**Appendix F – Monitoring & Adaptive Management Plan**

November 2024

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## 1.0 INTRODUCTION

This document is the Adaptive Management and Monitoring Plan (AMMP or plan) for the Hampton Roads Beneficial Use of Dredged Material (HRBU) project. The Project Delivery Team (PDT) developed this plan to describe monitoring and adaptive management strategies for the project and to provide metrics for evaluating project success. This AMMP is not intended to be a static document, but rather, a dynamic document that will be updated as necessary.

The proposed action, Alternative 4b.5, described in the HRBU environmental assessment (EA), requires adaptive management to ensure project success. This AMMP outlines how the results of the project-specific monitoring and adaptive management to achieve project goals and objectives.

The plan is based on currently available data and information obtained during plan formulation for the feasibility study and EA. Uncertainties, including exact project features and timelines, will be further developed during the Design and Implementation (D&I) phase of the project. During D&I phase, this AMMP will be revised to reflect new information, such as future cost estimates, modifications made to design, and recommendations.

## 2.0 STATUTES & GUIDANCE

The Water Resources Development Act (WRDA) of 1992, Continuing Authorities Program (CAP), Section 204, provides authority for the USACE to beneficially use material dredged from authorized Federal navigational channels for the protection, restoration, and creation of aquatic and related habitats. Section 204 is an ecosystem authority, justified on ecosystem benefits, and must follow USACE Ecosystem Restoration policy and guidance.

The following provides distinct Corps policy and guidance that are pertinent to developing this AMMP:

- Section 2039 of WRDA 2007, as amended by Section 1161 of WRDA 2016, Monitoring Ecosystem Restoration.

(a) IN GENERAL- In conducting a feasibility study for a project (or a component of a project) for ecosystem restoration, the Secretary shall ensure that the recommended project includes, as an integral part of the project, a plan for monitoring the success of the ecosystem restoration.

(b) MONITORING PLAN.- The monitoring plan shall-

(1) include a description of the monitoring activities to be carried out, the criteria for ecosystem restoration success, and the estimated cost and duration of the monitoring; and (2) specify that the monitoring shall continue until such time as the Secretary determines that the criteria for ecosystem restoration success will be met.

(c) COST SHARE.- For a period of 10 years from completion of construction of a project (or a component of a project) for ecosystem restoration, the Secretary shall consider the cost of carrying out the monitoring as a project cost. If the monitoring plan under subsection (b) requires monitoring beyond the 10-year period, the cost of monitoring shall be a non-federal responsibility.

(d) INCLUSIONS.- A monitoring plan under subsection (b) shall include a description of

(1) the types and number of restoration activities to be conducted;

(2) the physical action to be undertaken to achieve the restoration objectives of the project;

(3) the functions and values that will result from the restoration plan; and

(4) a contingency plan for taking corrective actions in cases in which monitoring demonstrates that restoration measures are not achieving ecological success in accordance with criteria described in the monitoring plan.

(e) CONCLUSION OF OPERATION AND MAINTENANCE RESPONSIBILITY.- The responsibility of a non-federal interest for operation and maintenance of the nonstructural and nonmechanical elements of a project, or a component of a project, for ecosystem restoration shall cease 10 years after the date on which the Secretary makes a determination of success under subsection (b)(2).

(f) FEDERAL OBLIGATIONS.-The Secretary is not responsible for the operation or maintenance of any components of a project with respect to which a non-federal interest is released from obligations under subsection (e).

- USACE. 2023. ER 1105-2-103, Guidance for Conducting Civil Works Planning Studies. Washington D.C.
- USACE. 2003a. ER 1105-2-404. Planning Civil Work Projects under the Environmental Operating Principles. Washington, D.C.

## 3.0 THE BENEFICIAL USE PLAN

3.1 Study Objectives

The primary goal is to beneficially use dredged material from federal channels for restoration and/or enhancements of the natural areas of shoaling. The study objectives include the following:

1. To beneficially use dredged material from federal navigation projects in Hampton Roads for aquatic ecosystem restoration from 2026 to 2076.
2. To restore and/or enhance existing nearshore area to create a safe, permanent seabird habitat that is sustainable and resilient from 2026 to 2076.
3. To restore and/or enhance habitat which will provide fish and wildlife benefits to multiple species from 2026 to 2076.
4. To improve safety in Hampton Roads by reducing potential vehicular and aircraft bird strike hazards from 2026 to 2076.
5. Adaptively manage restoration and/or enhancement site(s) to address sea level, subsidence, and erosion rise threats.

Please reference the EA document for more details.

3.2 PROJECT DESCRIPTION

Over the past 30 years, a large and diverse colony of seabirds used South Island of the Hampton Roads Bridge Tunnel (HRBT) in Virginia for nesting. The colony includes five species of conservation priority in Virginia, including the Royal Tern, Common Tern, Black Skimmer, Laughing Gull, and state threatened Gull-bill Tern, along with other regionally important nesting seabirds. The initiation of construction of the HRBT Expansion Project in late 2019 displaced the South Island colony. The Virginia Department of Wildlife Resources (DWR) and its partners have temporarily relocated the seabird colony to Rip Raps Island (an island immediately adjacent to South Island; City of Hampton) and an array of sand-covered flat-top barges anchored in the embayment between the two islands. While this temporary solution on Rip Raps Island and the barges has returned positive benefits for the colony, it is financially unsustainable, and there are numerous cultural resource concerns that make this site unfit to serve as a permanent solution for these nesting seabirds. The DWR pays more than $2.6 million annually to lease the barges. At the completion of the HRBT Expansion Project, the seabird colony will likely continue to attempt to nest on Rip Raps Island, and small numbers of some species may even attempt to nest on South Island in less disturbed areas, unless suitable alternative habitat is provided, active deterrence at South Island is continued, and active deterrence is undertaken at Rip Raps Island.

To create a suitable, long-term habitat for the seabird colony while also meeting objectives of the project, the proposed action is to construct a partially armored (rip rap and armor stone) 9.7-acre island on Hampton Bar (as measured along the harbor bottom) using dredged material from Anchorage F (or other Federal navigation channel with suitable sediment). This island will provide a total of 7.3 acres of seabird habitat above Mean Lower Low Water (MLLW), to include 5 acres of seabird nesting habitat and 2.3 acres of foraging, staging, or roosting habitat. Below MLLW, 0.47 acres of potential oyster habitat would exist on the submerged rip rap and armor stone.

Please reference the EA for more detailed description of the selected plan and screening of alternatives.

## 3.3 NATIONAL ECOSYSTEM RESTORATION PLAN COMPONENTS

The National Ecosystem Restoration (NER) plan is the plan that maximizes environmental benefits while remaining within the CAP funding limit. For this project, the NER plan is the Alternative 4b.5, located at Hampton Bar. This alternative takes advantage of an existing shoaling area near the HRBT to create a sustainable island habitat for the seabird colony. Implementation of the NER Plan would greatly improve the ecosystem conditions of the area in terms of productivity. Currently, the benthic resources are minimal in open bottom habitat, but with project implementation, there will be promotion of oyster habitat, which is far more productive. It is expected that oysters will naturally recruit to the area, however, if oysters do not meet success criteria, adaptive management measures will be implemented.

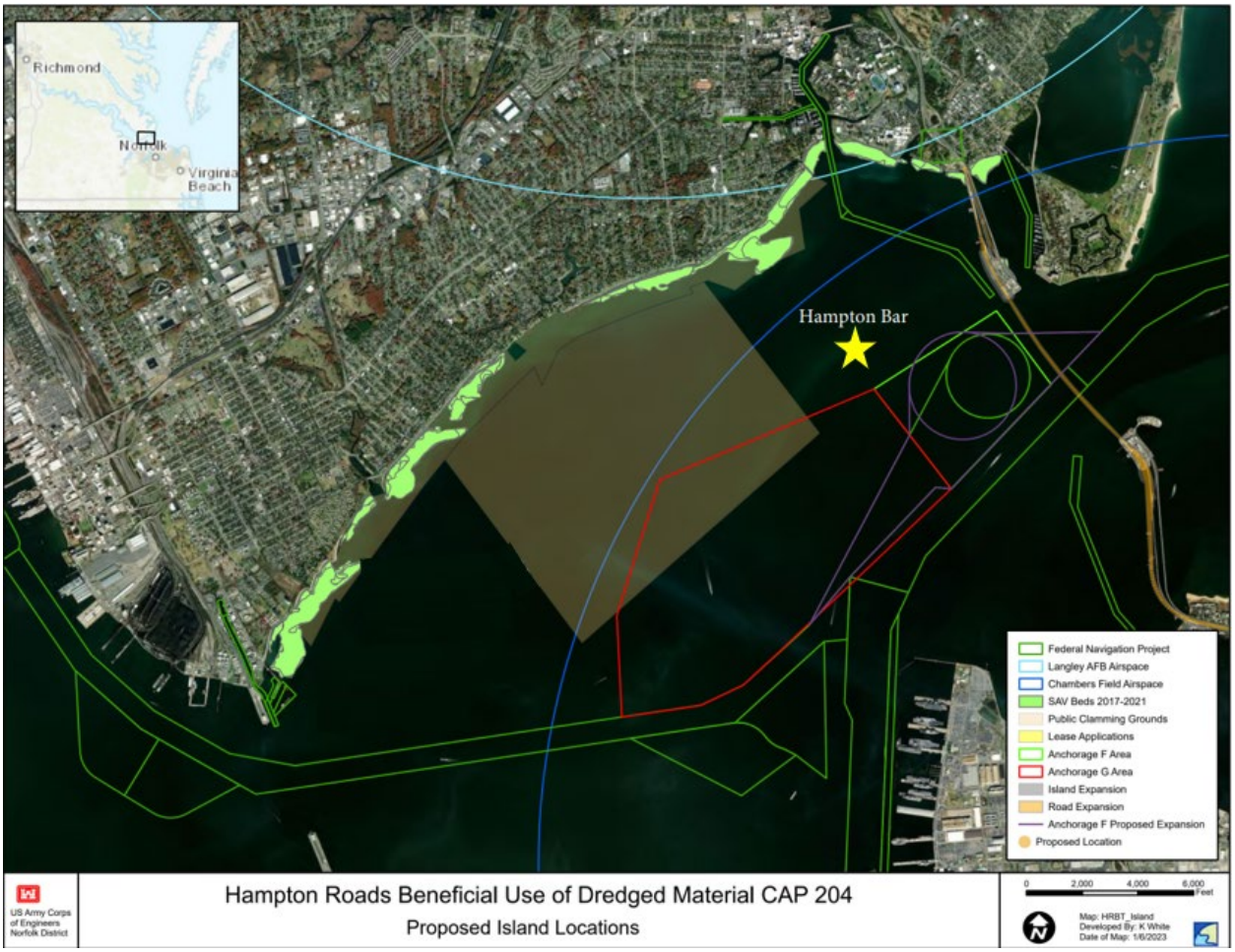


Figure 1: Proposed Project Location

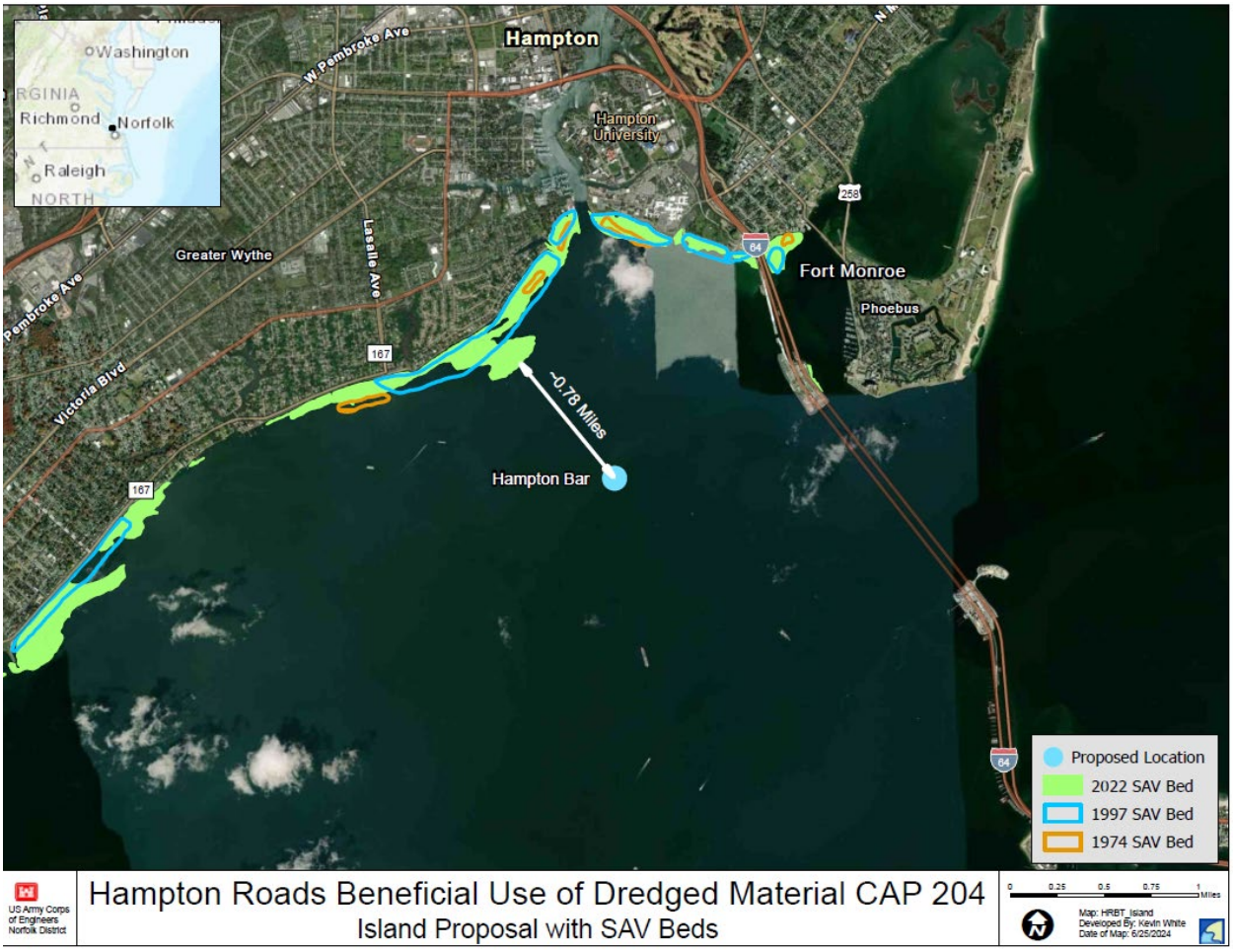


Figure 2:SAV beds near proposed project location.

## 3.4 ECOSYSTEM ENHANCEMENT METHODS

The following physical actions would be undertaken at the project site to achieve project objectives listed above:

- Armoring stone to provide additional habitat for fish and wildlife below MLLW.
- Beneficial use of dredged material to create permanent habitat for seabird colony, as well as additional species that may use the habitat and surrounding shallow areas.

## 3.5 ECOSYSTEM ENHANCEMENT OUTPUTS

Some of the ecological functions and values returned by implementing the NER plan are as follows:

- Establishes permanent habitat for seabird colony.
    - Seabird colonies provide nutrients to system and contribute to food chain as predators to various fish and invertebrate species.
- Establishes habitat suitable for oyster recruitment.

- Oyster habitat provides a series of ecosystem benefits including wave attenuation, shoreline and bottom stabilization, structural habitat and food source for other native flora and fauna, biofiltration, and nutrient transformation.

- Improves current productivity in the area.
  - See Habitat Equivalency Analysis (HEA) document in Environmental Appendix of EA.

## 3.6 RISK AND UNCERTAINTY

Table 1 below describes the associated risks and uncertainties with project implementation. Risks and uncertainties are defined as a potential impact (positive or negative) to the achievement of the desired objectives. These can be reduced through risk management and using best available information.

**Table 1** Risk and Uncertainty.

| | |
|---|---|
| **Risks** | • Factors outside of USACE control include cataclysmic weather events, hurricanes, freshets, or red tides. Large variations in water quality can lead to the decrease in restoration benefits due to species mortality. Oyster larvae and young are highly vulnerable to hypoxia.<br>• Predation of chicks by other bird species. The distance from shore should be far enough that other land predator species cannot swim to the island, however there is always risk of avian and aquatic predation.<br>• Predation of species occupying ecosystem enhancement habitats, including oysters.<br>• Disease and parasites can affect the bird colony, resulting in possible mortality.<br>• Adaptive management costs.<br>• Acquiring suitable material from other federal navigation channels in the future. The material acquired has to be linked to a dredge event, and we do not currently have other tested locations.<br>• There is risk the bird colony may not want to nest on the proposed island, though bird attractant methods will be in place.<br>• Human disturbance on the island will be minimized to the maximum extent practicable though risk of disturbance including fishing, trash, contamination, and human presence can impact the bird colony. |
| **Uncertainties** | • Establishment of sufficient oyster larvae on the armoring stones. Regional weather patterns and currents significantly influence oyster recruitment.<br>• The integrity of the proposed bird habitat to maintain the correct grade from sea floor over time. Materials can compact, settle, and erode over time.<br>• Climate change could impact the project site over time, particularly sea level rise, warming waters, increased salinity, and ocean acidification. These changes will be represented in adaptive management, but future climate change projections remain highly uncertain at this time.<br>• Sediment dynamics including subsidence and accretion rates. |

| | |
|---|---|
| | • Construction timing must match up with Anchorage F schedule. |

## 4.0 MONITORING

Monitoring the changes at a project site is not always a simple task. Ecosystems, by their very nature, are dynamic systems where populations of invertebrates, fish, birds, and other organisms fluctuate with natural cycles. A focused monitoring protocol of measurable components that are tied directly to the planning objectives is presented below.

### 4.1 THE MONITORING PLAN

The monitoring associated with the described ecosystem enhancement methods would evaluate the overall effectiveness of the project to determine if the planning objectives are met. The following monitoring specifics are proposed, which are focused on shorebird nesting habitat and oyster habitat attributed to the bird habitat. All habitat types would be monitored as specified below for a period of 6 to 10 years following construction completion, or until success criteria are met. After that, the site will be turned over to the non-federal sponsor Department of Wildlife Resources (DWR) for operation and maintenance. Monitoring for natural recruitment of oysters should take place approximately 3 years after construction completion.

This monitoring plan will accomplish the following:

1. Support adaptive management decisions by providing data on critical stages in the development of the habitats that can guide any potential next steps.
2. Evaluate intermediate conditions that help to track progress towards the project goals and objectives.
3. Aid in identifying unexpected stresses, environmental conditions, and/or ecological interactions that can affect the overall success of the project.

### 4.2 MONITORING CRITERIA AND METHODS

#### 4.2.1 Shorebird Nesting Habitat

*Attracting Target Species to the New Island*

In the first year the new island becomes available to nesting seabirds, the DWR will use social attraction equipment (i.e. audio lures [continuous broadcasting of target species' vocalizations] and decoys) to attract target species to the island. Target species include royal terns, sandwich terns, gull-billed terns, common terns, and black skimmers. At the same time, the DWR will implement measures that will make Ft. Wool, the current temporary nesting site, unattractive to nesting seabirds. These measures may include replacing the sandy substrate on the parade grounds with sod grass, planting State Historic Resources-approved shrubs and trees, installing decoys of predatory birds (e.g., owls, hawks, falcons) and broadcasting predatory bird vocalizations, and conducting multiple patrols per day with canines trained to deter birds from nesting on the parade grounds, building rooftops, and in the riprap. The agency will also discontinue the deployment of barges currently providing temporary nesting habitat.

*Nest Counts*

Throughout the six-year monitoring program, the DWR will conduct an annual nest count or incubating adult count (one incubating adult equals one nest) of each target and non-target species during the peak incubation period. Peak incubation is defined as the period when the

first-laid nests of each species begin to hatch. The success criterion is a 2% or greater annual increase in the number nests per target species or a 5% or greater increase in the number of nests among all target species combined. If the annual combined total of target and non-target species' nests appears to have stabilized (i.e. < 2% annual increase or decrease over a period of three consecutive years), then this would indicate that the island has reached maximum capacity or there is some other factor prohibiting colony growth. The success criterion will be re-evaluated, and management measures may be implemented.

*Recruitment of Breeding Adults from South Island, Ft. Wool and the Barges*

Each year, the DWR will conduct four re-sighting surveys of breeding-aged adults that were previously marked with uniquely coded plastic field readable bands (PRFB) on South Island, Ft. Wool or the barges (hereafter referred to as local recruitment). The surveys will occur in mid-May, mid-June, mid-July, and mid-August to maximize detection of banded individuals and confirm breeding. It is difficult to assign a quantifiable criterion to this measure of local recruitment because many seabird species have a natural tendency to shift from one breeding colony to another multiple times over the course of their lifetimes. Instead, the DWR will calculate an annual minimum number, or percentage, for each target species based on the number of banded individuals that are expected to be of breeding age during the survey year. The DWR has begun to measure recruitment rates of banded breeding royal terns in other Virginia colonies and will use those data to help develop thresholds for all target species utilizing the new nesting island.

*Hatch Success and On-site Survival*

To minimize disturbance to the colony, the DWR will use banded royal tern and sandwich tern chicks as the proxy for estimating the colony's hatch success and on-site survival. Because royal and sandwich tern chicks form creches at approximately two weeks of age, it is possible to band over 3,000 flightless young in a single day by corralling them into an enclosure and having enough staff available to hand capture, apply PFRB and U.S. Geological Survey Bird Banding Lab-issued metal bands, and release the chicks on site. This is not the case for the other target species, which require walking transects through the colony to locate, capture, and band chicks on a weekly basis. Because both species typically lay only one egg and occasionally two eggs, a gross estimate of annual hatch success will be obtained by dividing the number of royal chicks banded by the estimated number of royal tern nests. The same will be done for sandwich terns. Both estimates will serve as hatch success indices over the six-year monitoring period. The annual success criterion is $\geq$50% hatch rate. The DWR will conduct weekly resighting surveys of banded royal and sandwich tern chicks to estimate on-site survival. A gross estimate of annual on-site chick survival will be calculated by dividing the number of large, well-feathered banded royal chicks re-sighted by the total number of chicks banded. The same will be done for sandwich terns. Both estimates will serve as on-site survival indices over the six-year monitoring period. The annual success criterion is $\geq$75% on-site survival rate.

*Monitoring Predator Activity and Human Intrusion*

The DWR will install several video and game cameras with remote downloading capabilities to monitor predator and human activity in and around the colony. The images collected will help determine the presence or absence of avian and mammalian predators, identify predator species, and help gauge the extent of predator activity. This approach will enable the DWR to ascertain the type of predator management that is needed to address the issue effectively. The

images and video will also be used to monitor the degree of human disturbance to the colony throughout each breeding season and determine the level of law enforcement presence needed to deter the public from either getting too close to the island or entering the colony should other measures taken to keep people off the site fail.

### 4.2.2 Oyster Habitat

Metrics that will be determined from the sampling are:

1. Oyster biomass and condition and
2. Oyster population demographics (numbers and size classes of oysters).

A recently published report on oyster restoration metrics by a Chesapeake Bay Program state-Federal goal implementation team (GIT) recommended the following metrics for a successful reef: 50 grams dry weight of oyster biomass per square meter of reef along with at least 2 age classes of oysters present.

The anticipated biomass for the oyster habitat is represented in Table 2. By year six, the fully restored goal of 50 g/$m^2$ should be achieved and maintained. Biomass accumulates over time and may continue to increase past year six.

**Table 2** Oyster Biomass Goals Over Time.

| Year | Biomass (dry weight of oyster tissue in grams per square meter restored reef) | Non-Oyster Biomass | Total Biomass |
|---|---|---|---|
| 1 | 5 | 3 | 8 |
| 2 | 10 | 6 | 16 |
| 3 | 20 | 12 | 32 |
| 4 | 30 | 18 | 48 |
| 5 | 40 | 24 | 64 |
| 6 | 50 | 30 | 80 |

*Sustained population*

The number and age/size classes of oysters per unit of the reef area will be monitored. Initial settlement will progressively contain a higher ratio of females, so a younger class with a higher proportion of males is needed for sustained, successful spawning seasons.

*Oyster Biomass and Condition*

In calculating oyster biomass on a reef, all living oysters within a square meter quadrant are removed, dried, and weighed. To obtain the ash-free dry weight (AFDW), a three-step process is required:

1) Wet weight is calculated by weighing the shucked meat only (shell is discarded at the first step though it is weighed to determine shell weight)
2) Meat is then dried at relatively low temp in an oven to get dry weight

3) Burning the oyster meat at high temp to get rid of all organics in the sample, leaving behind just the non-burnable minerals that were in the tissues

The AFDW is the difference between dry weight and the ash (Dry weight – ash weight = AFDW). Therefore, AFDW is the weight of the organic content of the sample which is the metric reported as biomass. AFDW will be estimated on a randomly selected subset of oysters of various size classes to derive an annual AFDW/length relationship for the oysters on the reef. Dry mass (DM) prior to burning the sample to ash is also recorded.

Target biomass projections in Table 2 of restored reefs should average 80 grams ash free dry weight per square meter, based on a US Fish and Wildlife Service (USFWS) report. This number includes all benthic organisms on the reef, the majority of which should be live oysters. Most of this biomass should be from the oysters, and we have adopted the GIT goal of 50 grams of oyster biomass as the oyster-specific goal. So, for the 80 grams of biomass per square meter of reef, at least 50 (62.5%) of it should consist of oysters by year 6 post construction. Approximately 30 percent (37.5%) of it can consist of other organisms typically found on reefs, such as mussels, barnacles, gobies or other reef dependent fish, and crabs. Biomass of oysters will be estimated and recorded in the annual reports, as will the biomass of other benthic organisms.

## 4.3 MONITORING RESPONSIBILITIES

Once the construction of the island is complete, the DWR will initiate a six-year avian monitoring program that entails attracting target species to the new nesting site, monitoring target species' recruitment rates based on annual number of nests and the number of breeding adults that were previously banded on the HRBT's South Island, Ft. Wool, and the barges. The DWR will also monitor hatching success and on-site chick survival through banding and weekly re-sighting surveys of uniquely banded young. During this six-year monitoring period, the DWR will also conduct nest counts of non-target seabird nesting species, which may include laughing gulls, herring gulls, great black-backed gulls, brown pelicans, and double-crested cormorants. The primary point of contact for all monitoring activities is:

Becky Gwynn
Deputy Director
Virginia Department of Wildlife Resources
7870 Villa Park Dr.
Henrico, VA 23228

USACE Norfolk District will be responsible for monitoring oyster recruitment, as well as island stability for the first ten years following completion of the project. The primary point of contact for all monitoring activities is:

Gina Dotolo
Biologist
USACE, Norfolk District
803 Front St
Norfolk, VA 23510

## 4.4 REPORTING RESULTS

A short monitoring summary report would be drafted within 2 months after each monitoring season. These would briefly summarize the data collected and make notes in terms of adaptive management needs. A final monitoring report would be drafted by the USACE in conjunction with DWR that details the outcomes of the restoration project with recommendations for project closure.

## 4.5 MONITORING COST & SCHEDULES

### 4.5.1 Shorebird Nesting Success Monitoring

Based on monitoring and adaptive management costs reported in USACE AMMP's for dredged material placement, it can be estimated that for tasks including survey crew assessment of site and measuring depths and elevation, there would be a total annual cost assumption of $9,000. This cost includes labor and boat travel.

### 4.5.2 Oyster Monitoring

Oyster monitoring typically takes place at years 1, 3, and 6. Monitoring should begin 3 years after construction completion (2027) to provide enough time for natural recruitment, so first monitoring year would be in 2030, then 2033, and 2036. Including all labor, cost would be approximately $17,000 per year to monitor a 0.5-acre reef. This cost includes $15,000 for mob/demob and $1,700 per half acre of reef. Total monitoring for oysters would cost approximately $51,000.

## 5.0 ADAPTIVE MANAGEMENT PLAN

The primary incentive for implementing adaptive management is to increase the likelihood of achieving desired project outcomes given identified uncertainties. Adaptive management provides an organized, coherent, and documented process that suggests management actions in relation to measured project performance compared to desired project outcomes. Adaptive management establishes the critical feedback among project monitoring and informed project management and learning through reduced uncertainty. Effective adaptive management will ensure the success of the federal project and protect the public investment.

Adaptive management measures are not the same as typical operation and maintenance activities. These measures are response actions to changes that adversely affect how the system was predicted to respond. By taking an adaptive approach, absolute measures cannot be defined prior to issues arising. The primary adaptive management topics for this project are success of ecosystem enhancement habitats and stability of island design. Descriptions of adaptive management measures below are brief and will be further detailed during the design phase. This is necessary since the adaptive management measures will need to be based upon contracting bid items, final design features, and observable adverse responses.

Significant risk would be avoided by proper design, appropriate site selection, and correct seasonal timing of biotic applications. USACE Norfolk District applied experience gained from other beneficial use projects, as well as reef restoration projects to help inform the current project.

Table 5 summarizes the triggers and corresponding adaptive management measures in order to meet project objectives.

**Table 3:** Monitoring per Study Objective and Adaptive Management Triggers.

| Objective | Performance Indicator | Monitoring Target | Monitoring Responsibility | Action Criteria (AM Trigger) | AM Measure |
|---|---|---|---|---|---|
| Primary objective – create a safe, permanent seabird habitat | Bird colony growth. | 2% or greater annual increase in nest counts per target species; 5% or greater increase in nest counts among all target species. | DWR | <2% annual increase or decrease over 3 years. | Re-evaluate success criteria; vegetation control, predator control, signage for human disturbance control and police presence. |

| | | | | | |
|---|---|---|---|---|---|
| Primary objective – enhance habitat for oysters | Natural oyster recruitment. | Year 1: at least 5 grams dry weight of oyster tissue per square meter of reef. | USACE | No oyster recruitment observed after 3 years. | Apply spat on shell. |
| Compliance objective – protect infrastructure | Erosion or degradation of infrastructure. | Periodic inspection of habitat stability. | USACE | Adverse erosion or degradation observed. | |

5.1 USACE ADAPTIVE MANAGEMENT STRATEGIES

The following are example scenarios that may trigger adaptive management of the beneficial use project:

**Scenario 1 – Monitor for erosion, slope, armoring, and elevations.**

Performance Measure: Seabird habitat remains suitable for nesting, maintaining desired elevation levels, slope, and armoring.

Monitoring Activities: visual observations of island stabilization for degradation or erosion at a level that is unsuitable for meeting criteria of seabird habitat/ sustaining needs of the colony.

Corrective Actions: TBD

**Scenario 2 – Oyster larval recruitment (spat settlement) is not adequate (less than 15-50 spat per m^2) after year one, year three or year six monitoring events:**

Performance Measure: Year one monitoring should show spat on the armoring stones and have at least 5 grams dry weight of oyster tissue per square meter of reef. By year six there should be 50 grams dry weight of oyster tissue per square meter of reef.

Monitoring Activities

- Assess population density and year class frequency distributions on a yearly basis.
- Identify reef areas where oyster population densities are below the 15-50 m^2 range.
- Gather any available data on the stock source supplying larvae to the reefs and determine if it is too low to supply recruits.

Corrective Actions

- Assess sedimentation rates at project site by utilizing divers equipped with cameras and GPS equipment or by other methods, such as remote operate vehicle technology (ROV) including underwater cameras.

- Apply spat on shell during the following reproductive season to the hard substrate. This spat on shell should be hatchery produced using local stock of adult oysters, if possible. It would be applied at a minimum density of approximately 250 spat/m2.
- Place additional shell and large substrate throughout the reef that would increase reef elevation and habitat heterogeneity, plus deter poaching as a secondary benefit.

## 5.2 DWR ADAPTIVE MANAGEMENT STRATEGIES

There are several adaptive management strategies that can be implemented or intensified should one or more of the success criteria outlined previously not be achieved. Below are several known strategies the DWR is willing to deploy over the long term, as needed. The department is also prepared to test novel strategies developed in-house or by other natural resource agencies.

### *Vegetation Management*

With regard to maintaining habitat suitability, vegetation management is one of the most necessary and effective tools available to colony managers. Vegetation control can be achieved in various ways, depending on the extent of the problem and the type of vegetation that needs to be removed. The application of herbicides is the most common form, followed by direct removal either by hand or mechanical means. The periodic placement of additional substrate has also proved to be an effective way to control vegetation, and it provides the added benefit of maintaining proper island elevation. Each of these options are temporary fixes and must implemented either every few years, annually, or several times a year, depending on need. Many colony managers deploy more than one method, such as the combination of herbicide and mechanical removal. The DWR will monitor and manage the emergent vegetation on the island and likely deploy a combination of control methods over the expected life of the island.

### *Avian and Mammalian Predator Management*

Avian and ground predators are one the leading causes of colony failure and are one of the more difficult and expensive problems to address. Moreover, effective predator management requires constant vigilance on the part of colony managers and staff engaged in predator control efforts. The DWR has a long-standing contractual relationship with the US Department of Agriculture’s Wildlife Services program, which a proven record for conducting effective and humane predator management for the benefit of ground nesting seabirds and shorebirds in Virginia. In addition, Wildlife Services has considerable demonstrated experience justifying the need for lethal predator control at a site that is highly visible to the public. The DWR is prepared to contract with Wildlife Services to monitor and manage predator activity on the new nesting island over the long term. The DWR will assist Wildlife Services by providing access to the images and video streams captured by on-site cameras and offering logistical support, as needed.

### *Human Disturbance Management*

The construction of the new nesting island will likely include in-water and on-site infrastructure designed to keep people from accessing the site year-round, such as underwater rock chevrons, reef balls and/or fencing. The DWR will install “No Boats” regulatory buoys around the entire perimeter of the island to keep recreational boaters and commercial and governmental vessels from getting too close to the colony during the breeding season and to prevent public

use of the island outside of the breeding season. Additional regulatory measures are also being explored by the DWR to restrict public access to the island. The DWR's Conservation Police Officers (CPO) will conduct regular patrols around the island during the nesting season. Moreover, they will have access to the images and video streams captured by on-site cameras. The CPO are prepared to increase their presence, issue tickets, and make arrests for violations they observe. Partnerships with other law enforcement entities (e.g., Virginia Marine Resources Commission, local government police departments) will be leveraged to augment the CPO patrols and enforcement actions.

The DWR will launch an annual public information campaign about the nesting island that will inform the public of the importance of the island to breeding seabirds and the need to remain outside of the regulatory buoys and off the island year-round. These messages will be delivered via newspaper and magazine articles, television, social media channels, and other emerging technologies. The DWR will encourage local schools, colleges, and universities to use the constructed nesting island in their science classes and biology and environmental coursework.

## 5.3 ADAPTIVE MANAGEMENT COSTS

### 5.3.1 Shorebird Nesting Habitat Adaptive Management

Responsibility of DWR. Costs uncertain at this time.

### 5.3.2 Oyster Adaptive Management

Adaptive management costs for applying spat on shell to a 21,000 sq ft (0.5-acre) reef is approximately $10,000 per year. Ideally, performing spat on shell management would not be required more than once. Similar to cost of mob/demob for oyster monitoring, there would be an additional $15,000 for mob/demob of adaptive management activities.

So, a total of approximately $25,000 for adaptive management of applying spat on shell.