

Lockheed Martin Corporation
6801 Rockledge Drive MP: CCT-246
Bethesda, MD 20817
Telephone (240) 460-7508



November 29, 2022

VIA EMAIL AND PRIVATE CARRIER

Matthew Wallach
Tidal Wetlands Division
Wetlands & Waterways Program
Maryland Dept. of the Environment
1800 Washington Blvd, Suite 430
Baltimore, MD 21230

Subject: Transmittal of the 2022 Cow Pen Creek Wetland Restoration Monitoring Report
Lockheed Martin Corporation – Middle River Complex
2323 Eastern Boulevard, Middle River, Baltimore County, Maryland

Dear Mr. Wallach,

For your review and approval, please find enclosed one hard copy with a CD of the above-referenced document. This report documents wetland restoration as assessed in 2022, following sediment remediation that was completed at the end of 2017. Cow Pen Creek is located adjacent to the Lockheed Martin Middle River Complex in Middle River, Maryland.

We respectfully request the favor of your comments or approval by Tuesday, January 24, 2023.

Please let me know if you have any questions. My office phone is (240) 460-7508. My email address is tom.d.blackman@lmco.com.

Sincerely,

A handwritten signature in black ink, appearing to read "Tom D. Blackman", with a long horizontal flourish extending to the right.

Thomas D. Blackman
Project Lead, Environmental Remediation

cc: (via email without enclosure)
Christine Kline, Lockheed Martin
Mary Morningstar, Lockheed Martin
Tom Green, LMCPI
James Damm, LMCPI
Michael Martin, Tetra Tech
Cannon Silver, CDM Smith

cc: (via Secure Information Exchange {SIE} or Box)
Anuradha Mohanty, MDE {SIE}
Mark Mank, MDE {SIE}
Thomas Johnson, MDE {SIE}
Sara Albrecht, MDE {SIE}
Cheryl Kerr, MDE {SIE}
Remediation Records, Lockheed Martin {Box}
Scott Heinlein, LMCPI {Box}
Christopher Keller, LMCPI {Box}
Rina Scales, LMCPI {Box}
Bud Zahn, MRAS {Box}

**COW PEN CREEK WETLAND RESTORATION–
2022 MONITORING REPORT
2323 EASTERN BOULEVARD
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND**

Prepared for:
Lockheed Martin Corporation

Prepared by:
Tetra Tech, Inc.

November 2022

Revision: 0



Michael Martin, P.G.
Regional Manager



Bob Murphy
Project Manager

TABLE OF CONTENTS

Section	Page
Table of Contents	i
List of FIGURES	ii
Appendices	ii
Acronyms and Abbreviations	iii
Section 1 Introduction	1-1
1.1 Purpose of the Wetland Restoration, Monitoring, and Maintenance	1-1
1.2 Objectives	1-2
Section 2 Pre-Remedial Conditions and Background	2-1
Section 3 Wetland Monitoring and Data Collection IN 2022	3-1
3.1 Activities Performed	3-1
3.2 Recorded Observations	3-3
3.2.1 2022 Wetland Plot Descriptions.....	3-3
3.2.2 Site Wide Observations 2022	3-7
Section 4 Conclusions And Recommendations	4-1
4.1 Forested Wetland.....	4-1
4.2 Scrub-shrub Wetland	4-2
4.3 Emergent Wetland	4-2
4.4 Comparison to Long-Term Monitoring Goals	4-2
4.5 Future Monitoring/Maintenance Events.....	4-5
Section 5 References	5-1

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

- Figure 1-1 Wetland Restoration Monitoring Area and Revegetation Design
Figure 2-1 Location of Cow Pen Creek and Dark Head Cove near the Middle River Complex
Figure 3-1 Map of 2022 Wetland Monitoring Plot Locations
Figure 3-2 Plot 1– Scrub-shrub Wetland, near Upstream Limit of Project Area
Figure 3-3 Plot 2– Scrub-shrub Wetland Along Upper Portion of Cow Pen Creek
Figure 3-4 Plot 3– Forested Wetland Bordering Cow Pen Creek on Lockheed Martin Shoreline, Including View of Willows, Sycamores, and Silver Maple
Figure 3-5 Plot 4– View of Forested Wetland Bordering Cow Pen Creek on Lockheed Martin Shoreline, Including Willows and Sycamore (Rose Mallow in Foreground is on Wetter Downslope Edge)
Figure 3-6 Plot 5– Scrub-shrub. Low Area Along the Edge of the Creek with Willow, Cattail, and Jewelweed
Figure 3-7 Plot 6– Forested Wetland Across from Hawthorne Bar Including Willows and Sycamore
Figure 3-8 Plot 7– Emergent Wetland Across from the Hawthorne Bar (Dominant Plant Type is Pickerelweed)
Figure 3-9 Plot 8– Emergent Wetland Farthest Downstream on Lockheed Martin Side (Dominant Vegetation Includes Pickerelweed, Duck Potato, and Cattails)
Figure 3-10 Plot 9– Emergent Wetland on Downstream Edge of Hawthorne Bar; (Dominant Vegetation Includes Pickerelweed and Pennsylvania Smartweed)
Figure 3-11 Plot 10– Emergent wetland near center of Hawthorne Bar (Dominant Vegetation Includes Pickerelweed, Rushes, and Cattails)
Figure 3-12 Plot 11– Forested Wetland near Center of Hawthorn Bar, Close to the Upland Bank (Trees include Sycamore, Eastern Cottonwood, and Silver Maple)

LIST OF TABLES

- Table 3-1 Vegetation Data Recorded during 2022 Wetland Monitoring
Table 3-2 Soil and Wetland Hydrology Observations in 2022
Table 4-1 Square Footage of Non-Tidal Wetland Types in 2022

APPENDICES

- Appendix A – Additional Site Photographs from Annual Wetland Monitoring, August 2022
Appendix B – Previous (2021) Wetland Monitoring Report
Appendix C – Previous (2020) Wetland Monitoring Report
Appendix D – Previous (2019) Wetland Monitoring Report
Appendix E – Previous (2018) Wetland Monitoring Report

ACRONYMS AND ABBREVIATIONS

FAC	facultative species
FACW	facultative wetland (species)
ft ²	square feet
GIS	geographic information system
GPS	global positioning system
IRT	Interagency Review Team
LOA	Letter of Authorization
Lockheed Martin	Lockheed Martin Corporation
MAA	Maryland Aviation Administration
MDE	Maryland Department of the Environment
MRC	Middle River Complex
NOAA	National Oceanic and Atmospheric Administration
OBL	obligate (species)
Tetra Tech	Tetra Tech, Inc.
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture

This page intentionally left blank.

SECTION 1 INTRODUCTION

On behalf of Lockheed Martin Corporation (Lockheed Martin), Tetra Tech Inc. (Tetra Tech) has prepared the following monitoring report for 2022 documenting wetland restoration after sediment remediation was completed at the end of 2017. Cow Pen Creek is located adjacent to the Lockheed Martin Middle River Complex (MRC) in Middle River, Maryland (Figure 1-1).

1.1 PURPOSE OF THE WETLAND RESTORATION, MONITORING, AND MAINTENANCE

As part of the sediment remedy at the Middle River Complex, the upper portion of Cow Pen Creek, including both the stream channel and adjacent floodplain area, was excavated to remove contaminated sediment. Following excavation, the areas were restored per the approved project design (Tetra Tech, 2016). The restoration included reconstruction of the main channel and floodplains, placement of new channel substrate, streambank stabilization and vegetation, wetlands restoration, and revegetation of areas disturbed by sediment removal. The overall goal of restoration and mitigation was to replace the extent, function, and value of Cow Pen Creek wetlands and waters impacted by the remediation project. Documentation of the sediment removal action is provided in the *Season Two Cow Pen Creek Sediment Remedy Completion Report* (Tetra Tech, 2018a).

During remediation, approximately 1.5 acres of channel substrate were removed and replaced with clean material. During substrate removal and creek reconstruction, approximately four acres of vegetated habitat, comprised of forested, scrub/shrub, and emergent (herbaceous) wetlands along Cow Pen Creek were disturbed. This monitoring report focuses on wetland restoration. The approved work plan (Tetra Tech, 2017) does not contain established metrics to measure the success of the wetland restoration, so Tetra Tech has been comparing data collected annually during creek monitoring to determine whether the wetlands were improving. Ground coverage, plant species, and the goals and objectives established in the *Maryland Nontidal Wetland Mitigation Guidance* (Maryland Department of the Environment [MDE], 2011) have been compared annually, and at

the end of the five-year monitoring period in 2022. Specific goals to attain by 2022 included the following:

- a) Greater than 85% of the wetland mitigation site is vegetated (either by planted or naturally revegetated plants) by native wetland species like those found in the nontidal wetland lost, or by a species composition acceptable to the Nontidal Wetlands and Waterways Division. Vegetative communities not acceptable to the Division would include those communities dominated by common reed (*Phragmites australis*) or other nuisance vegetation, or communities that are dominated by facultative upland or upland species.
- b) The entire wetland restoration or creation area has sufficient hydrology to support a prevalence of wetland vegetation. The (United States) Army Corps of Engineers (USACE) and United States Environmental Protection Agency (USEPA) define wetlands as “Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.”
- c) For this determination, wetland vegetation is that which is readily observable in the field and can easily be used to help identify the extent of the wetland area. The wetland area was evaluated to determine the extent of the wetland, and to determine whether the entire area meets the definition of a wetland using the appropriate regional supplement to the *Corps of Engineers Wetland Delineation Manual* (USACE, 2010).
- d) The entire wetland restoration or creation area meets the hydric soil technical standard for saturated conditions and aerobic conditions, as developed by the National Technical Committee for Hydric Soils (United States Department of Agriculture [USDA], 2015).
- e) The site provides the functional goals and objectives established in the *Maryland Nontidal Wetland Mitigation Guidance* (Appendix F in MDE, 2011).

1.2 OBJECTIVES

The monitored restoration area in Cow Pen Creek is shown on Figure 1-1. The specific objectives of wetland monitoring were to:

- observe and report monitored conditions in Cow Pen Creek wetlands, and vegetation along and in Cow Pen Creek
- maintain vegetation within Cow Pen Creek, as needed.

SECTION 2 PRE-REMEDIAL CONDITIONS AND BACKGROUND

The Lockheed Martin Middle River Complex (MRC), which is part of the Chesapeake Industrial Park, is located at 2323 Eastern Boulevard in Middle River, Maryland, approximately 11.5 miles northeast of downtown Baltimore. The site is comprised of approximately 161 acres and includes twelve main buildings. The property also includes an active industrial area and yard, perimeter parking lots, an athletic field, a concrete-covered vacant lot, a trailer and parts storage lot, and numerous grass-covered green spaces along the facility's perimeter. Locked chain-link fences surround all exterior lots and the main industrial area. The site is bounded by Eastern Boulevard (Route 150) to the north, Dark Head Cove to the south, Cow Pen Creek to the west, and Wilson Point Road and Martin State Airport to the east (Figure 2-1).

Lockheed Martin started the removal of contaminated sediment from Dark Head Cove and Cow Pen Creek in 2014. Portions of Dark Head Cove and the lower reaches of Cow Pen Creek were conventionally dredged, and the sediment surface was restored by placing a six-inch-thick sand layer (residual management layer). During the remedial action in the upstream portion of Cow Pen Creek, approximately four acres of vegetated habitat including wetlands were damaged or removed. Wetlands are an important habitat for a variety of organisms, including ecologically important fish and invertebrate species (Brinson and Rheinhardt, 1996). In addition, wetlands provide an excellent food source for several waterfowl species, particularly in the freshwater and oligohaline portions of the Middle River and Chesapeake Bay. In response to the temporary loss of these ecosystems, and in compliance with a United States Army Corps of Engineers (USACE) permit and Maryland Department of the Environment (MDE) Tidal Wetlands Letter of Authorization (LOA), Lockheed Martin implemented a wetland restoration project in 2017-2018. After sediment removal and stream reconstruction was completed, seedlings were planted in the wetland areas along both banks of Cow Pen Creek (see Figure 1-1).

Pre-remedial functions and values (e.g., habitat, physical, and chemical conditions; and scenic, recreational, and other values) in the floodplain of Cow Pen Creek were restored to the extent practicable following the removal of contaminated soil/sediment. The restoration plan was developed to replace specific functions and values by designing features to provide habitat and moderate flood flow, to stabilize the shoreline and retain sediment, to remove toxicants, and to provide aesthetic and recreational values. Pre-remedial features were restored, and toxicants were reduced by replanting emergent vegetation to restore/improve fisheries habitat, and by replanting floodplain forest/shrub vegetation to moderate flood-flow, stabilize shorelines, and retain sediment. Other features, including replanting of riparian vegetation, were designed to restore visual/aesthetic appeal of the stream corridor. Stream restoration features are detailed in Cow Pen Creek design documents (Tetra Tech, 2016).

Under the approved work plan, wetland vegetation was monitored annually from 2018 through 2022. Monitoring was conducted during the forested/scrub-shrub system growing season (between May 1 and September 30), and during the growing season for emergent systems (between June 15 and September 30). Subsequent maintenance activities were conducted twice annually, in the spring (between May 1 and May 30 of each year), and in the fall (between September 15 and October 31 of each year through 2022). Appendix A contains photographs documenting the most recent (August 2022) monitoring of Cow Pen Creek wetland vegetation. Refer to Appendix B for the previous (2021) wetland restoration monitoring report.

SECTION 3 WETLAND MONITORING AND DATA COLLECTION IN 2022

3.1 ACTIVITIES PERFORMED

Tetra Tech conducted its fifth annual (2022) and final monitoring round of restored wetlands of Cow Pen Creek on August 1, 2022. The wetland vegetation survey and data collection were conducted in accordance with the methods specified in the approved *Cow Pen Creek Wetland Restoration Monitoring Work Plan* (Tetra Tech, 2017). Methods from the United States Army Corps of Engineers (USACE) wetlands delineation manual (USACE, 1987) and subsequent Atlantic and Gulf Coastal Plain regional supplement (USACE, 2010) were used to determine the extent of wetland areas.

Plots were randomly selected each monitoring year using the Middle River Complex (MRC) geographic information system (GIS) and a map of the restored area, and using site parameters (i.e., the total plot area) to ensure that sampling plots fall completely within the targeted habitat type (see Figure 3-1). Observations of each plot were made to: (1) identify the dominant plant species, (2) estimate the percentage of dominant species survival, (3) estimate the percentage of ground cover, (4) count the number of woody-stem plants, (5) determine whether invasive species were present, and (6) estimate the percentage of invasive groundcover (Table 3-1).

Vegetation and the designed habitat types were assessed using 400 square foot (ft²) randomly located sampling plots. Three sampling plots were selected and monitored in the scrub-shrub habitat and four 400 ft² plots in forest-dominated habitats. In the herbaceous dominated emergent wetland four, three-foot by three-foot sample plots, were randomly monitored (Table 3-1).

Soil was sampled at each plot and was determined to be hydric (Table 3-2). Soil was evaluated for hydric characteristics using the USACE regional supplement. Soil colors were determined using a Munsell Soil Color chart (Munsell Color, 2010).

Additional visual observations were made while walking the length of the site, and while crossing the site, to provide an overall view and condition of the entire area. The site-wide observations were made by walking both shorelines and transecting the wetlands that occur between areas of open water and upland borders.

This report also documents additional observations that include:

- The general health of each stratum of vegetation (e.g., estimating percent survival, percent coverage, and describing general health [e.g., vigorous, stunted, chlorotic, heights of strata, etc.]).
- Any invasive species, including percent coverage within each plot and sufficient description to describe the general locations of each species.
- Sitewide hydrologic conditions, and whether the hydrology is supporting the development of hydrophytic vegetation and hydric soils, including problem areas.
- A description of any observed damage to vegetation, soils, or other component of the restored system, including damage caused by animals, vandalism, or natural events.
- Whether the acreage of each wetland type is sufficient to meet LOA requirements.
- Whether the observed wetlands match the design intent and location of constructed wetlands (as designed and authorized).
- Areas exhibiting erosion (and its likely cause).
- Areas exhibiting sediment deposition (and its likely cause).

Observations and data collected at Cow Pen Creek assessed the following parameters:

1. dominant vegetative species identification (all plots)
2. percent ground cover (all plots)
3. number of woody-plant stems greater than 10 inches in height (total and number per acre; forest and scrub/shrub plots only)
4. percentage of dominant facultative (FAC), facultative wet (FACW), or obligate (OBL) species (all plots)
5. percent survival by planted species (all plots)
6. invasive/noxious species, including percent cover (all plots)

Other recorded data at each sampling plot included indicators of wetland hydrology and soil data (see Table 3-1). Onsite monitoring also documented bare spots of more than 10 square feet, areas of erosion, and areas of failed vegetation relative to the sampling plots. A photo point was established adjacent to each sampled plot, and a photograph was taken of each developing wetland area. Photo and sampling points were located using global positioning system (GPS) instruments, and locations were plotted on aerial photographic maps. The directionality of each photograph taken, as well as the habitat type photographed, were also recorded. Additional photos are included in Appendix A.

3.2 RECORDED OBSERVATIONS

The eleven sampling locations assessed for 2022 (numbered 1–11) are shown on Figure 3-1. Table 3-1 provides a summary of the vegetation observed and recorded at each site, per the monitoring and data collection objectives outlined in Section 3.1. No dead shrubs or trees were observed in the plots. Unless noted in the plot-specific descriptions below, both herbaceous and woody plants are thriving and expanding in coverage. Cattails are common in the scrub-shrub and emergent plots. Both broad leaf (*Typha latifolia*) and narrow leaf cattails (*Typha angustifoli*) are present. Narrow leaf cattail is abundant, but at this time does not appear to be crowding out other wetland vegetation.

3.2.1 2022 Wetland Plot Descriptions

Plot 1: This scrub-shrub location is farthest upstream area assessed in 2022. Ground cover is 100% with 48% creeping bentgrass (*Agrostis stolonifera*), 48% jewelweed (*Impatiens capensis*), and other rush species and mixed herbaceous plants adding to the coverage (Figures 3-1 and 3-2). Non-native creeping bentgrass was introduced here but was part of the approved restoration plan due to Maryland Aviation Administration (MAA) species restrictions. Eleven woody stems were counted in the plot including four sweet bay magnolia (*Magnolia virginiana*), five black willow (*Salix nigra*), one silver maple (*Acer saccharinum*), one green ash (*Fraxinus pennsylvanica*), and one sweet pepperbush (*Clethra alnifolia*). Soil at the monitoring location was wet or saturated at the surface and is hydric based on colors and features (Table 3-2). A small patch of invasive Japanese honeysuckle (*Lonicera japonica*) was observed on the edge of the plot and was treated with herbicide in October 2022. A patch of invasive common reed (*Phragmites australis*) observed near

Plot 1 was also treated with herbicide, but no reeds were observed within the sampling plot. A larger stand of phragmites was noted upstream of Plot 1 (and outside the restoration area).

Plot 2: This scrub-shrub location is the next evaluated section downstream of Plot 1 (Figures 3-1 and 3-3). Ground cover is 100% with no bare spots. The dominant herbaceous vegetation is jewelweed (60% coverage) and creeping bentgrass (30% coverage). The remaining coverage (10%) is made up of broad and narrow leaf cattail (*Typha* spp.). Seven woody stems were counted including two black willow, one silver maple, one sweet gum (*Liquidambar styraciflua*), one slippery elm (*Ulmus rubra*), one sweet pepperbush, and one buttonbush (*Cephalanthus occidentalis*). Soil at the monitoring location was wet or saturated at the surface and is hydric based on colors and features (Table 3-2). No invasive plants were within the sampling plot in October 2022. A patch of Japanese honeysuckle was observed near this location and was treated with herbicide. Bordering the northern side of the plot is a stand of broad leaf cattail.

Plot 3: This forested wetland location is downstream of Plot 2 on the Lockheed Martin (northern) side of the creek (Figures 3-1 and 3-4) and is within the wetland boundary. Ground cover is 95% with no bare spots, and the dominant herbaceous vegetation is jewelweed and creeping bentgrass (25% each), followed by goldenrod (*Solidago* sp.), and false nettle (*Boehmeria cylindrica*) each with 10% coverage. There is 5% cattail coverage of narrow leaf cattail on the wetter edge. A mix of common boneset (*Eupatorium perfoliatum*), sedges (*Carex* spp.) and grasses account for the remaining 20% coverage. Eleven plants with woody stems, including five black willows, five sycamores (*Platanus occidentalis*), and one sweet gum were observed in this plot. There is 100% survival of planted woody material, as no dead shrubs or trees were observed. Narrow leaf cattail, which is exotic and can be considered invasive, was observed within the plot. Soil in the monitoring location was moist at the surface and is hydric based on colors and features.

Plot 4: This forested wetland monitoring location (Figures 3-1 and 3-5) is on the Lockheed Martin side of the creek and farther downstream from Plot 3 at slightly lower elevation, and near the scrub-shrub wetland boundary. Ground cover is 100% with no bare spots, and the dominant herbaceous vegetation is soft rush (*Juncus effusus*) at 30% coverage followed by creeping bentgrass (20%) and sedges (10%) and rice cutgrass (*Leersia oryzoides*) (10%). The remaining herbaceous ground cover consists of common boneset, broadleaf cattail, and false nettle. Thirteen plants with woody

stems, including four sycamores, four river birch (*Betula nigra*), two boxelder (*Acer negundo*), one silver maple, one black willow, and one sweet gum. Survival of planted woody material is 100%, as no dead shrubs or trees were observed. Soil in the monitoring location was wet at the surface, saturated at a depth of 14 inches, and is hydric based on colors and features. No invasive plants were observed within the plot.

Plot 5: This scrub-shrub wetland sampling location is downstream and downslope of Plot 4 on the Lockheed Martin side of the creek (Figures 3-1 and 3-6). Ground cover is 95% and the dominant herbaceous vegetation is creeping bentgrass with an estimated 75% coverage. Other species included jewelweed, narrow leaf cattails, goldenrod, and sedges. Rose mallow (*Hibiscus moscheutos*) were common, making up about 10% coverage at the 0.5-to-1.5-meter height. No dead shrubs or trees were observed in or adjacent to the plot. Five planted and/or natural recruitment tree and woody shrub species were observed, including two sycamores and three willows. Soil in the monitoring location was saturated at the surface and is hydric based on colors and features.

Plot 6: This forested wetland sampling location is downstream on the Lockheed Martin side of the creek and is close to the transition to emergent wetlands (Figures 3-1 and 3-7). Ground cover is 95%, with creeping bentgrass estimated as 60% cover, jewelweed at 10% and soft rush at 10%, while Pennsylvania smartweed (*Persicaria pensylvanica*), common boneset, sedge, and grass species make up the remaining 15% cover. Ten living woody stems were counted, including seven black willow, two sycamore, and one silver maple. Several hibiscus plants were noted on the downslope edge of the site. No dead shrubs or trees were observed. Soil in the monitoring location was moist at the surface to saturated at 14 inches and is hydric based on colors and features. No invasive plants were observed within the plot.

Plot 7: This emergent wetland plot is down slope of Plot 6 along the water's edge (Figures 3-1 and 3-8). Herbaceous ground cover is 95% with 50% pickerelweed, 20% broad leaf cattail, 5% hibiscus, and 5% sedges and other herbaceous wetland plants. No woody plants were within the

sampling plot. No invasive plants were observed within the plot. The soil was flooded at the surface due to the level of the tide.

Plot 8: This emergent wetland plot is the farthest downstream on the Lockheed Martin side of the creek where the creek is widening (Figures 3-1 and 3-9). Herbaceous ground cover is 95% with 50% pickerelweed, 20 percent duck potato (*Sagittaria latifolia*), 20% narrow leaf cattail, 5% rose mallow, and 5% grass and sedge species. No woody plants were within the sampling plot. The soil was flooded at the surface due to the level of the tide.

Plot 9: This emergent wetland plot is on the Hawthorne Elementary School (southern) side of the creek on the silt and sand bar in an area that is frequently flooded at high tide, about halfway down the restored section of the creek (Figures 3-1 and 3-10). Herbaceous groundcover is 95% with rice cutgrass and pickerelweed estimated at 40% each. Pennsylvania smartweed covers another 15%. Broad leaf cattail is present. No woody plants were within the sampling plot. Soil in the monitoring location was saturated at the surface and is hydric based on colors and features. No invasive plants were observed within the plot.

Plot 10: This emergent wetland plot is on the Hawthorne Elementary School (southern) side of the creek and is closer to the water's edge than Plot 9 (Figures 3-1 and 3-11). Herbaceous coverage is about 85% with bare spots between clumps of pickerelweed and rushes. The bare spots may be due to the higher duration of flooding with the soil only exposed during low tide. The herbaceous cover include pickerelweed at 55%, soft rush at 20%, Pennsylvania smartweed at 5%, marsh fleabane (*Pluchea odorata*) at 5%, and narrow leaf cattail at 5% on the edge of the plot. No woody plants were within the sampling plot. Soil in the monitoring location was saturated at the surface, water filled the soil sampling hole.

Plot 11: This forested wetland plot on the Hawthorne Elementary School side is closer to the upland bank than Plots 10 and 11 (Figures 3-1 and 3-12). Ground cover is 95%, with about 50% jewelweed, 40% rice cutgrass, and 5% water hemlock (*Cicuta maculata*). Woody living stems include 10 sycamore, one eastern cottonweed, one sweet gum, and two groundsel bush (*Baccharis halimifolia*) shrubs. No dead shrubs or trees were observed. Soil in the monitoring location was

moist at the surface to saturated at 14 inches and is hydric based on colors and features. No invasive plants were observed within the plot.

3.2.2 Site Wide Observations 2022

- Phragmites continues to present in small patches, but areas containing it have been treated twice a year through 2022; progress is being made, as the stands are smaller and not as dense as in the past. A stand of phragmites is upstream and outside the restoration area. Other invasive plant species being treated in the Cow Pen Creek wetland monitoring area include Asiatic bittersweet (*Celastrus orbiculatus*), Chinese elm (*Ulmus parvifolia*), and honeysuckle, with both vine (*Lonicera japonica*) and bush honeysuckle (*Lonicera tatarica*) present. Some of these species are occurring near or just upland of the wetland boundary. Narrowleaf cattail (*Typha angustifolia*) is present in some of the emergent wetland areas but does not appear to have expanded in coverage. Barnyard grass (*Echinochloa crus-galli*) has been present as individual plants and is sprayed or hand pulled when found. Barnyard grass is a summer annual and does not seem to be increasing in coverage. Native wetland vegetation has filled in leaving no bare areas, which is helping to control the spread of any invasive species.
- No erosion was observed at any of the assessed wetland plots. One location on the eastern slope near the head of the project area that developed a rill/gully appears to be stable with no visible bare spots. This area is approximately 5 feet wide at its widest point and is 20 feet long. Additional stabilization was conducted in this area in early January 2021 to repair and control the erosion that was likely caused by, or contributed to, stormwater runoff from the adjacent parking lots.
- No observable sedimentation was noted in the restored wetland areas, other than possibly some sediment accretion on parts of the Hawthorne bar (where sampling plots 9, 10, and 11 are located; see Figure 3-1). Multi-year visual observations indicate that some sedimentation is occurring at the downstream bar where the channel widens, and water velocity (flow) slows. However, this area is within the stream channel and not within the boundary of one of the designed wetland types. At low tide, starting at the Hawthorne bar and moving downstream, are exposed mud flats that are outside of the wetland boundaries.

General observations from infrequently inundated areas are summarized below:

- Planted woody plants are in their fifth year and growing. Woody shrubs and trees are thriving with no signs of predation or disease. Seedlings from natural recruitment, including sycamore, red maple, and sweet gum, are occurring in the upper section of the restored area, and are as abundant as the trees that were planted. Some of the planted willows and sycamores are 14 – 20 feet high and provide beneficial shade to the stream. Most of the area will become bordered by trees, along and just inside the wetland boundary that marks the transition between wetland and upland. In addition to planted trees, trees from natural recruitment continue to increase in number and grow on most of the bars and shoreline that have sufficient elevation to avoid prolonged inundation. Many have become

established through natural recruitment from the stand of mature trees on the Hawthorne Elementary School (southern) side of the creek.

- The forested and scrub-shrub wetlands have a heathy herbaceous vegetation layer with increasing species diversity. There are no signs of decline in cover. Similar to 2021, the dominant herbaceous vegetation in much of emergent, scrub-shrub, and wetter forested areas is creeping bentgrass (see Appendix B). However, more sedges and rushes, along with switchgrass, arrowleaf tearthumb (*Persicaria sagittata*), rice cutgrass and other wetland species were observed in 2022. The diversity and coverage area of native perennials and shrubs continues to increase. Sweet pepperbush and buttonbush were planted and are thriving. Rose mallow, saltmarsh mallow (*Kosteletzkya pentacarpos*), and groundsel bush are examples of native plants expanding in coverage. Recruitment of other wetland species accounts for 15–25% of herbaceous ground cover. These species will likely continue to increase in coverage with additional species occurring over time.

Observations from frequently inundated areas include:

- Plants commonly found in scrub-shrub wetlands are increasing in number and diversity in areas designed as scrub–shrub wetlands. The most common is rose mallow, saltmarsh mallow, and groundsel bush. Other shrubs include Virginia sweetspire (*Itea virginica*) and sweet pepperbush.
- Planted woody plants have low survival in frequently flooded areas but herbaceous wetland vegetation is thriving in those areas. Natural recruitment of groundsel bush and rose mallow is also occurring in frequently flooded areas.
- The benches at the downstream section of the restoration are mostly unvegetated tidal mudflats. About 25% of the benches are vegetated primarily with pickerelweed, duck potato and soft rush.

SECTION 4

CONCLUSIONS AND RECOMMENDATIONS

4.1 FORESTED WETLAND

Wetland types were delineated by the type of vegetation they will support (forested, scrub-shrub, emergent). Whether a wetland area is dominated by trees (forested), shrubs or stunted trees (scrub-shrub), or emergent (herbaceous vegetation) is mainly determined by hydrologic conditions. The general hydrologic gradient follows elevation. Changes in vegetation type are observable, from forested at higher elevations moving to lower and wetter areas that support scrub-shrub wetlands with saturated soils, to emergent wetlands that are frequently flooded. Forested areas transition to shrubs and stunted trees (scrub-shrub) moving downslope and closer to open water. Where areas are frequently flooded, the predominant vegetation becomes emergent marsh plants.

A forensic wetland evaluation was performed in 2022 to determine type and area of wetlands impacted during excavation at Cow Pen Creek (Straughan, 2022), due to discrepancies regarding the accuracy of the 2015 wetland delineation. The impacted area was modified to reflect the forensic delineation, and subsequently approved by the Maryland Department of the Environment (MDE) through a modification to the letter of authorization (15-NT-0409/20156195, dated June 21, 2022). The overall area currently delineated as forested wetlands exceeds the area for forested wetlands listed in the modified letter of authorization (LOA) by approximately 5,910 square feet, based on the August 2022 wetland delineation (Table 4-1).

Although herbaceous vegetation is still dominated by creeping bentgrass in non-inundated areas of restored forested wetlands, other herbaceous wetland vegetation is increasing in coverage, including other grass species, sedges, and rushes. Creeping bentgrass was part of the approved seed mix and became well established in 2018. In general, trees and shrubs have vegetated the flooded areas through natural recruitment based on their tolerance to inundation and saturated soils. These trees will eventually shade out shade-intolerant herbaceous species.

4.2 SCRUB-SHRUB WETLAND

The first area of scrub-shrub wetland is an upstream linear area (Plots 1 and 2 on Figure 3-1), and the second scrub-shrub area is several hundred feet downstream, and just upstream of the middle of the restored area (Plot 5 on Figure 3-1). Areas of scrub-shrub wetlands that are not regularly flooded are dominated by creeping bentgrass and contain planted shrubs and trees. Part of the downstream scrub-shrub wetland closest to the stream channel was flooded with two to three inches of water at the time of the field survey and appears to be regularly inundated with water at high tide. Emergent vegetation dominates most of this regularly flooded area. Some of this area contains willows and wetland tolerant shrubs.

The area reconstructed as scrub-shrub wetland is currently over 1,000 square feet short of the scrub-shrub wetland area required under the revised June 2022 LOA. The pre-remedial wetlands based on the forensic delineation was 7,881 square feet, but as of August 2022, scrub-shrub wetlands occupy 6,864 square feet (Table 4-1) of the Cow Pen Creek restoration area.

4.3 EMERGENT WETLAND

As shown on Figure 3-1, emergent wetlands are present along the downstream banks (Plots 7, 9, and 10) of the site (Figure 3-1). The monitoring team observed several patches of pickerelweed on the downstream wetland benches, but overall vegetation coverage on these benches was less than 25%. Farther upstream, the shallow water along most of the shoreline was vegetated with emergent vegetation.

The emergent wetland area listed in the revised LOA is 16,925 square feet. The area reconstructed as emergent wetland is short of LOA conditions by 4,413 square feet (Table 4-1).

4.4 COMPARISON TO LONG-TERM MONITORING GOALS

Field monitoring and maintenance activities are designed to ensure the goals and objectives established in the *Maryland Nontidal Wetland Mitigation Guidance* (Maryland Department of the Environment [MDE], 2011) are met by the end of the five-year monitoring period (in 2022). Fifth year (2022) monitoring results indicate that the restored wetland area is meeting these goals. The total area for forested wetland exceeds LOA requirements by 5,910 square feet. Scrub-shrub

wetlands are short of the LOA requirements by 1,017 square feet, while emergent wetlands are short of LOA conditions by 4,413 square feet. Therefore, the combined total wetlands area exceeds the total LOA requirements by 480 square feet.

A summary of the five-year monitoring goals and their status after the fifth year of monitoring follows.

Vegetated Wetland Goal: Greater than 85% of the wetland mitigation site is vegetated (either by planted or naturally revegetated plants) by native wetland species like those found in the nontidal wetland before remediation, or by a species composition acceptable to the Nontidal Wetlands and Waterways Division (Division) of the Maryland Department of the Environment. Vegetative communities not acceptable to the Division would include those communities dominated by common reed or other nuisance vegetation, or communities that are dominated by facultative upland or upland species.

Fifth Year Monitoring Status: Similar to 2021, the wetland mitigation site is approximately 90% vegetated with native wetland species. The main exceptions are areas designed as emergent wetland or inter-tidal areas where inundation or flooding has occurred frequently enough to result in mortality of woody species, and where herbaceous species have either not become established or not persisted.

Hydrology Goal: The entire wetland restoration or creation area must have sufficient hydrology to support a prevalence of wetland vegetation. The Army Corps of Engineers and United States Environmental Protection Agency define wetlands as “Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.”

Fifth Year Monitoring Status: The entire site continues to have varied but ample wetland hydrology to support a prevalence of wetland vegetation. As described in previous reports, an area on the Hawthorne Elementary School side of the creek, including a bar and floodplain, does appear to be too frequently inundated to support most tree species (Plot 9, Figure 3-1). Most of the trees planted in this area during the initial restoration planting died by the end of

the first growing season (2018), most likely due to frequent inundation and/or inadequate acclimation; only about 10% of these trees survived. In these areas, outside of the sparsely vegetated tidal mudflats, the hydrology supports emergent wetland vegetation.

Wetland Vegetation Goal: For this determination, wetland vegetation is that which is readily observable in the field and can easily be used to help identify the extent of the wetland area. The wetland area will be evaluated to determine its extent and to determine if it meets the definition of a wetland using the appropriate regional supplement to the *Corps of Engineers Wetland Delineation Manual* (USACE, 1987 and 2010).

Fifth Year Monitoring Status: Observable wetland vegetation can be used to identify wetland extent in the mitigation area. Vegetation has become well established, and diversity is increasing. The entire wetland area is identifiable by wetland vegetation, except for inundated areas that resemble mudflats.

Hydric Soil Goal: The entire wetland restoration or creation area must meet the hydric soil technical standard for saturated conditions and aerobic conditions, as developed by the National Technical Committee for Hydric Soils (United States Department of Agriculture [USDA], 2015).

Fifth Year Monitoring Status: The restored wetland area was either flooded, or soil was saturated (wet) at the surface.

Functional Goal: The site will provide the functional goals and objectives established in Appendix F of the *Maryland Nontidal Wetland Mitigation Guidance* (MDE, 2011).

Fifth year Monitoring Status: No direct measurement of nutrient removal and sediment control was conducted, but these functions (nutrient removal and sediment control) are likely to be occurring for the wetland types at certain positions in the landscape. Sediment capture is occurring at the downstream silt and sand bar, likely resulting from decreased flow velocity in the creek as it widens in this portion of the channel. Nutrient removal is likely occurring via phosphorus binding to sediment particles and denitrification conditions in anaerobic soil and sediment.

4.5 FUTURE MONITORING/MAINTENANCE EVENTS

No additional monitoring or maintenance events are planned, as this fifth year of monitoring/maintenance concludes our required five years of monitoring/maintenance. Maintenance activities conducted in spring and fall 2022 included invasive species control in areas with common reed and other invasive species, observations to determine whether treatments to date have effectively controlled growth of invasive plants, and observations to determine whether additional treatments are needed to eliminate spreading. Small patches of common reed continue to appear likely due to the extensive stand of phragmites upstream of the site. Note that outside of those areas previously identified in the mudflats and wetland benches, no significant bare patches in need of replanting or reseeding were identified in 2022.

This page intentionally left blank.

SECTION 5 REFERENCES

- Brinson, M.M., and R. Rheinhardt, 1996. "The role of reference wetlands in functional assessment and mitigation." *Ecological Applications* 6: 69-76.
- Maryland Department of the Environment (MDE), 2011. *Maryland Nontidal Wetland Mitigation Guidance*. Prepared by Nontidal Wetland and Waterways Division. Funded by EPA State Wetland Program Development Grant CD 993010-01-1. Second Edition. January.
- Munsell Color. 2010. Munsell soil color charts with genuine Munsell color chips. Grand Rapids, Michigan: Munsell Color.
- Tetra Tech, Inc. (Tetra Tech), 2016. *Sediment Remedy 100% Design for Cow Pen Creek and Dark Head Cove, Middle River Remediation Site*. Lockheed Martin Middle River Complex, Middle River, Maryland. Project Design Plan Set. September.
- Tetra Tech, Inc. (Tetra Tech), 2017. *Cow Pen Creek Wetland Restoration Monitoring Work Plan*, Lockheed Martin Middle River Complex, Middle River, Maryland. November.
- Tetra Tech, Inc. (Tetra Tech), 2018a. *Season Two Cow Pen Creek Sediment Remedy Completion Report*. Lockheed Martin Middle River Complex, Middle River, Maryland. May.
- Tetra Tech, Inc. (Tetra Tech), 2018b. *Cow Pen Creek Bank Stabilization and Floodplain Reconstruction Monitoring: 2018 Report*. Lockheed Martin Middle River Complex, Middle River, Maryland. October.
- Tetra Tech, Inc. (Tetra Tech), 2018c *Cow Pen Creek Wetland Restoration 2018 Monitoring Report*. Lockheed Martin Middle River Complex, Middle River, Maryland. January.
- Tetra Tech, Inc. (Tetra Tech), 2019 *Cow Pen Creek Wetland Restoration 2019 Monitoring Report*. Lockheed Martin Middle River Complex, Middle River, Maryland. January.
- Tetra Tech, Inc. (Tetra Tech), 2020 *Cow Pen Creek Wetland Restoration 2020 Monitoring Report*. Lockheed Martin Middle River Complex, Middle River, Maryland. January.
- Straughan Environmental, Inc., 2022. *Lockheed Martin – Cow Pen Creek Forensic Wetland Investigation*. Technical Memorandum. February.
- United States Army Corps of Engineers (USACE), 1987. *Corps of Engineers Wetlands Delineation Manual*. Wetlands Research Program Technical Report Y-87-1. Final Report. January.

United States Army Corps of Engineers (USACE), 2010. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region* (Version 2.0), ed. J. S. Wakeley, R. W. Lichvar, and C. V. Noble. ERDC/EL TR-10-20. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

United States. Army Corps of Engineers (USACE), 2020. *National Wetland Plant List*, version 3.5, Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH <http://wetland-plants.usace.army.mil/>

United States Department of Agriculture (USDA), 2015. *Hydric Soils Technical Standard and Data Submission Requirements for Field Indicators of Hydric Soils*. Hydric Soils Technical Note 11. Natural Resources Conservation Service (NRCS), in cooperation with National Technical Committee for Hydric Soils. Washington, D.C.

FIGURES

-
- Figure 1-1 Wetland Restoration Monitoring Area and Revegetation Design**
- Figure 2-1 Location of Cow Pen Creek and Dark Head Cove near the Middle River Complex**
- Figure 3-1 Map of 2022 Wetland Monitoring Plot Locations**
- Figure 3-2 Plot 1– Scrub-shrub Wetland near Upstream Limit of Project Area**
- Figure 3-3 Plot 2– Scrub-shrub Wetland Along Upper Portion of Cow Pen Creek**
- Figure 3-4 Plot 3– Forested Wetland Bordering Cow Pen Creek on Lockheed Martin Shoreline Including View of Willows, Sycamores, and Silver Maple**
- Figure 3-5 Plot 4– View of Forested Wetland Bordering Cow Pen Creek on Lockheed Martin Shoreline Including Willows and Sycamore (Rose Mallow in Foreground is on Wetter Downslope Edge)**
- Figure 3-6 Plot 5– Scrub-shrub; Low Area Along the Edge of the Creek with Willow, Cattail, and Jewelweed**
- Figure 3-7 Plot 6– Forested Wetland Across from the Hawthorne Bar Including Willows and Sycamore**
- Figure 3-8 Plot 7 Emergent Wetland Across from the Hawthorne Bar (Dominant Vegetation is Pickerelweed)**
- Figure 3-9 Plot 8– Emergent Wetland Farthest Downstream on the Lockheed Martin Side (Dominant Vegetation Includes Pickerelweed, Duck Potato, and Cattails)**
- Figure 3-10 Plot 9– Emergent Wetland on Downstream Edge of Hawthorne Bar (Dominant Vegetation Includes Pickerelweed and Pennsylvania Smartweed)**
- Figure 3-11 Plot 10– Emergent Wetland Near Center of Hawthorne Bar (Dominant Vegetation Includes Pickerelweed, Rushes, and Cattails)**
- Figure 3-12 Plot 11– Forested Wetland near Center of Hawthorne Bar Close to the Upland Bank (Trees Include Sycamore, Eastern Cottonwood, and Silver Maple)**

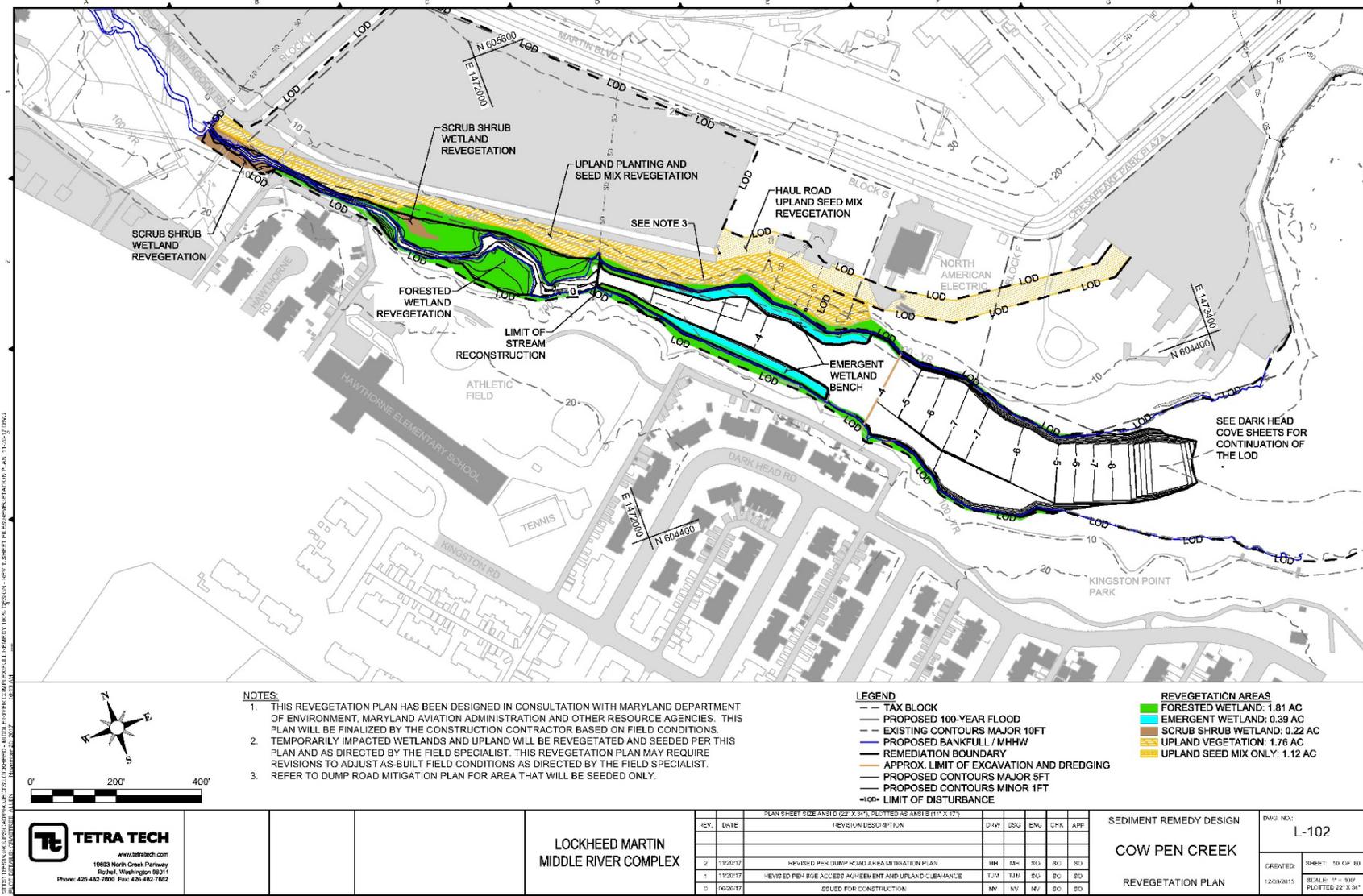


Figure 1-1. Wetland Restoration Monitoring Area and Revegetation Design.

9073 Tetra Tech • Lockheed Martin Middle River Complex •
Cow Pen Creek Wetland Restoration 2022 Monitoring Report



Figure 2-1. Location of Cow Pen Creek and Dark Head Cove near the Middle River Complex.



Figure 3-1. Map of 2022 Wetland Monitoring Plot Locations
(The wetland polygon areas are based on the August 2022 wetland delineation.)



Figure 3-2. Plot 1– Scrub-shrub Wetland near Upstream Limit of Project Area.



Figure 3-3. Plot 2– Scrub-shrub Wetland Along Upper Portion of Cow Pen Creek.



Figure 3-4. Plot 3– Forested Wetland Bordering Cow Pen Creek on Lockheed Martin Shoreline Including View of Willows, Sycamores, and Silver Maple.



Figure 3-5. Plot 4– View of Forested Wetland Bordering Cow Pen Creek on Lockheed Martin Shoreline Including Willows and Sycamore
(Rose Mallow in Foreground is on Wetter Downslope Edge)



Figure 3-6. Plot 5– Scrub-shrub; Low Area Along the Edge of the Creek with Willow, Cattail, and Jewelweed.



Figure 3-7. Plot 6– Forested Wetland Across from Hawthorne Bar Including Willows and Sycamore.



Figure 3-8. Plot 7– Emergent Wetland Across from the Hawthorne Bar
(Dominant Vegetation is Pickerelweed)



Figure 3-9. Plot 8– Emergent Wetland Farthest Downstream on the Lockheed Martin Side
(Dominant Vegetation Includes Pickerelweed, Duck Potato, and Cattails)



Figure 3-10. Plot 9– Emergent Wetland on Downstream Edge of Hawthorne Bar
(Dominant Vegetation Includes Pickerelweed and Pennsylvania Smartweed)



Figure 3-11. Plot 10– Emergent Wetland Near Center of Hawthorne Bar
(Dominant Vegetation Includes Pickerelweed, Rushes, and Cattails)



Figure 3-12. Plot 11– Forested Wetland near Center of Hawthorne Bar Close to the Upland Bank (Trees Include Sycamore, Eastern Cottonwood, and Silver Maple)

TABLES

Table 3-1 Vegetation Data Recorded during 2022 Wetland Monitoring

Table 3-2 Soil and Wetland Hydrology Observations in 2022

Table 4-1 Square Footage of Non-Tidal Wetland Types in 2022

**Table 3-1
Vegetation Data Recorded during 2022 Wetland Monitoring
Middle River Complex, Middle River, Maryland**

Plot ID	Latitude	Longitude	Wetland type	Dominant vegetation	Ground cover (%)	Woody stem (count)	Dominant species (%)	Woody plantings survival (%)	Invasive species present (yes/no)	Invasive groundcover (%)
1	39.3280	-76.4376	Scrub-shrub	creeping bentgrass (<i>Agrostis stolonifera</i>) jewelweed (<i>Impatiens capensis</i>) sweet bay magnolia (<i>Magnolia virginiana</i>) black willow (<i>Salix nigra</i>)	100	11	50	100	yes	2
2	39.3280	-76.4376	Scrub-shrub	jewelweed (<i>Impatiens capensis</i>) creeping bentgrass (<i>Agrostis stolonifera</i>) black willow (<i>Salix nigra</i>)	100	7	60	100	yes	5
3	39.3277	-76.4371	Forested	jewelweed (<i>Impatiens capensis</i>) creeping bentgrass (<i>Agrostis stolonifera</i>) goldenrod (<i>Solidago</i> sp.) false nettle (<i>Boehmeria cylindrica</i>) sycamore (<i>Platanus occidentalis</i>) black willow (<i>Salix nigra</i>)	95	11	25	100	no	0
4	39.3273	-76.4365	Forested	soft rush (<i>Juncus effusus</i>) creeping bentgrass (<i>Agrostis stolonifera</i>) sedges spp. rice cutgrass (<i>Leersia oryzoides</i>) sycamore (<i>Platanus occidentalis</i>) river birch (<i>Betula nigra</i>)	100	13	30	100	no	0
5	39.3272	-76.4365	Scrub-shrub	creeping bentgrass (<i>Agrostis stolonifera</i>) hibiscus (<i>Hibiscus moscheutos</i>) black willow (<i>Salix nigra</i>) sycamore (<i>Platanus occidentalis</i>)	95	5	75	100	yes	5
6	39.3268	-76.4355	Forested	creeping bentgrass (<i>Agrostis stolonifera</i>) jewelweed (<i>Impatiens capensis</i>) soft rush (<i>Juncus effusus</i>) black willow (<i>Salix nigra</i>) sycamore (<i>Platanus occidentalis</i>)	95	10	60	100	no	0
7	39.3267	-76.4356	Emergent	pickerelweed (<i>Pontederia cordata</i>) cattail (<i>Typha</i> sp.)	95	0	50	NA	no	0
8	39.3262	-76.4342	Emergent	pickerelweed (<i>Pontederia cordata</i>) cattail (<i>Typha</i> sp.) duck potato (<i>Sagittaria latifolia</i>)	95	0	50	NA	yes	20
9	39.3267	-76.4358	Emergent	rice cutgrass (<i>Leersia oryzoides</i>) pickerelweed (<i>Pontederia cordata</i>)	95	0	40	NA	no	0

**Table 3-2
Soil and Wetland Hydrology Observations in 2022
Middle River Complex, Middle River, Maryland**

Plot ID	Designed Wetland Type	Soil Depth (in.)	Matrix/Color	Percent Moisture (%)	Redox Features	Hydric Soil Indicator	Percent	Type	Loc	Texture	Remarks	Wetland Type
1	Scrub-Shrub	0 - 4	10 YR 3/1	100		Depleted matrix with concentrations				Silt Loam		Scrub-shrub
		4 - 14	10 YR 3/1	98	5 YR 4/5		2	Concentration	Matrix	Silt Loam	Water in the bottom of the hole	
2	Scrub-Shrub	0 - 4	10 YR 3/1	100		Depleted matrix with concentrations				Silt Loam		Scrub-shrub
		5 -16	10 YR 3/1	98	5 YR 4/5		2	Concentration	Matrix	Silt Loam	Water in the bottom of the hole	
3	Forested	0 - 5	10 YR 3/1	98		Depleted matrix with concentrations				Silt Loam		Forested
		5 -14	10 YR 3/1	98	5 YR 4/5		2	Concentration	Matrix	Silt Loam		
4	Forested	0 - 7	10 YR 4/1	100		Depleted matrix with concentrations				Silt Loam		Forested
		7 -14	10 YR 4/1	100	5 YR 4/5		3	Concentration	Matrix	Silt Loam		
5	Scrub-Shrub	0 - 5	10 YR 4/1	100		Depleted matrix with concentrations				Silt Loam		Scrub-shrub
		5 - 16	10 YR 3/1	98	5 YR 4/5		2	Concentration	Matrix	Silt Loam	Water in the bottom of the hole	
6	Forested	0 - 8	10 YR 4/2	98		Depleted matrix with concentrations				Silt Loam		Forested
		44789	10 YR 4/1	100	7.5 YR 4/4		2	Concentration	Matrix	Silt Loam		
7	Emergent	0 - 6	10 YR 3/1	100		Muck surface layer				Muck - Silt	Soil flooded at surface	Emergent
8	Emergent	0 - 6	10 YR 3/1	100		Muck surface layer				Muck - Silt	Soil flooded at surface	Emergent
9	Emergent	0 - 6	10 YR 3/1	100		Muck surface layer				Muck - Silt	Soil flooded at surface	Emergent
10	Emergent	0 - 6	10 YR 3/1	100		Muck surface layer				Muck - Silt	Water fills hole	Emergent
11	Forested	0 - 7	10 YR 4/1	98		Depleted matrix with concentrations				Silt Loam	Saturated to Surface	Forested
		7 - 16	10 YR 4/1	98	5 YR 4/5		3	Concentration	Matrix	Silt Loam		

**Table 4-1
Square Footage of Non-Tidal Wetland Types in 2022
Middle River Complex, Middle River, Maryland**

Wetland type	Wetland Impacts (Excavation Boundary) and Extent per from the Forensic Evaluation (in square feet)¹	Delineated wetland areas within excavation boundary – August 2022 (in square feet)²	Current shortage or overage of wetlands, based on 2022 survey (in square feet)
Forested	7,786	13,696	5,910
Shrub-Scrub	7,881	6,864	-1,017
Emergent	16,925	12,512	-4,413
Total	32,592	33,072	480

¹ – Based on forensic wetland delineation approved by MDE in revised letter of authorization (June 21, 2022).

² – Based on field delineation in August 2022.

APPENDICES

All Appendices are available upon request.

**Appendix A – Additional Site Photographs from Annual Wetland Monitoring,
August 2022**

Appendix B – Previous (2021) Wetland Monitoring Report

Appendix C – Previous (2020) Wetland Monitoring Report

Appendix D – Previous (2019) Wetland Monitoring Report

Appendix E – Previous (2018) Wetland Monitoring Report