SEDIMENT REMEDIATION ENDPOINTS REPORT

TIDAL FLATS AND OUTFALL 008

STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

Prepared for:

ACSIM - ODB
United States Army
2530 Crystal Drive
Arlington, VA 22202

Prepared by:

Amec Foster Wheeler Environment & Infrastructure, Inc.
511 Congress Street
Portland, Maine 04101

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ACRONYMS AND ABBREVIATION

AMEC	AMEC Environment & Infrastructure, Inc.
bgs	below ground surface
COC	chain of custody
CT DEEP	Connecticut Department of Energy and Environmental Protection
CT DOT	Connecticut Department of Transportation
ER-M	effects range - median
ERM-Q	effects range - median quotient
mg/kg	milligrams per kilogram
N/A	not applicable
ND	not detected
NOAA	National Oceanic and Atmospheric Administration
OF8	Outfall 008 Drainage Ditch
PAHs	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyl
ppm	parts per million
QC	Quality Control
RCPs	Reasonable Confidence Protocols
REF	Background/Reference Area
SAEP	Stratford Army Engine Plant
SIM	selective ion monitoring
SVOC	semi-volatile organic compound
TF	Tidal Flats
TOC	total organic carbon
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

1.0 INTRODUCTION

This report presents the results of 2014-2015 sediment chemical characterization, proposed sediment remediation endpoints, and preliminary remediation footprints for the areas known as the Tidal Flats and Outfall 008 at the Stratford Army Engine Plant (SAEP) in Stratford, Connecticut. The location of the SAEP is presented in **Figure 1-1**. The sediment areas of interest are presented in **Figure 1-2**.

1.1 Description of Sediment Areas

The locations of the Background/Reference Area, Tidal Flats, and Outfall 008 sediments areas are shown on **Figure 1-2**.

Tidal Flats

The Tidal Flats are classified by the United States Fish and Wildlife Service (USFWS) as estuarine and marine wetlands (USFWS, 2012). The Tidal Flats consist of fine-grained sediments exposed twice daily during low tide. These sediments are mostly un-vegetated, with the northwest portion supporting limited emergent vegetation. A Causeway extends from the upland to the river channel and divides the Tidal Flats into two areas. The Causeway was constructed over the Tidal Flats in 1929 to provide access to the river channel. A stone jetty in northern portion of Tidal Flats extends to the river channel and was built in 1932 to divert effluent from the Stratford Water Pollution Control Facility, which is located immediately upstream from the Tidal Flats. Numerous outfalls formerly released liquid waste streams from SAEP industrial operations to the Tidal Flats.

Outfall 008

The Outfall 008 drainage ditch is located at the southern boundary of the site, and was used to discharge treated wastewater associated with metal plating into a drainage ditch that flows to the south. The drainage ditch originates at Outfall 008. It is approximately 10 to 12 feet wide and generally less than 2 feet deep. From Outfall 008 the ditch extends south-southeast a distance of 1,000 feet to a partially collapsed steel culvert which runs underneath a dirt road. The partial collapse of the steel culvert currently limits the tidal fluctuation impacts in the portion of the ditch between the culvert and Outfall 008. From the dirt road, the ditch extends another 110 feet south-southeast, where it intersects a perpendicular ditch. This perpendicular ditch carries runoff from the airport (located to the southwest, across Main Street) to Marine Basin (located 250 feet east of the junction of the Outfall 008 Drainage Ditch and the perpendicular ditch). Water in the perpendicular drainage ditch flows to Marine Basin, which in turn drains to the Housatonic River.

As part of the Connecticut Department of Transportation (CT DOT) Runway Safety Area Project (Re-alignment of CT Route 113, CT DOT Project 15-336), in 2013 the Outfall 008 drainage ditch and a portion of the property adjacent to the ditch were evaluated for the presence of Raymark waste. The investigation determined that Raymark Waste is present adjacent to the Outfall 008 drainage ditch, making it difficult to discern which proportion of metals are attributable to the SAEP facility, and which are attributable to the Raymark waste. **Figure 1-3** presents the extent of

Raymark waste as depicted in the Removal Work Plan for the Raymark Waste (URS Corporation, February 28, 2014). The Removal Work Plan identifies Raymark wastes at depths up to 8 feet in areas adjacent to the drainage ditch, and states that "RMW (Raymark Waste) extends into the tidal channel". The delineation of Raymark Waste was not completed along the drainage channel to the north, toward Outfall 008. Review of historical aerial photographs indicates that this area was also filled sometime between 1951 and 1965, and given the presence of Raymark Waste in the fill areas that were investigated, it is likely that the areas to the north that were not investigated also contain Raymark Waste. The excavation of Raymark Waste was conducted in 2015, significantly altering the portion of the Outfall 008 drainage ditch adjacent to the former Raymark Waste.

Background/Reference Area

The Background/Reference Area is located across the Housatonic River from SAEP, in and around the marshy land mass known as Nell's Island (see **Figure 1-2**). The location of the Background/Reference area has been mutually agreed upon by the Army and CT DEEP, as other potential background/reference areas further upstream in the Housatonic River lacked the finer grained materials present in the Tidal Flats and Outfall 008 sediments.

1.2 Background Information

There have been numerous investigations of the sediments in the Tidal Flats and Outfall 008 areas prior to 2014, and are summarized as follows:

- Sampling of the Tidal Flats and Outfall 008 drainage ditch sediments was conducted by the U.S. Army in 1992, 1994, and 1999 as part of a Remedial Investigation.
- The Connecticut Department of Transportation (CTDOT) also conducted sediment investigations in the Outfall 008 drainage ditch in August 2012.
- Background/reference sediment sampling was conducted in 1994, 1999, 2009, and 2012.

In April 2014, the U.S. Department of the Army issued the Final Work Plan for Determination of Sediment Remediation Endpoints, Tidal Flats and Outfall 008, Stratford Army Engine Plant, Stratford, Connecticut (AMEC, 2014a). This work plan was reviewed by the Connecticut Department of Energy and Environmental Protection (CT DEEP). The Work Plan proposed sediment toxicity testing as a means to assist in developing the remediation endpoint goals for the sediments in question, and laid out the steps for development of the remediation endpoints. The Final Work Plan also presented some of the historical sediment data referenced above. In April and May 2014, additional sediment sampling and toxicity testing were conducted, and in September 2014 the Army issued the Draft Sediment Remediation Endpoints Report for the Tidal Flats and Outfall 008 (AMEC, 2014b). The report presented the results of sediment chemical characterization, toxicity testing results, and proposed sediment remediation endpoints for the Tidal Flats and Outfall 008 areas. The results of the toxicity testing were that toxicity is not definitively linked with a specific chemical present in the sediment. As an alternative to using toxicity test results alone for development of remediation endpoints, the report presented

statistical analyses of the data and proposed using an Effects Range Medium Quotient (ERM-Q) of 1.0 for the metals cadmium, chromium, and copper.

On December 2, 2014, the CT DEEP submitted comments on the Draft Sediment Remediation Endpoints Report (AMEC, 2014b). CT DEEP concluded from their review of the report that toxicity is not definitively linked with a specific chemical, and recommended setting the remedial goal based on multiple chemicals to more accurately describe the chemical quality associated with the non-toxic samples. CT DEEP's recommendations for determining the sediment remediation endpoint goals were as follows:

- Use an ERM-Q of 0.5 for the eight metals arsenic, cadmium, chromium, copper, lead, nickel, silver, and zinc; an ERM-Q > 0.5 would require remediation
- Concentrations of mercury and PCBs should generally not be present in post-remedial conditions
- Additional site characterization was needed to refine the area of sediment contamination both at depth within the Tidal Flat and Outfall 008 areas, as well as within surficial and deeper sediments between the eastern edge of the intertidal flats and the Housatonic River.

On February 17, 2015, the U.S. Department of the Army responded to CT DEEP's comments indicating that they agreed to removal of contaminated sediments with ERM-Qs > 0.5 from the 0-2 foot below ground surface (bgs) interval in both the Tidal Flats and Outfall 008 areas, as well as replacement with CT DEEP-approved backfill.

Following further discussions with CT DEEP, the U.S. Department of the Army issued a memorandum to CT DEEP on March 24, 2015 indicating that they were committed to proceeding with the additional sampling in a timely manner to ensure redevelopment of the SAEP site without further delay.

In April 2015, additional sediment sampling was conducted in the Tidal Flats and Outfall 008 areas, as follows:

- between the Tidal Flats and the margin of the dredged Housatonic River channel,
- at depths greater than 2 feet bgs in the Tidal Flats, and
- at depths greater than 2 feet bgs in the Outfall 008 drainage ditch.

This report presents the sediment data collected in 2014 and 2015 from the Tidal Flats and Outfall 008 areas, develops ERM-Qs for the eight metals, compares the calculated ERM-Qs to a remedial target of 0.5, and evaluates the contamination from total PCBs and mercury. Proposed remedial footprints (by depth interval) are also presented. This document is intended to be used in development of a Remedial Action Plan for removal of the contaminated sediments.

2.0 SAMPLING, ANALYSIS, AND VALIDATION

Sediment sampling activities were conducted in 2014 and 2015 in the Tidal Flats and Outfall 008 areas. Sampling activities were conducted in accordance with the Final Work Plan: Determination of Sediment Remediation Endpoints, Tidal Flats and Outfall 008, Stratford Army Engine Plant, Stratford, Connecticut (AMEC, 2014a), except where otherwise noted. The following subsections detail the locations, quantities and analyses for the program.

2.1 Sediment Sampling and Analysis Overview

2014 actual and 2015 proposed sediment sample locations for the Tidal Flats and Outfall 008 areas are presented in **Figures 2-1** and **2-2**, respectively. A summary of laboratory analyses performed on each of the samples is provided in **Table 2-1**. Field data records for collection of sediment samples are provided in **Appendix A.**

2.1.1 2014 Sediment Samples

2014 sediment samples were collected for chemical analysis from 110 locations, as follows:

- 24 samples from 24 locations from the Background/Reference Area (Nell's Island).
- 134 samples from 67 locations in the Tidal Flats, and
- 38 samples from 19 locations in the Outfall 008 area.

Sediment samples were collected from the 0-0.5 and the 1-2 foot bgs depth intervals. For the 0-0.5-foot depth interval samples, an aliquot of each was analyzed for SVOCs, metals (antimony, arsenic, cadmium, chromium (total), copper, lead, manganese, mercury, nickel, selenium, silver, thallium, and zinc), cyanide (total), PCB homologs, PCB Aroclors, asbestos (chrysotile only), and TOC. A subset of these samples was analyzed for grain size (see **Table 2-1**). Sediment samples collected for chemical analyses were submitted to York Analytical Laboratory, a CT DEEP-approved analytical laboratory located in Stratford, Connecticut.

Sediment samples were also collected from the 1-2 foot depth interval at each sampling location in the Tidal Flats and Outfall 008 areas, submitted to York Analytical Laboratory, and frozen pending results of the 0-0.5 foot bgs depth interval samples. Following preliminary assessment of the 0-0.5 foot depth interval sediment chemistry, it was determined that the 1-2 foot bgs depth interval samples be thawed and analyzed for metals (antimony, arsenic, cadmium, chromium (total), copper, lead, manganese, nickel, selenium, silver, thallium, and zinc), SVOCs, PCB homologs, PCB Aroclors, and TOC. Mercury was not analyzed for in the 1-2 foot bgs samples, as the 0-0.5 foot bgs sample results indicated that mercury was not detected above the reporting limit.

2.1.2 2015 Sediment Samples

To supplement the 2014 data and answer specific questions relative to CT DEEP requests for additional characterization, 2015 sediment samples were collected for chemical analysis from 76 locations, as follows:

- 114 samples from 58 locations in the Tidal Flats, and
- 33 samples from 18 locations in the Outfall 008 area.

Sediment samples were collected using a Vibracore rig mounted on a barge and operated by TGB Marine Services. A summary of coring locations, coordinates, penetration depths, and recovery are presented as **Appendix B**.

Characterization of Sediments between the Tidal Flats and the Housatonic River Channel

Locations of sediment cores with proposed sampling intervals of 0-1, 1-2, and 2-4 foot bgs collected between the Tidal Flats and the margin of the dredged Housatonic River channel (as defined by dredging activities of the USACE in 2012), are presented on **Figure 2-1** as blue diamonds. For each of the 2-4 foot sample intervals, the 2-3 foot interval and the 3-4 foot interval samples were held by the laboratory for potential future analysis pending results of the shallower sample intervals. Based on analytical results from shallower intervals indicating either ERM-Q values for the eight metals > 0.5 or PCBs > 1 ppm, a subset of the 2-3 foot and 3-4 foot interval samples were taken off hold and analyzed by the laboratory.

Several proposed sediment samples could not be collected, after multiple attempts, due to refusal of the coring device on coarse gravel and rocks, shell fragments, or peat/vegetative matter (see **Appendix B**). The locations of the samples that could not be collected are presented on **Figure 2-3**.

Sediment samples were analyzed for arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc and PCBs (Aroclors and homologs).

Characterization of Sediments Greater than 2 feet, bgs - Tidal Flats

Within the Tidal Flats, additional sediment samples were collected from 2-4 feet bgs at a lower density than samples collected in 2014 from the 0-2 foot bgs interval. Specifically, the areas previously proposed for remediation in the 1-2 foot bgs interval in the Tidal Flats were sampled to evaluate sediment chemistry at depths greater than 2 feet bgs. The proposed locations of these sediment samples are represented as yellow pentagons on **Figure 2-1**. For each of the 2-4 foot bgs sample intervals collected, the 2-3 foot bgs sample interval was analyzed, and the 3-4 foot bgs sample interval was held by the laboratory for future analysis pending results of the shallower interval. Based on analytical results from shallower intervals indicating either ERM-Q values for the eight metals > 0 5, or PCBs > 1 ppm, a subset of the 2-3 foot and 3-4 foot interval samples were taken off hold and analyzed by the laboratory. Sediment samples were analyzed

for arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc and PCBs (Aroclors and homologs).

In addition, sediment cores were collected in the vicinity of the former wastewater outfalls in the Tidal Flats, at intervals of 3-4, 5-6, and 7-8 feet bgs (see **Figure 2-1**). These samples were analyzed for arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc and PCBs (Aroclors and homologs).

Several proposed sediment samples could not be collected, after multiple attempts, due to refusal of the coring device on dense material, poor recovery, or peat/vegetative matter (see **Appendix B**). The locations of the samples that could not be collected are presented on **Figure 2-3**.

Characterization of Sediments Greater than 2 feet, bgs – Outfall 008

Within the Outfall 008 area, additional sediment samples were collected from the 2-4 feet, bgs interval along the entire portion of the drainage ditch, as presented in **Figure 2-2**. For each of the 2-4 foot sample intervals, the 2-3 foot interval was analyzed and the 3-4 foot sample interval was held by the laboratory for potential future analysis pending results of the shallower interval. The majority of 3-4 foot interval samples were analyzed by the laboratory. Sediment samples were analyzed for arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, asbestos, and PCBs (Aroclors and homologs).

Several proposed sediment samples could not be locations collected, after multiple attempts, due to poor recovery and/or samples consisting primarily of peat. The samples that could not be collected are presented on **Figure 2-4**.

Additional Sediment Sample Analyses Requested by USACE

In addition to the analyses referenced above, the U.S. Army Corps of Engineers (USACE) New England District requested that certain samples collected in 2015 also be analyzed for PCB congeners, PAHs, and TOC. The last three columns in **Table 2-1** indicate the 2015 samples selected for these analyses.

2.2 Data Validation

A chemist review was completed for all laboratory analyses to evaluate data quality in support of the CT DEEP Reasonable Confidence Protocols (RCPs). Data quality evaluations were completed using quality control (QC) limits specified by the CTDEEP RCPs and York Analytical Laboratory. If data quality issues were identified during the review, results were qualified in the final data set and interpretations on data biases provided. Data qualifications were completed using the professional judgment of the validation chemist and general procedures specified in Region I EPA-New England Data Validation Functional Guidelines for Evaluating Environmental Analyses (USEPA, 1996b). Chemist review summaries for the 2014 sediment 0-0.5 foot and 1-2 foot sample analyses can be found in **Appendices C-1** and **C-2**, respectively. Chemist review summary of the 2015 sediment sample analyses is presented in **Appendix C-3**.

3.0 SEDIMENT ANALYTICAL RESULTS

The following subsections present a summary of sediment analytical results for the Tidal Flats and Outfall 008 drainage area. The focus of the analytical discussions in this section are primarily on 1) calculated ERM-Q values for the eight metals arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, 2) total PCBs, and 3) mercury. Locations of sediment samples are presented in **Figures 2-1** and **2-2**. Detected analytes in sediment samples for each of the three areas are presented in **Table 3-1**. Complete analytical results for sediments collected during the 2014 and 2015 field programs are presented in **Appendix D**. Grain size data for 2014 and 2015 sediment samples can be found in **Appendix E**. Analytical results for sediment samples collected at the SAEP prior to April 2014 (i.e., the 2-4 foot bgs depth interval) can be found in Appendix A of the Final Work Plan (AMEC, 2014a).

The ERM-Q for the eight metals for each sample was calculated as follows:

- dividing the actual sediment metal concentration (for non-detects, the detection limit numeric value was used) at each sample location by the published Effects Range-Medium (ER-M) value (Long, et al. 1995) for the metal; and
- calculating the average of the ER-M ratios for the eight metals at each sample location to derive eight m ERM-Q for that sample.

The values of the individual metals concentrations for each sample, the ER-M value for each of the eight metals, and the calculated ERM-Q for each sample are presented in **Table 3-2**.

For the majority of sediment samples collected in 2014 and 2015, both homolog and Aroclor PCB analyses were conducted. The discussions of PCB contamination below incorporate both total homolog and total Aroclor results.

Mercury concentrations in sediment are compared to the ER-M value of 0.71 parts per million (ppm) for marine sediments in the discussions below.

3.1 Tidal Flats Sediment Chemistry

Sediments in the Tidal Flats contain metals, PCBs, and PAHs at concentrations exceeding those in reference locations (AMEC, 2014b). The distribution patterns of these analytes vary, but they are generally found at higher concentrations adjacent to the Dike in the vicinity of the former wastewater outfalls. In general, the concentrations of these analytes are highest in the 0-0.5 foot, below ground surface (bgs) interval, and generally decrease to concentrations equivalent to background at depths greater than 2 feet bgs. Exceptions to this trend are noted in the discussions below.

3.1.1 Metals ERM-Q

As indicated above, the focus of this subsection is to discuss the results of the calculated ERM-Q values relative to the remedial target of 0.5. The calculated ERM-Q values for each sample

are presented in **Table 3-2**, and plotted on **Figures 3-1** through **3-4**, for the depth intervals from 0-1, 1-2, 2-3, and 3-4 feet bgs, respectively.

For the Tidal Flats the 0-1 foot, bgs interval, ERM-Q values range from 0.05 to 2.55 (**Figure 3-1**). The majority of the 0-1 foot bgs interval in the Tidal Flats has ERM-Qs > 0.5, with the highest values located in the vicinity of the outfalls along the Dike. Areas outside the immediate perimeter of the Causeway and bordering the Housatonic River Channel have ERM-Qs < 0.5.

In the 1-2 foot bgs interval, ERM-Q values are generally lower than the 0-1 foot bgs interval (**Figure 3-2**). Less than half of the Tidal Flats area has ERM-Q values > 0.5. The highest ERM-Q values are located in the vicinity of the outfalls along the western portion of the Dike, and adjacent to the breakwater along the Housatonic River.

ERM-Q values in the 2-3 foot bgs interval are generally lower than the 1-2 foot bgs interval (**Figure 3-3**). ERM-Q values > 0.5 are limited to the tip of the Causeway and the eastern end of the breakwater along the Housatonic River. The locations where ERM-Q values exceed 0.5 would appear to indicate a source of metals contamination different than that of the outfalls along the Dike, with the possible exception of location SD2014-TF-LF3 (see **Figure 3-3**).

ERM-Q values in the 3-4 foot bgs interval are generally consistent with the 2-3 foot bgs interval (**Figure 3-4**). Similar to the 2-3 foot bgs interval, the ERM-Q values > 0.5 are limited to the tip of the Causeway and the eastern end of the breakwater along the Housatonic River. Again, the locations where ERM-Q values exceed 0.5 would appear to indicate a source of metals contamination different than that of the outfalls along the Dike, as evidenced by ERM-Q values < 0.5 adjacent to the outfalls along the western portion of the Dike (see **Figure 3-4**). The exceptions being the locations SD2014-TF-LF3 and SD2015-TF-H1 (see **Figure 3-4**).

ERM-Qs for the 5-6 and 7-8 foot bgs sample intervals, limited to areas adjacent to the outfalls along the Dike, were all less than 0.5 (see **Table 3-1**).

3.1.2 Total PCBs

For the 0-1 foot bgs interval of the Tidal Flats sediments, total PCBs exceed 1.0 ppm in two samples adjacent to Dike outfalls, and two samples on the western edge of the Causeway (**Figure 3-5**). These locations are coincident with ERM-Q values > 0.5.

Total PCBs in the 1-2 foot bgs interval are all < 1.0 ppm (**Figure 3-6**). Detectable PCBs are limited to three outfalls along the Dike, the tip of the Causeway, and the breakwater along the Housatonic River, which is generally consistent with ERM-Q values > 0.5 in the same depth interval (**Figure 3-2**). Again, similar to the EMR-Q values, the locations where detectable PCBs were found (tip of Causeway and the breakwater) would appear to indicate a source of PCB contamination different than that of the outfalls along the Dike.

In the 2-3 foot bgs interval, Total PCB concentrations exceed 1.0 ppm to the west of the tip of the Causeway (locations SD2014-TF-G5 and SD2014-TF-GH5) and at location SD2014-TF-L3 (**Figure 3-7**). Similar to the 1-2 foot bgs interval, the detections of PCBs were limited to the outer fringes of the Tidal Flats. PCBs were not detected at the outfall locations along the Dike,

providing further evidence that the outfalls may not be the source of PCB contamination evidenced in the 2-3 foot bgs interval.

Total PCBs detected in the 3-4 foot bgs interval were evident along the Dike at several of the outfalls, the outer fringes of the Tidal Flats, and at location SD2014-TF-L3 (**Figure 3-8**). The lone location with a total PCB concentration > 1.0 ppm was SD2015-TF-GH12 adjacent to outfall OF-005.

Analysis of total PCBs in the 5-6 and 7-8 foot bgs sample intervals, limited to areas adjacent to the outfalls along the Dike, indicated detections at only one location (SD2015-TF-D0) in both sample intervals (**Figures 3-9** and **3-10**). Total PCB concentrations exceeded 1.0 ppm in the 7-8 foot bgs sample interval (see **Figure 3-10**).

3.1.3 Mercury

For the 0-1 foot bgs interval of the Tidal Flats sediments, mercury was detected only in sediments at the outer fringes of the Tidal Flats (**Figure 3-11**). Concentrations of detectable mercury were less than the ER-M of 0.71 ppm. The detections of mercury were limited to the outer fringes of the Tidal Flats, and suggest that the outfalls may not be the source of mercury contamination in the 0-1 foot bgs interval.

The number of samples analyzed for mercury in the 1-2 foot depth interval is limited to the outer fringes of the Tidal Flats, as 2014 sediment samples from this interval were not analyzed for mercury. The samples in which mercury was detected indicated concentration < 0.71 ppm (**Figure 3-12**).

For the 2-3 foot bgs sample interval, mercury was detected at concentrations exceeding 3.0 ppm in the outer fringes of the Tidal Flats, near the tip of the Causeway and along the eastern end of the breakwater (**Figure 3-13**). This distribution, and the lack of detectable mercury in the vicinity of the outfalls, again indicates a potential source of sediment contamination from sources not associated with the SAEP facility.

Mercury detected in the 3-4 foot bgs sample interval indicates elevated concentrations above 0.71 ppm in the vicinity of outfalls OF-005 and OF-006, in addition to isolated locations along the breakwater, at the tip of the Causeway, and at location SD2014-TF-L3 (**Figure 3-14**).

Analysis of mercury in the 5-6 foot bgs sample interval, limited to areas adjacent to the outfalls along the Dike, indicated detections at only two locations adjacent to outfalls OF-001 and OF-006, at concentrations < 0.3 ppm (**Figure 3-15**). Mercury was not detected in the 7-8 foot bgs sample interval (**Figure 3-16**).

3.2 Outfall 008 Sediment Chemistry

Sediments in the Outfall 008 Drainage Ditch contain metals and PCBs at concentrations greater than Background/Reference locations (AMEC, 2014b). Concentrations of cadmium, chromium, copper, lead, nickel, silver, and zinc detected in sediment samples were all above Background/Reference location sample concentrations. In 2015, CT DOT remediated and restored the areas of Raymark Waste adjacent to the Outfall 008 drainage ditches. The

restoration of these areas appears to have significantly altered the drainage ditches. Therefore, the concentrations of metals and PCBs in the shallower (i.e., 0-1 and 1-2 foot bgs) sample intervals (collected spring 2014) from may not represent current conditions in these sections of the drainage ditch. The 2-3 and 3-4 foot bgs samples (collected in April 2015) are likely still representative of current conditions.

3.2.1 Metals ERM-Q

As indicated above, the focus of this subsection is to discuss the results of the calculated ERM-Q values relative to the remedial target of 0.5. The calculated ERM-Q values for each sample are presented in **Table 3-2**, and plotted on **Figures 3-17** through **3-20**, for the depth intervals from 0-1, 1-2, 2-3, and 3-4 feet bgs, respectively.

For the Outfall 008 drainage ditch the vast majority of samples from the 0-1, 1-2, 2-3, and 3-4 foot bgs samples have calculated ERM-Q values exceeding 0.5 (**Figures 3-17 through 3-20**). However, the extent of metals ERM-Q values > 0.5 does decrease in the 3-4 foot bgs interval.

3.2.2 Total PCBs

For the 0-1 and 1-2 foot bgs sediment sample intervals in the Outfall 008 drainage, concentrations of total PCBs were < 1.0 ppm (**Figures 3-21** and **3-22**).

Total PCBs in the 2-3 foot bgs interval were detected at concentrations > 1.0 ppm in the majority of the samples, with the exception of the first 250 feet east from the outfall OF-008. (**Figure 3-23**).

In the 3-4 foot bgs interval, the extent of total PCBs with concentrations > 1.0 ppm is much less than the 2-3 foot bgs interval, with only four sample locations in the eastern portion of the drainage exhibiting concentrations > 1.0 ppm (see **Figure 3-24**).

3.2.3 Mercury

For the 0-1 foot bgs interval of the Outfall 008 drainage area sediments, mercury was not detected (**Figure 3-25**). 1-2 foot bgs sediment samples collected in 2014 were not analyzed for mercury (see **Table 2-1**).

For the 2-3 and 3-4 foot bgs sample intervals, mercury was detected in over half the samples at concentrations < 0.71 ppm, with only one location in each interval having a concentration marginally exceeding 0.71 ppm (**Figures 3-26** and **3-27**).

3.3 Summary of Contamination

The following subsections present a summary of detected contaminants in sediment for the Tidal Flats and Outfall 008 areas.

3.3.1 Tidal Flats

The data indicate a general decrease in metals and PCB concentrations with depth, with the exception being the area around the tip of the Causeway, as well as the outer fringes of the Tidal Flats adjacent to the breakwater and toward the Housatonic River channel. The additional data collected at the outer limits of the Tidal Flats support prior interpretations that there may source(s) of contamination, which are not associated with the SAEP facility, transported to the Tidal Flats by the Housatonic River. This interpretation is supported by ERM-Q, total PCB, and mercury distributions in the 2-3 and 3-4 foot bgs sample intervals.

Total PCBs exceeding 1.0 ppm, and mercury concentrations greater than the ERM value of 0.71 ppm, are generally co-located with samples having an ERM-Q > 0.5.

The 5-6' and 7-8' figures indicate no criteria exceeded, with the exception of a 7-8' Total PCB concentration > 1.0 ppm along the Dike near outfalls OF-002 & OF-003.

3.3.2 Outfall 008

ERM-Q values generally exceed 0.5 along the entire length of the drainage area ditches between 0 and 4 feet bgs, with few exceptions.

Concentrations of total PCBs and mercury in the 0-1 and 1-2 foot bgs intervals are generally non-detect or less than 1.0 ppm and 0.71 ppm, respectively. In the 2-3 and 3-4 foot bgs sample intervals, the concentrations of total PCBs increase, and are present at concentrations > 1.0 ppm. Mercury concentrations in the sediments of the ditch from the 2-3 and 3-4 foot bgs intervals are less than the ER-M of 0.71 ppm, with the exception of one sample in each of the intervals at a concentration of 0 77 ppm each (see **Figures 3-26** and **3-27**).

In the summer of 2015, the CT DOT excavated the Raymark Waste (see **Figure 1-3**), significantly altering the drainage ditch sections adjacent to the former waste. As a result of the excavation and restoration of these sections of the drainage ditch, the results of the 2014 0-2 feet bgs sediment samples may no longer be representative of actual conditions in these sections of the drainage ditch.

4.0 PROPOSED SEDIMENT REMEDIATION FOOTPRINT

On February 17, 2015, the U.S. Department of the Army responded to CT DEEP comments on approach to sediment remediation, indicating that they agreed to removal of contaminated sediments with ERM-Qs > 0.5 from the 0-2 foot below ground surface (bgs) interval in both the Tidal Flats and Outfall 008 areas, as well as replacement with CT DEEP-approved backfill.

4.1 Proposed Remedial Footprints for the 0-2 foot bgs Interval

In the March 24, 2015 U.S. Department of the Army response to CT DEEP comments, approaches were presented for remediation of the Tidal Flats and Outfall 008 sediment depth interval from 0-2 feet bgs. The proposed remediation approach to the 0-2 foot bgs interval for the Tidal Flats has not changed. However, the excavation of Raymark Waste adjacent to the Outfall 008 drainage ditches has resulted in a slightly different proposed approach, which is discussed below.

Tidal Flats

For the 0-1 foot bgs interval in the Tidal Flats, the current remedial footprint, as defined by existing ERM-Q values >= 0.5, is depicted in **Figure 4-1**. The following bullets highlight the assumptions associated with the proposed remedial footprint for the 0-1 foot bgs interval.

- 200' x 200' grids with an ERM-Q >= 0.5 will be remediated
- 200' x 200' grids with an ERM-Q < 0.5 will not be remediated
- Grids in the vicinity of outfalls along the Dike adjacent to the Tidal Flats will be remediated (irrespective of ERM-Q value)
- For the remediation boundary between grids with ERM-Qs > 0.5 and grids with ERM-Qs < 0.5, the boundary will be drawn by assuming that the contamination is linear and interpolating a percent distance between a sample ERM-Q > 0.5 and sample ERM-Q < 0.5. Note that with the use of the interpolated remedial boundary, the Army is eliminating the additional sampling to further laterally delineate contamination as proposed in the January 20, 2015 submission to CT DEEP (refer to Figure 16 of that document).

For the 1-2 foot, bgs interval in the Tidal Flats, the current remedial footprint, as defined by existing ERM-Q values > 0.5, is depicted in **Figure 4-2**. The following bullets highlight the assumptions associated with the proposed remedial footprint for the 1-2 foot bgs interval:

- 200' x 200' grids with an ERM-Q >= 0.50 will be remediated
- 200' x 200' grids with an ERM-Q < 0.5 will not be remediated
- Grids in the vicinity of the outfalls along the Dike will be remediated (irrespective of ERM-Q values)
- For the remediation boundary between grids with ERM-Qs > 0.5 and grids with ERM-Qs < 0.5, the boundary will be drawn by assuming that the contamination is linear and

interpolating a percent distance between a sample ERM-Q > 0.5 and sample ERM-Q < 0.5. Note that with the use of the interpolated remedial boundary, the Army is eliminating the additional sampling to further laterally delineate contamination as proposed in the January 20, 2015 submission (refer to Figure 17 of that document).

The proposed remedial footprint for the 0-2 foot bgs interval, based on ERMQs >= 0.5, in the Tidal Flats sediments also encompasses total PCB concentrations > 1.0 ppm, as well as mercury concentrations greater than the ER-M value of 0.71.

Outfall 008

The March 24, 2015 Army submittal to CT DEEP proposed remediation of Outfall 008 drainage ditch sediments in the 0-2' depth interval where ERM-Q values exceed 0.5, which incorporates all detections of PCBs and mercury identified within this interval. The exception to this proposed 0-2 foot bgs remediation are the ditch sections formerly adjacent to the remediated Raymark Waste. As a result of the excavation and restoration of these sections of the drainage ditch, the results of the 2014 0-2 feet bgs sediment samples may no longer be representative of actual conditions in these sections of the drainage ditch. The Army proposes that the 0-2 foot bgs depth interval of these sections be re-sampled and analyzed for metals and PCBs to evaluate results against a metals ERM-Q of 0.5 and total PCBs concentration of 1.0 ppm.

For the 0-1 and 1-2 foot bgs intervals in the Outfall 008 drainage ditch, the proposed remedial footprint is depicted in **Figures 4-3** and **4-4**. These areas of proposed remediation may expand, pending results from potential additional sampling.

4.2 Discussion of Contamination at Depths Exceeding 2 feet bgs

This section presents the evaluation of potential remediation for the sediments greater than 2 feet bgs in the Tidal Flats and Outfall 008 drainage ditch.

Tidal Flats

In the Army's March 24, 2015 response to CT DEEP comments, it was stated that the Army is reluctant to pursue further sampling toward the Housatonic River channel due to upstream sources such as Raymark Operable Units 7 and 8, but sampling was conducted to meet CT DEEP's request. The Army also stated that it intends to have additional discussions about the remediation of this area if remediation is found to be necessary. As discussed in Section 3.3.1 above, the additional data collected at the outer limits of the Tidal Flats support prior interpretations that there may source(s) of contamination, which are not associated with the SAEP facility, transported to the Tidal Flats by the Housatonic River. This interpretation is supported by ERM-Q, total PCB, and mercury distributions in the 2-3 and 3-4 foot bgs sample intervals (see Section 3.1). Therefore, the areas of sediment at depths greater than 2 feet bgs at the outer fringes of the Tidal Flats, which reflect contamination from sources other than the SAEP facility, have not been included in the proposed remedial footprint.