SEASON TWO
IN SITU TREATMENT
COMPLETION REPORT
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
2323 EASTERN BOULEVARD
MIDDLE RIVER, MARYLAND

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ACRONYMS AND ABBREVIATIONS

BC	black carbon
CO_2	carbon dioxide
CoA	certificate of analysis
EOR	Engineer of Record
FCR	field-change request
GPS	global positioning system
ISU	*in situ* treatment unit
Lockheed Martin	Lockheed Martin Corporation
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
MRC	Middle River Complex
MSA	Magnuson-Stevens Act
NTU	nephelometric turbidity units
PAC	powdered activated carbon
PCB	polychlorinated biphenyl
pcf	pounds per cubic foot
QC	quality control
RBDAA	risk-based disposal-approval application
RFI	request for information
RML	residual-management layer
RTO	Remediation Technical Operations
SAV	submerged aquatic vegetation
SRA	sediment removal action
Tetra Tech	Tetra Tech, Inc.
TOC	total organic carbon
USEPA	United States Environmental Protection Agency

GLOSSARY

anadromous—Migration of a fish from saltwater to spawn in fresh water.

AquaGate+PAC 10%—Small stones (¼–⅜-inches) composed of bentonite, cellulosic polymer, and 10% powdered activated-carbon (PAC) by weight. The aggregate particles are used to deliver the PAC through the water column to a contaminated-sediment surface.

background (background level)—As defined by the United States Environmental Protection Agency (USEPA), substances in the environment that are not influenced by contaminant releases from a site are usually described as naturally occurring or anthropogenic. "Naturally occurring" is defined as substances in the environment in forms that have not been influenced by human activity. "Anthropogenic" is defined as natural and man-made substances occurring in the environment because of human activities, but not specifically related to the site in question.

benthic organism—An organism that lives on, in, or near the sediment of a seabed or riverbed, also known as the benthic zone. These organisms are also known as benthos, and include worms, clams, crabs, lobsters, sponges, and any other organisms that live in the bottom sediment.

bioaccumulation—The total accumulation of contaminants in the tissue of an organism via any route, such as from food or from the dissolved phase of contaminants in water.

bioavailability—The availability of a chemical to be absorbed by a living organism, possibly causing an adverse physiological or toxicological response.

black carbon—A fine particulate matter formed via the incomplete combustion of fossil fuels, biofuel, and biomass.

bulkhead—A retaining wall along a waterfront.

dead-man anchor—A support or anchoring system consisting of large concrete blocks fitted with steel hooks.

flexi-float—A combination of interlocking modular barges designed to support marine construction projects.

forklift—A vehicle with power-operated prongs that can be used to raise and lower heavy loads.

global positioning system (GPS)—A satellite navigation system used to determine the ground position of an object.

***in situ* treatment—**In this report, *in situ* treatment refers to the use of reactive or adsorptive materials (e.g., AquaGate+PAC 10%) to reduce the bioavailability of contaminants in sediment.

nephelometric—A measurement of the density of suspended particles in a liquid by measuring the degree to which the suspension scatters light.

piling—A steel beam driven into the ground to support a foundation and/or resist horizontal loads.

pilot study—A preliminary small-scale study to determine the feasibility, time, cost, adverse consequences, and improvements that might be needed to implement a larger-scale operation.

polychlorinated biphenyls (PCBs)—PCBs are manmade organic chemicals manufactured and used in construction materials and electrical products from approximately 1930 to 1979. PCBs belong to a broad family of organic chemicals known as chlorinated hydrocarbons. They vary in consistency from thin, light-colored liquids to yellow or black waxy solids. They have a range of toxicity, including carcinogenic and noncarcinogenic effects. The nonflammability, chemical stability, high boiling point, and electrical insulating properties of PCBs led to their widespread use in hundreds of industrial and commercial applications, including electrical transformers, hydraulic equipment, thermal insulation, fluorescent lights, oil-based paints, and carbonless copy paper. The manufacture of PCBs in the United States was banned in 1979.

powdered activated-carbon (PAC)—Used to adsorb natural organic compounds, taste and odor compounds, and synthetic organic chemicals.

push core—A 2.25-inch-circumference polycarbonate tube used to measure thickness of *in situ* material placed within the sediment.

remedial investigation/feasibility study—USEPA defines a remedial investigation (RI) involves collecting data to inform decision-makers about conditions at a site, including the nature and extent of contamination and the risks it poses to human health and the environment. Potential treatments might be assessed to evaluate their performance and costs. The remedial investigation is followed by a feasibility study (FS), which USEPA defines as a study wherein remedial-action alternatives are screened and evaluated against each other for their potential to clean up the site.

residual management-layer—A six-inch layer of fine sand material used to cap dredged areas.

rock outlet—An erosion control measure to prevent sediment scouring underneath outfalls and other discharge outlets.

site—The area of investigation or remediation.

sonde—An instrument probe that automatically transmits information about its surroundings underground, underwater, or in the atmosphere.

telehandler—A vehicle with an extendable boom and pallet forks that is used to move loads that a conventional forklift cannot reach.

temporary asphalt berm—A sediment control device used to divert sheet flow and runoff from entering a construction site.

total organic carbon—A measurement of the amount of carbon in an organic compound.

vibratory hammer—A hydraulic hammer used to drive piling in or out of the ground.

whirley crane—A crane free to rotate 360º to pick up and deposit its load.

EXECUTIVE SUMMARY

On behalf of Lockheed Martin Corporation (Lockheed Martin), Tetra Tech, Inc. (Tetra Tech) has prepared this completion report summarizing activities that placed *in situ* treatment material (namely, AquaGate+PAC [powdered activated carbon] 10%) throughout Dark Head Cove. This task aimed to reduce the bioavailability of polychlorinated biphenyls (PCBs) in benthic (i.e., sediment-dwelling) organisms by applying activated carbon to sediment. Tetra Tech placed 2,504 tons of AquaGate+PAC 10% throughout a 13.7-acre area within Dark Head Cove proximate to the Lockheed Martin Middle River Complex (MRC) in Middle River, Maryland, from October 2017 to December 2017.

This report discusses the construction performed to place material *in situ* in Dark Head Cove, and includes a summary of the applicable permits obtained, site preparation, the pilot study, application of the *in situ* material, and quality control (QC) procedures implemented to ensure that the *in situ* material was placed in compliance with the project specifications and the Lockheed Martin scope of work. This report will:

- summarize the *in situ* treatment preparation and placement
- document and verify that *in situ* material was placed in accordance with the approved construction documents

Quality control tests and laboratory analytical sampling results for the surficial sediment (top six inches) confirm that the design intent and project objectives were achieved. The activated carbon concentrations currently in Dark Head Cove sediment are considered adequate to reduce polychlorinated biphenyl concentrations within the pore water, resulting in an overall reduction of bioaccumulation.

SECTION 1
INTRODUCTION AND SITE BACKGROUND

On behalf of Lockheed Martin Corporation (Lockheed Martin), Tetra Tech, Inc., (Tetra Tech) has prepared this completion report summarizing placement of *in situ* treatment material (AquaGate+PAC 10%) throughout Dark Head Cove. This task was performed in the cove adjacent to the Lockheed Martin Middle River Complex (MRC) in Middle River, Maryland, from October 2017 to December 2017. The locations of the Middle River Complex and Dark Head Cove are shown on Figure 1-1.

This report discusses the construction completed to place *in situ* material within Dark Head Cove, including a summary of the applicable permits obtained, site preparation, a pilot study, application of the *in situ* material, and quality control (QC) procedures implemented to ensure that the *in situ* material was placed in compliance with the project specifications and the Lockheed Martin scope of work. The objectives of this report are to:

- summarize the *in situ* treatment preparation and placement activities
- document and verify that the *in situ* material was placed in accordance with the approved construction documents

This report is organized as follows:

Section 1: Introduction and Site Background

Section 2: Design, Permitting, and Site Setup

Section 3: Application of *In Situ* Treatment Material

Section 4: Quality Control Summary

Section 5: Real-Time Water Quality Monitoring

Section 6: Demobilization

Section 7: References

Tables and figures are at the end of the report body following Section 6.

1.1 SITE HISTORY AND INVESTIGATIONS

The Middle River Complex has been used as an aircraft and missile-launching systems design and development facility since the 1920s. Historical operations at the facility appear to have led to the release of polychlorinated biphenyls (PCBs) and other contaminants that reached the waters of Dark Head Cove and Cow Pen Creek, prompting Lockheed Martin to perform numerous environmental studies and feasibility evaluations within Dark Head Cove between 2005 and 2013. In 2013, a feasibility study was approved by the Maryland Department of the Environment (MDE) and United States Protection Agency (USEPA), allowing Lockheed Martin to begin remediation. Additional sampling in 2014 further delineated elevated polychlorinated biphenyl concentrations in shallow sediment near Outfall 005.

1.2 SEDIMENT REMEDIAL ACTIONS

In March 2015, Lockheed Martin completed a sediment-removal action (SRA) near Outfall 005, dredged 5,272-cubic yards of polychlorinated biphenyl-contaminated sediment, and cleaned up storm-drain Outfalls 005 East and 005 West. An estimated 415 pounds of polychlorinated biphenyls were removed. The sediment-removal action was completed in compliance with a risk-based disposal approval application (RBDAA) reviewed and approved by the Maryland Department of the Environment and United States Protection Agency (Tetra Tech, 2014). The successful completion of this project is documented in the *Construction Completion Report, Outfall 005 Sediment Removal Action, Lockheed Martin Middle River Complex, Middle River, Maryland* (Tetra Tech, 2015).

Results of the sediment characterization studies, remedial investigations, feasibility evaluations, and the sediment-removal action at Outfall 005 led to the development of the *Construction Sediment Remedy Design for Cow Pen Creek and Dark Head Cove (Rev. 0)* (Tetra Tech, 2016a). In March 2017, Lockheed Martin completed the Season 1 sediment remedy for Cow Pen Creek and Dark Head Cove that removed and disposed of approximately 35,000-cubic yards of contaminated sediment, cleaned approximately 3,350-linear feet of storm-drain leading to Dark Head Cove, and placed a residual-management layer (RML) of approximately 8,700-tons within dredged areas. An estimated 34 pounds of polychlorinated biphenyls were removed from the dredged areas in Cow Pen Creek and Dark Head Cove. The Season 1 sediment remedy was

completed in compliance with the *Risk-Based Disposal-Approval Application for PCB-Contaminated Sediment Removal in Dark Head Cove* (Tetra Tech, 2016b), with minor modifications. Details of the successful completion of Season 1 activities are in the *Construction Completion Report, Season One Sediment Remedy for Cow Pen Creek and Dark Head Cove, Lockheed Martin Middle River Complex* (Tetra Tech, 2018).

This report documents the successful execution and completion of the *in situ* treatment phase of Season 2 work for Dark Head Cove. Completion of Season 2 activities for the Cow Pen Creek sediment-remedy phase will be summarized in a separate report. Placement of the *in situ* material complied with the *Construction Sediment-Remedy Design for Cow Pen Creek and Dark Head Cove (Rev. 0)* (Tetra Tech, 2016a) and the *Risk-Based Disposal-Approval Application for In Situ Treatment of PCB Contaminated Sediment in Dark Head Cove* (Tetra Tech, 2016c), submitted by Tetra Tech, Inc. on June 17, 2016, (approved by the United States Environmental Protection Agency Region 3 on August 29, 2016, and by Maryland Department of the Environment on September 8, 2016). On September 25, 2017, Lockheed Martin Corporation (Lockheed Martin) submitted a letter to the USEPA and MDE requesting minor modifications to supersede the June 17, 2016, letter. MDE approved these minor modifications on December 12, and USEPA did so on September 25. Daily reports completed during field activities are in Appendix A.

SECTION 2
DESIGN, PERMITTING, AND SITE SETUP

The Season 2 *in situ* treatment permitting and setup includes:

- obtaining necessary permits and approvals
- installing temporary facilities
- installing and maintaining the turbidity curtain
- completing the remedy design

2.1 DESIGN AND PERMITS

Application of the in situ treatment in Dark Head Cove was limited to a work window of October 15, 2017, through February 15, 2018, due to Maryland Department of Natural Resources (MDNR) restrictions on in-water activities to protect anadromous1 fish spawning near the work site. Permitting activities began concurrent with the design work and continued until all applicable permits had been secured. In addition to approval of the risk-based disposal-approval application (RBDAA) approval, the following permits and approvals (copies of which are in Appendix B) were obtained for the *in situ* treatment remedy:

- United States Army Corps of Engineers "Nationwide Permit 38"
- MDE "Tidal Wetlands Protection" permits
- airport zoning permit
- Federal Magnuson-Stevens Act (MSA)
- MDNR fisheries, submerged aquatic vegetation (SAV), and time of year restrictions
- Baltimore County erosion and sediment-control requirements

2.2 INSTALLATION OF TEMPORARY FACILITIES

Following Lockheed Martin approval, Tetra Tech staged all construction-related equipment and materials required for the *in situ* treatment operation in Block F. The Block F staging area was large enough to safely accommodate construction equipment, construction material, 2,003 bulk bags of

[1]Anadromous fish migrate from saltwater to freshwater to spawn.

treatment material, and semi-trailer trucks used for equipment and material deliveries. Staging and handling of the treatment material is discussed in more detail in Section 3.1. The two project trailers used during the application of the treatment material were staged in Block G; both trailers were mobilized before Season 1 and remained in place for Season 2. Refer to the *Construction Completion Report, Season One Sediment Remedy for Cow Pen Creek and Dark Head Cove, Lockheed Martin Middle River Complex* (Tetra Tech, 2018) for trailer locations.

One trailer provided secure offices for Tetra Tech managers, and field staff and CDM Smith personnel used the second. Each trailer received electricity, lighting, and heating through connection to the local power grid. Portable toilets, a hand-washing station, and a tool storage container were also provided. An overview of the Block F site layout is on Figure 2-1. Individual tax blocks within the Lockheed Martin Middle River Complex and the Season 2 *in situ* treatment area in Dark Head Cove are shown in Figure 2-2.

2.3 TURBIDITY CURTAIN INSTALLATION AND MAINTENANCE

Before applying the treatment material, an outer turbidity curtain encasing the entire work area was installed in Dark Head Cove on October 21, 2017. This turbidity curtain spanned approximately 500 feet shore-to-shore and extended eight feet below the water surface. The curtain was secured to temporary wood pilings adjacent to the Wilson Point Park bulkhead and the western shoreline. The location of the turbidity curtain is shown on Figure 2-1.

Navigational buoys were placed on the downstream side of the curtain and were fitted with light-sensitive switches so that their lights operated only at night. They were powered by onboard batteries charged via onboard solar panels. The turbidity curtain consisted of floating-top booms with impermeable polyvinyl chloride skirts and steel ballast-chains. The curtain was inspected daily while in-water work was underway. Inspection reports were maintained in the Tetra Tech office trailer, in accordance with permit requirements. Baltimore County representatives also periodically inspected site activities.

When construction was finished, no notable damage to the curtain that would require replacement or repair was observed. The turbidity curtain was removed after application of the *in situ* treatment

was complete (December 6, 2017) on December 8, 2017, per Baltimore County approval. Turbidity monitoring is discussed in more detail in Section 5.

SECTION 3
APPLICATION OF *IN SITU* TREATMENT MATERIAL

This section summarizes the application of the *in situ* treatment material (AquaGate+PAC 10%) in the waters of Dark Head Cove, including:

- staging and handling bulk bags of *in situ* treatment material
- mobilization of *in situ* placement equipment
- installation of the cable-assisted placement system
- conducting the pilot study
- application of treatment material within Areas 7, 8, and 9

3.1 MATERIAL STAGING AND HANDLING

On August 15, 2017, Tetra Tech began receiving and staging (per the manufacturer's recommendations) the *in situ* treatment material in Block F. The material was routinely delivered in bulk one-cubic-yard water-resistant bags by semi-trailer trucks. The bulk bags were stacked two-high on top of lined pallets and covered with a polyethylene liner to minimize damage from sheet-flow runoff and precipitation. A temporary asphalt berm and rock outlet, left in place following Season 1, bordered the Block F staging area and provided additional protection from sheet-flow surface-runoff infiltration. Staging and handling of *in situ* material was completed on November 11, 2017; 2,003 bulk bags of *in situ* material were staged and secured for subsequent placement. The Block F material-staging and -handling area and its erosion and sediment controls are shown on Figure 2-1.

3.2 *IN SITU* PLACEMENT-EQUIPMENT MOBILIZATION

Mobilization of equipment entailed one cable-assisted barge for material placement, one large roller drum, one push boat, one telehandler, and one forklift. All equipment for *in situ* placement was shipped overland to Block F and required assembly upon arrival. The barge was constructed of several interlocking smaller barges/flexi-floats, and used a large roller-drum assembly mounted

topside to place the treatment material. Mobilization of the *in situ* placement-equipment was completed on October 13, 2017, and the barge was assembled and ready to begin in-water work on October 24, 2017.

3.3 CABLE-ASSISTED PLACEMENT-SYSTEM SETUP

A cable-assisted placement system, like that used during Season 1 to place the residual management layer (RML), was used to place the *in situ* treatment material. Refer to the *Construction Completion Report, Season One Sediment Remedy for Cow Pen Creek and Dark Head Cove, Lockheed Martin Middle River Complex* (Tetra Tech, 2018) for details on RML placement. This application method allowed for an accurate broadcast of *in situ* material across Dark Head Cove. The system consisted of steel cables secured to driven steel pilings and/or upland dead-man anchors that bordered the placement areas. The pulley-equipped barge was secured to the cables and pulled at a controlled rate through the desired placement area. The pilings and cables were continuously repositioned throughout Dark Head Cove as needed.

Unfavorable soil conditions were encountered while attempting to drive some of the pilings for the project. The soils were too stiff to successfully and safely drive the pilings to the required depths. Therefore, on November 28, 2017, Tetra Tech mobilized a barge-mounted whirley crane to drive the remaining pilings. The whirley crane was equipped with a large vibratory hammer capable of overcoming the resistant soils, and the task was completed. The remaining pilings were successfully installed by the following day (November 29, 2017).

3.4 PILOT STUDY

On October 26, 2017 and October 27, 2017, an *in situ* treatment pilot-study was conducted in Dark Head Cove to demonstrate that the proposed placement methods would achieve the target thickness (1.36-inches, with a tolerance of one-inch to 1.75-inches; see Section 4.0). The pilot-study demonstration was performed using the same equipment as would be used for the full-scale application. A 1.5-acre area adjacent to the Block D bulkhead, and within Areas 8 and 9, was used for the pilot study (see Figure 2-1). Quality control (QC) tests were performed continuously to monitor the thickness of the material placed on the sediment. Placement of weighted five-gallon buckets on top of the sediment and push core verification sampling via a polycarbonate tube was used to monitor treatment material thickness. QC testing procedures and results are discussed in

more detail in Section 4. The demonstration results confirm that a controlled 1–1.75-inch vertical placement could be achieved using the proposed methods. The pilot test was overseen by Maryland Department of the Environment (MDE), Lockheed Martin, CDM Smith, Tetra Tech, and AquaGate+PAC 10% representatives.

3.5 *IN SITU* MATERIAL PLACEMENT AREAS 7, 8, AND 9

Placement operations started after the Engineer of Record (EOR) approved the *in situ* treatment material (AquaGate+PAC 10%) product data, and after receipt of the "Certificates of Analysis" (CoA) from the manufacturer confirming that the average powdered activated carbon (PAC) content on the particles was 10%. The CoAs were continuously submitted to the EOR for approval throughout production and shipment. Discussion of the CoA results is in Section 4.

Tetra Tech began loading the bulk bags of *in situ* material on October 25, 2017. The bulk bags were uncovered from the stockpile in Block F and loaded onto the placement barge via telehandler. This operation was repeated until the placement crew confirmed that the quantity of treatment material placed on the barge was sufficient. Figure 2-1 shows the locations of the staging and loading operations within Block F. *In situ* placement operations during Season 2 started on October 28, 2017, after the pilot study had been completed.

Once the bulk bags of treatment material had been loaded, the deployment vessel was pushed to the designated placement area and secured to the cable system connected to the on-shore steel pilings and dead-man anchors. Treatment material was then loaded into the roller-drum hopper via an industrial forklift. The forklift operator hoisted the bulk bags over the hopper in a controlled fashion to ensure that they did not tear during loading. The bags were then split from the bottom to allow the material to flow slowly into the hopper, preventing material from falling off the side of the barge and into the water. The cable barge was then used to uniformly distribute the *in situ* material at a controlled rate (as specified during the pilot study). The barge was equipped with a real-time kinetic global positioning system (GPS) to ensure that the amendment was placed in the designated *in situ* treatment units (ISUs). The seven ISUs are subdivisions of the larger treatment areas (Areas 7, 8, and 9; see Figure 3-1).

Once the deployment vessel was depleted of *in situ* treatment material, it was returned to the Block F loading area to obtain more amendment. Material deployment continued within each ISU until Tetra Tech quality control personnel confirmed (via push core verification and bucket sampling) that the target thickness had been achieved. Quality control procedures and results are discussed in Section 4.

The barge could not obtain complete coverage of ISU-2, ISU-3, ISU-4, and ISU-6 (see Figure 3-1), as they are within shallow water and their borders abut marine structures. The barge was unable to safely access these locations without running aground, and/or incurring damage to itself or the adjacent marine structures. These structures include a riprap seawall, the Wilson Point pier, a boat dock, and the new Block D bulkhead. Tetra Tech personnel placed *in situ* material within the opposing borders of these inaccessible locations, after approval from Lockheed Martin and the EOR. This approach ensured that the full 13.7-acre *in situ* treatment area was covered per design specifications. Further details of the placement within inaccessible locations are in Appendix F.

Additional *in situ* material was placed within low areas where sample cores indicated amendment thickness of approximately 0.75-inches to one-inch. These locations were mainly within the pilot study area and near the Wilson Point Park pier. Section 4.1.3 includes information regarding procedures conducted if a push core showed a thickness outside of the target range. Table 3-1 summarizes the *in situ* coverage, location, tonnage placed, and average core-thickness placed during each workday. *In situ* treatment within Dark Head Cove was completed on December 6, 2017 and within the in-water work window specified by the Maryland Department of Natural Resources (MDNR). As indicated in Table 3-1, approximately 2,504 tons (2,003 bulk bags) of *in situ* material was placed within 13.7 acres of Dark Head Cove.

SECTION 4
QUALITY CONTROL SUMMARY

Tetra Tech implemented several quality control (QC) procedures during the Season 2 *in situ* treatment, including:

- testing and analysis to verify the adequacy of the *in situ* placement
- project documentation
- quality control inspections and tests
- deviations and requests for information (RFIs)

4.1 VERIFICATION OF *IN SITU* TREATMENT OPERATIONS

Tetra Tech performed several QC tests and analyses during the Season 2 *in situ* treatment to verify that material placement complied with the sediment remedy design (Tetra Tech, Inc., 2016a) and contract requirements. The following QC tests and analyses are summarized in this section:

- manufacturer's certificates of analysis (CoA) to measure the composition of the *in situ* material
- monitoring of material placement rates
- collecting push core verification samples to measure the thickness of the material placed
- analysis of the total organic carbon (TOC) and black carbon (BC) concentrations in the top six-inches of sediment

During the *in situ* treatment placement push core verification samples to measure the thickness of material was used to determine if additional actions were required to confirm the achievement of the target application rate.

4.1.1 Manufacturer's "Certificates of Analysis"

The powdered activated carbon (PAC) content on aggregate particles was targeted at 10% by weight; this is the required composition to ensure appropriate delivery of approximately 5% PAC

by weight to the sediment. The manufacturer of the treatment material routinely provided CoAs for the product being delivered to the site; these CoAs documented the average PAC generated on the particles during production. These results were submitted and approved by the Engineer of Record (EOR) before the material was placed. The average PAC content for all AquaGate+PAC 10% material delivered for the project was 10.27%. CoAs from the manufacturer are in Appendix C.

4.1.2 Monitoring *In Situ* Material-Placement Rates

Tetra Tech calibrated the barge used during the pilot study (see Section 3.4) to a target application rate of 178 tons per acre. The placement rate (barge speed and hopper revolutions) was confirmed via push core collection during application, which yielded acceptable results within the one-inch to 1.75-inch tolerance. Once the rate was confirmed to be acceptable, the remainder of the full-scale treatment was completed under those operation settings. As-built tracking records indicate that an average 182.7 tons of *in situ* material per acre was applied to a 13.7-acre area of Dark Head Cove. Note that the design application-rate target was calculated as: one acre (43,560 square feet) × 36 pounds per cubic foot (pcf) (dry bulk unit weight of sediment) × 0.5 ft (top six inches of sediment) × 5% (target PAC content) × $^{1}/_{2,200}$ (metric ton/lbs) × $^{1}/_{0.1}$ (10% PAC product) = 178 tons/acre. Table 3-1 provides a daily summary of the tonnage placed and area covered.

4.1.3 Measurement of *In Situ* Placement Thickness

In situ placement within the allowable tolerance was confirmed via push core verification sampling. After the treatment material had been placed, Tetra Tech advanced hand-held sampling tubes into the *in situ* layer to verify its thickness. Samples were collected at a frequency of 15 samples per acre, and a minimum of six samples was collected in the smallest ISU (ISU-1). The quality-control push core samples were laid out in a square grid (approximately 50 feet by 50 feet) within each ISU. Thickness results are shown on Figure 4-1 and Table 4-1. Photographic documentation of the push core samples is in Appendix D.

Thickness measurements were collected to confirm uniform placement of the *in situ* material and range from 0.75-inches to 1.5-inches, with an average of 1.1-inches. If the thickness outside of the target range was measured, additional cores located around the original push core location were

collected to confirm that the overall application thickness was acceptable. Subsequent core measurements surrounding the original samples documented an average thickness above one-inch.

4.1.4 Analysis of Total Organic Carbon and Black Carbon

At each push core sampling location, the top six inches of aggregate particles and sediment were collected for laboratory analysis of TOC and BC by the Lloyd Kahn method and by a modification of the Lloyd Kahn method (respectively). The Lloyd Kahn method measures TOC as carbon dioxide (CO_2) when the sample is combusted at high temperature, after inorganic carbon (carbonates) has been removed using acid treatment. Laboratory results indicate an average TOC content of 5.7% and a BC content of 1.4% in the top six inches of sediment after amendment application. To understand the relationship of TOC, BC, and the activated carbon in the AquaGate+PAC 10% material, laboratory analyses for TOC, BC, total carbon, and ash content were completed on samples collected during *in situ* treatment placement. These analyses were compared to the analysis of a vendor-prepared sample of the sodium bentonite/activated carbon mixture used to manufacture the AquaGate+PAC 10%. Results of the TOC analysis are illustrated in Figure 4-2 and summarized in Table 4-2; laboratory analytical results are in Appendix E.

During application, weighted buckets were placed ahead of the barge to collect the aggregate particles as they settled on top of the sediment. Photographic documentation of the bucket samples is in Appendix D; sampling results are in Table 4-3. Sediment fines (sodium bentonite/activated carbon) and aggregate separated in the samples were collected from these buckets. The fines samples and the vendor-prepared sodium bentonite/activated carbon mixture samples were both submitted to be analyzed for TOC, BC, total carbon, and ash content (see Table 4-4).

Test results indicate that BC measurements are less than would be expected from the measurements of TOC and total carbon. Ash-content analyses were between 70% and 75%. The fines have a sodium bentonite content of 60%, all of which is expected to remain as ash; therefore, the additional 10–15% is from the activated carbon portion of the mixtures. As such, activated carbon within the AquaGate+PAC 10% mixture has an estimated ash content between 26% and 38%; this ash content is not being measured as carbon by the TOC or BC analysis. Based on these results, the added organic carbon from placement of 5% activated carbon with AquaGate+PAC 10% is estimated to be 3.5%. Data from historical sampling, the treatability study, and the baseline

bioaccumulation study indicate that the sediment within the treatment area of Dark Head Cove had a TOC content of approximately 3% before the addition of amendment. Based on this average 3% content, and the 5.7% TOC result, the added organic carbon content is 2.7%.

BC analysis results for the sediment and fines samples indicate that not all carbon associated with the activated carbon is captured with the modified Lloyd Kahn method. With carbon being present as a large range of compounds in the source used to produce the activated carbon, some carbon is likely lost in the additional preparation associated with BC analysis at the laboratory, causing only the most refractory carbon to be retained in the analysis of the sample. Collected data indicate that TOC measurements provide the best representation of carbon content added to the sediment by the *in situ* treatment material.

4.1.5 Summary of Results

The placement of the *in situ* amendment was confirmed by manufacturer confirmation of the activated carbon content of the AquaGate+PAC delivered to the site, the tracking of the amount placed and area covered on a daily basis, collection of sediment cores for visual measurement of the in situ amendment, and testing for total organic carbon and black carbon content. Achievement of the target loading was verified through the weight of evidence of the data collected. During the *in situ* material placement the core thickness measurements were used to determine if additional confirmation actions were required to confirm the target application rate.

AquaGate+PAC 10%, with an average of 10.27% activated carbon by weight, was placed over the treatment areas. Amendment application averaged 182.7 tons per acre, slightly above the target application rate (178 tons per acre and acceptance range of 125 – 231 tons per acre). Push cores collected at a rate of 15 per acre measured, on average, 1.1-inches of *in situ* treatment aggregate particles, which is slightly above the one-inch threshold for the target of 1.36-inches and acceptance range of 0.95 – 1.8 inches. Laboratory analysis of sediment cores indicates an average TOC content of 5.7%, resulting in an addition of 2.7% organic carbon to the native TOC content of 3%, and near the target of 3.5% organic carbon content and acceptance range of 2.4 – 4.5% needed for a 5% by dry-weight application. Per the risk-based disposal approval application (RBDAA), the measured amount of *in situ* amendment should meet the performance requirements of individual samples within 30% of the 5% by-dry-weight target based on the manufacturer testing

results for the delivered material, the tracked amendment placement and the thickness measurements from the post placement cores collected. Where the thickness measurements did not meet the target criteria, additional cores were collected around the sample point to confirm placement (per Section 2.8.1 of the RBDAA Contingencies section). Each *in situ* treatment unit achieving the 5% by-dry-weight target was confirmed by manufacturer testing of the material, tracking of placement and thickness measurements (Tetra Tech, 2016c).

Measurements of black carbon and total organic carbon were found to have a higher variability for the confirmation samples. The lowest average results for a treatment area was ISU 1 near the SRA areas where sand had been placed during the SRA dredging. Two other treatment areas, ISU 4 and ISU 6 also had average adjusted TOC concentrations below the target level. Based on the other measurement and tracking completed, the target loading rate is expected to have been met in these areas. Total organic carbon results indicate across the site, overall placement target was met for the *in situ* treatment.

Treatability testing indicates that these characteristics adequately reduce PCB concentrations in pore water, thereby decreasing bioaccumulation. Long-term monitoring will be performed to confirm treatment effectiveness based on reduction in benthic organism bioaccumulation and pore water concentrations. Sampling during the long-term monitoring will include the analysis of total organic carbon and black carbon in the surface sediments.

4.2 PROJECT DOCUMENTATION

A daily construction report was completed on each day of construction. These reports summarize daily activities, the number of personnel on-site, and weather conditions, including a weekly look-ahead, daily photographs, materials/equipment delivered/staged to the site, a QC report, daily sign-in sheets, and daily health and safety briefings. These reports were provided to Lockheed Martin and CDM Smith for review each day. All project records and documents were stored in secure locations within the Tetra Tech field office. A submittal register including product submittals, tests, and manufacturer CoAs was maintained throughout the Season 2 work. Copies of the daily construction reports generated throughout *in situ* treatment activities are in Appendix A.

4.3 DEVIATIONS AND REQUESTS FOR INFORMATION

Two deviations from the sediment remedy design (Tetra Tech, 2016a) were made during Season 2 *in situ* treatment. Field-change requests (FCRs) were submitted to the EOR, the Remediation Technical Operations (RTO) representative, and Lockheed Martin for written approval before the changes were implemented. RFIs were also submitted to the EOR and RTO for clarification and/or for additional information regarding requirements of the sediment remedy design (Tetra Tech, 2016a). The approved FCR and RFI issued during the Season 2 *in situ* treatment are listed below; details are in Appendix F.

Document ID	Description
FCR 016	Placement of *in situ* material outside of the ISU boundaries to make up for inaccessible areas, due to adjacent marine structures and shallow waters
RFI 008	Clarification requested for *in situ* treatment confirmation methodology and *in situ* pilot test

SECTION 5
REAL-TIME WATER QUALITY MONITORING

Turbidity was monitored during all in-water work using a combination of fixed and mobile equipment. Three turbidity-monitoring buoys were installed at the locations shown on Figure 5-1: two buoys at the compliance points and one at the background point. Issues were encountered while positioning sondes[2] in the upper-and lower-water-column zones during Season 1. Per the risk-based disposal-approval application (RBDAA) letter approving minor modifications (submitted September 25, 2017) (Tetra Tech, 2016c), turbidity was recorded from a single sonde in the mid-water-column zone only. Refer to the *Construction-Completion Report, Season One Sediment-Remedy for Cow Pen Creek and Dark Head Cove, Lockheed Martin Middle River Complex* (Tetra Tech, 2018) for a discussion of corrective actions associated with turbidity monitoring. The Season 2 modification minimized false readings from bottom sediment movement, while still providing an equivalent level of monitoring.

Data were collected from all sensors and transmitted wirelessly to a computer, where the readings were averaged and reported every 30 minutes. In addition to continuous monitoring by the buoys, turbidity levels at additional locations were monitored during *in situ* treatment by Tetra Tech personnel using a skiff and handheld monitoring equipment. These mobile monitoring locations were positioned approximately 100-feet outside of ongoing placement areas. Early-warning mobile monitoring assessed the effects of *in situ* placement and the possible impacts from sediment migration by using multiple points inside Dark Head Cove to monitor turbidity. These early-warning mobile monitoring locations are shown on Figure 5-1.

The turbidity compliance-level was established jointly by Maryland Department of the Environment (MDE) and United States Environmental Protection Agency (USEPA) project representatives at 150 nephelometric[3] turbidity units (NTU) at any time, or 50 units as a monthly

[2]A *sonde* is an instrument probe that automatically transmits information about its underground, underwater, or atmospheric surroundings.
[3]A measurement of suspended particle density in a liquid, by measuring the degree to which the suspension scatters light.

average. Turbidity levels were continuously monitored during *in situ* placement (as described above), and operations were immediately modified if it appeared that the compliance level had been exceeded.

As in Season 1, if *in situ* placement caused the compliance level to be exceeded for two consecutive 30-minute monitoring-intervals, then *in situ* treatment operations would have ceased until turbidity levels returned to an acceptable (according to regulations) level. However, no turbidity exceedances were encountered during Season 2 *in situ* treatment. Turbidity-monitoring results from the compliance points, background, and mobile monitoring locations are in Appendix G; data validation reports are in Appendix H.

SECTION 6
DEMOBILIZATION

Temporary facilities, *in situ* placement equipment, upland material staging areas, and personnel were demobilized from Block F as tasks were completed and their services were no longer required. Final demobilization for the Season 2 *in situ* placement was completed on December 8, 2017.

SECTION 7
REFERENCES

Tetra Tech, Inc. (Tetra Tech), 2014. *Risk-Based Disposal-Approval Application (RBDAA) for the Outfall 005 Sediment Removal Action, Lockheed Martin Middle River Complex, Middle River, Maryland*. Report prepared for Lockheed Martin Corporation, Bethesda, Maryland by Tetra Tech, Inc., Germantown, Maryland. November.

Tetra Tech, Inc. (Tetra Tech), 2015. *Construction Completion Report, Outfall 005 Sediment Removal Action, Lockheed Martin Middle River Complex, Middle River, Maryland*. Report prepared for Lockheed Martin Corporation, Bethesda, Maryland by Tetra Tech, Inc., Germantown, Maryland. December.

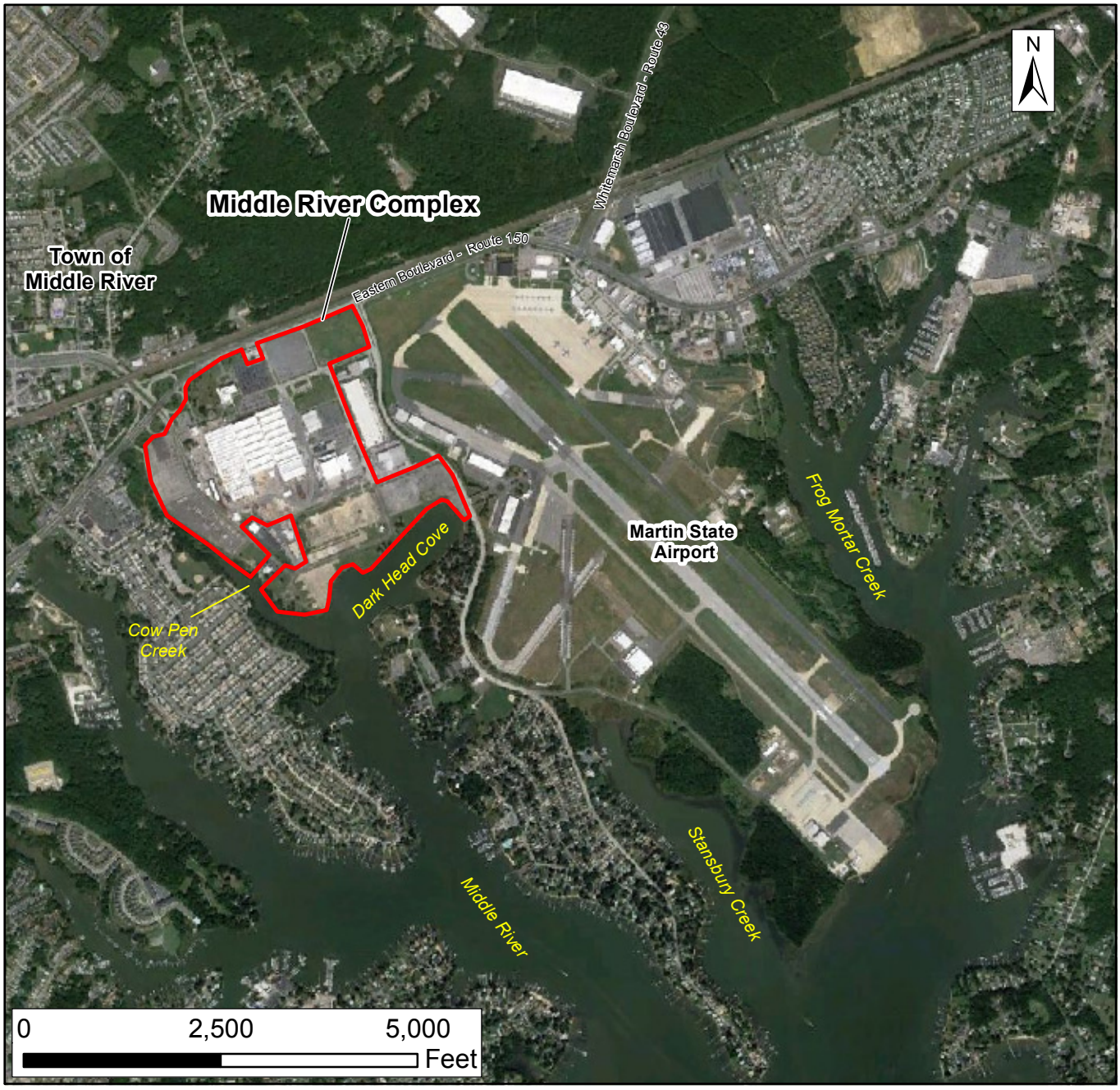
Tetra Tech, Inc. (Tetra Tech), 2016a. *Construction Sediment-Remedy Design for Cow Pen Creek and Dark Head Cove, Lockheed Martin Middle River Complex, Middle River, Maryland Rev. 0*. Report prepared for Lockheed Martin Corporation, Bethesda, Maryland by Tetra Tech, Inc., Germantown, Maryland. September.

Tetra Tech, Inc. (Tetra Tech), 2016b. *Risk-Based Disposal-Approval Application (RBDAA) for PCB-Contaminated Sediment Removal in Dark Head Cove, Lockheed Martin Middle River Complex, Middle River, Maryland*. Report prepared for Lockheed Martin Corporation, Bethesda, Maryland by Tetra Tech, Inc., Germantown, Maryland. June.

Tetra Tech, Inc. (Tetra Tech), 2016c. *Risk-Based Disposal-Approval Application for in situ Treatment of PCB-Contaminated Sediment in Dark Head Cove, Lockheed Martin Middle River Complex, Middle River, Maryland*. Report prepared for Lockheed Martin Corporation, Bethesda, Maryland by Tetra Tech, Inc., Germantown, Maryland. August.

Tetra Tech, Inc. (Tetra Tech), 2018. *Construction Completion Report, Season One Sediment Remedy for Cow Pen Creek and Dark Head Cove, Lockheed Martin Middle River Complex, Middle River, Maryland*. Report prepared for Lockheed Martin Corporation, Bethesda, Maryland by Tetra Tech, Inc., Germantown, Maryland. November.

FIGURES



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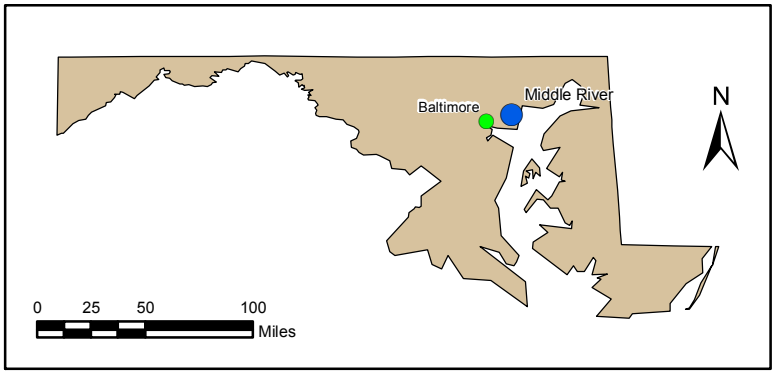


FIGURE 1-1

MIDDLE RIVER COMPLEX LOCATION MAP

Lockheed Martin Middle River Complex
Middle River, Maryland

DATE MODIFIED:	CREATED BY:
11/26/13	MP

TETRA TECH

Map Document: (K:\GProject\middle_river\Maps\MiddleRiver_MRC_Location Map_Fig 1-1_revised050113.mxd) 6/20/2013 -- 10:45:00 AM

STABILIZED CONSTRUCTION ENTRANCE

TEMPORARY ASPHALT BERM (TAB)

ROCK OUTLET

IN SITU MATERIAL STAGING AREA

OUTFALL 005 EAST

OUTFALL 005 WEST

OUTFALL 008

OUTFALL 006

OUTFALL 009

OUTFALL 007

OUTFALL 9OF001 (MSA)

OUTFALL 8OF001 (MSA)

OUTFALL IN159 (MSA)

PLACEMENT BARGE LOADING AREA

7
0.6 ACRE

8
10.6 ACRE

9
2.5 ACRE

LEGEND:
- *IN SITU* TREATMENT AREA
- STAGING AREA
- STORM DRAIN OUTFALL
- STORM DRAIN SYSTEM
- TURBIDITY CURTAIN

TETRA TECH

0' 200' 400'

LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MD

FIGURE 2-1
SEASON 2 *IN SITU* TREATMENT IN DHC
SITE LAYOUT

PROJECT: LOCKHEED - MIDDLE RIVER COMPLEXBOOK: FIGURES\FIGURE 3-2 DHC SEDIMENT UPDATES.DWG
PLOT DETAILS: POLSKI, DENNIS February 27, 2018 11:03 AM TT-BOTH-MAIN-COLOR.CTB

Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2013 ESRI and its data suppliers).

BLOCK 'A'
BLOCK 'A'
BLOCK 'B'
BLOCK 'D'
BLOCK 'D' PANHANDLE
BLOCK 'E'
BLOCK 'F'
BLOCK 'G'
BLOCK 'H'
BLOCK 'I'
ATHLETIC FIELD
PARKING LOT NO. 4
PARKING LOT NO. 5
BUILDING A
PARKING LOT NO. 1
PARKING LOT NO. 2
PARKING LOT NO. 3
BUILDING A
BUILDING B
BUILDING C
ENGINEERING RESEARCH BUILDING
PROGRAM BUILDING
VLS BUILDING
ANNEX BUILDING
MIDDLE RIVER POST OFFICE
JOHNSON AND TOWERS
FORMER BUILDING D
TILLEY CHEMICAL COMPANY
WATERFRONT LOT
Martin State Airport
DARKHEAD COVE
COWPENS CREEK
Eastern Blvd
Chesapeake Park Plz
Martin Blvd
Wilson Point Rd
Glenn Martin Lagoon Rd
Evergreen St
Duke St
Leland Ave
Magnolia Ave
Wampler Rd
MD-700
MD-7700 E
Baker Ave
Harlton Ave N
Old Eastern Ave
Volz Ave
Hawthorne Rd
S Hawthorne Rd
Whitethorn Way
Riverthorn Rd
Midthorn Rd
Fuchthorn Rd
Kingston Rd
Alder Dr
Mustang Dr

FIGURE 2-2

SITE LAYOUT AND TAX BLOCKS
MIDDLE RIVER COMPLEX

LEGEND

TAX BLOCK

Lockheed Martin Middle River Complex
Middle River, Maryland

0 225 450 Feet

N

DATE MODIFIED: 11/13/15

CREATED BY: JEE

TETRA TECH

Map Document: (P:\GIS\Middle_River\MapDocs\MXD\mrc_tax_blocks_nov2015_aerial.mxd)
11/13/15 -- JEE

ISU1

ISU2

ISU3

ISU4

ISU5

ISU6

ISU7

LEGEND:

IN SITU TREATMENT UNIT

ADDED *IN SITU* TREATMENT AREA

INACCESSIBLE AREA

TETRA TECH

0 150 300 Feet

LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MD

FIGURE 3-1

IN SITU TREATMENT UNITS
DARK HEAD COVE

R:\PROJECTS\MIDDLE_RIVER_8811\CONFIRMATION_SAMPLING\MAPS\CONFIRMATION_SAMPLING_AREA_DHC_ISUs.mxd

SAMPLING UNITS		
UNIT	AREA (AC)	NUMBER OF SAMPLES
ISU1	0.6	6
ISU2	3.2	50
ISU3	4.3	72
ISU4	1	16
ISU5	1.7	26
ISU6	0.7	14
ISU7	1.9	30

LEGEND:

- SAMPLE LOCATION
- *IN SITU* TREATMENT AREA

In situ measured thickness grid (inches)

0.75 | 1 | 1.25 | 1.35 | 1.5

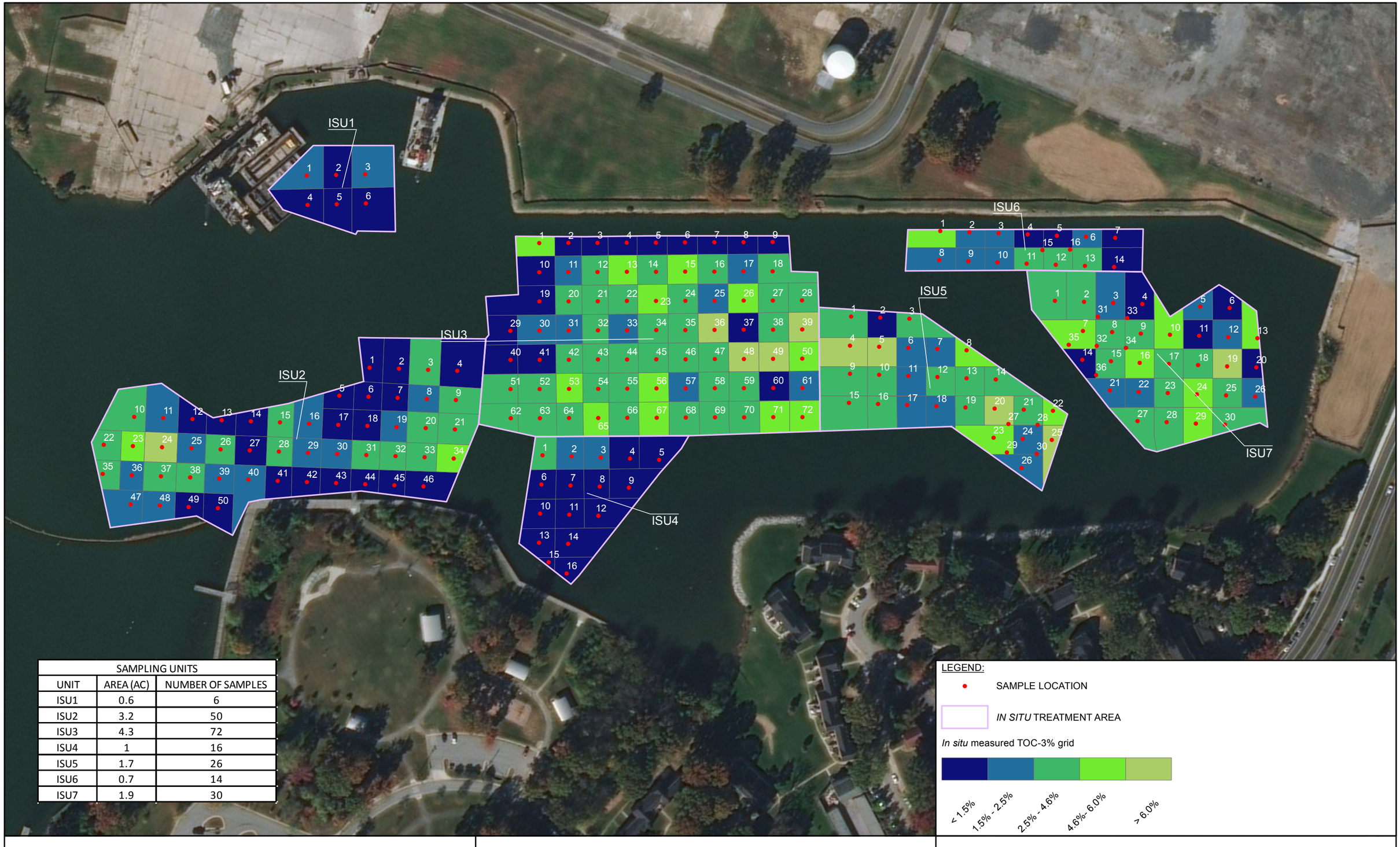
TETRA TECH

0 150 300 Feet

LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MD

FIGURE 4-1
PUSH CORE VERIFICATION RESULTS
IN SITU TREATMENT
DARK HEAD COVE

R:\PROJECTS\MIDDLE_RIVER_8811\CONFIRMATION_SAMPLING\MAPS\CONFIRMATION_SAMPLING_AREA_DHC_THICKNESS_20180313.mxd



SAMPLING UNITS		
UNIT	AREA (AC)	NUMBER OF SAMPLES
ISU1	0.6	6
ISU2	3.2	50
ISU3	4.3	72
ISU4	1	16
ISU5	1.7	26
ISU6	0.7	14
ISU7	1.9	30

LEGEND:

- SAMPLE LOCATION
- *IN SITU* TREATMENT AREA

In situ measured TOC-3% grid

< 1.5% | 1.5% - 2.5% | 2.5% - 4.6% | 4.6%- 6.0% | > 6.0%

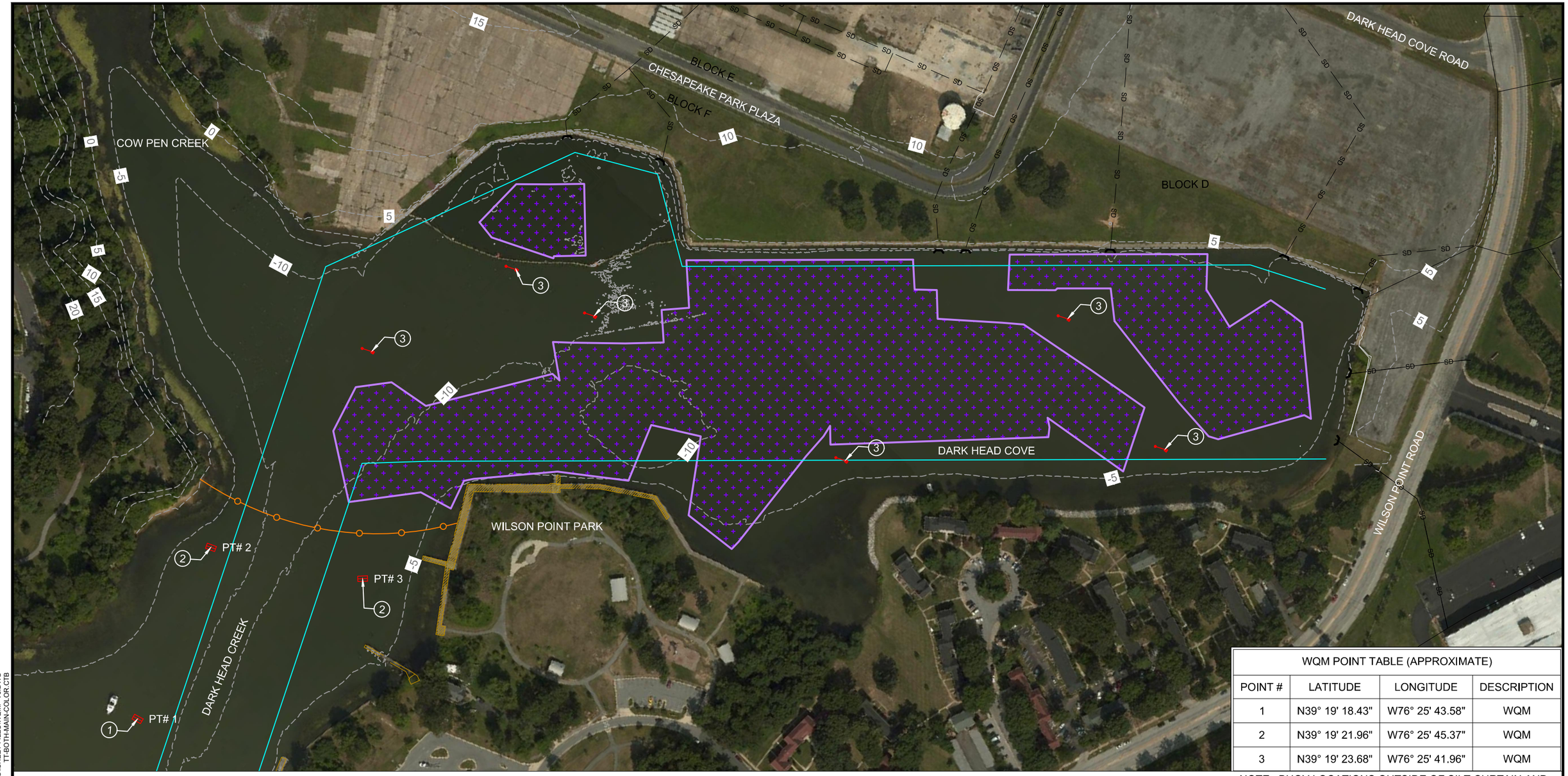
TETRA TECH

0 150 300 Feet

LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MD

FIGURE 4-2
TOTAL ORGANIC CARBON VERIFICATION RESULTS
IN SITU TREATMENT DARK HEAD COVE

R:\PROJECTS\MIDDLE_RIVER_8811\CONFIRMATION_SAMPLING\MAPS\CONFIRMATION_SAMPLING_AREA_DHC_TOC_3_20180313.mxd



WQM POINT TABLE (APPROXIMATE)			
POINT #	LATITUDE	LONGITUDE	DESCRIPTION
1	N39° 19' 18.43"	W76° 25' 43.58"	WQM
2	N39° 19' 21.96"	W76° 25' 45.37"	WQM
3	N39° 19' 23.68"	W76° 25' 41.96"	WQM

NOTE: BUOY LOCATIONS OUTSIDE OF SILT CURTAIN AND NAVIGATION CHANNEL.

NOTES:
1. ONE MAIN SILT CURTAIN REMAINED INSTALLED AT ALL TIMES DURING IN-WATER WORK.
2. EARLY MONITORING WAS PERFORMED OUTSIDE OF *IN SITU* TREATMENT AREAS. LOCATIONS WERE ADJUSTED DURING PLACEMENT.

(1) BACKGROUND DATA TURBIDITY MONITORING PLATFORM. (APPROXIMATELY 500 FT FROM THE SILT CURTAIN).
(2) COMPLIANCE POINT TURBIDITY MONITORING PLATFORM.
(3) EARLY WARNING MOBILE TURBIDITY MONITORING (EXAMPLE LOCATIONS SHOWN WITHIN 100FT OF *IN SITU* TREATMENT AREAS).

LEGEND:
- STORM DRAIN SYSTEM
- STORM DRAIN SYSTEM OUTFALL
- CONTOURS MAJOR 5FT
- DOCK STRUCTURES
- TURBIDITY CURTAIN
- *IN SITU* TREATMENT AREA
- USACE FEDERAL NAVIGATION CHANNEL 2015 DATA
- TURBIDITY MONITORING PLATFORM
- MOBILE TURBIDITY MONITORING

TETRA TECH

0' 200' 400'

LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MD

FIGURE 5-1
SEDIMENT REMEDY
WATER QUALITY MONITORING LOCATIONS - CONSTRUCTION SEASON 2

Z:\PROJECTS\LOCKHEED - MIDDLE RIVER COMPLEX\FULL REMEDY FIGURES\SHEET FILES\WQMP V3.DWG
PLOT DETAILS: POLSKI, DENNIS 11:00 AM February 27, 2018 TT-BOTH-MAIN-COLOR.CTB

TABLES

Table 3-1
Daily *in situ* Placement Summary
Dark Head Cove *in situ* Treatment Study
Lockheed Martin Middle River Complex, Middle River, Maryland

AREA	DATE	ACREAGE COVERED	BAGS PLACED	TONS PLACED	SAMPLE GRIDS COVERED	CORE THICKNESS
Area 9 (ISU 6, 7)	10/26/2017	0.09	48	60.00	ISU6 - 5 12/ ISU7 -2 7 14 35 36	1.1
	10/27/2017	0.10	16	20.00	ISU6 - 5 12/ ISU7 -2 7 14 35 36	1.1
	10/28/2017	0.51	43	53.13	ISU6 - 4 11/ ISU7 -1 6 13 3 8 15 21	1.2
	10/30/2017	0.03	11	13.75	ISU6 -3 10	1.0
	10/31/2017	0.14	39	48.75	ISU6 -2 9	1.0
	11/1/2017	0.10	34	42.50	ISU6 -1 8	1.1
	11/2/2017	0.27	45	56.25	ISU6 - 7 14/ ISU7- 4 9 16 22 27	1.0
	11/3/2017	0.61	110	137.50	ISU7 - 4 9 16 22 27 10 17 23 28	1.2
	11/4/2017	0.23	40	50.00	ISU7 - 5 11 18 24 29	1.3
	11/6/2017	0.34	34	42.50	ISU7 - 5 11 18 24 29 6 12 19 25 30	1.1
	11/7/2017	0.18	23	28.75	ISU7 - 13 20 26	1.0
Area 8 (ISU 2, 3, 4, 5)	10/27/2017	0.05	16	20.00	ISU5 - 22 25	1.2
	10/28/2017	0.36	43	53.13	ISU5 - 21 24 26 14 20 23	1.1
	10/30/2017	0.07	11	13.75	ISU5 - 8 13 19	1.3
	10/31/2017	0.29	39	48.75	ISU5 - 7 12 18	1.1
	11/1/2017	0.26	34	42.50	ISU5 - 3 6 11 17	1.0
	11/22/2017	0.93	95	118.75	ISU3 - 62 to 72/ ISU5-15, 16	1.0
	11/24/2017	1.31	124	155.00	ISU3 - 40 to 61/ ISU5-4 5 9 10	1.1
	11/25/2017	1.28	143	178.75	ISU3 -29 to 39/ ISU5-1 2	1.1
	11/27/2017	0.94	97	121.25	ISU3 - 10 to 28	1.1
	11/28/2017	0.40	67	83.75	ISU3 - 1 to 18	1.1
	11/29/2017	0.19	91	113.75	ISU2 - 47 to 50	1.1
	11/30/2017	1.49	194	242.50	ISU2 - 22 to 46	1.1
	12/1/2017	1.43	95	118.75	ISU2 - 1 to 21	1.1
	12/2/2017	0.66	108	135.00	ISU4 - 6 to 16	1.3
	12/4/2017	0.33	66	82.50	ISU4 - 1 to 5	1.2
Area 7 (ISU 1)	12/4/2017	0.49	66	82.50	ISU1- 1 to 5	1.3
	12/5/2017	0.09	13	16.25	ISU1- 4 to 6	1.2
Inaccessible and Low Area Coverage	12/5/2017	0.22	99	123.75	--	--
	12/6/2017	0.35	160	200.00	--	--
	TOTAL =	**13.7**	**2003**	**2504**	--	--

***Notes:**

Total *in situ* placement area is 13.7 acres (ISU 1 through ISU 7). On 12/5 & 12/6, further placement was performed to account for inaccessible locations and low areas.

Assume 1.25 tons of *in situ* material per bulk bag.

Average core thickness was calculated from the average thickness of in-situ material placed within the specified sample grids.

Table 4-1
Push Core Verification Results
Dark Head Cove *in situ* Treatment Study
Lockheed Martin Middle River Complex, Middle River, Maryland

SAMPLE PROCESSED DATE	SAMPLE ID	AGGREGATE DEPTH (in.)	*IN SITU* TREATMENT UNIT
12/5/2017	SSD-1-1-SS	1.25	ISU1
12/5/2017	SSD-1-2-SS	1.25	ISU1
12/5/2017	SSD-1-3-SS	1.25	ISU1
12/5/2017	SSD-1-4-SS	1.25	ISU1
12/5/2017	SSD-1-5-SS	1.25	ISU1
12/5/2017	SSD-1-6-SS	1	ISU1
12/5/2017	SSD-2-1-SS	1	ISU2
12/5/2017	SSD-2-2-SS	1	ISU2
12/5/2017	SSD-2-3-SS	1	ISU2
12/5/2017	SSD-2-4-SS	1	ISU2
12/5/2017	SSD-2-5-SS	1	ISU2
12/5/2017	SSD-2-6-SS	1	ISU2
12/5/2017	SSD-2-7-SS	1	ISU2
12/5/2017	SSD-2-8-SS	1.25	ISU2
12/5/2017	SSD-2-9-SS	1	ISU2
12/4/2017	SSD-2-10-SS	1.25	ISU2
12/5/2017	SSD-2-11-SS	1.25	ISU2
12/5/2017	SSD-2-12-SS	1	ISU2
12/5/2017	SSD-2-13-SS	1.25	ISU2
12/5/2017	SSD-2-14-SS	1.25	ISU2
12/5/2017	SSD-2-15-SS	1.25	ISU2
12/5/2017	SSD-2-16-SS	1.25	ISU2
12/5/2017	SSD-2-17-SS	1	ISU2
12/5/2017	SSD-2-18-SS	1	ISU2
12/5/2017	SSD-2-19-SS	1.25	ISU2
12/5/2017	SSD-2-20-SS	1.25	ISU2
12/5/2017	SSD-2-21-SS	1.25	ISU2
12/5/2017	SSD-2-22-SS	1	ISU2
12/4/2017	SSD-2-23-SS	1	ISU2
12/4/2017	SSD-2-24-SS	1.5	ISU2
12/4/2017	SSD-2-25-SS	1	ISU2
12/4/2017	SSD-2-26-SS	1	ISU2
12/4/2017	SSD-2-27-SS	1	ISU2
12/4/2017	SSD-2-28-SS	1.25	ISU2
12/4/2017	SSD-2-29-SS	1	ISU2
12/4/2017	SSD-2-30-SS	1	ISU2
12/4/2017	SSD-2-31-SS	1	ISU2
12/4/2017	SSD-2-32-SS	1	ISU2

Table 4-1
Push Core Verification Results
Dark Head Cove *in situ* Treatment Study
Lockheed Martin Middle River Complex, Middle River, Maryland

SAMPLE PROCESSED DATE	SAMPLE ID	AGGREGATE DEPTH (in.)	*IN SITU* TREATMENT UNIT
12/4/2017	SSD-2-33-SS	1	ISU2
12/4/2017	SSD-2-34-SS	1.25	ISU2
12/5/2017	SSD-2-35-SS	1.25	ISU2
12/5/2017	SSD-2-36-SS	1	ISU2
12/4/2017	SSD-2-37-SS	1.25	ISU2
12/4/2017	SSD-2-38-SS	1	ISU2
12/4/2017	SSD-2-39-SS	1	ISU2
12/4/2017	SSD-2-40-SS	1	ISU2
12/4/2017	SSD-2-41-SS	1	ISU2
12/4/2017	SSD-2-42-SS	1	ISU2
12/4/2017	SSD-2-43-SS	1	ISU2
12/4/2017	SSD-2-44-SS	1	ISU2
12/4/2017	SSD-2-45-SS	1.25	ISU2
12/4/2017	SSD-2-46-SS	1.25	ISU2
12/5/2017	SSD-2-47-SS	1	ISU2
12/4/2017	SSD-2-48-SS	1.25	ISU2
12/4/2017	SSD-2-49-SS	1	ISU2
12/4/2017	SSD-2-50-SS	1	ISU2
12/1/2017	SSD-3-1-SS	1.25	ISU3
12/1/2017	SSD-3-2-SS	1	ISU3
12/1/2017	SSD-3-3-SS	1.25	ISU3
12/1/2017	SSD-3-4-SS	1.25	ISU3
12/1/2017	SSD-3-5-SS	1.25	ISU3
12/1/2017	SSD-3-6-SS	1	ISU3
12/1/2017	SSD-3-7-SS	1	ISU3
12/1/2017	SSD-3-8-SS	1	ISU3
12/1/2017	SSD-3-9-SS	1	ISU3
12/1/2017	SSD-3-10-SS	1.25	ISU3
12/1/2017	SSD-3-11-SS	1	ISU3
12/1/2017	SSD-3-12-SS	1	ISU3
12/1/2017	SSD-3-13-SS	1.25	ISU3
12/1/2017	SSD-3-14-SS	1.25	ISU3
12/1/2017	SSD-3-15-SS	1.25	ISU3
12/1/2017	SSD-3-16-SS	1.25	ISU3
12/1/2017	SSD-3-17-SS	1	ISU3
12/1/2017	SSD-3-18-SS	1.25	ISU3
12/1/2017	SSD-3-19-SS	1	ISU3
12/1/2017	SSD-3-20-SS	1	ISU3

Table 4-1
Push Core Verification Results
Dark Head Cove *in situ* Treatment Study
Lockheed Martin Middle River Complex, Middle River, Maryland

SAMPLE PROCESSED DATE	SAMPLE ID	AGGREGATE DEPTH (in.)	*IN SITU* TREATMENT UNIT
12/1/2017	SSD-3-21-SS	1	ISU3
12/1/2017	SSD-3-22-SS	1	ISU3
12/1/2017	SSD-3-23-SS	1	ISU3
12/1/2017	SSD-3-24-SS	1	ISU3
12/1/2017	SSD-3-25-SS	1	ISU3
12/1/2017	SSD-3-26-SS	1	ISU3
12/1/2017	SSD-3-27-SS	1	ISU3
12/1/2017	SSD-3-28-SS	1	ISU3
12/1/2017	SSD-3-29-SS	1	ISU3
11/30/2017	SSD-3-30-SS	1	ISU3
11/30/2017	SSD-3-31-SS	1	ISU3
11/30/2017	SSD-3-32-SS	1	ISU3
11/30/2017	SSD-3-33-SS	1	ISU3
11/30/2017	SSD-3-34-SS	1	ISU3
11/30/2017	SSD-3-35-SS	1	ISU3
11/30/2017	SSD-3-36-SS	1	ISU3
11/30/2017	SSD-3-37-SS	1	ISU3
12/1/2017	SSD-3-38-SS	1	ISU3
12/1/2017	SSD-3-39-SS	1.25	ISU3
11/29/2017	SSD-3-40-SS	1.5	ISU3
11/29/2017	SSD-3-41-SS	1	ISU3
11/29/2017	SSD-3-42-SS	1	ISU3
11/29/2017	SSD-3-43-SS	1	ISU3
11/29/2017	SSD-3-44-SS	1	ISU3
11/29/2017	SSD-3-45-SS	1	ISU3
11/29/2017	SSD-3-46-SS	1	ISU3
11/30/2017	SSD-3-47-SS	1	ISU3
11/30/2017	SSD-3-48-SS	1	ISU3
11/30/2017	SSD-3-49-SS	1	ISU3
11/30/2017	SSD-3-50-SS	1	ISU3
11/28/2017	SSD-3-51-SS	1	ISU3
11/28/2017	SSD-3-52-SS	1.25	ISU3
11/28/2017	SSD-3-53-SS	1.25	ISU3
11/28/2017	SSD-3-54-SS	1	ISU3
11/28/2017	SSD-3-55-SS	1	ISU3
11/28/2017	SSD-3-56-SS	1	ISU3
11/28/2017	SSD-3-57-SS	1	ISU3
11/28/2017	SSD-3-58-SS	1	ISU3

Table 4-1
Push Core Verification Results
Dark Head Cove *in situ* Treatment Study
Lockheed Martin Middle River Complex, Middle River, Maryland

SAMPLE PROCESSED DATE	SAMPLE ID	AGGREGATE DEPTH (in.)	*IN SITU* TREATMENT UNIT
11/28/2017	SSD-3-59-SS	1	ISU3
11/29/2017	SSD-3-60-SS	1	ISU3
11/29/2017	SSD-3-61-SS	1	ISU3
11/27/2017	SSD-3-62-SS	1	ISU3
11/27/2017	SSD-3-63-SS	1	ISU3
11/27/2017	SSD-3-64-SS	1	ISU3
11/27/2017	SSD-3-65-SS	1.25	ISU3
11/27/2017	SSD-3-66-SS	1	ISU3
11/27/2017	SSD-3-67-SS	1	ISU3
11/27/2017	SSD-3-68-SS	1	ISU3
11/27/2017	SSD-3-69-SS	1.25	ISU3
11/28/2017	SSD-3-70-SS	1	ISU3
11/28/2017	SSD-3-71-SS	1	ISU3
11/28/2017	SSD-3-72-SS	1	ISU3
12/5/2017	SSD-4-1-SS	1.25	ISU4
12/5/2017	SSD-4-2-SS	1.25	ISU4
12/6/2017	SSD-4-3-SS	1	ISU4
12/6/2017	SSD-4-4-SS	1	ISU4
12/6/2017	SSD-4-5-SS	1.25	ISU4
12/6/2017	SSD-4-6-SS	1	ISU4
12/6/2017	SSD-4-7-SS	1.25	ISU4
12/6/2017	SSD-4-8-SS	1.25	ISU4
12/6/2017	SSD-4-9-SS	1	ISU4
12/6/2017	SSD-4-10-SS	1.25	ISU4
12/6/2017	SSD-4-11-SS	1.5	ISU4
12/6/2017	SSD-4-12-SS	1.5	ISU4
12/6/2017	SSD-4-13-SS	1.25	ISU4
12/6/2017	SSD-4-14-SS	1.25	ISU4
12/6/2017	SSD-4-15-SS	1.5	ISU4
12/6/2017	SSD-4-16-SS	1.25	ISU4
11/29/2017	SSD-5-1-SS	1.25	ISU5
11/30/2017	SSD-5-2-SS	1	ISU5
12/4/2017	SSD-5-3-SS	1	ISU5
11/29/2017	SSD-5-4-SS	1.5	ISU5
11/30/2017	SSD-5-5-SS	1.25	ISU5
12/5/2017	SSD-5-6-SS	1	ISU5
12/4/2017	SSD-5-7-SS	1.25	ISU5
11/2/2017	SSD-5-8-SS	1.25	ISU5

Table 4-1
Push Core Verification Results
Dark Head Cove *in situ* Treatment Study
Lockheed Martin Middle River Complex, Middle River, Maryland

SAMPLE PROCESSED DATE	SAMPLE ID	AGGREGATE DEPTH (in.)	*IN SITU* TREATMENT UNIT
11/30/2017	SSD-5-9-SS	1	ISU5
11/30/2017	SSD-5-10-SS	1	ISU5
12/4/2017	SSD-5-11-SS	1	ISU5
11/6/2017	SSD-5-12-SS	1	ISU5
11/2/2017	SSD-5-13-SS	1.25	ISU5
11/1/2017	SSD-5-14-SS	1.25	ISU5
11/29/2017	SSD-5-15-SS	1	ISU5
12/4/2017	SSD-5-16-SS	1	ISU5
12/4/2017	SSD-5-17-SS	1	ISU5
12/4/2017	SSD-5-18-SS	1	ISU5
12/3/2017	SSD-5-19-SS	1.25	ISU5
11/1/2017	SSD-5-20-SS	1.25	ISU5
11/1/2017	SSD-5-21-SS	1	ISU5
11/1/2017	SSD-5-22-SS	1	ISU5
11/3/2017	SSD-5-23-SS	1.5	ISU5
11/1/2017	SSD-5-24-SS	0.75	ISU5
11/1/2017	SSD-5-25-SS	1.35	ISU5
11/3/2017	SSD-5-26-SS	1	ISU5
11/10/2017	SSD-5-27-SS	1	ISU5
11/10/2017	SSD-5-28-SS	1.15	ISU5
11/10/2017	SSD-5-29-SS	1.5	ISU5
11/10/2017	SSD-5-30-SS	1.25	ISU5
11/3/2017	SSD-6-1-SS	1.25	ISU6
11/2/2017	SSD-6-2-SS	1	ISU6
11/2/2017	SSD-6-3-SS	1	ISU6
11/2/2017	SSD-6-4-SS	1.25	ISU6
10/31/2017	SSD-6-5-SS	0.75	ISU6
10/31/2017	SSD-6-6-SS	1.25	ISU6
11/3/2017	SSD-6-7-SS	1	ISU6
11/3/2017	SSD-6-8-SS	1	ISU6
11/2/2017	SSD-6-9-SS	1	ISU6
11/2/2017	SSD-6-10-SS	1	ISU6
11/2/2017	SSD-6-11-SS	1.5	ISU6
10/31/2017	SSD-6-12-SS	1	ISU6
10/31/2017	SSD-6-13-SS	1.25	ISU6
11/2/2017	SSD-6-14-SS	1	ISU6
11/10/2017	SSD-6-15-SS	1	ISU6
11/10/2017	SSD-6-16-SS	1	ISU6

Table 4-1
Push Core Verification Results
Dark Head Cove *in situ* Treatment Study
Lockheed Martin Middle River Complex, Middle River, Maryland

SAMPLE PROCESSED DATE	SAMPLE ID	AGGREGATE DEPTH (in.)	*IN SITU* TREATMENT UNIT
10/31/2017	SSD-7-1-SS	1.25	ISU7
10/31/2017	SSD-7-2-SS	1	ISU7
11/3/2017	SSD-7-3-SS	1.25	ISU7
11/4/2017	SSD-7-4-SS	1	ISU7
11/8/2017	SSD-7-5-SS	1.25	ISU7
11/8/2017	SSD-7-6-SS	1	ISU7
10/31/2017	SSD-7-7-SS	1.25	ISU7
11/3/2017	SSD-7-8-SS	1	ISU7
11/4/2017	SSD-7-9-SS	1	ISU7
11/7/2017	SSD-7-10-SS	1.5	ISU7
11/8/2017	SSD-7-11-SS	1.25	ISU7
11/8/2017	SSD-7-12-SS	1	ISU7
11/8/2017	SSD-7-13-SS	1	ISU7
10/31/2017	SSD-7-14-SS	0.75	ISU7
11/4/2017	SSD-7-15-SS	1	ISU7
11/4/2017	SSD-7-16-SS	1	ISU7
11/7/2017	SSD-7-17-SS	1.25	ISU7
11/8/2017	SSD-7-18-SS	1	ISU7
11/8/2017	SSD-7-19-SS	1	ISU7
11/8/2017	SSD-7-20-SS	1	ISU7
11/4/2017	SSD-7-21-SS	1.25	ISU7
11/4/2017	SSD-7-22-SS	1	ISU7
11/7/2017	SSD-7-23-SS	1.5	ISU7
11/8/2017	SSD-7-24-SS	1.25	ISU7
11/8/2017	SSD-7-25-SS	1	ISU7
11/8/2017	SSD-7-26-SS	1	ISU7
11/4/2017	SSD-7-27-SS	1	ISU7
11/7/2017	SSD-7-28-SS	1	ISU7
11/8/2017	SSD-7-29-SS	1.5	ISU7
11/8/2017	SSD-7-30-SS	1	ISU7
11/10/2017	SSD-7-31-SS	1	ISU7
11/10/2017	SSD-7-32-SS	1	ISU7
11/10/2017	SSD-7-33-SS	1.25	ISU7
11/10/2017	SSD-7-34-SS	1.25	ISU7
--	AVERAGE=	1.10	--

Table 4-2
Total Organic Carbon and Black Carbon Results
Dark Head Cove In Situ Treatment Study
Lockheed Martin Middle River Complex, Middle River, Maryland

SAMPLE	PLACEMENT DATE	SAMPLE DATE	THICKNESS (in.)	BC (%)	TOC (%)	QUALIFIER	TOC - 3%
SSD-1-1-SS	4-Dec	5-Dec	1.25	0.84	4.8	J	1.8
SSD-1-2-SS	4-Dec	5-Dec	1.25	1.2	3.1	J	0.1
SSD-1-3-SS	4-Dec	5-Dec	1.25	0.96	4.9	J	1.9
SSD-1-4-SS	4-Dec	5-Dec	1.25	0.41	3.2	J	0.2
SSD-1-5-SS	4-Dec	5-Dec	1.25	0.79	3.6	J	0.6
SSD-1-6-SS	4-Dec	5-Dec	1	0.28	1.4	J	0
ISU 1	AVERAGE		1.2	0.75	3.5		0.8
SSD-2-10-SS	1-Dec	5-Dec	1.25	0.66	6		3
SSD-2-11-SS	1-Dec	5-Dec	1.25	1.3	5.5	J	2.5
SSD-2-12-SS	1-Dec	5-Dec	1	0.63	3.5	J	0.5
SSD-2-13-SS	1-Dec	5-Dec	1.25	0.68	4.2		1.2
SSD-2-14-SS	1-Dec	5-Dec	1.25	0.73	3.3		0.3
SSD-2-15-SS	1-Dec	5-Dec	1.25	2.0	5.9		2.9
SSD-2-16-SS	1-Dec	5-Dec	1.25	1.8	5.3		2.3
SSD-2-17-SS	30-Nov	5-Dec	1	0.74	4.2		1.2
SSD-2-18-SS	30-Nov	5-Dec	1	1.1	3.5		0.5
SSD-2-19-SS	30-Nov	5-Dec	1.25	1.3	5.1		2.1
SSD-2-1-SS	1-Dec	5-Dec	1	0.71	3.3	J	0.3
SSD-2-20-SS	30-Nov	5-Dec	1.25	2.4	7.3		4.3
SSD-2-21-SS	30-Nov	5-Dec	1.25	1.3	5.6	J	2.6
SSD-2-22-SS	30-Nov	5-Dec	1	2.8	7.3		4.3
SSD-2-23-SS	30-Nov	4-Dec	1	1.7	8.7		5.7
SSD-2-24-SS	30-Nov	4-Dec	1.5	1.4	12		9
SSD-2-25-SS	30-Nov	4-Dec	1	0.25	4.8		1.8
SSD-2-26-SS	30-Nov	4-Dec	1	0.89	5.7		2.7
SSD-2-27-SS	30-Nov	4-Dec	1	0.29	4.2		1.2
SSD-2-28-SS	30-Nov	4-Dec	1.25	1.4	5.6		2.6
SSD-2-29-SS	30-Nov	4-Dec	1	0.64	5.2		2.2
SSD-2-2-SS	1-Dec	5-Dec	1	0.67	3.2	J	0.2
SSD-2-30-SS	30-Nov	4-Dec	1	0.76	5.5		2.5
SSD-2-31-SS	30-Nov	4-Dec	1	0.66	6.9		3.9
SSD-2-32-SS	30-Nov	4-Dec	1	2.4	7.5	J	4.5
SSD-2-33-SS	30-Nov	4-Dec	1	2.4	7	J	4
SSD-2-34-SS	30-Nov	4-Dec	1.25	4.4	7.7	J	4.7
SSD-2-35-SS	30-Nov	4-Dec	1.25	2.1	6.5	J	3.5
SSD-2-36-SS	30-Nov	5-Dec	1	0.81	4.9	J	1.9
SSD-2-37-SS	30-Nov	4-Dec	1.25	2.4	6.3	J	3.3
SSD-2-38-SS	30-Nov	4-Dec	1	0.97	7.3		4.3
SSD-2-39-SS	30-Nov	4-Dec	1	0.75	4.9		1.9
SSD-2-3-SS	1-Dec	5-Dec	1	1.1	6.3	J	3.3
SSD-2-40-SS	30-Nov	4-Dec	1	0.47	5.3		2.3
SSD-2-41-SS	30-Nov	4-Dec	1	0.6	4.5		1.5
SSD-2-42-SS	30-Nov	4-Dec	1	0.25	1.3		0
SSD-2-43-SS	30-Nov	4-Dec	1	0.31	1.3		0
SSD-2-44-SS	30-Nov	4-Dec	1	0.35	1.3		0
SSD-2-45-SS	30-Nov	4-Dec	1.25	0.25	1.3		0
SSD-2-46-SS	30-Nov	4-Dec	1.25	1.2	4.2		1.2
SSD-2-47-SS	29-Nov	5-Dec	1	1.0	5.2	J	2.2
SSD-2-48-SS	29-Nov	4-Dec	1.25	0.9	5.5		2.5
SSD-2-49-SS	29-Nov	4-Dec	1	0.29	2.4		0
SSD-2-4-SS	1-Dec	5-Dec	1.25	0.75	2.9	J	0
SSD-2-50-SS	29-Nov	4-Dec	1	0.23	1.8		0
SSD-2-5-SS	1-Dec	5-Dec	1	0.87	3.3	J	0.3
SSD-2-6-SS	1-Dec	5-Dec	1	1.2	4.2	J	1.2
SSD-2-7-SS	1-Dec	5-Dec	1	0.96	4.2	J	1.2
SSD-2-8-SS	1-Dec	5-Dec	1.25	1.2	5.4	J	2.4
SSD-2-9-SS	1-Dec	5-Dec	1	1.1	6	J	3
ISU 2	AVERAGE		1.1	1.12	5.0		2.2
SSD-3-10-SS	27-Nov	1-Dec	1.25	0.37	3.2		0.2
SSD-3-11-SS	27-Nov	1-Dec	1	0.78	5.4		2.4
SSD-3-12-SS	27-Nov	1-Dec	1	0.57	6.9		3.9
SSD-3-13-SS	27-Nov	1-Dec	1.25	1.8	8		5
SSD-3-14-SS	27-Nov	1-Dec	1.25	1.5	7.2		4.2
SSD-3-15-SS	27-Nov	1-Dec	1.25	1.2	8.3		5.3
SSD-3-16-SS	27-Nov	1-Dec	1.25	3.2	6.3	J	3.3
SSD-3-17-SS	27-Nov	1-Dec	1	0.71	5.4	J	2.4
SSD-3-18-SS	27-Nov	1-Dec	1.25	2.2	6.1	J	3.1

Table 4-2
Total Organic Carbon and Black Carbon Results
Dark Head Cove In Situ Treatment Study
Lockheed Martin Middle River Complex, Middle River, Maryland

SAMPLE	PLACEMENT DATE	SAMPLE DATE	THICKNESS (in.)	BC (%)	TOC (%)	QUALIFIER	TOC - 3%
SSD-3-19-SS	27-Nov	1-Dec	1	1.8	3.3		0.3
SSD-3-1-SS	28-Nov	1-Dec	1.25	1.9	7.7		4.7
SSD-3-20-SS	27-Nov	1-Dec	1	3.0	7.3		4.3
SSD-3-21-SS	27-Nov	1-Dec	1	2.8	7.2		4.2
SSD-3-22-SS	27-Nov	1-Dec	1	3.4	7		4
SSD-3-23-SS	27-Nov	1-Dec	1	2.8	7.9		4.9
SSD-3-24-SS	27-Nov	1-Dec	1	2.2	6.3		3.3
SSD-3-25-SS	27-Nov	1-Dec	1	1.2	5.3		2.3
SSD-3-26-SS	27-Nov	1-Dec	1	2.2	7.8		4.8
SSD-3-27-SS	27-Nov	1-Dec	1	1.7	6.2		3.2
SSD-3-28-SS	27-Nov	1-Dec	1	1.3	5.6		2.6
SSD-3-29-SS	25-Nov	1-Dec	1	1.3	1.8		0
SSD-3-2-SS	28-Nov	1-Dec	1	0.50	2		0
SSD-3-30-SS	25-Nov	30-Nov	1	0.48	4.6		1.6
SSD-3-31-SS	25-Nov	30-Nov	1	1.7	5.5		2.5
SSD-3-32-SS	25-Nov	30-Nov	1	1.5	6.3		3.3
SSD-3-33-SS	25-Nov	30-Nov	1	1.8	5.5		2.5
SSD-3-34-SS	25-Nov	30-Nov	1	1.1	5.7		2.7
SSD-3-35-SS	25-Nov	30-Nov	1	1.2	6.7		3.7
SSD-3-36-SS	25-Nov	30-Nov	1	2.4	9.3		6.3
SSD-3-37-SS	25-Nov	30-Nov	1	0.69	4.5		1.5
SSD-3-38-SS	25-Nov	1-Dec	1	2.8	6.1		3.1
SSD-3-39-SS	25-Nov	1-Dec	1.25	2.5	12		9
SSD-3-3-SS	28-Nov	1-Dec	1.25	0.06	3.2		0.2
SSD-3-40-SS	24-Nov	29-Nov	1.5	0.72	4.4	**J**	1.4
SSD-3-41-SS	24-Nov	29-Nov	1	0.76	2.8	**J**	0
SSD-3-42-SS	24-Nov	29-Nov	1	1.6	5.6	**J**	2.6
SSD-3-43-SS	24-Nov	29-Nov	1	2.0	6.2	**J**	3.2
SSD-3-44-SS	24-Nov	29-Nov	1	1.2	6	**J**	3
SSD-3-45-SS	24-Nov	29-Nov	1	1.3	5.6	**J**	2.6
SSD-3-46-SS	24-Nov	29-Nov	1	1.6	7.6	**J**	4.6
SSD-3-47-SS	24-Nov	30-Nov	1	1.3	6.3		3.3
SSD-3-48-SS	24-Nov	30-Nov	1	1.6	9.5		6.5
SSD-3-49-SS	24-Nov	30-Nov	1	1.7	9.2	**J**	6.2
SSD-3-4-SS	28-Nov	1-Dec	1.25	0.59	3.6		0.6
SSD-3-50-SS	24-Nov	30-Nov	1	1.0	8.2	**J**	5.2
SSD-3-51-SS	22-Nov	28-Nov	1	1.3	6.3	**J**	3.3
SSD-3-52-SS	22-Nov	28-Nov	1.25	0.95	5.6	**J**	2.6
SSD-3-53-SS	22-Nov	28-Nov	1.25	2.4	8	**J**	5
SSD-3-54-SS	22-Nov	28-Nov	1	1.8	7.2	**J**	4.2
SSD-3-55-SS	22-Nov	28-Nov	1	1.5	6.3	**J**	3.3
SSD-3-56-SS	22-Nov	28-Nov	1	1.5	7.8	**J**	4.8
SSD-3-57-SS	22-Nov	28-Nov	1	0.88	5.2	**J**	2.2
SSD-3-58-SS	22-Nov	28-Nov	1	1.1	6.4	**J**	3.4
SSD-3-59-SS	22-Nov	28-Nov	1	0.86	7.3	**J**	4.3
SSD-3-5-SS	28-Nov	1-Dec	1.25	0.52	2.1		0
SSD-3-60-SS	22-Nov	29-Nov	1	1.5	4.3	**J**	1.3
SSD-3-61-SS	22-Nov	29-Nov	1	1.4	4.7	**J**	1.7
SSD-3-62-SS	22-Nov	27-Nov	1	2.0	6.1		3.1
SSD-3-63-SS	22-Nov	27-Nov	1	2.8	7.6	**J**	4.6
SSD-3-64-SS	22-Nov	27-Nov	1	3.4	7.5	**J**	4.5
SSD-3-65-SS	22-Nov	27-Nov	1.25	3.5	7.8	**J**	4.8
SSD-3-66-SS	22-Nov	27-Nov	1	2.7	6.3	**J**	3.3
SSD-3-67-SS	22-Nov	27-Nov	1	2.0	8.3	**J**	5.3
SSD-3-68-SS	22-Nov	27-Nov	1	1.6	5.9		2.9
SSD-3-69-SS	22-Nov	27-Nov	1.25	1.5	6.6		3.6
SSD-3-6-SS	28-Nov	1-Dec	1	0.80	4.1		1.1
SSD-3-70-SS	22-Nov	27-Nov	1	1.9	5.9	**J**	2.9
SSD-3-71-SS	22-Nov	27-Nov	1	2.4	7.9	**J**	4.9
SSD-3-72-SS	22-Nov	27-Nov	1	1.5	8.1	**J**	5.1
SSD-3-7-SS	28-Nov	1-Dec	1	0.34	2.7		0
SSD-3-8-SS	28-Nov	1-Dec	1	0.50	3.6		0.6
SSD-3-9-SS	28-Nov	1-Dec	1	0.29	2.4		0
ISU 3	AVERAGE		1.1	1.57	6.1		3.2
SSD-4-10-SS	2-Dec	5-Dec	1.25	0.73	2.5		0
SSD-4-11-SS	2-Dec	5-Dec	1.5	0.8	4		1
SSD-4-12-SS	2-Dec	5-Dec	1.5	1.3	4		1

Table 4-2
Total Organic Carbon and Black Carbon Results
Dark Head Cove In Situ Treatment Study
Lockheed Martin Middle River Complex, Middle River, Maryland

SAMPLE	PLACEMENT DATE	SAMPLE DATE	THICKNESS (in.)	BC (%)	TOC (%)	QUALIFIER	TOC - 3%
SSD-4-13-SS	29-Nov	5-Dec	1.25	0.52	1.5		0
SSD-4-14-SS	29-Nov	5-Dec	1.25	0.6	1.9		0
SSD-4-15-SS	2-Dec	5-Dec	1.5	1.0	3.4		0.4
SSD-4-16-SS	2-Dec	5-Dec	1.25	0.65	2.5		0
SSD-4-1-SS	4-Dec	5-Dec	1.25	2.6	6.2	**J**	3.2
SSD-4-2-SS	4-Dec	5-Dec	1.25	2.4	5.5	**J**	2.5
SSD-4-3-SS	4-Dec	5-Dec	1	1.1	5		2
SSD-4-4-SS	2-Dec	5-Dec	1	1.5	3.8		0.8
SSD-4-5-SS	2-Dec	5-Dec	1.25	1.4	4.4		1.4
SSD-4-6-SS	2-Dec	5-Dec	1	0.7	3.6		0.6
SSD-4-7-SS	2-Dec	5-Dec	1.25	1.8	3.6		0.6
SSD-4-8-SS	2-Dec	5-Dec	1.25	1.3	4		1
SSD-4-9-SS	2-Dec	5-Dec	1	1.5	4		1
ISU 4	AVERAGE		1.2	1.2	3.7		1.0
SSD-5-01-SS	25-Nov	29-Nov	1.25	1.3	7.2	**J**	4.2
SSD-5-02-SS	25-Nov	30-Nov	1	2.0	4.5		1.5
SSD-5-03-SS	1-Dec	4-Dec	1	1.3	5.8	**J**	2.8
SSD-5-04-SS	24-Nov	29-Nov	1.5	1.8	11	**J**	8
SSD-5-05-SS	24-Nov	30-Nov	1.25	3.6	11		8
SSD-5-06-SS	1-Dec	5-Dec	1	2.0	5.4	**J**	2.4
SSD-5-07-SS	31-Oct	4-Nov	1.25	2.5	5.4	**J**	2.4
SSD-5-08-SS	31-Oct	2-Nov	1.25	1.1	7.8		4.8
SSD-5-09-SS	24-Nov	30-Nov	1	1.9	6.2		3.2
SSD-5-10-SS	24-Nov	30-Nov	1	2.7	5.8		2.8
SSD-5-11-SS	1-Dec	4-Dec	1	0.91	5	**J**	2
SSD-5-12-SS	31-Oct	6-Nov	1	1.3	7.1	**J**	4.1
SSD-5-13-SS	31-Oct	2-Nov	1.25	0.95	5.6		2.6
SSD-5-14-SS	28-Oct	1-Nov	1.25	1.5	6.5		3.5
SSD-5-15-SS	22-Nov	29-Nov	1	2.5	6.9	**J**	3.9
SSD-5-16-SS	22-Nov	4-Dec	1	2.0	6	**J**	3
SSD-5-17-SS	1-Dec	4-Dec	1	2.2	5.5	**J**	2.5
SSD-5-18-SS	31-Oct	4-Nov	1	0.77	5.4	**J**	2.4
SSD-5-19-SS	31-Oct	3-Nov	1.25	0.76	6		3
SSD-5-20-SS	28-Oct	1-Nov	1.25	6.3	14		11
SSD-5-21-SS	28-Oct	1-Nov	1	1.4	5.6		2.6
SSD-5-22-SS	27-Oct	1-Nov	1	2.8	7.9		4.9
SSD-5-23-SS	28-Oct	3-Nov	1.5	1.2	8.7		5.7
SSD-5-24-SS	28-Oct	1-Nov	0.75	1.3	4.7		1.7
SSD-5-27-SS	28-Oct	10-Nov	1	Collected to confirm thickness around SSD-5-24-SS			
SSD-5-28-SS	28-Oct	10-Nov	1.15				
SSD-5-29-SS	28-Oct	10-Nov	1.5				
SSD-5-30-SS	28-Oct	10-Nov	1.25				
SSD-5-25-SS	27-Oct	1-Nov	1.35	6.4	11		8
SSD-5-26-SS	28-Oct	3-Nov	1	0.93	5.1		2.1
ISU 5	AVERAGE		1.1	2.05	7.0		4.0
SSD-6-01-SS	1-Nov	3-Nov	1.25	0.72	8.1		5.1
SSD-6-02-SS	31-Oct	2-Nov	1	0.57	5.1		2.1
SSD-6-03-SS	30-Oct	2-Nov	1	0.44	4.9		1.9
SSD-6-04-SS	28-Oct	2-Nov	1.25	0.7	4		1
SSD-6-05-SS	28-Oct	31-Oct	0.75	0.50	3.6		0.6
SSD-6-15-SS	28-Oct	10-Nov	1	Collected to confirm thickness around SSD-6-05-SS			
SSD-6-16-SS	27-Oct	10-Nov	1				
SSD-6-06-SS	28-Oct	31-Oct	1.25	1.1	5		2
SSD-6-07-SS	2-Nov	3-Nov	1	0.26	3.5		0.5
SSD-6-08-SS	1-Nov	3-Nov	1	0.54	5		2
SSD-6-09-SS	31-Oct	2-Nov	1	0.68	5.1		2.1
SSD-6-10-SS	30-Oct	2-Nov	1	0.77	4.9		1.9
SSD-6-11-SS	28-Oct	2-Nov	1.5	0.57	5.8		2.8
SSD-6-12-SS	28-Oct	31-Oct	1	2.5	6.8		3.8
SSD-6-13-SS	28-Oct	31-Oct	1.25	2.4	6.5		3.5
SSD-6-14-SS	2-Nov	3-Nov	1	0.26	3.5		0.5
ISU 6	AVERAGE		1.1	0.86	5.1		2.1
SSD-7-01-SS	28-Oct	31-Oct	1.25	2.2	6.6		3.6
SSD-7-02-SS	28-Oct	31-Oct	1	1.5	5.6		2.6
SSD-7-03-SS	2-Nov	3-Nov	1.25	0.59	5.5		2.5
SSD-7-04-SS	3-Nov	4-Nov	1	0.53	3.7	**J**	0.7
SSD-7-05-SS	28-Oct	31-Oct	1.25	0.65	4.8		1.8

Table 4-2
Total Organic Carbon and Black Carbon Results
Dark Head Cove In Situ Treatment Study
Lockheed Martin Middle River Complex, Middle River, Maryland

SAMPLE	PLACEMENT DATE	SAMPLE DATE	THICKNESS (in.)	BC (%)	TOC (%)	QUALIFIER	TOC - 3%
SSD-7-06-SS	6-Nov	3-Nov	1	0.53	3.3		0.3
SSD-7-07-SS	28-Oct	4-Nov	1.25	3.2	8.4		5.4
SSD-7-08-SS	2-Nov	31-Oct	0.75	0.55	6.3		3.3
SSD-7-31-SS	28-Oct	10-Nov	1	Collected to confirm thickness around SSD-7-08-SS and SSD-7-14-SS			
SSD-7-32-SS	28-Oct	10-Nov	1				
SSD-7-33-SS	3-Nov	10-Nov	1.25				
SSD-7-34-SS	3-Nov	10-Nov	1.25				
SSD-7-09-SS	3-Nov	4-Nov	1	1.3	6.5	**J**	3.5
SSD-7-10-SS	3-Nov	4-Nov	1.5	1.3	7.8		4.8
SSD-7-11-SS	4-Nov	4-Nov	1.25	0.89	3.4		0.4
SSD-7-12-SS	4-Nov	4-Nov	1	0.51	5.1		2.1
SSD-7-13-SS	4-Nov	4-Nov	1	1.1	8		5
SSD-7-14-SS	28-Oct	31-Oct	0.75	1.1	4.4		1.4
SSD-7-35-SS	28-Oct	7-Dec	1.5	Collected to confirm thickness around SSD-7-14-SS			
SSD-7-36-SS	28-Oct	7-Dec	2				
SSD-7-15-SS	2-Nov	4-Nov	1	1.1	6.2	**J**	3.2
SSD-7-16-SS	3-Nov	4-Nov	1	1.5	8.1	**J**	5.1
SSD-7-17-SS	3-Nov	7-Nov	1.25	1.0	7.4		4.4
SSD-7-18-SS	4-Nov	8-Nov	1	0.96	6.4		3.4
SSD-7-19-SS	7-Nov	8-Nov	1	1.2	9.2		6.2
SSD-7-20-SS	7-Nov	8-Nov	1	0.1	1.9		0
SSD-7-21-SS	2-Nov	4-Nov	1.25	0.44	4.7	**J**	1.7
SSD-7-22-SS	3-Nov	4-Nov	1	0.53	5.2	**J**	2.2
SSD-7-23-SS	3-Nov	7-Nov	1.5	0.53	6.6		3.6
SSD-7-24-SS	4-Nov	8-Nov	1.25	1.1	8.6		5.6
SSD-7-25-SS	7-Nov	8-Nov	1	0.48	5.9		2.9
SSD-7-26-SS	7-Nov	8-Nov	1	0.36	5.4		2.4
SSD-7-27-SS	3-Nov	4-Nov	1	0.83	6.5	**J**	3.5
SSD-7-28-SS	3-Nov	7-Nov	1	0.70	5.8		2.8
SSD-7-29-SS	4-Nov	8-Nov	1.5	1.5	8.5		5.5
SSD-7-30-SS	7-Nov	8-Nov	1	0.9	6.7		3.7
ISU 7	AVERAGE		1.1	0.97	6.1		3.1
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Table 4-3
Bucket Sample Verification Results Dark Head Cove *in situ* Treatment Study
Lockheed Martin Middle River Complex, Middle River, Maryland

DATE	BUCKET ID	AGGREGATE DEPTH	*IN SITU* TREATMENT UNIT
11/1/2017	B-001	1.25	ISU5
11/1/2017	B-002	1	ISU5
11/2/2017	B-003	1.25	ISU6
11/2/2017	B-004	1.25	ISU6
11/3/2017	B-005	1.5	ISU5
11/3/2017	B-006	1.5	ISU5
11/4/2017	B-007	1	ISU7
11/4/2017	B-008	1	ISU7
11/6/2017	B-009	1	ISU7
11/6/2017	B-010	1	ISU7
11/7/2017	B-011	1.25	ISU7
11/7/2017	B-012	1.25	ISU7
11/22/2017	B-013	0.5	ISU3
11/22/2017	B-014	0.5	ISU3
11/24/2017	B-015	N/A	ISU3
11/24/2017	B-016	1	ISU3
11/25/2017	B-017	1	ISU3
11/25/2017	B-018	N/A	ISU3
11/27/2017	B-019	1	ISU3
11/27/2017	B-020	1	ISU3
11/28/2017	B-021	1	ISU3
11/28/2017	B-022	1	ISU3
11/29/2017	B-023	1.25	ISU2
11/29/2017	B-024	1.25	ISU2
11/30/2017	B-025	N/A	ISU2
11/30/2017	B-026	1	ISU2
12/1/2017	B-027	1	ISU2
12/1/2017	B-028	1	ISU2
12/2/2017	B-029	1	ISU5
12/2/2017	B-030	1.25	ISU5
	AVERAGE=	1.07	--

***Notes:**

N/A = Not Applicable

Table 4-4
Fines Analysis Results
Dark Head Cove *in situ* Treatment Study
Lockheed Martin Middle River Complex, Middle River, Maryland

SAMPLE	TC	TOC	BC	TOM	Ash	Moisture
AB-MR-01 (Fines)	25%	25%	4.9%	29.4%	70.6%	2.0%
AB-MR-03 (Fines)	28%	21%	4.6%	26.8%	73.2%	3.6%
AB-MR-02 (Fines)	25%	19%	4.4%	24.9%	75.1%	1.9%
AB-MR-04 (Fines)	27%	17%	4.4%	25.0%	75.0%	4.4%

***Notes:**

All results presented as percentage (%)

BC - Black Carbon

TOC - Total Organic Carbon

TC - Total Carbon

TOM - Total Organic Material

APPENDICES

Appendix A—Daily Reports

Appendix B—Permits and Approvals

Appendix C—Manufacturer's "Certificates of Analysis"

Appendix D—Push Core and Bucket-Sample Photo Log

Appendix E—Laboratory Analytical Results of Carbon Content

Appendix F—Quality Control Documentation

Appendix G—Water Quality Monitoring Results

Appendix H—Data Validation Reports

Appendix I—Response to USEPA Comments