# Appendix C
# Air Conformity Applicability Analysis and Record of Non-Applicability

## Abbreviations and Acronyms

| Acronym | Definition |
|---|---|
| CFR | Code of Federal Regulations |
| NAAQS | National Ambient Air Quality Standards |
| $NO_x$ | nitrogen oxides |
| NSA | Naval Support Activity |
| $PM_{2.5}$ | fine particulate matter less than or equal to 2.5 micrometers in diameter |
| USEPA | U.S. Environmental Protection Agency |
| VOC | volatile organic compound |

## List of Tables

# Air Quality Applicability Analysis

## Introduction

The Clean Air Act requires federal actions in air pollutant nonattainment or maintenance areas to conform to the applicable State Implementation Plan. A State Implementation Plan is designed to achieve or maintain an attainment designation of air pollutants, as defined by the National Ambient Air Quality Standards (NAAQS). The regulations governing this requirement are found in 40 Code of Federal Regulations (CFR) part 93, also known as the General Conformity Rule. The threshold (*de minimis*) emission rates have been established for actions with the potential to have significant air quality impacts. A federal agency must determine if a project/action in a nonattainment area or maintenance area exceeds the *de minimi*s rates, which would require a general conformity determination be prepared to address significant impacts.

The Navy proposes to replace the utility bridge at College Creek at Naval Support Activity (NSA) Annapolis, Maryland. NSA Annapolis is in Anne Arundel County, which is within the Metropolitan Baltimore Intrastate Air Quality Control Region (40 CFR 81.28). Anne Arundel County is designated as a nonattainment area for 8-hour ozone, with a classification of moderate for the 2008 standard and marginal for the 2015 standard (USEPA, 2019). A portion of the county, which includes NSA Annapolis, is also in nonattainment for sulfur dioxide under the 2010 standard. It is unclassified or in attainment for all other criteria pollutants. Anne Arundel County was formerly classified as a maintenance area for the 1997 standard for particulate matter less than or equal to 2.5 micrometers ($PM_{2.5}$), but this standard was revoked in 2016.

Potential emissions from all criteria pollutants are presented in this appendix; however, only the *de minimis* thresholds for the ozone precursor pollutants, nitrogen oxides ($NO_x$) and volatile organic compounds (VOC), and sulfur dioxide apply to the conformity applicability analysis. Because this region is also within the ozone transport region that was established by the 1990 Clean Air Act Amendments, the *de minimis* threshold for VOC is further reduced.

## Project Description

The Navy proposes to replace the utility bridge at College Creek at NSA Annapolis. During construction of the new utility bridge, the existing bridge and utilities would remain in place until the new structure is completed. Following completion of the new bridge, the existing bridge would be demolished. The new bridge would be approximately the same width and length as the existing bridge (approximately 18 feet wide and 474 feet long), and the bridge deck would be located at approximately the same elevation. The proposed bridge would be designed to ensure that boats, specifically those from the adjacent Hubbard Hall (Building 260), would be able to access the waterway on both sides of the bridge. Construction is estimated to occur in fiscal year 2026.

The Navy is considering the No Action Alternative and three location alternatives for the new utility bridge on NSA Annapolis, as well as an additional option of locating some utility components underground using directional boring techniques:

- No Action Alternative: Minimal maintenance to the bridge would continue, but no major repairs would occur. Continued deterioration places the bridge at risk of suddenly failing.
- Alternative 1: The proposed utility bridge would be constructed at any location within 50 feet northeast of the existing utility bridge alignment, adjacent to the King George Street Bridge. Alternative 1 is the Navy’s preferred alternative.

- Alternative 2: The proposed utility bridge would be constructed at any location within 115 feet southwest of the Decatur Avenue Bridge (Hill Bridge). Following completion of the new bridge, the existing bridge would be demolished.
- Alternative 3: The proposed utility bridge would be constructed between the locations of Alternatives 1 and 2 (i.e., the remaining approximate 250-foot-width between Alternatives 1 and 2, while also avoiding Hubbard Hall [Building 260] and its associated docks). Following completion of the new bridge, the existing bridge would be demolished.
- Underground Utility Option: All utilities would be situated underground except one utility line, which cannot be bored underground. This utility line would remain aboveground and attached to the proposed utility bridge structure. Under any of the alternatives selected, the bore entry point would be on the Upper Yard in the vicinity of the existing bridge and exit directly across College Creek on the Lower Yard.

### Federal Requirements

Section 176(c) of the Clean Air Act, as amended, requires federal agencies to ensure that actions undertaken in nonattainment or maintenance areas are consistent with the Clean Air Act and with federally enforceable air quality management plans. The Clean Air Act places responsibility on individual states to achieve and maintain the NAAQS through USEPA-approved State Implementation Plans.

Under the General Conformity Rule (40 CFR part 93, subpart B), emissions of criteria pollutants and their precursors that are associated with an action in a nonattainment area for a given pollutant must be below *de minimis* emission rates for that pollutant to be exempt from a formal conformity determination. The *de minimis* rates for the NAAQS pollutants of concern are listed in Table C-1. Actions that contribute less than these amounts and have no other conformity requirements are exempt from the General Conformity Rule. Actions that exceed the pollutant *de minimis* rates in any given year must undergo a detailed analysis, and a formal conformity determination is required. Finally, mitigation would be required if the detailed analysis indicates an exceedance of the *de minimis* levels for any of the pollutants of concern.

**Table C-1 Criteria Pollutant *de minimis* Emission Rates Applicable to the Proposed Action**

| *Pollutant* | *Attainment Status* | *Criteria Pollutant (tpy)* | *Precursor (tpy)* |
|---|---|---|---|
| $NO_x$ | Moderate ozone nonattainment | — | 100 |
| VOC | Moderate ozone nonattainment, inside an ozone transport region | — | 50 |
| Sulfur dioxide | Nonattainment | 100 | — |

Sources: 40 CFR 93.153; USEPA, 2019.

Key: $NO_x$ = nitrogen oxides; VOC = volatile organic compound; tpy = tons per year.

### Methodology

In accordance with 40 CFR part 93, subpart B, the incremental increase in emissions above the existing conditions has been considered and includes reasonably foreseeable direct and indirect emissions. The total estimated emissions from the Proposed Action have been evaluated to assess if any of the applicable *de minimis* rates would be exceeded.

Specific construction schedules and design plans under any location alternative are not yet known. Considering the variability of possible construction, emissions resulting from the Proposed Action were estimated based on the maximum expected number, type, and duration of construction operations to complete the Proposed Action. This analysis considers estimated impacts from construction and demolition as if occurring in one calendar year to present a maximum impact.

Once construction is complete, long-term operations from the new bridge would be comparable to existing conditions. The proposed bridge would have no new or modified operational air sources. No long-term changes in air emissions would occur.

The only measurable difference between the alternatives is the distance for underground utilities trenching (approximately 2,100 feet total, along both sides of the College Creek). Alternative 2 would be expected to require the most trenching as it is furthest from the existing bridge, so emissions for Alternative 2 are estimated in this applicability analysis. However, the actual differences of trencher operations would account for minimal differences in emissions among the alternatives, and this difference does not warrant quantitative estimation. The option of installing utilities underground is considered separately.

### Construction Emissions

Emissions resulting from the Proposed Action were estimated based on the expected number, type, and duration of construction operations to complete the Proposed Action. Construction emissions would result from the operation of heavy equipment, delivery trucks, and construction workers. The project would require a mix of construction equipment that would vary as the construction activity progresses. To estimate emissions, methodologies were used based on the kind of equipment (which all have varying rates of criteria pollutant emissions, referred to as emissions factors), and either the average hours to complete the work or the average distance traveled.

#### *Nonroad Emissions from Construction Equipment*

Nonroad emissions are those from the construction equipment operating immediately at the project site (such as backhoes, forklifts, impact hammers, pile drivers, saws, diesel generators, and cranes). Conservative construction equipment assumptions were developed based on review of other projects. Emissions for nonroad equipment were estimated using composite emissions factors. Table C-2 and Table C-3 contain the emissions factors and operating hours assumptions and the total estimated emissions for nonroad construction equipment, respectively.

#### *Onroad Emissions from Construction Equipment*

Onroad emissions are those that come to and leave the site via the road network on a more frequent basis (including diesel-powered heavy delivery trucks and gasoline-powered passenger trucks from construction workers). Conservative construction equipment assumptions were developed based on review of other projects. Emissions for nonroad equipment were estimated using composite emissions factors. Table C-4 and Table C-5 contain the emissions factors and operating hours assumptions and the total estimated emissions for nonroad construction equipment, respectively.

#### *Fugitive Dust Emissions*

Fugitive dust occurs directly from vehicles disturbing and suspending particulate matter while operating on unpaved surfaces, or from soil stockpiles on an active construction site; it also occurs indirectly from dust and dirt being brought onto paved surfaces from nonroad construction operations, and then disturbed and suspended as onroad vehicles drive over it. A conservative empirical estimate for fugitive dust was used for this analysis; actual fugitive dust emissions would likely be lower as they are directly proportional to the amount of activity that is being worked. Higher activity days have greater potential for generating fugitive dust than lower activity days that do not involve equipment actively disturbing the site. This analysis assumes that entire site would be uncovered and worked at any given time during construction. Fugitive dust controls would be implemented; this analysis assumes an 80 percent control efficiency. See estimates and notes Table C-6.

## Table C-2 Construction: Nonroad Equipment Emissions Factors and Operating Hours Assumptions

| *Equipment Description* | *Total Operating Hours* | *$NO_X$ (lb/hr)* | *ROG (lb/hr)* | *CO (lb/hr)* | *$SO_x$ (lb/hr)* | *PM (lb/hr)* |
|---|---|---|---|---|---|---|
| ***Site Preparation*** | | | | | | |
| Tractors/Loaders/Backhoes Composite | 168 | 0.041 | 0.361 | 0.251 | 0.0008 | 0.011 |
| Graders Composite | 168 | 0.086 | 0.575 | 0.521 | 0.0015 | 0.025 |
| Rubber Tired Dozers Composite | 168 | 0.202 | 0.766 | 1.466 | 0.0025 | 0.058 |
| ***Demolition*** | | | | | | |
| Rubber Tired Dozers Composite | 336 | 0.202 | 0.766 | 1.466 | 0.0025 | 0.058 |
| Excavators Composite | 336 | 0.069 | 0.511 | 0.358 | 0.0013 | 0.016 |
| Tractors/Loaders/Backhoes Composite | 336 | 0.041 | 0.361 | 0.251 | 0.0008 | 0.011 |
| Forklifts Composite | 336 | 0.029 | 0.215 | 0.146 | 0.0006 | 0.006 |
| ***Construction*** | | | | | | |
| Tractors/Loaders/Backhoes Composite | 2,016 | 0.021 | 0.212 | 0.154 | 0.0004 | 0.004 |
| Forklifts Composite | 2,016 | 0.029 | 0.215 | 0.146 | 0.0006 | 0.006 |
| Cranes Composite | 4,032 | 0.085 | 0.387 | 0.603 | 0.0014 | 0.023 |
| Generator Sets Composite | 2,016 | 0.036 | 0.271 | 0.298 | 0.0007 | 0.013 |
| ***Miscellaneous*** | | | | | | |
| Trenchers Composite | 504 | 0.087 | 0.423 | 0.433 | 0.0007 | 0.031 |

Source: SCAQMD, 2018.

Key: $NO_x$ = nitrogen oxides; ROG = reactive organic gases (= volatile organic compounds); CO = carbon monoxide; $SO_x$ = sulfur oxides; PM = particulate matter; lb = pounds; hr = hour.

Notes: Particulate matter is estimated to be 10 micrometers with 92 percent of that fraction being less than 2.5 micrometers in diameter. A fleet year of 2021 was used, which provides more conservative emissions factors.

## Table C-3 Construction: Nonroad Emissions

| *Equipment* | *$NO_X$* | *VOC* | *CO* | *$SO_2$* | *$PM_{10}$* | *$PM_{2.5}$* |
|---|---|---|---|---|---|---|
| **Total Nonroad Construction Emissions (tons)** | 0.36 | 2.04 | 2.49 | 0.01 | 0.10 | 0.09 |

Source: SCAQMD, 2018.

Key: $NO_x$ = nitrogen oxides; VOC = volatile organic compounds; CO = carbon monoxide; $SO_2$ = sulfur dioxide; $PM_{10}$ = suspended particulate matter less than or equal to 10 micrometers in diameter; $PM_{2.5}$ = fine particulate matter less than or equal to 2.5 micrometers in diameter.

Notes:

Emissions (tons) = emissions factor (pounds/hour) × total hours operated × 1 ton/2,000 pounds, *for each kind of equipment*.

Example: Nonroad $NO_x$ emissions = [(168 hr × 0.041 lb/hr) + (168 hr × 0.086 lb/hr) + (168 hr × 0.202 lb/hr) + (336 hr × 0.202 lb/hr) + (336 hr × 0.069 lb/hr) + (336 hr × 0.041 lb/hr) + (336 hr × 0.029 lb/hr) + (2,016 hr × 0.021 lb/hr) + (2,016 hr × 0.029 lb/hr) + (4,032 hr × 0.085 lb/hr) + (2,016 hr × 0.036 lb/hr) + (504 hr × 0.087 lb/hr) + (1 ton/2,000 lb) = 0.4 tons $NO_x$.

For $PM_{2.5}$, the emissions factor was multiplied by 0.92 to obtain the $PM_{2.5}$ fraction of total particulate matter.

## Table C-4 Construction: Onroad Equipment Emissions Factors and Vehicle Miles Traveled Assumptions

| ***Equipment Description*** | ***VMT*** | ***$NO_X$ (lb/mi)*** | ***ROG (lb/mi)*** | ***CO (lb/mi)*** | ***$SO_x$ (lb/mi)*** | ***$PM_{10}$ (lb/mi)*** | ***$PM_{2.5}$ (lb/mi)*** |
|---|---:|---:|---:|---:|---:|---:|---:|
| Heavy-Duty Diesel Truck (33,001+ lb) [1] | 12,600 | 0.0118 | 0.001 | 0.005 | 0.00004 | 0.001 | 0.0009 |
| Passenger Vehicles, Gasoline [2] | 45,360 | 0.0004 | 0.0005 | 0.0042 | 0.00001 | 0.0001 | 0.0001 |

Sources: SCAQMD, 2008a, 2008b.

Key: $NO_x$ = nitrogen oxides; ROG = reactive organic gases (=volatile organic compounds); CO = carbon monoxide; $SO_x$ = sulfur oxides; $PM_{10}$ = particulate matter less than 10 micrometers in diameter; $PM_{2.5}$ = particulate matter less than 2.5 micrometers in diameter; VMT = vehicle miles traveled; lb = pounds; mi = mile.

Notes: A fleet year of 2021 was used, which provides more conservative emissions factors.

[1] Approximate VMT = 1 truck per day × 50 miles per day × 252 days of construction.

[2] Approximate VMT = 6 workers per day × 30 miles per day × 252 days of construction.

## Table C-5 Construction: Onroad Emissions

| ***Equipment*** | ***$NO_X$*** | ***VOC*** | ***CO*** | ***$SO_2$*** | ***$PM_{10}$*** | ***$PM_{2.5}$*** |
|---|---:|---:|---:|---:|---:|---:|
| **Total Onroad Construction Emissions (tons)** | 0.08 | 0.02 | 0.13 | 0.001 | 0.01 | 0.01 |

Sources: SCAQMD, 2008a, 2008b.

Key: $NO_x$ = nitrogen oxides; VOC = volatile organic compounds; CO = carbon monoxide; $SO_2$ = sulfur dioxide; $PM_{10}$ = suspended particulate matter less than or equal to 10 micrometers in diameter.$PM_{2.5}$ = fine particulate matter less than or equal to 2.5 micrometers in diameter.

Notes: Emissions (tons) = emissions factor (pounds/mile) × total vehicle miles traveled × 1 ton/2,000 pounds, for each kind of equipment.

Example: Onroad $NO_x$ emissions = [(12,600 mi × 0.0118 lb/mi) + (45,360 mi × 0.0004 lb/mi)] × 1 ton/2,000 lb = 0.1 tons $NO_x$.

## Table C-6 Construction: Fugitive Dust Emissions

| ***Calculation*** | ***$PM_{10}$*** | ***$PM_{2.5}$*** |
|---|---:|---:|
| Emissions factor (tons particulate matter/acre/month) | 1.2 | 1.2 |
| Fractional contents of particulate matter by size [1] | 59.4% | 21.2% |
| **Total (tons)** [2] | 1.0 | 0.2 |

Sources: USEPA, 1996; SCAQMD, 2006.

Key: $PM_{10}$ = suspended particulate matter less than or equal to 10 micrometers in diameter; $PM_{2.5}$ = fine particulate matter less than or equal to 2.5 micrometers in diameter.

Notes:

[1] $PM_{10}$ is assumed to be 59.4 percent of total particulate emissions, and $PM_{2.5}$ is assumed to be 21.2 percent of $PM_{10}$.

[2] Emissions $PM_{10}$ (tons) = 1.2 tons/acre/month × 0.594 × 0.56 acres × 12 months × (1 - 0.8);
Emissions $PM_{2.5}$ (tons) = $PM_{10}$ emissions in tons × 0.212.

### Underground Utility Option

Installation of underground utilities would result in criteria pollutant emissions similar to those described for general construction activities from equipment operations. Due to the small size of the bore hole, fugitive dust emissions are expected to be negligible. See estimates and notes in Table C-7.

**Table C-7 Underground Utility Option Emissions**

| *Activity* | *$NO_x$* | *VOC* | *CO* | *$SO_2$* | *$PM_{10}$* | *$PM_{2.5}$* |
|---|---|---|---|---|---|---|
| Emissions factor for large stationary diesel engine (lb/hp-hr) | 0.024 | 0.000705 | 0.0055 | 0.00809 | 0.0007 | 0.0007 |
| **Total Horizontal Boring Emissions (tons)** | **2.03** | **0.06** | **0.46** | **0.68** | **0.06** | **0.06** |

Sources: USEPA, 2001, for large diesel engine emission factors; ERG, 2015, to provide upper boundary operating equipment surrogates for horizontal drilling.
Key: $NO_x$ = nitrogen oxides; VOC = volatile organic compounds; CO = carbon monoxide; $SO_2$ = sulfur dioxide; $PM_{2.5}$ = fine particulate matter less than or equal to 2.5 micrometers in diameter.
Notes: Emissions (tons) = emissions factor (pounds/horsepower-hour) × engine output in horsepower × approximate hours of operation × number of engines × average load as a percentage × 1 ton/2,000 pounds. Example: Option $NO_x$ emissions = 0.024 lb/hp-hr × 1,340 hp engine × 70 hours × 3 engines × 60% average load× 1 ton/2,000 lb = 2.03 tons $NO_x$.

### Results and Conclusion

Total estimated emissions for the proposed utility bridge under Alternative 2 (as a maximum impact) and optional underground utilities installation are shown in Table C-8. The total short-term construction emissions represent minor increases in regional air emissions.

Activities would be well below the *de minimis* thresholds for a marginal/moderate ozone nonattainment area in an ozone transport region and sulfur dioxide nonattainment area. Therefore, the action is exempt from the General Conformity Rule requirements to prepare a full conformity determination.

**Table C-8 Summary of Total Criteria Pollutant Emissions**

| *Activity* | *$NO_x$* | *VOC* | *CO* | *$SO_2$* | *$PM_{10}$* | *$PM_{2.5}$* |
|---|---|---|---|---|---|---|
| **Applicable *de minimis* Thresholds** | **100** | **50** | **—** | **100** | **—** | **—** |
| **Maximum Estimated Emissions (Alternative 2 + Underground Utility Option)** | **2.5** | **2.1** | **3.1** | **0.7** | **1.1** | **0.4** |
| Alternative 2: Construction (total tons) | 0.44 | 2.06 | 2.62 | 0.01 | 1.07 | 0.31 |
| *Construction Phase: Nonroad (tons)* | *0.36* | *2.04* | *2.49* | *0.01* | *0.10* | *0.09* |
| *Construction Phase: Onroad (tons)* | *0.08* | *0.02* | *0.13* | *0.001* | *0.01* | *0.01* |
| *Construction Phase: Fugitive Dust (tons)* | — | — | — | — | *0.96* | *0.20* |
| Underground Utility Option (total tons) | 2.03 | 0.06 | 0.46 | 0.68 | 0.06 | 0.06 |

Key: VOC = volatile organic compound; CO = carbon monoxide; $NO_x$ = nitrogen oxides; $SO_2$ = sulfur dioxide; $PM_{10}$ = suspended particulate matter less than or equal to 10 micrometers in diameter; $PM_{2.5}$ = fine particulate matter less than or equal to 2.5 micrometers in diameter; tpy = tons per year.
Note: Emissions may not total precisely due to rounding.

## Appendix C References

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# General Conformity Rule—Record of Non-Applicability (RONA) for Clean Air Act Conformity

## Environmental Assessment for Utility Bridge Replacement at Naval Support Activity Annapolis

### Proposed Action

| | |
|---|---|
| Action Proponent: | Naval Support Activity (NSA) Annapolis |
| Proposed Action Name: | Utility Bridge Replacement |
| Location: | NSA Annapolis, Maryland |
| Project Construction Period: | 2026 |
| Proposed Action Point of Contact: | Ms. Shelbi Pullen<br>NAVFAC Washington<br>1314 Harwood Street SE<br>Washington Navy Yard, DC 20374<br>NAVFACWashNEPA1@navy.mil |

Proposed Action Summary:

The Clean Air Act requires federal actions in air pollutant nonattainment or maintenance areas to conform to the applicable State Implementation Plan. The State Implementation Plan is designed to achieve or maintain an attainment designation of air pollutants as defined by the National Ambient Air Quality Standards. The regulations governing this requirement are found in 40 Code of Federal Regulations (CFR) part 93, also known as the “General Conformity Rule,” which applies to federal actions occurring in regions designated as nonattainment or areas subject to maintenance plans. The threshold (*de minimis*) emission rates have been established for actions with the potential to have significant air quality impacts. A project/action in an area designated as nonattainment and exceeding the *de minimis* rates must have a general conformity determination prepared to address significant impacts.

NSA Annapolis is in Anne Arundel County, Maryland, which is within the Metropolitan Baltimore Intrastate Air Quality Control Region (40 CFR 81.28). This area is designated as being in moderate nonattainment for the 2008 8-hour ozone standard, marginal nonattainment for the 2015 8-hour ozone standard, and nonattainment for the 2010 sulfur dioxide standard. Anne Arundel County was formerly classified as a maintenance area for the 1997 $PM_{2.5}$ standard, but this standard was revoked in 2016. Therefore, the *de minimis* thresholds for ozone precursors (i.e., nitrogen oxides [$NO_x$] and volatile organic compounds [VOCs]) and sulfur dioxide apply to the conformity applicability analysis. Because this region is also with the ozone transport region, established by the 1990 Clean Air Act Amendments, the *de minimis* threshold for VOCs is further reduced.

### Air Emissions Summary

Based on the maximum total project emission estimates identified in the table on the following page, a general conformity determination is not required because the total maximum direct and indirect emission estimates for the Proposed Action, including the underground utility option, are well below the *de minimis* thresholds.

Supporting documentation and emissions estimates can be found in the Environmental Assessment in Section 3.1, Air Quality, and Appendix C, Air Quality Conformity Applicability Analysis.

## Summary of Total Criteria Pollutant Emissions Compared to Applicable *de minimis* Thresholds

| *Activity* | *$NO_x$* | *VOC* | *$SO_2$* |
|---|---:|---:|---:|
| **Applicable *de minimis* Thresholds** | **100** | **50** | **100** |
| **Exceeds *de minimis*?** | **No** | **No** | **No** |
| **Proposed Action (Maximum, total)** | **2.47** | **2.12** | **0.69** |
| Construction Emissions (total tons) | 0.44 | 2.06 | 0.01 |
| Additional Underground Utility Option (total tons) | 2.03 | 0.06 | 0.68 |

Key: $NO_x$ = nitrogen oxides; VOC = volatile organic compound; $SO_2$ = sulfur dioxide; tpy = tons per year.

RONA Prepared by: Naval Facilities Engineering Systems Command Washington

RONA Approval

Digitally signed by
KLIMOSKI.MATTHEW.R.1204834543
Date: 2022.08.29 10:44:03 -04'00'

29 AUG 2022

Signature Date

# Appendix D
# Essential Fish Habitat Assessment

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# Essential Fish Habitat Assessment

## Naval Facilities Engineering Command (NAVFAC)

King George Street Utility Bridge Replacement Project
Project No. 127317

Final
June 19, 2021

# 1.0 INTRODUCTION

This report presents an Essential Fish Habitat (EFH) assessment conducted for the Department of the Navy (Navy) to replace the utility bridge at College Creek at Naval Support Activity (NSA) Annapolis, Maryland (Figure 1-1). This assessment is required under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) of 1976, amended in 1996 by the U.S. Congress under the Sustainable Fisheries Act (SFA), and reauthorized in 2006. The SFA recognized that many fisheries depend on marine, nearshore, and estuarine habitats for at least part of their lifecycles and introduced requirements to protect estuarine and marine ecosystems through identification and conservation of EFH for those species regulated under a federal fisheries management plan. The National Marine Fisheries Service (NMFS) is mandated by the SFA to coordinate with other federal agencies to avoid, minimize, mitigate, or offset adverse effects on EFH that could result from proposed activities. EFH is defined as "waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (NMFS, 2007 [16 U.S.C. 1802(10)]). Fish are defined as finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds (NMFS, 2007 [16 U.S.C. 1802(12)]).

## 1.1 Purpose of and Need for the Proposed Action

The Navy's Proposed Action is to replace the utility bridge at College Creek at the NSA Annapolis, Maryland (Figure 1-1) (Department of the Navy, 2020). NSA Annapolis consists of three main areas: the Upper Yard and Lower Yard of the U.S. Naval Academy (USNA), and North Severn. NSA Annapolis supports multiple tenants, of which the USNA is the main tenant.

Utility bridges are structures that can be used for moving piping, equipment, and lines across rivers, railways, highways, or other obstructions. The bridge was originally constructed in 1931 as a train trestle bridge and retrofitted in 1986 to its current use (Department of the Navy, 2020). Currently, the utility bridge is a service infrastructure bridge; it does not support vehicular or pedestrian traffic. The bridge is composed of two rolled steel beams, seventeen reinforced concrete bents, and two reinforced concrete abutments. The existing utility bridge carries utility lines over College Creek between the Upper Yard and the Lower Yard of USNA. Each utility line is approximately 600 linear feet. A photograph of the utility bridge is provided in Figure 1-2.

**Figure 1-1: Site Location Map**

September 2019
Source: NSA Annapolis,
ESRI Data and Maps 2019

Source: Department of the Navy (2020)

**Figure 1-2: Utility Bridge, West View**

Source: Department of the Navy (2020)

The purpose of the Proposed Action is to ensure continued utility service to portions of the USNA. The Proposed Action is needed because the current utility bridge is in a severely deteriorated state and requires extensive repair (Department of the Navy, 2020). If the bridge fails, utility services would be interrupted. Sudden failure of the bridge could sever the utility lines that cross College Creek, resulting in a rupture that is capable of damaging nearby infrastructure and natural systems.

An inspection of the utility bridge from June 2019 determined the bridge is in poor condition overall, and numerous deficiencies require correction within 12 months (Department of the Navy, 2020). The 2019 inspection report concluded that the superstructure is in fair condition while the substructure is in poor condition (NAVFAC EXWC, 2019). The bridge superstructure (i.e., the parts of the bridge that are mounted on a supporting system) includes the deck, slab, and girders. The bridge substructure supports the superstructure and transfers the structural load to the foundations (i.e., piers and abutments).

The existing bridge is aging with multiple failed components and other components in critical need of repair related to the piles, support beams, reinforcements, and surface coatings. Specific findings of the inspection report included the following (Department of the Navy, 2020):

- The transverse support beam at the top of the south tower is severely twisted, and two rollers are missing in the main span.
- The transverse support beam at the top of the tower over Pier 9 is severely twisted.
- The bottom of the pile caps at Piers 10 and 16 exhibit large spalls, with exposed longitudinal and transverse steel reinforcement members, and up to 100 percent section loss.
- Loose and corroded anchor bolt nuts are at the northwest and northeast columns of the north tower above Pier 10.
- Twisted pipeline transverse support beams are above Pier 7 and on the north approach.
- A large-scaled area is located at the bottom of Abutment 1, with exposed and corroded steel reinforcement, and up to 100 percent section loss at the ends.
- The abutments, concrete pile caps, pedestals, and fascia panels show vertical and horizontal cracks, peeling, and flaking, which leads to internal structural weakness.
- The steel superstructure, beams, main span frame members, bearings, and connection hardware have moderate surface corrosion.
- The bearing hardware (i.e., anchor rods, nuts, and washers) at the abutments and at isolated piers exhibit moderate-to-severe surface corrosion with up to 50 percent section loss.
- Twenty-three piles (16 percent of the total piles) are in critical or failed condition, and 14 piles (10 percent of the total piles) are in poor condition. These piles exhibit varying degrees of cracking and exposure of reinforcing steel.

The inspection report also determined that the lack of catwalks and ladders to provide access for future inspection, maintenance, or repair pose a safety concern.

## 1.2 Report Organization

The contents of this EFH assessment are provided to meet the requirements described by the NMFS to comply with the Magnuson-Stevens Act. An EFH assessment must include all of the following mandatory elements: (i) a description of the action, (ii) an analysis of the potential adverse effects of the action on EFH and the managed species, (iii) the federal agency’s conclusions regarding the effects of the action on EFH, and (iv) proposed mitigation, if applicable. Table 1-1 shows the organization of this report.

**Table 1-1: Report Organization**

| Section | Report Chapter Title |
|---|---|
| Chapter 2 | Proposed Action and Alternatives |
| Chapter 3 | Environmental Setting |
| Chapter 4 | Essential Fish Habitat Designations |
| Chapter 5 | Analysis of Potential Impacts on EFH |
| Chapter 6 | Conclusions Regarding the Effects on EFH |
| Chapter 7 | Mitigation Measures |
| Chapter 8 | Literature Cited |
| Appendix A | Engineering Drawings of the Alternatives |
| Appendix B | Existing Condition Bathymetric Survey |

# 2.0 PROPOSED ACTION AND ALTERNATIVES

This chapter provides a description of the Proposed Action, screening factors, and alternatives carried forward for analysis in the Environmental Assessment (EA) and in this EFH assessment.

## 2.1 Proposed Action

The Proposed Action involves replacing the utility bridge at College Creek at NSA Annapolis. Specifically, this includes construction of a new utility bridge, connection of new utility lines, and demolition and removal of the existing bridge. During construction of the new utility bridge, the existing bridge and utilities would remain in place until the new structure is completed. The utility bridge over College Creek is approximately 18 feet wide and 474 feet long (Department of the Navy, 2020). The new bridge would be approximately the same width and length, and the bridge deck would be located at approximately the same elevation. The proposed bridge would be designed to ensure that boats, specifically those from the adjacent Hubbard Hall (Building 260), would be able to access the waterway on both sides of the bridge.

As previously discussed, the existing bridge carries utility lines over College Creek between the Upper Yard and the Lower Yard of the USNA. All current utility connections would be included in the proposed utility bridge; there would be no long-term changes in services or capacity. Utilities would be reattached to the bridge structure; however, an underground utility option is also being considered as discussed in Section 2.1.1.

The existing utility bridge does not provide the infrastructure to access the bridge; as a result, the utilities currently must be inspected by boat. Under the Proposed Action, infrastructure would be included so that personnel could access the new bridge safely to conduct future inspections, maintenance, and repairs. Infrastructure to access the proposed bridge would likely include catwalks and ladders. In addition, the proposed bridge would meet codes for safety and security. Security measures would include devices such as fencing and locks.

### 2.1.1 Underground Utility Option

The Proposed Action includes reattaching the utilities to the bridge structure, which is how they are currently situated (Department of the Navy, 2020). The utility lines would be replaced and reattached for all alternatives. Aboveground utilities are generally easier to install and maintain than underground utilities. However, the presence of utility conduit on bridges in the long term can make maintenance of the structure more difficult as the utilities may also be more vulnerable to damage. In addition, implementing safety and security measures can be more difficult. Therefore, as part of the decisionmaking process, the Navy will evaluate an underground utility option to determine if there are substantial differences or notable environmental impacts associated with aboveground or belowground utilities for this Proposed Action. The underground utilities option applies to Alternatives 1 through 3.

Under this option, all of the utilities would be situated underground except for one utility line that cannot be bored underground; therefore, one line would remain aboveground and attached to the proposed utility bridge structure.

Placing utilities underground provides increased protection of those infrastructure components from weather and accidents, which increases long-term utility reliability and safety. Codes for safety and security measures would be easier to implement if the utilities were underground. In addition, utilities are also often less affected by temperature and humidity because these factors are more constant underground. However, repair of underground utilities, if needed, can be more challenging due to limited access as compared to aboveground utilities. Undergrounding utilities may also include additional environmental considerations such as needed permitting or clearances.

Underground utilities would be placed using directional boring from the banks of College Creek. The boring would start on the northern side of the creek bed and move towards the southern side. The boring would not directly affect water resources as it would occur on the banks and under the creek bed without disturbing creek sediment. As a result, no dams or cofferdams would be used. At this time, the required depth of the borings has not been determined, but the area would likely be approximately 36 inches in diameter.

## 2.2 Screening Factors

National Environmental Policy Act (NEPA) implementing regulations provide guidance on the consideration of alternatives to a federally proposed action and require rigorous exploration and objective evaluation of reasonable alternatives. Only those alternatives determined to be reasonable and that meet the purpose and need (see Section 2.1) require detailed analysis (Department of the Navy, 2020).

Potential alternatives that meet the Proposed Action’s purpose and need were evaluated against the following screening factors:

- The bridge abutments must be on Navy property to provide security for military utility services.
- The utility lines need to be in close proximity to existing infrastructure and utility connections. Rerouting the utility lines to the northeast of Decatur Avenue (Hill Bridge) would involve extensive relocation to tie back into utility infrastructure. In addition, the creek bed on the

southern side of College Creek curves further south, expanding the width of the creek in this region. Therefore, the length of the utility bridge immediately northeast of Decatur Avenue would be considerably longer. Consequently, the utility bridge should be no further than approximately 350 feet to the northeast of the existing alignment.

Various site location alternatives were evaluated against the screening factors. The alternatives considered include the following, which are shown on Figure 2-1:

- No Action Alternative
- Alternative 1: King George Street Bridge Alignment
- Alternative 2: Decatur Avenue Bridge Alignment
- Alternative 3: Between King George Street and Decatur Avenue Bridge Alignment

The project-specific construction and bridge demolition methods for each alternative have yet not been finalized. Preparation, construction, and demolition activities are expected to use a variety of methods to complete the project. Only mechanical methods are anticipated for construction and demolition activities.

## 2.3 Alternatives Carried Forward for Analysis

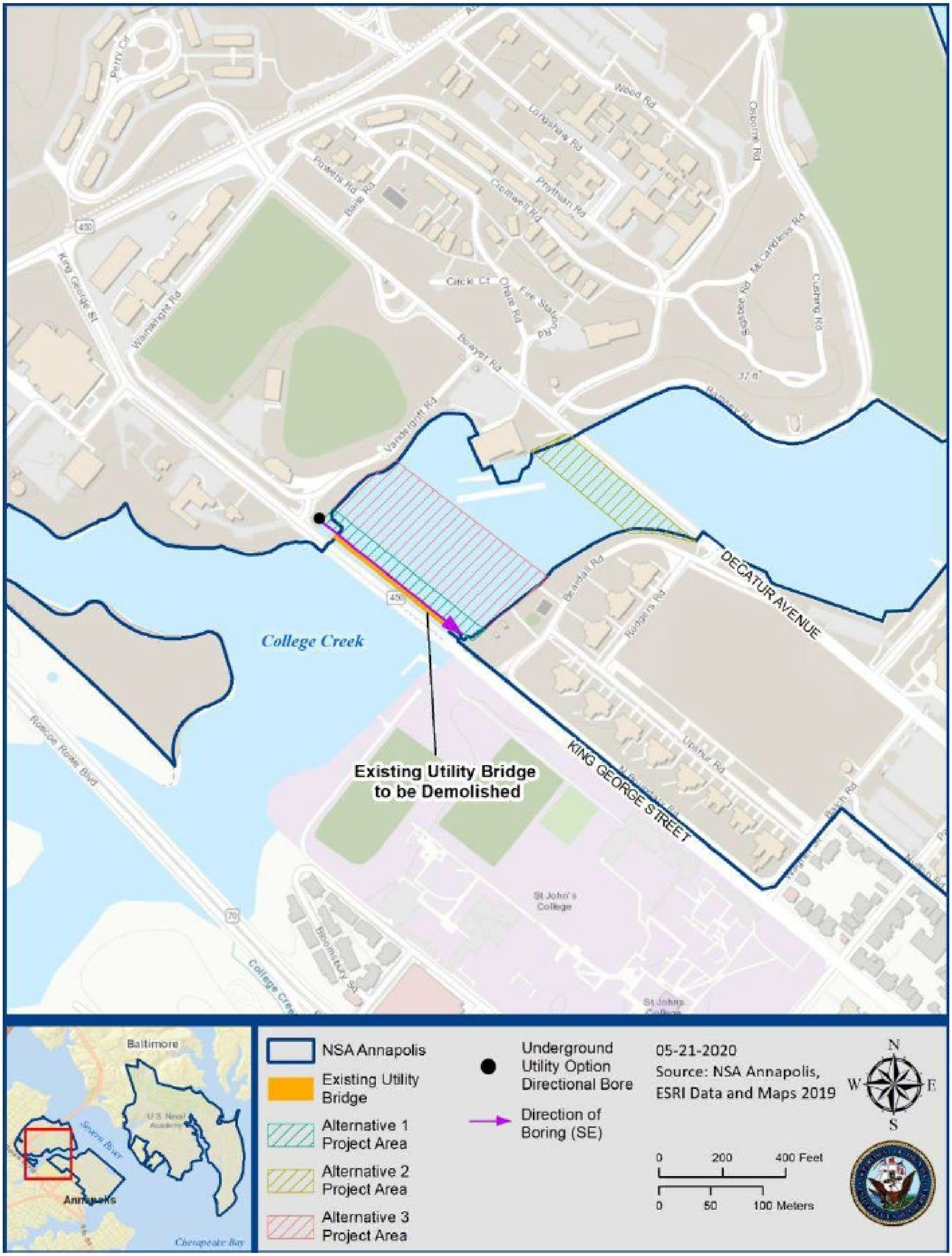
Based on the reasonable alternative screening factors and meeting the project purpose and need, three alternatives were identified, as well as the No Action Alternative. Alternatives considered but not carried forward are discussed in Section 2.4 of the EA (Department of the Navy, 2020).

### 2.3.1 No Action Alternative

Under the No Action Alternative, the Proposed Action would not be implemented. The existing utility bridge would continue to deteriorate until failure is imminent or occurs (Department of the Navy, 2020). As discussed in Section 1.1, the utility bridge over College Creek carries utility lines between the Upper Yard and the Lower Yard of the USNA. If the bridge fails, these services would be interrupted, which would interfere with the training of midshipmen.

Currently, the bridge undergoes routine maintenance to ensure the utilities and the surrounding populations are safe. Routine maintenance to the bridge would continue, but no major repairs would

Figure 2-1: Locations of Alternatives



Source: Department of the Navy (2020)

occur. The worst-case scenario under the No Action Alternative would be a sudden failure of the bridge, possibly severing the utility lines that cross College Creek. Instantaneous ruptures of pressurized lines could be capable of damaging nearby infrastructure and natural systems. Infrastructure systems that cross on the utility bridge have emergency shut-off protocols in place to minimize the likelihood for catastrophic damage under this worst-case scenario. Additional operational constraints as a result of a failure would be needed including emergency response, permitting, and strategic planning for minimization of additional unforeseen failures (Department of the Navy, 2020).

The No Action Alternative would not meet the purpose of and need for the Proposed Action; however, the No Action Alternative is carried forward for analysis in the EA to establish a comparative baseline for analysis.

### 2.3.2 Alternative 1: King George Street Bridge Alignment

Under Alternative 1, the proposed utility bridge would be constructed 50 feet east of the existing utility bridge alignment, which is adjacent to the King George Street Bridge (Department of the Navy, 2020) (Figure 2-2). Given that the King George Street Bridge and the installation boundary are directly south of the current utility bridge, the proposed bridge must be located to the northeast of the current utility bridge location. Per the Feasibility Study to replace the existing utility bridge, the new utility bridge constructed in Alternative 1 may consists of the following bridge types and construction materials (Wiley/Wilson and Burns & McDonnell, 2021):

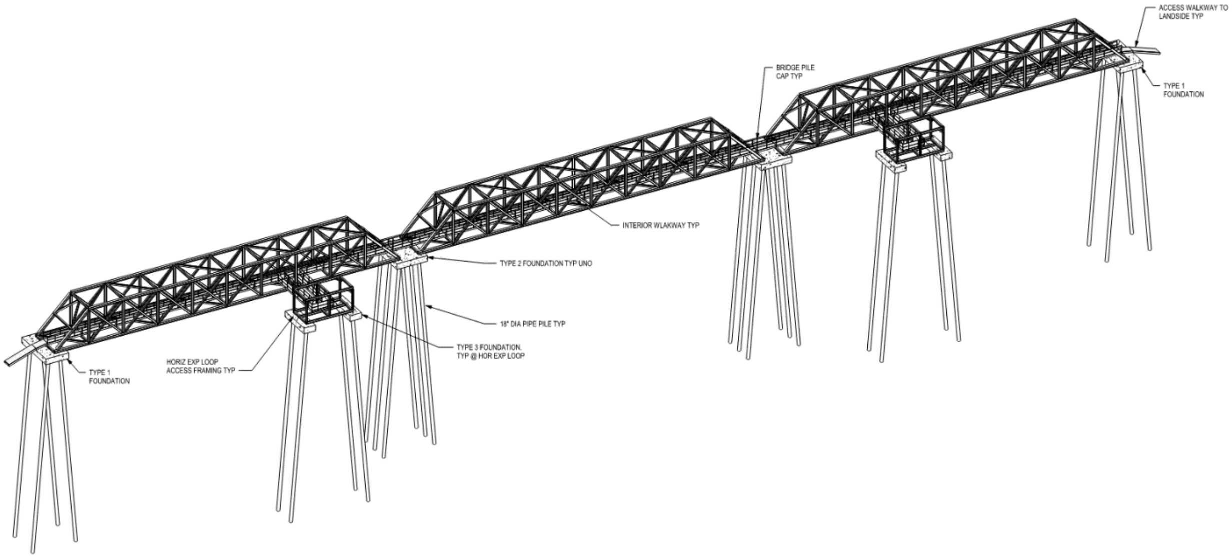
- An X-diagonal, tapered steel space truss superstructure consisting of three (3) 180-foot x 17-foot x 18-foot (L x W x H) bridge sections with integrated access walkways and two (2) 24-foot x 12-foot x 12-foot (L x W x H) expansion loop sections (Figure 2-3). The steel pipe piles are anticipated to be 18 inches in diameter and will extend through the depth of the creek to approximately 100 feet below the creek substrate. A total of 28 pipe piles will be required.
- A concrete bridge with AASHTO Type IV prestressed girders with transverse cast in place beams doweled into the side of the girders which differs from the steel superstructure (Figure 2-4). The spans for a concrete-only bridge are limited to approximately 80 feet. As such, the shorter spans have the most environmental impact given the increased number of foundations and piles in the water. This bridge design consists of pile cap foundations which project out of the water 10 feet and driven steel pipe piles within each foundation. The steel pipe piles are anticipated to be 18 inches in diameter and will extend through the depth of the creek to approximately 100 feet below the creek substrate. A total of 35 pipe piles will be required.

The Proposed Action would be implemented as discussed in Section 2.1. During construction of the new utility bridge, the existing bridge and utilities would remain in place until the new structure is completed. Upon completion of the new utility bridge, the existing bridge would be demolished, and the pile caps would be removed and hauled off-site (Department of the Navy, 2020). Pile driving and minor excavation for new pile caps would likely occur. This alternative includes consideration of the environmental impacts associated with the aboveground and underground utility options.

**Figure 2-2: Alternative 1 Site General Location**

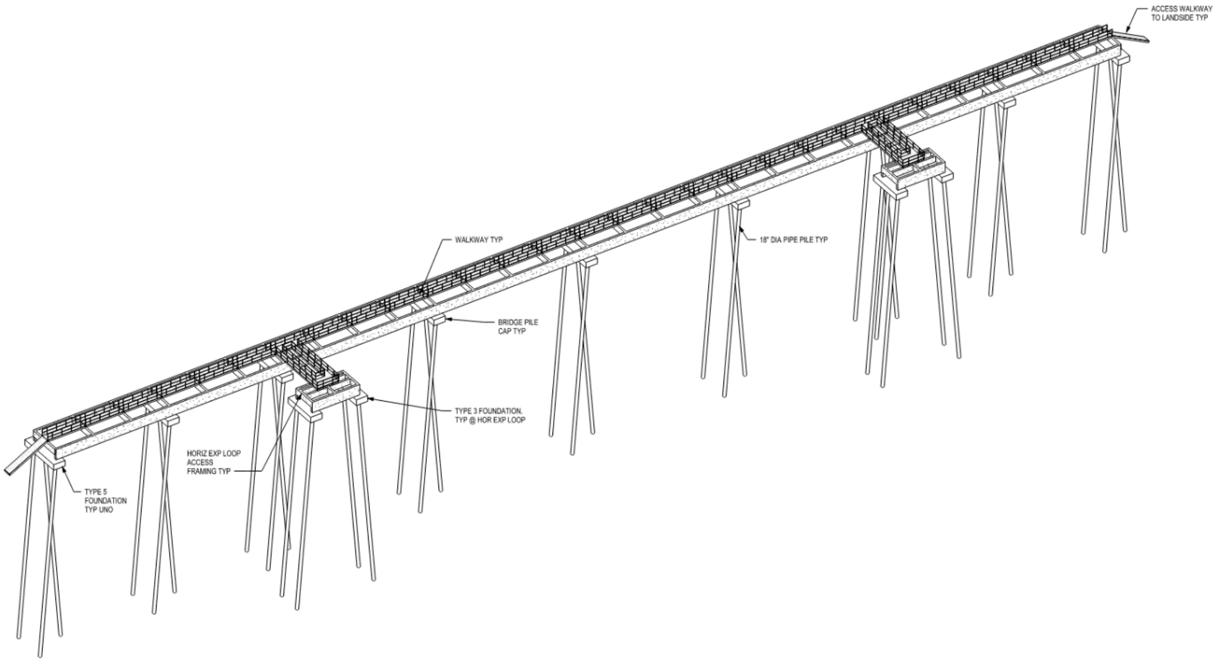
Source: Department of the Navy (2020)

**Figure 2-3: Alternative 1 Site – X-Diagonal Steel Space Truss**



Source: Wiley/Wilson and Burns & McDonnell (2021)

**Figure 2-4: Alternative 1 Site – Precast Concrete**



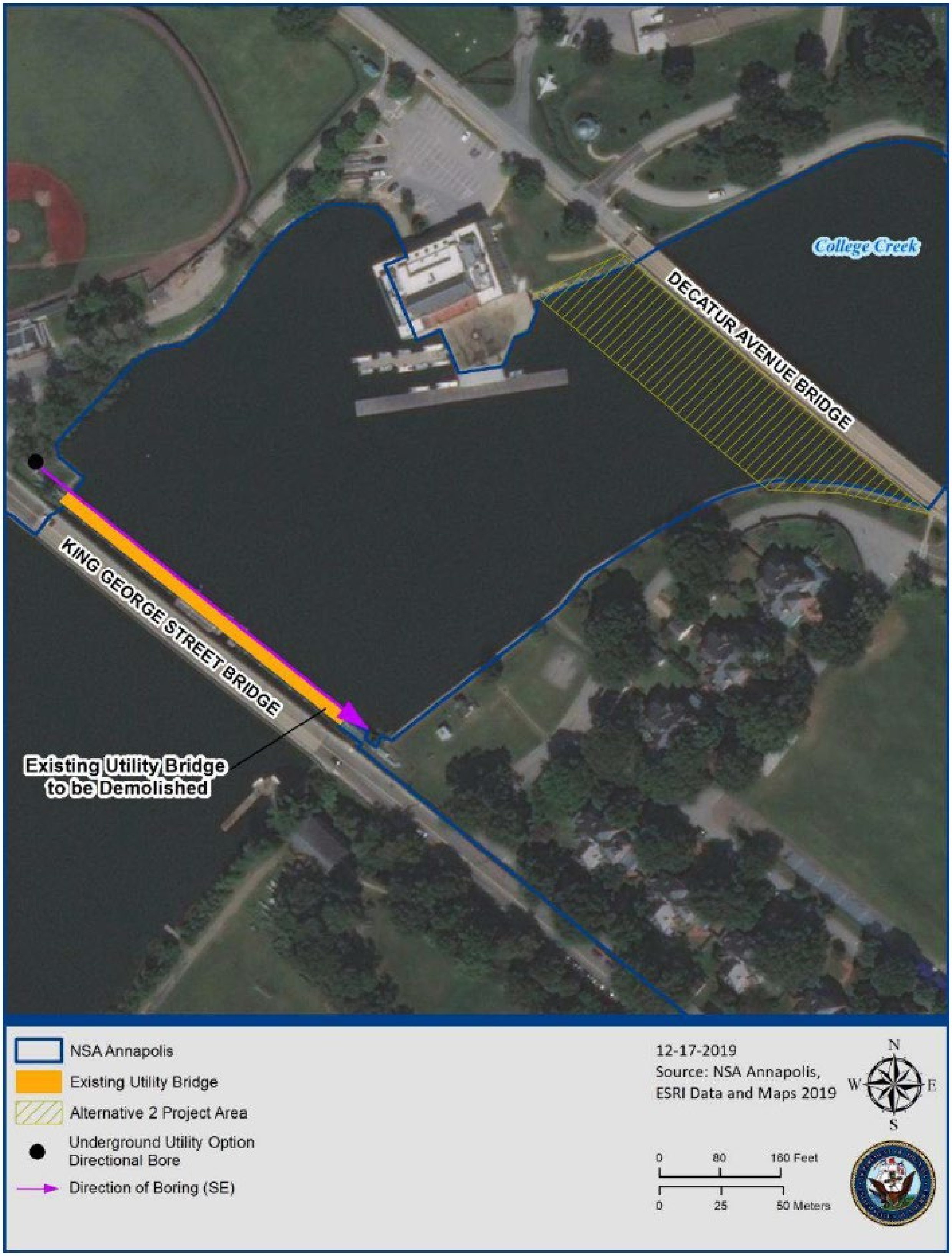
Source: Wiley/Wilson and Burns & McDonnell (2021)

### 2.3.3 Alternative 2: Decatur Avenue Bridge Alignment

Under Alternative 2, the proposed utility bridge would be constructed within 115 feet of the Decatur Avenue Bridge (Hill Bridge) (Department of the Navy, 2020) (Figure 2-5). As discussed in Section 2.2, the utility bridge needs to be situated southwest of the Decatur Avenue Bridge to tie back into utility infrastructure without major realignment. Per the Feasibility Study to replace the existing utility bridge, the new utility bridge constructed in Alternative 2 may consists of a pratt, tapered steel space truss superstructure consisting of three (3) 120-foot x 17-foot x 12-foot (L x W x H) bridge sections with a vertical expansion loop in the center formed by bridge columns at either end (Figure 2-6) (Wiley/Wilson and Burns & McDonnell, 2021). A total of 20 pipe piles will be required.

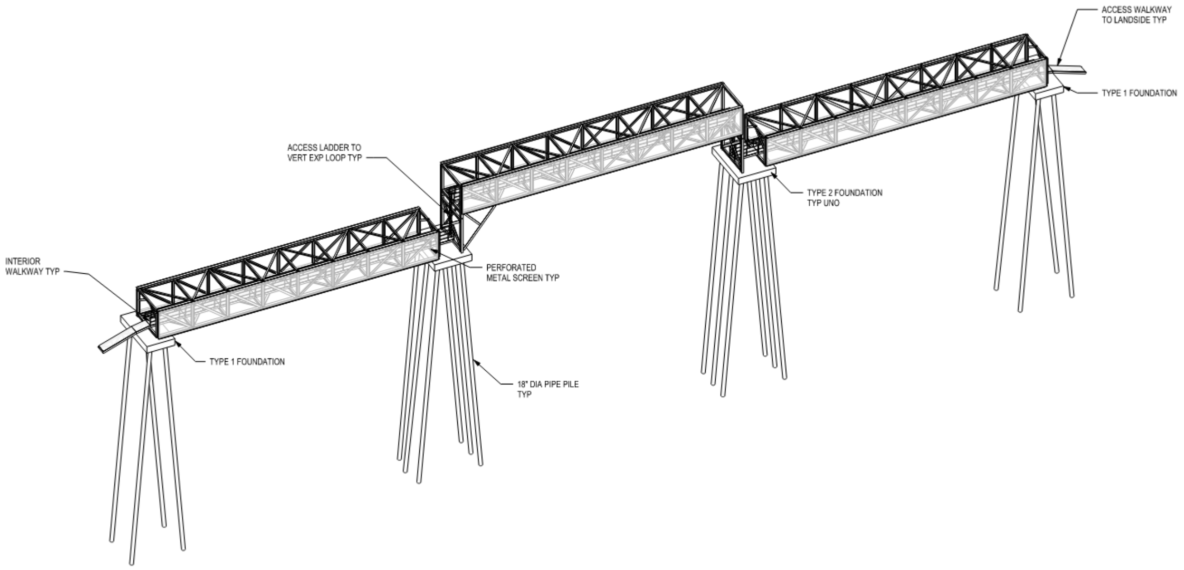
The Proposed Action would be implemented as discussed in Section 2.1, and construction would occur as discussed under Alternative 1 (Section 2.3.2). This alternative includes consideration of the environmental impacts associated with the aboveground and underground utility options.

**Figure 2-5: Alternative 2 Site General Location**



Source: Department of the Navy (2020)

**Figure 2-6: Alternative 2 Site – Pratt Steel Space Truss**



Source: Wiley/Wilson and Burns & McDonnell (2021)

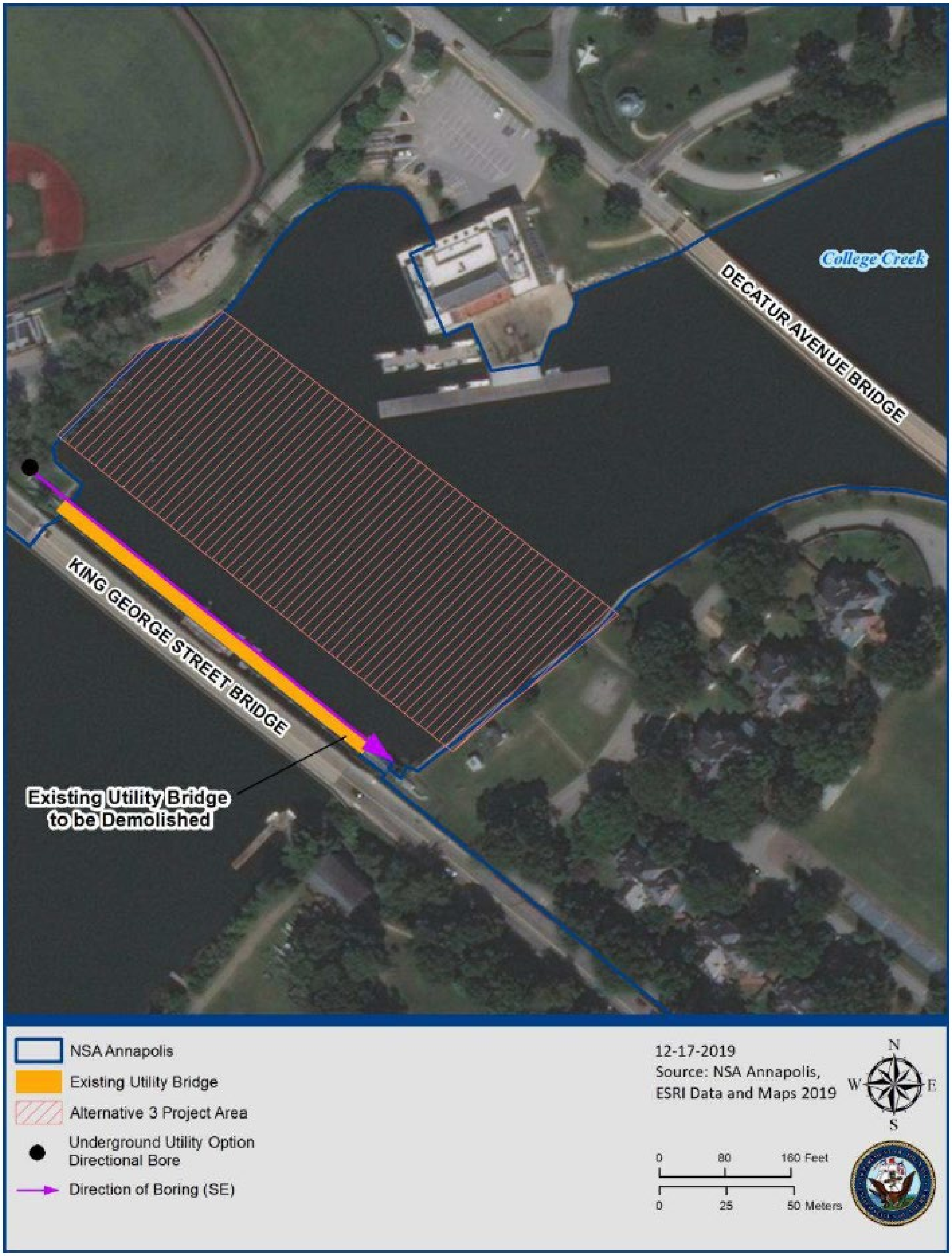
### 2.3.4 Alternative 3: Between King George Street and Decatur Avenue Bridge Alignment

Under Alternative 3, the proposed utility bridge would be constructed between the locations of Alternatives 1 and 2 (while also avoiding Hubbard Hall [Building 260] and its associated docks) (Department of the Navy, 2020) (Figure 2-7). Per the Feasibility Study to replace the existing utility bridge, the new bridge constructed in Alternative 3 may consists of the following bridge types and construction materials (Wiley/Wilson and Burns & McDonnell, 2021):

- A tubular bowstring truss superstructure consisting of three (3) 180-foot x 17-foot x 25-foot (L x W x H) bridge sections with integrated access walkways and two (2) 24-foot x 12-foot x 12-foot (L x W x H) expansion loop sections (Figure 2-8). A total of 28 pipe piles will be required.
- An X-diagonal, tapered steel spaced truss superstructure with jack and bore below the creek bed for the potable and raw water utilities (Figure 2-9). The superstructure may consist of three (3) 180-foot x 12-foot x 15-foot (L x W x H) bridge sections with integrated access walkways and two (2) 24-foot x 12-foot x 12-foot (L x W x H) expansion loop sections. A total of 24 pipe piles will be required. For this alternative, boring would require an approximate 20 x 40 foot pit and a minimum staging area of 150 feet x 100 feet to support the entry and exit points for boring operations.

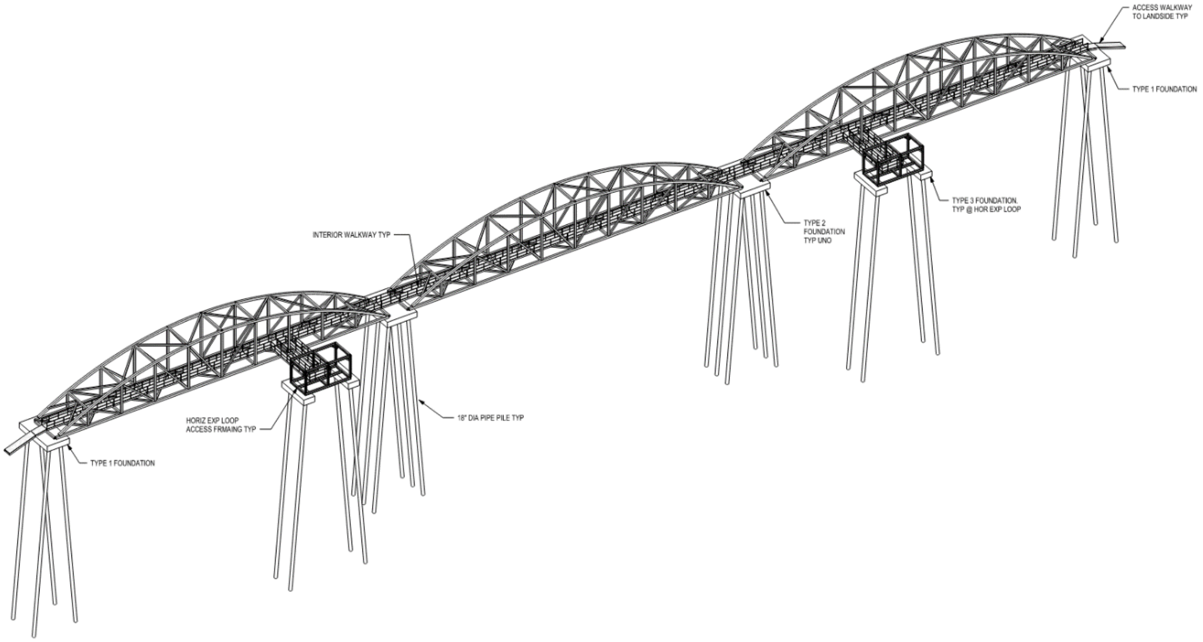
The Proposed Action would be implemented as discussed in Section 2.1, and construction would occur as discussed under Alternative 1 (Section 2.3.2). This alternative includes consideration of the environmental impacts associated with the aboveground and underground utility options.

**Figure 2-7: Alternative 3 Site General Location**



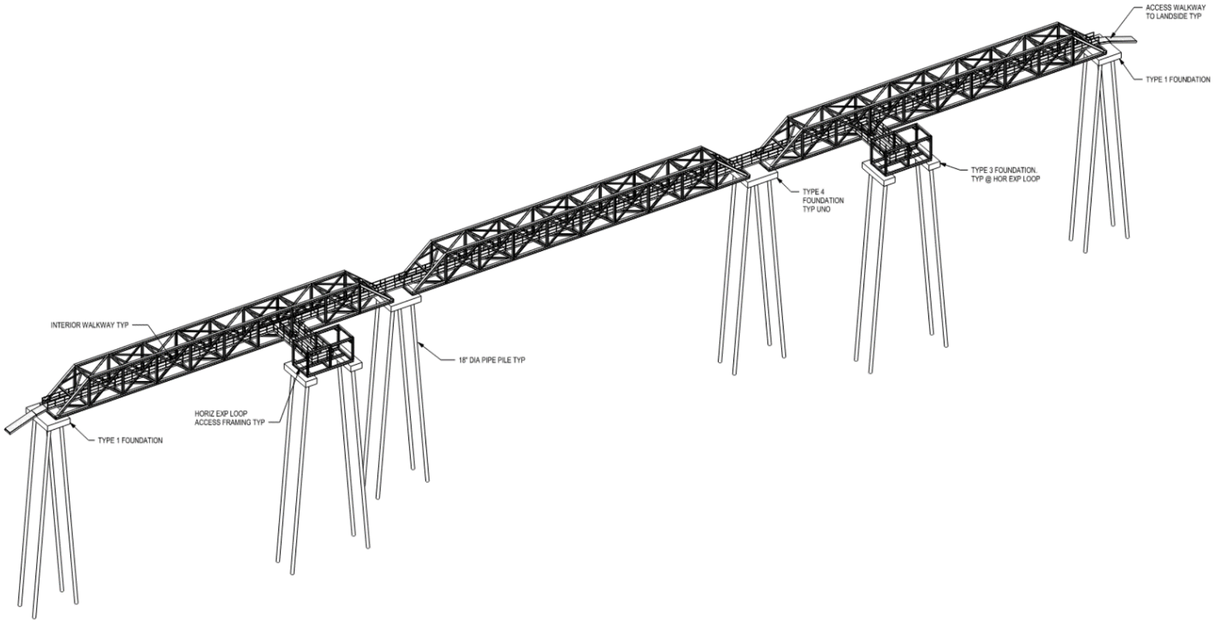
Source: Department of the Navy (2020)

Figure 2-8: Alternative 3 Site – Tubular Bowstring Truss



Source: Wiley/Wilson and Burns & McDonnell (2021)

Figure 2-9: Alternative 3 Site – X Diagonal Steel Space Truss with Jack and Bore



Source: Wiley/Wilson and Burns & McDonnell (2021)

### 2.3.5 Best Management Practices Included in the Proposed Action

This section presents an overview of the general best management practices (BMPs) that are incorporated into the Proposed Action. BMPs are existing policies, practices, and measures that the Navy would adopt to reduce the environmental impacts of designated activities, functions, or processes (Department of the Navy, 2020). Although BMPs mitigate potential impacts by avoiding, minimizing, or reducing/eliminating impacts, BMPs are distinguished from potential mitigation measures because BMPs are (1) existing requirements for the Proposed Action; (2) ongoing, regularly occurring practices; or (3) not unique to this Proposed Action. As such, the BMPs identified in this document are inherently part of the Proposed Action and are not potential mitigation measures proposed as a function of the NEPA environmental review process for the Proposed Action. Table 2-1 includes a list of general BMPs for the project. Proposed mitigation measures specifically addressed to avoid/minimize impacts to EFH are discussed separately in Chapter 7.

**Table 2-1: Best Management Practices**

| Best Management Practice | Description | Impacts Reduced/Avoided |
|---|---|---|
| Fugitive dust practices | Examples of measures could include wetting soil, covering soil stockpiles, and ceasing operations during high winds. | Control fugitive dust emissions. |
| Construction equipment | Good housekeeping measures for construction equipment (i.e., petroleum, oil, and/or lubricants) for optimal performance. | Prevent leeching of contaminants into groundwater and surface water. |
| Erosion and sediment control | Examples could include silt fences, silt or turbidity curtains, inlet and outlet protection, erosion-control matting, sediment logs, construction entrances, temporary and permanent seeding, mulching, and check dams. | Minimize sediment transport into surface water. |

Source: Department of the Navy (2020).

# 3.0 ENVIRONMENTAL SETTING

NSA Annapolis is in Anne Arundel County, Maryland, along the Severn River and Chesapeake Bay in Annapolis, approximately 30 miles southeast of Baltimore and 33 miles east of Washington, DC. There are three main areas of NSA Annapolis: the Upper Yard and Lower Yard of the USNA, and North Severn. The Upper Yard and Lower Yard along the southern shore of the Severn River are separated by College Creek (Figure 1-1). The USNA campus is located here. North Severn is on the northern shore of the Severn River at the confluence with the Chesapeake Bay. The Upper Yard and Lower Yard are surrounded by the fairly dense development of Annapolis, whereas the North Severn area is more suburban and buffered by forest.

## 3.1 Water Resources

The following provides a physical description of Severn River and College Creek and water quality.

### 3.1.1 Physical Description

The Chesapeake Bay and Severn River are the major surface water features in the vicinity of NSA Annapolis. NSA Annapolis is located within the Severn River watershed, which has a drainage area of 70 square miles (USNA, 2001). The 12.5-mile Severn River is a tidal tributary to the Chesapeake Bay, which receives drainage from tributaries, backwaters, and side channels in Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia. The Severn River watershed contains the following subbasins: Carr Creek, College Creek, Mill Creek, Severn River, Shady Lake, and Spa Creek. The Proposed Action is located near the confluence of the Severn River with the Chesapeake Bay, so tidally interconnected surface waters are brackish in salinity.

The Severn River was declared a Scenic River by the General Assembly of Maryland in 1971. Maryland water quality standards specify that all surface waters of the State shall be protected for water contact recreation, fishing, and protection of aquatic life and wildlife. The designated use of the Severn River is Class II, Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting. The Maryland Department of the Environment (MDE) has identified the waters of the Severn River as impaired by nitrogen and phosphorus, sediments, fecal coliform in tidal portions of the basin, and polychlorinated biphenyls in fish tissue (MDE, 2019). MDE classifies the tidal areas of the Severn River for nursery use from February 1 to May 31, shallow water submerged aquatic vegetation use from April 1 to October 30 to a depth of one meter (m), and open water fish and shellfish use year-round (Code of Maryland Regulations, 2014).

College Creek is a small tidal creek that flows into the Severn River. The USNA is located at the mouth of College Creek at its confluence with the Severn River. The shoreline of College Creek is mostly natural with a wooded riparian corridor above the King George Street Bridge, and mostly altered (i.e., bulkhead and riprap shoreline) below the King George Street Bridge along the areas owned by USNA.

Bathymetric, subsurface exploration, and geotechnical engineering services were conducted in College Creek within the vicinity of the Proposed Action. Grain size analysis demonstrated that the majority of the sediment was silty sand or elastic silt (Terrecon Consultants, Inc., 2021). Depths ranged from approximately 1.0 to 2.2 feet along the Upper Yard shoreline; 10.4 to 11.9 feet in the center of the channel; and 1.4 to 2.8 feet along the Lower Yard shoreline, as the channel deepens near the Decatur Avenue Bridge (christopher consultants, 2020) (Appendix A).

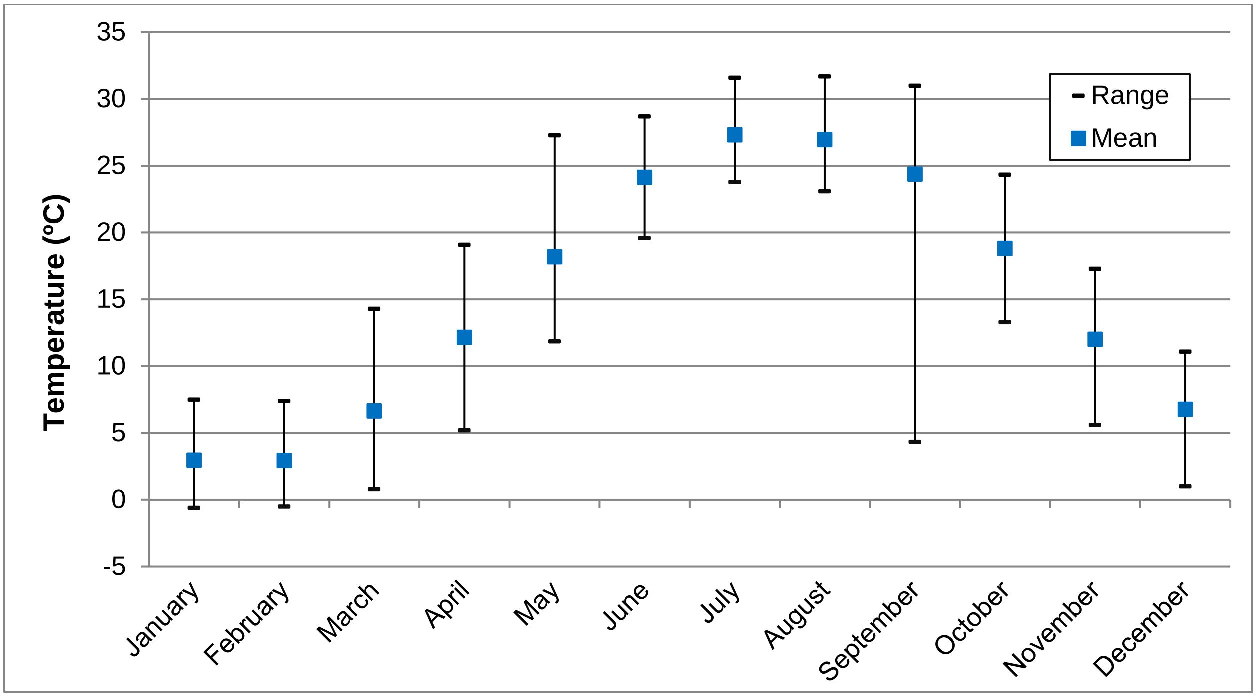
### 3.1.2 Water Quality

A watershed assessment was conducted for the College Creek Watershed in 2007, and water quality in the creek was similar to what was measured in the nearby Severn River and Magothy River (Friends of College Creek, 2007). Water quality data were retrieved and analyzed from the National Oceanic and Atmospheric Administration’s (NOAA) Chesapeake Bay Interpretive Buoy System. NOAA maintains a water quality buoy at the confluence of the Severn River and Chesapeake Bay (“Annapolis” buoy), located approximately 3 miles southeast from NSA Annapolis (38.962778 N latitude, -76.446992 W longitude). Daily data for an approximate 10-year period from January 2010 to April 2020 for temperature, salinity, dissolved oxygen, and turbidity were available for analysis and the results are provided below. All of these are important abiotic factors that influence the types of aquatic plants and animals that live in a waterbody, and their geographical distribution, behavior, and reproduction. These parameters change with the season and can be highly variable from year to year.

#### 3.1.2.1 Temperature

Water temperature in the Chesapeake Bay near Annapolis demonstrated typical seasonal variation with the lowest temperatures in winter and highest temperatures in summer. Average monthly water temperature ranged from 2.9 degrees Celsius (ºC) in January and February to 27.3 ºC in August (Figure 3-1).

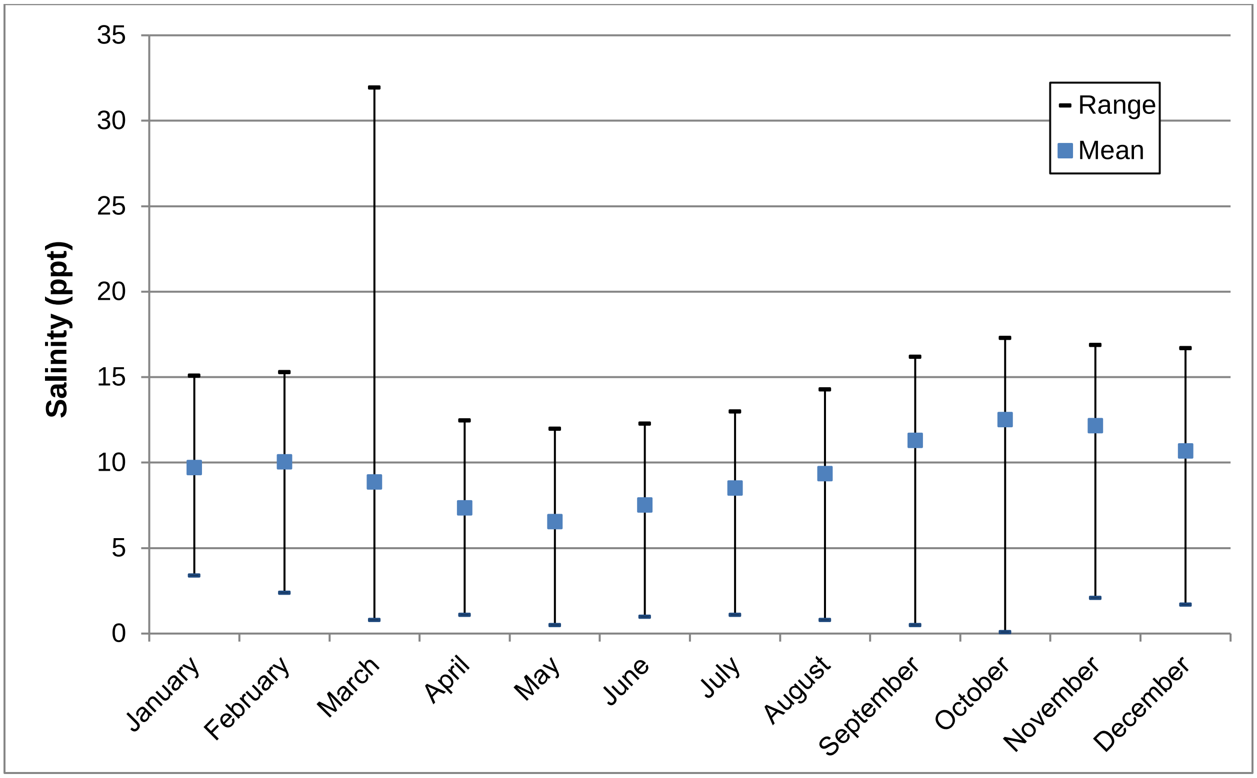
Figure 3-1: Monthly Temperature in the Chesapeake Bay at Annapolis (2011 – 2020)



### 3.1.2.2 Salinity

Salinity is the quantity of dissolved salt content in the water. Salinity ranges from 0 to 0.5 parts per thousand (ppt) in freshwater, 0.5 to 30 ppt in estuarine or brackish systems, and 30 to 50 ppt in oceans. Salinity changes with the season and is variable from year to year. Salinity in the Chesapeake Bay near Annapolis ranged from 0.5 parts per thousand (ppt) to 32 ppt and averaged 9.5 ppt. Average monthly salinity ranged between 6.5 ppt in May to 12.5 ppt in October (Figure 3-2). Lower salinities were observed in the in the spring and higher salinities occurred in the fall. Salinity in College Creek has been observed to range from approximately 6 to 11 ppt (Friends of College Creek, 2007).

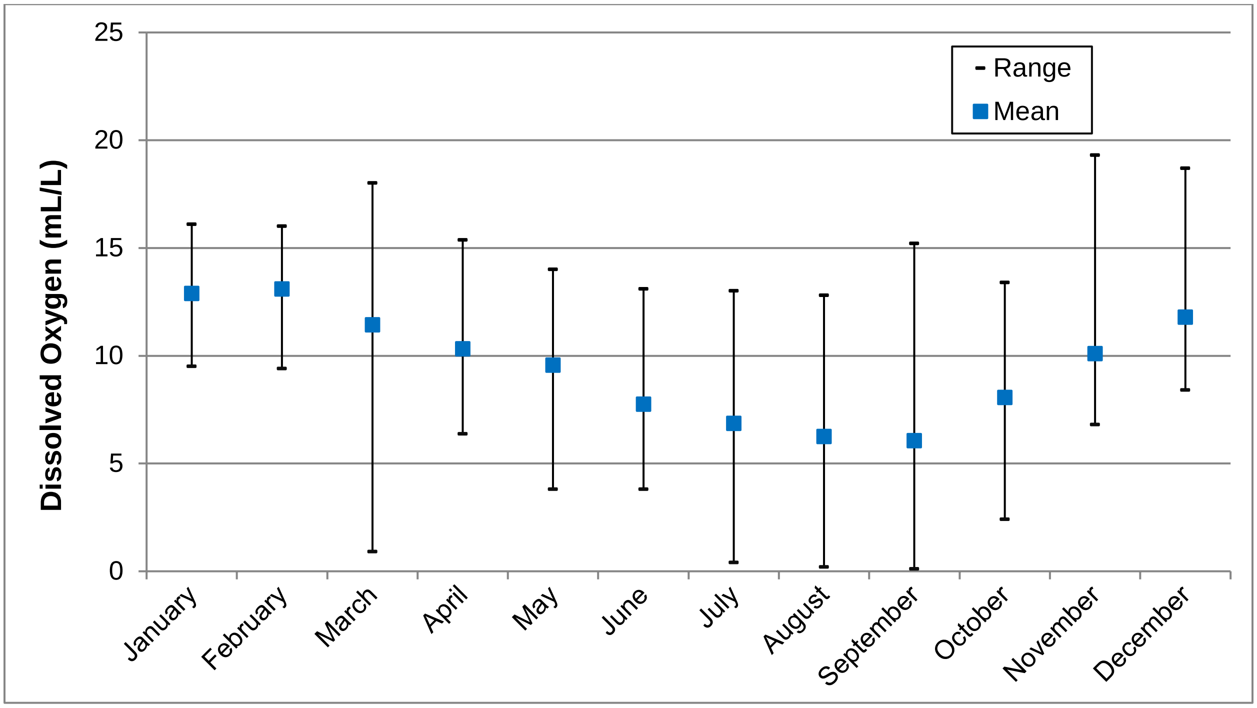
**Figure 3-2: Monthly Salinity in the Chesapeake Bay at Annapolis (2011 – 2020)**



### 3.1.2.3 Dissolved Oxygen

Fish and other aquatic life require levels of dissolved oxygen to survive. Seasonal algae blooms deplete dissolved oxygen and may render deep waters of the Chesapeake Bay uninhabitable to certain species. Dissolved oxygen levels above 5.0 mg/l (or approximately 6.7 milliliters per liter [mL/L] at 20 ºC and 1 atmosphere of pressure) are normally sufficient to support most life. Dissolved oxygen in the Chesapeake Bay near Annapolis ranged from 0.1 mL/L to 18.0 mL/L and averaged 9.1 mL/L. Average monthly oxygen ranged between 6.1 mL/L in September to 13.1 mL/L in February (Figure 3-3). Lower oxygen levels were typically observed in late summer/early fall and higher oxygen levels occurred in the winter.

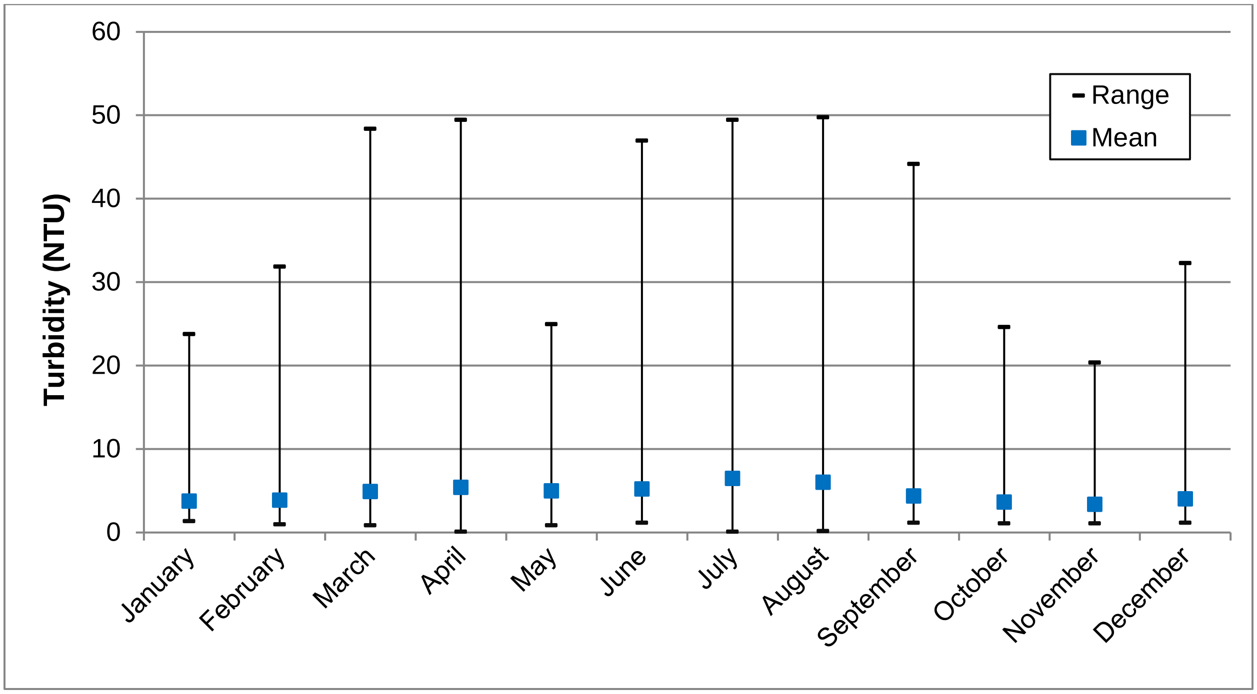
**Figure 3-3: Monthly Oxygen in the Chesapeake Bay at Annapolis (2011 – 2020)**



### 3.1.2.4 Turbidity

Turbidity is an optical property of water that causes light to be scattered and absorbed by particles and molecules. Turbidity is the clarity of water due to the presence of suspended particulates and it is an important factor in water quality. Turbidity is highly variable due to seasonal changes in suspended sediments, algal blooms and wind-driven suspension of sediments. High concentrations of particulate matter affect light penetration and ecological productivity, recreational values, and habitat quality. Turbidity in the Chesapeake Bay near Annapolis ranged from 0.1 Nephelometric Turbidity Units (NTU) to 49.0 NTU and averaged 4.7 NTU. Average monthly turbidity ranged between 3.4 NTU in November to 6.5 NTU in July (Figure 3-4). Higher turbidity was typically observed in July and August.

**Figure 3-4: Monthly Turbidity in the Chesapeake Bay at Annapolis (2011 – 2020)**



## 3.2 Aquatic Biological Resources

The following provides a description of the aquatic biological resources relevant to this EFH assessment.

### 3.2.1 Macroinvertebrates

The Friends of College Creek (2007) collected macroinvertebrates from two stream sites in the College Creek watershed, and one site in the Spa Creek watershed in May 2007. The macroinvertebrate data were used to calculate an Index of Biological Integrity (IBI) score to rate the health of the streams. All three sites had very poor IBI scores (1.29 to 1.57) based on the samples. Watersheds that contain higher amounts of impervious surface, such as College Creek, normally produce lower scores. IBI scores from Maryland Biological Stream Survey sites that were sampled from previous years in the Severn River watershed have ranged from very poor to good (1.57 to 4.71).

**Table 3-1: Macroinvertebrates Sampling in College Creek and Spa Creek (2007)**

| Taxa | Common Name | Site 1 | Site 2 | Site 3 |
|---|---|---|---|---|
| Asellidae | Sow bugs | 32 | 3 | 2 |
| Chironomidae | Midge flies | 13 | 62 | 14 |
| Crangonyctidae | Cave-dwelling amphipod | 27 | 6 | 0 |
| Dytiscidae | Predacious diving beetles | 2 | 14 | 12 |
| Hydrophilidae | Water scavenger beetles | 0 | 0 | 1 |

| Taxa | Common Name | Site 1 | Site 2 | Site 3 |
|---|---|---|---|---|
| Libelluliidae | Percher/skimmer dragonflies | 0 | 0 | 1 |
| Lumbriculidae | Oligochaete worms | 0 | 3 | 7 |
| Lymnaeidae | Pond snails | 0 | 0 | 2 |
| Physidae | Pond snails | 2 | 20 | 35 |
| Sciomyzidae | Marsh flies | 0 | 1 | 1 |
| Sphaeriidae | Fingernail clams | 3 | 5 | 23 |
| Tipulidae | Crane flies | 2 | 1 | 1 |
| Tubificidae | Oligochaete worms | 0 | 3 | 4 |
| **Number of Individuals** | | **81** | **118** | **103** |
| **Number of Taxa** | | **7** | **10** | **12** |
| **IBI Score** | | **1.29** | **1.57** | **1.57** |

Source: Friends of College Creek (2007)

### 3.2.2 Fish

Maryland Department of Natural Resources (MDNR) conducted fish surveys in the Severn River from 1989 through 1994. Fish that occur in the Severn River are influenced by the salinity, with freshwater fish dominating the fresher tidal headwater areas of the tributaries, and more salinity-tolerant marine fish in the major tidal waters. Of the 40 species captured during the surveys, most were estuarine residents; however, 12 species were marine migrants and 7 were primarily freshwater species. The most commonly observed fish included the inland silverside (*Menidia beryllina*), Atlantic menhaden (*Brevoortia tyrannus*), striped killifish (*Fundulus majalis*), striped bass (*Morone saxatilis*), mummichog (*Fundulus heteroclitus*), Atlantic silverside (*Menidia menidia*), bay anchovy (*Anchoa mitchilli*), Atlantic croaker (*Micropogonias undulatus*), white perch (*Morone americana*), and spot (*Leiostomus xanthurus*).

The 2007 College Creek Watershed Assessment surveyed for macrofaunal species via beach seine and observed 20 species of fish (Friends of College Creek, 2007). The most commonly observed fish along bulkhead shorelines included Atlantic menhaden, pumpkinseed (*Lepomis gibbosus*), Atlantic silverside, mummichog, white perch, striped killifish, bluefish (*Pomatomus saltatrix*), and Atlantic needlefish (*Strongylura marina*). The most commonly observed fish in the natural marsh were pumpkinseed and mummichog. Spot, stickleback (*Apeltes quadracus*), pipefish, and bay anchovy were only collected in the natural marsh.

**Table 3-2: Beach Seine Results in College Creek (July 2006)**

| Common Name | Scientific Name | Bulkhead Mean Density (#/m$^2$) | Natural Marsh Mean Density (#/m$^2$) |
|---|---|---|---|
| Atlantic menhaden | *Brevoortia tyrannus* | 1.50 | 0.0021 |
| Pumpkinseed | *Lepomis gibbosus* | 0.14 | 0.27 |
| Atlantic silverside | *Menidia* | 0.055 | 0.017 |
| Mummichog | *Fundulus heteroclitus* | 0.014 | 0.119 |
| White perch | *Morone americana* | 0.0059 | 0.0021 |
| Striped killifish | *Fundulus majalis* | 0.0041 | 0.0041 |
| Chain pickerel | *Esox niger* | 0.004 | 0.025 |
| Rainwater killifish | *Fundulus diaphanous* | 0.0021 | 0.0083 |
| Bluefish | *Pomatomus saltatrix* | 0.0021 | 0.00 |
| Atlantic needlefish | *Strongylura marina* | 0.0019 | 0.0019 |
| Spot | *Leiostomus xanthurus* | 0.00 | 0.0083 |
| Stickleback | *Apeltes quadracus* | 0.00 | 0.059 |
| Pipefish | *Syngnathus fuscus* | 0.00 | 0.0021 |
| Bay anchovy | *Anchoa mitchilli* | 0.00 | 0.0021 |

Source: Friends of College Creek (2007)

### 3.2.3 Submerged Aquatic Vegetation

Submerged aquatic vegetation (SAV) beds are considered Special Aquatic Sites under Section 404 of the Clean Water Act (40 CFR Part 230, Section 404 (b)(1)) and are an important resource in the Chesapeake Bay. SAV provide protection and nursery habitat for a broad range of aquatic organisms and contribute to the oxygenation of the water.

NSA Annapolis has not conducted surveys for SAV on or near the installation. However, ongoing mapping of SAV by organizations such as the Virginia Institute of Marine Science (VIMS), Chesapeake Bay Foundation, and local watershed groups such as Friends of College Creek have mapped SAV in several rivers and creeks along NSA Annapolis. The VIMS interactive SAV mapping tool was used to identify potential SAV in the vicinity of the Proposed Action. The VIMS interactive SAV mapping tool did not identify any SAV beds in College Creek from 2011 to 2019 (Figure 3-5).

**Figure 3-5: Submerged Aquatic Vegetation Map from VIMS (2011 – 2019)**

Source: Virginia Institute of Marine Science (2020) (2011-2019)
Green areas = Submerged aquatic vegetation (SAV) bed

Local mapping efforts in 2007, however, indicated that SAV occurred in College Creek but mostly limited to the upper portions of the creek (Figure 3-2). SAV species identified included horned pondweed (*Zannichellia palustris*), redhead grass (*Potamogeton perfoliatus*), sago pondweed (*Stuckenia pectinate*), the invasive Eurasian watermilfoil (*Myriophyllum spicatum*), widgeongrass (*Ruppia maritima*), and common waterweed (*Elodea canadensis*). SAV observations on two dates (May 15 and July 11, 2007) were reported by the Friends of College Creek (Figure 3-6). Observations on May 15, 2007 (yellow labels in Figure 3-2) noted horned pondweed as the most common SAV with dense beds of horned pondweed (Zp) in Peters Cove and the upper College Creek, sparse horned pond weed in a few other areas, and one piece of Eurasian watermilfoil (Ms). Observations on July 11, 2007 (blue labels in Figure 3-2) noted sparse beds of horned pondweed (Zp) in Peters Cove and upper College Creek; sparse widgeongrass (Rm) in two areas, sparse and dense redhead grass (Ppf) in three areas; and sparse Eurasian watermilfoil (Ms) in two areas. On both dates, no SAV was found in the lower College Creek to the east of King George Street Bridge except a single observation of sparse horned pondweed (Zp) (Friends of College Creek, 2007). Although water quality was observed to be better in this area, the presence of bulkhead and riprap shorelines and lack of suitable habitat precludes the presence of SAV (Friends of College Creek, 2007). As mentioned above, the VIMS interactive SAV mapping tool did not identify any SAV beds in College Creek from 2011 to 2019. Therefore, no SAV beds are anticipated to occur in the vicinity of the Proposed Action.

**Figure 3-6: Map of Submerged Aquatic Vegetation in College Creek (2007)**

Source: Friends of College Creek (2007)
Notes: Zp = horned pondweed; Ms = Eurasian watermilfoil; Rm = widgeongrass; Ppf = redhead grass

# 4.0 ESSENTIAL FISH HABITAT DESIGNATIONS

This chapter provides life history information for federally managed species with designated EFH, potential prey species of managed species, federally listed fish species, and migratory fish species.

## 4.1 Federally Managed Species

NOAA Fisheries works with the regional fishery management councils to identify the EFH for every life stage of each federally managed species using the best available scientific information. EFH designations emphasize the importance of habitat protection to healthy fisheries and serve to protect and conserve the habitat of marine, estuarine, and anadromous finfish; mollusks; and crustaceans. EFH includes both the water column (including its physical, chemical, and biological growth properties) and the underlying substrate (including sediment, hard bottom, and other submerged structures). Under the EFH definition, necessary habitat is that which is required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. EFH is designated for a species complete life cycle, including spawning, feeding, and growth to maturity, and may be specific for each life stage (e.g., eggs, larvae). EFH designations for some species have been defined for specific life stages based on their occurrence in tidal freshwater (<0.5 ppt), estuarine (mixing/brackish salinity zone [0.5 to 25.0 ppt) and marine (seawater salinity zone [>25 ppt]) waters and based on various levels of information available for a species life stage distribution, abundance, and habitat-productivity relationships. EFH includes all types of aquatic habitat including wetlands, coral reefs, seagrasses, and rivers, and all locations where fish spawn, breed, feed, or grow to maturity. EFH has been described for approximately 1,000 managed species to date.

EFH designations have been described based on 10-foot x 10-foot squares of latitude and longitude along coastal sections of the northeastern United States. For estuarine, riverine or other locations lying outside of that coastal grid, NOAA has provided species listings for major estuaries, bays or rivers. These listings were used to determine the fish species with designated EFH in College Creek near the Proposed Action. The NOAA listing for College Creek includes a total of 11 fish species, 24 life stages, and one Habitat Area of Particular Concern (HAPCs) (Table 4-1). Life history characteristics and available species information are provided below to evaluate species and life stage presence/absence in College Creek.

**Table 4-1: Essential Fish Habitat and HAPC Near Proposed Action**

| Common Name | Scientific Name | Eggs | Larvae | Juveniles | Adults | HAPC |
|---|---|---|---|---|---|---|
| Bluefish | *Pomatomus saltatrix* | — | — | Yes | Yes | — |
| Scup | *Stenotomus chrysops* | — | — | Yes | Yes | — |

| Common Name | Scientific Name | Eggs | Larvae | Juveniles | Adults | HAPC |
|---|---|---|---|---|---|---|
| Summer flounder | *Paralichthys dentatus* | — | Yes | Yes | Yes | Yes |
| Black sea bass | *Centropristis striata* | — | — | Yes | Yes | — |
| Atlantic butterfish | *Peprilus triacanthus* | Yes | Yes | — | Yes | — |
| Little skate | *Leucoraja erinacea* | — | — | — | Yes | — |
| Atlantic herring | *Clupea harengus* | — | — | Yes | Yes | — |
| Red hake | *Urophycis chuss* | Yes | Yes | Yes | Yes | — |
| Windowpane flounder | *Scophthalmus aquosus* | — | — | Yes | Yes | — |
| Winter skate | *Leucoraja ocellata* | — | — | — | Yes | — |
| Clearnose skate | *Raja eglanteria* | — | — | Yes | Yes | — |

Source: NOAA Fisheries(2020)
HAPC = Habitat Areas of Particular Concern; — = not EFH for the life stage or HAPC

### 4.1.1 Bluefish

College Creek is designated as EFH for juvenile and adult bluefish (*Pomatomus saltatrix*) (NOAA Fisheries, 2019). EFH for juvenile and adult bluefish includes the pelagic water column and inland within the mixing (0.5 to 25.0 ppt) and seawater (>25 ppt) salinity zones (Mid-Atlantic Fishery Management Council [MAFMC], 1998a).

Bluefish is a highly migratory, schooling, pelagic species that ranges in the western North Atlantic from Nova Scotia and Bermuda to Argentina, but it is rare between southern Florida and northern South America (Shepherd and Packer, 2006). Bluefish, a visitor to the Chesapeake Bay waters from spring to autumn, is abundant in the lower bay and common most years in the upper bay (Murdy et al., 1997).

Bluefish spawn offshore from Massachusetts through Florida. Discrete groups spawn at different times and are referred to by the season in which they spawn: the spring-spawned cohort and the summer-spawned cohort (ASFMC, 2018a). In the Chesapeake Bay area, peak spawning is in July over the outer continental shelf (Murdy et al., 1997). Eggs are pelagic and highly buoyant. Eggs are released in open ocean waters with temperatures ranging from 18 to 22 degrees Celsius (°C) and salinities greater than 31 ppt (MAFMC, 1998a). Larvae develop into juveniles in continental shelf waters and eventually move to estuarine and nearshore shelf habitats. Larvae are generally found close to the surface of oceanic waters with temperatures from 18 to 24°C and salinity levels in the range from 30 to 32 ppt. Larvae migrate to the surface at night and down as far as 4 m in daylight hours (ASFMC, 2018a).

As larvae develop into juveniles, they move into coastal oceans, bays, and estuaries of the Mid- and South Atlantic Bights, but are less common in the South Atlantic Bight. Juveniles typically inhabit estuaries from May to October, preferring temperatures between 20 to 30ºC, and salinities between 23 and 33 ppt

(Shepherd and Packer, 2006). Early juveniles (25 to 50 millimeters [mm]) enter the lower bay and its tributaries in late summer and early fall. Juveniles have been reported to intrude into waters with salinities as low as 3 ppt and temperatures as low as 15ºC. Juveniles generally prefer sandy bottom habitats, but will also inhabit bottoms with some mud, silt, and clay. Juvenile bluefish may also inhabit areas vegetated with *Ulva* (sea lettuce), *Zostera* (eelgrass) beds, and *Spartina* (marsh cord grass) or *Fucus* (brown seaweed) (ASFMC, 2018a). In early autumn, bluefish begin to migrate out of the bay and move along the coast (Murdy et al., 1997).

Adult and juvenile bluefish are found primarily in waters less than 20 m deep along the Atlantic coast. Adults use both inshore and offshore areas of the coast and favor warmer water temperatures, although they are found in a variety of hydrographic environments. Adults are not found in the Mid-Atlantic Bight when temperatures drop below 14 to 16°C.

Bluefish migrate in large schools following prey fish. Juvenile and adult bluefish primarily prey on pelagic fish, such as bay anchovy, Atlantic menhaden, Atlantic silversides, river herring, and striped bass (Shepherd and Packer, 2006; ASFMC, 2018a).

Bluefish were collected in low density (0.0021 $\#/m^2$) in College Creek at the bulkhead location during the beach seine sampling in 2007 (Friends of College Creek). However, their abundance in College Creek is anticipated to be low and restricted to a few transient individuals. This species is not an estuarine resident and would only use this area on a seasonal basis primarily for foraging by juveniles and adults. Bluefish is a highly migratory species that is only a seasonal visitor to the Chesapeake Bay in May through October and salinity in College Creek (6.5 to 12.5 ppt) is not preferred by juvenile and adult bluefish (> 23 ppt).

### 4.1.2 Scup

College Creek is designated as EFH for juvenile and adult scup (*Stenotomus chrysops*) (NOAA Fisheries, 2019). Inshore EFH for juvenile and adult scup includes the estuaries within mixing (0.5 to 25.0 ppt) and seawater (>25 ppt) salinity zones (MAFMC, 1998b).

Scup is a migratory, schooling, bottom-dwelling species found along the Atlantic coast in the Mid-Atlantic Bight from Massachusetts to South Carolina but have been reported as far north as the Bay of Fundy in southern Nova Scotia, and as far south as Florida (ASMFC, 2018b). Scup migrate to offshore, deeper winter habitats along the outer continental shelf south of New Jersey. Juveniles follow adults to wintering areas, although some remain in larger and deeper estuaries during warmer winters. Scup migrate to summering grounds in spring when water temperatures start to rise above 7°C (ASMFC, 2018b). Scup is a common to abundant visitor to the lower Chesapeake Bay from spring to autumn, extending as far north as the York River (Murdy et al., 1997).

Scup spawn once per year from May through August and peaking in June (ASMFC, 2018b). Spawning occurs in coastal waters, and both eggs and early larvae are pelagic until approximately 1.3 centimeters (cm) to 3.1 cm total length (MAFMC, 1998b). Spawning begins during the inshore migration when water temperatures are above 10°C, usually over weedy or sandy areas (ASMFC, 2018b). Most spawning occurs in southern New England from Massachusetts Bay south to the New York Bight. Eggs are pelagic and commonly found in large bodies of coastal waters in and near southern New England during spring and summer. Eggs and larvae are typically found in coastal waters with temperatures from 11ºC to 23°C (MAFMC 1998b). As larvae mature, they settle to the seafloor and develop into juveniles.

Most juvenile scup are found in waters with temperatures about 10°C in the spring and from 16 to 22°C from summer to fall (ASMFC, 2018b). Young of the year scup inhabit polyhaline waters of the Chesapeake Bay from June to October in water temperatures greater than 7°C and salinities greater than 15 ppt (Murdy et al., 1997; MAFMC, 1998b). Juvenile and adult scup live in a variety of intertidal and subtidal habitats such as rocky ledges; artificial reefs; mussel beds; sand, silty-sand, shell, and mud bottoms; and eelgrass. During the summer and early fall, juveniles and adults are common in most large estuaries, open sandy bottoms, and structured habitats such as mussel beds, reefs, or rock rubble (ASMFC, 2018b). Adults prefer waters with temperatures around 7°C but have been found in waters with temperatures ranging from 6 to 27°C. Dietary constituents of both juvenile and adult scup include benthic invertebrates and small fish. Scup are able to crush crabs, sea urchins, snails and clams with their strong molars (Murdy et al., 1997).

Juvenile or adult scup are not likely to inhabit College Creek. Although scup is common to abundant in the Chesapeake Bay, its northern range is up to the York River which is 120 miles south of NSA Annapolis. Furthermore, salinity in College Creek (6.5 to 12.5 ppt) is not preferred by juvenile and adult scup which ranges from 18 to 30 ppt.

### 4.1.3 Summer Flounder

College Creek is designated as EFH for larvae, juvenile and adult summer flounder (*Paralichthys dentatus*) (NOAA Fisheries, 2019). Inshore EFH for summer flounder larvae is within the mixing (0.5 to 25.0 ppt) and seawater (>25 ppt) salinity zones. EFH for juvenile and adult summer flounder includes bottom waters, including tidal guts. Juveniles may use estuarine habitats such as SAV beds and open bay areas as nursery areas, and adults generally inhabit shallow estuarine waters during warmer months.

Summer flounder is a left-sided, benthic flatfish that ranges from Nova Scotia to Florida. Summer flounder are most abundant in the Mid-Atlantic Bight from Cape Cod, Massachusetts to Cape Hatteras, North Carolina (ASMFC, 2018c). Summer flounder migrate annually between inshore, coastal, or estuarine summering grounds and offshore wintering grounds on the outer continental shelf. The timing of the seasonal migrations varies with latitude (ASMFC, 2018c). Most summer flounder visit the Chesapeake Bay from spring to autumn and are more common in the lower bay than in the upper bay, extending as far north as the Gunpowder River (Murdy et al., 1997).

Summer flounder spawn in the late fall and winter while they migrate offshore to wintering grounds, continuing through December in the northern parts of the range and up to March in the southern areas. Eggs are pelagic, buoyant, and most abundant between Cape Cod and Cape Hatteras. Eggs are commonly found in waters with temperatures between 14 and 17°C. Summer flounder larvae are pelagic and generally most abundant nearshore (12 to 50 miles from shore) at depths between 30 and 70 feet in the fall and from 10 to 30 feet in the spring (Packer et al., 1999). Larvae are transported to estuarine nursery areas by prevailing water currents for metamorphosis into juveniles. Larvae enter the Chesapeake Bay during October through May (Murdy et al., 1997). In the Mid-Atlantic Bight, larvae are found in the northern part from September to February, and in the southern part from November to May. Larval abundances typically peak in November in waters with temperatures between 9 to 18°C (ASMFC, 2018c).

Juveniles use estuarine marsh creeks, seagrass beds, mud flats, and open bay areas for habitat in water temperatures greater than 3 °C and salinities from 10 to 30 ppt range (MAFMC, 1998c). Juveniles are most abundant in areas with a predominantly sandy bottom or sand-shell substrate. Juveniles bury in the sediment. Burying behavior is influenced by substrate type, water temperature, time of day, tide, salinity, and predator and prey abundance. Adults spend most of their life on or near the sea bottom burrowing in the sandy substrate. Adults prefer sandy habitats, but are also found in marsh creeks, seagrass beds, and sand flats.

Adults and juveniles often feed in estuaries and shelf waters in the warmer months and are active during daylight hours as they are primarily visual feeders. Summer flounder larvae and juveniles are opportunistic feeders but primarily feed on crustaceans and polychaetes (Packer et al., 1999). Adult prey includes shrimp, mysids, anchovies, and Atlantic silversides.

Summer flounder larvae, juveniles or adults could potentially inhabit College Creek. However, their abundance is anticipated to be low. Summer flounder is a seasonal visitor to the Chesapeake Bay from spring to autumn and are more common in the lower bay than in the upper bay. Furthermore, salinity in College Creek (6.5 to 12.5 ppt) does not consistently provide the preferred salinities for juvenile and adult summer flounder (10 to 30 ppt).

### 4.1.4 Black Sea Bass

College Creek is designated as EFH for juvenile and adult black sea bass (*Centropristis striata*) (NOAA Fisheries, 2019). EFH for juvenile and adult black sea bass includes estuaries within mixing (0.5 to 25.0 ppt) and seawater (>25 ppt) salinity zones with temperatures warmer than 6°C (MAFMC, 1998d).

Black sea bass is a benthic, temperate reef fish that is strongly associated with structured habitats. Black sea bass is found from the Gulf of Maine to the Florida Keys and has two distinct stocks. The northern stock is distributed from the Gulf of Maine south to Cape Hatteras and the southern stock extends from Cape Hatteras south to the Gulf of Mexico (ASMFC, 2018d).

The northern stock migrates between inshore, coastal areas, and bays (in southern New England and the Mid-Atlantic Bight) and offshore wintering areas (from central New Jersey to North Carolina) due to changes in water temperature. In fall, when coastal bottom water temperatures decline and approach 7°C, black sea bass migrate offshore to wintering areas at depths of 240 to 540 feet. In spring, when bottom waters exceed 7°C, black sea bass move inshore to waters at depths of less than 120 feet (ASMFC, 2018d). The black sea bass is common in the mid-lower Chesapeake Bay from spring to late autumn, extending as far north as Solomons Island (Murdy et al., 1997).

Black sea bass is a protogynous hermaphrodite, functioning as a female at smaller sizes and younger ages, and then undergoing sexual succession to become a functional male when older and larger (MAFMC, 1998d; Murdy et al., 1997). Black sea bass spawn at depths ranging from 20 to 50 m on the inner continental shelf, generally between the Chesapeake Bay and Montauk Point, Long Island (ASMFC, 2018d). Spawning begins in June, peaks in August, and continues through October in the Mid-Atlantic Bight (Murdy et al., 1997). Eggs are pelagic, colorless, and spherical (Able and Fahay, 1998). Eggs and larvae are found in mid-shelf coastal waters from late spring to late summer. Larvae migrate to coastal waters and move to bottom habitats (ASMFC, 2018d).

Juveniles are found during summer and spring in estuaries with salinities greater than 18 ppt, and typically found in association with shallow, hard-bottom areas with structure that includes shellfish (oyster and mussels), sponge, amphipod tubes, submerged aquatic vegetation beds, cobble, and shoals as well as wharves, pilings, wrecks, artificial reefs, and crab and conch pots (MAFMC, 1998d; ASMFC, 2018d). Adults are usually associated with structured habitats including submerged aquatic vegetation, oyster and mussel beds, rocky reefs, cobble and rock fields, stone coral patches, and exposed clay and stone aggregate. Non-natural structures including artificial reefs, shipwrecks, piers, pilings, jetties, groins, fish and lobster traps, and rough bottom along the sides of navigation channels also serve as black sea bass habitat. Wintering adult black sea bass are typically found offshore (MAFMC, 1998d). Offshore winter habitats occupied by adults are poorly known (ASMFC, 2018d).

Black sea bass are opportunistic visual predators with a broad diet. Juvenile black sea bass prey upon benthic crustaceans, such as isopods, small crabs, shrimp and copepods (Steimle et al., 1999). Adult prey includes epibenthic invertebrates (mussels, razor clams), crabs, juvenile American lobster, small fish and squid (Steimle et al., 1999; ASMFC, 2018d).

Juvenile or adult black sea bass are not likely to inhabit College Creek. Although black sea bass is common in the mid-lower Chesapeake Bay from spring to late autumn, its northern range extends up to Solomons Island which is 50 miles south of NSA Annapolis. Furthermore, salinity in College Creek (6.5 to 12.5 ppt) is not preferred by juvenile and adult black sea bass which is greater than 18 ppt.

### 4.1.5 Atlantic Butterfish

College Creek is designated as EFH for eggs, larvae, and adult Atlantic butterfish (*Peprilus triacanthus*) (NOAA Fisheries, 2019). EFH for Atlantic butterfish eggs, larvae, and adults include pelagic habitats in inshore estuaries and embayments from Massachusetts to North Carolina, including the Chesapeake Bay. EFH for eggs is generally found over bottom depths of 1,500 m or less where average temperatures in the upper 200 meters of the water column are 6 to 21°C. Larvae EFH is within similar temperature ranges, and generally found over bottom depths between 41 and 350 m. EFH for juvenile Atlantic butterfish is generally found over bottom depths between 10 and 280 m where bottom water temperatures are between 6.5 and 27°C and salinities are above 5 ppt. Adult EFH is generally found over bottom depths between 10 and 250 m and where salinities are above 5 ppt (MAFMC, 2011).

Butterfish is a pelagic species that ranges on the Atlantic Coast from Nova Scotia to South Carolina and in deeper offshore waters as far south as Florida. Butterfish are most abundant from the Gulf of Maine to Cape Hatteras (Cross et al., 1999). Butterfish are fast-growing, short-lived, pelagic fishes that form loose schools, often near the surface (Cross et al., 1999). Butterfish migrate seasonally moving southward and offshore in the winter to avoid cooler waters and northward and shoreward to feed and spawn during the summer. They winter near the edge of the continental shelf in the Mid-Atlantic Bight and migrate inshore in the spring into southern New England and Gulf of Maine waters. During the summer, butterfish occur over the entire Mid-Atlantic shelf from sheltered bays and estuaries out to about 200 m. In late fall, butterfish move southward and offshore in response to falling water temperatures. Butterfish occurs in the Chesapeake Bay from March through November and is common to abundant in the lower bay and occasional in the upper bay extending as far north as the Patapsco River (Murdy et al., 1997).

Spawning occurs primarily over continental shelf waters in the Mid-Atlantic Bight between May and October, although some eggs and larvae have been collected in coastal and estuarine waters (Able and Fahay, 1998). Appropriate conditions for spawning include temperatures above 15ºC at depths between 3 and 145 m (Cross et al. 1999). Butterfish may spawn throughout their annual migration north and inshore as temperatures increase (Cross et al. 1999). Eggs and larvae are common in the high salinity zones of some estuaries in southern New England and the Mid-Atlantic Bight and in the mixing zone in Chesapeake Bay. Eggs are pelagic and spherical and reach a peak in July in the central part of the Mid-Atlantic Bight (Able and Fahay, 1998). Eggs are reported to be most abundant in water temperatures between 11 and 17ºC and can range in salinities from 25 to 33 ppt (Cross et al., 1999).

Larval, juvenile, and adult Atlantic butterfish are pelagic, occurring in the estuary and adjacent coastal areas during the fall. Larval, juvenile and adults occur in both shallow and deep waters (Cross et al. 1999). Atlantic butterfish are euryhaline (5 ppt to 32 ppt) and eurythermal (4.4ºC to 21.6ºC). Larvae are typically found at temperatures between 9ºC and 19ºC, depths less than 120 m, and salinity ranging between 6 ppt and 37 ppt. Juveniles and adults may congregate near the bottom during the day and disperse upwards at night. Juveniles and adults are typically found over sandy and muddy substrates at temperatures between 4ºC and 30ºC, depths ranging from 10 to 330 m, and salinity ranging between 3 ppt and 33 ppt. Adult and juvenile Atlantic butterfish form schools and are found over a range of sandy and muddy substrates (Cross et al., 1999). Atlantic butterfish are common in inshore areas, including the surf zone, and in high salinity and mixed salinity zones of bays and estuaries.

Butterfish primarily prey upon urochordates (tunicates) but may also feed upon a wide variety of planktonic cnidarians (jellyfish, hydroids, anemones), small fishes, copepods, amphipods, decapods and polychaetes (Cross et al., 1999). Juvenile and adults are preyed upon by haddock, silver hake, bluefish, swordfish, weakfish, goosefish, sharks, skates, and long-finned squid.

Butterfish eggs and larvae are not likely to inhabit College Creek. College Creek does not provide the preferred salinities for eggs and does not consistently provide the preferred salinities for larvae. Spawning occurs primarily over continental shelf waters and eggs are most abundant in salinities from 25 to 33 ppt. Larvae inhabit depths less than 120 m and salinity ranging between 6 ppt and 37 ppt. Butterfish are most common in the mixing zone of the lower bay from March through November and only occasional in the upper bay.

### 4.1.6 Little Skate

College Creek is designated as EFH for adult little skate (*Leucoraja erinacea*) (NOAA Fisheries, 2019). EFH for adult little skate includes intertidal and sub-tidal benthic habitat, extending to a maximum depth of approximately 330 feet, and including high-salinity zones (>25 ppt) in the Chesapeake Bay. EFH occurs primarily on sand and gravel substrates but also occasionally mud (New England Fishery Management Council [NEFMC], 2017).

Little skate is a small skate with very rounded diamond-shaped pectoral discs that are dark brown or grey with cloudy splotches, and white to grey undersides. The little skate occurs from Nova Scotia to Cape Hatteras and is one of the dominant members of the demersal fish community of the northwest Atlantic (Packer et al., 2003a). The little skate juveniles have been generally absent from the Chesapeake Bight in the summer months.

This species is typically found on sandy or gravely bottoms, but also on mud, and is often associated with particular microhabitat features during the day, including biogenic depressions and flat sand, but are randomly distributed at night (Packer et al., 2003a). Juvenile and adult skates can be found from shallow waters to 110 m in the Mid-Atlantic Bight. The preferred temperature range for little skate is generally 1ºC to 21ºC, although most are found between 2ºC and 15ºC. In the Delaware Bay, little skate have been collected at salinity ranges between 15 to 35 ppt, but most were found between 25 to 30 ppt. Little skate do not undertake extensive migrations, but they do move to shallower water during the summer and to deeper water in fall or early winter.

Little skate is incapable of persisting within College Creek and therefore will not be affected by the Proposed Action. The Proposed Action is entirely within the mixing-salinity zone of College Creek, which has a much lower salinity than preferred adult little skate habitat.

### 4.1.7 Atlantic Herring

College Creek is designated as EFH for juvenile and adult Atlantic herring (*Clupea harengus*) (NOAA Fisheries, 2019). EFH for juveniles include intertidal and sub-tidal pelagic habitats to 300 m. Young juveniles can tolerate low salinities, but older juveniles avoid brackish water. Older juveniles are usually found in water temperatures as high as 22°C in the Mid-Atlantic. EFH for adult Atlantic herring includes the seawater mixing (0.5 to 25.0 ppt) and seawater (>25 ppt) salinity zones of the Chesapeake Bay (NEFMC, 2017).

Atlantic herring is a pelagic, schooling, plankton-feeding species found in the Atlantic Ocean from Labrador to Cape Hatteras. Atlantic herring are found in the Chesapeake Bay during winter and spring and extend as far north as the Susquehanna flats, but more abundant in the lower bay (Murdy et al., 1997). Adult herring make extensive seasonal migrations between summer spawning grounds on Georges Bank and in the Gulf of Maine and overwintering areas in southern New England and the Mid-Atlantic region (Stevenson and Scott, 2005).

Atlantic herring deposit adhesive, demersal eggs in deep water (50 to 90 m) in areas with strong tidal currents on a variety of course substrates ranging from boulders, rocks, and gravel, to sand, shell fragments, and macrophytes (Stevenson and Scott, 2005). Herring do not spawn in the Chesapeake Bay. Eggs require water temperatures ranging from 7 to 15°C, depths from 5 to 90 m, and high-energy environments (well mixed water with currents of 1.5 to 3.0 knots) (ASMFC, 2018e). In the Georges Bank, egg beds are found at temperatures between 12 and 15ºC, at depths between 40 and 80 m, and at 32 ppt salinity (Reid et al., 1999). Larvae are pelagic and overwinter offshore and in coastal waters to metamorphose into juveniles in the spring. Larvae have been observed in depths up to 1,500 m but are generally found in depths in the 41 to 220 m range and temperatures below 12.5°C in the Gulf of Maine, Georges Bank, and southern New England (ASMFC, 2018e).

Juveniles and adult herring are pelagic and form large schools, feeding on planktonic organisms. In general, juveniles are commonly found in waters with temperatures from 2.5 to 14.5°C, depths between 4 to 300 m, and salinities ranging from 20 to 32 ppt. Adults occupy the same geographic range and similar habitats as juveniles, but typically prefer more saline waters (> 28 ppt) (ASMFC, 2018e).

Atlantic herring larvae primarily prey on copepods and a variety of planktonic organisms. Juveniles and adults prey on zooplankton including copepods, decapod larvae and larval mollusks (Stevenson and Scott, 2005).

Atlantic herring juvenile and adults are incapable of persisting within College Creek and therefore will not be affected by the Proposed Action. The Proposed Action is entirely within the mixing-salinity zone of College Creek, which has a much lower salinity than preferred juvenile and adult habitat.

### 4.1.8 Red Hake

College Creek is designated as EFH for eggs, larval, juvenile, and adult red hake (*Urophycis chuss*) (NOAA Fisheries, 2019). EFH for eggs and larvae include surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the Mid-Atlantic south to Cape Hatteras. EFH for juveniles includes bottom habitats with a substrate of shell fragments, including areas with an abundance of live scallops, in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the Mid-Atlantic south to Cape Hatteras. EFH for adults includes benthic habitats in depressions with a substrate of sand and mud in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the Mid-Atlantic south to Cape Hatteras (NEFMC, 1998).

Red hake is a relatively short-lived, demersal fish that occurs from North Carolina to Southern Newfoundland and is most abundant between Georges Bank and New Jersey (Sosebee, 1998; Able and Fahay, 1998). Red hake make seasonal migrations to follow preferred temperature ranges. During warmer months, hake are most common in depths less than 100 m while in the colder months, most common in depths greater than 100 m (Steimle et al., 1998). Red hake is a seasonal visitor to Chesapeake Bay, sometimes common in the lower bay during late winter and spring and occasionally found in the upper bay as far north as the Patuxent River (Murdy et al., 1997).

Spawning occurs on the continental shelf, at temperatures between 5 and 10ºC and is most abundant in May and June in the New York Bight (Steimle et al., 1999). Spawning occurs in the Mid-Atlantic Bight between April and October (Able and Fahay, 1998). There is a strong peak in spawning activity during late June and July off Maryland and northern Virginia (Able and Fahay, 1998). Spawning red hake adults are generally found in water temperatures below 10°C, water depths less than 100 m and salinity less than 25 ppt. Red hake eggs are pelagic and are approximately 0.6 to 1.0 mm in diameter (Steimle et al., 1999). Eggs tend to be restricted to the deeper marine (seawater zone) area (Able and Fahay, 1998). Eggs are found in temperatures below 10ºC and salinities of 25 ppt or less (Steimle et al., 1999). Red hake larvae are pelagic and have been collected from the mid- to outer-continental shelf of the Mid-Atlantic Bight at temperatures between 8 and 23ºC and in water depths of 200 m or less (Steimle et al., 1999). Larvae prefer salinities greater than 0.5 ppt (NMFS, 2003a).

Juvenile red hake are pelagic, becoming demersal after reaching 23 to 49 mm in length. Juveniles seek shelter along the continental shelf bottom among protective structure but are most commonly associated with sea scallop beds. Juveniles remain associated with sea scallop beds through their first fall and winter (until they are approximately 90 mm to 116 mm in length), and then occupy either estuarine or inshore marine waters over sand or mud substrate, prior to joining adults in the offshore migration during their second winter. Red hake juveniles are found in water temperatures below 16° C, depths less than 100 m and a salinity range from 31 to 33 ppt (NEFMC, 1998). Adult red hake EFH includes bottom habitats of sand, muddy sand, mud and gravel substrate, between water depths of 10 to 130 m (Steimle et al., 1998). Adults are typically found in water temperatures below 12°C and a salinity range from 33 to 34 ppt (NEFMC, 1998).

Larval red hake typically feed on copepods. Juveniles prey on benthic and pelagic crustaceans, such as shrimp, mysids, euphausiids and amphipods (Steimle et al., 1998). Adults have similar diets to juveniles and also consume pelagic fish and squid.

Red hake eggs, larvae, juvenile and adults are not likely to be present in College Creek. This species is a seasonal visitor to the Chesapeake Bay, present during late winter and spring in the deep channels of the bay. Red hake is only occasionally in the upper bay extending as far north as the Patuxent River, which is approximately 45 miles south of NSA Annapolis. Red hake eggs and larvae are found in pelagic habitats but are not typically found within Chesapeake Bay estuaries and embayments. Eggs are spawned offshore on the continental shelf and larvae and juveniles inhabit the mid- to outer-continental shelf. Adult red hake EFH includes the seawater-salinity zone of the Chesapeake Bay (NEFMC, 2017). The Proposed Action is entirely within the mixing-salinity zone of College Creek, which has a much lower salinity than preferred red hake habitat.

### 4.1.9 Windowpane Flounder

College Creek is designated as EFH for juvenile and adult windowpane flounder (*Scophthalmus aquosus*) (NOAA Fisheries, 2019). EFH for juvenile and adult windowpane flounder includes bottom habitats with a substrate of mud and fine-grained sand, water temperatures below 77 degrees Fahrenheit, and salinities between 5.5 and 36 ppt (mixing- and high-salinity zones) within the Chesapeake Bay (NEFMC, 2017).

The windowpane is a left-eyed flounder with a thin body and nearly round outline. The windowpane is a eurythermal, euryhaline, and fast-growing fish occurring from the Gulf of Saint Lawrence to Florida but is most abundant from Georges Bank to Chesapeake Bay (Chang et al., 1999). They occur in most of the bays and estuaries south of Cape Cod, including Chesapeake Bay, Delaware Bay, Sandy Hook Bay, Raritan Bay, Long Island Sound, and Narragansett Bay (Chang et al., 1999). Windowpane generally inhabit shallow waters (< 110 m) with sand to sand/silt or mud substrates. They are most abundant from depths of 1 to 2 m to depths greater than 56 m. Windowpane is a year-round resident of the Chesapeake Bay that is occasional to common in the upper bay and common to abundant in the lower bay (Murdy et al., 1997).

Spawning occurs from spring to autumn with a possible hiatus during the warmest winter months (Murdy et al., 1997). Spawning occurs from February through November in coastal, inner continental shelf waters peaking in the mid-Atlantic Bight during May (Able and Fahay, 1998). Preferred temperatures for spawning range from 6 to 21ºC (Chang et al., 1999). Eggs are buoyant and spherical with a diameter of 0.9 to 1.4 mm (Able and Fahay, 1998). Eggs are typically found in planktonic habitats, less than 70 m deep and at temperatures between 6 and 14ºC in the spring, 10 and 16ºC in the summer and 14 and 20ºC in autumn (Chang et al., 1999). Larvae are pelagic and settle to the bottom at approximately 10 mm to 20 mm total length and occur in the polyhaline portion of the estuary, primarily in spring (Able and Fahay, 1998).

Juveniles and adults inhabit nearshore bays and estuaries at depths less than 75 m and prefer bottom habitats of mud or fine-grained sand. Juveniles and adults are typically found at bottom temperatures less than 24ºC, and salinity between 15 ppt and 33 ppt (Chang et al., 1999).

Windowpane commonly feed on epibenthic invertebrates as juveniles and on epibenthic invertebrates and fish as adults. Juvenile windowpanes prey on polychaetes and small crustaceans, especially mysids. They can be eaten by adults of own and other species (spiny dogfish, thorny skate, goosefish, cod). Adult windowpanes diet consists of polychaetes, small crustaceans (mysids, decapod shrimp) and various small fishes (hakes, tomcod). Windowpane juvenile and adults are eaten by adults of various fishes (spiny dogfish, thorny skate, goosefish, cod).

Windowpane is a year-round resident of the Chesapeake Bay and could potentially inhabit College Creek. However, their abundance in College Creek is anticipated to be low and restricted to a few transient individuals because they are only occasionally present in the upper bay. Furthermore, the salinity in College Creek (6.5 to 12.5 ppt) is not preferred by juvenile and adult summer flounder (15 ppt to 33 ppt).

### 4.1.10 Winter Skate

College Creek is designated as EFH for adult winter skate (*Leucoraja ocellata*) (NOAA Fisheries, 2019). EFH for adult winter skate includes sub-tidal benthic habitats in coastal waters from the shoreline to a maximum depth of approximately 79 m, including the high-salinity zones of the Chesapeake Bay. EFH occurs on sand and gravel substrates, but this species is also found on mud (NEFMC, 2017).

The winter skate occurs from the south coast of Newfoundland and the southern Gulf of St. Lawrence to Cape Hatteras. It is an occasional winter to springtime visitor to the southern Chesapeake Bay (Murdy et al., 1997). Egg cases are produced throughout the range but greatest numbers from summer to autumn. Winter skate are typically found on sandy or gravelly bottoms, but it was also reported on mud bottoms (Murdy et al., 1997; Packer et al., 2003b). Winter skate remains buried in depressions during the day and are more active at night. Winter skate can be found from shallow waters to 371 m in the Mid-Atlantic Bight but are more abundant at depths less than 110 m. In the Hudson-Raritan Estuary, winter skate are found in waters from about 4 to 22 m in depth but occur mostly around 5 to 8 m during a good part of the year. The temperature range of winter skate is generally -1.2ºC to 19ºC (Packer et al., 2003b). Winter skate can tolerate salinity ranges between 20 ppt and 35 ppt but the majority are between 32 and 33 ppt.

Juvenile and adult winter skate’s most important prey in terms of numbers or occurrence are polychaetes and amphipods, followed by decapods, isopods, bivalves, and fish. In terms of weight, amphipods, decapods and fish can be most important. Fish are especially dominant in larger skates (Packer et al., 2003b). Predators of winter skate include sharks, other skates, gray seals, and gulls.

Winter skate adults are incapable of persisting within College Creek and therefore will not be affected by the Proposed Action. The Proposed Action is entirely within the mixing-salinity zone of College Creek, which has a much lower salinity than preferred adult habitat.

### 4.1.11 Clearnose Skate

College Creek is designated as EFH for juvenile and adult clearnose skate (*Raja eglanteria*) (NOAA Fisheries, 2019). EFH for adult clearnose skate includes sub-tidal benthic habitats in coastal waters from the shoreline to approximately 130 feet, including the high-salinity zones of the Chesapeake Bay. EFH occurs primarily on mud and sand but also gravelly and rocky bottoms (NEFMC, 2017).

The clearnose skate inhabits coastal areas along the eastern U.S. coast from the Nova Scotian Shelf to northeastern Florida as well as in the northern Gulf of Mexico from northwestern Florida to Texas. Clearnose skate are abundant seasonal visitors to the lower Chesapeake Bay during summer and fall. In autumn, they leave the embayments and shallow areas to move offshore and southward (Murdy et al., 1997).

The clearnose skate is typically found on soft bottoms along the continental shelf, but also occurs on rocky or gravelly bottoms. They are most abundant at depths less than 111 m (Packer et al., 2003c). Clearnose skate inhabit waters with a temperature between 9 and 30ºC (most abundant between 9 and 20ºC in northern part of its range) and salinities between 20 and 36 ppt (Packer et al. 2003c). Clearnose skate have a variable diet that includes polychaetes, amphipods, mysid shrimp and other invertebrates as well as small fishes such as soles, weakfish, butterfish, and scup (Packer et al., 2003c).

Clearnose skate juveniles and adults are incapable of persisting within College Creek and therefore will not be affected by the Proposed Action. The Proposed Action is entirely within the mixing-salinity zone of College Creek, which has a much lower salinity than preferred adult habitat.

### 4.1.12 Managed Species Summary

Of the 11 NOAA listed fish species with designated EFH, bluefish, summer flounder, and windowpane flounder juveniles and adults are likely to inhabit College Creek and have the potential to be affected by the Proposed Action because they can occur in the range of temperatures and salinities within College Creek for at least part of the year. Five of the species are incapable of persisting within College Creek due to the low salinity levels of the creek as compared to the preferred higher, seawater salinities: Atlantic herring, clearnose skate, little skate, red hake, and winter skate. The remaining three fish species (scup, black sea bass, and Atlantic butterfish), are not likely to inhabit Collect Creek because College Creek is located north of their geographic range and/or College Creek does not consistently provide the preferred habitat (water temperature, salinity, and depth) for their designated life stages.

### 4.1.13 Habitat Area of Particular Concern

HAPCs are subsets of EFH that merit special considerations to conserve the habitat. These habitat conditions are listed in the EFH Guidelines (50 CFR 600.815(a)(8)) and summarized as: 1) the importance of the ecological function provided by the habitat; 2) the extent to which the habitat is sensitive to human-induced environmental degradation; 3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and 4) the rarity of the habitat type.

HAPC was designated for summer flounder in College Creek. All native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, including loose aggregations, within adult and juvenile summer flounder EFH is considered designated HAPC. However, SAV beds have not been observed by VIMS since 2011 and only one observation of horned pondweed was observed east of the King George Street Bridge (Friends of College Creek, 2007; VIMS, 2020). Therefore, designated HAPC is not anticipated to exist in College Creek or anticipated to be affected by the Proposed Action.

## 4.2 Potential Prey Species of Managed Species

For the assessment of indirect effects of the Proposed Action, forage species are included because of their importance in maintaining the stocks of managed (and non-managed species). All of these species are anticipated to inhabit College Creek. These species also represent important components of the aquatic life community of College Creek because of their generally wide distribution and abundance. Life history information for these species is provided below.

### 4.2.1 Atlantic Croaker

Atlantic croaker is a small, bottom-feeding sciaenid (a member of the drum family) commonly found in U.S. coastal waters from New Jersey to Florida (ASMFC, 2015a). Atlantic croaker is one of the most abundant inshore demersal fish along the southeastern coast of the U.S, found over mud and sandy mud bottoms in coastal waters to about 100 m depth and in estuaries where the nursery and feeding grounds are located (Murdy et al., 1997; VIMS, 2021a).

Atlantic croaker spawn in tidal inlets, estuaries, and on the continental shelf at depths ranging from 7 to 81 m and temperatures ranging from 16 to 25°C (ASMFC, 2015a). Atlantic croaker has a relatively long spawning season beginning in late summer to early spring, with peaks in late fall and winter. Females release between 100,000 and 2 million eggs, each about 0.35 mm in diameter (Texas Parks and Wildlife, 2021).

Atlantic croaker post-larvae inhabit estuarine areas often associated with shallow marsh habitats. Juvenile fish often prefer deeper tidal creeks where salinity changes are usually less than in shallow flats and marsh creeks (ASMFC, 2015a). As they grow larger, Atlantic croaker move seaward towards higher salinity environments. Adults occur in water temperatures ranging from 5 to 36°C and salinities between 0.2 and 70 ppt but are most common in waters with salinities from 6 to 20 ppt (ASMFC, 2015a). Adults prefer muddy and sandy substrates in waters shallow enough to support submerged aquatic plant growth and offers protection from predators (ASMFC, 2015a).

### 4.2.2 Atlantic Menhaden

The Atlantic menhaden is a seasonally abundant clupeid, occurring in large schools in coastal bays and estuaries. On the Atlantic coast, Atlantic menhaden inhabit nearshore and inland tidal waters from Nova Scotia, Canada to Florida (Murdy et al., 1997). Atlantic menhaden migrate seasonally along the Atlantic coast from Maine to central Florida, moving north through the Mid-Atlantic Bight during spring and south during fall to overwinter in waters south of Cape Hatteras (Able and Fahay 1998). Atlantic menhaden are common to abundant in all salinities throughout Chesapeake Bay in spring, summer, and autumn but move to south to deeper water during the winter months (Murdy et al., 1997).

Atlantic menhaden primarily spawn at sea in continental shelf waters along the U.S. Atlantic coast (ASMFC, 2018f). Spawning occurs from May to March and then again in September to October in shelf waters of the Chesapeake Bay (Murdy et al., 1997). Eggs are pelagic and spherical with diameters from 1.3 to 1.9 mm. Larvae hatch at 2.4 to 4.5 mm and are transported by ocean currents to estuaries where they transform into juveniles (Able and Fahay 1998). Juveniles occur in unconsolidated bottom habitats mostly consisting of sand and mud, with various mixtures of organic material (ASMFC, 2018f). Large schools of juveniles inhabit estuaries during the summer before migrating offshore in the fall. Adults prefer water temperatures near 18°C, tolerate a wide-ranging salinity (1 ppt to 36 ppt), and habitats with sand, mud, and organic material to marine sand and mud (ASMFC, 2018f; Able and Fahay, 1998; Ahrenholz et al., 1989).

Atlantic menhaden larvae feed on zooplankton, primarily copepods. Adults are strictly filter feeders and graze on phytoplankton and small zooplankton, including small annelid worms, decapod larvae, and rotifers (Ahrenholz et al., 1987).

### 4.2.3 Atlantic Silverside

Atlantic silversides are small schooling fish that inhabit tidal marshes, seagrass bed and shallow shore areas from the southern Gulf of St. Lawrence to Florida (Able and Fahay, 1998). The Atlantic silverside is one of the most abundant fishes in the bay, occurring in dense schools and represent an important prey resource for larger predatory fishes, including striped bass, bluefish, and weakfish (Murdy et al., 1997).

Spawning occurs in large schools at temperatures between 9ºC and 12°C during daytime high tides (Murdy et al., 1997). Eggs are deposited in the intertidal zone at depths ranging from 1.5 to 1.8 m above the mean low water mark on stems or roots of salt marsh cordgrass (*Spartina alterniflora*) or on mats of detritus (Conover and Kynard, 1984). The benthic eggs are spherical and adhesive and range from 1.0 to 1.5 mm in diameter (Able and Fahay, 1998). In the Chesapeake Bay, Atlantic silverside larvae were present throughout low salinity areas of upper bay, from April through December. Larvae were most abundant in surface waters less than 3 m and at salinities of 8 or 9 ppt (Dovel, 1971). Larvae, and juveniles remain in estuary areas or the coastal surf zone throughout most of the year (Conover and Murawski,1982). Habitat preferences include sand and gravel substrates, salt marshes and eelgrass beds. Atlantic silversides tolerate a wide range of temperature and salinity conditions, but are most commonly encountered from 7ºC to 31ºC and 4 ppt to 36 ppt. During winter months, Atlantic silverside migrate out of estuaries and occupy deeper coastal waters (Conover and Ross, 1982).

Atlantic silverside are opportunistic omnivores, feeding on a variety of available organisms including amphipods, copepods, cladocerans, fish eggs, mysid shrimp, young squid, molluscan larvae, annelid worms, and insects. Plant food may include algae, diatoms, and detritus. Predators include large predatory fish such as bluefish, mackerel and striped bass, as well as shorebirds such as egrets, gulls and cormorants (Chesapeake Bay Program, 2021).

### 4.2.4 Bay Anchovy

Bay anchovy is a small schooling coastal species that occurs from the Gulf of Maine to Florida and throughout the Gulf of Mexico (Murdy et al., 1997; Able and Fahay, 1998). It is one of the most abundant species in Atlantic coast estuaries and is an important prey resource for larger, predatory fishes, including bluefish, striped bass, and weakfish.

Bay anchovy is abundant throughout the Chesapeake Bay and lower reaches of its tributaries in salinities of 1 to 33 ppt (Murdy et al., 1997). Spawning occurs in the Chesapeake Bay from late April through late September with a peak in July. Spawning typically occurs in estuaries at night where water temperatures are at least 12ºC and salinities are greater than 10 ppt (Murdy et al., 1997). Eggs are slightly oval to spherical and range from 0.8 to 1.3 mm (Able and Fahay, 1998). Juveniles and adults are abundant in a variety of coastal habitats, including near-shore waters off sandy beaches, SAV beds, and shallow to deep offshore waters (Morton, 1989). Juvenile and adult bay anchovy are pelagic, tolerant of a wide range of salinity (1 to 33 ppt) and temperature, and commonly found in depths ranging from 1 to 37 m (Murdy et al., 1997).

### 4.2.5 Spot

Spot is a medium to small sized fish found in estuarine and coastal waters along the U.S. Atlantic coast from the Gulf of Maine to Florida but are most abundant from the Chesapeake Bay to South Carolina (Murdy et al., 1997). Spot are largely demersal but since they occur mostly in shallow estuarine habitats, they utilize the entire water column, particularly around vertical structure (ASMFC, 2015b).

Spawning occurs in offshore coastal waters in late fall to early spring, with a peak in February (Murdy et al., 1997; Able and Fahay, 1998). Spot eggs are pelagic, spherical and range from 0.72 to 0.87 mm in diameter. Larvae are 1.6 to 1.7 mm at hatching (Able and Fahay, 1998). Larval development occurs in continental shelf waters. Larvae are then transported into low salinity tidal creeks where they develop into juveniles (ASMFC, 2015b). Primary nursery habitat includes low salinity bays and tidal marsh creeks with mud and detrital bottoms and eelgrass beds in the Chesapeake Bay and North Carolina.

Spot migrate seasonally between coastal and estuarine waters. Adults and juveniles enter the Chesapeake Bay during the spring and remain until fall, when they migrate to south of Cape Hatteras (Murdy et al., 1997). Adult spot occurs in a wide range of temperatures (1 to 37°C) and salinities (< 1 ppt up to 60 ppt) (ASMFC, 2015b) and found over sandy or muddy bottoms in coastal waters to about 60 m (VIMS, 2021b). Their diet includes mainly benthic worms, small crustaceans, and organic detritus.

### 4.2.6 White Perch

White perch is a medium to small sized fish found in estuarine and coastal waters along the U.S. Atlantic coast from Nova Scotia to South Carolina but most abundant from Hudson River to Chesapeake Bay

(Murdy et al., 1997). The white perch is an abundant year-round resident found in all tributaries of the Chesapeake Bay from Havre de Grace, Maryland to Cape Henry, Virginia.

Spawning occurs in brackish and freshwater areas during late March to early June after a migration from deeper, wintering habitats. In the Chesapeake Bay, spawning peaks at temperatures of 10 to 16°C over beds of fine gravel or sand (Able and Fahay, 1998). The eggs are spherical, demersal, and adhesive with diameters that range from 0.75 to 1.04 mm. The adhesive eggs attach to the substrate or objects on the bottom in still water but may drift with currents (Mansueti, 1964; Able and Fahay, 1998). Larvae hatch at about 2.6 mm and drift downriver from the spawning area and move inshore as they develop into juveniles (Able and Fahay, 1998). In the Chesapeake Bay, juvenile and adult white perch are present from spring through autumn on flats and in channels and then move to deep channels in the winter with depths between 12 and 18 m and in temperatures between 2 and 5°C (Murdy et al., 1997; Able and Fahay, 1998). White perch are ubiquitous in estuaries and freshwater ecosystems, usually inhabiting waters with salinities less than 18 ppt (VIMS, 2021c).

White perch are carnivores whose dietary constituents change with age and habitat. Juveniles feed on aquatic insects and small crustaceans, whereas larger white perch prey on crabs, shrimps and small fishes (Murdy et al., 1997).

## 4.3 Federally Listed Fish Species

A list of species protected under the Endangered Species Act that may potentially be present within the vicinity of the Proposed Action was obtained from the U.S. Fish and Wildlife Service (USFWS) through their Information for Planning and Consultation (IPaC) tool (USFWS, 2020). The only species listed as potentially occurring in the vicinity of the Proposed Action was the northern long-eared bat (*Myotis septentrionalis*), a federally threatened species. No protected fish species were listed.

Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and shortnose sturgeon (*Acipenser brevirostrum*), both listed as a federally endangered species, are present in the Chesapeake Bay and some of its tributary rivers but are unlikely to be present in College Creek or the Severn River. EFH is not designated for Atlantic sturgeon in College Creek or Severn River; however, these species have been included in this assessment. The following provides a summary of their life history.

### 4.3.1 Atlantic Sturgeon

Atlantic sturgeon is an anadromous fish with brown, tan or bluish-black body, whitish belly, and five rows of bony plates (called scutes) that cover its head and body. It is primarily a marine species found close to shore but migrates into freshwater to spawn. Atlantic sturgeon inhabits large rivers and coastal waters from Maine to Florida and are currently present in 22 of the 38 historical rivers known to have sturgeon populations along the Atlantic coast of the U.S. (NOAA Fisheries, 2021a).

Atlantic sturgeon is anadromous, migrating from the ocean into coastal estuaries and inland rivers to spawn (USFWS, 2021). Spawning occurs in flowing, tidal freshwater regions of large estuaries, or far upstream in inland freshwater, in waters where the temperatures range from 13.2 to 26°C (ASMFC, 2018g). Spawning intervals range from 1 to 5 years for males and 2 to 5 years for females, with males returning almost every year and females usually returning every other year or every third year (NOAA Fisheries 2021a). Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces such as boulders, cobble gravel, coarse sand, and bedrock outcrops in rapids (ASMFC, 2018g; USFWS, 2021). Most juveniles remain in their river of birth (natal river) for at least several months before migrating out to the ocean. Juveniles have been found mostly in deep, brackish (> 3 ppt) waters over sand substrates, but also over rocks, cobble, and mud (ASMFC, 2018g).

They are among the longest-lived fish, with a life span thought to up to 80 years, but average approximately 60 years or greater (NOAA Fisheries, 2021a). They are benthic omnivores that dig in the sand or mud for marine invertebrates, shrimp, and other prey (NOAA Fisheries, 2021a)

There is a small spawning population in Virginia’s James River and York River, approximately 140 miles and 120 miles south of NSA Annapolis, respectively. Spawning is not known to occur in Maryland waters (MDNR, 2020). The Atlantic sturgeon Chesapeake Bay Distinct Population Segment is federal- and state-listed as endangered. The Chesapeake Bay Distinct Population Segment includes five critical habitat units for the species: Potomac River, Rappahannock River, York River system (including Pamunkey and Mattaponi Rivers), James River, and Nanticoke River/Marshyhope Creek (NMFS, 2017). The species has not been found in the Severn River and is unlikely to inhabit College Creek near the Proposed Action.

### 4.3.2 Shortnose Sturgeon

Shortnose sturgeon is an anadromous fish with yellowish-brown and generally have a black head, back, and sides. Their bellies are white to yellow-brown, and they have five rows of bony plates that cover its head and body. The shortnose sturgeon currently inhabits 41 rivers and bays from St. John’s River, New Brunswick to St. John’s River, Florida (NOAA Fisheries, 2021b; Murdy et al., 1997). Unlike Atlantic sturgeon, the shortnose sturgeon generally occupies freshwater to low salinity brackish water reaches of its natal river and estuaries, remaining primarily in deep river channels (Dadswell et al., 1979).

Spawning adults generally migrate upriver in spring from April to May in the Mid-Atlantic Bight and spawn in swift water over rocky substrates (NOAA Fisheries, 2021b; Murdy et al., 1997). Spawning intervals are about 1 to 2 years for males and every 3 to 5 years for females. After spawning, the adults typically move quickly back downstream to the lower river and estuaries. Juveniles move downstream and live in brackish waters for a few months. Shortnose sturgeon are benthic feeders and mostly feed at night (Murdy et al., 1997). Adults are reported to feed on insects, crustaceans, and mollusks (Bain, 1997). In winter, shortnose sturgeon generally remain in deeper channel waters to feed, with feeding occurring on an infrequent basis.

This species has been collected in the upper Chesapeake Bay in the lower Susquehanna River, and it is possible that shortnose sturgeon have entered the upper bay via the Chesapeake and Delaware canal from the Delaware River, where a well-documented population exists (Murdy et al., 1997). Shortnose sturgeon are primarily found near the Chesapeake Bay in the freshwater and brackish waters of the Potomac and Susquehanna Rivers, approximately 110 miles south and 45 miles north of NSA Annapolis, respectively. This species has not been found in the Severn River or its tributaries and is unlikely to inhabit College Creek near the Proposed Action.

## 4.4 Migratory Fish Species

Diadromous is a general category of migratory fish that spend portions of their life cycles partially in fresh water and partially in salt water. Diadromous fish are represented by both anadromous and catadromous fish. True anadromous fish spend most of their adulthood in the ocean but migrate from the ocean to spawn in freshwater rivers or sometimes in the brackish upper reaches of an estuary. Catadromous fishes spawn in the marine environment and move to the riverine environment to mature over a several-year period.

Anadromous species annually migrate from the ocean into the coastal tributaries of the Chesapeake Bay, including the Severn River watershed. Anadromous species evaluated in this assessment are the following: alewife (*Alosa pseudoharengus*), blueback herring (*A. aestivalis*), American shad (*A. sapidissima*), hickory shad (*A. mediocris*), and striped bass. The only catadromous species evaluated in this assessment is the American eel (*Anguilla rostrata*). All of these species are anticipated to inhabit College Creek. The following provides life history information for migratory species with the potential to inhabit College Creek near the Proposed Action.

### 4.4.1 Alewife and Blueback Herring

Alewife and blueback herring are similar anadromous, euryhaline, coastal, pelagic fish that occur in similar habitat and are difficult to distinguish from one another (Bigelow and Schroeder, 1953; Collette and Klein-MacPhee, 2002). They are often grouped together under the common name “river herring”.

Alewife and blueback herring comprise the once commercially important river herring fishery and are important prey items for federally managed fish species, including bluefish, summer flounder, and windowpane.

Alewife occur in riverine, estuarine, and western Atlantic coastal waters from northeastern Newfoundland to North Carolina (ASMFC, 2015c; Murdy et al., 1997). Alewives form large schools during their upstream spring spawning migrations from the ocean into coastal rivers. Spawning migrations occur in a south-to-north progression as water temperatures warm in the spring and there is a high degree of fidelity to their natal stream. Alewife enter the Chesapeake Bay in the spring to spawn in late March and April in large rivers, small streams, and ponds. Spawning sites are shallow (usually less than 1 m) in slow-moving water over a variety of substrates including hard sand, gravel and stone (Murdy et al., 1997; Able and Fahay, 1998). Spawning begins at temperatures between 13 and 15°C and ends when waters are warmer than 27°C (Able and Fahay, 1998). Eggs are semipelagic (float near the bottom), moderately adhesive and range from 0.8 to 1.27 mm in diameter. Larvae hatch at 2.5 to 5.0 mm in total length and become juveniles at approximately 20 mm (Able and Fahay, 1998). After spawning, adults return to sea while young-of-year remain in fresh water for several months before gradually descending to the ocean by their first autumn (Bigelow and Schroeder, 1953; Neves, 1981). In the Chesapeake Bay, juveniles can be found among SAV beds (ASMFC, 2015c). Juveniles emigrate from fresh to brackish water in waves during late summer to fall (Able and Fahay, 1998). Juveniles have been shown to prefer temperatures between 20 and 22°C and salinities of 4 to 6 ppt. Alewife diet consist of diatoms, copepods, ostracods, shrimp, amphipods, insects, small fishes, squids and fish eggs (Murdy et al., 1997).

Blueback herring range from Cape Breton, Nova Scotia south to St. John’s River, Florida (ASMFC, 2018h; Murdy et al., 1997). Blueback herring in the Chesapeake Bay are most abundant in the tributaries of the Chesapeake Bay, in the Delaware River, and in adjacent offshore waters (ASMFC, 2018h). Blueback herring is similar to alewife in its ecology and life history. They attain about the same size as the alewife, grow and mature in saltwater, migrate in spring to spawn in freshwater, and consume the same diet as the alewife. Their breeding habits differ from the alewife in that by spawning later in the spring (April and May) and by preferring to spawn at night in swift-flowing, deeper stretches of rivers and streams (Murdy et al., 1997). Brackish and tidal areas are rarely used. Spawning can occur in temperatures as low as 14°C but optimum temperatures are between 21 and 24°C. Similar to alewife, eggs are semipelagic, moderately adhesive, and range from 0.87 to 1.11 mm in diameter (Able and Fahay, 1998). Larvae hatch at 3.1 to 5.0 mm and become juveniles at about 20 mm in length. Juveniles spend 3 to 9 months in their natal rivers before moving downstream to the ocean in response to declining water temperatures beginning in late summer (ASMFC, 2015c).

### 4.4.2 American Shad

American shad are an anadromous, highly migratory, coastal pelagic, schooling species that spend the majority of their life in the ocean. American shad occur along the Atlantic coast from the St. Lawrence River, Canada to the St. John’s River, Florida (ASMFC, 2015d). The center of abundance is between Connecticut and North Carolina (Able and Fahay, 1998). American shad migrate to the Chesapeake Bay from January to June to spawn over fresh to low-salinity flats in the tributaries, as far north as the Susquehanna River (Murdy et al., 1997). American shad is an important food source for federally managed fish species, including bluefish, summer flounder, and windowpane.

The majority of American shad return to their natal rivers and tributaries to spawn. Spawning typically occurs in water temperatures between 12 to 21°C at depths of less than 3 m and over areas where the bottom substrate often consists of sand, silt, muck, gravel, or boulders (ASMFC, 2015d). Eggs, released and fertilized in open water, are transparent, weakly demersal, and range from 2.5 to 3.8 mm in diameter (Able and Fahay, 1998). Larvae hatch at 5.7 to 10.0 mm and are pelagic for 2 to 3 weeks. Larvae may remain in freshwater or drift into brackish water and grow rapidly; transforming into juveniles approximately 4 to 5 weeks after hatch (Stier and Crance, 1985). Juveniles disperse downstream and spend their first summer in the lower portion of their natal river, before emigrating to the ocean (ASMFC, 2015d).

### 4.4.3 Hickory Shad

Hickory shad are anadromous fish, spending most of their adult lives at sea but return to coastal rivers during spawning migrations. Hickory shad are distributed along the Atlantic coast, historically as far north as the Bay of Fundy to the Tomoka River, Florida (ASMFC, 2018i); however, the current northern boundary is Cape Cod, Massachusetts. The greatest abundance of hickory shad is concentrated between South Carolina and Delaware. The hickory shad migrates into the Chesapeake Bay during the spring (April to June) to spawn (Murdy et al., 1997; Able and Fahay, 1998).

Spawning grounds extend as far north in the bay as the Susquehanna River. Spawning occurs in tidal freshwater during May and early June between dusk and midnight in water temperatures ranging from 8 to 22°C (ASMFC, 2018i). After spawning, adults leave the estuary, emigrating downstream to the ocean by mid-summer. Eggs are slightly adhesive and range from 0.96 to 1.65 mm (Able and Fahay, 1998). Larvae hatch between 5.2 and 6.5 mm. Juveniles leave the nursery grounds in summer but may remain in estuarine waters before migrating to the sea (Murdy et al., 1997; Able and Fahay, 1998). Little is known about juvenile and adult distribution and movements once in their ocean habitat. Adult hickory shad have been reported in Maryland waters near ledges and fallen trees (ASMFC, 2018i). Hickory shad is more piscivorous than other local shad, feeding on small fishes as well as on squid, crustaceans, and fish eggs.

### 4.4.4 Striped Bass

Striped bass are a schooling, semi-anadromous, coastal fish found along the eastern North America coast from the lower St. Lawrence River in Canada to St. Johns River, Florida, and into the Gulf of Mexico (Able and Fahay, 1998). They are silvery, shading to olive-green on the back and white on the belly, with seven or eight uninterrupted horizontal stripes on each side of the body. The striped bass is an abundant year-round resident in all tributaries of the Chesapeake Bay from Havre de Grace, Maryland to Cape Henry, Virginia (Murdy et al., 1997). Striped bass is a commercially and recreationally important species.

The tributaries of Chesapeake Bay constitute the principal spawning areas of striped bass and the activity is most intense in the first 40 kilometers (km) of freshwater over sand and mud bottom (Murdy et al., 1997). Significant reproduction also occurs in tributaries to Albemarle Sound, the Chesapeake and Delaware canal, and certain tributaries to and the mainstems of the Delaware and Hudson Rivers (Able and Fahay, 1998). In the Chesapeake Bay region, spawning migrations begin as early as March, with peak spawning activity at the end of April or early May when water temperature ranges from 13 to 20°C (Murdy et al., 1997). Eggs are spherical, nonadhesive, buoyant to semibuoyant, and range from 1.3 to 4.6 mm in diameter. Larvae hatch at 2.0 to 3.7 mm, drift downstream to the larval nurseries in the nearshore and brackish areas of the spawning sites and mature into juveniles (Able and Fahay, 1998). Striped bass remain in coastal sounds and estuaries for two to four years, before migrating to the Atlantic Ocean (VIMS, 2021d).

Juvenile striped bass are reported to be abundant in inter-pier areas, but they can also be found in high concentrations in open water. They prefer deep to moderately deep inter-pier basins over shallow basins in the lower Hudson River Estuary (Cantelmo and Wahtola, 1992). The optimum environmental ranges for juveniles are about 16 to 23°C and 10 to 20 ppt while 0 to 30°C and 0 to 34 ppt are optimal for adults (Clemon et al., 1983). Adult striped bass are often found in areas with high tidal and current flows and in the wash of breaking waves along the shore. They are seldom found in water more than 6 to 8 km from shore (Collette and Klein-MacPhee, 2002). Adult and juvenile striped bass feed on a variety of fishes, crustaceans, squids, mussels, and worms (Murdy et al., 1997).

### 4.4.5 American Eel

The American eel (*Anguilla rostrata*) is facultatively catadromous species, meaning that they spawn in saltwater and some individuals move into freshwater to mature while others may remain in estuarine and marine waters. The America eel has an elongated, cylindrical, serpentine body with a depressed snout and a lower jaw that extends beyond the upper jaw. It has one long dorsal fin and no pelvic fins. The American eel occurs in brackish waters and their freshwater tributaries along the Atlantic Coast and an abundant resident of all tributaries to the Chesapeake Bay (Murdy et al., 1997).

Reproductive migration most commonly occurs at night in autumn, with adults moving downstream from rivers to travel to the Sargasso Sea (a large portion of the western Atlantic Ocean east of the Bahamas and south of Bermuda) where spawning occurs in January (Murdy et al., 1997). Eels have been recorded leaving the Chesapeake Bay in November (Able and Fahay, 1998). Ovarian eggs are slightly elliptical and range from 0.59 to 1.25 mm in diameter (Able and Fahay, 1998). Adults die after spawning. The planktonic leptocephalus larvae are transported by the Gulf Stream to the eastern seaboard for about 9 to 12 months before entering coastal waters, where they mature into the transparent glass eel stage (Murdy et al., 1997, ASMFC, 2015e). The glass eels move into the estuary where they become pigmented elvers. Triggered by a temperature decrease to about 12 to 14°C, elvers migrate varying distances upstream in waves and become more active during the day. The next life stage, the yellow eel, migrates upstream or remain in brackish portions of rivers for 7 to 19 years until they mature into adults (silver eels) (ASMFC, 2015e; Able and Fahay, 1998). Silver eels migrate downriver to marine waters and return to the Sargasso Sea, where they spawn. American eels are nocturnally active omnivores, feeding on worms, crustaceans, mollusks, and small fish (Murdy et al., 1997).

# 5.0 ANALYSIS OF POTENTIAL IMPACTS ON EFH

This chapter provides an analysis of the potential permanent, temporary, and cumulative impacts on EFH from the Proposed Action.

## 5.1 Adverse Effect

The EFH final rule defines an adverse effect as: “any impact which reduces the quality and/or quantity of EFH (NMFS, 2003b).” The EFH final rule further states that:

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

Bridge construction activities will potentially impact EFH through 1) habitat alteration or loss that can result in direct or indirect mortality, 2) increased suspended sediment and turbidity, and 3) underwater noise. Bridge demolition activities by mechanical techniques will potentially impact EFH through 1) habitat alteration (i.e., falling debris) and 2) increased suspended sediment and turbidity. Overall, impacts from mechanical methods are less extensive than those for explosive methods. If a controlled explosives technique such as blasting is required, potential impacts to EFH could also include pressure and shock wave impacts involving behavioral disturbances, non-lethal injury (i.e., hearing threshold shifts), and lethal injury (i.e., ruptured swim bladders and other vital organs) to fish species (Oviatt and Archibald, 2000). However, blasting will not be required for this project. Only mechanical methods are anticipated for construction and demolition activities.

## 5.2 Direct EFH Impacts

The following provides the anticipated direct EFH impacts from the Proposed Action.

### 5.2.1 Permanent In-water Structures

The replacement of the existing utility bridge will require the placement of structures (either permanent or temporary) into aquatic habitat. Permanent in-water structures for this project will include the pipe bridges (steel trusses or concrete beams) and their associated pipe pile foundations. In terms of foundation construction, all three alternatives discussed in Chapter 2 share the same foundation system but differ with respect to the required quantity pipe piles and size / number of foundations. The 18-inch diameter steel pipe piles extend 75 to 100 feet below the water line and are installed at a 1:12 batter. For construction, it is anticipated that the pipe piles will be installed in 2 to 3 spliced sections to facilitate manageable sections for delivery. After pile driving efforts are complete, the piles will be filled with concrete one foot below the mudline and hooked reinforcement will extend out of the pile to develop bending moment into the pile cap. The foundations can be formed up completely above the water using the installed pipe piles as frame support to avoid the use of expensive cofferdams. After the foundations have been constructed, the steel superstructure can be built once the concrete has reached an acceptable strength. Table 5-1 provides a summary of permanent impacts and the estimated footprint below the high-water elevation for each alternative and bridge type.

**Table 5-1: Area of Permanent In-River Structures for Each Alternative**

| Alternative / Bridge Type | Number of Pipe Piles | Permanent Impacts ($ft^2$) |
|---|---|---|
| Alternative 1 | | |
| X-Diagonal Steel Space Truss | 28 | 49.5 |
| Precast Concrete | 35 | 61.9 |
| Alternative 2 | | |
| Pratt Steel Space Truss | 20 | 35.3 |
| Alternative 3 | | |
| Tubular Bowstring Space Truss | 28 | 49.5 |
| X-Diagonal Steel Space Truss with Jack and Boring | 24 | 42.4 |

Of the three alternatives and bridge types, Alternative 1 with a precast concrete bridge has the largest permanent impacts. Therefore, the potential permanent impacts from this Alternative and bridge type is evaluated under this section. With respect to foundations, this design consists of pile cap foundations which project out of the water 10 feet and driven steel pipe piles within each foundation. The pipe piles are anticipated to be 18 inches in diameter, and these will extend through the depth of the creek to approximately 100 feet below the creek substrate. A total of 35 pipe piles will be required and the piles will be battered at a 1:12 slope. Therefore, the maximum total permanent in-water impact is estimated to be 62 square feet ($ft^2$).

Effects of the Proposed Action on EFH will be confined to the area immediately surrounding the bridge. Following the removal of the existing utility bridge support structures, an estimated 230 $ft^2$ of benthic, in-river habitat will be returned to the bottom creek elevation and available to potentially support EFH species. This will result in a permanent net gain of benthic habitat of approximately 168 $ft^2$ once the new bridge is erected and the old bridge is demolished. The benthic habitat in the locations of the existing utility bridge will return to its natural substrate and benthic fauna given time and exposure to natural flow and sediment transport dynamics. Therefore, the Proposed Action will have a net gain in benthic habitat available for bluefish, summer flounder, and windowpane flounder juveniles and adults, and the potential prey and migratory species potentially present in College Creek.

### 5.2.2 Temporary EFH Impacts

Temporary impacts are those that are limited in duration and that allow the particular environment to recover without measurable impact. The following provides a description of temporary EFH impacts for in-water structures, underwater noise, and sedimentation and turbidity associated with replacement of the utility bridge.

#### 5.2.2.1 In-water Structures

Temporary in-water structures for all three alternatives will include the footprint of the construction crane and removal of the existing concrete bridge piles. The use of barge cranes will be preferred over an in-water construction crane for all site alternatives and bridge types. However, installation of an in-water crane will be required if barge cranes are unable to perform the necessary lifts. To be conservative, this analysis assumes that an in-water crane will be used to assess potential temporary impacts to EFH. Therefore, the maximum total temporary in-water impact is estimated to be 730 ft$^2$. Table 5-2 provides a summary of temporary impacts and the estimated footprint below the high-water elevation.

**Table 5-2: Type and Area of Temporary In-River Structures for All Alternatives**

| Impact Type | Temporary Impacts (ft$^2$) |
|---|---|
| Construction Crane Installation | 500 |
| Existing Bridge Removal | 230 |
| **Total Temporary Impacts** | **730** |

#### 5.2.2.2 Underwater Noise

Three in-water activities typically result in elevated underwater noise (sound pressure) during construction (depending upon the project): (1) drilling, (2) hydraulic rock breaker (hoe ram) and (3) blasting. For this project, the main in-water activity that could cause an increase in noise and potentially impact EFH is driving the new bridge pilings into the College Creek sediment. Underwater noise during demolition of the existing utility bridge is not anticipated to impact EFH because in-water work would not be completed. Mechanical methods are anticipated and the equipment used for demolition would be located above the water surface. Underwater noise for the underground utility option would also not result in EFH impacts because the head of the jack and bore will be approximately 10-feet below the creek substrate and the only noise increases will be generated at the entry and exit pits on land.

Sound is described as having two components: 1) a pressure component and 2) a particle motion component. Sound pressure consists of continuous (e.g., motorized vessel) and impulsive (e.g., explosions, pile driving or hydraulic hammering) (Southall et al., 2007; Hawkins and Popper, 2014). Particle motion is the oscillatory displacement, velocity, or acceleration of fluid particles in a sound field. All fish are sensitive to particle motion; however, some fish have adaptions (e.g., gas bubbles near the ear or swim bladders that functionally affect the ear) that also make them sensitive to sound pressure. Fishes with swim bladders (or other gas bubbles) that functionally affect the ear generally have lower thresholds and wider hearing bandwidths than species without these adaptations (Normandeau, 2012).

The pressure fluctuations resulting from impulsive noise are expressed in units of pressure (e.g., pounds per square inch [psi]). Measurements of pressure are:

- Peak sound pressure level: the largest absolute value of the instantaneous sound pressure expressed in decibels referenced to 1 micro Pascal (decibel [dB] re: 1 µPa) in water.
- Root Mean Square (RMS): the square root of the average squared pressures over the duration of a pulse; most pile-driving impulses occur over a 50 to 100 millisecond (msec) period, with most of the energy contained in the first 30 to 50 msec (Illingworth and Rodkin, Inc. 2010). Therefore, RMS pressure levels are generally “produced” within seconds of the operations and represent the effective pressure and the intensity (in dB re: 1 µPa) produced by a sound source.

Measurements of energy are:

- Sound exposure level (SEL): the integral of the squared sound pressure over the duration of the pulse (e.g., a full pile driving strike). SEL is the integration over time of the square of the acoustic pressure in the signal and is thus an indication of the total acoustic energy received by an organism from a particular source (such as pile strikes). Measured in dB re 1µPa2-s.
- Single Strike SEL (sSEL): the amount of energy in one strike of a pile.
- Cumulative SEL (cSEL): the energy accumulated over multiple strikes or continuous vibration over a period of time; the cSEL value is not a measure of the instantaneous or maximum noise level but is a measure of the accumulated energy over a period of time to which an animal is exposed.

Aquatic species are believed to have different tolerances to noise and may show different effects and responses to the same noise source. The types of effect on and response to a sound source will depend on distance. The potential for effects declines as distance increases between the individual and the source. Effects on organisms very close to the source range from mortality to behavioral changes, while organisms further from the source may have effects that range from physiological to behavioral effects, but mortality would not occur. The actual nature of effects depends on a number of other factors, such as fish hearing sensitivity, source level, sound propagation and resultant sound level at the fish, whether the fish stays in the vicinity of the source, and motivation level of the fish.

Man-made underwater noise has the potential to cause behavioral disturbances, hearing impairment or threshold shifts, physical injury, or mortality to marine organisms (Southall et al., 2007, Popper and Hastings, 2009; Popper et al., 2014). These effects depend on the intensity and characteristics of the sound, the distance and location of the fish in the water column relative to the sound source, the size and mass of the fish, and the fish's anatomical characteristics (Yelverton et al. 1975 as cited in Hastings and Popper, 2005). Fish have several methods for detecting sounds including through the swim bladder and inner ear (otoliths). When fish are exposed to a sound wave, gas in their swim bladder expands and contracts and otoliths vibrate from sound pressure waves. High intensity pressure waves can potentially damage or rupture these structures. Damage to the swim bladder and/or otoliths can reduce or eliminate the ability of a fish to maintain its equilibrium within the water column. Fish with swim bladders are particularly sensitive to underwater impulsive sounds. As the pressure wave passes through a fish, the swim bladder is rapidly squeezed and then expanded (California Department of Transportation [CalTrans], 2001 as cited in NMFS, 2012). The pneumatic pounding on tissues contacting the swim bladder may rupture capillaries in the internal organs as suggested by observed blood in the abdominal cavity, and maceration of the kidney tissues (CalTrans, 2001 as cited in NMFS, 2012). Potential physiological effects from sound exposure can range from small ruptures of capillaries in fins to severe hemorrhaging of major organ systems such as the liver, kidney, or brain. Hearing loss can result in the reduced ability to detect and avoid predators, locate prey, communicate with peers, or sense physical environment.

Underwater sounds must be louder than background level to be detected by a fish and a sound may need to be biologically relevant to an individual to elicit a particular behavioral response (Plachta and Popper, 2003, Doksaeter et al., 2009). Behavioral responses may range from a temporary startle to avoidance of an ensonified area.

#### 5.2.2.2.1 Pile Driving

Pile driving, commonly used for the construction of foundations for a large number of structures including bridges, buildings, retaining walls, harbor facilities, and offshore wind turbines, can be a source of underwater sound if the pile being driven is in water or on land near water. Impact pile driving involves multiple strikes over an extended period of time, with an average strike interval of 1.0 to 1.5 seconds.

When a pile is struck with an impact hammer the pile vibrates and radiates sound energy into the water. The peak sound pressure occurs immediately after the pile is struck. The pile will then continue to ring for a few hundred milliseconds (CalTrans, 2015). Peak sound pressure levels are useful for characterizing pile driving strikes but do not account for the total energy of the sound. The SEL, as described above, is related to the total acoustic energy of the pulse and enables sound exposures of differing duration to be related to one another for purposes of assessing exposure risk.

### 5.2.2.2.2 Underwater Noise Modeling

NMFS and USFWS set interim criteria for injury to fish from pile driving activities in June 2008. The criteria identify sound pressure levels of 206 $dB_{peak}$ (Peak Sound Pressure Level) and 187 dB $SEL_{cum}$ (cumulative sound exposure level) for all fish except for those that are less than 2 grams as potentially causing physical injury. For fish less than 2 grams, the injury threshold for $SEL_{cum}$ is 183 dB. Additionally, SELs greater than 150 dB may cause behavioral effects (Fisheries Hydroacoustic Working Group, 2008). Exposure to noise levels of 150 dB will not always result in behavioral modifications, and behavioral modifications will not always result in adverse effects (i.e., harm or harassment to listed species), but that there is the potential for behavioral response (NMFS, 2012).

**Table 5-3: Fish Injury and Behavioral Disruption Thresholds for Underwater Noise**

| Fish Mass (grams) | Onset of Physical Injury: Peak | Onset of Physical Injury: Cumulative SEL | Behavior Threshold |
|---|---|---|---|
| ≥ 2 grams | 206 dB | 187 SEL dB | 150 $dB_{RMS}$ |
| < 2 grams | | 183 SEL dB | |

Source: Fisheries Hydroacoustic Working Group 2008; dB = decibel; $dB_{RMS}$ = root mean square decibels

To calculate the impacts of underwater pile driving noise on fish, the Simplified Attenuation Formula (SAF), developed by NMFS Greater Atlantic Regional Fisheries Office (GARFO) (2020), was used to calculate the impacts of underwater noise on fish. NMFS GARFO recommends the SAF over the practical spreading loss model (PSLM) for calculating underwater noise impacts in shallow, nearshore, and port environments. According to NMFS GARFO, this provides more accurate estimates of project-related underwater noise impacts in nearshore environments, while the PSLM is more appropriate to use for calculating underwater impacts in the open ocean (e.g., construction noise associated with building offshore wind turbines).

The Simplified Attenuation Formulas are presented in NMFS GARFO Acoustics Tool as:

Distance (m) to Fish Injury Threshold = C+((SEL(A)-SEL(B))/T)*10)

Distance (m) to Fish Behavioral Threshold = C+((RMS(A)-RMS(B))/T)*10)

where: C = distance (m) from pile where sound measurement was taken
T = underwater noise attenuation rate (dB/10m)
SEL(A) = SEL (dB) estimated at C m from pile
SEL(B) = SEL (dB) injury threshold for fish (150 sSEL)
RMS(A) = RMS (dB) estimated at C m from pile
RMS(B) = RMS (dB) behavioral threshold for fish (150 $dB_{RMS}$)

The following values are the inputs and assumptions included in the GARFO Acoustics Tool:

- RMS SPL for underwater impact pile driving estimated as 189 $dB_{RMS}$ at 10 meters with a SPLpeak of 203 and a dB SEL of 178 (data from in the San Francisco Bay, Rodeo California in 5 meters of water).
- Onset of physical injury for fish ≥ 2 grams at 206 SPLpeak and 183 dB SEL (Fisheries Hydroacoustic Working Group, 2008).
- Onset of physical injury for fish < 2 grams at 206 SPLpeak and 187 dB SEL (Fisheries Hydroacoustic Working Group, 2008).
- Behavioral disruption for impulsive noise for fish at 150 $dB_{RMS}$ (Fisheries Hydroacoustic Working Group, 2008).
- Transmission loss constant of 5 for nearshore underwater noise.

Based on the results of the SAF model, pile driving associated with the Proposed Action will not result in underwater noise levels ($dB_{peak}$) that could cause physical injury to fish from pile driving activities. Using the cumulative physical injury of fish of 183 and 187 dB SEL, negative numbers are the result. The GARFO Acoustics Tool states that when it is not possible to accurately calculate the distance to the 187 dB cSEL, the distance to the 150 dB SEL isopleth is used as a surrogate. Using this approach, cumulative noise levels (cSEL) may cause physical injury to fish at 103.3 m of pile driving. Pile driving will likely also disrupt the normal behaviors of fish foraging within 140 m of construction activities.

**Table 5-4: Metrics Used for the Underwater Noise Impact Calculations**

| Pile Location | Pile Diameter and Type | Driver or Extractor | Water Depth (m) | Total Number of Piles | Estimated Number of Piles per Day | Estimated Number of Strikes per Pile | Estimated Strike Duration | $SPL_{peak}$[a] | SEL[a] | Estimated Source RMS SPL[a] |
|---|---|---|---|---|---|---|---|---|---|---|
| In-water piers | 24-inch, steel piles | Impact | 5 | 35 | 2 | 1,000 | 100 msec[c] | 203 | 178 | 189 |

a) Inputs based on data from in the San Francisco Bay, Rodeo California

**Table 5-5: Estimated Distances to Fish and Behavioral Thresholds**

| Fish Class | Peak Threshold (dB) | Cumulative (cSEL) Threshold (dB) | Behavioral Threshold ($dB_{RMS}$) | Distance (m) to Peak Threshold (injury) | Distance (m) to Cumulative Threshold (cSEL)[a] | Distance (m) to 150 dBsSEL (surrogate for 183 and 187 dBcSEL injury)[a] | Distance (m) to Behavioral Disturbance Threshold (150 $dB_{RMS}$) |
|---|---|---|---|---|---|---|---|
| ≥ 2 grams | 206 | 183 | 150 | 0.0 | -6.7 | 103.3 | 140.0 |
| < 2 grams | 206 | 187 | 150 | 0.0 | -20.0 | 103.3 | 140.0 |

a) The GARFO Acoustics Tool states that when it is not possible to accurately calculate the distance to the 187 dB cSEL, the distance to the 150 dB SEL isopleth is used as a surrogate.

#### 5.2.2.3 Sedimentation and Turbidity

Several activities associated with construction of the new bridge and demolition of the existing structure have potential to disturb bottom sediments and increase turbidity in the vicinity of the Proposed Action. The substrate in College Creek is silty sand or elastic silt. These actions include:

- Construction of 35 pipe piles anticipated between 18 inches in diameter
- Removal of existing bridge support structures

Effects on fish from short-term turbidity increases (hours or days) are temporary and are reversed when turbidity levels return to background levels (Robertson et al., 2007). Potential adverse effects of increases in turbidity on fish may include the following (Robertson et al., 2007, Newcombe, 1994):

- Reduction in feeding rates
- Increased mortality
- Physiological stress, including changes in cardiac output, ventilation rate, and blood sugar level
- Behavioral avoidance
- Physical injury (e.g., gill abrasion)
- Reduction in macroinvertebrates as a prey source
- Reduction in territorial behavior

Pile driving activities produce total suspended solids (TSS) concentrations of approximately 5 to 10 milligrams per liter (mg/L) above background levels within approximately 300 feet of the pile being driven (Federal Highway Administration, 2012). The small resulting sediment plume is expected to settle out of the water column within a few hours. Studies of the effects of turbid water on fish suggest that concentrations of suspended sediment can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton, 1993). The TSS levels expected for pile driving or removal (5 to 10 mg/L) are well below those shown to have adverse effect on fish (typically up to 1,000 mg/L) (Burton, 1993; Wilber and Clarke, 2007). Therefore, sedimentation and turbidity associated with the Proposed Action are anticipated to have no adverse effect on EFH. Furthermore, juveniles and adults can avoid or swim through this portion of College Creek to areas with their preferred water quality.

## 5.3 Indirect Impacts

The construction and demolition activities with the Proposed Action may potentially result in localized indirect impacts. Indirect impacts primarily include the potential reduction in prey for federally managed species due to the displacement of prey species from the area during with the construction and demolition activities. The pelagic forage fish species are mobile and would avoid the temporary in-water construction and demolition activities, requiring juvenile and adult bluefish, summer flounder, and windowpane flounder to follow forage species to other acceptable pelagic and demersal habitats within College Creek or the Severn River. The loss of benthic organisms from the installation of 35 pipe piles could potentially reduce or displace finfish feeding in College Creek for juvenile and adult bluefish, summer flounder and windowpane flounder. However, the permanent loss of only 62 $ft^2$ of estuarine sand bottom habitat would be short lived and impacts would be minimal. The habitat temporarily or permanently impacted is a small fraction of that available to these species in this area. Furthermore, following the removal of the existing utility bridge support structures, an estimated 230 $ft^2$ of benthic, in-river habitat will be returned to its natural state. This will result in a permanent net gain of benthic habitat of approximately 168 $ft^2$ in College Creek.

## 5.4 Cumulative Impacts

Section 4 of the EA provides an evaluation of cumulative impacts. The EA (1) defines cumulative impacts; (2) describes past, present, and reasonably foreseeable future actions relevant to cumulative impacts; (3) analyzes the incremental interaction the proposed action may have with other actions; and (4) evaluates cumulative impacts potentially resulting from these interactions (Department of the Navy, 2020). The findings are summarized below.

Cumulative impacts are most likely to arise when a relationship or synergism exists between a proposed action and other actions expected to occur in a similar location or during a similar period. Actions overlapping with or near a proposed action would be expected to have more potential for a relationship than those more geographically separated. Similarly, relatively concurrent actions would tend to offer a higher potential for cumulative impacts. To identify cumulative impacts, the analysis needs to address the following three fundamental questions.

- Does a relationship exist such that affected resource areas of the Proposed Action might interact with the affected resource areas of past, present, or reasonably foreseeable actions?
- If one or more of the affected resource areas of the Proposed Action and another action could be expected to interact, would the Proposed Action affect, or be affected by, impacts of the other action?
- If such a relationship exists, then does an assessment reveal any potentially significant impacts not identified when the Proposed Action is considered alone?

Projects included in the cumulative impact analysis are described in the EA and are shown on Figures 5-1 through 5-3. Of the 15 past, present, and reasonably foreseeable future projects at, and near, the Proposed Action, only the construction activities occurring along College Creek, including the Center for Cyber Security Studies, Alumni Service Center and Headquarters facility, seawall and shoreline repair and restoration activities, and the Proposed Action, could have cumulative contributions of increased noise or turbidity affecting EFH. Shoreline repairs and the construction and demolition activities associated with the Proposed Action would have the greatest likelihood of cumulative contributions as these activities would occur within and along the shorelines of College Creek. Construction activities would adhere to all federal and state regulations and permits and would use sediment- and erosion-control measures and, if applicable, stormwater controls.

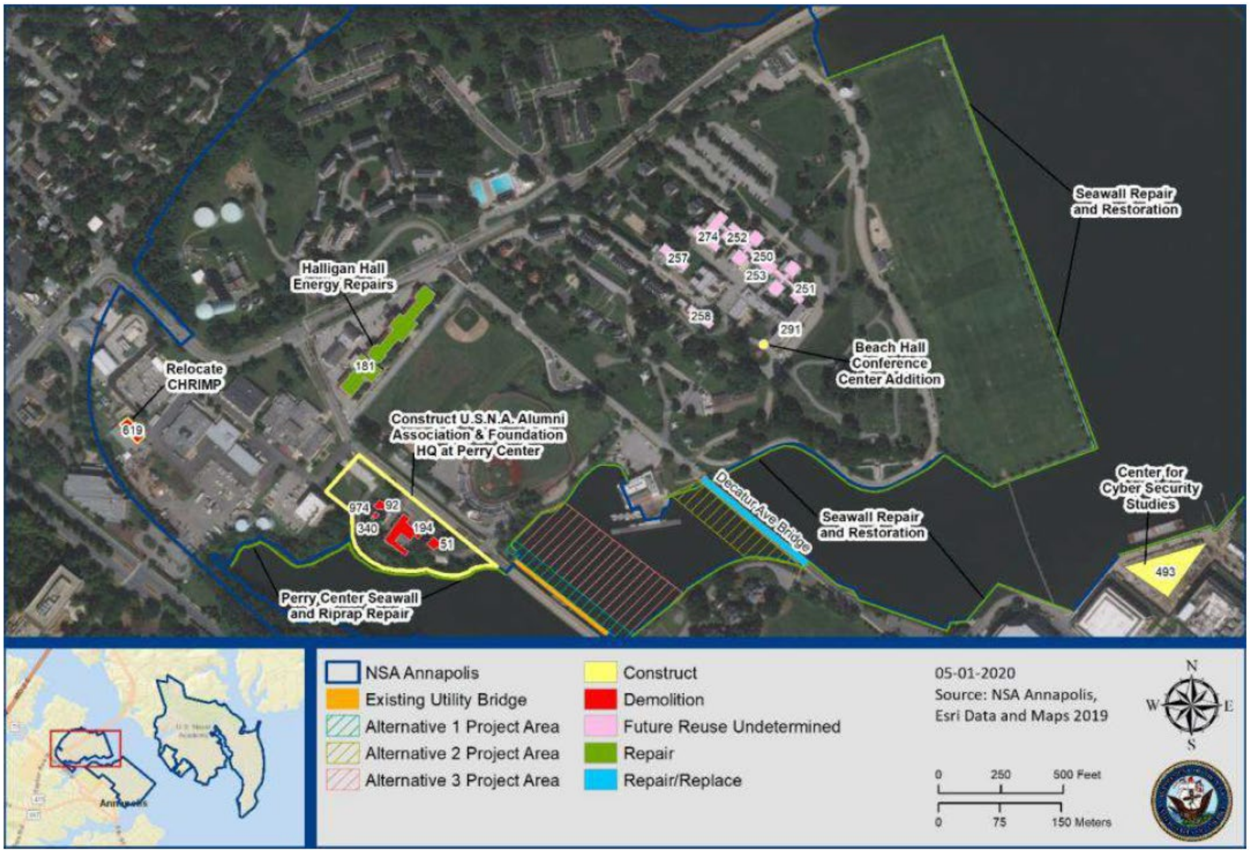
**Table 5-6: Cumulative Action Evaluation**

| Action | Level of NEPA Analysis Completed |
|---|---|
| **Past Actions** | |
| Navy Exchange, Commissary, Health Clinic | Environmental Assessment |
| Halligan Hall Energy Repairs | Categorical Exclusion |
| Perry Center Seawall Repair | Categorical Exclusion |
| **Present and Reasonably Foreseeable Future Actions** | |
| Wastewater Treatment Plant Upgrades | Environmental Assessment |
| Center for Cyber Security Studies | Environmental Assessment |
| Porter Road Stormwater Management Repairs | Categorical Exclusion |
| Chapel Roof Repairs | Categorical Exclusion |
| Chapel and Leahy Hall Steam Distribution Repairs | Categorical Exclusion |
| Sampson Hall Roof and Exterior Repairs | Categorical Exclusion |
| U.S. Naval Academy Alumni Association and Foundation Headquarters | Environmental Assessment |
| Mail Center and CHRIMP Relocation | Environmental Assessment |
| Perry Center Riprap Repair | Categorical Exclusion |

| Action | Level of NEPA Analysis Completed |
|---|---|
| Beach Hall Conference Center Addition | Categorical Exclusion |
| Seawall Repair and Restoration | Environmental Assessment (ongoing) |
| Decatur Avenue Bridge Repair/Replacement | To be determined |

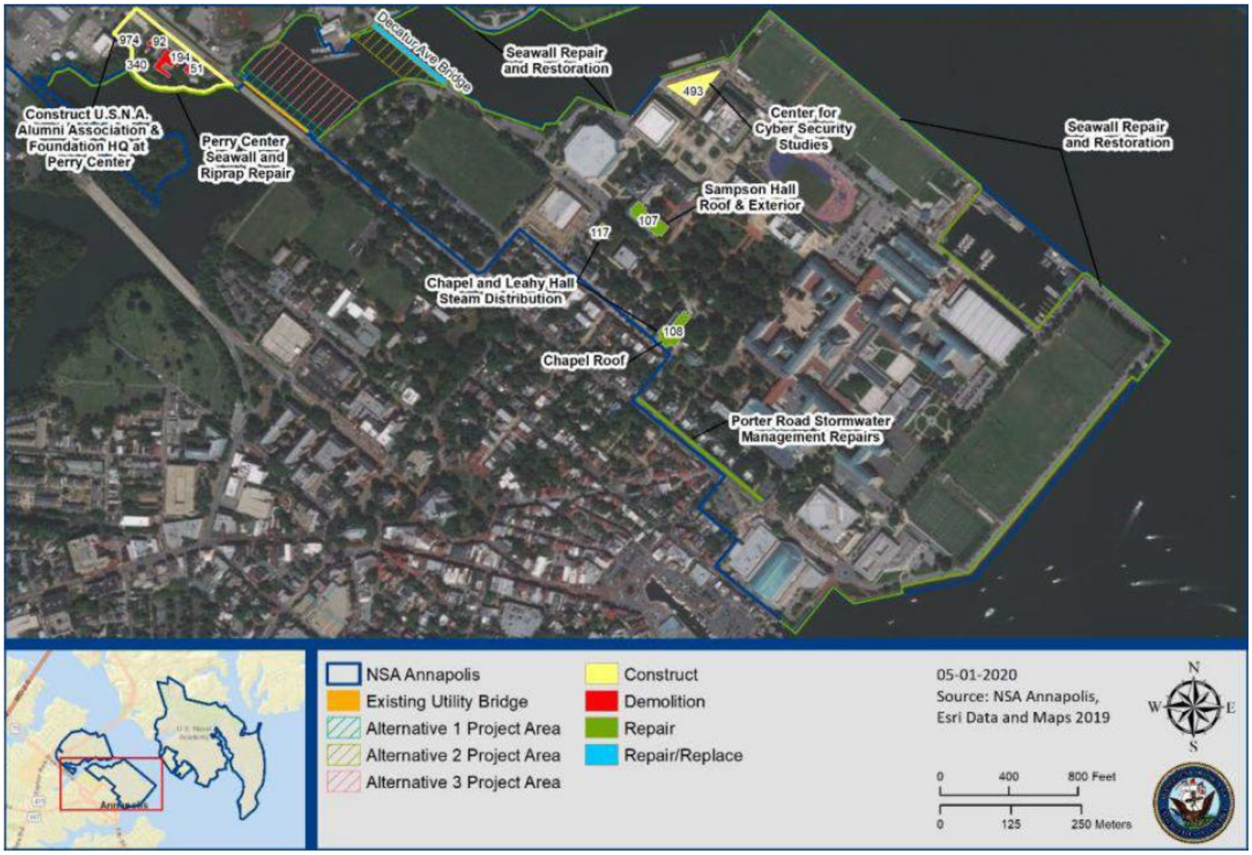
Sources: NAVFAC Washington, 2015; NAVFAC Washington, 2018a; NAVFAC Washington, 2018b
CHRIMP = Consolidated Hazardous Material Reutilization Inventory Management Program; NEPA = National Environmental Policy Act

**Figure 5-1: Cumulative Projects on the Upper Yard**



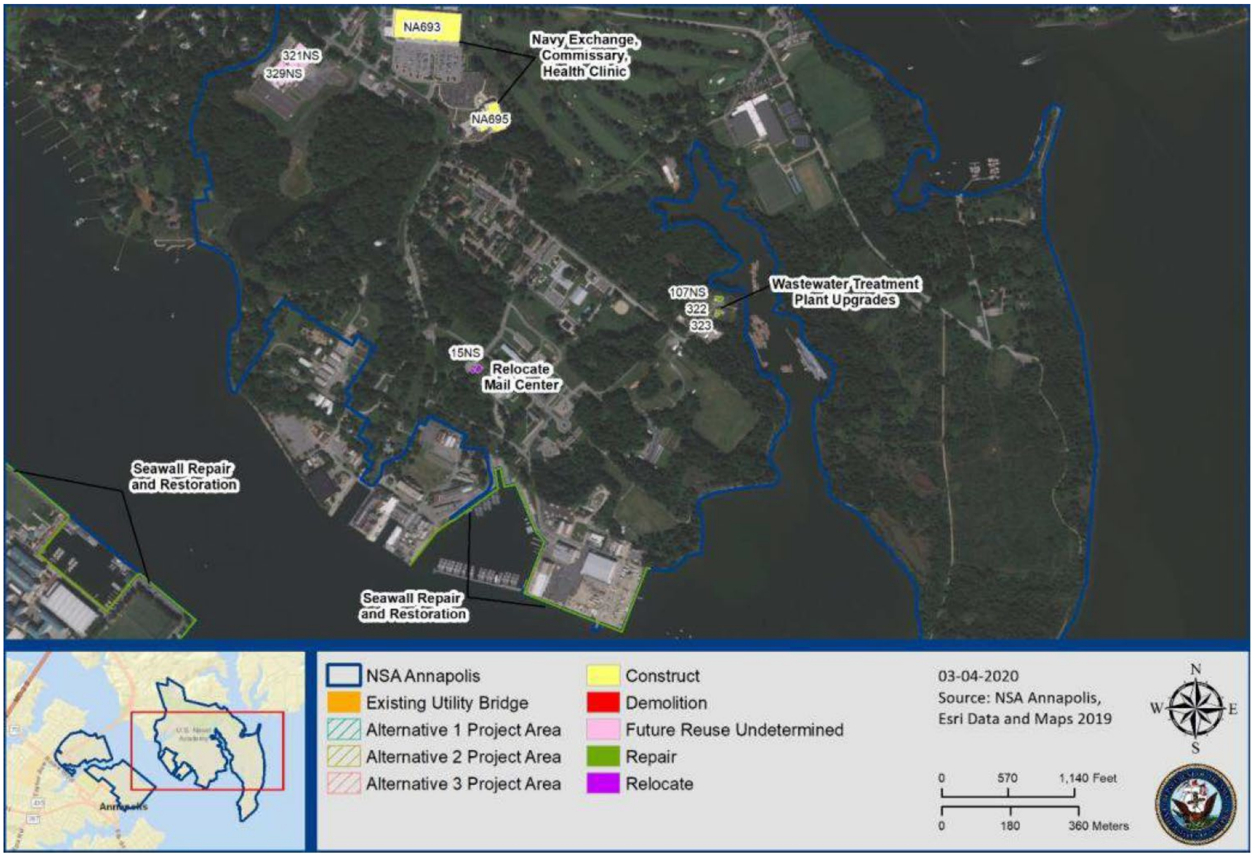
Source: Department of the Navy (2020)

**Figure 5-2: Cumulative Projects on the Lower Yard**



Source: Department of the Navy (2020)

**Figure 5-3: Cumulative Projects on North Severn**



Source: Department of the Navy (2020)

# 6.0 CONCLUSIONS REGARDING THE EFFECTS ON EFH

The species with EFH that could inhabit College Creek and have the potential to be affected by the Proposed Action are bluefish, summer flounder, and windowpane flounder juveniles and adults. All of the potential prey species of managed species, and migratory species are likely to inhabit College Creek near the Proposed Action. None of the federally-listed fish species have been found in the Severn River and are unlikely to inhabit College Creek near the Proposed Action. The potential adverse effects on EFH associated with the Proposed Action are provided in Section 5.0.

Agency EFH conclusions regarding the effects on EFH are categorized as:

1. No adverse effect to EFH
2. Minimal adverse effect or less than substantial effect to EFH or
3. Substantial adverse effect to EFH

Minimal impacts are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions (NMFS, 2007). Substantial adverse effects are effects that may pose a relatively serious threat to EFH and typically could not be alleviated through minor modifications to a proposed action (NMFS, 2007).

The following provides the conclusions regarding the effects on EFH from the direct and indirect impacts from the Proposed Action and determination.

## 6.1 In-water Structures

Effects from the Proposed Action will be confined to the areas immediately surrounding both the existing utility bridge during demolition and at the location of the new bridge during construction. The maximum total direct temporary and permanent in-water impacts for the new bridge are estimated to be 730 $ft^2$ and 62 $ft^2$, respectively. Following the removal of the existing utility bridge support structures, an estimated 230 $ft^2$ of benthic, in-river habitat will be returned to a natural state. This will result in a permanent net gain of benthic habitat of approximately 168 $ft^2$ once the new bridge is erected and the old bridge is demolished. The benthic habitat in the locations of the existing utility bridge will return to its natural substrate and benthic fauna given time and exposure to natural flow and sediment transport dynamics. Therefore, the Proposed Action will have a net gain in benthic habitat available for bluefish, summer flounder, and windowpane flounder juveniles and adults, and the potential prey and migratory species potentially present in College Creek. As such, in-water structures associated with the Proposed Action are anticipated to have no adverse effect on EFH.

## 6.2 Underwater Noise

The main in-water activity that could cause an increase in noise and potentially impact EFH is driving the new bridge pilings into the College Creek sediment. Underwater noise during demolition of the existing utility bridge is not anticipated to impact EFH because in-water work would not be completed. Underwater noise for the underground utility option would also not result in EFH impacts because the head of the jack and bore will be approximately 10-feet below the creek substrate and the only noise increases will be generated at the entry and exit pits on land.

Based on the results of the SAF model, pile driving associated with the Proposed Action will not result in underwater peak noise levels ($dB_{peak}$) that could cause physical injury to fish from pile driving activities. Cumulative noise levels ($SEL_{cum}$) may cause physical injury to fish at 103 m of pile driving. Pile driving will likely also disrupt the normal behaviors of fish foraging within 140 m of pile driving.

Underwater noise associated with the Proposed Action is anticipated to have no adverse effect on EFH. Impacts would be temporary, limited to active pile driving activities, and limited to up to 140 meters from the pile cap foundation area. Cumulative physical injury or behavioral effects to juvenile and adult bluefish, summer flounder, and windowpane flounder would only occur if an individual continued to inhabit the area within the 103 or 140 m isopleth of the pile driving. Juveniles and adults of these species frequenting the site are mobile and will avoid areas where active pile driving is underway, moving to other suitable pelagic or benthic habitats in College Creek or the Severn River. The area impacted at any one time is a small fraction of that available to these species in this area.

Potential indirect impacts from underwater noise disturbance of prey species and migratory species would be temporary, limited to during pile driving activities, and limited to up to 140 meters from the pile cap foundation area. Juvenile and adult bluefish primarily prey on pelagic fish (bay anchovy, Atlantic menhaden, Atlantic silversides, river herring and striped bass). Juvenile summer and windowpane flounder feed on polychaetes, and small crustaceans (mysids, decapod shrimp). Adult summer flounder prey on shrimp, mysids, and pelagic fish (anchovies and Atlantic silversides) while the adult windowpane diet consists of polychaetes, small crustaceans (mysids, decapod shrimp) and various small demersal fishes (hakes, tomcod). These prey species are abundant and widely distributed. The pelagic forage species are mobile and would avoid in-water construction and demolition activities, requiring juvenile and adult bluefish, summer flounder, and windowpane flounder to follow forage species to other acceptable pelagic and demersal habitats within College Creek or the Severn River that have reduced underwater noise. The migratory species are also highly mobile and would avoid in-water construction and demolition activities, moving to acceptable pelagic habitats within College Creek or the Severn River that has reduced underwater noise and would return once construction disturbance has subsided.

## 6.3 Turbidity

Sedimentation and turbidity associated with the Proposed Action is anticipated to have no adverse effect on juvenile and adult bluefish, summer flounder, and windowpane flounder EFH or their prey species. Impacts would be temporary, limited to active pile driving and removal activities, and limited to the pile cap foundation area. The small resulting sediment plume from pile driving is expected to settle out of the water column within a few hours. The TSS levels expected for pile driving or removal (5 to 10 mg/L) are well below those shown to have adverse effect on fish (typically up to 1,000 mg/L)(Burton 1993; Wilber and Clarke, 2007). Furthermore, juvenile and adult bluefish, summer flounder, and windowpane flounder and their prey species are mobile and will avoid areas where active pile driving or demolition activities are underway, moving to other suitable pelagic or benthic habitats with lower TSS levels in College Creek or the Severn River. The migratory species are also highly mobile and will avoid areas where active pile driving is underway, moving to other suitable pelagic or benthic habitats with lower TSS levels in College Creek or the Severn River. The area impacted at any one time is a small fraction of that available to these species in this area.

## 6.4 Cumulative Impacts

Long-term, adverse cumulative impacts on EFH are not expected from construction or demolition activities. Implementation of the Proposed Action combined with the past, present, and reasonably foreseeable future projects, would not result in significant impacts in EFH or their prey species.

# 7.0 MITIGATION MEASURES

Mitigation measures are recommended actions that minimize adverse effects or encourage the conservation and enhancement of EFH. Avoidance and minimization measures are often incorporated into the project during the design phase and include design and timing elements to avoid or minimize the potential exposure of fish to adverse effects. BMPs are actions incorporated into the project during the construction phase, such as the use of sound attenuation devices, to avoid or minimize exposure of fish to adverse effects.

## 7.1 Description of Potential Mitigation Measures

The following provides a description of potential mitigation measures to avoid or minimize adverse effects of fish.

### 7.1.1 Time of Year Restrictions

Resource agencies typically set in-water work windows or time of year restrictions (TOYRs) to avoid or minimize the effects of construction on fish species. The in-water work windows represent the periods with the least potential for a species, or a particular life history stage of a species, to be present in areas that might be affected by a project (CalTrans, 2015). Maryland waterways are divided into four main use classifications (I, II, III, and IV), and the TOYRs vary for each use classification (Table 7-1). TOYRs can minimize effects for both underwater noise and sedimentation and turbidity. As mentioned in Chapter 3, College Creek is tidal and is designated as a Class II waterbody. Maryland does not have a specific TOYR for this use classification.

**Table 7-1: Time of Year Restrictions in Maryland**

| Stream Use Classification | Stream Type | Instream Work Prohibited From |
|---|---|---|
| I | Nontidal Streams | March 1 - June 15 |
| II | Tidal Waters | Variable depending on species present |
| III | Nontidal Cold Water (Naturally Reproducing Trout Streams) | October 1 - April 30 |
| IV | Recreational Trout Waters (Stocked Trout Streams) | March 1 through May 31 |

### 7.1.2 Underwater Noise

Various mitigations measures have been developed to attenuate underwater sound generated by in-water pile driving. These measures fall into two general categories (CalTrans, 2015):

- Treatments that reduce the transmission of sound through the water
- Treatments to reduce the sound generated by the pile

The first category includes air bubble curtains, confined air bubble curtains, and cofferdams . The second category includes isolation casings and alternative hammer types, such as vibratory hammers and oscillating, rotating, or press-in systems. The use of wood, nylon, and micarta pile caps also would fall in the second category. The following subsections provide a description of the potential mitigation measures and estimated reductions in noise.

### 7.1.2.1 Air Bubble Curtains

Air bubble curtains infuse the area surrounding the pile with air bubbles, creating a bubble screen that inhibits the propagation of sound from the pile (CalTrans, 2015). The underlying mechanism of bubble curtains is changing the local impedance in the area where the bubbles are introduced, producing the following two effects:

1. To act as a barrier for the sound to pass through once the sound is radiated from the pile.
2. To reduce the radiation of sound from the pile into the water by having the low-density bubbles very close to the pile.

The effectiveness of air bubble curtains in reducing sound pressure waves have been observed to vary greatly. The effectiveness of air bubble curtains in reducing sound has been observed to vary from 0 to 10 dB reduction in RMS sound pressure levels and reduce peak pressures by 5 to 30 dB (Washington Department of Transportation [WSDOT], 2006). Because of the uncertainties associated with degree of attenuation that would be provided by an air bubble curtain, it is recommended that attenuation assumed for any attenuation device be limited to 5 dB (CalTrans, 2015).

### 7.1.2.2 Cofferdams

Cofferdams are temporary structures most commonly fabricated from sheet piling or inflatable water bladders used to isolate an area generally submerged underwater from the water column (CalTrans, 2015). Cofferdams are sometimes used during in-water and near-water pile driving and may be used for acoustic or non-acoustic reasons. Cofferdams typically are dewatered to isolate the piling from the water, which attenuates sound by providing an air space between the exposed pile and the water column.

Dewatered cofferdams generally can be expected to provide attenuation that is at least as great as the attenuation provided by air bubble curtains. Because of the uncertainties associated with degree of attenuation that would be provided by a cofferdam, it is recommended that attenuation assumed for any attenuation device be limited to 5 dB (CalTrans, 2015).

#### 7.1.2.3 Isolation Casings

Isolation casings are hollow casings that are slightly larger in diameter than the piling to be driven that are inserted into the water column and bottom substrate. The casing then is dewatered, and the piling is driven within the dewatered isolation casing. Isolation casings are similar to cofferdams in that they isolate the work area from the water column; however, because isolation casings have a smaller footprint, they cannot be used to isolate large areas (CalTrans, 2015).

Dewatered isolation casings generally can be expected to provide attenuation that is at least as great as the attenuation provided by air bubble curtains. Because of the uncertainties associated with degree of attenuation that would be provided by isolation casings, it is recommended that attenuation assumed for any attenuation device be limited to 5 dB (CalTrans, 2015).

#### 7.1.2.4 Vibratory Hammers

Three types of pile drivers may be used: 1) vibratory, 2) push, and 3) impact hammer pile drivers. The type and size of pile driving equipment can affect the underwater sound generated during pile driving events (CalTrans, 2015).

Impact pile driving is the most commonly used pile driving method. Impact pile drivers are piston-type drivers that use various means (ignition, hydraulics, or steam) to lift a piston to a desired height and drop the piston (via gravity) against the head of the pile in order to drive it into the substrate. The size and type of impact driver used depend on the energy needed to drive a certain type of pile in various substrates to the necessary depth. The magnitude and characteristics of underwater sound generated by a pile strike depend on the energy of the strike, and the pile size and composition.

In some instances, a vibratory hammer may be used to drive piles. Vibratory hammers use oscillatory hammers that vibrate the pile, causing the sediment surrounding the pile to liquefy and allow pile penetration. Vibratory hammers are routinely used on smaller piles and to install sheet pile. Vibratory drivers, however, can be used as a mitigation measure to reduce the potential for adverse effects from an impact driver. A vibratory driver is first used to drive a pile as far as possible. An impact hammer is then used to drive the pile to its final position.

Peak sound pressure levels for vibratory hammers can exceed 180 dB; however, the sound from these hammers rises relatively slowly. The vibratory hammer produces sound energy that is spread out over time and is generally 10 to 20 dB lower than impact pile driving (CalTrans, 2015). However, the total energy imparted can be comparable to impact driving because the vibratory hammer operates continuously and requires more time to install the pile. In addition, to meet pile resistance requirements for some projects, piles need to be struck multiple times with an impact hammer which can preclude the use of vibratory hammers in many cases (CalTrans, 2015).

#### 7.1.2.5 Cushion Blocks

During impact pile driving, pile caps are typically placed between the top of the pile and the hammer. The caps are typically 1 to 3 inches thick and made with wood, nylon, or a polymer material. The caps are used to absorb and dissipate heat and to protect the top of the pile from damage. WSDOT conducted a study to evaluate the effectiveness of each of the material types in reducing underwater sound generation (WSDOT, 2006) during the driving of 12-inch diameter steel pipe piles. The study results indicate the following reductions in sound levels relative to having no pile cap in place (CalTrans, 2015):

- Wood – 11 to 26 dB
- Polymer – 7 to 8 dB
- Nylon – 4 to 5 dB

### 7.1.3 Turbidity

Turbidity curtains allow suspended sediment to settle out of the water column in a controlled area, thus minimizing the sediment transport from the area of disturbance. Turbidity curtains are floating impermeable barriers that are constructed of flexible reinforced thermoplastic material with an upper hem containing floatation material and a lower hem that is weighted. Turbidity screens are similar in construction but are constructed of permeable geosynthetic fabric and thus allow for some water to flow through. Turbidity curtains are one of the primary methods for controlling turbidity generated from construction activities.

## 7.2 Proposed Mitigation Measures

Based on the fish life history information for juvenile and adult bluefish, summer flounder and windowpane flounder, their prey species, and migratory species; the duration and extent of the Project Action; and the magnitude of the potential permanent and temporary impacts associated with the construction and demolition activities, the Proposed Action will have no adverse effect on EFH. Therefore, the Navy does not anticipate the need for a TOYR, or the use of noise or turbidity mitigation measures for this Project.

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# Appendix E
# Noise Calculations

## Distance Calculations for Construction Noise

$$dB1 - 10\ x\ a\ x\ Log_{10}\ \left(\frac{R2}{R1}\right) = dB2$$

Where:
dB1 = noise level at construction site
dB2 = noise level at receptor (in dBA, or A-weighted decibels)
a = conventional drop-off rate coefficient
a = 2.0 for point source, no ground or atmospheric absorption
R1 = distance from referenced noise level
R2 = distance from receptor
{$Log_{10}$ is base 10 logarithm}

## Specific Calculations for Utility Bridge EA

### Alternative 1

Construction site is 100 feet from receptor; noise level is 74 dBA at construction site.

$$74 - 10\ x\ 2\ x\ Log_{10}\left(\frac{100}{50}\right) = 67.98\ dBA$$

Construction site is 100 feet from receptor; noise level is 101 dBA at construction site.

$$101 - 10\ x\ 2\ x\ Log_{10}\left(\frac{100}{50}\right) = 94.98\ dBA$$

Construction site is 150 feet from receptor; noise level is 74 dBA at construction site.

$$74 - 10\ x\ 2\ x\ Log_{10}\left(\frac{150}{50}\right) = 64.46\ dBA$$

Construction site is 150 feet from receptor; noise level is 101 dBA at construction site.

$$101 - 10\ x\ 2\ x\ Log_{10}\left(\frac{150}{50}\right) = 91.46\ dBA$$

### Alternative 2

Construction site is 400 feet from receptor; noise level is 74 dBA at construction site.

$$74 - 10\ x\ 2\ x\ Log_{10}\left(\frac{400}{50}\right) = 55.94\ dBA$$

Construction site is 400 feet from receptor; noise level is 101 dBA at construction site.

$$101 - 10\ x\ 2\ x\ Log_{10}\left(\frac{400}{50}\right) = 82.94\ dBA$$

Construction site is 65 feet from receptor; noise level is 74 dBA at construction site.

$$74 - 10\ x\ 2\ x\ Log_{10}\left(\frac{65}{50}\right) = 71.72\ dBA$$

Construction site is 65 feet from receptor; noise level is 101 dBA at construction site.

$$101 - 10\ x\ 2\ x\ Log_{10}\left(\frac{65}{50}\right) = 98.72\ dBA$$