanced and expanded habitat, and increased fisheries resources. Minor, temporary impacts from construction activities are likely to affect benthic organisms, local turbidity, recreational and commercial fishermen, some lifestages of fish (eggs, larval, and juvenile stages), noise, and aesthetics for residents. The only negative impact identified by public coordination was 1) the potential to negatively impact the ability of residents to safely navigate to and from their docks with boats that have deep drafts, and 2) a concern that alternate reef restoration sites would disrupt trotlining for crabs across those sites. During the public coordination process discussed in more detail in Section 8.1, USACE-Baltimore received input from over 50 residents within the Tred Avon watershed. During this process, all proposed oyster restoration sites that posed any interference for safe navigation to and from residents' docks and public marinas were removed.

SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT FOR THE TRED AVON RIVER OYSTER SANCTUARY PROJECT

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ACHP	Advisory Council on Historic Preservation
AIS	Automatic Identification System
B-IBI	benthic index of biotic integrity
BOEM	Bureau of Ocean Energy Management
CBF	Chesapeake Bay Foundation
CBP	Chesapeake Bay Program
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CFR	Code of Federal Regulations
CMECS	Coastal and Marine Ecological Classification Standard
DO	dissolved oxygen
DPS	distinct population segments
E.O.	Executive Order
EA	environmental assessment
EFH	essential fish habitat
ERDC	Engineer Research and Development Center
ESA	Endangered Species Act
EWDA	Energy and Water Development Appropriations Act
GIS	geographic information systems

GIT	Goal Implementation Team
HAB	harmful algal blooms
m^3	cubic meters
MD DNR	Maryland Department of Natural Resources
MDE	Maryland Department of the Environment
MGS	Maryland Geological Survey
MHT	Maryland Historical Trust
MIW	Maryland Oyster Restoration Interagency Workgroup
MLLW	mean lower low water
MLW	mean low water
MRC	Midshore Riverkeeper Conservancy
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
N	nitrogen
NCBO	NOAA Chesapeake Bay Office
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOB	natural oyster bars
OMP	Oyster Management Plan
OMW	Oyster Metrics Workgroup
ORA	Oyster Recovery Areas
ORET	Oyster Restoration Evaluation Team
ORP	Oyster Recovery Partnership
P	phosphorus
ppt	parts per thousand
RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation Recovery Information System
SAV	submerged aquatic vegetation
SHPO	State Historic Preservation Officer
TMDL	total maximum daily load
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USGS	U.S. Geological Service
VIMS	Virginia Institute of Marine Science
VMRC	Virginia Marine Research Commission
WRDA	Water Resources Development Act

1.0 INTRODUCTION

The Baltimore District of the U.S. Army Corps of Engineers (USACE-Baltimore) began native Eastern oyster restoration (*Crassostrea virginica*) efforts in 1996 and is proposing to extend oyster reef restoration into shallower water depths than has previously been performed by USACE-Baltimore in the Tred Avon River Oyster Sanctuary, Talbot County, MD. This environmental assessment (EA) evaluates constructing substrate reef habitat in waters between 6.5 to9 feet mean lower low water (MLLW) and planting disease-free spat-on-shell, or oyster seed, from state-owned hatcheries on those constructed oyster reefs as well as on existing reefs at water depths between 4 to 20 feet MLLW. Oyster seed is young-of-the-year oysters set on oyster shell in a hatchery. Previously, National Environmental Policy Act (NEPA) documentation evaluated the impacts of oyster reef restoration at water depths that maintain at least an 8 foot water column (MLLW) above restored reefs, including many proposed sites in the Tred Avon River (USACE 1996, 1999, and 2009).

Currently, between 6 inches to 1 foot of substrate material is placed on the bottom to restore reef habitat, which limits restoration to water depths deeper than 8.5 to9 feet MLLW in order to maintain 8 feet of navigational water clearance. This supplemental EA will evaluate the placement of reef habitat substrate in depths between 6.5 to9 feet MLLW and the planting of spat-on-shell on constructed and existing oyster reefs in depth between 4 to20 feet MLLW. Oyster reef construction through substrate placement at depths between 6.5 to9 feet MLLW would maintain at least a 6 foot water column above restored reefs. Depending on water depth available, 6-inch or 12-inch reefs are proposed for restoration. Restoration using the seed-only treatment, whereby spat-on-shell is planted on existing oyster bars, is targeted in waters 4 to20 feet deep. Plantings on existing reefs are not subject to navigational clearance requirements as these sites are current reefs and a minor change in height will result from the project. By expanding oyster reef restoration to areas that will provide a minimum 6-foot clearance, science-based oyster restoration goals for this tributary could be achieved; ultimately restoring native oyster populations and improving local habitat conditions throughout the tributary.

USACE's primary role in oyster restoration is construction of substrate reefs. Maryland Department of Natural Resources (MD DNR), the non-federal sponsor, is the primary lead for spat-on-shell plantings on both substrate reefs and existing oyster bars. The planting of spat-on-shell by MD DNR serves as the sponsor's in-kind contribution for the project, and therefore is evaluated in this EA as part of the 704(b) oyster restoration program.

1.1 Authority

This project is authorized under Section 704(b) of the Water Resources Development Act (WRDA) of 1986, as amended by Section 505 of WRDA 1996, Section 342 of WRDA 2000, Section 113 of the Energy and Water Development Appropriations Act (EWDA) of 2002, Section 126 of the EWDA of 2006, and Section 5021 of WRDA 2007. The authorization for the program is codified at 33 U.S.C. 2263, entitled 'Study of USACE Capability to Conserve Fish and Wildlife'. The full text of this authority and amendments is provided below:

(b) Projects
(1) In general
The Secretary is further authorized to conduct projects of alternative or beneficially modified habitats for fish and wildlife, including but not limited to man-made reefs for fish. There is authorized to be appropriated not to exceed $60,000,000 to carry out such projects.
(2) Inclusions
Such projects shall be developed, and their effectiveness evaluated, in consultation with the Director of the Fish and Wildlife Service and the Assistant Administrator for Fisheries of the National Oceanic and Atmospheric Administration. Such projects shall include--
...
(D) the restoration and rehabilitation of habitat for fish, including native oysters, in the Chesapeake Bay and its tributaries in Virginia and Maryland, including--
(i) the construction of oyster bars and reefs;
(ii) the rehabilitation of existing marginal habitat;
(iii) the use of appropriate alternative substrate material in oyster bar and reef construction;
(iv) the construction and upgrading of oyster hatcheries; and
(v) activities relating to increasing the output of native oyster broodstock for seeding and monitoring of restored sites to ensure ecological success.
(3) Restoration and rehabilitation activities
The restoration and rehabilitation activities described in paragraph (2)(D) shall be--
(A) for the purpose of establishing permanent sanctuaries and harvest management areas; and
(B) consistent with plans and strategies for guiding the restoration of the Chesapeake Bay oyster resource and fishery.
(4) Cost sharing
(A) In general
The non-Federal share of the cost of any project under this subsection shall be 25 percent.
(B) Form
The non-Federal share may be provided through in-kind services, including--
(i) the provision by the non-Federal interest of shell stock material that is determined by the Secretary to be suitable for use in carrying out the project; and
(ii) in the case of a project carried out under paragraph (2)(D) after June 10, 2014, land conservation or restoration efforts undertaken by the non-Federal interest that the Secretary determines provide water quality benefits that--
(I) enhance the viability of oyster restoration efforts;
(II) are integral to the project; and
(III) are cost effective.
(C) Applicability
The non-Federal interest shall be credited with the value of in-kind services provided on or after October 1, 2000, for a project described in paragraph (1) completed on or after that date, if the Secretary determines that the work is integral to the project.
(5) Definition of ecological success
In this subsection, the term “ecological success” means--
(A) achieving a tenfold increase in native oyster biomass by the year 2010, from a 1994 baseline; and
(B) the establishment of a sustainable fishery as determined by a broad scientific and economic consensus.
In carrying out paragraph (4), the Chief of Engineers may solicit participation by and the services of commercial watermen in the construction of the reefs.

This supplemental EA is prepared in accordance with NEPA, 1969 as amended,as a separate and concise document that builds upon prior NEPA documentation. The scope, however, is a tributary-level assessment of impacts including project alternatives for federal oyster restoration to occur within legally defined Natural Oyster Bars (NOBs) (as designated by the State of Maryland) of the Tred Avon River Oyster Sanctuary. Targeted restoration involving reef construction, seeding, and monitoring are proposed for up to 154 acres in the Tred Avon River based on the tributary plan developed by the Maryland Oyster Restoration Interagency Workgroup (MIW) (Appendix A).

1.2 Study Area

The study area for this project is the Tred Avon River Oyster Sanctuary within the Tred Avon River. The Tred Avon River is a tidal estuarine system located on Maryland's Eastern Shore in Talbot County (Figure 1). From Easton Point the river meanders nine miles to the southwest, where a broad, mile-wide, mouth discharges into the Choptank River. The river is long and shallow with several major tributaries and many minor creeks and streams. It is one of the main subwatersheds in the lower Choptank River system and historically was a major source of oysters, fish and other aquatic wildlife. The Tred Avon drains approximately 6 percent of the Choptank River watershed (approximately 7,300 acres) with a mean water volume of 3,476,500 m^3 (918.4 M gallons). The Choptank River system contributes 1.2 percent of the freshwater outflow to the Chesapeake Bay[3].

MD DNR has designated the Tred Avon River Oyster Sanctuary as all of the waters of the Tred Avon River north and east of a line beginning at a point on the shore on the east side of Town Creek, defined by Lat. $38^0$41.835'N, Long. $76^0$9.923'W; then running 255^0 True to a point defined by Lat. $38^0$41.823'N, Long. $76^0$9.981'W; then running 0^0 True to a point on the shore of the east side of Plaindealing Creek, defined by Lat. $38^0$42.576'N, Long. $76^0$9.978'W. Figure 2 provides a graphic of the Tred Avon River. The sanctuary boundary as designated by MD DNR includes all waters within the outlined pink border. The Tred Avon River Oyster Sanctuary was designated as a permanent sanctuary in September 2010 when MD DNR expanded the State's sanctuary network from 9 percent of the remaining oyster bar habitat to one that protects 24 percent of oyster bars. MD DNR expanded the sanctuary network in response to the recommendations of the Oyster Advisory Commission's 2008 Legislative Report and a comprehensive Federal/State Programmatic Environmental Impact Statement for Oyster Restoration in the Chesapeake Bay completed in 2009 (USACE 2009b). Areas selected at that time were chosen based on current water quality and restoration potential, computer-simulated wild oyster larvae dispersal patterns, and the realities of establishing enforceable boundaries (MD DNR 2010). MD DNR reviews the effectiveness of the locations of permanent sanctuaries and proposes changes where needed every five years.

System-wide, populations of the native Eastern oyster were once abundant throughout the Tred Avon River system (Appendix A). Today, *Crassostrea virginica* stocks and biogenic reef systems in the Tred Avon and the larger Chesapeake Bay have been significantly reduced from historic levels due to overfishing, habitat destruction, degraded water quality, sedimentation, and consequences of disease (Bricker et al. 1992). Due to the severity of the situation, targeted oyster

[3]http://waterdata.usgs.gov/md/nwis/annual/?format=sites_selection_links&search_site_no=01491000&referred_module=qw

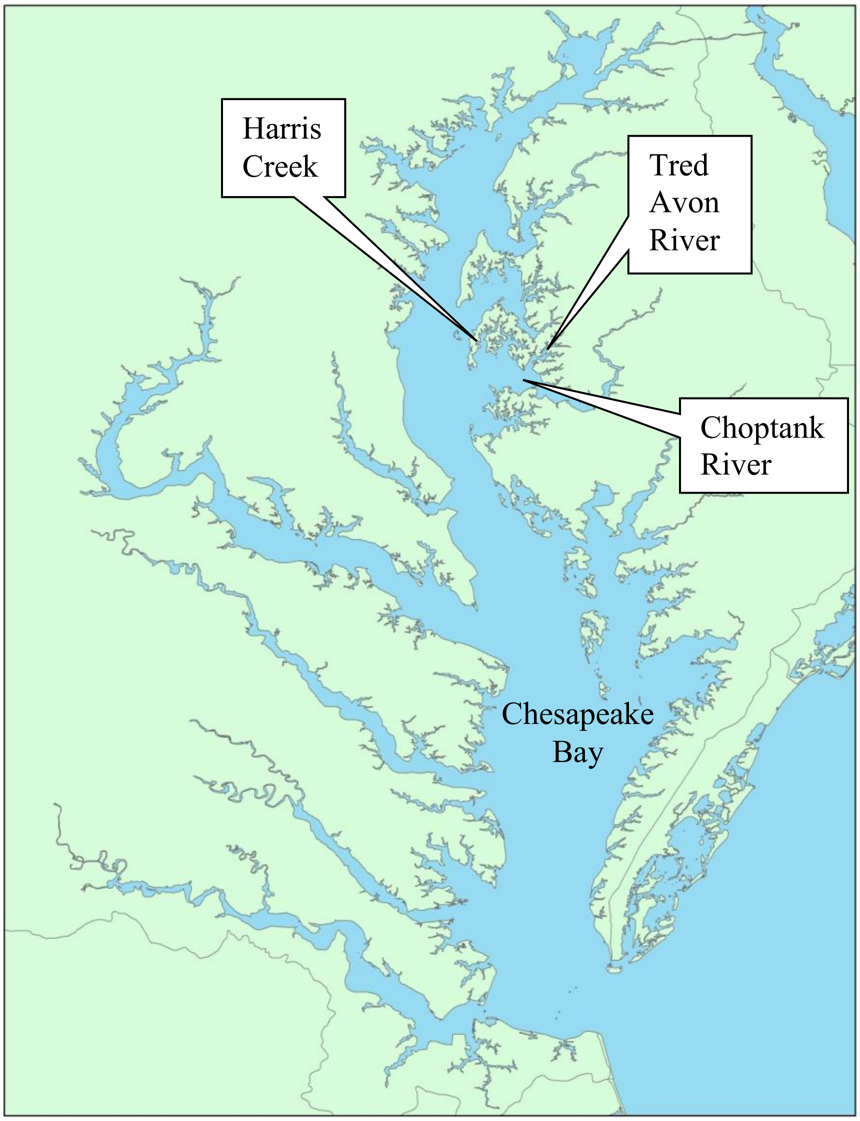

Figure 1. Tred Avon River within the Chesapeake Bay

restoration is being planned for the State of Maryland-designated Tred Avon River Oyster Sanctuary. The Tred Avon River is one of three initial tributaries selected for federal restoration work to be implemented by USACE-Baltimore in collaboration with the National Oceanic and Atmospheric Administration (NOAA) and MD DNR. Restoration efforts discussed in this EA are limited to the Tred Avon River Oyster Sanctuary established by MD DNR. To justify its investment is in the federal interest, USACE undertakes oyster restoration efforts in areas designated as sanctuaries by MD DNR.

Federal restoration investments in those sanctuaries are expected to be maintained as sanctuaries in perpetuity. The Tred Avon River Oyster Sanctuary itself covers approximately 3,937 acres, where no commercial harvest of oysters is allowed as of the 2010 sanctuary designation. Contained within the sanctuary limits is 2,101 acres designated by the State of Maryland as legally defined

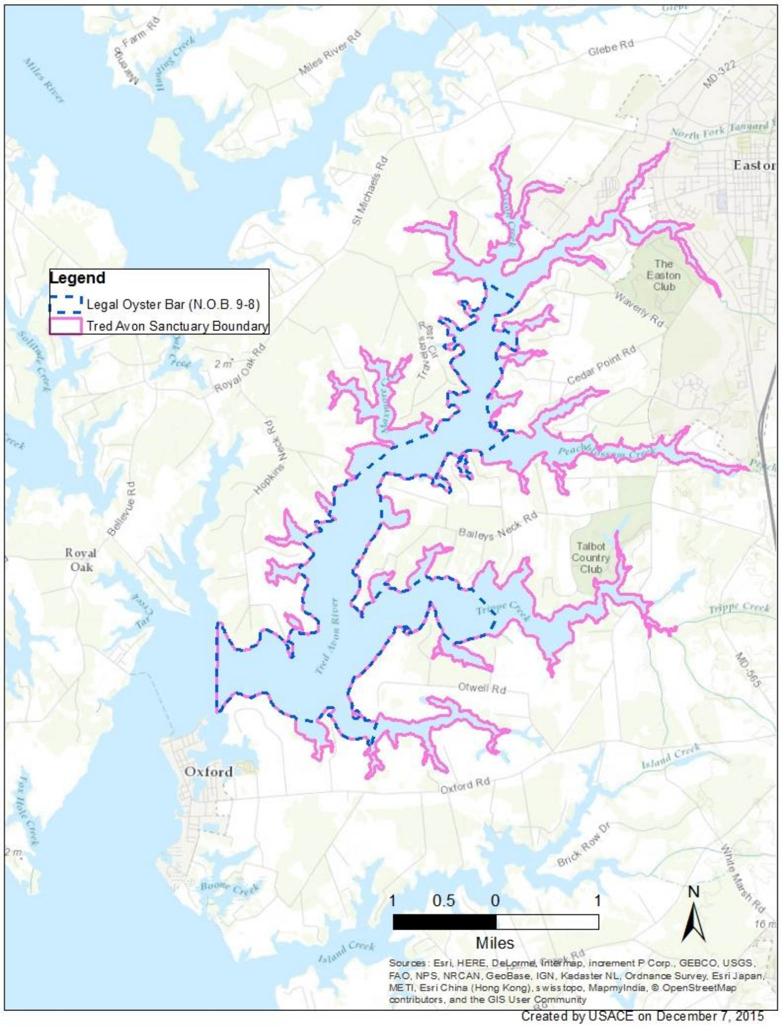

Figure 2. Location of the Tred Avon River Oyster Sanctuary

Natural Oyster Bars (NOBs). The NOBs represent locations and classifications of legally defined oyster bars formally adopted in 1983 by the State of Maryland. The historic oyster bar locations that were charted in the Yates Survey of 1913 were the original basis for the Maryland NOB designations. The goal of the restoration work within the NOBs is to facilitate large-scale oyster recovery and long-term sustainability of oyster populations throughout the Tred Avon River.

1.3 Recent and Proposed Federal Actions

1.3.1 Existing NEPA Analyses

In 1996, USACE-Baltimore produced a report entitled *Chesapeake Bay Oyster Recovery Project, Maryland* that identified six Oyster Recovery Areas (ORA's) including the Choptank River complex. Three years later, a 1999 supplemental EA evaluated the impacts associated with constructing 18 acres of seed bar habitat in Eastern Bay located in Queen Anne's County, Maryland. In May 2002, USACE-Baltimore prepared an additional decision document to include construction, known as Phase II, continues today. In May 2009, USACE-Baltimore completed a separate standalone EA that evaluated the use of alternate substrate materials for constructing reef habitat due to the shortage of oyster shell entitled *Chesapeake Bay Oyster Restoration Using Alternate Substrate, Maryland*. Most recently in 2014, USACE-Baltimore completed a supplemental EA focused on shallow water oyster restoration in Harris Creek.

1.3.2 Chesapeake Bay Protection and Restoration Executive Order

In 2009, the *Chesapeake Bay Protection and Restoration Executive Order* (E.O. 13508) was signed, calling on all federal agencies involved in Chesapeake Bay oyster restoration to formulate comprehensive strategies and to set clear and measurable goals for restoring native oyster habitat and populations in 10 tributaries by 2025 (revised from 20 tributaries). In response to the executive order, USACE recognized that a more coordinated Bay-wide approach throughout the Maryland and Virginia portions of the Chesapeake Bay was needed to guide future oyster restoration efforts and the investment of federal funding. As a result, the 2012 USACE *Native Oyster Restoration Master Plan* (Master Plan) evaluated problems and opportunities for oyster restoration in tributaries of the Chesapeake Bay, formulated broad plans, and offered recommendations for implementation of large-scale oyster restoration. A summary of past USACE restoration actions prior to 2011 is included in the Master Plan (USACE 2012).

The Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team (GIT) is charged with advancing the oyster goal of E.O. 13508. The GIT convened the Oyster Metrics Workgroup (OMW) to establish definitions and metrics to use in determining if restoration projects and tributaries have been successfully restored (OMW 2011). The GIT then established interagency workgroups in Maryland and Virginia to plan restoration work in each state, in consultation with appropriate partners. The Maryland Oyster Restoration Interagency Workgroup (MIW) is composed of representatives from NOAA, MD DNR, USACE-Baltimore, and the Oyster Recovery Partnership. The MIW is charged with developing and implementing large-scale oyster restoration plans to meet the oyster goal of E.O. 13508 and their respective agencies' goals.

<u>1.3.2.1Efforts to meet E.O. 13508 Oyster Goals</u>

MIW, in consultation with Maryland oyster restoration partners, selected Harris Creek as its first tributary for large-scale oyster restoration based on consideration of salinity levels, available restorable bottom, protection from harvest, historical spat set, and other factors. Harris Creek is a tributary on the north shore of the Choptank River, near its confluence with the Bay's mainstem. MIW developed a tributary restoration plan that outlines an objective of restoring and rehabilitating 377 acres of oyster reef habitat. Initial population surveys identified that 3 acres of existing reef habitat met the metric goals for oyster density. Between 2011 – 2015, USACE constructed 80 acres of 1-foot high oyster reefs using alternate substrates, composed primarily of mixed shell and granite, under the 704(b) authority, and MD DNR provided spat-on-shell for those sites as in-kind credit. These reefs were constructed within water depths 9 ft and deeper. In winter 2014 – 2015, USACE constructed an additional 55 acres of alternate substrate reefs in Harris Creek that provide for a 5 foot navigational clearance under the 704(b) authority and MD DNR provided spat-on-shell for those sites as in-kind credit. MD DNR also constructed and seeded 62 acres of substrate reef habitat. Additionally, 150 acres of existing reef habitat (seed-only sites) were rehabilitated with the addition of spat-on-shell plantings. All seeding and shell reefs were efforts credited under the 704(b) program. Some acreage was determined to be unsuitable as the plan was implemented, resulting in the final restoration of 350 acres (3 + 80 + 55 + 62 + 150), rather than 377 acres as initially identified in the Harris Creek Tributary Plan.

The Little Choptank River is the second tributary selected for restoration by the MIW. The Little Choptank River Tributary Plan outlines a goal of restoring 440 acres. Initial pre-restoration monitoring showed that 40 acres currently met the restoration targets. Between 2014 and 2015, 27.3 acres of reef habitat have been constructed by MD DNR and seeded. Another 124.5 acres have been constructed by MD DNR and partially seeded or have not received spat-on-shell yet. These reefs will be planted with seed oysters in 2016, as hatchery production allows.

The Tred Avon River, which is the focus of this document, is the third tributary selected for restoration. As USACE-Baltimore has existing NEPA documentation to enable restoration efforts in a portion of the Tred Avon (USACE 1996 and 2009), but not in the Little Choptank River, the MIW made the decision that in order to use resources most efficiently, USACE resources would be focused on reef restoration in the Tred Avon River, while MD DNR resources would be devoted toward reef restoration efforts in the Little Choptank River to fulfill E.O. 13508 oyster goals and the plans developed by MIW.

1.3.3 Tred Avon River Oyster Restoration Target Establishment

The oyster metrics report (OMW 2011) considered two criteria when establishing the definition for a successfully-restored tributary: 1) the current bottom condition, and 2) the extent of historical oyster reef habitat. A successfully-restored tributary is defined as a tributary where 50 – 100 percent of currently restorable bottom is restored. Additionally, the amount of restorable bottom that is restored must be at least 8 – 16 percent of historic oyster habitat. The Tred Avon River Oyster Sanctuary Restorable Bottom Assessment and Data Summary (NOAA 2013) identified approximately 251 acres of currently-restorable bottom habitat based on data from the USACE master plan, the oyster sanctuary boundaries, water quality data, and bottom survey data from Maryland Geological Survey and NOAA. In order to meet the 50 – 100 percent of currently-restorable bottom goal, 125 to 251 acres would need to be restored in the Tred Avon River (Appendix B, Figure 8). The second part of the Oyster Metrics goal is that this amount—125 to 251 acres—must constitute at least 8 percent of historical oyster habitat. The Yates Survey of 1913 is used to represent historical oyster habitat since it is the oldest Maryland-wide survey. However, Yates bars represent historical legal bars and not biological boundaries. Yates charted 851 acres of legal oyster bar boundaries in the river; 8 to 16 percent of that is 68 to 136 acres (Yates 1913) (Figure 3). Therefore, restoring between 125 and 251 acres would meet both of the Oyster Metrics goals.

The 251 acres were analyzed in GIS to make more uniform polygons that could be feasibly constructed, incorporate public input on waterway use conflicts, and provide for buffers around navigational channels, aids to navigation, and private docks. This reduced the target to 182.4 acres. An additional 28 acres were removed from the restoration target to serve as project controls (see controls section). The result was a target of 154.4 acres (rounded to 154). A total of 71 of the 154 acres are planned as seed-only treatment (spat-sets) and the remaining 83 acres for the placement of substrate and seeding. One final adjustment was made to reach the final Tred Avon restoration

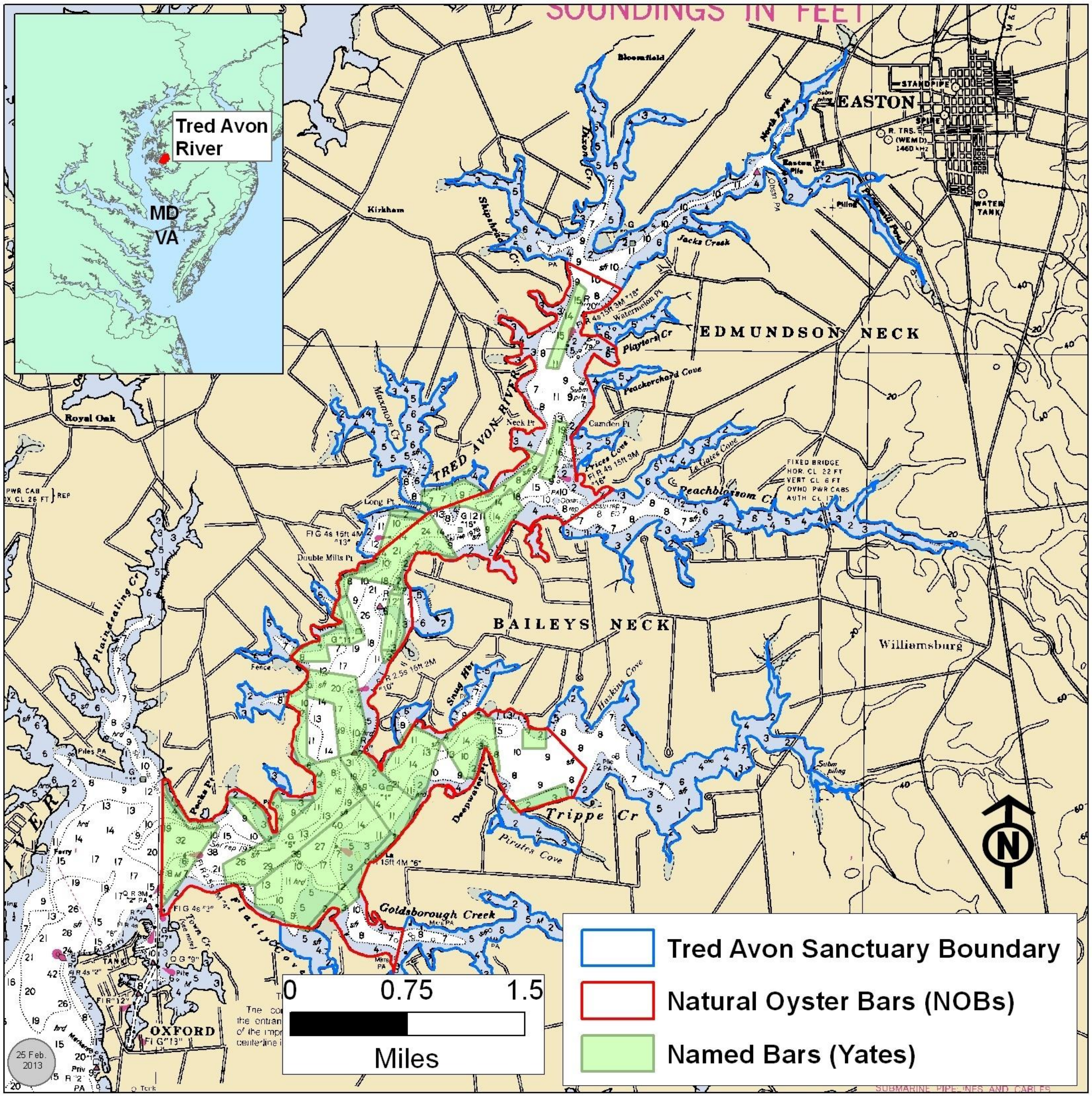

Figure 3. Yates Bars in the Tred Avon River (provided by NOAA)

goal. Diver ground truthing has shown that sonar surveys may overestimate the area of shell bottom suitable for placing oysters on existing bars. Based on restoration field experience, the MIW assumed that the suitable area as determined by sonar will be reduced by 10 percent upon examination by divers. Therefore, a 10-percent reduction *of the area targeted for seed-only* provides for a range of 63 – 71 acres (rounded) of seed-only acreage and reduces the 154 acres identified to 146 acres. This amount, 146 acres, is the actual oyster restoration goal for the Tred Avon oyster sanctuary. [The current Tred Avon River Tributary Plan states 147 acres. The

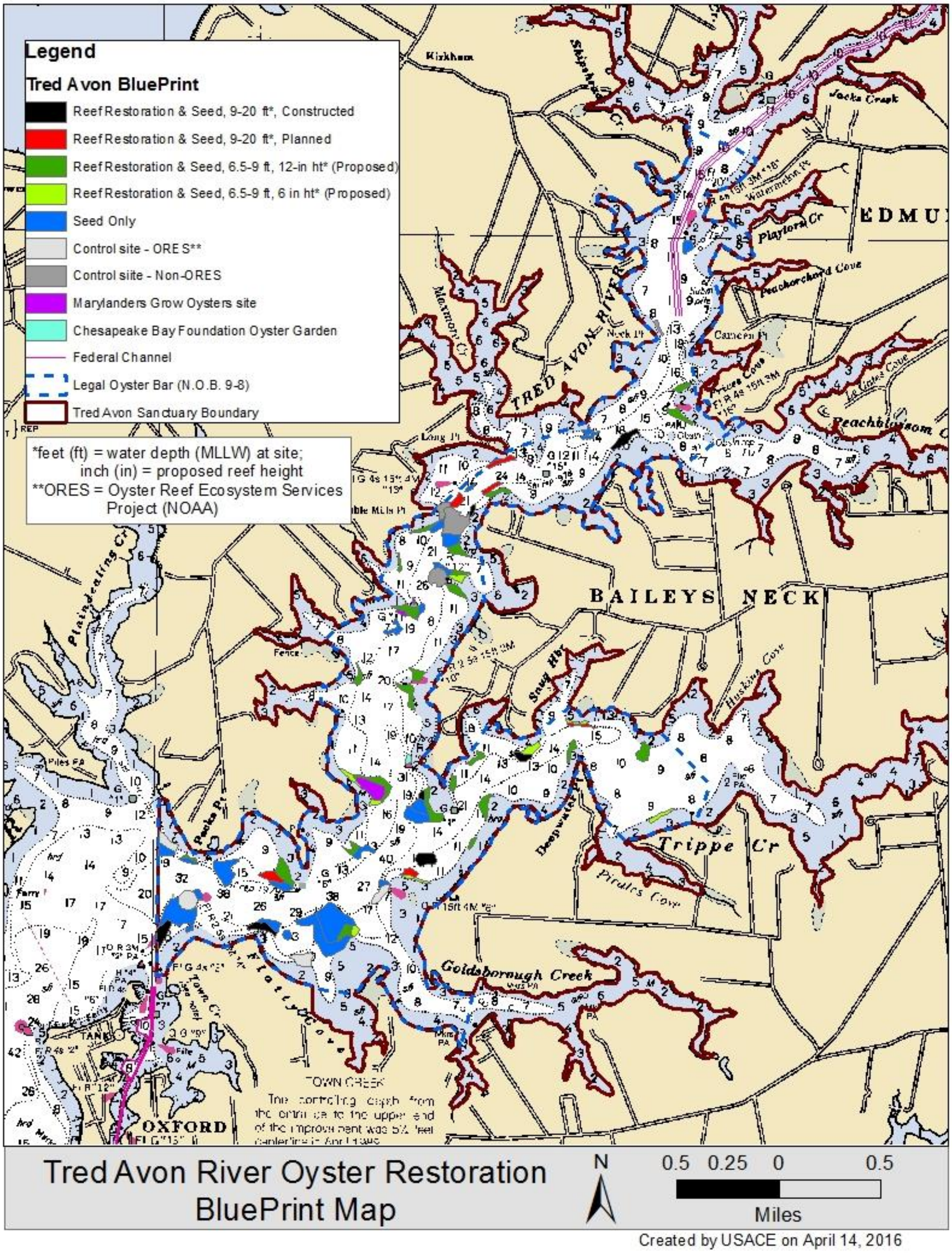

Figure 4. Tred Avon River Tributary Plan BluePrint Map

Tributary Plan is a living document, and as such will be updated to reflect the 146 acre target at a future time.]

The complete 71 acres of seed-only treatment is evaluated because it is unknown which acreages will be determined to be unsuitable with future investigations such as diver ground truthing. Figure 4 presents the Tred Avon Tributary Plan. Of the 83 acres planned as substrate reefs: 26 (25.8) acres would provide 8 feet navigational clearance (>9 feet MLLW) and 57 (57.1) acres would provide 6 feet navigational clearance (6.5 – 9 feet MLLW).

The workgroup considers new information as it develops to make any needed changes to the areas designated in the Tributary Plan for substrate placement and seeding. Although the restoration goal is set at 146 acres, this EA evaluates restoration and rehabilitation efforts throughout the sanctuary to cover any minor adjustments to polygon boundaries that may be necessary in the future. The total acreage that has been determined to be technically feasible for either substrate placement in water depths between 6.5 and 9 feet MLLW (57 acres) or seed-only treatment on existing bars (71 acres) is 130 acres based on current information in the Tred Avon River Tributary Plan. The 130 acres plus the 24 acres of deep water alternate substrate restoration comprises the total 154 acres of the Tred Avon River Tributary Plan. Build-out for the entire project is estimated to take 3 to 5 years from initial construction. Table 1 provides a summary of the derivation of the restoration target.

Table 1. Calculation of the Tred Avon River Restoration Target

	Acres
Tred Avon Sanctuary	**3,937**
Restorable Bottom	**251**
Metrics Goal #1 - 50-100% of Restorable Bottom	125-251
Yates Bars	**851**
Metrics Goal #2 - 8-16% of Yates Bars	68-136
Accounting for navigation and dock buffers, irregularity of boundaries, public input (68.6 ac)	182.4
Removal of Control Sites (28 ac)	154.4
ACREAGE AVAILABLE FOR RESTORATION	**154**
Reduce seed-onlys sites by 10% to account for groundtruthing loss (8 acres)	63-71
RESTORATION TARGET	**146**
Substrate and seed sites, > 9 ft MLLW	***26***
Substrate and seed sites, 6.5-9 ft MLLW	***57***
Seed-only sites	***71***

2.0 PURPOSE, NEEDS, and OBJECTIVES

This supplemental EA is being prepared for the Tred Avon River Oyster Sanctuary to expand oyster restoration and rehabilitation activities for reef bar construction and seeding into shallower depths of the sanctuary. This supplemental EA evaluates the impacts of restoring oyster reef habitat through substrate placement in water depths that maintain a 6-foot water column above restored substrate reefs. The supplemental EA also evaluates spat-on-shell plantings on constructed and existing oyster bars that will have a minor change in their elevation by approximately 1 – 3 inches. The potential impacts of expanding substrate reef restoration work into shallower depths have not been evaluated under existing NEPA documentation. As a result of changing an 8-foot minimum navigational depth clearance to allow substrate reefs to be placed in areas with a 6-foot minimum navigation depth clearance, the NEPA process provides the opportunity for USACE-Baltimore to evaluate the effects of this action on the quality of the human environment. Given the focus on large-scale tributary based restoration, it is necessary and appropriate to consider restoring oyster reef habitat across broader depth contours within the historic oyster habitat footprint. By removing the 8-foot minimum navigation depth clearance, oyster restoration goals for this tributary could be achieved to help restore native oyster populations and improve local habitat conditions throughout the tributary.

2.1 Purpose

The proposed activities that are the subject of this supplemental EA include 1) replacing the 8-foot minimum navigational depth clearance for previously authorized activities under the 704(b) Program with a 6-foot minimum navigational clearance for placement of substrate to restore reef habitat, 2) the construction of oyster reef habitat, and 3) the planting of spat-on-shell on restored reefs and on existing shell reefs.

Prior to large-scale restoration efforts, maintaining a standard 8 foot navigational clearance was a straightforward way to address and avoid navigational conflicts from placement of substrate for reef restoration, and there was sufficient habitat in deeper waters to satisfy the smaller restoration efforts. However, with the understanding that large-scale oyster restoration was necessary to achieve system-wide impacts (USACE 2012), shallower water depths are needed to utilize areas for restoration that historically contained oyster habitat in order to maximize habitat coverage and diversity. Maintaining a 6-foot minimum navigational clearance applies only to reefs that require substrate placement for restoration, and not to augmentation of existing reefs with spat-on-shell. Seeding of existing oyster reef is situated in water depths between 4 and 20 feet. As spat-on-shell reduces water depths by 1 – 3 inches at seed-only sites, there would be no significant impact on navigation. Reefs rehabilitated using shell (if available) or alternate substrate will also receive a planting of spat-on-shell in the Tred Avon River.

The purpose of this supplemental EA is to evaluate the environmental impacts of the expansion of oyster reef restoration between the depths of 6.5 to 9 feet MLLW within the Tred Avon River oyster sanctuary. Expanding the potential area where oyster restoration activities can occur will allow *Chesapeake Bay Protection and Restoration Executive Order* (E.O. 13508) outcomes and 2014 Chesapeake Bay Agreement goals to be met and implement restoration efforts over a broader portion of historical habitat.

2.2 Needs

The Oyster Metrics Workgroup and the USACE team that developed USACE's Oyster Restoration Master Plan (USACE 2012) worked to define the scale needed to have a system-wide impact on a tributary in order to achieve a sustainable long-term project. The USACE team considered the size typically reserved for Marine Protected Areas (20 – 70%), the fact that sessile bivalves such as the oyster would be expected to fall on the lower end of the Marine Protected Areas (MPA) range, as well as past knowledge of the scale of restoration efforts in the Chesapeake Bay. This information guided the decision to target 20 – 40% of historical oyster habitat within the sanctuary, which equates to 8 – 16% of Yates Bars once adjustments were made for discrepancies in historical boundaries (USACE 2012 provides a detailed explanation of the determination of scale). The team recognized that one number will not fit every circumstance, and therefore included the recommendation that the range should be revised to a more precise number by the follow-on tributary plans. Further explanation on defining scale is available in USACE (2012).

Incorporating the Master Plan definition of scale, The Oyster Metrics Workgroup (OMW 2011) defined success criteria for oyster restoration efforts in the Chesapeake Bay. The following metrics were established:

- A successfully-restored reef should:
  - have a minimum mean density of 50 oysters and 50 grams dry weight/square meter (m2) covering at least 30 percent of the target restoration area at 6 years post restoration;
  - have two or more age classes present; and
  - exhibit stable or increasing spatial extent, reef height and shell budget[4].
- A successfully-restored tributary is one where 50 – 100 percent of the currently restorable bottom has oyster reefs that meet the reef-level metrics above. Restorable bottom is defined as area that, at a minimum, has appropriate bottom quality and water quality for oyster survival.
- A suitable candidate tributary is one where 50 – 100 percent of the currently restorable bottom is equivalent to at least 8 percent, and preferably more, of its historic oyster bottom.

These metrics are applicable for a tributary or a portion of a tributary based on the sanctuary boundaries. For the Tred Avon River, these metrics will be applied to restoration efforts within the Tred Avon River Oyster sanctuary boundaries.

The overall tributary plan for the Tred Avon River has identified 154 acres available for oyster restoration within water depths of 4 and 20 feet MLLW (Table 2), with a resulting target of 146

[4] Shell budget refers to the accounting of the material oyster shells are made from. That is, the processes to result in the addition and subtraction of shell from a system. Failure to maintain existing shell quantities or continued loss of shell is a signal that the project is not sustainable.

Table 2. Summary of Restoration Acreage

Restoration Type	Depth Interval (feet)	Total Acres	Mean Acres per Site	Min. Acres per Site	Max. Acres per Site	Number of Restoration sites
Substrate and Seed	6.5-9	57	1.7	0.6	4.1	33
Substrate and Seed (previously evaluated under NEPA)	9-20	26	2.0	0.7	3.4	14
Seed Only	4-20	71	3.1	0.5	23.3	23
Total Restorable Bottom	4-20	154				

acres. The potential acreage includes areas that have some degree of exposed shell that will only require planting of oyster seed (between depths of 4 and 20 feet) as well as hard bottom that willneed placement of reef substrate and oyster seed (between depths of 6.5 and 20 feet). There are 83 acres of the 154 acre target that are designated as areas for reef construction with seed planting. Of the 83 acres, only 26 acres are at depths greater than 9 feet and have currently been evaluated under NEPA for implementation. The majority of sites targeted for reef construction, USACE's primary role in Maryland oyster restoration, are within water depths between 6.5 and 9 feet. Therefore, it is necessary to expand the water depths where oyster reef habitat restoration can occur to reach the restoration target of the tributary plan and provide the greatest likelihood that restored oyster resources will have a system-wide response and become self-sustaining.

2.3 Problem Identification

Chesapeake Bay oyster resources have been classified as "poor," (Beck et al. 2011) which equates to a 90 to 99 percent habitat loss with partial or complete fishery collapse. While some bars remain, their long-term viability is questionable. The demise of Chesapeake Bay oyster populations can be attributed to four main causes: loss of habitat (substrate), oyster diseases, water quality degradation, and commercial harvesting. Further discussion of the problems facing oysters and historic oyster decline in the Chesapeake Bay is available in USACE (2009) and USACE (2012). Oyster restoration efforts prior to signing of E.O. 13508 were geographically scattered and too small in scale to have a system-wide impact with the exception of the Great Wicomico River, VA project. The current Maryland strategy to address these past problems is to work within large, designated sanctuaries, take a tributary approach and work throughout all feasible water depths within that tributary to restore habitat in order to provide the appropriate scale. Given the current limitation of placing substrate materials for reef construction in locations where 8-feet of water depth must be maintained above the reef structure, the spatial scale at which additional reef habitat could be constructed would be substantially limited to a degree that would jeopardize project objectives.

Restoration at diverse depths throughout the Tred Avon River will increase the spatial extent and connectivity of restoration actions to maximize habitat and support larval retention and settlement success, a particular focus of USACE's Master Plan. Previous restoration efforts in the Chesapeake Bay tributaries have been limited in scope and spatial connectivity (USACE 2012). By removing the 8-feet minimum navigational depth clearance for placement of substrate to restore reef habitat, two identified goals for a successfully-restored tributary are met in addition to expanding federal activities into historically recognized zones of oyster spawning, transport, and larval setting. Work in a broad range of water depths provides the best circumstances for influencing stock/recruit relationships, which, in turn, will make on-the-ground restoration more likely to achieve ecological success (USACE 2012).

Research supports expanding substrate reef restoration activities at the 6-foot bathymetric contour. Seliger and Boggs (1988) studied oyster populations in Broad Creek and the Tred Avon River and determined that the 6-foot MLLW zone is a zone that was highly supportive of oyster habitat where it was associated with steep bathymetric gradients. Bathymetric gradients promote successful restoration due to continuous influx of food and efflux of sediment and waste and are a targeted area for construction of individual reefs and rehabilitation (USACE 2012).

Shallower areas may allow oyster larvae to take full advantage of flood tidal currents by timing their vertical swimming activity (Boicourt 1982). Further, shallow-water oyster beds have a lower risk of exposure to anoxic conditions (Seliger et al. 1982).

If the 8 feet depth restriction on substrate reef restoration is not changed to 6 feet MLLW, restoration would only be capable of reaching 8 percent of historic Yates's Bars surveyed (68 acres). In that situation, 26 acres of deep water substrate reefs would be restored as well as 63 – 71 acres of seed-only treatment. The goal of restoring 50 – 100 percent (125 – 251 acres) of currently restorable bottom surveyed would not be attainable. Removing the 8-foot minimum navigation depth clearance for placement of substrate to restore reefs meets both habitat goals and allows for increased restoration acreage to be obtained (up to 154 acres). This, in turn, is anticipated to support higher reproduction levels for larval transport models and retention rates within the tributary contributing to a more sustainable restoration project long-term.

2.3.1 Brief Description of the Project

The Tred Avon River was selected as the third candidate tributary for large-scale oyster restoration by MIW. The selection is predicated on the findings of the 2012 Master Plan, fall survey data collected by MD DNR, existing Chesapeake Bay Program water quality monitoring data, Maryland oyster sanctuary designations, and bottom survey data obtained by the Maryland Geological Survey (MGS) and NOAA. Following identification of a tributary for restoration, a detailed tributary plan is developed to determine the restoration target and specific locations for restoration within the tributary. Restoration efforts are then carried out in subsequent years until the restoration target is reached. Monitoring and adaptive management occur in the years following completion of initial restoration efforts. Typical roles of oyster restoration partners follow:

- NOAA- pre- and post-restoration bottom surveying and GIS analysis,
- USACE-Baltimore- substrate reef construction, monitoring,
- MD DNR- hatchery operation/spat-on-shell production, monitoring, substrate reef construction, acquire necessary permits for spat-on-shell planting, and
- ORP (Oyster Recovery Partnership)[5]- spat-on-shell plantings, pre-restoration surveys, post-planting surveys.

A number of surveys were conducted to develop the tributary plan and identify specific restoration locations. Initially, MGS and NOAA Chesapeake Bay Office (NCBO) conducted side-scan sonar surveys for the Tred Avon River in 2009 that provided baseline data identifying bottom type. A more detailed multi-beam survey of the riverbed was completed by NCBO to determine the quality of the bottom habitat and its ability to support restoration actions. Only the areas between minus 4 and 20 feet MLLW were considered suitable for restoration since deeper waters typically experience lower dissolved oxygen (DO) levels and higher sedimentation rates that are not conductive to reef community structure. After completing a waterways analysis for the Tred Avon River, water depths in the range of minus 4 – 6 feet MLLW were determined to be unsuitable for substrate additions due to concerns about navigational use conflicts on the waterway and for safe vessel operation. Thus, only water depths between minus 6.5 and 20 feet MLLW are considered suitable for reef construction. The 20 foot bathymetric cutoff was determined as the deepest zone where restoration activities could occur due to concerns about potential hypoxia and anoxia typical of deeper water (reference CBP OMP). The depth limit of minus 6.5 feet MLLW allows for safe navigation over the substrate at vertical clearance of minus 6 feet MLLW to top of reef structures. Areas at the 6.5 foot contour are suitable for placement of 6 inches of substrate material to restore reefs, while areas greater than 7 feet MLLW are targeted to receive up to 12 inches (1 foot) of substrate material. It is anticipated that when detailed plans are completed, some areas within proposed sites near the 6.5 foot contour will prove to be too shallow to provide 6 inches of depth for substrate placement plus 1 – 3 inches of depth for spat-on-shell. In those situations, the boundaries of sites will be adjusted to remove these areas.

The more recent decline in overall Chesapeake Bay oyster populations has been attributed primarily to the introduction of two diseases to which the Eastern oyster had no resistance: Dermo and MSX. The Tred Avon River has been selected as part of an overall salinity-based strategy to address disease and promote the development of disease resistance. Disease pressure and mortality of adult oysters increase with increasing salinity (USACE 2012). Since the Tred Avon River is classified as a mesohaline tributary, it is a prime candidate to encourage disease resistance to potentially develop in the wild population. Focusing ecological restoration efforts in a large-scale, interconnected fashion (river system wide) is the strategy most likely to allow large populations of oysters to persist in the face of disease and other stressors (USACE 2012).

[5] ORP is a non-profit organization that plans, promotes and implements science-based and sustainable shellfish restoration, aquaculture and wild fishery activities to protect our environment, support our economy and preserve our cultural heritage.

2.3.2 Tred Avon Oyster Populations

Historically, the Tred Avon River system supported large productive reefs where free-swimming oyster larvae could colonize on oyster shell or other hard substrate habitats. Roughly 851 acres of once active oyster beds were mapped as of the 1913 Yates Bars survey (Figure 3). By 1980, those same areas saw a reduction in area by an estimated 86 percent bottom coverage (i.e. 14 percent of historical charted acreage remained) in the lower reaches of the Tred Avon River (Seliger and Boggs 1988). The major driver of those habitat losses prior to 1980 was higher levels of sedimentation and siltation of upstream reefs and other hard bottom areas affecting natural spat-sets (Seliger and Boggs 1988). Despite higher larval concentrations and high spat-sets measured between the years of 1980 and 1981, mature oysters were not present in 1983 and 1984 suggesting that siltation of once actively harvested reef sites was contributing to the lower oyster populations observed. Shell removal by harvesting activities is also expected to have played a role in the degradation of reefs in the Tred Avon River.

Past surveys by Federal and State biologists indicate the Tred Avon River has been an area with very poor spat settlement success since the 1960s.[6] Spat monitoring performed from 1961 to 1966 by Shaw (1967, 1969) showed numerically spat-set occurrence and intensity of settlement for Broad Creek was higher than those levels measured in the Tred Avon River. A comparison study conducted by Kennedy (1980) shows the average number of oyster spat settling on the bottom in 1978 was very low for the Tred Avon, but average numbers in 1977 and 1979 were comparable to or slightly greater than the 1961 – 1966 values observed by Shaw. Generally, the Tred Avon River has seen very low levels of natural spat-sets since 1985. Recently, only the years of 1985 and 1991 saw significant spat-sets (MD DNR 2012). Spatially explicit data collected by MD DNR (1985 to 2014) which assessed the location and quantity of existing oyster populations, indicates the Tred Avon River continues to experience very low natural spat-sets (MD DNR 2014 (Figure 5).

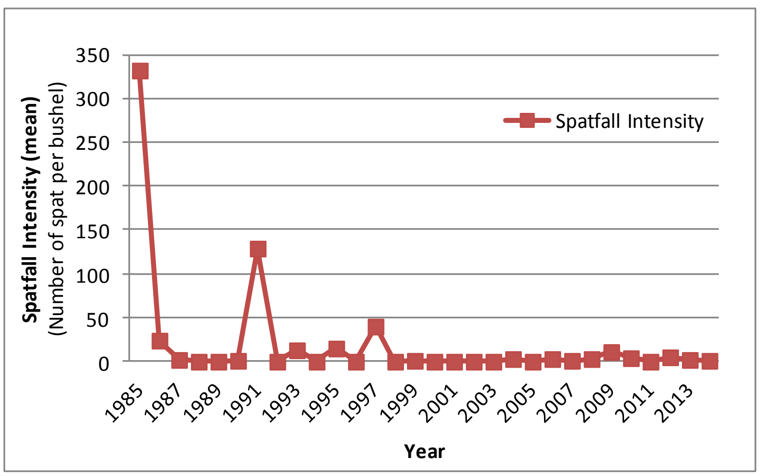

Figure 5. Tred Avon River Spatfall Intensity 1985-2014 (MD DNR 2014)

[6] Maryland Sea Grant – University of Maryland. Biology of the Oyster. 2013. Available online at: http://nsgd.gso.uri.edu/aqua/ mdut81003.pdf

Research by Boicourt (1982) suggests the need for broodstock and hard bottom habitat restoration since historical oyster population dynamics in the Tred Avon appear to be highly dependent on local production of larvae for spat settlement versus reproductive input from the Choptank River. Larvae in the Tred Avon River are dependent upon upriver oyster populations for broodstock supply because circulation patterns at the confluence tend to block the entrance of larvae from outside of the system to supplement the upriver populations (Boicourt 1982). This adds further to the complexity and precipitous decline in oyster populations occurring in the Tred Avon.

The need for seeding and broodstock is further supported by a spatially-explicit population and density survey conducted by MD DNR in May 2012 to determine the extent of currently restorable oyster bottom. Only 29% of the total 161 samples taken contained live oysters. Oyster shell rubble with sand contained live oyster densities of less than 5 oysters per square meter. Based on survey results, the tributary plan calls for designating approximately 98% of the existing shelled bottom surveyed as seed-only restoration. Coupled with the low spat-sets currently occurring in the river and low existing broodstock, the need for elevated hard bottom habitat is critical to recover oyster populations.

2.4 Goals and Objective

The goal of this project is to enable implementation of the Tred Avon Tributary Plan. Full implementation of the Tred Avon Tributary Plan would provide 146 acres of restored oyster reef habitat in the Tred Avon River. This level of implementation would provide for the greatest potential scale of oyster restoration with the objective of producing a system-wide impact to oyster populations. The approach of MIW is to restore all habitat that is deemed restorable given available resources because habitat is drastically degraded and reduced from historic levels. The objective of this EA is to evaluate the impacts that would result from reducing the navigational clearance in the Tred Avon River above oyster reef restoration sites to a designated 6 feet MLLW from 8 feet MLLW and the alternatives to that action. This will enable the goal to be achieved. Adding spat-on-shell to existing oyster habitat in water depths between 4 and 20 feet is not subject to the requirements to maintain a designated navigational clearance, but impacts from this action are evaluated.

3.0 ALTERNATIVES

Alternative development and analysis is focused on 1) seeding existing oyster habitat between 4 and 20 feet MLLW, 2) substrate reef restoration in water depths between 6.5 and 9 feet MLLW, and 3) planting spat-on-shell on restored substrate reefs.

3.1 Alternatives Considered

The alternatives were developed based on the following three management measures (Table 3):

Table 3. Management Measures

A	Seed existing oyster habitat (seed-only sites).
B	Restore oyster reef habitat by planting substrate in water depths between 6.5 and 9 ft MLLW.
C	Plant spat-on-shell on substrate reefs in water depths between 6.5 and 9 ft MLLW.

These management measures were combined to build a list of feasible and reasonable alternatives. Management measure 'C' can only be undertaken after 'B' has been completed, and therefore cannot occur without 'B'. The alternatives considered are summarized in Table 4. Substrate reef restoration is designated for USACE to implement. Spat-on-shell plantings would be carried out by MIW partner efforts (MD DNR and ORP).

Table 4. Alternatives Considered

Alternative		Description
1	No Action	No shallow water alternate substrate habitat would be restored. Restoration would be limited to 25.8 acres of seeded alternate substrate reef in 9 – 20 ft of water.
2	A	Plant spat-on-shell on existing oyster habitat (seed-only sites).
3	B	Extend restoration efforts to areas that would provide 6 ft of navigational clearance. Restore oyster reef habitat in water depths between 6.5 – 9 ft MLLW.
4	AB	Plant spat-on-shell on seed-only sites and extend reef restoration into areas that would provide 6 ft of navigational clearance by restoring reef habitat between 6.5 – 9 ft MLLW.
5	BC	Extend reef restoration into areas that would provide 6 ft of navigational clearance and plant spat-on-shell on those reefs.
6	ABC	Full restoration: Plant spat-on-shell on seed-only sites, extend restoration to areas that would provide 6 ft of navigational clearance, and plant those reefs with spat-on-shell.
7	ABC_nav	Full restoration with limits placed within navigational pathway. Plant spat-on-shell on seed-only sites, extend restoration to areas that would provide 6 ft of navigational clearance outside the navigational pathway, and plant those reefs with spat-on-shell.

3.2 Ecosystem Benefits

There are many ecosystem services provided by oysters and their associated reef habitat. Grabowski and Peterson (2007) have identified 7 categories of ecosystem services provided by oysters:

(1) production of oysters;

(2) water filtration and concentration of biodeposits (largely as they affect local water quality);
(3) provision of habitat for epibenthic fishes (and other vertebrates and invertebrates-(Coen et a1. 1999; ASMFC 2007);
(4) sequestration of carbon;
(5) augmentation of fishery resources in general,
(6) stabilization of benthic or intertidal habitat (e.g. marsh); and
(7) increase of landscape diversity (see also reviews by Coen et a1. 1999, Coen et al. 2007, Coen and Luckenbach 2000, ASMFC 2007).

Additionally, Ulanowicz and Tuttle (1992) identified how oyster restoration would promote beneficial food web dynamics in the Chesapeake system. These benefits are discussed in further detail in USACE (2012).

Given existing knowledge, ecosystem benefits are closely tied to the acreage restored. Therefore, the greater the acreage restored, the greater the connectivity of the oyster resources in a tributary, and the greater the ecosystem benefits. Promoting connectivity is another reason for utilizing suitable acreage throughout the entire extent of the sanctuary. Reef boundaries are set by the location of suitable bottom or existing shell, and differ based on the shape and condition in any individual tributary. The plan has purposefully included suitable areas throughout the entire sanctuary. It is not known how far apart reefs should be situated. However, by maximizing the reef footprint in the plan, the restoration effort will have the greatest likelihood of re-establishing connectivity to the system. Additionally, the intent of large-scale oyster restoration is to increase oyster biomass such that restoration projects become self-sustaining and able to provide oyster recruits to suitable surrounding oyster habitat outside the restoration project area.

There is no existing model to adequately document the diverse benefits and value of oyster restoration. However, USACE-Norfolk and USACE's Engineer Research and Development Center (ERDC) in coordination with VMRC are working to develop a model to estimate ecosystem benefits and services from oyster restoration as part of their common ground activities. Preliminary results have identified the high ecosystem outputs generated by sanctuary reefs in Virginia (Swannack, personal communication). USACE (2012) also provides a summary of documented efforts made toward quantifying the economic value of restored oyster habitat.

Recognizing the connection between acreage of healthy reef habitat and benefits, Table 5 summarizes the restored acreage that would be achieved by each alternative. An acre of reef is not fully restored in the Tred Avon River until it has been planted with spat-on-shell due to the lack of broodstock in the current river system. Therefore, there is a distinction made between reef habitat that has been constructed and that which has also been seeded. Reef acreage that does not receive spat-on-shell would provide reef structure for other organisms and benefit reef dwelling species, but would not provide the ecosystem benefits and full restoration potential for oysters. 'Acres Completed Toward Goal' includes seed only sites as well substrate sites that have been planted with spat-on-shell.

Acreage ranges are provided to capture the uncertainty in the natural environment. For seed-only sites, groundtruthing prior to planting may identify that a small portion of the site has degraded since data was collected and is no longer suitable for planting. Substrate placement sites could be reduced if water depths no longer are available to provide for the planting of at least 6 inches of substrate material plus spat-on-shell. This situation is most likely on the shoreward side (typical area within a proposed site where water depths are shallowest) of some of the proposed sites where navigational clearance would be reduced to 6 feet.

Table 5. Ecosystem Benefits- Restored Acreage

Alternative		Reef Habitat Constructed	Functioning Oyster Reef Restored	Completed Toward Goal*
1	No Action	0	0	26
2	A	0	63 – 71	89 – 97
3	B	52 – 57	0	26
4	AB	52 – 57	63 – 71	89 – 97
5	BC	52 – 57	52 – 57	78 – 83
6	ABC	52 – 57	115 – 128	141 – 154
7	ABC_nav	49 – 53	112 – 124	138 – 150
*acres rounded to nearest whole number				

3.3 Evaluation of Alternatives

As determined by the Restorable Bottom Analysis (NOAA 2013), there is a total of 251 acres of bottom that could be restored in the Tred Avon River. However, following consideration of navigational uses by the public; allowing for buffers around navigational channels, buoys, and docks; setting area aside as controls; and incorporating public input, the potential bottom was reduced to 154 acres. An alternative was not included that considered the restoration of the full restorable bottom (251 acres) because that level of restoration was determined to not be feasible as outlined in Section 1.3.3.

The alternatives are formulated and evaluated based on current information available to differentiate reef construction sites from seed-only sites. These determinations are subject to change as updated information is acquired. For example, if a good spatset were to occur prior to construction, sites that are currently considered to be poor quality shell sites and, therefore, targeted for substrate additions, may have sufficient shell to be switched to a seed-only site. Additionally, groundtruthing prior to planting of spat-on-shell could reduce or expand boundaries. For all these reasons, restoration sites and boundaries may undergo minor adjustments prior to implementation.

Alternative 1: No action

This alternative would not replace the current 8 foot water depth navigational clearance with a 6 foot water depth navigational clearance at substrate reef locations. USACE-Baltimore would continue activities to restore the 25.8 acres identified for alternate substrate reefs in water depths greater than 9 feet MLLW, and DNR/ORP would seed that acreage. Under the No action alternative, restoration work by MIW partners would achieve restoration of 25.8 acres of seeded reef habitat in the Tred Avon River, but no additional reef habitat.

This level of restoration would not meet the project goal and objective, and therefore would satisfy none of the restoration goals established by the Tred Avon Tributary Plan. This alternative would provide for the fewest ecosystem benefits as the lowest level of reef restoration would be undertaken. It would be expected that the 25.8 acres of alternate substrate reef habitat would not be self-sustaining, and would degrade over time in the absence of more extensive restoration efforts. Restoration of substrate reefs would be limited to deeper parts of the water column that are at greatest risk to low dissolved oxygen conditions. Locations of only deep water reef habitat would not provide resiliency to the project given that there would be no reefs in shallow water to repopulate the deep water reefs in the event of a severe anoxic event. Although larval transport is not entirely understood in the Tred Avon, implementation of this level of restoration would minimize habitat that would provide for spat settlement, and therefore minimize reproductive connectivity. Project objectives would not be met. Compared with historical habitat, the population and reef network would still be significantly diminished.

Alternative 2: Restore seed-only sites (A)

This alternative would plant spat-on-shell on the 63 – 71 acres of existing reef habitat (seed-only sites) that were identified to have minimal (<5 oysters/m^2) oyster density. This alternative would not expand oyster substrate reef restoration between the depths of 6.5 to 9 feet MLLW within the Tred Avon River nor replace the current 8 foot water depth navigational clearance with a 6 foot water depth navigational clearance at substrate reef locations. Navigational clearances and water depths at the 63 – 71 acres of existing reef restoration sites (seed-only) would be reduced by 1 – 3 inches. The addition of spat-on-shell to sites is a practice that has been undertaken for decades and is expected to have a minor, unrecognizable impact on navigation. USACE-Baltimore would continue activities to restore the 25.8 acres identified for alternate substrate reefs in water depths greater than 9 feet MLLW, and DNR/ORP would seed that acreage. This alternative would provide 63 – 71 acres of functioning oyster habitat that would provide moderate resiliency and connectivity to the oyster habitat network in the Tred Avon in addition to the 25.8 acres of deep water reefs, for a total of 88.8 – 96.8 acres of restored habitat. The Tributary Plan target of 146 acres would not be met, neither would the goal of restoring 50 percent of restorable bottom (125 acres). However, 8 percent of the extent of Yates Bars would be achieved (68 acres). Compared with historical habitat, the population and reef network would still be greatly diminished.

Alternative 3: Construct oyster reef habitat in water depths between 6.5 and 9 feet MLLW (B)

This alternative would replace the current 8 foot water depth navigational clearance with a 6 foot water depth navigational clearance at substrate reef sites and construct 52 – 57 acres of oyster reef habitat in water depths between 6.5 and 9 feet MLLW in the Tred Avon River. Based on current bathymetry, approximately 47.8 acres are planned for reef construction 1 foot in height (in waters deeper than approximately 7.5 feet MLLW) and reefs 6 inches high would be established on 9.3 acres (in water depths between approximately 6.5 and 7.5 feet MLLW). To provide adequate relief into the water column, restoration efforts target placement of at least a 6 inch high reef. Therefore, if bathymetry changes, any areas determined to have less than 6 inches of available water depth for reef placement prior to construction would be eliminated from final design plans. Substrate reefs would not be planted with spat-on-shell under this alternative. Water depths would be reduced between 6 and 12 inches (6 – 12 inches of substrate) by this proposed alternative.

Alternative 3 would affect the navigational clearance in the Tred Avon River. The water depth would be reduced between 7 – 15 inches at 33 sites across 52.4 – 57.1 acres where substrate would be placed, thereby reducing the navigational clearance for boaters in those areas.

USACE-Baltimore would continue activities to restore the 25.8 acres identified for alternate substrate reefs in water depths greater than 9 feet MLLW, and DNR/ORP would seed those reefs with spat-on-shell. Under Alternative 3, restoration work by MIW partners would achieve construction of 78 – 83 acres of reef habitat in the Tred Avon River, but no additional functioning oyster reef habitat beyond the 25.8 acres of deep water restoration would be provided because the reefs in shallower water depths would not be seeded.

This level of restoration would satisfy none of the restoration goals. Providing reef structure without seeding in the Tred Avon where current oyster densities are low, would likely result in the reef habitat becoming degraded by sedimentation and other sessile organisms such as barnacles and mussels. In the absence of broodstock additions, it is unlikely that wild spat sets would increase over current levels. Therefore, it could be expected that in a short time, the reef habitat would provide very little if any oyster habitat value. Reef habitat diversity would be improved as reef structure would be in place across a variety of depths. Habitat connectivity would be increased, but in the absence of spat-on-shell plantings, reproductive connectivity enhancement is questionable. The Tributary Plan target and the restoration goals would not be met. Compared with historical habitat, the population and reef network would still be diminished.

Alternative 4: Plant spat-on-shell on seed-only sites and extend reef restoration into shallower water depth (AB)

This alternative would replace the current 8 foot water depth navigational clearance with a 6 foot water depth navigational clearance at substrate reef sites and construct 52 – 57 acres of oyster reef habitat in water depths between 6.5 and 9 feet MLLW in the Tred Avon River. Based on current bathymetry, approximately 47.8 acres are planned for reef construction 1 foot in height (in waters deeper than approximately 7.5 feet MLLW) and reefs 6 inches high would be established on 9.3

acres (in water depths between approximately 6.5 and 7.5 feet MLLW). To provide adequate relief into the water column, restoration efforts target placement of at least a 6 inch high reef. Therefore, if bathymetry changes, any areas determined to have less than 6 inches of available water depth for reef placement prior to construction would be eliminated from final design plans. The substrate reefs would not be seeded under this alternative.

Alternative 4 would also plant spat-on-shell on the 63 – 71 acres of existing reef habitat that was identified to have minimal (<5 oysters/m^2) oyster density. Water depths would be reduced between 1 and 12 inches (6 – 12 inches on substrate sites or 1 – 3 inches at seed-only sites) depending on the restoration action taken at a site.

USACE-Baltimore would continue activities to restore the 25.8 acres identified for alternate substrate reefs in water depths greater than 9 feet MLLW and DNR/ORP would seed that reef acreage. In total, Alternative 4 would result in the seeding of 63 – 71 acres and the construction of 52 – 57 substrate reef acres, in addition to the 25.8 acres of deep water reef. Providing reef structure without seeding in the Tred Avon where current oyster densities are low, would likely result in the reef habitat becoming degraded by sedimentation and sessile organisms such as barnacles and mussels. In the absence of broodstock additions, it is unlikely that wild spat sets would increase over current levels. Therefore, it could be expected that in a short time, the reef habitat would provide very little or no oyster habitat value. The reef habitat structure would provide benefits as habitat, nursery habitat, and foraging habitat to reef-dwelling species. USACE-Baltimore would continue activities to restore the 25.8 acres identified for alternate substrate reefs in water depths greater than 9 feet MLLW, and DNR/ORP would seed those reefs.

Alternative 4 would affect the water depths and navigational clearance at 33 sites across 52 – 57 acres of substrate planting areas in the Tred Avon River Oyster Sanctuary as presented by Alternative 3. Furthermore, water depths and navigational clearance would be reduced between 1 – 3 inches on an additional 63 – 71 acres of the Tred Avon River Oyster Sanctuary for spat-on-shell seeding activities of existing oyster reefs which is expected to have a minor, unrecognizable, impact on navigation.

Under Alternative 4, restoration work by MIW partners would achieve construction of 89 – 97 acres of function oyster reef habitat (25.8 acres of deep water reefs plus 63 – 71 acres of seed only reef restoration) in the Tred Avon River, as well as 52 – 57 acres of unplanted substrate reef structure. This alternative would provide moderate resiliency and connectivity to the oyster habitat network in the Tred Avon River. The Tributary Plan target of 146 acres would not be met, neither would the goal of restoring 50% of restorable bottom. However, 8% of the extent of Yates Bars would be achieved. Compared with historical habitat, the population and reef network would still be diminished.

Alternative 5: Extend reef restoration to shallow water depths and plant those reefs with spat-on-shell (BC)

This alternative would replace the current 8 foot water depth navigational clearance with a 6 foot water depth navigational clearance at substrate reef locations and construct 52 – 57 acres of oyster reef habitat in water depths between 6.5 and 9 feet MLLW in the Tred Avon River. These reefs would then receive spat-on-shell. Based on current bathymetry, approximately 47.8 acres are planned for reef construction 1 foot in height (in waters deeper than approximately 7.5 feet MLLW) and reefs 6 inches high would be established on 9.3 acres (in water depths between approximately 6.5 and 7.5 feet MLLW). To provide adequate relief into the water column, restoration efforts target placement of at least a 6 inch high reef. Therefore, if bathymetry changes, any areas determined to have less than 9 inches of available water depth (6 inches for substrate and 1 – 3 inches for spat-on-shell) for reef placement prior to construction would be eliminated from final design plans. USACE-Baltimore would continue activities to restore the 25.8 acres identified for alternate substrate reefs in water depths greater than 9 feet MLLW, and DNR/ORP would seed those reefs with spat-on-shell. This alternative would result in 78 – 83 acres (25.8 acres of deep water reefs plus 52 – 57 acres of shallow water reef restoration) of constructed and functioning oyster habitat.

Alternative 5 would reduce water depths and navigational clearance between 7 – 15 inches at 33 sites across 52 – 57 acres in the Tred Avon River as a result of substrate placement and spat-on-shell seeding activities of those areas.

This alternative would provide moderate resiliency and connectivity to the oyster habitat network in the Tred Avon River. The Tributary Plan target of 146 acres would not be met, neither would the goal of restoring 50% of restorable bottom. However, 8% of the extent of Yates Bars would be achieved. Compared with historical habitat, the population and reef network would still be diminished. Habitat connectivity and diversity would be increased from current levels, but the scale is expected to be too little to provide a system-level change. Reproductive connectivity enhancement is questionable. Compared with historical habitat, the population and reef network would still be diminished.

Alternative 6: Full restoration- Plant spat-on-shell on 63 – 71 acres of seed-only sites, extend restoration to shallow water depths and plant the 57 acres of shallow water reefs with spat-on-shell (ABC)

This alternative would replace the 8 foot water depth navigational clearance with a 6 foot water depth navigational clearance at substrate reef locations to construct 52 – 57 acres of oyster reef habitat in water depths between 6.5 and 9 feet MLLW in the Tred Avon River. These reefs would then receive spat-on-shell. Based on current bathymetry, approximately 47.8 acres are planned for reef construction 1 foot in height (in waters deeper than approximately 7.5 feet MLLW) and reefs 6 inches high would be established on 9.3 acres (in water depths between approximately 6.5 and 7.5 feet MLLW). To provide adequate relief into the water column, restoration efforts target placement of at least a 6 inch high reef. Therefore, if bathymetry changes, any areas determined to have less than 9 inches of available water depth (6 inches for substrate and 1 – 3 inches for spat-on-shell) for reef placement prior to construction would be eliminated from final design plans.

Additionally, DNR/ORP would plant spat-on-shell on 63 – 71 acres of seed-only sites. USACE-Baltimore would continue activities to restore the 25.8 acres identified for alternate substrate reefs in water depths greater than 9 feet MLLW, and DNR/ORP would seed those reefs with spat-on-shell.

Alternative 6 would affect the water depths and navigational clearance at 33 sites across 52 – 57 acres of the Tred Avon River as presented in Alternative 5. Furthermore, alternative 6 would reduce water depths and navigational clearance by 1 – 3 inches on an additional 63 – 71 acres of the Tred Avon River Oyster Sanctuary as a result of seeding existing oyster reef activities with spat-on-shell. Seeding is expected to have a minor, unrecognizable, impact on navigation.

This alternative would result in 141 – 154 acres of constructed and functioning oyster habitat. Restoration efforts completed under Alternative 6 could achieve restoration of the full acreage (146) targeted in the tributary plan in the Tred Avon River. This level of restoration would satisfy the goal set to restore a minimum of 8 – 16 percent of historic habitat (68 acres) and the restorable bottom goal (125 – 251 acres). Maximizing restoration effort is important to provide the best foundation for long-term success and sustainability. This alternative would provide for maximum habitat restoration and thereby, maximize (compared to other potential alternatives) ecosystem benefits, resiliency, habitat diversity, and reproductive connectivity.

Alternative 7: Full restoration with limits placed within navigational pathway. Plant spat-on-shell on seed-only sites, extend restoration to areas that would provide 6 feet of navigational clearance outside the navigational pathway, and plant those reefs with spat-on-shell.

USCG general guidance for oyster restoration plan design (see Section 5.4.2.2) includes a recommendation to not site restoration efforts within identified channels. In the absence of a maintained channel, USCG suggested maintaining a navigational pathway free of substrate reef restoration efforts. As documented in Section 5.4.2.2, coordination with USCG identified three sites that were located in the navigational pathway of the Tred Avon River that pose a likely impediment to navigation of the waterway. USCG recommended removing sites SS_08 (1.58 acres) and SS_58 (1.47 acres) from restoration plans to avoid navigational impacts. USCG recommended eliminating the portion of SS_13 that is channelward of the edge of the navigational pathway to avoid navigational impacts. This reduction would result in a loss of approximately 0.65 acres from SS_13. Revising the tributary plan for these three sites would reduce restoration efforts by approximately 3.7 acres, but would maintain the navigational pathway clear of sites that would reduce navigational clearance to 6 feet. USCG raised no issues with pursuing seed-only sites within the navigational pathway. See Section 5.4.2.2 for a full discussion of USCG coordination and the navigational pathway analysis.

Alternative 7 is identical to Alternative 6 with the elimination of SS_08, SS_58, and the reduction of SS_13. This alternative would replace the 8 foot water depth navigational clearance with a 6 foot water depth navigational clearance at substrate reef locations to construct 49 – 53 acres of oyster reef habitat in water depths between 6.5 and 9 feet MLLW in the Tred Avon River. These reefs would then receive spat-on-shell. Based on current bathymetry, approximately 44.1 acres are planned for reef construction 1 foot in height (in waters deeper than approximately 7.5 feet MLLW) and reefs 6 inches high would be established on 9.3 acres (in water depths between

approximately 6.5 and 7.5 feet MLLW). To provide adequate relief into the water column, restoration efforts target placement of at least a 6 inch high reef. Therefore, if bathymetry changes, any areas determined to have less than 9 inches of available water depth (6 inches for substrate and 1 – 3 inches for spat-on-shell) for reef placement prior to construction would be eliminated from final design plans.
Additionally, DNR/ORP would plant spat-on-shell on 63 – 71 acres of seed-only sites. USACE-Baltimore would continue activities to restore the 25.8 acres identified for alternate substrate reefs in water depths greater than 9 feet MLLW, and DNR/ORP would seed those reefs with spat-on-shell.

Alternative 7 would affect the water depths and navigational clearance at 31 sites across 49 – 53 acres of the Tred Avon River. Furthermore, alternative 7 would reduce water depths and navigational clearance by 1 – 3 inches on an additional 63 – 71 acres of the Tred Avon River Oyster Sanctuary as a result of seeding existing oyster reef activities with spat-on-shell. Seeding is expected to have a minor, unrecognizable, impact on navigation.

This alternative would result in 138 – 150 acres of constructed and functioning oyster habitat. Restoration efforts completed under Alternative 7 could achieve restoration of the full acreage (146) targeted in the tributary plan in the Tred Avon River. This level of restoration would satisfy the goal set to restore a minimum of 8 – 16 percent of historic habitat (68 acres) and the restorable bottom goal (125 – 251 acres). Although this alternative would not maximize benefits, due to having less restored acreage than Alternative 6, this alternative would provide nearly the maximum habitat restoration and thereby, would nearly maximize (compared to other potential alternatives) ecosystem benefits, resiliency, habitat diversity, and reproductive connectivity.

Table 6 provides a summary of the alternatives evaluation:

Table 6. Alternatives Evaluation

Alternative		Meet proposed objective/ Tributary Plan target	Meets *8-26%* restoration goal set by Oyster Metrics Workgroup	Meet both restoration goals set by Oyster Metrics Workgroup	Maximize diversity and resiliency in design	Maximize reproductive connectivity	Maximize ecosystem benefits
1	No Action	N	N	N	N	N	N
2	A	N	Y	N	N	N	N
3	B	N	N	N	N	N	N
4	AB	N	Y	N	N	N	N
5	BC	N	Y	N	N	N	N
6	ABC	Y	Y	Y	Y	Y	Y
7	ABC_nav	Y	Y	Y	N	N	N

3.4 Preferred Alternative

The preferred alternative is Alternative 7. This alternative is able to fulfill all goals and objectives, and achieve nearly the full extent of potential restoration, while addressing navigational concerns. The large-scale of the proposed restoration across a variety of water depths in Alternative 7 provides for the greatest opportunity to achieve sustainability. Alternative 7 nearly maximizes ecosystem benefits, diversity, resiliency, and reproduction potential.

3.5 Implementation

The tributary plan would be implemented by USACE-Baltimore District, NOAA, MD DNR, and ORP. USACE-Baltimore's role is to provide beneficial reef material and to place the substrate at discrete locations. Substrate reef restoration efforts would be restricted to placement between December and March based on coordination with NMFS to limit/avoid impacts to SAV, HAPC, and EFH. NOAA supports the hatchery, and provides planning, mapping and surveying efforts. MD DNR supports the hatchery-production of spat-on-shell, acquires the necessary permits for planting spat-on-shell, and coordinates the planting of spat-on-shell by ORP.

Combined restoration techniques for the Tred Avon River would be system-wide to aid in the rehabilitation of oyster habitat and the re-establishment of an abundant and self-sustaining population. The implementation timeframe would depend primarily on the availability of funds. The Tributary Plan identifies total estimated project costs of $11.4 million over a period of three to five years, dependent on availability of funding, substrate, and spat-on-shell. These costs are planned investments under the 704(b) program for USACE and sponsor in-kind credits. Approximately $1.37 million has been spent on constructing 16 acres of alternate substrate reefs in water depths below 9 feet MLLW, with additional costs ($0.36 million) for spat-on-shell. There are 9.8 acres remaining in water depths below 9 feet MLLW which would require an investment of $1.2 million ($0.98 million for substrate and $0.2 for seed), 15,800 cy of material, and 39.6 million spat-on-shell to complete.

For the proposed project, approximately $5.2 million will be required to purchase and place approximately 88,000 cubic yards of substrate material over 57 acres of the sanctuary. Production and planting of hatchery-produced seed (an estimated 558 million larvae) is estimated to cost $2.79 million. The oyster seed costs are around $5,000 per million seed planted (Oyster Restoration Partnership, July 2013). Purchasing and placing reef material (1,613 cubic yards per acre), 1-foot in height would cost around $62 per cubic yard of substrate. Monitoring is estimated for the full Tributary Plan at a cost of $693,000 over 6 years. All material cost estimates are based on deploying stone; however, costs could be higher or lower depending on availability of other suitable materials such as mixed shell, oyster shell or reclaimed oyster shell. It is anticipated that construction will extend for three years, through 2018. Both MD DNR and NOAA also anticipate contributing funds in future years for the seeding activities. The timeline for USACE-Baltimore to complete restoration of reef habitat in waters that would provide a 6 feet navigational clearance is dependent upon available funding and the availability of suitable substrate. If either of these are not available in the quantities needed to completed efforts, the remaining acreage would be completed in the following year. With sufficient resources, construction would occur in 2016, 2017, and 2018; monitoring would extend through 2024.

4.0 AFFECTED ENVIRONMENT AND GENERAL EFFECTS

This section describes in more detail the relevant environmental areas affected by implementing the alternatives in Section 3.0 including the proposed action. The affected environment is therefore the existing environmental conditions of the area forming the baseline from which each project alternative including the "no-action" alternative is evaluated. The relative severity of the environmental consequence accrued to the ecosystem is later discussed in Section 5 of this report forming the basis for the USACE-Baltimore decision making process. The following documents are incorporated by reference in the report and are available at http://www.nab.usace.army.mil/Missions/Environmental/OysterRestoration.aspx:

USACE 2009. Final Environmental Assessment and Finding of No Significant Impact: Chesapeake Bay Oyster Restoration Using Alternate Substrate Maryland. (Appendix F)

USACE. 2009. Final Programmatic Environmental Impact Statement for Oyster Restoration in Chesapeake Bay Including the Use of a Native and/or Nonnative Oyster. (http://www.nao.usace.army.mil/Portals/31/docs/civilworks/oysters/FinalPEISOysterRestoration.pdf)

USACE 2012. Chesapeake Bay Oyster Recovery: Native Oyster Restoration Master Plan, Maryland and Virginia. (http://www.nab.usace.army.mil/Missions/Environmental/OysterRestoration/OysterMasterPlan.aspx)

Draft Tred Avon River Oyster Restoration Tributary Plan: A blueprint for sanctuary restoration dated April 3, 2015.

*NOAA 2013.*Draft Tred Avon River Oyster Sanctuary Restorable Bottom Assessment and Data Summary.

4.1 Physical Environment

4.1.1 Substrate

Physical substrate conditions and quality are important determinates of oyster recruitment and growth. In general, oysters survive best on bottoms that are firm, such as those of shell, rock, and firm or sticky mud (Kennedy 1991). Loose, sandy bottoms are not conducive to reef establishment since sand is subject to continual shifting activity and has been shown to result in oyster abrasion and valve injury (Kennedy 1991).

To determine the existing physical substrate conditions occurring within the Tred Avon River, seafloor conditions were mapped using sonar technology in conjunction with various ground-truthing methods. Within the sanctuary limits, data collected by MGS in the winter of 2009 and by the NCBO in the spring of 2013, identified existing bottom conditions, the quality of the bottom, and its ability to support restoration actions. In addition to establishing a baseline from which to evaluate restoration progress, hard substrates that will support the weight of the reef material must be identified for alternate substrate placement. Hard benthic habitat was defined as areas that, per the acoustic surveys, were found to have the Coastal and Marine Ecological Classification Standard (CMECS) [7] classifications of artificial reef, aggregate patch reef, fringe reef, patch reef, sand and scattered oyster shell, sandy mud, sand, and muddy sand. Survey results were then field verified with data collected by MD DNR patent tong surveys (Appendices B, C). Based on these spatially explicit data sets, areas suitable for seed-only restoration are classified as dense biogenic and anthropogenic oyster shell rubble.

The final array of restorable bottom within the Tred Avon was comprised of hard sand (25 percent of total restorable bottom), muddy sand (51 percent), sandy mud (14 percent), anthropogenic oyster shell rubble (1 percent), biogenic oyster shell rubble with co-occurring sand (1 percent), and unclassified sediments (9 percent) (NOAA 2013). Sub-bottom profiling sonar indicates the sandy mud bottoms identified as restorable are located on hard base sediments. Unclassified bottoms are presumed to be on hard base sediments because of their association with shallow water, shorelines, and shoals (Figure 6).

Bottom surface sediments tend to be hard sand, shell, and sand or mud mixed with shell. The finer sediments such as mud are found within the mainstem of the river channel, with sandier sediments toward the shoreline and oyster rubble. Generally, bottom sediments are sand and clay mud in the upper to middle region, within increasing amounts of sand near the mouth.

4.1.2 Sedimentation

Sedimentation is not only important to the growth rate in *C. virginica*, but to the species' survival. Rates of high sedimentation can blanket oyster bars and other hard bottom habitats essentially smothering existing oyster communities and precluding free swimming larvae from finding suitable hard bottom habitat to settle on (USACE 2012). High sedimentation rates have been shown by researchers to be a major contributing factor to the historic loss of biogenic reefs (Rothschild et al. 1994). It has also been hypothesized that siltation may be contributing to the susceptibility of the Eastern oyster to disease due to flattening of oyster bar profile (Rothschild et al. 1994). Thus the remaining low profile reefs existing today may be substantially poorer in quality and possibly suboptimal for adults or new recruits (Rothschild et al. 1994). USACE (2012) further discusses sedimentation and its negative impacts on oyster reefs.

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[7] Full definition of Chesapeake Bay- CMECS is provided in the Tred Avon Tributary Plan.

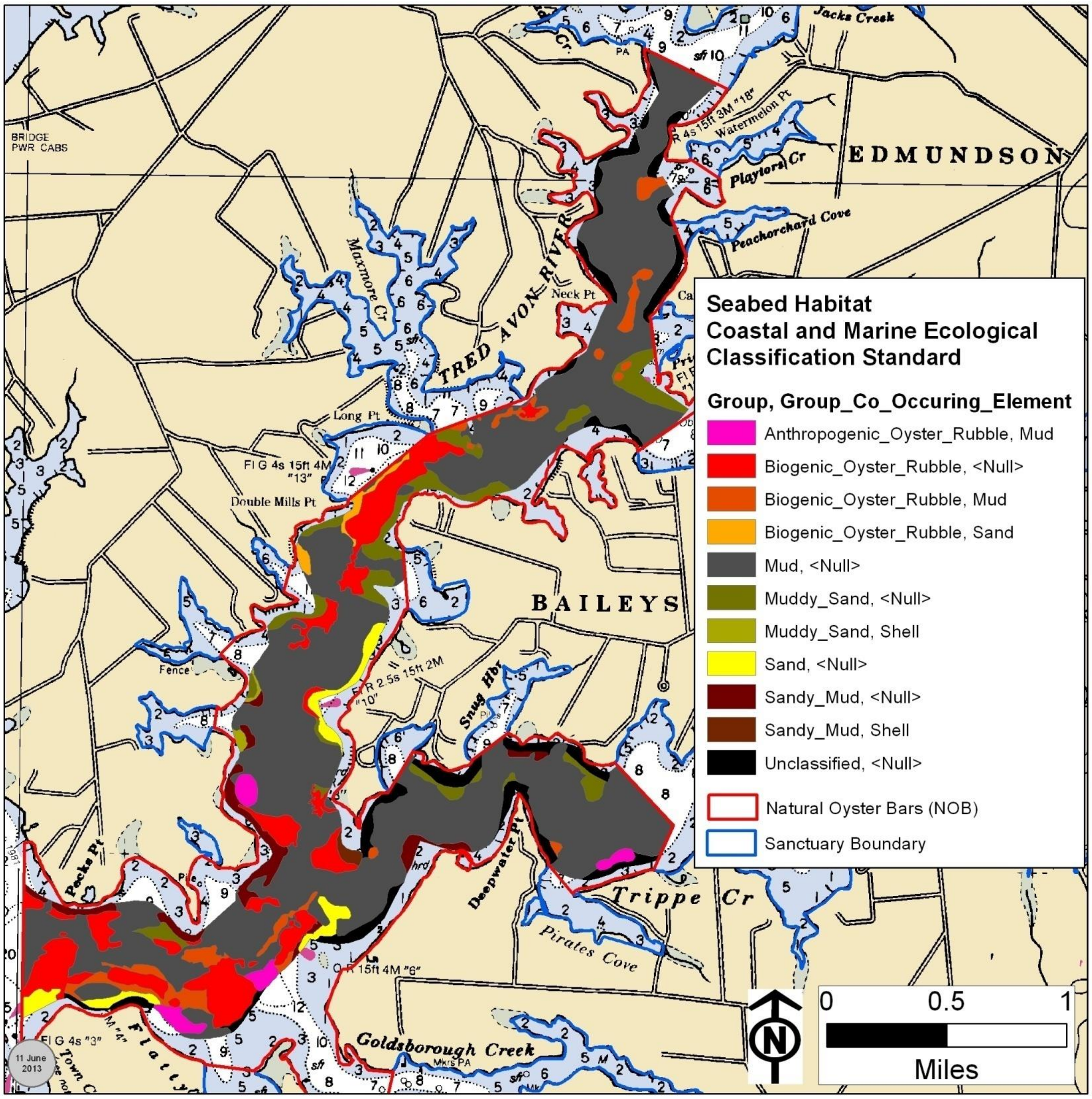

Figure 6. Tred Avon Substrate Classification (provided by NOAA)

Total suspended solids (TSS) varies seasonally and interannually due mainly to variability in freshwater inflow, and varies spatially, depending on proximity to shoreline, oceanic, and riverine sources of sediment. Because the Tred Avon is an area of high sediment deposition, its basin is characterized by predominately soft-sediments and is subject to continual sediment influx from the surrounding watershed; which is typical of Coastal Plain rivers located on Maryland's Eastern Shore. In contrast to rivers with functioning riparian areas, the Tred Avon acts more as a pipeline system (USGS Water-Resources Investigations Report 03-4123). As a result, its sediment budget is more heavily influenced by the characteristics of the river system itself than by sub-watershed size. Data available from the U.S. Geological Service (USGS) numerically shows the Tred Avon receives a considerable amount of runoff from the surrounding landscape, which is predominately agricultural land-use and urban development. This results in the higher suspended sediment loads observed as compared to normal sediment loads encountered in nature from the effects or wind, currents, runoff from land, etc. In the nearshore zone, sediment processes are mostly influenced by waves and local shoreline erosion sources. The inshore sediments are therefore coarser in nature. The finer grained sediments are found in the deeper waters of the river due to the stronger influence by tidal currents.

4.1.3 Water Depths and Circulation

Water depths in the sanctuary range from minus 1- to 40-feet MLLW. The Tred Avon's central channel varies from minus 7 feet at the edge of the channel to over 38 feet in the deepest sections of the channel. The greatest depth is mid-channel. The bathymetry shows 9 percent of the sanctuary area within the NOB is between 4 and 6 feet in depth; 20 percent is between 6 and 9 feet in depth and 45 percent is between 9 and 20 feet in depth.

Tides are semi-diurnal but sustained strong winds, both locally and over the Chesapeake Bay, affect tidal frequency and amplitude in the Tred Avon. Distribution in the lower portions of the river show a strong tendency of freshwater to enter the tributary from the Choptank on the eastern side of the river, while surface layers on the western side are moving seaward (Boicourt 1982). Water circulation patterns in addition to other hydrodynamics can explain specific tributary based larval retention and transport rates observed in the Tred Avon. Circulation processes can also account for the marked differences in spat settlement between tributaries of the same drainage basin. Unlike its neighbor Broad Creek, the Tred Avon River has a weaker wind-driven component of its circulation. This is due to the curvature of the main stem, which does not allow for a consistent axial pressure gradient to build up over long reaches of the river (Boicourt 1982). The weaker wind-driven component helps explain why the Tred Avon appears to be primarily dependent on local production of larvae for spat settlement, while Broad Creek has a significantly greater ability to augment its larvae supply with recruitment from the Choptank River (Boicourt 1982). These patterns, and larval behavior responses, influence the direction and distance that larvae could be transported in the Tred Avon. Larvae produced within the system are generally retained, whereas larvae outside the system from the mainstem Choptank would probably be prevented from entering in any significant numbers. Thus, the Tred Avon River may be an area of poor spat settlement because brood stock numbers on the upper river grounds are too low to self-recruit and provide sufficient larvae downstream, and because there may be no recruitment of larvae from outside the river.

An earlier survey dating from the 1980s identified that oyster bars in shallow depths that had not been degraded by sedimentation in the river generally followed a 6-foot bathymetric depth contour where steep gradients existed. Where they extended into deeper water, oyster bars are sharply delineated by the 18-foot bathymetric contour (Seliger and Boggs 1988). There are 14 sites being considered to reduce navigational clearance to 6 feet situated near the 6-foot contour. Of these, nine exhibit the steep gradient identified by Seliger and Boggs (1988).

4.2 Water Quality

4.2.1 Salinity and Temperature

The eastern oyster is accustomed to water temperatures ranging annually from 28.4 – 96.9 degrees Fahrenheit (°F), and salinity ranging annually from 5 to 40 parts per thousand (ppt), although most major populations occur in salinities between 10 and 30 ppt. USACE (2012) summarizes the results of various investigations focused on defining suitable salinity ranges for various oyster life stages. USACE (2012) identified suitable areas as those with a mean growing season salinity greater than 5 ppt.

The Tred Avon is classified as a mesohaline system, partially to well-mixed with surface salinities ranging from 5 to 18 ppt, with salinity stratification in the tributary varying seasonally (Appendix B, Figure 1 and 2). The Tred Avon is a brackish salinity system that generally favors good reproduction and relatively low disease rates (MD DNR 2013). Analysis performed by USACE (2012) determined that salinity levels were suitable throughout the Tred Avon River for oysters. Current water quality data for the Tred Avon River collected from May to October over the last two seasons (2013 – 2015) by the Mid-shore Riverkeeper is provided in Table 7. Average summer salinity in the Tred Avon River ranges from 7.9 ppt at the head of the river near Easton to 9.5 ppt at the mouth.

The salinity dataset compiled in USACE (2012) was used to evaluate the Tred Avon River for the potential risk from freshets. The risk of freshets to oysters increases with proximity to the headwaters and typically is a greater concern for oysters in low salinity waters. Since the Tred Avon River is a smaller mesohaline tributary on the Eastern Shore, it does not typically receive large influxes of freshwater as does the Potomac River on the Western Shore, so freshets are less of a concern in implementing the tributary specific restoration plan.

Temperature in the Tred Avon River does not appear to be a limiting factor as the temperature ranges from 32 °F to about 86°F (MD DNR 2013). A summary of annual normal air temperature (1981 – 2010) for the Royal Oak 2 SSW monitoring station shows a mean annual air temperature minimum of 49°F to a maximum 67°F. The maximum observed mean monthly air temperature was 88°F in July and the minimum temperature was 28°F in January. Ambient water temperatures from fall through the winter range from a high of 57.2°F to a low of 42.8°F. From spring to summer, water temperatures range from a low of 52.5°F to high of 87.8°F (NOAA National Data Buoy Center 2014b). Average summer water temperatures vary slightly from head to mouth (76.2-78.1 ° F).

Table 7. 2013-2105 Tred Avon Water Quality Data (Mid-shore Riverkeeper)

		Salinity (ppt)			Temperate (F)			Bottom D.O. (mg/L)		
Station		average	max	min	average	max	min	average	max	min
TA1	head near Easton	7.9	11.4	4.8	78.1	88.5	65.7	4.9	8.9	1.1
TA2	mainstem near Dixon/Shipshead Cr	8.3	12.3	5	77.8	90.7	65.7	6.7	9.9	4.1
TA3	mainstem near Peachblossom Cr	8.9	13.2	5.5	77.2	92.3	64.8	6.9	9.5	4.7
TA4	mainstem near Goldsborough Cr	9.4	14.4	6.1	76.5	89.6	63.5	7.2	9.5	5.4
TA5	mainstem near Oxford	9.4	14.5	6.4	76.2	88.2	63	7.1	9.3	5.4
TA6	mouth	9.5	14.8	6.4	77.1	90.0	62.2	6.8	9.8	4.7

		pH	Total N (mg/L)	Total P (mg/L)
Station		average	average	average
TA1	head near Easton	7.8	0.91	0.14
TA2	mainstem near Dixon/Shipshead Cr	7.8		
TA3	mainstem near Peachblossom Cr	7.8		
TA4	mainstem near Goldsborough Cr	7.9	0.60	0.06
TA5	mainstem near Oxford	8.0	0.53	0.05
TA6	mouth	8.0	0.62	0.06

4.2.2 Dissolved Oxygen

Hypoxia can directly affect shellfish via reduced recruitment and survival (Breitburg 1992) and indirectly by altering community structure through predation or competition (Lenihan et al. 1998). Initial analysis performed by USACE (2012) determined that DO levels were at suitable concentrations throughout the Tred Avon River. Average summer bottom DO (Table 2) varies between 4.9 – 7.2 mg/L throughout the length of the river. The minimum threshold was set at an average summer DO level greater than or equal to 5 mg/L needed to support oysters and reef community structure. No oyster restoration is planned for the head of the river near Easton where the average summer DO was just under 5 mg/L. The 5 mg/L target concentration does not represent a specific tolerance level for oysters, but was rather used to define those areas where DO concentration is a limiting factor to habitat value and broader restoration outcomes. Therefore, minimum levels just below 5 mg/L (4.1 to 4.7 mg/L) measured at some of the sites should not have a significant negative impact on oysters in those areas.

4.2.3 Nutrients and Harmful Algal Blooms

The Tred Avon River is included in the segment designated as the Choptank River mesohaline mouth 1 (CHOMH1) on Maryland's 303(d) list. This segment is listed as a 303(d) waterbody for nutrients (nitrogen and phosphorus), total suspended sediment, and biological impairments (benthics). Current monitoring identifies average total nitrogen (TN) ranging from 0.53 – 0.91 mg/L and average total phosphorus (TP) ranging from 0.05 – 0.14 mg/L. These levels do not meet the healthy TN standard set by Talbot County Creekwatchers of <0.02 mg/L, nor the TP standard set at <0.05 mg/L. Both TN and TP levels are at impaired levels. Nitrogen and phosphorus are not, by themselves, impairments to oysters. However, elevated N and P fuel algal blooms. When algae die, large amounts of organic matter sink to the bottom which increases the demand for DO, and subsequently hastens seasonal oxygen depletion which can impact oyster reproduction and growth. Average pH ranges from 7.8 – 8.0. *Chlorophyll a* levels are <15µg/L (µg/L – micrograms per liter) indicating impaired levels[8]. *Chlorolphyll a* is an indication of algal content. Elevated levels can result in reduced DO levels as discussed above.

Harmful algal blooms (HAB) resulting from *Prorocentrum minimum* and *Karlodinium veneficum* blooms have been documented in the Choptank River (Brownlee et al. 2005; Glibert et al. 2001), but the Tred Avon River has not been identified to have significant HAB problems or susceptibilities. Blooms of *Prorocentrum minimum* and *Ulva lactuca* have been documented in the past (MD DNR 2013).

4.3 Biological Resources

4.3.1 Submerged Aquatic Vegetation

SAV data compiled for the CBP (VIMS 2012) was utilized to evaluate SAV resources in Tred Avon River. From 2008 – 2013, no documented SAV was shown to be occurring where reef construction and seeding activities would be undertaken. The following SAV are present in the Tred Avon River system: *Zannichellia palustris* (horned pondweed); *Ruppia maritima* (widgeon grass); *Potamogeton perfoliatus* (redhead-grass); and *Stuckenia pectinata* (sago pondweed). However, the areal extent is found mainly in the shallow creeks outside the NOB limits. On average, there have been 140 acres of SAV beds in the Tred Avon River in the past 10 years (2003 – 2012). SAV beds were more expansive in the decade prior to that, averaging 500 acres annually (1993 – 2002). In 2011, a number of the small creeks within the Tred Avon system (Hudson Creek, Back Creek, Phillips Creek, Beckwith Creek, and Smith Creek) supported SAV beds.

4.3.2 Wetlands

The Tred Avon watershed contains nearly100 acres of estuarine and marine intertidal wetlands[9]. Wetland impact data since 1991 shows a net gain of 34.91 acres in the watershed[10]. Midshore Riverkeeper Conservancy in Easton, Maryland has launched a new pilot project in the Tred Avon River to improve water quality involving artificially constructed floating wetlands[11]. The artificial floating wetlands are being used for nitrogen and phosphorus uptake.

4.3.3 Benthic Macroinvertebrates

Benthic communities play a central role in the transfer of materials from the water column to higher levels in the food web. Much of the productivity of fisheries in the Chesapeake Bay is linked directly to benthos through feeding (Virnstein 1977; Holland et al. 1988; Diaz and Schaffner 1990). In Chesapeake Bay, the distribution and kinds of benthic organisms (> 500 µm) are strongly correlated with salinity and are further influenced by the kind of sediment, patterns of DO, and other physical factors in a given location (Diaz and Schaffner 1990; Llansó et al. 2002). The

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[8] Talbot County Creekwatchers. 2009. Talbot County Creekwatchers 2009 Water Quality Report.
[9] U.S. Fish and Wildlife Service - National Wetlands Inventory. 2013b. Available online at: http://www.fws.gov/wetlands/Data/Mapper.html
[10] Maryland's Surf Your Watershed – Watershed Profile Lower Choptank. http://mddnr.chesapeakebay.net/wsprofiles/surf/prof/wsprof.cfm?watershed=02130403
[11] http://talbotspy.com/chesapeake-bay-floating-islands-launches-at-bay-street-ponds/

variety and density of organisms generally increases with increasing salinity. Generally mesohaline (5 to 18 ppt) regions of the Bay such as the Tred Avon exhibit high densities of bivalves (e.g., clams, oysters), except where low oxygen conditions prevail; segmented worms (i.e., polychaete annelids), small crustacea, and suspension-feeding bivalves *(Rangia cuneata, Macoma spp.*) dominate these areas. Suspension feeding polychaetes and tunicates are important contributors to biomass in high salinity environments of the Bay. The Chesapeake Bay benthic index of biotic integrity (B-IBI) was developed to assess benthic community health and environmental quality in the Chesapeake Bay. Large portions of the benthic habitat of the Bay are considered degraded, including areas in the Tred Avon. As reported by the Chesapeake Bay Program, 0 – 25 percent of B-IBI scores for the Choptank River complex which includes the Tred Avon meet the goal set by the CBP[12].

4.3.3.1 Eastern Oysters

Existing Eastern oyster resources in the Tred Avon River are discussed previously in Section 2.3.2. Figure 7 provides the results of a patent tong survey conducted by MD DNR Shellfisheries Division in May 2012. The dots show the sampling location. The color of the dots represents oyster abundance. Only 29% of the samples contained live oysters. A total of 163 samples were collected.

4.3.3.2 Clams

There are three clam species in the Maryland portion of the Chesapeake Bay that are or have been of commercial importance: the soft-shell clam, *Mya arenaria*, the stout razor clam, *Tagelus plebeius*, and the hard clam, *Mercenaria mercenaria*.

The soft-shell clam, *M. arenaria* and the hard-shell clam, *M. mercenaria* are the two primary species historically observed in the Tred Avon River. Both can be found over a wide range of bottom types, but prefer substrates of fine sand and silt mixes. Both bivalve mollusks are harvested predominately in subtidal areas ranging in depth from 6 to 20 feet historically (2012 Master Plan). However, there are currently no hard clams in the Tred Avon River. Soft-shell clams have been documented and studied in the Tred Avon River system by Shaw (1962), but extensive current surveys are lacking. *M. arenaria* are found throughout the Chesapeake Bay in water depths ranging from 10 – 20 feet within a salinity range of 5 – 20 ppt. Commercial stocks of soft-shell clams, like oysters, are today primarily found in the middle Bay area, with the highest concentrations in Talbot, Dorchester and Queen Anne's counties.

4.3.3.3 Phytoplankton

Phytoplankton provides food for oysters and small invertebrate animals called zooplankton, which in turn provide food for fish and other animals in the Bay.

Anthropogenic nutrients and sediment that enter the Bay have fueled excessive phytoplankton production (eutrophication). Coupled with the loss of oysters, eutrophication and the loss of the Bay's primary filter feeder has altered the system from one dominated by benthic production and

[12] Chesapeake Bay Program – Benthic Habitat. 2012. Available online at: *http://www.chesapeakebay.net/indicators/indicator/bottom_habitat*

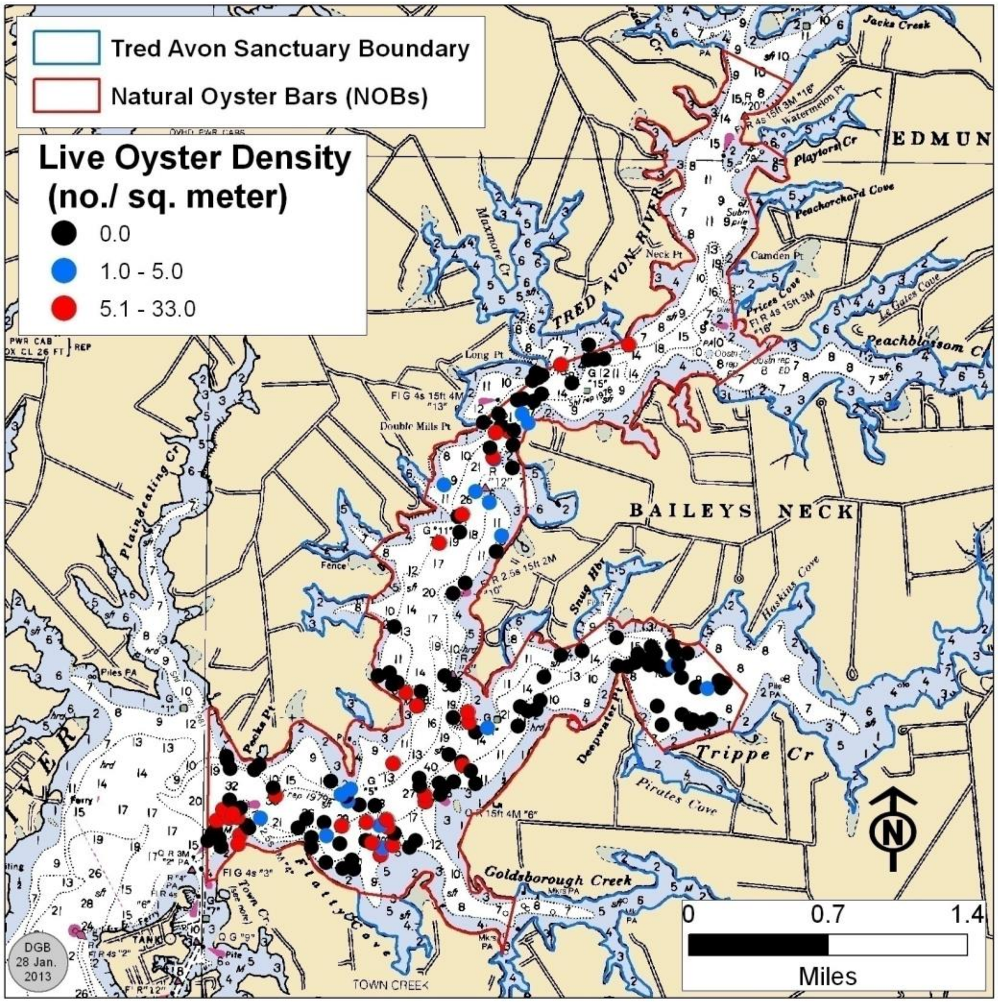

Figure 7. Tred Avon River Oyster Abundance from 2012 MD DNR Patent Tong Survey (provided by NOAA)

SAV to one heavily influenced by pelagic (water column) processes (mainly phytoplankton production) (Newell 1988, Ulanowicz and Tuttle 1992). Although food for oysters is plentiful under these conditions, failure of a reef to accrete shell because of overharvesting, disease, and other factors allows otherwise favorable substrate to become covered with sediment from either natural or anthropogenic sources, rendering it unsuitable for oyster habitat. Concomitant increased suspended sediments and loss of SAV further degrades quality of the Bay as habitat for oyster.

Oysters interact with the phytoplankton community both directly and indirectly. The primary interaction is direct: selective feeding reduces phytoplankton biomass and alters the species composition of the community. Many studies have demonstrated that benthic suspension feeders exert top-down control on phytoplankton production in freshwater, estuarine, and coastal waters (Cohen et al. 1984; Riemann et al. 1988; Cloern and Alpine 1991). Indirectly, oyster filtration and biodeposition work to sequester nutrients, thereby reducing phytoplankton production fueled by excessive nutrients in the water column.

4.3.3.4 Zooplankton

Zooplankton communities in the freshwater and oligohaline regions of Chesapeake Bay are diverse, and their abundance and biomass are usually high. Abundance, biomass, and diversity are generally lower in the mesohaline and polyhaline zones, although high densities of larval polychaetes, mollusks, and decapods occur in specific areas.

4.3.3.5 Blue crab

Mobile predators such as the blue crab produce strong direct effects of predation and disturbance on the benthic communities in Chesapeake Bay (Hines et al. 1990). The blue crab occupies a variety of aquatic habitats ranging from the mouth of the Bay to fresher rivers and creeks and occupies different trophic levels during various stages of its life cycle.

The blue crab is an important predator of bivalves, such as young oysters, in the Bay. Although adult oysters are too large for blue crabs to open and prey upon (White and Wilson 1996), crabs do feed readily and opportunistically on juvenile oysters (Eggleston 1990). Oysters attain a partial refuge from predation at low densities (Eggleston 1990), but predation by blue crabs might increase with increasing oyster abundance.

4.3.4 Fish

Approximately 267 species of fish can be found in the Chesapeake Bay (White 1989). The fishes of the Bay are either resident or migratory. Migratory fish fall into two categories: (1) anadromous fish, which spawn in the Bay or its tributaries, and (2) catadromous fish, which spawn in the ocean. Anadromous fish migrate varying distances to spawn in freshwater. Striped bass spawn in the tidal freshwater areas of the Bay and major tributaries; younger fish remain in the Bay to feed while many adults migrate to ocean waters after spawning. Shad and herring are truly anadromous, traveling from the ocean to freshwater to spawn and returning to the ocean to feed. Eels are the only catadromous species in Chesapeake Bay. Other migratory fish use the Bay strictly for feeding. Some species, like croaker, drum, menhaden, weakfish, and spot, journey into the Bay while still in their larval stage to take advantage of the rich supply of food. Bluefish generally enter the Bay as juveniles or adults.

Fish in the Bay can also be categorized as planktivorous, reef-oriented, or piscivorous. Planktivorous fish are a key part of the food web in Chesapeake Bay. They consume plankton, and are preyed upon by larger fishes such as striped bass and bluefish (piscivores). The larval and early juvenile stages of all fish species in the Bay feed on plankton; however, bay anchovy and menhaden are the only two major species in Chesapeake Bay that feed primarily on plankton throughout their life cycles. Although oysters and planktivorous fish both feed on phytoplankton, competition is typically not an issue because phytoplankton are typically not limiting.

Oyster bars provide habitat for several species of fish (reef-oriented), many of which are important in commercial and recreational fisheries. The naked goby resides on oyster bars throughout its juvenile and adult lifestages (Breitburg 1991) and is considered an exclusively reef-dwelling species. Black sea bass (*Centropristis striata*), which is considered to be a temperate reef fish, is found seasonally on oyster bars and other hard substrate and structures in the middle and lower

Bay during warm months. Although black sea bass generally migrate to ocean waters during the winter, they are reef dependent for a significant portion of each year. Other obligate reef dwellers that inhabit oyster reefs are skilletfish and toadfish. Additional reef-oriented fish include species such as the Atlantic croaker that use a variety of habitats but frequent hard-bottom habitat, such as oyster bars.

4.3.5 Avifauna

Many avian piscivore species use the abundant fish populations of Chesapeake Bay as their primary food sources including walking and wading shorebirds, raptors, and waterfowl. Two of the species documented best in the literature are the bald eagle (*Haliaeetus leucocephalus*) and the North American osprey (*Pandion haliaetus*) both of which frequent and nest along the Tred Avon River. The U.S. Fish and Wildlife Service documents that over 30 nests occur along the shorelines of the Tred Avon. The Chesapeake Bay also has one of the highest concentrations of bald eagles in the lower 48 states.

Other avian species depend on hooked mussels, clams, and other species that inhabit oyster reefs. Black ducks along with a number of sea ducks (surf scoter, black scoter, bufflehead, common merganser, hooded merganser, common goldeneye, long-tailed duck, red-breasted merganser, and white-winged scoter) use oyster reefs for foraging in the winter. The loss of oyster reefs is a likely contributor to the decline sea duck populations.

The black duck (*Anas rubripes*) is a good representative of a benthic-feeding avian waterfowl species. The black duck is a medium to large dabbling duck that is most similar to the mallard (*Anas platyrhynchos*), but it lacks the male mallard's characteristic green head and white collar. Black ducks depend upon the condition of the bottom of the bays and wetlands in which they feed. Black ducks feed on a combination of plants and animals. They forage underwater, primarily on the seeds of grasses, sedges, pondweeds, and other aquatic vegetation. They will also readily eat snails, Baltic clams, hooked mussels, and fish (Krementz 1991). Diving ducks such as canvasbacks (*Aythya valisineria*) depend completely on aquatic habitats throughout their life cycle. They feed on plants and animals in wetlands and shallow benthic habitats. At one time, canvasbacks in Chesapeake Bay consumed wild celery almost exclusively, but the decline in wild celery caused the species to shift its diet to small clams. As bottom feeders, canvasbacks are likely to be able to forage on and around many oyster bars.

Neither black ducks nor canvasback ducks, nor any of the other waterfowl known to inhabit Chesapeake Bay, feed directly on oysters to any significant extent; however, many feed on or around oyster bars. The primary mechanism of interaction between oysters and these benthic-feeding birds is indirect, through changes in the types, abundance, and distribution of benthic invertebrates that could inhabit restored oyster reefs and provide food for benthic-feeding birds.

4.3.5.1 Avian Oyster Predators

Some avian species will feed directly on oysters such as the American oystercatcher (*Haematopus palliates*). Oystercatchers are large shorebirds with strong white or black-and-white markings. They consume oysters and other shellfish and have powerful, brightly colored bills that they use to open the shells of bivalves. Oystercatchers were once hunted almost to extinction but are now conspicuous shorebirds found throughout the Chesapeake Bay region.

Several studies have shown that a decrease in shellfish stocks negatively affects the oystercatcher population (Goss-Custard et al. 2003; Atkinson et al. 2003; Tuckwell and Nol 1997). The primary mechanism of interaction for oystercatchers is direct, through a change in the availability of oysters as a food source. When the abundance of shellfish is low, the birds can survive on alternative prey species, but these species often do not enable the birds to maintain good body condition (Smit et al. 1998). Tuckwell and Nol (1997b) showed that kleptoparasitism by other species (e.g., gulls) increases when oystercatchers are feeding on non-oyster shellfish.

4.3.6 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 04-267), requires all federal agencies to consult with the National Marine Fisheries Service (NMFS) on all actions, or proposed actions, permitted, funded, or undertaken by the agency that may adversely affect essential fish habitat (EFH).

The 1996 amendments to the MSFCMA strengthened the ability of NMFS to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. Essential fish habitat is defined in 50 Code of Federal Regulations (CFR) part 600 as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity.”

<u>4.3.6.1 Essential Fish Habitat Species in Study Area</u>

Previous consultation with John Nichols, NMFS, (email February 9, 2009) as part of the 2009 *Chesapeake Bay Oyster Restoration Using Alternate Substrate, Maryland* Environmental Assessment determined that some areas of the Chesapeake Bay under consideration for oyster restoration in Maryland lie within the general area that may provide EFH for some of the species managed by NMFS. Species for which EFH is a concern are as follows: summer flounder (*Paralichthys dentatus*), juvenile and adult life stages; bluefish (*Pomatomus saltatrix*), juvenile and adult life stages; windowpane flounder (*Scopthalmus aquosus*), juvenile and adult life stages; cobia (*Rachycentron canadum*), all life stages; red drum (*Sciaenops ocellatus*), all life stages; king mackerel (*Scomberomorus cavalla*), all life stages; and Spanish mackerel (*Scomberomorus maculatus*) (National Marine Fisheries Service, Northeast Region, Habitat Conservation Division EFH web site; www.nero.nmfs.gov/ro/doc/hcd.htm).

Due to specific habitat needs, it is unlikely that cobia, king mackerel, Spanish mackerel, or windowpane flounder would be in the project area (Murdy et al. 1994). Windowpane flounder EFH habitat does not extend into the Tred Avon River oyster sanctuary. Cobia more commonly inhabits areas of higher salinity than would be found at most of the project area. Spanish mackerel are most abundant from the mouth of the Chesapeake Bay region to south Florida. They prefer polyhaline regions (18 – 30 ppt) of the lower Bay. Finally, none of the life stages of king mackerel are typically found within the project area. As a result, this EFH analysis will focus on bluefish, summer flounder, and red drum (Table 8). Focusing on these three species for the Tred Avon

River EFH Assessment was confirmed in a phone conversation with David O'Brien, NMFS, on December 12, 2013.

Table 8. Summary of EFH within Choptank River for 7 Federally Managed Species

Species	Eggs	Larvae	Juveniles	Adults
bluefish (*Pomatomus saltatrix*)			M	M
summer flounder (*Paralicthys dentatus*)			M	M
red drum (*Sciaenops occelatus*)	X	X	X	X

S º The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).
M º The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).
F º The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).

4.3.7 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. There are no federally listed plants in the study area. Specific to animals, prior coordination completed for the 2009 Alternate Substrate EA identified the potential presence of the following rare, threatened, and endangered species: the threatened loggerhead turtle (*Caretta caretta*), the endangered Kemp's ridley turtle (*Lepidochelys kempii*), and the endangered leatherback turtle (*Dermochelys coriacea*). These species can occasionally move into the central and upper Chesapeake Bay during warm weather months. The Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*) may also be in the project area. The shortnose stugeon (*Acipenser brevirostrum)* has been listed for the entire Chesapeake Bay and its tributaries. Additionally, there are 9 animals (Table 9) and 15 plant species (Table 10) found in Talbot County on Maryland's rare, threatened, or endangered species list. Alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) were listed as species of concern under the Endangered Species Act (ESA) throughout all or a significant portion of their range or as specific distinct population segments (DPS)[13]. Following Table 9 and 10 are explanations of the rank and status applicable to the species shown in the tables. The explanation of all established rank and status criteria are provided in Appendix G, or online at http://dnr2.maryland.gov/wildlife/Documents/rte_Animal_List.pdf.

[13] NOAA Fisheries Service. ESA Species of Concern. Available online at: http://www.nmfs.noaa.gov/pr/species/fish/bluebackherring.htm

Table 9. Rare, Threatened, and Endangered Animals in Talbot County, MD

Scientific Name	Common Names	Global Rank	State Rank	State Status	Federal Status
Animals					
Acipenser brevirostrum	Shortnose sturgeon	G3	S1	E	LE
Acipenser oxyrhynchus oxyrhynchus	Atlantic sturgeon	G3	S1		C
Alasmidonta heterodon	Dwarf Wedge Mussel	G1G2	S1	E	LE
Alasmidonta undulata	Triangle Floater	G4	S1	E	
Alosa aestivalis	Alewife				SOC
Alosa pseudoharengus	Blueback herring				SOC
Botaurus lentiginosus	American Bittern	G4	S1S2B	I	
Caretta caretta	Loggerhead sea turtle	G3	S1	T	LT
Demochelys coriacea	Leatherback sea turtle	G2	S1	E	LE
Gallinula chloropus	Common Moorhen	G5	S2B	I	
Haliaeetus leucocephalus	Bald Eagle	G5	S3B		
Hoperius planatus	A Dytiscid Beetle	GNR	S2		
Hydrochus spangleri	Seth Forest Water Scavenger Beetle	G1	S1	E	
Ixobrychus exilis	Least Bittern	G5	S2S3B	I	
Laterallus jamaicensis	Black Rail	G4	S1	E	
Lepidochelys kempii	Kemp's Ridley sea turtle	G1	S1N	E	LE
Sciurus niger cinereus	Delmarva Fox Squirrel	G5T3	S1	E	LE
Sternula antillarum	Least Tern	G4	S2B	T	
Stygobromus tenuis tenuis	Slender Stygobromid	G4T4	SU		

Table 10. Rare, Threatened, and Endangered Plants in Talbot, County, MD

Note: There are no federally listed plants in the study area.

Scientific Name	Common Names	Global Rank	State Rank	State Status	Federal Status
Plants					
Agalinis setacea	Thread-leaved Gerardia	G5?	S1	E	
Antennaria solitaria	Single-headed Pussytoes	G5	S2	T	
Bidens coronata	Tickseed Sunflower	G5	S2S3		
Boltonia asteroides	Aster-like Boltonia	G5	S1	E	
Cardamine pratensis	Cuckooflower	G5	S1		
Carex lacustris	Lake-bank Sedge	G5	S2		
Carex silicea	Sea-beach Sedge	G5	S1	E	
Carex tenera	Slender Sedge	G5	SH	X	
Carex venusta	Dark Green Sedge	G4	S2	T	
Centrosema virginianum	Spurred Butterfly-pea	G5	S2		
Croton capitatus	Hogwort	G5	SU		
Cuscuta coryli	Hazel Dodder	G5?	SH	X	
Desmodium ochroleucum	Cream-flowered Tick-trefoil	G1G2	S1	E	
Desmodium pauciflorum	Few-flowered Tick-trefoil	G5	S1	E	
Dichanthelium oligosanthes	Few-flowered Panicgrass	G5	S2S3		
Eupatorium maculatum	Spotted Joe-pye-weed	G5	SU	X	
Geranium robertianum	Herb-robert	G5	S1		
Gymnocarpium dryopteris	Oak Fern	G5	S1	E	
Hottonia inflata	Featherfoil	G4	S1	E	
Hypericum drummondii	Drummond's St. John's-wort	G5	SH	X	
Leptochloa fusca ssp. fascicularis	Long-awned Diplachne	G5T5	SU		
Linum intercursum	Sandplain Flax	G4	S2	T	
Matelea carolinensis	Anglepod	G4	S1	E	
Morella caroliniensis	Evergreen Bayberry	G5	S1	E	
Paspalum dissectum	Walter's Paspalum	G4?	S2	T	
Pedicularis lanceolata	Swamp Lousewort	G5	S1	E	
Pluchea camphorata	Marsh Fleabane	G5	S1	E	
Salix bebbiana	Bebb's Willow	G5	SH	X	
Schoenoplectus novae-angliae	Salt-marsh Bulrush	G5	S2		
Sporobolus asper	Long-leaved Rushgrass	G5	S1		
Triadenum tubulosum	Large Marsh St. John's-wort	G4?	S1		
Vitis cinerea	Graybark	G4G5	SU		

Explanation of Global Rank

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or less than 1000 individuals) or because of extreme vulnerability to extinction due to some natural or man-made factor.
G2 = Imperiled globally because of rarity (6 to 20 occurrences or less than 3000 individuals) or because of vulnerability to extinction due to some natural or man-made factor.
G3 = Either very rare and local throughout its range (21-100 occurrences or less than 10,000 individuals) or found locally in a restricted range or vulnerable to extinction from other factors.
G4 = Apparently secure globally (may be rare in parts of range).
G5 = Demonstrably secure globally.
G#? = Tentative rank (e.g., G2?).
G#G# = Range of rank; insufficient data to assign specific global rank (e.g., G2G3).
G#T# = Rank of a taxonomic subgroup such as a subspecies or variety; the G portion of the rank refers to the entire species and the T portion refers to the specific subgroup; numbers have same definition as above (e.g., G3T1).
GNR = Element not yet ranked (temporary).

Explanation of State Rank

S1 = Highly State rare. Critically imperiled in Maryland because of extreme rarity (typically 5 or fewer estimated occurrences or very few remaining individuals or acres in the State) or because of some factor(s) making it especially vulnerable to extirpation. Species with this rank are actively tracked by the Natural Heritage Program.
S2 = State rare. Imperiled in Maryland because of rarity (typically 6 to 20 estimated occurrences or few remaining individuals or acres in the State) or because of some factor(s) making it vulnerable to becoming extirpated. Species with this rank are actively tracked by the Natural Heritage Program.
S3 = Rare to uncommon with the number of occurrences typically in the range of 21 to 100 in Maryland. It may have fewer occurrences but with a large number of individuals in some populations, and it may be susceptible to large-scale disturbances. Species with this rank are not actively tracked by the Natural Heritage Program.
SH = Historically known from Maryland, but not verified for an extended period (usually 20 or more years), with the expectation that it may be rediscovered.
SU = Possibly rare in Maryland, but of uncertain status for reasons including lack of historical records, low search effort, cryptic nature of the species, or concerns that the species may not be native to the State. Uncertainty spans a range of 4 or 5 ranks as defined above.
-B = This animal species is migratory and the rank refers only to the breeding status of the species. Such a migrant may have a different rarity rank for non-breeding populations.

Explanation of State Status

E = Endangered; a species whose continued existence as a viable component of the State's flora or fauna is determined to be in jeopardy.
I = In Need of Conservation; an animal species whose population is limited or declining in the State such that it may become threatened in the foreseeable future if current trends or conditions persist.
T = Threatened; a species of flora or fauna which appears likely, within the foreseeable future, to become endangered in the State.
X = Endangered Extirpated; a species that was once a viable component of the flora or fauna of the State, but for which no naturally occurring populations are known to exist in the State.

Explanation of Federal Status

LE = Taxa listed as endangered; in danger of extinction throughout all or a significant portion of their range.
LT = Taxa listed as threatened; likely to become endangered within the foreseeable future throughout all or a significant portion of their range.
C = Candidate taxa for listing for which the Service has on file enough substantial information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened.
SOC = Species of concern

4.4 Community Setting

4.4.1 Land Use

Talbot County contains over 600 miles of tidal shoreline and is bounded on three sides by waters of the Chesapeake Bay and the Choptank River. The Tred Avon River is a tidal estuarine system that drains approximately 6 percent of the Lower Choptank River watershed. The land area is approximately 48.5 square miles containing 107.2 miles of stream features. The river contains a small drainage basin characterized by low topographic relief, with agriculture being the predominant land use. The watershed covers roughly 7,932 acres with only 15.5 percent remaining in forested cover (MDE 2004). Prior to European settlement in the last 17th Century, it is estimated that the Choptank River basin was over 90 percent forested with the remainder as wetlands (Benitez and Fisher 2004). There are 1,233 acres of forests and nearly 100 acres of wetlands in the Tred Avon watershed (USFWS 2013b). The upper reaches are highly impacted by urban stormwater runoff (Stack et al. 2013). Agricultural land-use is mostly cultivated crops and pasture/hay with some forested, wetlands, and developed areas. Easton, situated at the head of the Tred Avon River, is the densest and largest urban/suburban development in the watershed.

4.4.2 Recreation

Public landings in the County offer boat ramps, mooring facilities, fishing and crabbing piers, picnic areas and parking facilities. Although public landings provide waterfront access opportunities, most facilities are small in land area and limited in size.

4.4.2.1 Fishing

The Maryland portion of the Chesapeake Bay supports a significant recreational fishery. According to data available from the Maryland Saltwater Sportfishermen's Association, the value of recreational fishing is estimated to be over $1 billion to the State's economy. The key species targeted in the lower reaches of the Choptank River complex which emcompasses the Tred Avon are black seabass *(Centropristis ocyurus)*; bluefish (*Pomatomus saltatrix*); Atlantic croaker (*Micropogonias undulates*); spot (*Leiostomus xanthurus)*; weakfish (*Cynoscion regalis*); striped bass (*Morone saxatilis)*; summer flounder (*Paralichthys dentatus)*; perch (*Pomoxis annularis*); tautog (*Tautoga onitis)*; and yellowfin tuna (*Thunnus albacares*). Historically the striped bass has been one of Maryland's most valuable fisheries. Fishermen along the Tred Avon may fish for a number of different species including striped bass, catfish and perch. They also use several different methods, including using a charter boat, their own boat, or fishing from the shore. Numerous saltwater species enter the river to spawn in springtime, starting with catfish and perch in March and April, followed by croaker in April and May, and then bluefish and both grey and speckled trout in the ensuing months. Many of the Chesapeake Bay's striped bass head up the river on their spring spawn run as well. Recreational crabbers are also found in the Tred Avon River.

Recreational oystering is legal, but uncommon in the Bay today. However, it is not allowed in sanctuaries. Many owners of shoreline property participate in oyster-rearing programs coordinated by the State of Maryland. Under the State of Maryland Grow Oysters program initiated in 2008, the Tred Avon River was the first tributary to carry out a public-private partnership to enhance oyster reefs by waterfront property owners who volunteer to grow young oysters in cages suspended from their private piers to be planted after one year onto local sanctuaries. Fish species supported by oyster habitat are key elements in providing recreational opportunities.

4.4.2.2 Waterfowl Hunting

The eastern shore of Maryland is an important stopover for many migratory waterfowl species along the Atlantic Flyway in addition to the home to numerous resident waterfowl. The Chesapeake Bay is located along the Atlantic Flyway with the annual seasonal migration of millions of waterfowl to the Bay. About 1 million swans, geese and ducks winter on the Bay[14]. Four categories of waterfowl inhabit the Chesapeake Bay: dabbling ducks, diving ducks, geese, and swans. All four kinds depend on agricultural areas, bay bottom, and wetlands for food and nesting habitat.

Talbot County is steeped in a rich waterfowl hunting tradition and is an important wintering area for many targeted species of waterfowl. American black ducks, mallards, canvasbacks, and Canada geese are prized waterfowl species that frequent the Tred Avon River. At least 15 professional guide services and outfitters exist in the Tred Avon River vicinity providing services to local area residents and travelers to the region contributing economic revenue to the local economy and the State. The annual Waterfowl Festival is held in Easton which pays tribute to the deep roots of waterfowl hunting in the area's culture. The festival draws 18,000 to 20,000 visitors each year. Also, The Talbot County Ducks Unlimited Chapter is very active in the area conserving and restoring over 8,000 acres of wetland to date[15]. According to the 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, the average migratory bird hunter in Maryland spends $1,104 per year on hunting-related expenses. Of that $1,104, $299 is spent on hunting trip-related costs.

4.4.2.3 Boating and Navigation

There are two federally maintained navigation channels within proximity to the project area as depicted in Figure 8. In the southern section of the Tred Avon River just north of the mouth is the federal project in Town Creek. The Town Creek navigation channel is authorized to a width varying from 60 to100 feet by 7 to10 feet in depth. Setbacks from the edge of the channel are 30 feet. A U.S. Army Corps of Engineers survey of the channel in 2011 found depths adjacent to the Oxford Yacht Agency marina in the range of minus 6.1 feet MLLW to 6.7 feet MLLW. The Town Creek channel was originally authorized in 1945 and no federal maintenance has occurred since 1985. The authorized project length is 4,800 feet. The Town Creek channel would not be impacted as a result of undertaking the proposed restoration project since restoration work would be entirely outside the limits of the federal channel and no work is within 150 feet horizontal limits of the channel. Therefore, no interference with the structural integrity of USACE-Baltimore's navigation project and/or obstruction to navigation within the Town Creek Channel is proposed. In the upper reaches of the Tred Avon River is another federally maintained channel authorized to a depth of minus 12 feet which was last dredged in 1987.

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[14] FWS. Migratory Birds. 2013a. Available online at: http://www.fws.gov/chesapeakebay/migbird.html

[15] Duck Unlimited. Talbot County. 2013. Available online at: http://www.ducks.org/how-to-help/chapter-spotlights/talbot-county

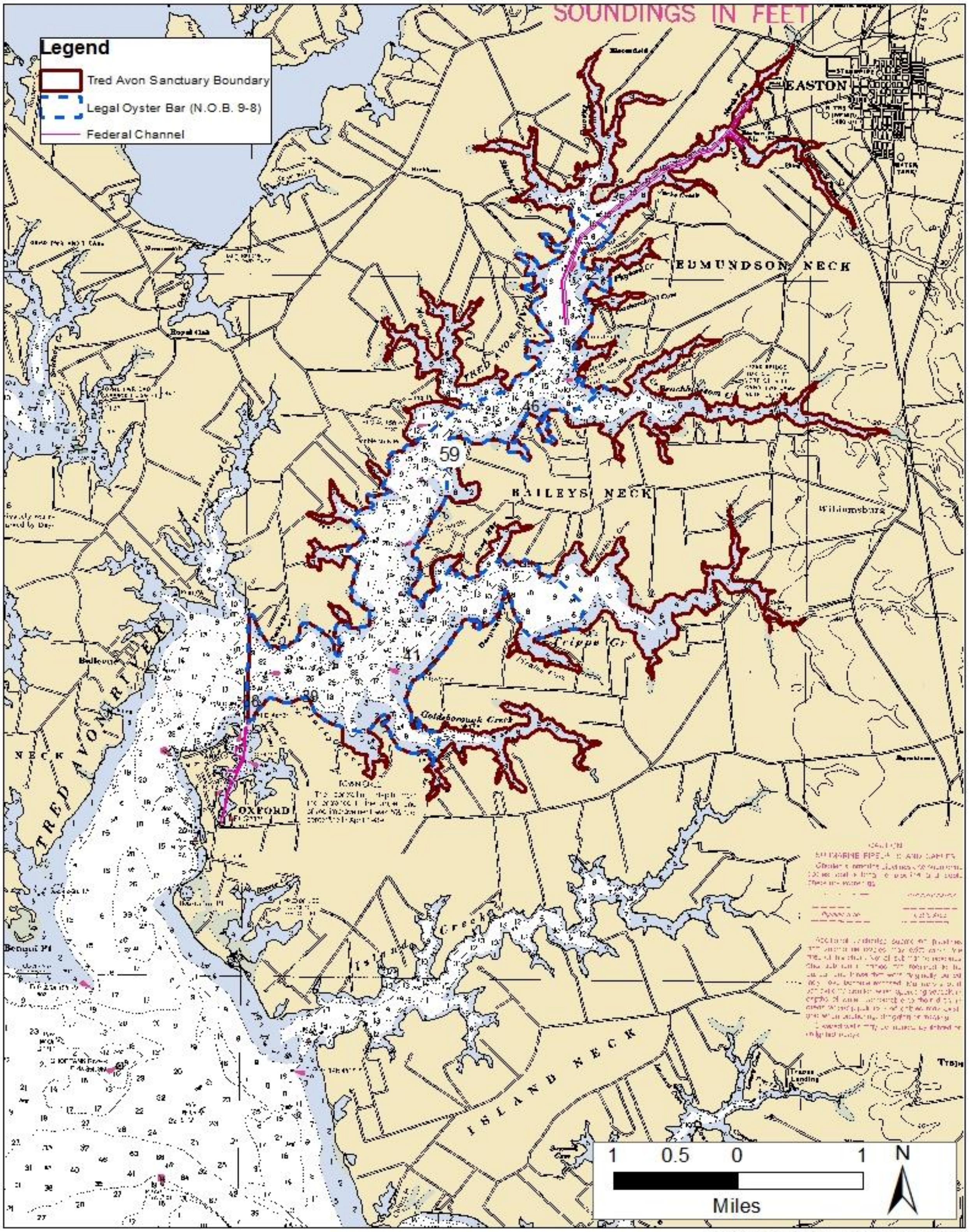


Figure 8. Federal navigation channels in the Tred Avon River

The Tred Avon River federal navigation project maintains a channel that is 150 feet wide from Easton Point to the North Fork for 1,400 feet. A turning basin 12 feet deep by 250 feet wide and 600 feet long is provided for in the South Fork on the east side of the main channel at Easton Point. The project length is 2 miles. Setbacks from the edge of the channel are 40-feet. Reef construction is proposed in depth intervals of minus 6 to minus 9 feet in close proximity to the federal channel.

The Tred Avon River is used by commercial watermen, a ferry boat operation, recreational users, and one commercial boating operation. Historically many steam boats from Baltimore drawing more than 8-feet of water made regular trips as far as Easton Point, and many schooners and motor boats also frequented the river[16]. The geographic setting of the Tred Avon is located in an area prominent in shipping activities since the earliest colonial times. Today, there is one primary commercial boating operation on the Tred Avon: Vulcan Materials, Inc. Coordination with Vulcan identified that their barges typically draw 8.5 to 9 feet with a maximum draft of 9.5 feet. Just outside the southern boundary of the Tred Avon River oyster sanctuary, the Town of Oxford leases the ferry wharf to a ferry operator for the Oxford to Bellevue ferry service. This ferry service was established in 1683 and is one of the oldest privately owned ferries in continuous operation in the United States. Ferry departures and arrivals occur approximately every 45 minutes from Oxford to Bellevue.

Many wharfs and remnants of old marine railways still occur along the shoreline. A majority of the wharfs in Town Creek today are home to boatyards, marinas and boat repair facilities including the Oxford Yacht Agency. Approximately 1.5 miles north from the entrance of the river is Town Creek, a major anchorage area for pleasure craft near the Town of Oxford, south of the sanctuary limits. Easton, to the north, is the county seat roughly 10 miles from the Town of Oxford.

Recreational boating activities include fishing, sailing, cruising, entertaining/socializing, swimming, nature observation/sightseeing, waterskiing, tubing, racing, and other water-related activities. Over the years, use of the waterway has changed from a mainly watermen's to a recreational boating community. Recreational boats are larger vessels approximately 40 to 50 feet long, 12 to 16 feet wide, and drafts of generally 1 to 9 feet compared to the working boats used by watermen. Pleasure boating today serves as the basis for a number of industries in this and neighboring tributaries. Recreational boaters spend money in the community and in the process generate economic impacts for the local area. The annual summer regatta in Oxford is held at the Tred Avon Yacht Club.

A survey of residents and local waterway users garnered input from 50 persons. Input received included required drafts and navigational paths used. The responses reinforced the importance of sail boating to the users of the Tred Avon River.

An additional source of data on navigational use of the Tred Avon River is Automatic Identification System (AIS) data collected by the USCG through an onboard navigation safety device. The Bureau of Ocean Energy Management (BOEM) and NOAA have made some of these

[16] Department of Commerce. United States Coast Pilot: Atlantic Coast. Sandy Hook to Cape Henry. Section C. 1916. Available online at: http://books.google.com

records available online (marinecadastre.gov). Passage densities (number of kilometers of tracklines within a 100 yd x 100 yd cell per year; low can be loosely characterized as less than 1, medium as 1 – 10, and high >10 – >7,500) are computed for all vessels, as well as for specific uses: cargo, passenger, pleasure craft and sailing, tanker, tug and towing, and fishing. In 2013, there were no vessels classified as cargo, passenger, tanker, or fishing that used the Tred Avon River. There was passenger activity up to Oxford in 2011 and 2012 which is outside the study area. Figure 9 shows the vessel density compilation of all uses in the Tred Avon River. The compiled density is low to medium with some high use up to Oxford. Figures 10 – 11 portray 'pleasure craft and sailing' and 'tug and towing' density, respectively. Tug and towing use is attributed to Vulcan Materials and is of low density. Based on vessels using AIS, pleasure craft and sailing has a medium density presence in the Tred Avon River, with some high usage in the Oxford area[17].

4.4.2.4 Swimming

There are no official, monitored swimming beaches on the Tred Avon River. Given the ongoing efforts to regulate and control pollutants and nutrients entering the Tred Avon River, the quality of swimming and opportunities for recreational swimming may vary by location within the waterway. The water quality of the Tred Avon is degraded by low oxygen, sediment, nutrients, fecal coliform, and biological impairments. A Chesapeake Bay Foundation Report published in 2000 highlights the impact on public health in the Chesapeake Bay region due to the increased presence of several pollutants that pose threats to human health[18]. These include vibrio, cyanobacteria (blue green algae), cryptosporidium, mercury, and nitrates.

4.4.2.5 Wildlife Viewing

In addition to waterfowl viewing opportunities associated with the Tred Avon's location in the Atlantic Flyway, the Chesapeake Bay Gateway Network connects visitors and locals to a network of trails including waterway trails in the vicinity of the project. The network includes a waterway trail in the Choptank River that passes the Tred Avon River. There are numerous community and neighborhood parks primarily located in Easton and Oxford. There are County designated parks that allow for wildlife viewing in the Tred Avon watershed.

4.4.3 Cultural and Historic Resources

The project, as a Federal undertaking, falls within the review requirements of the National Historic Preservation Act of 1966, as amended, and its implementing regulations 36 CFR, Part 800. These regulations require the USACE-Baltimore to identify, evaluate and mitigate impacts to National Register eligible or listed cultural resources prior to project initiation, in consultation with the appropriate State Historic Preservation Officer (SHPO), and at times, the Advisory Council on Historic Preservation (ACHP). Talbot County has numerous listings on the National Register for

[17] As AIS is not required on self-propelled vessels less than 65 feet in length and there is no legal requirement for recreational sailboats to have an AIS transceiver or transponder, this is not a complete representation of all vessel usage of the Tred Avon River.

[18] Bad Water 2009: The Impact on Human Health in the Chesapeake Bay Region. (2010). Chesapeake Bay Foundation. Available online at: http://www.cbf.org/document.doc?id=328.
Foundation. Available at http://www.cbf.org/document.doc?id=328.

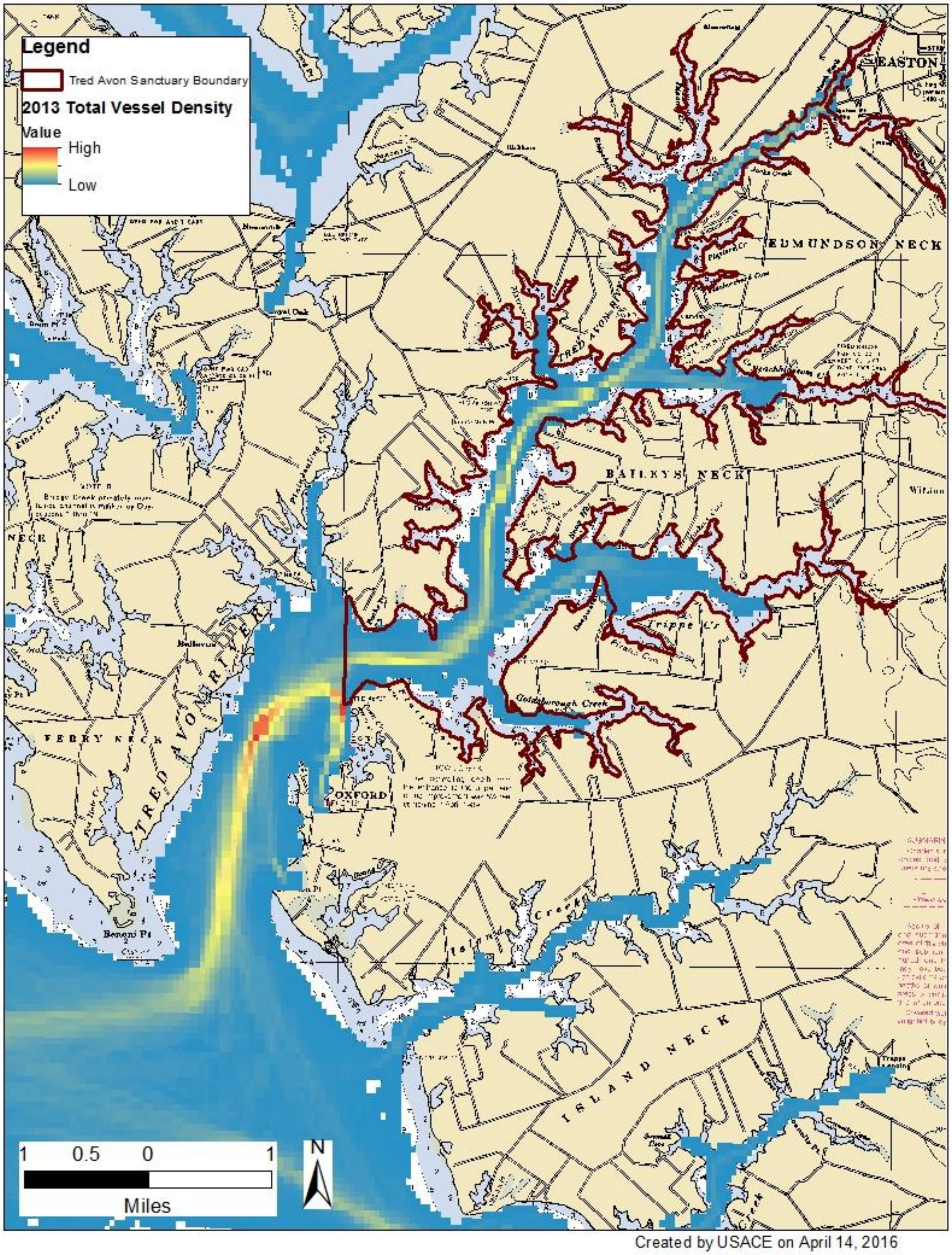
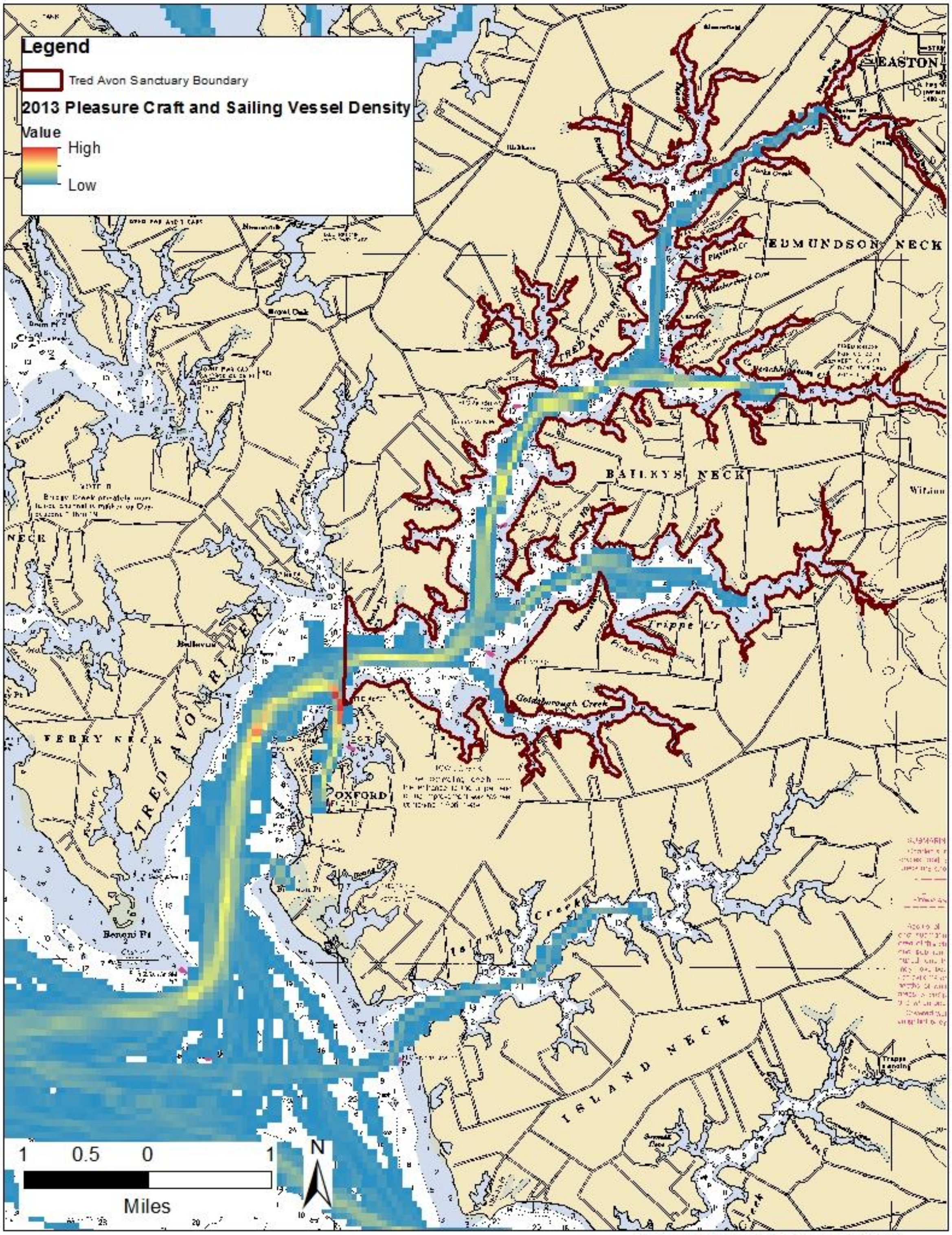


Figure 9. 2013 Total Vessel Density in the Tred Avon River
(source: NOAA Office for Coastal Management http://marinecadastre.gov/data/)



Created by USACE on April 14, 2016

Figure 10. 2013 Pleasure Craft and Sailing Vessel Density in the Tred Avon River
(source: NOAA Office for Coastal Management http://marinecadastre.gov/data/)

Created by USACE on April 14, 2016

Figure 11. 2013 Tug and Towing Vessel Density in the Tred Avon River
(source: NOAA Office for Coastal Management http://marinecadastre.gov/data/)

Maryland in addition to maintaining an active Historic Preservation Commission since 1976[19]. Also, Section 101(b)(4) of NEPA requires Federal agencies to coordinate and plan their actions so as to preserve important historic, cultural, and natural aspects of the country's national heritage. This section focuses on aquatic historic resources that could potentially be impacted by the project. National Historic Landmarks within Talbot County include the *Rebecca R. Ruark*, oldest vessel in the skipjack oyster dredging fleet; The *Kathryn*, one of 16 surviving fore-and-aft planked skipjacks; the *Hilda M. Willing* a skipjack originally built in 1905; and the *Edna E. Lockwood*, the last bugeye to retain a sailing rig and unaltered working appearance.

Coordination with the Maryland Historical Trust (MHT) (the SHPO) has occurred since the inception of the Chesapeake Bay Oyster Recovery Project (1996). Through coordination for the 2009 EA, MHT provided a list of recommended areas that should be avoided due to known or suspected historical resources. There are no areas within the Tred Avon River on that list. In October 2015, MHT reviewed the Tred Avon River Blueprint Map and determined that no cultural resources reconnaissance, identification, or evaluation studies have been undertaken and no historic properties or potential historic properties have been reported within any of the proposed oyster restoration sites. A full archeological review of the river bottom has not been conducted, nor was it recommended by MHT during the 2009 or 2015 coordination processes.

4.4.4 Hazardous, Toxic, and Radioactive Waste

The EPA EnviroFacts website was consulted to acquire a listing of Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) and Resource Conservation Recovery Information System (RCRIS) sites within the project area. There are no listed sites in the area proposed for restoration efforts.

4.4.5 Socioeconomic Conditions

The population estimate for Talbot County in 2014 was 37,643 with the demographic makeup for the county as outlined in Table 11. According to the most recently adopted Comprehensive Plan for Talbot County (2005) (currently being updated), the current and projected population and household data for 2000 to 2030 prepared by the Maryland Department of Planning shows that by 2030, the County's population would grow to 38,950 residents. Age distribution shows the largest cohort in 2000 to be individuals aged 20 to 44 years of age. The median age was 43.3 years compared to the statewide average of 36 years. In 2000, there were 1.36 jobs for every person in the labor force with 76.1 percent of employed residents working in the county. The total number of county jobs held by residents was 62 percent, with non-residents holding 38 percent of the jobs. The major economic sectors include services, retail trade, and manufacturing. The agriculture, fisheries, forestry, government, transportation, communication and public utilities sectors have decreased their share of total employment over the last three decades.

[19] Talbot County Comprehensive Plan. 2005. Available online at: http://www.talbotcountymd.gov/uploads/File/P&Z/maps/MAP12-1%20Historic%20Districts%20and%20Sites.jpg

Table 11. Talbot County Demographics Census 2014

Demographic Group	Talbot County
White alone, percent, 2012 (a)	83.3%
Black or African American alone, percent, 2012 (a)	13.2%
American Indian and Alaska Native alone, percent, 2012 (a)	0.3%
Asian alone, percent, 2012 (a)	1.5%
Native Hawaiian and Other Pacific Islander alone, percent, 2012 (a)	0.2%
Two or More Races, percent, 2012	1.5%
Hispanic or Latino, percent, 2012 (b)	6.3%
White alone, not Hispanic or Latino, percent, 2012	78.1%

(a) Includes persons reporting only one race
(b) Hispanics may be of any race, so also are included in applicable race categories

4.4.6 Visual and Aesthetic Resources

Low topographic relief and irregular shorelines characterize the eastern shore of the Chesapeake Bay and provide a general backdrop to the Tred Avon River. The river, creeks, birds, foliage and small historic towns characterizing the Tred Avon River offer residents and visitors many opportunities to view visual and aesthetic resources of the surrounding area. Traditional waterfront communities, such as Oxford, are of particular aesthetic value along this river. The historic watermen's communities and rural heritage offer an aesthetic charm and have contributed greatly to tourist-based industries in these areas. Traditional workboats operating in the area bring aesthetic appeal to the region as well as cultural value. Notably, Maryland's historic skipjack fleet has become a visual symbol of the state and has received attention as the nation's last sail-powered, commercial fishing fleet.

4.4.7 Public Health and Safety

One of the most important issues is the impact of water quality on public health, safety and welfare. Water quality is a fundamental problem facing most of the Chesapeake Bay and its oyster populations (CBF 2013). The 2012 report card by the Midshore Riverkeeper Conservancy (MRC) using volunteer monitoring data collected at various tributary-wide sites graded the river at an overall C+ rating for water clarity, dissolved oxygen, temperature, pH, salinity, nitrogen, phosphorus, and *chlorophyll a* (MRC 2013). However, the monitoring protocols used by MRC are not the same as those parameters used to screen the Tred Avon as a candidate for large-scale oyster restoration and are a general measure used to assess water quality by the non-profit.

Oyster harvesting is restricted in various areas by the Maryland Department of the Environment (MDE) for public health reasons, including areas with excessive coliform bacteria counts, and setbacks from marinas and municipal discharges. As of the June 2013 State of Maryland Shellfish

Closure Areas, the Tred Avon had three total closure areas[20] that were established in October 2011. None of the areas are within the project area.

4.4.8 Noise

The study area is open tidal waters of the Tred Avon River in depths ranging from a minus 4 to 20 feet depth contour in an area that includes residential buildings and marine waterfront centers. Estuarine shorelines abutting specific restoration site are characterized as predominately private homesteads with piers and other waterfront structures. Ambient noise levels are low, and typical of those found in rural tributaries with low-density development. High noise levels experienced near urban centers such as Easton, Trappe, and Oxford are an exception. While background noise levels for residents within the vicinity of the project area might typically be 40 dBA, a resident may also hear acute noise sources, particularly in the daytime, associated with suburban neighborhoods such as a power mower, which will generate 65 – 95 dBA at 50 feet or a leafblower (110 dBA at 50 feet). Route 333 traffic is in the range of 70 dBA at 50 feet, although large trucks may typically generate 90 dBA (CHC 2014). Noise level of boats using the waterway vary from approximately 72 dBA for a classic inboard motor to 109 dBA for racing boats (PWIA, accessed 2016).

Sensitive noise receptors in the vicinity include residents living near the water. Overwintering and resident waterfowl are also sensitive to certain activities such as in-water pile driving and dredging and many in-water construction activities are limited based on MD DNR time of year restrictions.

The proposed oyster restoration actions would result in temporary construction noise associated with the initial reef build-out; however, BMPs will be employed to minimize the temporary noise impact during construction including: limiting work to daytime hours. Twin 375 horsepower diesel engines power the typical vessel used to construct oyster habitat. Cruising speeds are generally 12.7 knots.

4.4.9 Other Waterway Uses

4.4.9.1 Commercial Navigation

As described in Section 4.4.2.2, there are two federally maintained navigation channels in proximity to the project area. Commercial navigation includes charter boats, commercial watermen, and barge traffic (Vulcan Materials, Inc.).

4.4.9.2 Commercial Fishing

Commercial species sought by Bay watermen include oysters, blue crabs, soft-shell clams, eels, and several species of finfish (among them striped bass, bluefish, menhaden, and perch). The 2012 annual totals for commercial landings in Maryland were 33,300.8 metric tons (73,414,971

[20] MDE. 2013. Notice of Opening to Shellfish Waters. Available online at: http://www.mde.state.md.us/programs/PressRoom/PublishingImages/www.mde.state.md.us/assets/image/Tred_Avon_River_Reclassification_Map.jpg

lbs) generating $77,858,646 in revenue[21]. Prior to the 1920s the Tred Avon River system supported large productive oyster reefs where commercial oystering was an important staple of the local economy. Data available for the Choptank River complex which includes the Tred Avon River from 1962 shows a little over 1.2 million lbs of commercial landings. By calendar year 1991, the numbers were just under half at 552,208 lbs[22] The history of commercial oyster harvests in the Chesapeake Bay is discussed in prior NEPA documents (USACE 2009; USACE 2012). Canneries and oyster packing houses associated with the oyster industry were once prolific on the Eastern Shore. An oyster packing house was located in the village of Bellevue town on the west side of the Tred Avon River, ¾ mile northward of Oxford. Today areas outside of the State designated sanctuary limits are still commercially fished for oysters during the season from September to April. The dockside value of oysters landed in 2013 was $7.36 million in Maryland (NMFS 2014). This equates to 787,889 pounds caught. Oysters and striped bass have traded places a few times over the last few decades for third- and fourth-most valuable Chesapeake Bay fisheries, behind blue crabs and Atlantic menhaden (NOAA). The total commercial blue crab landings for the Choptank River complex were 4.3 million pounds for calendar year 2008. Annual commercial striped bass landings for the Choptank River were 33,532 lbs in 2004.

Other shellfish of commercial significance in the Chesapeake Bay include the soft-shell clam (*Mya arenaria*), the hard-shell clam (*Mercenaria mercenaria*) and the blue crab (*Callinectes sapidus*). The current soft-shell clam fishery in the Chesapeake Bay can be classified as remnant (MD DNR 2013). Soft-shell clams were first harvested intensely during the early 1950s to meet market demands. Few in the clam industry target soft-shell clam species today with total landings now measured in the hundreds of bushels. The use of a hydraulic clam dredge is prohibited in Talbot County, between the shoreline and the center of the channel, except in the months of October and November, where dredging is allowed within 1,200 feet of the Federal Research Laboratory at Oxford (House Bill 1059). Also, as a result of sanctuary designation in the Tred Avon River by the State of Maryland, the sanctuary protects non-oyster bottom habitat that surrounds the larger areas of interconnected natural oyster bars. The 2010 sanctuary designation for the Tred Avon as in other tributaries in Maryland permit oyster clamming within the new sanctuary boundaries, but clamming is limited to existing clamming areas, and maintains the existing 150 foot buffer from any natural or legal oyster bars further limiting their commercial viability. As a result of nearly the entire Tred Avon River oyster sanctuary being designated as a legal oyster bar, there is effectively no clamming activity in the study area. Based on communication with DNR, there is one reported clam harvest record in the Tred Avon (NOAA Code 637) from 1990-present. In 2015, 2 bushels of soft clams were reported harvested.

Annual commercial blue crab harvests from Chesapeake Bay since 2004 have been approximately 60 million pounds, which is well below the 73-million-pound annual average for the period 1968 to 2004 (CBP 2007). This is attributed to low exploitable stock abundance and restrictive harvest

[21] NMFS Annual Landings by Species for Maryland. 2013a. Available online at: http://www.st.nmfs.noaa.gov/pls/webpls/mf_lndngs_grp.data_in
[22] NMFS Landings. 2014. Available online at: http://www.st.nmfs.noaa.gov/pls/webpls/MF_ANNUAL_LANDINGS.RESULTS

management measures enacted in 2001 and 2002. In 2006, the abundance of adult crabs was about 57 percent of the CBP's interim restoration goal of 232 million crabs (CBP 2007).

4.4.9.3 Aquaculture

There are no current aquaculture leases (oysters) within the proposed project area.

4.4.10 Sea Level Rise and Climate Change

4.4.10.1 Project Sensitivity to Sea Level Rise

The ability of oysters to keep pace with sea level rise depends upon their capacity to grow upward at a rate greater than the rate of sedimentation. Annual growth on restored reefs in Maryland waters, at 25 to 30 mm/yr (greater than 1 inch), shows that oysters are capable of keeping pace with sea level rise in less saline waters (Paynter 2008). Results of a recent investigation by Rodriguez et al. (2014) suggest that intertidal reefs in North Carolina are capable of keeping pace with sea level rise through 2100.

4.4.10.2 Climate Change

Climate change has the potential to alter many of the conditions for oyster restoration projects proposed for the Tred Avon River. However, the specific risk from climate change and the influence those impacts may have on restoration outcomes is uncertain at this time. Scientists at the CBP are working to understand the possible effects of climate change on the Chesapeake Bay and its watersheds, including how these changes may affect oyster restoration efforts. Relative sea-level-rise, increasing temperatures, changes in species distribution, and altered water chemistry are likely to produce both positive and negative benefits to oysters and expected ecosystem services. USACE (2012) discusses potential climate change-driven impacts to Chesapeake Bay resources. Table 12 summarizes the potential impacts. Alterations in the Tred Avon River would be expected to be similar to those that occur Bay-wide.

One of the principal strategies in developing tributary-level restoration plans was to target initial restoration actions in tributaries that provide the greatest potential to allow for adaptation to climate change on behalf of the oyster. An overall salinity-based strategy to address disease and promote the development of disease resistance was integral to initial screening criteria. The Tred Avon River is a mesohaline salinity system and as such provides for the potential to develop disease resiliency in response to disease challenges. In addition to the salinity-based strategy, focusing ecological restoration tributary-wide is the strategy most likely to allow large populations of oysters to persist in the face of disease and other stressors. However, the cumulative impacts resulting from sea-level rise, temperature variability, extreme weather and precipitation, and acidification are unknown.

Table 12. Potential Climate Change Impacts to Oyster Resources

Parameter	Potential Climate Change Alteration	Impact to Oysters	
Temperature	Higher winter temperatures	longer growing season would increase productivity, growth rates, size, reduce time to maturity	positive
	Higher water temperatures	decrease oxygen in water, reduce habitat	negative
	Higher year round temperatures	increase disease pressure	negative
		reduce surface freezing could expand intertidal habitat	positive
Salinity	Increase	higher reproduction/growth	positive
		higher disease pressure	negative
		expanded habitat	positive
	Decrease (localized)	reduced habitat	negative
		lower reproduction/growth	negative
		lower disease pressure	positive
Rainfall	Increased freshwater runoff from more extreme storms	stronger stratification would reduce oxygen levels in deep waters	negative
		decrease salinity	negative and positive effects
		reduced habitat	negative
Carbon dioxide levels in the water column	Increase	increase the dissolution of shell reefs; reduce oyster's ability to form shell	negative

5.0 ENVIRONMENTAL CONSEQUENCES

5.1 Physical Environment

5.1.1 Substrate

USACE-Baltimore would physically construct reef habitat on 57 acres at 33 unique sites throughout the NOB limits by deploying substrate materials onto the seafloor thereby creating relief. The mean site area is 1.7 acres, but sizes range from 0.6 – 4.1 acres. Reef construction would occur only in depths ranging from minus 6.5 – 20 feet MLLW. The newly constructed bars would then be planted with hatchery-produced oyster spat-on-shell throughout the NOB in accordance with the tributary-level restoration plan. The underlying bottom hard substrate composition would be overlain with no more than 12 inches of substrate, but would not otherwise change as a result of undertaking the proposed project. These areas historically were oyster reefs. In some cases, they are areas identified to contain some shell, but less than 5 oysters/m^2. Therefore, there is the possibility that there are small patches within the sites that contain shell or a few oysters. In those situations, the shell and oysters would be replaced by substrate and spat-on-shell. Current local sedimentation patterns will be altered by the underwater reef structures, but minimally.

The proposed project would also place spat-on-shell on 63 – 71 acres of existing oyster reef habitat. These areas are currently oyster shell with 0 – 14 oyster/m^2. The substrate type in these areas would not change. However, existing shell would be covered by 1 – 3 inches of shell with attached spat.

5.1.2 Sedimentation

Current sedimentation patterns will be altered by the construction of oyster reef habitat deployed on the existing river bottom. Turbidity levels would increase in the short-term due to temporary suspension during construction, which is expected to settle within a short-period of time. Any suspended matter will eventually settle out of the water column. Healthy oyster populations are anticipated to improve sediment condition in the long-term through filtration and the production of biodeposits. A functioning filtering oyster community is expected to reduce TSS levels, improving local ecological conditions.

5.1.3 Water Depth and Circulation

Restoration will result in a direct and permanent impact on water depth at restoration sites. Water depth above restored substrate habitat will be reduced by 7 to15 inches with a corresponding reduction in the navigational clearance over a site. Existing oyster reef is located throughout the Tred Avon River in water depths between 4 and 20 feet. Water depth above seed only sites will be reduced by approximately 1to 3 inches. At all reef construction sites, at least 6 feet of navigational clearance will remain.

Circulation is not expected to be altered at the larger, tributary-level. However, at the local scale, on a reef, areas of deposition and erosion could be altered by reef establishment. Minimal changes are expected. In areas where 1 foot reefs are placed, there could be increased circulation due to an increase in bottom heterogeneity and gradient that would beneficially reduce sedimentation on the reef habitat.

5.2 Physiochemical Environment

5.2.1 Water Quality

Oysters once contributed significantly to maintaining water quality and aquatic habitat in the Chesapeake Bay ecosystem. Oysters both affect local water quality and are affected by water quality. Restoring oyster reef communities in the Tred Avon River is expected to provide a direct improvement to water quality in waters adjacent to restored reefs due to the filtration capacity of oysters. Filtration rates increase with oyster size and vary based on season. Therefore, water quality improvements will be minor initially following restoration, but will increase with time as oysters increase in size. The greatest positive benefit to water quality is expected to occur in the late spring through summer when temperature-driven filtration rates are highest (Newell 2004).

Oyster reef construction involves the placing of shells and/or alternative hard substrate (concrete, granite or similar stone, limestone etc.) on the river bottom. Stone to be used would be between 3 and 6 inches in size. This placement can result in temporary, local increases in turbidity. This increase is due to any soils or muds on the materials, as well as re-suspending recently settled sediments on river bottom where the materials are placed. This disruption is expected to be temporary and limited in extent. Background levels of local TSS are not expected to increase to levels that negatively impact fish, shellfish, SAV or other estuarine life due to the placement of reef base materials. Due to the limited time the construction materials will be in the water column as well as the fact that materials used in construction are typically rinsed during their mining to remove loose soils and sediments, little material is expected to be washed off the materials while they are being lowered onto the bottom. Once on the bottom, the construction materials are expected to lower TSS levels, even without oysters, due to the impermeable nature of the material, as opposed to open bay bottom, which is typically loose sediments of varying size from fine silts to coarse sands. However, this benefit will also be limited as it is the oysters themselves who are expected to provide the great majority of the water quality improvements, not the materials making up the initial reef base themselves. Negative impacts to water quality are expected to be short-term and not significant.

5.2.2 Dissolved Oxygen

Increasing existing oyster populations in the Tred Avon River as a result of undertaking the restoration project would remove DO from the water column through oyster respiration, but all models indicate there is adequate DO concentration levels occurring in the tributary and the restoration would not create oxygen-depleted conditions for other aquatic organisms in the water column. Rather, oxygen improvements are anticipated due to removal of organic matter by oyster filtration that would otherwise decompose in the benthos and consume dissolved oxygen.

5.2.3 Salinity and Temperature

No changes to ambient salinity or temperature would occur from undertaking the proposed restoration project.

5.3 Biological Resources

5.3.1 Submerged Aquatic Vegetation (SAV)

No adverse impacts to SAV are anticipated as a result of USACE-Baltimore undertaking the proposed oyster restoration project. The presence of SAV is considered during Tributary Plan development and it was determined that no SAV occurs in the vicinity of the restoration footprint and reefs. SAV is typically not found in areas greater than 6 feet in depth depending on water clarity (2012 Master Plan). Substrate reef deployment would occur in waters deeper than 6.5 feet MLLW. Therefore, SAV is not likely to occur within the proposed project areas based on VIMS coverage data. Also, reefs would be constructed between December and March when SAV are dormant. If SAV were to be found in the vicinity of a restoration site, additional pre-construction groundtruthing for SAV prior to reef substrate deployment and seeding activities would occur. There is a chance that SAV could be found adjacent to seeding sites at sites shallower than 6 feet MLLW. It is unlikely that SAV would be located within seed-only sites as the sites have been determined to be shell by bottom surveys, a bottom type that does not encourage SAV growth. MD DNR would need to consider the presence of SAV per their seeding permit.

Previous coordination with NMFS in 2009 via email correspondence determined that time of year restrictions may be necessary to protect SAV from elevated turbidity within 500 yards of the substrate placement for reef restoration. Provided the placement of reef material occurs between December and March of any year, as indicated in the EFH assessment, NMFS agreed that minimal adverse impact to adjacent SAV or HAPC is anticipated.

SAV beds also have the potential to benefit oyster habitat by trapping suspended sediments in the water column thus reducing the potential siltation of reef habitat and turbidity in the water affecting free-swimming larvae. SAV and oysters both positively impact local water quality which in turn benefits the entire estuarine ecosystem. The location of oyster bars adjacent to other estuarine habitats such as shorelines and SAV has the potential to provide cumulative benefits to these habitats and the Tred Avon River system. SAV is known to benefit from the presence of oyster reefs, which dampen wave energy (Turner et al. 1999; Heiss and Bortone 1999). Although, not anticipated to be a significant benefit in the Tred Avon River due to the targeted water depths, constructing new oyster reefs may protect shorelines and SAV beds with greater ability to reduce the force of approaching wave energy (2012 Master Plan). SAV may benefit from the proposed project.

5.3.2 Wetlands

No wetlands would be impacted as a result of undertaking this project since no wetlands are in the vicinity of the restoration footprint since restoration work would only occur in depths from minus 4- to 20-feet MLLW outside areas where estuarine intertidal wetlands occur. Therefore, the proposed project achieves the national policy of “no-net-loss” of wetland functions and values under the Clean Water Act.

5.3.3 Benthic Macroinvertebrates

Oyster habitat is a unique feature of Bay benthic habitats. The bars and reefs themselves provide hard structure used by a diversity of macroinvertebrates (e.g., blue crabs and epifauna (organisms that attach to hard bottom)) and fish. Some organisms eat various oyster life stages. For example, sea nettle, anemones, and other filter feeders consume larvae, and flatworms and mud crabs feed on spat. Blue crabs will eat older spat and first-year oysters.

Oyster reef establishment is expected to have positive benefits to adjacent benthic communities and their predators. Rodney and Paynter (2006) showed that the total macrofaunal abundance (free living macrofauna + fouling organisms) was an order of magnitude higher on restored bars compared to unrestored reefs. Further, many organisms that were significantly more abundant on restored reefs are also known to be important food items for several commercially and recreationally important finfish species.

As a result of constructing substrate reef habitat in the sanctuary, benthic substrate would be permanently shaded and buried by the proposed reef structures. The proposed actions would lead to a permanent transformation of bare benthic bottom to reef habitat on 57 acres. This would be a conversion to a more historic condition when extensive oyster reef habitat existed in the Chesapeake Bay, although where alternate substrates are deployed, the composition of the reefs would differ from natural shell reefs. Temporary displacement related to construction activities is anticipated, but no more than minimal. Benthic biomass and community composition is likely to significantly increase. The combined restoration work would provide an important food source for benthos, particularly for deposit-feeding epifauna. The three-dimensional habitats associated with oyster reefs are anticipated to build vertically overtime as individual oysters accumulate and form increased community diversity and bottom floor structure. The vertical relief would greatly affect benthic biomass at restoration sites, especially during the first year after deployment.

It is anticipated that benthic communities on seed-only sites would be enhanced in the long-term by the addition of shell and oysters. However, there may be minor, temporary, impacts initially following construction to sessile organisms from being covered by placed materials.

5.3.3.1 Eastern Oysters

Restoration efforts are expected to result in enhanced recruitment, settlement, and growth of oysters. This is turn, over time, could increase the size of reef structures. Expanding restoration actions into depths that would maintain 6 feet of navigational clearance provides for a high likelihood of achieving sustainability, and provides significant ecosystem benefits, diversity, resiliency, and reproduction potential. The only anticipated negative impact to oysters from the proposed project is the potential for sparsely existing oysters within the footprint of substrate reefs to be covered by placed materials.

5.3.3.2 Clams

The major potential mechanisms for these species to interact with oysters are through competition for food and space. It is anticipated that as a result of undertaking the substrate reef restoration work, direct competition for space could occur on a local scale if an increase in oyster populations causes an expansion of hard-bottom habitat over existing soft-bottom habitat. Increased competition between clams and oysters for food could result in a reduction in the abundance of infaunal bivalves (2012 Master Plan). Soft-shell clams occupy sandy or sandy-mud bottoms, unlike the harder bottoms preferred by oysters[23]. However, the habitat occupied by soft-shell clams does overlap with that of oysters, and clams are frequently found beneath oyster cultch and directly adjacent to oyster bars. However, the impact of competition for suitable bottom is expected to be minimal. Areas not suitable for oysters in mud and silt bottoms would be available for colonization by clam species since the oyster restoration polygons are targeted only to those areas most preferential toward successful restoration outcomes including those areas that existed historically.

5.3.3.3 Phytoplankton

Since oysters feed primarily on phytoplankton they may compete for food with other filter-feeding invertebrates, planktivorous fish, and zooplankton (Kennedy et al. 1996; NRC 2004). The extent of such competition resulting from restoration depends on the food preferences of the competing species; moreover, significant competition is likely to occur only when the concentration of phytoplankton in the water is low in relation to the number of consumers which is a condition not anticipated. Currently, competition for phytoplankton is believed to be minimal because oyster numbers are low compared with their historical abundance and because nutrient input and the resultant production of phytoplankton are high (Newell 1988). The impact of competition for food resulting from a successful restoration outcome is expected to be minimal. Increasing oyster biomass in the Tred Avon River would likely result in greater cropping of phytoplankton populations through increased filtration thereby improving local water quality and periods of anoxia. Expansion of restoration into shallower waters will expose more of the water column to the potential benefits of increased filtration by oysters.

5.3.3.4 Zooplankton

Using a simple quasi-equilibrium, mass-action model (Ulanowicz and Tuttle 1992), researchers have predicted that an increase in the abundance of oysters in the Bay would decrease phytoplankton productivity; the abundances of pelagic microbes, ctenophores, and medusae; and particulate organic carbon. The model also predicted increases in benthic primary production and fish stocks. Many reef-dwelling benthic invertebrates produce planktonic larvae; therefore, oyster reefs might provide both sources of larvae and recruitment sites at the end of planktonic development (Harding 2001). The primary mechanism of interaction between oysters and the zooplankton community would be indirect, through competition for planktonic food. The impact of competition for food resulting from a successful restoration outcome is expected to be minimal.

5.3.3.5 Blue Crab

Expanding oyster reef restoration into shallower habitats would directly benefit blue crab populations by providing valuable habitat, increasing their food supply, and providing habitat for blue crab prey species. If SAV increases due to oyster filtration, there could be a benefit to the blue crab population. Expanded SAV could enhance blue crabs by providing more refuge for

[23] Maryland's Chesapeake Bay Commercial Fisheries. 1978. Available online at: http://www.gpo.gov/fdsys/pkg/CZIC-sh222-m3-m3-1978/html/CZIC-sh222-m3-m3-1978.htm

juvenile crabs. Additionally, oyster bars and reefs provide valuable habitat for many organisms, including the blue crab which is a commercially important species in the Bay. As the oyster communities develop in the Tred Avon River to include dense seasonal populations of rapidly growing recent recruits there is an expectancy of intensive blue crab predatory activity. Therefore it is anticipated that oyster restoration actions in this river would provide synergistic and beneficial effects to trophic interaction.

5.3.4 Fish

The proposed project is expected to result in beneficial impacts to aquatic resources as oysters at different life stages are an import food source for some species of fish such as black drum and cownose rays. In addition, these reef structures will provide shelter, cover, and foraging habitat for mobile finfish that prefer reef structure such as oyster toadfish, skilletfish, tautog, spotted sea trout, and naked gobies. Through the creation of new oyster bars and the rehabilitation of existing nonproductive bars, a portion of historic oyster habitat will be restored. Placement of shell and seeding activities will form an elevated reef structure with greatly increased surface area for the attachment of sessile organisms (e.g. algae, barnacles, sponges, etc.) that could be used as forage for finfish. The three-dimensional habitat of an oyster bar results in a higher level of benthic primary and secondary production than is produced in most other benthic substrates that in turn, enhance food supply for larger finfish.

Substrate and spat-shell placement may cause re-suspension of sediments and generate turbidity which could potentially impact fish eggs, larvae, and juvenile stages. However, this impact would be temporary, minor and confined to a limited area. In addition, most of the construction work will be occurring in the late fall or winter during which time fish species in the area do not spawn and they would still be mobile enough to not be impacted by the construction efforts.

5.3.5 Avifauna

The expansion of oyster restoration into shallow waters is expected to have a direct benefit on avian piscivore species (e.g. raptors), benthic-feeding species (e.g. Black Duck, diving ducks), and those such as oystercatchers that feed directly on oysters by providing additional foraging habitat.

5.3.6 Essential Fish Habitat

In a letter dated February 11, 2014, NMFS concurred with USACE-Baltimore's determination that shallow water oyster restoration (between 6 and 9 feet MLL W) in the Tred Avon River will not have a significant adverse effect on EFH or habitat area of particular concern (HAPC), and that over time the reefs will benefit water quality and aquatic habitat.

As indicated in the *Shallow Water Oyster Restoration in the Tred Avon River Oyster Sanctuary* EFH assessment, the placement of natural shell or alternative substrate (non-shell) will be conducted at existing oyster bars within the Tred Avon River at water depths between 6.5 and 9 feet MLLW. Some areas of substrate placement will occur adjacent (within 300 feet.) to existing submerged aquatic vegetation (SAV), designated a HAPC for federally managed red drum and summer flounder. Previous coordination with NMFS in 2009 via email correspondence determined that time of year restrictions may be necessary to protect SAV from elevated turbidity within 500 yards of the substrate placement for reef restoration. Provided the placement of reef material occurs between December and March of any year, as indicated in our EFH assessment, NMFS agreed that minimal adverse impact to adjacent SAV or HAPC is anticipated. NMFS support efforts underway by the USACE, the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team (GIT) and MIW to restore oyster reef habitat, critically important to various life stages of numerous state and federally managed species, in Maryland tributaries such as the Tred Avon River.

5.3.7 Rare, Threatened, and Endangered Species (RTE)

Based on data compiled from the USFWS Information, Planning, and Conservation System, there are no aquatic RTE species within the study area under the purview of USFWS. A letter dated February 11, 2014, from USFWS confirmed this information. In a letter dated April 15, 2014, NOAA confirmed that the proposed project would not affect the RTE species (sea turtles and Atlantic sturgeon) under their jurisdiction. Further, NOAA stated that no further consultation in accordance with Section 7 of the ESA is necessary. Based on this information, it is concluded that there will be no detrimental or beneficial impacts to RTE species from the project.

5.4 Community Setting

5.4.1 Land Use

The proposed action will have no impact on land use. Sustainable land use policies and practices within the Tred Avon River watershed and control of run-off will benefit the proposed project by providing for suitable water quality.

5.4.2 Recreation

5.4.2.1 Fishing

It is anticipated that the proposed restoration work, if successful, would improve ecological conditions with increasing oyster biomass and resulting benthic inveterate habitat. It is well-recognized that three dimensional oyster reef habitats increases secondary finfish production (Grabowski and Peterson 2007) and therefore the proposed action is expected to have a long-term benefit to recreational and commercial fishing. Any temporary disturbance on the waterway would be localized during reef placement and seeding actions.

5.4.2.2 Boating and Navigation

Recreational boaters, commercial watermen, and commercial barging operations are the primary users of the waterway. As of 2014, there were approximately 714 registered boats in the Tred Avon River. Drafts were available for 297 of the 714 registered boats. On average, these boats draw 3.2 feet, with a maximum of 11.8 feet. Of the registered boats with identified drafts, 26 boats have drafts greater than or equal to 6 feet. This equates to 8.75 percent of registered boats. USACE-Baltimore reached out to over 500 residents along the Tred Avon River as well as to several marinas and the Tred Avon Yacht Club to determine where boat users traverse within the Tred Avon River and what common pathways are used. Further information on this outreach is discussed in the public involvement section of the report. No impact is expected to use of the waterway, including activities such as the summer regatta.

The Town Creek channel would not be impacted as a result of undertaking the proposed restoration project since oyster restoration would occur entirely outside the limits of the federal channel. The Tred Avon River channel south of Easton would not be impacted either, because no action undertaken by USACE-Baltimore is proposed within 150 feet of the horizontal limits of the channel. Therefore, no interference with the structural integrity of the USACE-Baltimore federal navigation project and/or obstruction to general navigation within either federal channel in the project vicinity is expected.

USACE-Baltimore solicited input from local residents and the boating community in September 2014 on the drafts required by waterway users of the Tred Avon River. A mailing was sent to over 500 residents, as well as flyers posted in 10 public places (see Appendix I). Based on input received, the initial plan to provide 5 feet MLLW of navigational clearance following construction was revised to provide the currently proposed 6 feet MLLW clearance at substrate reef restoration sites. Due to this change, a number of sites were eliminated from the proposed project that fell between the 6 and 6.5 feet depths. Additionally, sites in 6.5 feet MLLW depths were converted from up to 12 inch to 6 inch in height to enable restoration in those areas while maintaining the necessary navigational clearance that were identified by the waterway users.

The proposed project would not impact operations of the Oxford-Bellevue Ferry.

The USCG provided guidelines for all future oyster restoration plan development (during the initial Harris Creek planning efforts) as listed below:

1. Establishment of oyster sanctuaries and reefs to remain a minimum of 250 feet from established Aids to Navigation (AtoN) to allow for safe navigation and accessibility of servicing units. Placement of sanctuary or reef material should allow servicing units unobstructed ingress and egress access to the aid from the main channel;

2. Oyster sanctuaries and reefs remain a minimum of 150 feet outside/shoreward of maintained channel limits (Note- maintained channel means Corps maintained channels-pers. comm. from John Walters USCG to Woody Francis Corps.)

3. Where no established and maintained channel exists, establishment of oyster sanctuaries and reefs are to remain outside/shoreward of line segments extended between adjacent AtoN;

4. If it is not possible to adhere to the reef placement recommendations provided above, conduct an Army Corps Waterways Risk Assessment to determine the effect of placing reef-based obstructions in a waterway. This methodology is currently being incorporated into the placement of renewable energy installations in the coastal marine environment and

is conducted by the renewable energy infrastructure owner/permit applicant. Reef restoration projects should be assessed in a similar manner, since both reefs and offshore energy installations are obstructions being introduced into a waterway, thereby changing vessel operating conditions.

These guidelines have been incorporated to the extent possible to enable large-scale restoration goals to be met. Recommendation #1 (AtoN buffers) was fully incorporated and depicted in Figure 12. With regards to #2, the Federal project is upriver of the restoration areas, thus that recommendation is not applicable. With regards to #3, there is no established and maintained dredged channel in the Tred Avon River within the boundaries of the restoration project scope, although there is a connection downriver to non-Corps maintained channels. Therefore, USACE conducted outreach with residents, commercial waterway users (as discussed above), and reviewed the plan in detail with USCG to address recommendation #4. A navigational path between the AtoN is depicted in Figure 12. This identifies the proposed restoration sites that fall within the area that USCG requested restoration avoid. Proposed restoration sites are largely along the edge of navigational path.

There are four locations where proposed restoration sites fall within the navigational path. Figure 13 depicts these areas within the sanctuary (outlined by pink circles). Figures 14 – 16 provide an analysis of the focus areas. The analysis considered water depth, as well as the width of deep water (>13 feet) passage that would exist around the restoration sites. For this analysis, deep water is defined as greater than 13 feet because the controlling depth of the Tred Avon River channel at the head of the River is 12 feet. Proposed substrate restoration sites at 13 feet would result in bottom depths between 12 and 11.75 feet following restoration.

The proposed restoration sites in the lower portion of the sanctuary are shown in Figure 14. SS_08, a proposed substrate restoration is situated in 7 – 9 feet MLLW of water. SO_05, a seed only site, is located in water depths between 9 and 13 feet MLLW. Following restoration, there would remain a navigational clearance of at least 6.5 feet MLLW at SS_08. Water depths at seed only sites such as SO_05 would undergo a minimal change in water depth of 1 – 3 inches. There is a wide path of deep water available for navigation around these two sites to their east within the navigation pathway as shown in Figure 14.

In the middle of the sanctuary SS_13, SS_58, and SO_23 are within the navigation pathway. Water depths at SS_13 range from 7 feet on the shoreward side to greater than 13 feet on its western most edge. Water depths are greater than 9 feet above the proposed SS_58 and SO_23 with the exception of a few points that are 7 feet along its western edge. There is greater than 225 feet or more of deep water available for navigation around these two sites.

The greatest concentration of proposed activity is in the vicinity of Double Mills Point (Figure 16). The navigational area off Double Mills Point in the middle of the sanctuary contains control sites (not depicted) where no restoration will occur, seed areas (blue in Figure 16) that are currently existing oyster reefs and would experience a depth change of only 1 – 3 inches following restoration actions, and substrate placement sites within that area of the navigational pathway. Most of the proposed restoration work in this area is in waters deeper than 13 feet. At SO_11, there is a width of 350 feet of deep water for navigation available. SO_24 is the site that appears to have the greatest potential to impair the navigation pathway. The depths in this area range between 13 and 21ft. There is 150 feet of deep water available to navigate around the restored area. However, as a seed only site, water depth changes would be a minimal 1 – 3 inches, and therefore the navigational pathway at approximately 500 feet in width through this area would be largely unchanged. SO_12, SS_55B, and SS_60 are located in water depths between 13 and 20 feet. This cluster of sites is projected to provide sufficient navigable clearance following restoration.

In summary, the proposed sites within the navigation pathway are largely in waters deeper than 9 feet (many deeper than 13 feet), but do have some shoreward edges that are shallower than 9 feet. Some of these shallow edges are within the navigational pathway. Coordination with USCG from October 2015 through April 2016 resulted in the following additional input and adjustments to sites within the navigational pathway:

- USCG communicated that there is no concern for navigational impacts associated with seed-only sites within the navigational pathway.
- USCG recognizes that the aids to navigation are not always in the exact location shown on the NOAA charts. Current locations are incorporated into the tributary plan.
- USCG identified that substrate placement in waters deeper than 11 feet in the Tred Avon River are not a concern as reef placement would maintain the 9.5 feet of navigational clearance identified by Vulcan for their barges.

- SS_55B – Retain this site as a proposed restoration site in its entirety. SS_55B was coded incorrectly in the geodatabase, and is not a shallow water site. SS_55B is situated in water depths greater than 13 feet.
- SS_13 – Remove from restoration plans the portion of this site that is channelward of the navigational pathway (0.65 acres) to provide sufficient clearance for navigation. Retain the remainder of the site.
- SS_58 – Remove this site in its entirety (1.47 acres) to provide sufficient clearance for barges.
- SS_08 – Remove this site in its entirety (1.58 acres) to provide sufficient clearance for barges as it is entirely in the navigational pathway.
- SS_18 – Retain this site as a proposed restoration site in its entirety as the portion within the navigational pathway is in water depths greater than 13.5 feet.

A detailed account of coordination with USCG is provided in Appendix G.

Following the changes prompted by public outreach and the navigation assessment presented above, USACE determined that the proposed work would not adversely affect general navigation as shown on the tributary plan. It is anticipated that USACE-Baltimore would provide the USCG all proposed reef coordinates including minimum depth information in advance of the proposed placement date. Additionally for purposes of federal charting, USACE would coordinate the as-built surveys of constructed reefs sites with NOAA's Marine Chart Division. Based on on-going

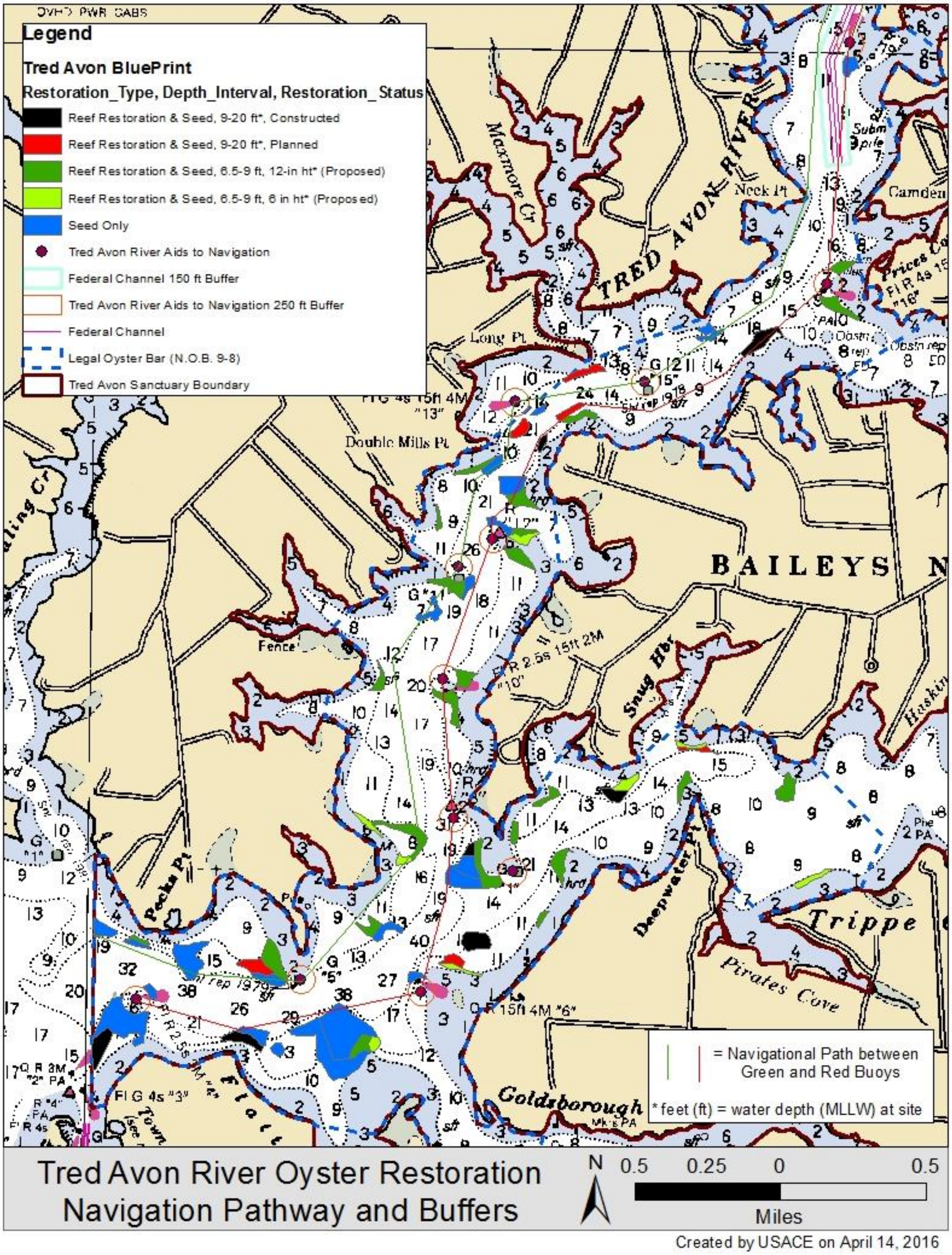


Figure 12. Navigational Pathway Between Aids to Navigation with the Tred Avon River

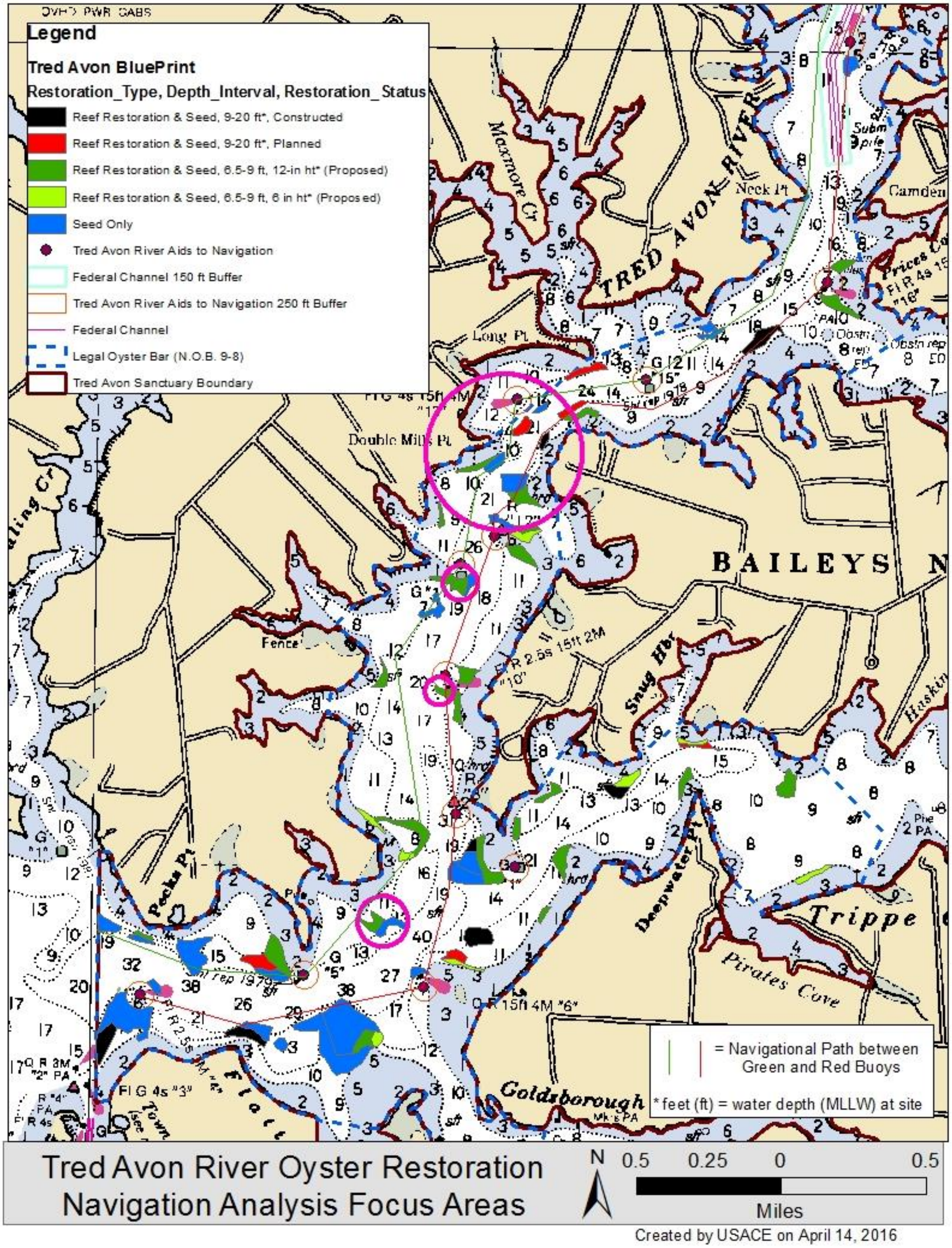


Figure 13. Focus Areas for Detailed Navigational Assessment

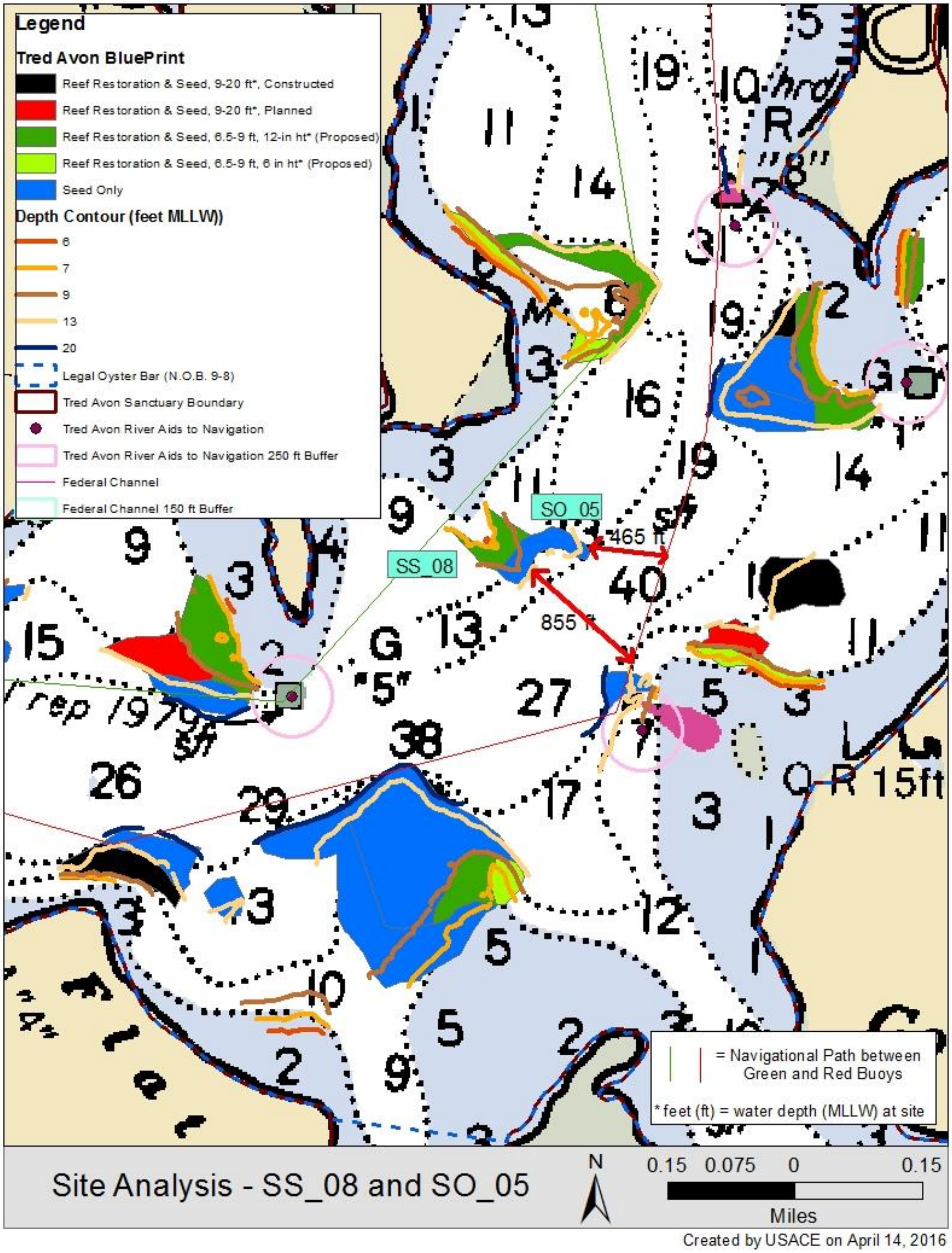


Figure 14. Site Analysis of Navigation in the Lower Sanctuary

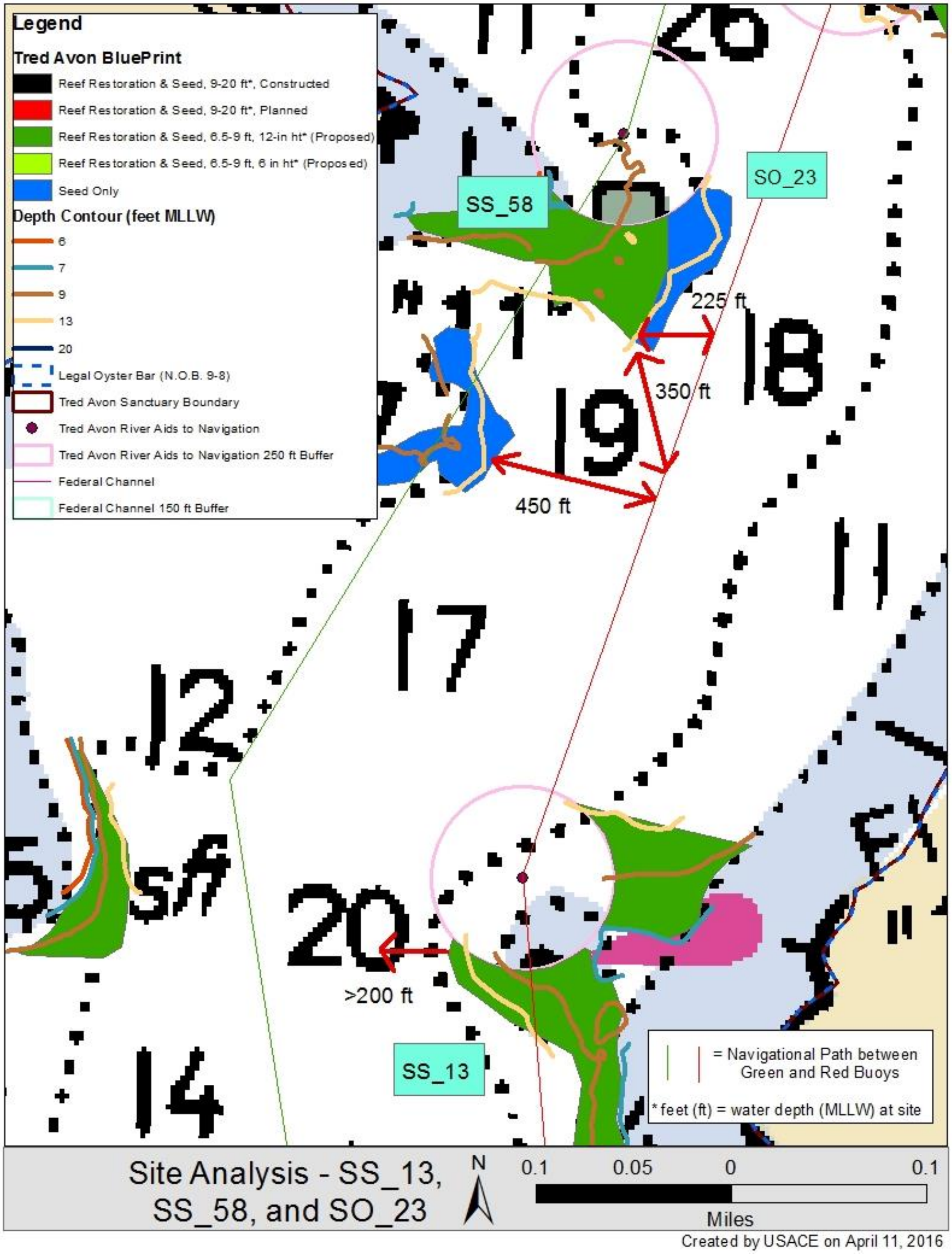


Figure 15. Site Analysis of Navigation in the Mid-Sanctuary

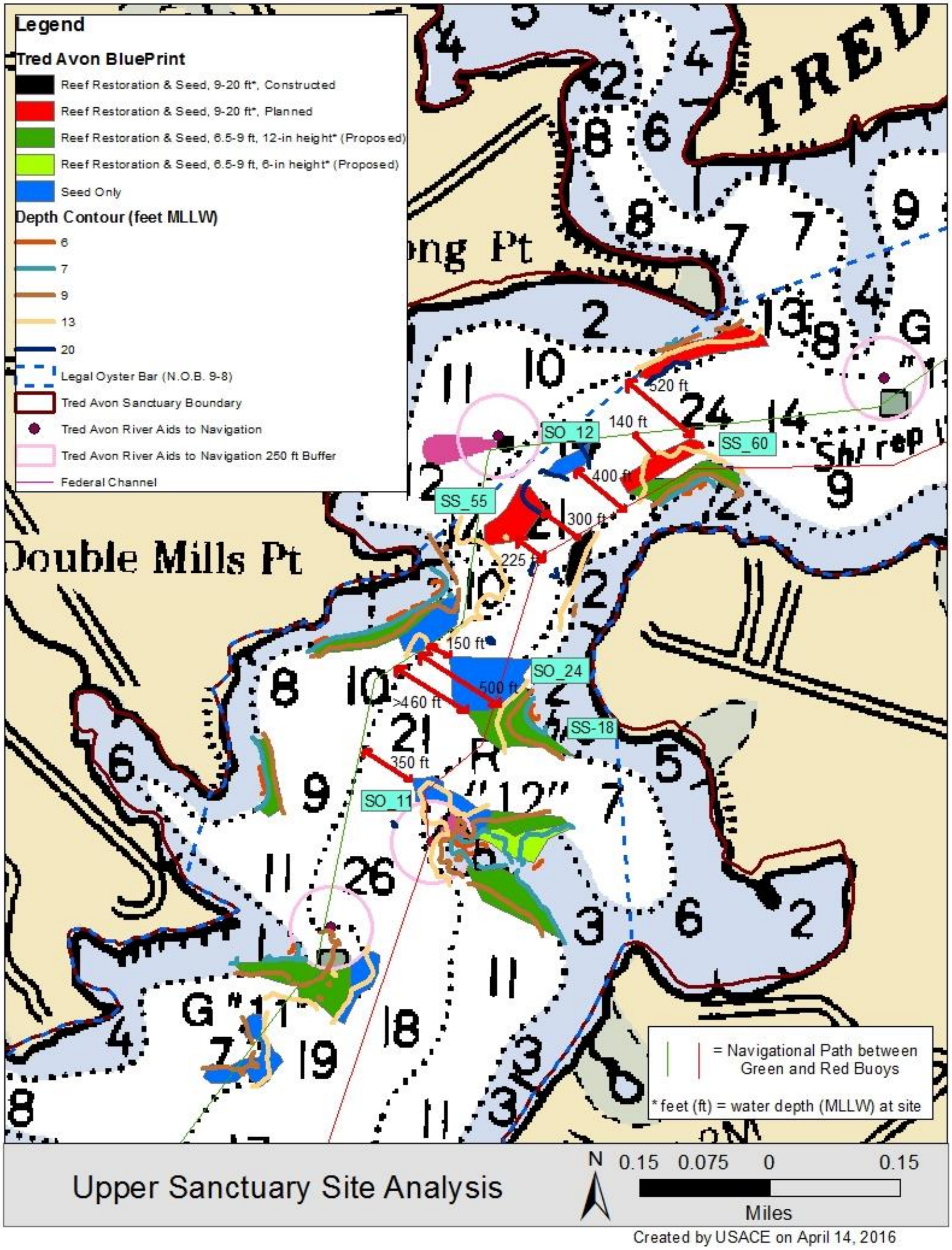


Figure 16. Site Analysis of Navigation in the Upper Sanctuary (off Double Mills Point)

coordination with USCG, a Local Notice to Mariners will be provided, as determined to be appropriate.

If restored reefs should, in the future, upon growth of the oysters into the water column cause unreasonable obstructions to navigation, the MIW will address the situation by incorporating adaptive management strategies. Data collected at the 3 year and 6 year check-in, per the established Oyster Monitoring Metrics, will be utilized to identify reef height and current water depths. It is not anticipated, but should the situation arise where there are reefs within the navigational pathway that are posing a problem by encroaching on the navigational clearance within the navigational pathway, oysters could be removed from the reef and transplanted to other sanctuary sites. This should be a minimal concern as the selected Alternative 7 has eliminated reefs within the navigational pathway that would have reduced navigational clearance to 6 feet. Those outside the navigational pathway will be evaluated as to whether these reefs can be left alone to develop their natural structure and reef height if in areas where there is little navigational passage. If so, revised bathymetry will be submitted to NOAA to update navigational charts with current heights.

5.4.2.3 Waterfowl Hunting

There is the potential for waterfowl hunting to be enhanced with restoration of additional oyster reef habitat that would provide further foraging habitat for hunted avian species. If the oyster restoration activities as proposed are successful especially in the shallower water depths of the NOB, the population of diving ducks may increase locally given a recognized relationship in the region between healthy oyster populations and SAV habitat. It is anticipated that restoration actions would stabilize and/or increase opportunities for SAV providing for increased numbers of ducks, including canvasback and redhead ducks which feed on the SAV.

5.4.2.4 Swimming

The oysters' contribution to improving water quality as a result of restoration actions when combined with TMDL actions could contribute to an increase in recreational activities such as swimming, and a reduction in the costs of water quality improvement measures. Restoration efforts are likely to return reefs to functioning ecosystems in the Tred Avon River that provide many benefits to people. A single oyster can filter up to 50 gallons of water a day (Newell et al. 2004, Luckenbach 2009) aiding in cleaner water and better opportunities for recreational swimming due to fewer toxic blooms and hypoxic events.

5.4.2.5 Wildlife Viewing

As a result of undertaking the proposed project, a minor temporary disruption to wildlife viewing may occur during reef placement at specific sites, but it is anticipated upon project completion that oyster restoration efforts could provide better opportunities for wildlife viewing throughout the Tred Avon River. Restoring healthy oyster populations is expected to draw waterfowl to the area such as diving ducks that feed on oyster bars.

5.4.3 Cultural and Historic Resources

Oyster reef construction has the potential to affect underwater historic and/or archeological resources; however, the proposed actions and alternatives do not impact any such resources since there are no documented and/or undocumented historical and/or archeological properties including shipwrecks in the vicinity of any restoration polygon. Placing 1-foot of relief through the tributary at identified reef placement sites would not compromise the structure integrity of the bottom of any potential historical or archeological site. The proposed reef structures would not be visible from the waterway and "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion" would not be affected by this undertaking. However, MHT has requested that they be notified if materials or geophysical anomalies are known or discovered which could indicate the presence of historic properties within the various project areas. USACE will notify the MHT upon discovery of any previously unknown historic, cultural, or archeological resources or remains within or immediately adjacent to the Tred Avon River oyster restoration project areas during acoustic and diver led surveys conducted by project partners and associates. USACE will inform the MHT of objects, structures, or geophysical anomalies that could indicate the presence of a historic property (e.g., structural timbers, rigging, machinery, and glass, ceramic, and/or metal artifacts that could indicate the presence of a historic shipwreck; concentrations of bone, stone, and/or ceramic artifacts that could indicate the presence of a prehistoric archeological site; or magnetic or bathymetric anomalies, side scan sonar contacts, or sub-bottom reflectors that could indicate the presence of the aforementioned items), and avoid activities that may affect the resources or remains until the required coordination with MHT has been completed. USACE will initiate the Federal, Tribal, and state coordination necessary to determine if any such items or remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

5.4.4 Hazardous, Toxic, and Radioactive Waste

The proposed action will have no impact on CERCLIS or RCRA sites within the Tred Avon River.

5.4.5. Socioeconomic Conditions

No direct impacts are expected to socioeconomic conditions from the proposed project. However, indirect positive and negative impacts may result. The action has the potential to negatively affect commercial crabbers that use trotlines if certain alternate substrates are used. Alternatively, a healthy oyster reef network may benefit the crab population by providing additional foraging opportunities. The action has the potential to positively affect commercial fisherman that target fish species benefited by reef habitat. Additionally, the proposed project has the potential to positively impact watermen that harvest oysters by contributing to the oyster population (export of larvae from sanctuary reefs to harvest areas) in areas open to harvest.

5.4.6 Visual and Aesthetic Resources

No detrimental or beneficial impacts to aesthetic resources are expected to occur as a result of undertaking the proposed oyster restoration project. Reef construction and seeding activities would involve waterway vessel equipment including operation of an onboard crane which would be visible from the waterway and abutting shorelines during the construction period. A typical oyster restoration vessel is 60-feet long with a beam width of 19-feet which draws 3.5- to 5-feet of water. The vessel is used to transport and place hatchery-produced seed oysters onto designated sanctuary sites. The vessel also carries oyster shell and other alternate materials for reef construction. A 4,000 pound crane is onboard to deploy material. Twin 375 horsepower diesel engines power the vessel. Cruising speeds are generally 12.7 knots. The extent and perception of the aesthetic alteration would vary depending upon the nature of the surrounding area and the values of the public using the waterway. Following completion of restoration actions, there would be no changes to the existing visual or aesthetic resources.

5.4.7 Public Health and Safety

The proposed project would have no negative impacts on public health and safety. Expansion of oyster restoration into shallow waters is anticipated to provide a positive impact to water quality, at least in the vicinity of restored reefs. In addition, groups like MRC and other nonprofits are working with landowners to reduce pollution from agricultural related land-uses which dominate the watershed. Actions include the State of Maryland’s cover-crop program. Undertaking the proposed restoration in the sanctuary may provide improved water quality conditions, however threats from sewage and bacteria may present concerns throughout the tributary. There is an important relationship between water quality and oyster restoration, where water quality has declined precipitously due to a continual decline in oyster populations. The State of Maryland is actively targeting fecal bacteria seeped from sewage and septic tank leaks, pet waste and boats. It is anticipated that collective actions undertaken by the federal, state, and local governments in addition to actions by environmental nonprofits and through citizen engagement would improve public health and safety in project areas tributary-wide.

5.4.8 Noise

Noise would increase in the immediate vicinity of restoration work during placement of substrate and spat-on-shell. No work would occur at night. It is not anticipated that the proposed project would result in ambient noise levels outside those noise levels already experienced on the waterway from existing navigational uses. Following completion of restoration actions, there would be no impacts to noise levels.

5.4.9 Commercial Waterway Uses

<u>5.4.9.1 Commercial Navigation</u>

As described in Section 5.4.2.2, commercial navigation impacts were thoroughly considered. Areas of potential conflict with navigational interests were removed from consideration for restoration based on input received from local residents as well as USCG. No negative impacts are expected for commercial navigation from expansion of oyster restoration into shallower water depths as the existing channel will not be affected.

5.4.9.2 Commercial Fishing
No negative impacts are anticipated to commercial fishing of finfish, eels, or clams by expanding oyster restoration into water depths between 6.5 – 9 feet MLLW. Throughout public coordination for the Tred Avon restoration work, commercial crabbers identified a concern that alternate substrate reefs posed a problem for crabbing with trotlines and could lead to a negative impact on that industry. Crabbers were asked to provide input on site selection. Large stone was identified as posing the greatest problem for trotliners. Stone to be used would be between 3 and 6 inches in size. To minimize this impact, mixed shell was utilized to the maximum extent possible for reef restoration of deep water sites. USACE and its partners will continue to work with the watermen community to minimize or prevent this potential impact. However, it is anticipated that there will not be sufficient shell available to restore the entire 57 acres. Other approaches could be pursued such as using a base of stone with shell placed on top to prevent trotlines from snagging. Commercial clamming operations would not be impacted as there is no clamming within 150 feet of a legal NOB and most of the Tred Avon River oyster sanctuary is currently designated as a legal NOB.

5.4.10 Climate Change

The specific risk from climate change and the influence those impacts may have on restoration outcomes is uncertain at this time. Scientists at the CBP are working to understand the possible effects of climate change on the Chesapeake Bay and its watersheds, including how these changes may affect oyster restoration efforts. Relative sea-level-rise, increasing temperatures, changes in species distribution, and altered water chemistry are likely to produce both positive and negative benefits to oysters and expected ecosystem services. USACE (2012) discusses potential climate change-driven impacts to Chesapeake Bay resources. The reefs restored in accordance with the Master Plan (USACE 2012) are anticipated to be capable of growing vertically and keeping pace with sea level rise in the Tred Avon River; however, monitoring will confirm that accretion and reef growth is occurring at a pace that is positive in the face of climate-driven effects. In the event that reefs are not keeping pace with sea level rise or are being negatively impacted by other climate change related alterations, adaptive management measures will be taken. These measures would likely consist of adding spat-on-shell plantings to the reef to increase height, add carbonate to the system, and add broodstock. However, in more extreme cases, substrate could also be placed to provide additional elevation. Table 10 summarizes the potential climate change impacts to oysters. Alterations in the Tred Avon River would be expected to be similar to those that occur Bay-wide. However, the cumulative impacts resulting from sea-level rise, temperature variability, extreme weather and precipitation, and acidification are unknown.

6.0 CUMULATIVE EFFECTS ANALYSIS

Cumulatively, expanding oyster restoration into shallow water depths is expected to have a positive, direct impact on the Tred Avon River ecosystem. The proposed work is a part of the broader Tred Avon River Oyster Restoration Tributary Plan, which has set a target of restoring 146 acres of oyster reef habitat in the Tred Avon River. Thus far, restoration on 24 acres of reef habitat has commenced with 16 acres of alternate substrate reef construction complete. Implementation of the Tred Avon River Tributary Plan is part of a Chesapeake Bay-wide effort focused on restoring sustainable oyster populations. The Tred Avon efforts, with those that have been undertaken in Harris Creek and the Little Choptank River are aimed at meeting the oyster outcome of E.O. 13508 and the oyster goals of the 2014 Chesapeake Bay Agreement. Additional work is ongoing in Virginia. Maryland and Virginia are working towards restoring oyster populations in five tributaries each with a combined goal of restoring ten tributaries in the Bay.

Tributary plans developed for each tributary look to achieve large-scale restoration that will be of a sufficient scale to produce a system-wide impact. The tributary plans target restoration of 377 acres of oyster reef habitat in Harris Creek, 146 acres in the Tred Avon River, and 440 acres in the Little Choptank River. In Harris Creek, initial restoration efforts have been completed on 350 acres out of 600 potentially restorable bottom acres. Although, the initial target of 377 acres has not been reached, initial restoration efforts have been implemented on all available bottom. (Acreage reductions from the 377 acre target occurred throughout implementation and led to a feasible implementation of 350 acres rather than 377 acres.) Tred Avon River restoration plans call for restoring 146 acres out of a total 251 restorable bottom acres, of which work on 16 acres has been initiated. In the Little Choptank, a total of 685 acres of potentially restorable bottom was identified. Thus far, 126 acres of alternate substrate reefs have been constructed and 34 of those acres have been received spat-on-shell. Another 12 acres of seed-only sites have received spat-on-shell plantings. Additionally, 40 acres met the oyster metrics for success and require no restoration action. From these efforts, the Little Choptank River system has 178 acres with some level of restoration or function.

Initial large-scale oyster restoration efforts in Harris Creek were completed in summer 2015. Between 2011 and 2015, USACE-Baltimore restored 135 acres of 1-foot high oyster reef in Harris Creek using alternate substrates, primarily mixed shell and granite. MD DNR has restored another 62 acres of alternate substrate reef habitat. Additionally, 150 acres of existing reef habitat were designated seed-only sites in the Tributary Plan and planted with spat-on-shell. The result of coordinated efforts in Harris Creek is the restoration of 347 acres of oyster reef habitat to augment the 3 acres that supported a healthy oyster population prior to restoration for a combined 350 acres of oyster reef habitat in Harris Creek. Over 2 billion spat-on-shell oysters were planted in Harris Creek. Total restoration expenditures in Harris Creek $26.8 million across all partners.

In total, across the three tributaries in which Maryland has initiated oyster restoration work, 275 acres have been restored, another 112 acres constructed but unseeded, 1.71 billion spat-on-shell planted, at an (state and federal) expense of $39.13 million through 2015 (MIW 2016).

Along with the oyster restoration work, monitoring efforts of oyster habitat and water quality are being planned and implemented by USACE, NOAA, and MD DNR. NOAA is funding coordinated research to investigate reef ecosystem services such as the nitrogen removal potential of restored oyster reefs and finfish fish utilization of the expanded habitat network. USACE is performing further work with the University of Maryland to better understand larval transport and enhancement of oyster resources in adjacent non-restored areas. The first set of reefs (those planted in 2012) underwent 3-year monitoring in Fall 2015. Preliminary results identified that all reefs seeded (100 acres) in 2012 currently meet the threshold success criterion (15 oysters m^{-2} over 30 percent of the bottom), and 50 percent meet the higher target criterion (50 oysters m^{-2} over 30 percent of the bottom). Monitoring will continue to track the health and abundance of the oyster population, as well as to understand the resulting anticipated benefits to the ecosystem.

All three Maryland tributaries (Harris Creek, Tred Avon River, and Little Choptank River) that have or are undergoing large-scale oyster restoration efforts are considered part of the Choptank Complex on the Eastern Shore of Maryland. In May 2014, NOAA designated the Choptank River complex in Maryland and Delaware, which includes the Tred Avon River, as one of two Habitat Focus Areas under their Habitat Blueprint. The Habitat Blueprint is NOAA's strategy to integrate habitat conservation throughout their agency, focus efforts in priority areas, and leverage internal and external collaborations to achieve measureable benefits within key habitats (NOAA 2014a). It enables them to prioritize long-term habitat science and conservation efforts in selected areas. NOAA will be developing an implementation plan for the area. The intent is to successfully protect and restore the ecological health of the watershed.

Cumulatively, the coordinated large-scale oyster restoration work along with the designation of the Choptank Complex as a Habitat Focus Area is designed to have significant positive benefits on the oyster resources in the region, and the Tred Avon River and lower Choptank ecosystem. Broad ecosystem services as discussed in Section 3.2 are expected to be re-established or enhanced due to the concerted efforts. Larval transport modeling suggests that there is interconnectedness amongst these three tributaries. The restoration of expansive habitat should provide a connected network of reef habitat to a large-scale that does not exist elsewhere in Maryland waters of the Chesapeake Bay. This network is expected to provide foraging and refuge habitat for a diverse assemblage of fish and estuarine fauna.

Other projects that need to be considered along with oyster restoration are SAV restoration, shoreline stabilization efforts, watershed management, and various efforts to improve water quality. In addition to oyster restoration, broad efforts are being undertaken by jurisdictions across the Bay watershed to support the Chesapeake Bay Restoration and Protection Executive Order 13508 and the nutrient reduction goals established in the Chesapeake Bay TMDL that will help address water quality issues. The oyster restoration work will further support ongoing Bay restoration efforts by improving local water quality within the Tred Avon River. The Executive Order goals targeting water quality, habitat, and fish and wildlife and the efforts of the various GITs are directly related to achieving oyster restoration goals. Opportunities to match oyster restoration efforts, spatially and temporally, with land management projects are anticipated as a result of implementing specific watershed improvement plans for the county under these mandates. The oyster restoration work being undertaken by the USACE and its partners will further support these TMDL efforts by improving local water quality within the Tred Avon River.

The location of oyster bars adjacent to other estuarine habitats such as shorelines and SAV has the potential to provide cumulative benefits to these habitats and the Tred Avon system. SAV beds have the potential to benefit oyster habitat by trapping suspended sediments in the water column thus reducing the potential siltation of reef habitat and turbidity in the water affecting free-swimming larvae. SAV and oysters both positively impact local water quality which in turn benefits the entire estuarine ecosystem. SAV is known to benefit from the presence of oyster reefs, which dampen wave energy (Turner et al. 1999; Heiss and Bortone 1999). There is the potential for SAV to increase once large-scale oyster restoration is complete due to water quality improvements.

In addition, groups like MRC and other nonprofits are working with landowners to reduce pollution from agricultural related land-uses that dominate the watershed through programs such as the State of Maryland's cover-crop program. Undertaking the proposed restoration in the sanctuary may provide improved water quality conditions; however, threats from sewage and bacteria may present concerns throughout the tributary. There is an important relationship between water quality and oyster restoration. Although watershed development plays a large role, water quality has declined precipitously as oyster populations continue to decline. The State of Maryland is actively targeting fecal bacteria seeped from sewage and septic tank leaks, pet waste and boats. It is anticipated that collective actions undertaken by the federal, state, and local governments in addition to actions by environmental nonprofits and through citizen engagement would improve public health and safety in project areas tributary-wide.

Restoration on such a large scale does have associated trade-offs. Commercial watermen may experience negative impacts to crab trotlining on alternate substrate sites, but healthy oyster reefs may benefit the crab population. Additionally, healthy oyster reefs are expected to provide habitat for reef-dwelling fish, which will benefit commercial and recreational fisherman. Waterway users are no longer accustomed to expansive three-dimensional reef networks. Re-establishing oyster reefs could lead to changes in how people navigate the waters. Although 6 feet of navigational clearance will remain above substrate reefs following construction, some people may choose to avoid those areas. Additionally, healthy oyster reefs should continue to grow up into the water column over time. This will be a slow process that occurs over long periods of time and it is anticipated that waterway users will be able to co-exist, but it would alter the underwater landscape.

7.0 ENVIRONMENTAL COMPLIANCE

In addition to the environmental impacts discussed in this EA, a review of the proposed action has been made with regard to other potential areas of concern. Environmental compliance was fulfilled through a number of avenues. Coordination through past NEPA documents for oyster restoration was built upon for this supplemental EA. Table 13 summarizes the compliance status of the proposed project.

7.1 Clean Water Act

Due to the expected impacts, a 404(b)(1) analysis of the proposed project on waters of the United States was performed pursuant to the guidelines promulgated by the Administrator, U.S. EPA., under authority of Section 404 of the Clean Water Act. A report of that evaluation can be found in

Appendix E. All proposed work to construct reef habitat will be completed under the purview of the Section 401 Water Quality Certification for Wetlands License 14-WQC-01 acquired by USACE-Baltimore. This certification is provided in Appendix C. Per the Water Quality Certification received, MD DNR will be required by MDE to obtain a separate Water Quality Certification for their work to place spat-on-shell.

7.2 Coastal Zone Management Act

Through coordination with MDE, USACE-Baltimore received Wetlands License 14-WQC-01. That license states that the Maryland Department of the Environment determined that the proposed activities comply with, and will be conducted in a manner consistent with, the State's Coastal Zone Management Program, as required by Section 307 of the Federal Coastal Zone Management Act of 1972, as amended.

7.3 Endangered Species Act

Endangered Species Act coordination was fulfilled by the actions completed as part of the NEPA process completed by USACE-Baltimore. No rare, threatened, or endangered species under the purview of FWS were identified in the project area in a preliminary Endangered Species Act species list generated using FWS's Information, Planning, and Conservation decision support system. This was communicated to FWS in a letter from January 2014. For those resources under the purview of NOAA, USACE provide NOAA a Section 7 Endangered Species Act Assessment in March 2014 concluding that USACE-Baltimore had determined that there would be no negative impacts to rare, threatened, and endangered resources or critical habitat as a result of the proposed oyster restoration efforts. In a letter dated April 15, 2014, NOAA provided their determination that no species listed under their jurisdiction would be exposed to any direct or indirect effects of the proposed project based on their review of the proposed action, the project location, and the timing of the project activities. Additional coordination with NOAA in March 2015 confirmed that the expansion of the scope of the project to include seeding of existing reef habitat and substrate reef restoration does not require further consultation in accordance with Section 7 Endangered Species Act. All ESA documentation and correspondence is provided in Appendix G.

7.4 Fish and Wildlife Coordination Act

Coordination for Section 7 of the ESA and Fish and Wildlife Coordination Act was initiated by a letter sent to USFWS in January 2014 and a formal letter stating full compliance with FWCA and FWS support for the project was received on February 11, 2014. Additional coordination with

Table 13. Compliance of the Proposed Action with Environmental Protection Statutes and Other Environmental Requirements

Federal Statutes	Level of Compliance[1]
Archeological and Historic Preservation Act	Full
Clean Air Act	Full
Clean Water Act	Full
Coastal Barrier Resources Act	N/A
Coastal Zone Management Act	Full
Comprehensive Environmental Response, Compensation and Liability Act	N/A
Endangered Species Act	Full
Estuary Protection Act	N/A
Farmland Protection Policy Act	N/A
Federal Water Project Recreation Act	N/A
Fish and Wildlife Coordination Act	Full
Land and Water Conservation Fund Act	N/A
Magnuson-Stevens Act	Full
Marine Mammal Protection Act	Full
Marine Protection, Research, and Sanctuaries Act	Full
National Historic Preservation Act	Full
National Environmental Policy Act	Full
Resource Conservation and Recovery Act	Full
Rivers and Harbors Act	Full
Water Resources Planning Act	Full
Watershed Protection and Flood Prevention Act	Full
Wild and Scenic Rivers Act	N/A
Executive Orders, Memoranda, etc.	
Migratory Bird (E.O. 13186)	Full
Protection and Enhancement of Environmental Quality (E.O. 11514)	Full
Protection and Enhancement of Cultural Environment (E.O. 11593)	Full
Floodplain Management (E.O. 11988)	Full
Protection of Wetlands (E.O. 11990)	Full
Prime and Unique Farmlands (CEQ Memorandum, 11 Aug 80)	N/A
Environmental Justice in Minority and Low-Income Populations (E.O. 12898)	Full
Protection of Children from Health Risks & Safety Risks (E. O. 13045)	Full
Chesapeake Bay Protection and Restoration (E.O. 13508)	Full
Invasive Species (E.O. 13112)	Full
Indian Sacred Sites (E.O. 13007)	Full
Stewardship of the Oceans, Our Coasts, and the Great Lakes (E.O. 13547)	Full
Facilitation of Cooperative Conservation (E.O. 13352)	Full

[1] Level of Compliance:
Full Compliance (Full): Having met all requirements of the statute, E.O., or other environmental requirements for the current stage of planning.
Non-Compliance (NC): Violation of a requirement of the statute, E.O., or other environmental requirement.
Not Applicable (N/A): No requirements for the statute, E.O., or other environmental requirement for the current stage of planning.

NOAA in July 2015 confirmed that the expansion of the scope of the project to include seeding of existing reef habitat and substrate reef restoration does not require further consultation.

7.4 Fish and Wildlife Coordination Act

Coordination for Section 7 of the ESA and Fish and Wildlife Coordination Act was initiated by a letter sent to USFWS in January 2014 and a formal letter stating full compliance with FWCA and FWS support for the project was received on February 11, 2014. Additional coordination with NOAA in July 2015 confirmed that the expansion of the scope of the project to include seeding of existing reef habitat and substrate reef restoration does not require further consultation.

7.5 Magnuson-Stevens Act (Essential Fish Habitat)

EFH coordination was continued from prior coordination via email sent to NMFS on January 6, 2014. Based on this coordination an EFH assessment was completed (Appendix F) and was submitted to NMFS for review and approval. A letter documenting NFMS's concurrence was received in February 2014. Additional coordination with NOAA in July 2015 confirmed that the expansion of the scope of the project to include seeding of existing reef habitat and substrate reef restoration does not require further consultation.

8.0 PUBLIC INVOLVEMENT AND AGENCY COORDINATION

8.1 Public Involvement

Public involvement was initiated with an open house held by the MIW in Oxford, MD on November 7, 2013. The intent of the open house was to present initial oyster restoration plans for the Tred Avon River to the public and solicit public input to incorporate into potential plan revisions. There were 43 registered attendees. Four comments were received during the open house, which were largely supportive of the restoration efforts. There was one comment asking if the Tred Avon River would ever be open again to public oyster harvesting. Although, the open house was not completed as part of the NEPA process, the draft tributary plan presented for review has matured into the existing plan that constitutes the activities planned for implementation under the 704(b) program.

In an effort to identify navigational needs in the Tred Avon River, flyers requesting input were mailed to 555 stakeholders on September 23, 2014. These flyers were also placed and/or posted at the following locations on Sept. 12, 2014:

- Tred Avon Yacht Club;
- Oxford Boatyard Marina Store and Office;
- Brewer Oxford Boat Yard and Marina;
- Hinckley Yacht Services Ship Store;
- Oxford Market;

- the Oxford community news and info bulletin board;
- the Oxford Community Center bulletin board;
- Easton Point Marina;
- Tred Avon Bait and Supplies, and
- the Talbot County Community Center.

A press release discussing the proposed oyster restoration efforts in the Tred Avon also ran in the Star Democrat (Easton, MD) and the notice was posted on USACE-Baltimore's website as well as the District's various social media outlets 3 times reaching over 300 individuals. Out of the 555 flyers mailed to the various stakeholders within the Tred Avon watershed, USACE Baltimore District received 10 letters and 40 emails. Each of the letters and emails were individually responded to in order to ensure that concerns were addressed and planned restoration sites were modified if necessary to allow for the safe navigation use of the Tred Avon River. USACE Baltimore District also reached out to several marina owners in the Tred Avon watershed as well as the Tred Avon Yacht Club to determine common paths sailing regattas take and common drafts boats that traverse the Tred Avon River require. More detailed information from this correspondence is provided in Appendix D. USACE additionally requested the list of boats registered in the Tred Avon River from the MD DNR. USACE was able to determine the required drafts for 297 of the 714 registered boats.

As a result of this outreach effort, USACE increased the proposed navigational clearance above substrate reef restoration sites from 5 feet MLLW to 6 feet MLLW, revised restoration areas in the shallowest areas to be 6 inch high reefs rather than 12 inch high reefs in order to maintain the necessary navigational clearance, and cut nearly 20 acres of potential reef habitat from the draft Tributary Plan that posed a direct impact to navigation.

In the Spring of 2015, USACE, MD DNR, and representatives from the watermen's community met over a series of meetings and site visits to work through concerns raised by the watermen on the planned deep water restoration of 24 acres in waters deeper than 9 feet MLLW (This restoration is covered by existing NEPA, and as such is not part of the work being evaluated by this supplemental EA). Information generated through these meetings is relevant and beneficial to incorporate in future Tred Avon oyster restoration work. Coordination with the watermen community and other stakeholders will continue throughout the restoration process.

USACE communicated the proposed plans to a number of other entities including Delmarva Water Transport Committee, Vulcan Materials Company, and Maryland Grows Oysters.

Public involvement is ongoing. A public review period is targeted for May/June 2016 which will include a public meeting.

8.2 Agency Coordination

Agency coordination letters and correspondence are provided in Appendix G and summarized in Section 7. In addition, coordination with USCG was undertaken throughout development of the Tred Avon Tributary Plan and supplemental EA as presented below:

November 9, 2012: USCG provided USACE (via letter) recommendations to be used to implement Harris Creek restoration plans as well as for developing future oyster restoration plans.

March 6, 2013: USCG contacted USACE (via letter) reiterating restoration recommendations in light that there were two construction efforts (one by MDNR and one by USACE) ongoing in Harris Creek.

February 11, 2014: USACE provided USCG via email the drafted Tred Avon River Oyster Restoration Tributary Plan.

October 7, 2015: USACE provided USCG (Albert Grimes and Doug Simpson) via email an updated Tred Avon River Oyster Restoration Tributary Plan for review.

November 10, 2015: USACE provided USCG via email the navigational pathway analysis. This analysis focused on application of the USCG general oyster restoration guidelines to implementation of the Tred Avon River Oyster Restoration Tributary Plan.

December 23, 2015: USACE (Angie Sowers) discussed (via phone) USCG (Doug Simpson) review and projected date for an expectation of a date for comments to be submitted to USCG.

March 29, 2016: USCG provided USACE (via email) comments on the Tred Avon River Oyster restoration proposed plan.

April 4, 2016: USCG (Doug Simpson) and USACE (Angie Sowers) met via webinar/teleconference to discuss USCG comments, review GIS data, and come to agreement on any adjustments needed to address navigation concerns in the proposed restoration plans.

April 5, 2016: USACE provided USCG a memorandum for the record of the discussion of the 4 April 2016 webinar.

April 11, 2016: USACE (Angie Sowers) and USCG (Doug Simpson) discussed (via phone) to finalize the approach for SS_58, SS_13, and SS_18.

Detailed analyses performed with the USCG are documented in Section 5.4.2.2. These discussions led to a clear understanding of the proposed work by USCG, as well as navigational concerns by USACE. Two whole and one partial site were removed from proposed plans where these substrate reefs sites occurred within the navigational pathway between aids to navigation. Additionally, steps to communicate restoration efforts to boaters through the use of USCG notice to mariners and NOAA charting services were outlined.

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