Monitoring Survey at the Central Long Island Sound Disposal Site
September/October 2016

Disposal Area
Monitoring System DAMOS

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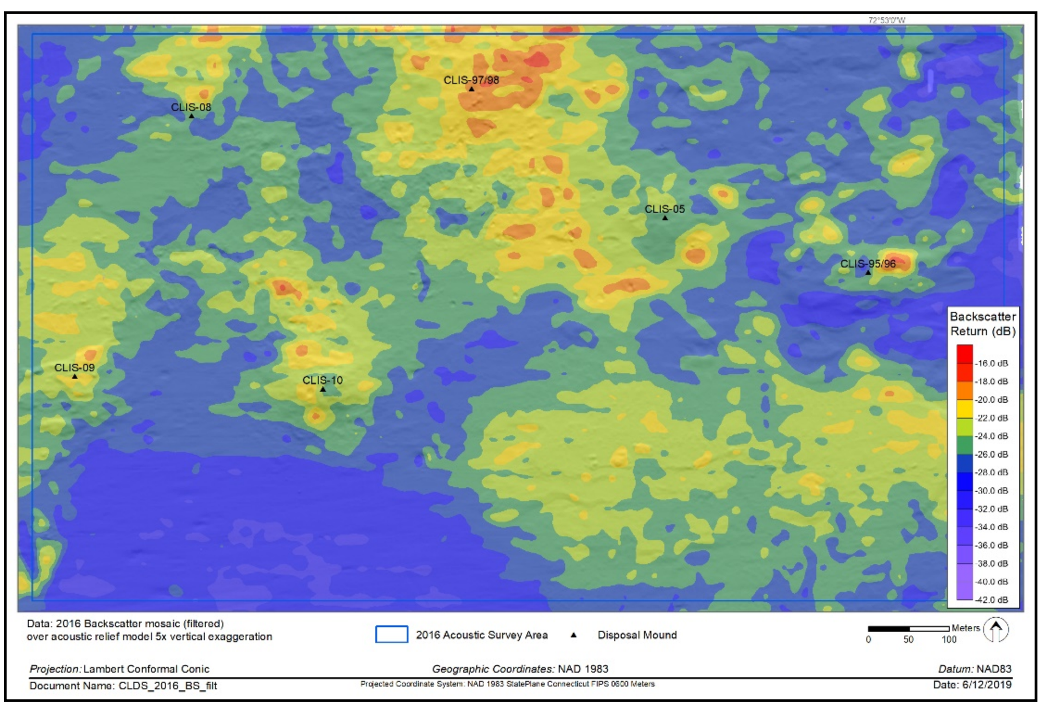
New England District

D A M O S
DISPOSAL AREA MONITORING SYSTEM



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13. ABSTRACT
A comprehensive monitoring survey was conducted at the Central Long Island Sound Disposal Site (CLDS) in September and October 2016 as part of the U.S. Army Corps of Engineers' (USACE) New England District (NAE) Disposal Area Monitoring System (DAMOS) Program. The 2.0 × 4.1 km rectangular site lies approximately 10 km south of East Haven, Connecticut, and was designated by the U.S. Environmental Protection Agency (EPA) as an Ocean Dredged Material Disposal Site (ODMDS) under Section 102(c) of the Marine Protection, Research, and Sanctuaries Act in 2005. This survey was jointly funded by the EPA under Interagency Agreement DW-096-95829701 and by the USACE's DAMOS Program.

Documented dredged material disposal within the approximate boundary of CLDS began in the early 1970s, but this general location has been utilized for the disposal of sediments dredged from surrounding harbors in Long Island Sound for at least 60 years making for a complex distribution of disposed sediment on the seafloor. Prior to the 1970s, there were little or no requirements for testing dredged material prior to its disposal resulting in a wide range of sediment quality given the long industrial history of many ports and harbors on Long Island Sound. Further, although general areas had been specified for the disposal to occur, the lack of a high accuracy navigation likely led to the spreading of dredged material over a broad zone within and surrounding the specified disposal area.

Target buoys were deployed beginning in the 1970s making for a more focused distribution of disposed material. With the introduction of sediment testing requirements, material from large dredging projects with elevated levels of contaminants or biological toxicity were capped within the current CLDS boundaries using material found to be suitable for unconfined disposal (i.e., suitable to remain exposed on the seafloor). A series of these large-project capped mounds were created within the boundaries of CLDS in the 1970s and 1980s. As part of a joint EPA and USACE research project known as the Field Verification Program (FVP), dredged material with elevated contaminant levels was left uncapped on the seafloor (termed the FVP mound) to evaluate the effectiveness of post-disposal monitoring techniques. The process of creating large-project capped mounds was discontinued in the 1990s as formal designation as an EPA ODMDS was underway. With advancements in electronic positioning, disposal at the site has continued employing both focused disposal to create additional small-footprint disposal mounds and spreading disposals over a grid of targets to a create broader distribution of material.

The 2016 CLDS survey was a combined confirmatory survey to delineate the footprint of the recently disposed dredged material, and a focused study to map the surficial sediment quality over much of the site and surrounding reference areas as part of longer-term site management and cumulative and historical impact assessment. A multibeam hydroacoustic survey was conducted at recently used portions of the site and, for the first time, at reference areas to support mapping bathymetry and characterization of surficial sediments. The comprehensive assessment of sediment quality included sediment profile imaging (SPI) and plan view imaging (PV) to provide additional information on sediment physical characteristics and to assess benthic health and function; sediment grab sampling for benthic community analysis and sediment chemistry; and trawling with a clam rake for collection of non-motile species for tissue chemical analysis.

The bathymetric survey confirmed that disposal of approximately 102,000 m3 of dredged material during the 2015/2016 season was successfully coordinated for CLDS with relatively even distribution of the dredged material around the target area approximately 1 to 3 m in height. Aside from the expected consolidation over the area where disposal had been terminated since the previous survey, there was no evidence of erosion of dredged material deposits.

For the sediment quality assessment, the SPI/PV images and laboratory analyses were grouped based on location and site history: three individual mounds created in the 1970s and 1980s by capping unsuitable dredged material; the FVP mound created in the 1980s that intentionally left unsuitable dredged material exposed; two areas that received varying thicknesses of dredged material since the 1990s placed over areas of assumed historical (pre-testing) disposal; and the three reference areas associated with CLDS.

The imagery data, benthic community assessment, and laboratory analyses did not indicate the presence of historically disposed dredged material at any of the three reference areas, supporting their continued use as a baseline of comparison for data collected within CLDS. The SPI/PV data and benthic community analysis documented recovery of the benthic community at historical and recent disposal locations within CLDS. At the FVP mound, lower infaunal abundances were found as well as a statistically significant difference in the assemblage, suggesting that while advance successional taxa exist at FVP, some aspects of community structure are partially arrested.

Sediment and tissue concentrations of both inorganic and organic contaminants for samples collected within CLDS generally compared well with those of the reference areas indicating the effectiveness of sequestration of contaminants at the older capped mounds and the effectiveness of the sampling and testing that has been required since the 1970s to evaluate dredged material for disposal at CLDS. However, there were moderate elevations of some sediment and tissue concentrations identified at the FVP mound (where unsuitable dredged material had been intentionally left exposed) and over the area where there was likely incomplete coverage of historically disposed material (disposed prior to rigorous testing requirements). Based on these data and the conclusion of FVP investigation at this site, future management of disposal at CLDS should focus on broad coverage of the FVP mound as well as any areas with indications of historical disposal.

14. SUBJECT TERMS DAMOS, dredged material, CLDS, Central Long Island Sound Disposal Site, acoustic, multibeam, SPI, PV, benthic, infauna, sediment grabs, sediment chemistry, tissue chemistry

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Note on units of this report: As a scientific data summary, information and data are presented in the metric system. However, given the prevalence of English units in the dredging industry of the United States, conversions to English units are provided for general information in Section 1. A table of common conversions can be found in Appendix A.

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LIST OF ACRONYMS

ACSM	American Congress on Surveying and Mapping
aRPD	Apparent redox potential discontinuity
ASCII	American Standard Code for Information Interchange
BCA	Benthic Community Analysis
CI	Confidence interval
CLDS	Central Long Island Sound Disposal Site
CLT	Central Limit Theorem
COCs	Contaminants of concern
CS-1	Cap Site 1 (mound)
CS-2	Cap Site 2 (mound)
DAMOS	Disposal Area Monitoring System
DGPS	Digital Global Positioning System
DMMP	Dredged Material Management Plan
DQM	Dredging Quality Management System
Eh	Redox potential (the potential generated between a platinum electrode and a standard hydrogen electrode when placed into the medium being tested, where hydrogen is considered the reference electrode)
EIS	Environmental Impact Statement
ER-L	Effects range low
ER-M	Effects range median
FDA	Food and Drug Administration
FVP	Field Verification Program (mound)
GIS	Geographic information system
GPS	Global Positioning System
GRD	Gridded data
HPAH	High molecular weight fraction of total PAHs
LPTL	Lowest practicable taxonomic level
MBES	Multibeam echo sounder
MLLW	Mean Lower Low Water
MPRSA	Marine Protection, Research, and Sanctuaries Act
MQR	Mill-Quinnipiac River (mound)
MRU	Motion reference unit
NAD83	North American Datum of 1983
NAE	USACE, New England Division

NEF	Nikon Electronic Format
NHAV93	New Haven 1993 (mound)
NHAV14	New Haven 2014 (target placement grid)
NOAA	National Oceanic and Atmospheric Association
NOS	National Ocean Service
ODMDS	Ocean Dredged Material Disposal Site
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
PSD	Photoshop Document
PV	Plan View
QAPP	Quality Assurance Project Plan
RTK	Real time kinematic GPS - vertical accuracy is approximately 2 cm, enabling use for tide corrections in some circumstances. RTK GPS is suitable for both horizontal and centimeter level vertical positioning, including tide corrections
R/V	Research vessel
SLR	Single-lens reflex
SD	Standard deviation
SMMP	Site Management and Monitoring Plan
SOD	Sediment oxygen demand
SOP	Standard Operating Procedures
SPI	Sediment Profile Imaging
TIF	Tagged image file
TOC	total organic carbon
TKN	total Kjeldahl nitrogen
UNH/NOAA CCOM	University of New Hampshire's NOAA Center for Coastal and Ocean Mapping
USACE	U.S. Army Corps of Engineers
USEPA/EPA	U.S. Environmental Protection Agency
UTL	Upper Tolerance Limit
VDATUM	Vertical Datum Transformation

EXECUTIVE SUMMARY

A comprehensive monitoring survey was conducted at the Central Long Island Sound Disposal Site (CLDS) in September and October 2016 as part of the U.S. Army Corps of Engineers' (USACE) New England District (NAE) Disposal Area Monitoring System (DAMOS) Program. The 2.0 × 4.1 km rectangular site lies approximately 10 km south of East Haven, Connecticut, and was designated by the U.S. Environmental Protection Agency (EPA) as an Ocean Dredged Material Disposal Site (ODMDS) under Section 102(c) of the Marine Protection, Research, and Sanctuaries Act in 2005. This survey was jointly funded by the EPA under Interagency Agreement DW-096-95829701 and by the USACE's DAMOS Program.

Documented dredged material disposal within the approximate boundary of CLDS began in the early 1970s, but this general location has been utilized for the disposal of sediments dredged from surrounding harbors in Long Island Sound for at least 60 years making for a complex distribution of disposed sediment on the seafloor. Prior to the 1970s, there were little or no requirements for testing dredged material prior to its disposal resulting in a wide range of sediment quality given the long industrial history of many ports and harbors on Long Island Sound. Further, although general areas had been specified for the disposal to occur, the lack of a high accuracy navigation likely led to the spreading of dredged material over a broad zone within and surrounding the specified disposal area.

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1.0 INTRODUCTION

Monitoring surveys were conducted at the Central Long Island Sound Disposal Site (CLDS) as part of a joint effort of the U.S. Army Corps of Engineers (USACE) New England District (NAE) Disposal Area Monitoring System (DAMOS) Program and the U.S. Environmental Protection Agency (EPA) Ocean Dredged Material Disposal Site (ODMDS) monitoring. DAMOS is a comprehensive monitoring and management program designed and conducted to address environmental concerns associated with use of aquatic dredged material disposal sites throughout the New England region. DAMOS works collaboratively with EPA to manage and monitor EPA-designated ODMDS in New England. An introduction to the DAMOS Program and CLDS, including a brief description of previous dredged material disposal activities and previous monitoring surveys, is provided below. This survey was jointly funded by the DAMOS Program and by EPA under Interagency Agreement DW-096-95829701.

1.1 Overview of the DAMOS Program and EPA Monitoring of ODMDS

The DAMOS Program features a tiered monitoring protocol which is consistent with monitoring required by EPA at ODMDS, designed to ensure that any potential adverse environmental impacts associated with dredged material disposal are promptly identified and addressed (Germano et al. 1994). For over 40 years, the DAMOS Program has collected and evaluated dredged material disposal site data throughout New England. Based on these data, patterns of physical, chemical, and biological responses of seafloor environments to dredged material disposal activity have been documented along with evaluation of any impacts to water quality (Fredette and French 2004).

DAMOS monitoring surveys fall into two general categories: confirmatory studies and focused studies. The data collected and evaluated during these studies provide answers to strategic questions in determining next steps in the disposal site management process. DAMOS monitoring results guide the management of disposal activities at existing sites, support planning for use of future sites, and evaluate the long-term status of historical sites (Wolf et al. 2012).

Confirmatory studies are designed to test hypotheses related to expected physical and ecological response patterns following placement of dredged material on the seafloor at established, active disposal sites. Two primary goals of DAMOS confirmatory monitoring surveys are to document the physical location and stability of dredged material placed into the aquatic environment and to evaluate the biological recovery of the benthic community following placement of dredged material. Several survey techniques are employed in order to characterize these responses to dredged material placement. Sequential acoustic monitoring surveys (including bathymetric, acoustic backscatter, and side-scan sonar data collection) are performed to characterize the height and spread of discrete dredged material deposits or mounds created at open water sites as well as the accumulation/consolidation of dredged material into confined aquatic disposal cells.

Sediment profile (SPI) and plan view (PV) imaging surveys are performed in confirmatory studies to provide further physical characterization of the material and to support evaluation of seafloor (benthic) habitat conditions and recovery over time. Each type of data collection activity is conducted periodically at disposal sites, and the conditions found after a defined period of disposal activity are compared with the long-term data set at specific sites to determine the next step in the disposal site management process (Germano et al. 1994).

Focused studies are periodically undertaken within the DAMOS Program to evaluate candidate sites, as baseline surveys at new sites, to evaluate inactive or historical disposal sites, and to contribute to the development of dredged material management and monitoring techniques. Focused DAMOS monitoring surveys may also feature additional types of data collection activities as deemed appropriate to achieve specific survey objectives, such as grab or core sampling of sediment for physical/chemical/biological analyses, sub-bottom profiling, or video image files.

The EPA and USACE jointly prepare and update a Site Management and Monitoring Plan (SMMP) for CLDS, as is required for all designated ODMDS (USEPA/USACE 2018). The SMMP identifies specific monitoring objectives that are reviewed during the survey design. The 2016 CLDS survey was a combined confirmatory survey to delineate the recent disposal of dredged material, and a focused study to map the surficial sediment quality over the full site and surrounding area as part of longer-term site management, and cumulative and historical impact assessment. The survey entailed an acoustic multibeam component, SPI/PV imaging and analysis, and sediment collection for laboratory analysis of sediment chemistry, benthic community structure, and benthic tissue chemistry of non-motile organisms. This comprehensive survey was jointly funded by the EPA and USACE.

1.2 Introduction to the Central Long Island Sound Disposal Site

The Central Long Island Sound Disposal Site (CLDS, also historically referred to as CLIS) is located approximately 10.4 km (5.6 nm) south of South End Point, East Haven, Connecticut (Figure 1-1). This general location has been utilized for the disposal of sediments dredged from surrounding harbors for at least 60 years, with well-documented disposal locations since 1973 (ENSR 1998). Starting in 1979, the site has been regularly monitored by the DAMOS Program (ENSR 1998) (Table 1-1).

The EPA reconfigured the site boundary of CLDS in 2005 as part of an official designation of CLDS as a long-term disposal site under Section 102(c) of the Marine Protection, Research, and Sanctuaries Act (MPRSA) (USEPA 2005). Specifically, the boundary of CLDS was extended northward and eastward to encompass the historical disposal mounds CS-2 and FVP (Figure 1-2) (ENSR 2007). The current boundary of CLDS is a rectangle measuring 4.1 × 2.0 km (total area of 8.2 km^2; or 2.2 × 1.1 nm [total area of 2.4 nm^2]), centered at 41° 08.95' N and 72° 52.95' W (NAD 83) (Figure 1-1). As part of the site designation, an SMMP was developed (USEPA/USACE 2018).

In 2016, EPA completed the final designation of the Central Long Island Sound, as well as the Western Long Island Sound dredged material disposal sites (USEPA 2016). Designation of the sites incorporated standards and procedures for their use consistent with those recommended in the Long Island Sound Dredged Material Management Plan (DMMP), which was completed by the USACE in January 2016 (USACE 2016). The DMMP identified a wide range of alternatives to open-water disposal with the goal of long-term reduction or elimination of the open-water disposal of dredged material into Long Island Sound to the extent practicable. In addition, as a requirement of MPRSA) the SMMP was reviewed and updated as part of final CLDS designation (USEPA/USACE 2018).

1.3 Historical Dredged Material Disposal Activity

Anecdotal accounts of dredged material disposal in the vicinity of the existing CLDS date back to at least the 1950s. More formal documentation and monitoring of disposal began in the early 1970s, and a summary of the chronology of dredged material placement at CLDS is provided below.

Pre-1970:

- Disposal in the vicinity of the current CLDS that occurred prior to the beginning of formal documentation was likely spread over a broad area given the lack of electronic positioning or placement at a target buoy. Further, as there were no requirements for testing dredged material, a wide range in quality of material disposed in the vicinity of CLDS is expected, particularly since many of the numerous ports and harbors that are in close proximity to CLDS were centers of development during the Industrial Revolution.

1970s and 1980s:

- The first large project to experiment with sequential disposal of progressively cleaner sediment, termed *de facto* capping, was the creation of the NHAV-74 disposal mound (Figure 1-2). An estimated volume of 959,600 m^3 (1.25 M yd^3) was dredged from October 1973 to March 1974, followed by dredging of an estimated 214,200 m^3 (280,000 yd^3) of material from October to November 1973 (Bokuniewicz et al. 1974). The protocols used to monitor these early projects, published in an early series of NAE Scientific Reports (SR), lead to many of the monitoring protocols now practiced by the DAMOS Program and EPA (SR-7 to SR-26: https://www.nae.usace.army.mil/Missions/Disposal-Area-Monitoring-System-DAMOS/Reports/).
- Following this project, a management approach of directed placement of small to moderate volumes of sediment was conducted to form individual disposal mounds spaced relatively far apart within the site boundary (Figure 1-2).
- Seven mounds were formed in the late 1970s-early 1980s as part of a series of management projects (SAIC 1995) involving the placement and confinement of

unsuitable dredged material (Norwalk, STNH-N, STNH-S, MQR, CS-1, CS-2, and FVP; Figure 1-3). Four of these mounds (MQR, CS-1, CS-2, and FVP) were selected for sampling for the 2016 survey.

- Most of these early disposal mounds were subsequently covered with suitable coarse- and/or fine-grained material from New Haven Harbor (or Norwalk Harbor in the case of the Norwalk mound) that was determined to be suitable for unconfined open water placement in a process termed level-bottom capping (SAIC 1995).
- The Field Verification Program (FVP) mound was left uncapped as part of an evaluation of monitoring methodology. The FVP mound was created in the northeast corner of CLDS during the 1982–83 disposal season as part of the joint EPA/USACE Interagency Field Verification of Testing and Predictive Methodologies for Dredged Material Disposal Alternatives Program, known simply as the Field Verification Program (Myre and Germano 2007; Peddicord 1988; Gentile et al. 1988). The program ran from 1982 to 1988, and its objective was to field-verify existing test methods for predicting the environmental consequences of dredged material disposal in aquatic, wetland, and upland conditions (Peddicord 1988). The aquatic portion of this work was conducted by the EPA's Environmental Research Laboratory in Narragansett, RI (Gentile et al. 1988). Approximately 55,000 m^3 (72,000 yd^3) of dredged material from Black Rock Harbor, CT with elevated levels of metals and organic contaminants with demonstrated biological toxicity was deposited in the northeastern section of CLDS forming the FVP mound (Scott et al. 1987). As examples of the elevated concentrations, testing of samples from Black Rock Harbor resulted in average concentrations of total PAHs of 142,000 ± 30,000 µg/kg, 6,400 ± 840 µg/kg of PCBs (as Aroclor 1254), and 2,900 ± 310 mg/kg of copper (Myre and Germano 2007). The mound was sampled quite frequently during the first five years after disposal as part of the FVP research program (Scott et al. 1987), with concurrent and subsequent monitoring under the management of the DAMOS Program. Periodic monitoring occurred throughout the 1980s and 1990s to examine ecosystem recovery and long-term trends in benthic recolonization on the mound (Morton et al. 1984a; Germano and Rhoads 1984; Parker and Revelas 1988; Morris 1997; Myre and Germano 2007).
- The Mill-Quinnipiac River (MQR) mound has a long and complicated disposal history and received material from a variety of sources. Initially, in 1982, material dredged from the Mill River (42,000 m^3 [55,000 yd^3]) was capped with silty material from the Quinnipiac River (133,200 m^3 [174,000 yd^3]). In March and April of 1983 66,800 m^3 (87,300 yd^3) of Black Rock Harbor material was placed on the mound. From March to May of 1983 400,000 m^3 (523,000 yd^3) of outer New Haven Harbor material was deposited on the mound, and then a very small amount (3,000 m^3 [3,900 yd^3]) of Black Rock Harbor was placed on top of the cap; subsequent monitoring suggested impaired benthic recovery, and thus additional cap material was recommended. In 2009, 2013, and 2014 additional material from a variety of

locations was placed at MQR effectively capping the small amount of exposed Black Rock material (AECOM 2013; Hopkins et al. 2017).

- The two Cap Site mounds (CS-1, CS-2) were developed near the western boundary of CLDS in the early 1980s to determine the feasibility and effectiveness of using level-bottom capping to isolate sediment with elevated contaminant levels from the marine environment into a small-footprint mound on the seafloor (Figure 1-3). In addition, these two projects experimented with different types of sediment for cap material. Cap Site 1 was capped with fine-grained silt, while Cap Site 2 was capped with fine sand.
- CS-1 received dredged material from Black Rock Harbor in April 1983 (33,200 m^3 [43,400 yd^3]) as the unsuitable base layer. Silty dredged material from New Haven Harbor, CT was designated as the capping layer. Capping operations in 1983, however, resulted in a thinner cap or apron of material (<20cm) over some of the underlying deposit due to discrepancies between planned and actual operations (Morton et al. 1984b). The unsuitable material was placed east and southeast of the buoy, while the cap material was placed southwest of the buoy, resulting in an offset between the two layers. The offset was attributed to the targeted placements points, the different directions from which the scows transited to the site, as well as overall accuracy of the LORAN-C system used during that period (Morton et al. 1984b). As a result, the eastern portion was covered with an apron of silty cap material detected by sediment profile imaging. Therefore CS-1 was sampled based on the presence of a thin layer of cap on the eastern flank.
- At the same time as CS-1, dredged material dredged from Black Rock Harbor (23,700 m^3 [31,000 yd^3]) was placed at a separate taut-wire buoy in April and May 1983 designated as Cap Site 2 (CS-2; Figure 1-3). Coarse sediment dredged from outer New Haven Harbor (42,000 m^3 [55,000 yd^3]) was deposited at the CS-2 mound as a sand cap to compare with the use of silt for a cap at CS-1 (Fredette 1994). Like CS-1, capping operations with LORAN-C alone were problematic so a taut-wire buoy was used as a target to place the majority of the cap material; taut-wire buoys then became standard for dredging operations due to the increased accuracy of material placement. The resulting CS-2 mound was sufficiently covered with a minimum of 40 cm of cap (SAIC 1995).
- Mounds were extensively monitored over time to assess sediment chemistry, mound stability, thickness of dredged material, and benthic recolonization status relative to previous monitoring results, and in comparison to nearby reference areas (Scott et al. 1987; SAIC 1995). Results of this monitoring showed the capped mounds to be stable (no loss of material through erosion) as well as following a normal pattern of biological recolonization.

1990s

- The management strategy was modified, whereby suitable dredged material was placed in a series of closely spaced or contiguous mounds with the eventual goal of creating circular or semicircular berms or rings on the seafloor. This advance creation of berms aided in subsequent management of large-scale confined aquatic disposal operations and in placement of highly fluid dredged material or material judged to require capping and confinement. Within the berm, the potential for lateral spread of the material is reduced since the energy of the disposal process is insufficient to climb the berm slope. Subsequently, the resulting deposit can be more efficiently covered with additional dredged material as part of long-term management of the site (Fredette 1994).

- The first containment cell was completed and used to confine material from the inner New Haven Harbor in 1993 (NHAV93 mound complex). A second containment cell was completed in 1999 (ENSR 2007).
- By the end of the 1990s, the practice of allowing unsuitable material to be placed at the sites and capped had been discontinued.

2000-2013

- Dredged material was placed in a series of closely spaced mounds contributing to the formation of circular or semi-circular berms or rings on the seafloor to aid in management of site capacity.

2013-2015

- Advancements in electronic positioning of scows coupled with the USACE Dredging Quality Management System (DQM) for logging the track of each scow and its release point allowed for initiation of the use of grids for more effective management of dredged material from large and/or multiple projects placing material at the site in a single season.
- To better manage the large volume of material and multiple project sequencing requirements during the 2013/2014 dredging season from two Federal Navigation projects in Connecticut, a target placement grid (NHAV14) was defined in the south-central part of CLDS with a total of 25 target placement cells grouped into north and south grids, NHAV14-N and NHAV14-S (Figure 1-3). Dredged material from Norwalk Harbor was placed into the southern management area, NHAV14-S; and initial material from New Haven Harbor and multiple private projects was placed into the northern management, NHAV14-N, a previously established containment cell. Both NHAV14-N and NHAV14-S grids received final cover from New Haven outer harbor material (Figure 1-3; Hopkins et al. 2017). Although there is no record of dredged material disposal in this area, the initial multibeam survey of CLDS in 2005 clearly showed indications of historical disposal in this area.
- In the 2014/2015 dredging season approximately 93,000 m^3 (121,700 yd^3; Table 1-2) of dredged material was placed at the site since the large-scale New Haven and Norwalk projects (Beaver and Bellagamba-Fucile 2017).

1.4 Previous Monitoring Events

Extensive monitoring of older mounds and a baseline data collection in 2000 were summarized in two publications (SAIC 1995 and USEPA/USACE 2004). A comprehensive high-resolution bathymetric survey of the entire site, conducted in July 2005, followed the initial EPA designation of CLDS as a long-term disposal site (Table 1-1). The site designation included the development of an SMMP that called for a tiered monitoring approach to determine disposal permit compliance, evaluate the short-term and long-term fate of dredged material placed at the site, and assess potential adverse environmental impacts from the use of CLDS for the disposal of dredged material (USEPA/USACE 2018).

The 2005 survey confirmed the results of many earlier surveys that the seafloor landscape within the CLDS boundary was characterized by multiple mounds of accumulated dredged material and disposal traces resulting from both historical and more recent placement activities (ENSR 2007). The seafloor within the boundary of CLDS gently sloped from a depth of 18 m (59 ft.) mean lower low water (MLLW) in the northwest to a depth of 22 m (72 ft.) in the southeast (Figure 1-2). The placement of dredged material created localized areas with shallower depths ranging from 14 to 17 m (46 to 56 ft.) MLLW. This high-resolution bathymetric survey of the entire site continues to serve as a post-2005 baseline for delineating placement of material at the site and to determine the long-term stability of dredged material deposits at CLDS.

Since 2005, monitoring to implement the tiered approach outlined in the SMMP was performed at CLDS in 2009 and 2011 (Table 1-1) delineating placement of material and recovery of the benthic community following placement. These investigations included bathymetric and SPI surveys of the active portions of the site along with a focused survey of the older experimental FVP disposal mound (described below). The 2009 survey documented the formation of four discrete disposal mounds formed over the previous four disposal seasons; CLIS-05, CLIS-06, CLIS-07, and CLIS-08 (Valente et al. 2012). The 2009 SPI survey identified conditions at the two older mounds (CLIS-05 and CLIS-06) consistent with reference areas and confirmed the prediction of intermediate benthic recovery at the two newer mounds (CLIS-07 and CLIS 08) (Valente et al. 2012).

The 2011 survey documented the formation of new disposal mounds from prior placement activity at the site (CLIS-09 and CLIS-10) and confirmed the continued stability of previously formed mounds (AECOM 2013). Benthic recovery was measured at three recently formed mounds and found to be comparable to reference conditions at CLIS-07 and CLIS-09 with a transitional recovery status at CLIS-08 like that seen in 2009 (AECOM 2013). The CLIS-10 mound was still actively receiving dredged material at the time of the 2011 survey, so it was not analyzed for benthic recovery.

In addition to the active portion of the site, the 2011 survey also investigated the stability and benthic recolonization status of the historical FVP mound. Follow-up monitoring of FVP showed the mound to exhibit phases of classic benthic recovery (early colonizing species replaced by species of a more mature ecosystem) with periodic relapses thought to be due to environmental stresses such as shallow reworking of contaminated sediment (Myre and Germano 2007). The 2011 survey utilized very detailed analyses of surface sediment features and depth changes over time and found the mound to be physically stable with evidence of active sediment deposition and advanced benthic succession throughout the mound surface (Myre and Germano 2007; AECOM 2013). Based on these results, the FVP mound was left uncapped and periodically monitored to continue building a library of information on natural recovery of the benthic system after cessation of dredged material disposal in the central Long Island Sound region.

A December 2013 bathymetric survey documented the initial placement of material from Norwalk Harbor into a grid of target cells within the NHAV14-S management area; and material from New Haven Harbor and several private projects into a grid in the northern management area (NHAV14-N). The 125-m (410-ft) grid cells were only slightly larger than the scows themselves, resulting in good distribution of the dredged material with no sequencing issues related to the concurrent projects and multiple dredge contractors. Only ~20 of the hundreds of disposal events that occurred in this management area fell outside the target cell boundaries (but still within CLDS), typically within one cell length away (Hopkins et al. 2017). Depth difference analysis of the target grids showed an accumulation of 1 to 2 m (3.3 to 6.6 ft) of material, 3.5 m (11.5 ft) at the previously used CLIS-10 mound and expected consolidation of the older CLIS-09 mound. There was also accumulation of material just west of the NHAV14-N grid (but within the disposal site) resulting from the slightly off-target placements from a single private project.

The January 2014 bathymetric survey was performed to delineate the ongoing placement of New Haven Harbor material in the NHAV14-N and NHAV14-S grids. The NHAV14-N grid showed accumulation up to ~0.7 m (~3.0 ft) in the period between surveys while the NHAV14-S showed amounts up to ~2.0 m (6.6 ft), although the majority of accumulation in NHAV14-S was ~0.7 m (Hopkins et al. 2017).

A final survey in this sequence took place in August 2014 after the completion of both New Haven and Norwalk projects and multiple private projects. This survey documented the final distribution of material in the two target grids. The NHAV14-N grid showed substantial accumulation in the period between January and August while NHAV14-S showed accumulation in only three cells. This acoustic survey extended beyond the active placement area to record the bottom conditions at the entire CLDS site. Since the last survey of the entire site in 2005, the dredged material features at CLDS have continued to show the physical stability seen in previous work at the site. Apart from expected areas of accumulation associated with recent placement activity and expected areas of consolidation of dredged material mounds after initial placement, there was no identifiable surface sediment transport beyond the site boundaries or within the site or even within the site itself.

Most recently, a focused bathymetric survey was conducted in October of 2015 to characterize the seafloor topography and surface features over the active portion of CLDS where approximately 93,000 m^3 (121,700 yd^3; Table 1-2) of dredged material was placed at the site since the large-scale New Haven and Norwalk projects (Beaver and Bellagamba-Fucile 2017).

1.5 Recent Dredged Material Disposal Activity

Since the most recent DAMOS survey in October 2015, approximately 102,000 m^3 (133,000 yd^3) of material has been deposited at CLDS (Table 1-3). The largest project contributing to this total was the Mystic River Federal Navigation Project (21,102 m^3, [27,600 yd^3]) (Table 1-3). All of the material placed during the 2015/2016 disposal season was targeted north of the CLIS-09 and CLIS-10 mounds and south of the CLIS-97/98 mound (Figure 1-4).

A detailed record of barge disposal activity at CLDS for the period from October 2015 to May 2016, including the origin of dredged material and the volume deposited, is provided in Appendix B.

1.6 2016 Survey Objectives

The 2016 survey was a combined confirmatory and focused survey. The confirmatory element was designed to track the recent placement of material. Confirmatory surveys at CLDS have consistently shown rapid recovery of the benthic community following placement of dredged material at the site. However, as CLDS is the most extensively used disposal site in New England waters, efforts are periodically made to collect additional data on biological conditions at the site. The focused element of the 2016 survey was designed to map the surficial sediment quality over both recent areas of dredged material placement and historical mounds of CLDS, as well as the reference areas, as part of longer term site management. Interest in the distribution of contaminants of concern (COCs) and nutrients in Long Island Sound has renewed attention to the potential for dredged material placement to affect sediment-bound inventories of these compounds. Specifically, the September/October 2016 survey was designed to:

- Characterize the seafloor topography and surficial features over the active portions of the site and reference areas (2500W, 4500E, and CLDS-REF) by completing an acoustic survey.
- Use SPI and PV imaging to further define the physical characteristics of surficial sediment and to assess the benthic community of CLDS and reference areas and assess the benthic recolonization status of the area with recent disposal activity as well as the older disposal mounds.
- Characterize and compare the surficial sediment quality over the site and surrounding area through the collection of sediment for laboratory analysis of sediment physical and chemical parameters and benthic community structure, and collection and analysis of non-motile organism (worm) tissue analyzed for contaminant chemistry.

Table 1-1.

Overview of DAMOS Survey Activities at CLDS since 2005

Date	Survey Type/Purpose	Acoustic Survey Size	Additional Survey Elements	Publication	Reference
July 2005	Acoustic Monitoring	Entire Site 2500 × 4500 m	None	DAMOS Contribution 177	ENSR 2007
Sept/Oct 2009	Acoustic Monitoring	Active Portion of CLDS 1000 × 1500 m	SPI Stations: 40 on Disposal Mounds and 18 at Reference Areas	DAMOS Contribution 184	Valente et al. 2012
Sept/Oct 2011	Acoustic and Sediment Profile Monitoring	Active Portion of CLDS 1000 × 1900 m FVP Mound 1000 × 950	SPI Stations: 35 on Disposal Mounds, 15 at FVP Mound, and 18 at Reference Areas	DAMOS Contribution 192	AECOM 2013
Dec 2013	Acoustic Confirmatory	NHAV14-S and NHAV14-N Target Placement Grids	Sediment grabs for qualitative visual inspection	DAMOS Contribution 197	Hopkins et al. 2017
Jan 2014	Acoustic Confirmatory	NHAV14-S and NHAV14-N Target Placement Grids	Sediment grabs for qualitative visual inspection	DAMOS Contribution 197	Hopkins et al. 2017
Aug 2014	Acoustic and Sediment Profile Monitoring	Entire Site 2500 × 4500 m	Sediment grabs for qualitative visual inspection	DAMOS Contribution 197	Hopkins et al. 2017
Oct 2015	Acoustic Monitoring	Active Portion of CLDS 1000 × 1000 m	None	DAMOS Data Summary Report	Beaver and Bellagamba Fucile 2017

Table 1-2.

Disposal Activity at CLDS during the 2014/2015 Disposal Season (per scow logs provided by USACE, March 2016)

Project name	City/Town	State	Placement Dates	Volume (m^3)	Volume (yd^3)	Permit number
Between the Bridges Marina	Old Saybrook	CT	02/18/2015 - 04/30/2015	4,587	6,000	NAE-2006-126
Brewers Point Marina	Westbrook	CT	12/22/2014 - 02/02/2015	6,116	8,000	NAE-2011-2437
Clinton Yacht Haven	Clinton	CT	11/09/2014 - 04/29/2015	7,986	10,445	NAE-2008-2993
Guilford Harbor FNP	Guilford	CT	12/12/2014 - 03/14/2015	36,665	47,956	W912WJ-14-C-0029
Guilford Yacht Club	Guilford	CT	05/17/2015 - 05/25/2015	10,251	13,408	NAE-2007-1989
Gwenmor Marina	Mystic	CT	10/28/2014	191	250	NAE-2008-425
Hammock River Marina	Clinton	CT	05/19/2015 - 05/29/2015	3,058	4,000	NAE-2005-4021
Hammonasset Marina	Clinton	CT	11/05/2015-11/10/2015	459	600	NAE-2013-2551
Knutson Trust	Huntington	NY	11/17/2014 - 12/30/2014	7,263	9,500	NAE-2013-00847
New Haven Harbor	New Haven	CT	11/14/2014	153	200	1983C0007
S & S Marine Holdings	Old Saybrook	CT	12/14/2014 - 12/20/2014	1,049	1,372	NAE-2008-2185
Shennecossett Yacht Club	Groton	CT	11/12/2014 - 05/24/2015	6,881	9,000	NAE-2008-1468
St. Ann Boat Club	Norwalk	CT	10/30/2014	191	250	NAE-2012-904
USCG Academy	New London	CT	12/08/2014 - 01/04/2015	8,194	10,718	NAE-1994-340
Total				**93,044**	**121,699**	

Table 1-3.

Disposal Activity at CLDS since October 2015 (per Scow Logs provided by USACE, December 2016)

Permit Number	Project Name	Target Site Code	Volume (m^3)	Volume (yd^3)
NAE-2001-2437	Brewers Pilots Point Marina	CLDS 15/16 1B	6,116	8,000
NAE-2004-4113	Harbor One Marina	CLDS 15/16 1C	229	300
NAE-2005-499	Pine Island Marina	CLDS 15/16 1B	8,104	10,600
NAE-2007-2158	Saybrook Point Marina	CLDS 14/15 1B	5,715	7,475
NAE-2007-833	Commander Terminal	CLDS 14/15 1C	1,741	2,277
NAE-2007-923	Brewer Ferry Point Marina	CLDS 14/15 1C	7,378	9,650
NAE-2008-1468	Shennecossett Yacht Club	CLDS 15/16 1B	4,817	6,300
NAE-2009-287	Motiva	CLDS 15/16 1B	7,263	9,500
NAE-2012-234	Castaways Yacht Club	CLDS 15/16 1B	9,442	12,350
NAE-2014-00063	Black Hall River/Four Mile River	CLDS 14/15 1C	17,556	22,963
NAE-2015-306	Brewer Yacht Haven Marina	CLDS 14/15 1B	4,970	6,500
NAN-2013-1160	Fisher Island YC	CLDS 14/15 1C	7,149	9,350
W912WJ-14-C-0037	Mystic River FNP	CLDS 15/16 1A	21,102	27,600
Total			**101,583**	**132,865**

2.0 METHODS

The September 2016 survey at CLDS was conducted by a team of investigators from INSPIRE Environmental and Battelle including ACSM certified hydrographer Christopher Wright (#266) aboard the 55-foot *R/V Jamie Hanna*. The acoustic survey was conducted from 26-27 September 2016. The sediment profile/plan view (SPI/PV) imaging survey was conducted from 28 September to 2 October 2016, and the sediment/benthic grab sampling between 3 and 12 October 2016. Detailed Standard Operating Procedures (SOPs) for data collection and processing are available in the Quality Assurance Project Plan (QAPP) for the DAMOS Program (Battelle 2015) and QAPP Addendum 1 (Battelle 2016).

2.1 Navigation and On-Board Data Acquisition

Navigation for the acoustic survey was accomplished using a Hemisphere VS-330 Real Time Kinematic Global Positioning System (RTK GPS) which received base station correction through the Keynet NTRIP broadcast. Horizontal position accuracy in fixed RTK mode was approximately 2 cm. A dual-antennae Hemisphere VS110 differential GPS (DGPS) was available if necessary as a backup. The GPS system was interfaced to a desktop computer running HYPACK hydrographic survey software. HYPACK continually recorded vessel position and GPS satellite quality and provided a steering display for the vessel captain to accurately maintain the position of the vessel along pre-established survey transects and targets. Vessel heading measurements were provided by an IxBlue Octans III fiber optic gyrocompass.

Navigation for the sediment grab sampling and SPI survey was accomplished using a Hemisphere R110 DGPS capable of sub-meter horizontal accuracy. Navigation data were recorded using HYPACK software.

2.2 Acoustic Survey

The acoustic survey included bathymetric, backscatter, and side-scan sonar data collection. The bathymetric data provided measurements of water depth that, when processed, were used to map the seafloor topography. Backscatter and side-scan sonar data provided images that supported characterization of surface sediment texture and roughness. Each of these acoustic data types is useful for assessing dredged material distribution and surface sediment features.

2.2.1 Acoustic Survey Planning

The acoustic survey featured a high spatial resolution survey over the active portion of the site (700 × 1200 m) and over three 600 × 600 m reference areas (2500W, 4500E, and CLDS-REF). INSPIRE hydrographers coordinated with USACE NAE scientists and reviewed alternative survey designs. Hydrographers obtained site coordinates, imported them into geographic information system (GIS) software, and created maps to aid design of a survey that would provide greater than 100-percent coverage within the survey area. Base bathymetric data were obtained from the National Ocean Service Hydrographic Database to estimate the transect separation required to obtain full bottom coverage using an assumed beam angle limit of 90-degrees (45 degrees to port, 45 degrees to starboard). Transects spaced 80 m apart and cross-lines spaced 250 m apart were created to meet conservative beam angle constraints (Figure 2-1). The proposed survey area and design were then reviewed and approved by NAE scientists.

2.2.2 Acoustic Data Collection

The 2016 multibeam bathymetric survey of CLDS was conducted 26-27 September 2016. Data layers generated by the survey included bathymetric, acoustic backscatter, and side-scan sonar and were collected using an R2Sonic 2022 broadband multibeam echo sounder (MBES). This 200-400 kHz system forms up to 256 1- to 2-degree beams (frequency dependent) distributed equiangularly or equidistantly across a 10- to 160-degree swath. For this survey, a frequency of 200 kHz and pulse length of 0.08 msec were selected to maximize the resolution of bathymetric data without compromising the quality of acoustic backscatter data. The MBES transducer was mounted amidships to the port rail of the survey vessel using a high strength adjustable boom. The primary GPS antenna was mounted atop the transducer boom. The transducer depth below the water surface (draft) and antenna height were checked and recorded at the beginning and end of data acquisition, and draft was confirmed using the "bar check" method.

An IxBlue Octans III motion reference unit (MRU) was interfaced to the MBES topside processor and to the acquisition computer. Precise linear offsets between the MRU and MBES were recorded and applied during acquisition. Depth and backscatter data were synchronized using pulse per second timing and transmitted to the HYPACK MAX® acquisition computer via Ethernet communications. Several patch tests were conducted during the survey to allow computation of angular offsets between the MBES system components.

The system was calibrated for local water mass speed of sound by performing sound velocity profile (SVP) casts at frequent intervals throughout the survey day using an AML, Inc. MinosX sound velocity profiler.

2.2.3 Bathymetric Data Processing

Bathymetric data were processed using HYPACK HYSWEEP® software. Processing components are described below and included:

- Adjustment of data for tidal elevation fluctuations
- Correction of ray bending (refraction) due to density variation in the water column
- Removal of spurious points associated with water column interference or system errors
- Development of a grid surface representing depth solutions
- Statistical estimation of sounding solution uncertainty

- Generation of data visualization products

Tidal adjustments were accomplished using RTK GPS verified against tide data using records obtained from the National Oceanic and Atmospheric Association's (NOAA) New Haven Tide Station (#8465705). Water surface elevations derived using RTK were adjusted to Mean Lower Low Water (MLLW) elevations using NOAA's VDATUM Model. Correction of sounding depth and position (range and azimuth) for refraction due to water column stratification was conducted using a series of nine sound-velocity profiles acquired by the survey team. Data artifacts associated with refraction remain in the bathymetric surface model at a relatively fine scale (generally less than 5 to 10 cm) relative to the survey depth.

Bathymetric data were filtered to accept only beams falling within an angular limit of 60° to minimize refraction artifacts. Spurious sounding solutions were rejected based on the careful examination of data on a sweep-specific basis.

The R2Sonics 2022 MBES system was operated at 200 kHz. At this frequency, the system has a published beam width of 2.0°. Assuming an average depth of 20.5 m and a maximum beam angle of 60°, the average diameter of the beam footprint mid-swath was calculated at approximately 0.9 × 0.8 m (~0.75 m^2). Data were reduced to a cell (grid) size of 1.0 × 1.0 m, acknowledging the system's fine range resolution while accommodating beam position uncertainty. This data reduction was accomplished by calculating and exporting the average elevation for each cell in accordance with USACE recommendations (USACE 2013).

Statistical analysis of data as summarized on Table 2-1 showed negligible tide bias and vertical uncertainty substantially lower than values recommended by USACE (2013) or NOAA (2015). Note that the most stringent National Ocean Service (NOS) standard for this project depth (Special Order 1A) would call for a 95th percentile confidence interval (95% CI) of 0.32 m at the maximum observed depth (26.0 m) and 0.29 m at the average observed depth (20.5 m).

Reduced data were exported in ASCII text format with fields for Easting, Northing, and MLLW elevation (meters). All data were projected to the Connecticut State Plane, NAD83 (metric). A variety of data visualizations were generated using a combination of ESRI ArcMap (V.10.1) and Golden Software Surfer (V.13.6). Visualizations and data products included:

- ASCII data files of all processed soundings including MLLW depths and elevations,
- Contours of seabed elevation (20-cm, 50-cm and 1.0-m intervals) in a geospatial data file format suitable for plotting using GIS and computer-aided design software,
- 3-dimensional surface maps of the seabed created using 5× vertical exaggeration and artificial illumination to highlight fine-scale features not visible on contour layers delivered in grid and tagged image file (TIF) formats, and

- An acoustic relief map of the survey area created using 2× vertical exaggeration, delivered in georeferenced TIF format.

2.2.4 Backscatter Data Processing

Backscatter data were extracted from cleaned MBES TruePix formatted files and then used to provide an estimation of surface sediment texture based on seabed surface roughness. Mosaics of backscatter data were created using HYPACK's implementation of GeoCoder software developed by scientists at the University of New Hampshire's NOAA Center for Coastal and Ocean Mapping (UNH/NOAA CCOM). A seamless mosaic of unfiltered backscatter data was developed and exported in grayscale TIF format. Backscatter data were also exported in ASCII format with fields for Easting, Northing, and backscatter (dB). A Gaussian filter was applied to backscatter data to minimize nadir artifacts, and the filtered data were used to develop backscatter values on a 0.5-m grid. The grid was delivered in ESRI binary GRD format to facilitate comparison with other data layers.

2.2.5 Side-Scan Sonar Data Processing

Side-scan sonar data were processed using Chesapeake Technology, Inc. SonarWiz software and GeoCoder software to generate a database of images that maximized both textural information and structural detail.

Seamless mosaics of side-scan sonar data were developed using SonarWiz and exported in grayscale TIF format using a resolution of 0.20-m per pixel. Data were adjusted using Empirical Gain Normalization (EGN) and manual gain adjustment methods to minimize nadir artifacts and facilitate visualization of fine seabed structures.

2.2.6 Acoustic Data Analysis

The processed bathymetric grids were converted to rasters, and bathymetric contour lines and acoustic relief models were generated and displayed using GIS. The backscatter mosaics and filtered backscatter grid were combined with acoustic relief models in GIS to facilitate visualization of relationships between acoustic datasets. This is done by rendering images and color-coded grids with sufficient transparency to allow three-dimensional acoustic relief model to be visible underneath.

2.3 Sediment Profile and Plan View Imaging Survey

Sediment profile and plan view (SPI/PV) imaging is a monitoring technique used to provide data on the physical characteristics of the seafloor and the health of the benthic biological community (Germano et al. 2011).

A 60-station SPI/PV survey was performed within the area of the disposal site including 45 stations located within the boundary of the disposal site (Figures 2-2 and 2-3), and five stations in each of the three reference areas (2500W, 4500E, and CLDS-REF) (Figure 2-4). The stations sampled within CLDS were based on disposal history presented in Section 1.3 including the historical mounds CS-1, CS-2, MQR, and FVP and from two broader areas of dredged material disposal including eight stations that fall within the NHAV14 grid (Stations 01-08), representing the area of most recent disposal, and a region across central CLDS designated as CLDS-Other, representing nine stations within the boundary of the disposal site yet not represented in one of the other groups (Stations 09-17). The data were grouped for assessment based on disposal history:

- Historical capped and uncapped mounds (CS-1, CS-2, MQR, and FVP in Figure 2-2) were evaluated individually - CS-2 and MQR represent capped mounds (areas with historical placement of unsuitable dredged material that were fully covered with suitable material). At CS-1, SPI stations were located in the main area of the thinly capped unsuitable material (southeast of the buoy) and south of the visible spread of the cap placement material due to the predicted presence of a thin cap (Section 1.3). FVP represents an uncapped mound (area with historical placement of unsuitable dredged material that received no cover material).

- NHAV14 – This gridded target area (Figure 2-2) received dredged material from multiple projects in 2013-14. As the material was spread over a broad area rather than focused on building individual mounds, surficial sediment in this area is considered a mix of recent dredged material disposal and historical disposal that is known to have occurred in the area prior to testing and record keeping requirements.

- CLDS-Other – This grouping included stations from two additional areas that included multiple focused dredged material disposal targets dating back to 1999 (Figure 2-2).

- Reference Sites – This grouping included stations from all three reference areas (2500W, 4500E, and CLDS-REF in Figure 2-4).

SPI/PV station target locations are provided in Table 2-2 and SPI/PV station replicate locations are provided in Appendix C. The methodology for data acquisition and analysis for these images was consistent with the sampling methods described in detail in the QAPP (Battelle 2015) and INSPIRE standard operating procedures (SOPs).

2.3.1 Sediment Profile Imaging

The SPI technique involves deploying an underwater camera system to photograph a cross-section of the sediment–water interface. High-resolution SPI images were acquired using a Nikon® D7100 digital single-lens reflex (SLR) camera mounted inside an Ocean Imaging® Model 3731 pressure housing. The pressure housing sat atop a wedge-shaped steel prism with a glass front faceplate and a back mirror, mounted at a 45° angle. The camera lens looked down at the mirror, which reflected the image from the faceplate. The prism had an internal strobe mounted inside at the back of the wedge to provide illumination for the image; this chamber was filled with distilled water, so the camera always had an optically clear path. As the prism penetrated the seafloor, a trigger activated a time-delay circuit that fired an internal strobe to obtain a cross-sectional image of the upper 15–20 cm of the sediment column (Figure 2-5). The camera remained on the seafloor for approximately 20 seconds to ensure that successful images were obtained. Visual checks and hand tightening checks of all nuts/bolts on the SPI/PV camera frame were conducted periodically to make sure nothing vibrated loose during the survey.

Test exposures of a X-Rite Color Checker Classic Color Calibration Target were made on deck at the beginning of the survey to verify that all internal electronic systems were working to design specifications and to provide a color standard against which final images could be checked for proper color balance. Test images were also captured to confirm proper camera settings for site conditions. Images were checked periodically throughout the survey to confirm that the initial camera settings were still resulting in the highest possible quality images. All camera settings were recorded in the field log (Appendix D). For this survey, the ISO-equivalent was set at 640, shutter speed was 1/250, f-stop was f9, and storage was in compressed raw Nikon Electronic Format (NEF) files (approximately 30 MB each). Additional camera settings used were: white balance set to flash, color mode set to Adobe RGB, sharpening set to none, noise reduction off. Details of the camera settings for each digital image also are available in the associated parameters file embedded in each electronic image file.

Whenever the camera was brought back on board (typically after every third to fifth station), the frame counter was checked to ensure that the requisite number of replicates had been obtained. In addition, a prism penetration depth indicator on the camera frame was checked to verify that the optical prism had penetrated the bottom to a sufficient depth. If images were missed or the penetration depth was insufficient, the camera frame stop collars were adjusted and/or weights were added or removed, and additional replicate images were taken. Frame counts, changes in prism weight amounts, the presence or absence of mud doors, and frame stop collar positions were recorded in the field log for each replicate image (Appendix D).

Prior to field operations, the internal clock in the digital SPI system was synchronized with the vessel's GPS navigation system. Each image was assigned a unique time stamp in the digital file attributes by the camera's data logger and cross-checked with the time stamp in the navigational system's computer data file. In addition, the field crew kept redundant written sample logs (Appendix D). Images were downloaded periodically to verify successful sample acquisition and/or to assess the type(s) of sediment/depositional layer present at a given station. Digital image files were renamed with the appropriate station names immediately after downloading as a further quality assurance step.

2.3.2 Plan View Imaging

An Ocean Imaging® Model DSC16000 plan view underwater camera (PV) system with two Ocean Imaging® Model 400-37 Deep Sea Scaling lasers was attached to the sediment profile camera frame and used to collect plan view photographs of the seafloor surface. Both SPI and PV images were collected during each "drop" of the system. The PV system consisted of a Nikon® D-7100 SLR camera encased in an aluminum housing, a 24

VDC autonomous power pack, a 500 W strobe, and a bounce trigger. A weight was attached to the bounce trigger with a stainless-steel cable so that the weight hung below the camera frame; the scaling lasers projected two red dots that were separated by a constant distance (26 cm) regardless of the field-of-view of the PV system. The field-of-view can be varied by increasing or decreasing the length of the trigger wire and, thereby, the camera height above the bottom when the picture is taken. As the SPI/PV camera system was lowered to the seafloor, the weight attached to the bounce trigger contacted the seafloor prior to the camera frame reaching the seafloor and triggered the PV camera (Figure 2-5). Visual checks and hand tightening checks of all nuts/bolts on the SPI/PV camera frame were conducted periodically to make sure nothing vibrated loose during the survey.

During set up and testing of the PV camera, the positions of lasers on the PV camera were checked and calibrated to ensure separation of 26 cm. Test images were also captured to confirm proper camera settings for site conditions. Images were checked periodically throughout the survey to confirm that the initial camera settings were still resulting in the highest possible quality images. All camera settings were recorded in the field log (Appendix D). For this survey, the ISO-equivalent was set at 400, shutter speed was 1/30, f-stop was f14, and storage was in compressed raw Nikon Electronic Format (NEF) files (approximately 30 MB each). Additional camera settings used were: white balance set to flash, color mode set to Adobe RGB, sharpening set to none, noise reduction off. Details of the camera settings for each digital image also are available in the associated parameters file embedded in each electronic image file.

Prior to field operations, the internal clock in the digital PV system was synchronized with the vessel's GPS navigation system and the SPI camera. Each image was assigned a unique time stamp in the digital file attributes by the camera's data logger and cross-checked with the time stamp in the navigational system's computer data file. In addition, the field crew kept redundant written sample logs (Appendix D). Throughout the survey, PV images were downloaded at the same time as SPI images and were evaluated for successful image acquisition and image clarity. Digital image files were renamed with the appropriate station names immediately after downloading as a further quality assurance step.

The ability of the PV system to collect usable images is dependent on the clarity of the water column. Water conditions during this survey allowed use of a 0.5-m trigger wire, resulting in approximate image widths of 0.4 m.

2.3.3 SPI and PV Data Collection

The SPI/PV survey was conducted at CLDS from September 28 to October 2, 2016 aboard the R/V *Jamie Hanna*. At each station, the vessel was positioned at the target coordinates and the camera was deployed within a defined station tolerance of 10 m. Four replicate SPI and PV images were collected at each of the stations (Appendix D). The three replicates with the best quality images from each station were chosen for analysis (Appendix E).

The DGPS described above was interfaced to HYPACK® software via laptop serial ports to provide a method to locate and record sampling locations. Throughout the survey, the HYPACK® data acquisition system received DGPS data. The incoming data stream was digitally integrated and stored on the PC's hard drive. The system provided a steering display to enable the vessel captain to navigate to the pre-established survey target locations. The navigator electronically recorded the vessel's position when the equipment contacted the seafloor and the winch wire went slack. Each replicate SPI/PV position was recorded and time stamped. Actual SPI/PV sampling locations were recorded using this system.

2.3.4 Image Conversion and Calibration

Following completion of the field operations, the raw image files were color calibrated in Adobe Camera Raw® by synchronizing the raw color profiles to an X-Rite Color Checker Classic Color Calibration Target that was photographed prior to field operations with the SPI camera. The raw images were then converted to high-resolution Photoshop Document (PSD) format files, using a lossless conversion file process, maintaining an Adobe RGB (1998) color profile. The PSD images were then calibrated and analyzed in Adobe Photoshop®. Image calibration was achieved by measuring the pixel length of a 5-cm scale bar printed on the X-Rite Color Checker Target, providing a pixel per centimeter calibration. This calibration information was applied to all SPI images analyzed. Linear and area measurements were recorded as the number of pixels and converted to scientific units using the calibration information.

2.3.5 SPI and PV Data Analysis

Computer-aided analysis of SPI/PV images provided a set of standard measurements to allow comparisons among different locations and surveys. The DAMOS Program has successfully used this technique for over 30 years to map the distribution of disposed dredged material and to monitor benthic recolonization at disposal sites.

Measured parameters for SPI and PV images were recorded in Microsoft Excel© spreadsheets. These data were subsequently checked by one of INSPIRE's senior scientists as an independent quality assurance/quality control review before final interpretation was performed. Spatial distributions of SPI/PV parameters were mapped using ArcGIS.

2.3.6 Sediment Profile Image Analysis Parameters

The parameters discussed below were assessed and/or measured for each replicate SPI image. Descriptive comments were also made for each replicate image.

<u>Sediment Type</u> – The sediment grain size major mode and range were estimated visually using a visual grain size comparator created at a similar scale. Results were reported using the phi scale. A cross-walk between phi size classes, mm size ranges, and Udden-Wentworth size classes is provided in Appendix F. The presence and thickness of dredged material were also assessed.

Penetration Depth – The depth to which the camera penetrated the seafloor was measured to provide an indication of the sediment bearing capacity and shear strength. The penetration depth can range from a minimum of 0 cm (i.e., no penetration on hard substrata) to a maximum of 20 cm (full penetration of very soft substrata).

Surface Boundary Roughness – Surface boundary roughness is a measure of the vertical relief of features at the sediment–water interface. Surface boundary roughness was determined by measuring the vertical distance between the highest and lowest points of the sediment–water interface. The surface boundary roughness measured over the width of sediment profile images typically ranges from 0 to 4 cm and may be related to physical structures (e.g., ripples, rip-up structures) or biogenic features (e.g., burrow openings, fecal mounds, foraging depressions).

Mud Clasts – When fine-grained, cohesive sediments are disturbed, either by physical bottom scour or faunal activity (e.g., decapod foraging) intact clumps of sediment are often scattered across the seafloor. The number of clasts observed at the sediment–water interface were counted and their oxidation state assessed. The detection of reduced mud clasts in an obviously aerobic setting suggests a recent origin (Germano 1983). Mud clasts that are artifacts of SPI sampling (mud clots can fall off the back of the prism or wiper blade) are not recorded in the analysis sheet, but may be noted in the "Comments" field.

Apparent Redox Potential Discontinuity (aRPD) Depth – The aRPD depth provides a measure of the integrated time history of the balance between near-surface oxygen conditions and biological reworking of sediments. Oxidized surface sediments contain particles coated with ferric hydroxide (an olive or tan color when associated with particles) (Fenchel 1969; Lyle 1983). As the particles are buried or moved down by biological activity, they are exposed to reducing oxygen concentrations in subsurface porewaters and their oxic coating slowly changes color to dark gray or black (Fenchel 1969; Lyle 1983). The aRPD serves as a proxy for the RPD, the boundary between positive Eh and negative Eh regions of the sediment column (where Eh=0) that indicates a switch from dominantly aerobic to dominantly anaerobic processes. The mean aRPD measured in SPI has been shown to be a suitable proxy for the RPD with the depth of the actual Eh = 0 horizon generally either equal to or slightly shallower than the depth of the optical reflectance boundary (Rosenberg et al. 2001; Simone and Grant 2017). When biological activity is high, the aRPD depth increases; when it is low or absent, the aRPD depth decreases. The aRPD depth was measured by visually assessing color and reflectance boundaries within the images and, for each image, a mean aRPD was calculated.

Measures related to Organic Enrichment

Sediment Oxygen Demand – Sediment oxygen demand (SOD) represents the overall rate of oxygen consumption, biologically and chemically, by the sediment column. Organic loading to a system results in increased SOD and results in reduced sediments. The relative amount of organic enrichment is indicated by sediment color; darker coloration indicates that sediment is more reduced and has greater organic loading (Fenchel 1969; Rhoads 1974; Lyle

1983; Bull and Williamson 2001). SOD levels (i.e., none, low, medium, and high) were assessed for all images.

Low Dissolved Oxygen – Images in which dark gray or black reduced sediments were in contact with the water column across the entire length of the sediment–water interface were recorded as having low dissolved oxygen condition.

Sedimentary Methane – If organic loading is extremely high, porewater sulfate is depleted and methanogenesis occurs. The process of methanogenesis is indicated by the appearance of methane bubbles in the sediment column. These gas-filled voids are readily discernable in SPI images because of their irregular, generally circular aspect and glassy texture (due to the reflection of the strobe off the gas bubble).

Thiophilic Bacteria (*Beggiatoa*) – The presence of sulfur-oxidizing bacterial colonies indicates hypoxic dissolved oxygen concentrations in the water column at the benthic boundary-layer (Rosenberg and Diaz 1993). The presence and extent (e.g., threads, trace, patches, mat) of the *Beggiatoa* or *Beggiatoa*-like colonies were noted.

Infaunal Successional Stage – Infaunal successional stage is a measure of the biological community inhabiting the seafloor. Current theory holds that organism-sediment interactions in fine-grained sediments follow a predictable sequence of development after a major disturbance (e.g., dredged material disposal) (Pearson and Rosenberg 1978; Rhoads and Germano 1982; Rhoads and Boyer 1982). This continuum has been divided subjectively into four stages: Stage 0, indicative of a sediment column that is largely devoid of macrofauna, occurs immediately following a physical disturbance or in close proximity to an organic enrichment source; Stage 1 is the initial community of tiny, densely populated polychaete assemblages; Stage 2 is the start of the transition to head-down deposit feeders; and Stage 3 is the mature, equilibrium community of deep-dwelling, head-down deposit feeders (Figure 2-6). Successional stage was assigned by assessing the types of species or organism-related activities apparent in the images. Additional variables related to the infaunal community and their role in bioturbation are often important to consider as bioturbation is related not only to sediment oxygen dynamics, but also nutrient and contaminant fluxes (Reible and Thibodeaux 1999). In this study, the minimum and maximum linear distances from the sediment surface to feeding voids were measured.

2.3.7 Plan View Analysis Parameters

Plan view images provide a much larger field-of-view than SPI images and provide valuable information about the landscape ecology and sediment topography in the area where the pinpoint "optical core" of the sediment profile was taken (Figure 2-7). Unusual surface sediment layers, textures, or structures detected in any of the sediment profile images can be interpreted considering the larger context of surface sediment features; i.e., is a surface layer or topographic feature a regularly occurring feature and typical of the seafloor in this general vicinity or an isolated anomaly? The scale information provided by the underwater lasers allows accurate density counts of attached epifaunal colonies, sediment burrow openings, or larger macrofauna or fish which may have been missed in the sediment profile cross section, as well as measurements of the percent cover of *Beggiatoa* colonies and other features of interest observable on the seafloor at the sampling location. Information on sediment transport dynamics and bedform wavelength were also available from PV image analysis.

For each replicate PV image, the field-of-view was calculated and the sediment type, oxidation state of surface sediment, presence and type of bedforms; presence and notes related to dredged material; estimations of the relative percent cover of burrows, tubes, tracks, macrophytes; types of epifauna, flora, and debris; quantitative measures of *Beggiatoa* percent cover; number of fish; and descriptive comments were recorded.

2.4 Sediment and Tissue Collection

Sediment samples were collected for chemical analyses and benthic community structure analysis (BCA) to characterize sediment quality in and around CLDS. *In situ* worm (*Nephtys incisa*) tissue samples were collected and analyzed for contaminants of concern to assess potential bioaccumulation within the disposal and reference areas.

2.4.1 Sediment Grab Collection

A 60-station sediment grab survey was performed including 45 stations located within the boundary of the disposal site (Figures 2-8 and 2-9) and five stations in each of the three reference areas (Figure 2-10). The stations sampled within CLDS were divided into the same six groups based on disposal history as for the SPI stations described in Section 2.3 (CS-1, CS-2, MQR, FVP, NHAV14, and CLDS-Other). Sediment samples for analytical chemistry and grain size analysis were collected using a 0.1 m^2 Van Veen sampler. After collection and homogenization in the field, samples were placed in appropriate containers, chilled, and hand delivered to Battelle's Norwell, MA facility for later delivery to the appropriate laboratories for chemical analyses (Table 2-3).

At 16 of the 60 sediment grab stations, additional material was collected for BCA. The stations were distributed near the FVP and CS-1 mounds, NHAV14 and Reference 4500E areas. These samples were collected from the top 10 cm of sediment at each of the 16 stations using a 0.04 m^2 Van Veen grab sampler in October 2016. Benthic samples were processed using a 0.5-mm sieve and fixed with formalin at the time of collection. The fixed samples were stored at room temperature and hand delivered to Battelle's Norwell, MA facility for later shipment to the benthic sorting lab, Barry Vittor and Associates (Table 2-3).

Sediment grab station locations and coordinates are provided in Table 2-2 and Figures 2-8, 2-9, 2-10, and Appendix C. Navigation for the sediment grab collection was as described for the SPI methods above. All sediment sample collection and subsequent analyses were conducted in accordance with the QAPP for the DAMOS Program (Battelle 2015) and Addendum (Battelle 2016).

2.4.2 Tissue Collection

Samples for tissue chemical analysis were collected from trawls deployed at the same 16 stations sampled for BCA using a clam rake with a 0.25-inch mesh net. The primary target species for tissue chemistry analysis was *Nephtys incisa* that were found at all stations and in sufficient abundance to collect the minimum 30 g of tissue as required for chemical analysis except for one station at FVP (insufficient tissue for lipids analyses), and within the allotted maximum average sampling window of three hours per station. No alternate species were found in any abundance in the trawl collections, as *N. incisa* were found in sufficient abundance, collection of an alternate species was made unnecessary. *Nephtys incisa* is a dominant constituent of soft-bottom communities in nearshore New England water. Ambient populations of *N. incisa* may go through several population "phases" resulting from temporal and spatial fluctuations in recruitment, individual growth, and reproductive activity. The response of this worm to disturbance depends on which phase the population is in at the time of disturbance (internal population conditions such as age/size structure) and factors external to the population (e.g., environmental influences on settlement and recruitment and/or the nature of the disturbance) (Zajac and Whitlatch 1988; Rainer 1990).

The worm samples collected for tissue analysis were oxygenated and chilled in glass jars to depurate for 24 hours after collection as detailed in the DAMOS QAPP (Battelle 2015) and Addendum (Battelle 2016). The samples were hand delivered to Battelle's Norwell facility for homogenization and splitting. Tissue trawl locations and coordinates are provided in Figures 2-8, 2-9, 2-10, and Appendix C.

2.5 Chemical and Biological Analyses

2.5.1 Sediment and Tissue Chemistry

Surficial sediment samples were collected from all 60 stations for analysis of grain size, total organic carbon (TOC), nitrates/nitrites, total Kjeldahl nitrogen, total phosphorus, metals (As, Cd, Cr, Cu, Ni, Pb, Zn), PAHs, pesticides, and PCBs (Table 2-3).

Worm samples were homogenized at Battelle's Norwell laboratory and split and sent to the appropriate laboratories for chemical analyses (lipids, PAHs, pesticides, PCBs, and metals) (Table 2-3). Additional details of the analytical and quality control methods are provided in the DAMOS QAPP Addendum for the DAMOS Program (Battelle 2016).

Total PAH was calculated as the sum of the 18 PAH compounds analyzed (naphthalene, 2-methylnaphthalene, 1-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, anthracene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene). Total PCB was estimated as the sum of the 18 NOAA National Status and Trends (NS&T) congeners multiplied by two. Total DDx was calculated as the sum of 4,4'DDT, 4,4'DDD and 4,4'DDE. Total chlordane was calculated as the sum of the primary individual chlordane components analyzed (alpha-chlordane, gamma-chlordane, and heptachlor). Non-detected compounds were summed using ½ the MDL.

2.5.2 Benthic Community Analysis

Benthic infauna were collected from the top 10 cm of sediment at each station using a 0.04 m^2 Van Veen grab sampler in October 2016. Benthic samples were processed using a 0.5 mm sieve and wet weight infauna were identified and enumerated to the lowest practicable taxonomic level (LPIL). Biomass was measured for all individuals aggregated by phylum (Annelida, Mollusca, Arthropoda, Echinodermata) for each sample.

2.6 Fishing Gear Assessment via Surface Marker Buoy

During the CLDS acoustic survey the approximate location of fishing gear was recorded to provide insight into the amount of fishing taking place at the site. Fishing gear locations were digitally recorded as time-stamped GPS fixes within HYPACK each time gear was observed alongside the vessel in and around the acoustic survey area. Each target was labeled based on its port/starboard position relative to the vessel's course and the marker buoy's color patterns. A file of marker buoy GPS locations was created and used to generate a map of surface marker buoy locations throughout CLDS.

2.7 Statistical Methods

2.7.1 aRPD and Successional Stage Statistical Methods

One objective of this survey was to assess the status of benthic community recolonization of the sediment at disposal areas relative to reference area conditions. Statistical analyses were conducted to compare key SPI variables between sampled disposal areas (target areas where placement activity was concentrated) and reference areas (control areas with no placement activity). The aRPD depth and successional stage measured in each image are the best indicators of infaunal activity measured by SPI and were, therefore, used in this comparative analysis. Standard boxplots were generated for visual assessment of the central tendency and variation in each of these variables within each disposal area and each reference area. Tests rejecting the inequivalence between the reference and disposal areas were conducted, as described in detail below.

The objective to look for differences has conventionally been addressed using a point null hypothesis of the form, "There is no significant difference in benthic conditions between the reference area and the disposal target areas." However, there is always some difference (perhaps only to a very small decimal place) between groups, but the statistical significance of this difference may or may not be ecologically meaningful. On the other hand, differences may not be detected due to insufficient statistical power. Without a power analysis and specification of what constitutes an ecologically meaningful difference, the results of conventional point null hypothesis testing often provide inadequate information for ecological assessments (Germano 1999). An approach using an inequivalence null hypothesis will identify when groups are statistically similar, within a specified interval, which is more suited to the objectives of the DAMOS monitoring program.

For an inequivalence test, the null hypothesis presumes the difference is great; this is recognized as a "proof of safety" approach because rejection of the inequivalence null hypothesis requires sufficient proof that the difference was actually small (McBride 1999). The null and alternative hypotheses for the inequivalence hypothesis test are:

H_0: $d < -\delta$ or $d > \delta$ (presumes the difference is great)

H_A: $-\delta < d < \delta$ (requires proof that the difference is small)

where d is the difference between a reference mean and a site mean.

The test of this inequivalence (interval) hypothesis can be broken down into two one-sided tests (TOST) (McBride 1999; Schuirmann 1987). Assuming a symmetric distribution, the inequivalence hypothesis is rejected at an α of 0.05 if the 90% confidence interval for the measured difference (or, equivalently, the 95% upper limit and the 95% lower limit for the difference) is wholly contained within the equivalence interval $[-\delta, +\delta]$. The size of δ should be determined from historical data, and/or professional judgment, to identify the bounds that are within background variability and is therefore not ecologically meaningful. Previously established δ values of 1 cm for aRPD depth and 0.5 for successional stage rank (on the 0-3 scale) were used.

The statistics used to test the interval hypotheses shown here are based on the Central Limit Theorem (CLT) and basic statistical properties of random variables. A simplification of the CLT states that the mean of any random variable is normally distributed. Linear combinations of normal random variables are also normal so a linear function of means is also normally distributed. When a linear function of means is divided by its standard error the ratio follows a t-distribution with degrees of freedom associated with the variance estimate. Hence, the t-distribution can be used to construct a confidence interval around any linear function of means.

In this survey, nine distinct areas were sampled; three were categorized as reference areas (2500W, 4500E, and CLDS-REF), four were historical disposal mounds (CS-1, CS-2, MQR, and FVP), and two were regions of general disposal, including CLDS-Other and NHAV14 representing the area of recent placement.

The statistical approach used to evaluate the sampled disposal areas utilized non-simultaneous confidence intervals for the difference between each group and reference [Eq.1] for a total of six pairwise comparisons. Non-simultaneous intervals do not attempt to control the family-wise error rate. This is considered appropriate in this evaluation where the primary objective is to have 95% confidence for the comparison of each individual disposal area relative to reference, rather than across the family of all six comparisons. Hence, each confidence statement is constructed with an α of 0.05. The difference equations of interest were the linear contrasts of the average of the three reference means minus each of the six disposal area means [Eq.1], or

$\hat{d}$ = [1/3 x ($Mean_{2500W}$ + $Mean_{4500E}$ + $Mean_{CLDS\text{-}REF}$) – ($Mean_{Disposal}$)] [Eq. 1]

where:

$Mean_{Disposal}$ = the mean for one of the six disposal areas (CS-1, CS-2, FVP, MQR, CLDS-Other, and NHAV14)

The difference equations, $\hat{d}$, for the comparisons of interest were specified by Eq. 1 and the standard error of each difference equation used the fact that the variance of a sum is the sum of the variances for independent variables, or:

$$SE(\hat{d}) = \sqrt{\sum_j \left(S_j^2 c_j^2 / n_j\right)}$$ [Eq. 2]

where:

c_j = coefficients for the *j* means in the difference equations, $\hat{d}$ [Eq. 1] (i.e., the coefficients were 1/3 for each of the 3 reference areas, and -1 for the disposal group).

S_j^2 = variance for the j_{th} group. If equal variances are assumed, the pooled residual variance estimate equal to the mean square error from an *ANOVA* based on all groups involved, can be used for each S_j^2.

n_j = number of stations for the j_{th} group.

The inequivalence null hypothesis was rejected (and equivalence concluded) if the confidence interval on the difference of means, $\hat{d}$, was fully contained within the interval [–δ, + δ]. Thus, the decision rule was to reject H0 (the two groups were inequivalent) if:

$D_L = \hat{d} - t_{\alpha,\upsilon} SE(\hat{d}) \geq -\delta$ and $D_U = \hat{d} + t_{\alpha,\upsilon} SE(\hat{d}) \leq \delta$ [Eq. 3]

where:

$\hat{d}$ = observed difference in means ([Eq. 1]).

$t_{\alpha,\upsilon}$ = upper (1-α)*100_{th} percentile of a Student's t-distribution with υ degrees of freedom (α = 0.05)

$SE(\hat{d})$ = standard error of the difference ([Eq. 2])

υ = degrees of freedom for the standard error. If a pooled residual variance estimate was used, this was the residual degrees of freedom from an ANOVA on all groups (total number of stations minus the number of groups); if separate variance estimates were used, degrees of freedom were calculated based on the Welch-Sattherthwaite estimation (Satterthwaite 1946; Zar 1996).

The three reference areas collectively represented ambient conditions, but if the means were different among these three areas, then pooling them into a single reference group would inflate the variance estimate because it would include the variability between areas, rather than only the variability between stations within each single homogeneous area. The effect of keeping the three reference areas separate had no effect on the grand reference mean when sample size was equal among these areas, but it ensured that the variance is truly the residual variance within a single population with a constant mean.

Validity of normality and equal variance assumptions was tested using Shapiro-Wilk's test for normality on the area residuals ($\alpha = 0.05$) and Levene's test for equality of variances among areas ($\alpha = 0.05$). If normality was not rejected but equality of variances was, then normal parametric confidence bounds were calculated, using separate variance estimates for each group. If normality was rejected, then non-parametric bootstrapped estimates of the confidence bounds were calculated.

2.7.2 aRPD and Successional Stage Temporal Statistical Methods

Temporal statistical analyses were conducted to compare key SPI variables between two survey years, 2016 and 2014, for the sampled disposal areas and reference areas. Similar to the comparisons described above (Section 2.7.1) the aRPD depth and successional stage were used in these temporal comparisons. Standard boxplots were generated for visual assessment of the central tendency and variation of these variables within each area for both years. Tests evaluating the inequivalence between the 2016 and 2014 conditions for each reference and disposal area were conducted, using the methods detailed in Section 2.7.1.

The difference equation of interest here was the linear contrast of the location mean in 2016 minus the location mean in 2014 (i.e., disposal or reference location), or

$$\hat{d} = [(\text{Mean}_{2016}) - (\text{Mean}_{2014})] \qquad \text{[Eq. 4]}$$

where:

Mean_{20xx} = the mean in year 2014 or 2016, for one of the sampled disposal groups (MQR, CLDS-Other, or NHAV14) or the grand mean of the reference areas (2500W, 4500E, and CLDS-REF).

2.7.3 Benthic Community Analysis Statistical Methods

Univariate

Summary statistics that characterized benthic infaunal samples included overall density/m^2 and species richness. Separate one-way Analysis of Variance (ANOVA) tests were used to examine potential differences in these parameters among the four disposal mounds/areas (FVP, CS-1, NHAV14, and CLDS-Other) and the reference area (4500E). Simultaneous 90% confidence intervals for the differences between individual areas were constructed for these parameters using Tukey's HSD test[1]. A one-way ANOVA was calculated on Annelid biomass. Biomass data for other phyla did not meet test assumptions following transformation and therefore were tested for differences among areas using the non-parametric Kruskal-Wallis test. Univariate statistical tests were conducted using R version 3.5.2 (R Core Team 2018).

Multivariate

The taxonomic composition of benthic infaunal assemblages was compared among areas using multivariate analyses conducted using the *vegan* package (Oksanen et al. 2019) for RStudio statistical software Version 1.1.463 (RStudioTeam 2019). Abundance data were aggregated at the family level prior to analysis because species within families share functional roles, therefore, data aggregation permits an examination of community similarity that may reflect biological functions (e.g., prey resource, filtration, bioturbation). Data aggregation also reduces the influence of individual species distributions and eliminates false distinctions that may result if a taxon is identified both at a LPIL and species level. A one-way Analysis of Similarity (ANOSIM) test was conducted to test whether the infaunal compositions significantly differed by area. ANOSIM is a permutation test that compares the similarity between samples from different groups to the similarity between samples within groups (a permutation value of 10,000 was used for this analysis). Prior to calculating similarities, the abundance data were log(x+1) transformed to reduce the influence of abundant taxa and permit taxa with low or rare occurrences to contribute. Ranks of the Bray-Curtis similarity metric were used to describe relationships among samples based on their infaunal assemblages. The ANOSIM R statistic is derived from the average ranks between and within groups; the R-value ranges from -1 to 1, with $R = 0$ indicating that the assemblages were indistinguishable from each other among areas, and $R = 1$ indicating no similarity in assemblages among areas. R-values >0.5 indicate clear differences among areas with some degree of overlap (Clarke and Gorley 2015). If assemblages significantly differed among areas ($p < 0.05$), SIMPER (similarity percentages, Clarke et al. 2014) was used to identify the taxa that contributed the most to distinguishing these assemblages. Non-metric multidimensional scaling (nMDS) ordinations provide a visual depiction of the ANOSIM results, illustrating the relative similarity/dissimilarity in assemblage composition among samples in each area. On the nMDS plots, symbols representing samples with similar

[1] Tukey's HSD test (using *TukeyHSD* function in R) adjusts the α-level for each pairwise confidence interval to maintain the family-wise confidence level at 90%.

infaunal assemblages are positioned more closely to each other than samples with dissimilar assemblage composition. This ordination was found by maximizing the correlation between observed dissimilarities and the dissimilarities in this 2-dimensional plot using monotonic regression. The stress values associated with the nMDS plots indicate the goodness-of-fit of the two-dimensional representations. A smaller stress value (e.g., <10%) indicates that the nMDS ordination is a good representation of the original pairwise relationships between samples. The smaller the stress, the better the representation. Generally, stress values under 10% are considered "good" and values over 15% are considered "poor".

2.7.4 Sediment Chemistry Comparison Guidelines

There are no site-specific sediment quality guidelines (SQGs) for use in Long Island Sound, so the analysis in this report makes use of national guidelines that define expected toxic effects based on sediment contaminant concentrations (Long and Morgan 1990; Long et al. 1995). These SQGs were derived using a database compiled from many studies performed by numerous investigators containing paired sediment chemistry and bioassay data. In the study, samples in which adverse effects were reported were identified. From this data, the 10th and 50th percentile of the effects values were identified for each chemical of concern. The 10th percentile values were named the effects range low (ER-L), indicative of concentrations below which adverse effects rarely occur. The 50th percentiles were named the effects range median (ER-M) values, representative of concentrations above which effects frequently occur. The national guidelines, although useful, should be used with caution as they have not been tested against local Long Island Sound data.

In order to begin to develop a regional dataset of Long Island Sound (LIS) data against which to compare the sediment chemistry results, historical sediment chemistry data from LIS dredged material disposal sites and surrounding areas were compiled and evaluated to support ongoing assessments and inform an evaluation of existing management approaches (Appendix G; Battelle 2017). Sources of historical and recent sediment chemistry and bioassay data were identified, compiled, and evaluated for usability based on specific criteria. Once the usable data were compiled and standardized, the database was used to develop a Central Long Island Sound ambient sediment dataset sufficiently robust to develop representative ambient values for comparison.

The representative ambient value selected for this analysis is the Upper Tolerance Limit (UTL); values were calculated as the 90% upper confidence limit of the 90^{th} percentile (90/90 UTL) for LIS ambient dataset to use for comparing disposal site chemical concentrations with the surrounding Sound. The 90/90 UTL can be interpreted as the level below which 90% of the ambient (outside of the disposal site) population is expected to fall, 90% of the time. Thus, any individual samples that exceed this evaluation level are flagged as different from ambient.

The 90/90 UTL values were used in the analysis to place the sediment chemistry results in a larger context, in addition to contemporaneous reference area values and available sediment quality guidelines. While reference data provide information on potential contemporaneous widespread contamination during the time of the survey, the 90/90 UTL values are compiled over a longer term and over a larger spatial extent (within 1 km of the disposal site boundary), providing an understanding of when disposal site values can be confidently assessed as different from (and generally higher than) sediment concentrations expected in this area of Central Long Island Sound. Due to historical input of contaminants to Long Island Sound (Mitch and Anisfeld 2010), the 90/90 UTL values are not necessarily associated with pristine or even non-toxic concentrations, but simply describe the range of concentrations already present in ambient sediments in the area of CLDS.

Chemical concentrations as measured in *Nephtys* tissue samples from the disposal mounds/areas were compared to those measured at the reference site. In addition, data from *Nephtys* samples collected in 2000 (USEPA/USACE 2004) from CLDS reference, as well as composited from two disposal mounds (FVP and NHAV93, another capped mound created in 1993), were also used for comparison to the 2016 data. As there are no published standards for tissue concentrations for non-motile benthic species, Food and Drug Administration (FDA) action levels that reflect tolerance levels in the edible portion of fish also are included for comparison.

Table 2-1.

Accuracy and Uncertainty Analysis of Bathymetric Data

Survey Date	Quality Control Metric	Results (m) Mean	95% Uncertainty	Range
9/26-27/2016	Cross-Line Swath Comparisons	0.00	0.08	
	Within Cell Uncertainty	0.04	0.08	0.00 - 1.12
	Beam Angle Uncertainty (0 - 60d)	0.00	0.08	0.00 - 0.15

Notes:
1. The mean of cross-line nadir and full swath comparisons are indicators of tide bias.
2. 95% uncertainty values were calculated using the sums of mean differences and standard deviations expressed at the 2-sigma level.
3. Within cell uncertainty values include biases and random errors.
4. Beam angle uncertainty was assessed by comparing cross-line data (60-degree swath limit) with a reference surface created using mainstay transect data.
5. Swath and cell based comparisons were conducted using 1.0m x 1.0m cell averages. These analyses do not exclude sounding variability associated with terrain slopes or objects.

Table 2-2.

CLDS 2016 SPI, Sediment Grab, BCA, and Tissue Chemistry Station IDs, Sample IDs, and Target Coordinates

Category	Station ID	No. of Sampling Locations	Sample ID	X	Y	Latitude	Longitude	SPI	Sediment Grab (Physical and Chemical)	Biological Community Analysis (BCA)	Tissue Chemistry
Historical Mounds	FVP-01	7	CLDS_16B1_SPI_FVP-01	295471	188261	41.156187	-72.86115	√	√		
	FVP-02		CLDS_16B1_SPI_FVP-02	295484	188257	41.156143	-72.861	√	√	√	√
	FVP-03		CLDS_16B1_SPI_FVP-03	295458	188293	41.15647	-72.86131	√	√		
	FVP-04		CLDS_16B1_SPI_FVP-04	295504	188301	41.156544	-72.86076	√	√		
	FVP-05		CLDS_16B1_SPI_FVP-05	295518	188295	41.156493	-72.86059	√	√	√	√
	FVP-06		CLDS_16B1_SPI_FVP-06	295486	188308	41.156609	-72.86097	√	√	√	√
	FVP-07		CLDS_16B1_SPI_FVP-07	295552	188317	41.156689	-72.86019	√	√		
	CS-1-01	7	CLDS_16B1_SPI_CS-1-01	292063	187592	41.150115	-72.90174	√	√	√	√
	CS-1-02		CLDS_16B1_SPI_CS-1-02	292037	187643	41.150574	-72.90205	√	√		
	CS-1-03		CLDS_16B1_SPI_CS-1-03	292060	187621	41.150371	-72.90178	√	√		
	CS-1-04		CLDS_16B1_SPI_CS-1-04	292034	187664	41.150763	-72.90208	√	√		
	CS-1-05		CLDS_16B1_SPI_CS-1-05	292067	187696	41.151048	-72.90169	√	√	√	√
	CS-1-06		CLDS_16B1_SPI_CS-1-06	292107	187668	41.150797	-72.90122	√	√		
	CS-1-07		CLDS_16B1_SPI_CS-1-07	292085	187709	41.151167	-72.90148	√	√	√	√
	MQR-01	7	CLDS_16B1_SPI_MQR-01	292466	186809	41.143067	-72.89692	√	√		
	MQR-02		CLDS_16B1_SPI_MQR-02	292498	186798	41.142974	-72.89654	√	√		
	MQR-03		CLDS_16B1_SPI_MQR-03	292429	186847	41.143407	-72.89736	√	√		
	MQR-04		CLDS_16B1_SPI_MQR-04	292453	186857	41.143496	-72.89708	√	√		
	MQR-05		CLDS_16B1_SPI_MQR-05	292531	186858	41.143509	-72.89615	√	√		
	MQR-06		CLDS_16B1_SPI_MQR-06	292466	186923	41.144099	-72.89693	√	√		
	MQR-07		CLDS_16B1_SPI_MQR-07	292549	186908	41.143959	-72.89594	√	√		
	CS-2-01	7	CLDS_16B1_SPI_CS-2-01	291959	188344	41.156878	-72.903	√	√		
	CS-2-02		CLDS_16B1_SPI_CS-2-02	291990	188346	41.156904	-72.90262	√	√		
	CS-2-03		CLDS_16B1_SPI_CS-2-03	291954	188369	41.157103	-72.90305	√	√		
	CS-2-04		CLDS_16B1_SPI_CS-2-04	292005	188386	41.157258	-72.90245	√	√		
	CS-2-05		CLDS_16B1_SPI_CS-2-05	292012	188378	41.15719	-72.90237	√	√		
	CS-2-06		CLDS_16B1_SPI_CS-2-06	291957	188393	41.15732	-72.90302	√	√		
	CS-2-07		CLDS_16B1_SPI_CS-2-07	291978	188394	41.157329	-72.90277	√	√		

Category	Station ID	No. of Sampling Locations	Sample ID	X	Y	Latitude	Longitude	SPI	Sediment Grab (Physical and Chemical)	Biological Community Analysis (BCA)	Tissue Chemistry
Central Regions	NHAV14-01	17	CLDS_16B1_SPI_01	293504	186723	41.142309	-72.88455	√	√		
	NHAV14-02		CLDS_16B1_SPI_02	293375	186890	41.143812	-72.8861	√	√	√	√
	NHAV14-03		CLDS_16B1_SPI_03	293384	187147	41.146126	-72.88599	√	√		
	NHAV14-04		CLDS_16B1_SPI_04	293582	187139	41.146059	-72.88363	√	√		
	NHAV14-05		CLDS_16B1_SPI_05	293313	187364	41.148081	-72.88684	√	√	√	√
	NHAV14-06		CLDS_16B1_SPI_06	293581	187494	41.149252	-72.88366	√	√		
	NHAV14-07		CLDS_16B1_SPI_07	293246	187649	41.150639	-72.88764	√	√	√	√
	NHAV14-08		CLDS_16B1_SPI_08	293448	187643	41.150592	-72.88524	√	√		
	CLDS-Other-09		CLDS_16B1_SPI_09	293894	187765	41.151694	-72.87994	√	√		
	CLDS-Other-10		CLDS_16B1_SPI_010	294097	187645	41.150615	-72.87751	√	√	√	√
	CLDS-Other-11		CLDS_16B1_SPI_011	294402	188019	41.15399	-72.87389	√	√		
	CLDS-Other-12		CLDS_16B1_SPI_012	294490	188100	41.154717	-72.87283	√	√		
	CLDS-Other-13		CLDS_16B1_SPI_013	292647	187056	41.145294	-72.89477	√	√	√	√
	CLDS-Other-14		CLDS_16B1_SPI_014	292811	186985	41.144661	-72.89281	√	√	√	√
	CLDS-Other-15		CLDS_16B1_SPI_015	292410	187149	41.146128	-72.89759	√	√		
	CLDS-Other-16		CLDS_16B1_SPI_016	292582	187169	41.146311	-72.89555	√	√		
	CLDS-Other-17		CLDS_16B1_SPI_017	292786	187204	41.146633	-72.89312	√	√		
Reference Areas	CLDS-REF-01	5	CLDS_16B1_SPI_CLDS-REF-01	297555	185711	41.133243	-72.83629	√	√		
	CLDS-REF-02		CLDS_16B1_SPI_CLDS-REF-02	297790	185711	41.133245	-72.8335	√	√		
	CLDS-REF-03		CLDS_16B1_SPI_CLDS-REF-03	297672	185945	41.135353	-72.8349	√	√		
	CLDS-REF-04		CLDS_16B1_SPI_CLDS-REF-04	297907	185945	41.135355	-72.83211	√	√		
	CLDS-REF-05		CLDS_16B1_SPI_CLDS-REF-05	297555	186077	41.13654	-72.83629	√	√		
	4500E-01	5	CLDS_16B1_SPI_4500E-01	296990	187960	41.153487	-72.84305	√	√	√	√
	4500E-02		CLDS_16B1_SPI_4500E-02	297224	187960	41.153489	-72.84026	√	√	√	√
	4500E-03		CLDS_16B1_SPI_4500E-038	297107	188194	41.155597	-72.84166	√	√	√	√
	4500E-04		CLDS_16B1_SPI_4500E-04	297341	188009	41.153933	-72.83887	√	√		
	4500E-05		CLDS_16B1_SPI_4500E-05	297224	188248	41.156084	-72.84026	√	√	√	√
	2500W-01	5	CLDS_16B1_SPI_2500W-01	289906	187870	41.152578	-72.92744	√	√		
	2500W-02		CLDS_16B1_SPI_2500W-02	289977	187870	41.15258	-72.92659	√	√		
	2500W-03		CLDS_16B1_SPI_2500W-03	289860	188104	41.154687	-72.92799	√	√		
	2500W-04		CLDS_16B1_SPI_2500W-04	290094	188104	41.154691	-72.9252	√	√		
	2500W-05		CLDS_16B1_SPI_2500W-05	289977	188338	41.156798	-72.9266	√	√		
Total		60						60	60	16	16

Notes
1. Grid coordinates are NAD_1983_StatePlane_Connecticut_FIPS_0600_Meters
2. Geographic coordinates are NAD83 decimal degrees

Table 2-3.

Sample Containers, Sample Sizes, Preservative Requirements, and Holding Times for CLDS Samples

Sample Type	Compound Class	Minimum Sample Size[1]	Container[2]	Preservation	Holding Time[3]	Total # of Samples (*not including QC samples*)	Ship to (Laboratory)[5]
Sediment	Grain size	200 g	8 oz. G [4]	Chill: 4°±2°C	6 months	60	Katahdin
Sediment	TOC	10 g	4 oz. G	Chill: 4°±2°C	28 days	60	Katahdin
Sediment	Percent moisture	10 g	From TOC jar	Chill: 4°±2°C	14 days	60	Katahdin
Sediment	Total N	10 g	From TOC jar	Chill: 4°±2°C	48 hours	60	Katahdin
Sediment	Total P	10 g	From TOC jar	Chill: 4°±2°C	28 days	60	Katahdin
Sediment	Metals	10 g/30 g	4 oz. G.	Chill: 4°±2°C or Freeze -20°	6 months; Hg – 28 days	60	ESI
Sediment	PCB Congeners, Pesticides, PAHs	30/90 g	8 oz. G	Chill: 4°±2°C or Freeze -20°	14 days chilled; 1 year frozen/ 40 days	60	Battelle
Rinsate Blank	PCB Congeners, Pesticides, PAH	2 L	1-L Amber Glass	Chill: 4°±2°C	7 days/40 days	1	Battelle
Rinsate Blank	Metals (except Hg)	100 mL	500 mL P	HNO_3: 4°±2°C	6 months	1	ESI
Rinsate Blank	Hg	100 mL	500 mL G	HCL	28 days	1	ESI
Tissue	PCB Congeners, Pesticides, PAH, Total Lipids	20g	8 oz. G	Chill: 4°±2°C	14 days chilled; 1 year frozen/ 40 days	16	Battelle
Tissue	Metals	10g	From organics jar (prior to compositing)	Chill: 4°±2°C	6 months; Hg – 28 days	16	Battelle (Homogenization – Battelle will split for metals and send to ESI)
Sediment	Benthic Invertebrate Taxonomy	Entire grab	Plastic	10% concentrated formalin.	N/A	16	Barry Vittor Associates

[1] "x"/"y" = minimum sample size for each sample / minimum sample size for each QC sample (matrix spike/matrix spike duplicate)
[2] Container Types: G = Glass/Teflon-lined lid. P = Plastic. All sample bottles will be provided by the respective laboratory and will be pre-cleaned and certified.
[3] "x" days/"y" days = maximum days from sampling to extraction/maximum days from extraction to analysis.
[4] If large rocks or significant quantities of gravel are in the sample, then additional sediment is required for analysis.

3.0 RESULTS

An acoustic survey was conducted over the active placement areas of CLDS and at three reference areas (2500W, 4500E, and CLDS-REF) from 26-27 September 2016. A SPI/PV survey was conducted over the active placement areas of the site, over four older mounds of interest (FVP, MQR, CS-1, and CS-2), and at three reference areas from 28 September 2016 through 02 October 2016. Sediment grab samples and tissue samples were also collected following the bathymetric and SPI/PV surveys and generally targeted the same area as the SPI/PV survey. Grab and clam rake efforts for tissue collection took place 3-7 and 11-12 October 2016. Data from these investigations are presented below and in the subsequent tables and figures.

3.1 Existing Bathymetry

The acoustic survey (bathymetric, side-scan and backscatter data collection) was performed over the active portion of CLDS (located in the south-central portion of the site; Figure 3-1) and at three reference areas (2500W, 4500E, and CLDS-REF). A bathymetric contour map of the reference areas was not provided because the depth at these areas was spatially homogenous (addressed below). Within CLDS, the active survey area covered the mounds CLIS-95/96, CLIS-97/98, CLIS-05, CLIS-08, CLIS-09, and CLIS-10. Multibeam bathymetric data rendered as a color scale by depth over an acoustic relief model (grayscale with hillshading) provided a detailed representation of the surface of the seafloor at CLDS and the reference locations (Figures 3-2 and 3-3). The seafloor was approximately 22.0 m (MLLW) at the deepest portions of the surveyed area in CLDS and as shallow as 14 m over the tallest mounds (CLIS-97/98 and CLIS-10). The majority of the mounds within the target area (CLIS-95/96, CLIS-97/98, CLIS-05, CLIS-09, and CLIS-10) were apparent as discrete formations that rose 5–6 m above the surrounding seafloor with shoulder areas surrounding the mounds that were 1–2 m high (Figure 3-1). Mound CLIS-08 did not contain a distinct peak, and instead formed a rough plateau that was approximately 2-3 m above the surrounding seabed. Each of these mounds had been previously identified (ENSR 2007) and were formed by previous targeted disposal of dredged material in this area. Color scale presentation of multibeam bathymetric data enhanced the visibility of irregular depressions that were located in this area. A series of small craters (shallow depressions with a ring of displaced material indicative of a single placement event) consistent with dredged material placement “pock-marked” the seafloor in the survey area.

The reference areas were each at different depths, but all three were characterized by a relatively flat bottom with distinct large-scale linear topographic features (Figure 3-3). The features are consistent with the presence of sedimentary furrows across wide areas of Long Island Sound and described in detail in previous investigations (ENSR 2007; AECOM 2013). Reference area 2500W was the shallowest at approximately 17 m, followed by 4500E at 21 m, and CLDS-REF was the deepest at 24 m.

3.1.1 Acoustic Backscatter and Side-Scan Sonar

Acoustic backscatter data were recorded during the September 2016 acoustic survey at CLDS and provided a clear representation of several areas with patterns of dredged material disposal activity (Figure 3-4). The mosaic of backscatter intensity displayed light areas (higher backscatter intensity) that corresponded to historical and recent dredged material placement locations and correlated more with surface texture characteristics than relief. Areas that corresponded with disposal activity exhibited a stronger return than the surrounding seafloor, with the strongest returns observed around mound CLIS-97/98 in the north-central portion of the survey area (-18 to -16 dB). Higher returns of -26 to -20 dB were indicative of placed material, and lower returns of -34 to -30 dB were generally limited to the native seafloor. The mosaic had clear evidence of isolated disposal impact features and curved trails of dredged material that have been observed in previous surveys (ENSR 2007; Carey et al. 2012; Valente et al. 2012). Consistent with previous surveys, trails of barge disposal were visible in the eastern and northeastern portion of the survey area, and the irregularity of the seafloor in and around the disposal mounds was evident (Figure 3-4).

At the reference areas, backscatter results documented each area to have a relatively smooth and flat seabed composed of soft sediment (Figure 3-5). Lower returns of -34 to -30 dB were indicative of soft sediment and were representative of the ambient seafloor in these areas. Each reference area had similar returns despite the differences in water depth. There were a few locations in 2500W and 4500E that had small localized areas with higher returns of -18 to -16 dB. At 2500W these areas were found in the southwest and southeast, and at 4500E this was observed in the east of the area near the boundary perimeter.

Filtered backscatter results were processed into a grid file and presented in a quantitative form where backscatter intensity values were assigned a color (Figure 3-6). In this filtered and gridded display, the finer-scale details were less visible, but the relative intensity of backscatter returns were easier to discern. Dredged material placed around the mound designations (e.g., CLIS-95/96 CLIS-97/98) produced irregular areas with moderate to strong returns (-26 to -16 dB). These areas were distinct from the weaker returns observed in the background native sediment.

At the reference areas filtered backscatter results supported the raw backscatter findings. The seabed at each reference areas was largely smooth, flat, and composed of soft sediment. At 2500W and 4500E there were several small areas with higher returns indicating localized areas with hard substrata (Figure 3-7).

Side-scan sonar results also provide a clear representation of disposal activity over the surveyed area of CLDS. Side-scan results supported observations from the backscatter results, but with additional detail (Figure 3-8). Curved tracks and the irregular seafloor surface features, indicative of disposal, were clearly visible. Additionally, pock-marks of disposal activity (shallow depressions with a ring of displaced material indicative of a single placement event) were distinguishable, with a high concentration of these features visible in the north central portion of the surveyed area just south of mound CLIS-97/98. These features coincide with one of the locations where the highest amount of recent disposal activity occurred (Figure 1-4). The side-scan sonar results have a higher resolution and are more responsive to minor surface textural features and slope than backscatter results. Some of the disposal impact features and curved marks were clearer in the side-scan sonar data indicating that they retained some surface topographical/textural qualities. At the reference areas side-scan results affirmed the seabed to be smooth with a few localized areas containing small irregularities (Figure 3-9).

3.1.2 Comparison with Previous Bathymetry

The 2014 acoustic survey at CLDS served as a periodic, high-resolution bathymetric survey of the full site for management of the site and for comparison with future surveys. A depth comparison between the 2014 survey and the 2016 acoustic survey documented changes in seafloor topography due to dredged material placement and natural processes at the site over that time period (Figure 3-10). During that two-year period, the placement of material in the south-central portion of CLDS resulted in elevation increases ranging from 0.4 to 3.2 m. Targeted placement created an area with irregular mounds composed of relatively smooth peaks of 3.2 m of elevation difference. These peaks had shoulder slopes with 1.5 m elevation increase which were surrounded by a relatively flat base with 0.4 to 0.6 m of elevation increase.

There were locations where the depth difference between the 2014 and 2016 surveys was negative, with a -0.4 to -0.6 m difference in elevation. These negative differences were localized and did not exhibit patterns associated with sediment transport suggesting they were the result of sediment consolidation which is a normal geological process which takes place in the first few years following placement of dredged material (Carey et al. 2006; Silva et al. 1994; Poindexter-Rollins 1990).

3.2 Sediment Profile and Plan View Imaging

The SPI and PV data from the disposal site stations and the three reference areas were assessed to determine physical and biological benthic characteristics. Three of the four replicate drops of the SPI/PV camera system were selected for analysis at each station. The measurements from three replicates for aRPD depth, prism penetration depth, boundary roughness, and maximum void depth were averaged to provide a mean value per station. Successional status across replicates for each station was displayed as a pie chart. A summary of the SPI and PV results for the disposal site and reference area stations is presented in Tables 3-1 and 3-2 as well as in Appendix E.

3.2.1 Reference Area Stations

3.2.1.1 Physical Sediment Characteristics

The sediments at all three reference areas were spatially homogenous, composed of well mixed, light brown over olive gray silt-clay, with a grain size major mode of >4 phi at all stations (Figures 3-11 and 3-12). One of the three reference areas (2500W) was located due west of CLDS in an area ~7 m shallower than the other two reference locations. There was no evidence of dredged material at any of the stations sampled in the reference areas (Table 3-1; Figure 3-13), and no evidence of low dissolved oxygen or sedimentary methane (Appendix E).

The SPI camera system stop collar settings were kept relatively constant (stop collar settings ranged from 11 to 12.5 inches [~32 cm]), and no weights were added to the carriage (Appendix D); so the variation in camera penetration depth was a good measure of relative sediment shear strength among locations within the reference areas. Mean replicate camera prism penetration values among the reference area stations ranged from 14.7 to 18.8 cm with an overall reference station mean of 16.5 cm (SD±1.2) (Table 3-1; Figure 3-14) indicating that shear strength of surficial sediments was similar across the reference area stations. The overall high mean penetration depths at the reference stations suggest low weight bearing strength and supported the observations of fine, less-compact sediment grains observed at the reference area stations (Figure 3-12).

Means of replicate small-scale boundary roughness ranged from 0.4 to 3.8 cm with an overall reference area mean of 0.9 cm (SD±0.8) (Table 3-1; Figure 3-15); the majority of small-scale topography can be attributed to the surface and sub-surface activity of benthic organisms, evidenced by small burrowing openings, pits, and mounds at the sediment–water interface (Table 3-1; Figure 3-16). Mean boundary roughness was spatially homogenous, with only one station (4500E-03) containing large mean boundary roughness values (Figure 3-15). The large boundary roughness values observed at Station 4500E-03 were likely driven by a large biogenic disturbance of the sediment–water interface for one of the replicates (Figure 3-17). PV images support the SPI findings; in all images that could be classified, the sediment was identified as silt-clay with no bedforms resulting from sediment transport or hydrodynamic forcing (e.g., Figure 3-16; Appendix E).

3.2.1.2 Biological Conditions

Among reference area stations the means of replicate aRPD depths ranged from 2.2 to 3.8 cm (Table 3-1; Figure 3-18) with an overall mean of 2.8 cm (SD±0.4). Contrast between the shallowest aRPD depth at Station CLDS-REF-03 and the deepest at Station 4500E-04 are shown in Figure 3-19. The aRPD depths at the reference area stations were biologically modified by infaunal reworking resulting in moderately deep aRPDs, suggesting a benthic ecosystem without apparent physical or chemical impairment.

Stage 3 infauna were present at every reference area station (Figure 3-20), with the majority of stations classified as Stage 1 on 3 (Table 3-1). Evidence for the presence of Stage 3 fauna included large-bodied infauna, deep subsurface burrows, and/or deep feeding voids (Figure 3-21). Opportunistic Stage 1 taxa were indicated by the presence of small tubes at the sediment–water interface. Subsurface feeding voids, indicating Stage 3 fauna, were present in at least 1 replicate of each station surveyed. The mean of maximum subsurface feeding void depth ranged from 8.0 to 15.9 cm, with an overall reference area mean of 12.0 cm (SD±2.3) (Table 3-1; Figure 3-22).

Further indications of subsurface faunal activity from Stage 3 taxa were observed in the PV images as the presence of small and large burrows, which were sparse (<10% coverage) in their presence on the seafloor (Figure 3-16). The presence of tubes, indications of Stage 1 and 2 taxa, ranged from areas where no tubes were observed, to present (10-25% coverage; Figures 3-16 and 3-23; Appendix E). Tracks across the seafloor, often created by epifauna (decapods, gastropods), were seen at all three reference areas (Figure 3-16; Appendix E). The seafloor of the reference areas occasionally contained debris of small shell fragments (Figure 3-16B), but no fish or flora were observed in the PV images across the reference areas (Appendix E).

3.2.2 Disposal Site Stations

The physical and biological characteristics of the disposal site stations are presented below based on the categories discussed in Section 2. Historical dredged material disposal mounds include those with cap material (CS-1, CS-2 and MQR), and FVP as the historical uncapped mound. Following presentation of the results of the historical mounds are the results from the more disperse central regions of disposal, including NHAV14 and CLDS-Other (defined in Section 2.3).

3.2.2.1 Historical Mounds (CS-1, CS-2, MQR, and FVP)

Physical Sediment Characteristics

Dredged material was documented at every station within the four historical mounds (Figure 3-24). The sediments at MQR and CS-2 were spatially homogenous, with a depositional layer of very fine sand over silt-clay with a grain size major mode of 4 to 3 over >4 (Table 3-2; Figure 3-25) predominating. Two stations to the south of CS-2 had predominant grain sizes entirely composed of very fine sand (Figures 3-25 and 3-26A), likely due to the sand cap material placed at this mound. The sediment at CS-1 and FVP were characterized by the predominance of fine sediment; the majority of stations were silt-clay with a grain size major mode of >4 phi. A few stations located near the center of FVP contained thin depositional layers of fine and very fine sand over silt-clay (Figure 3-25).

There were contrasts in the optical signatures of the sediment amongst these mounds. The sediment at stations around CS-2 was light brown very fine sand over olive gray silt-clay (Figure 3-26A and B), while the MQR mound was composed of light brown very fine sand over a reddish-brown silt-clay (Figure 3-26C). The optical signature of the sediment at CS-1 was more similar to CS-2 (Figure 3-27A). In contrast, the sediment at FVP was defined by light brown oxidized sediment at the surface contrasting with the dark black sediment at depth (Figure 3-27B and C). The dark optical signature of the subsurface sediments indicated high sediment oxygen demand. One station at CS-1 (CS-1-04), was optically similar to the sediments at FVP (Figure 3-28). In each image, the dredged material extended past the penetration depth of the prism. The composition of the dredged material differed between the mounds, and mirrored the optical signatures described above.

The SPI camera system stop collar settings were kept relatively constant (stop collar settings ranged from 11 to 12.5 inches [~32 cm]), and no weights were added to the carriage (Appendix D); so the variation in camera penetration depth was a good measure of the relative sediment shear strength among station locations among the mounds. Mean replicate camera prism penetration values among the historical mounds were near or lower than reference (mean 16.5 cm) (Table 3-2; Figure 3-29). MQR penetration values ranged from 12.3 to 14.6 cm with an overall station mean of 13.2 cm (SD±0.7). The spatial distribution in sediment shear strength was similar at all of the MQR stations, as indicated by the low standard deviation in prism penetration depth. The overall high mean penetration depths at the MQR stations suggested low weight-bearing strength and supported the observations of fine, less-compact sediment observed at MQR (Figure 3-26C). Mean replicate camera prism penetration values among the CS-1 stations had a narrow range very similar to reference, from 16.0 to 17.9 cm with an overall station mean of 17.0 cm (SD±0.8). At FVP, mean replicate camera prism penetration values ranged from 11.3 to 15.8 cm with an overall station mean of 13.6 cm (SD±1.6). At CS-2, mean replicate camera prism penetration values ranged from 6.1 to 17.3 cm with an overall station mean of 12.6 cm (SD±3.6). Sediment shear strength was variable at CS-2 as indicated by prism penetration depth. There was a non-discrete radial variation in prism penetration depth; stations farthest from the center of the mound (Stations CS-2-01 and CS-2-03) had higher mean penetration depths suggesting low weight bearing strength (Figure 3-26A), and the station closest to the center (right on the edge of an impact crater) had shallow prism penetration depths, likely related to the presence of coarse-grained sediment in the cap (Station CS-2-05; Figure 3-30).

At the CS-1 mound, means of replicate small-scale boundary roughness ranged from 0.6 to 0.9 cm with an overall mean of 0.7 cm (SD±0.1) (Table 3-2; Figure 3-31). Mean boundary roughness at CS-2 ranged from 0.8 to 1.3 cm with an overall mean of 1.0 cm (SD±0.2). At MQR, means of replicate small-scale boundary roughness ranged from 0.8 to 2.7 cm with an overall mean of 1.2 cm (SD±0.7). Finally, FVP boundary roughness ranged from 0.6 to 1.2 cm with an overall mean of 0.9 cm (SD±0.2). For all of the mounds the majority of small-scale topography was attributed to the surface and sub-surface activity of benthic organisms, evidenced by small burrowing openings, pits, and mounds at the sediment–water interface (Table 3-2; Figures 3-32, 3-33). Mean boundary roughness was spatially homogenous at both mounds, with only one station (MQR-06) containing a large mean boundary roughness value (Figure 3-31). The large boundary roughness value observed at Station MQR-06 was driven by a large biogenic disturbance (burrowing structure) at the sediment–water interface in one of the replicates (Figure 3-34). PV images supported the SPI findings; in all images that could be classified, the sediment surface was identified as very fine sand with no indications of hydrodynamic-induced bedforms (Figures 3-32, 3-33; Appendix E).

Biological Conditions

The aRPD results for CS-1 and CS-2 were similar with low variability among stations and deeper aRPD values overall, while FVP and MQR both showed higher variability and shallower aRPD values (Table 3-2; Figure 3-35). The CS-1 and CS-2 mounds had results that were generally consistent with those measured at the reference stations (mean±SD values of 3.0 ±0.2 cm, 2.6 ±0.3 cm, and 2.8 ±0.4 cm, respectively), and each of these mounds had stations with aRPD depths greater than 3 cm (Station CS-2-04 and Station CS-1-02; Figure 3-36A and 3-37A, respectively). In contrast, the MQR and FVP mounds had the shallowest aRPD values of all disposal areas (mean ±SD: 1.6 ±0.5 cm at MQR and 1.4 ±0.7 cm at FVP), with several stations showing aRPD values less than 1 cm (e.g., Station MQR-04, Figure 3-36B; and Station FVP-04; Figure 3-37B).

Stage 3 infauna were present in at least one replicate for all the stations sampled at these four mounds (Table 3-2; Figure 3-38). Evidence for the presence of Stage 3 fauna included large-bodied infauna, deep subsurface burrows, and/or deep feeding voids (Figure 3-39). Stage 2 taxa were also prevalent at many of the stations in the capped mounds (Table 3-2; Figure 3-38). Stage 2 taxa were indicated by shallow to medium depths of burrowing beneath the sediment–water interface (example shown in Figure 3-39B). When present, feeding voids were generally observed deep beneath the sediment–water interface (Table 3-2; Figures 3-37B and 3-39); there were two stations with shallow void depths located in the northeast of mound CS-2 (Stations CS-2-04 and CS-2-05; Figure 3-40). Opportunistic Stage 1 taxa were indicated by the presence of small tubes at the sediment–water interface and were observed at several mounds in the presence of Stage 3 taxa receiving a Stage 1 on 3 designation (Table 3-2; Figure 3-28). At FVP the presence of Stage 3 taxa was accompanied by Stage 2 taxa resulting in a Stage 2 on 3 designation; Stage 2 taxa were indicated by shallow to medium burrowing beneath the sediment–water interface and/or tubes at the sediment surface (Figure 3-37A).

Maximum subsurface feeding void depth at CS-1, where values ranged from 9.1 to 17.7 cm and overall mean was 13.0 cm (SD±2.9), was similar to the reference area range of 8.0 to 15.9 cm (mean of 12.0 ±2.3 cm). At CS-2, values were also in the reference range with the exception of two stations in the northeast portion of the sampling area which had depths ≤2.3 cm; overall values at CS-2 ranged from 1.9 to 13.1 cm with a mean of 8.2 cm (SD±4.8). MQR had slightly shallower feeding void depths with values ranging from 8.6 to 12.4 cm and overall mean of 9.7 cm (SD±1.4). FVP values were also shallower than reference with a range of 5.5 to 14.8 cm and overall mean of 9.6 cm (SD±3.2 cm; (Table 3-2; Figure 3-40).

3.2.2.2 CLDS Central Disposal Regions (NHAV14 and CLDS-Other)

Physical Sediment Characteristics

Dredged material was documented at every station sampled at both NHAV14 and CLDS-Other areas (Figure 3-41). In each instance, the dredged material extended past the penetration depth of the prism. The composition of the dredged material was largely homogenous with the difference in optical reflectance the only major difference; some stations in the CLDS-Other group had sediments with a high optical reflectance (Figures 3-42 and 3-43).

The sediment at stations within the NHAV14 and CLDS-Other groups were largely a composition of well mixed, light brown very fine sand over olive to dark gray silt-clay with a grain size major mode of 4 to 3 over >4 (Table 3-2; Figures 3-42A, 3-44). Two stations differed in grain size; Station 02, composed of silt-clay (Figure 3-42B), and Station 14, consisting predominantly of very-fine sand with a depositional layer of fine sand at depth (Figure 3-42C). All of the stations within NHAV14 (Stations 01 through 08) consisted of surface sediments with a high optical reflectance which contrasted with the subsurface sediments that had a much lower optical reflectance (e.g., Figure 3-42A). The CLDS-Other group (Stations 09 through 17) contained stations with a mix of sediment optical properties. Some stations mirrored the optical properties observed in NHAV14 (Figure 3-42B), and other stations consisted of an entire sediment column with high optical reflectance (Figure 3-43).

The SPI camera system stop collar settings were kept relatively constant (stop collar settings ranged from 11 to 12.5 inches [~32 cm]), and no weights were added to the carriage (Appendix D), so the variation in camera penetration depth was a good measure of the relative sediment shear strength among station locations. Mean replicate camera prism penetration values among the NHAV14 stations ranged from 12.8 to 19.6 cm with an overall station mean of 16.8 cm (SD±2.2) (Table 3-2; Figure 3-45). The spatial distribution in sediment shear strength was the same at all of the NHAV14 stations, as indicated by the low standard deviation in prism penetration depth. Prism penetration depths at the NHAV14 stations were high (no stations had penetration values less than 12.8 cm) suggesting the sediment at NHAV14 contained low weight bearing strength and high porewater concentrations. Similar prism penetration values were observed at the CLDS-Other stations. Mean replicate camera prism penetration values ranged from 13.4 to 19.6 cm with an overall station mean of 16.8 cm (SD±1.7) (Table 3-2; Figure 3-45). Similar to NHAV14, sediment shear strength was low at CLDS-Other as indicated by the large prism penetration values. There was a general trend of low sediment shear strength at all of the mounds sampled within the CLDS-Other group.

At the NHAV14 stations, means of replicate small-scale boundary roughness ranged from 0.4 to 1.0 cm with an overall mean of 0.7 cm (SD±0.2) (Table 3-2; Figure 3-46). At the CLDS-Other stations, means of replicate small-scale boundary roughness ranged from 0.4 to 1.2 cm with an overall mean of 0.8 cm (SD±0.3) (Table 3-2; Figure 3-46). Mean boundary roughness was spatially homogenous at CLDS-Other. All of the small-scale topography observed at the NHAV14 and CLDS-Other stations was attributed to biological activity (Table 3-2) driven by small tube formation at the sediment–water interface (Figure 3-47; Appendix E). The PV images supported the SPI findings; the sediment surface of these areas showed little to no indications of hydrodynamic forcing at the NHAV14 and CLDS-Other stations (Figure 3-47; Appendix E).

Biological Conditions

The aRPD depths were variable at stations within the NHAV14 and CLDS-Other areas (Table 3-2; Figure 3-48). The means of replicate aRPD depths ranged from 1.1 to 2.6

cm with an overall mean of 1.8 cm (SD±0.5) at NHAV14 stations. At the CLDS-Other stations mean replicate aRPD depths ranged from 1.5 to 3.4 cm with an overall mean of 2.6 cm (SD±0.7). The shallowest aRPD depths were seen at Station 05 (1.1 cm) and deepest at Station 12 (Table 3-2; 3.4 cm; Figures 3-48, 3-49, respectively). Generally, stations in these two regions had aRPD depths that were shallow to moderate; two exceptions were seen at Stations 09 and 12 which had aRPD depths reworked deep within the sediment column to depths greater than 3 cm (Figures 3-48 and 3-49B, respectively). Similar to the reference areas and historical mounds, the aRPD depths at these area stations were biologically mediated by infaunal reworking.

Stage 3 infauna were present in at least one replicate for all the stations sampled at the recent placement areas and, in most instances, were present in every replicate (Figure 3-50). Evidence for the presence of Stage 3 fauna included deep subsurface burrows and/or deep feeding voids (Figure 3-51). The presence of Stage 3 taxa was often accompanied by Stage 1 taxa resulting in a Stage 1 on 3 designation (Table 3-2; Figure 3-50); opportunistic Stage 1 taxa were indicated by the presence of small tubes at the sediment–water interface. When present, feeding voids were generally observed at intermediate to deep depths beneath the sediment–water interface (Table 3-2; Figure 3-51). At one station (Station 16) shallow feeding voids were observed (Table 3-2; Figures 3-51 and 3-52). The mean of maximum subsurface feeding void depth ranged from 7.0 to 12.1 cm at NHAV14, and 5.5 to 18.3 cm at CLDS-Other. Overall mean void depths were 9.5 cm (SD±2.1) and 12.6 cm (SD±4.3) at NHAV14 and CLDS-Other, respectively (Table 3-2; Figure 3-51).

3.2.3 Comparison to Reference Areas

Each of the six disposal mounds/areas that were evaluated with SPI/PV (i.e., FVP, MQR, CS-1, CS-2, NHAV14, and CLDS-Other) were compared to the grand mean of the three reference areas (2500W, 4500E, and CLDS-REF, referred in this section simply as "reference areas") for aRPD depth, successional stage, number of feeding voids, and feeding void depth (summary statistics for each of these measurement variables by area are shown in Table 3-3). Statistical determinations of equivalence/inequivalence of aRPD values are presented in Table 3-4 for comparison of each disposal mound with the combined three reference areas. Because advanced successional taxa were documented at all stations for all of the disposal groups and reference areas there was no need to statistically analyze equivalency for successional taxa; i.e., successional taxa were the same at the reference and disposal areas. The aRPD means for each of the disposal mounds/areas FVP, MQR, and NHAV14 were statistically inequivalent (not within ± 1 cm) from the reference area mean, with each of these disposal areas having significantly lower mean values than reference (Table 3-4; Figure 3-53a). In contrast, the aRPD means for the mounds/disposal areas CLDS-Other, CS-1, and CS-2 were found to be statistically equivalent (within ± 1cm) to the reference area mean (Table 3-4; Figure 3-53a).

3.2.4 Comparison to 2014

A temporal comparison of the aRPD depth and successional stage data from 2016 and 2014 was conducted to assess potential temporal changes in benthic conditions at CLDS where data from the two survey years were available, i.e., CLDS-Other, NHAV14, MQR, and the three reference areas (2500W, 4500E, and CLDS-REF). Statistical determinations of temporal equivalence/inequivalence are presented in Tables 3-5 and 3-6, and data are graphically displayed in Figure 3-53b. For each site, the change in mean values over time were statistically inequivalent (not within ± 1 cm) (Figure 3-53b). The aRPD mean depths were significantly deeper in 2016 for CLDS-Other and NHAV14, and shallower for MQR. At reference areas 2500W and 4500E the changes in mean values over time were statistically inequivalent (not within ± 1cm), with aRPD depths significantly shallower in 2016 than in 2014. Only reference area CLDS-REF had aRPD depths that were statistically equivalent (within ± 1cm) between 2014 and 2016 (Figure 3-53b).

The infaunal succession was Stage 3 at every station surveyed in 2016. Stage 3 taxa were also present at every station in 2014 for the reference areas and MQR; for these areas statistical tests on successional stage were not necessary to conclude equivalence. At CLDS-Other stations, the successional stage rank was statistically equivalent (within ± 0.5 rank) between 2014 and 2016 (Table 3-6). At NHAV14, successional stage was statistically inequivalent (not within ± 0.5 rank) between years, with a significant improvement in successional stage from 2014 to 2016 (Table 3-6).

3.3 Sediment and Tissue Samples

Results for sediment analyses (grain size, TOC, nutrients, total PCB, total PAH, selected pesticides and metals) and benthic species tissue analyses (lipids, total PCB, total PAH, selected pesticides and metals) are provided below. Summary statistics for both sediment and tissue chemistry results are presented using the same classification system as for SPI results. Laboratory replicates were averaged prior to calculating summary statistics for the station values. Sediment data are also presented using standard boxplots by area relative to reference, as well as the associated ER-L and ER-M values (Long et al. 1995) and LIS ambient 90/90 UTL (Battelle 2017), if available (Section 2.7.4). Tissue sample analytical results are also presented below. As there are no published standards for tissue concentrations for non-motile benthic species, Food and Drug Administration (FDA) action levels that reflect tolerance levels in the edible portion of fish are included for comparison. Full results and laboratory reports for all parameters are provided in Appendices H and I.

3.3.1 Grain Size, Total Organic Carbon, and Nutrients

Grain size results are summarized in Table 3-7 and presented in Figures 3-54 and 3-55. Percent fines, defined as the sum of the silt and clay fractions, were highest at the three reference stations where values were all greater than 97%. The percent fines at the disposal locations were variable, ranging from 16.1% at CS-2 (reflective of the sand cap), to 96.5% within the general CLDS-Other area. The historical mounds had the lowest average values of percent fines, all <65% except for the mean value at CS-1 (silt cap), Total organic carbon (TOC) results are summarized in Table 3-8 and in Figure 3-56. The range of TOC at the reference areas was relatively narrow, with an overall average of 2.0% (Table 3-8, Figure 3-56). The highest average TOC values were measured at MQR and NHAV14 (averaging 2.7% and 2.9%, respectively). CS-1 and CLDS-Other TOC values were within the range of reference, while the lowest TOC values were measured at FVP and CS-2 (averages of 1.6% and 1.2%, respectively), consistent with the higher sand concentrations at these mounds.

Nitrogen and phosphorous results are presented in Table 3-9 and in Figures 3-57 and 3-58, respectively. Nitrogen was detected as total Kjeldahl nitrogen (TKN). Nitrates and nitrites were not detected in any samples above detection limits. The average TKN level in the reference locations was 1,820 mg/kg (Table 3-9). The pattern of TKN was similar to that of TOC; values were lower than reference at FVP and CS-2, with the minimum value of 360 mg/kg measured at CS-2. The highest values were measured at stations from NHAV14 (Figure 3-57). Total phosphorus was detected in all samples with patterns similar to that of TKN (Figure 3-58), with concentrations ranging from 130 mg/kg at CS-2 to 850 mg/kg at NHAV14.

3.3.2 Sediment Chemistry

Total PAH and total PCB results are summarized in Table 3-10 and Figures 3-59, 3-60, 3-61, and 3-62, respectively. PAHs were detected in all sediment samples. The range of total PAHs observed at disposal locations were similar to or lower than the reference areas, with the exception of a few samples collected at FVP and NHAV14 stations (Figure 3-59). Total PAHs in samples collected from the reference areas ranged from 740 to 1456 µg/kg (Table 3-10; all values reported in dry weight). Total PAHs in sediment collected from historical mounds CS-1, CS-2, and MQR as well as CLDS-Other ranged from 76 to 1,892 µg/kg. In sediment collected from NHAV14, PAHs ranged from 1,315 to 4,496 µg/kg. The highest total PAH concentrations were found at the uncapped FVP stations where total PAHs ranged from 993 to 11,059 µg/kg (Figures 3-59, 3-60). In general, total PAHs in most sediments at CLDS were well below the ER-L value of 4,022 µg/kg. However, two NHAV14 stations were near or slightly above the ER-L value, as were two FVP stations (Figure 3-60; Appendix H). All total PAH values were well below the ER-M value of 44,792 µg/kg.

Total PCBs followed similar trends as total PAHs . Total PCBs in sediments from the reference areas ranged from 6.0 to 15.6 µg/kg (Table 3-10). In disposal site samples, total PCBs measured in sediments from CS-1, CS-2, and CLDS-Other ranged from 1.3 to 32.7 µg/kg. Total PCBs were detected in a few samples at somewhat higher concentrations at MQR and NHAV14, ranging from 1.6 to 113 µg/kg. The highest total PCBs measured were in sediment from FVP, with concentrations ranging from 21.6 to 750 µg/kg (Table 3-10; Figure 3-61). In general, about half of the 22 congeners analyzed were detected with the exception of FVP samples, where all but one of the congeners analyzed were detected in samples from that area (Appendix H). Total PCBs exceeded the ER-L value of 22.7 µg/kg in at least one sample from CS-1, MQR, and CLDS-Other, as well as five of eight samples collected from NHAV14, and in all but one FVP sample (Figure 3-62). All but the FVP samples and one sample from MQR fell below the ambient 90/90 UTL value of 95 µg/kg. Two samples from FVP exceeded the ER-M value of 180 µg/kg (Figure 3-62).

Chlorinated pesticides detected in sediments from the disposal locations and the reference areas are summarized in Table 3-11, and selected pesticides are shown in Figures 3-63 a-c and Figures 3-64 a-c. Of the 19 chlorinated pesticides analyzed, 11 pesticides (4,4'-DDD, DDE, DDT; aldrin, alpha chlordane, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, gamma chlordane and methoxychlor) were detected in at least one sediment sample from the disposal site. Only five of these (4,4'-DDD, DDE, dieldrin, endosulfan II, and gamma chlordane) were detected in sediment collected from at least one of the reference areas. Pesticides were generally found at similar concentrations at the reference areas and at a number of the disposal areas, including CS-1, CS-2, MQR and CLDS-Other. Pesticide concentrations found in sediments from NHAV14 were generally higher than the reference area sediments. The highest pesticide concentrations were found in sediments from FVP. ER-L values for total DDx compounds (the sum of DDD, DDE and DDT) were exceeded in at least one sediment sample collected from all sampling locations with the exception of one of the reference areas (2500W) (Figures 3-63a, 3-64a). ER-M values were exceeded in two samples from the FVP mound (Figure 3-64a). The ER-M value was exceeded for total chlordane for two samples from FVP (Figures 3-63b, 3-64b). Concentrations of dieldrin exceeded the ER-L in all disposal site and reference samples but were all well below the ER-M (Figure 3-63c, 3-64c).

The eight metals analyzed – arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn) – were detected in all sediment samples collected from the disposal site and the reference areas. Metals concentrations are summarized in Table 3-12, and individual results for each metal are shown in Figures 3-65 a-h and Figures 3-66 a-h. All metals except for As and Ni were highest in samples collected at FVP (Table 3-12). Arsenic was below the ER-L (8.2 mg/kg) in all samples except in three samples from NHAV14 (maximum of 8.53 mg/kg) (Figure 3-65a, 3-66a). The highest Ni concentrations were measured in samples collected from the MQR mound, and exceeded the ER-L (20.9 mg/kg) in at least one sample from all disposal site and reference stations with the exception of CS-2 (Figures 3-65g, 3-66g). Cadmium (Figures 3-65b, 3-66b) and Cr (Figures 3-65c, 3-66c) concentrations exceeded the ER-L levels in a two of FVP samples (FVP-01 and FVP-04). Lead (Figures 3-65e, 3-66e) and Zn (Figures 3-65, 3-66h) had exceedances of the ER-L values in NHAV14 and FVP samples, but all were well below the ER-M. Copper (Figures 3-65d, 3-66d) and Hg (Figures 3-65f, 3-66) exceeded ER-Ls in at least one sample from all stations with the exception of CS-2, as well as reference areas 4500E and CLDS-REF. Only copper exceeded the ER-M value in one sample from FVP. Ambient metal concentrations in sediments near CLDS based on the 90/90 UTLs (Battelle 2017) are similar to ER-L values for most metals. Normalization to percent fines affected the relative concentrations of a number of metals; most apparent is As where concentrations at the disposal sites increased relative to those found at the reference areas.

3.3.3 Tissue Chemistry

Tissue lipids results are summarized in Table 3-13 and in Figure 3-67. Lipids were only measured in 2 of the 3 stations from FVP due to insufficient tissue mass collected. Percent lipids in the worm tissue were similar at all stations and ranged from 1.08 to 1.95% with a mean of 1.43% (Table 3-13).

Total PAH and PCB in worm tissue are summarized in Table 3-14 and in Figures 3-68 and 3-69, respectively. Average total PAHs measured in samples collected from the 4500E reference station was 31.1 ±2.3 µg/kg (all values are in wet weight). Total PAHs were detected in all samples from the disposal site, with a maximum of 250 µg/kg at Station 07 within the NHAV14 disposal area (Figure 3-68). Average total tissue PAH concentrations were higher than those of reference at all four historical areas (Table 3-14).

Average total PCBs measured in samples collected from the 4500E reference station was 25.1 ±1.7 µg/kg. As with PAHs, the lowest concentrations were observed in tissue collected from the reference area and the highest concentrations were found in tissue collected at stations from the NHAV14 area (57 µg/kg at Station 05; Figure 3-69). Average total PCB concentrations were higher than those of reference at all four historical areas (Table 3-14), although more than an order of magnitude lower than FDA fish tissue consumption limits of 2,000 µg/kg as well below EPA's Region 2 Historic Area Remediation Site-specific worm bioaccumulation tissue PCB criterion of 113 µg/kg, established for determining the suitability of proposed dredged material for use as remediation material at the offshore dredged material disposal site outside of New York Harbor (USEPA 2003). Normalization of the tissue concentrations to lipids did not impact the relative concentrations among the samples due to the narrow range of measured lipids concentrations.

Chlorinated pesticides detected in worm tissue from the disposal site and the reference area are summarized in Table 3-15, and individual results for selected pesticides are shown in Figures 3-70 a-d. Of the 19 chlorinated pesticides analyzed, nine pesticides were detected in at least one tissue sample (4,4'-DDD, DDE; alpha and gamma chlordane, dieldrin, endosulfan II, endosulfan sulfate, heptachlor epoxide, and methoxychlor). In general, pesticide concentrations detected in tissue collected from the disposal areas were within the range or only slightly above the concentrations found in tissues from the reference area (Table 3-15). The exception to this was observed for a number of pesticides at Stations 05 and 07 within the NHAV14 disposal area and at Station FVP-06 (Figure 3-70 a-d). However, pesticide concentrations detected in worm tissue from all locations were approximately two orders of magnitude below available FDA action levels for fish tissue.

The eight metals analyzed (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn) were detected in all tissue samples collected from both the disposal site and the reference areas. Metals concentrations are summarized in Table 3-16, and individual results for each metal are shown in Figures 3-71a-h. Metals concentrations in worm tissue collected from the disposal areas were generally similar and within the range of or lower than concentrations found in worms from the reference area. The only FDA action level available is for Hg in the edible portion of fish, and concentrations in worms from CLDS were all nearly two orders of magnitude lower than the FDA fish consumption limit of 1 mg/kg.

3.4 Benthic Community Analysis

Five taxa accounted for 60% of total benthic infaunal abundance (Appendix J). The nut clam *Nucula proxima* and bubble snail *Acteocina canaliculata* were the two most abundant species. Nut clams (Nuculidae) were most abundant in the reference, CLDS-Other and CS-1 (historical disposal) area. *A. canaliculata* (Scaphandridae) was fairly evenly distributed among the reference, central region (NHAV14 and CLDS-Other), and CS-1 disposal areas, and was not found in the FVP (historical uncapped) disposal mound (Table 3-17). Polychaetes *Sigambra tentaculata* (Pilargidae), Spionidae (LPIL), and *Levinsenia gracilis* (Paraonidae) were the next most abundant taxa (Appendix J). All of these polychaetes were similarly abundant among the reference, NHAV14, CLDS-Other, and CS-1, with lower abundances from FVP (Table 3-17).

Univariate

Overall infaunal densities differed significantly among the five areas ($F(4,11)$[2] = 10.65, $p < 0.001$). The mean density value at FVP was significantly lower than all other areas, while the mean density value at CS-1 was significantly greater than all other areas with the exception of CLDS-Other (Tables 3-18 and 3-19). Taxonomic richness ranged from 26 to 45 taxa per sample and did not significantly differ among areas ($F(4,11) = 1.1$, $p = 0.41$). Similar to the density results, mean richness values at FVP were the lowest (33), and among the highest at CS-1 and CLDS-Other (Table 3-18). Variability in richness values was high, and as a result, none of the areas had statistically significant differences in mean richness from any other area (90% family-wise confidence level, Table 3-19). With the exception of arthropods, the biomass of each of the remaining phyla and total biomass did not statistically differ among areas (all p-values >0.39), with annelids and molluscs accounting for most biomass in each sample (Table 3-20). Arthropod biomass statistically differed among areas (Kruskal-Wallis $p = 0.034$), with the highest average values measured from CLDS-Other and FVP, while arthropods were absent or nearly absent at Reference 4500E, CS-1, and NHAV14. High molluscan biomass at Station FVP-02 and high arthropod at Station 14 contributed to high variation in the data for these phyla and total biomass (Table 3-20).

Multivariate

Differences in benthic assemblages were contrasted among stations from Reference 4500E (n=3), historical mounds CS-1 (n=3) and FVP (n=3), and central regional disposal areas NHAV14 (n=3) and CLDS-Other (n=3). The assemblages differed significantly among these five areas (ANOSIM $R = 0.35$, $p < 0.001$), indicating that there was more similarity of the benthic assemblages within areas than between areas. The samples from FVP had the most distinct assemblages (nMDS plot in Figure 3-72A). With the exception of

[2] F(4,11) indicates results are for an F-test from the ANOVA, with 4 degrees of freedom for the factor Area, and 11 residual degrees of freedom.

tellinid bivalves, calyptraeid gastropods, and capitellid polychaetes, infaunal abundances were lower at the FVP mound than in other areas (families contributing 5% or more to the differences between groups, based on SIMPER analysis, Table 3-21). A second ANOSIM was conducted with the FVP samples removed from the analysis to test whether there were assemblage differences among the other three areas. Significant differences were found among the assemblages from these areas (ANOSIM $R = 0.16$, $p = 0.08$; nMDS plot in Figure 3-72B), however none of the post-hoc pairwise comparisons were significantly different from one another (adjusted p-values >0.49[3]). The greatest distinctions are observed between Reference and each of the disposal areas. Bubble snails (Scaphandridae) were more abundant in the reference area and tellinid clams were absent in the reference area (Table 3-21). The stress values for the second nMDS plot (Figure 3-72B) is approximately 10%, indicating a good representation of the complete Bray-Curtis similarities among samples. The near-perfect 0% stress value for the first nMDS plot which included FVP illustrates the large contrast between FVP and other areas. The higher stress of the second nMDS plot reflects the overall greater similarity seen among all samples from these four groups.

3.5 Fishing Gear Assessment

No fishing related gear were observed at the site or at any of the reference areas during the acoustic survey.

[3] Adjusted p-values are designed to control the false-discovery rate, the proportion of "discoveries" (rejected null hypotheses) that occur by chance, using method of Benjamini and Yekutieli (2001).

Table 3-1.

Summary of CLDS Reference Sediment Profile Imaging Results (Station Means), October 2016

Area	Station	Water Depth (m)	Grain Size Major Mode (phi) [a]	Mean Prism Penetration Depth (cm)	Mean Boundary Roughness (cm)	Dominant Type of Boundary Roughness	Mean aRPD Depth (cm)	Mean Dredged Material Thickness (cm)	Mean # of Subsurface Feeding Voids	Mean of Maximum Subsurface Feeding Void Depth (cm)	Successional Stages Present [b]		
CLDS-REF	CLDS-REF-01	26.2	>4	15.1	0.7	Biological	3.1	-	0.7	8.2	2 -> 3	1 on 3	1 on 3
CLDS-REF	CLDS-REF-02	26.5	>4	15.5	1.1	Biological	2.9	-	2.7	12.1	2 -> 3	2 on 3	2 on 3
CLDS-REF	CLDS-REF-03	26.2	>4	15.7	0.4	Biological	2.2	-	3.0	13.2	1 on 3	1 on 3	1 on 3
CLDS-REF	CLDS-REF-04	26.2	>4	15.3	0.4	Biological	2.8	-	2.7	13.3	1 on 3	1 on 3	1 on 3
CLDS-REF	CLDS-REF-05	25.6	>4	15.3	0.7	Biological	3.0	-	1.7	11.3	1 on 3	1 on 3	1 on 3
CLDS-REF	**Max**	26.5		15.7	1.1		3.1		3.0	13.3			
	Min	25.6		15.1	0.4		2.2		0.7	8.2			
	Mean	26.2		15.4	0.7		2.8		2.1	11.6			
	Std Dev	0.3		0.2	0.3		0.3		1.0	2.1			
2500W	2500W-01	19.5	>4	18.8	0.7	Biological	2.5	-	2.0	13.8	1 on 3	1 on 3	1 on 3
2500W	2500W-02	19.5	>4	16.2	0.7	Biological	2.4	-	1.0	9.4	1 on 3	1 on 3	1 on 3
2500W	2500W-03	19.5	>4	17.3	0.7	Biological	2.9	-	1.7	9.3	1 on 3	1 on 3	1 on 3
2500W	2500W-04	19.5	>4	17.6	0.7	Biological	2.7	-	3.0	15.9	1 on 3	1 on 3	1 on 3
2500W	2500W-05	19.2	>4	16.5	0.4	Biological	2.9	-	3.0	13.6	1 on 3	1 on 3	1 on 3
2500W	**Max**	19.5		18.8	0.7		2.9		3.0	15.9			
	Min	19.2		16.2	0.4		2.4		1.0	9.3			
	Mean	19.4		17.3	0.7		2.7		2.1	12.4			
	Std Dev	0.1		1.0	0.1		0.2		0.9	2.9			
4500E	4500E-01	21.9	>4	18.2	0.5	Biological	3.1	-	2.3	12.9	1 on 3	1 on 3	1 on 3
4500E	4500E-02	21.3	>4	17.3	0.6	Biological	2.9	-	2.0	8.0	1 on 3	1 on 3	1 on 3
4500E	4500E-03	21.0	>4	14.7	3.8	Biological	2.8	-	1.0	12.4	1 on 3	1 on 3	IND
4500E	4500E-04	21.3	>4	17.4	0.7	Biological	3.8	-	1.3	13.7	2 -> 3	1 on 3	1 on 3
4500E	4500E-05	21.0	>4	16.0	0.7	Biological	2.4	-	3.3	12.8	1 on 3	1 on 3	1 on 3
4500E	**Max**	21.9		18.2	3.8		3.8		3.3	13.7			
	Min	21.0		14.7	0.5		2.4		1.0	8.0			
	Mean	21.3		16.7	1.3		3.0		2.0	12.0			
	Std Dev	0.4		1.4	1.4		0.5		0.9	2.2			
All Reference	**Max**	26.5		18.8	3.8		3.8		3.3	15.9			
	Min	19.2		14.7	0.4		2.2		0.7	8.0			
	Mean	22.3		16.5	0.9		2.8		2.1	12.0			
	Std Dev	2.9		1.2	0.8		0.4		0.8	2.3			

IND=Indeterminate; a Grain Size: "/" indicates layer of one phi size range over another (see Appendix F)

b Successional Stage: "on" indicates one Stage is found on top of another Stage (i.e., 1 on 3); "->" indicates one Stage is progressing to another Stage (i.e., 2 -> 3)

Table 3-2.

Summary of CLDS Sediment Profile Imaging Results (Station Means), October 2016

Mound	Station	Water Depth (m)	Grain Size Major Mode (phi) [a]	Mean Prism Penetration Depth (cm)	Mean Boundary Roughness (cm)	Dominant Type of Boundary Roughness	Mean aRPD Depth (cm)	Mean Dredged Material Thickness (cm)	Mean # of Subsurface Feeding Voids	Mean of Maximum Subsurface Feeding Void Depth (cm)	Successional Stages Present [b]		
CS-1	CS-1-01	20.1	>4	17.6	0.7	Biological	2.7	17.6	1.3	14.9	2 -> 3	1 on 3	1 on 3
CS-1	CS-1-02	19.8	>4	17.9	0.6	Biological	3.3	17.9	2.0	9.1	1 on 3	1 on 3	2 on 3
CS-1	CS-1-03	20.1	>4	16.7	0.7	Biological	2.9	16.7	0.3	17.7	2	2 -> 3	2 on 3
CS-1	CS-1-04	19.5	>4	16.3	0.9	Biological	3.0	16.3	2.0	11.7	1 on 3	1 on 3	1 on 3
CS-1	CS-1-05	19.8	>4	16.0	0.7	Biological	2.9	16.0	1.7	12.5	1 on 3	1 on 3	1 on 3
CS-1	CS-1-06	19.8	>4	17.6	0.7	Biological	2.9	17.6	2.0	12.1	1 on 3	2 on 3	2 on 3
	Max	20.1		17.9	0.9		3.3	17.9	2.0	17.7			
CS-1	**Min**	19.5		16.0	0.6		2.7	16.0	0.3	9.1			
	Mean	19.9		17.0	0.7		3.0	17.0	1.6	13.0			
	Std Dev	0.2		0.8	0.1		0.2	0.8	0.7	2.9			
CS-2	CS-2-01	19.8	4-3	15.2	1.3	Biological	2.5	15.2	1.3	13.1	1 on 3	1 on 3	2 -> 3
CS-2	CS-2-02	19.8	4-3	13.8	0.8	Biological	2.8	13.8	1.3	10.3	2 -> 3	2 -> 3	2 on 3
CS-2	CS-2-03	19.5	4-3/>4	17.3	0.8	Biological	2.8	17.3	1.7	10.7	2 on 3	2 on 3	2 on 3
CS-2	CS-2-04	18.9	4-3/>4	13.1	0.9	Biological	3.2	13.1	0.3	2.3	2	2 -> 3	2 on 3
CS-2	CS-2-05	18.6	4-3/>4	6.1	1.1	Biological	2.5	6.1	0.3	1.9	2	2	2 on 3
CS-2	CS-2-06	18.9	4-3/>4	10.3	0.8	Biological	2.2	10.3	0.0	-	2	2 -> 3	2 on 3
CS-2	CS-2-07	18.6	4-3/>4	12.1	1.2	Biological	2.4	12.1	1.0	11.0	1 on 3	2 on 3	2 on 3
	Max	19.8		17.3	1.3		3.2	17.3	1.7	13.1			
CS-2	**Min**	18.6		6.1	0.8		2.2	6.1	0.0	1.9			
	Mean	19.2		12.6	1.0		2.6	12.6	0.9	8.2			
	Std Dev	0.5		3.6	0.2		0.3	3.6	0.6	4.8			

IND=Indeterminate

a Grain Size: "/" indicates layer of one phi size range over another (see Appendix F)

b Successional Stage: "on" indicates one Stage is found on top of another Stage (i.e., 1 on 3); "->" indicates one Stage is progressing to another Stage (i.e., 2 -> 3)

Table 3-2. (continued)

Summary of CLDS Sediment Profile Imaging Results (Station Means), October 2016

Mound	Station	Water Depth (m)	Grain Size Major Mode (phi) [a]	Mean Prism Penetration Depth (cm)	Mean Boundary Roughness (cm)	Dominant Type of Boundary Roughness	Mean aRPD Depth (cm)	Mean Dredged Material Thickness (cm)	Mean # of Subsurface Feeding Voids	Mean of Maximum Subsurface Feeding Void Depth (cm)	Successional Stages Present [b]		
FVP	FVP-01	19.5	>4	14.4	1.1	Biological	0.8	14.4	1.3	6.4	2 -> 3	2 on 3	2 on 3
FVP	FVP-02	19.5	>4	14.7	1.0	Biological	1.8	14.7	0.7	10.9	2 on 3	2 on 3	2 on 3
FVP	FVP-03	19.5	>4	15.8	0.6	Biological	2.5	15.8	2.3	14.8	2 on 3	2 on 3	2 on 3
FVP	FVP-04	18.9	3-2/>4	11.3	1.2	Biological	0.7	11.3	0.7	8.8	2	2	2 on 3
FVP	FVP-05	18.9	4-3/>4	12.9	0.8	Biological	1.2	12.9	0.7	11.5	1 -> 2	1 on 3	1 on 3
FVP	FVP-06	18.9	3-2/>4	12.1	0.9	Biological	1.0	12.1	0.7	5.5	2	1 on 3	2 on 3
FVP	FVP-07	19.2	>4	14.2	0.7	Biological	1.9	14.2	1.7	9.5	1 on 3	1 on 3	2 on 3
	Max	19.5		15.8	1.2		2.5	15.8	2.3	14.8			
FVP	**Min**	18.9		11.3	0.6		0.7	11.3	0.7	5.5			
	Mean	19.2		13.6	0.9		1.4	13.6	1.1	9.6			
	Std Dev	0.3		1.6	0.2		0.7	1.6	0.7	3.2			
MQR	MQR-01	19.2	4-3/>4	12.8	1.1	Biological	1.8	12.8	1.0	8.9	2	1 on 3	2 on 3
MQR	MQR-02	18.9	4-3/>4	13.6	0.9	Biological	1.8	13.6	1.0	9.4	2	2 on 3	2 on 3
MQR	MQR-03	18.9	4-3/>4	12.7	1.0	Biological	1.7	12.7	1.3	8.6	2	2 on 3	2 on 3
MQR	MQR-04	18.6	4-3/>4	12.3	0.8	Biological	0.9	12.3	1.3	10.5	2	1 on 3	2 on 3
MQR	MQR-05	19.2	4-3/>4	14.6	0.9	Biological	2.3	14.6	1.7	9.1	2 -> 3	1 on 3	1 on 3
MQR	MQR-06	18.3	4-3/>4	13.3	2.7	Biological	1.2	13.3	0.7	12.4	2	2	1 on 3
MQR	MQR-07	19.2	4-3/>4	13.2	1.4	Biological	1.4	13.2	0.7	8.9	2	2 on 3	2 on 3
	Max	19.2		14.6	2.7		2.3	14.6	1.7	12.4			
MQR	**Min**	18.3		12.3	0.8		0.9	12.3	0.7	8.6			
	Mean	18.9		13.2	1.2		1.6	13.2	1.1	9.7			
	Std Dev	0.4		0.7	0.7		0.5	0.7	0.4	1.4			

IND=Indeterminate

a Grain Size: "/" indicates layer of one phi size range over another (see Appendix F)

b Successional Stage: "on" indicates one Stage is found on top of another Stage (i.e., 1 on 3); "->" indicates one Stage is progressing to another Stage (i.e., 2 -> 3)

Table 3-2. (continued)

Summary of CLDS Sediment Profile Imaging Results (Station Means), October 2016

Site	Station	Water Depth (m)	Grain Size Major Mode (phi) [a]	Mean Prism Penetration Depth (cm)	Mean Boundary Roughness (cm)	Dominant Type of Boundary Roughness	Mean aRPD Depth (cm)	Mean Dredged Material Thickness (cm)	Mean # of Subsurface Feeding Voids	Mean of Maximum Subsurface Feeding Void Depth (cm)	Successional Stages Present [b]		
NHAV14	01	19.2	4-3/>4	12.8	0.6	Biological	1.4	12.8	1.3	9.0	1 on 3	1 on 3	1 on 3
NHAV14	02	19.2	>4	17.5	0.4	Biological	2.4	17.5	1.3	10.6	1 on 3	2 on 3	2 on 3
NHAV14	03	19.2	4-3/>4	16.0	0.8	Biological	1.5	16.0	2.7	12.1	1 on 3	1 on 3	1 on 3
NHAV14	04	19.2	4-3/>4	18.0	1.0	Biological	1.8	18.0	3.0	11.2	1 on 3	2 on 3	2 on 3
NHAV14	05	19.4	4-3/>4	14.6	0.8	Biological	1.1	14.6	1.7	7.0	2 -> 3	1 on 3	2 on 3
NHAV14	06	18.9	4-3/>4	18.1	0.8	Biological	2.2	18.1	1.7	11.7	1 on 3	1 on 3	1 on 3
NHAV14	07	18.0	4-3/>4	19.6	0.6	Biological	2.6	19.6	1.3	7.5	2 -> 3	1 on 3	1 on 3
NHAV14	08	19.4	4-3/>4	17.4	0.7	Biological	1.5	17.4	0.3	7.2	2 -> 3	2 -> 3	1 on 3
NHAV14	**Max**	19.4		19.6	1.0		2.6	19.6	3.0	12.1			
	Min	18.0		12.8	0.4		1.1	12.8	0.3	7.0			
	Mean	19.1		16.8	0.7		1.8	16.8	1.7	9.5			
	Std Dev	0.5		2.2	0.2		0.5	2.2	0.8	2.1			
CLDS-Other	09	18.0	4-3/>4	16.6	0.8	Biological	3.2	16.6	3.7	11.3	1 on 3	1 on 3	2 on 3
CLDS-Other	10	19.5	4-3/>4	18.0	0.5	Biological	2.9	18.0	3.0	16.5	1 on 3	1 on 3	1 on 3
CLDS-Other	11	18.6	4-3/>4	15.7	0.8	Biological	2.5	15.7	2.0	8.8	1 on 3	1 on 3	1 on 3
CLDS-Other	12	19.2	4-3/>4	17.8	0.9	Biological	3.4	17.8	4.0	15.9	1 on 3	1 on 3	2 on 3
CLDS-Other	13	19.5	4-3/>4	19.6	1.2	Biological	3.0	19.6	1.0	18.3	2	2	2 on 3
CLDS-Other	14	19.8	4-3/3-2	16.3	0.9	Biological	1.8	16.3	3.0	16.0	1 on 3	1 on 3	1 on 3
CLDS-Other	15	20.4	4-3/>4	16.7	0.7	Biological	2.7	16.7	1.7	8.7	2 -> 3	2 -> 3	1 on 3
CLDS-Other	16	20.1	4-3/>4	17.3	1.0	Biological	2.5	17.3	0.7	5.5	2 -> 3	1 on 3	1 on 3
CLDS-Other	17	19.2	4-3/>4	13.4	0.4	Biological	1.5	13.4	1.7	12.3	2 -> 3	1 on 3	1 on 3
CLDS-OTHER	**Max**	20.4		19.6	1.2		3.4	19.6	4.0	18.3			
	Min	18.0		13.4	0.4		1.5	13.4	0.7	5.5			
	Mean	19.4		16.8	0.8		2.6	16.8	2.3	12.6			
	Std Dev	0.7		1.7	0.3		0.7	1.7	1.2	4.3			

IND=Indeterminate

a Grain Size: "/" indicates layer of one phi size range over another (see Appendix F)

b Successional Stage: "on" indicates one Stage is found on top of another Stage (i.e., 1 on 3); "->" indicates one Stage is progressing to another Stage (i.e., 2 -> 3)

Table 3-3.

Summary of 2014 and 2016 Sediment Profile Imaging Results (Station Means) by Sampling Location

	Mean aRPD Depth (cm)			Maximum Successional Stage Rank		Number of Feeding Voids			Mean Maximum Feeding Void Depth (cm)	
Area	**N[1]**	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**	**N[2]**	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
2016										
Reference Area										
CLDS-REF	5	2.8	0.3	3.0	0.0	5	2.1	1.0	11.6	2.1
2500W	5	2.7	0.2	3.0	0.0	5	2.1	0.9	12.4	2.9
4500E	5	3.0	0.5	3.0	0.0	5	2.0	0.9	12.0	2.2
Mean		2.8		3.0			2.1		12.0	
Disposal Site Mound/Area										
CS-1	6	3.0	0.2	3.0	0.0	6	1.6	0.7	13.0	2.9
CS-2	7	2.6	0.3	3.0	0.2	6	0.9	0.6	8.2	4.8
FVP	7	1.4	0.7	3.0	0.0	7	1.1	0.7	9.6	3.2
MQR	7	1.6	0.5	3.0	0.0	7	1.1	0.4	9.7	1.4
NHAV14	8	1.8	0.5	3.0	0.0	8	1.7	0.8	9.5	2.1
CLDS-Other	9	2.6	0.7	3.0	0.0	9	2.3	1.2	12.6	4.3
Mean		2.2		3.0			1.4		10.4	
2014										
Reference Area										
CLDS-REF	5	2.9	0.3	3.0	0.0	20	1.3	1.2	12.1	4.5
2500W	5	3.5	0.4	3.0	0.0	28	1.9	1.4	15.5	3.6
4500E	5	3.6	0.2	3.0	0.0	21	1.4	1.1	14.5	3.8
Mean		3.3		3.0			1.5		14.0	
Disposal Site Mound/Area										
MQR	4	2.4	0.1	3.0	0.0	12	1.0	1.5	11.7	3.4
NHAV14	26	1.2	0.6	2.2	0.6	72	0.9	1.2	5.8	2.4
CLDS-Other	15	2.1	0.7	2.8	0.3	64	1.4	1.6	9.3	4.4
Mean		1.9		2.7			1.1		8.9	

[1] Number of stations surveyed per area, including any stations which had no penetration (and indeterminate results)
[2] The number of feeding voids observed, used to determine means and standard deviations

Table 3-4.

Summary Statistics and Results of Inequivalence Hypothesis Testing for aRPD Values

Difference Equation	**Observed Difference (*d*)**	**SE *d***	***df* for SE**	**Confidence Bounds (D_L to D_U)[1]**	**Results[2]**
$Mean_{REF} - Mean_{CS-1}$	-0.12	0.13	13	-0.36 to 0.11	s
$Mean_{REF} - Mean_{FVP}$	1.4	0.27	7.9	0.90 to 1.9	d
$Mean_{REF} - Mean_{CS-2}$	0.19	0.16	12.6	-0.09 to 0.47	s
$Mean_{REF} - Mean_{MQR}$	1.2	0.20	9.8	0.86 to 1.6	d
$Mean_{REF} - Mean_{Other}$	0.21	0.24	11.3	-0.21 to 0.64	s
$Mean_{REF} - Mean_{NAV-14}$	1.0	0.22	10.7	0.62 to 1.4	d

[1] D_L and D_U as defined in [Eq. 3]

[2] s = Reject the null hypothesis of inequivalence: the two group means are significantly equivalent, within ± 1 cm.
d = Fail to reject the null hypothesis of inequivalence between the two group means: the two group means are different.

Table 3-5.

Summary Statistics and Results of Inequivalence Hypothesis Testing for Temporal Change in aRPD Values

Difference Equation	Observed Difference (*d*)	SE *d*	*df* for SE	Confidence Bounds (D_L to D_U)[1]	Results[2]
$OTHER_{2016} – OTHER_{2014}$	0.52	0.29	22	0.02 to 1.03	d
$NHAV14_{2016} – NHAV14_{2014}$	0.63	0.24	32	0.23 to 1.03	d
$MQR_{2016} – MQR_{2014}$	-0.82	0.24	9	-1.27 to -0.38	d
$2500W_{2016} – 2500W_{2014}$	-0.77	0.18	8	-1.12 to -0.42	d
$4500E_{2016} – 4500E_{2014}$	-0.55	0.26	8	-1.04 to -0.06	d
$CLDS\text{-}REF_{2016} – CLDS\text{-}REF_{2014}$	-0.08	0.20	8	-0.46 to 0.29	s

[1] D_L and D_U as defined in [Eq. 3]
[2] s = Reject the null hypothesis of inequivalence: the two group means are significantly equivalent, within ± 1.0.
d = Fail to reject the null hypothesis of inequivalence between the two group means, the two group means are different.

Table 3-6.

Summary Statistics and Results of Inequivalence Hypothesis Testing for Temporal Change in Successional Stage Values

Difference Equation	Observed Difference ($\hat{d}$)	SE $\hat{d}$	*df* for SE	Confidence Bounds (D_L to D_U)[1]	Results[2]
$OTHER_{2016} - OTHER_{2014}$	0.23	0.07	22	0.12 to 0.34	s
$NHAV14_{2016} - NHAV14_{2014}$	0.78	0.12	31	0.57 to 0.97	d

[1] D_L and D_U as defined in [Eq. 3]
[2] s = Reject the null hypothesis of inequivalence: the two group means are significantly equivalent, within ± 0.5.
d = Fail to reject the null hypothesis of inequivalence between the two group means: the two group means are different.

Table 3-7.

Grain Size Data for CLDS 2016 Sediments

	Gravel (>4.75 mm) %					Coarse Sand (2.00-4.75) %					Medium Sand (0.425-2.00 mm) %					Fine Sand (0.075-0.425 mm) %				
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site																				
CS-1	7	0.0	3.6	0.8	1.4	7	0.0	2.2	0.3	0.8	7	0.6	6.6	2	2.1	7	4.7	12.7	7.1	2.6
CS-2	7	0.0	0.0	0.0	0.0	7	0.0	0.0	0.0	0.0	7	3.1	18.3	10.6	5.8	7	19.6	65.9	44.3	19.9
MQR	7	0.0	5.3	1.9	2.1	7	0.0	2.2	0.8	0.8	7	0.9	11.4	5.5	3.5	7	12.4	41.5	27.2	10.4
FVP	7	0.0	15.4	3.6	5.7	7	0.0	4.9	2.4	2.0	7	1.4	24.8	14.6	7.9	7	4.9	45.4	24.8	12.8
CLDS-Other	9	0.0	4.6	0.5	1.5	9	0.0	2.6	0.3	0.9	9	0.7	15.5	3.3	4.8	9	2.8	31.6	15.2	11.1
NHAV14	8	0.0	0.7	0.1	0.3	8	0.0	0.6	0.1	0.2	8	0.6	8.7	3	2.9	8	6.2	18.6	11.0	4.5
Disposal Site Total	**6**	**0.0**	**15.4**	**1.2**	**-**	**6**	**0.0**	**4.9**	**0.7**	**-**	**6**	**0.6**	**24.8**	**6.5**	**-**	**6**	**2.8**	**65.9**	**21.6**	**-**
Reference																				
2500W	5	0.0	0.0	0.0	0.0	5	0.0	0.0	0.0	0.0	5	0.0	0.4	0.2	0.2	5	0.8	2.7	1.6	0.8
4500E	5	0.0	0.0	0.0	0.0	5	0.0	0.0	0.0	0.0	5	0.0	0.4	0.2	0.2	5	0.4	1.5	1.0	0.5
CLDS-REF	5	0.0	0.0	0.0	0.0	5	0.0	0.0	0.0	0.0	5	0.0	0.2	0.1	0.1	5	1.4	2.6	1.9	0.6
Reference Total	**3**	**0.0**	**0.0**	**0.0**	**-**	**3**	**0.0**	**0.0**	**0.0**	**-**	**3**	**0.0**	**0.4**	**0.2**	**-**	**3**	**0.4**	**2.7**	**1.5**	**-**

Table 3-7. (continued)

Grain Size Data for CLDS 2016 Sediments

	Silt (0.005-0.075 mm) %					Clay (<0.005 mm) %					Fines (Silt + Clay) %				
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site															
CS-1	7	65.5	83.6	79.6	6.3	7	9.4	11.2	10.2	0.7	7	74.9	94.3	89.8	6.8
CS-2	7	11.3	66.1	36.3	23.4	7	4.8	11.3	8.8	2.5	7	16.1	76.7	45.1	25.6
MQR	7	40.2	73.9	60.7	13.8	7	2.3	5.1	3.9	1.1	7	44.4	79.1	64.6	14.3
FVP	7	20.0	87.4	49.5	22.4	7	3.1	6.7	5.1	1.3	7	23.1	93.7	54.6	23.1
CLDS-Other	9	42.0	89.3	73.6	16.1	9	2.8	8.9	7.1	2.1	9	50.9	96.5	80.7	16.0
NHAV14	8	71.2	86.1	79.4	5.4	8	2.4	8.5	6.4	1.9	8	76.3	92	85.8	5.8
Disposal Site Total	**6**	**11.3**	**89.3**	**63.2**	**-**	**6**	**2.3**	**11.3**	**6.9**	**-**	**6**	**16.1**	**96.5**	**70.1**	**-**
Reference															
2500W	5	86.7	89.1	87.8	1.0	5	9.5	12.1	10.4	1.0	5	97.1	99.2	98.2	0.9
4500E	5	87.2	89.3	88.0	0.8	5	9.7	11.6	10.9	0.7	5	98.5	99.6	98.9	0.5
CLDS-REF	5	86.7	88.5	87.8	0.8	5	9.9	11.0	10.3	0.4	5	97.2	98.6	98.0	0.6
Reference Total	**3**	**86.7**	**89.3**	**87.9**	**-**	**3**	**9.5**	**12.1**	**10.5**	**-**	**3**	**97.1**	**99.6**	**98.4**	**-**

Table 3-8.

Total Organic Carbon in CLDS 2016 Sediments

	Total Organic Carbon % dry wt.				
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site					
CS-1	7	2.1	2.4	2.3	0.1
CS-2	7	0.3	2.0	1.2	0.7
MQR	7	1.4	4.6	2.7	1.0
FVP	7	1.4	2.0	1.6	0.2
CLDS-Other	9	1.6	2.4	2.1	0.3
NHAV14	8	2.0	3.9	2.9	0.7
Disposal Site Total	**6**	**0.3**	**4.6**	**2.1**	**-**
Reference					
2500W	5	2.2	2.4	2.3	0.1
4500E	5	2.0	2.0	2.0	0.0
CLDS-REF	5	1.7	1.8	1.8	0.1
Reference Total	**3**	**1.7**	**2.4**	**2.0**	**-**

Note: Lab replicates have been averaged prior to generating statistics.

Table 3-9.

Nutrients in CLDS 2016 Sediments

	Nitrate as N mg/kg					Nitrite as N mg/kg					Total Kjeldahl Nitrogen mg/kg					Phosphorus, Total as P mg/kg				
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site																				
CS-1	7	11 U	14 U	12.6 U	N/A	7	11 U	14 U	12.6 U	N/A	7	1800	2300	2071	180	7	580	680	623	35.0
CS-2	7	6 U	12 U	8.86 U	N/A	7	6 U	12 U	8.86 U	N/A	7	360	1600	946	514	7	130	520	321	160
MQR	7	8 U	12 U	10.4 U	N/A	7	8 U	12 U	10.4 U	N/A	7	1100	2600	1800	523	7	380	610	510	77.9
FVP	7	7.5 U	12 U	9.5 U	N/A	7	7.5 U	12 U	9.5 U	N/A	7	1000	1900	1271	345	7	380	650	504	111
CLDS-Other	9	8.5 U	14 U	11.3 U	N/A	9	8.5 U	14 U	11.3 U	N/A	9	1200	2400	1889	483	9	470	660	578	66.3
NHAV14	8	9 U	14 U	12.3 U	N/A	8	9 U	14 U	12.3 U	N/A	8	2100	2800	2400	283	8	580	850	710	94.7
Disposal Site Total	**6**	**6 U**	**14 U**	**10.8 U**	**-**	**6**	**6 U**	**14 U**	**10.8 U**	**-**	**6**	**360**	**2800**	**1730**	**-**	**6**	**130**	**850**	**541**	**-**
Reference																				
2500W	5	1.2 U	1.4 U	1.28 U	N/A	5	1.2 U	1.4 U	1.28 U	N/A	5	1900	2100	2020	83.7	5	500	730	660	93.0
4500E	5	12 U	13 U	12.6 U	N/A	5	12 U	13 U	12.6 U	N/A	5	1700	2000	1840	114	5	540	820	676	122
CLDS-REF	5	1.1 U	1.2 U	1.18 U	N/A	5	1.1 U	1.2 U	1.18 U	N/A	5	1500	1700	1600	70.7	5	540	680	622	62.6
Reference Total	**3**	**1.1 U**	**13 U**	**5.02 U**	**-**	**3**	**1.1 U**	**13 U**	**5.02 U**	**-**	**3**	**1500**	**2100**	**1820**	**-**	**3**	**500**	**820**	**653**	**-**

U = Non-detect
N/A = Not Applicable

Table 3-10.

Total PAH and Total PCB in CLDS 2016 Sediments

	Total PAH[1] µg/kg dry wt.						Total PCB (18 Congener)[2] µg/kg dry wt.					
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**Mean % Detected**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**Mean % Detected**
Disposal Site												
CS-1	7	1,452	1,892	1,629	145	100	7	16.4	32.7	21.5	5.48	78.6
CS-2	7	290	1,454	845	505	100	7	1.3	15.9	8.35	5.55	50.8
MQR	7	76	1,211	804	407	100	7	1.6	113	25.4	39.5	58.7
FVP	7	993	11,059	4,040	3,817	100	7	21.6	750	229	264	95.2
CLDS-Other	9	704	2,095	1,456	426	100	9	2.85	25.3	14.3	7.92	63.6
NHAV14	8	1,315	4,496	2,552	1,135	100	8	14.51	90.2	41.7	26.7	81.3
Disposal Site Total	**6**	**76**	**11,059**	**1,888**	**-**	**100**	**6**	**1.3**	**750**	**56.7**	**-**	**71.4**
Reference												
2500W	5	1,272	1,456	1,346	93	100	5	11.9	15.6	14	1.58	67.8
4500E	5	871	1,130	1,002	109	100	5	7.37	10.7	8.79	1.38	54.4
CLDS-REF	5	740	948	811	80	100	5	6.04	8.35	6.76	0.913	55.6
Reference Total	**3**	**740**	**1,456**	**1,053**	**-**	**100**	**3**	**6.04**	**15.6**	**9.85**	**-**	**59.3**

[1]Total PAH is the sum of the 18 PAH compounds analyzed (naphthalene, 2-methylnaphthalene, 1-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, anthracene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene). Non-detected compounds were summed using ½ the MDL.

[2]Total PCB is the sum of the 18 NOAA NS&T congeners multiplied by 2. Non-detected congeners were summed using ½ the MDL

Table 3-11.

Chlorinated Pesticides Detected in CLDS 2016 Sediments

	4,4'-DDD µg/kg dry weight					4,4'-DDE µg/kg dry weight					4,4'-DDT µg/kg dry weight				
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site															
CS-1	7	0.482	1.15	0.67	0.219	7	0.759	1.06	0.889	0.109	7	0.476	1.26	0.812	0.254
CS-2	7	0.0616 U	1.4	0.596	0.492	7	0.102 J	0.737	0.399	0.266	7	0.0895 U	0.69	0.243	0.218
MQR	7	0.105 U	2.04	0.848	0.622	7	0.0968 U	2.4	0.802	0.766	7	0.118 U	0.748	0.299	0.282
FVP	7	1.03	40.6	16	15.9	7	0.728	28.8	7.22	9.9	7	0.118 U	2	0.39	0.695
CLDS-Other	9	0.186 J	2.98	0.987	0.797	9	0.296	1.24	0.805	0.325	9	0.133	2.62	0.49	0.808
NHAV14	8	0.535	2.2	1.3	0.57	8	0.894	2.79	1.73	0.767	8	0.15	6.66	2.15	2.75
Disposal Site Total	**6**	**0.0616 U**	**40.6**	**3.4**	**-**	**6**	**0.0968 U**	**28.8**	**1.97**	**-**	**6**	**0.0895 U**	**6.66**	**0.731**	**-**
Reference															
2500W	5	0.598	0.83	0.719	0.0823	5	0.783	0.917	0.85	0.055	5	0.164 U	0.177 U	0.168 U	N/A
4500E	5	0.446	0.541	0.490	0.0382	5	0.557	0.737	0.649	0.082	5	0.153 U	0.161 U	0.156 U	N/A
CLDS-REF	5	0.32 J	0.439	0.380	0.0457	5	0.509	0.692	0.563	0.075	5	0.146 U	0.15 U	0.147 U	N/A
Reference Total	**3**	**0.32 J**	**0.83**	**0.530**	**-**	**3**	**0.509**	**0.917**	**0.687**	**-**	**3**	**0.146 U**	**0.177 U**	**0.157 U**	**-**

The following pesticides were not included in the summary table as there were no detections in any of the tissues samples: alpha-BHC, beta-BHC, delta-BHC, endrin, heptachlor, heptachlor epoxide, gamma HCH, and toxaphene.
U = Non-detect
J = Estimated
N/A – Not Applicable

Table 3-11. (continued)

Chlorinated Pesticides Detected in CLDS 2016 Sediments

	Aldrin µg/kg dry weight					Alpha-chlordane µg/kg dry weight					Total Chlordane µg/kg dry weight				
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site															
CS-1	7	0.0709 U	0.0771 U	0.0755 U	N/A	7	0.0746 U	0.0812 U	0.0795 U	N/A	7	0.14 U	1.28	0.305	N/A
CS-2	7	0.0415 U	0.35	0.0985	0.111	7	0.0437 U	0.073 U	0.0575 U	N/A	7	0.0776 U	0.811	0.213	0.266
MQR	7	0.0549 U	0.0748 U	0.0658 U	N/A	7	0.0577 U	0.12	0.077	0.019	7	0.122 U	0.98	0.548	0.36
FVP	7	0.0534 U	0.072 U	0.0598 U	N/A	7	0.0578 U	2.83	1.13	1.186	7	0.706	19.3	6.33	6.44
CLDS-Other	9	0.0553 U	0.0813 U	0.070 U	N/A	9	0.0582	0.0855	0.0738	0.00913	9	0.128 U	1.3	0.353	0.398
NHAV14	8	0.0694 U	0.0897 U	0.080 U	N/A	8	0.073	0.696	0.25	0.25	8	0.136 J	3.23	1.56	1.2
Disposal Site Total	**6**	**0.0415 U**	**0.35**	**0.749 U**	**-**	**6**	**0.0437 U**	**2.83**	**0.278**	**-**	**6**	**0.0776 U**	**19.3**	**1.55**	**-**
Reference															
2500W	5	0.0762 U	0.0823 U	0.0781 U	N/A	5	0.0802 U	0.0866 U	0.0822 U	N/A	5	0.142 U	0.154 U	0.146 U	N/A
4500E	5	0.0709 U	0.0745 U	0.0725 U	N/A	5	0.0746 U	0.0784 U	0.0763 U	N/A	5	0.132 U	0.691	0.246	N/A
CLDS-REF	5	0.0679 U	0.0698 U	0.0685 U	N/A	5	0.0714 U	0.0734 U	0.0721 U	N/A	5	0.127 U	0.13 U	0.128 U	N/A
Reference Total	**3**	**0.0679 U**	**0.0823 U**	**0.0730 U**	**-**	**3**	**0.0714 U**	**0.0866 U**	**0.0768 U**	**-**	**3**	**0.127 U**	**0.691**	**0.1733**	**-**

The following pesticides were not included in the summary table as there were no detections in any of the tissues samples: alpha-BHC, beta-BHC, delta-BHC, endrin, heptachlor, heptachlor epoxide, gamma HCH, and toxaphene.
U = Non-detect
J = Estimated
N/A – Not Applicable

Table 3-11. (continued)

Chlorinated Pesticides Detected in CLDS 2016 Sediments

	Dieldrin µg/kg dry weight					Endosulfan I µg/kg dry weight					Endosulfan II µg/kg dry weight				
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site															
CS-1	7	0.0709 U	0.0771 U	0.0755 U	N/A	7	0.0787 U	0.0856 U	0.0838 U	N/A	7	0.751	1.27	0.931	0.175
CS-2	7	0.0415 U	0.0694 U	0.0547 U	N/A	7	0.0461 U	0.077 U	0.0607 U	N/A	7	0.0524 J	0.848	0.388	0.297
MQR	7	0.0549 U	0.154 J	0.0889	0.0396	7	0.0609 U	0.083 U	0.0730 U	N/A	7	0.0557 U	1.3	0.382	0.442
FVP	7	0.0752 J	3.06	1.1	1.14	7	0.0593 U	0.0799 U	0.0663 U	N/A	7	0.488	5.3	2.75	1.881
CLDS-Other	9	0.0553 U	0.156	0.106	0.0381	9	0.0614	0.0902	0.0778	0.0096	9	0.234 J	0.978	0.608	0.205
NHAV14	8	0.0817	0.681	0.349	0.226	8	0.077	1.59	0.54	0.652	8	0.28	2.17	1.08	0.65
Disposal Site Total	**6**	**0.0415 U**	**3.06**	**0.296**	**-**	**6**	**0.0461 U**	**1.59**	**0.150**	**-**	**6**	**0.0524 J**	**5.3**	**1.02**	**-**
Reference															
2500W	5	0.169 J	0.229 J	0.205 J	0.0272	5	0.0846 U	0.0913 U	0.0867 U	N/A	5	0.681	0.788	0.746	0.041
4500E	5	0.161 J	0.196 J	0.182 J	0.0142	5	0.0787 U	0.0827 U	0.0804 U	N/A	5	0.454	0.603	0.541	0.0798
CLDS-REF	5	0.123 J	0.184 J	0.153 J	0.0241	5	0.0754 U	0.0774 U	0.076 U	N/A	5	0.43	0.545	0.468	0.048
Reference Total	**3**	**0.123 J**	**0.229 J**	**0.180 J**	**-**	**3**	**0.0754 U**	**0.0913 U**	**0.0810 U**	**-**	**3**	**0.43**	**0.788**	**0.585**	**-**

The following pesticides were not included in the summary table as there were no detections in any of the tissues samples: alpha-BHC, beta-BHC, delta-BHC, endrin, heptachlor, heptachlor epoxide, gamma HCH, and toxaphene.
U = Non-detect
J = Estimated
N/A – Not Applicable

Table 3-11. (continued)

Chlorinated Pesticides Detected in CLDS 2016 Sediments

	Endosulfan sulfate µg/kg dry weight					Gamma-chlordane µg/kg dry weight					Methoxychlor µg/kg dry weight				
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site															
CS-1	7	0.106 U	0.222 J	0.125	0.043	7	0.071 U	1.18	0.231	0.419	7	0.294 U	0.507	0.34	0.074
CS-2	7	0.059 U	0.0985 U	0.0776 U	N/A	7	0.0393 U	0.714	0.155	0.248	7	0.172 U	0.288 U	0.227 U	N/A
MQR	7	0.0779 U	1.3	0.268	0.455	7	0.0619 U	0.814	0.453	0.335	7	0.228 U	0.31 U	0.273 U	N/A
FVP	7	0.0758 U	1.98	0.355	0.716	7	0.629	16.4	5.15	5.39	7	0.222 U	0.299 U	0.248 U	N/A
CLDS-Other	9	0.0785 U	0.115 U	0.0994 U	N/A	9	0.0648 U	1.2	0.279	0.387	9	0.23 U	0.337 U	0.291 U	N/A
NHAV14	8	0.0984 U	0.127 U	0.1128 U	N/A	8	0.069	2.46	1.27	0.935	8	0.288 U	0.372 U	0.330 U	N/A
Disposal Site Total	**6**	**0.059 U**	**1.98**	**0.173**	**-**	**6**	**0.0393 U**	**16.4**	**1.26**	**-**	**6**	**0.172 U**	**0.507**	**0.285**	**-**
Reference															
2500W	5	0.108 U	0.117 U	0.111 U	N/A	5	0.0721 U	0.0779 U	0.07394 U	N/A	5	0.316 U	0.342 U	0.324 U	N/A
4500E	5	0.101 U	0.106 U	0.103 U	N/A	5	0.0672 U	0.587	0.172	0.232	5	0.294 U	0.31 U	0.301 U	N/A
CLDS-REF	5	0.0964 U	0.099 U	0.0972 U	N/A	5	0.0643 U	0.066 U	0.0648 U	N/A	5	0.282 U	0.29 U	0.284 U	N/A
Reference Total	**3**	**0.0964 U**	**0.117 U**	**0.104 U**	**N/A**	**3**	**0.0643 U**	**0.587**	**0.104**	**-**	**3**	**0.282 U**	**0.342 U**	**0.303 U**	**-**

The following pesticides were not included in the summary table as there were no detections in any of the tissues samples: alpha-BHC, beta-BHC, delta-BHC, endrin, heptachlor, heptachlor epoxide, gamma HCH, and toxaphene.
U = Non-detect
J = Estimated
N/A – Not Applicable

Table 3-12.

Metals in 2016 CLDS Sediments

	Arsenic mg/kg dry wt.					Cadmium mg/kg dry wt.					Chromium mg/kg dry wt.					Copper mg/kg dry wt.				
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site																				
CS-1	7	6.46	7.09	6.85	0.207	7	0.17	0.26	0.204	0.0299	7	46.7	48.9	47.6	0.825	7	41.6	52.4	44.5	3.69
CS-2	7	1.9	6.07	3.87	1.86	7	0.04	0.12	0.087	0.0304	7	9.42	39.1	23.5	12.2	7	9.15	33.6	20.8	10.6
MQR	7	5.47	7.78	6.53	0.88	7	0.17	1.13	0.349	0.346	7	28.1	55.8	37.7	11.5	7	14.5	60.3	29.6	15.9
FVP	7	4.15	6.8	5.59	1.01	7	0.19	5.66	1.59	2.08	7	28.5	206	81.6	61.4	7	25.3	430	142	148
CLDS-Other	9	5.21	7.42	6.39	0.765	9	0.13	0.34	0.239	0.068	9	24.7	48	37.9	9.2	9	16.7	43.1	33.8	9.86
NHAV14	8	6.54	8.53	7.61	0.769	8	0.25	1	0.554	0.302	8	44.5	69.4	55.6	9.69	8	43.3	112	70	25.2
Disposal Site Total	**6**	**1.9**	**8.53**	**6.14**	**-**	**6**	**0.04**	**5.66**	**0.504**	**-**	**6**	**9.42**	**206**	**47.3**	**-**	**6**	**9.15**	**430**	**56.8**	**-**
Reference																				
2500W	5	6.71	7.56	7.14	0.324	5	0.12	0.13	0.124	0.00548	5	46.4	48.2	47.5	0.76	5	39.2	41.9	40.2	1.08
4500E	5	6.02	6.63	6.26	0.29	5	0.092	0.12	0.1	0.0115	5	37.7	39.4	38.5	0.63	5	28.5	30.1	29.6	0.644
CLDS-REF	5	5.71	6.07	5.85	0.14	5	0.076	0.097	0.085	0.00805	5	34.3	38.7	35.7	1.75	5	24.7	28.5	26.1	1.55
Reference Total	**3**	**5.71**	**7.56**	**6.42**	**-**	**3**	**0.076**	**0.13**	**0.103**	**-**	**3**	**34.3**	**48.2**	**40.6**	**-**	**3**	**24.7**	**41.9**	**32.0**	**-**

Table 3-12. (continued)

Metals in 2016 CLDS Sediments

	Lead mg/kg dry wt.					Mercury mg/kg dry wt.					Nickel mg/kg dry wt.					Zinc mg/kg dry wt.				
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site																				
CS-1	7	32.9	41.5	34.99	3	7	0.169	0.201	0.182	0.0107	7	19.1	22	21.3	1.01	7	108	114	111	2.15
CS-2	7	6.81	27.5	16.52	8.74	7	0.029	0.149	0.085	0.049	7	4.53	18.8	11.4	5.91	7	24.7	93.4	57	29.4
MQR	7	7.39	29.6	19.48	9.28	7	0.02	0.179	0.103	0.0623	7	19	50.2	28	11.1	7	47.3	104	71.5	24
FVP	7	16.7	109	44.2	32.4	7	0.085	0.45	0.209	0.127	7	12.5	27.1	19.5	5.14	7	61.8	214	121	53.2
CLDS-Other	9	11.6	35.9	26.3	8.57	9	0.051	0.182	0.137	0.0461	9	14.6	35.7	22.9	6.25	9	61.9	118	93.3	20.6
NHAV14	8	32.1	64.7	45.1	12.3	8	0.173	0.289	0.234	0.04915	8	18.3	25.6	22.1	2.45	8	110	178	139	27.1
Disposal Site Total	**6**	**6.81**	**109**	**31.1**	**-**	**6**	**0.02**	**0.45**	**0.158**	**-**	**6**	**4.5**	**50.2**	**20.9**	**-**	**6**	**24.7**	**214**	**98.8**	**-**
Reference																				
2500W	5	31.1	33	32.4	0.815	5	0.169	0.177	0.174	0.00311	5	22.1	23.1	22.6	0.412	5	111	116	113	2.3
4500E	5	25.6	27.1	26.2	0.604	5	0.12	0.129	0.127	0.00383	5	20.4	21.4	20.9	0.397	5	94.6	99.2	97.1	2.07
CLDS-REF	5	23.3	26.2	24.28	1.18	5	0.105	0.119	0.113	0.00666	5	19.2	21.7	20	0.991	5	87.3	99.6	91.2	4.9
Reference Total	**3**	**23.3**	**33**	**27.6**	**-**	**3**	**0.105**	**0.177**	**0.138**	**-**	**3**	**19.2**	**23.1**	**21.2**	**-**	**3**	**87.3**	**116**	**100**	**-**

Table 3-13.

Lipid Data for CLDS 2016 Tissues

	Lipids % Wet weight				
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site					
CS-1	3	1.42	1.57	1.47	0.0866
FVP	2[(1)]	1.39	1.62	1.51	0.163
CLDS-Other	3	1.21	1.95	1.55	0.373
NHAV14	3	1.08	1.26	1.19	0.099
Disposal Site Total	**4**	**1.08**	**1.95**	**1.43**	**-**
Reference					
4500E	4	1.44	1.53	1.48	0.0377
Reference Total	**1**	**1.44**	**1.53**	**1.48**	**-**

(1) Lipids were only measured in 2 of the 3 stations from FVP due to insufficient tissue mass.

Table 3-14.

Total PAH and Total PCB Data for CLDS 2016 Tissues

Area	Total PAH[1] µg/kg wet wt.						Total PCB (18 Congener)[2] µg/kg wet wt.					
	n	MIN	MAX	Mean	StdDev	Mean % Detected[3]	n	MIN	MAX	Mean	StdDev	Mean % Detected[3]
Disposal Site												
CS-1	3	41.9	51.0	47.4	4.86	100	3	32.6	38.2	35.7	2.84	89
FVP	3	39.8	80.5	53.4	23.4	100	3	28.1	43.9	34.5	8.34	94
CLDS-Other	3	47.0	89.0	62.3	23.6	100	3	24.1	31.0	28.0	3.73	89
NHAV14	3	106	250	176	72.3	100	3	40.1	57.0	48.9	8.39	94
Disposal Site Total	**4**	**39.8**	**250**	**84.8**	**-**	**100**	**4**	**24.1**	**57**	**36.8**	**-**	**92**
Reference												
4500E	4	29.2	33.4	31.1	2.28	100	4	23.5	26.9	25.1	1.67	90
Reference Total	**1**	**29.2**	**33.4**	**31.1**	**-**	**100**	**1**	**23.5**	**26.9**	**25.1**	**-**	**90**

[1]Total PAH is the sum of the 18 PAH compounds analyzed (naphthalene, 2-methylnaphthalene, 1-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, anthracene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene). Non-detected compounds were summed using ½ the MDL.

[2]Total PCB is the sum of the 18 NOAA NS&T congeners multiplied by 2. Non-detected congeners were summed using ½ the MDL

[3]The Mean % Detected indicates the mean percent of individual compounds (PAHs or PCB Congeners) detected in samples from that station.

Table 3-15.

Pesticide Data for CLDS 2016 Tissues

	4,4'-DDD µg/kg wet weight					4,4'-DDE µg/kg wet weight					Alpha-chlordane µg/kg wet weight				
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site															
CS-1	3	0.42	0.44	0.43	0.0113	3	1.21	1.42	1.32	0.105	3	0.0690 J	0.104 J	0.089	0.0179
FVP	3	0.49	1.75	0.96	0.687	3	1.15	1.69	1.39	0.275	3	0.0573 J	0.109 J	0.085	0.026
CLDS-Other	3	0.59	1.3	0.87	0.382	3	1.07	1.36	1.25	0.155	3	0.0802 J	0.137	0.116	0.031
NHAV14	3	0.43	0.94	0.71	0.257	3	1.7	2.12	1.98	0.24	3	0.114	0.381	0.276	0.143
Disposal Site Total	**4**	**0.42**	**1.75**	**0.74**	**-**	**4**	**1.07**	**2.12**	**1.49**	**-**	**4**	**0.0573 J**	**0.381**	**0.1413**	**-**
Reference															
4500E	4	0.39	1.04	0.7	0.308	4	1.06	1.22	1.16	0.0714	4	0.0594 J	0.0666 J	0.063	0.00308
Reference Total	**1**	**0.39**	**1.04**	**0.7**	**-**	**1**	**1.06**	**1.22**	**1.16**	**-**	**1**	**0.0594 J**	**0.0666 J**	**0.063**	**-**

	Total Chlordane µg/kg wet weight					Dieldrin µg/kg wet weight					Endosulfan II µg/kg wet weight				
Areas	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site															
CS-1	3	0.263	0.340	0.300	0.0385	3	0.14	0.17	0.15	0.0145	3	0.36	0.481	0.42	0.0605
FVP	3	0.295	0.613	0.420	0.170	3	0.15	0.22	0.19	0.0344	3	0.307	0.506	0.4	0.1
CLDS-Other	3	0.298	0.412	0.36	0.0588	3	0.16	0.18	0.17	0.012	3	0.303	0.355	0.337	0.029
NHAV14	3	0.38	0.887	0.703	0.281	3	0.18	0.93	0.47	0.399	3	0.43	0.686	0.568	0.129
Disposal Site Total	**4**	**0.263**	**0.887**	**0.447**	**-**	**4**	**0.14**	**0.93**	**0.25**	**-**	**4**	**0.303**	**0.686**	**0.431**	**-**
Reference															
4500E	4	0.187 J	0.251	0.229	0.0286	4	0.14	0.28	0.2	0.066	4	0.271	0.299	0.285	0.0151
Reference Total	**1**	**0.187 J**	**0.251**	**0.229**	**-**	**1**	**0.14**	**0.28**	**0.2**	**-**	**1**	**0.271**	**0.299**	**0.285**	**-**

The following pesticides were not included in the summary table as there were no detections in any of the tissues samples: 4,4'-DDT, aldrin, alpha-BHC, beta-BHC, delta-BHC, endosulfan I, endrin, heptachlor, gamma HCH, and toxaphene.

U = Non-detect

J = Estimated

Table 3-15. (continued)

Pesticide Data for CLDS 2016 Tissues

	Endosulfan sulfate µg/kg wet weight					Gamma-chlordane µg/kg wet weight					Heptachlor epoxide µg/kg wet weight				
Area	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site															
CS-1	3	0.0488 U	0.577	0.368	0.281	3	0.172	0.226	0.19	0.0309	3	0.0659 U	0.0668 U	0.0663 U	N/A
FVP	3	0.467	0.728	0.58	0.134	3	0.215	0.483	0.313	0.148	3	0.0661 U	0.0726 U	0.0694 U	N/A
CLDS-Other	3	0.456	0.514	0.477	0.032	3	0.19	0.254	0.225	0.032	3	0.0659 U	0.0881	0.07	0.01
NHAV14	3	0.0481 U	1.04	0.559	0.497	3	0.245	0.487	0.406	0.139	3	0.0659 U	0.0662	0.07	0
Disposal Site Total	**4**	**0.0481 U**	**1.04**	**0.496**	**-**	**4**	**0.172**	**0.487**	**0.284**	**-**	**4**	**0.0659 U**	**0.0881**	**0.0689**	**-**
Reference															
4500E	4	0.337	0.451	0.402	0.0493	4	0.104 J	0.169	0.144	0.0281	4	0.0659 U	0.128	0.0829	0.0302
Reference Total	**1**	**0.337**	**0.451**	**0.402**	**-**	**1**	**0.104 J**	**0.169**	**0.144**	**-**	**1**	**0.0659 U**	**0.128**	**0.0829**	**-**

	Methoxychlor µg/kg wet weight				
Areas	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site					
CS-1	3	0.666 U	0.675 U	0.670 U	N/A
FVP	3	0.668 U	0.734 U	0.701 U	N/A
CLDS-Other	3	0.666 U	0.982 B	0.772	0.182
NHAV14	3	0.666 U	0.669	0.668	0.002
Disposal Site Total	**4**	**0.666 U**	**0.982 B**	**0.703**	**-**
Reference					
4500E	4	0.665 U	0.721 U	0.686 U	N/A
Reference Total	**1**	**0.665 U**	**0.721 U**	**0.686 U**	**-**

The following pesticides were not included in the summary table as there were no detections in any of the tissues samples: 4,4'-DDT, aldrin, alpha-BHC, beta-BHC, delta-BHC, endosulfan I, endrin, heptachlor, gamma HCH, and toxaphene.
U = Non-detect
J = Estimated

Table 3-16.

Metals Data for CLDS 2016 Tissues

	Arsenic mg/kg wet wt.					Cadmium mg/kg wet wt.					Chromium mg/kg wet wt.					Copper mg/kg wet wt.				
Areas	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site																				
CS-1	3	5.98	6.03	6.01	0.0252	3	0.19	0.21	0.197	0.0115	3	0.095	0.1	0.098	0.00289	3	2.23	2.36	2.28	0.0681
FVP	3	5.58	6.46	5.9	0.489	3	0.16	0.19	0.173	0.0153	3	0.096	0.23	0.142	0.0762	3	2.35	2.93	2.56	0.319
CLDS-Other	3	4.56	5.16	4.78	0.328	3	0.16	0.2	0.18	0.0200	3	0.076	0.16	0.105	0.0477	3	1.4	1.61	1.53	0.114
NHAV14	3	4.35	5.41	4.94	0.539	3	0.13	0.16	0.147	0.0153	3	0.1	0.24	0.153	0.0757	3	1.04	1.64	1.37	0.306
Disposal Site Total	**4**	**4.35**	**6.46**	**5.41**	**-**	**4**	**0.13**	**0.21**	**0.17**	**-**	**4**	**0.076**	**0.24**	**0.12**	**-**	**4**	**1.04**	**2.93**	**1.94**	**-**
Reference																				
4500E	4	5.59	5.71	5.66	0.052	4	0.15	0.17	0.16	0.00816	4	0.093	0.17	0.136	0.0318	4	2.24	2.82	2.52	0.255
Reference Total	**1**	**5.59**	**5.71**	**5.66**	**-**	**1**	**0.15**	**0.17**	**0.16**	**-**	**1**	**0.093**	**0.17**	**0.136**	**-**	**1**	**2.24**	**2.82**	**2.52**	**-**

	Lead mg/kg wet wt.					Mercury mg/kg wet wt.					Nickel mg/kg wet wt.					Zinc mg/kg wet wt.				
Areas	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**	**n**	**MIN**	**MAX**	**Mean**	**StdDev**
Disposal Site																				
CS-1	3	0.43	0.75	0.573	0.163	3	0.016	0.016	0.016	0	3	0.41	0.44	0.423	0.0153	3	29.4	29.7	29.5	0.153
FVP	3	0.41	0.58	0.487	0.0862	3	0.016	0.017	0.017	0.000577	3	0.41	0.49	0.44	0.0436	3	26.5	29.1	27.8	1.3
CLDS-Other	3	0.3	0.39	0.353	0.0473	3	0.007	0.01	0.008	0.00153	3	0.3	0.47	0.367	0.0907	3	23.7	25.4	24.7	0.874
NHAV14	3	0.31	0.72	0.487	0.211	3	0.005	0.009	0.007	0.002	3	0.28	0.36	0.33	0.0436	3	24.8	26.9	25.7	1.07
Disposal Site Total	**4**	**0.30**	**0.75**	**0.475**	**-**	**4**	**0.005**	**0.017**	**0.0119**	**-**	**4**	**0.28**	**0.49**	**0.39**	**-**	**4**	**23.7**	**29.7**	**26.9**	**-**
Reference																				
4500E	4	0.38	0.94	0.665	0.268	4	0.018	0.02	0.019	0.000957	4	0.44	0.49	0.468	0.0206	4	26.1	28.8	27.9	1.22
Reference Total	**1**	**0.38**	**0.94**	**0.665**	**-**	**1**	**0.018**	**0.02**	**0.019**	**-**	**1**	**0.44**	**0.49**	**0.468**	**-**	**1**	**26.1**	**28.8**	**27.9**	**-**

Table 3-17.

Average Abundances of Benthic Infauna in Samples from the Reference Area, Central Regions, and Historical Mounds

Class and Family	Reference	Central Regions		Historical Mounds	
	REF-4500E	CLDS-OTHER	NHAV14	CS-1	FVP
Anopla					
Lineidae	0.00	0.33	0.00	0.33	0.33
Tubulanidae	6.00	9.00	12.67	3.33	2.33
Bivalvia					
Arcidae	0.00	0.00	0.00	0.00	5.33
Astartidae	0.00	0.00	0.00	0.00	0.33
Lasaeidae	4.75	0.00	0.00	5.67	3.33
Lyonsiidae	0.75	0.33	1.33	0.33	0.00
Nuculidae	102.50	137.33	19.67	270.00	18.00
Pandoridae	0.25	0.00	0.67	0.00	0.00
Tellinidae	0.00	40.67	50.33	20.33	22.00
Veneridae	2.25	5.00	8.00	7.33	1.00
Yoldiidae	2.00	2.67	1.33	4.00	0.00
Enteropneusta					
Ptychoderidae	20.75	8.00	5.00	11.33	0.33
Gastropoda					
Acteonidae	1.75	1.33	1.67	1.67	0.00
Calyptraeidae	0.00	0.00	0.00	0.33	22.33
Columbellidae	0.00	0.00	0.00	0.00	0.67
Haminoeidae	4.75	2.00	0.33	2.67	0.00
Mangeliidae	1.00	1.00	0.33	1.67	0.00
Nassariidae	5.50	7.33	7.67	6.00	2.67
Naticidae	2.50	1.33	0.67	4.33	0.00
Pyramidellidae	10.25	29.67	10.00	34.67	0.00
Scaphandridae	155.00	120.00	93.33	136.00	0.00
Turridae	1.00	0.00	0.00	0.00	0.00
Malacostraca					
Ampeliscidae	1.50	8.33	5.00	1.33	5.67
Caprellidae	0.00	0.00	0.00	0.00	0.33
Crangonidae	0.00	0.33	0.00	0.00	0.00
Diastylidae	0.50	0.67	0.00	0.33	0.00
Idoteidae	0.50	0.67	1.00	0.33	0.00
Ischyroceridae	0.00	0.00	0.33	0.00	0.00
Mysidae	0.00	0.33	0.33	0.33	2.00
Paguridae	0.00	0.33	0.00	0.00	2.00
Pinnotheridae	0.00	0.00	0.00	0.67	0.33
Porcellanidae	0.00	0.00	0.00	0.00	0.33
Squillidae	0.00	0.33	0.00	0.00	0.00
Stenothoidae	0.00	0.00	0.00	0.00	0.67
Xanthidae	0.00	0.00	0.00	0.00	2.00
Oligochaeta					
Naididae	1.00	10.33	10.00	1.67	1.33
Ophiuroidea					
Amphiuridae	1.00	1.33	1.00	0.33	0.00

Table 3-17. (continued)

Average Abundances of Benthic Infauna in Samples from the Reference Area, Central Regions, and Historical Mounds

Class and Family	Reference	Central Regions		Historical Mounds	
	REF-4500E	CLDS-OTHER	NHAV14	CS-1	FVP
Phoronidae					
Phoronidae	0.00	0.00	0.00	0.00	0.33
Polychaeta					
Ampharetidae	16.00	22.67	21.67	29.33	1.33
Capitellidae	6.25	27.00	9.67	6.00	12.33
Chaetopteridae	1.00	0.67	1.00	1.33	8.00
Cirratulidae	2.25	4.33	2.67	1.00	0.67
Cossuridae	1.25	0.33	1.67	0.33	0.33
Glyceridae	0.25	0.33	0.33	0.00	0.67
Goniadidae	0.25	0.00	0.00	0.00	0.00
Lumbrineridae	0.25	0.33	0.00	0.33	0.00
Maldanidae	0.75	2.33	2.00	5.67	2.00
Nephtyidae	21.00	28.67	31.00	31.67	21.67
Nereididae	0.00	0.67	0.00	0.00	0.00
Oweniidae	0.75	8.00	4.33	11.00	1.67
Paraonidae	23.75	29.33	31.33	41.67	3.00
Pectinariidae	7.00	21.67	12.00	25.67	2.00
Phyllodocidae	0.00	0.33	0.67	1.00	0.67
Pilargidae	36.25	34.00	59.67	44.00	5.00
Polynoidae	0.00	0.33	0.00	0.00	0.00
Spionidae	23.50	40.67	31.33	42.33	3.00
Terebellidae	0.75	1.67	1.00	0.67	1.67
Trichobranchidae	0.25	0.00	0.00	0.00	0.00
Sipunculidea					
Phascolionidae	10.25	7.00	4.00	11.67	0.33

Table 3-18.

Summary Statistics Describing Benthic Infauna Density (m^2) and Species Richness in Samples from the Reference Area, Central Regions, and Historical Mounds

Area	Station	Density (m^2)	No. Taxa
Reference	4500E-01	10,125	26
	4500E-02	12,300	34
	4500E-03	15,650	45
	4500E-05	11,100	36
Central Regions	NHAV14-02	8,225	33
	NHAV14-05	1,2425	40
	NHAV14-07	13,225	39
	CLDS-Other-10	17,950	43
	CLDS-Other-13	16,525	39
	CLDS-Other-14	12,450	41
Historical Mounds	CS-1-01	16,075	32
	CS-1-05	17,025	38
	CS-1-07	25,300	40
	FVP-02	3,975	29
	FVP-05	4,900	37
	FVP-06	3,550	32

Table 3-19.

Differences in Means Between Areas with Simultaneous Pairwise Confidence Intervals for the Means (Family Wise Confidence Level of 90%) of Density and Richness

	REF 4500E	NHAV14	CLDS-Other	CS-1
Differences in mean density (per m^2) between Areas [a]				
NHAV14	1002 [-5472, 7476]	0		
CLDS-Other	-3348 [-9822, 3126]	-4350 [-11271, 2571]	0	
CS-1	-7173 [-13647, -698]	-8175 [-15096, -1254]	-3825 [-10746, 3096]	0
FVP	8152 [1678, 14626]	7150 [229, 14071]	11500 [4579, 18421]	15325 [8403, 22246]
Differences in richness between Areas				
NHAV14	-2 [-13, 9]	0		
CLDS-Other	-6 [-17,5]	-4 [-15,8]	0	
CS-1	-1 [-12,10]	1 [-11,12]	4 [-7,16]	0
FVP	3 [-8,14]	5 [-7,16]	8 [-3,20]	4 [-8,16]

[a] Cell values show the difference as Column - Row, e.g., the first entry indicates REF 4500E mean minus the NHAV14 mean was 1002 animals/m^2, with simultaneous 90% confidence interval [-5472, 7476].

Note: differences shown in shaded cells are not significantly different from 0 (family-wise $\alpha = 0.10$)

Table 3-20.

Total Biomass (grams) for Annelids, Molluscs, Arthropods, Echinoderms, Miscellaneous, and Total Biomass in Samples from the Reference Area, Central Regions, and Historical Mounds

Area	Station	Ann.	Mol.	Art.	Ech.	Misc.	Total
Reference	4500E-01	0.23	0.23	0.00	0.01	0.00	0.48
	4500E-02	0.36	0.60	0.00	0.00	0.25	1.21
	4500E-03	0.24	0.22	0.00	0.00	0.12	0.58
	4500E-05	0.32	0.30	0.00	0.02	0.05	0.70
Central Regions	NHAV14-02	0.28	0.25	0.01	0.02	0.00	0.56
	NHAV14-05	0.41	0.52	0.00	0.00	0.25	1.18
	NHAV14-07	0.48	0.28	0.00	0.00	0.00	0.76
	CLDS-Other-10	0.62	0.70	0.09	0.00	0.00	1.41
	CLDS-Other-14	0.33	0.26	5.56	0.00	0.01	6.16
	CLDS-Other-13	0.36	0.55	0.00	0.00	0.00	0.92
Historical Mounds	CS-1-01	0.33	0.44	0.00	0.00	0.01	0.77
	CS-1-05	0.23	0.35	0.00	0.00	0.03	0.61
	CS-1-07	0.51	0.49	0.00	0.00	0.26	1.27
	FVP-02	0.14	3.57	0.57	0.00	0.00	4.28
	FVP-05	0.23	0.37	0.19	0.00	0.04	0.83
	FVP-06	0.48	0.11	0.11	0.01	0.02	0.72

Table 3-21.

Mean Abundances Per Sample of Benthic Infaunal Families Contributing 5% or More to Dissimilarities Among Areas (SIMPER) in Samples from the Reference Area, Central Regions, and Historical Mounds

		Reference Area	Central Regions		Historical Mounds	
Class	**Family**	**4500E**	**NHAV14**	**CLDS-Other**	**CS-1**	**FVP**
Bivalvia	Nuculidae	103	20	137	270	18
	Tellinidae	0	50	41	20	22
Gastropoda	Calyptraeidae	0	0	0	0.3	22
	Pyramidellidae	10	10	30	35	0
	Scaphandridae	155	93	120	136	0
Polychaeta	Capitellidae	6	10	27	6	12
	Oweniidae	1	4	8	11	2
	Pilargidae	36	60	34	44	5

4.0 DISCUSSION

As specified in the SMMP for CLDS, monitoring activities are conducted periodically at the site to determine compliance with disposal conditions, to evaluate the short-term and long-term fate of dredged material placed at the site, and to assess potential adverse environmental impacts from the use of CLDS for disposal of dredged material (USEPA/USACE 2018). The monitoring activities performed in 2016 represent a comprehensive survey of the active and historical portions of the site as well as the reference areas associated with CLDS. The acoustic survey was conducted to characterize seafloor topography and features over the active portions of the site and reference areas, and document the distribution of recent placement of dredged material. The SPI/PV survey further defined the physical characteristics of surficial sediments, dredged material distribution, and determined benthic community status at CLDS and the reference areas. Sediment grabs were collected to provide information on the composition of the benthic community and sediment chemistry. Clam dredges deployed on and around the disposal mounds and at the reference areas collected non-motile animals for tissue analysis to assess potential bioaccumulation of chemicals of concern.

The historical mounds sampled for this project represent different disposal histories. CS-1 and CS-2 were created simultaneously and with similar unsuitable sediment, but CS-1 was capped with silt, and CS-2 was capped with sand. Samples collected from CS-1 were evaluated in the context of the potentially thinner cap on the eastern half of the mound (Section 1.3). Formation of MQR was more complex, including a series of capping episodes as monitoring suggested additional cap material would be a prudent measure (SAIC 1995). Therefore, samples collected at MQR were evaluated to ensure that the final cap continues to be an effective barrier to underlying unsuitable sediment. The final historical mound, FVP, was not capped as part of a national study evaluating the effectiveness of sediment monitoring techniques.

The two central regional areas sampled, NHAV14 and CLDS-Other, represent samples collected from disposal that has occurred at the site since the late 1990s but placed over areas of older historical disposal. During this period, a modified management strategy has been employed at CLDS, whereby the dredged material was placed in a series of closely spaced or contiguous cells, with the goal of eventually creating a circular or semicircular berm or ring on the seafloor to confine subsequent placement of dredged material (Fredette 1994). Through 2013, dredged material was placed at a series of closely spaced targets during each disposal season contributing to the formation of circular or semi-circular berms on the seafloor. These mounds are referred to in this survey collectively as the CLDS-Other placement area.

During the 2013/2014 dredging seasons, approximately one million m^3 of dredged material from two Federal Navigation projects and multiple private projects was placed into the NHAV14 management area. These areas are referred to in this survey collectively as the NHAV14 central region placement area.

Discussion of the results is presented for each category of disposal: the historical uncapped mound FVP, the other historical mounds CS-1, CS-2, and MQR, the areas representing more recent disposal interspersed with historical disposal (NHAV14 and CLDS-Other), and reference conditions outside the boundaries of CLDS.

4.1 Historical Mounds

4.1.1 Field Verification Program (FVP) Mound

Previous surveys found the FVP mound to be physically stable but with apparent cycling of benthic successional stage, apparently high sediment oxygen demand (SOD), and shallower aRPD depths relative to reference (AECOM 2013). The 2016 survey found similar results with aRPD depths statistically inequivalent to reference values (Table 3-4). At the SPI stations, the mound displayed dark optical signature of subsurface sediments, indicating high sediment oxygen demand at depth, although evidence of advanced benthic succession suggests recolonization of the mound has occurred. Despite documentation of advanced successional taxa, notably lower infaunal abundances were observed at FVP than all the other areas in 2016 as well as notable differences in the assemblage (Table 3-18). When the infaunal community is taken into consideration with SPI results, it suggests that while advanced successional taxa exist at FVP, some aspects of community structure are partially arrested (e.g., infauna abundance, species richness).

Variability in physical and chemical factors measured at grab stations distinguished FVP from other areas including the presence of a wide range of particle sizes and contaminants of concern (COCs) as illustrated for percent fines (Figure 3-54), total PAHs (Figures 3-59, 3-60), total PCBs (Figures 3-61, 3-62), total DDx (Figure 3-64a), total chlordane (Figure 3-64b), dieldrin (Figures 3-63c, 3-64c) and a number of metals (Figures 3-66 a-h). Sediment from FVP was coarser with lower TOC relative to reference stations. Despite the coarser sediment, selected FVP sample concentrations exceeded available benchmarks including the ER-L, ER-M, as well as disposal site reference and ambient concentrations. In particular, the station-averaged concentrations of total PAHs, PCBs, as well as Cd, Cr, Cu, and Hg were higher than the calculated 90/90 UTL, demonstrating that the FVP sediments were outside of (higher than) the expected range of concentrations found in sediment in this region of Long Island Sound (shaded values on Table 4-1). Contaminant concentrations measured at FVP, however, were at least an order of magnitude lower than measured in the source sediment (Black Rock Harbor; Section 1.3). Surface sediment concentrations at FVP have been decreasing over time likely due to active sedimentation taking place in this area of Central Long Island Sound; reported average sedimentation rates for this area are 0.78-0.82 cm/year (Myre and Germano 2007).

Despite the elevated contaminant levels in the sediment at FVP, there were no indications from the tissue data that the infauna contained elevated levels of COCs (Table 4-2; Figures 3-67 to 3-71, 4-1). It is typical that metals do not show a relationship between sediment and tissue concentrations; in evaluation of paired sediment/tissue chemistry samples, there was a linear relationship found for *Nereis* for many of the organic chemicals evaluated (Fredette et al. 2006). The lack of a relationship between higher sediment organic contaminant concentrations and tissue concentrations at FVP (Figure 4-2) may be due to the fact that the trawls extended well beyond the boundary of the small FVP mound (Figure 2-9) due to the difficulty of recovering sufficient tissue on the mound itself (e.g., insufficient tissue was collected for lipids analyses). In addition, there is evidence that at high sediment concentrations, bioaccumulation may decrease as sediment concentrations increase (Fredette et al. 2006). Infauna observed during the 2016 survey contained tissue concentrations that were similar, and often lower, than concentrations found in infauna collected in 2000 (Table 4-2; Figure 4-1) (USEPA/USACE 2004); the CLDS-2000 samples were composited from both FVP as well as NHAV93 (a capped mound).

FVP did have evidence of a diminished macrobenthic community structure: shallow aRPDs, distinct benthic assemblage and infaunal abundances lower than in other areas. However, the level of species richness, biomass and the presence of advanced successional taxa suggests that the species present have some resiliency to the COCs present at FVP. In fine-grained aquatic sediments throughout the world, the presence of advanced successional taxa is strong evidence that the level of physical or chemical (nutrient load or COCs) disturbance is insufficient to cause the macrobenthic community to retrograde to a Stage 1 or impaired condition (Germano et al. 2011). The biomass and species richness also suggest that FVP is not merely supporting a depauperate ‘pollution tolerant’ community.

4.1.2 Cap Site 1 (CS-1) Mound

The Cap Site 1 (CS-1) mound was developed near the western boundary of CLDS in the early 1980s. As a result of the placement operations CS-1 was expected to have thin deposits of New Haven Harbor silt over the Black Rock Harbor deposit. In grabs collected in 2016, CS-1 surficial sediment was uniformly composed of fine-grained material (silt and clay) that were found to be organically rich (high TOC content) similar to reference area sediments (Figures 3-54 and 3-56). The optical reflectance of the sediment, where moderately deep light brown sediment was present over olive gray sediment, suggests the SOD at CS-1 was more similar to reference than at the uncapped mound FVP, which contained dark black sediment, likely due to the presence of a relatively thin layer or recently deposited material. At CS-1, SPI and grab stations in 2016 were located in the main area of the Black Rock Harbor deposit (southeast of the buoy) and south of the New Haven Harbor cap deposit (Figures 2-2 and 2-9). The identified macrobenthic community structure of CS-1 exhibited infaunal recolonization and benthic assemblages similar to reference area communities. Evidence of advanced successional taxa were found at every station sampled and void depths regularly exceeded 10 cm.

Although Cu and Hg concentrations at CS-1 were slightly elevated relative to ER-L values, none of the station-averaged concentrations of contaminants exceeded the 90/90 UTL, suggesting that the surface sediment at CS-1 was not different than ambient sediments in this region of Long Island Sound (Table 4-1). Similarly, there were pesticide values at CS-1 that exceeded the ER-L, although concentrations at the reference stations were approximately similar suggesting elevated background levels were persistent across this area of Long Island Sound (e.g., total chlordane, dieldrin; Figures 3-63b and c; Tables 4-1 and 4-2). Tissue concentrations were also similar to reference values (Table 4-2) except for slightly elevated total PCBs (Figure 4-1).

Nucula proxima, the nut clam, was highly abundant at CS-1 but otherwise the assemblage composition, abundance and richness was similar to reference conditions. The clam *Nucula proxima* is typically associated with fine-grained sediments with high TOC levels (Chang et al. 1992). In summary, the chemical and biological data collected from CS-1 suggested that the thin cap placed in the southeast portion of the mound was sufficient to sequester contaminants from the surficial biologically active zone.

4.1.3 Cap Site 2 (CS-2) Mound

The Cap Site 2 (CS-2) mound is situated at the northwestern corner of CLDS and was formed in 1983 at the same time that mound CS-1, but capped with sand cap to compare with the use of silt for a cap at CS-1 (Fredette 1994). The placement operations shifted the physical conditions at CS-2 from a predominantly organic rich silt-clay bottom, to one of very fine sand often layered over silt-clay. The cap material contained slightly coarser grain sizes compared to the surrounding ambient bottom (Figure 3-25) but had similar levels of relatively low organic enrichment, low to moderate SOD, and moderately deep aRPD depths as those observed at reference locations. Overall the sediments at CS-2 were optically similar to reference sediments, with a high reflectance (e.g., contrast Figure 3-36B with 3-12C).

Evidence of advanced successional taxa was documented at the majority of stations within CS-2 which suggests that benthic recolonization at this mound has been sustained. This is expected given that cessation in disposal activity over 30 years ago has allowed for resident fauna to reestablish and thrive. Without any direct perturbations from disposal activity these communities are expected to remain in a state of advanced succession, i.e., Stage 3 (Pearson and Rosenberg 1978).

The sediment chemistry data at CS-2 highlights the effectiveness of the fine sand cap in sequestering the deeper contaminated deposit, preventing that material from being accessible to the surficial biologically active zone. Concentrations of COCs at CS-2 were in almost every case the lowest observed, even in comparison to reference areas (Figures 3-59 to 3-66 a-h). None of the station-averaged concentrations of contaminants exceeded the 90/90 UTL (Table 4-1).

4.1.4 Mill-Quinnipiac River (MQR) Mound

The complicated disposal history of MQR was reflected in a sediment surface that was composed of very fine sand layered over a patchy assortment of silt-clays. The spatial heterogeneity at MQR was observed between stations and sometimes even on the scale of a single station (e.g., Station MQR-02), where each replicate image had a different optical profile of the silt-clay layer. Despite the variability and spatial heterogeneity of the physical sediment characteristics at stations sampled at the MQR mound, the successional taxa were functionally advanced and mirrored observations at the reference areas.

The presence of numerous voids and burrowing activity in the dredged material at every station sampled (Table 3-2; Figures 3-34, 3-39B) indicated that advanced successional taxa occupied the mound. Similar to the other older mounds, successional recovery had occurred and appeared sustained at MQR following cessation of disposal activity. Despite this biological recovery, the aRPD values were low and statistically inequivalent to reference reflecting the presence of high SOD in the sediments (Table 3-4).

Consistent with the presence of apparent high SOD, MQR had the highest total organic carbon found among the mounds (Table 3-8). The average sediment chemistry concentrations at MQR suggested that the surface sediments of this mound were not different than those of ambient sediments (90/90 UTL) except for Cd and Ni, although both metals were lower than the ER-L (Table 4-1). The only COC slightly higher than the ER-L was total PCBs (average of 25.4 µg/kg dw relative to an ER-L of 22.7). In summary, results from MQR suggest the presence of organic-rich sediments with a few slightly elevated COCs, but the area contains an advanced benthic community consistent with reference conditions.

4.2 CLDS Central Disposal Regions

4.2.1 New Haven (NHAV14) Recent Placement Area

The gridded disposal cell approach was used for the NHAV14 project. Due to the large volume of material projected to be disposed at CLDS in 2013-14, placement was expanded to a grid with 25 separate targets, divided into northern and southern management areas (Figure 1-3). The results of sampling from NHAV14 were evaluated in context with the presence of recently deposited dredged material.

Like many of the other targeted deposits, NHAV14 was composed of very fine sand layered over silt-clays. The fine sediments at NHAV14 had a high SOD, indicative of the organic rich nature of the recently deposited dredged material that composed these sediments. A primary diagnostic feature indicating sediments have high SOD and are organically rich is the low optical reflectance of the sediment (Germano et al. 2011). High labile organic material, typical of fresh dredged material, increases SOD and, subsequently, sulfate reduction rates and the associated abundance of sulfide end products (Canuel and Martens 1993). This results in more highly reduced, lower-reflectance sediments at depth and higher aRPD contrasts, which was observed in NHAV14 sediments (Figures 3-42A, 3-49A).

As a result of the organic content of the sediment and the recent placement, NHAV14 had some of the lowest observed aRPD depths at CLDS with aRPD values significantly shallower than reference (Figure 3-53). The rate of deepening of the aRPD within the sediment is relatively slow in organic-rich muds like those observed at NHAV14, on the order of 200 to 300 micrometers per day (Germano and Rhoads 1984). Despite recent disposal activity and lower aRPD depths, evidence of advanced successional taxa were documented at every station in the NHAV14 management area. These results suggest that the benthic community at NHAV14 stations was equally as advanced as at the reference stations. The lack of difference in successional taxa between the NHAV14 stations and reference illustrates the rapid recovery of the benthic community to the disturbance caused by the deposition of dredged material; advanced benthic communities were already established along with the early colonizing opportunistic assemblages.

A logical explanation for the rapid recovery in the benthic community at the stations in the NHAV14 management areas is that the deposition of the dredged material occurred in thin enough layers that the existing fauna could burrow up and re-establish themselves at the surface. It takes a quantum input of 30 cm or more (sometimes greater than 50 cm) to completely smother existing infauna (Mauer et al. 1986). The similarity in grain size (fine sediment) between the NHAV14 material and ambient bottom likely also helped facilitate benthic recovery. These findings were reflected in the observed benthic community structure. Although the NHAV14 management area differed slightly from the reference areas in terms of infaunal composition (Figure 3-72B), overall abundances were comparable between the areas within higher-level taxonomic categories. For instance, nut clams were more abundant at the reference area whereas tellinid clams were more abundant at the recent NHAV14 disposal area, but both are small surface deposit-feeding bivalves (Table 3-17; Lopez and Levinton 1982). The recent NHAV14 disposal area exhibited infaunal recolonization similar to reference area communities.

Despite a healthy biological status for the benthos, the NHAV14 management area was notable for several elevated COCs measured at individual stations equal to, or higher than, concentrations measured in the reference areas. Average concentrations of three metals (Cd, Cu, and Hg) were outside of the 90/90 UTL, suggesting that they were higher than would be expected in the ambient range of sediment in this area of Long Island Sound. The range of tissue concentrations for organic contaminants at NHAV14 were highest among the samples analyzed in 2016 (Figure 4-1). The relatively higher concentrations of, for example, the high molecular weight fraction of total PAHs (HPAHs) in sediment and tissue at NHAV14 (Figure 4-2) was consistent with bioaccumulation sediment accumulation factor (BSAF) data showing that higher concentrations often drive the relationship between these two matrices (Fredette et al. 2006). The relationship between sediment and tissue values from this dataset, however, should be interpreted with caution due to the spatial disparity between the sediment and tissue samples.

Mean COC concentrations at NHAV14 were driven by the values at Stations 07 and 08 (Tables 3-10 to 3-16) including total PAHs, total PCBs, total DDx, total chlordane, dieldrin, and a number of metals. These two stations are located at the northern boundary of the NHAV14 target placement grid, an area that was managed with placement of dredged material from outer New Haven Harbor over initial project material from private projects (Figure 2-2; Hopkins et al. 2017). This area received relatively small volumes of recent placement (Hopkins et al. 2017). Apparent in the initial multibeam survey at CLDS performed in 2005 was evidence of historical disposal over much of this portion of CLDS, originating from dredging projects that were performed when limited or no testing of sediment was required as a condition of disposal. Hence, it is possible that sediment samples from NHAV14, particularly Stations 07 and 08, included older historical dredged material disposed prior to testing requirements. This observation highlights the importance of placing a thicker layer of dredged material over the target grid and extending disposal past the project grid to ensure full cover.

4.2.2 CLDS-Other Area

The CLDS-Other group (Stations 09–17) represents the area of the CLDS containing dredged material disposal since 2000, and not confined within the boundaries of the NHAV14 target placement grid (Figure 2-2). The focused placement of dredged material in this area throughout the years has created multiple localized mounds (CLDS-01, -02, -03, -04, -08) with shallower depths (mounds of accumulated dredged material) ranging from 14 to 17 m (ENSR 2007). Previous surveys have documented the formation and stability of these discrete mounds, highlighting benthic recovery at each (Valente et al. 2012; AECOM 2013). Part of the CLDS group represented the area of CLDS actively receiving material, with disposal taking place as recently as May 2016, a few months before this survey including an area sampled at Station 14 (Figure 1-4).

The CLDS group was highly variable due to the large spatial variability of station locations (Figure 2-2). One common characteristic of CLDS stations was the presence of very fine sand layered over silt-clay. This was observed at many of the other placement locations and is a common characteristic of CLDS sediments. Most of the stations in the CLDS group contained high SOD. The fine-grained sediments at these stations were organically rich, typical of dredged sediments, despite some outliers with low to medium SOD. Most stations in the CLDS group had low optical reflectance, a contrast to the ambient bottom.

Similar to the other disposal areas, stations in the CLDS-Other group were documented to have evidence of advanced successional taxa. The presence of feeding voids in the sediment column at these stations indicated that head-down deposit feeding infauna had recolonized these areas. Similar to NHAV14, the composition of the fauna at stations in the CLDS-Other group differed slightly from reference (Figure 3-72B), but overall abundances were comparable between these two areas (Table 3-19).

The average sediment chemistry concentrations at the CLDS stations suggested these sediments were within the range expected in ambient Long Island Sound sediment as calculated through the 90/90 UTL (Table 4-1) and compared well to reference site concentrations. Although this material was likely disposed over areas of historical disposal similar to NHAV14, unlike NHAV14, the recent dredged material was disposed in a thicker layer that is assumed to have fully sequestered historically disposed material.

Table 4-1.

Summary of Area Mean Sediment Concentrations (+/- S.D.) Compared to ER-L, ER-M Benchmarks, 90/90 UTLs and Other CLIS Ambient Concentrations

	Historical Mounds				Central CLDS Regions		Reference Areas							
Area	CS-1	FVP	CS-2	MQR	NHAV14	Other	2500W	4500E	CLDS-REF	ER-L[4]	ER-M[5]	90/90 UTL[6]	CLIS-M[7]	CLIS-90[7]
Total PAH[1]	1629 (145)	4040 (3817)	845 (505)	804 (407)	1456 (426)	2552 (135)	1346 (93)	1002 (109)	811 (80)	4,022	44,792	2,700	2,860	10,900
Total PCB[1,2]	21.5 (5.48)	229 (264)	8.35 (5.55)	25.4 (39.5)	14.3 (7.92)	41.7 (26.7)	14 (1.58)	8.79 (1.38)	6.76 (0.913)	22.7	180	95	32.6	35.3
Arsenic[3]	6.85 (0.207)	5.59 (1.01)	3.87 (1.86)	6.53 (0.875)	7.61 (0.769)	6.39 (0.765)	7.14 (0.324)	6.26 (0.290)	5.85 (0.140)	8.2	70	8.1	5.69	10.56
Cadmium[3]	0.204 (0.0299)	1.59 (2.08)	0.087 (0.0304)	0.349 (0.346)	0.554 (0.302)	0.239 (0.0675)	0.124 (0.00548)	0.1 (0.0115)	0.085 (0.00805)	1.2	9.6	0.25	0.92	2.16
Chromium[3]	47.6 (0.825)	81.6 (61.4)	23.5 (12.2)	37.7 (11.5)	55.6 (9.69)	37.9 (9.20)	47.5 (0.760)	38.5 (0.630)	35.7 (1.75)	81	370	79	62	109
Copper[3]	44.5 (3.69)	142 (148)	20.8 (10.6)	29.6 (15.9)	70 (25.2)	33.8 (9.86)	40.2 (1.08)	29.6 (0.644)	26.1 (1.55)	34	270	63	83.8	185
Lead[3]	35 (3.00)	44.2 (32.4)	16.5 (8.74)	19.5 (9.28)	45.1 (12.3)	26.3 (8.57)	32.4 (0.815)	26.2 (0.604)	24.3 (1.18)	46.7	218	60	45.6	85.9
Mercury[3]	0.182 (0.0107)	0.209 (0.127)	0.084 (0.0490)	0.103 (0.0623)	0.234 (0.0491)	0.137 (0.0461)	0.174 (0.00311)	0.127 (0.00383)	0.113 (0.00666)	0.15	0.71	0.21	0.21	0.47
Nickel[3]	21.3 (1.01)	19.5 (5.14)	11.4 (5.91)	28 (11.1)	22.1 (2.45)	22.9 (6.25)	22.6 (0.412)	20.9 (0.397)	20 (0.991)	20.9	51.6	28	22.5	37
Zinc[3]	111 (2.15)	121 (53.2)	57 (29.4)	71.5 (24.0)	139 (27.1)	93.3 (20.6)	113 (2.30)	97.1 (2.07)	91.2 (4.90)	150	410	160	137	221

[1] Units are µg/kg dry wt.
[2] Total PCBs are 18 NOAA NS&T congeners x 2.
[3] Units are mg/kg dry wt.
[4] Effects Range Low (ER-L) (Long et al. 1995)
[5] Effects Range Median (ER-M) (Long et al. 1995)
[6] The Upper Tolerance Limit (UTL) values were calculated as the 90% upper confidence limit of the 90th percentile (90/90 UTL) for Central Long Island Sound ambient dataset as a "proof-of-concept" to use for analyzing disposal site chemical concentrations. The 90/90 UTL can be interpreted as the threshold below which 90% of the ambient (outside of the disposal site) population is expected to fall, 90% of the time. Shaded values represent values at or exceeding 90/90 UTL.
[7] Mean and 90th percentile values for Central Long Island Sound (Mitch and Anisfeld 2010)

Table 4-2.

Summary of FVP, CLDS-Other, NHAV14, CS-1, and CLDS REF Mean Worm Tissue Concentrations (+/- S.D.) Compared to CLDS EIS Worm Tissue Concentrations from 2000

Parameter	2016				2000 CLDS EIS FVP/NHAV93[4]	2016	2000
	FVP	CLDS-Other	NHAV14	CS-1		4500E REF	CLDS EIS REF[5]
Total PAH[1]	53.4 (23.4)	62.3 (23.6)	176 (72.3)	47.4 (4.86)	78.2	31.1 (2.28)	24.9
Total PCB[1,2]	34.5 (8.34)	28 (3.73)	48.9 (8.4)	35.7 (2.84)	66.2	25.1 (1.67)	30.2
Total DDX	2.38 (0.956)	2.14 (0.44)	2.71 (0.49)	1.77 (0.11)	5.13	1.89 (0.353)	2.21
Dieldrin	0.19 (0.0344)	0.17 (0.012)	0.47 (0.399)	0.15 (0.015)	0.38	0.204 (0.066)	0.3
Arsenic[3]	5.9 (0.489)	4.78 (0.33)	4.94 (0.54)	6.01 (0.03)	3.64	5.66 (0.052)	4.01
Cadmium[3]	0.17 (0.015)	0.18 (0.02)	0.14 (0.015)	0.19 (0.012)	0.14	0.16 (0.0082)	0.13
Chromium[3]	0.14 (0.076)	0.10 (0.018)	0.15 (0.076)	0.0 (0.003)	0.16	0.136 (0.032)	0.15
Copper[3]	2.56 (0.319)	1.5 (0.11)	1.37 (0.31)	2.28 (0.07)	2.99	2.52 (0.255)	2.34
Lead[3]	0.48 (0.086)	0.3 (0.047)	0.4 (0.211)	0.57 (0.163)	0.53	0.665 (0.268)	0.37
Mercury[3]	0.017 (0.0006)	0.008 (0.002)	0.007 (0.002)	0.016 (0.000)	0.01	0.019 (0.001)	0.01
Nickel[3]	0.44 (0.044)	0.367 (0.091)	0.33 (0.04)	0.423 (0.015)	0.52	0.468 (0.021)	0.59
Zinc[3]	27.8 (1.3)	24.7 (0.87)	25.7 (1.1)	29.5 (0.15)	19.7	27.9 (1.22)	18.3

[1] Units are µg/kg wet wt.
[2] Total PCBs are 18 NOAA NS&T congeners x 2.
[3] Units are mg/kg wet wt.
[4] CLDS EIS April 2004; average of 3 *Nephtys* replicates each from stations FVP and NHAV93.
[5] CLDS EIS April 2004; average of 3 *Nephtys* replicates from the CLDS reference station.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The 2016 survey at CLDS was designed to evaluate the short-term and long-term fate of dredged material disposed at the site and to assess potential environmental impacts from the use of CLDS for dredged disposal. This was achieved through an acoustic survey over the active disposal area, and a sediment profile imaging survey and benthic sampling over historical and recently used disposal areas coupled with sediment sampling for chemical analysis and collection of non-motile benthic organisms for analysis of tissue chemistry.

5.1 Material Stability

- Disposal of approximately 102,000 m^3 of dredged material during the 2015/2016 season was successfully coordinated for CLDS. An acoustic survey delineated the disposal of material following the dredging season, and revealed relatively even distribution of material with elevation differences of ~1-3 m.
- Apart from expected areas of accumulation associated with recent disposal activity and expected areas of consolidation of dredged material mounds after initial disposal, there was no evidence of significant sediment transport within the area surveyed.

5.2 Benthic Recovery

- The SPI/PV data and benthic community analysis surveys documented the recovery of the benthic community at historical and recent disposal locations within CLDS. The presence of organic-rich sediment at the historical mound MQR, the subsurface sediment with higher apparent SOD at FVP, as well as the recently disposed material at NHAV14, all resulted in shallower aRPDs at these areas.
- Recovery at the historical locations reaffirmed that with a cessation in disposal activity, communities will recover. The recovery of advanced successional taxa in the actively remediated areas showed the speed at which recovery of benthic communities can often take given favorable conditions.
- FVP, a deposit of unsuitable dredged material left intentionally exposed as a long-term investigation of monitoring techniques by EPA and USACE, had lower infaunal abundances, as well as a statistically significant difference in the assemblage, suggesting that while advanced successional taxa exist at FVP, some aspects of community structure are partially arrested.
- The community composition of some historical disposal mounds was different from ambient, but functionally the benthic communities at the disposal and reference areas were similar.

5.3 Sediment and Tissue Chemistry

- In general, sediment contaminant concentrations were at or below ambient levels as measured in samples within one km of the disposal site (90/90 UTLs). Selected COCs were elevated relative to reference areas in several disposal site samples, especially at FVP, NHAV14, and to a more limited extent, MQR.

- The NHAV14 management area had elevated COCs relative to reference primarily in two stations on the northern boundary of NHAV14 suggesting that historical dredged material, possibly placed prior to the onset of testing and monitoring protocols, was not adequately covered. The presence of these sediments at the surface is a concern and should be managed with disposal of suitable dredged material.
- The FVP mound contained several elevated COCs that exceeded reference and ambient concentrations, consistent with the combination of Black Rock Harbor and ambient sedimentation at the surface of this mound. Tissue concentrations were not concomitantly elevated, although this could be due to the spatial disparity between sediment and tissue samples. The presence of pesticide and metal contaminants at levels above the ER-L level at sites other than FVP (above which biological effects may begin to occur) are likely driven by background levels as evidenced by similar concentrations at the reference areas and compared to ambient conditions in the vicinity of the disposal site.
- Tissue concentrations were generally within the range measured in reference, with the exception of total PAHs, and to a lesser extent total PCBs, in samples from NHAV14. The lack of contaminants measured in sediment samples collected from a wide variety of CLDS deposits is consistent with relatively low levels of sediment concentrations.

5.4 Reference Areas

- The performance of a multibeam acoustic survey over the reference areas provided a first-time detailed mapping of the seafloor over these areas. Coupled with the SPI/PV imagery and the sediment and tissue chemistry results, these data revealed no indication of historical dredged material disposal over the reference areas. Hence, use of these three areas should be continued in assessing conditions at CLDS.

5.5 Recommendations

- Although sediment and tissue concentrations were relatively low amongst survey samples, targeted placement of dredged material at MQR, FVP, and along the northern margin of NHAV14 is recommended as a prudent management action to sequester the elevated sediment concentrations.
    - Sufficient information has been collected from the study of FVP regarding monitored natural recovery of dredged material with elevated COCs. With the focused collection of sediment samples that document the COC concentrations after decades on the seafloor, cessation of the study and covering this site with suitable dredged material is recommended.
    - The presence of a wide range of sediment types at MQR and the patchy distribution of newer dredged material indicated that the mound would benefit from additional cover material to ensure all unsuitable material has been isolated.
    - The lower aRPD values at MQR and NHAV14 should be evaluated through additional SPI sampling after any placement has been completed.

- Given the potential for lower sediment quality related to historical disposal at CLDS (prior to requirements for sediment testing), the general management approach for disposal at this site should continue with broad coverage over areas identified as historically receiving dredged material.

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MONITORING SURVEY AT THE CENTRAL LONG ISLAND SOUND DISPOSAL SITE SEPTEMBER/OCTOBER 2016

FIGURES

CONTRIBUTION #202

March 2021

Contract No. W912WJ-12-D-0004

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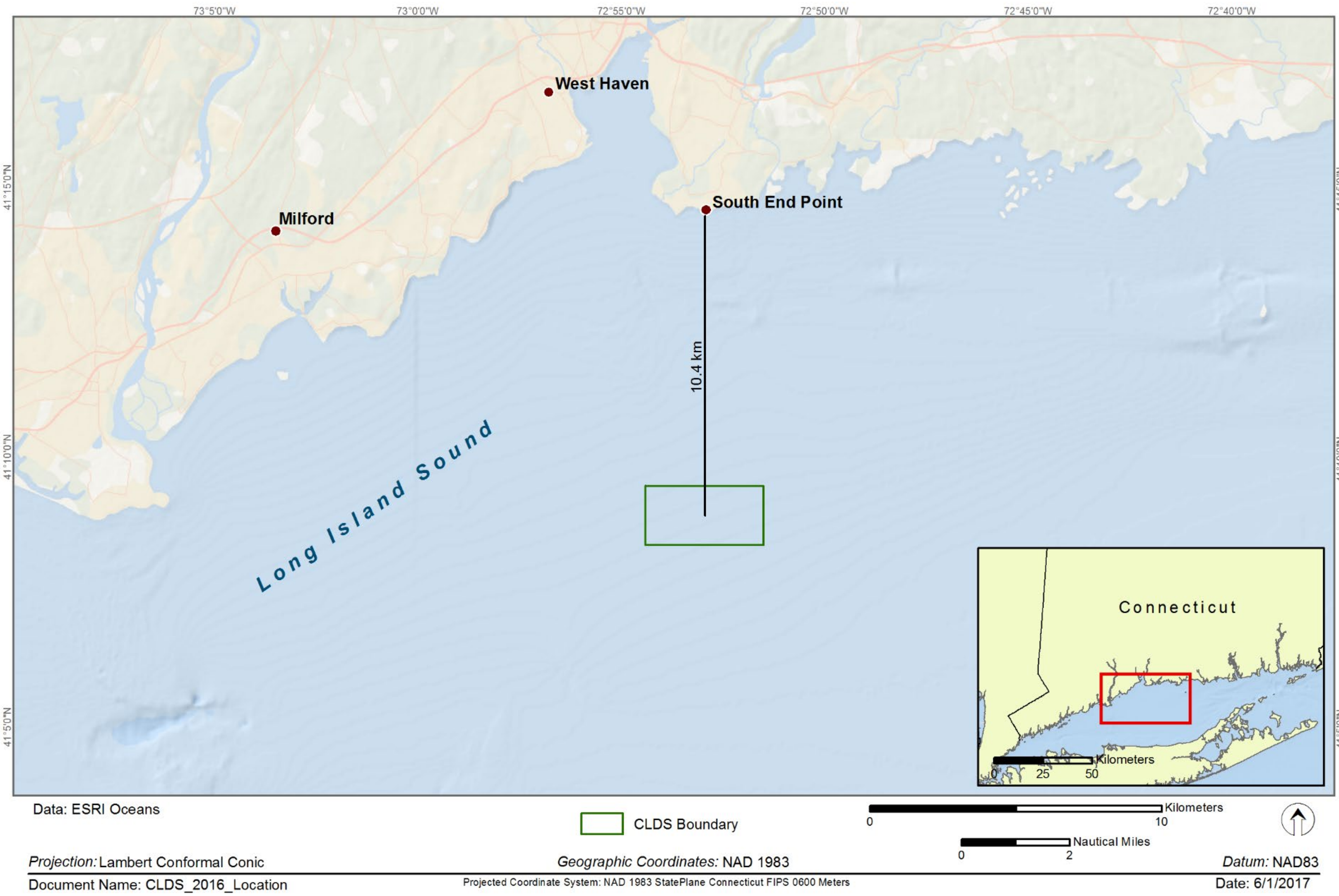


Figure 1-1. Location of the Central Long Island Sound Disposal Site (CLDS)

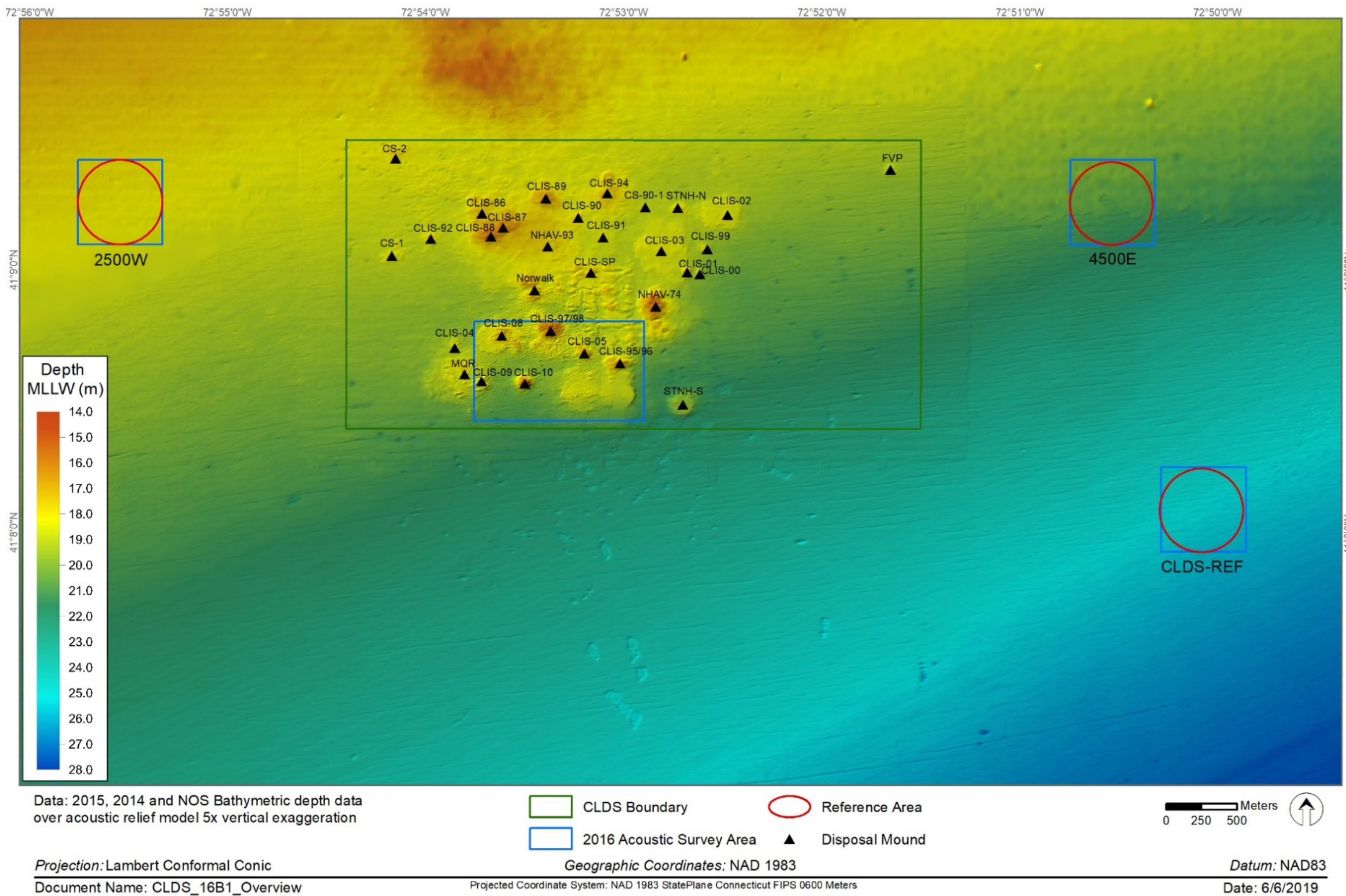
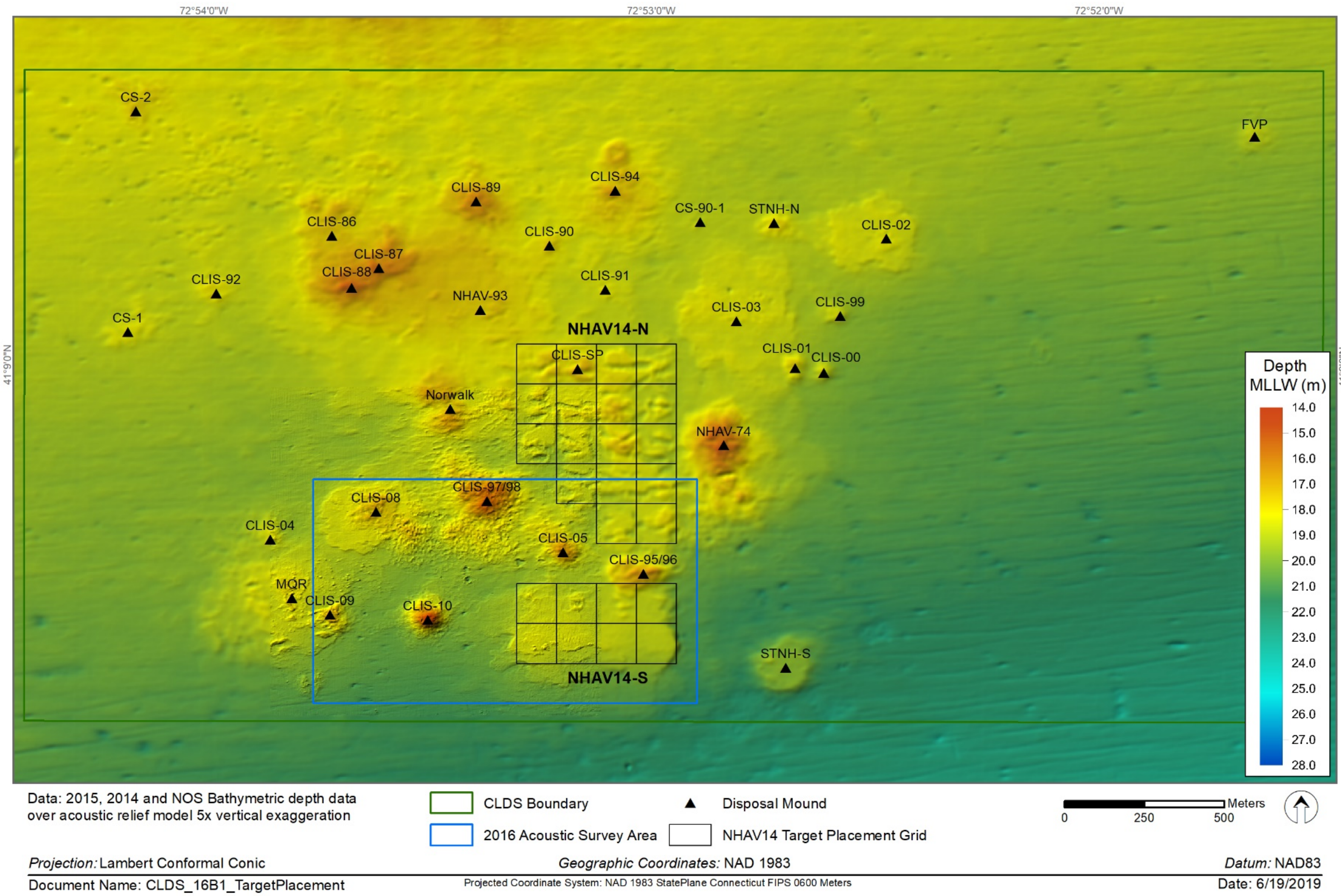


Figure 1-2. Overview of CLDS boundary with disposal mound designations and location of reference areas



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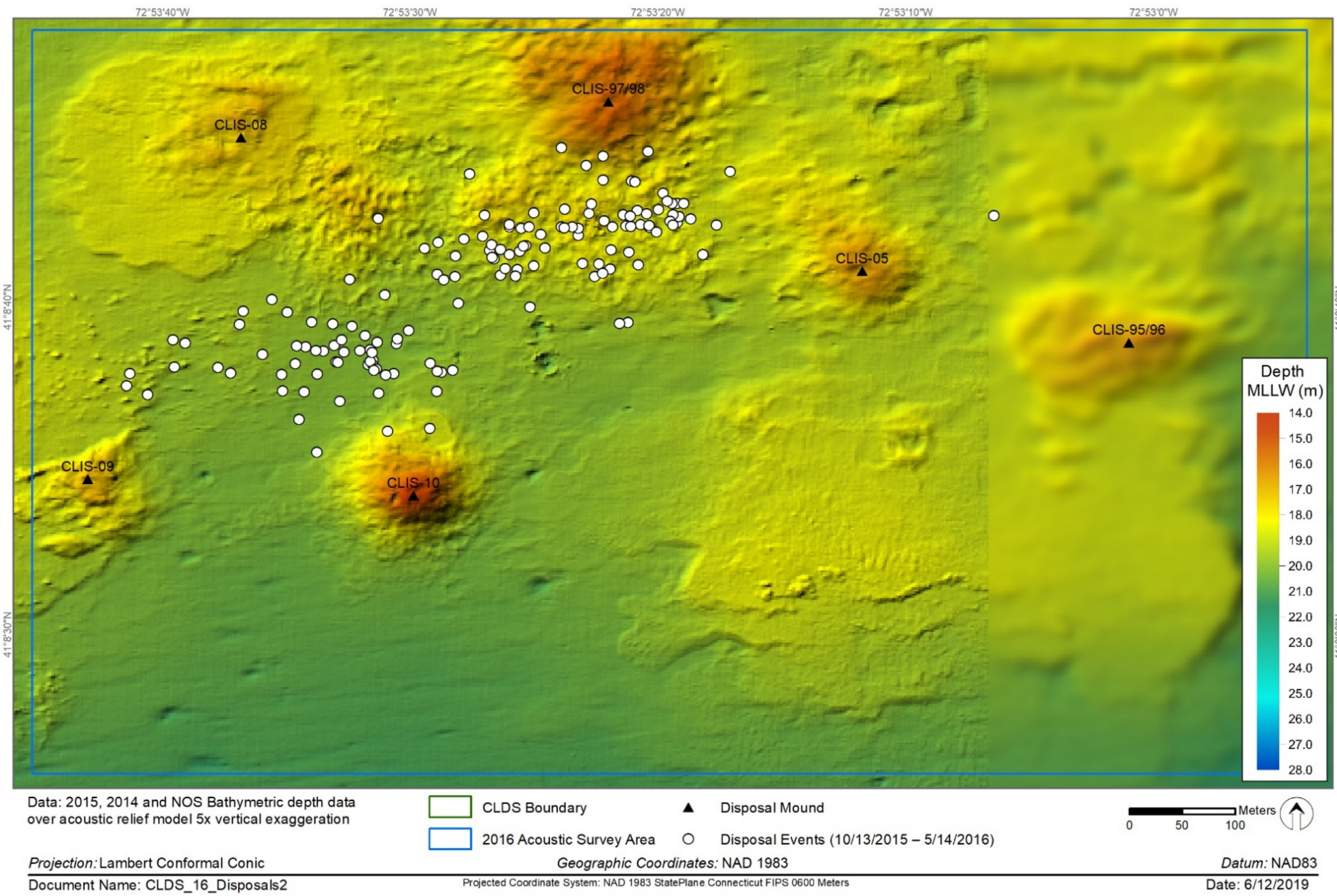


Figure 1-4. Location of reported disposal events in the southern portion of CLDS from October 2015 to May 2016

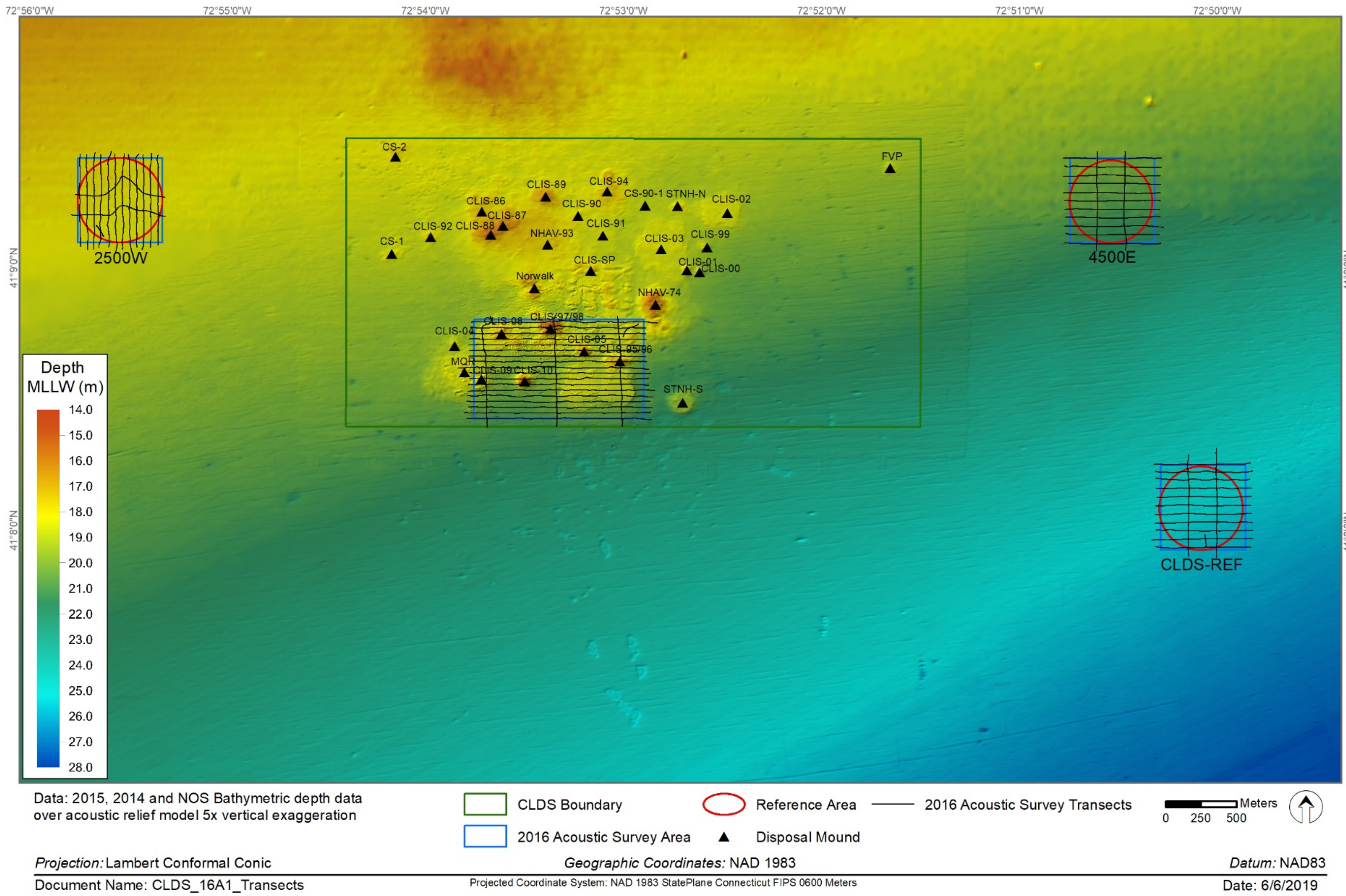


Figure 2-1. CLDS 2016 acoustic survey area and tracklines

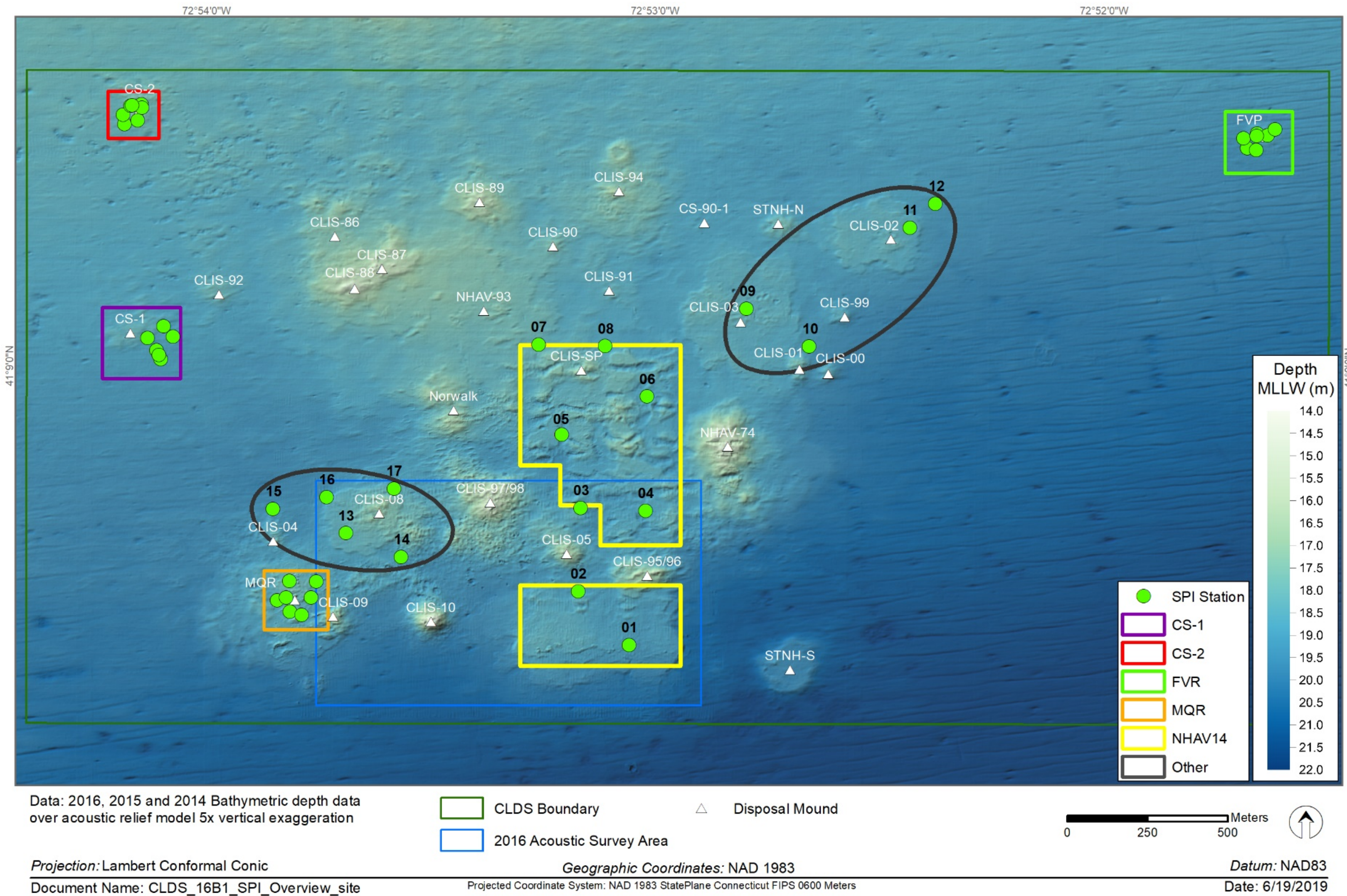


Figure 2-2. Sediment profile and plan view station locations within CLDS

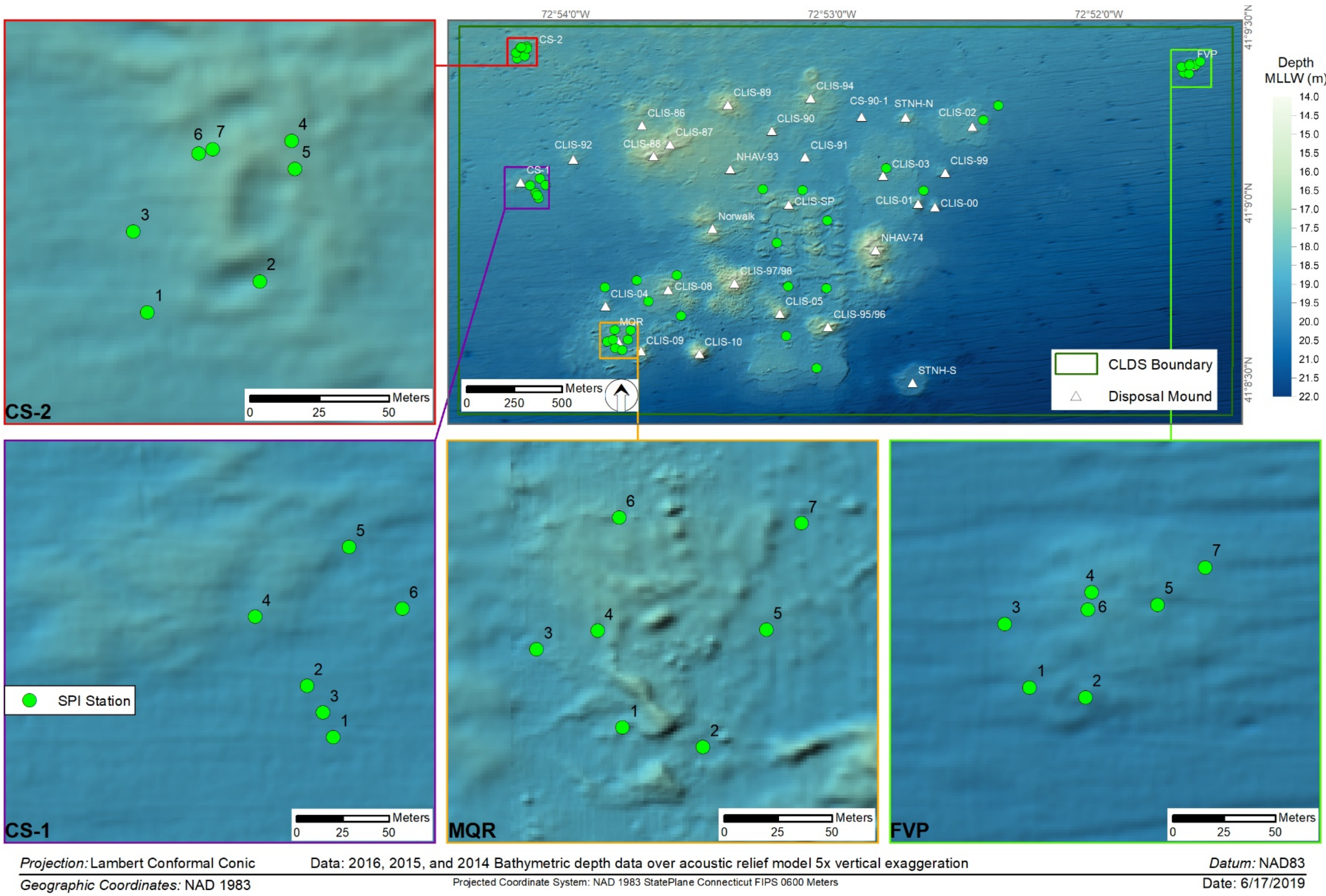


Figure 2-3. Sediment profile and plan view station locations at the CLDS CS-1, CS-2, MQR, and FVP mounds

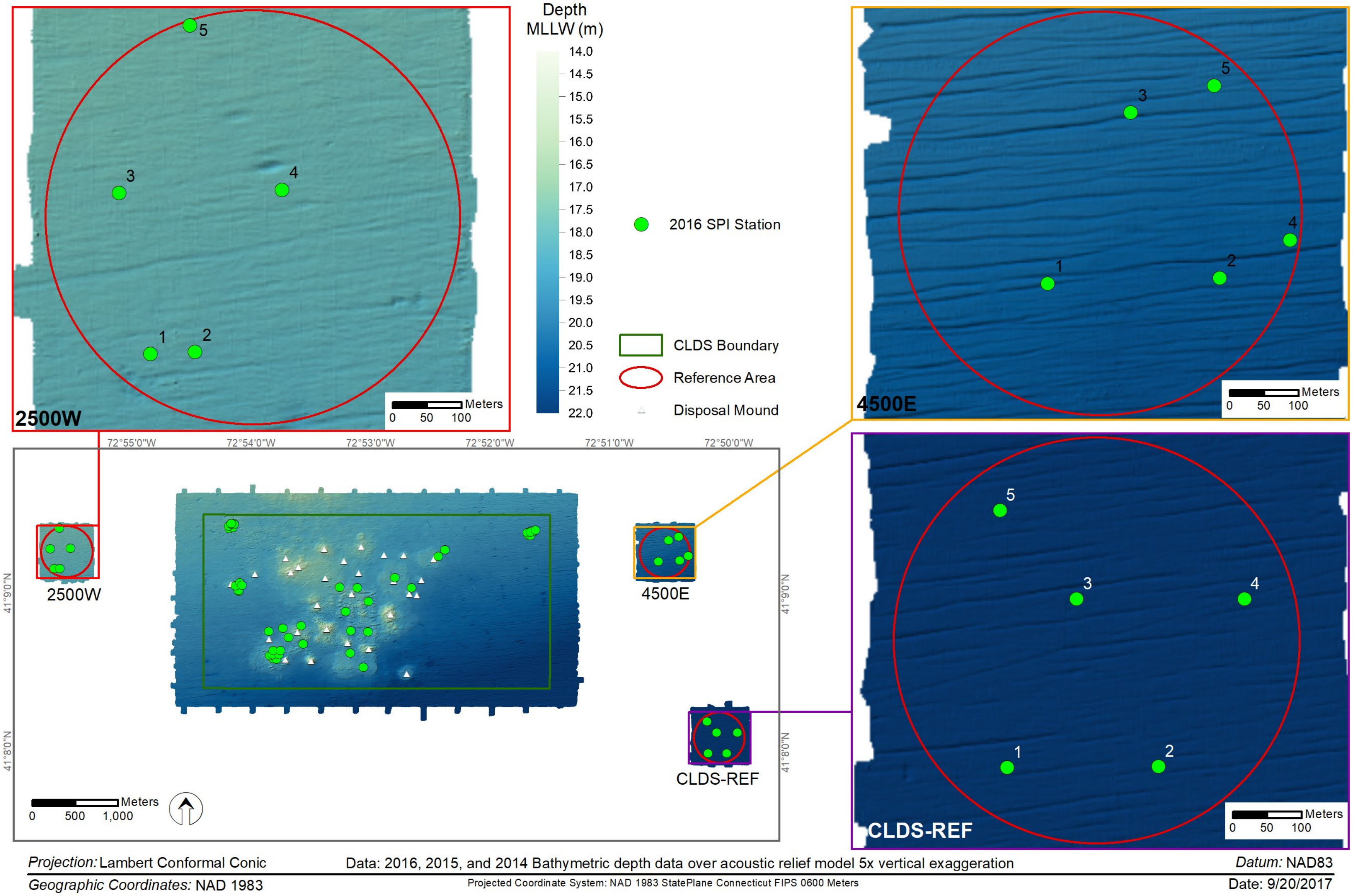
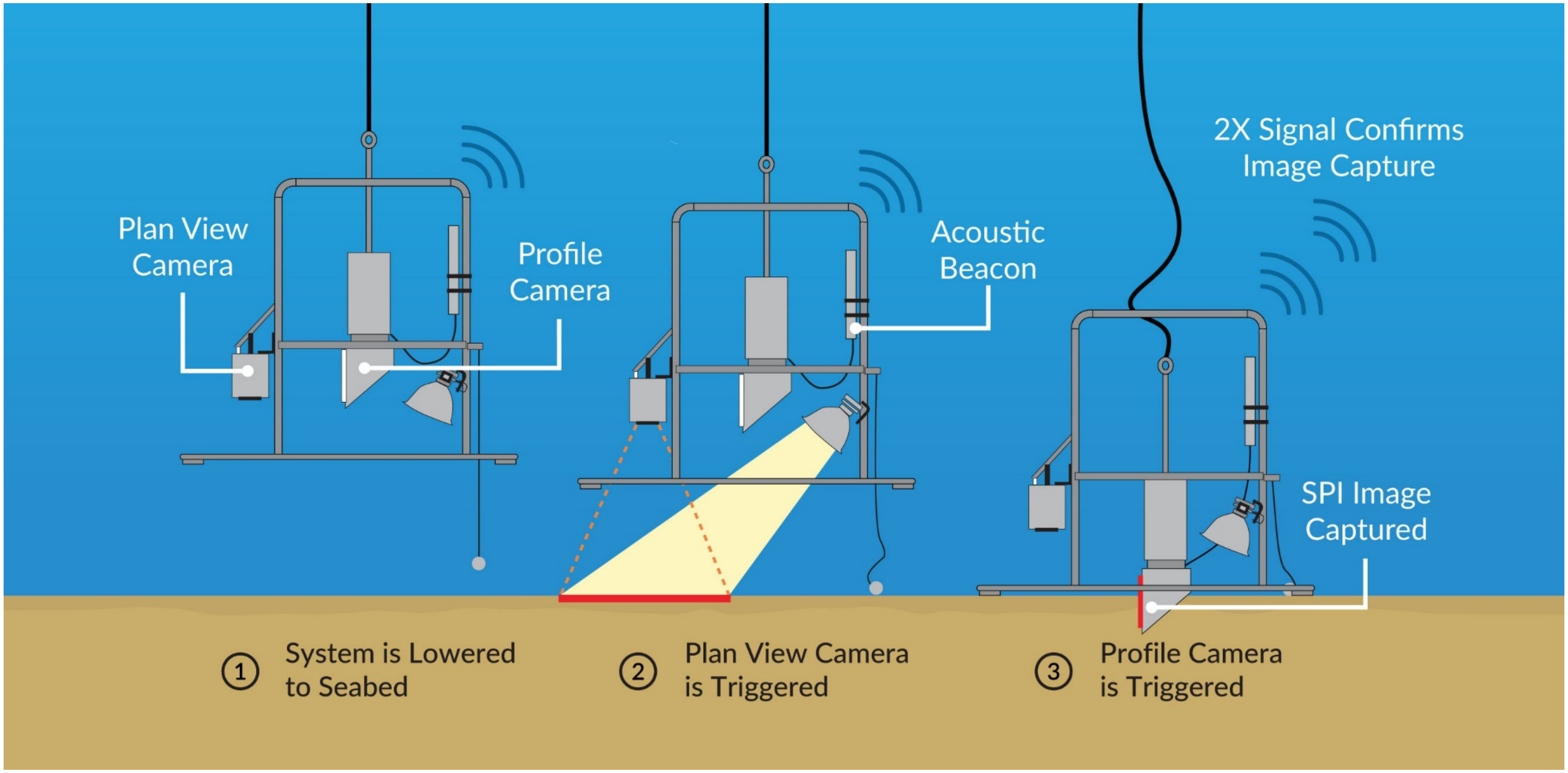


Figure 2-4. Sediment profile and plan view station locations at the CLDS reference areas



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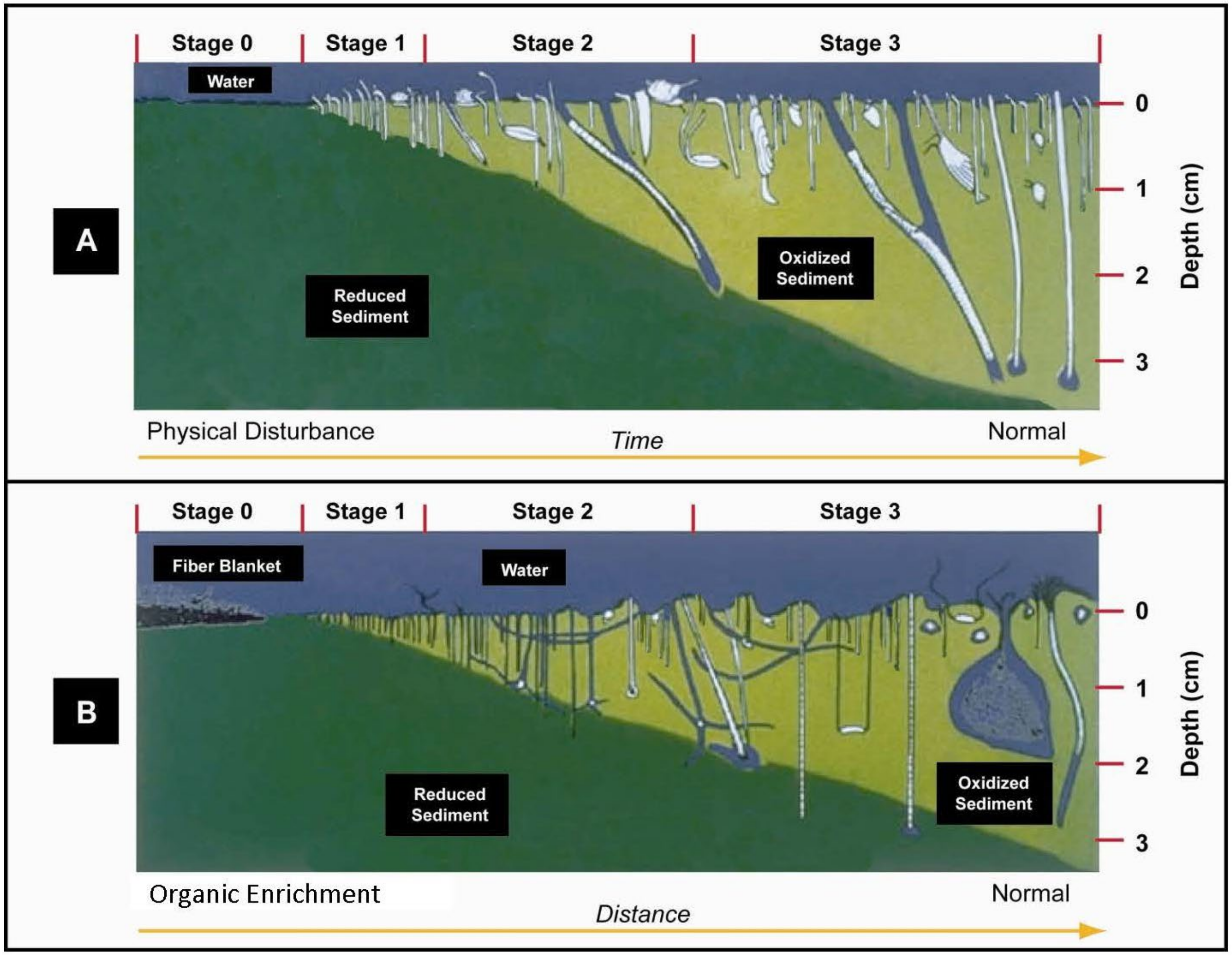

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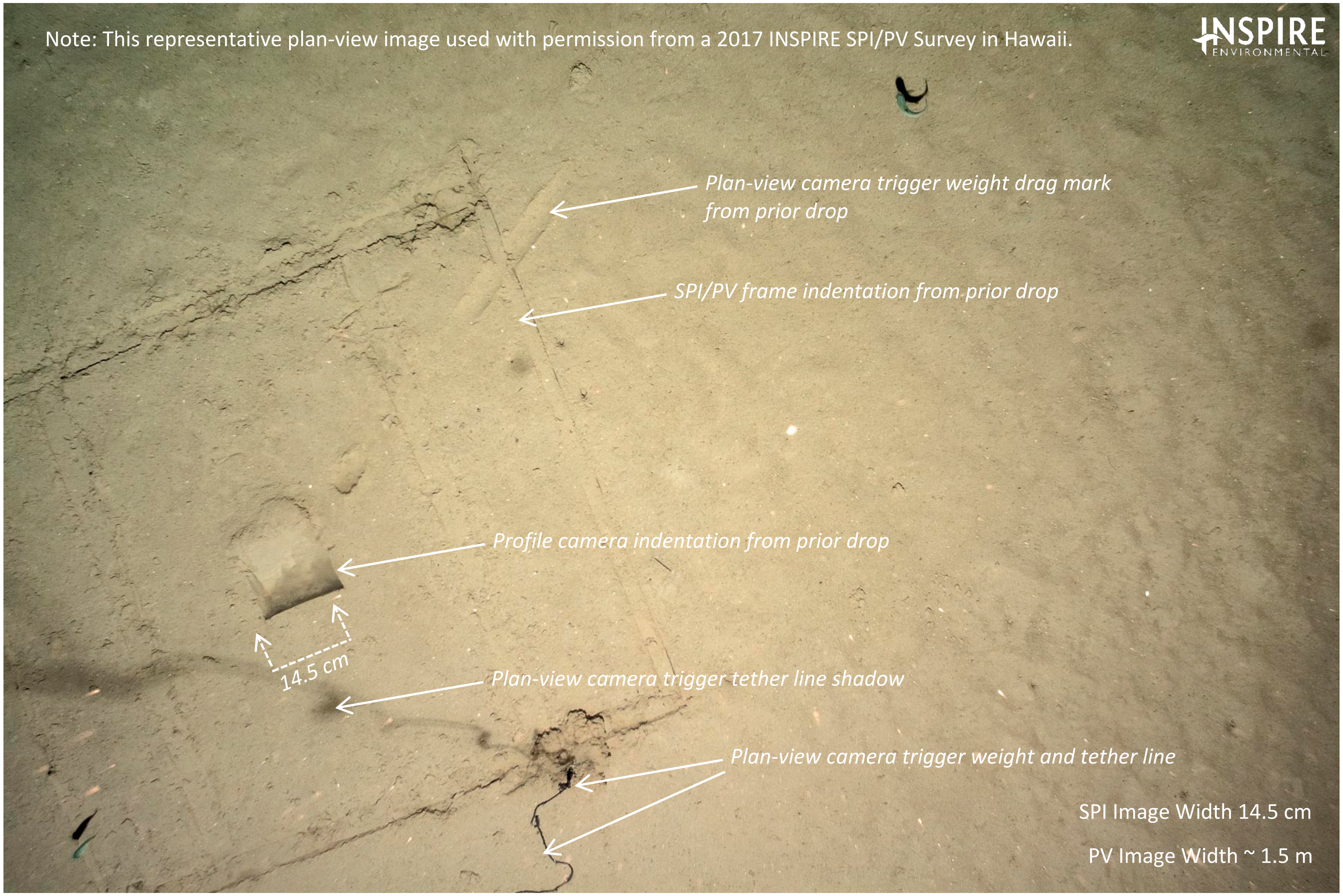


Figure 2-7. This representative plan view image shows the sampling relationship between plan view and sediment profile images. Note: plan view images differ between surveys and stations and the area covered by each plan view image may vary slightly between images and stations.

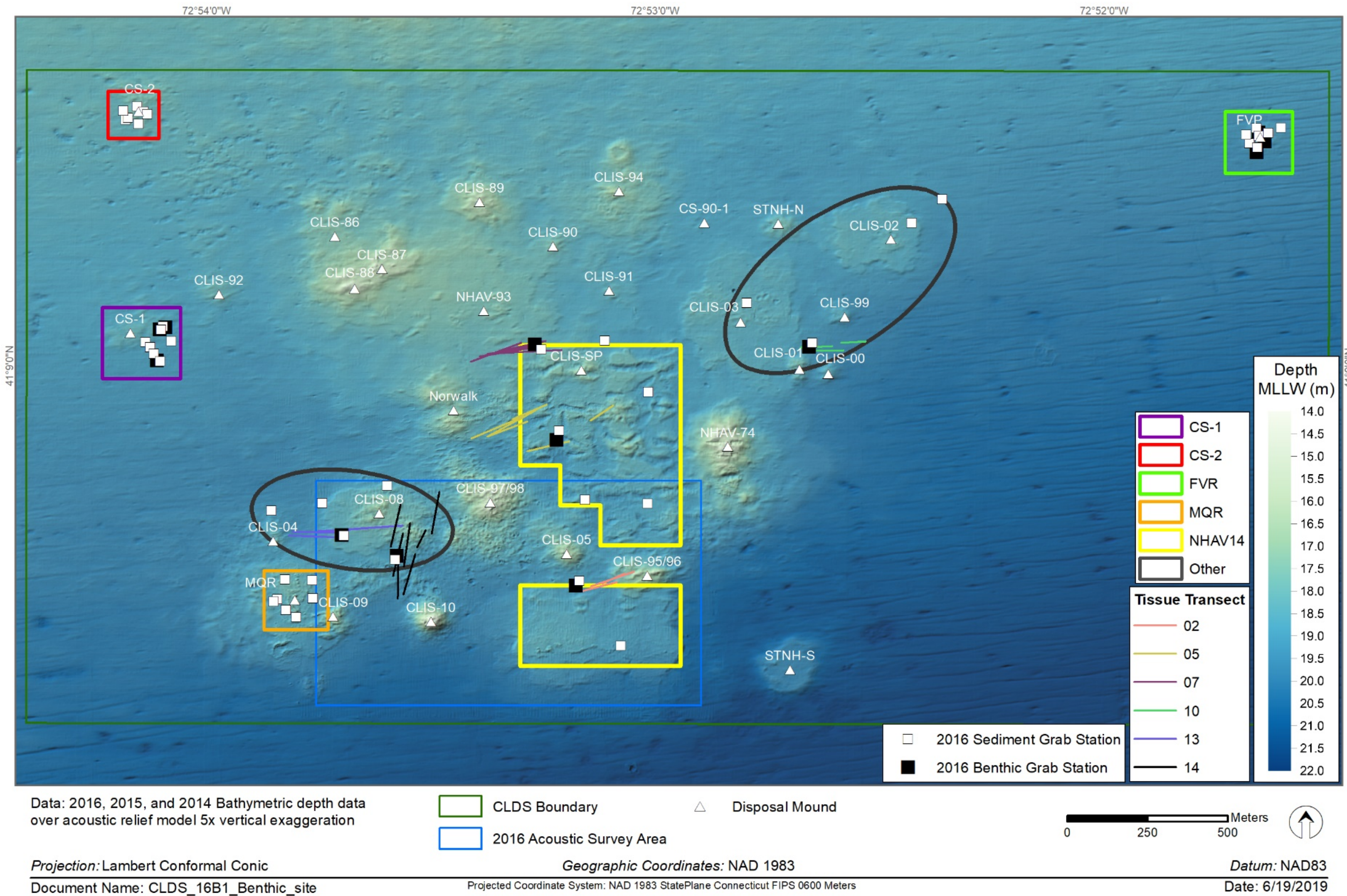


Figure 2-8. Sediment grab and tissue transect locations within CLDS

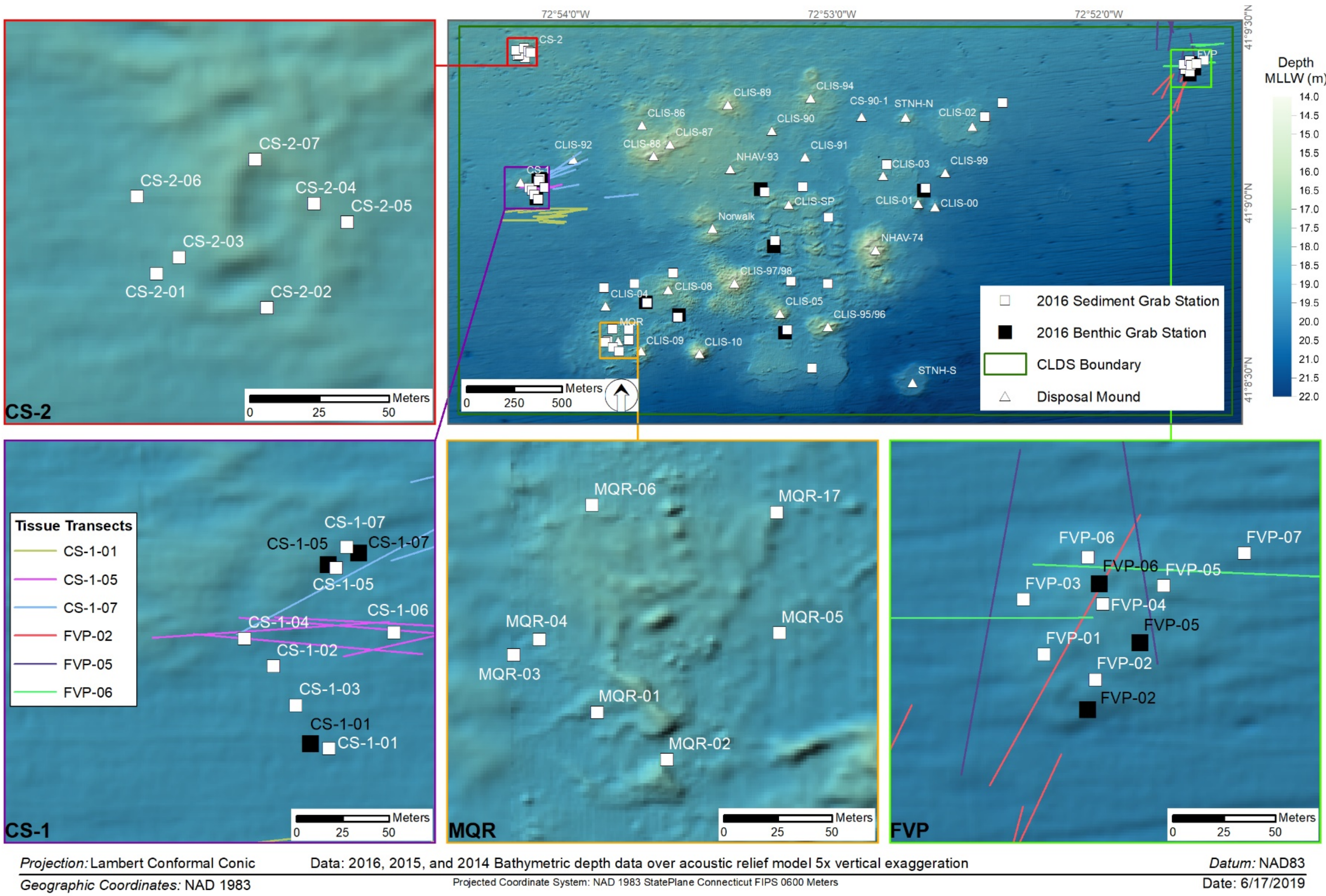


Figure 2-9. Sediment grab station locations at the CLDS CS-1, CS-2, MQR, and FVP mounds

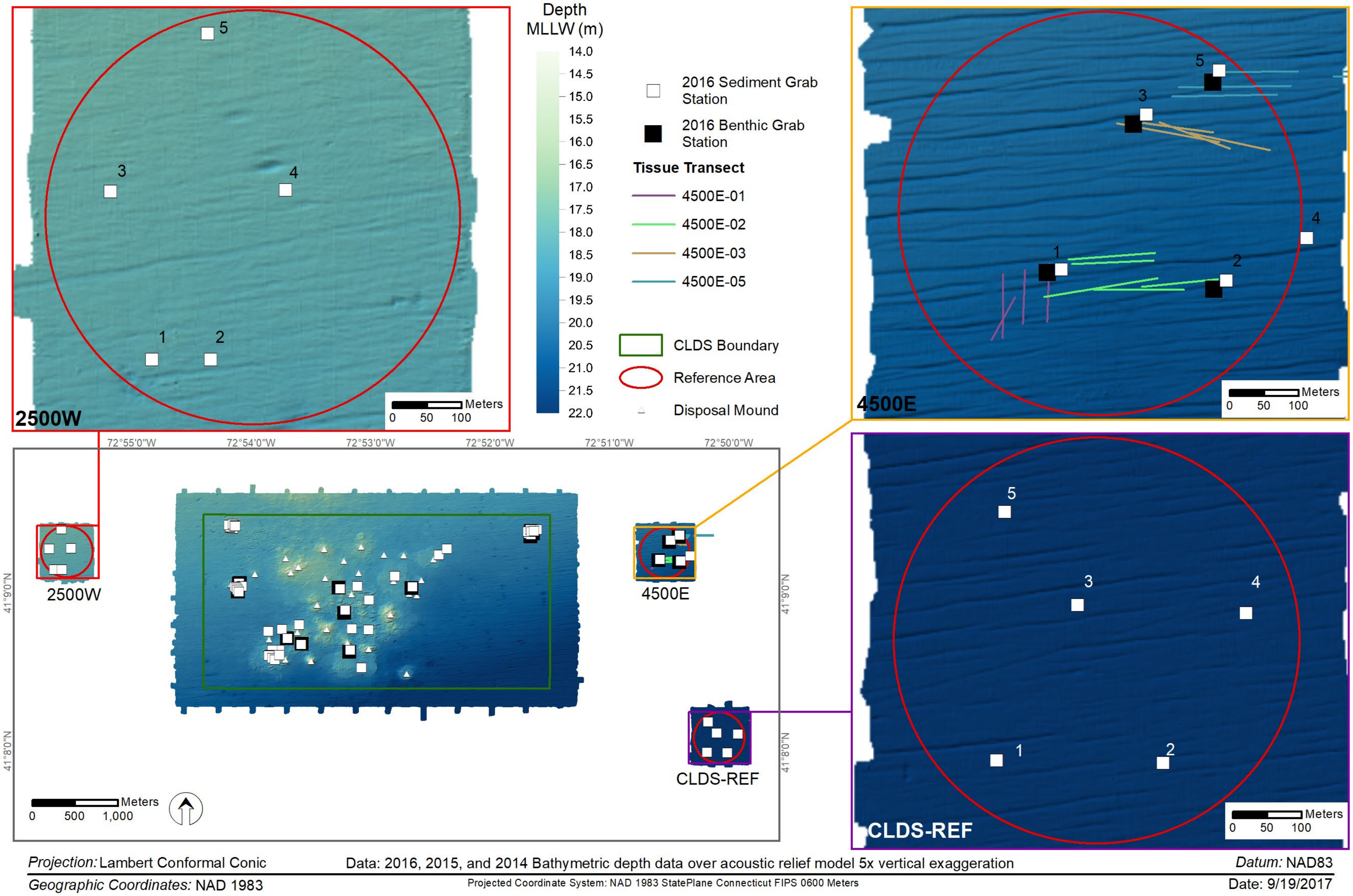


Figure 2-10. Sediment grab and tissue transect locations at the CLDS reference areas

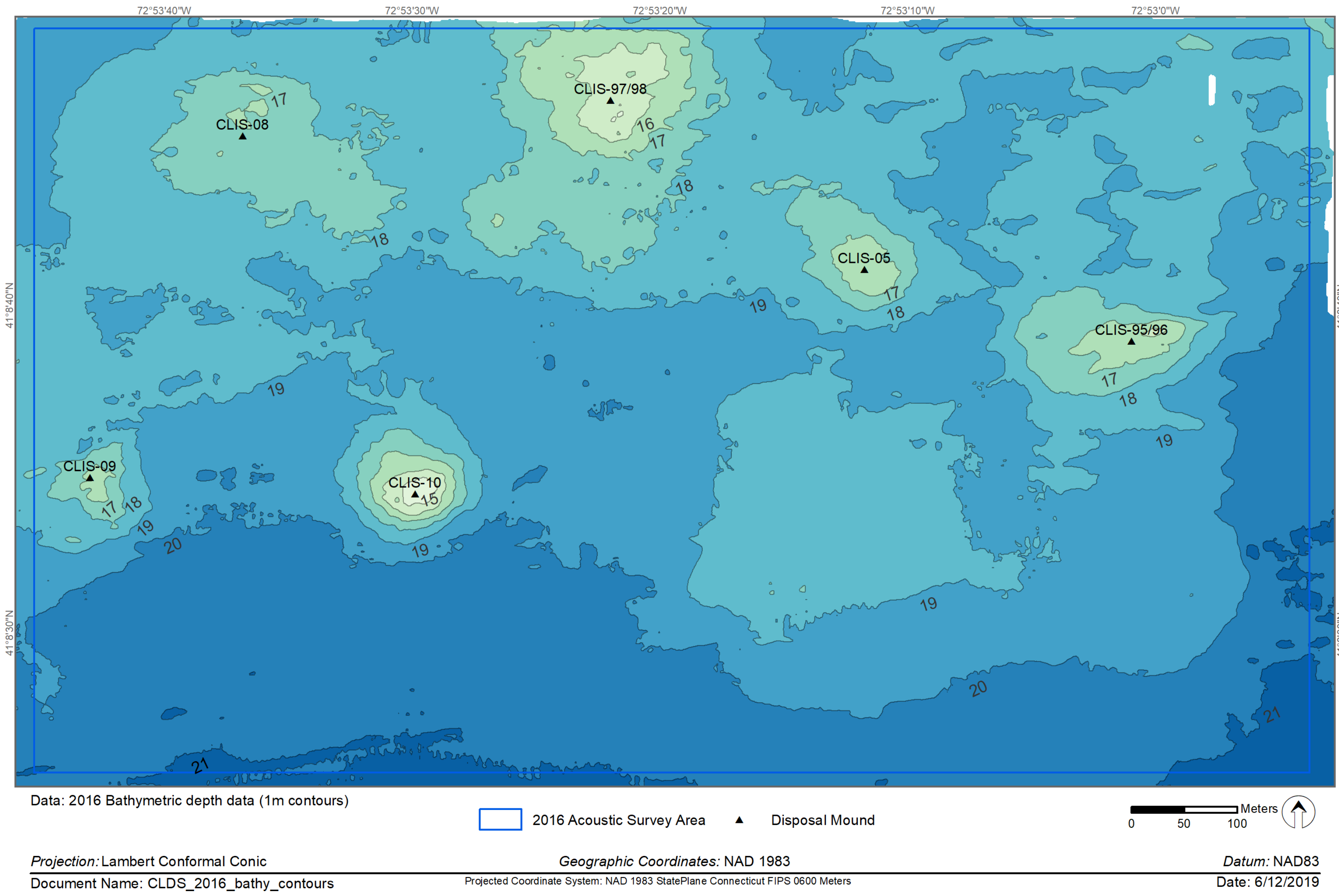


Figure 3-1. Bathymetric contour map of the south-central portion of CLDS - September 2016

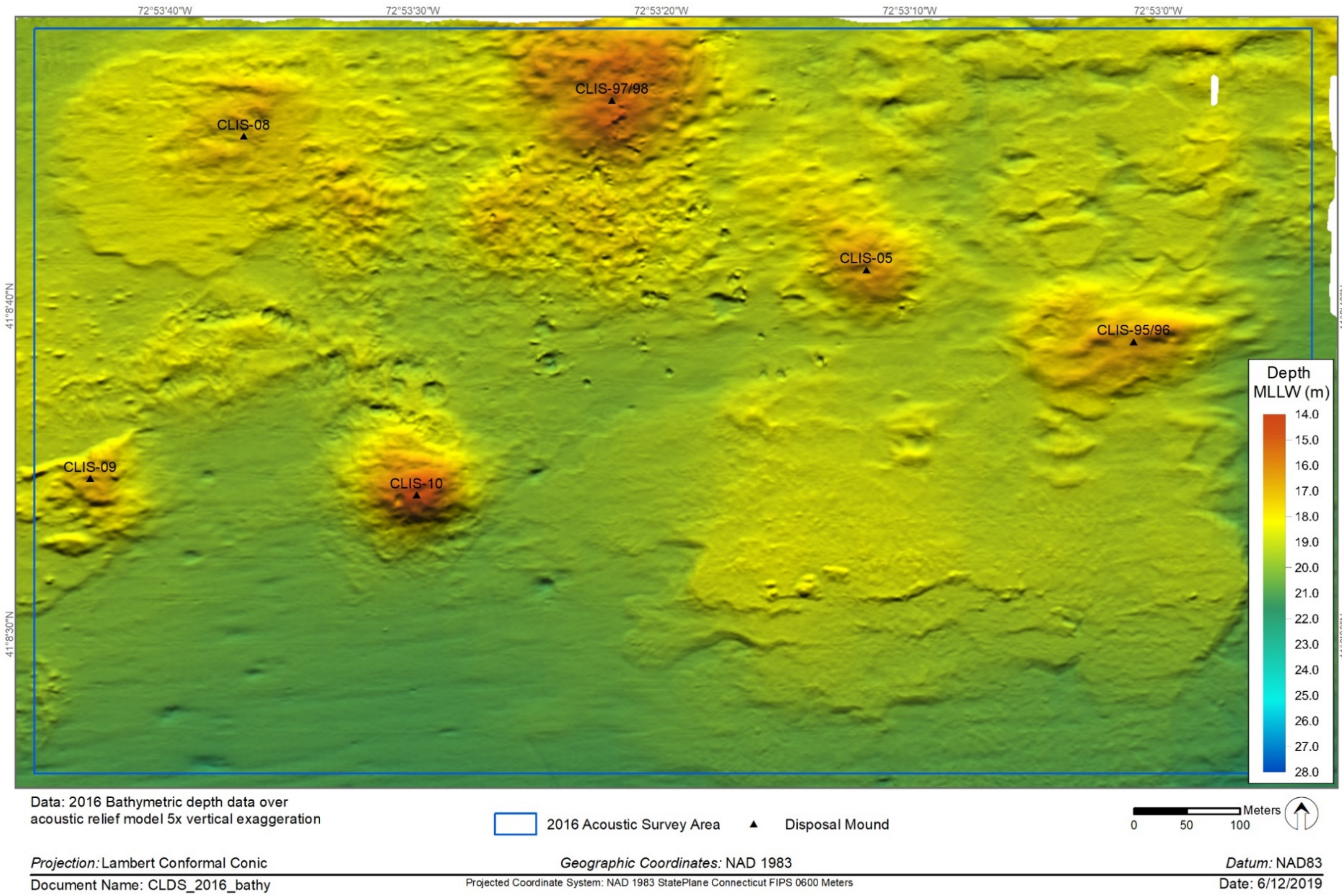
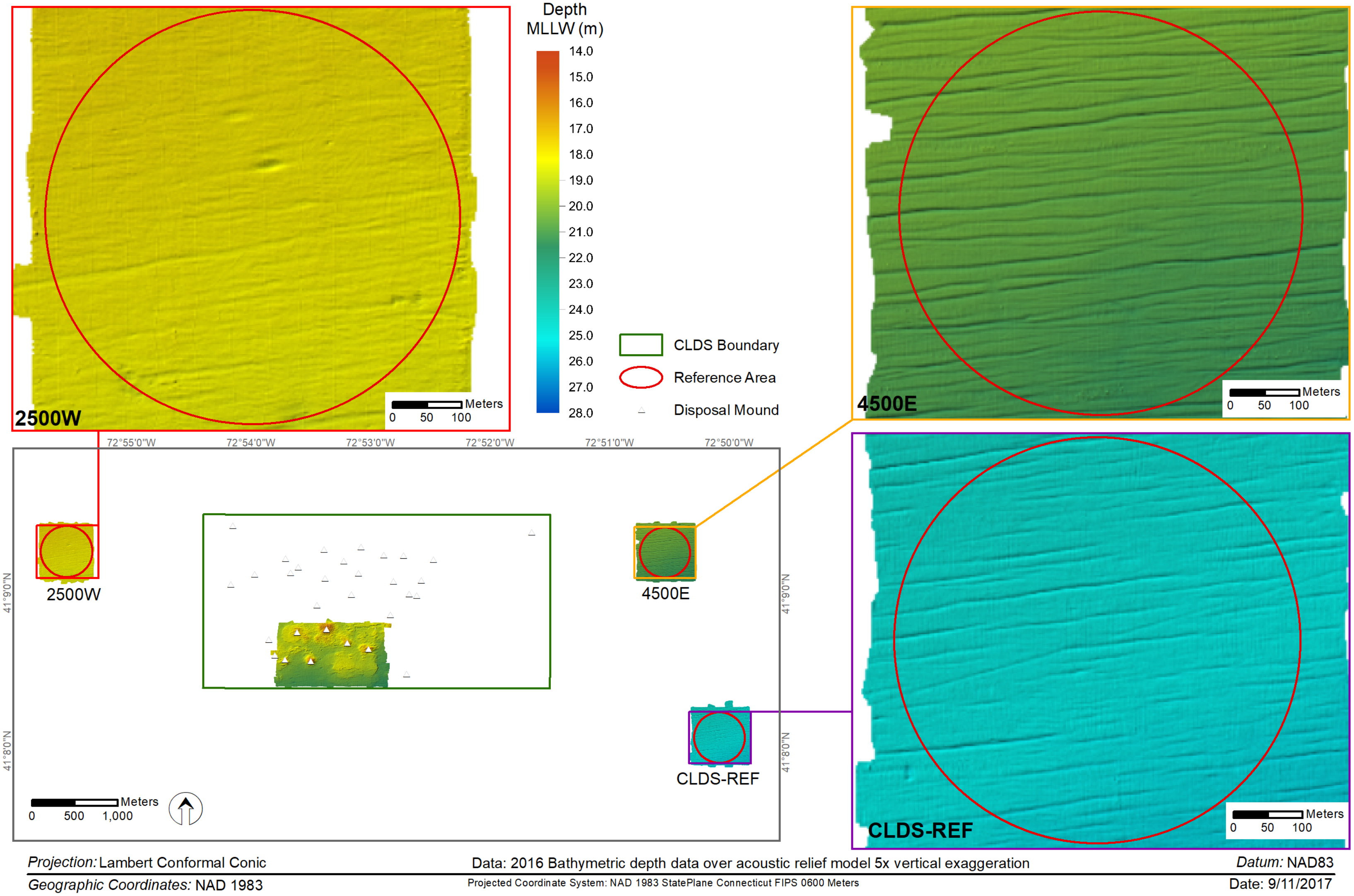


Figure 3-2. Bathymetric depth data over acoustic relief model of the south-central portion CLDS - September 2016



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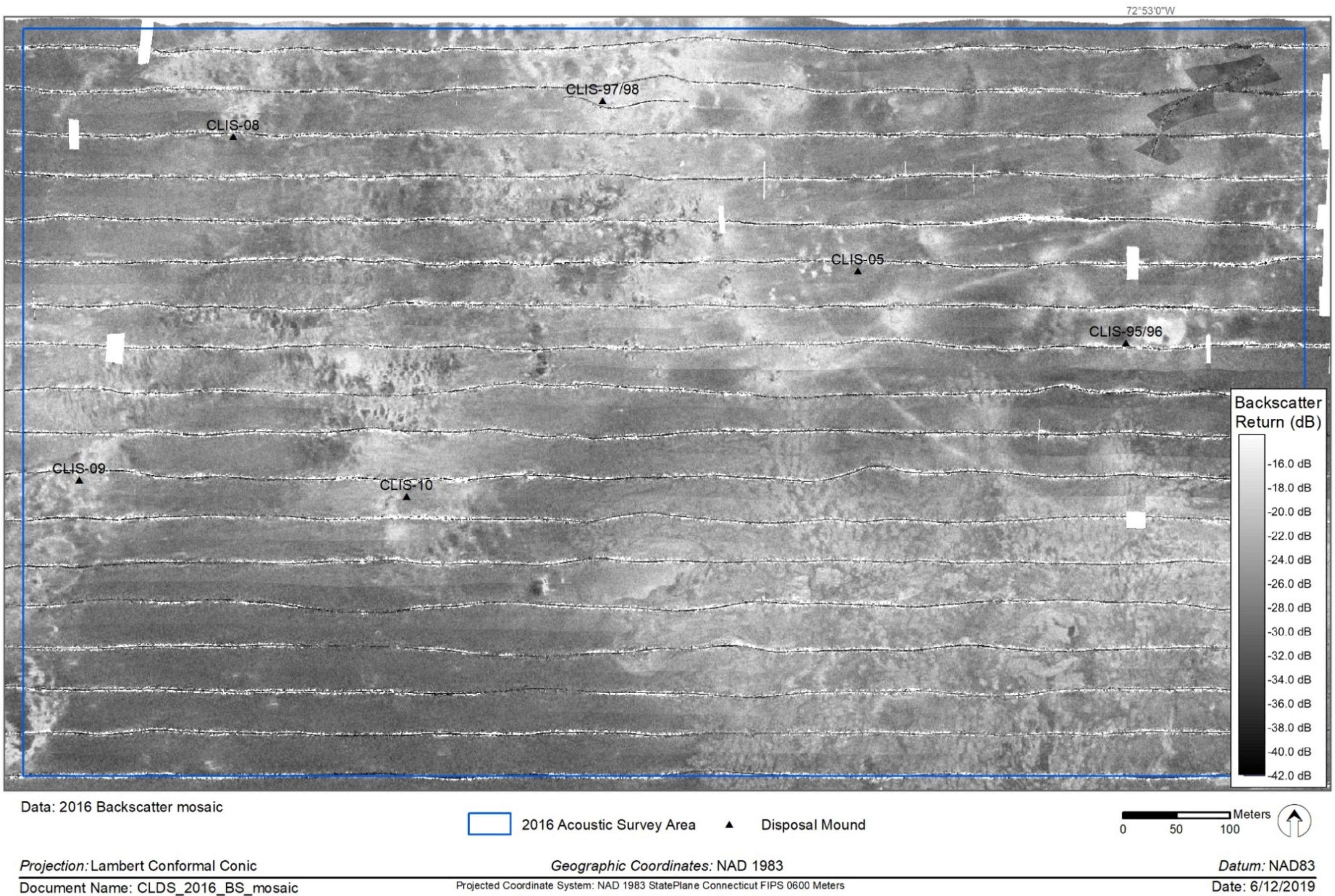


Figure 3-4. Mosaic of unfiltered backscatter data of the south-central portion CLDS - September 2016

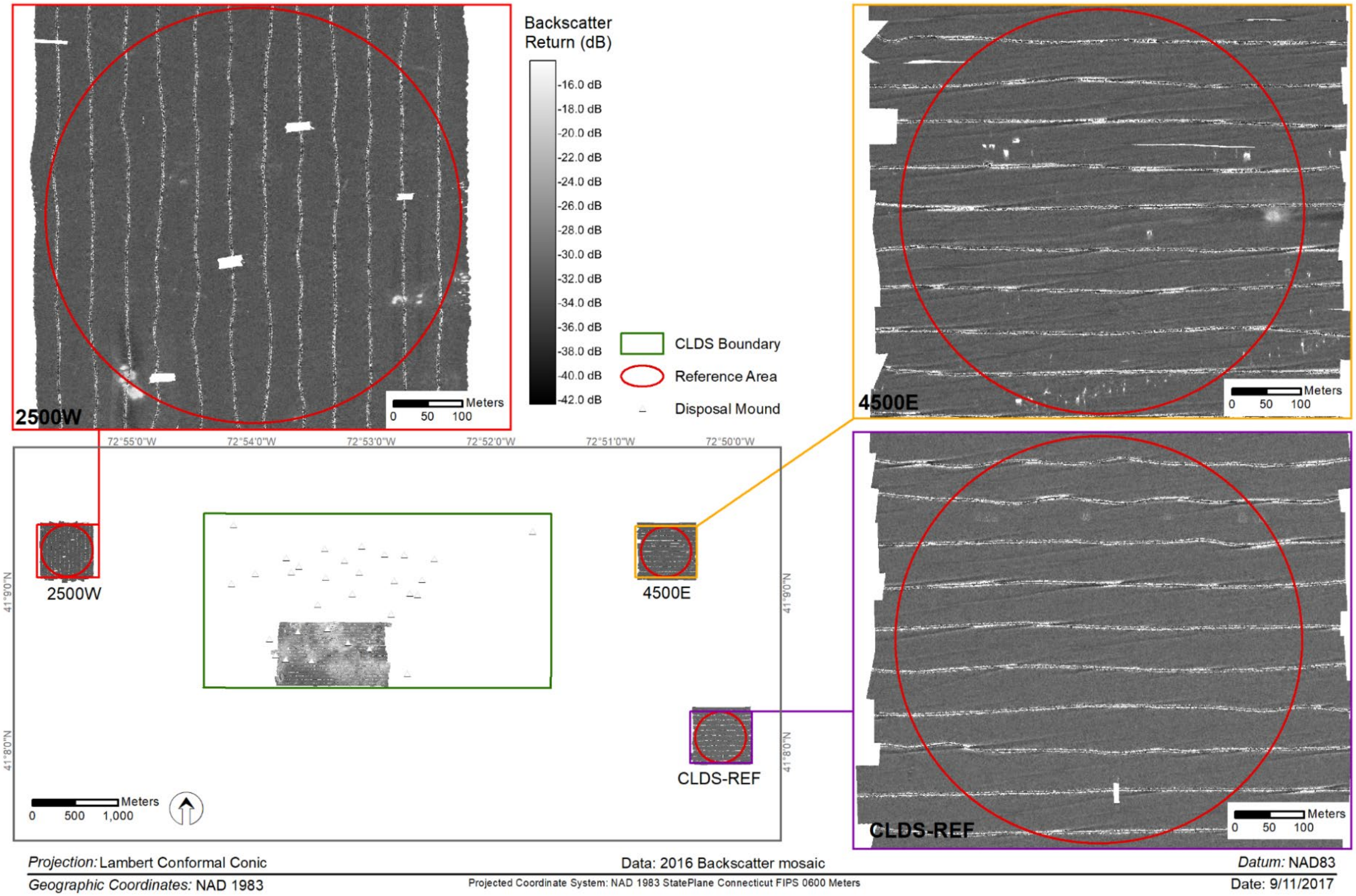


Figure 3-5. Mosaic of unfiltered backscatter data of CLDS reference areas - September 2016

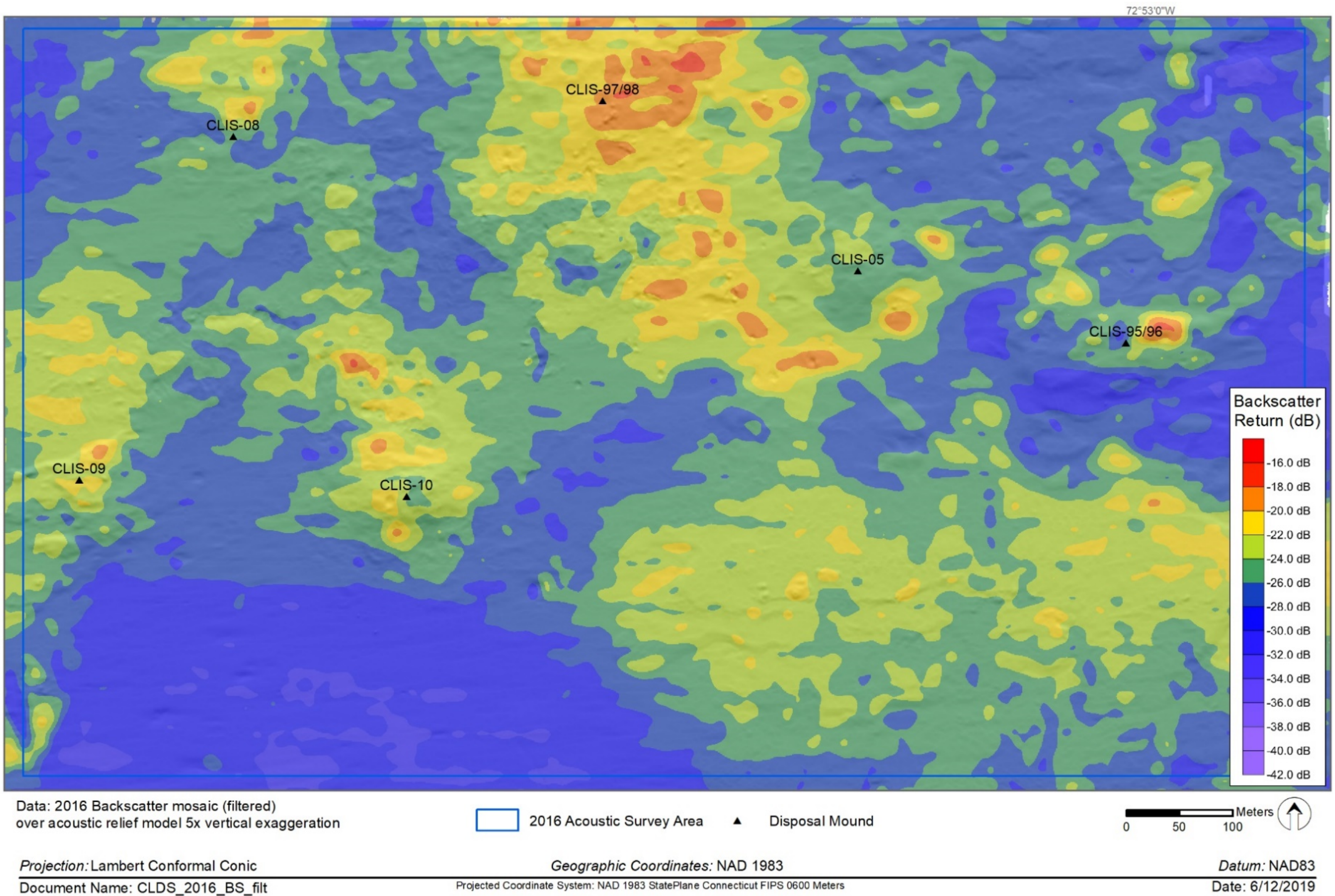


Figure 3-6. Filtered backscatter model of the south-central portion CLDS - September 2016

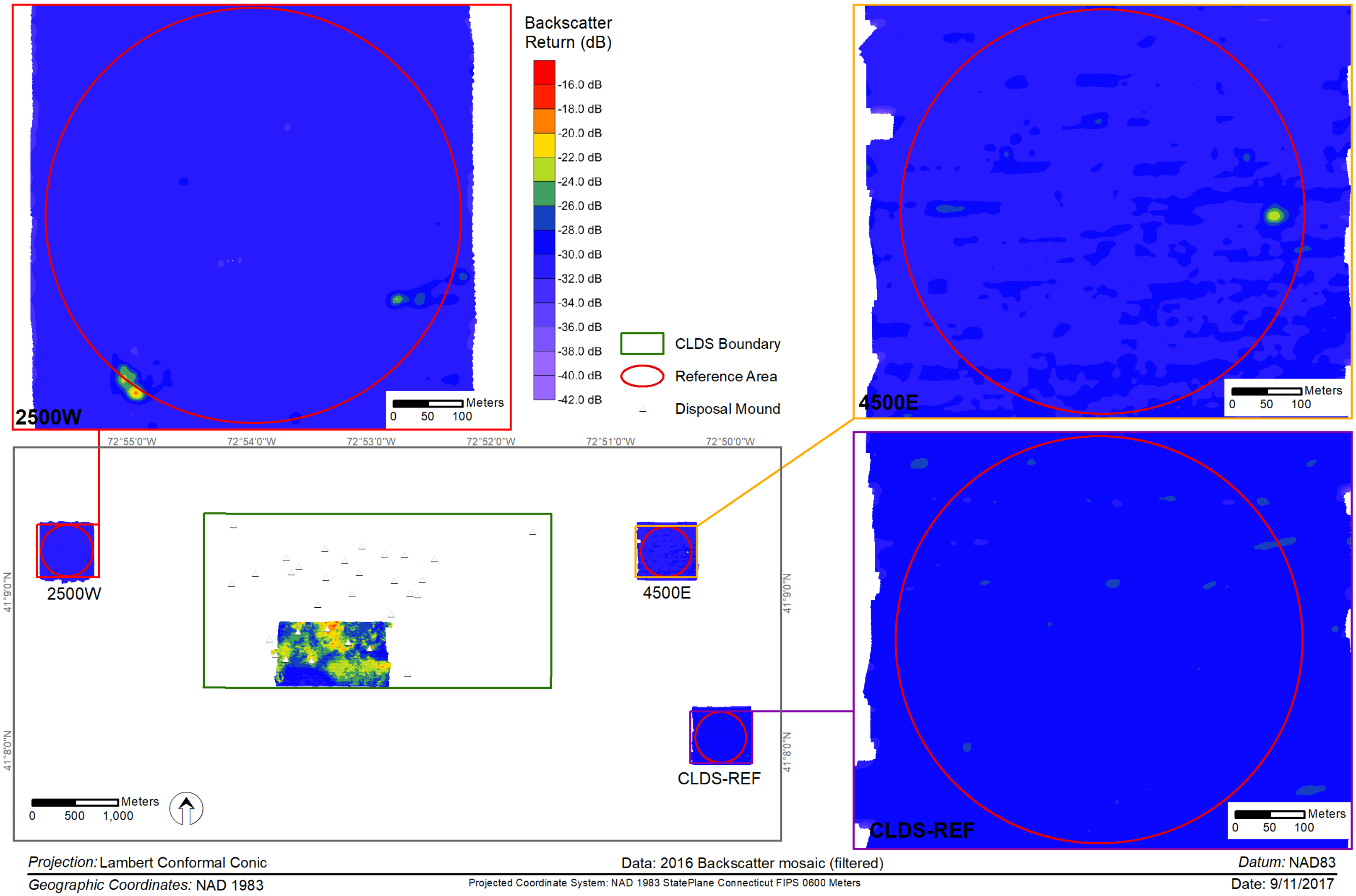


Figure 3-7. Filtered backscatter model of CLDS reference areas - September 2016

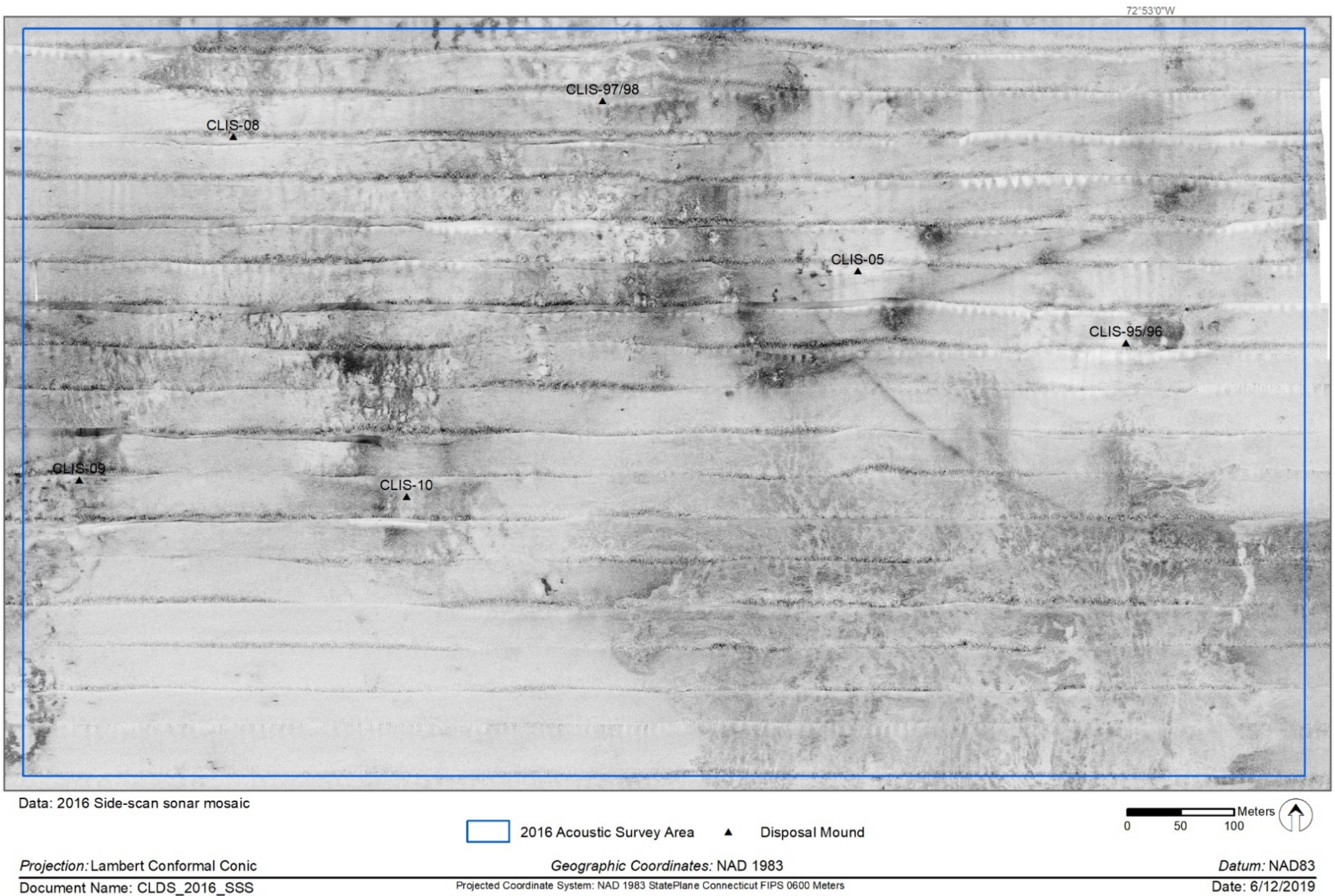


Figure 3-8. Side-scan sonar mosaic of the south-central portion CLDS - September 2016

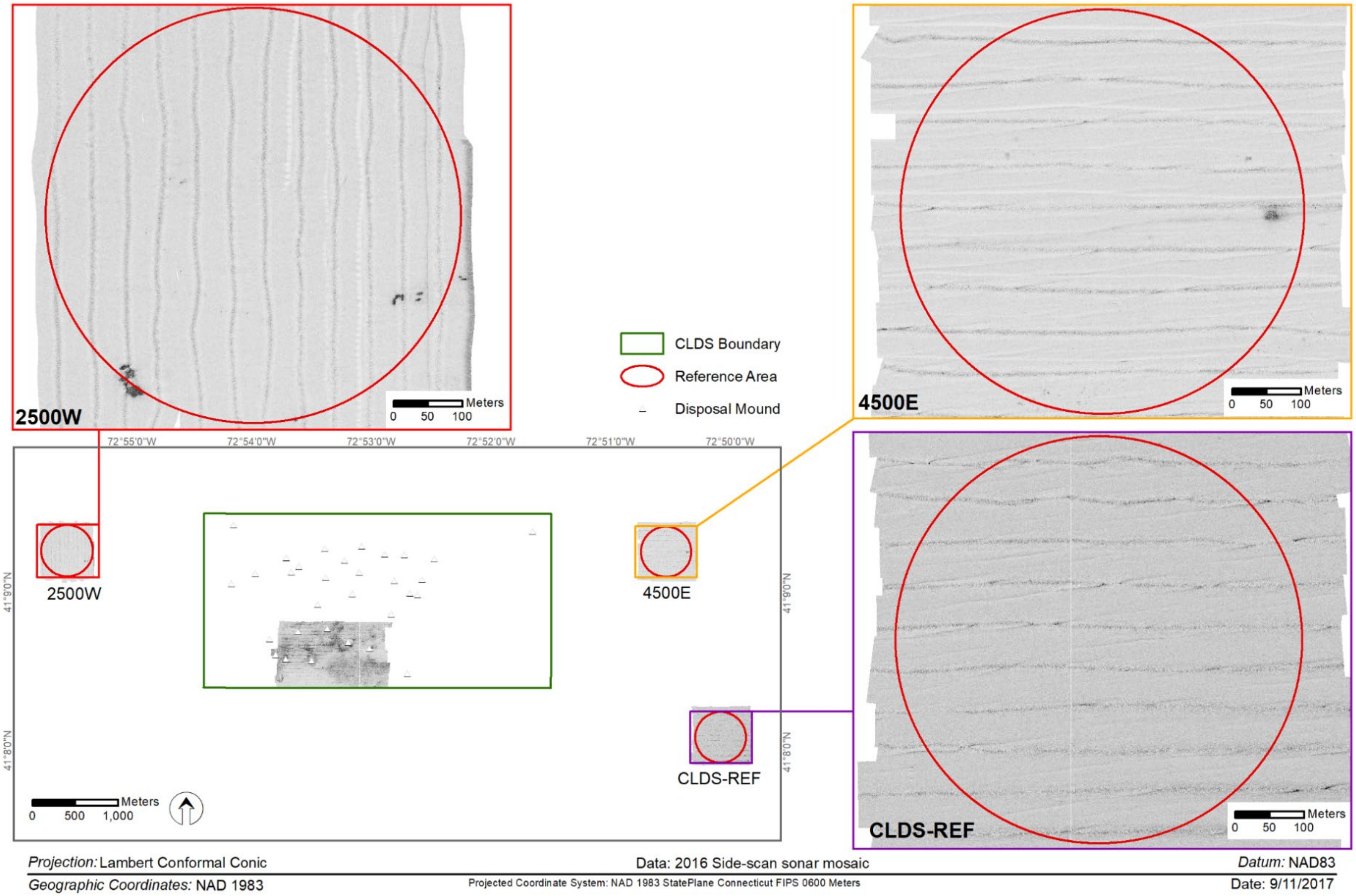


Figure 3-9. Side-scan sonar mosaic of CLDS reference areas - September 2016

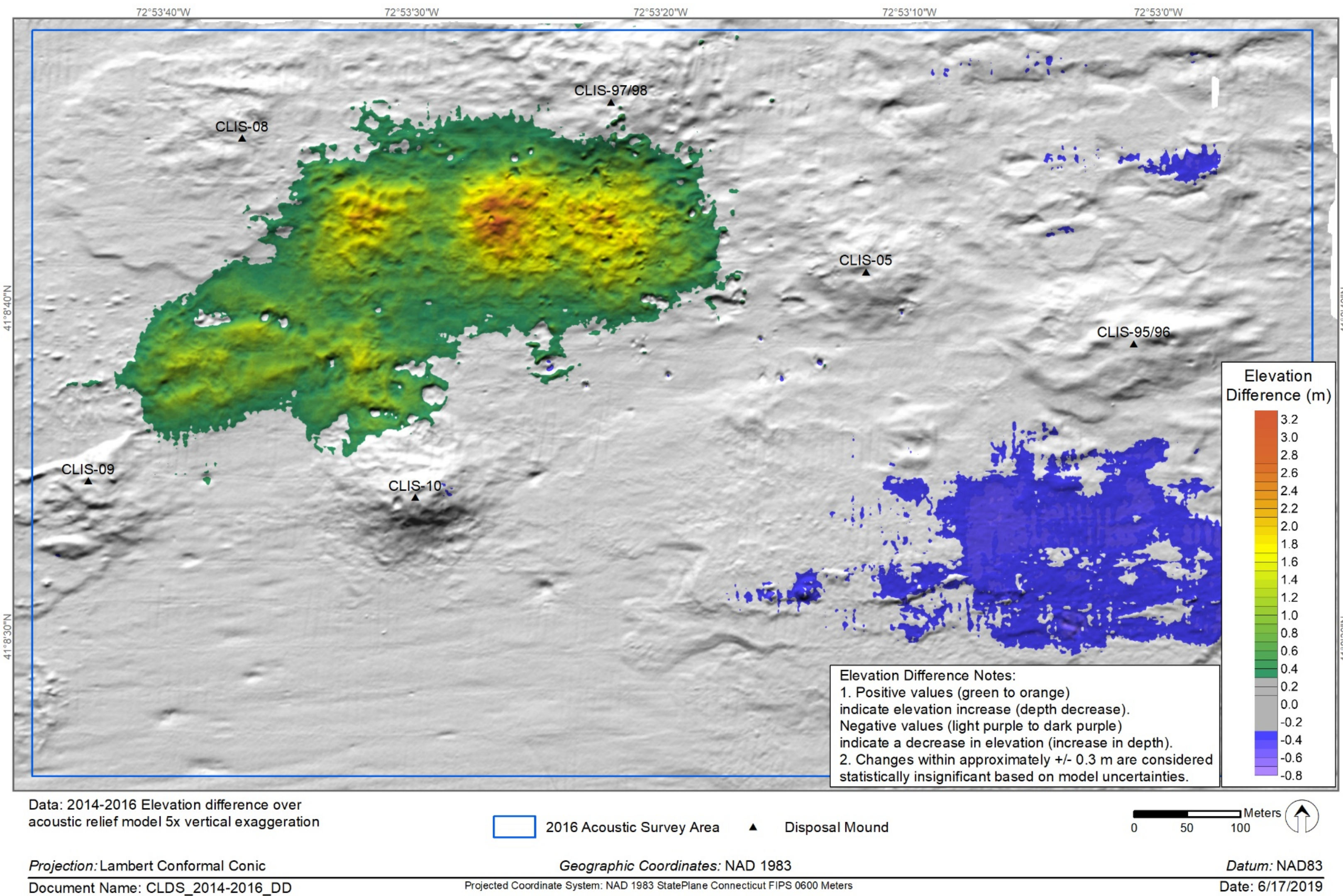


Figure 3-10. CLDS disposal area elevation difference of the south-central portion of CLDS: 2016 vs. 2014

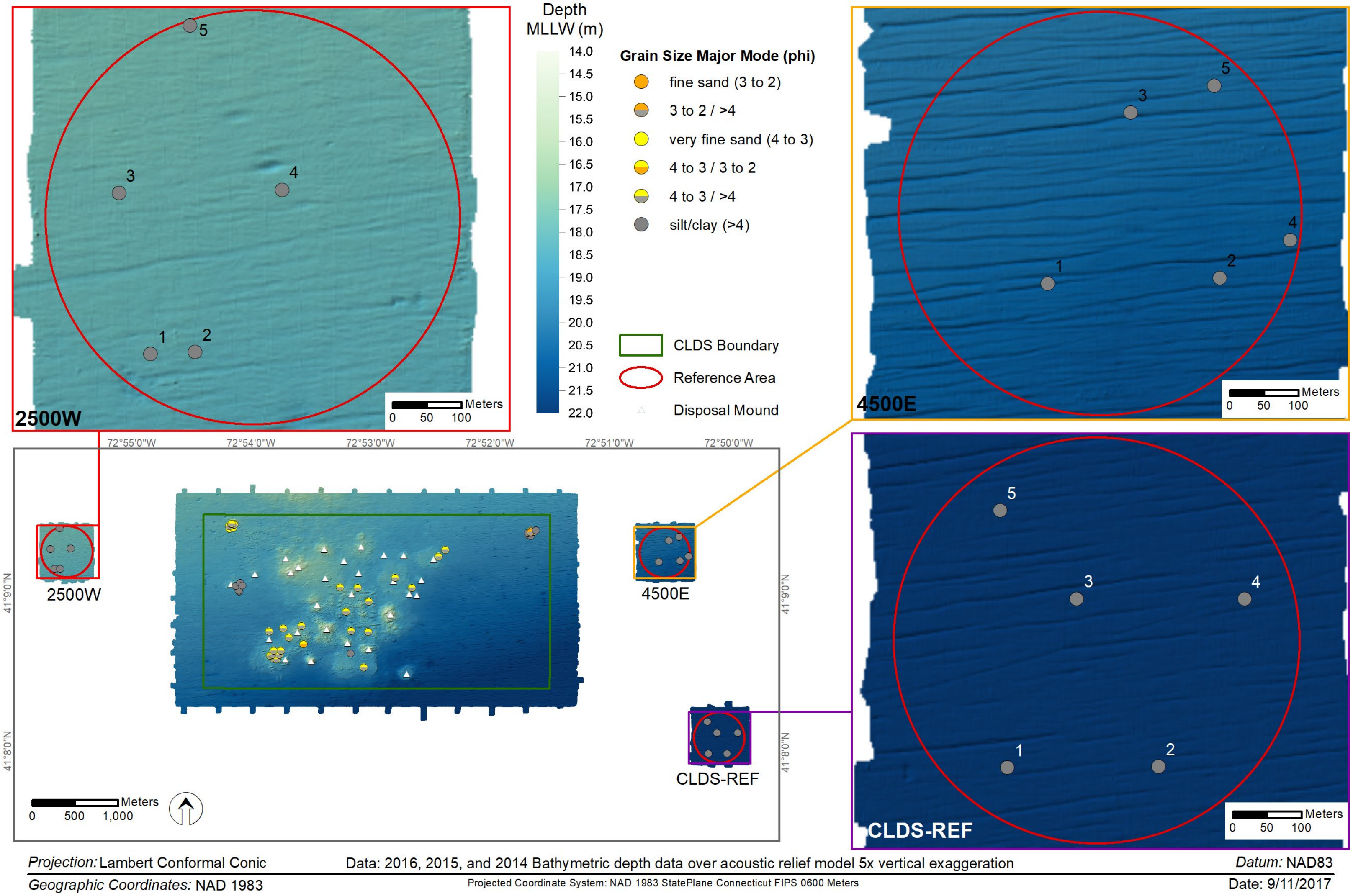
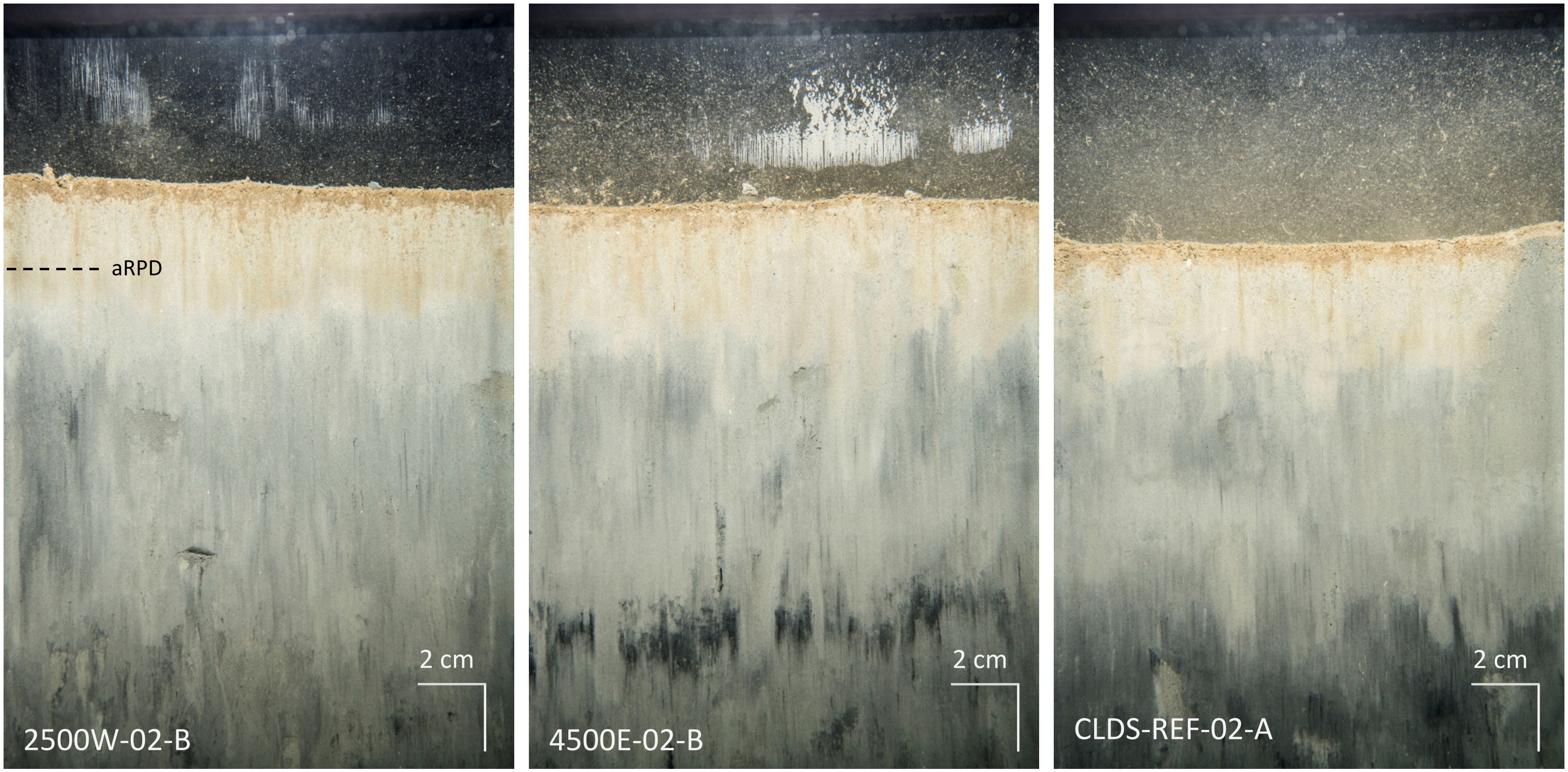


Figure 3-11. Sediment grain size major mode (phi units) at the CLDS reference areas



(A) **(B)** **(C)**

Figure 3-12. Sediment profile images from the reference areas; (A) 2500W-02 with a well-developed aRPD and light brown over olive gray silt-clay; (B) 4500E-02 with light brown over olive gray silt-clay; and (C) CLDS-REF-02 with light brown over olive gray silt-clay

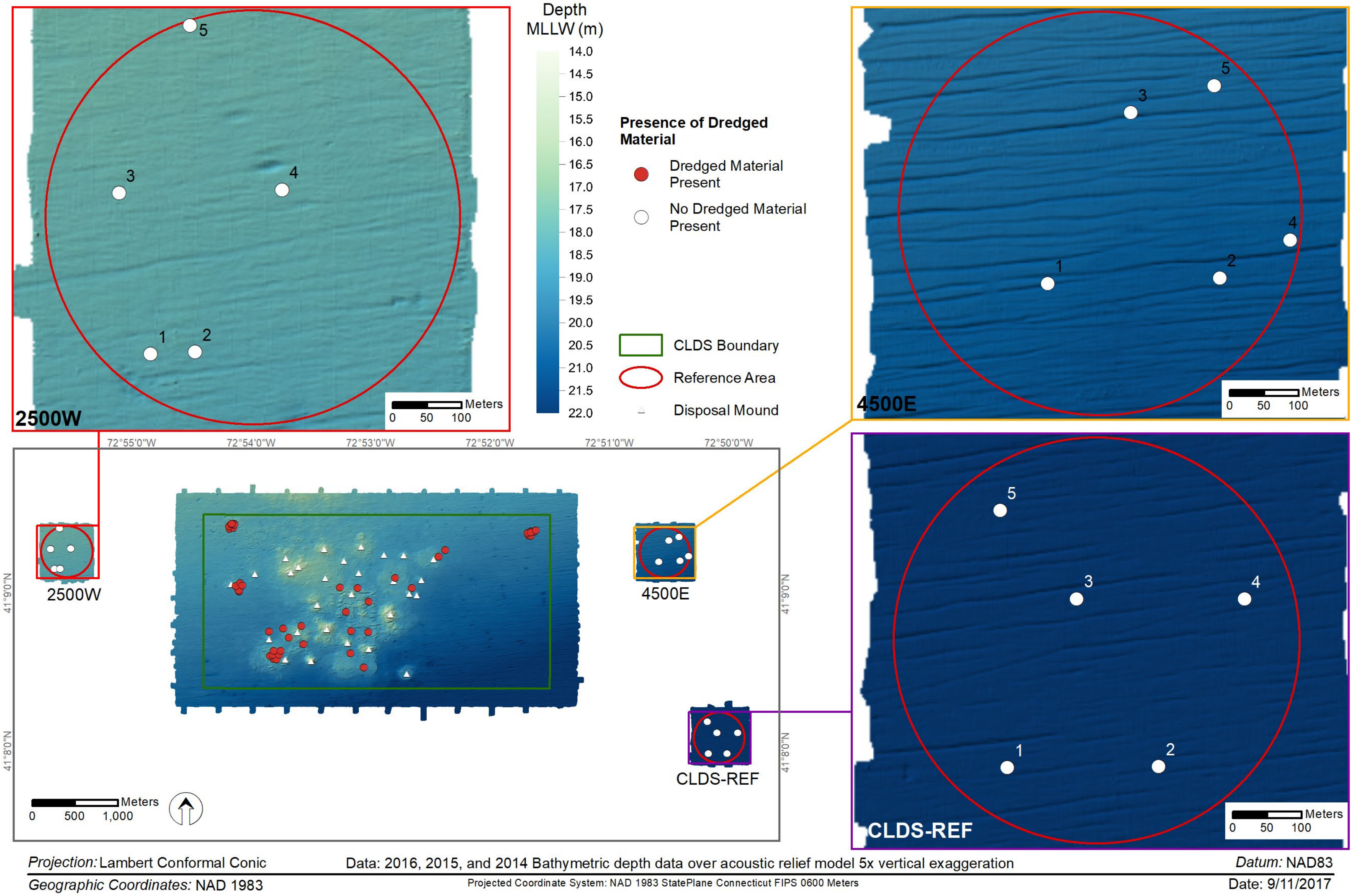


Figure 3-13. Presence/absence of dredged material at the CLDS reference areas

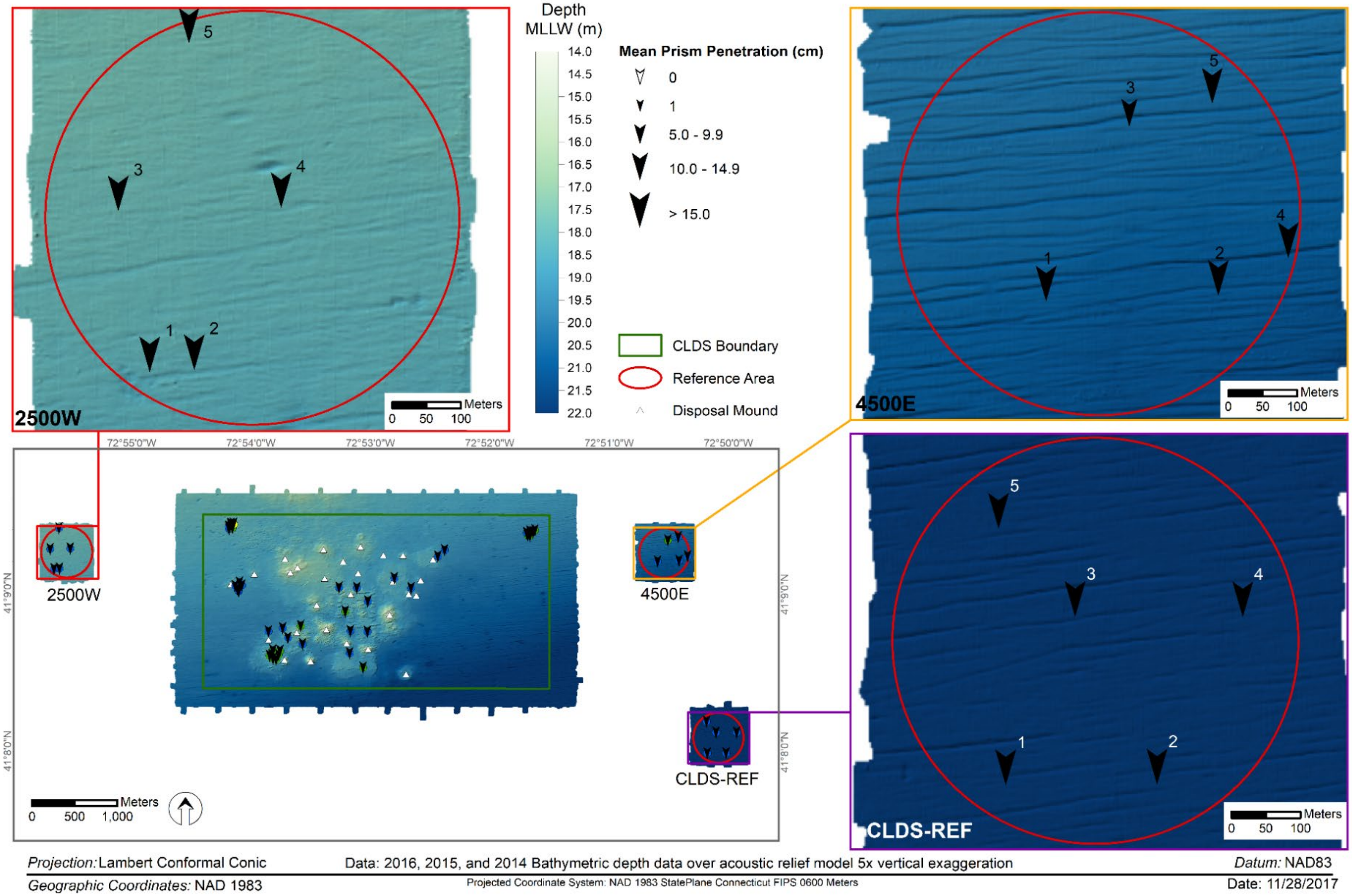


Figure 3-14. Mean station camera prism penetration depths (cm) at the CLDS reference areas

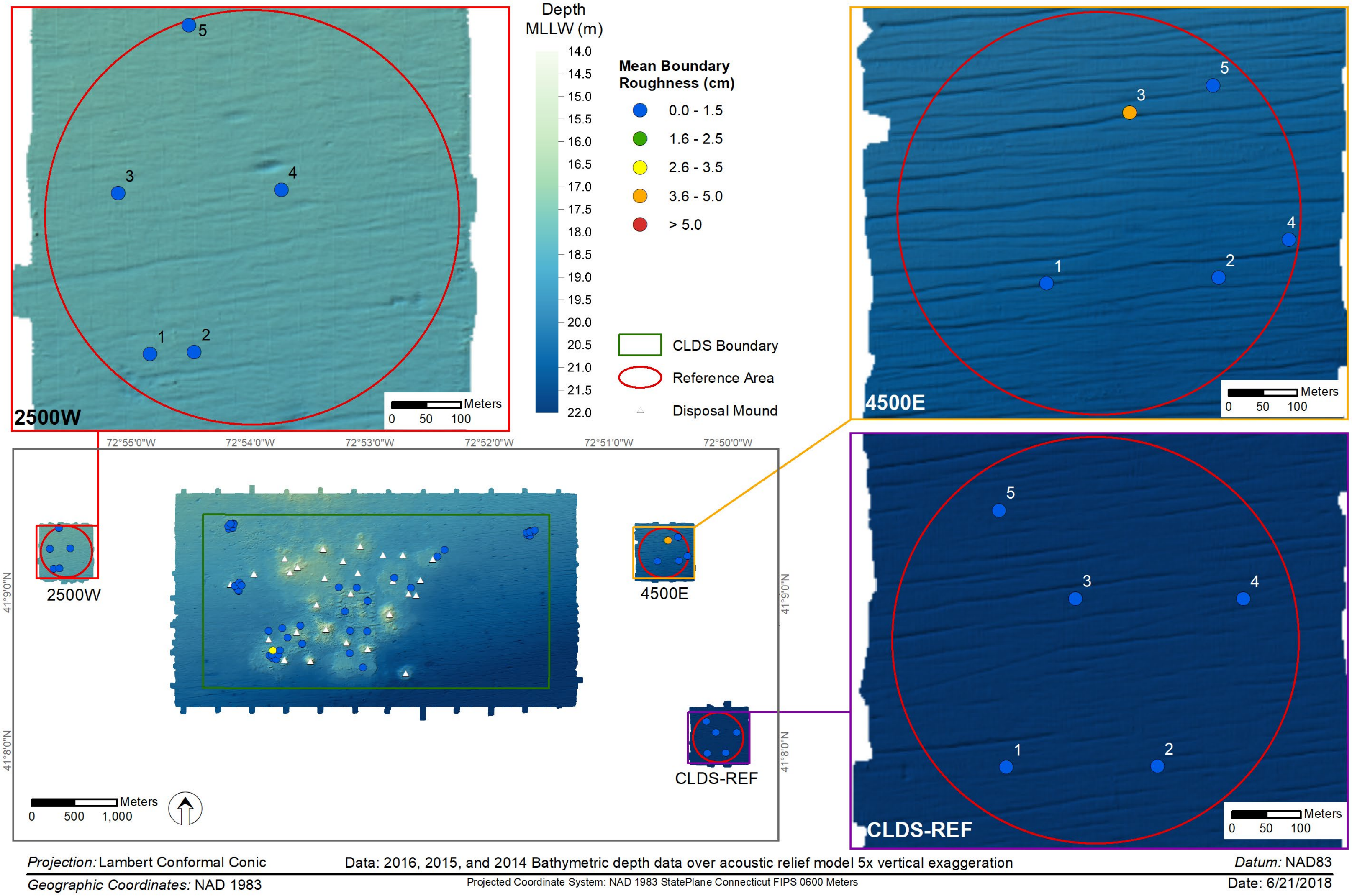
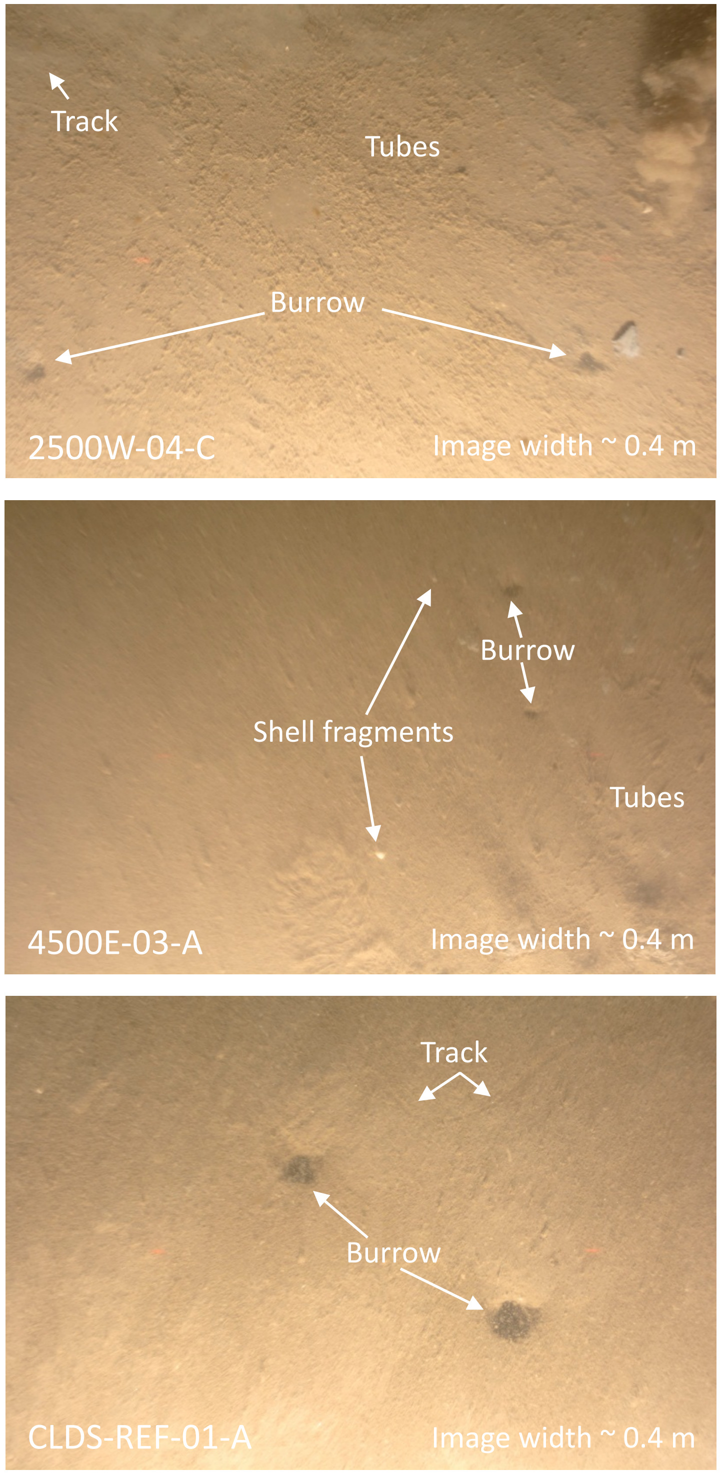


Figure 3-15. Mean station small-scale boundary roughness values (cm) at the CLDS reference areas



(A)

(B)

(C)

Figure 3-16. Plan view images from the reference areas depicting burrow openings, Stage 1 tubes, and tracks at (A) 2500W-04-C; (B) 4500E-03-A; and (C) CLDS-REF-01-A

Figure 3-17. Sediment profile images from Station 4500E-03 depicting biogenic disturbance of the sediment–water interface

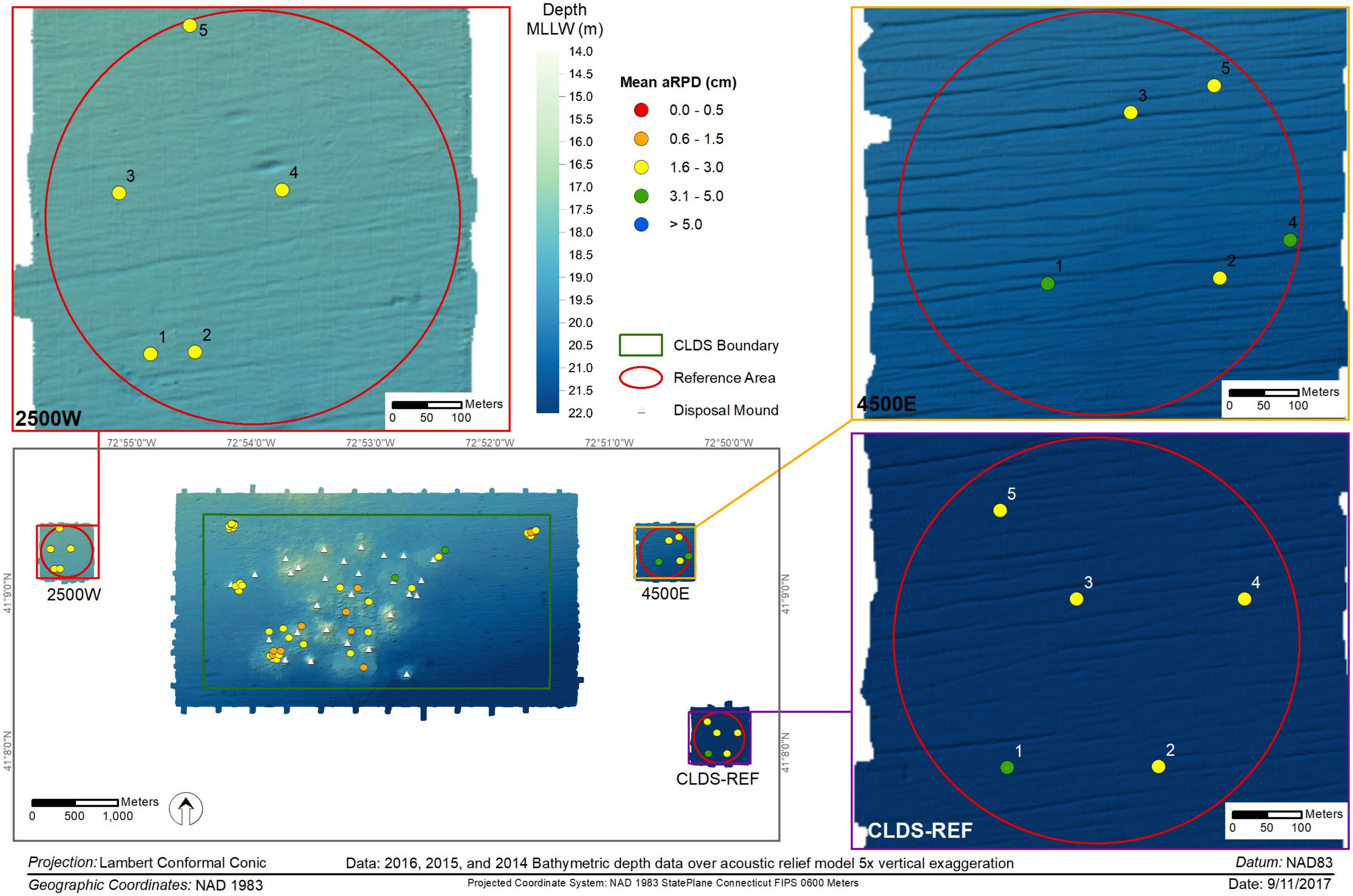
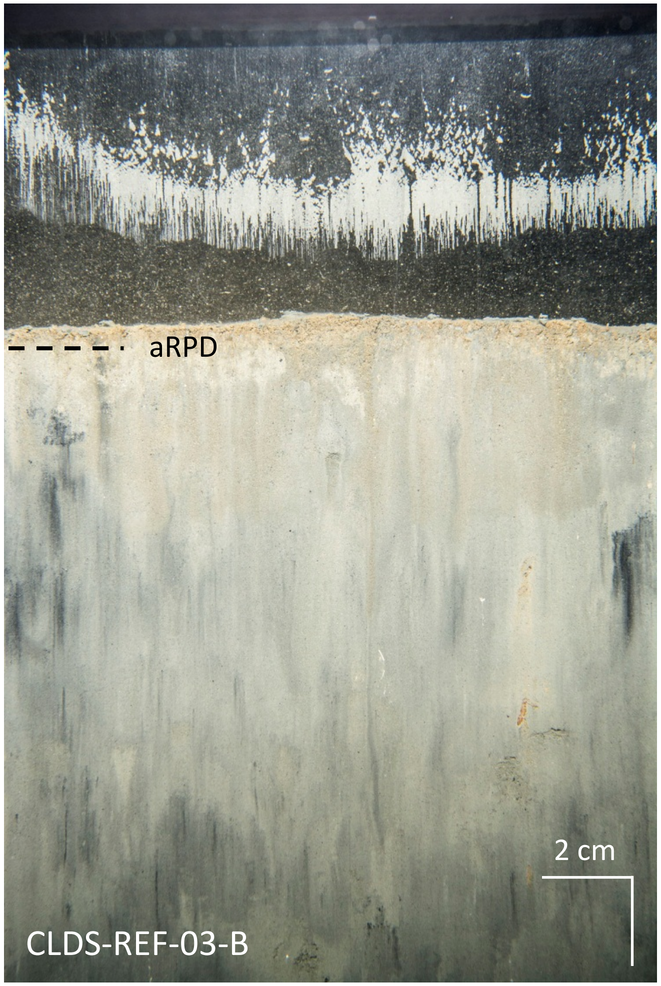
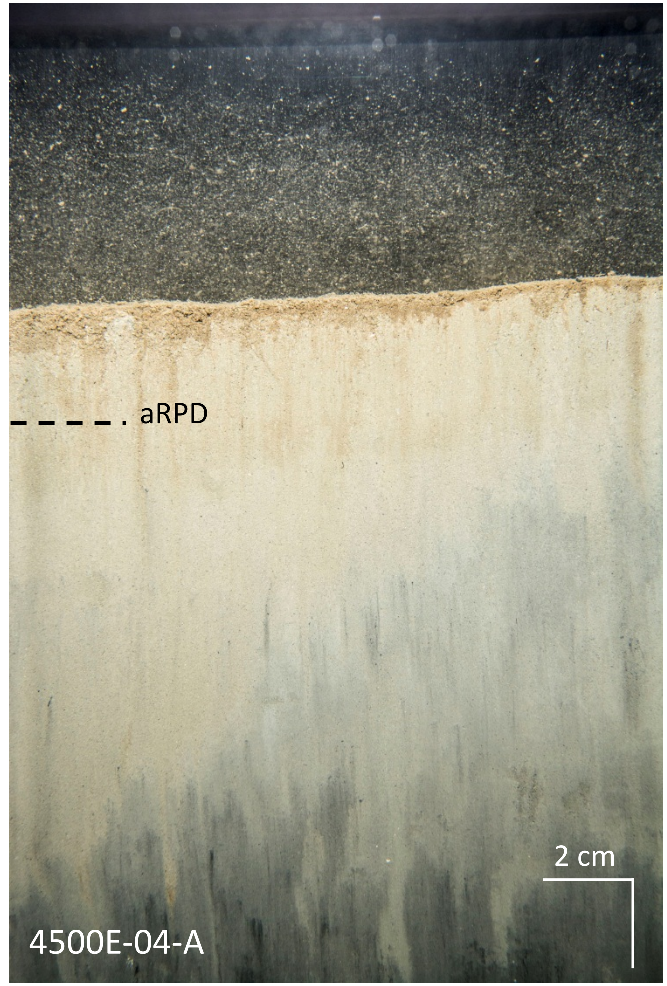


Figure 3-18. Mean station aRPD depth values (cm) at the CLDS reference areas



(A)



(B)

Figure 3-19. Sediment profile images depicting (A) the shallowest aRPD depth, and (B) the deepest observed aRPD depth, at the reference stations

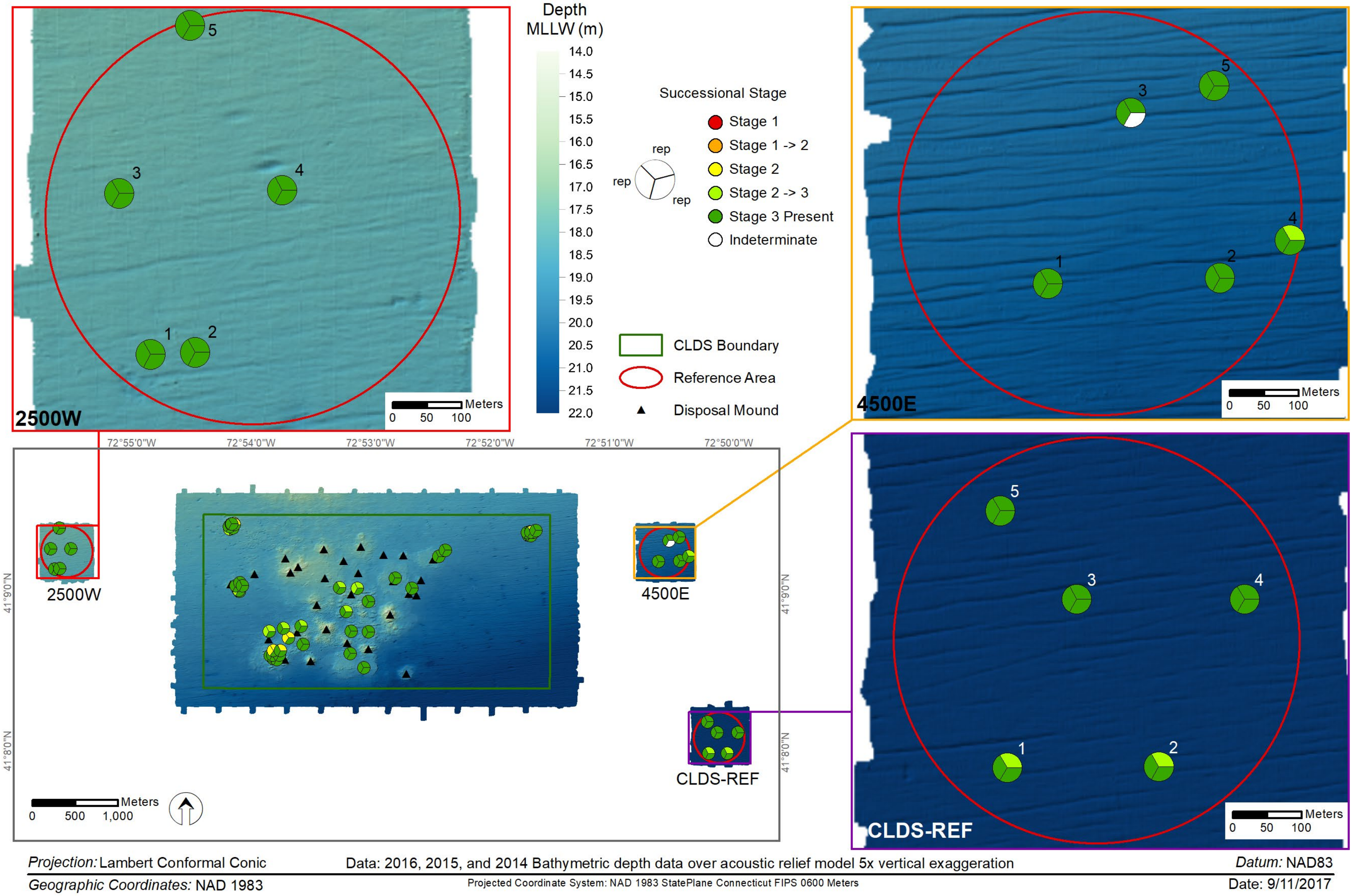
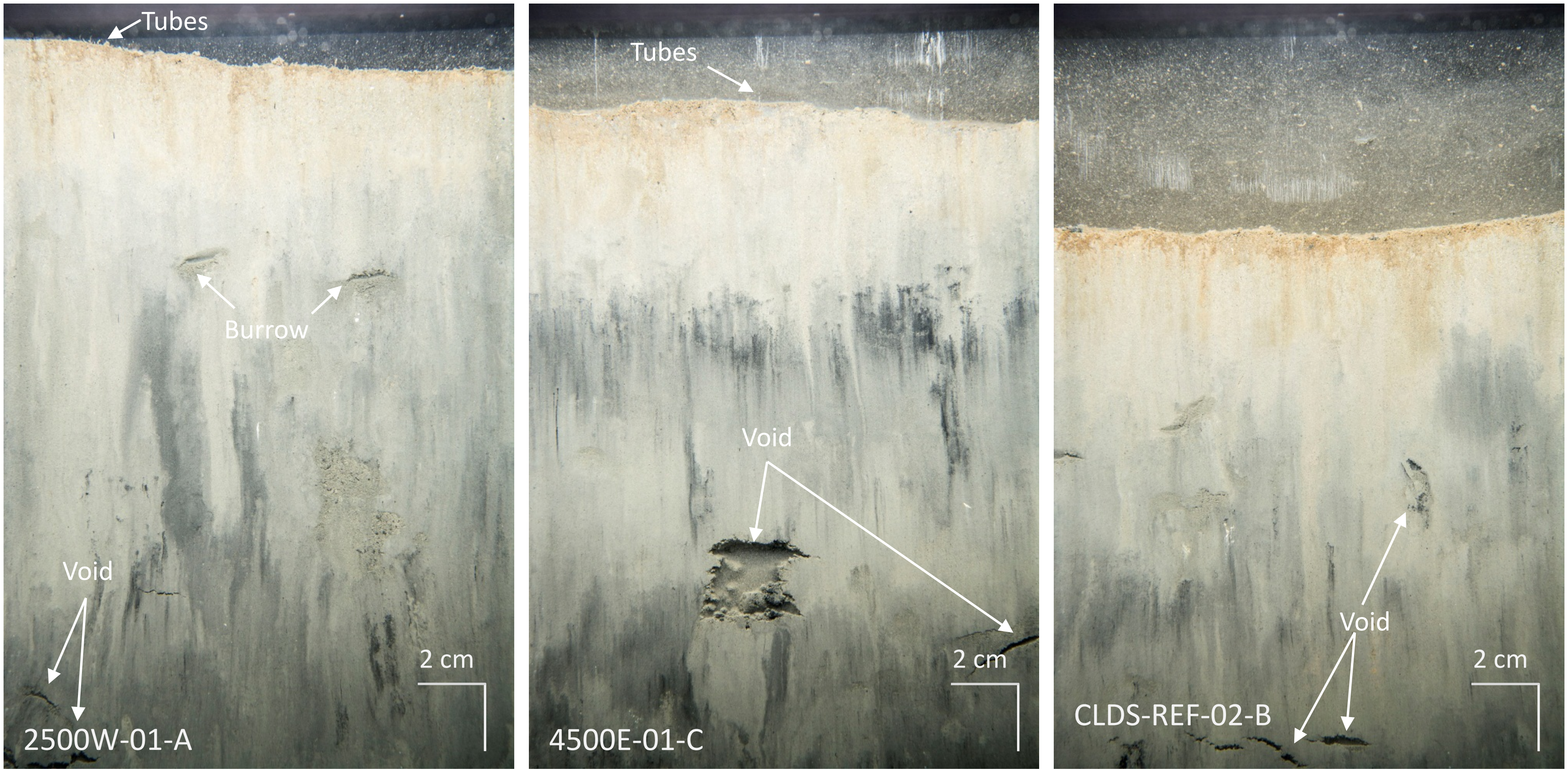


Figure 3-20. Infaunal successional stages observed at the CLDS reference areas



(A) **(B)** **(C)**

Figure 3-21. Sediment profile images from stations (A) 2500W-01-A indicating Stage 1 on 3 fauna with surface tubes, shallow burrows and deep feeding voids; (B) 4500E-01-C indicating Stage 1 on 3 fauna represented by small tubes at the sediment water interface and feeding voids at depth; and (C) CLDS-REF-02-B indicating Stage 3 fauna represented by numerous feeding voids

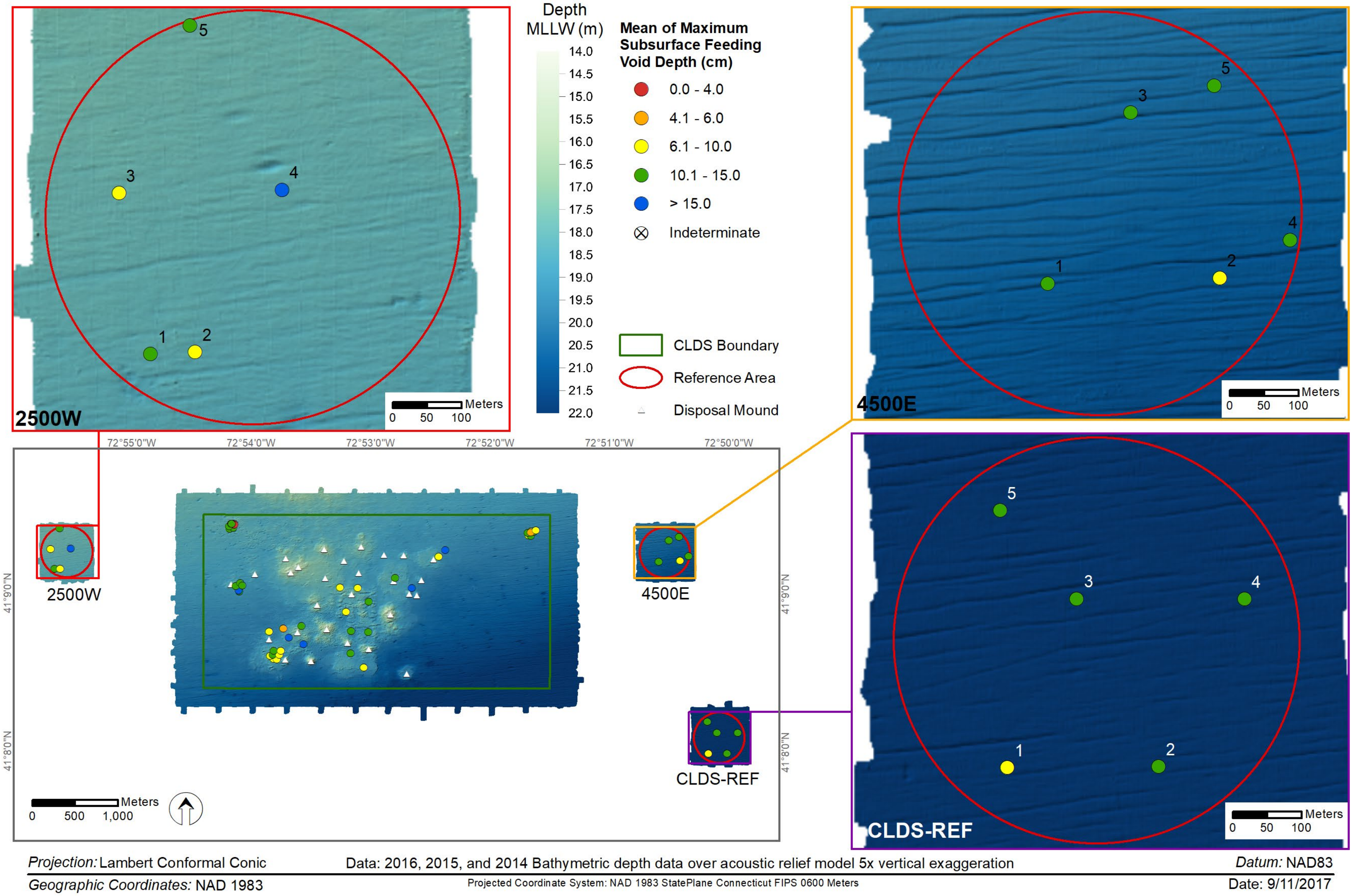


Figure 3-22. Mean subsurface feeding void depth (cm) at the CLDS reference areas

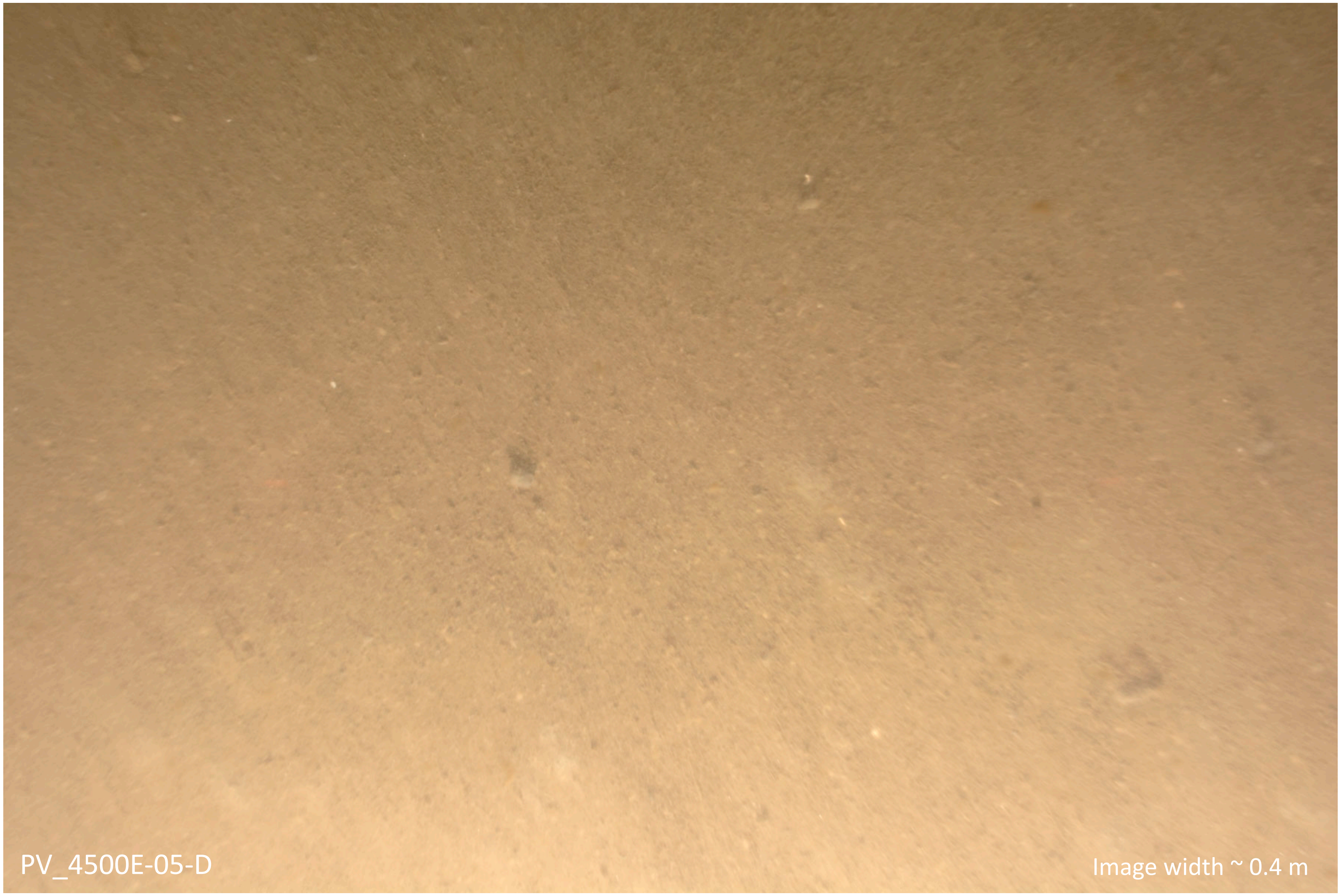


Figure 3-23. Plan view image from the reference station 4500E-05

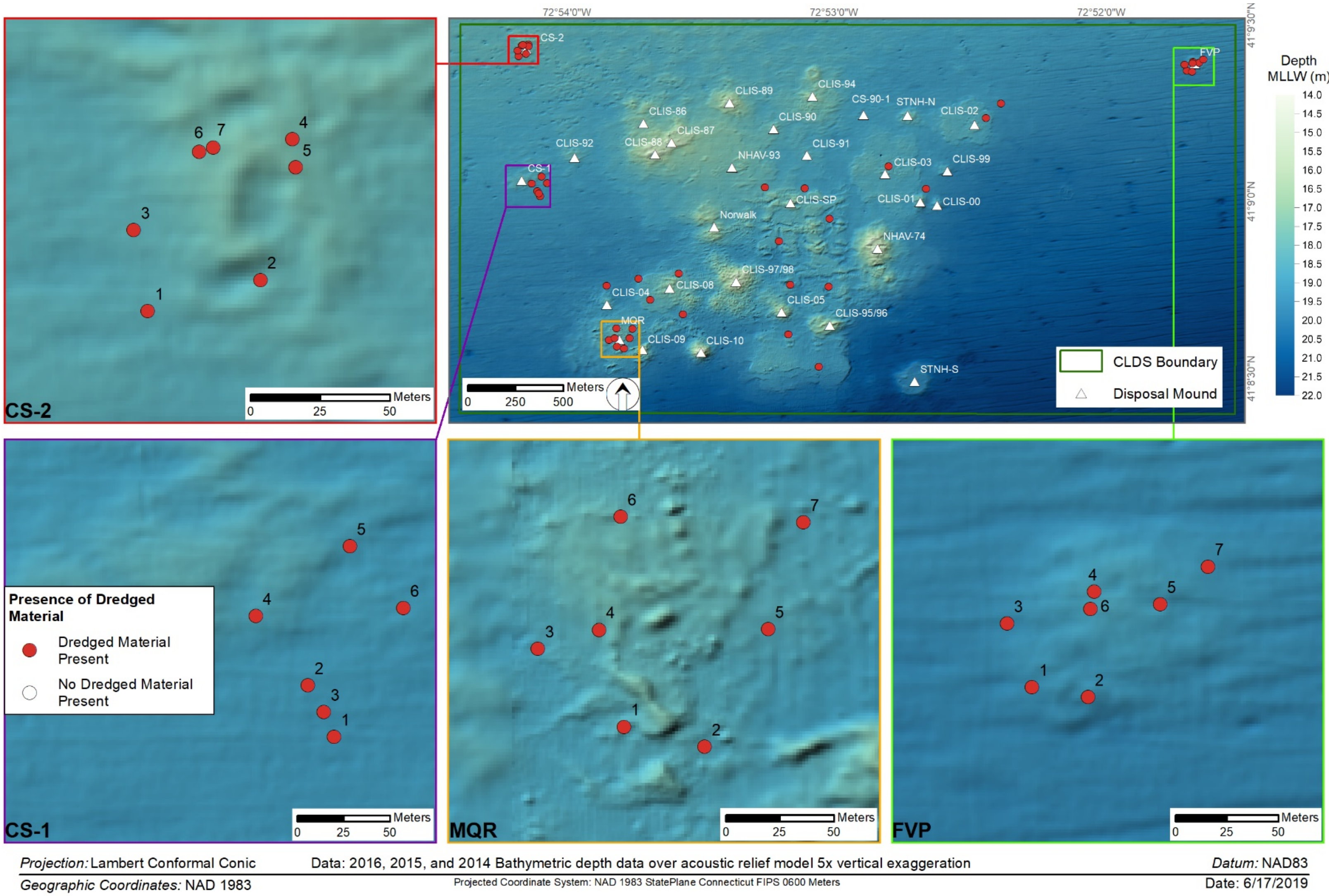


Figure 3-24. Presence/absence of dredged material at the CLDS CS-1, CS-2, MQR, and FVP mounds

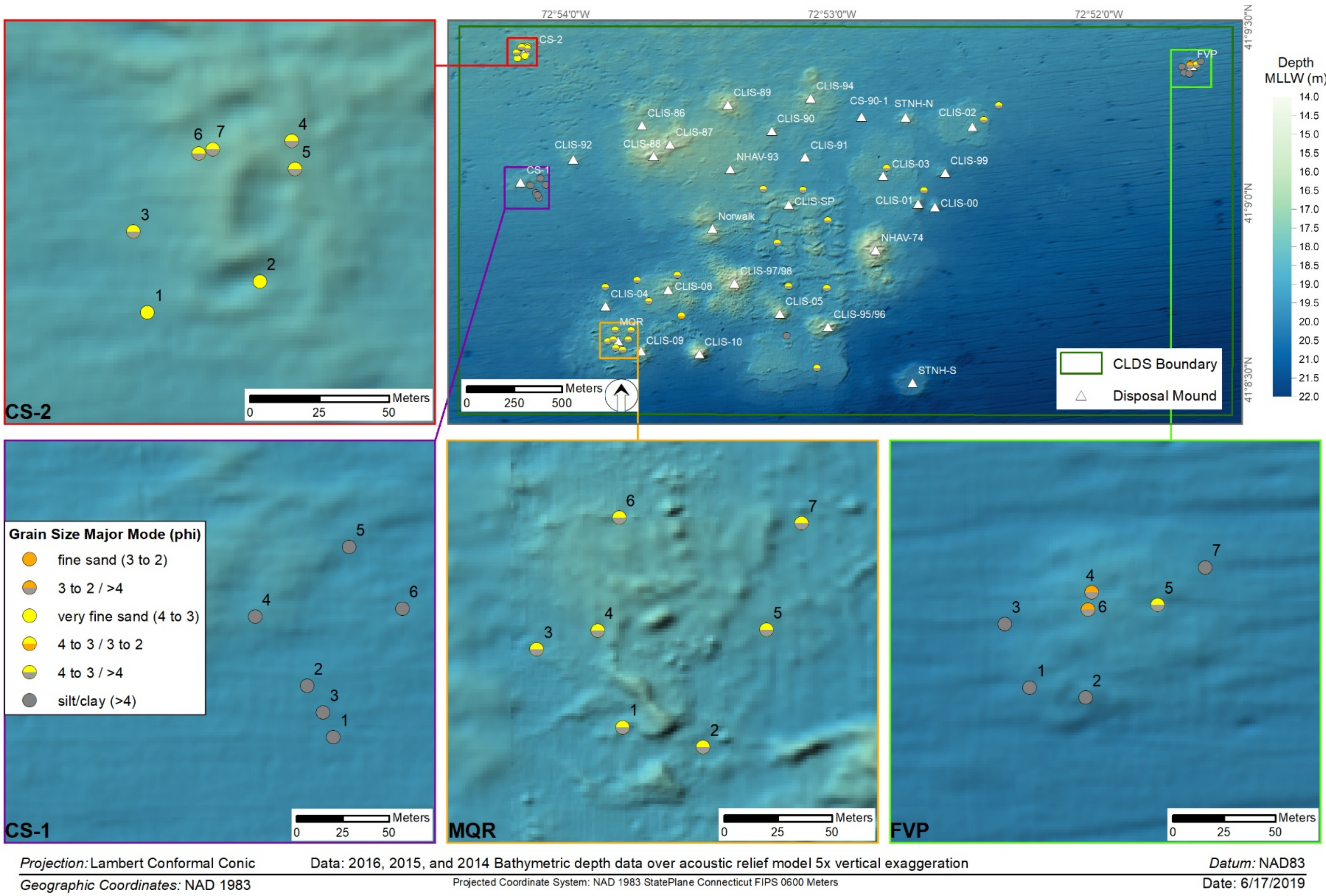
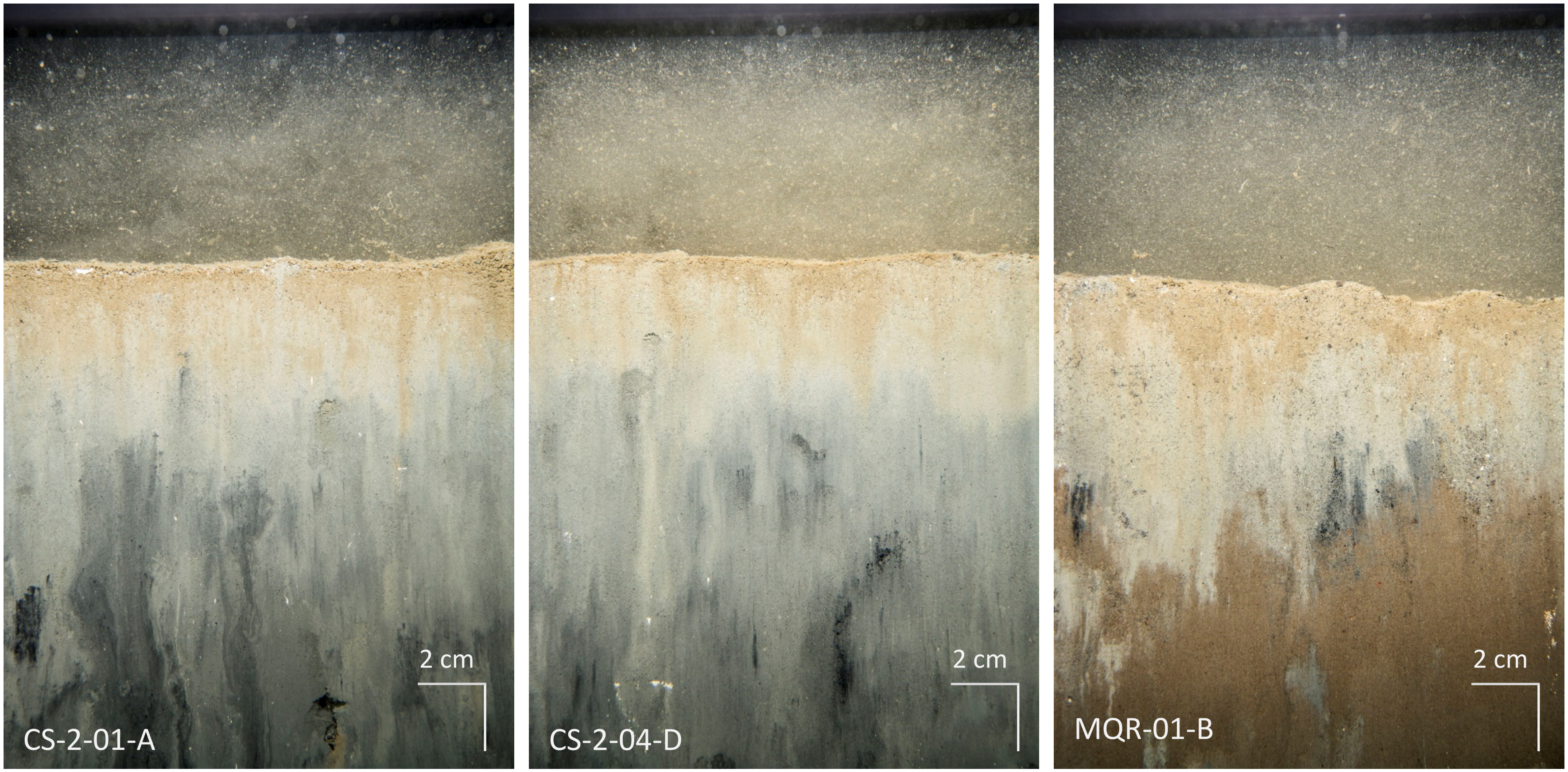
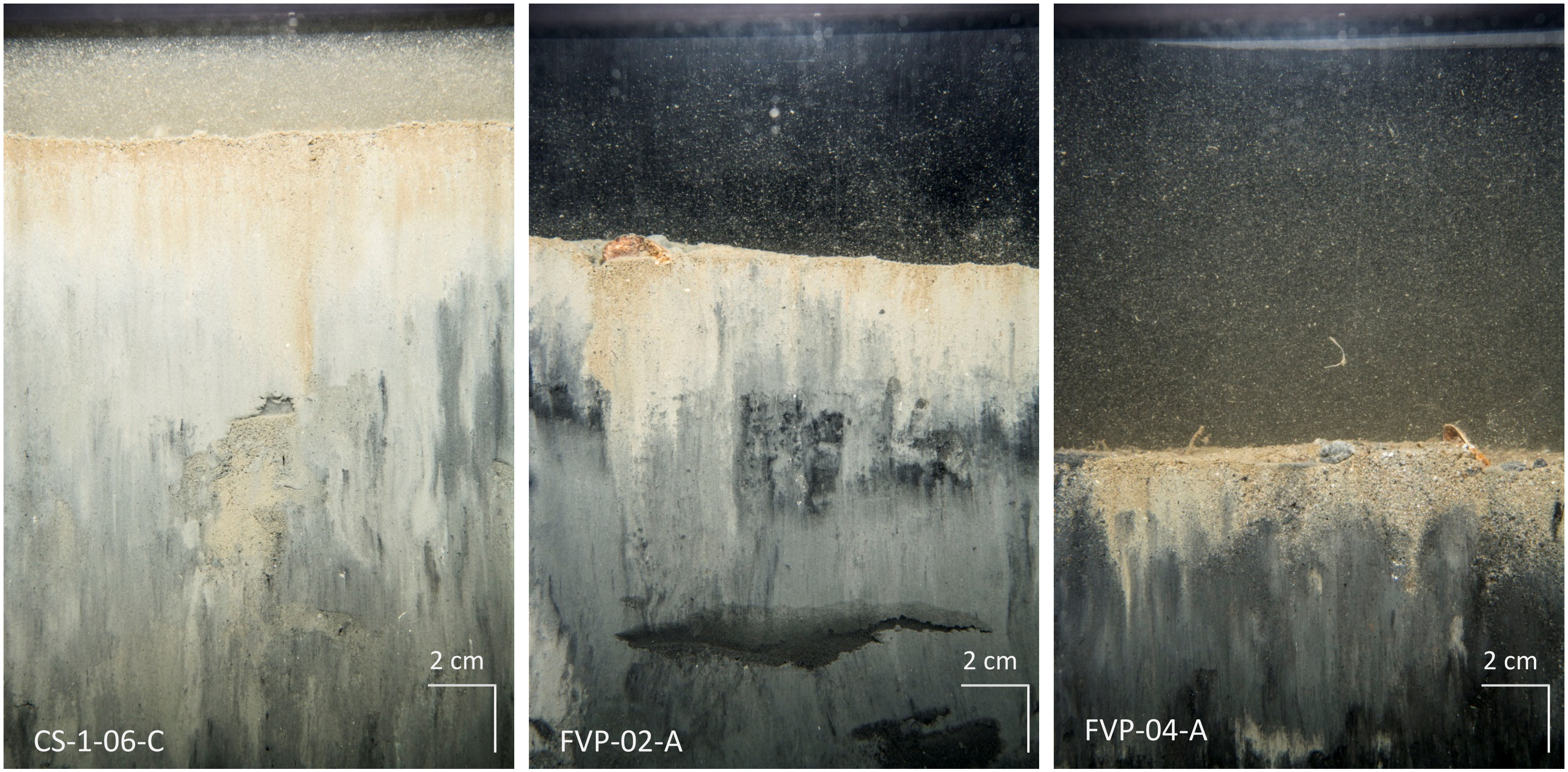


Figure 3-25. Sediment grain size major mode (phi units) at the CLDS CS-1, CS-2, MQR and FVP mounds



(A) **(B)** **(C)**

Figure 3-26. Sediment profile images with a sediment column of dredged material from (A) Station CS-2-01 depicting a predominant grain size of very fine sand and Stage 1 on 3 taxa; (B) Station CS-2-04 depicting a predominant grain size of light brown very fine sand over olive gray silt-clay; and (C) Station MQR-01 depicting light brown very fine sand over a reddish-brown silt-clay and shallow burrowing by Stage 2 taxa



(A) **(B)** **(C)**

Figure 3-27. Sediment profile images from CS-1 and FVP mounds with a sediment column of dredged material at (A) Station CS-1-06 with predominant grain size of light brown over olive gray silt-clay; (B) Station FVP-02 with light brown over gray and black silt-clay with an apparent high sediment oxygen demand; and (C) Station FVP-04 with light brown very fine sand over black silt-clay with an apparent high sediment oxygen demand

Figure 3-28. Sediment profile images from Station CS-1-04 depicting a silt-clay sediment column with a brown surface transitioning to olive gray to black, and Stage 1 on 3 taxa

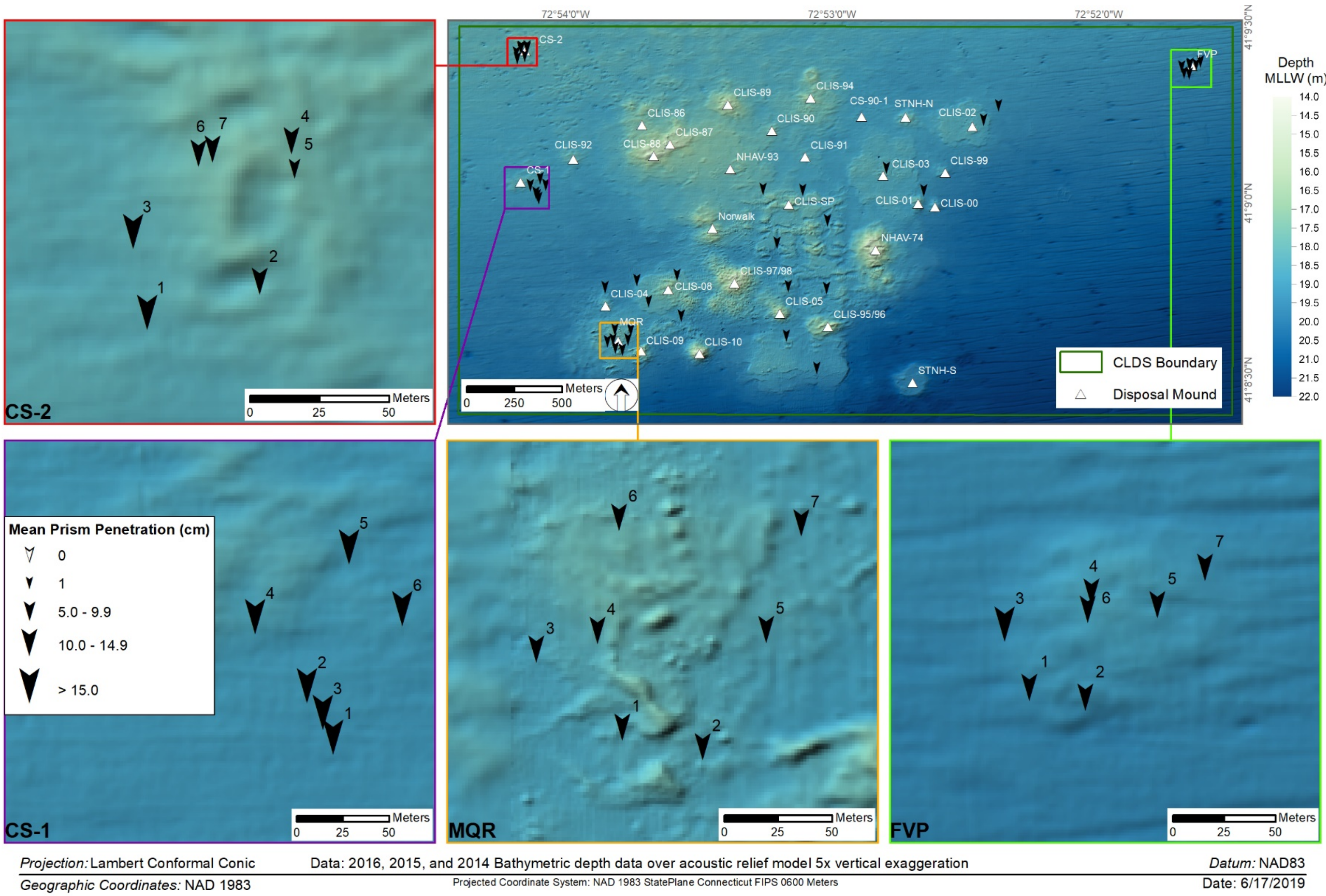


Figure 3-29. Mean station camera prism penetration depths (cm) at the CLDS CS-1, CS-2, MQR, and FVP mounds

Figure 3-30. Sediment profile image depicting a shallow prism penetration suggesting high sediment shear strength at mound CS-2 that was capped with coarse grained material

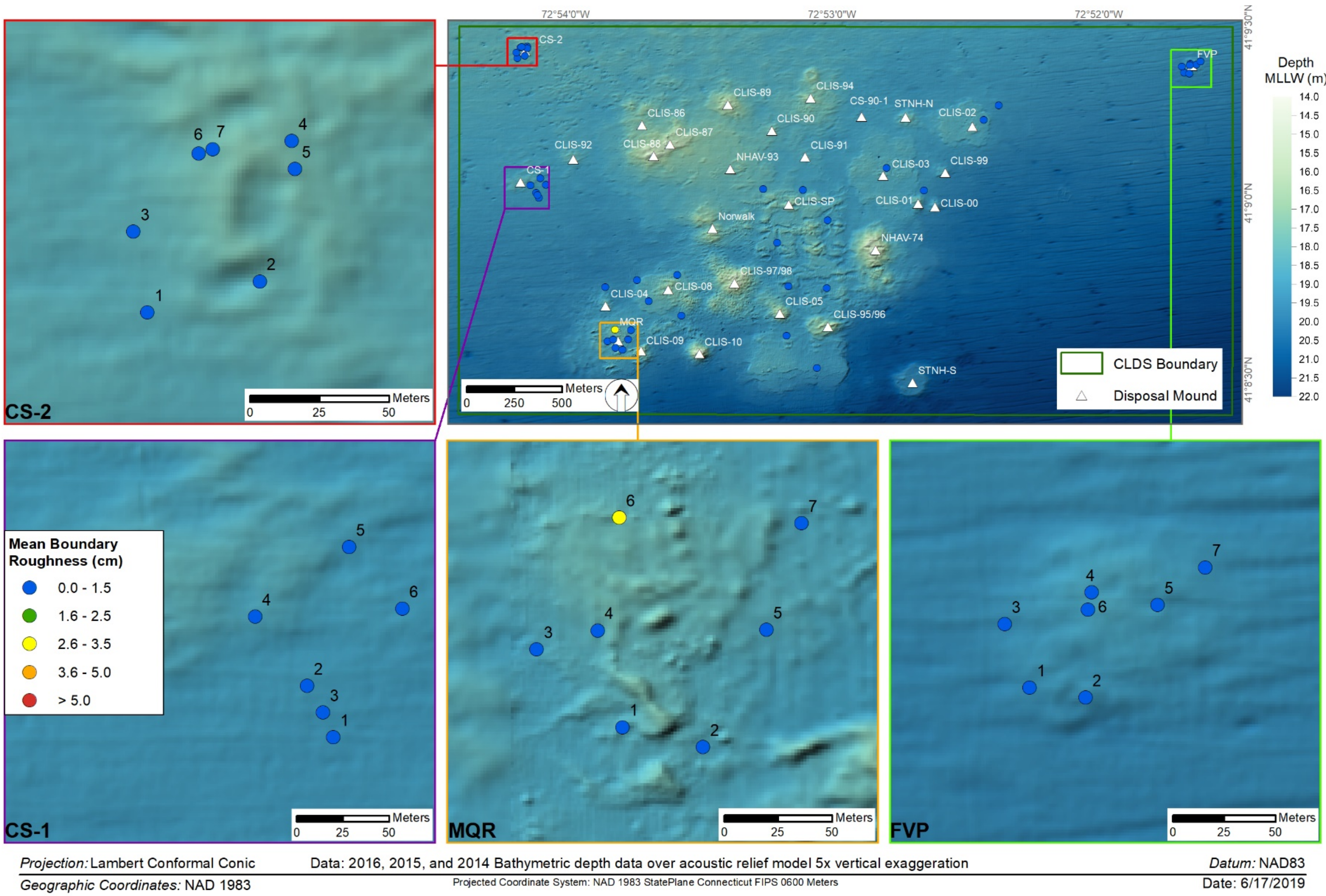


Figure 3-31. Mean station small-scale boundary roughness values (cm) at the CLDS CS-1, CS-2, MQR, and FVP mounds

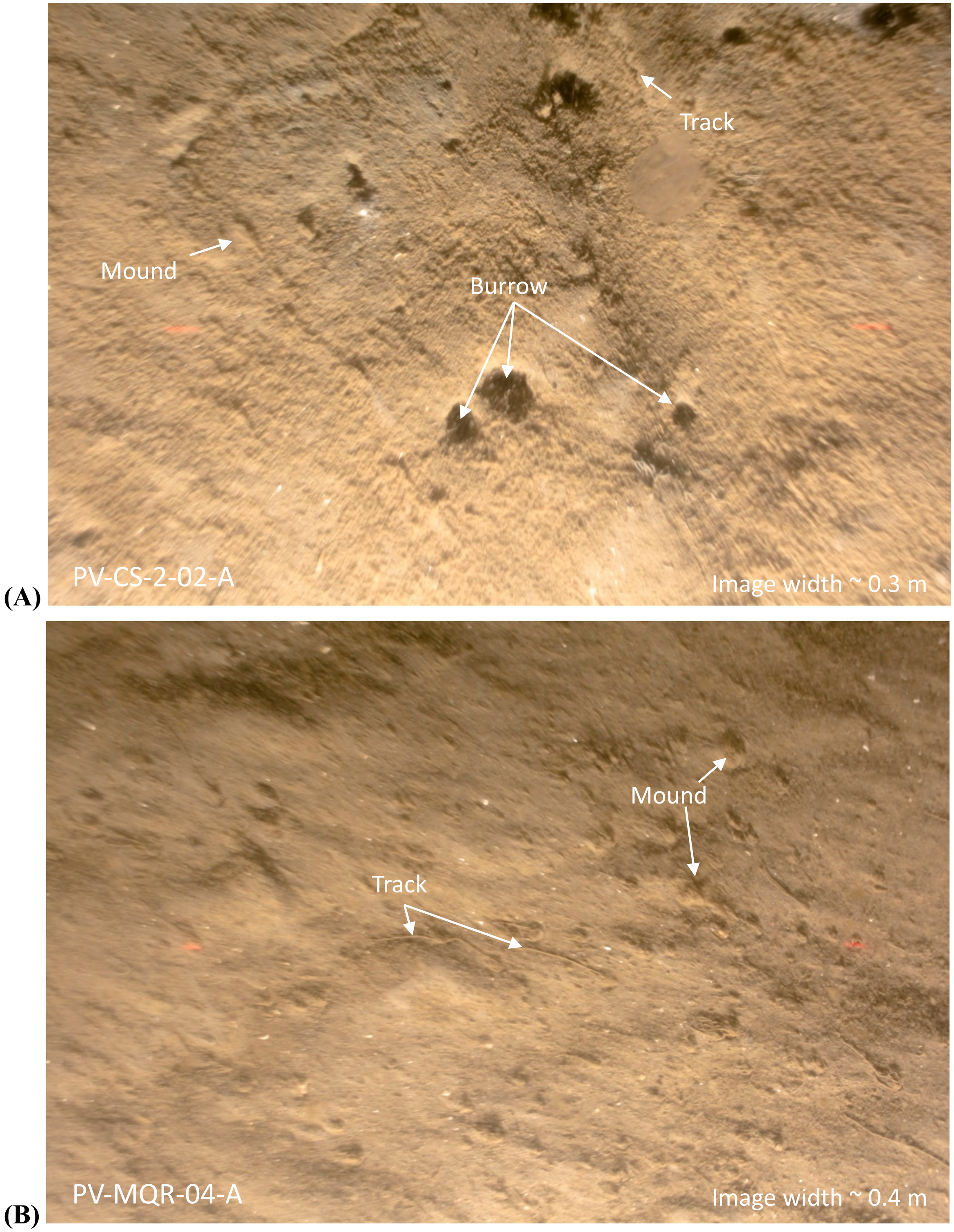


Figure 3-32. Plan view images from depicting small and large burrow openings, mounds, and tracks at (A) CS-2-02; and (B) MQR-04

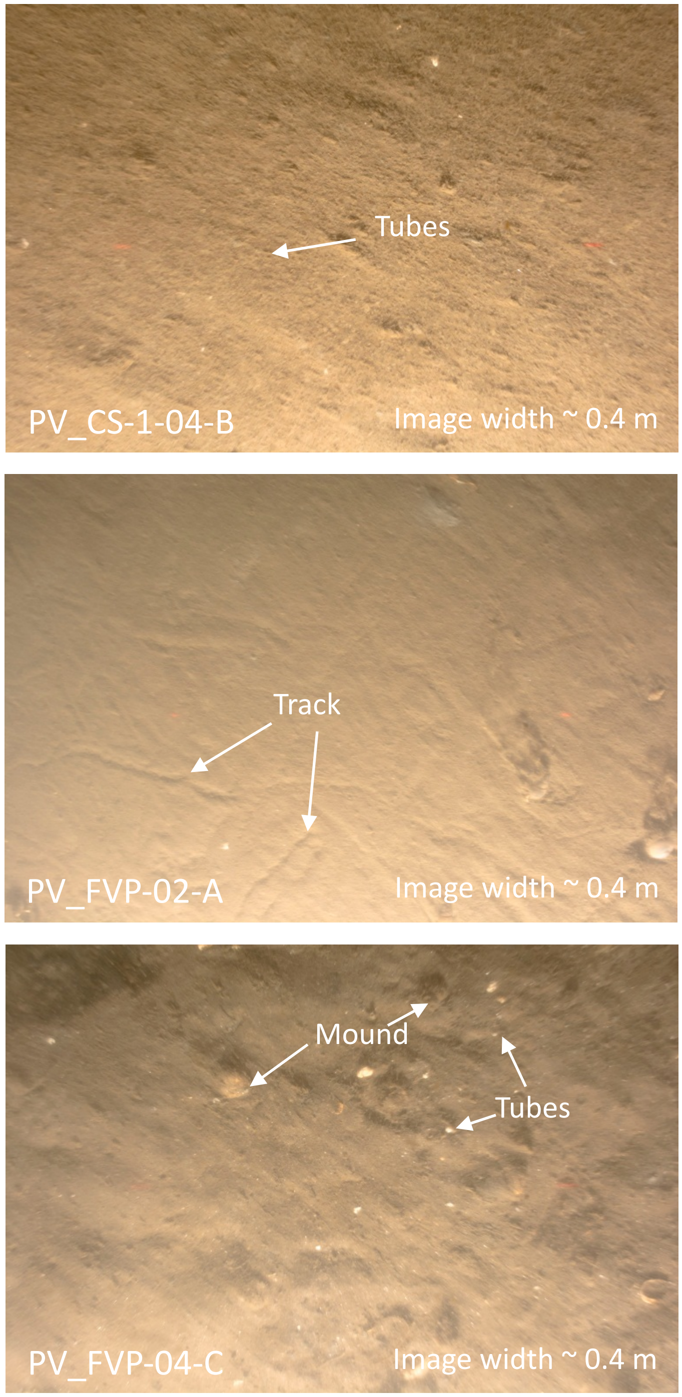


Figure 3-33. Plan view images from CS-1 and FVP mounds depicting a relatively stable seafloor with little to no hydrodynamic forcing at (A) Station CS-1-04 with a silt-clay sediment surface with small tubes; and (B) FVP-02 with silt-clay seafloor covered in tracks; and (C) Station FVP-04 with a seabed of very fine sand, shell fragments, tubes and mounds

Figure 3-34. Sediment profile image from Station MQR-06 depicting biogenic disturbance of the sediment–water interface from a large burrow

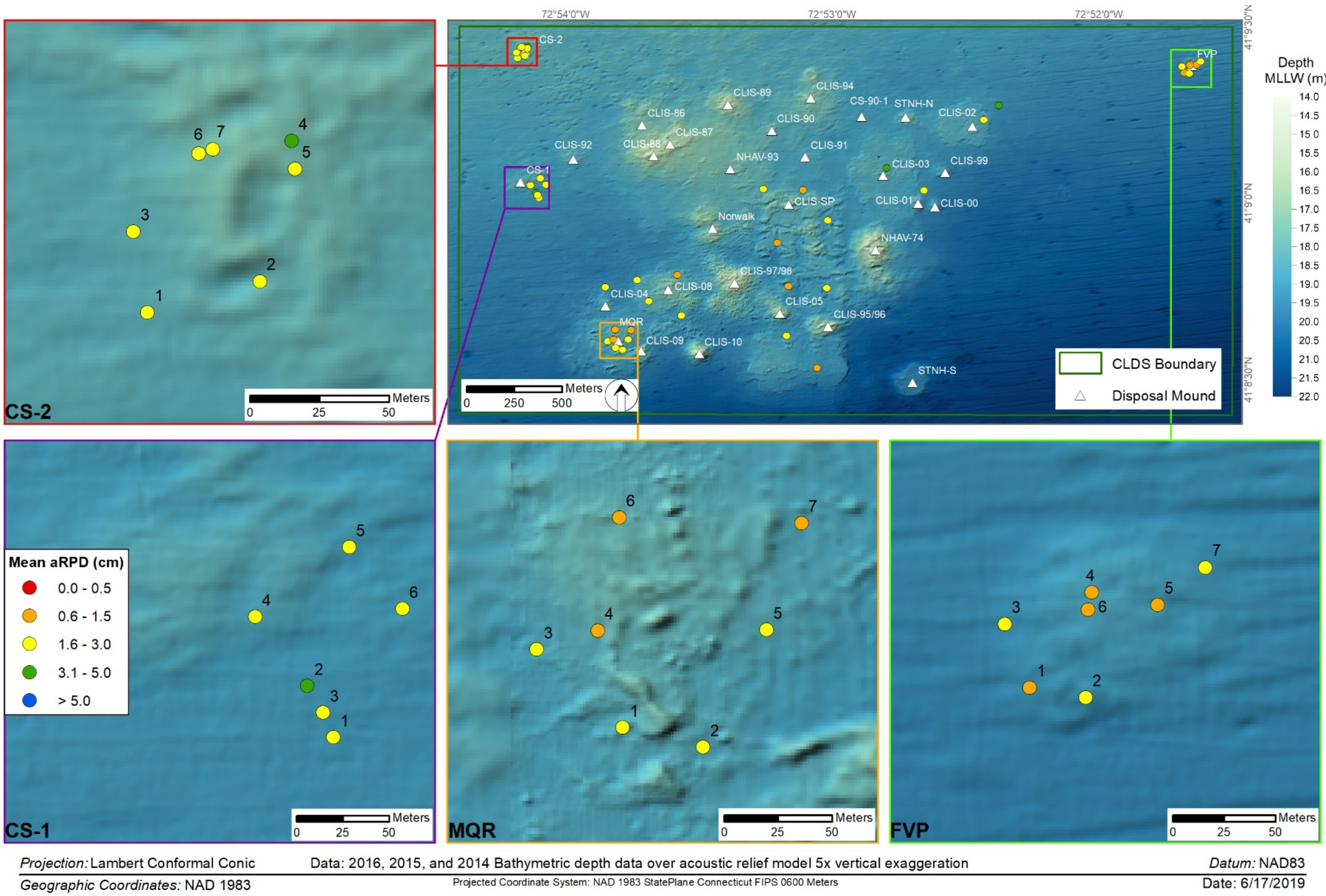


Figure 3-35. Mean station aRPD depth values (cm) at the CLDS CS-1, CS-2, MQR, and FVP mounds

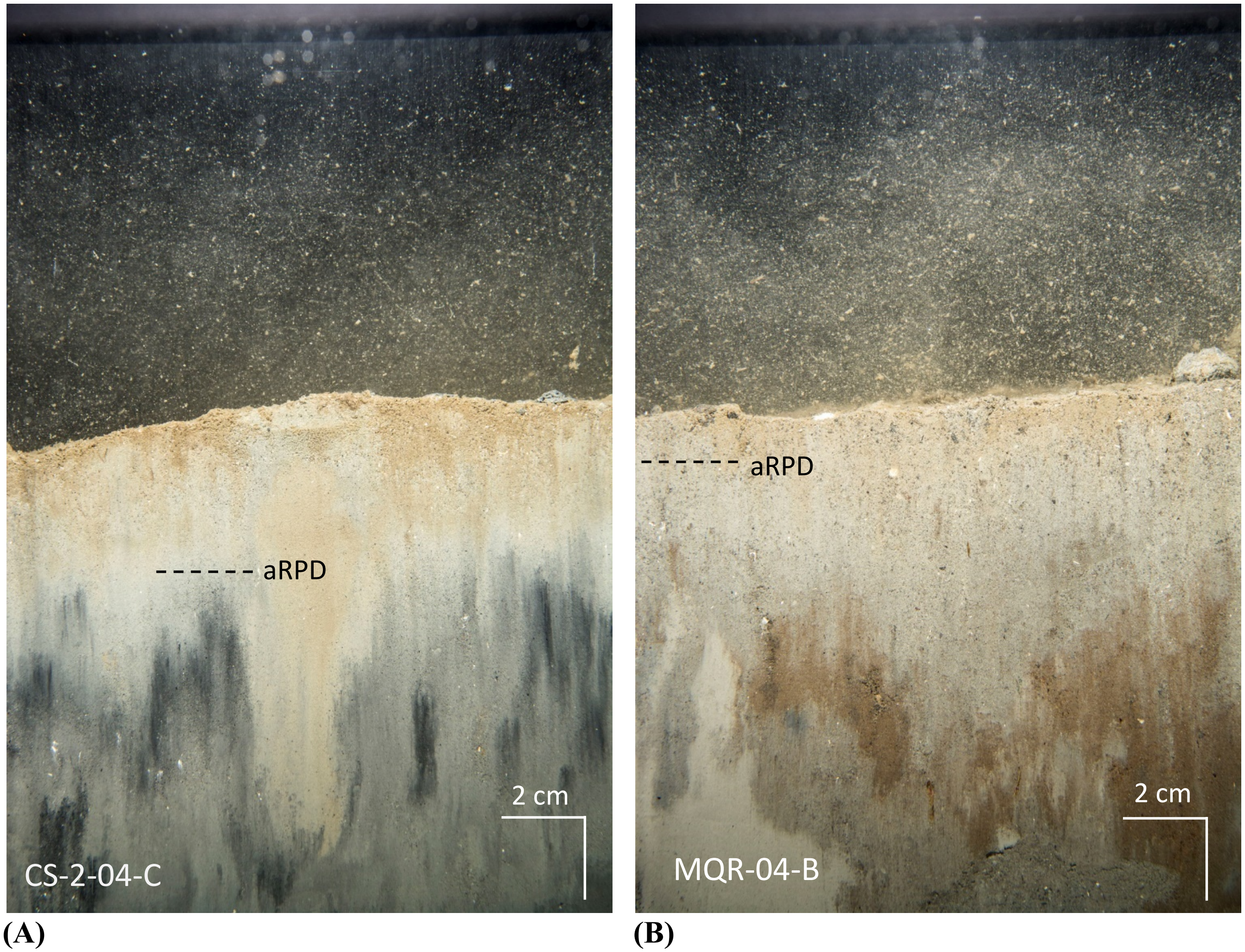
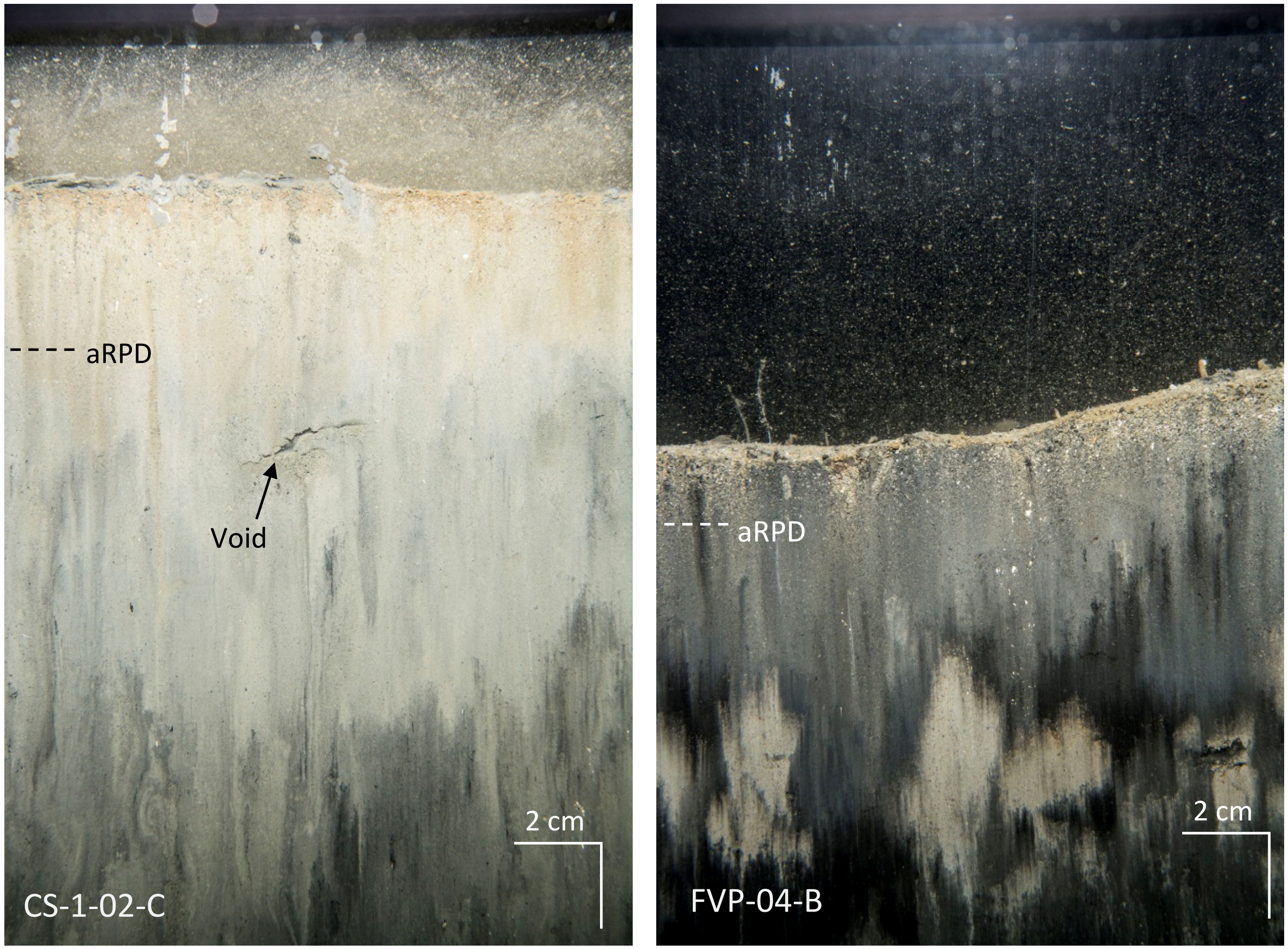


Figure 3-36. Sediment profile images from the capped mounds depicting (A) the deepest aRPD at CS-2 (3.2 cm), and (B) the shallowest aRPD at MQR (0.8 cm)



(A) **(B)**

Figure 3-37. Sediment profile images from CS-1 and FVP mounds depicting (A) the deepest aRPD depth and Stage 3 feeding voids at Station CS-1-02; and (B) the shallowest aRPD depth and Stage 2 on 3 taxa at Station FVP-04

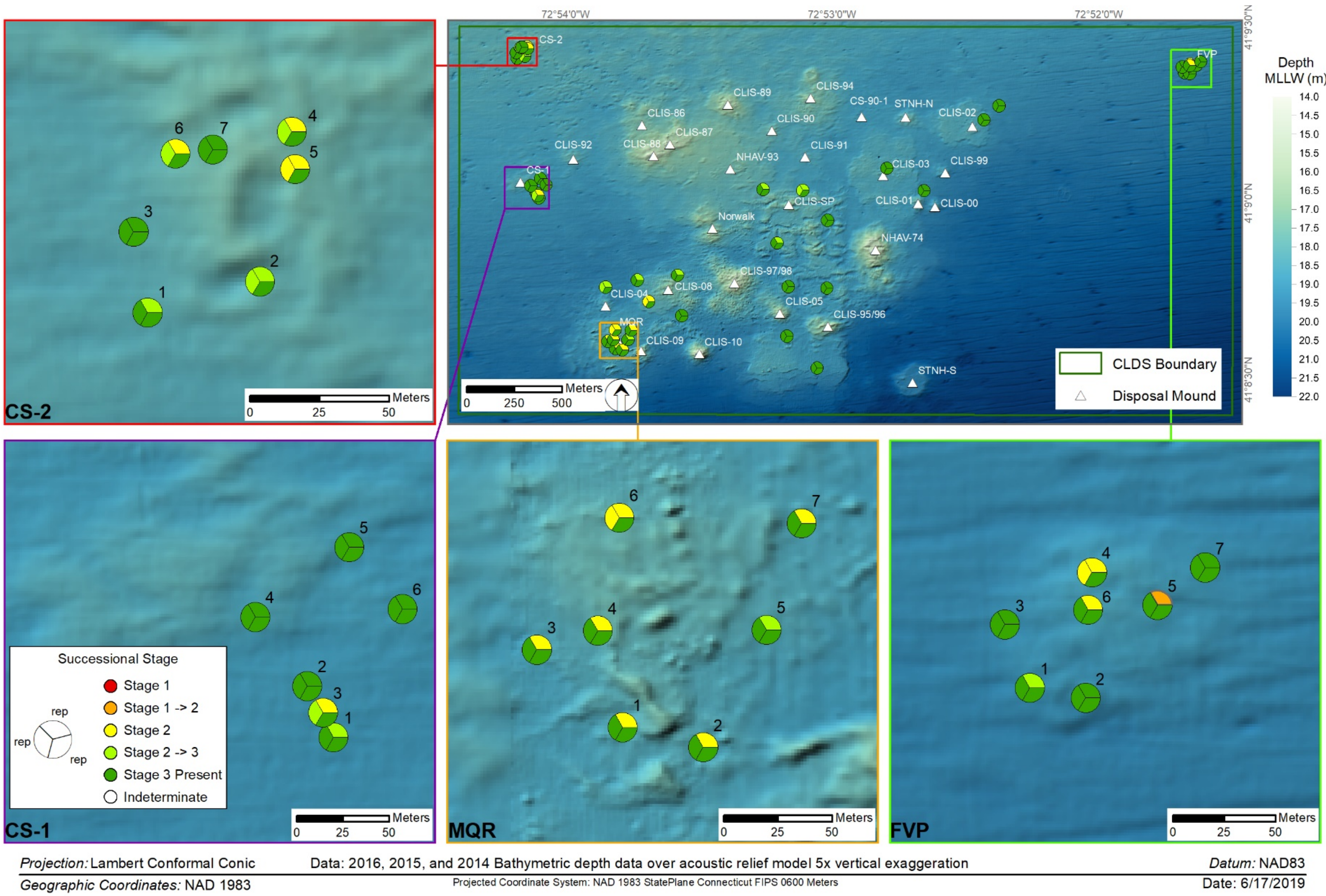
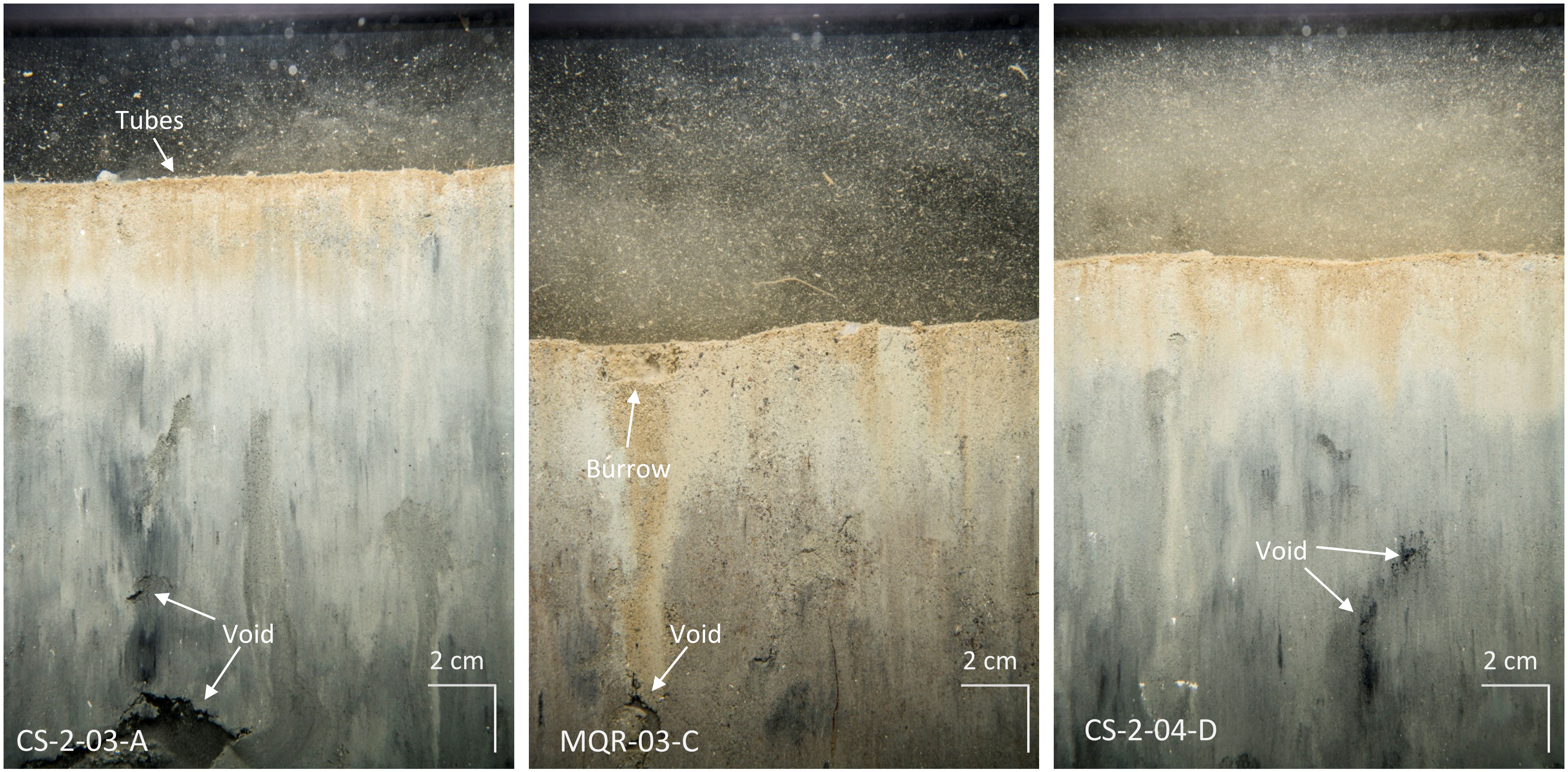


Figure 3-38. Infaunal successional stages found at the CLDS CS-1, CS-2, MQR, and FVP mounds



(A) (B) (C)

Figure 3-39. Sediment profile images from (A) Station CS-2-03 indicating Stage 1 on 3 fauna with surface tubes and deep feeding voids; (B) Station MQR-03 indicating Stage 2 on 3 fauna represented by shallow and deep burrowing, and feeding voids at depth; and (C) Station CS-2-04 a representative depiction of a Stage 2 on 3 shallow feeding void

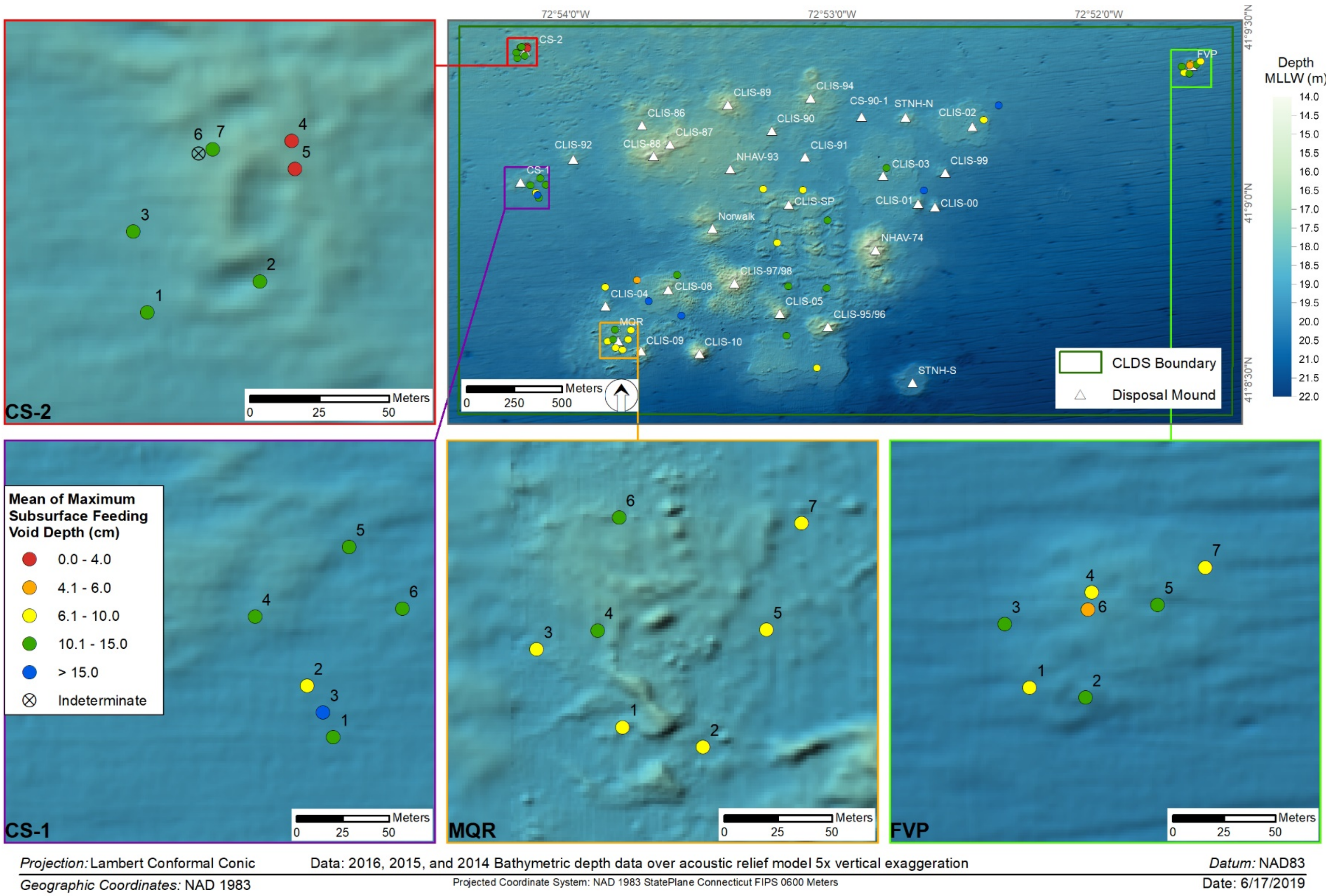


Figure 3-40. Mean subsurface feeding void depth (cm) at the CLDS CS-1, CS-2, MQR, and FVP mounds

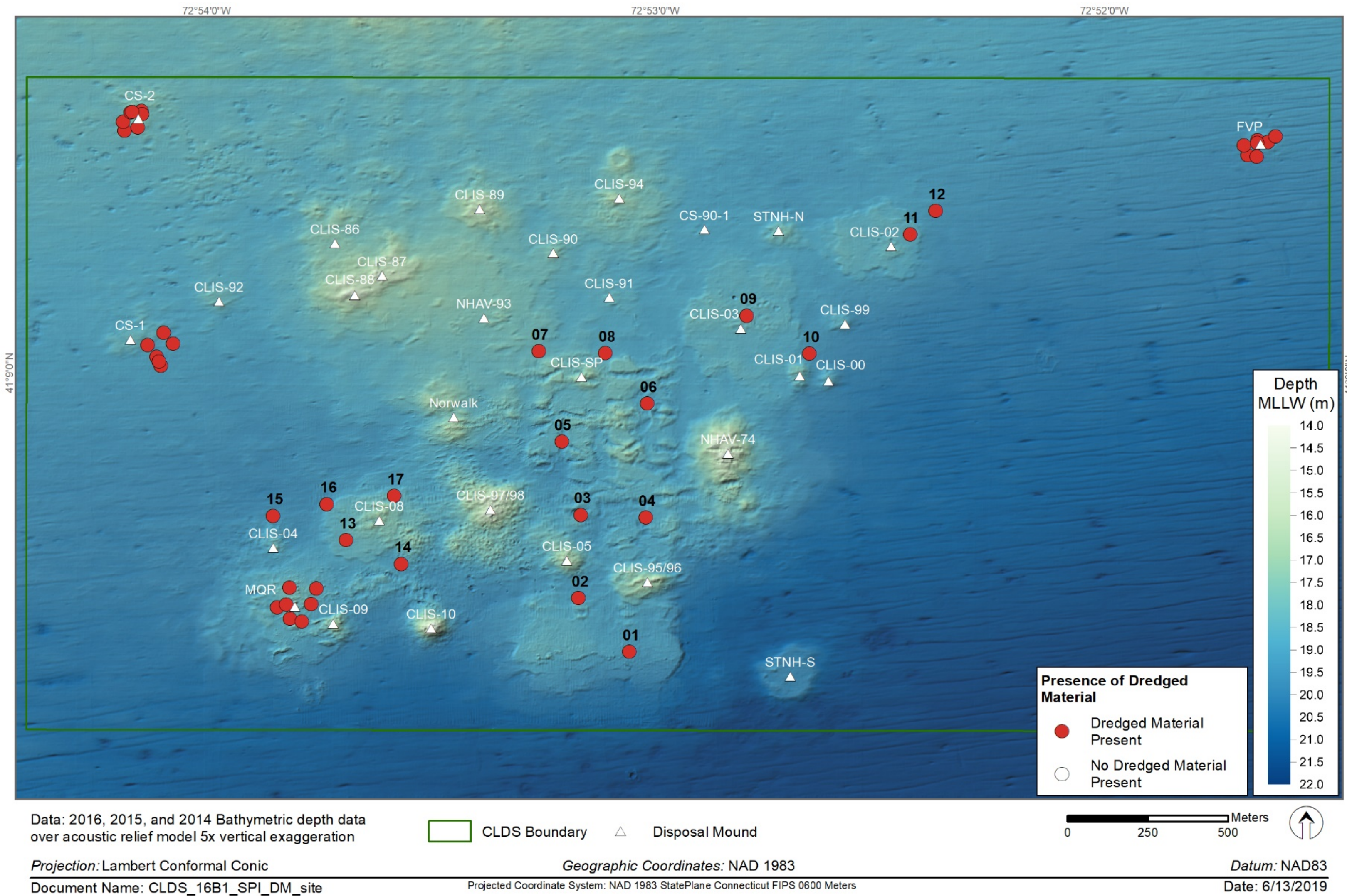
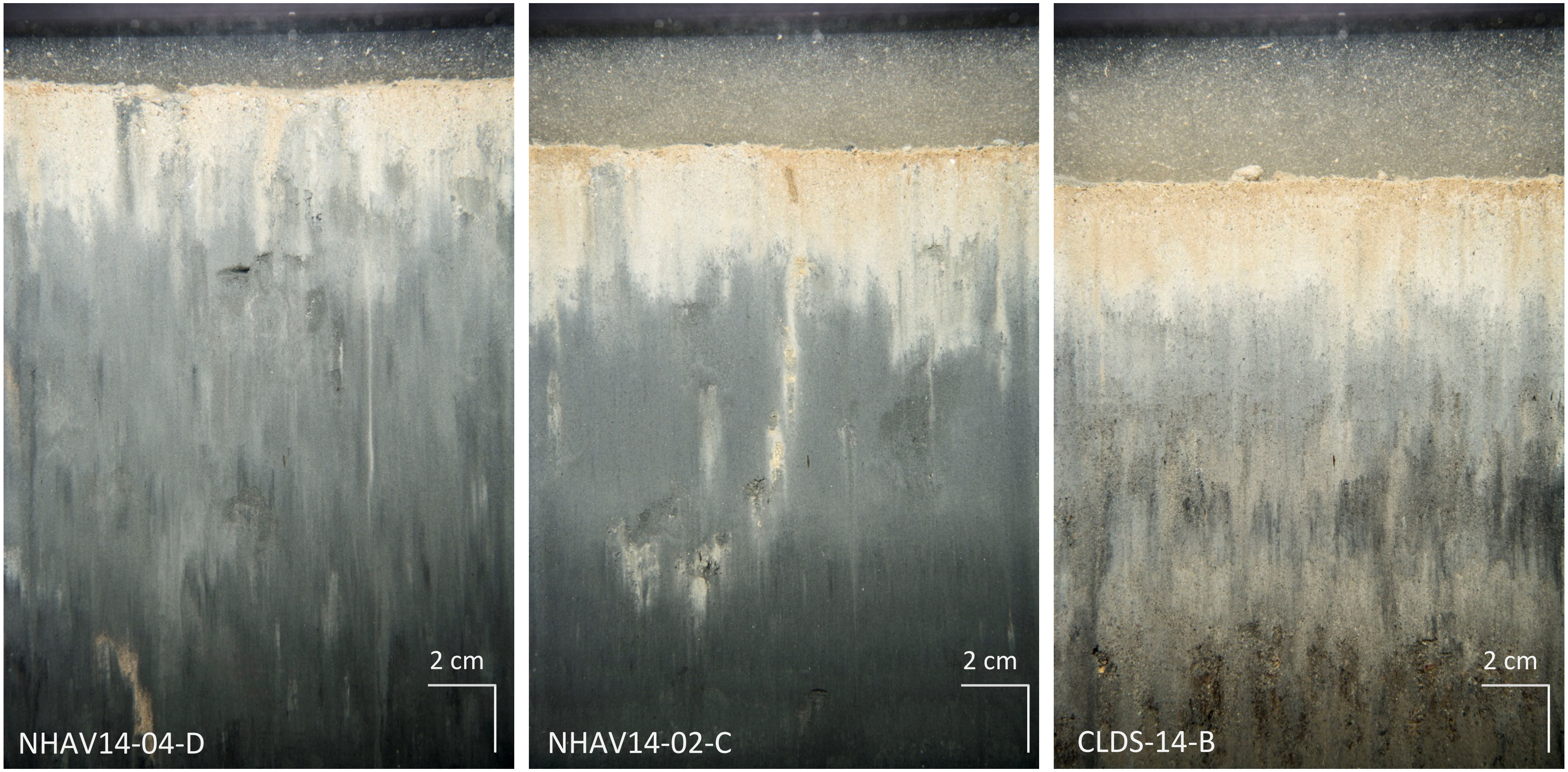


Figure 3-41. Presence/absence of dredged material within CLDS



(A) **(B)** **(C)**

Figure 3-42. Sediment profile images highlighting the variability of the dredged material in the sediment column from (A) Station 04 depicting a predominant grain size of light brown very fine sand over olive gray silt-clay; (B) Station 02 depicting a predominant grain size of light brown over olive gray silt-clay; and (C) Station 14 depicting light brown very fine sand over a grayish-brown fine sand

Figure 3-43. Sediment profile image depicting a sediment column with high optical reflectance

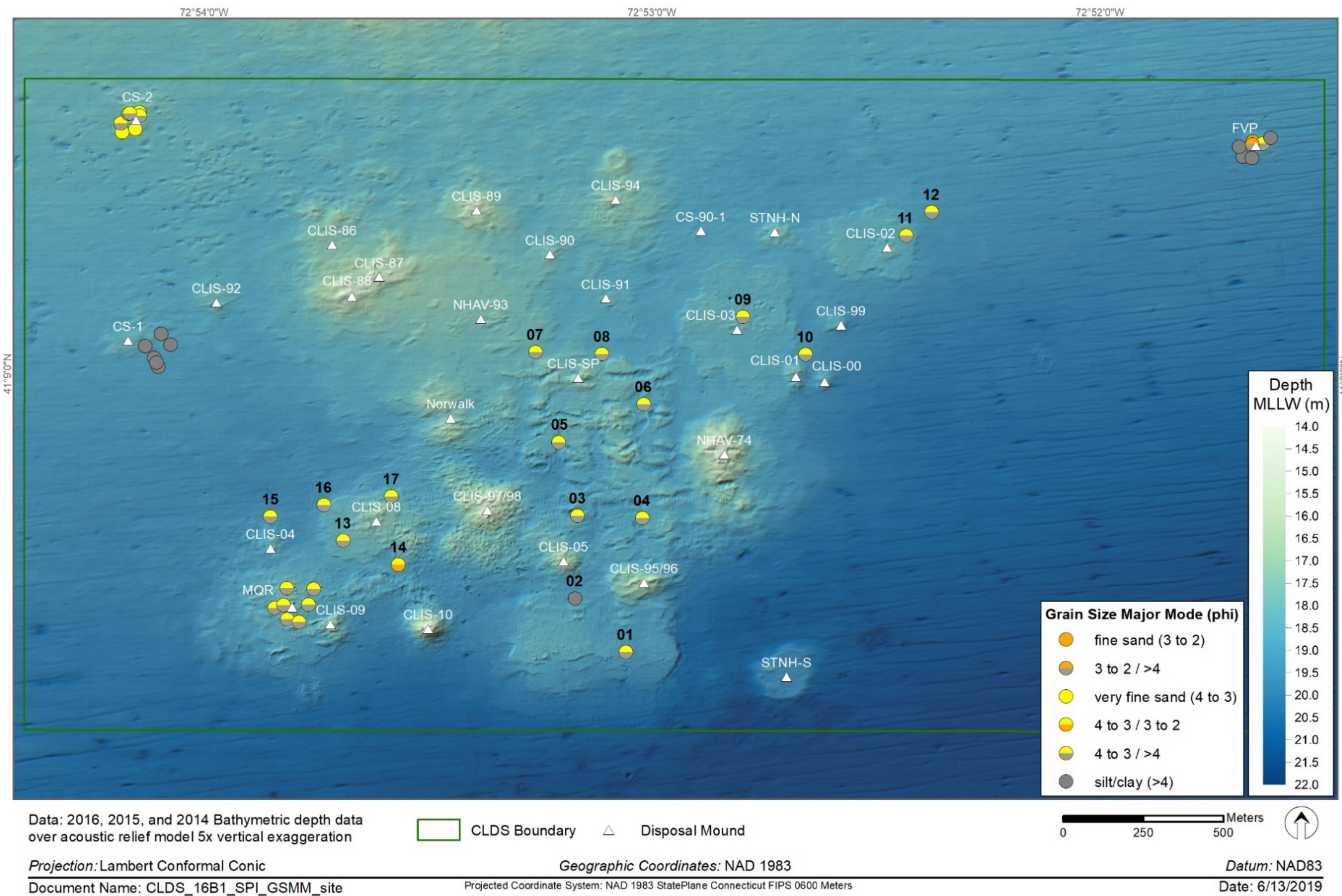


Figure 3-44. Sediment grain size major mode (phi units) within CLDS

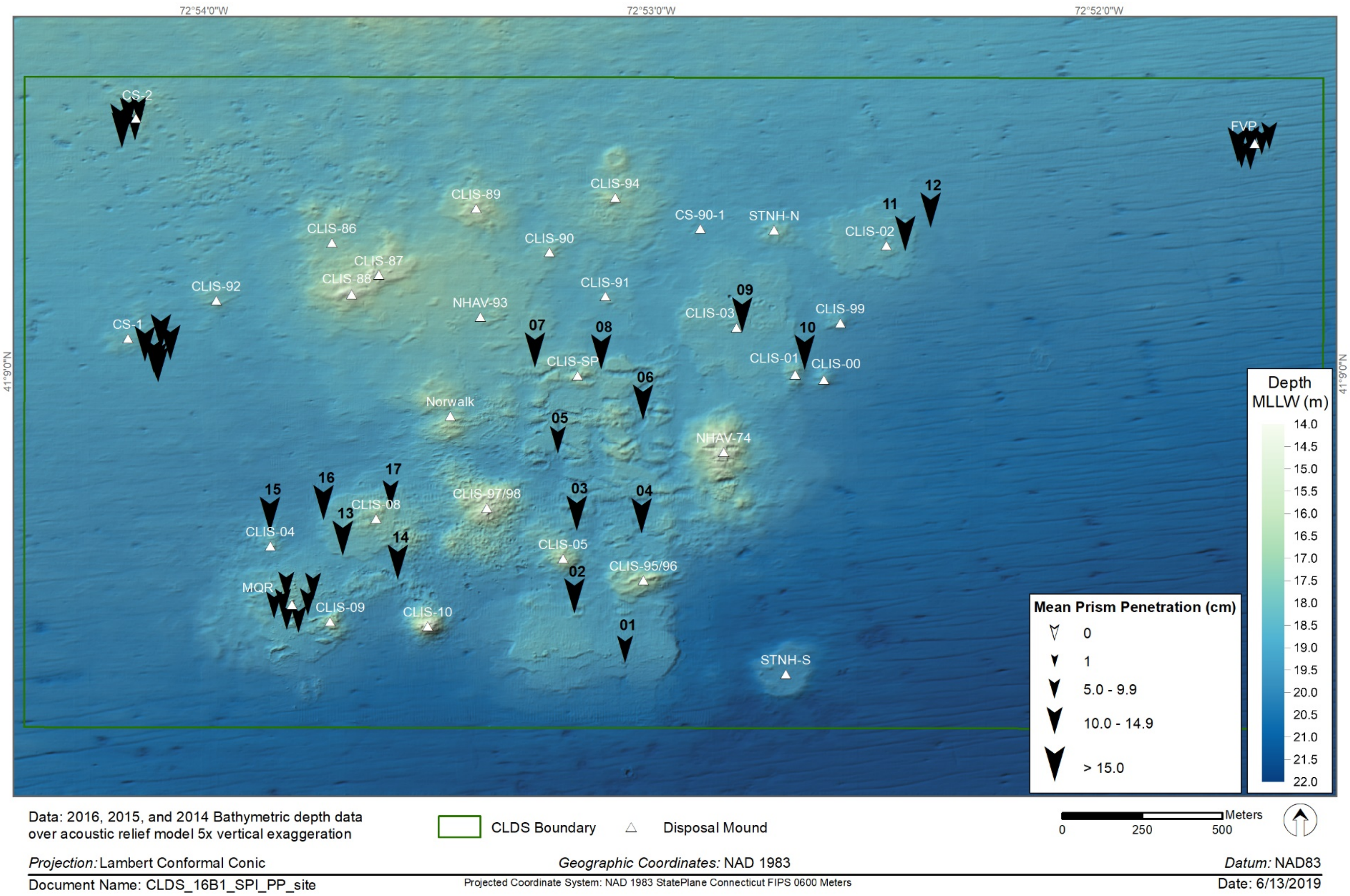


Figure 3-45. Mean station camera prism penetration depths (cm) within CLDS

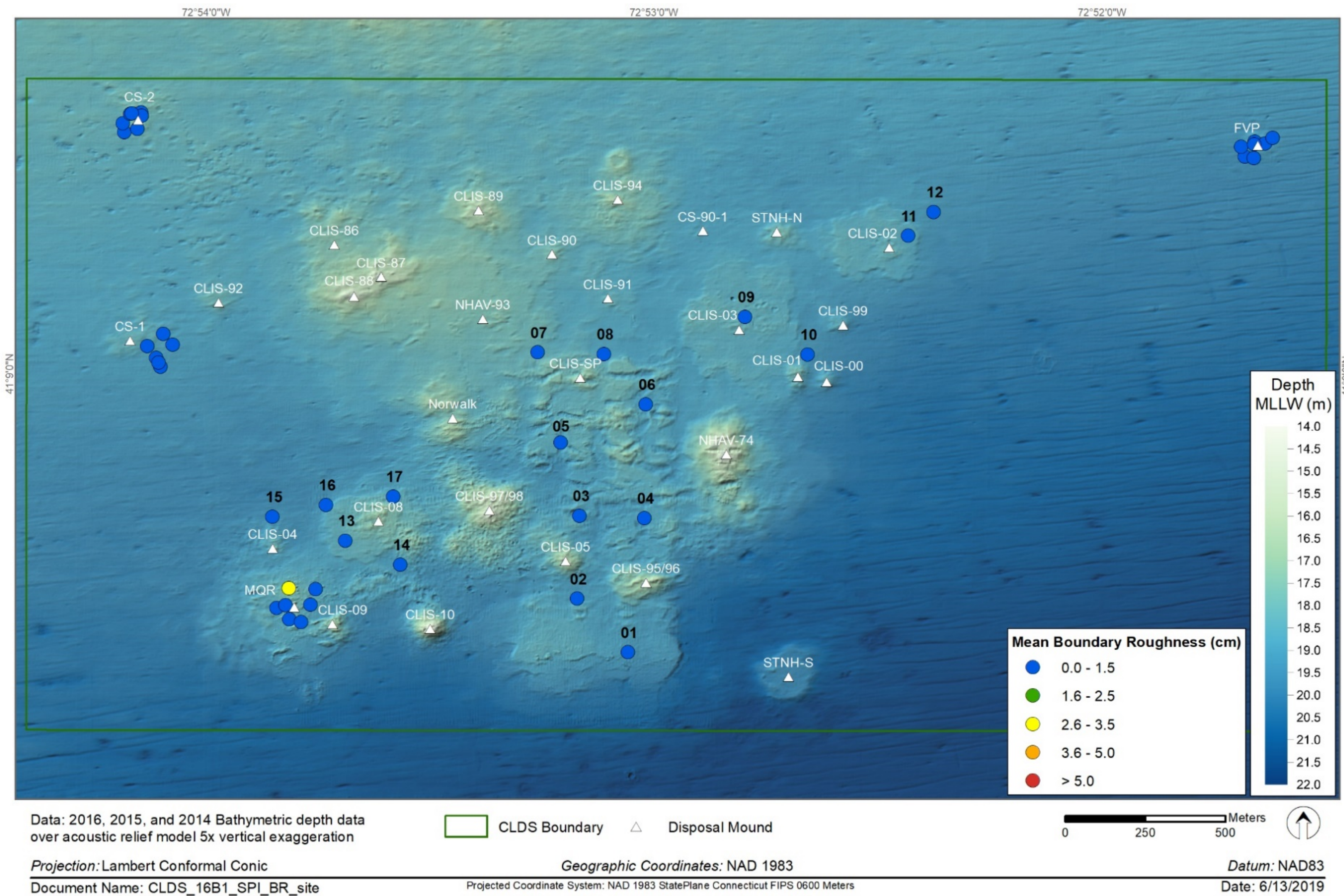
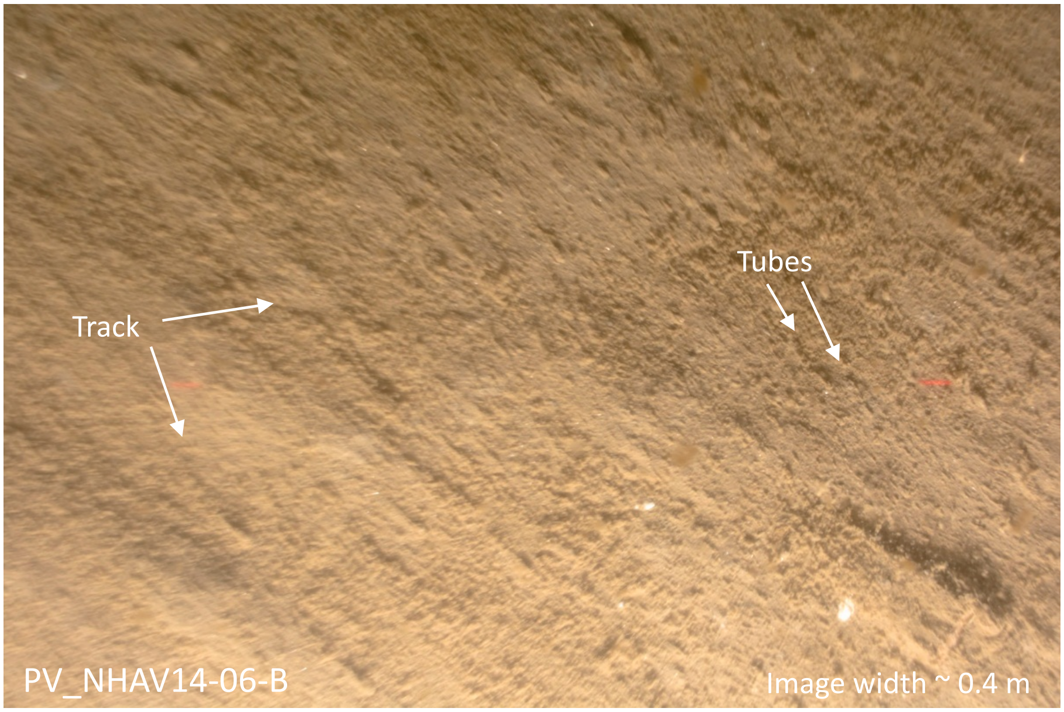
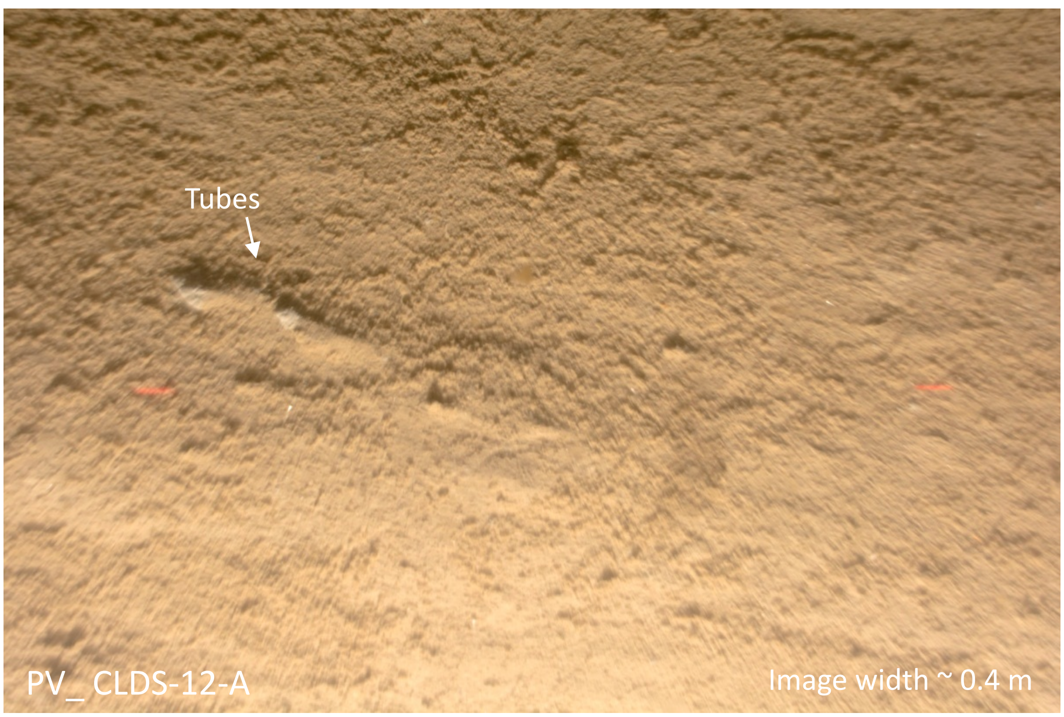


Figure 3-46. Mean station small-scale boundary roughness values (cm) within CLDS



(A)



(B)

Figure 3-47. Plan view images from the recent and/or historically active areas of CLDS depicting a relatively stable seafloor with little to no hydrodynamic forcing at (A) Station 06 with a very fine sediment surface with small tubes and biogenic tracks; and (B) Station 12 with a very fine sand seabed covered in a dense assemblage of small tubes

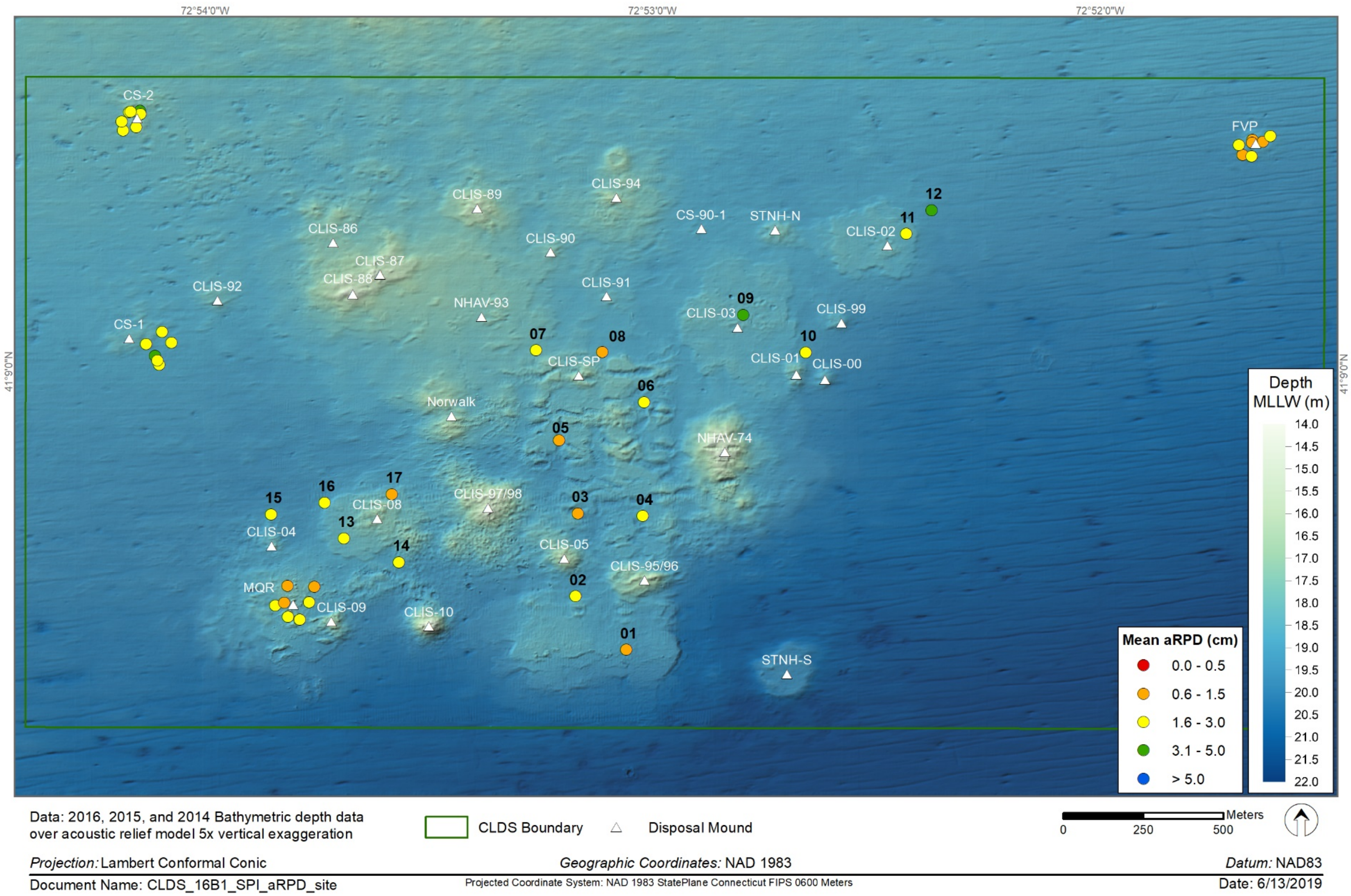


Figure 3-48. Mean station aRPD depth values (cm) within CLDS

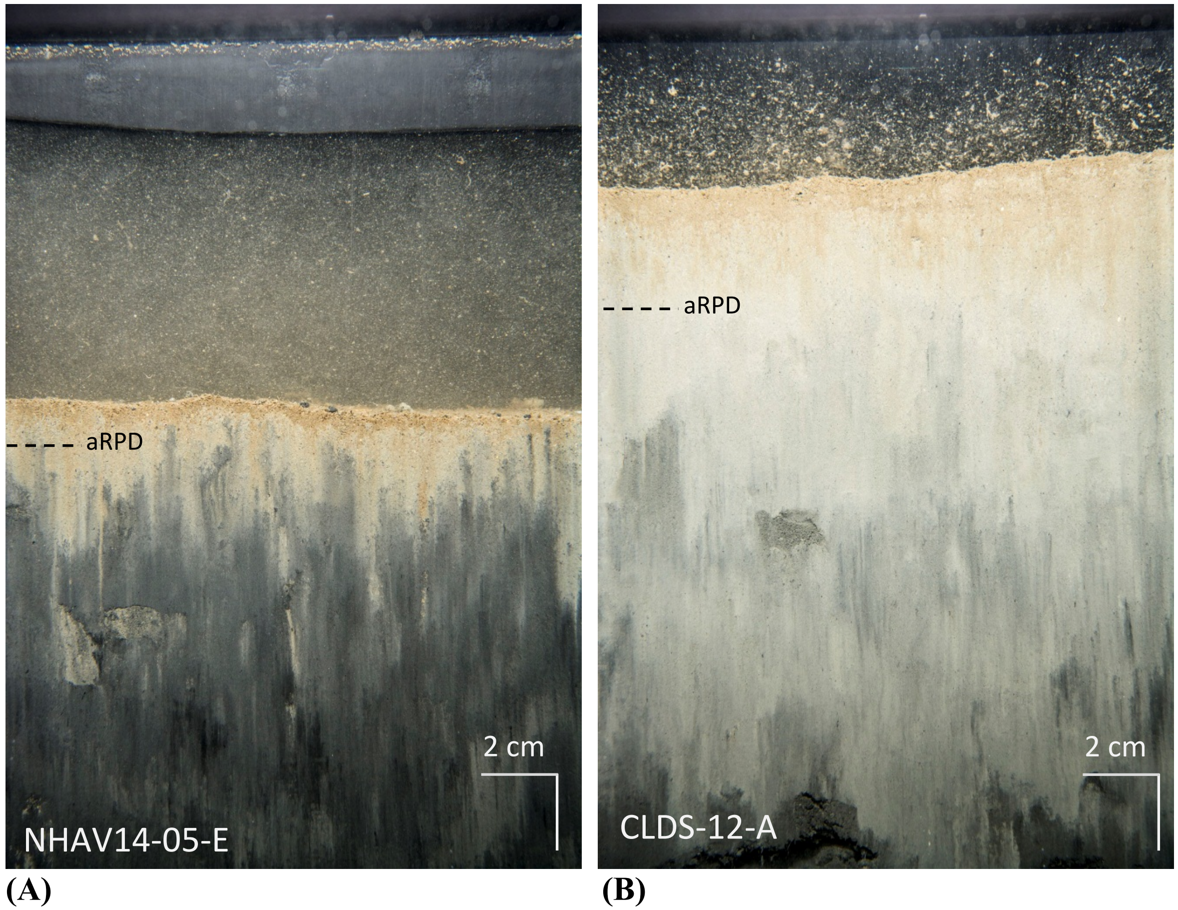


Figure 3-49. Sediment profile images from the NHAV14 and CLDS recent placement areas depicting (A) the shallowest aRPD depth and Stage 1 on 3 successional taxa at Station 05, and (B) the deepest aRPD depth at Station 12

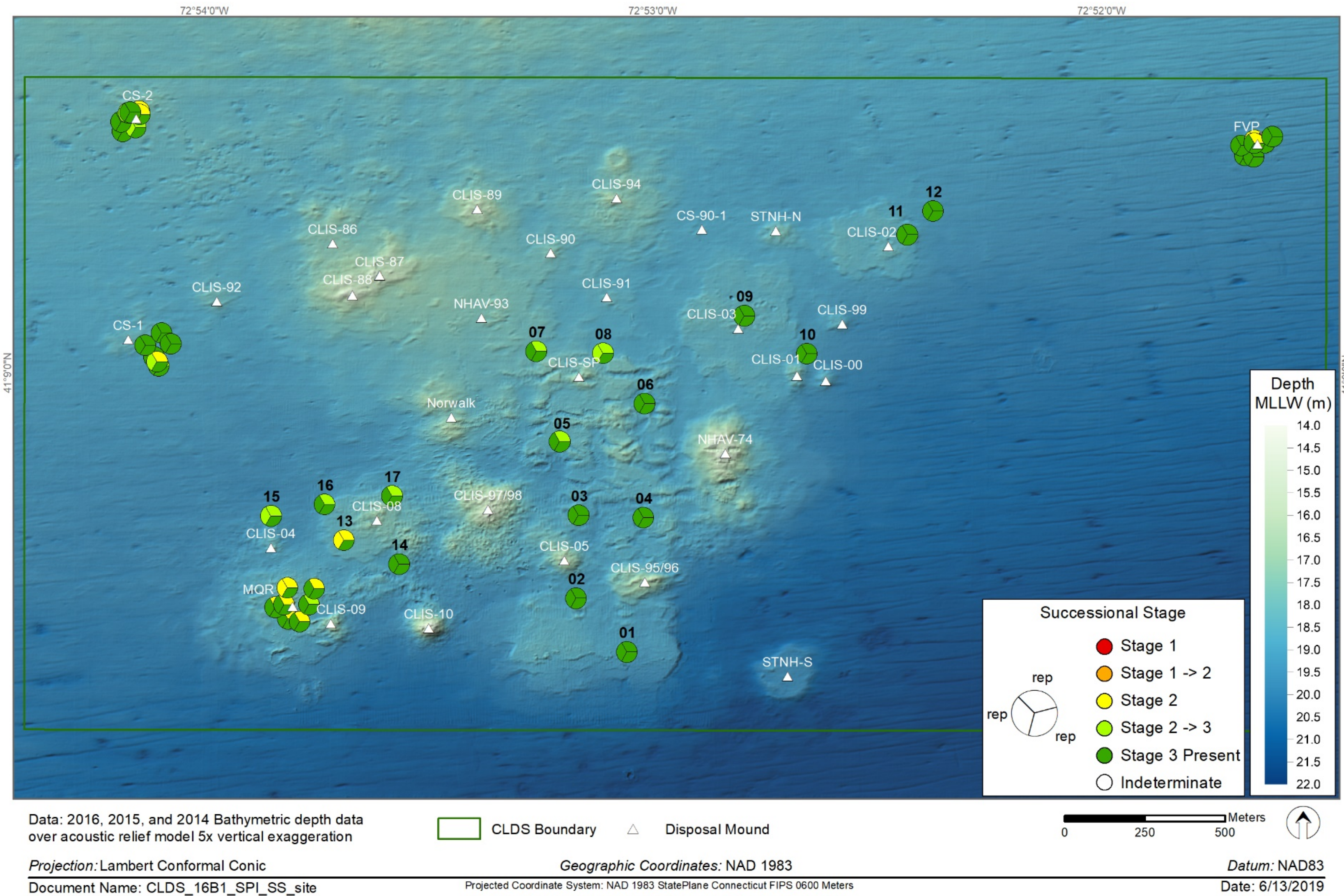


Figure 3-50. Infaunal successional stages found within CLDS

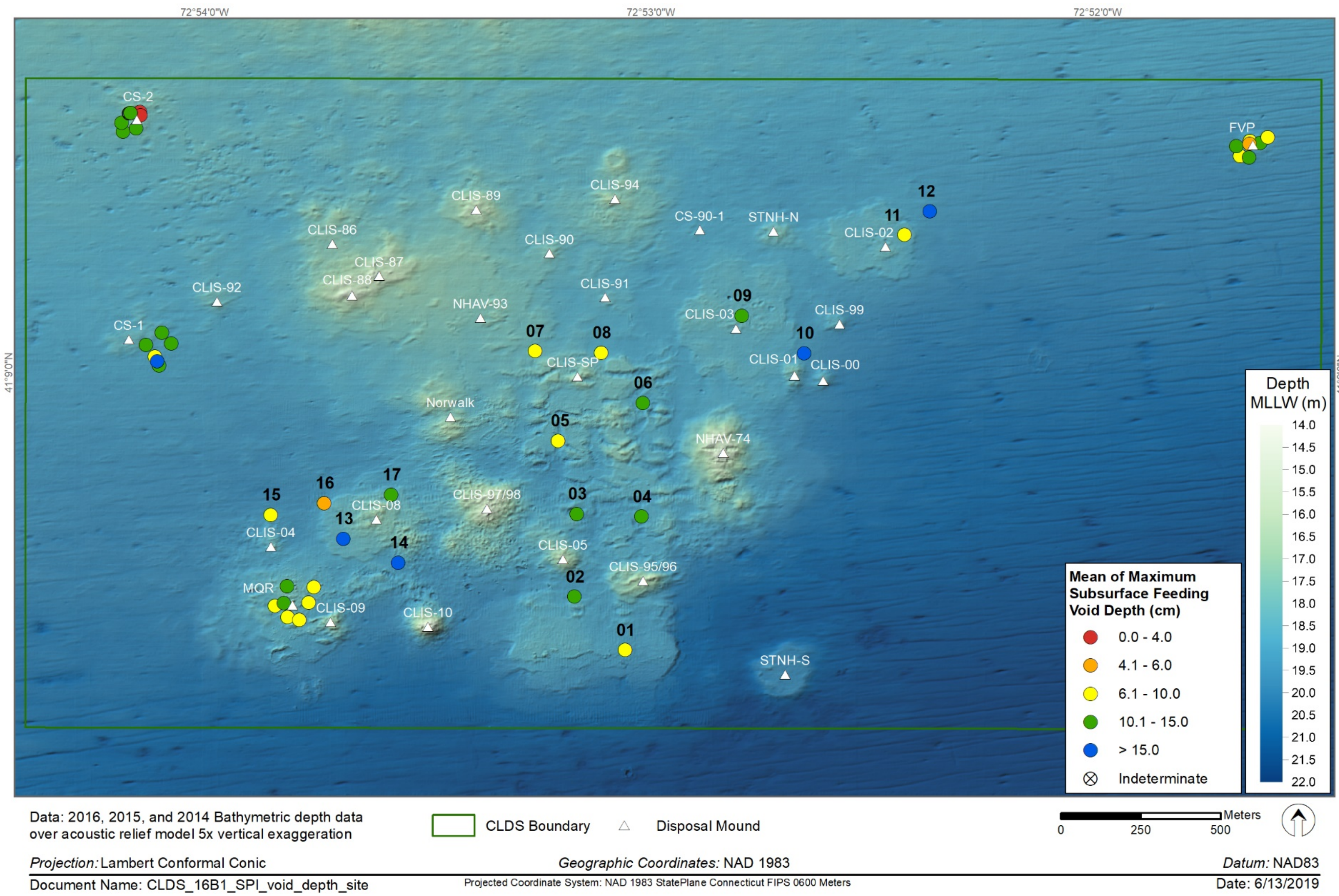
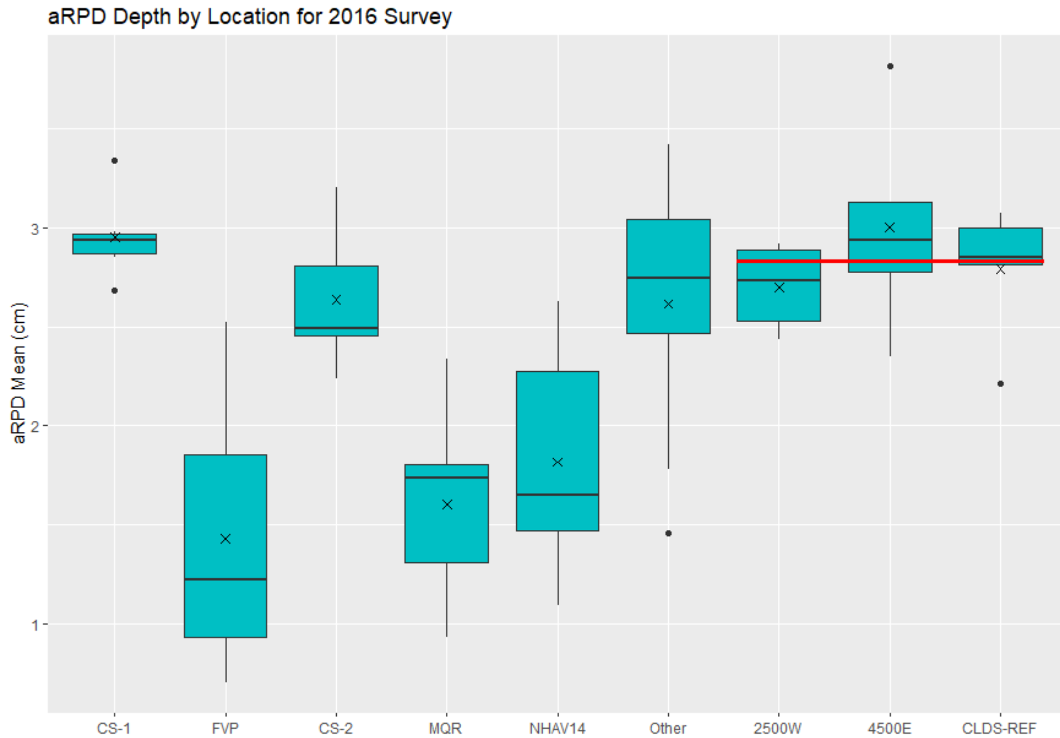
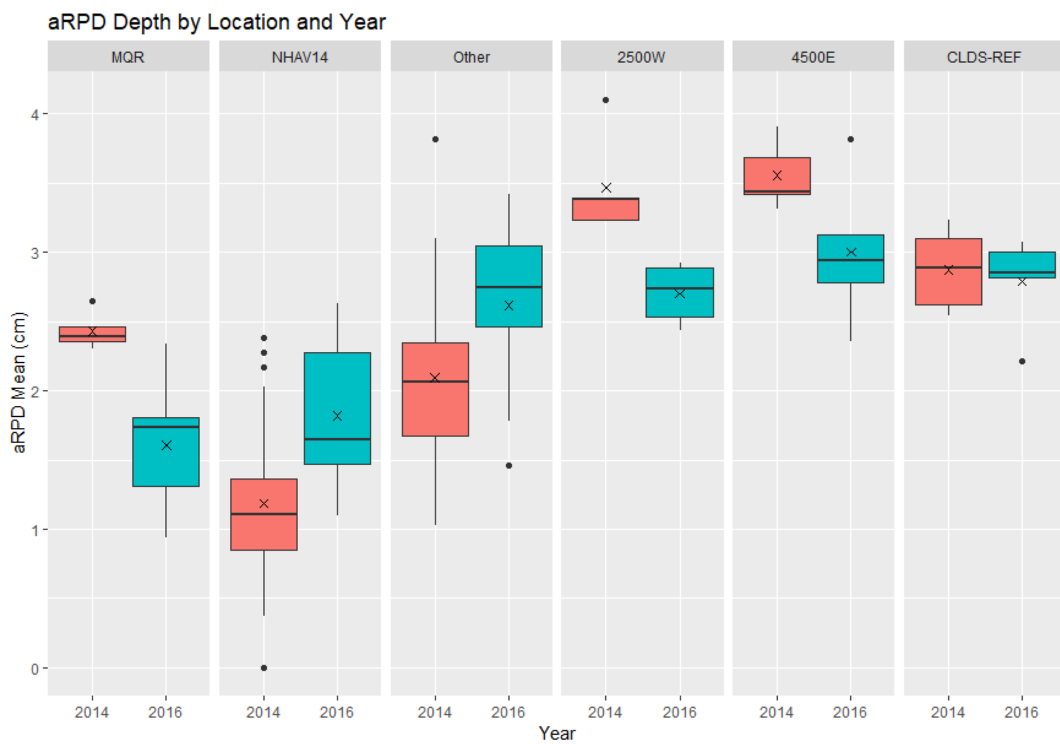


Figure 3-51. Mean subsurface feeding void depth (cm) within CLDS

Figure 3-52. Sediment profile image at Station 16 depicting a sediment column of dredged material with a shallow feeding void



(A)



(B)

Figure 3-53. Boxplots showing aRPD results for (A) all locations surveyed during the 2016 survey (the red line represents the grand reference area mean); and (B) the six locations surveyed in both 2014 and 2016

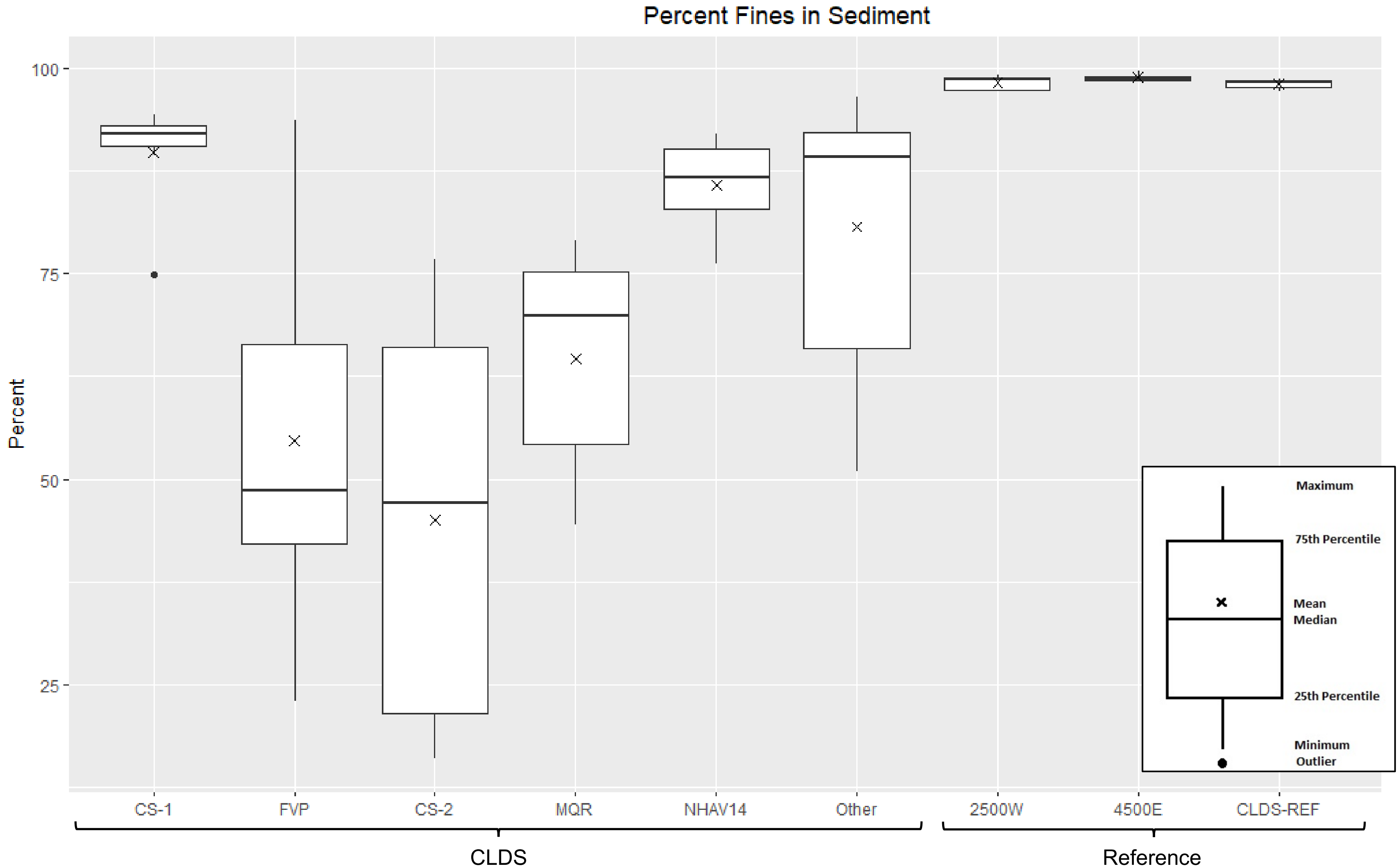


Figure 3-54. Boxplots showing percent fines by area in sediments from CLDS and reference areas 2016

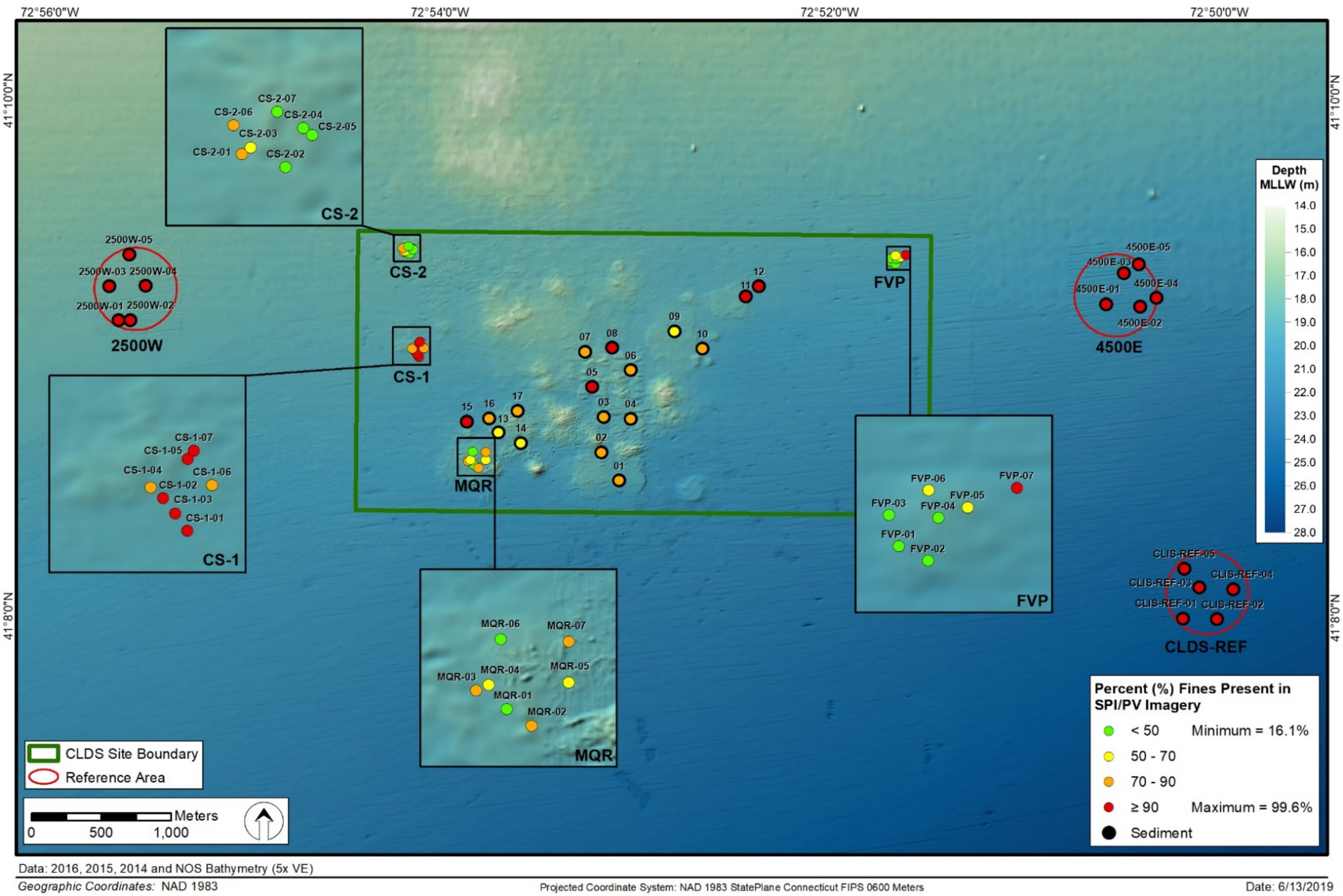


Figure 3-55. Percent fines by station in sediments from CLDS and reference areas 2016

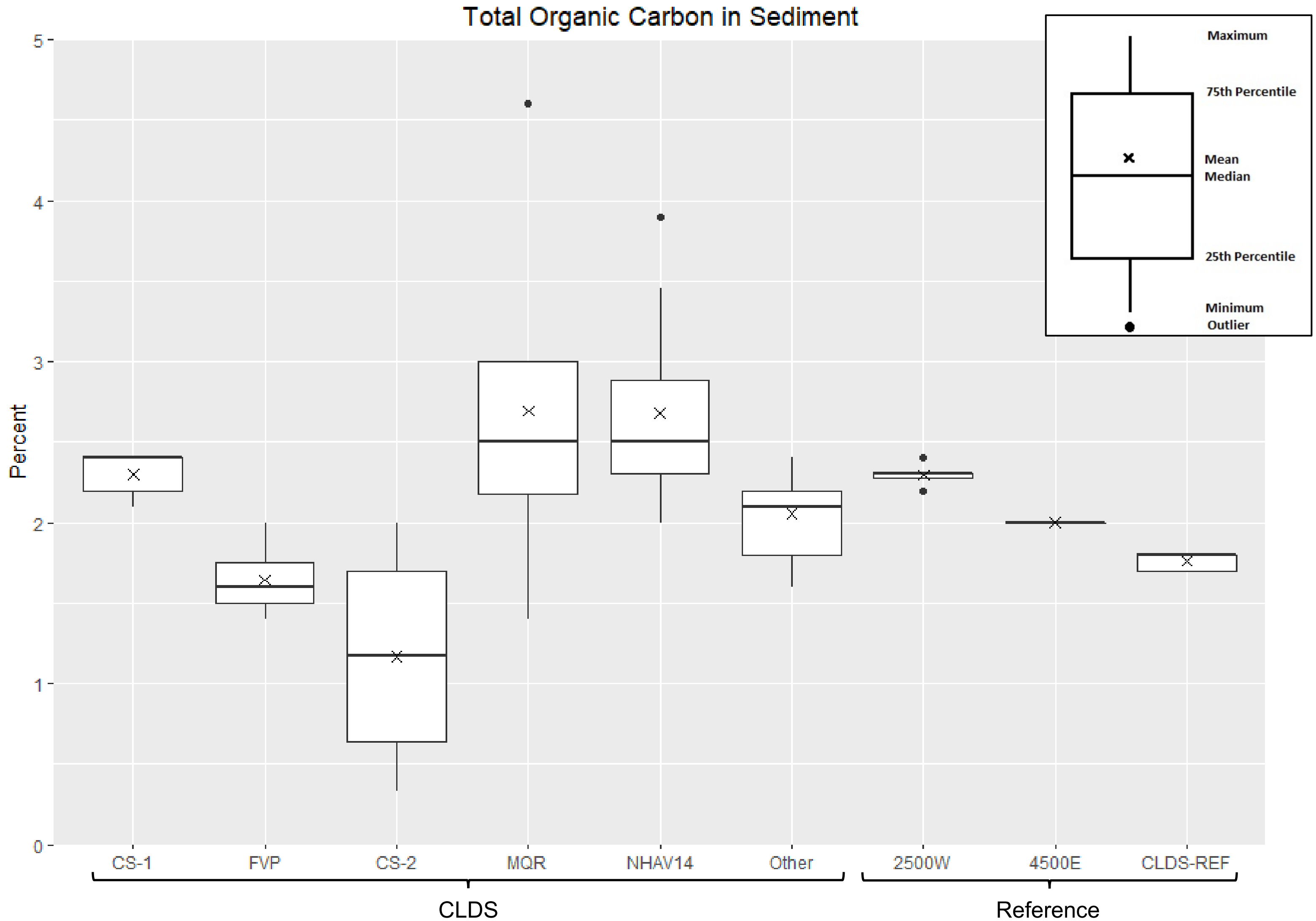


Figure 3-56. Boxplots showing TOC by area in sediments from CLDS and reference areas 2016. Laboratory replicates presented as averages in plot.

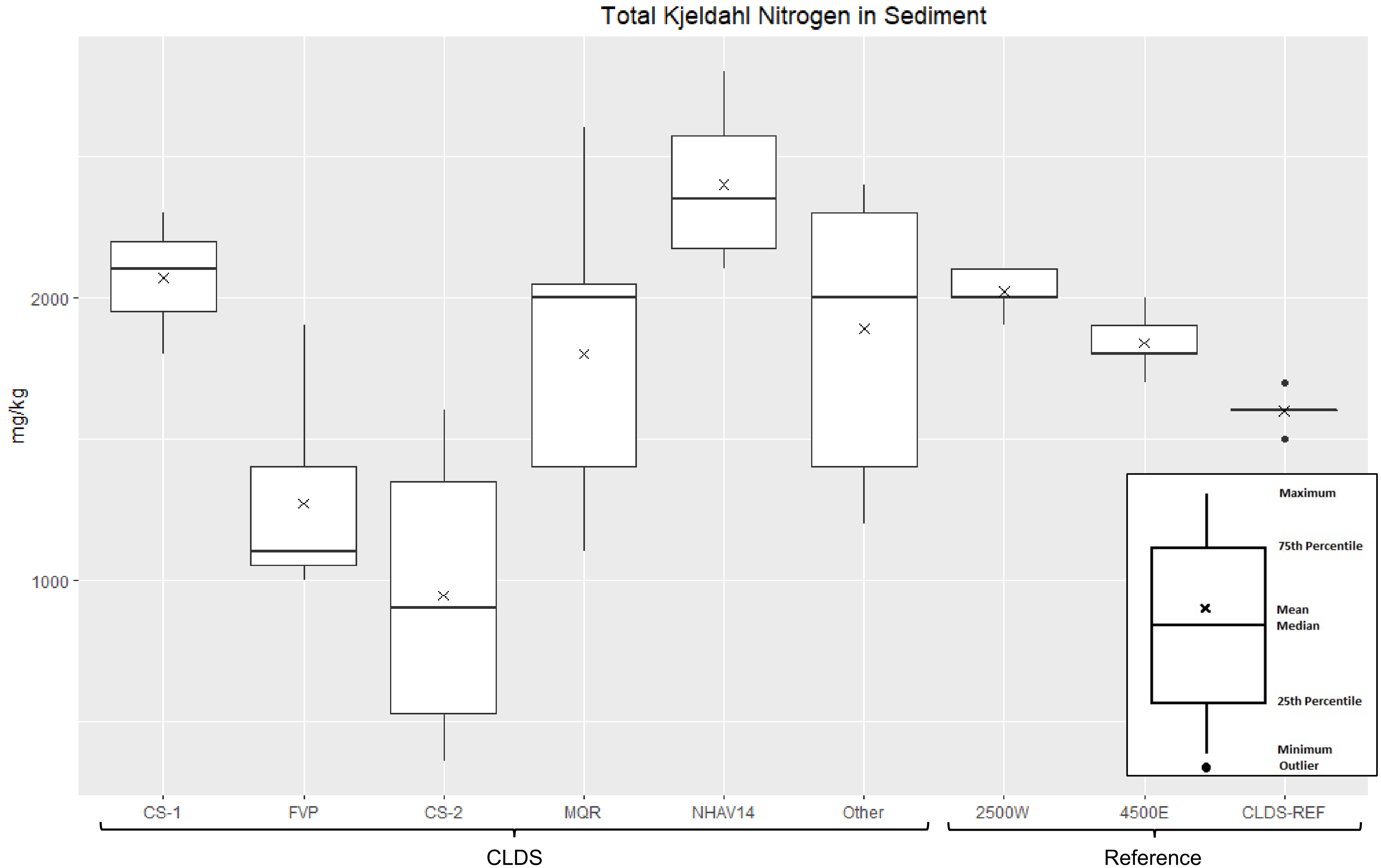


Figure 3-57. Boxplots showing total Kjeldahl nitrogen (mg/kg) by area in sediments from CLDS and reference areas 2016

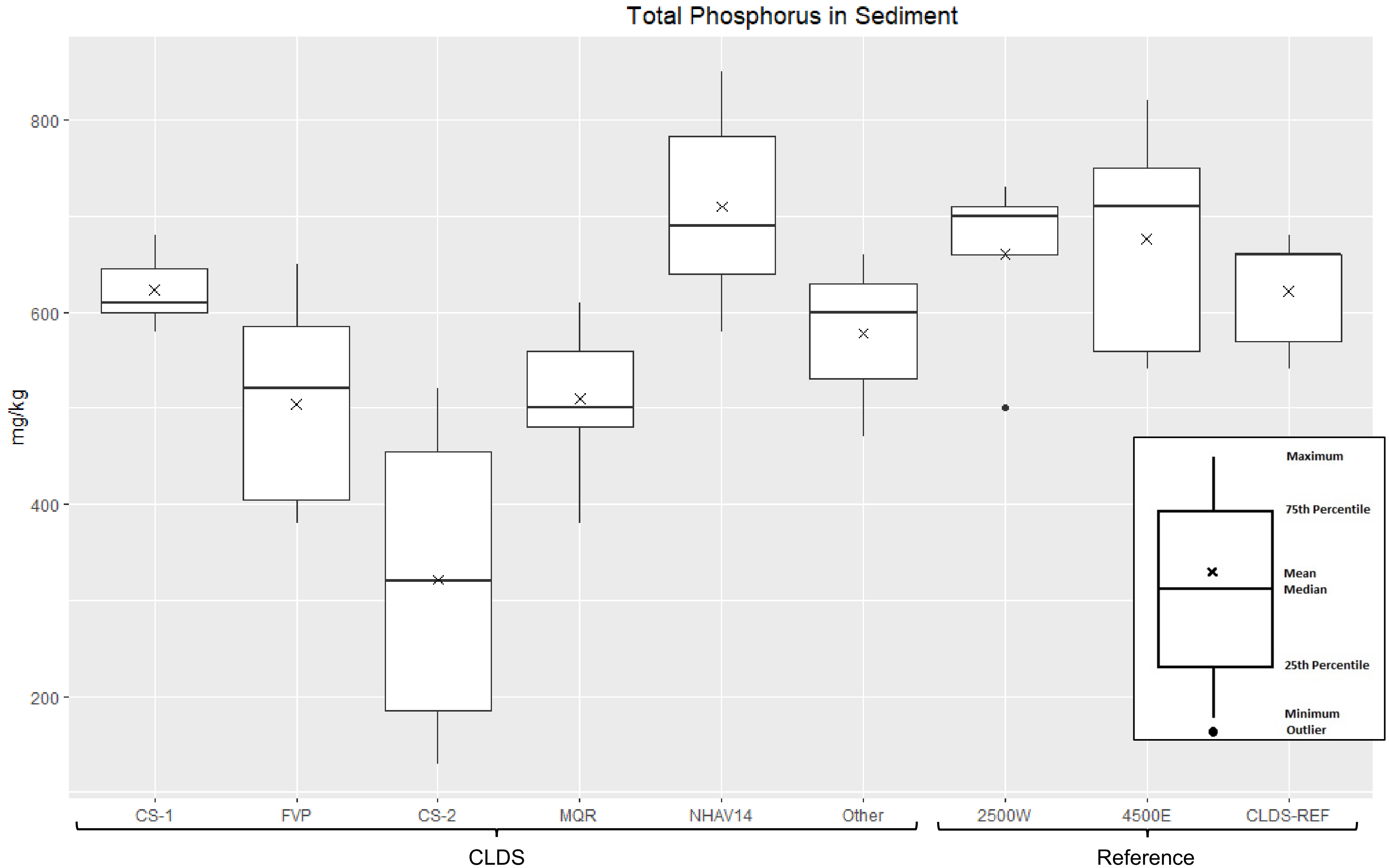


Figure 3-58. Boxplots showing total phosphorus (mg/kg) by area in sediments from CLDS and reference areas 2016

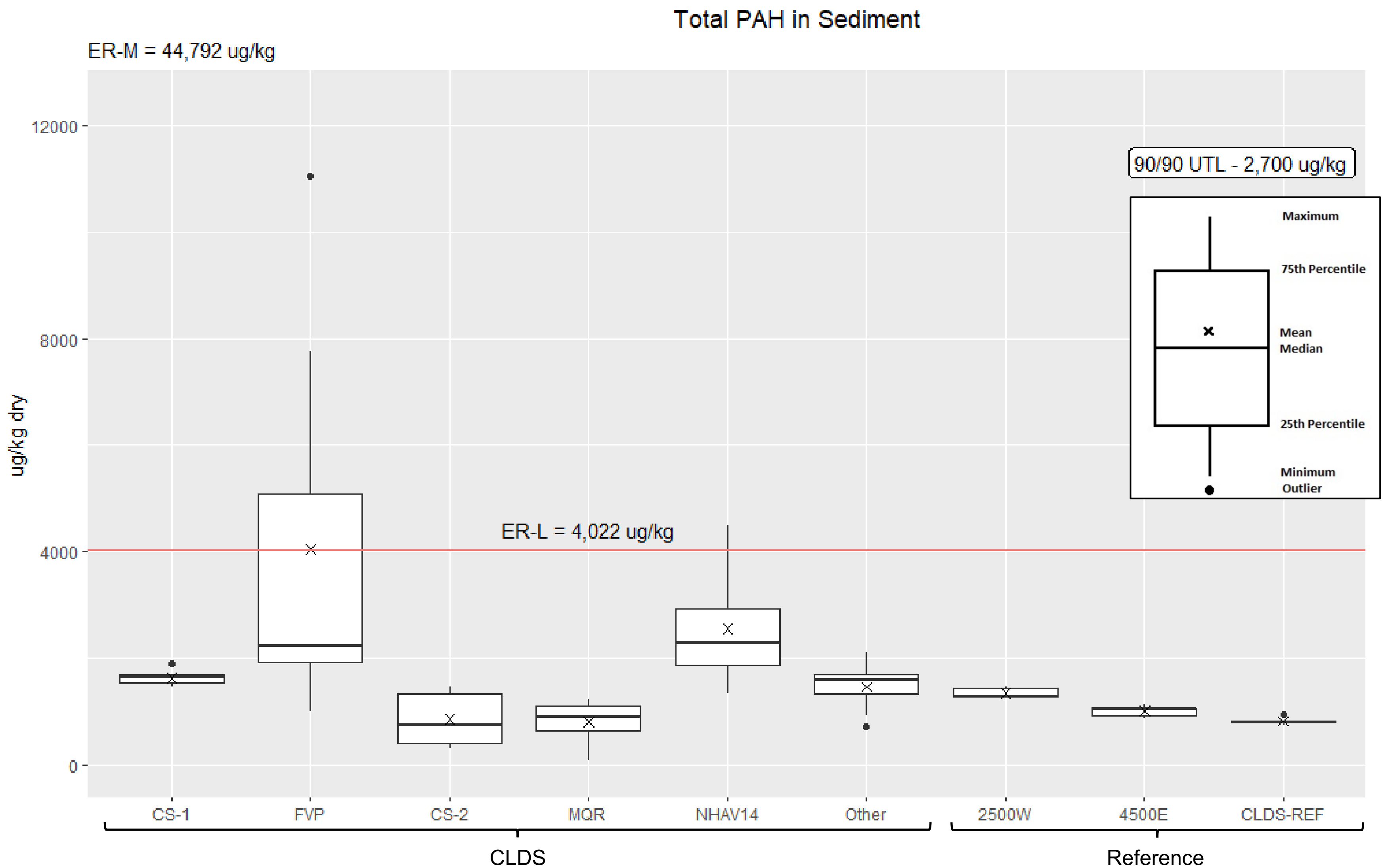


Figure 3-59. Boxplots showing total PAH (µg/kg dry-wt.) by area in sediments from CLDS and reference areas 2016

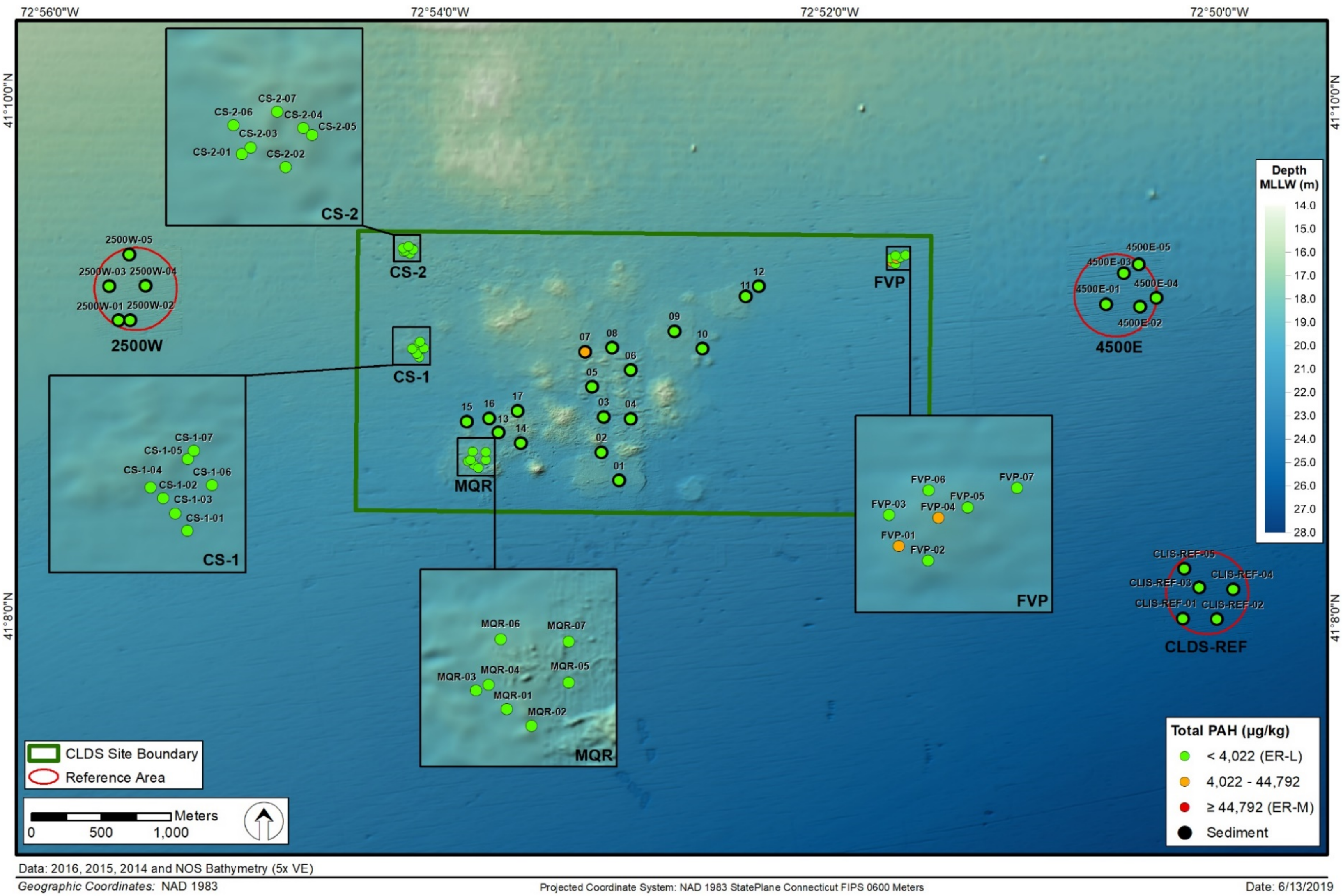


Figure 3-60. Total PAH by station in sediments from CLDS and reference areas 2016

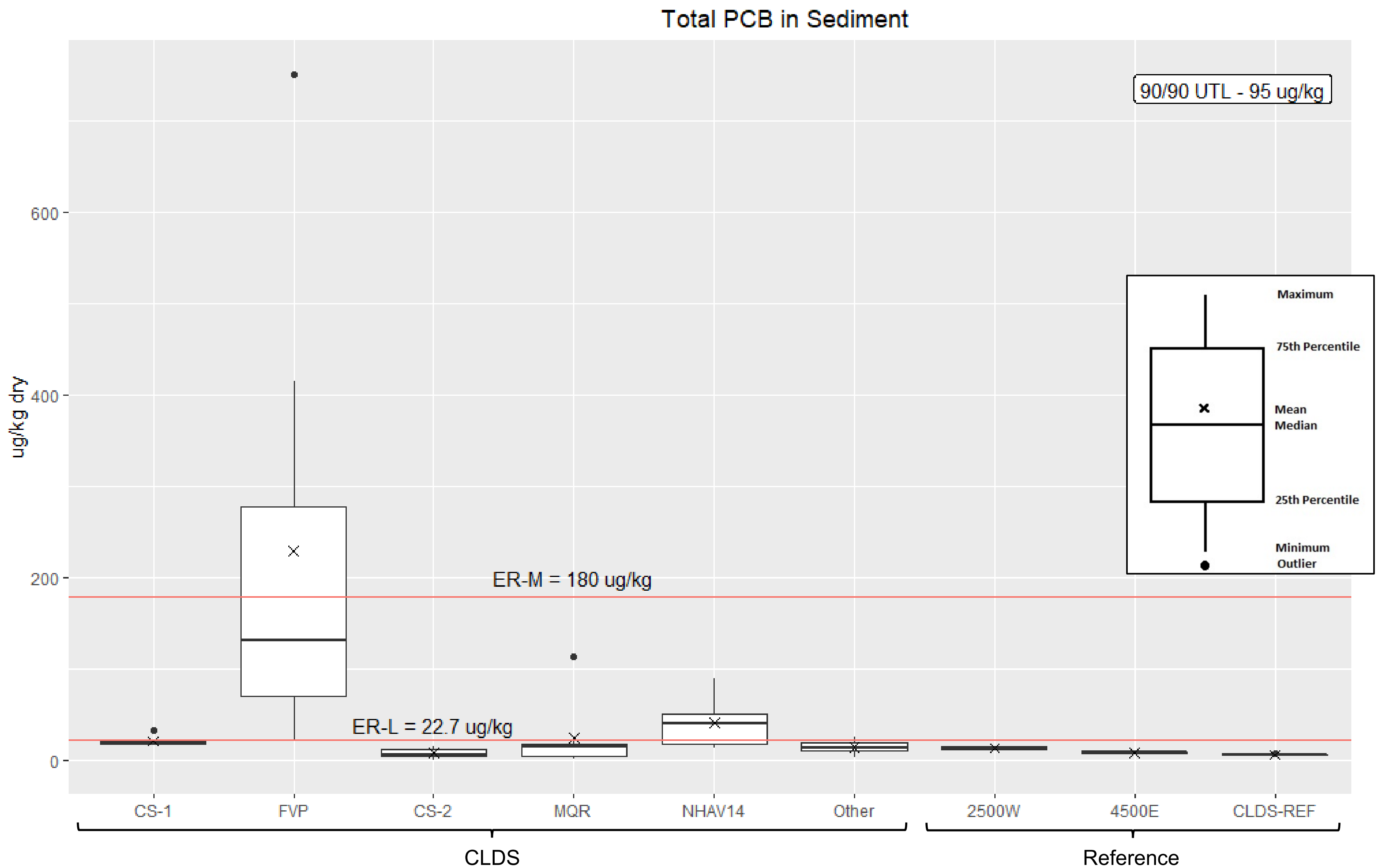


Figure 3-61. Boxplots showing total PCB (µg/kg dry-wt.) by area in sediments from CLDS and reference areas 2016

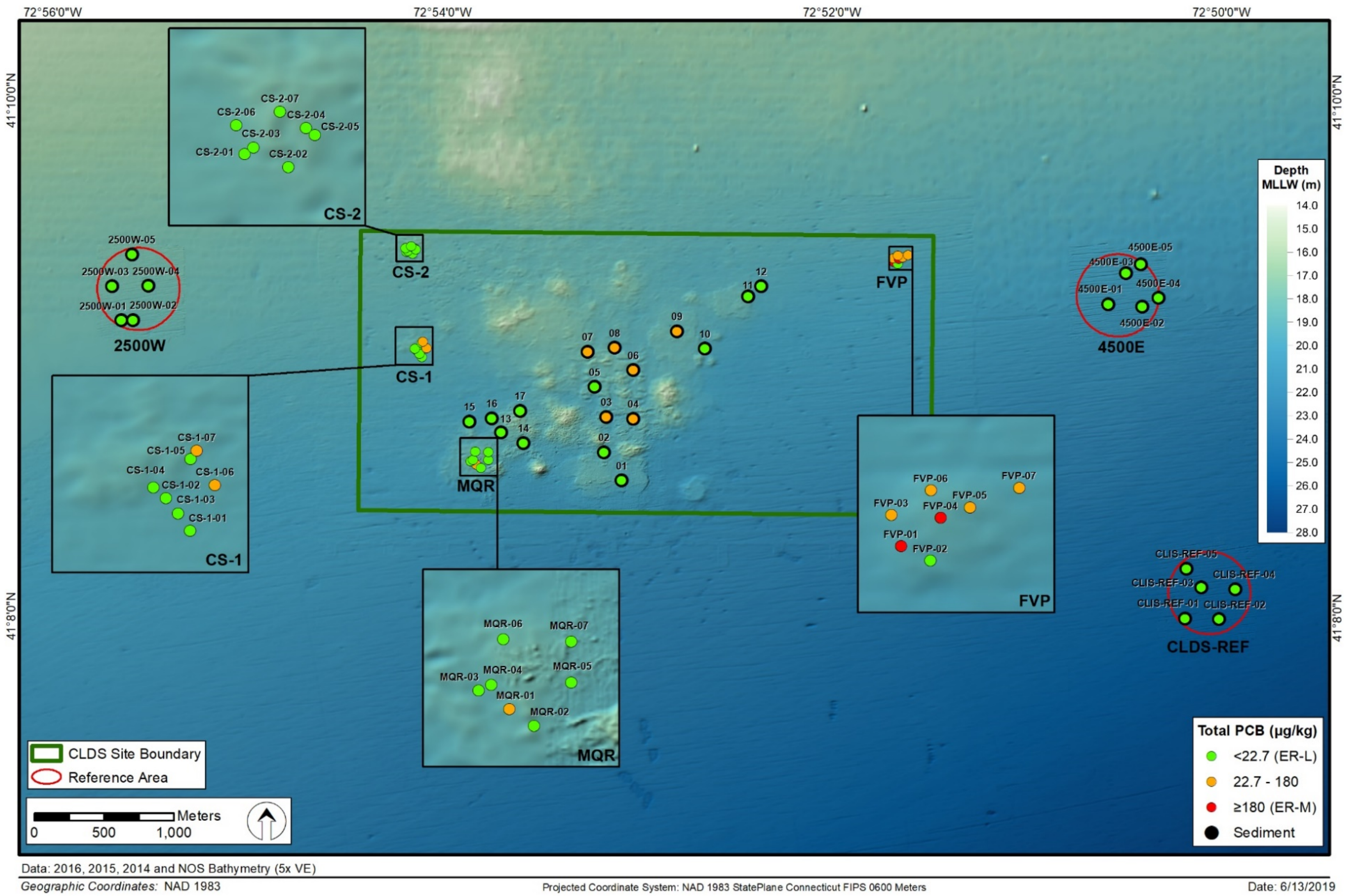


Figure 3-62. Total PCB by station in sediments from CLDS and reference areas 2016

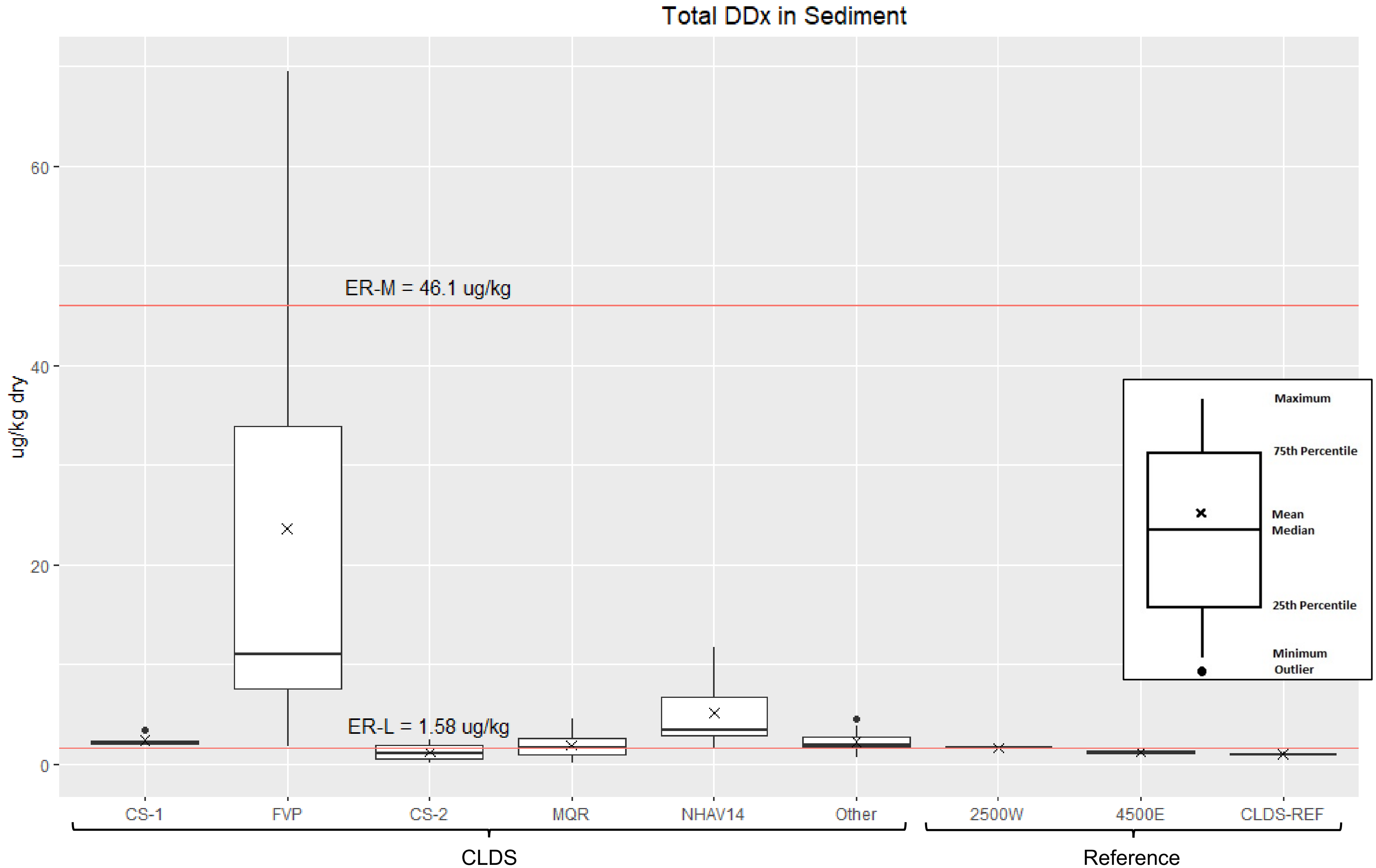


Figure 3-63a. Boxplots showing total DDx (µg/kg dry-wt.) by area in sediments from CLDS and reference areas 2016

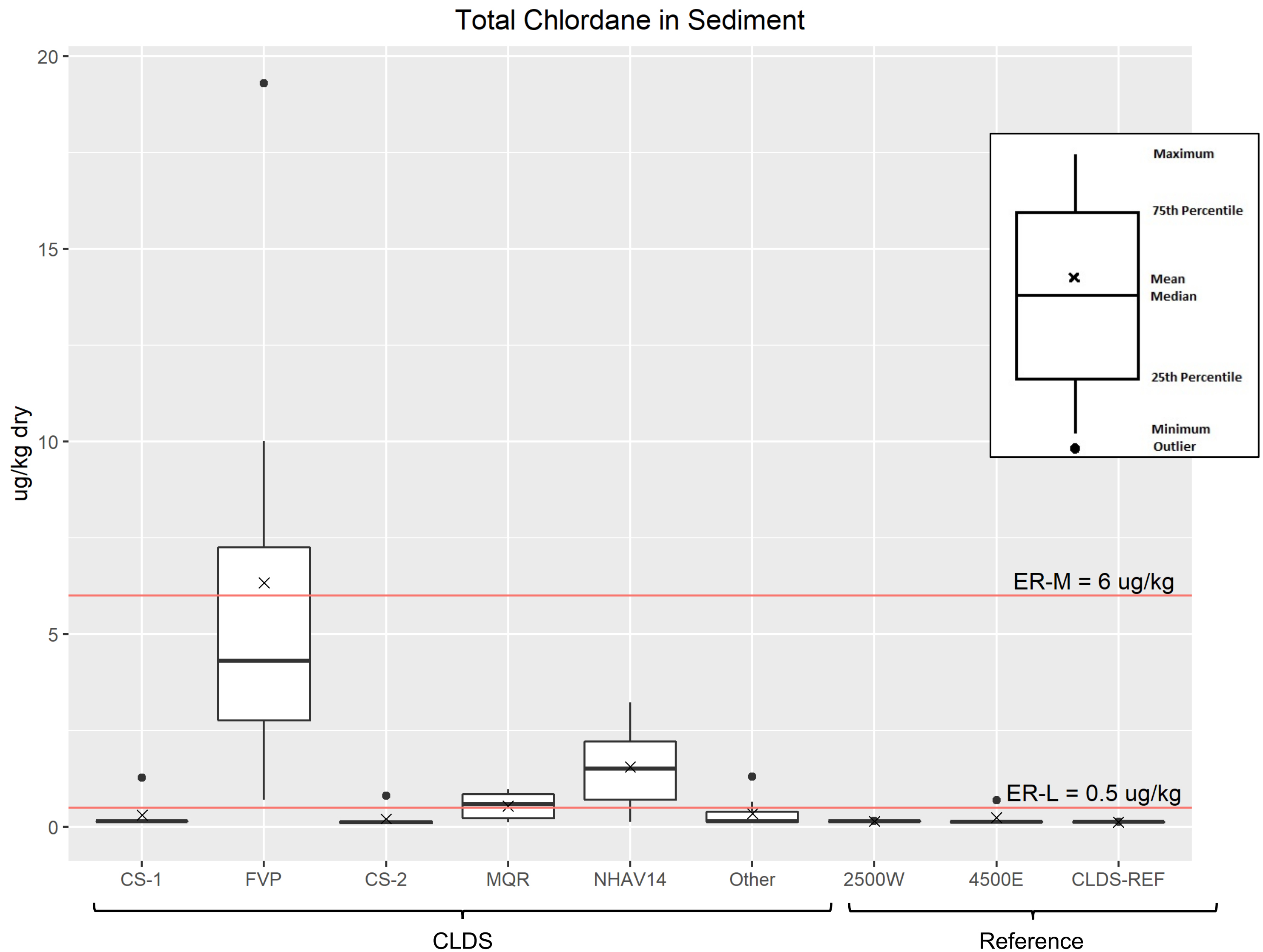


Figure 3-63b. Boxplots showing total chlordane (μg/kg dry-wt.) by area in sediments from CLDS and reference areas 2016

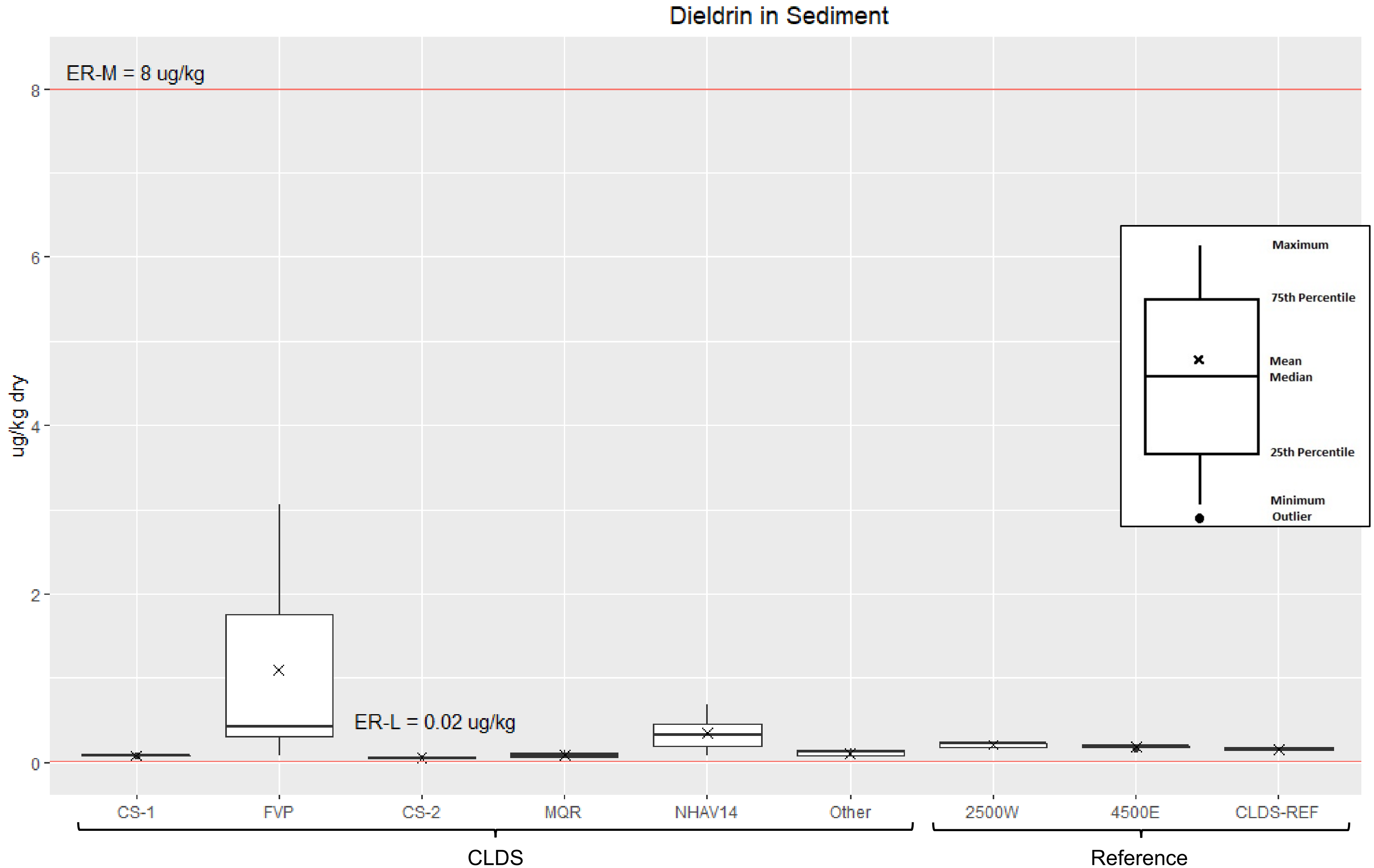


Figure 3-63c. Boxplots showing dieldrin (µg/kg dry-wt.) by area in sediments from CLDS and reference areas 2016

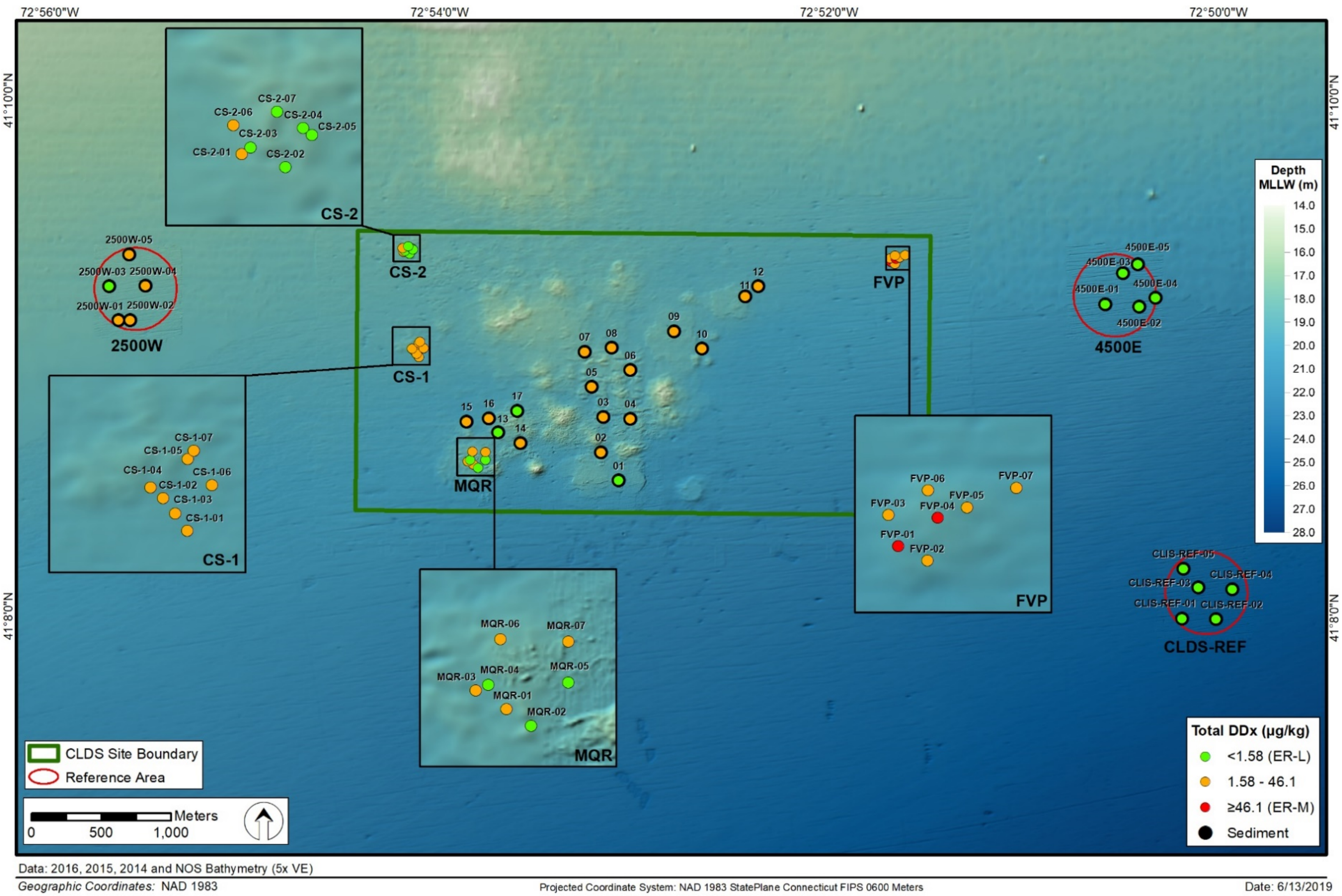


Figure 3-64a. Total DDx (µg/kg dry-wt.) by station in sediments from CLDS and reference areas 2016

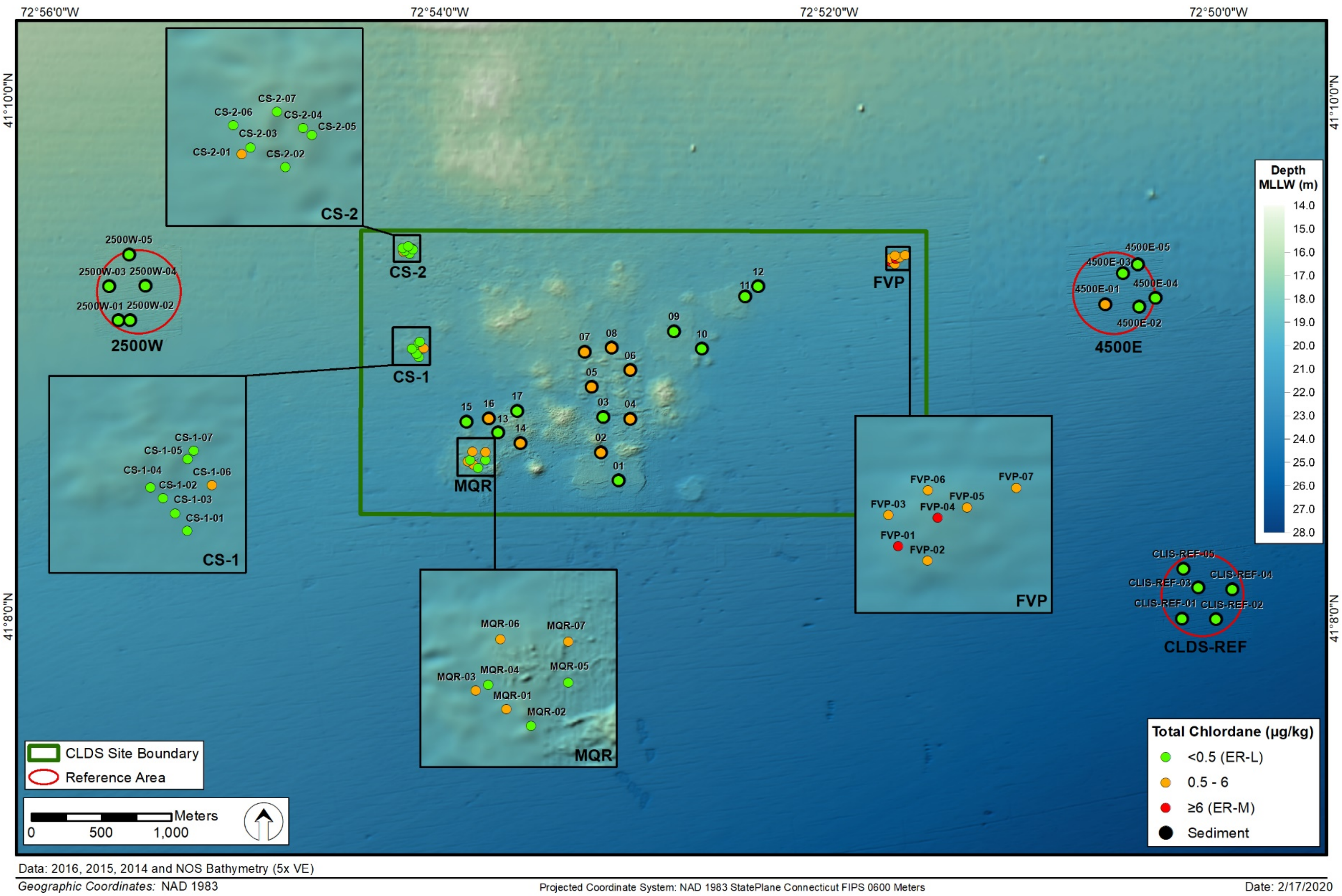


Figure 3-64b. Total chlordane (µg/kg dry-wt.) by station in sediments from CLDS and reference areas 2016

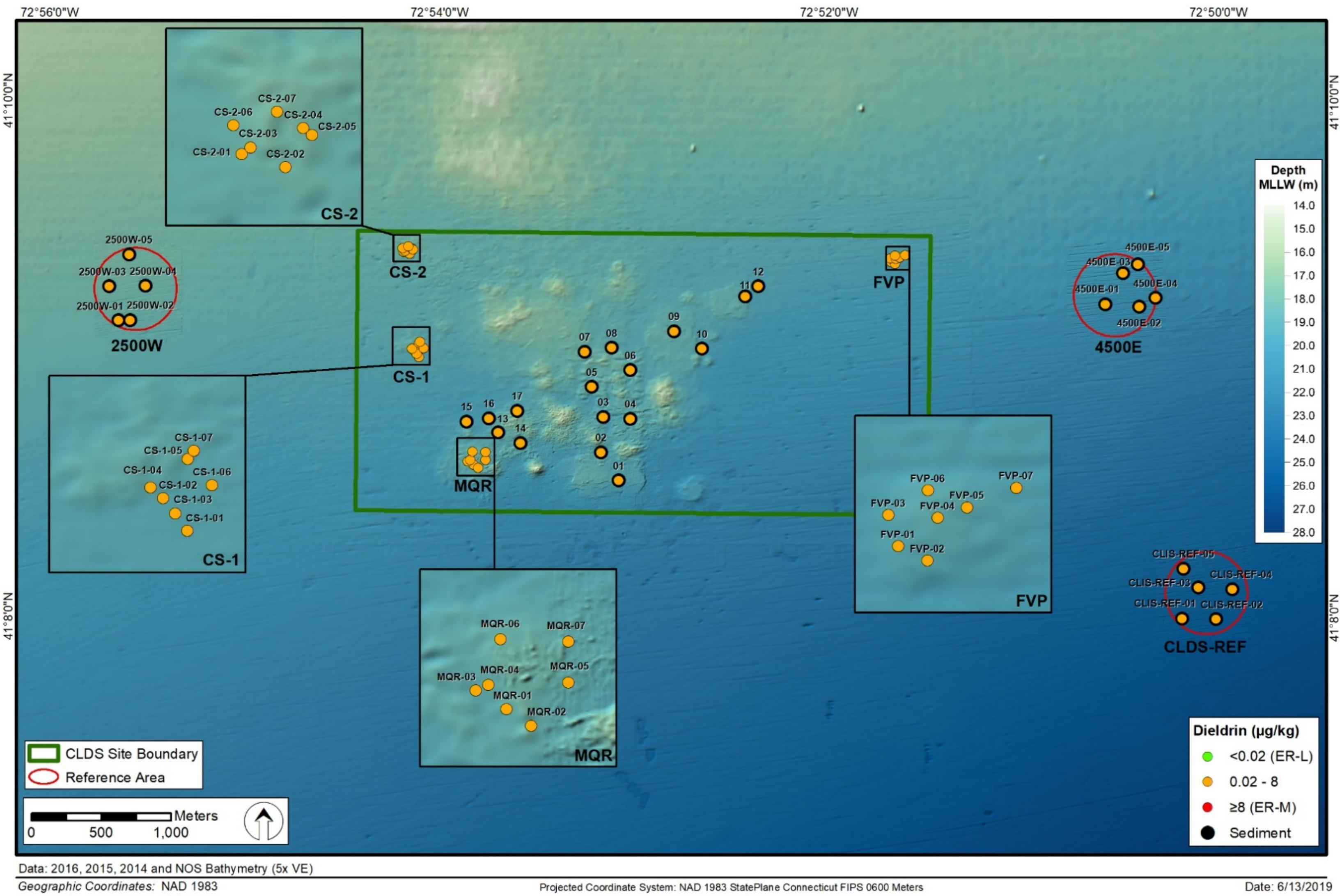


Figure 3-64c. Dieldrin (µg/kg dry-wt.) by station in sediments from CLDS and reference areas 2016

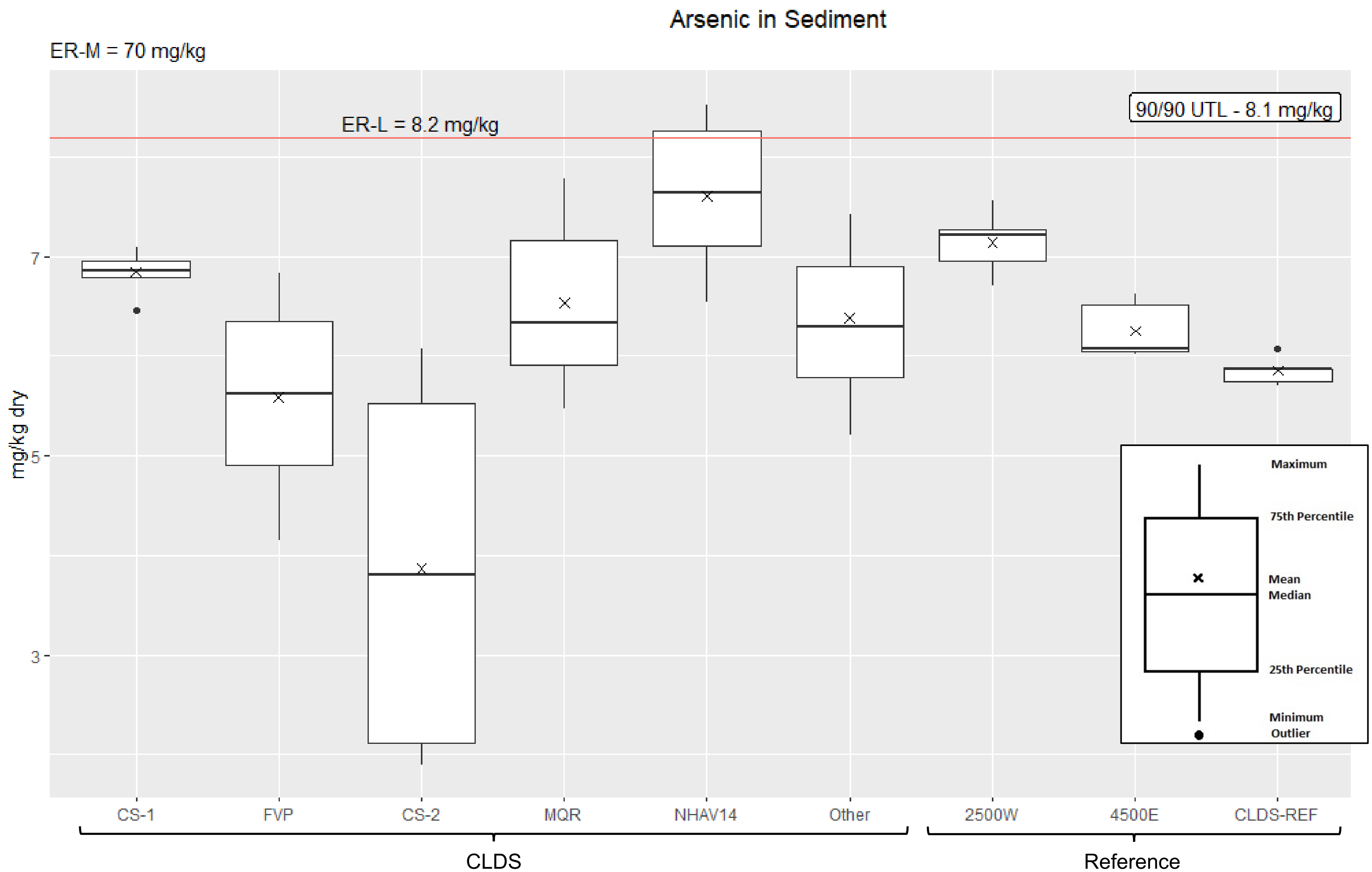


Figure 3-65a. Boxplots showing arsenic (mg/kg dry-wt.) by area in sediments from CLDS and reference areas 2016

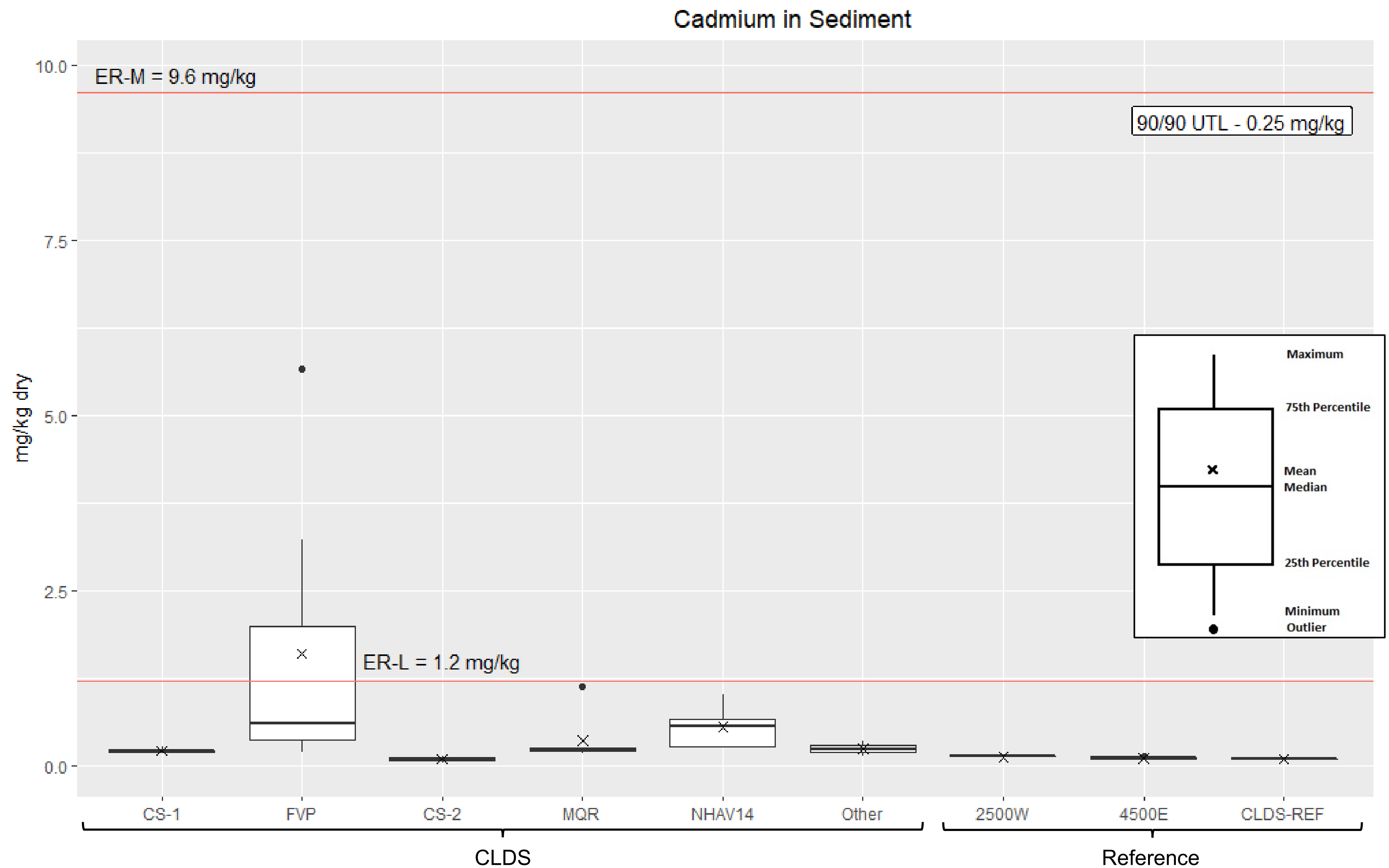


Figure 3-65b. Boxplots showing cadmium (mg/kg dry-wt.) by area in sediments from CLDS and reference areas 2016

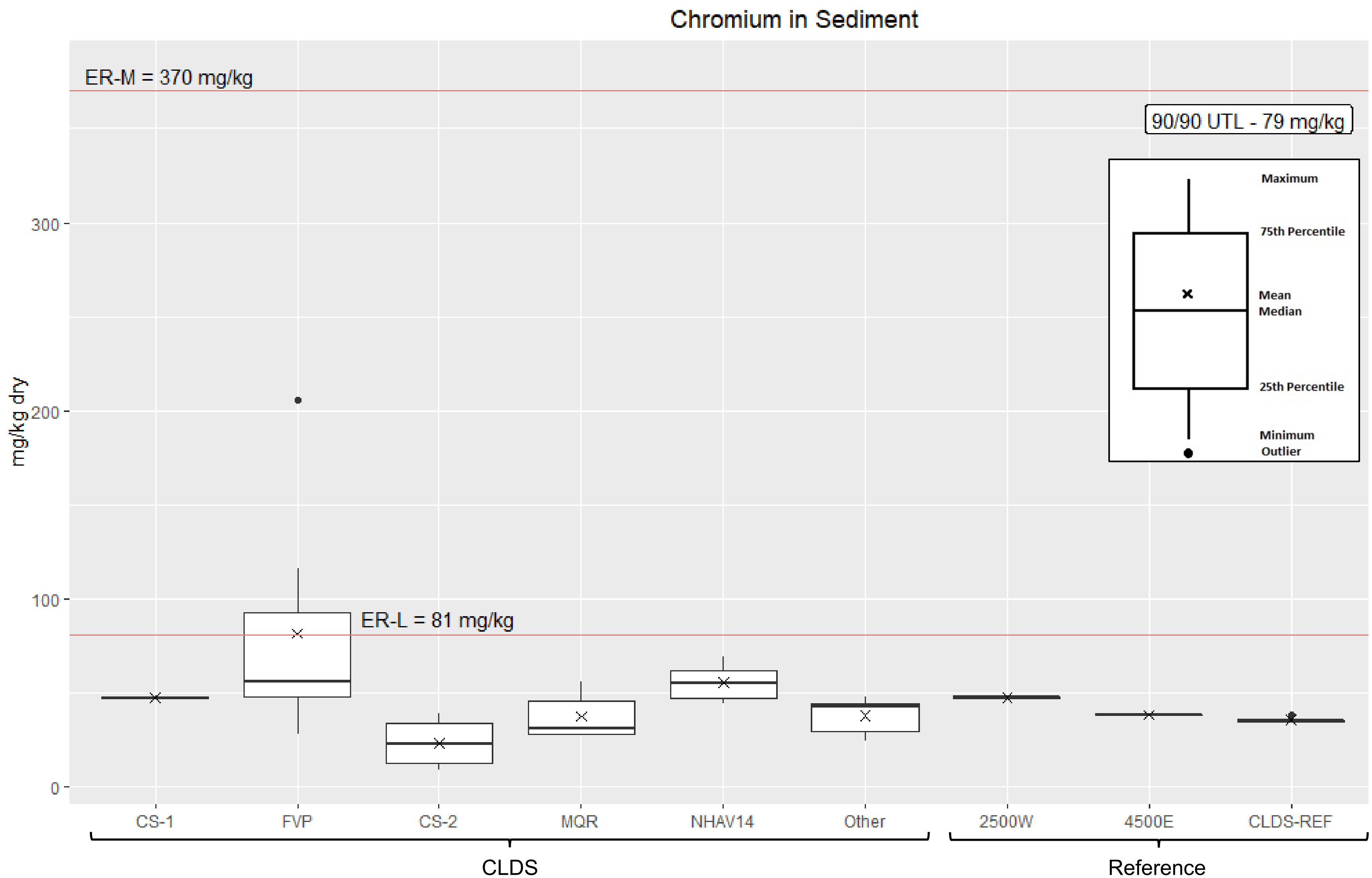


Figure 3-65c. Boxplots showing chromium (mg/kg dry-wt.) by area in sediments from CLDS and reference areas 2016

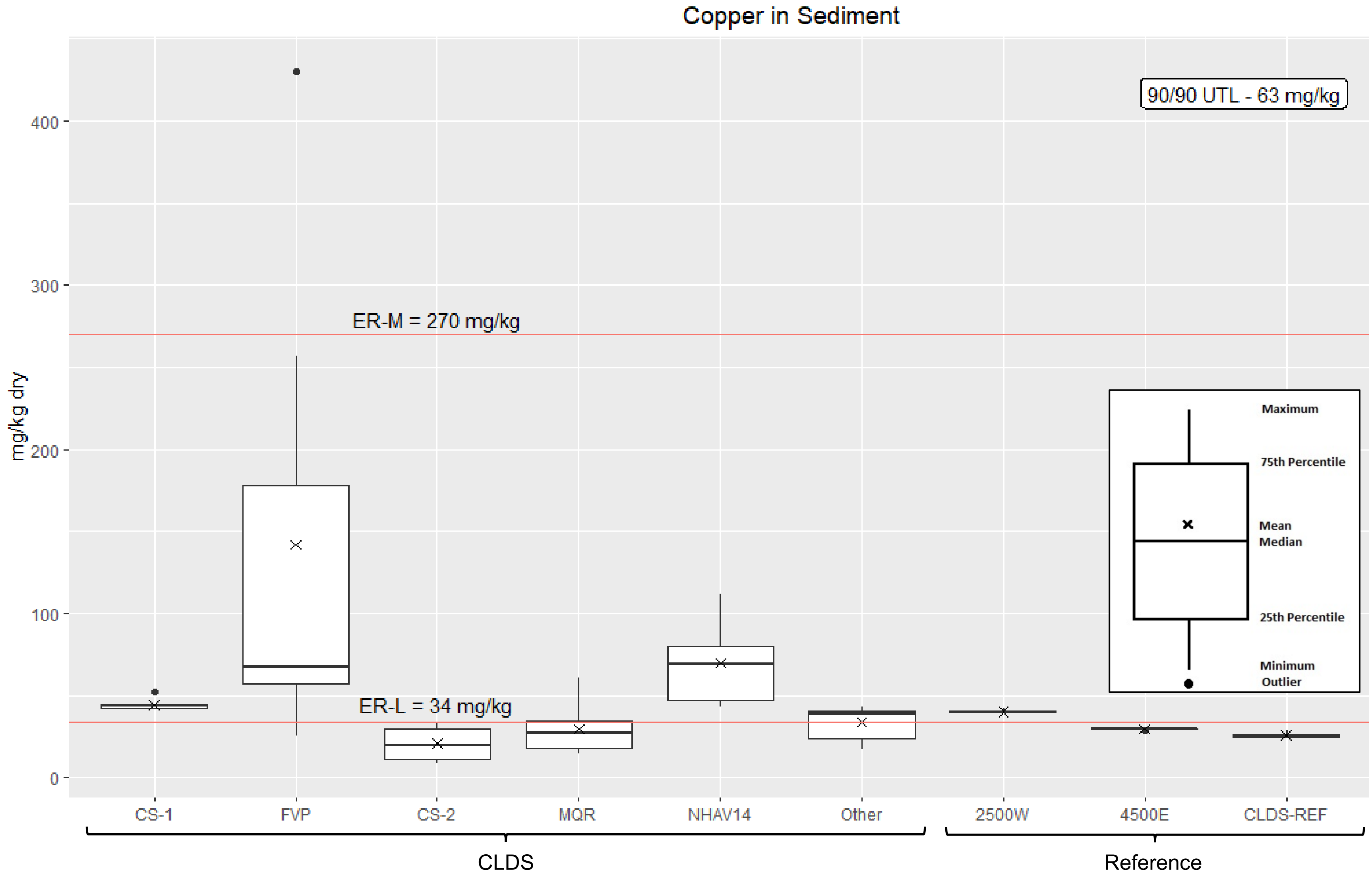


Figure 3-65d. Boxplots showing copper (mg/kg dry-wt.) by area in sediments from CLDS and reference areas 2016

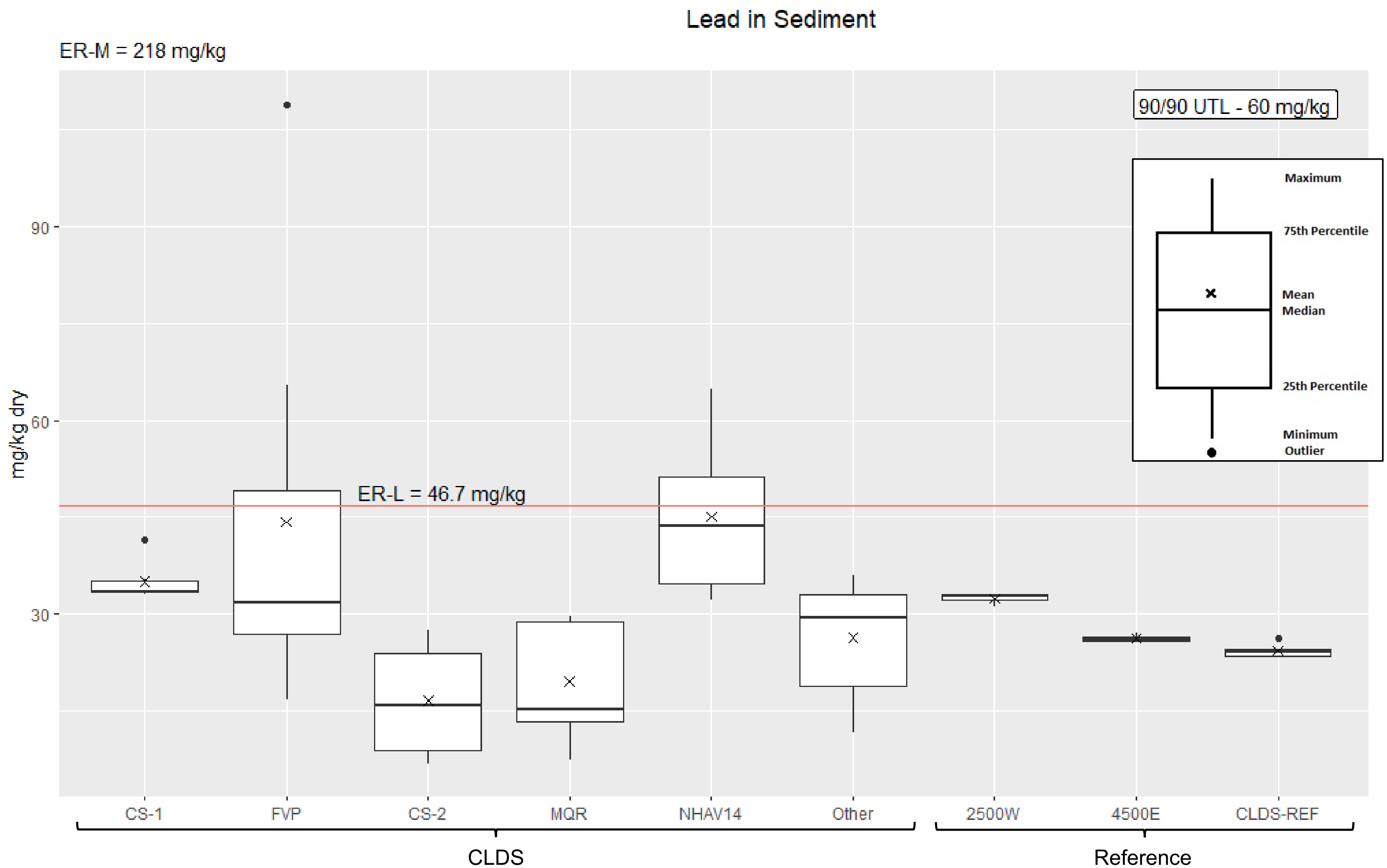


Figure 3-65e. Boxplots showing lead (mg/kg dry-wt.) by area in sediments from CLDS and reference areas 2016

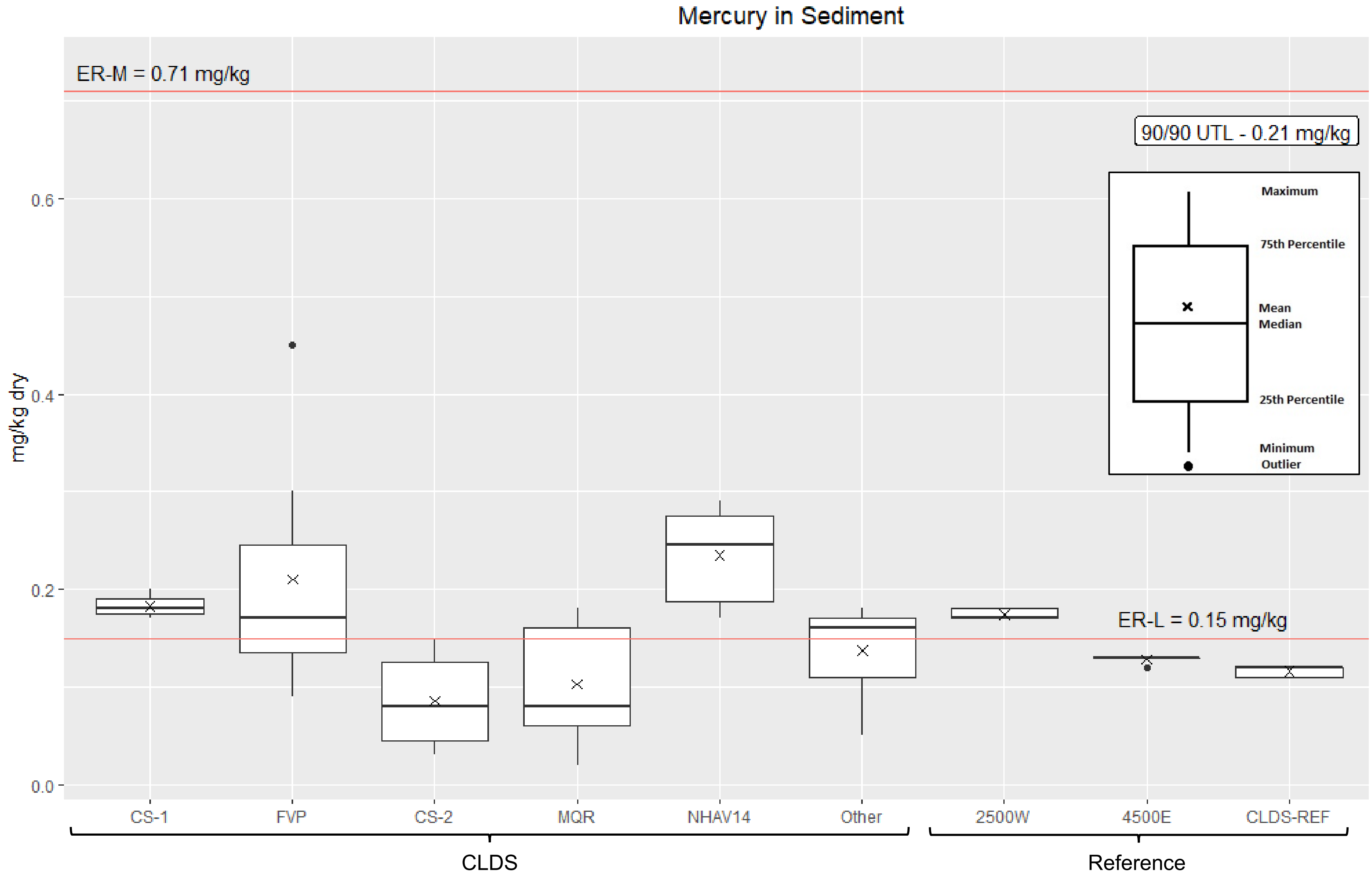


Figure 3-65f. Boxplots showing mercury (mg/kg dry-wt.) by area in sediments from CLDS and reference areas 2016

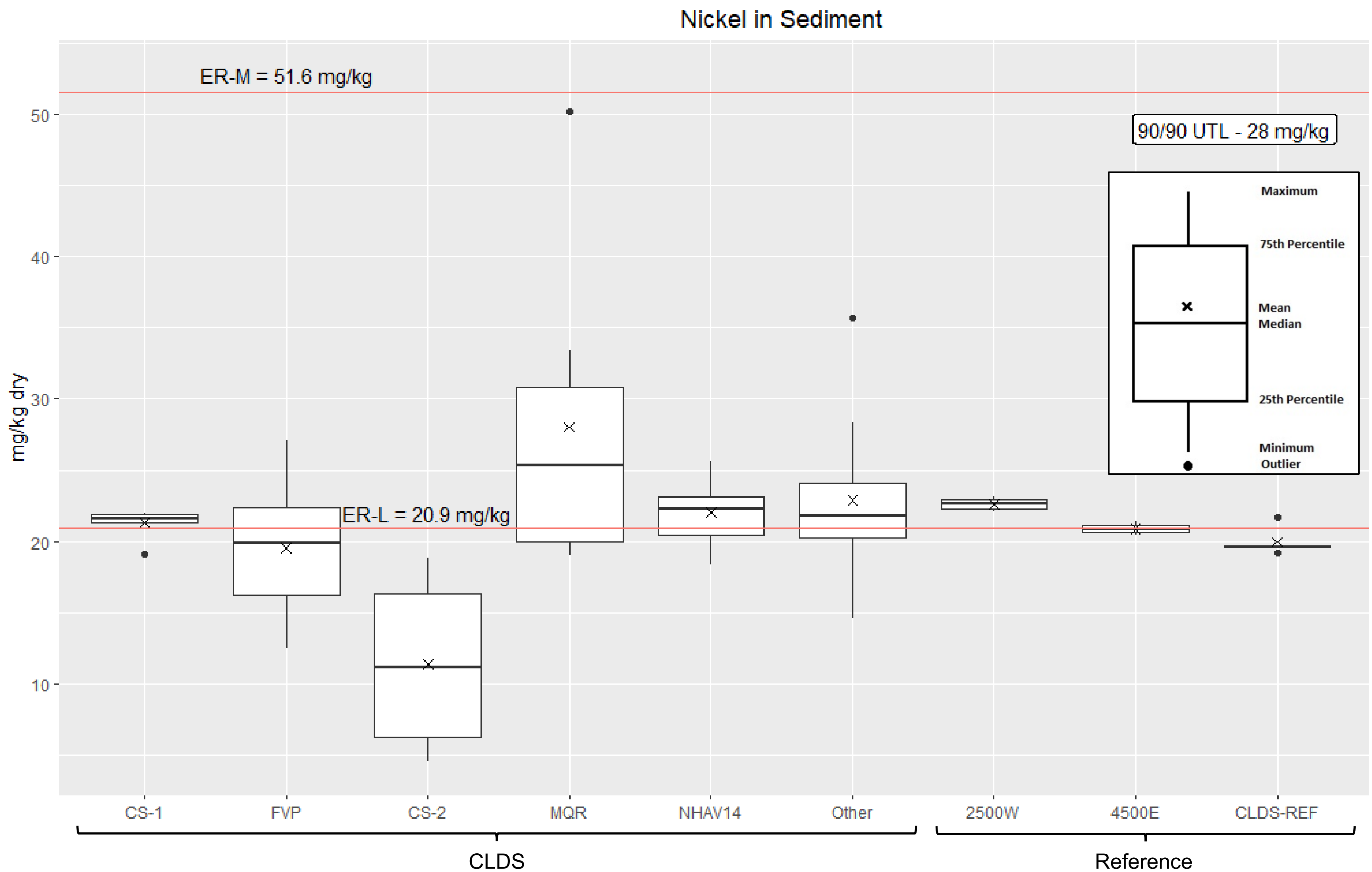


Figure 3-65g. Boxplots showing nickel (mg/kg dry-wt.) by area in sediments from CLDS and reference areas 2016

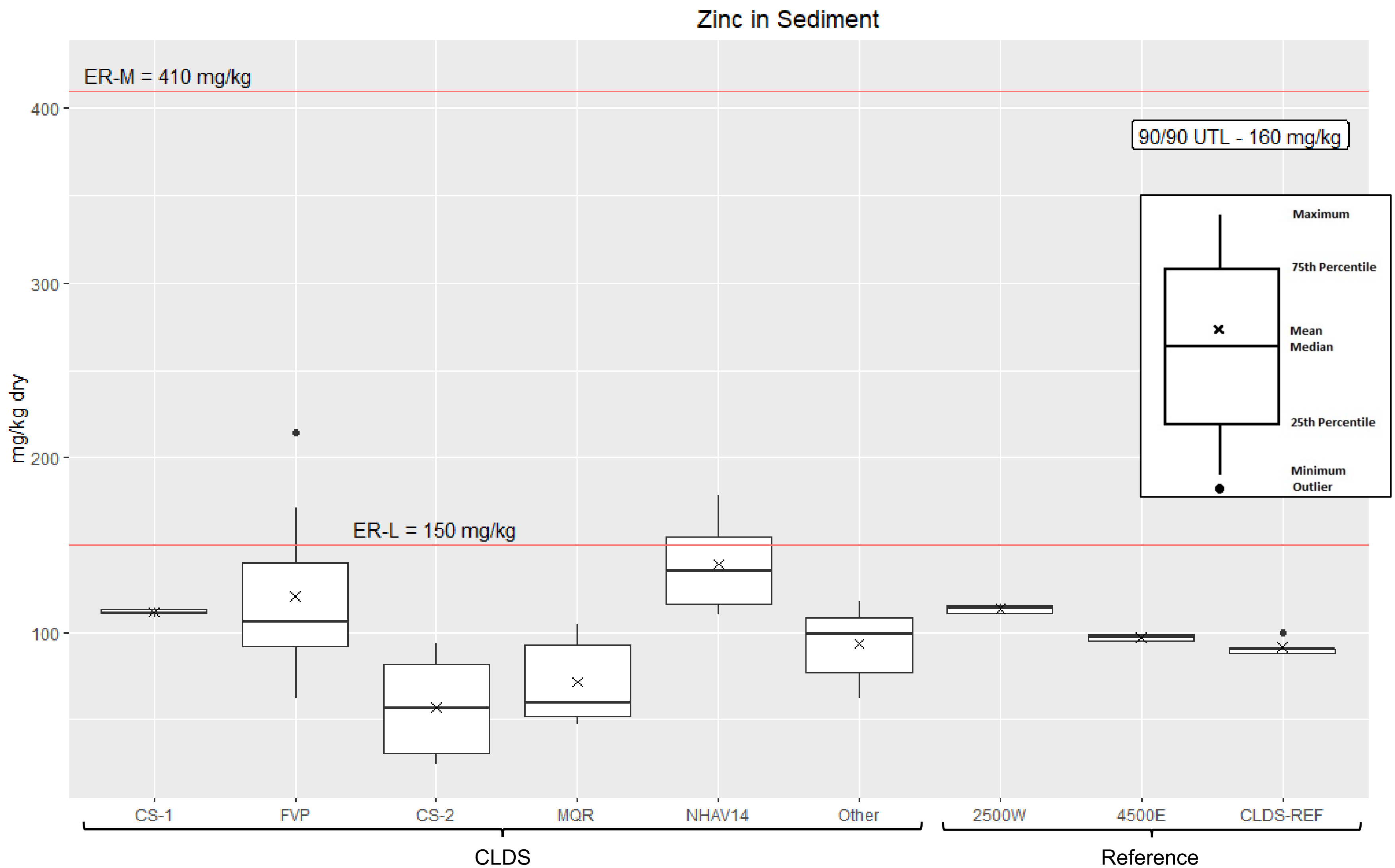


Figure 3-65h. Boxplots showing zinc (mg/kg dry-wt.) by area in sediments from CLDS and reference areas 2016

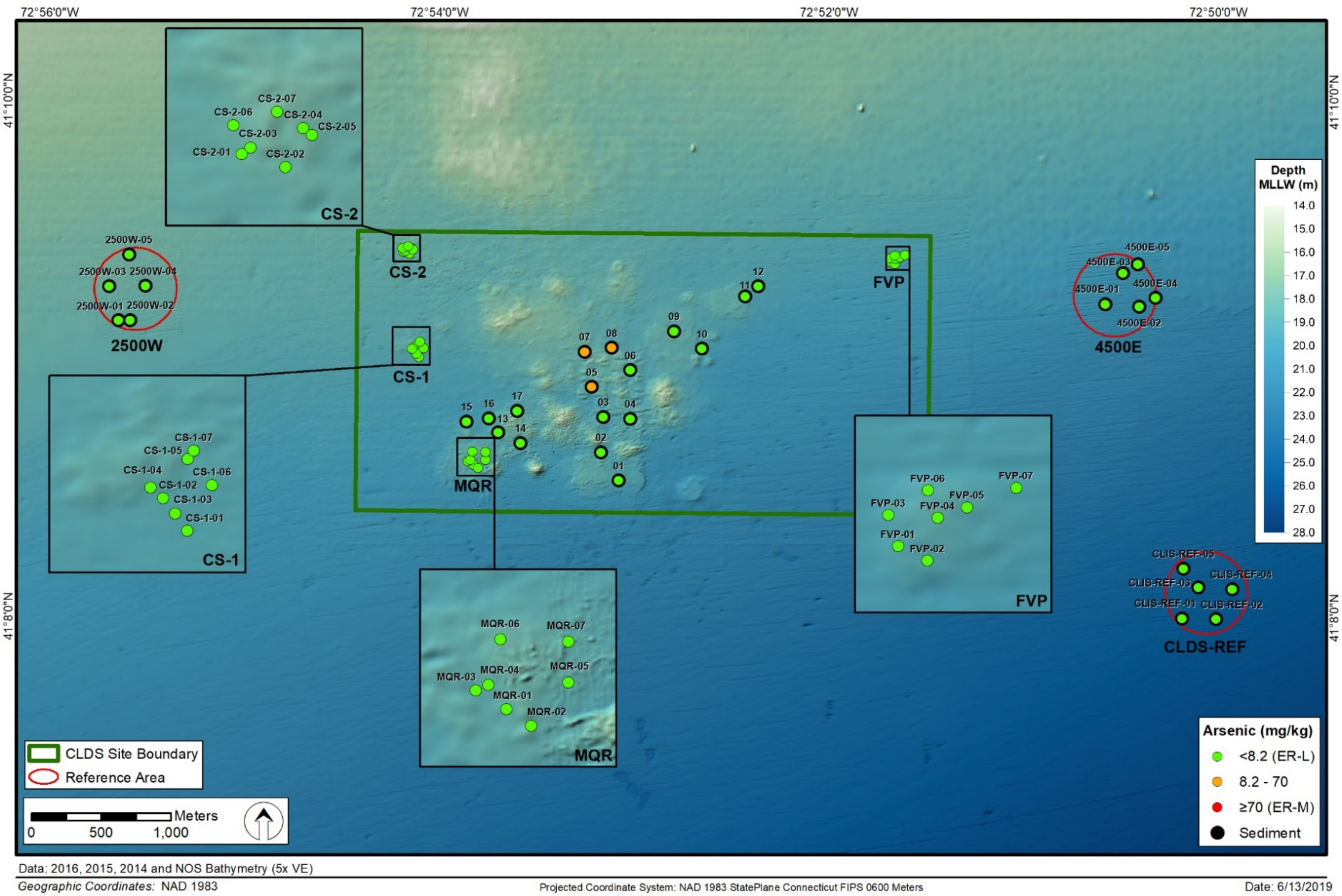


Figure 3-66a. Arsenic (mg/kg dry-wt.) by station in sediments from CLDS and reference areas 2016

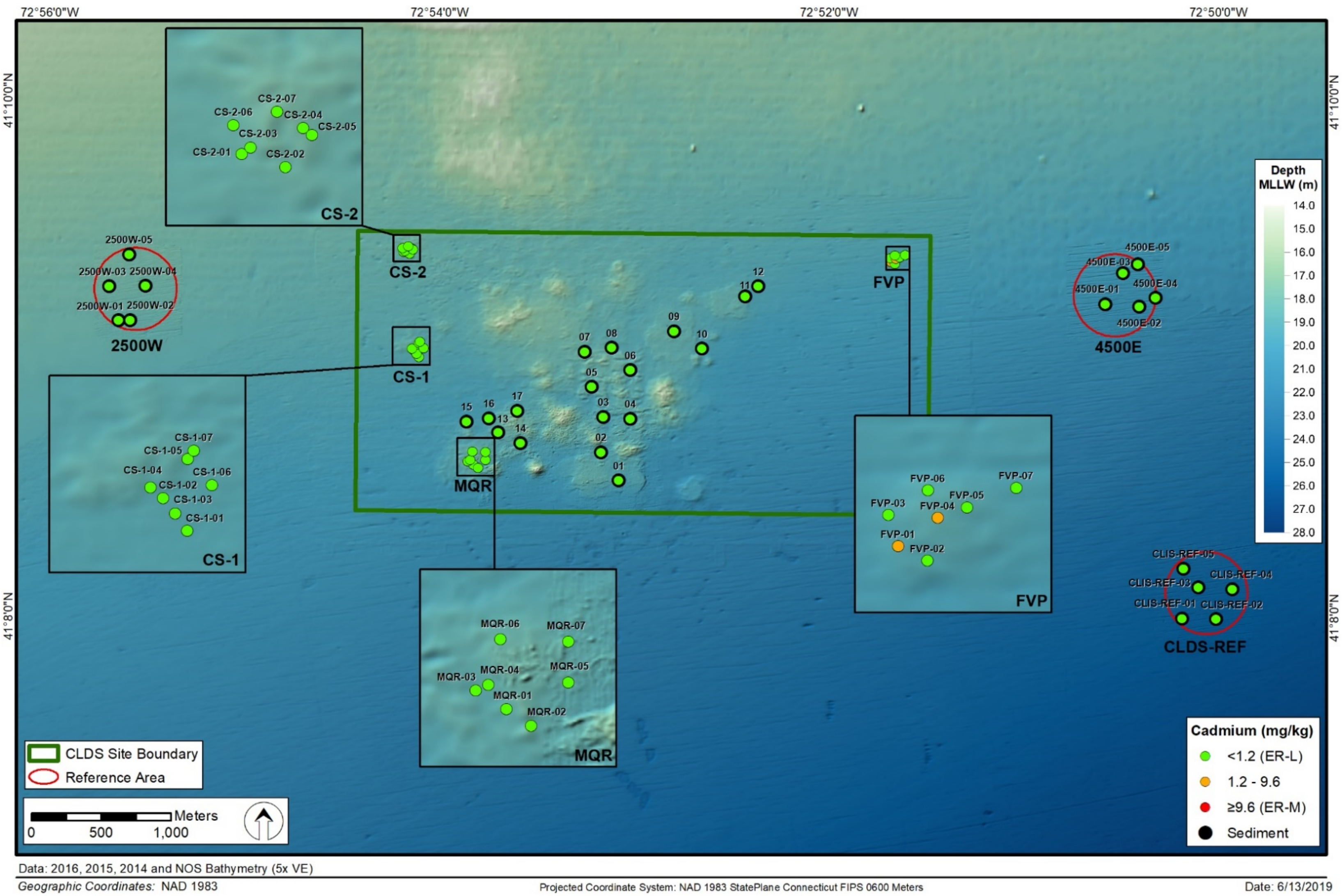


Figure 3-66b. Cadmium (mg/kg dry-wt.) by station in sediments from CLDS and reference areas 2016

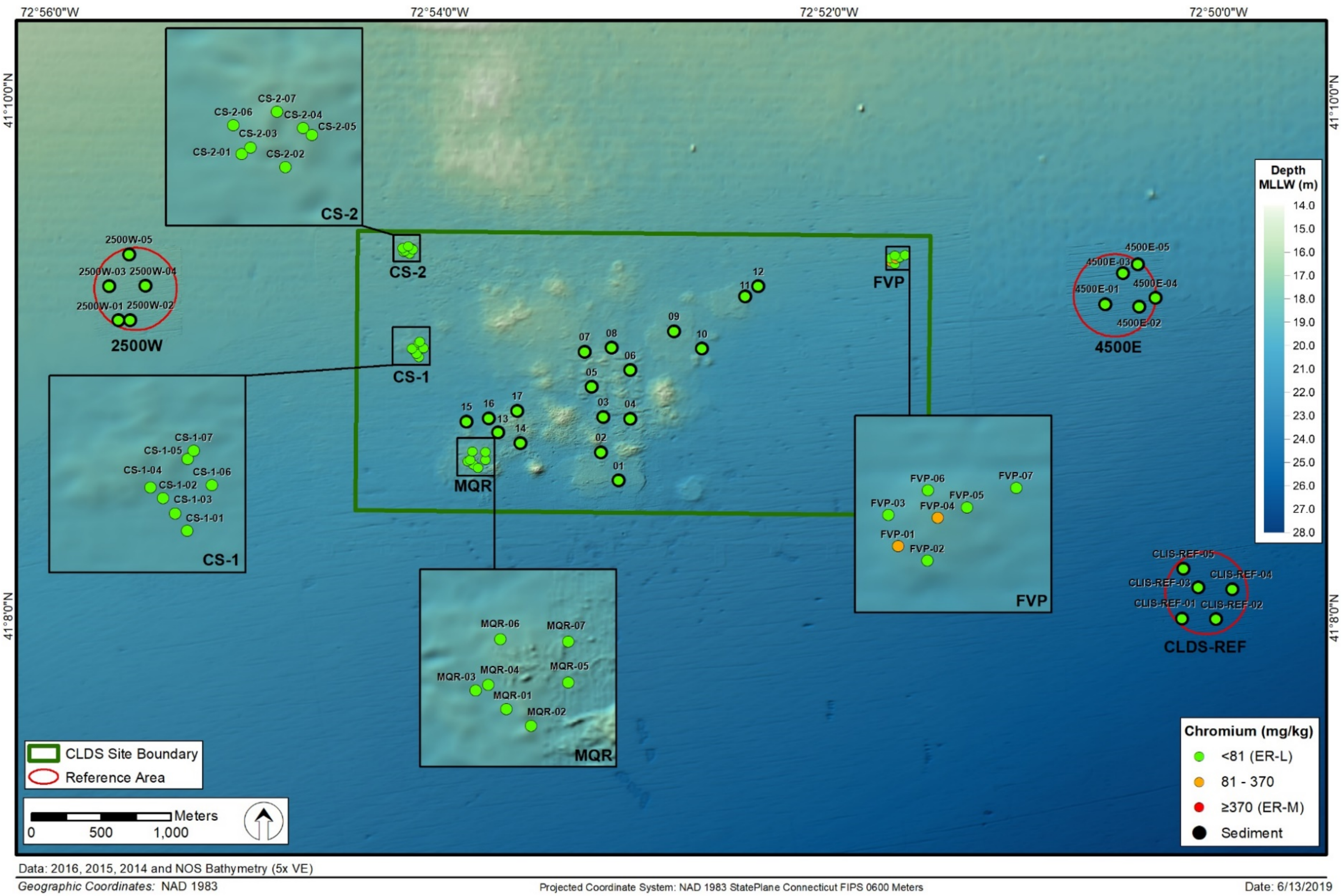


Figure 3-66c. Chromium (mg/kg dry-wt.) by station in sediments from CLDS and reference areas 2016

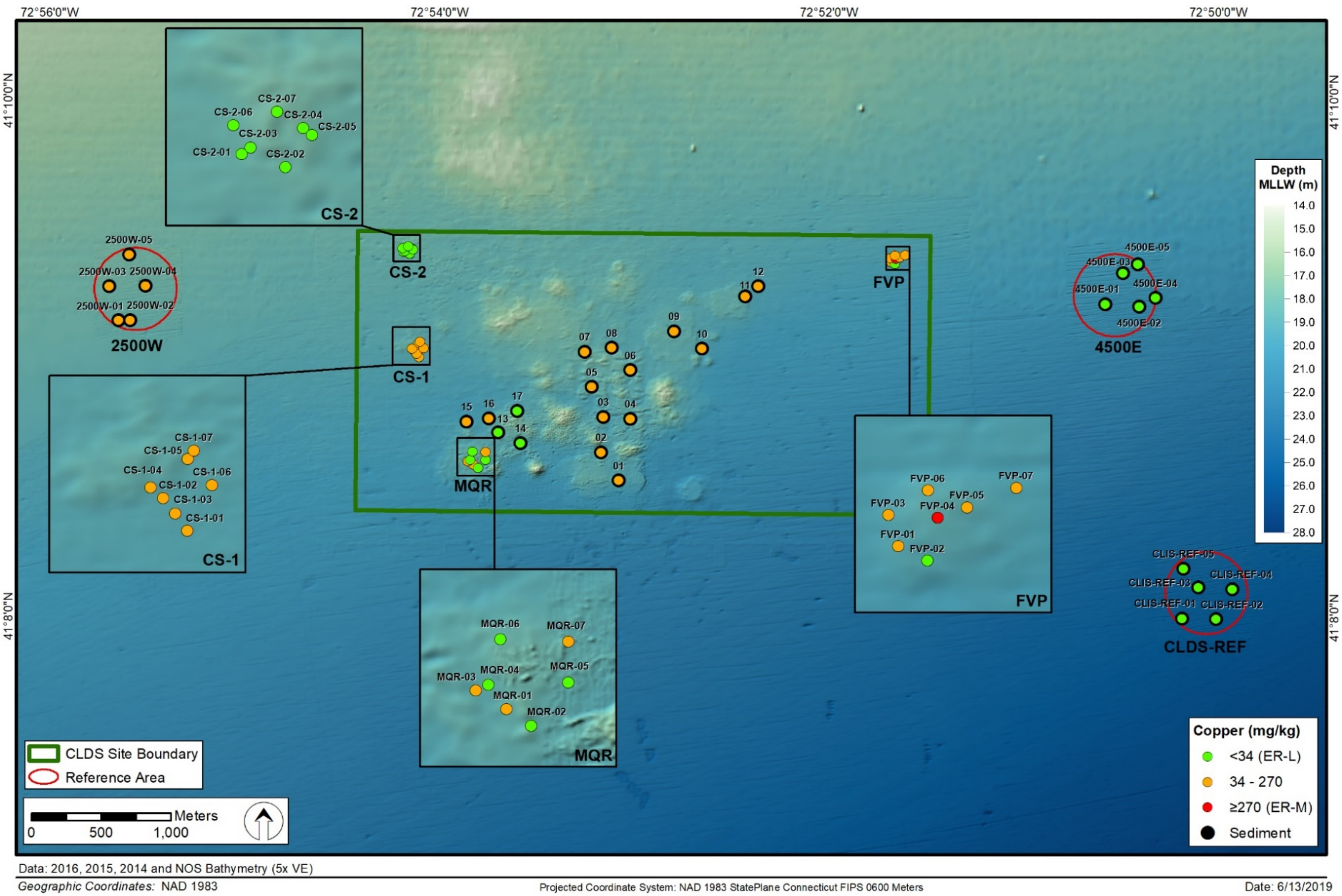


Figure 3-66d. Copper (mg/kg dry-wt.) by station in sediments from CLDS and reference areas 2016

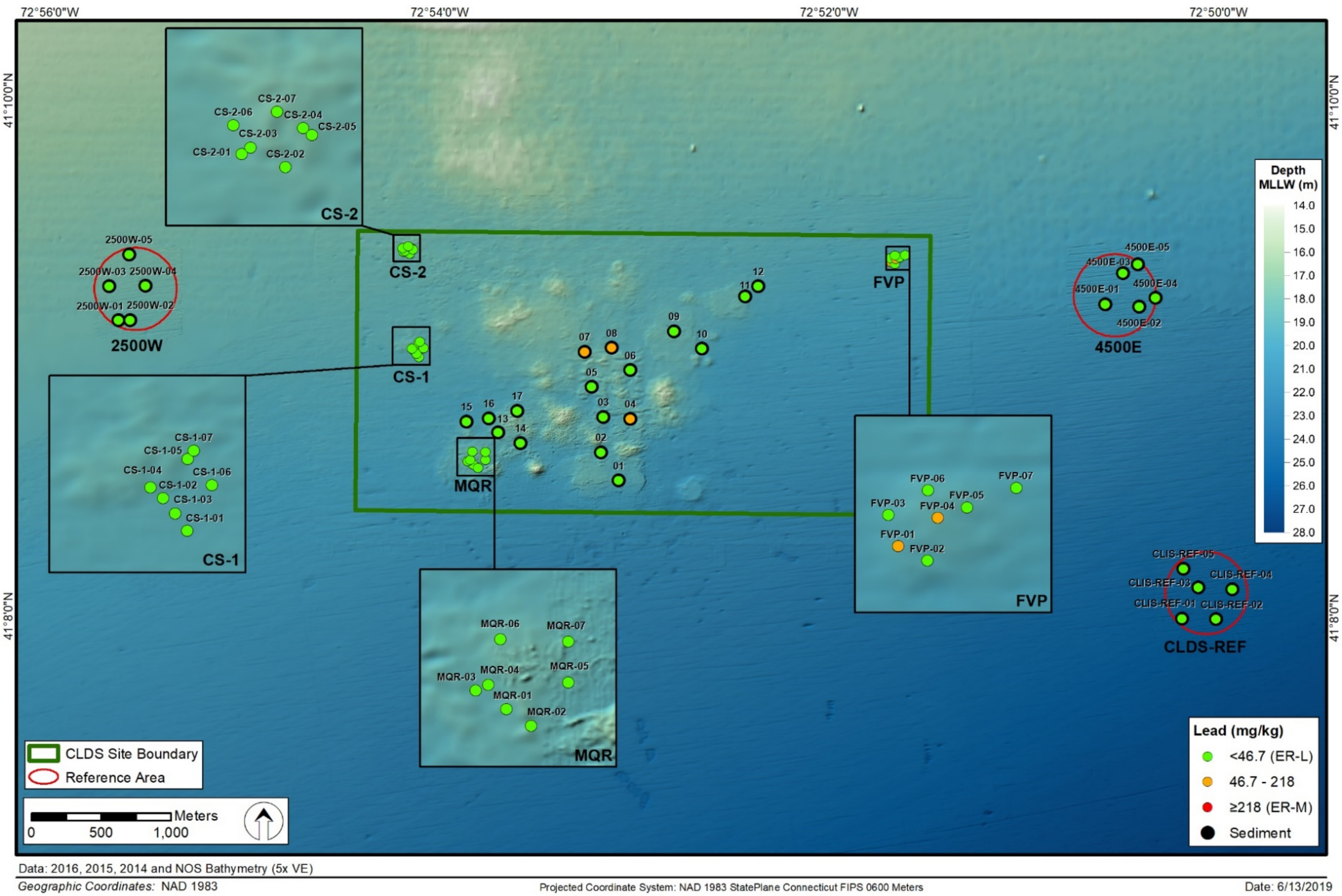


Figure 3-66e. Lead (mg/kg dry-wt.) by station in sediments from CLDS and reference areas 2016

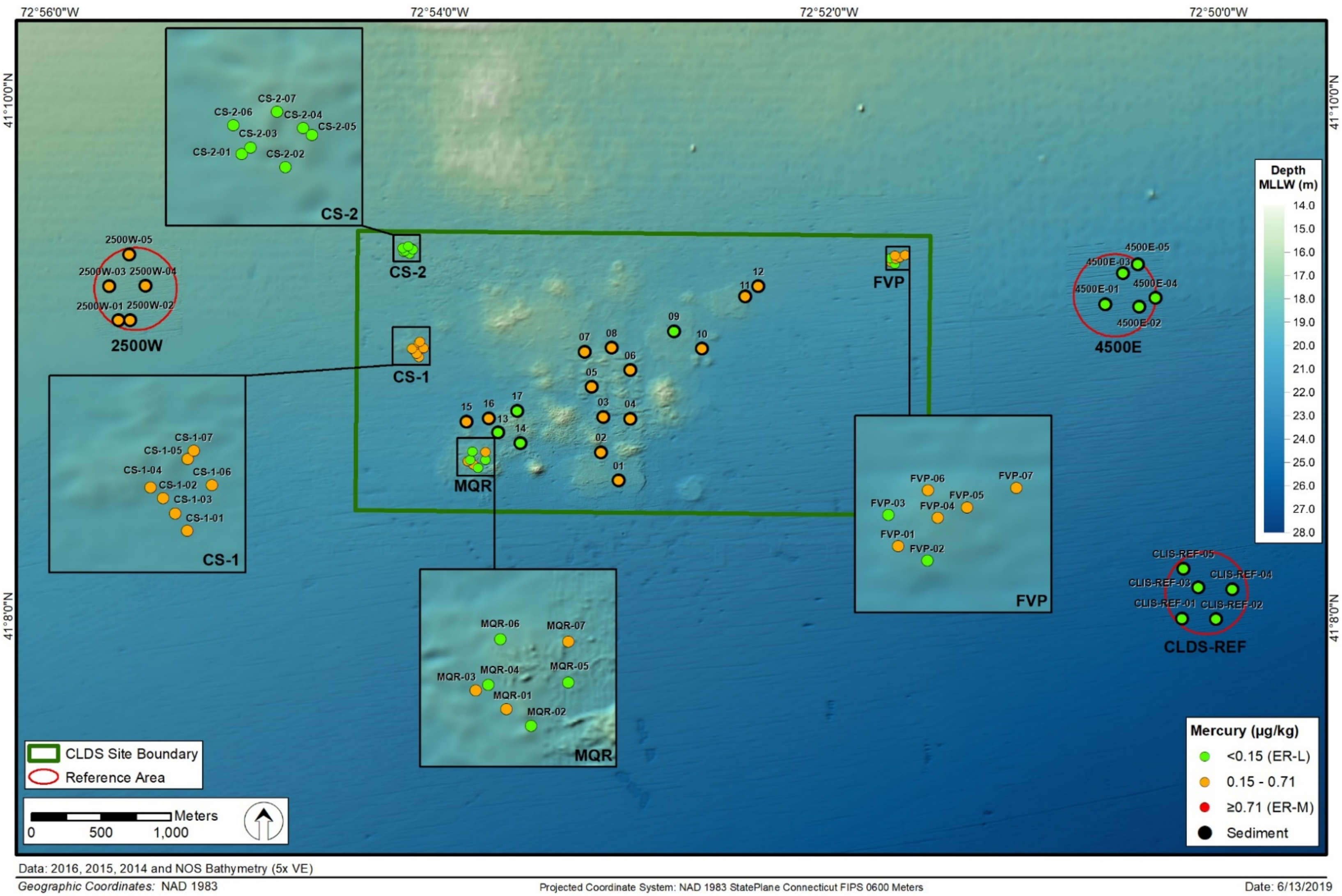


Figure 3-66f. Mercury (mg/kg dry-wt.) by station in sediments from CLDS and reference areas 2016

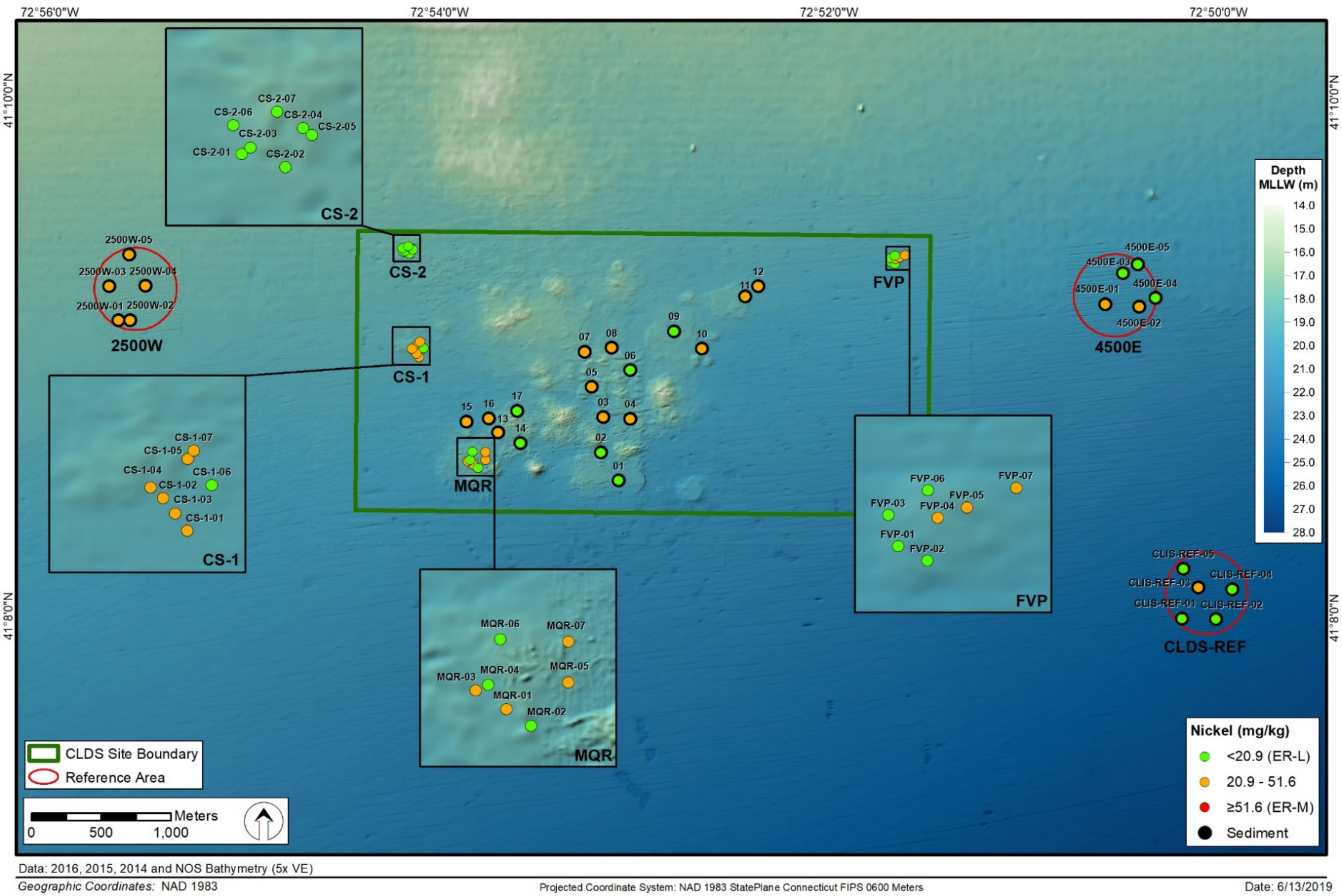


Figure 3-66g. Nickel (mg/kg dry-wt.) by station in sediments from CLDS and reference areas 2016

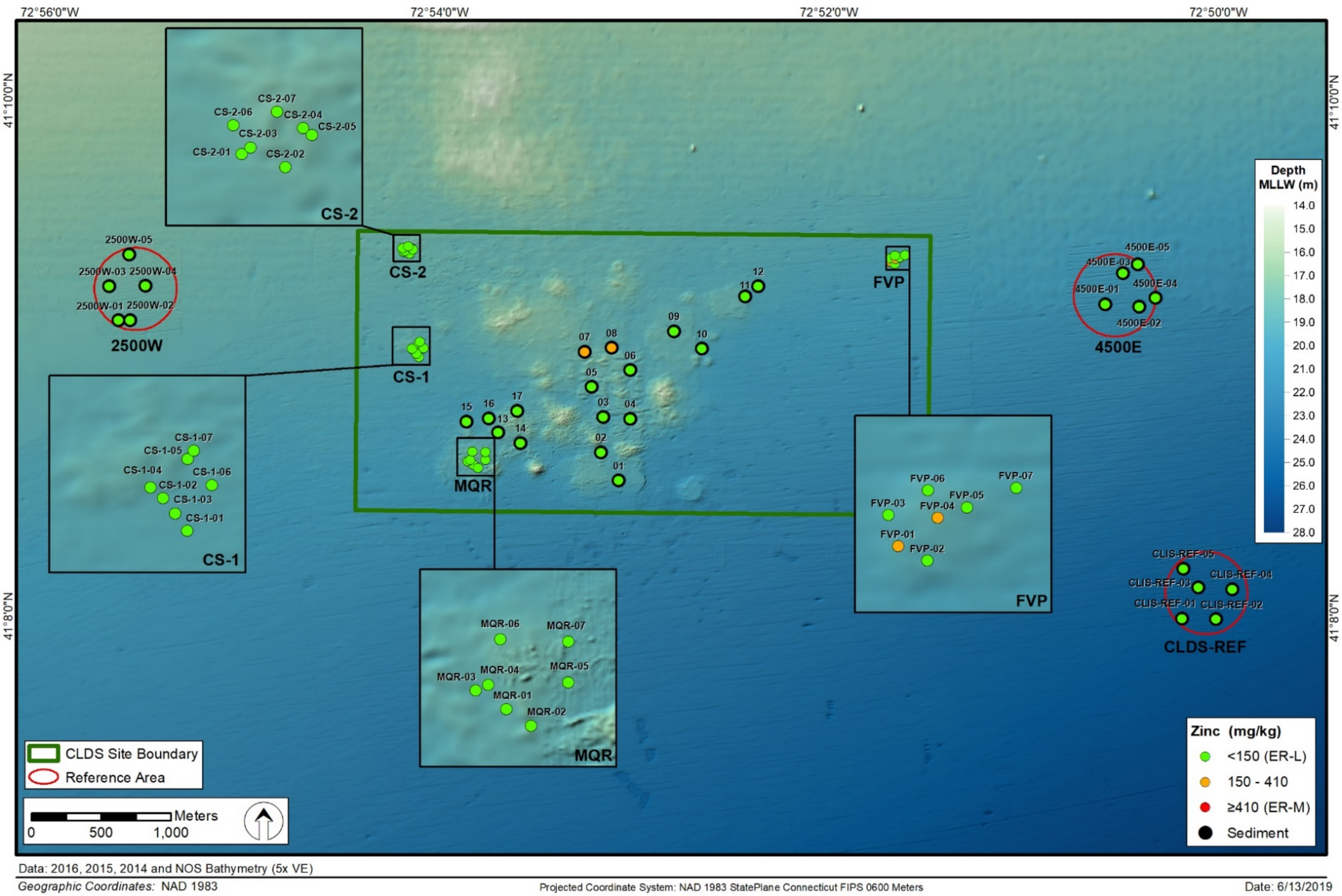


Figure 3-66h. Zinc (mg/kg dry-wt.) by station in sediments from CLDS and reference areas 2016

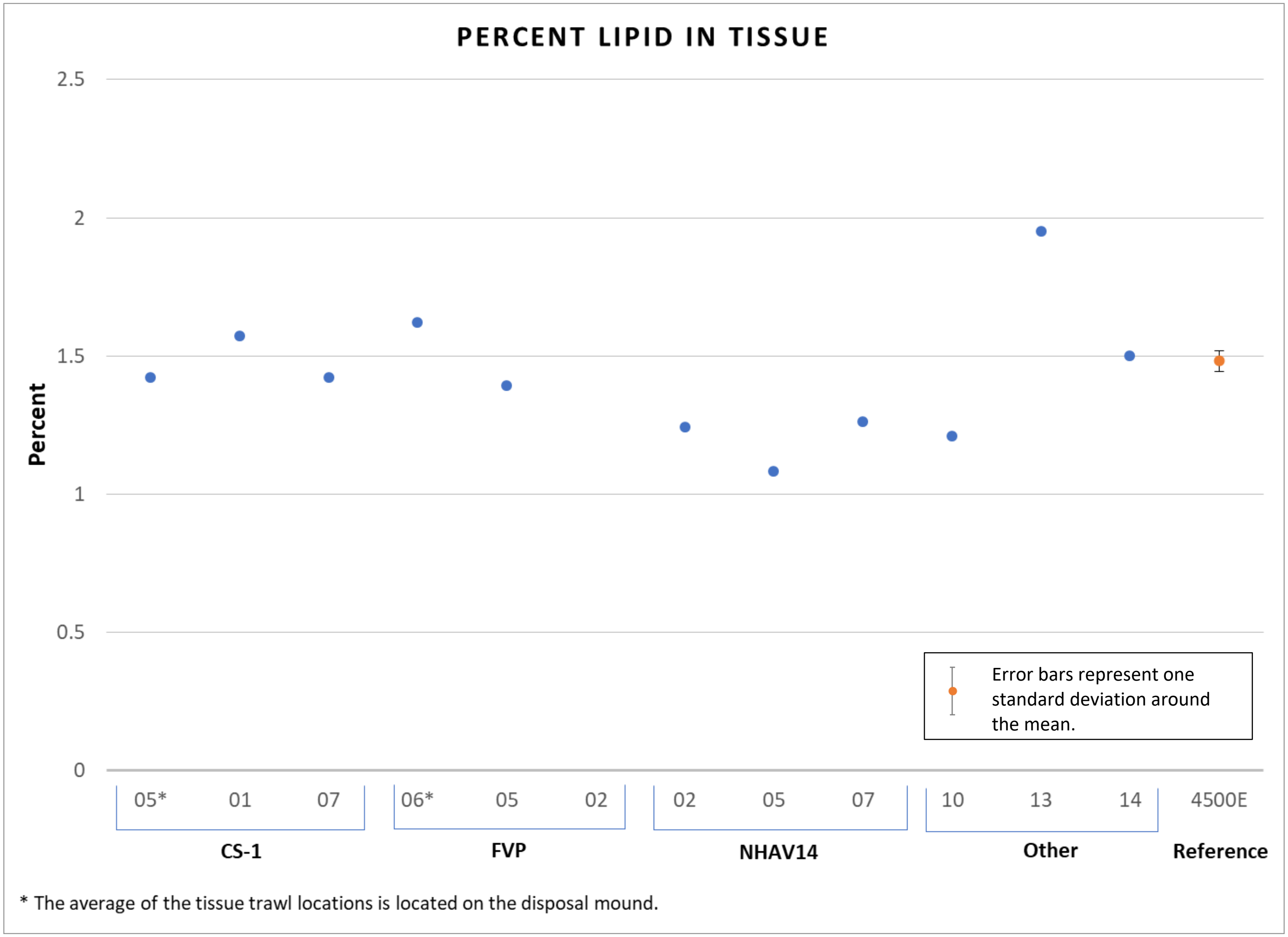


Figure 3-67. Percent lipids in tissue from CLDS and reference area 2016

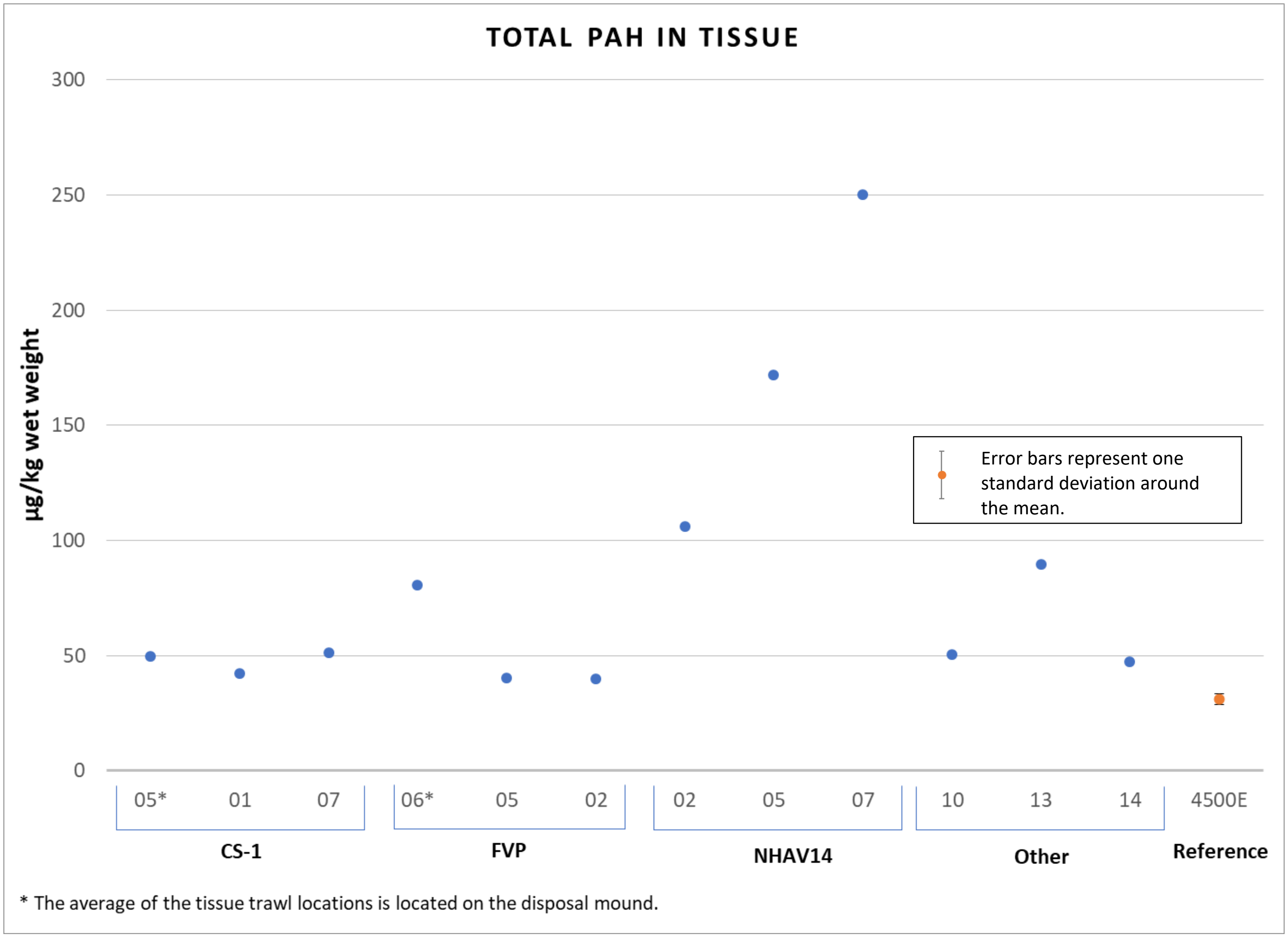


Figure 3-68. Total PAH (µg/kg wet-wt.) in tissue from CLDS and reference area 2016

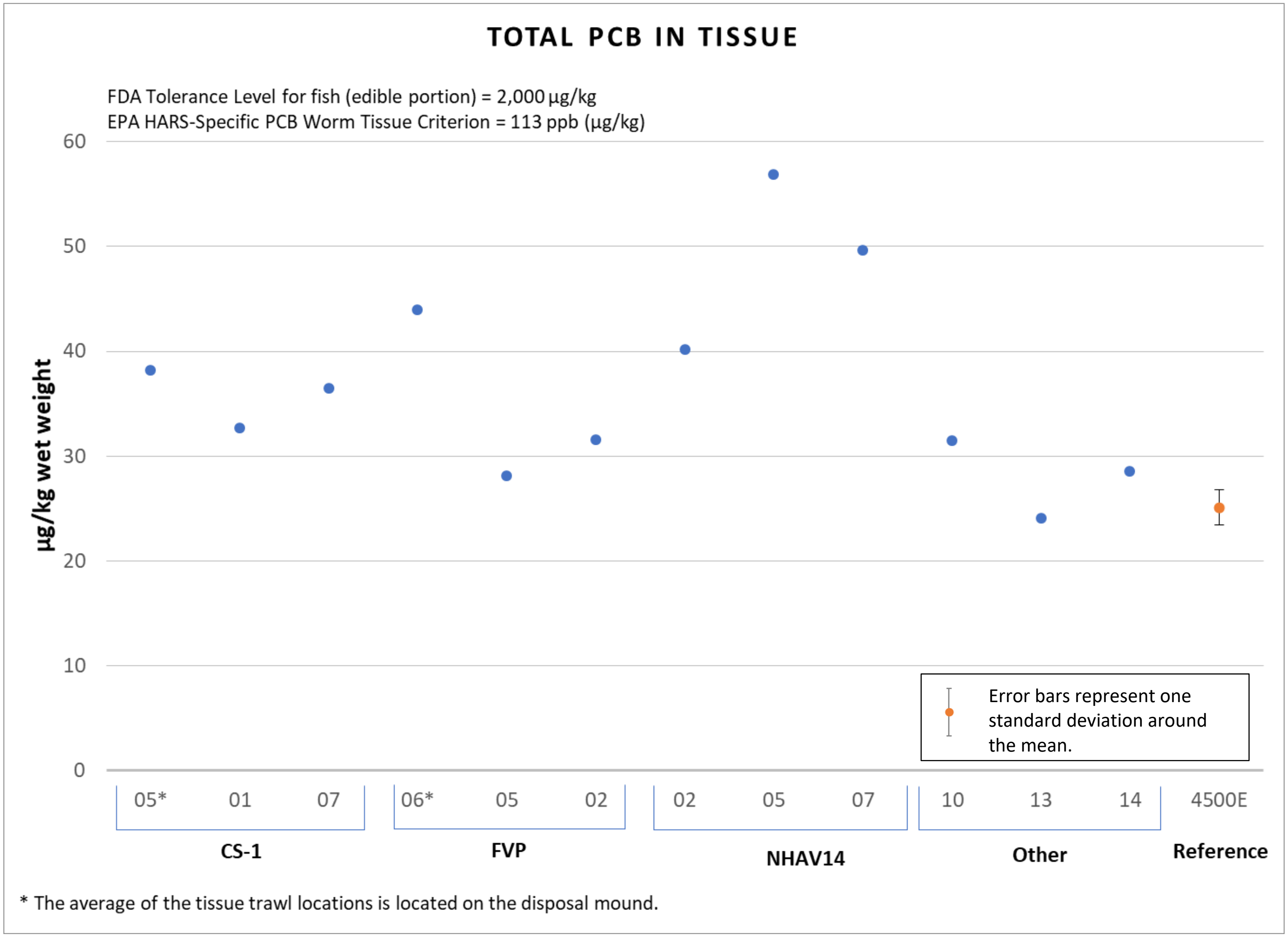


Figure 3-69. Total PCB (µg/kg wet-wt.) in tissue from CLDS and reference area 2016

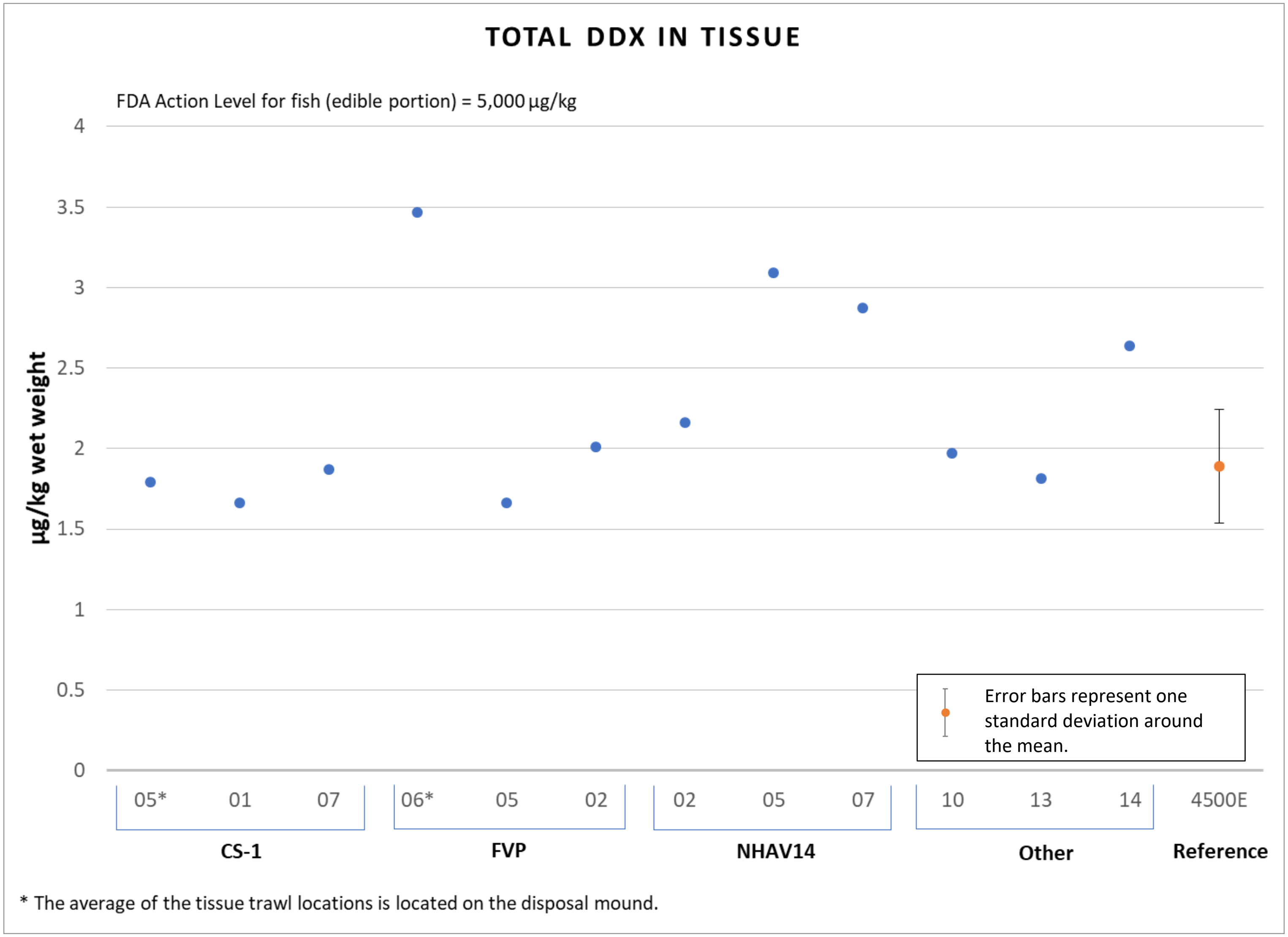


Figure 3-70a. Total DDX (µg/kg wet-wt.) in tissue from CLDS and reference area 2016

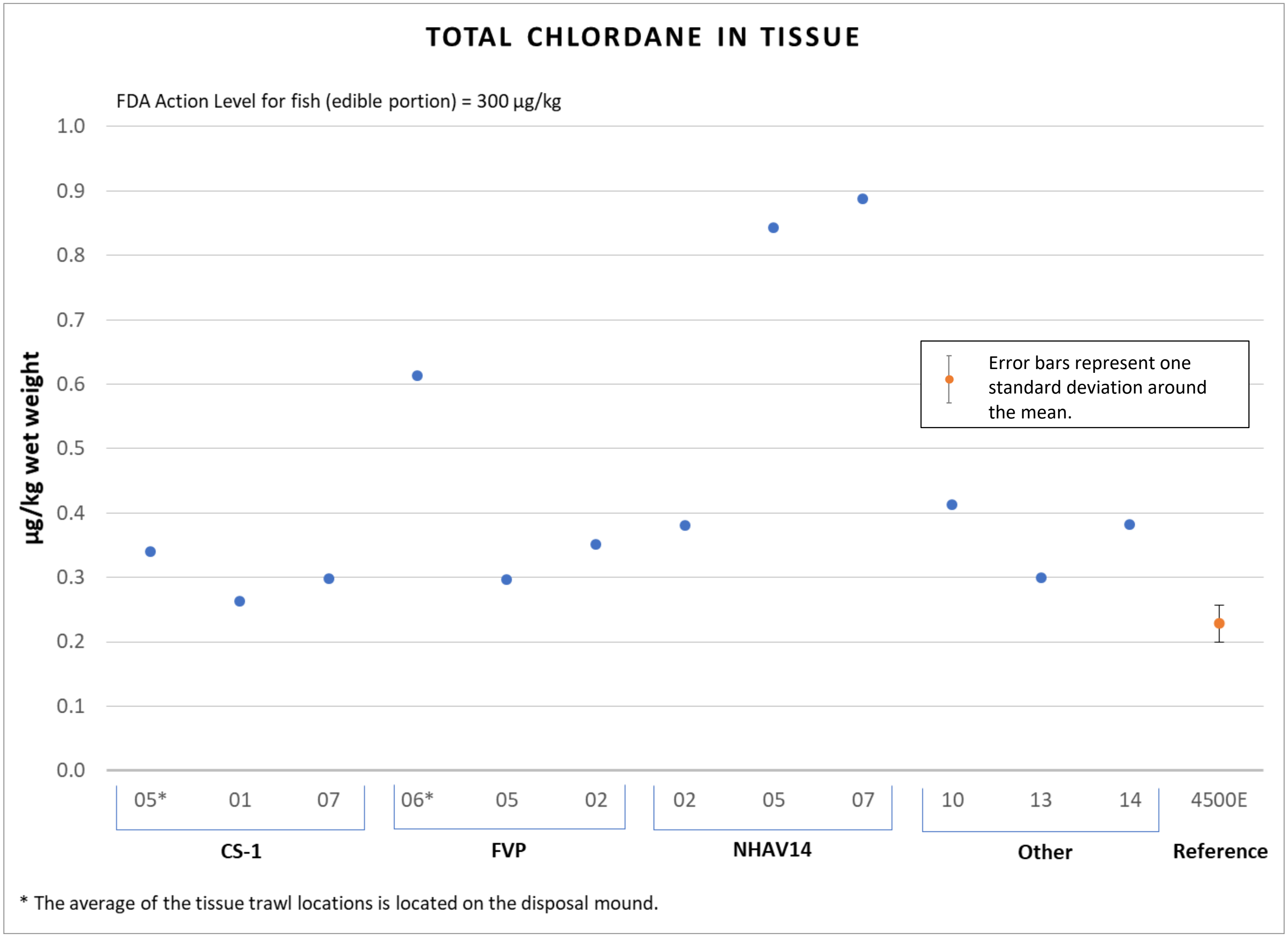


Figure 3-70b. Total chlordane (µg/kg wet-wt.) in tissue from CLDS and reference area 2016

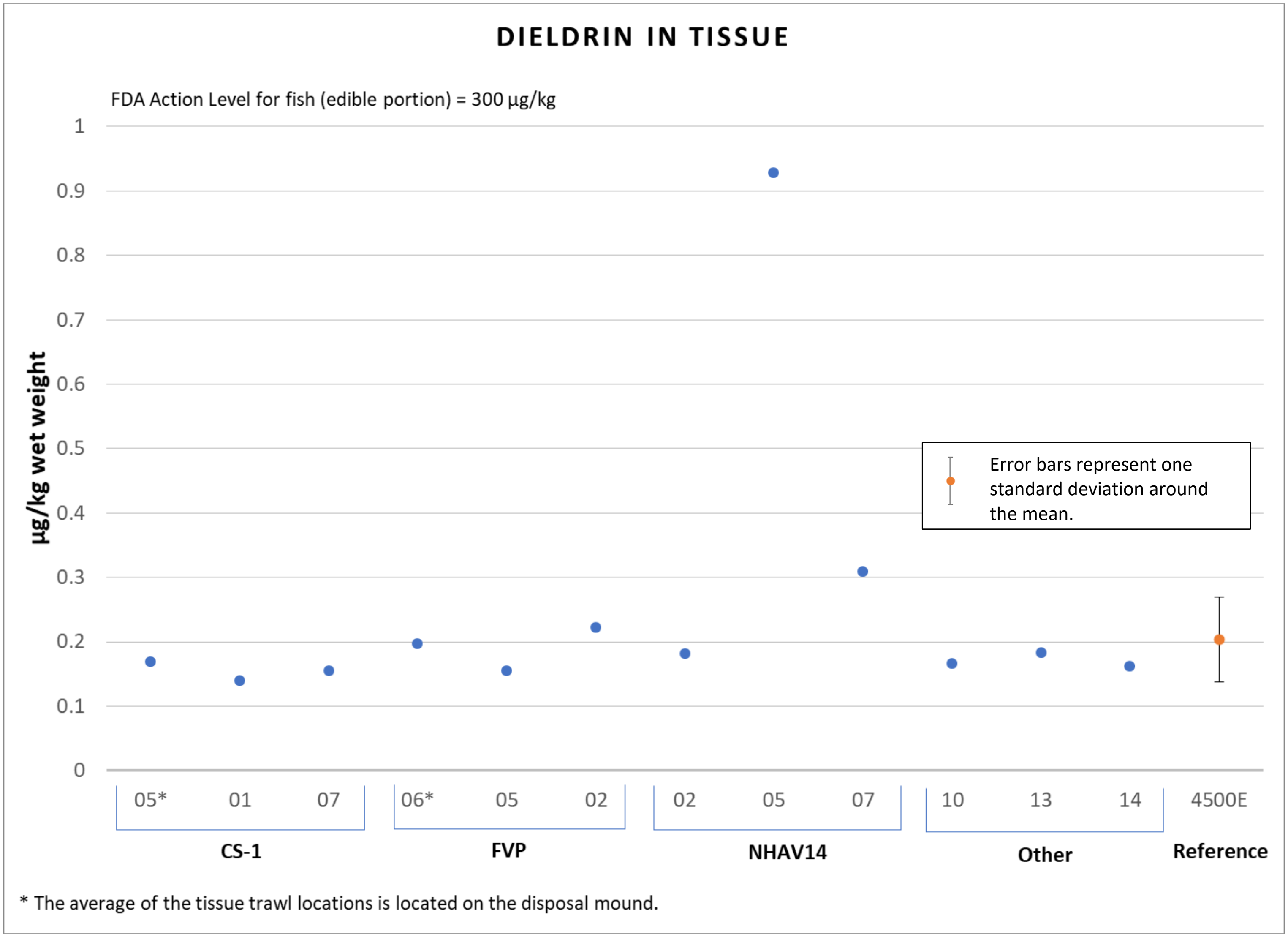


Figure 3-70c. Dieldrin (µg/kg wet-wt.) in tissue from CLDS and reference area 2016

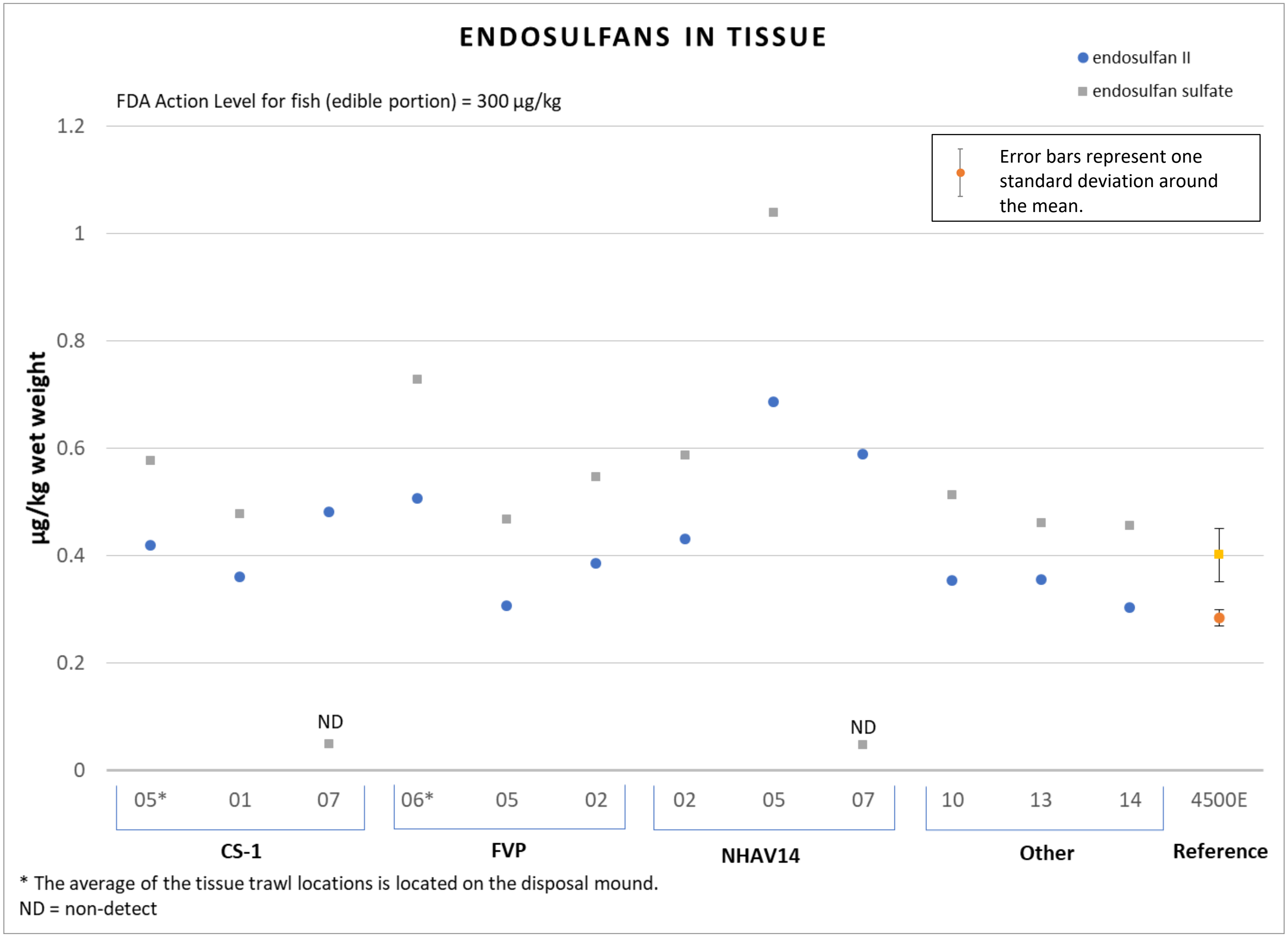


Figure 3-70d. Endosulfans (µg/kg wet-wt.) in tissue from CLDS and reference area 2016

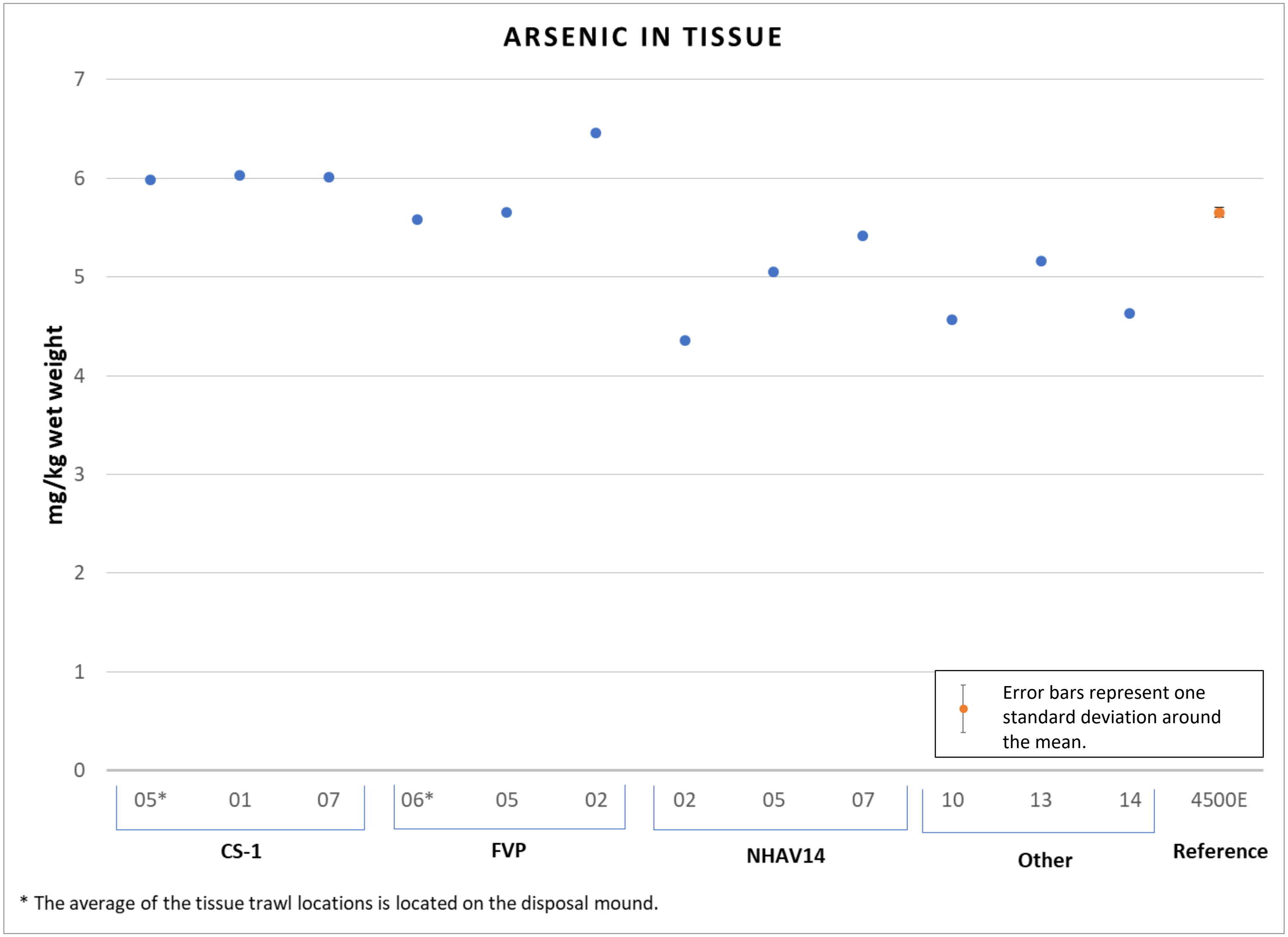


Figure 3-71a. Arsenic (mg/kg wet-wt.) in tissue from CLDS and reference area 2016

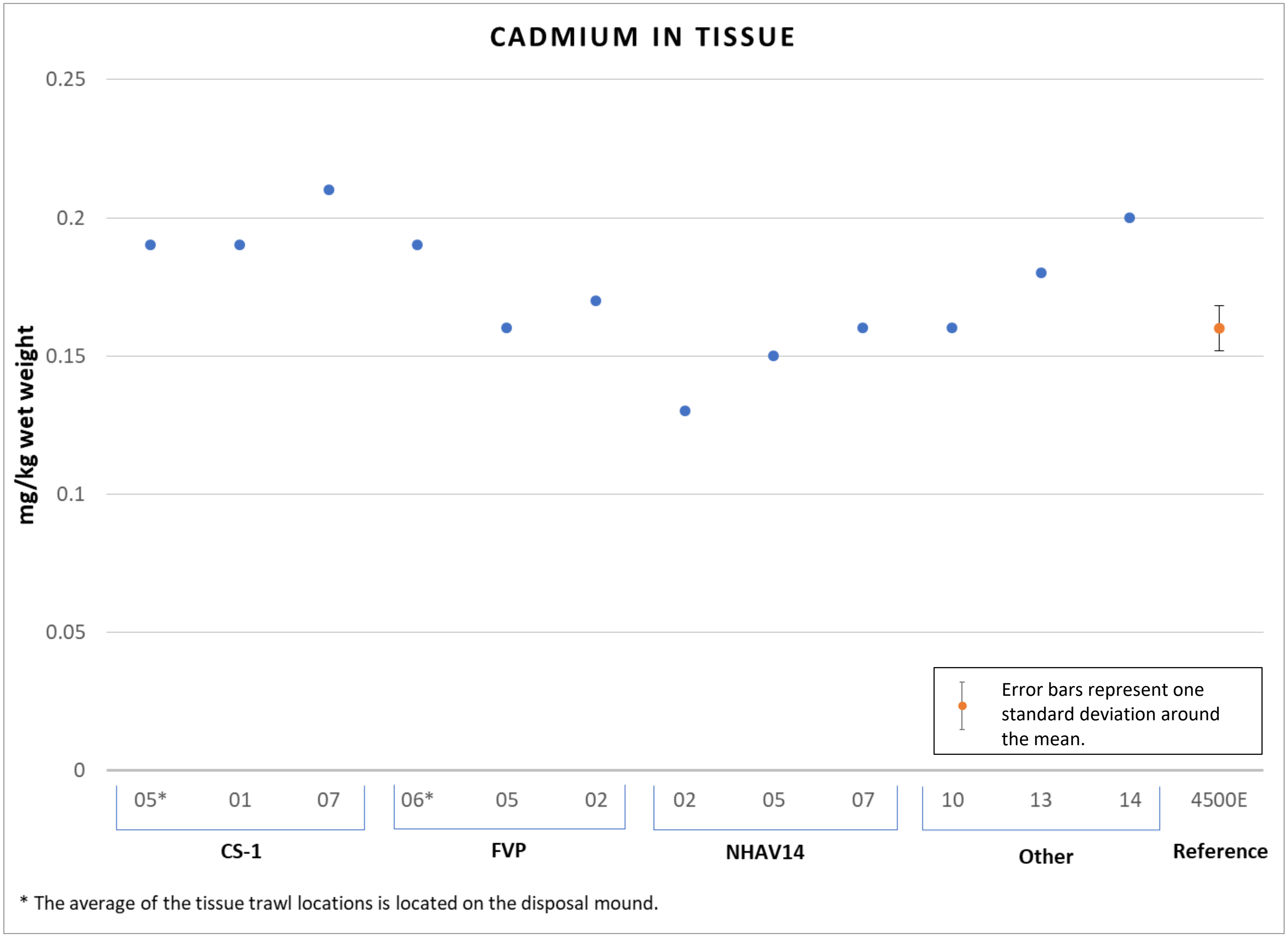


Figure 3-71b. Cadmium (mg/kg wet-wt.) in tissue from CLDS and reference area 2016

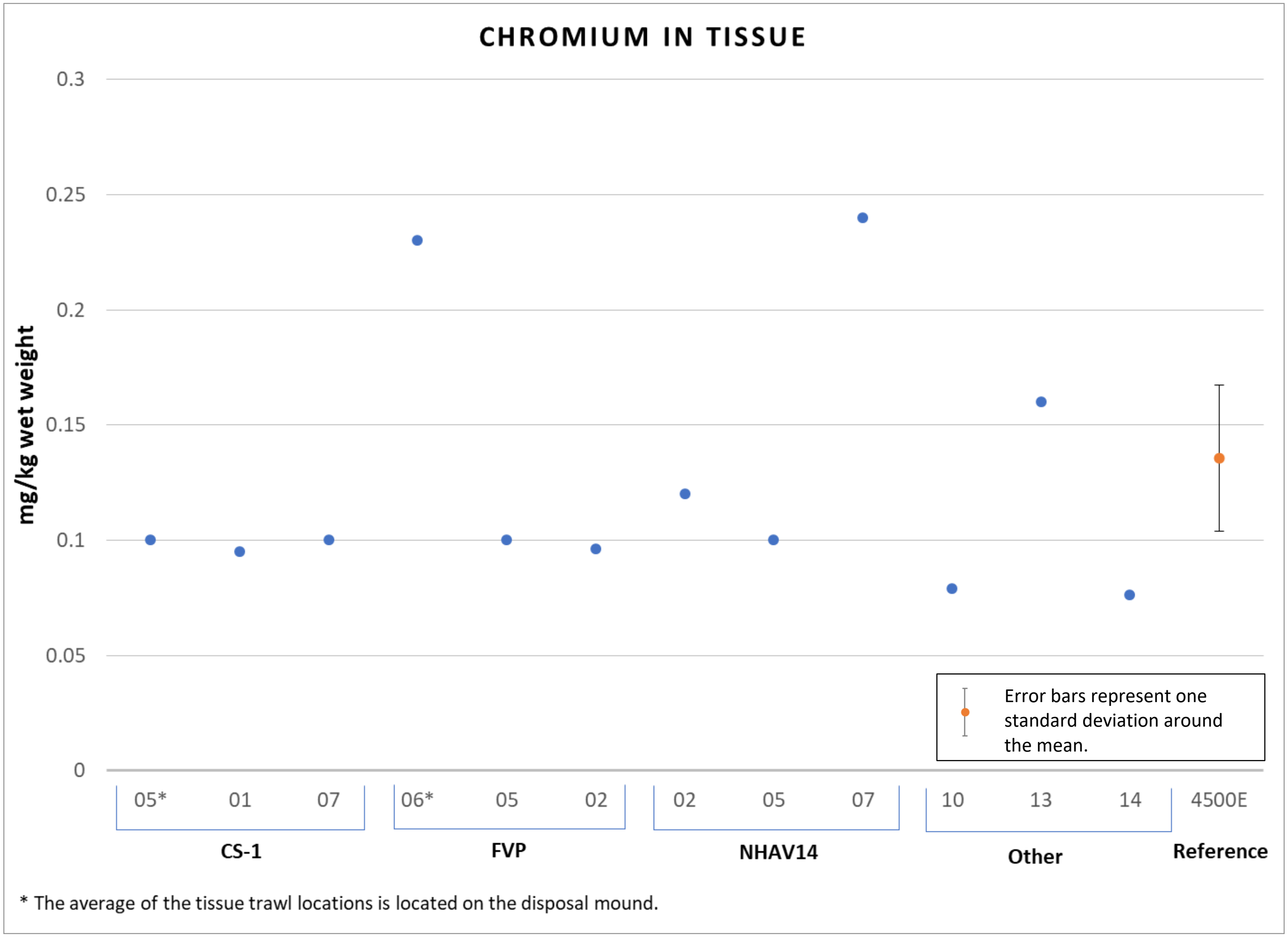


Figure 3-71c. Chromium (mg/kg wet-wt.) in tissue from CLDS and reference area 2016

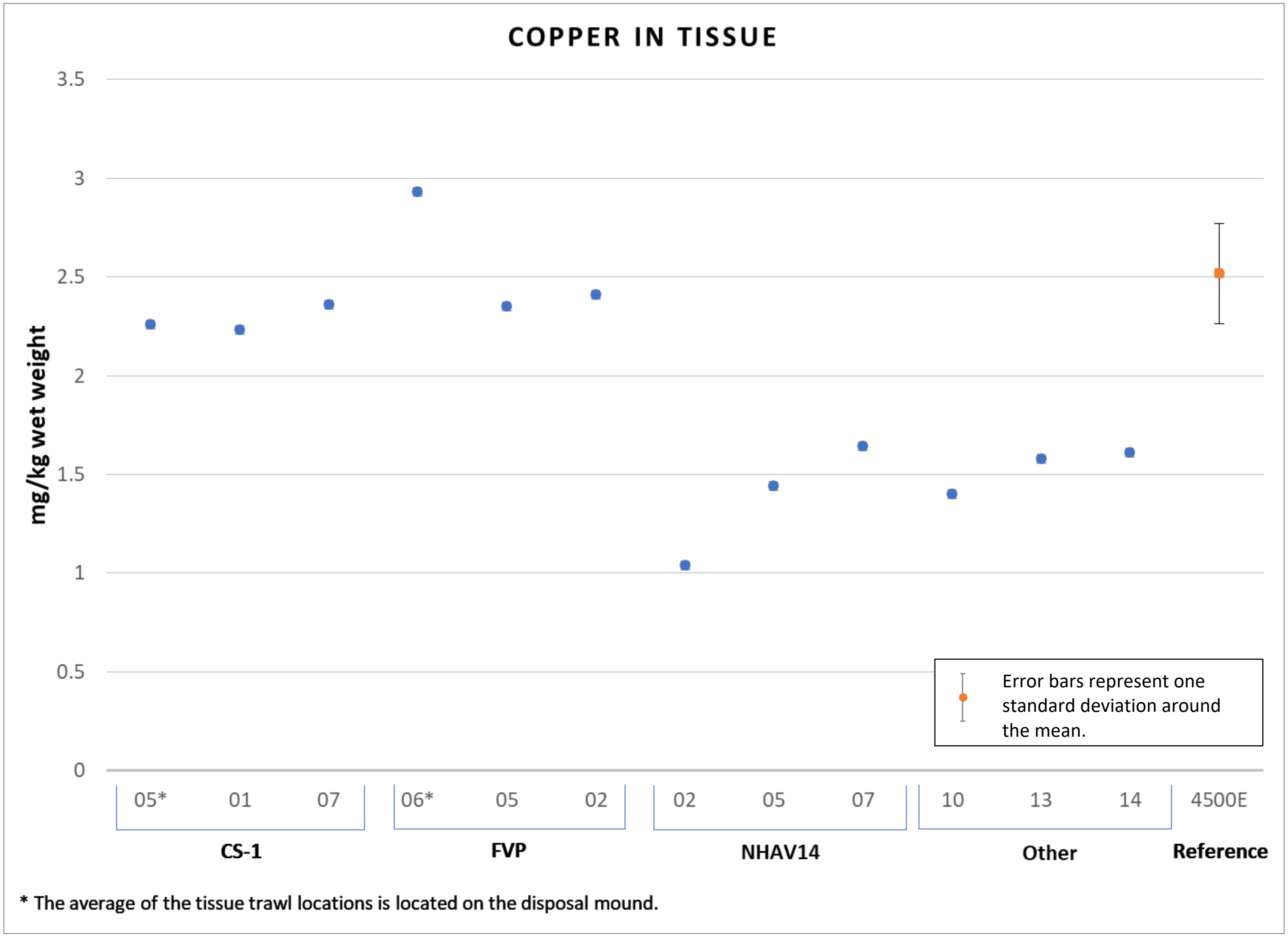


Figure 3-71d. Copper (mg/kg wet-wt.) in tissue from CLDS and reference area 2016

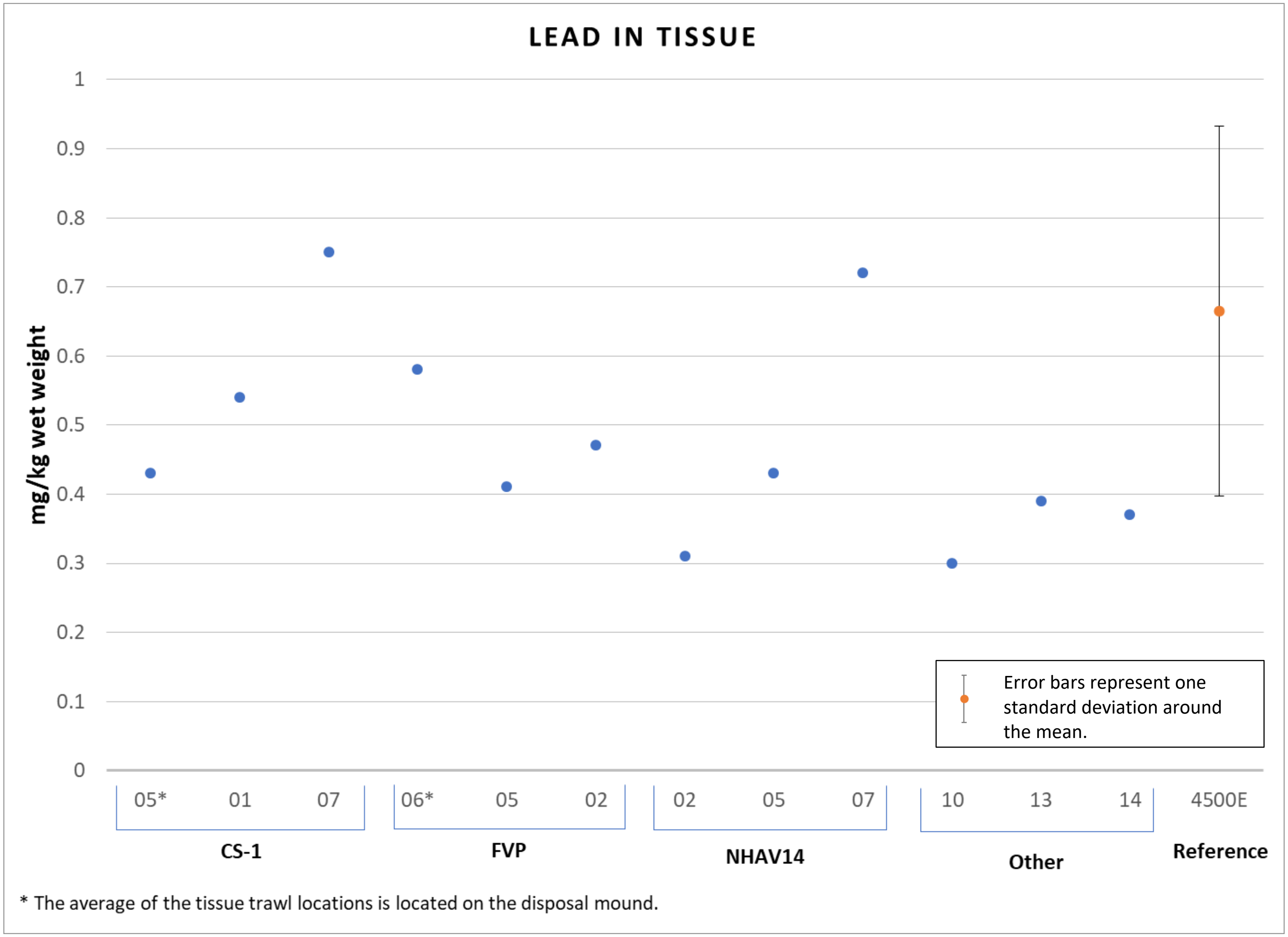


Figure 3-71e. Lead (mg/kg wet-wt.) in tissue from CLDS and reference area 2016

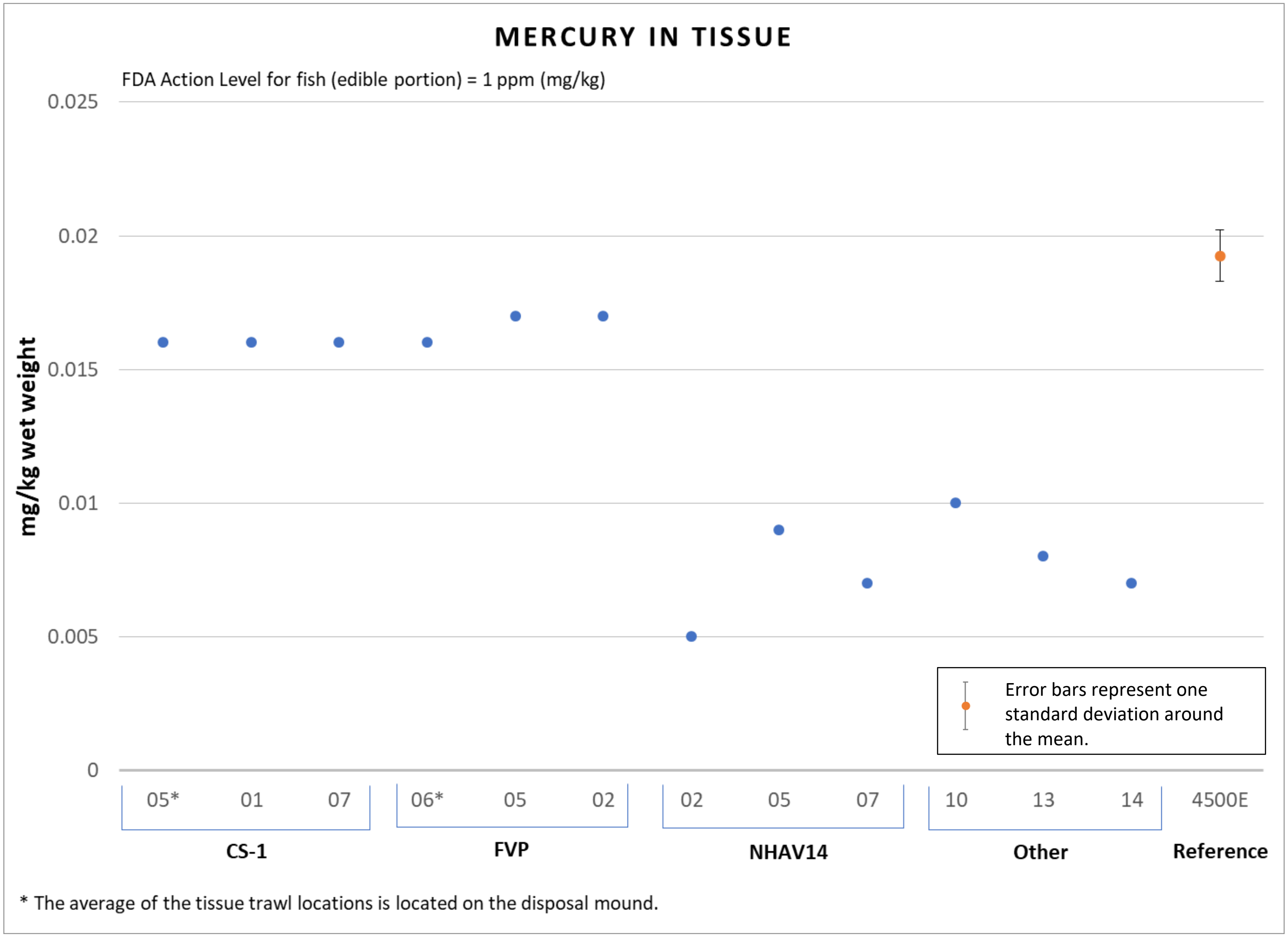


Figure 3-71f. Mercury (mg/kg wet-wt.) in tissue from CLDS and reference area 2016

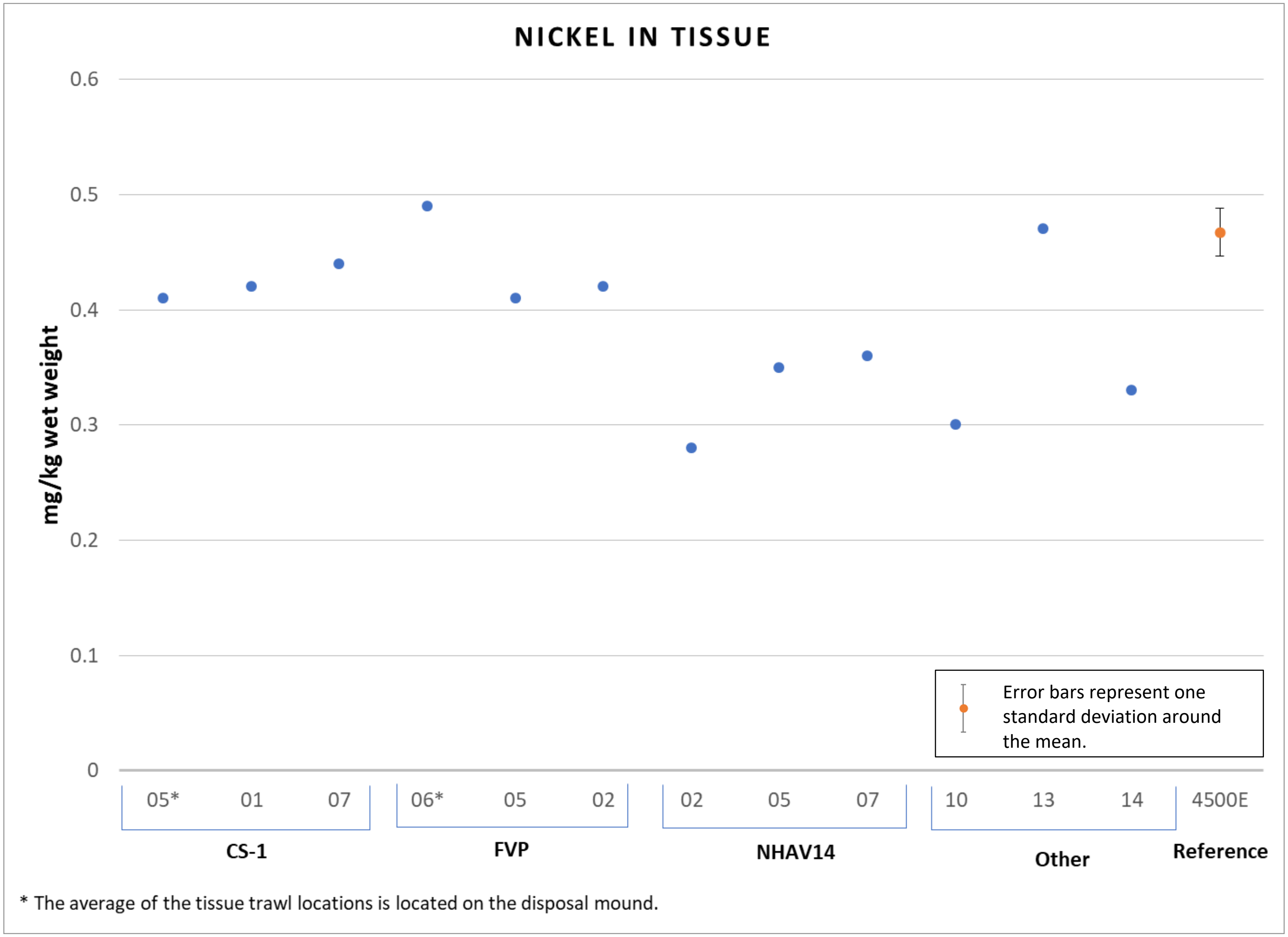


Figure 3-71g. Nickel (mg/kg wet-wt.) in tissue from CLDS and reference area 2016

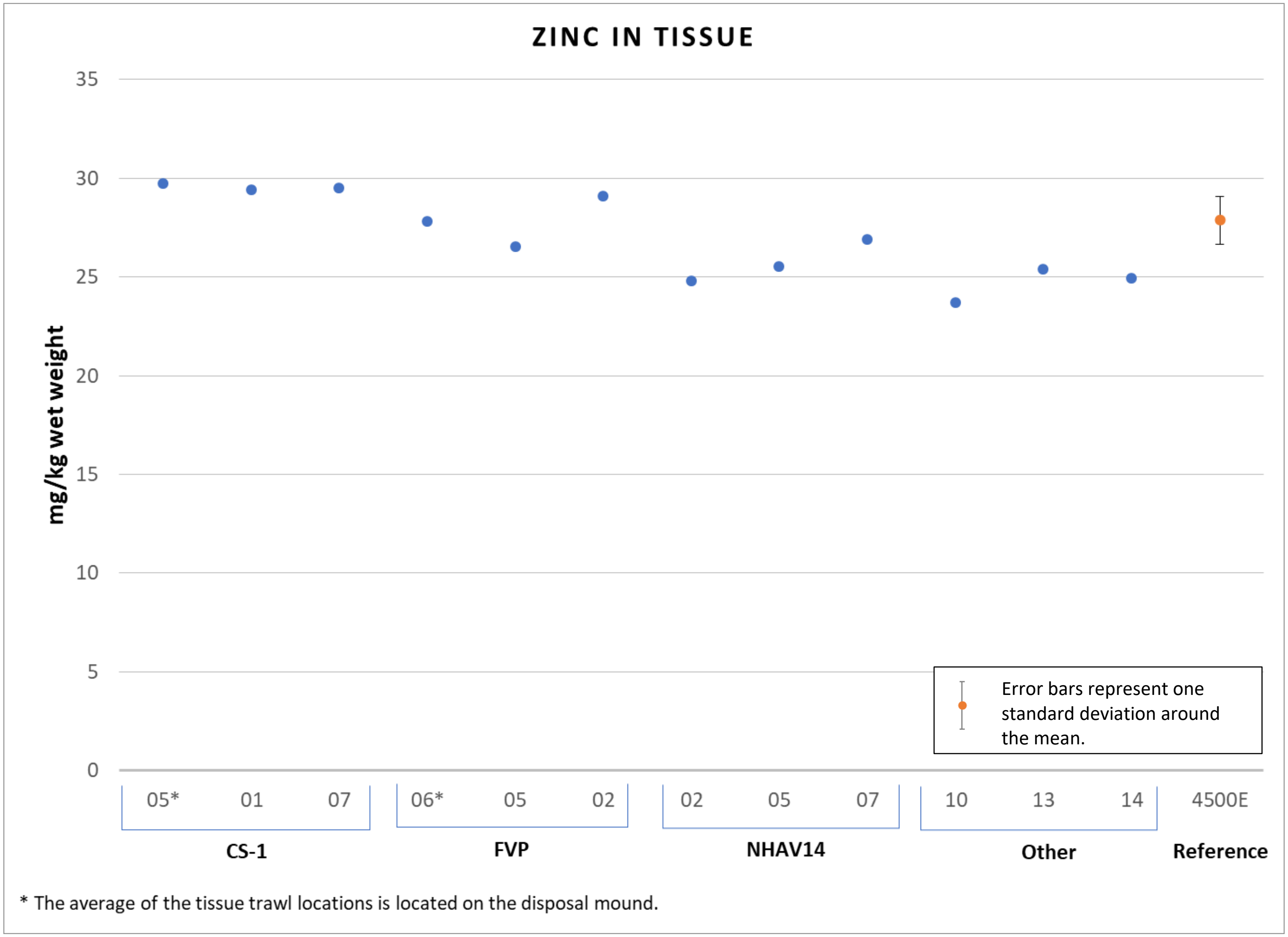
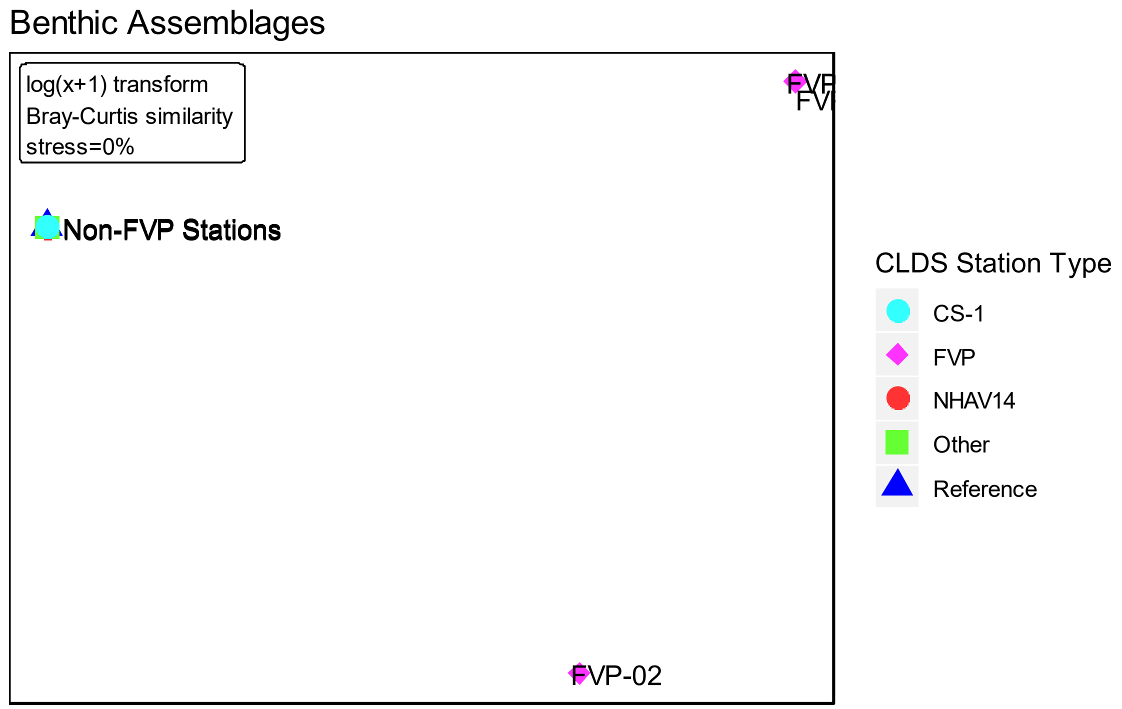
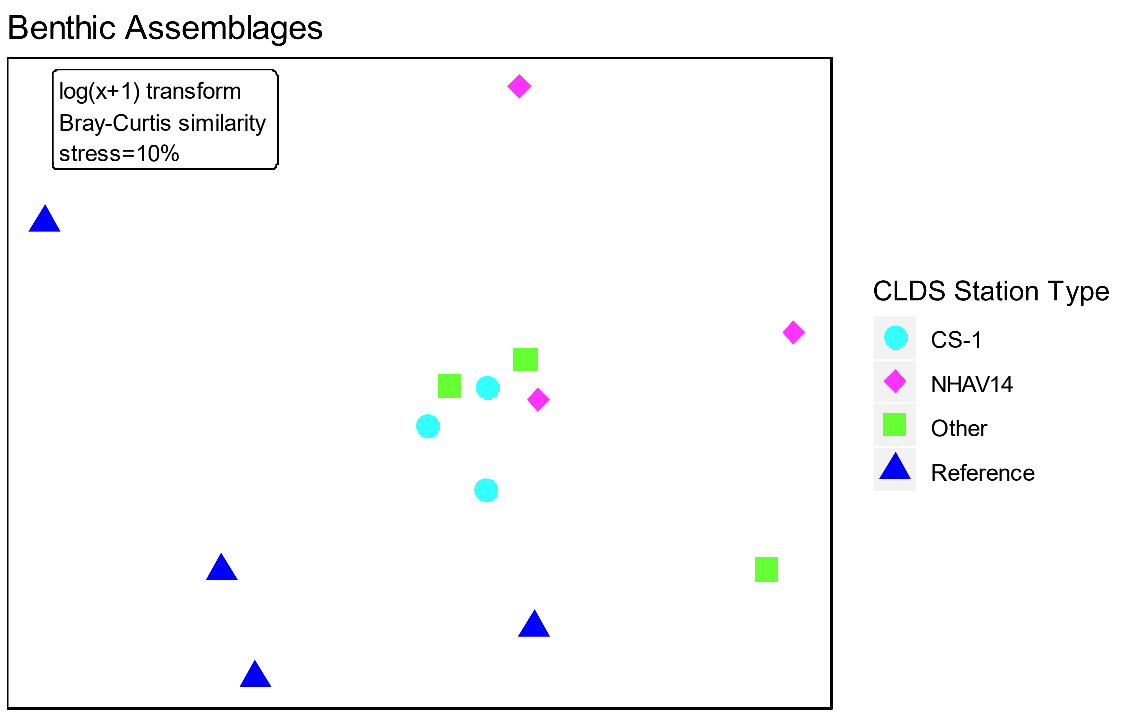


Figure 3-71h. Zinc (mg/kg wet-wt.) in tissue from CLDS and reference area 2016



(A)



(B)

Figure 3-72. Non-metric multidimensional scaling plots depicting the relative similarity of benthic infaunal assemblages in the reference and disposal (CS-1, FVP, NHAV14, and CLDS-Other) areas

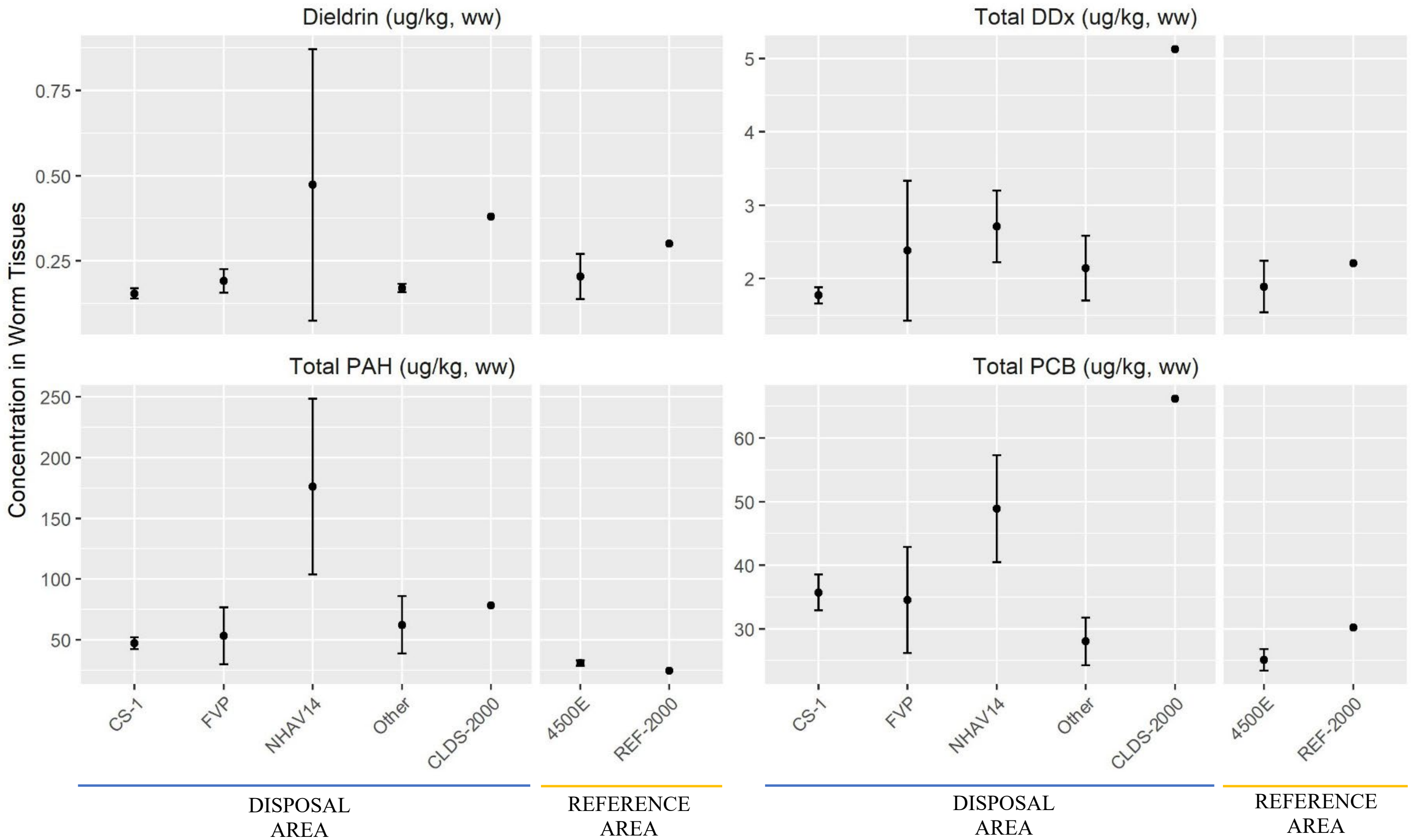


Figure 4-1. Mean concentrations (+/- standard deviation) of organic contaminants in worm tissues in mounds/areas measured in 2016, and from reference area 4500E. For comparison, results from the survey in 2000 are shown for the average concentration of samples composited from FVP and NHAV93 mounds (CLDS-2000) and from reference (REF-2000).

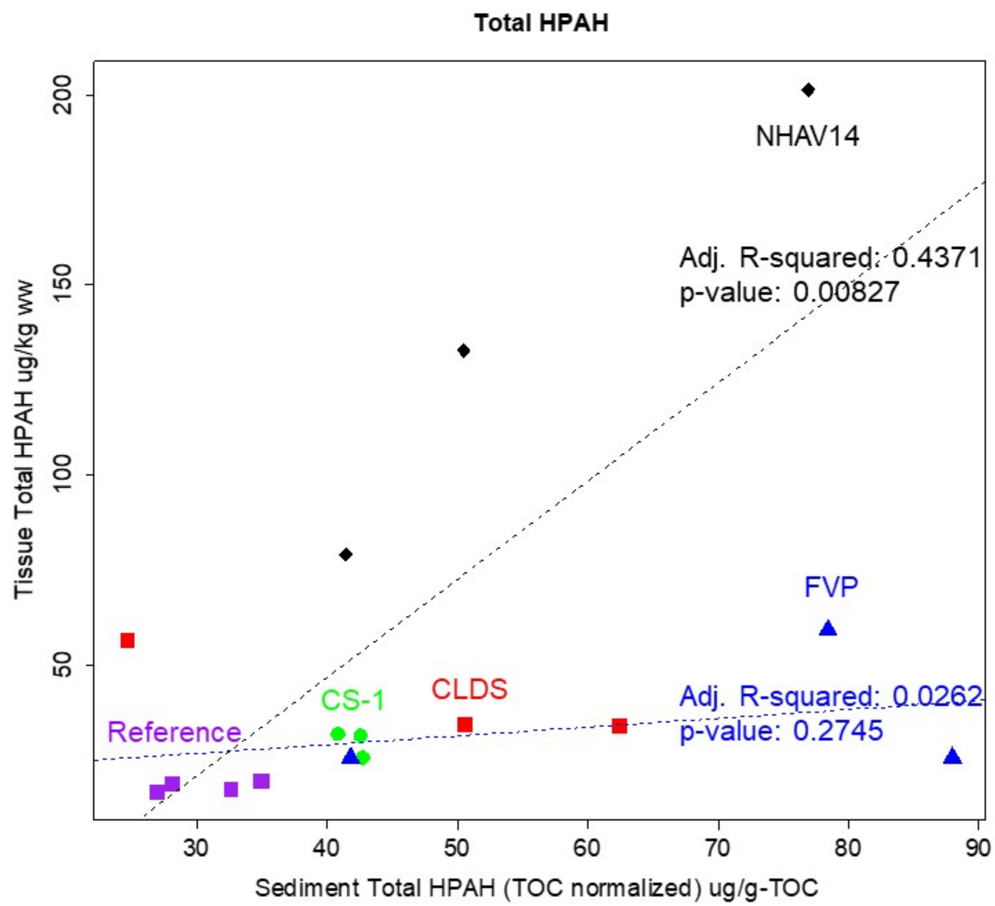


Figure 4-2. Sediment (TOC-normalized) and tissue concentrations of high molecular weight fraction of total PAHs (HPAHs) for each sample from the disposal site and reference area. Top regression line is for entire dataset; lower regression line is for all samples excluding NHAV14.

MONITORING SURVEY AT THE CENTRAL LONG ISLAND SOUND DISPOSAL SITE SEPTEMBER/OCTOBER 2016

APPENDICES

CONTRIBUTION #202

March 2021

Contract No. W912WJ-12-D-0004

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LIST OF APPENDICES

APPENDIX A

TABLE OF COMMON CONVERSIONS

APPENDIX A

TABLE OF COMMON CONVERSIONS

Metric Unit Conversion to English Unit		**English Unit Conversion to Metric Unit**	
1 meter 1 m	3.2808 ft	1 foot 1 ft	0.3048 m
1 square meter 1 m^2	10.7639 ft^2	1 square foot 1 ft^2	0.0929 m^2
1 kilometer 1 km	0.6214 mi	1 mile 1 mi	1.6093 km
1 cubic meter 1 m^3	1.3080 yd^3	1 cubic yard 1 yd^3	0.7646 m^3
1 centimeter 1 cm	0.3937 in	1 inch 1 in	2.54 cm

APPENDIX B

CLDS DISPOSAL LOG DATA FROM OCT 2015 TO MAY 2016

Central Long Island Sound Disposal Site Disposal Logs October 2015 to May 2016

Placement site name	Project name	Permit number	Target Site Code	Placement date/time	Placement latitude	Placement longitude	City/town	State	Load volume (Cubic meters)	Load volume (Cubic yards)	DQM trip number	Placement ID
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	13-Oct-15	41.14528	-72.88888	Old Lyme	CT	605	791	4577334	57388
CLDS	Fisher Island YC	NAN-2013-1160	CLDS 14/15 1C	13-Oct-15	41.14506	-72.88978	Fishers Island	NY	1,021	1335	4606510	57381
CLDS	Fisher Island YC	NAN-2013-1160	CLDS 14/15 1C	15-Oct-15	41.145235	-72.889278	Fishers Island	NY	1,021	1335	4606551	57382
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	17-Oct-15	41.14577	-72.889	Old Lyme	CT	605	791	4602224	57389
CLDS	Fisher Island YC	NAN-2013-1160	CLDS 14/15 1C	19-Oct-15	41.145132	-72.889395	Fishers Island	NY	1,021	1335	4606631	57383
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	19-Oct-15	41.14512	-72.88978	Old Lyme	CT	605	791	4648207	57390
CLDS	Fisher Island YC	NAN-2013-1160	CLDS 14/15 1C	22-Oct-15	41.14514	-72.889242	Fishers Island	NY	1,021	1335	4606685	57384
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	23-Oct-15	41.1456	-72.88808	Old Lyme	CT	605	791	4648208	57391
CLDS	Fisher Island YC	NAN-2013-1160	CLDS 14/15 1C	24-Oct-15	41.144935	-72.889412	Fishers Island	NY	1,021	1335	4616187	57385
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	24-Oct-15	41.1458	-72.88997	Old Lyme	CT	605	791	4648509	57392
CLDS	Fisher Island YC	NAN-2013-1160	CLDS 14/15 1C	27-Oct-15	41.144822	-72.88973	Fishers Island	NY	1,021	1335	4623309	57386
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	28-Oct-15	41.14558	-72.891	Old Lyme	CT	605	791	4648673	57393
CLDS	Commander Terminal	NAE-2007-833	CLDS 14/15 1C	30-Oct-15	41.14518	-72.88875	Oyster Bay	NY	870	1138	4631450	57701
CLDS	Fisher Island YC	NAN-2013-1160	CLDS 14/15 1C	01-Nov-15	41.145653	-72.889692	Fishers Island	NY	1,025	1340	4639643	57387
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	02-Nov-15	41.14533	-72.88867	Old Lyme	CT	605	791	4648674	57394
CLDS	Commander Terminal	NAE-2007-833	CLDS 14/15 1C	05-Nov-15	41.14528	-72.88993	Oyster Bay	NY	871	1139	4648705	57702
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	06-Nov-15	41.14553	-72.8895	Old Lyme	CT	605	791	4652110	57395
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	09-Nov-15	41.14527	-72.88912	Old Lyme	CT	605	791	4676264	57396
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	12-Nov-15	41.14513	-72.88985	Old Lyme	CT	605	791	4676265	57397
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	12-Nov-15	41.145223	-72.889195	Old Saybrook	CT	409	535	4702834	57460
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	17-Nov-15	41.144313	-72.889317	Old Saybrook	CT	409	535	4688116	57461
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	18-Nov-15	41.145123	-72.889937	Old Saybrook	CT	409	535	4690548	57462
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	18-Nov-15	41.14573	-72.8895	Old Lyme	CT	605	791	4806740	57398
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	19-Nov-15	41.145247	-72.889658	Old Saybrook	CT	409	535	4702204	57463
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	20-Nov-15	41.14513	-72.88997	Old Lyme	CT	605	791	4806741	57399
CLDS	Brewer Yacht Haven Marina	NAE-2015-306	CLDS 14/15 1B	21-Nov-15	41.1448	-72.89028	Stamford	CT	414	541	4884737	57652
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	21-Nov-15	41.145145	-72.888987	Old Saybrook	CT	409	535	4778425	57465
CLDS	Brewer Yacht Haven Marina	NAE-2015-306	CLDS 14/15 1B	22-Nov-15	41.14493	-72.89077	Stamford	CT	414	541	4884738	57653
CLDS	Brewer Yacht Haven Marina	NAE-2015-306	CLDS 14/15 1B	23-Nov-15	41.14497	-72.89037	Stamford	CT	414	541	4884739	57654
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	24-Nov-15	41.14432	-72.88922	Old Lyme	CT	605	791	4806742	57400
CLDS	Brewer Yacht Haven Marina	NAE-2015-306	CLDS 14/15 1B	24-Nov-15	41.14498	-72.89075	Stamford	CT	414	541	4884740	57655
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	24-Nov-15	41.145242	-72.889012	Old Saybrook	CT	409	535	4798168	57466
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	28-Nov-15	41.145235	-72.888717	Old Saybrook	CT	409	535	4810904	57467
CLDS	Brewer Yacht Haven Marina	NAE-2015-306	CLDS 14/15 1B	28-Nov-15	41.14512	-72.89042	Stamford	CT	414	541	4884741	57656
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	29-Nov-15	41.145135	-72.88919	Old Saybrook	CT	409	535	4810944	57468
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	29-Nov-15	41.14515	-72.88908	Old Lyme	CT	605	791	4807822	57401
CLDS	Brewer Yacht Haven Marina	NAE-2015-306	CLDS 14/15 1B	29-Nov-15	41.14513	-72.89055	Stamford	CT	414	541	4884742	57657
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	30-Nov-15	41.144818	-72.889547	Old Saybrook	CT	409	535	4810963	57469
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	30-Nov-15	41.14513	-72.88898	Old Lyme	CT	605	791	4857349	57402
CLDS	Brewer Yacht Haven Marina	NAE-2015-306	CLDS 14/15 1B	01-Dec-15	41.14472	-72.89065	Stamford	CT	414	541	4884743	57658
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	01-Dec-15	41.145183	-72.889492	Old Saybrook	CT	409	535	4813661	57470
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	02-Dec-15	41.145513	-72.889147	Old Saybrook	CT	409	535	4818337	57471
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	03-Dec-15	41.14517	-72.88867	Old Lyme	CT	605	791	4857350	57403
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	05-Dec-15	41.14542	-72.88883	Old Lyme	CT	605	791	4857351	57404
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	05-Dec-15	41.144205	-72.892167	Westbrook	CT	339	444	4828854	57633
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	06-Dec-15	41.14552	-72.88918	Old Lyme	CT	605	791	4857352	57405
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	06-Dec-15	41.144138	-72.891813	Westbrook	CT	339	444	4828924	57634
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	07-Dec-15	41.14533	-72.8886	Old Lyme	CT	605	791	4857353	57406

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Placement site name	Project name	Permit number	Target Site Code	Placement date/time	Placement latitude	Placement longitude	City/town	State	Load volume (Cubic meters)	Load volume (Cubic yards)	DQM trip number	Placement ID
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	07-Dec-15	41.143885	-72.891848	Westbrook	CT	339	444	4831407	57635
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	08-Dec-15	41.1449	-72.88838	Old Lyme	CT	605	791	4857354	57407
CLDS	Castaways Yacht Club	NAE-2012-234	CLDS 15/16 1B	08-Dec-15	41.14408	-72.89272	New Rochelle	NY	1,349	1764	4906741	57693
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	08-Dec-15	41.144087	-72.892108	Westbrook	CT	339	444	4834538	57636
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	09-Dec-15	41.14522	-72.88865	Old Lyme	CT	605	791	4857355	57408
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	09-Dec-15	41.143997	-72.892078	Westbrook	CT	339	444	4837341	57637
CLDS	Castaways Yacht Club	NAE-2012-234	CLDS 15/16 1B	10-Dec-15	41.14417	-72.89243	New Rochelle	NY	1,349	1764	4836857	57694
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	10-Dec-15	41.14533	-72.88873	Old Lyme	CT	605	791	4857356	57409
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	11-Dec-15	41.144683	-72.892343	Westbrook	CT	339	444	4845422	57638
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	12-Dec-15	41.14535	-72.88878	Old Lyme	CT	605	791	4857371	57410
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	12-Dec-15	41.143397	-72.891915	Westbrook	CT	339	444	4845465	57639
CLDS	Castaways Yacht Club	NAE-2012-234	CLDS 15/16 1B	12-Dec-15	41.14398	-72.89247	New Rochelle	NY	1,349	1764	4857049	57695
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	13-Dec-15	41.14396	-72.89213	Westbrook	CT	339	444	4845549	57640
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	14-Dec-15	41.1452	-72.89202	Old Lyme	CT	605	791	4857372	57412
CLDS	Castaways Yacht Club	NAE-2012-234	CLDS 15/16 1B	16-Dec-15	41.14388	-72.8927	New Rochelle	NY	1,349	1764	4857050	57696
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	17-Dec-15	41.143957	-72.892075	Westbrook	CT	339	444	4861066	57641
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	18-Dec-15	41.14399	-72.892107	Westbrook	CT	339	444	4861087	57642
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	18-Dec-15	41.14513	-72.89033	Old Lyme	CT	605	791	4857373	57411
CLDS	Castaways Yacht Club	NAE-2012-234	CLDS 15/16 1B	21-Dec-15	41.14425	-72.89168	New Rochelle	NY	1,349	1764	4870901	57697
CLDS	Brewer Yacht Haven Marina	NAE-2015-306	CLDS 14/15 1B	22-Dec-15	41.14523	-72.89083	Stamford	CT	414	541	4884744	57659
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	22-Dec-15	41.14418	-72.891803	Westbrook	CT	339	444	4872598	57643
CLDS	Brewer Yacht Haven Marina	NAE-2015-306	CLDS 14/15 1B	23-Dec-15	41.14525	-72.89028	Stamford	CT	414	541	4884745	57660
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	23-Dec-15	41.1452	-72.88852	Old Lyme	CT	605	791	4870953	57413
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	23-Dec-15	41.144078	-72.892225	Westbrook	CT	339	444	4874685	57644
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	27-Dec-15	41.144288	-72.892313	Westbrook	CT	339	444	4887045	57645
CLDS	Brewer Yacht Haven Marina	NAE-2015-306	CLDS 14/15 1B	27-Dec-15	41.14515	-72.89055	Stamford	CT	414	541	4884746	57661
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	28-Dec-15	41.14523	-72.88512	Old Lyme	CT	605	791	4882946	57414
CLDS	Brewer Yacht Haven Marina	NAE-2015-306	CLDS 14/15 1B	28-Dec-15	41.14505	-72.89085	Stamford	CT	414	541	4932581	57662
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	30-Dec-15	41.144077	-72.892633	Westbrook	CT	339	444	4891435	57646
CLDS	Castaways Yacht Club	NAE-2012-234	CLDS 15/16 1B	31-Dec-15	41.14373	-72.89285	New Rochelle	NY	1,349	1764	4890471	57698
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	31-Dec-15	41.143983	-72.892493	Westbrook	CT	339	444	4902613	57647
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	07-Jan-16	41.14515	-72.88823	Old Lyme	CT	605	791	4913126	57415
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	07-Jan-16	41.143718	-72.892015	Westbrook	CT	339	444	4915874	57648
CLDS	Castaways Yacht Club	NAE-2012-234	CLDS 15/16 1B	08-Jan-16	41.14365	-72.89245	New Rochelle	NY	1,350	1766	4915243	57699
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	08-Jan-16	41.144063	-72.892087	Westbrook	CT	339	444	4925567	57649

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Placement site name	Project name	Permit number	Target Site Code	Placement date/time	Placement latitude	Placement longitude	City/town	State	Load volume (Cubic meters)	Load volume (Cubic yards)	DQM trip number	Placement ID
CLDS	Brewer Yacht Haven Marina	NAE-2015-306	CLDS 14/15 1B	08-Jan-16	41.14495	-72.89015	Stamford	CT	420	549	4932625	57678
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	09-Jan-16	41.14414	-72.894182	Mystic	CT	1,319	1725	4928833	57709
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	10-Jan-16	41.143935	-72.893818	Mystic	CT	1,319	1725	4928813	57710
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	12-Jan-16	41.144305	-72.892528	Mystic	CT	1,319	1725	4929562	57711
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	12-Jan-16	41.14417	-72.89432	Mystic	CT	1,319	1725	4936033	57712
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	14-Jan-16	41.144112	-72.892832	Mystic	CT	1,319	1725	4936005	57713
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	15-Jan-16	41.143937	-72.894303	Mystic	CT	1,319	1725	4954618	57714
CLDS	Brewers Pilots Point Marina - 2012	NAE-2001-2437	CLDS 15/16 1B	16-Jan-16	41.144153	-72.892032	Westbrook	CT	346	452	4952895	57650
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	16-Jan-16	41.143968	-72.89295	Mystic	CT	1,319	1725	4954590	57715
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	17-Jan-16	41.144858	-72.890727	Old Saybrook	CT	300	393	4954635	57734
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	17-Jan-16	41.143888	-72.893672	Mystic	CT	1,319	1725	4954671	57716
CLDS	Black Hall River/Four Mile River	NAE-2014-00063	CLDS 14/15 1C	18-Jan-16	41.14515	-72.88872	Old Lyme	CT	623	815	4946987	57753
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	20-Jan-16	41.144122	-72.892513	Mystic	CT	1,319	1725	4954678	57717
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	21-Jan-16	41.144513	-72.893212	Mystic	CT	1,319	1725	4971450	57718
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	21-Jan-16	41.144947	-72.891502	Old Saybrook	CT	300	393	4972201	57735
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	22-Jan-16	41.14487	-72.890748	Old Saybrook	CT	300	393	4972387	57736
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	22-Jan-16	41.144323	-72.892765	Mystic	CT	1,319	1725	4971434	57719
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	25-Jan-16	41.143883	-72.894803	Mystic	CT	1,319	1725	4971522	57720
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	26-Jan-16	41.144923	-72.890437	Old Saybrook	CT	300	393	4974632	57737
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	27-Jan-16	41.143705	-72.894605	Mystic	CT	1,319	1725	4980990	57721
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	28-Jan-16	41.144302	-72.893575	Mystic	CT	1,319	1725	4980970	57722
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	28-Jan-16	41.144998	-72.891348	Old Saybrook	CT	300	393	4981411	57738
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	29-Jan-16	41.144118	-72.892933	Mystic	CT	1,319	1725	4990010	57723
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	29-Jan-16	41.145025	-72.891063	Old Saybrook	CT	300	393	4990190	57739
CLDS	Motiva	NAE-2009-287	CLDS 15/16 1B	29-Jan-16	41.1439	-72.891312	New Haven	CT	1,816	2375	5010643	57703
CLDS	Motiva	NAE-2009-287	CLDS 15/16 1B	30-Jan-16	41.143875	-72.8931	New Haven	CT	1,816	2375	5010655	57704
CLDS	Mystic River FNP	W912WJ-14-C-0037	CLDS 15/16 1A	30-Jan-16	41.143778	-72.894842	Mystic	CT	1,319	1725	4990043	57724
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	31-Jan-16	41.144768	-72.890463	Old Saybrook	CT	300	393	4990216	57740
CLDS	Motiva	NAE-2009-287	CLDS 15/16 1B	31-Jan-16	41.143975	-72.891438	New Haven	CT	1,816	2375	5010676	57705
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	01-Feb-16	41.144938	-72.890653	Old Saybrook	CT	300	393	4993744	57741
CLDS	Motiva	NAE-2009-287	CLDS 15/16 1B	02-Feb-16	41.143497	-72.892905	New Haven	CT	1,816	2375	5010687	57706
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	02-Feb-16	41.144968	-72.890395	Old Saybrook	CT	300	393	4998268	57742
CLDS	Pine Island Marina	NAE-2005-499	CLDS 15/16 1B	02-Feb-16	41.144405	-72.893038	Groton	CT	900	1177	5001536	57725

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Placement site name	Project name	Permit number	Target Site Code	Placement date/time	Placement latitude	Placement longitude	City/town	State	Load volume (Cubic meters)	Load volume (Cubic yards)	DQM trip number	Placement ID
CLDS	Pine Island Marina	NAE-2005-499	CLDS 15/16 1B	03-Feb-16	41.144045	-72.89332	Groton	CT	900	1177	5001468	57727
CLDS	Pine Island Marina	NAE-2005-499	CLDS 15/16 1B	05-Feb-16	41.143927	-72.892042	Groton	CT	900	1177	5004848	57728
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	06-Feb-16	41.144897	-72.890552	Old Saybrook	CT	300	393	5013405	57743
CLDS	Pine Island Marina	NAE-2005-499	CLDS 15/16 1B	06-Feb-16	41.144412	-72.893535	Groton	CT	900	1177	5013370	57729
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	07-Feb-16	41.144777	-72.890597	Old Saybrook	CT	300	393	5013418	57744
CLDS	Pine Island Marina	NAE-2005-499	CLDS 15/16 1B	07-Feb-16	41.143737	-72.89309	Groton	CT	900	1177	5013387	57730
CLDS	Pine Island Marina	NAE-2005-499	CLDS 15/16 1B	09-Feb-16	41.143913	-72.891187	Groton	CT	900	1177	5018448	57731
CLDS	Pine Island Marina	NAE-2005-499	CLDS 15/16 1B	10-Feb-16	41.143217	-72.892705	Groton	CT	900	1177	5020927	57732
CLDS	Shennecossett Yacht Club	NAE-2008-1468	CLDS 15/16 1B	11-Feb-16	41.143873	-72.891938	Groton	CT	1,204	1575	5023252	57757
CLDS	Shennecossett Yacht Club	NAE-2008-1468	CLDS 15/16 1B	12-Feb-16	41.143737	-72.891362	Groton	CT	1,204	1575	5023240	57758
CLDS	Shennecossett Yacht Club	NAE-2008-1468	CLDS 15/16 1B	13-Feb-16	41.143907	-72.89136	Groton	CT	1,204	1575	5028818	57759
CLDS	Shennecossett Yacht Club	NAE-2008-1468	CLDS 15/16 1B	16-Feb-16	41.143423	-72.891442	Groton	CT	1,204	1575	5032860	57760
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	17-Feb-16	41.144712	-72.89048	Old Saybrook	CT	300	393	5046870	57745
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	18-Feb-16	41.144483	-72.891122	Old Saybrook	CT	300	393	5046897	57746
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	19-Feb-16	41.144728	-72.891358	Old Saybrook	CT	300	393	5058051	57747
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	21-Feb-16	41.144682	-72.891288	Old Saybrook	CT	300	393	5058104	57748
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	27-Feb-16	41.144708	-72.89116	Old Saybrook	CT	300	393	5138263	57749
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	01-Mar-16	41.144552	-72.891947	Old Saybrook	CT	300	393	5138369	57750
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	03-Mar-16	41.144883	-72.891153	Old Saybrook	CT	300	393	5129225	57751
CLDS	Saybrook Point Marina	NAE-2007-2158	CLDS 14/15 1B	07-Mar-16	41.145065	-72.890197	Old Saybrook	CT	307	401	5129526	57752
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	09-Mar-16	41.14471	-72.889593	Old Saybrook	CT	409	535	5140993	57472
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	10-Mar-16	41.144775	-72.889422	Old Saybrook	CT	409	535	5141024	57473
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	11-Mar-16	41.145325	-72.889633	Old Saybrook	CT	409	535	5150840	57474
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	13-Mar-16	41.14481	-72.889107	Old Saybrook	CT	409	535	5150881	57475
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	16-Mar-16	41.14474	-72.889505	Old Saybrook	CT	424	555	5162498	57476
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	17-Mar-16	41.145087	-72.888903	Old Saybrook	CT	409	535	5165479	57477
CLDS	Brewer Ferry Point Marina	NAE-2007-923	CLDS 14/15 1C	19-Mar-16	41.144917	-72.889213	Old Saybrook	CT	409	535	5175213	57478
CLDS	Harbor One Marina-4113	NAE20044113	CLDS 15/16 1C	09-Apr-16	41.14445	-72.89032	Old Saybrook	CT	229	300	5272778	57775
CLDS	Pine Island Marina	NAE-2005-499	CLDS 15/16 1B	14-Apr-16	41.144068	-72.892402	Groton	CT	900	1177	5311608	57726
CLDS	Pine Island Marina	NAE-2005-499	CLDS 15/16 1B	14-May-16	41.143915	-72.892065	Groton	CT	905	1184	5403733	57733

APPENDIX C

ACTUAL SPI/PV AND SEDIMENT GRAB REPLICATE LOCATIONS

CLDS 2016 ACTUAL SPI/PV STATION IDS/COORDINATES							
Station ID	**Replicate**	**Date**	**Time**	**X**	**Y**	**Latitude**	**Longitude**
1	A	9/28/2016	2:52:59 PM	293526.76	186710.5	41.142197	-72.884285
1	B	9/28/2016	2:53:48 PM	293517.13	186724.4	41.142322	-72.8844
1	C	9/28/2016	2:54:33 PM	293526.41	186719.3	41.142276	-72.884289
1	D	9/28/2016	2:56:16 PM	293487.49	186712.7	41.142216	-72.884753
2	A	9/28/2016	2:58:55 PM	293368.31	186877.9	41.143702	-72.886176
2	B	9/28/2016	2:59:43 PM	293364.21	186891.8	41.143827	-72.886225
2	C	9/28/2016	3:00:34 PM	293372.83	186881.9	41.143738	-72.886122
2	D	9/28/2016	3:01:21 PM	293362.61	186878.6	41.143709	-72.886243
3	A	9/28/2016	3:04:32 PM	293376.22	187137.3	41.146038	-72.886086
3	B	9/28/2016	3:05:50 PM	293386.91	187152.8	41.146177	-72.885959
3	C	9/28/2016	3:06:33 PM	293385.74	187140.3	41.146065	-72.885973
3	D	9/28/2016	3:07:16 PM	293386.95	187133.8	41.146006	-72.885958
4	A	9/28/2016	3:11:45 PM	293568.86	187131.2	41.145985	-72.883791
4	B	9/28/2016	3:12:52 PM	293577.8	187129.4	41.14597	-72.883685
4	C	9/28/2016	3:14:24 PM	293579.59	187128.4	41.145961	-72.883663
4	D	9/28/2016	3:15:43 PM	293581.08	187130.7	41.145981	-72.883646
5	A	9/28/2016	3:20:46 PM	293311.29	187363	41.148069	-72.886864
5	B	9/28/2016	3:21:56 PM	293317.27	187366.7	41.148103	-72.886793
5	C	9/28/2016	3:22:45 PM	293313.86	187353.6	41.147984	-72.886833
5	D	9/28/2016	3:23:28 PM	293307.78	187349.7	41.147949	-72.886905
5	E	9/29/2016	8:28:03 AM	293312.06	187366.6	41.148101	-72.886855
5	F	9/29/2016	8:28:59 AM	293322.41	187358.5	41.148029	-72.886731
5	G	9/29/2016	8:29:47 AM	293328.46	187353.9	41.147987	-72.886659
5	H	9/29/2016	8:32:41 AM	293316.17	187356.7	41.148013	-72.886806
5	I	9/29/2016	8:36:53 AM	293289.71	187371.8	41.148148	-72.887121
6	A	9/28/2016	3:28:39 PM	293579.82	187498.9	41.149297	-72.883668
6	B	9/28/2016	3:29:26 PM	293582.08	187485.1	41.149173	-72.88364
6	C	9/28/2016	3:30:13 PM	293574.44	187489.1	41.149208	-72.883731
6	D	9/28/2016	3:31:02 PM	293573.86	187480.9	41.149135	-72.883738
7	A	9/28/2016	3:40:00 PM	293244.27	187647.6	41.15063	-72.887668
7	B	9/28/2016	3:41:10 PM	293248.54	187632.7	41.150497	-72.887616
7	C	9/28/2016	3:42:24 PM	293246.55	187641.9	41.150579	-72.88764
7	D	9/28/2016	3:43:59 PM	293241	187636	41.150526	-72.887706
8	A	9/28/2016	3:34:29 PM	293452.31	187642.3	41.150586	-72.885189
8	B	9/28/2016	3:35:31 PM	293449.32	187628.4	41.150461	-72.885225
8	C	9/28/2016	3:36:16 PM	293440.31	187638.2	41.150549	-72.885332
8	D	9/28/2016	3:37:05 PM	293443.13	187629.2	41.150468	-72.885298
8	E	9/29/2016	8:21:11 AM	293442.1	187643.1	41.150593	-72.885311
8	F	9/29/2016	8:22:06 AM	293449.14	187643.7	41.150598	-72.885227
8	G	9/29/2016	8:23:05 AM	293452.18	187637.7	41.150544	-72.885191

CLDS 2016 ACTUAL SPI/PV STATION IDS/COORDINATES							
Station ID	**Replicate**	**Date**	**Time**	**X**	**Y**	**Latitude**	**Longitude**
8	H	9/29/2016	8:24:05 AM	293461.86	187631.3	41.150487	-72.885075
9	A	9/28/2016	3:50:10 PM	293893.01	187758.7	41.15164	-72.879941
9	B	9/28/2016	3:51:13 PM	293890.86	187758.8	41.151641	-72.879967
9	C	9/28/2016	3:52:10 PM	293885.61	187747.3	41.151538	-72.880029
9	D	9/28/2016	3:53:12 PM	293887.66	187749.1	41.151554	-72.880005
10	A	9/28/2016	3:57:11 PM	294087.86	187640.9	41.150582	-72.877618
10	B	9/28/2016	3:58:02 PM	294078.89	187639.4	41.150569	-72.877725
10	C	9/28/2016	3:59:07 PM	294087.4	187638.2	41.150558	-72.877624
10	D	9/28/2016	4:00:14 PM	294095.66	187636.5	41.150542	-72.877525
11	A	9/28/2016	4:07:59 PM	294401.5	188011.5	41.153923	-72.873888
11	B	9/28/2016	4:09:00 PM	294388.19	188004.8	41.153862	-72.874047
11	C	9/28/2016	4:10:09 PM	294394.32	188011.7	41.153925	-72.873974
11	D	9/28/2016	4:11:04 PM	294400.14	188003.4	41.15385	-72.873904
12	A	9/28/2016	4:13:40 PM	294480.85	188085.9	41.154594	-72.872944
12	B	9/28/2016	4:15:08 PM	294478.41	188090.1	41.154632	-72.872973
12	C	9/28/2016	4:16:05 PM	294487.75	188086.5	41.1546	-72.872862
12	D	9/28/2016	4:16:59 PM	294476.72	188090.6	41.154637	-72.872993
13	A	9/28/2016	1:29:31 PM	292635.97	187053.4	41.145271	-72.894902
13	B	9/28/2016	1:30:36 PM	292644.52	187059.3	41.145324	-72.894801
13	C	9/28/2016	1:31:20 PM	292645.33	187050.7	41.145247	-72.894791
13	D	9/28/2016	1:32:08 PM	292638.28	187062.3	41.145352	-72.894875
14	A	9/28/2016	1:23:47 PM	292816.64	186984.6	41.144655	-72.892749
14	B	9/28/2016	1:24:41 PM	292815.32	186983.4	41.144644	-72.892765
14	C	9/28/2016	1:25:28 PM	292816.34	186972.4	41.144545	-72.892752
14	D	9/28/2016	1:26:21 PM	292818.73	186971.2	41.144534	-72.892724
15	A	9/28/2016	1:05:04 PM	292417.25	187134.6	41.145999	-72.897509
15	B	9/28/2016	1:06:10 PM	292423.09	187149	41.146129	-72.89744
15	C	9/28/2016	1:07:04 PM	292421.26	187157	41.146201	-72.897462
15	D	9/28/2016	1:08:09 PM	292423.09	187150.5	41.146143	-72.89744
16	A	9/28/2016	1:10:28 PM	292583.83	187171.1	41.14633	-72.895526
16	B	9/28/2016	1:11:22 PM	292586.27	187172.2	41.14634	-72.895497
16	C	9/28/2016	1:12:15 PM	292588.71	187166.5	41.146289	-72.895467
16	D	9/28/2016	1:13:03 PM	292590.24	187168	41.146302	-72.895449
17	A	9/28/2016	1:16:02 PM	292794.43	187197.4	41.146571	-72.893018
17	B	9/28/2016	1:17:08 PM	292790.8	187194.4	41.146543	-72.893061
17	C	9/28/2016	1:17:56 PM	292796.53	187199.2	41.146587	-72.892993
17	D	9/28/2016	1:18:41 PM	292795.82	187202.7	41.146618	-72.893001
CS-1-01	A	9/28/2016	12:13:18 PM	292067.49	187602.1	41.150203	-72.901685
CS-1-01	B	9/28/2016	12:14:22 PM	292071.81	187591.8	41.150111	-72.901634
CS-1-01	C	9/28/2016	12:15:15 PM	292068.46	187590.5	41.150099	-72.901674

CLDS 2016 ACTUAL SPI/PV STATION IDS/COORDINATES							
Station ID	**Replicate**	**Date**	**Time**	**X**	**Y**	**Latitude**	**Longitude**
CS-1-01	D	9/28/2016	12:16:06 PM	292057.96	187589.9	41.150093	-72.901799
CS-1-02	A	9/28/2016	12:22:35 PM	292053.35	187629.8	41.150452	-72.901854
CS-1-02	B	9/28/2016	12:23:28 PM	292034.54	187640.5	41.150548	-72.902079
CS-1-02	C	9/28/2016	12:24:16 PM	292025.34	187640.5	41.150548	-72.902188
CS-1-02	D	9/28/2016	12:25:40 PM	292038.76	187647.8	41.150614	-72.902029
CS-1-03	A	9/28/2016	12:17:55 PM	292061.78	187615.5	41.150323	-72.901754
CS-1-03	B	9/28/2016	12:19:09 PM	292068.84	187622	41.150382	-72.90167
CS-1-03	C	9/28/2016	12:20:12 PM	292070.19	187625.5	41.150414	-72.901654
CS-1-03	D	9/28/2016	12:21:09 PM	292070.69	187624.6	41.150406	-72.901648
CS-1-04	A	9/28/2016	12:27:07 PM	292025.26	187667.2	41.150789	-72.90219
CS-1-04	B	9/28/2016	12:28:12 PM	292031.72	187658.6	41.150711	-72.902113
CS-1-04	C	9/28/2016	12:28:55 PM	292020.04	187675.8	41.150866	-72.902252
CS-1-04	D	9/28/2016	12:29:49 PM	292022.48	187668.7	41.150802	-72.902223
CS-1-05	A	9/28/2016	12:34:03 PM	292075.92	187704.9	41.151129	-72.901587
CS-1-05	B	9/28/2016	12:34:51 PM	292070.31	187707.8	41.151155	-72.901654
CS-1-05	C	9/28/2016	12:35:40 PM	292069.92	187695.6	41.151045	-72.901658
CS-1-05	D	9/28/2016	12:36:29 PM	292066.16	187701.7	41.1511	-72.901703
CS-1-06	A	9/28/2016	12:37:43 PM	292104.84	187671.5	41.150828	-72.901242
CS-1-06	B	9/28/2016	12:38:30 PM	292096.88	187672.1	41.150834	-72.901337
CS-1-06	C	9/28/2016	12:39:17 PM	292104.1	187673	41.150843	-72.901251
CS-1-06	D	9/28/2016	12:40:43 PM	292107.32	187670.5	41.15082	-72.901212
CS-1-06	E	9/28/2016	12:41:30 PM	292102.49	187674.2	41.150853	-72.90127
CS-2-01	A	9/28/2016	11:33:10 AM	291954.72	188334.7	41.156798	-72.903044
CS-2-01	B	9/28/2016	11:34:12 AM	291964.71	188343.9	41.156881	-72.902925
CS-2-01	C	9/28/2016	11:35:09 AM	291969.1	188338.4	41.156832	-72.902873
CS-2-01	D	9/28/2016	11:36:00 AM	291967.75	188337.2	41.156821	-72.902889
CS-2-02	A	9/28/2016	11:05:33 AM	291995.04	188345.9	41.1569	-72.902564
CS-2-02	B	9/28/2016	11:06:57 AM	291984.87	188343.3	41.156876	-72.902685
CS-2-02	C	9/28/2016	11:08:06 AM	291988.21	188350.5	41.156941	-72.902646
CS-2-02	D	9/28/2016	11:08:58 AM	291984.77	188341.4	41.156859	-72.902686
CS-2-03	A	9/28/2016	11:40:29 AM	291949.68	188363.8	41.15706	-72.903105
CS-2-03	B	9/28/2016	11:41:23 AM	291947.14	188371.2	41.157126	-72.903135
CS-2-03	C	9/28/2016	11:42:37 AM	291955.44	188371.2	41.157127	-72.903036
CS-2-03	D	9/28/2016	11:43:30 AM	291949.55	188354.2	41.156974	-72.903106
CS-2-04	A	9/28/2016	11:46:24 AM	291996.17	188380.3	41.157209	-72.902551
CS-2-04	B	9/28/2016	11:47:34 AM	292006.48	188396.3	41.157354	-72.902429
CS-2-04	C	9/28/2016	11:48:23 AM	291999.69	188389.5	41.157293	-72.90251
CS-2-04	D	9/28/2016	11:49:13 AM	291990.85	188389.6	41.157293	-72.902615
CS-2-05	A	9/28/2016	11:51:00 AM	292007.73	188386.2	41.157263	-72.902414
CS-2-05	B	9/28/2016	11:52:15 AM	292017.13	188391.9	41.157314	-72.902302

CLDS 2016 ACTUAL SPI/PV STATION IDS/COORDINATES							
Station ID	**Replicate**	**Date**	**Time**	**X**	**Y**	**Latitude**	**Longitude**
CS-2-05	C	9/28/2016	11:53:29 AM	292031.32	188380.3	41.15721	-72.902133
CS-2-05	D	9/28/2016	11:54:17 AM	292015.12	188379	41.157198	-72.902326
CS-2-06	A	9/28/2016	11:56:52 AM	291973.13	188391.8	41.157313	-72.902826
CS-2-06	B	9/28/2016	11:57:39 AM	291965.96	188390.8	41.157304	-72.902911
CS-2-06	C	9/28/2016	11:58:30 AM	291963.31	188381.5	41.15722	-72.902943
CS-2-06	D	9/28/2016	11:59:05 AM	291956.66	188391.5	41.15731	-72.903022
CS-2-06	E	9/28/2016	12:00:02 PM	291962.95	188382.9	41.157232	-72.902947
CS-2-07	A	9/28/2016	12:03:57 PM	291978.09	188393.3	41.157326	-72.902767
CS-2-07	B	9/28/2016	12:04:46 PM	291976.5	188395.7	41.157347	-72.902786
CS-2-07	C	9/28/2016	12:05:50 PM	291980.84	188397.1	41.15736	-72.902734
CS-2-07	D	9/28/2016	12:06:35 PM	291970.73	188394.6	41.157338	-72.902855
MQR-01	A	9/28/2016	1:50:57 PM	292469.31	186814	41.143113	-72.896883
MQR-01	B	9/28/2016	1:52:19 PM	292475.28	186806	41.143041	-72.896811
MQR-01	C	9/28/2016	1:53:08 PM	292474.28	186812.3	41.143098	-72.896823
MQR-01	D	9/28/2016	1:53:55 PM	292474.74	186805.8	41.143039	-72.896818
MQR-02	A	9/28/2016	1:45:21 PM	292506.46	186804.7	41.14303	-72.89644
MQR-02	B	9/28/2016	1:46:38 PM	292510.68	186801.8	41.143004	-72.89639
MQR-02	C	9/28/2016	1:47:27 PM	292512.78	186792.8	41.142923	-72.896364
MQR-02	D	9/28/2016	1:48:25 PM	292505.75	186798.4	41.142973	-72.896448
MQR-03	A	9/28/2016	2:05:06 PM	292429.67	186849.8	41.143435	-72.897356
MQR-03	B	9/28/2016	2:05:51 PM	292436.24	186849.9	41.143436	-72.897277
MQR-03	C	9/28/2016	2:06:41 PM	292433.34	186848.5	41.143423	-72.897312
MQR-03	D	9/28/2016	2:07:24 PM	292431.92	186853.7	41.14347	-72.897329
MQR-04	A	9/28/2016	1:55:49 PM	292457.83	186858.6	41.143515	-72.89702
MQR-04	B	9/28/2016	1:56:41 PM	292456.33	186863.5	41.143559	-72.897038
MQR-04	C	9/28/2016	1:57:33 PM	292462.81	186851.7	41.143452	-72.896961
MQR-04	C	9/28/2016	1:58:32 PM	292461.73	186861.5	41.143541	-72.896974
MQR-04	D	9/28/2016	1:58:52 PM	292461.68	186864.9	41.143571	-72.896975
MQR-05	A	9/28/2016	1:41:25 PM	292535.63	186858.9	41.143519	-72.896094
MQR-05	B	9/28/2016	1:42:14 PM	292538.46	186864	41.143565	-72.89606
MQR-05	C	9/28/2016	1:42:57 PM	292538.29	186866.2	41.143585	-72.896062
MQR-05	D	9/28/2016	1:43:42 PM	292536.18	186867	41.143591	-72.896087
MQR-06	A	9/28/2016	2:00:37 PM	292467.69	186910.8	41.143985	-72.896904
MQR-06	B	9/28/2016	2:01:29 PM	292473.94	186909.1	41.14397	-72.896829
MQR-06	C	9/28/2016	2:02:33 PM	292466.12	186925.3	41.144116	-72.896923
MQR-06	D	9/28/2016	2:03:18 PM	292472.7	186917.7	41.144047	-72.896844
MQR-07	A	9/28/2016	1:35:22 PM	292551.9	186908.2	41.143963	-72.895901
MQR-07	B	9/28/2016	1:36:31 PM	292558.55	186909.9	41.143978	-72.895822
MQR-07	C	9/28/2016	1:37:19 PM	292552.01	186899.9	41.143888	-72.895899
MQR-07	D	9/28/2016	1:38:09 PM	292548.92	186895	41.143844	-72.895936

CLDS 2016 ACTUAL SPI/PV STATION IDS/COORDINATES							
Station ID	**Replicate**	**Date**	**Time**	**X**	**Y**	**Latitude**	**Longitude**
FVP-01	A	10/2/2016	8:25:08 AM	295453.88	188259	41.156165	-72.861355
FVP-01	B	10/2/2016	8:26:02 AM	295458.5	188259.8	41.156172	-72.8613
FVP-01	C	10/2/2016	8:26:43 AM	295461.16	188264.9	41.156218	-72.861268
FVP-01	D	10/2/2016	8:27:26 AM	295456.42	188256.8	41.156144	-72.861324
FVP-02	A	10/2/2016	8:06:19 AM	295481.1	188254.2	41.156121	-72.86103
FVP-02	B	10/2/2016	8:07:04 AM	295488.87	188248.3	41.156069	-72.860938
FVP-02	C	10/2/2016	8:07:57 AM	295478.48	188241.7	41.156009	-72.861061
FVP-02	D	10/2/2016	8:08:51 AM	295482.14	188248.1	41.156067	-72.861018
FVP-03	A	10/2/2016	8:30:39 AM	295441.78	188289.9	41.156443	-72.861499
FVP-03	B	10/2/2016	8:31:51 AM	295448.39	188302.1	41.156553	-72.861421
FVP-03	C	10/2/2016	8:32:41 AM	295451.8	188291.1	41.156454	-72.86138
FVP-03	D	10/2/2016	8:33:29 AM	295449.8	188295.1	41.156489	-72.861404
FVP-04	A	10/2/2016	8:41:53 AM	295484.21	188305.5	41.156584	-72.860994
FVP-04	B	10/2/2016	8:43:15 AM	295497.2	188309.6	41.156621	-72.860839
FVP-04	C	10/2/2016	8:44:19 AM	295489.58	188315.8	41.156676	-72.86093
FVP-04	D	10/2/2016	8:45:13 AM	295497.07	188309.8	41.156623	-72.860841
FVP-05	A	10/2/2016	8:47:05 AM	295516.16	188299.5	41.15653	-72.860613
FVP-05	B	10/2/2016	8:47:46 AM	295512.89	188297.3	41.156511	-72.860652
FVP-05	C	10/2/2016	8:48:33 AM	295509.74	188295	41.156489	-72.86069
FVP-05	D	10/2/2016	8:49:23 AM	295511.24	188296.8	41.156506	-72.860672
FVP-06	A	10/2/2016	8:36:46 AM	295482.34	188297.1	41.156508	-72.861016
FVP-06	B	10/2/2016	8:37:37 AM	295481.87	188305	41.156579	-72.861022
FVP-06	C	10/2/2016	8:38:26 AM	295488.18	188299.1	41.156526	-72.860947
FVP-06	D	10/2/2016	8:39:07 AM	295474.52	188297.1	41.156508	-72.861109
FVP-07	A	10/2/2016	8:52:59 AM	295539.4	188317.7	41.156695	-72.860337
FVP-07	B	10/2/2016	8:53:50 AM	295543.04	188304.3	41.156573	-72.860293
FVP-07	C	10/2/2016	8:54:53 AM	295540.9	188319.1	41.156707	-72.860319
FVP-07	D	10/2/2016	8:55:37 AM	295539.64	188307	41.156598	-72.860334
CLIS-REF-01	A	10/2/2016	11:06:26 AM	297560.01	185705.5	41.133194	-72.836232
CLIS-REF-01	B	10/2/2016	11:07:14 AM	297555.2	185714.5	41.133275	-72.83629
CLIS-REF-01	C	10/2/2016	11:07:56 AM	297549.89	185708.5	41.133221	-72.836353
CLIS-REF-01	D	10/2/2016	11:08:36 AM	297548.84	185705.8	41.133197	-72.836365
CLIS-REF-02	A	10/2/2016	10:59:58 AM	297779.55	185706.8	41.133208	-72.833618
CLIS-REF-02	B	10/2/2016	11:00:55 AM	297785.15	185707.6	41.133215	-72.833551
CLIS-REF-02	C	10/2/2016	11:01:43 AM	297788.38	185710	41.133237	-72.833513
CLIS-REF-02	D	10/2/2016	11:02:31 AM	297786.13	185708.2	41.13322	-72.833539
CLIS-REF-03	A	10/2/2016	10:43:49 AM	297660.66	185949.7	41.135393	-72.835036
CLIS-REF-03	B	10/2/2016	10:44:46 AM	297668.61	185952.9	41.135423	-72.834942
CLIS-REF-03	C	10/2/2016	10:45:40 AM	297669.07	185957.5	41.135464	-72.834936
CLIS-REF-03	D	10/2/2016	10:46:33 AM	297669.9	185955.9	41.135449	-72.834927

CLDS 2016 ACTUAL SPI/PV STATION IDS/COORDINATES							
Station ID	**Replicate**	**Date**	**Time**	**X**	**Y**	**Latitude**	**Longitude**
CLIS-REF-04	A	10/2/2016	10:52:30 AM	297903.67	185949.3	41.135392	-72.832142
CLIS-REF-04	B	10/2/2016	10:53:14 AM	297900.08	185949.3	41.135392	-72.832185
CLIS-REF-04	C	10/2/2016	10:53:57 AM	297899.49	185950.7	41.135405	-72.832192
CLIS-REF-04	D	10/2/2016	10:54:42 AM	297893.66	185945.8	41.13536	-72.832261
CLIS-REF-05	A	10/2/2016	10:36:08 AM	297549.59	186077.5	41.136543	-72.836361
CLIS-REF-05	B	10/2/2016	10:36:54 AM	297546.73	186070.3	41.136478	-72.836395
CLIS-REF-05	C	10/2/2016	10:37:48 AM	297550.56	186070.6	41.136481	-72.836349
CLIS-REF-05	D	10/2/2016	10:38:41 AM	297544.66	186067.8	41.136456	-72.836419
4500E-01	A	10/2/2016	9:38:52 AM	296977.56	187952	41.153417	-72.843198
4500E-01	B	10/2/2016	9:39:37 AM	296981.54	187962.6	41.153512	-72.843151
4500E-01	C	10/2/2016	9:40:24 AM	296978.29	187969.5	41.153574	-72.843189
4500E-01	D	10/2/2016	9:41:19 AM	296978.28	187972.7	41.153603	-72.84319
4500E-02	A	10/2/2016	9:32:28 AM	297227.19	187960.1	41.153492	-72.840224
4500E-02	B	10/2/2016	9:33:09 AM	297216.89	187960.7	41.153497	-72.840347
4500E-02	C	10/2/2016	9:34:09 AM	297217.01	187967.6	41.153559	-72.840345
4500E-02	D	10/2/2016	9:35:03 AM	297217.37	187971.1	41.15359	-72.840341
4500E-03	A	10/2/2016	9:11:30 AM	297098.06	188199.7	41.155648	-72.841765
4500E-03	B	10/2/2016	9:12:22 AM	297092.94	188195.7	41.155612	-72.841826
4500E-03	C	10/2/2016	9:13:06 AM	297088.78	188192.1	41.15558	-72.841876
4500E-03	D	10/2/2016	9:13:50 AM	297092.34	188198.3	41.155635	-72.841834
4500E-04	A	10/2/2016	9:27:21 AM	297328.61	188015.1	41.153988	-72.839017
4500E-04	B	10/2/2016	9:28:06 AM	297329.81	188009.2	41.153935	-72.839002
4500E-04	C	10/2/2016	9:28:50 AM	297327.76	188016.6	41.154001	-72.839027
4500E-04	D	10/2/2016	9:29:38 AM	297330.78	188010.5	41.153947	-72.838991
4500E-05	A	10/2/2016	9:19:54 AM	297218.58	188238.8	41.156001	-72.84033
4500E-05	B	10/2/2016	9:20:56 AM	297213.91	188249	41.156093	-72.840386
4500E-05	C	10/2/2016	9:21:44 AM	297209.15	188240.3	41.156015	-72.840442
4500E-05	D	10/2/2016	9:22:31 AM	297206.84	188241	41.156021	-72.84047
2500W-01	A	10/2/2016	11:51:12 AM	289904.3	187866.1	41.152543	-72.927461
2500W-01	B	10/2/2016	11:52:02 AM	289909.77	187867.6	41.152557	-72.927396
2500W-01	C	10/2/2016	11:52:50 AM	289901.06	187866.1	41.152543	-72.9275
2500W-01	D	10/2/2016	11:53:35 AM	289909.58	187868.8	41.152568	-72.927398
2500W-02	A	10/2/2016	11:46:48 AM	289968.71	187869.1	41.152571	-72.926694
2500W-02	B	10/2/2016	11:47:35 AM	289971.89	187874.1	41.152616	-72.926656
2500W-02	C	10/2/2016	11:48:16 AM	289972.56	187876.2	41.152635	-72.926648
2500W-02	D	10/2/2016	11:49:09 AM	289966.66	187870.1	41.152581	-72.926718
2500W-03	A	10/2/2016	12:05:53 PM	289858.54	188099.3	41.154643	-72.928012
2500W-03	B	10/2/2016	12:06:36 PM	289858.87	188097.4	41.154625	-72.928008
2500W-03	C	10/2/2016	12:07:14 PM	289862.9	188094.5	41.154599	-72.92796
2500W-03	D	10/2/2016	12:07:55 PM	289855.56	188094	41.154595	-72.928047

CLDS 2016 ACTUAL SPI/PV STATION IDS/COORDINATES							
Station ID	**Replicate**	**Date**	**Time**	**X**	**Y**	**Latitude**	**Longitude**
2500W-04	A	10/2/2016	12:00:15 PM	290094.9	188104.2	41.154691	-72.925196
2500W-04	B	10/2/2016	12:01:04 PM	290098.4	188106.4	41.154711	-72.925155
2500W-04	C	10/2/2016	12:01:44 PM	290091.71	188099.7	41.15465	-72.925234
2500W-04	D	10/2/2016	12:02:30 PM	290097.69	188102.9	41.154679	-72.925163
2500W-05	A	10/2/2016	12:12:30 PM	289961.23	188342.5	41.156834	-72.926794
2500W-05	B	10/2/2016	12:13:16 PM	289958.26	188350.7	41.156908	-72.92683
2500W-05	C	10/2/2016	12:14:32 PM	289983.08	188347.1	41.156876	-72.926534
2500W-05	D	10/2/2016	12:15:13 PM	289973.21	188348	41.156884	-72.926652

Notes
1. Grid coordinates are NAD_1983_StatePlane_Connecticut_FIPS_0600_Meters
2. Geographic coordinates are NAD83 decimal degrees

CLDS 2016 ACTUAL GRAB STATION IDS/COORDINATES FOR SEDIMENT CHEMISTRY ANALYSIS						
Sample ID	**Date**	**Time**	**X**	**Y**	**Latitude**	**Longitude**
Sed-CLDS-01	10/3/2016	12:00:10	293501.6	186708.9	41.14218	-72.8846
Sed-CLDS-02	10/3/2016	13:01:32	293372.3	186911.2	41.144	-72.8861
Sed-CLDS-03	10/3/2016	13:09:13	293390.8	187164.4	41.14628	-72.8859
Sed-CLDS-04	10/3/2016	13:17:07	293585.7	187152	41.14617	-72.8836
Sed-CLDS-05	10/3/2016	13:25:07	293309.7	187379.3	41.14822	-72.8869
Sed-CLDS-06	10/3/2016	13:31:50	293587.7	187500	41.14931	-72.8836
Sed-CLDS-07	10/3/2016	13:45:51	293254.3	187633.2	41.1505	-72.8875
Sed-CLDS-08	10/3/2016	13:39:29	293452.3	187660.3	41.15075	-72.8852
Sed-CLDS-09	10/3/2016	13:56:31	293893.2	187778.6	41.15182	-72.8799
Sed-CLDS-10	10/3/2016	14:10:38	294097.7	187653.7	41.1507	-72.8775
Sed-CLDS-11	10/3/2016	14:17:43	294408.4	188028.2	41.15407	-72.8738
Sed-CLDS-12	10/3/2016	14:25:55	294503.3	188100.7	41.15473	-72.8727
Sed-CLDS-13	10/3/2016	10:32:35	292637.6	187052.5	41.14526	-72.8949
Sed-CLDS-14	10/3/2016	10:47:51	292798.4	186977.6	41.14459	-72.893
Sed-CLDS-15	10/3/2016	10:08:45	292412.1	187130.8	41.14597	-72.8976
Sed-CLDS-16	10/3/2016	10:15:00	292570.7	187154	41.14618	-72.8957
Sed-CLDS-17	10/3/2016	10:24:27	292773.6	187208.5	41.14667	-72.8933
Sed-CS-1-01	10/3/2016	9:57:27	292065	187596	41.15015	-72.9017
Sed-CS-1-02	10/3/2016	9:42:40	292035	187640.4	41.15055	-72.9021
Sed-CS-1-03	10/3/2016	9:49:40	292047.2	187619.4	41.15036	-72.9019
Sed-CS-1-04	10/3/2016	9:28:59	292019.4	187655.5	41.15068	-72.9023
Sed-CS-1-05	10/3/2016	9:13:18	292068.9	187693.6	41.15103	-72.9017
Sed-CS-1-06	10/3/2016	9:20:43	292100.3	187658.6	41.15071	-72.9013
Sed-CS-1-07	10/3/2016	9:05:43	292074.7	187704.8	41.15113	-72.9016
Sed-CS-2-01	10/3/2016	8:19:45	291958	188348.7	41.15692	-72.903
Sed-CS-2-02	10/3/2016	8:11:09	291997.6	188336.4	41.15681	-72.9025
Sed-CS-2-03	10/3/2016	8:27:14	291966	188354.6	41.15698	-72.9029
Sed-CS-2-04	10/3/2016	8:51:00	292014.5	188373.9	41.15715	-72.9023

CLDS 2016 ACTUAL GRAB STATION IDS/COORDINATES FOR SEDIMENT CHEMISTRY ANALYSIS						
Sample ID	Date	Time	X	Y	Latitude	Longitude
Sed-CS-2-05	10/3/2016	8:58:45	292026.5	188367.2	41.15709	-72.9022
Sed-CS-2-06	10/3/2016	8:34:49	291950.9	188376.4	41.15717	-72.9031
Sed-CS-2-07	10/3/2016	8:43:03	291993.5	188389.6	41.15729	-72.9026
Sed-MQR-01	10/3/2016	11:33:24	292457.5	186820.9	41.14318	-72.897
Sed-MQR-02	10/3/2016	11:41:17	292489.8	186798.9	41.14298	-72.8966
Sed-MQR-03	10/3/2016	11:25:16	292418.9	186847.3	41.14341	-72.8975
Sed-MQR-04	10/3/2016	11:12:45	292430.8	186854.4	41.14348	-72.8973
Sed-MQR-05	10/3/2016	11:49:26	292541.8	186857.4	41.14351	-72.896
Sed-MQR-06	10/3/2016	11:03:38	292455.2	186916.5	41.14404	-72.8971
Sed-MQR-17	10/3/2016	10:56:48	292540.5	186913.1	41.14401	-72.896
Sed-FVP-01	10/3/2016	14:49:31	295460.9	188275.3	41.15631	-72.8613
Sed-FVP-02	10/3/2016	14:56:48	295485.8	188263	41.1562	-72.861
Sed-FVP-03	10/3/2016	15:04:46	295450.9	188302	41.15655	-72.8614
Sed-FVP-07	10/3/2016	15:12:01	295558.7	188324.7	41.15676	-72.8601
Sed-FVP-06	10/3/2016	15:23:52	295482.3	188322.7	41.15674	-72.861
Sed-FVP-04	10/3/2016	15:34:02	295489.7	188299.8	41.15653	-72.8609
Sed-FVP-05	10/3/2016	15:40:28	295519.3	188308.7	41.15661	-72.8606
Sed-CLIS-REF-01	10/6/2016	10:24:33	297544.8	185715.8	41.13329	-72.8364
Sed-CLIS-REF-02	10/6/2016	10:15:19	297785.7	185712.3	41.13326	-72.8335
Sed-CLIS-REF-03	10/6/2016	9:52:07	297661.8	185940.6	41.13531	-72.835
Sed-CLIS-REF-04	10/6/2016	10:05:29	297906.2	185928.8	41.13521	-72.8321
Sed-CLIS-REF-05	10/6/2016	9:40:44	297556.6	186075.3	41.13652	-72.8363
Sed-4500E-01	10/3/2016	15:52:03	296997.8	187972.1	41.1536	-72.843
Sed-4500E-02	10/3/2016	16:00:06	297236.8	187956.1	41.15346	-72.8401
Sed-4500E-03	10/3/2016	16:08:53	297353.2	188017.9	41.15401	-72.8387
Sed-4500E-04	10/3/2016	16:17:33	297120.7	188197	41.15562	-72.8415
Sed-4500E-05	10/3/2016	16:25:37	297226.5	188260.3	41.1562	-72.8402
Sed-2500W-01	10/6/2016	8:53:44	289906.1	187858.6	41.15248	-72.9274
Sed-2500W-02	10/6/2016	9:02:34	289991.2	187858.4	41.15248	-72.9264
Sed-2500W-03	10/6/2016	8:44:56	289846	188101.7	41.15466	-72.9282
Sed-2500W-04	10/6/2016	8:35:16	290100	188104.1	41.15469	-72.9251
Sed-2500W-05	10/6/2016	8:23:51	289987	188330.8	41.15673	-72.9265

Notes

1. Grid coordinates are NAD_1983_StatePlane_Connecticut_FIPS_0600_Meters
2. Geographic coordinates are NAD83 decimal degrees

CLDS 2016 ACTUAL GRAB STATION IDS/COORDINATES FOR BENTHIC COMMUNITY STRUCTURE ANALYSIS (BCA)						
Sample ID	Date	Time	X	Y	Latitude	Longitude
BCA-CLDS-02	10/6/2016	13:25:15	293360.2	186896.1	41.14387	-72.8863
BCA-CLDS-05	10/6/2016	13:01:13	293301.1	187350.4	41.14796	-72.887
BCA-CLDS-07	10/6/2016	12:54:03	293233.3	187648.5	41.15064	-72.8878
BCA-CLDS-10	10/6/2016	12:46:33	294087.1	187641.6	41.15059	-72.8776

BCA-CLDS-13	10/6/2016	13:43:46	292630.7	187054.4	41.14528	-72.895
BCA-CLDS-14	10/6/2016	13:33:52	292803	186989.4	41.1447	-72.8929
BCA-CS-1-01	10/6/2016	13:51:47	292055.3	187598.7	41.15017	-72.9018
BCA-CS-1-05	10/6/2016	14:00:20	292064.8	187695.3	41.15104	-72.9017
BCA-CS-1-07	10/6/2016	14:08:31	292081.3	187701.6	41.1511	-72.9015
BCA-FVP-02	10/6/2016	12:17:27	295482.3	188248.3	41.15607	-72.861
BCA-FVP-05	10/6/2016	12:30:42	295507.9	188281	41.15636	-72.8607
BCA-FVP-06	10/6/2016	12:24:11	295487.9	188309.7	41.15662	-72.861
BCA-4500E- 01	10/6/2016	11:02:00	296977.8	187967.7	41.15356	-72.8432
BCA-4500E- 02	10/6/2016	11:12:40	297219.2	187943.8	41.15335	-72.8403
BCA-4500E- 03	10/6/2016	11:19:19	297102.5	188183	41.1555	-72.8417
BCA-4500E- 05	10/6/2016	11:28:34	297217.1	188243.7	41.15605	-72.8403

Notes
1. Grid coordinates are NAD_1983_StatePlane_Connecticut_FIPS_0600_Meters
2. Geographic coordinates are NAD83 decimal degrees

CLDS 2016 ACTUAL TRAWL STATION IDS/COORDINATES FOR TISSUE CHEMISTRY ANALYSIS						
Sample ID	**Date**	**Time**	**X**	**Y**	**Latitude**	**Longitude**
Tis-CLDS-02a-sol	10/12/2016	11:16:58	293488.5	186906.7	41.14396	-72.8847
Tis-CLDS-02a-eol	10/12/2016	11:18:59	293380	186879.2	41.14371	-72.886
Tis-CLDS-02b-sol	10/12/2016	11:41:16	293512.4	186933.9	41.14421	-72.8845
Tis-CLDS-02b-eol	10/12/2016	11:43:19	293443.6	186903.2	41.14393	-72.8853
Tis-CLDS-02c-sol	10/12/2016	12:08:36	293540.8	186939.9	41.14426	-72.8841
Tis-CLDS-02c-eol	10/12/2016	12:10:39	293408.3	186894	41.14385	-72.8857
Tis-CLDS-05a-sol	10/4/2016	15:12:44	293340.8	187346.5	41.14792	-72.8865
Tis-CLDS-05a-eol	10/4/2016	15:14:50	293209.3	187315.3	41.14764	-72.8881
Tis-CLDS-05b-sol	10/4/2016	15:32:46	293476.5	187457.5	41.14892	-72.8849
Tis-CLDS-05b-eol	10/4/2016	15:34:53	293405.7	187410.2	41.1485	-72.8857
Tis-CLDS-05b-sol	10/4/2016	16:03:48	293246.7	187450.3	41.14885	-72.8876
Tis-CLDS-05c-eol	10/4/2016	16:05:53	293181	187412.3	41.14851	-72.8884
Tis-CLDS-05c-sol	10/4/2016	16:22:53	293269.3	187461.2	41.14895	-72.8874
Tis-CLDS-05d-eol	10/4/2016	16:24:59	293164.5	187414.7	41.14853	-72.8886
Tis-CLDS-05e-sol	10/5/2016	8:37:48	293232.8	187441.7	41.14878	-72.8878
Tis-CLDS-05e-eol	10/5/2016	8:39:50	293084.4	187360.8	41.14805	-72.8896
Tis-CLDS-05f-sol	10/5/2016	8:56:18	293209.1	187408	41.14847	-72.8881
Tis-CLDS-05f-eol	10/5/2016	8:58:23	293084.5	187360.3	41.14804	-72.8896
Tis-CLDS-05g-sol	10/5/2016	9:29:18	293194.6	187422.8	41.14861	-72.8883
Tis-CLDS-05g-eol	10/5/2016	9:31:23	293035	187355.4	41.148	-72.8902

CLDS 2016 ACTUAL TRAWL STATION IDS/COORDINATES FOR TISSUE CHEMISTRY ANALYSIS						
Sample ID	**Date**	**Time**	**X**	**Y**	**Latitude**	**Longitude**
Tis-CLDS-07a-sol	10/4/2016	12:27:40	293316.1	187631.6	41.15049	-72.8868
Tis-CLDS-07a-eol	10/4/2016	12:29:48	293109.9	187620.7	41.15039	-72.8893
Tis-CLDS-07b-sol	10/4/2016	12:50:11	293245.8	187648.5	41.15064	-72.8877
Tis-CLDS-07b-eol	10/4/2016	12:52:14	293084.9	187617.5	41.15036	-72.8896
Tis-CLDS-07c-sol	10/4/2016	13:08:02	293250	187642.7	41.15059	-72.8876
Tis-CLDS-07c-eol	10/4/2016	13:10:06	293060.6	187611.1	41.1503	-72.8899
Tis-CLDS-07d-sol	10/4/2016	13:34:48	293208.9	187642.6	41.15059	-72.8881
Tis-CLDS-07d-eol	10/4/2016	13:36:56	293064.2	187610	41.15029	-72.8898
Tis-CLDS-07e-sol	10/4/2016	14:09:57	293266.4	187658.5	41.15073	-72.8874
Tis-CLDS-07e-eol	10/4/2016	14:12:08	293109.6	187624.3	41.15042	-72.8893
Tis-CLDS-07f-sol	10/4/2016	14:39:55	293190.3	187652.8	41.15068	-72.8883
Tis-CLDS-07f-eol	10/4/2016	14:42:07	293034	187594.8	41.15015	-72.8902
Tis-CLDS-10a-sol	10/12/2016	9:53:33	294159.1	187643.4	41.15061	-72.8768
Tis-CLDS-10a-eol	10/12/2016	9:55:38	294062	187638.9	41.15056	-72.8779
Tis-CLDS-10b-sol	10/12/2016	10:15:16	294194.9	187630	41.15049	-72.8763
Tis-CLDS-10b-eol	10/12/2016	10:17:17	294103.4	187628.6	41.15047	-72.8774
Tis-CLDS-10c-sol	10/12/2016	10:37:28	294264.3	187657.6	41.15073	-72.8755
Tis-CLDS-10c-eol	10/12/2016	10:39:33	294188	187652.9	41.15069	-72.8764
Tis-CLDS-13a-sol	10/6/2016	14:24:29	292620.8	187047.3	41.14522	-72.8951
Tis-CLDS-13a-eol	10/6/2016	14:26:35	292466.9	187052.3	41.14526	-72.8969
Tis-CLDS-13b-sol	10/6/2016	14:45:33	292557.9	187065	41.14538	-72.8958
Tis-CLDS-13b-eol	10/6/2016	14:47:33	292684	187072.4	41.14544	-72.8943
Tis-CLDS-13c-sol	10/6/2016	15:10:38	292616.9	187061.1	41.14534	-72.8951
Tis-CLDS-13c-eol	10/6/2016	15:12:41	292476.6	187063.8	41.14536	-72.8968
Tis-CLDS-13d-sol	10/6/2016	15:30:13	292649.6	187071.6	41.14544	-72.8947
Tis-CLDS-13d-eol	10/6/2016	15:32:15	292820.1	187083.4	41.14554	-72.8927
Tis-CLDS-14a-sol	10/7/2016	8:25:32	292865.3	187016	41.14494	-72.8922
Tis-CLDS-14a-eol	10/7/2016	8:27:35	292892.2	187068.1	41.14541	-72.8919
Tis-CLDS-14b-sol	10/7/2016	8:40:29	292910.9	187058.5	41.14532	-72.8916
Tis-CLDS-14b-eol	10/7/2016	8:42:41	292934.4	187187.3	41.14648	-72.8914
Tis-CLDS-14c-sol	10/7/2016	9:10:08	292790.3	186926.3	41.14413	-72.8931
Tis-CLDS-14c-eol	10/7/2016	9:12:11	292821.2	187058	41.14532	-72.8927
Tis-CLDS-14d-sol	10/7/2016	9:29:50	292824.6	186954.9	41.14439	-72.8927
Tis-CLDS-14d-eol	10/7/2016	9:31:54	292843.5	187091.2	41.14562	-72.8924
Tis-CLDS-14e-sol	10/7/2016	9:48:35	292805	186855.6	41.14349	-72.8929
Tis-CLDS-14e-eol	10/7/2016	9:50:39	292807.3	186977.3	41.14459	-72.8929
Tis-CLDS-14f-sol	10/7/2016	10:07:26	292823.1	186868.9	41.14361	-72.8927
Tis-CLDS-14f-eol	10/7/2016	10:09:32	292859.4	186993.6	41.14474	-72.8922

CLDS 2016 ACTUAL TRAWL STATION IDS/COORDINATES FOR TISSUE CHEMISTRY ANALYSIS						
Sample ID	**Date**	**Time**	**X**	**Y**	**Latitude**	**Longitude**
Tis-CLDS-14g-sol	10/7/2016	10:32:11	292783.2	187016.6	41.14494	-72.8931
Tis-CLDS-14g-eol	10/7/2016	10:34:16	292814.6	187149.9	41.14614	-72.8928
Tis-CS-1-01a-sol	10/5/2016	9:48:23	292309.1	187545.2	41.1497	-72.8988
Tis-CS-1-01a-eol	10/5/2016	9:50:25	292120.5	187545.5	41.1497	-72.9011
Tis-CS-1-01b-sol	10/5/2016	10:12:41	292064.6	187549.6	41.14973	-72.9017
Tis-CS-1-01b-eol	10/5/2016	10:14:46	291885.9	187529.2	41.14954	-72.9038
Tis-CS-1-01c-sol	10/5/2016	10:34:44	292124.3	187541.8	41.14966	-72.901
Tis-CS-1-01c-eol	10/5/2016	10:36:44	291961.1	187526.8	41.14952	-72.903
Tis-CS-1-01d-sol	10/5/2016	10:52:44	292317.1	187543.9	41.14968	-72.8987
Tis-CS-1-01d-eol	10/5/2016	10:54:54	292143.1	187527.7	41.14953	-72.9008
Tis-CS-1-01e-sol	10/5/2016	11:09:25	292244.3	187535.9	41.14961	-72.8996
Tis-CS-1-01e-eol	10/5/2016	11:11:31	292075	187524.2	41.1495	-72.9016
Tis-CS-1-01-f-sol	10/5/2016	11:30:45	292199.2	187506.4	41.14934	-72.9001
Tis-CS-1-01f-eol	10/5/2016	11:32:44	292060.1	187494.6	41.14924	-72.9018
Tis-CS-1-01g-sol	10/5/2016	12:33:20	292236.9	187533.7	41.14959	-72.8997
Tis-CS-1-01g-eol	10/5/2016	12:35:23	292071.4	187521.7	41.14948	-72.9016
Tis-CS-1-01h-sol	10/5/2016	12:57:56	292216	187509.8	41.14938	-72.8999
Tis-CS-1-01h-eol	10/5/2016	12:59:57	292037.7	187504.9	41.14933	-72.902
Tis-CS-1-01I-sol	10/5/2016	13:14:43	292321.8	187548	41.14972	-72.8987
Tis-CS-1-01i-eol	10/5/2016	13:16:45	292124.6	187507.6	41.14935	-72.901
Tis-CS-1-01j-sol	10/5/2016	13:28:29	292069	187484.5	41.14914	-72.9017
Tis-CS-1-01j-eol	10/5/2016	13:30:32	291873.4	187487.2	41.14917	-72.904
Tis-CS-1-01k-sol	10/5/2016	13:48:00	292211.3	187476.7	41.14908	-72.9
Tis-CS-1-01k-eol	10/5/2016	13:50:04	292059.8	187488.7	41.14918	-72.9018
Tis-CS-1-01l-sol	10/5/2016	14:11:30	292198	187469.9	41.14902	-72.9001
Tis-CS-1-01l-eol	10/5/2016	14:13:32	292070.2	187475.7	41.14907	-72.9017
Tis-CS-1-05a-sol	10/5/2016	14:33:51	292149.2	187656.3	41.15069	-72.9007
Tis-CS-1-05a-eol	10/5/2016	14:35:54	292016.6	187666.7	41.15078	-72.9023
Tis-CS-1-05b-sol	10/5/2016	15:12:47	292097.5	187664.4	41.15077	-72.9013
Tis-CS-1-05b-eol	10/5/2016	15:14:48	291969.6	187655.9	41.15069	-72.9029
Tis-CS-1-05c-sol	10/5/2016	15:34:24	292187.6	187671.7	41.15083	-72.9003
Tis-CS-1-05c-eol	10/5/2016	15:36:25	292073.1	187645.8	41.1506	-72.9016
Tis-CS-1-05d-sol	10/5/2016	15:51:48	292149.4	187660.8	41.15073	-72.9007
Tis-CS-1-05d-eol	10/5/2016	15:53:50	292035.7	187667.1	41.15079	-72.9021
Tis-CS-1-05e-sol	10/5/2016	16:15:34	292115.8	187647	41.15061	-72.9011
Tis-CS-1-05e-eol	10/5/2016	16:17:39	291991.9	187657.9	41.15071	-72.9026
Tis-CS-1-07a-sol	10/4/2016	8:55:38	292259.8	187750.1	41.15154	-72.8994
Tis-CS-1-07a-eol	10/4/2016	8:57:44	292098.7	187697.5	41.15106	-72.9013

CLDS 2016 ACTUAL TRAWL STATION IDS/COORDINATES FOR TISSUE CHEMISTRY ANALYSIS

Sample ID	Date	Time	X	Y	Latitude	Longitude
Tis-CS-1-07b-sol	10/4/2016	9:11:00	292276.9	187673	41.15085	-72.8992
Tis-CS-1-07b-eol	10/4/2016	9:13:07	292145	187648	41.15062	-72.9008
Tis-CS-1-07c-sol	10/4/2016	9:36:18	292588.5	187621.2	41.15038	-72.8955
Tis-CS-1-07c-eol	10/4/2016	9:38:31	292414	187604.3	41.15023	-72.8976
Tis-CS-1-07d-sol	10/4/2016	9:58:40	292323.8	187804.8	41.15203	-72.8986
Tis-CS-1-07d-eol	10/4/2016	10:00:47	292149.6	187732.7	41.15138	-72.9007
Tis-CS-1-07e-sol	10/4/2016	10:27:58	292288	187844.1	41.15239	-72.8991
Tis-CS-1-07e-eol	10/4/2016	10:30:04	292124.7	187729.7	41.15135	-72.901
Tis-CS-1-07f-sol	10/4/2016	10:49:13	292155.1	187732.1	41.15138	-72.9006
Tis-CS-1-07f-eol	10/4/2016	10:51:17	292015.4	187657.6	41.1507	-72.9023
Tis-CS-1-07g-sol	10/4/2016	11:13:20	292284.4	187783.1	41.15184	-72.8991
Tis-CS-1-07g-eol	10/4/2016	11:15:25	292109.4	187740	41.15145	-72.9012
Tis-FVP-02a-sol	10/7/2016	11:03:05	295450.5	188201.1	41.15564	-72.8614
Tis-FVP-02a-eol	10/7/2016	11:05:07	295413	188060.3	41.15438	-72.8618
Tis-FVP-02b-sol	10/7/2016	11:25:53	295434.4	188211.4	41.15574	-72.8616
Tis-FVP-02b-eol	10/7/2016	11:27:55	295507.8	188343.3	41.15692	-72.8607
Tis-FVP-02c-sol	10/7/2016	11:48:54	295267.8	187901.9	41.15295	-72.8636
Tis-FVP-02c-eol	10/7/2016	11:51:05	295393.3	188054.7	41.15432	-72.8621
Tis-FVP-02d-sol	10/7/2016	12:36:17	295399.3	188078.4	41.15454	-72.862
Tis-FVP-02d-eol	10/7/2016	12:38:24	295469.3	188226.8	41.15588	-72.8612
Tis-FVP-02e-sol	10/7/2016	12:54:38	295336.4	188126.7	41.15497	-72.8628
Tis-FVP-02e-eol	10/7/2016	12:56:42	295396.3	188250.6	41.15609	-72.862
Tis-FVP-02f-sol	10/7/2016	13:18:17	295289.1	188145	41.15514	-72.8633
Tis-FVP-02f-eol	10/7/2016	13:20:21	295383	188244.2	41.15603	-72.8622
Tis-FVP-05a-sol	10/7/2016	13:40:26	295309.3	188380.8	41.15726	-72.8631
Tis-FVP-05a-eol	10/7/2016	13:42:27	295316.6	188575.2	41.15901	-72.863
Tis-FVP-05b-sol	10/7/2016	14:05:24	295449.2	188375	41.15721	-72.8614
Tis-FVP-05b-eol	10/7/2016	14:07:29	295420.4	188216.7	41.15578	-72.8618
Tis-FVP-05c-sol	10/7/2016	14:23:18	295381	188445.2	41.15784	-72.8622
Tis-FVP-05c-eol	10/7/2016	14:25:24	295387.1	188588.3	41.15913	-72.8622
Tis-FVP-05d-sol	10/7/2016	14:41:48	295393.6	188530.5	41.15861	-72.8621
Tis-FVP-05d-eol	10/7/2016	14:43:50	295371.1	188376.1	41.15722	-72.8623
Tis-FVP-05e-sol	10/7/2016	15:00:26	295516.2	188270.6	41.15627	-72.8606
Tis-FVP-05e-eol	10/7/2016	15:02:30	295486.2	188463.8	41.15801	-72.861
Tis-FVP-05f-sol	10/7/2016	15:15:36	295329	188630.3	41.15951	-72.8628
Tis-FVP-05f-eol	10/7/2016	15:17:41	295397.1	188469.6	41.15806	-72.862
Tis-FVP-06a-sol	10/12/2016	8:12:56	295455.7	188319.3	41.15671	-72.8613
Tis-FVP-06a-eol	10/12/2016	8:14:58	295614.8	188312.6	41.15665	-72.8594

CLDS 2016 ACTUAL TRAWL STATION IDS/COORDINATES FOR TISSUE CHEMISTRY ANALYSIS						
Sample ID	**Date**	**Time**	**X**	**Y**	**Latitude**	**Longitude**
Tis-FVP-06b-sol	10/12/2016	8:33:54	295484.5	188293.3	41.15647	-72.861
Tis-FVP-06b-eol	10/12/2016	8:35:56	295345.8	188293	41.15647	-72.8626
Tis-FVP-06c-sol	10/12/2016	9:00:15	295489.1	188406.8	41.1575	-72.8609
Tis-FVP-06c-eol	10/12/2016	9:02:16	295620.5	188405.6	41.15749	-72.8594
Tis-FVP-06d-sol	10/12/2016	9:26:00	295658.5	188412.6	41.15755	-72.8589
Tis-FVP-06d-eol	10/12/2016	9:28:01	295517.9	188398.3	41.15742	-72.8606
Tis-4500E-01a-sol	10/11/2016	14:32:39	296980	187981.3	41.15368	-72.8432
Tis-4500E-01a-eol	10/11/2016	14:34:41	296976.9	187897.1	41.15292	-72.8432
Tis-4500E-01b-sol	10/11/2016	14:54:06	296944.5	187971.8	41.15359	-72.8436
Tis-4500E-01b-eol	10/11/2016	14:56:08	296942.1	187894.1	41.1529	-72.8436
Tis-4500E-01c-sol	10/11/2016	15:16:11	296913.4	187965.4	41.15354	-72.844
Tis-4500E-01c-eol	10/11/2016	15:18:13	296912.3	187873.3	41.15271	-72.844
Tis-4500E-01d-sol	10/11/2016	15:38:19	296929.9	187932.2	41.15324	-72.8438
Tis-4500E-01d-eol	10/11/2016	15:40:21	296896.5	187870.5	41.15268	-72.8442
Tis-4500E-02a-sol	10/11/2016	12:08:38	297223.7	187958.5	41.15348	-72.8403
Tis-4500E-02a-eol	10/11/2016	12:10:39	297114.3	187947.5	41.15338	-72.8416
Tis-4500E-02b-sol	10/11/2016	13:01:14	297175.3	187943.3	41.15334	-72.8408
Tis-4500E-02b-eol	10/11/2016	13:03:17	297044.9	187943.2	41.15334	-72.8424
Tis-4500E-02c-sol	10/11/2016	13:22:26	297136.4	187960	41.15349	-72.8413
Tis-4500E-02c-eol	10/11/2016	13:24:28	296972.2	187933	41.15325	-72.8433
Tis-4500E-02d-sol	10/11/2016	13:40:16	297008	187987	41.15373	-72.8428
Tis-4500E-02d-eol	10/11/2016	13:42:19	297133.4	187996.3	41.15382	-72.8413
Tis-4500E-02e-sol	10/11/2016	14:08:06	297012.7	187980.3	41.15367	-72.8428
Tis-45003-02e-eol	10/11/2016	14:10:10	297130.7	187985.7	41.15372	-72.8414
Tis-4500E-03a-sol	10/11/2016	10:23:07	297217.3	188170.7	41.15539	-72.8403
Tis-4500E-03a-eol	10/11/2016	10:25:09	297098.1	188186.9	41.15553	-72.8418
Tis-4500E-03b-sol	10/11/2016	10:49:34	297226.4	188157.3	41.15527	-72.8402
Tis-4500E-03b-sol	10/11/2016	10:51:37	297078.2	188184.4	41.15551	-72.842
Tis-4500E-03c-sol	10/11/2016	11:13:39	297299.7	188145.2	41.15516	-72.8394
Tis-4500E-03c-eol	10/11/2016	11:15:40	297183.6	188170.3	41.15539	-72.8407
Tis-4500E-03d-sol	10/11/2016	11:34:15	297242	188147.5	41.15518	-72.8401
Tis-4500E-03d-eol	10/11/2016	11:36:17	297139.9	188185.5	41.15552	-72.8413
Tis-4500E-05a-sol	10/11/2016	8:08:34	297329.8	188238.3	41.156	-72.839
Tis-4500E-05a-eol	10/11/2016	8:10:35	297167.2	188235.9	41.15598	-72.8409
Tis-4500E-05b-sol	10/11/2016	8:24:15	297309.6	188225.9	41.15589	-72.8392
Tis-4500E-05b-eol	10/11/2016	8:26:18	297157.8	188223.3	41.15586	-72.8411
Tis-4500E-05c-sol	10/11/2016	8:40:17	297339.6	188260	41.15619	-72.8389
Tis-4500E-05c-eol	10/11/2016	8:42:22	297235.3	188258.2	41.15618	-72.8401

CLDS 2016 ACTUAL TRAWL STATION IDS/COORDINATES FOR TISSUE CHEMISTRY ANALYSIS						
Sample ID	**Date**	**Time**	**X**	**Y**	**Latitude**	**Longitude**
Tis-4500E-05d-sol	10/11/2016	9:00:44	297583	188258.5	41.15618	-72.836
Tis-4500E-05d-eol	10/11/2016	9:02:48	297406	188258.8	41.15618	-72.8381
Tis-4500E-05e-sol	10/11/2016	9:21:18	297516	188250.5	41.15611	-72.8368
Tis-4500E-05e-eol	10/11/2016	9:23:21	297392	188252.6	41.15613	-72.8383
Tis-4500E-05f-sol	10/11/2016	9:39:46	297617.1	188258.3	41.15618	-72.8356
Tis-4500E-05f-eol	10/11/2016	9:41:51	297477.6	188258.9	41.15619	-72.8372
Tis-4500E-05f-sol	10/11/2016	9:59:03	297619	188255.2	41.15615	-72.8356
Tis-4500E-05f-eol	10/11/2016	10:01:04	297478.8	188259.7	41.15619	-72.8372

Notes

1. Grid coordinates are NAD_1983_StatePlane_Connecticut_FIPS_0600_Meters
2. Geographic coordinates are NAD83 decimal degrees
3. sol = Start of Line; eol = End of Line

APPENDIX D

SPI/PV FIELD LOG

StationID	Replicate	Date	Time	Frame	Stops_inches	Weights_per_side	Depth_ft	Comments
CS-2-02	A	09/28/2016	11:05:33	3	12	0	65	Frame count = 2, color card shot, focus good
CS-2-02	B	09/28/2016	11:06:57	4	12	0	65	SPI Camera s/n 2621653, lens s/n 341587: f9, 1/250 ISO 640
CS-2-02	C	09/28/2016	11:08:06	5	12	0	65	PV Camera: s/n 27069619, lens s/n 532303: f14 ISO 400, 1/30 shutter, 1'8" trigger
CS-2-02	D	09/28/2016	11:08:58	6	12	0	65	Download, frame count 6, stops shifted and weights added to 12.5 and 0
CS-2-01	A	09/28/2016	11:33:10	7	12.5	0	65	
CS-2-01	B	09/28/2016	11:34:12	8	12.5	0	65	
CS-2-01	C	09/28/2016	11:35:09	9	12.5	0	65	
CS-2-01	D	09/28/2016	11:36:00	10	12.5	0	65	
CS-2-03	A	09/28/2016	11:40:29	11	12.5	0	64	
CS-2-03	B	09/28/2016	11:41:23	12	12.5	0	64	
CS-2-03	C	09/28/2016	11:42:37	13	12.5	0	64	
CS-2-03	D	09/28/2016	11:43:30	14	12.5	0	64	
CS-2-04	A	09/28/2016	11:46:24	15	12.5	0	62	
CS-2-04	B	09/28/2016	11:47:34	16	12.5	0	62	
CS-2-04	C	09/28/2016	11:48:23	17	12.5	0	62	
CS-2-04	D	09/28/2016	11:49:13	18	12.5	0	62	
CS-2-05	A	09/28/2016	11:51:00	19	12.5	0	61	
CS-2-05	B	09/28/2016	11:52:15	20	12.5	0	61	
CS-2-05	C	09/28/2016	11:53:29	21	12.5	0	61	
CS-2-05	D	09/28/2016	11:54:17	22	12.5	0	61	
CS-2-06	A	09/28/2016	11:56:52	23	12.5	0	62	
CS-2-06	B	09/28/2016	11:57:39	24	12.5	0	62	
CS-2-06	C	09/28/2016	11:58:30	25	12.5	0	62	
CS-2-06	D	09/28/2016	11:59:05	26	12.5	0	62	
CS-2-06	E	09/28/2016	12:00:02	27	12.5	0	62	
CS-2-07	A	09/28/2016	12:03:57	28	12.5	0	61	
CS-2-07	B	09/28/2016	12:04:46	29	12.5	0	61	
CS-2-07	C	09/28/2016	12:05:50	30	12.5	0	61	
CS-2-07	D	09/28/2016	12:06:35	31	12.5	0	61	
CS-1-01	A	09/28/2016	12:13:18	32	12.5	0	66	
CS-1-01	B	09/28/2016	12:14:22	33	12.5	0	66	
CS-1-01	C	09/28/2016	12:15:15	34	12.5	0	66	
CS-1-01	D	09/28/2016	12:16:06	35	12.5	0	66	
CS-1-03	A	09/28/2016	12:17:55	36	12.5	0	66	
CS-1-03	B	09/28/2016	12:19:09	37	12.5	0	66	
CS-1-03	C	09/28/2016	12:20:12	38	12.5	0	66	
CS-1-03	D	09/28/2016	12:21:09	39	12.5	0	66	
CS-1-02	A	09/28/2016	12:22:35	40	12.5	0	65	
CS-1-02	B	09/28/2016	12:23:28	41	12.5	0	65	
CS-1-02	C	09/28/2016	12:24:16	42	12.5	0	65	
CS-1-02	D	09/28/2016	12:25:40	43	12.5	0	65	
CS-1-04	A	09/28/2016	12:27:07	44	12.5	0	64	
CS-1-04	B	09/28/2016	12:28:12	45	12.5	0	64	

StationID	Replicate	Date	Time	Frame	Stops_inches	Weights_per_side	Depth_ft	Comments
CS-1-04	C	09/28/2016	12:28:55	46	12.5	0	64	
CS-1-04	D	09/28/2016	12:29:49	47	12.5	0	64	
CS-1-05	A	09/28/2016	12:34:03	48	12.5	0	65	
CS-1-05	B	09/28/2016	12:34:51	49	12.5	0	65	
CS-1-05	C	09/28/2016	12:35:40	50	12.5	0	65	
CS-1-05	D	09/28/2016	12:36:29	51	12.5	0	65	
CS-1-06	A	09/28/2016	12:37:43	52	12.5	0	65	
CS-1-06	B	09/28/2016	12:38:30	53	12.5	0	65	
CS-1-06	C	09/28/2016	12:39:17	54	12.5	0	65	
CS-1-06	D	09/28/2016	12:40:43	55	12.5	0	65	
CS-1-06	E	09/28/2016	12:41:30	56	12.5	0	65	Download, frame count 56
15	A	09/28/2016	13:05:04	57	12.5	0	67	
15	B	09/28/2016	13:06:10	58	12.5	0	67	
15	C	09/28/2016	13:07:04	59	12.5	0	67	
15	D	09/28/2016	13:08:09	60	12.5	0	67	
16	A	09/28/2016	13:10:28	61	12.5	0	66	
16	B	09/28/2016	13:11:22	62	12.5	0	66	
16	C	09/28/2016	13:12:15	63	12.5	0	66	
16	D	09/28/2016	13:13:03	64	12.5	0	66	
17	A	09/28/2016	13:16:02	65	12.5	0	63	
17	B	09/28/2016	13:17:08	66	12.5	0	63	
17	C	09/28/2016	13:17:56	67	12.5	0	63	
17	D	09/28/2016	13:18:41	68	12.5	0	63	
14	A	09/28/2016	13:23:47	69	12.5	0	65	
14	B	09/28/2016	13:24:41	70	12.5	0	65	
14	C	09/28/2016	13:25:28	71	12.5	0	65	
14	D	09/28/2016	13:26:21	72	12.5	0	65	
13	A	09/28/2016	13:29:31	73	12.5	0	64	
13	B	09/28/2016	13:30:36	74	12.5	0	64	
13	C	09/28/2016	13:31:20	75	12.5	0	64	
13	D	09/28/2016	13:32:08	76	12.5	0	64	
MQR-07	A	09/28/2016	13:35:22	77	12.5	0	63	
MQR-07	B	09/28/2016	13:36:31	78	12.5	0	63	
MQR-07	C	09/28/2016	13:37:19	79	12.5	0	63	
MQR-07	D	09/28/2016	13:38:09	80	12.5	0	63	
MQR-05	A	09/28/2016	13:41:25	81	12.5	0	63	
MQR-05	B	09/28/2016	13:42:14	82	12.5	0	63	
MQR-05	C	09/28/2016	13:42:57	83	12.5	0	63	
MQR-05	D	09/28/2016	13:43:42	84	12.5	0	63	
MQR-02	A	09/28/2016	13:45:21	85	12.5	0	62	
MQR-02	B	09/28/2016	13:46:38	86	12.5	0	62	
MQR-02	C	09/28/2016	13:47:27	87	12.5	0	62	
MQR-02	D	09/28/2016	13:48:25	88	12.5	0	62	

StationID	Replicate	Date	Time	Frame	Stops_inches	Weights_per_side	Depth_ft	Comments
MQR-01	A	09/28/2016	13:50:57	89	12.5	0	63	
MQR-01	B	09/28/2016	13:52:19	90	12.5	0	63	
MQR-01	C	09/28/2016	13:53:08	91	12.5	0	63	
MQR-01	D	09/28/2016	13:53:55	92	12.5	0	63	
MQR-04	A	09/28/2016	13:55:49	93	12.5	0	61	
MQR-04	B	09/28/2016	13:56:41	94	12.5	0	61	
MQR-04	C	09/28/2016	13:57:33	95	12.5	0	61	
MQR-04	D	09/28/2016	13:58:32	96	12.5	0	61	
MQR-06	A	09/28/2016	14:00:37	97	12.5	0	60	
MQR-06	B	09/28/2016	14:01:29	98	12.5	0	60	
MQR-06	C	09/28/2016	14:02:33	99	12.5	0	60	
MQR-06	D	09/28/2016	14:03:18	100	12.5	0	60	
MQR-03	A	09/28/2016	14:05:06	101	12.5	0	62	
MQR-03	B	09/28/2016	14:05:51	102	12.5	0	62	
MQR-03	C	09/28/2016	14:06:41	103	12.5	0	62	
MQR-03	D	09/28/2016	14:07:24	104	12.5	0	62	Download, frame count 104, PV trigger assembly changed due to degraded performance
01	A	09/28/2016	14:52:59	105	12.5	0	63	
01	B	09/28/2016	14:53:48	106	12.5	0	63	
01	C	09/28/2016	14:54:33	107	12.5	0	63	
01	D	09/28/2016	14:56:16	108	12.5	0	63	
02	A	09/28/2016	14:58:55	109	12.5	0	63	
02	B	09/28/2016	14:59:43	110	12.5	0	63	
02	C	09/28/2016	15:00:34	111	12.5	0	63	
02	D	09/28/2016	15:01:21	112	12.5	0	63	
03	A	09/28/2016	15:04:32	113	12.5	0	63	
03	B	09/28/2016	15:05:50	114	12.5	0	63	
03	C	09/28/2016	15:06:33	115	12.5	0	63	
03	D	09/28/2016	15:07:16	116	12.5	0	63	
04	A	09/28/2016	15:11:45	117	12.5	0	63	
04	B	09/28/2016	15:12:52	118	12.5	0	63	
04	C	09/28/2016	15:14:24	119	12.5	0	63	
04	D	09/28/2016	15:15:43	120	12.5	0	63	
05	A	09/28/2016	15:20:46	121	12.5	0	61	
05	B	09/28/2016	15:21:56	122	12.5	0	61	
05	C	09/28/2016	15:22:45	123	12.5	0	61	
05	D	09/28/2016	15:23:28	124	12.5	0	61	
06	A	09/28/2016	15:28:39	125	12.5	0	62	
06	B	09/28/2016	15:29:26	126	12.5	0	62	
06	C	09/28/2016	15:30:13	127	12.5	0	62	
06	D	09/28/2016	15:31:02	128	12.5	0	62	
08	A	09/28/2016	15:34:29	129	12.5	0	61	
08	B	09/28/2016	15:35:31	130	12.5	0	61	

StationID	Replicate	Date	Time	Frame	Stops_inches	Weights_per_side	Depth_ft	Comments
08	C	09/28/2016	15:36:16	131	12.5	0	61	
08	D	09/28/2016	15:37:05	132	12.5	0	61	
07	A	09/28/2016	15:40:00	133	12.5	0	59	
07	B	09/28/2016	15:41:10	134	12.5	0	59	
07	C	09/28/2016	15:42:24	135	12.5	0	59	
07	D	09/28/2016	15:43:59	136	12.5	0	59	
09	A	09/28/2016	15:50:10	137	12.5	0	59	
09	B	09/28/2016	15:51:13	138	12.5	0	59	
09	C	09/28/2016	15:52:10	139	12.5	0	59	
09	D	09/28/2016	15:53:12	140	12.5	0	59	
10	A	09/28/2016	15:57:11	141	12.5	0	64	
10	B	09/28/2016	15:58:02	142	12.5	0	64	
10	C	09/28/2016	15:59:07	143	12.5	0	64	
10	D	09/28/2016	16:00:14	144	12.5	0	64	
11	A	09/28/2016	16:07:59	145	12.5	0	61	
11	B	09/28/2016	16:09:00	146	12.5	0	61	
11	C	09/28/2016	16:10:09	147	12.5	0	61	
11	D	09/28/2016	16:11:04	148	12.5	0	61	
12	A	09/28/2016	16:13:40	149	12.5	0	63	
12	B	09/28/2016	16:15:08	150	12.5	0	63	
12	C	09/28/2016	16:16:05	151	12.5	0	63	
12	D	09/28/2016	16:16:59	152	12.5	0	63	End of day.
08	E	09/29/2016	8:21:11	155	11	0	65	
08	F	09/29/2016	8:22:06	156	11	0	65	
08	G	09/29/2016	8:23:05	157	11	0	65	
08	H	09/29/2016	8:24:05	158	11	0	65	
05	E	09/29/2016	8:28:03	159	11	0	65	
05	F	09/29/2016	8:28:59	160	11	0	65	
05	G	09/29/2016	8:29:47	161	11	0	65	
05	H	09/29/2016	8:32:41	162	11	0	65	
05	I	09/29/2016	8:36:53	163	11	0	65	Ended survey due to weather.
FVP-02	A	10/02/2016	8:06:19	165	12.5	0	64	
FVP-02	B	10/02/2016	8:07:04	166	12.5	0	64	
FVP-02	C	10/02/2016	8:07:57	167	12.5	0	64	
FVP-02	D	10/02/2016	8:08:51	168	12.5	0	64	Download, frame count 169
FVP-01	A	10/02/2016	8:25:08	170	12.5	0	64	
FVP-01	B	10/02/2016	8:26:02	171	12.5	0	64	
FVP-01	C	10/02/2016	8:26:43	172	12.5	0	64	
FVP-01	D	10/02/2016	8:27:26	173	12.5	0	64	
FVP-03	A	10/02/2016	8:30:39	174	12.5	0	64	
FVP-03	B	10/02/2016	8:31:51	175	12.5	0	64	
FVP-03	C	10/02/2016	8:32:41	176	12.5	0	64	
FVP-03	D	10/02/2016	8:33:29	177	12.5	0	64	

StationID	Replicate	Date	Time	Frame	Stops_inches	Weights_per_side	Depth_ft	Comments
FVP-06	A	10/02/2016	8:36:46	178	12.5	0	62	
FVP-06	B	10/02/2016	8:37:37	179	12.5	0	62	
FVP-06	C	10/02/2016	8:38:26	180	12.5	0	62	
FVP-06	D	10/02/2016	8:39:07	181	12.5	0	62	
FVP-04	A	10/02/2016	8:41:53	182	12.5	0	62	
FVP-04	B	10/02/2016	8:43:15	183	12.5	0	62	
FVP-04	C	10/02/2016	8:44:19	184	12.5	0	62	
FVP-04	D	10/02/2016	8:45:13	185	12.5	0	62	
FVP-05	A	10/02/2016	8:47:05	186	12.5	0	62	
FVP-05	B	10/02/2016	8:47:46	187	12.5	0	62	
FVP-05	C	10/02/2016	8:48:33	188	12.5	0	62	
FVP-05	D	10/02/2016	8:49:23	189	12.5	0	62	
FVP-07	A	10/02/2016	8:52:59	190	12.5	0	63	
FVP-07	B	10/02/2016	8:53:50	191	12.5	0	63	
FVP-07	C	10/02/2016	8:54:53	192	12.5	0	63	
FVP-07	D	10/02/2016	8:55:37	193	12.5	0	63	Download, frame count 193
4500E-03	A	10/02/2016	9:11:30	194	12.5	0	69	
4500E-03	B	10/02/2016	9:12:22	195	12.5	0	69	
4500E-03	C	10/02/2016	9:13:06	196	12.5	0	69	
4500E-03	D	10/02/2016	9:13:50	197	12.5	0	69	
4500E-05	A	10/02/2016	9:19:54	198	12.5	0	69	
4500E-05	B	10/02/2016	9:20:56	199	12.5	0	69	
4500E-05	C	10/02/2016	9:21:44	200	12.5	0	69	
4500E-05	D	10/02/2016	9:22:31	201	12.5	0	69	
4500E-04	A	10/02/2016	9:27:21	202	12.5	0	70	
4500E-04	B	10/02/2016	9:28:06	203	12.5	0	70	
4500E-04	C	10/02/2016	9:28:50	204	12.5	0	70	
4500E-04	D	10/02/2016	9:29:38	205	12.5	0	70	
4500E-02	A	10/02/2016	9:32:28	206	12.5	0	70	
4500E-02	B	10/02/2016	9:33:09	207	12.5	0	70	
4500E-02	C	10/02/2016	9:34:09	208	12.5	0	70	
4500E-02	D	10/02/2016	9:35:03	209	12.5	0	70	
4500E-01	A	10/02/2016	9:38:52	210	12.5	0	72	
4500E-01	B	10/02/2016	9:39:37	211	12.5	0	72	
4500E-01	C	10/02/2016	9:40:24	212	12.5	0	72	
4500E-01	D	10/02/2016	9:41:19	213	12.5	0	72	Download, frame count 215, changed PV battery, color card shot
CLIS-REF-05	A	10/02/2016	10:36:08	216	12.5	0	84	
CLIS-REF-05	B	10/02/2016	10:36:54	217	12.5	0	84	
CLIS-REF-05	C	10/02/2016	10:37:48	218	12.5	0	84	
CLIS-REF-05	D	10/02/2016	10:38:41	219	12.5	0	84	
CLIS-REF-03	A	10/02/2016	10:43:49	220	12.5	0	86	
CLIS-REF-03	B	10/02/2016	10:44:46	221	12.5	0	86	
CLIS-REF-03	C	10/02/2016	10:45:40	222	12.5	0	86	

StationID	Replicate	Date	Time	Frame	Stops_inches	Weights_per_side	Depth_ft	Comments
CLIS-REF-03	D	10/02/2016	10:46:33	223	12.5	0	86	
CLIS-REF-04	A	10/02/2016	10:52:30	224	12.5	0	86	
CLIS-REF-04	B	10/02/2016	10:53:14	225	12.5	0	86	
CLIS-REF-04	C	10/02/2016	10:53:57	226	12.5	0	86	
CLIS-REF-04	D	10/02/2016	10:54:42	227	12.5	0	86	
CLIS-REF-02	A	10/02/2016	10:59:58	228	12.5	0	87	
CLIS-REF-02	B	10/02/2016	11:00:55	229	12.5	0	87	
CLIS-REF-02	C	10/02/2016	11:01:43	230	12.5	0	87	
CLIS-REF-02	D	10/02/2016	11:02:31	231	12.5	0	87	
CLIS-REF-01	A	10/02/2016	11:06:26	232	12.5	0	86	
CLIS-REF-01	B	10/02/2016	11:07:14	233	12.5	0	86	
CLIS-REF-01	C	10/02/2016	11:07:56	234	12.5	0	86	
CLIS-REF-01	D	10/02/2016	11:08:36	235	12.5	0	86	Download, frame count 235
2500W-02	A	10/02/2016	11:46:48	236	12.5	0	64	
2500W-02	B	10/02/2016	11:47:35	237	12.5	0	64	
2500W-02	C	10/02/2016	11:48:16	238	12.5	0	64	
2500W-02	D	10/02/2016	11:49:09	239	12.5	0	64	
2500W-01	A	10/02/2016	11:51:12	240	12.5	0	64	
2500W-01	B	10/02/2016	11:52:02	241	12.5	0	64	
2500W-01	C	10/02/2016	11:52:50	242	12.5	0	64	
2500W-01	D	10/02/2016	11:53:35	243	12.5	0	64	
2500W-04	A	10/02/2016	12:00:15	244	12.5	0	64	
2500W-04	B	10/02/2016	12:01:04	245	12.5	0	64	
2500W-04	C	10/02/2016	12:01:44	246	12.5	0	64	
2500W-04	D	10/02/2016	12:02:30	247	12.5	0	64	
2500W-03	A	10/02/2016	12:05:53	248	12.5	0	64	
2500W-03	B	10/02/2016	12:06:36	249	12.5	0	64	
2500W-03	C	10/02/2016	12:07:14	250	12.5	0	64	
2500W-03	D	10/02/2016	12:07:55	251	12.5	0	64	
2500W-05	A	10/02/2016	12:12:30	252	12.5	0	63	
2500W-05	B	10/02/2016	12:13:16	253	12.5	0	63	
2500W-05	C	10/02/2016	12:14:32	254	12.5	0	63	
2500W-05	D	10/02/2016	12:15:13	255	12.5	0	63	End of day.

APPENDIX E

SEDIMENT PROFILE AND PLAN VIEW IMAGE ANALYSIS RESULTS

Area	Location	StationID	Replicate	Date	Time	Water Depth (m)	Stop Collar Setting (in)	# of Weights (per side)	Image Width (cm)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range (phi)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)
NHAV14	Site	01	A	9/28/2016	14:53:00	19.2	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	12.9	12.6	13.1	0.5
NHAV14	Site	01	B	9/28/2016	14:53:48	19.2	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	11.9	11.6	12.2	0.6
NHAV14	Site	01	C	9/28/2016	14:54:34	19.2	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	13.7	13.4	14.1	0.8
NHAV14	Site	02	A	9/28/2016	14:58:56	19.2	12.5	0	14.6	>4	>4	2	>4 to 2	18.7	18.4	18.9	0.6
NHAV14	Site	02	B	9/28/2016	14:59:43	19.2	12.5	0	14.6	>4	>4	2	>4 to 2	16.0	15.9	16.2	0.3
NHAV14	Site	02	C	9/28/2016	15:00:34	19.2	12.5	0	14.6	>4	>4	0	>4 to 0	17.7	17.6	17.9	0.3
NHAV14	Site	03	A	9/28/2016	15:04:27	19.2	12.5	0	14.6	4-3/>4	>4	-2	>4 to -2	17.4	16.9	17.9	1.1
NHAV14	Site	03	B	9/28/2016	15:05:50	19.2	12.5	0	14.6	4-3/>4	>4	2	>4 to 2	17.2	16.9	17.6	0.6
NHAV14	Site	03	C	9/28/2016	15:06:33	19.2	12.5	0	14.6	3-2/>4	>4	1	>4 to 1	13.5	13.1	13.9	0.8
NHAV14	Site	04	B	9/28/2016	15:12:53	19.2	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	17.1	16.7	17.5	0.8
NHAV14	Site	04	C	9/28/2016	15:14:24	19.2	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	17.3	16.9	18.4	1.4
NHAV14	Site	04	D	9/28/2016	15:15:41	19.2	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	19.5	19.1	19.8	0.6
NHAV14	Site	05	B	9/28/2016	15:21:57	18.6	12.5	0	14.6	>4	>4	1	>4 to 1	20.6	19.9	21.0	1.0
NHAV14	Site	05	E	9/29/2016	8:28:06	19.8	11	0	14.6	4-3/>4	>4	1	>4 to 1	11.7	11.3	12.0	0.7
NHAV14	Site	05	F	9/29/2016	8:29:05	19.8	11	0	14.6	4-3/>4	>4	1	>4 to 1	11.6	11.2	12.0	0.8
NHAV14	Site	06	B	9/28/2016	15:29:26	18.9	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	18.8	18.4	19.1	0.6
NHAV14	Site	06	C	9/28/2016	15:30:12	18.9	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	19.6	18.7	20.2	1.5
NHAV14	Site	06	D	9/28/2016	15:31:03	18.9	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	15.7	15.5	15.9	0.4
NHAV14	Site	07	A	9/28/2016	15:40:00	18.0	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	18.6	18.3	19.0	0.7
NHAV14	Site	07	B	9/28/2016	15:41:11	18.0	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	19.9	19.7	20.2	0.5
NHAV14	Site	07	C	9/28/2016	15:42:24	18.0	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	20.4	20.1	20.7	0.5
NHAV14	Site	08	A	9/28/2016	15:34:29	18.6	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	18.5	18.0	18.9	0.9
NHAV14	Site	08	F	9/29/2016	8:22:12	19.8	11	0	14.6	4-3/>4	>4	0	>4 to 0	16.4	16.1	16.6	0.6
NHAV14	Site	08	H	9/29/2016	8:24:10	19.8	11	0	14.6	4-3/>4	>4	0	>4 to 0	17.2	16.9	17.5	0.6
CLDS-Other	Site	09	A	9/28/2016	15:50:10	18.0	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	14.8	14.3	15.3	1.0
CLDS-Other	Site	09	B	9/28/2016	15:51:13	18.0	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	17.6	17.3	17.8	0.5
CLDS-Other	Site	09	C	9/28/2016	15:52:09	18.0	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	17.4	16.9	17.9	0.9
CLDS-Other	Site	10	A	9/28/2016	15:57:12	19.5	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	19.4	19.0	19.8	0.8
CLDS-Other	Site	10	B	9/28/2016	15:58:02	19.5	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	17.0	16.7	17.2	0.5
CLDS-Other	Site	10	C	9/28/2016	15:59:08	19.5	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	17.5	17.4	17.6	0.3
CLDS-Other	Site	11	A	9/28/2016	16:07:59	18.6	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	14.4	14.0	14.8	0.8
CLDS-Other	Site	11	B	9/28/2016	16:08:59	18.6	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	17.7	17.0	18.2	1.2
CLDS-Other	Site	11	C	9/28/2016	16:10:10	18.6	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	15.0	14.8	15.2	0.4
CLDS-Other	Site	12	A	9/28/2016	16:13:41	19.2	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	17.6	17.2	18.2	1.1
CLDS-Other	Site	12	B	9/28/2016	16:15:09	19.2	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	18.2	17.9	18.7	0.8
CLDS-Other	Site	12	C	9/28/2016	16:16:05	19.2	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	17.6	17.0	17.9	0.9
CLDS-Other	Site	13	B	9/28/2016	13:30:36	19.5	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	20.1	18.9	21.0	2.1
CLDS-Other	Site	13	C	9/28/2016	13:31:21	19.5	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	19.1	18.5	19.4	0.9
CLDS-Other	Site	13	D	9/28/2016	13:32:08	19.5	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	19.6	19.1	19.8	0.7
CLDS-Other	Site	14	A	9/28/2016	13:23:48	19.8	12.5	0	14.6	4-3/3-2	>4	-1	>4 to -1	14.5	14.0	15.4	1.4
CLDS-Other	Site	14	B	9/28/2016	13:24:41	19.8	12.5	0	14.6	4-3/3-2	>4	-1	>4 to -1	16.8	16.7	17.0	0.3
CLDS-Other	Site	14	C	9/28/2016	13:25:29	19.8	12.5	0	14.6	4-3/3-2	>4	0	>4 to 0	17.4	16.9	17.8	0.9
CLDS-Other	Site	15	A	9/28/2016	13:05:05	20.4	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	18.6	18.3	19.4	1.1
CLDS-Other	Site	15	B	9/28/2016	13:06:10	20.4	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	17.8	17.6	18.0	0.4
CLDS-Other	Site	15	C	9/28/2016	13:07:05	20.4	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	13.7	13.5	14.1	0.6
CLDS-Other	Site	16	A	9/28/2016	13:10:28	20.1	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	17.3	17.0	17.7	0.7

Area	Location	StationID	Replicate	Date	Time	Water Depth (m)	Stop Collar Setting (in)	# of Weights (per side)	Image Width (cm)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range (phi)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)
CLDS-Other	Site	16	B	9/28/2016	13:11:24	20.1	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	17.4	16.7	18.1	1.4
CLDS-Other	Site	16	C	9/28/2016	13:12:15	20.1	12.5	0	14.6	4-3/>4	>4	-2	>4 to -2	17.3	16.6	17.6	1.1
CLDS-Other	Site	17	A	9/28/2016	13:16:02	19.2	12.5	0	14.6	4-3/>4	>4	-2	>4 to -2	12.8	12.6	13.1	0.5
CLDS-Other	Site	17	B	9/28/2016	13:17:09	19.2	12.5	0	14.6	4-3/>4	>4	-2	>4 to -2	13.8	13.5	13.9	0.4
CLDS-Other	Site	17	C	9/28/2016	13:17:56	19.2	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	13.5	13.4	13.7	0.3
Reference	2500W	2500W-01	A	10/2/2016	11:51:12	19.5	12.5	0	14.6	>4	>4	0	>4 to 0	20.3	19.9	20.9	1.0
Reference	2500W	2500W-01	B	10/2/2016	11:52:02	19.5	12.5	0	14.6	>4	>4	0	>4 to 0	19.4	19.2	19.6	0.4
Reference	2500W	2500W-01	C	10/2/2016	11:52:50	19.5	12.5	0	14.6	>4	>4	-1	>4 to -1	16.6	16.4	17.2	0.9
Reference	2500W	2500W-02	A	10/2/2016	11:46:48	19.5	12.5	0	14.6	>4	>4	1	>4 to 1	16.2	15.8	16.6	0.7
Reference	2500W	2500W-02	B	10/2/2016	11:47:35	19.5	12.5	0	14.6	>4	>4	1	>4 to 1	16.7	16.5	17.0	0.5
Reference	2500W	2500W-02	C	10/2/2016	11:48:16	19.5	12.5	0	14.6	>4	>4	0	>4 to 0	15.5	15.0	15.9	0.9
Reference	2500W	2500W-03	A	10/2/2016	12:05:53	19.5	12.5	0	14.6	>4	>4	0	>4 to 0	16.7	16.6	16.8	0.3
Reference	2500W	2500W-03	B	10/2/2016	12:06:36	19.5	12.5	0	14.6	>4	>4	-2	>4 to -2	18.7	18.4	18.9	0.5
Reference	2500W	2500W-03	C	10/2/2016	12:07:15	19.5	12.5	0	14.6	>4	>4	-1	>4 to -1	16.6	16.0	17.4	1.4
Reference	2500W	2500W-04	A	10/2/2016	12:00:15	19.5	12.5	0	14.6	>4	>4	0	>4 to 0	18.2	17.8	18.6	0.8
Reference	2500W	2500W-04	B	10/2/2016	12:01:04	19.5	12.5	0	14.6	>4	>4	1	>4 to 1	18.6	18.2	19.0	0.8
Reference	2500W	2500W-04	C	10/2/2016	12:01:43	19.5	12.5	0	14.6	>4	>4	-2	>4 to -2	16.1	15.9	16.3	0.4
Reference	2500W	2500W-05	A	10/2/2016	12:12:30	19.2	12.5	0	14.6	>4	>4	1	>4 to 1	14.6	14.4	14.8	0.4
Reference	2500W	2500W-05	B	10/2/2016	12:13:16	19.2	12.5	0	14.6	>4	>4	-1	>4 to -1	18.0	17.8	18.1	0.4
Reference	2500W	2500W-05	C	10/2/2016	12:14:32	19.2	12.5	0	14.6	>4	>4	0	>4 to 0	17.0	16.8	17.3	0.5
Reference	4500E	4500E-01	A	10/2/2016	9:38:52	21.9	12.5	0	14.6	>4	>4	1	>4 to 1	16.3	16.2	16.4	0.2
Reference	4500E	4500E-01	B	10/2/2016	9:39:37	21.9	12.5	0	14.6	>4	>4	-2	>4 to -2	19.6	19.5	19.8	0.3
Reference	4500E	4500E-01	C	10/2/2016	9:40:24	21.9	12.5	0	14.6	>4	>4	-2	>4 to -2	18.8	18.2	19.2	1.0
Reference	4500E	4500E-02	A	10/2/2016	9:32:28	21.3	12.5	0	14.6	>4	>4	-2	>4 to -2	17.9	17.7	18.0	0.4
Reference	4500E	4500E-02	B	10/2/2016	9:33:09	21.3	12.5	0	14.6	>4	>4	0	>4 to 0	16.2	16.0	16.5	0.4
Reference	4500E	4500E-02	C	10/2/2016	9:34:09	21.3	12.5	0	14.6	>4	>4	1	>4 to 1	17.7	17.2	18.2	1.0
Reference	4500E	4500E-03	A	10/2/2016	9:11:29	21.0	12.5	0	14.6	>4	>4	0	>4 to 0	19.5	19.3	19.6	0.3
Reference	4500E	4500E-03	B	10/2/2016	9:12:21	21.0	12.5	0	14.6	>4	>4	0	>4 to 0	15.2	15.0	15.3	0.3
Reference	4500E	4500E-03	C	10/2/2016	9:13:06	21.0	12.5	0	14.6	>4	>4	0	>4 to 0	9.4	6.0	16.9	11.0
Reference	4500E	4500E-04	A	10/2/2016	9:27:21	21.3	12.5	0	14.6	>4	>4	1	>4 to 1	15.4	14.9	15.8	0.8
Reference	4500E	4500E-04	B	10/2/2016	9:28:06	21.3	12.5	0	14.6	>4	>4	-1	>4 to -1	17.3	17.1	17.6	0.5
Reference	4500E	4500E-04	C	10/2/2016	9:28:49	21.3	12.5	0	14.6	>4	>4	1	>4 to 1	19.5	19.1	19.9	0.8
Reference	4500E	4500E-05	A	10/2/2016	9:19:54	21.0	12.5	0	14.6	>4	>4	0	>4 to 0	16.5	16.1	16.8	0.7
Reference	4500E	4500E-05	B	10/2/2016	9:20:56	21.0	12.5	0	14.6	>4	>4	0	>4 to 0	16.1	15.8	16.7	0.9
Reference	4500E	4500E-05	C	10/2/2016	9:21:44	21.0	12.5	0	14.6	>4	>4	1	>4 to 1	15.3	15.1	15.6	0.5
Reference	CLIS-REF	CLIS-REF-01	A	10/2/2016	11:06:27	26.2	12.5	0	14.6	>4	>4	0	>4 to 0	15.1	14.9	15.2	0.3
Reference	CLIS-REF	CLIS-REF-01	B	10/2/2016	11:07:14	26.2	12.5	0	14.6	>4	>4	0	>4 to 0	15.3	15.2	15.6	0.4
Reference	CLIS-REF	CLIS-REF-01	C	10/2/2016	11:07:56	26.2	12.5	0	14.6	>4	>4	0	>4 to 0	14.9	14.2	15.6	1.5
Reference	CLIS-REF	CLIS-REF-02	A	10/2/2016	10:59:59	26.5	12.5	0	14.6	>4	>4	-1	>4 to -1	15.1	14.9	15.6	0.7
Reference	CLIS-REF	CLIS-REF-02	B	10/2/2016	11:00:55	26.5	12.5	0	14.6	>4	>4	-1	>4 to -1	15.4	15.2	16.0	0.8
Reference	CLIS-REF	CLIS-REF-02	C	10/2/2016	11:01:43	26.5	12.5	0	14.6	>4	>4	-1	>4 to -1	16.0	15.3	17.1	1.8
Reference	CLIS-REF	CLIS-REF-03	A	10/2/2016	10:43:50	26.2	12.5	0	14.6	>4	>4	0	>4 to 0	16.4	16.2	16.5	0.3
Reference	CLIS-REF	CLIS-REF-03	B	10/2/2016	10:44:43	26.2	12.5	0	14.6	>4	>4	0	>4 to 0	14.8	14.6	14.9	0.4
Reference	CLIS-REF	CLIS-REF-03	C	10/2/2016	10:45:41	26.2	12.5	0	14.6	>4	>4	0	>4 to 0	15.9	15.7	16.3	0.6

Area	Location	StationID	Replicate	Date	Time	Water Depth (m)	Stop Collar Setting (in)	# of Weights (per side)	Image Width (cm)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range (phi)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)
Reference	CLIS-REF	CLIS-REF-04	A	10/2/2016	10:52:30	26.2	12.5	0	14.6	>4	>4	0	>4 to 0	15.2	15.1	15.4	0.3
Reference	CLIS-REF	CLIS-REF-04	B	10/2/2016	10:53:14	26.2	12.5	0	14.6	>4	>4	0	>4 to 0	15.3	15.0	15.5	0.5
Reference	CLIS-REF	CLIS-REF-04	C	10/2/2016	10:53:57	26.2	12.5	0	14.6	>4	>4	0	>4 to 0	15.4	15.1	15.6	0.5
Reference	CLIS-REF	CLIS-REF-05	A	10/2/2016	10:36:09	25.6	12.5	0	14.6	>4	>4	0	>4 to 0	17.1	16.8	17.3	0.5
Reference	CLIS-REF	CLIS-REF-05	B	10/2/2016	10:36:55	25.6	12.5	0	14.6	>4	>4	0	>4 to 0	14.8	14.6	15.0	0.4
Reference	CLIS-REF	CLIS-REF-05	C	10/2/2016	10:37:48	25.6	12.5	0	14.6	>4	>4	1	>4 to 1	14.1	13.5	14.6	1.1
Historical Mound	CS-1	CS-1-01	A	9/28/2016	12:13:18	20.1	12.5	0	14.6	>4	>4	-1	>4 to -1	19.7	19.0	20.3	1.3
Historical Mound	CS-1	CS-1-01	B	9/28/2016	12:14:21	20.1	12.5	0	14.6	>4	>4	-1	>4 to -1	16.8	16.5	17.0	0.5
Historical Mound	CS-1	CS-1-01	C	9/28/2016	12:15:15	20.1	12.5	0	14.6	>4	>4	0	>4 to 0	16.2	16.1	16.5	0.4
Historical Mound	CS-1	CS-1-02	A	9/28/2016	12:22:34	19.8	12.5	0	14.6	>4	>4	0	>4 to 0	18.5	18.3	18.6	0.4
Historical Mound	CS-1	CS-1-02	B	9/28/2016	12:23:28	19.8	12.5	0	14.6	>4	>4	-1	>4 to -1	17.5	17.1	18.1	1.0
Historical Mound	CS-1	CS-1-02	C	9/28/2016	12:24:16	19.8	12.5	0	14.6	>4	>4	0	>4 to 0	17.6	17.3	17.8	0.5
Historical Mound	CS-1	CS-1-03	A	9/28/2016	12:17:56	20.1	12.5	0	14.6	>4	>4	1	>4 to 1	14.9	14.7	15.2	0.5
Historical Mound	CS-1	CS-1-03	B	9/28/2016	12:19:09	20.1	12.5	0	14.6	>4	>4	0	>4 to 0	17.8	17.6	18.1	0.5
Historical Mound	CS-1	CS-1-03	C	9/28/2016	12:20:12	20.1	12.5	0	14.6	>4	>4	0	>4 to 0	17.3	16.8	17.7	0.9
Historical Mound	CS-1	CS-1-04	A	9/28/2016	12:27:07	19.5	12.5	0	14.6	>4	>4	0	>4 to 0	17.8	17.2	18.2	1.0
Historical Mound	CS-1	CS-1-04	B	9/28/2016	12:28:03	19.5	12.5	0	14.6	>4	>4	-2	>4 to -2	14.4	14.2	14.8	0.6
Historical Mound	CS-1	CS-1-04	C	9/28/2016	12:28:52	19.5	12.5	0	14.6	>4	>4	-1	>4 to -1	16.6	16.1	17.3	1.2
Historical Mound	CS-1	CS-1-05	A	9/28/2016	12:34:03	19.8	12.5	0	14.6	>4	>4	-1	>4 to -1	17.2	16.9	17.5	0.5
Historical Mound	CS-1	CS-1-05	B	9/28/2016	12:34:51	19.8	12.5	0	14.6	>4	>4	0	>4 to 0	15.5	15.0	16.0	1.0
Historical Mound	CS-1	CS-1-05	C	9/28/2016	12:35:40	19.8	12.5	0	14.6	>4	>4	0	>4 to 0	15.4	15.1	15.6	0.5
Historical Mound	CS-1	CS-1-06	A	9/28/2016	12:38:31	19.8	12.5	0	14.6	>4	>4	0	>4 to 0	16.5	16.3	16.7	0.4
Historical Mound	CS-1	CS-1-06	B	9/28/2016	12:39:18	19.8	12.5	0	14.6	>4	>4	1	>4 to 1	18.2	17.9	18.9	1.0
Historical Mound	CS-1	CS-1-06	C	9/28/2016	12:40:43	19.8	12.5	0	14.6	>4	>4	0	>4 to 0	18.2	17.9	18.5	0.6
Historical Mound	CS-2	CS-2-01	A	9/28/2016	11:33:10	19.8	12.5	0	14.6	4-3	>4	-1	>4 to -1	14.5	14.4	15.0	0.7
Historical Mound	CS-2	CS-2-01	B	9/28/2016	11:34:13	19.8	12.5	0	14.6	4-3	>4	0	>4 to 0	15.4	14.9	16.0	1.1
Historical Mound	CS-2	CS-2-01	C	9/28/2016	11:35:08	19.8	12.5	0	14.6	4-3	>4	-2	>4 to -2	15.7	15.0	16.9	2.0
Historical Mound	CS-2	CS-2-02	A	9/28/2016	11:05:37	19.8	12	0	14.6	4-3	>4	0	>4 to 0	13.6	13.1	14.1	1.0
Historical Mound	CS-2	CS-2-02	B	9/28/2016	11:06:59	19.8	12	0	14.6	4-3	>4	-1	>4 to -1	12.4	11.8	12.7	0.9
Historical Mound	CS-2	CS-2-02	C	9/28/2016	11:08:06	19.8	12	0	14.6	4-3/>4	>4	-2	>4 to -2	15.3	15.0	15.5	0.5
Historical Mound	CS-2	CS-2-03	A	9/28/2016	11:40:30	19.5	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	17.0	16.7	17.3	0.6
Historical Mound	CS-2	CS-2-03	B	9/28/2016	11:41:23	19.5	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	17.3	16.9	17.6	0.7
Historical Mound	CS-2	CS-2-03	C	9/28/2016	11:42:37	19.5	12.5	0	14.6	>4	>4	-1	>4 to -1	17.8	17.2	18.2	1.1
Historical Mound	CS-2	CS-2-04	B	9/28/2016	11:47:35	18.9	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	12.6	12.2	13.0	0.8
Historical Mound	CS-2	CS-2-04	C	9/28/2016	11:48:23	18.9	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	12.1	11.0	12.5	1.5
Historical Mound	CS-2	CS-2-04	D	9/28/2016	11:49:13	18.9	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	14.6	14.4	14.8	0.4
Historical Mound	CS-2	CS-2-05	A	9/28/2016	11:50:59	18.6	12.5	0	14.6	3-2	>4	1	>4 to 1	4.0	3.7	4.4	0.7
Historical Mound	CS-2	CS-2-05	B	9/28/2016	11:52:15	18.6	12.5	0	14.6	3-2/>4	>4	0	>4 to 0	9.5	8.9	10.2	1.4
Historical Mound	CS-2	CS-2-05	C	9/28/2016	11:53:29	18.6	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	4.8	4.2	5.3	1.1
Historical Mound	CS-2	CS-2-06	A	9/28/2016	11:56:51	18.9	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	6.7	6.1	7.4	1.2
Historical Mound	CS-2	CS-2-06	B	9/28/2016	11:57:40	18.9	12.5	0	14.6	4-3/>4	>4	-2	>4 to -2	9.2	9.0	9.4	0.4
Historical Mound	CS-2	CS-2-06	C	9/28/2016	11:58:26	18.9	12.5	0	14.6	>4	>4	0	>4 to 0	15.1	14.8	15.5	0.7
Historical Mound	CS-2	CS-2-07	A	9/28/2016	12:03:57	18.6	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	11.0	9.7	11.5	1.8
Historical Mound	CS-2	CS-2-07	B	9/28/2016	12:04:47	18.6	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	13.1	12.5	13.5	1.0
Historical Mound	CS-2	CS-2-07	C	9/28/2016	12:05:50	18.6	12.5	0	14.6	4-3/>4	>4	-2	>4 to -2	12.3	11.8	12.6	0.8
Historical Mound	FVP	FVP-01	A	10/2/2016	8:25:08	19.5	12.5	0	14.6	>4	>4	0	>4 to 0	16.5	16.1	16.8	0.7
Historical Mound	FVP	FVP-01	B	10/2/2016	8:26:02	19.5	12.5	0	14.6	>4	>4	-1	>4 to -1	14.1	13.6	14.7	1.1

Area	Location	StationID	Replicate	Date	Time	Water Depth (m)	Stop Collar Setting (in)	# of Weights (per side)	Image Width (cm)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Grain Size Range (phi)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)
Historical Mound	FVP	FVP-01	C	10/2/2016	8:26:43	19.5	12.5	0	14.6	>4	>4	0	>4 to 0	12.8	12.3	13.9	1.6
Historical Mound	FVP	FVP-02	A	10/2/2016	8:06:20	19.5	12.5	0	14.6	>4	>4	0	>4 to 0	14.6	14.2	15.2	0.9
Historical Mound	FVP	FVP-02	B	10/2/2016	8:07:04	19.5	12.5	0	14.6	>4	>4	-2	>4 to -2	12.4	11.8	13.1	1.4
Historical Mound	FVP	FVP-02	C	10/2/2016	8:07:58	19.5	12.5	0	14.6	>4	>4	-2	>4 to -2	17.2	16.8	17.5	0.7
Historical Mound	FVP	FVP-03	A	10/2/2016	8:30:39	19.5	12.5	0	14.6	>4	>4	0	>4 to 0	15.3	14.9	15.5	0.6
Historical Mound	FVP	FVP-03	B	10/2/2016	8:31:51	19.5	12.5	0	14.6	>4	>4	0	>4 to 0	15.9	15.7	16.0	0.3
Historical Mound	FVP	FVP-03	C	10/2/2016	8:32:41	19.5	12.5	0	14.6	>4	>4	0	>4 to 0	16.3	16.0	16.9	0.9
Historical Mound	FVP	FVP-04	A	10/2/2016	8:41:53	18.9	12.5	0	14.6	3-2/>4	>4	-1	>4 to -1	8.9	8.5	9.1	0.7
Historical Mound	FVP	FVP-04	B	10/2/2016	8:43:15	18.9	12.5	0	14.6	3-2/>4	>4	-1	>4 to -1	12.0	11.3	13.3	2.0
Historical Mound	FVP	FVP-04	C	10/2/2016	8:44:19	18.9	12.5	0	14.6	3-2/>4	>4	-1	>4 to -1	12.9	12.4	13.3	0.8
Historical Mound	FVP	FVP-05	A	10/2/2016	8:47:05	18.9	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	13.4	13.1	13.6	0.5
Historical Mound	FVP	FVP-05	B	10/2/2016	8:47:46	18.9	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	15.0	14.7	15.4	0.6
Historical Mound	FVP	FVP-05	C	10/2/2016	8:48:32	18.9	12.5	0	14.6	3-2/>4	>4	-1	>4 to -1	10.3	9.9	11.0	1.2
Historical Mound	FVP	FVP-06	A	10/2/2016	8:36:46	18.9	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	14.3	13.9	14.6	0.7
Historical Mound	FVP	FVP-06	B	10/2/2016	8:37:37	18.9	12.5	0	14.6	3-2/>4	>4	1	>4 to 1	12.0	11.5	12.5	1.0
Historical Mound	FVP	FVP-06	C	10/2/2016	8:38:26	18.9	12.5	0	14.6	3-2/>4	>4	-2	>4 to -2	10.1	9.4	10.5	1.1
Historical Mound	FVP	FVP-07	A	10/2/2016	8:52:58	19.2	12.5	0	14.6	>4	>4	1	>4 to 1	15.2	14.9	15.4	0.5
Historical Mound	FVP	FVP-07	B	10/2/2016	8:53:50	19.2	12.5	0	14.6	>4	>4	1	>4 to 1	12.7	12.2	13.1	0.8
Historical Mound	FVP	FVP-07	C	10/2/2016	8:54:53	19.2	12.5	0	14.6	>4	>4	1	>4 to 1	14.7	14.3	15.2	0.9
Historical Mound	MQR	MQR-01	A	9/28/2016	13:50:57	19.2	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	12.3	11.7	12.8	1.2
Historical Mound	MQR	MQR-01	B	9/28/2016	13:52:20	19.2	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	13.7	13.2	14.2	0.9
Historical Mound	MQR	MQR-01	C	9/28/2016	13:53:09	19.2	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	12.4	12.0	13.2	1.1
Historical Mound	MQR	MQR-02	A	9/28/2016	13:45:21	18.9	12.5	0	14.6	>4/4-3	>4	-1	>4 to -1	17.3	17.1	17.5	0.5
Historical Mound	MQR	MQR-02	B	9/28/2016	13:46:39	18.9	12.5	0	14.6	4-3/>4	>4	1	>4 to 1	11.6	10.8	12.1	1.3
Historical Mound	MQR	MQR-02	C	9/28/2016	13:47:27	18.9	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	11.9	11.6	12.4	0.8
Historical Mound	MQR	MQR-03	A	9/28/2016	14:05:07	18.9	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	12.4	12.0	12.5	0.5
Historical Mound	MQR	MQR-03	B	9/28/2016	14:05:50	18.9	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	13.5	13.2	13.7	0.5
Historical Mound	MQR	MQR-03	C	9/28/2016	14:06:41	18.9	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	12.3	11.0	12.9	1.8
Historical Mound	MQR	MQR-04	A	9/28/2016	13:55:50	18.6	12.5	0	14.6	4-3/>4	>4	-2	>4 to -2	12.4	12.2	12.9	0.7
Historical Mound	MQR	MQR-04	B	9/28/2016	13:56:41	18.6	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	12.3	11.8	12.9	1.0
Historical Mound	MQR	MQR-04	C	9/28/2016	13:57:33	18.6	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	12.3	11.9	12.6	0.6
Historical Mound	MQR	MQR-05	A	9/28/2016	13:41:25	19.2	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	13.9	13.4	14.2	0.9
Historical Mound	MQR	MQR-05	B	9/28/2016	13:42:14	19.2	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	13.7	13.3	13.9	0.7
Historical Mound	MQR	MQR-05	C	9/28/2016	13:43:00	19.2	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	16.2	15.7	16.8	1.1
Historical Mound	MQR	MQR-06	A	9/28/2016	14:00:33	18.3	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	13.4	7.7	14.6	6.9
Historical Mound	MQR	MQR-06	B	9/28/2016	14:01:25	18.3	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	13.1	12.6	13.3	0.7
Historical Mound	MQR	MQR-06	C	9/28/2016	14:02:31	18.3	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	13.5	13.2	13.7	0.5
Historical Mound	MQR	MQR-07	A	9/28/2016	13:35:22	19.2	12.5	0	14.6	4-3/>4	>4	-1	>4 to -1	11.6	10.9	12.7	1.7
Historical Mound	MQR	MQR-07	B	9/28/2016	13:36:31	19.2	12.5	0	14.6	4-3/>4	>4	-2	>4 to -2	14.2	13.3	14.8	1.5
Historical Mound	MQR	MQR-07	C	9/28/2016	13:37:19	19.2	12.5	0	14.6	4-3/>4	>4	0	>4 to 0	13.8	13.4	14.2	0.8

Area	Location	StationID	Replicate	Boundary Roughness Type	aRPD Mean (cm)	aRPD > Pen	Mud Clast Number	Mud Clast State	Methane Present?	Number of Methane Bubbles	Dredged Material Present?	Mean depth below Sediment Surface of top of Dredged Material Layer (cm)	Dredged Material Layer Mean Thickness (cm)	Dredged Material > Pen
NHAV14	Site	01	A	Biological	2.1				no		yes		12.9	TRUE
NHAV14	Site	01	B	Biological	0.9				no		yes		11.9	TRUE
NHAV14	Site	01	C	Biological	1.2				no		yes		13.7	TRUE
NHAV14	Site	02	A	Biological	1.5				no		yes		18.7	TRUE
NHAV14	Site	02	B	Biological	3.2				no		yes		16.0	TRUE
NHAV14	Site	02	C	Biological	2.5				no		yes		17.7	TRUE
NHAV14	Site	03	A	Biological	1.9				no		yes		17.4	TRUE
NHAV14	Site	03	B	Biological	1.4				no		yes		17.2	TRUE
NHAV14	Site	03	C	Biological	1.2				no		yes		13.5	TRUE
NHAV14	Site	04	B	Biological	2.1				no		yes		17.1	TRUE
NHAV14	Site	04	C	Biological	2.1				no		yes		17.3	TRUE
NHAV14	Site	04	D	Biological	1.2				no		yes		19.5	TRUE
NHAV14	Site	05	B	Biological	IND				no		yes		20.6	TRUE
NHAV14	Site	05	E	Biological	1.0		4	red	no		yes		11.7	TRUE
NHAV14	Site	05	F	Biological	1.2				no		yes		11.6	TRUE
NHAV14	Site	06	B	Biological	2.9		1	ox	no		yes		18.8	TRUE
NHAV14	Site	06	C	Biological	3.3				no		yes		19.6	TRUE
NHAV14	Site	06	D	Biological	0.5				no		yes		15.7	TRUE
NHAV14	Site	07	A	Biological	2.8				no		yes		18.6	TRUE
NHAV14	Site	07	B	Biological	1.3				no		yes		19.9	TRUE
NHAV14	Site	07	C	Biological	3.7				no		yes		20.4	TRUE
NHAV14	Site	08	A	Biological	0.4				no		yes		18.5	TRUE
NHAV14	Site	08	F	Biological	1.3				no		yes		16.4	TRUE
NHAV14	Site	08	H	Biological	2.8				no		yes		17.2	TRUE
CLDS-Other	Site	09	A	Biological	2.7				yes	1	yes		14.8	TRUE
CLDS-Other	Site	09	B	Biological	3.7				no		yes		17.6	TRUE
CLDS-Other	Site	09	C	Biological	3.2				no		yes		17.4	TRUE
CLDS-Other	Site	10	A	Biological	3.3				no		yes		19.4	TRUE
CLDS-Other	Site	10	B	Biological	2.6				no		yes		17.0	TRUE
CLDS-Other	Site	10	C	Biological	3.0				no		yes		17.5	TRUE
CLDS-Other	Site	11	A	Biological	3.3				no		yes		14.4	TRUE
CLDS-Other	Site	11	B	Biological	2.9				no		yes		17.7	TRUE
CLDS-Other	Site	11	C	Biological	1.3		1	red	no		yes		15.0	TRUE
CLDS-Other	Site	12	A	Biological	3.6				no		yes		17.6	TRUE
CLDS-Other	Site	12	B	Biological	3.8				no		yes		18.2	TRUE
CLDS-Other	Site	12	C	Biological	2.8				no		yes		17.6	TRUE
CLDS-Other	Site	13	B	Biological	3.7				yes	2	yes		20.1	TRUE
CLDS-Other	Site	13	C	Biological	2.3		1	ox	no		yes		19.1	TRUE
CLDS-Other	Site	13	D	Biological	3.1				yes	2	yes		19.6	TRUE
CLDS-Other	Site	14	A	Biological	1.4				no		yes		14.5	TRUE
CLDS-Other	Site	14	B	Biological	2.6		1	ox	no		yes		16.8	TRUE
CLDS-Other	Site	14	C	Biological	1.3				no		yes		17.4	TRUE
CLDS-Other	Site	15	A	Biological	3.1				no		yes		18.6	TRUE
CLDS-Other	Site	15	B	Biological	3.1		1	ox	no		yes		17.8	TRUE
CLDS-Other	Site	15	C	Biological	2.0				no		yes		13.7	TRUE
CLDS-Other	Site	16	A	Biological	2.4		1	ox	no		yes		17.3	TRUE

Area	Location	StationID	Replicate	Boundary Roughness Type	aRPD Mean (cm)	aRPD > Pen	Mud Clast Number	Mud Clast State	Methane Present?	Number of Methane Bubbles	Dredged Material Present?	Mean depth below Sediment Surface of top of Dredged Material Layer (cm)	Dredged Material Layer Mean Thickness (cm)	Dredged Material > Pen
CLDS-Other	Site	16	B	Physical	IND				no		yes		17.4	TRUE
CLDS-Other	Site	16	C	Biological	2.5				no		yes		17.3	TRUE
CLDS-Other	Site	17	A	Biological	1.5				yes	5	yes		12.8	TRUE
CLDS-Other	Site	17	B	Biological	0.7				no		yes		13.8	TRUE
CLDS-Other	Site	17	C	Biological	2.2				no		yes		13.5	TRUE
Reference	2500W	2500W-01	A	Biological	2.9		2	ox	no		no			
Reference	2500W	2500W-01	B	Biological	2.4		1	ox	no		no			
Reference	2500W	2500W-01	C	Biological	2.3				no		no			
Reference	2500W	2500W-02	A	Biological	2.5				no		no			
Reference	2500W	2500W-02	B	Biological	2.3		1	ox	no		no			
Reference	2500W	2500W-02	C	Biological	2.5				no		no			
Reference	2500W	2500W-03	A	Biological	2.9				no		no			
Reference	2500W	2500W-03	B	Biological	IND				no		no			
Reference	2500W	2500W-03	C	Physical	IND				no		no			
Reference	2500W	2500W-04	A	Biological	2.5				no		no			
Reference	2500W	2500W-04	B	Biological	2.7				no		no			
Reference	2500W	2500W-04	C	Biological	3.0				no		no			
Reference	2500W	2500W-05	A	Biological	3.0				no		no			
Reference	2500W	2500W-05	B	Biological	3.3				no		no			
Reference	2500W	2500W-05	C	Biological	2.5				no		no			
Reference	4500E	4500E-01	A	Biological	2.7				no		no			
Reference	4500E	4500E-01	B	Biological	3.6				no		no			
Reference	4500E	4500E-01	C	Biological	3.1				no		no			
Reference	4500E	4500E-02	A	Biological	2.7				no		no			
Reference	4500E	4500E-02	B	Biological	3.0		2	ox	no		no			
Reference	4500E	4500E-02	C	Biological	3.0		2	ox	no		no			
Reference	4500E	4500E-03	A	Biological	2.9				no		no			
Reference	4500E	4500E-03	B	Biological	2.7				no		no			
Reference	4500E	4500E-03	C	Physical	IND				no		no			
Reference	4500E	4500E-04	A	Biological	5.6				no		no			
Reference	4500E	4500E-04	B	Biological	2.6				no		no			
Reference	4500E	4500E-04	C	Biological	3.3				no		no			
Reference	4500E	4500E-05	A	Biological	1.5				no		no			
Reference	4500E	4500E-05	B	Biological	2.7				no		no			
Reference	4500E	4500E-05	C	Biological	2.9		1	ox	no		no			
Reference	CLIS-REF	CLIS-REF-01	A	Biological	3.7				no		no			
Reference	CLIS-REF	CLIS-REF-01	B	Biological	2.6				no		no			
Reference	CLIS-REF	CLIS-REF-01	C	Biological	2.9				no		no			
Reference	CLIS-REF	CLIS-REF-02	A	Biological	2.4				no		no			
Reference	CLIS-REF	CLIS-REF-02	B	Biological	2.9				no		no			
Reference	CLIS-REF	CLIS-REF-02	C	Biological	3.2				no		no			
Reference	CLIS-REF	CLIS-REF-03	A	Biological	2.4		1	ox	no		no			
Reference	CLIS-REF	CLIS-REF-03	B	Biological	0.8				no		no			
Reference	CLIS-REF	CLIS-REF-03	C	Biological	3.4				no		no			

Area	Location	StationID	Replicate	Boundary Roughness Type	aRPD Mean (cm)	aRPD > Pen	Mud Clast Number	Mud Clast State	Methane Present?	Number of Methane Bubbles	Dredged Material Present?	Mean depth below Sediment Surface of top of Dredged Material Layer (cm)	Dredged Material Layer Mean Thickness (cm)	Dredged Material > Pen
Reference	CLIS-REF	CLIS-REF-04	A	Biological	2.8				no		no			
Reference	CLIS-REF	CLIS-REF-04	B	Biological	2.9		2	ox	no		no			
Reference	CLIS-REF	CLIS-REF-04	C	Biological	2.7				no		no			
Reference	CLIS-REF	CLIS-REF-05	A	Biological	2.9				no		no			
Reference	CLIS-REF	CLIS-REF-05	B	Biological	3.4				no		no			
Reference	CLIS-REF	CLIS-REF-05	C	Biological	2.7				no		no			
Historical Mound	CS-1	CS-1-01	A	Biological	3.1				no		yes		19.7	TRUE
Historical Mound	CS-1	CS-1-01	B	Biological	2.4				no		yes		16.8	TRUE
Historical Mound	CS-1	CS-1-01	C	Biological	2.6				no		yes		16.2	TRUE
Historical Mound	CS-1	CS-1-02	A	Biological	2.9				no		yes		18.5	TRUE
Historical Mound	CS-1	CS-1-02	B	Biological	3.2				no		yes		17.5	TRUE
Historical Mound	CS-1	CS-1-02	C	Biological	3.9				no		yes		17.6	TRUE
Historical Mound	CS-1	CS-1-03	A	Biological	3.2				no		yes		14.9	TRUE
Historical Mound	CS-1	CS-1-03	B	Biological	2.6		3	ox	no		yes		17.8	TRUE
Historical Mound	CS-1	CS-1-03	C	Biological	2.9				no		yes		17.3	TRUE
Historical Mound	CS-1	CS-1-04	A	Biological	3.6				no		yes		17.8	TRUE
Historical Mound	CS-1	CS-1-04	B	Biological	2.4				no		yes		14.4	TRUE
Historical Mound	CS-1	CS-1-04	C	Biological	3.0				no		yes		16.6	TRUE
Historical Mound	CS-1	CS-1-05	A	Biological	3.2				no		yes		17.2	TRUE
Historical Mound	CS-1	CS-1-05	B	Biological	2.7		1	ox	no		yes		15.5	TRUE
Historical Mound	CS-1	CS-1-05	C	Biological	3.0				no		yes		15.4	TRUE
Historical Mound	CS-1	CS-1-06	A	Biological	2.6				no		yes		16.5	TRUE
Historical Mound	CS-1	CS-1-06	B	Biological	3.1		4	ox	no		yes		18.2	TRUE
Historical Mound	CS-1	CS-1-06	C	Biological	2.9				no		yes		18.2	TRUE
Historical Mound	CS-2	CS-2-01	A	Biological	2.6				no		yes		14.5	TRUE
Historical Mound	CS-2	CS-2-01	B	Biological	2.6				no		yes		15.4	TRUE
Historical Mound	CS-2	CS-2-01	C	Biological	2.2		3	ox	no		yes		15.7	TRUE
Historical Mound	CS-2	CS-2-02	A	Biological	2.5				no		yes		13.6	TRUE
Historical Mound	CS-2	CS-2-02	B	Biological	2.9				no		yes		12.4	TRUE
Historical Mound	CS-2	CS-2-02	C	Biological	3.0		2	ox	no		yes		15.3	TRUE
Historical Mound	CS-2	CS-2-03	A	Biological	2.4		1	ox	no		yes		17.0	TRUE
Historical Mound	CS-2	CS-2-03	B	Biological	2.7				no		yes		17.3	TRUE
Historical Mound	CS-2	CS-2-03	C	Biological	3.4				no		yes		17.8	TRUE
Historical Mound	CS-2	CS-2-04	B	Biological	3.7		3	red	no		yes		12.6	TRUE
Historical Mound	CS-2	CS-2-04	C	Biological	3.1				no		yes		12.1	TRUE
Historical Mound	CS-2	CS-2-04	D	Biological	2.9				no		yes		14.6	TRUE
Historical Mound	CS-2	CS-2-05	A	Biological	1.8				no		yes		4.0	TRUE
Historical Mound	CS-2	CS-2-05	B	Biological	2.9		1	ox	no		yes		9.5	TRUE
Historical Mound	CS-2	CS-2-05	C	Biological	2.7				no		yes		4.8	TRUE
Historical Mound	CS-2	CS-2-06	A	Biological	1.5				no		yes		6.7	TRUE
Historical Mound	CS-2	CS-2-06	B	Biological	2.6				no		yes		9.2	TRUE
Historical Mound	CS-2	CS-2-06	C	Biological	2.7		3	ox	no		yes		15.1	TRUE
Historical Mound	CS-2	CS-2-07	A	Biological	2.1				no		yes		11.0	TRUE
Historical Mound	CS-2	CS-2-07	B	Biological	2.7		2	ox	no		yes		13.1	TRUE
Historical Mound	CS-2	CS-2-07	C	Biological	2.5				no		yes		12.3	TRUE
Historical Mound	FVP	FVP-01	A	Biological	1.0				no		yes		16.5	TRUE
Historical Mound	FVP	FVP-01	B	Biological	0.5				no		yes		14.1	TRUE

Area	Location	StationID	Replicate	Boundary Roughness Type	aRPD Mean (cm)	aRPD > Pen	Mud Clast Number	Mud Clast State	Methane Present?	Number of Methane Bubbles	Dredged Material Present?	Mean depth below Sediment Surface of top of Dredged Material Layer (cm)	Dredged Material Layer Mean Thickness (cm)	Dredged Material > Pen
Historical Mound	FVP	FVP-01	C	Biological	1.0				no		yes		12.8	TRUE
Historical Mound	FVP	FVP-02	A	Biological	1.3				no		yes		14.6	TRUE
Historical Mound	FVP	FVP-02	B	Biological	1.8				no		yes		12.4	TRUE
Historical Mound	FVP	FVP-02	C	Biological	2.3				no		yes		17.2	TRUE
Historical Mound	FVP	FVP-03	A	Biological	2.8		1	ox	no		yes		15.3	TRUE
Historical Mound	FVP	FVP-03	B	Biological	2.6				no		yes		15.9	TRUE
Historical Mound	FVP	FVP-03	C	Biological	2.1		1	ox	no		yes		16.3	TRUE
Historical Mound	FVP	FVP-04	A	Biological	0.9				no		yes		8.9	TRUE
Historical Mound	FVP	FVP-04	B	Biological	0.2				no		yes		12.0	TRUE
Historical Mound	FVP	FVP-04	C	Biological	1.0				no		yes		12.9	TRUE
Historical Mound	FVP	FVP-05	A	Biological	1.0				no		yes		13.4	TRUE
Historical Mound	FVP	FVP-05	B	Biological	1.5				no		yes		15.0	TRUE
Historical Mound	FVP	FVP-05	C	Biological	1.1				no		yes		10.3	TRUE
Historical Mound	FVP	FVP-06	A	Biological	2.1				no		yes		14.3	TRUE
Historical Mound	FVP	FVP-06	B	Biological	0.2				no		yes		12.0	TRUE
Historical Mound	FVP	FVP-06	C	Biological	0.8				no		yes		10.1	TRUE
Historical Mound	FVP	FVP-07	A	Biological	3.0				no		yes		15.2	TRUE
Historical Mound	FVP	FVP-07	B	Biological	1.9				no		yes		12.7	TRUE
Historical Mound	FVP	FVP-07	C	Biological	0.9				no		yes		14.7	TRUE
Historical Mound	MQR	MQR-01	A	Biological	2.1				no		yes		12.3	TRUE
Historical Mound	MQR	MQR-01	B	Biological	1.8				no		yes		13.7	TRUE
Historical Mound	MQR	MQR-01	C	Biological	1.5				no		yes		12.4	TRUE
Historical Mound	MQR	MQR-02	A	Biological	2.2				no		yes		17.3	TRUE
Historical Mound	MQR	MQR-02	B	Physical	1.3				no		yes		11.6	TRUE
Historical Mound	MQR	MQR-02	C	Biological	1.8				no		yes		11.9	TRUE
Historical Mound	MQR	MQR-03	A	Biological	1.7				no		yes		12.4	TRUE
Historical Mound	MQR	MQR-03	B	Biological	2.1				no		yes		13.5	TRUE
Historical Mound	MQR	MQR-03	C	Biological	1.4				no		yes		12.3	TRUE
Historical Mound	MQR	MQR-04	A	Biological	1.3				no		yes		12.4	TRUE
Historical Mound	MQR	MQR-04	B	Biological	0.8				no		yes		12.3	TRUE
Historical Mound	MQR	MQR-04	C	Biological	0.8				no		yes		12.3	TRUE
Historical Mound	MQR	MQR-05	A	Biological	2.3				no		yes		13.9	TRUE
Historical Mound	MQR	MQR-05	B	Biological	2.2				yes	1	yes		13.7	TRUE
Historical Mound	MQR	MQR-05	C	Biological	2.6				no		yes		16.2	TRUE
Historical Mound	MQR	MQR-06	A	Biological	1.5				no		yes		13.4	TRUE
Historical Mound	MQR	MQR-06	B	Biological	1.3				no		yes		13.1	TRUE
Historical Mound	MQR	MQR-06	C	Biological	0.9				no		yes		13.5	TRUE
Historical Mound	MQR	MQR-07	A	Biological	1.0				no		yes		11.6	TRUE
Historical Mound	MQR	MQR-07	B	Biological	1.0				no		yes		14.2	TRUE
Historical Mound	MQR	MQR-07	C	Biological	2.2				no		yes		13.8	TRUE

Area	Location	StationID	Replicate	Dredged Material Notes	Low DO Present?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Successional Stage
NHAV14	Site	01	A		no	High	no		2	7.5	11.5	1 on 3
NHAV14	Site	01	B		no	High	no		1	6.3	7.2	1 on 3
NHAV14	Site	01	C		no	High	no		1	8.1	8.3	1 on 3
NHAV14	Site	02	A		no	Medium	no		0			1 on 3
NHAV14	Site	02	B		no	Medium	no		2	3.8	5.7	2 on 3
NHAV14	Site	02	C		no	Medium	no		2	9.6	15.5	2 on 3
NHAV14	Site	03	A		no	Medium	no		3	4.1	13.3	1 on 3
NHAV14	Site	03	B		no	Medium	no		0			1 on 3
NHAV14	Site	03	C		no	Medium	no		5	3.2	10.9	1 on 3
NHAV14	Site	04	B		no	High	no		3	1.7	8.1	1 on 3
NHAV14	Site	04	C		no	High	no		4	7.0	13.3	2 on 3
NHAV14	Site	04	D		no	High	no		2	5.0	12.1	2 on 3
NHAV14	Site	05	B		no	High	no		0			2 -> 3
NHAV14	Site	05	E		no	High	no		3	2.7	5.9	1 on 3
NHAV14	Site	05	F		no	High	no		2	7.4	8.1	2 on 3
NHAV14	Site	06	B		no	High	no		2	4.1	17.1	1 on 3
NHAV14	Site	06	C		no	High	no		1	3.7	4.3	1 on 3
NHAV14	Site	06	D		no	High	no		2	4.2	13.7	1 on 3
NHAV14	Site	07	A		no	High	no		3	3.5	7.2	1 on 3
NHAV14	Site	07	B		no	High	no		1	4.2	7.8	1 on 3
NHAV14	Site	07	C		no	High	no		0			2 -> 3
NHAV14	Site	08	A		no	High	no		1	6.4	7.2	1 on 3
NHAV14	Site	08	F		no	High	no		0			2 -> 3
NHAV14	Site	08	H		no	High	no		0			2 -> 3
CLDS-Other	Site	09	A		no	High	no		3	5.3	7.5	1 on 3
CLDS-Other	Site	09	B		no	Medium	no		3	2.4	13.2	2 on 3
CLDS-Other	Site	09	C		no	High	no		5	3.1	13.2	1 on 3
CLDS-Other	Site	10	A		no	High	no		5	3.1	18.2	1 on 3
CLDS-Other	Site	10	B		no	High	no		3	8.1	15.1	1 on 3
CLDS-Other	Site	10	C		no	High	no		1	15.9	16.2	1 on 3
CLDS-Other	Site	11	A		no	High	no		3	8.0	13.1	1 on 3
CLDS-Other	Site	11	B		no	High	no		1	6.2	6.5	1 on 3
CLDS-Other	Site	11	C		no	High	no		2	5.9	6.9	1 on 3
CLDS-Other	Site	12	A		no	Medium	no		3	8.3	17.4	1 on 3
CLDS-Other	Site	12	B		no	Medium	no		6	3.4	12.9	2 on 3
CLDS-Other	Site	12	C		no	Medium	no		3	12.8	17.2	1 on 3
CLDS-Other	Site	13	B		no	High	no		3	3.7	18.3	2 on 3
CLDS-Other	Site	13	C		no	High	no		0			2
CLDS-Other	Site	13	D		no	High	no		0			2
CLDS-Other	Site	14	A		no	Medium	no		2	14.2	14.8	1 on 3
CLDS-Other	Site	14	B		no	Medium	no		3	13.2	15.8	1 on 3
CLDS-Other	Site	14	C		no	Medium	no		4	11.7	17.3	1 on 3
CLDS-Other	Site	15	A		no	Medium	no		5	3.1	8.7	1 on 3
CLDS-Other	Site	15	B		no	Medium	no		0			2 -> 3
CLDS-Other	Site	15	C		no	Medium	no		0			2 -> 3
CLDS-Other	Site	16	A		no	High	no		0			2 -> 3

Area	Location	StationID	Replicate	Dredged Material Notes	Low DO Present?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Successional Stage
CLDS-Other	Site	16	B		no	High	no		1	7.6	8.0	1 on 3
CLDS-Other	Site	16	C		no	High	no		1	2.7	3.1	1 on 3
CLDS-Other	Site	17	A		no	low	no		0			2 -> 3
CLDS-Other	Site	17	B		no	low	no		3	7.2	12.0	1 on 3
CLDS-Other	Site	17	C		no	low	no		2	8.8	12.5	1 on 3
Reference	2500W	2500W-01	A		no	low	no		5	5.5	20.6	1 on 3
Reference	2500W	2500W-01	B		no	low	no		0			1 on 3
Reference	2500W	2500W-01	C		no	low	no		1	6.7	7.0	1 on 3
Reference	2500W	2500W-02	A		no	low	no		1	14.2	14.5	1 on 3
Reference	2500W	2500W-02	B		no	low	no		1	10.4	10.6	1 on 3
Reference	2500W	2500W-02	C		no	Medium	no		1	2.7	3.0	1 on 3
Reference	2500W	2500W-03	A		no	Medium	no		1	9.6	10.7	1 on 3
Reference	2500W	2500W-03	B		no	low	no		2	3.5	5.6	1 on 3
Reference	2500W	2500W-03	C		no	Medium	no		2	8.5	11.5	1 on 3
Reference	2500W	2500W-04	A		no	low	no		4	1.4	16.8	1 on 3
Reference	2500W	2500W-04	B		no	low	no		2	6.0	16.8	1 on 3
Reference	2500W	2500W-04	C		no	Medium	no		3	6.2	14.0	1 on 3
Reference	2500W	2500W-05	A		no	Medium	no		2	11.8	14.1	1 on 3
Reference	2500W	2500W-05	B		no	low	no		6	3.8	16.1	1 on 3
Reference	2500W	2500W-05	C		no	low	no		1	9.8	10.5	1 on 3
Reference	4500E	4500E-01	A		no	low	no		3	4.4	6.5	1 on 3
Reference	4500E	4500E-01	B		no	Medium	no		3	9.8	17.3	1 on 3
Reference	4500E	4500E-01	C		no	low	no		1	12.6	14.8	1 on 3
Reference	4500E	4500E-02	A		no	low	no		2	0.5	2.5	1 on 3
Reference	4500E	4500E-02	B		no	low	no		1	4.7	6.0	1 on 3
Reference	4500E	4500E-02	C		no	low	no		3	12.6	15.6	1 on 3
Reference	4500E	4500E-03	A		no	low	no		1	9.6	10.1	1 on 3
Reference	4500E	4500E-03	B		no	low	no		2	3.9	14.7	1 on 3
Reference	4500E	4500E-03	C		no	low	no		0			IND
Reference	4500E	4500E-04	A		no	low	no		0			2 -> 3
Reference	4500E	4500E-04	B		no	low	no		2	12.7	15.1	1 on 3
Reference	4500E	4500E-04	C		no	low	no		2	8.6	12.3	1 on 3
Reference	4500E	4500E-05	A		no	low	no		2	2.1	13.9	1 on 3
Reference	4500E	4500E-05	B		no	low	no		6	3.4	15.1	1 on 3
Reference	4500E	4500E-05	C		no	low	no		2	9.0	9.3	1 on 3
Reference	CLIS-REF	CLIS-REF-01	A		no	low	no		1	4.8	5.4	1 on 3
Reference	CLIS-REF	CLIS-REF-01	B		no	low	no		1	8.8	10.9	1 on 3
Reference	CLIS-REF	CLIS-REF-01	C		no	low	no		0			2 -> 3
Reference	CLIS-REF	CLIS-REF-02	A		no	low	no		0			2 -> 3
Reference	CLIS-REF	CLIS-REF-02	B		no	low	no		7	5.4	15.2	2 on 3
Reference	CLIS-REF	CLIS-REF-02	C		no	low	no		1	8.4	9.1	2 on 3
Reference	CLIS-REF	CLIS-REF-03	A		no	low	no		5	4.9	15.4	1 on 3
Reference	CLIS-REF	CLIS-REF-03	B		no	low	no		1	9.1	9.4	1 on 3
Reference	CLIS-REF	CLIS-REF-03	C		no	low	no		3	6.0	14.7	1 on 3

Area	Location	StationID	Replicate	Dredged Material Notes	Low DO Present?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Successional Stage
Reference	CLIS-REF	CLIS-REF-04	A		no	low	no		3	6.9	12.8	1 on 3
Reference	CLIS-REF	CLIS-REF-04	B		no	Medium	no		1	14.5	15.0	1 on 3
Reference	CLIS-REF	CLIS-REF-04	C		no	Medium	no		4	3.9	12.1	1 on 3
Reference	CLIS-REF	CLIS-REF-05	A		no	low	no		2	2.6	7.5	1 on 3
Reference	CLIS-REF	CLIS-REF-05	B		no	low	no		1	10.5	12.2	1 on 3
Reference	CLIS-REF	CLIS-REF-05	C		no	low	no		2	4.8	14.2	1 on 3
Historical Mound	CS-1	CS-1-01	A		no	Medium	no		2	9.6	14.4	1 on 3
Historical Mound	CS-1	CS-1-01	B		no	Medium	no		2	8.8	15.4	1 on 3
Historical Mound	CS-1	CS-1-01	C		no	low	no		0			2 -> 3
Historical Mound	CS-1	CS-1-02	A		no	low	no		4	1.3	17.7	1 on 3
Historical Mound	CS-1	CS-1-02	B		no	low	no		1	3.3	3.4	1 on 3
Historical Mound	CS-1	CS-1-02	C		no	low	no		1	5.5	6.3	2 on 3
Historical Mound	CS-1	CS-1-03	A		no	low	no		0			2
Historical Mound	CS-1	CS-1-03	B		no	low	no		1	17.2	17.7	2 on 3
Historical Mound	CS-1	CS-1-03	C		no	low	no		0			2 -> 3
Historical Mound	CS-1	CS-1-04	A		no	Medium	no		2	12.7	14.2	1 on 3
Historical Mound	CS-1	CS-1-04	B		no	Medium	no		1	6.9	7.2	1 on 3
Historical Mound	CS-1	CS-1-04	C		no	Medium	no		3	8.4	13.6	1 on 3
Historical Mound	CS-1	CS-1-05	A		no	Medium	no		1	15.7	16.0	1 on 3
Historical Mound	CS-1	CS-1-05	B		no	low	no		3	5.6	9.3	1 on 3
Historical Mound	CS-1	CS-1-05	C		no	low	no		1	11.6	12.1	1 on 3
Historical Mound	CS-1	CS-1-06	A		no	low	no		1	3.9	4.2	1 on 3
Historical Mound	CS-1	CS-1-06	B		no	low	no		3	10.4	15.7	2 on 3
Historical Mound	CS-1	CS-1-06	C		no	low	no		2	7.5	16.3	2 on 3
Historical Mound	CS-2	CS-2-01	A		no	Medium	no		1	12.3	13.1	1 on 3
Historical Mound	CS-2	CS-2-01	B		no	low	no		3	1.9	13.1	1 on 3
Historical Mound	CS-2	CS-2-01	C		no	low	no		0			2 -> 3
Historical Mound	CS-2	CS-2-02	A		no	Medium	no		2	3.8	13.7	2 -> 3
Historical Mound	CS-2	CS-2-02	B		no	Medium	no		1	11.9	12.1	2 on 3
Historical Mound	CS-2	CS-2-02	C		no	Medium	no		1	4.8	4.9	2 -> 3
Historical Mound	CS-2	CS-2-03	A		no	Medium	no		2	11.7	16.8	2 on 3
Historical Mound	CS-2	CS-2-03	B		no	Medium	no		2	3.8	8.9	2 on 3
Historical Mound	CS-2	CS-2-03	C		no	Medium	no		1	5.9	6.2	2 on 3
Historical Mound	CS-2	CS-2-04	B		no	Medium	no		0			2
Historical Mound	CS-2	CS-2-04	C		no	Medium	no		0			2 -> 3
Historical Mound	CS-2	CS-2-04	D		no	Medium	no		1	2.1	2.3	2 on 3
Historical Mound	CS-2	CS-2-05	A		no	IND	no		0			2
Historical Mound	CS-2	CS-2-05	B		no	low	no		0			2
Historical Mound	CS-2	CS-2-05	C		no	Medium	no		1	1.7	1.9	2 on 3
Historical Mound	CS-2	CS-2-06	A		no	Medium	no		0			2
Historical Mound	CS-2	CS-2-06	B		no	Medium	no		0			2 -> 3
Historical Mound	CS-2	CS-2-06	C		no	low	no		0			2 on 3
Historical Mound	CS-2	CS-2-07	A		no	low	no		1	8.8	9.6	2 on 3
Historical Mound	CS-2	CS-2-07	B		no	Medium	no		1	12.4	13.2	1 on 3
Historical Mound	CS-2	CS-2-07	C		no	High	no		1	7.0	10.2	2 on 3
Historical Mound	FVP	FVP-01	A		no	low	no		1	1.0	1.9	2 -> 3
Historical Mound	FVP	FVP-01	B		no	low	no		1	7.8	8.1	2 on 3

Area	Location	StationID	Replicate	Dredged Material Notes	Low DO Present?	Sediment Oxygen Demand	Beggiatoa Present?	Beggiatoa Type/Extent	# of Feeding Voids	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Successional Stage
Historical Mound	FVP	FVP-01	C		no	High	no		2	4.1	9.3	2 on 3
Historical Mound	FVP	FVP-02	A		no	High	no		1	9.7	9.9	2 on 3
Historical Mound	FVP	FVP-02	B		no	Medium	no		1	11.2	12.0	2 on 3
Historical Mound	FVP	FVP-02	C		no	Medium	no		0			2 on 3
Historical Mound	FVP	FVP-03	A		no	Medium	no		4	9.0	14.3	2 on 3
Historical Mound	FVP	FVP-03	B		no	Medium	no		1	13.3	14.5	2 on 3
Historical Mound	FVP	FVP-03	C		no	low	no		2	7.0	15.7	2 on 3
Historical Mound	FVP	FVP-04	A		no	High	no		0			2
Historical Mound	FVP	FVP-04	B		no	High	no		2	5.6	8.8	2 on 3
Historical Mound	FVP	FVP-04	C		no	High	no		0			2
Historical Mound	FVP	FVP-05	A		no	Medium	no		0			1 -> 2
Historical Mound	FVP	FVP-05	B		no	Medium	no		1	12.5	12.8	1 on 3
Historical Mound	FVP	FVP-05	C		no	High	no		1	8.6	10.2	1 on 3
Historical Mound	FVP	FVP-06	A		no	Medium	no		1	3.5	3.9	1 on 3
Historical Mound	FVP	FVP-06	B		no	High	no		0			2
Historical Mound	FVP	FVP-06	C		no	High	no		1	6.8	7.1	2 on 3
Historical Mound	FVP	FVP-07	A		no	High	no		3	4.7	11.8	2 on 3
Historical Mound	FVP	FVP-07	B		no	High	no		1	4.1	5.2	1 on 3
Historical Mound	FVP	FVP-07	C		no	High	no		1	11.2	11.6	1 on 3
Historical Mound	MQR	MQR-01	A		no	low	no		2	2.5	9.2	1 on 3
Historical Mound	MQR	MQR-01	B		no	low	no		0			2
Historical Mound	MQR	MQR-01	C		no	low	no		1	8.2	8.5	2 on 3
Historical Mound	MQR	MQR-02	A		no	low	no		2	8.2	16.7	2 on 3
Historical Mound	MQR	MQR-02	B		no	low	no		1	1.6	2.0	2 on 3
Historical Mound	MQR	MQR-02	C		no	low	no		0			2
Historical Mound	MQR	MQR-03	A		no	low	no		0			2
Historical Mound	MQR	MQR-03	B		no	low	no		1	6.4	6.7	2 on 3
Historical Mound	MQR	MQR-03	C		no	low	no		3	6.3	10.6	2 on 3
Historical Mound	MQR	MQR-04	A		no	low	no		3	3.2	9.9	2 on 3
Historical Mound	MQR	MQR-04	B		no	low	no		1	10.9	11.1	1 on 3
Historical Mound	MQR	MQR-04	C		no	low	no		0			2
Historical Mound	MQR	MQR-05	A		no	low	no		3	1.5	10.5	1 on 3
Historical Mound	MQR	MQR-05	B		no	low	no		1	12.6	13.2	1 on 3
Historical Mound	MQR	MQR-05	C		no	Medium	no		1	1.9	3.7	2 -> 3
Historical Mound	MQR	MQR-06	A		no	low	no		2	6.1	12.4	1 on 3
Historical Mound	MQR	MQR-06	B		no	low	no		0			2
Historical Mound	MQR	MQR-06	C		no	low	no		0			2
Historical Mound	MQR	MQR-07	A		no	low	no		1	5.1	5.5	2 on 3
Historical Mound	MQR	MQR-07	B		no	low	no		1	11.9	12.2	2 on 3
Historical Mound	MQR	MQR-07	C		no	low	no		0			2

Area	Location	StationID	Replicate	Comment
NHAV14	Site	01	A	A small tube at SWI. Evidence of bioturbation beneath aRPD boundary including an infilled void and an open void.
NHAV14	Site	01	B	Shallow aRPD boundary. Infilled void beneath aRPD boundary.
NHAV14	Site	01	C	Shallow aRPD boundary. Open void beneath aRPD boundary and open burrow beneath void filled with what appears to be fragments of shell.
NHAV14	Site	02	A	Shallow aRPD boundary with a small tube at SWI. Infilled burrows begin at aRPD boundary and extend all the way to depth.
NHAV14	Site	02	B	Many small tubes/arms at SWI. Large, open void at aRPD boundary and small void beneath aRPD boundary. Infilled burrowing present beneath aRPD boundary.
NHAV14	Site	02	C	Small tubes/arms at SWI. Partially infilled burrows begin shallow and extend to depth. A few partially infilled voids associated with burrows beneath aRPD boundary.
NHAV14	Site	03	A	Shallow aRPD boundary with many large, infilled burrows and open and infilled voids beginning just beneath aRPD boundary and continuing to depth.
NHAV14	Site	03	B	Shallow aRPD boundary with infilled burrows present beneath aRPD boundary.
NHAV14	Site	03	C	Shallow aRPD with many large, open voids beneath aRPD boundary.
NHAV14	Site	04	B	Open void at aRPD boundary. Evidence of bioturbation extending beyond aRPD boundary.
NHAV14	Site	04	C	Many infilled and open burrows and voids beneath aRPD boundary and continuing to depth.
NHAV14	Site	04	D	Shallow aRPD boundary with a few small tubes at SWI. Open void just beneath aRPD boundary. Evidence of deep bioturbation.
NHAV14	Site	05	B	Bioturbation evident beginning at SWI and continuing to depth.
NHAV14	Site	05	E	Small tubes at SWI. A few dark mud clasts at SWI. Infilled burrows and an infilled void beneath aRPD boundary.
NHAV14	Site	05	F	Small tubes at SWI. Infilled and open voids beneath aRPD boundary.
NHAV14	Site	06	B	Small tubes at SWI. Open void at aRPD boundary and infilled void at depth.
NHAV14	Site	06	C	Many small tubes at SWI. Open void at aRPD boundary. Small burrows appear just beneath aRPD boundary.
NHAV14	Site	06	D	Very shallow aRPD boundary but open and infilled voids beneath boundary and at depth.
NHAV14	Site	07	A	Small tubes at SWI. Open voids at aRPD boundary and infilled burrows and an infilled void beneath aRPD boundary.
NHAV14	Site	07	B	Small tubes at SWI. Evidence of bioturbation beneath aRPD boundary but no identifying characteristics of stage 3 presense.
NHAV14	Site	07	C	Small tubes at SWI. Evidence of bioturbation beneath aRPD boundary but no identifying characteristics of stage 3 presense.
NHAV14	Site	08	A	Very shallow aRPD boundary with an open void and infilled burrows beneath aRPD boundary. PV image shows long tubes at sediment surface.
NHAV14	Site	08	F	Shallow aRPD. Some very small, shallow burrows. PV image shows long tubes at sediment surface.
NHAV14	Site	08	H	Shallow aRPD with small and larger burrows near SWI not yet extending beyond aRPD boundary. PV image shows long tubes at sediment surface.
CLDS-Other	Site	09	A	A small tube at SWI. Evidence of bioturbation beneath aRPD boundary including an open void. Methane bubble just beneath aRPD.
CLDS-Other	Site	09	B	Open voids above and below aRPD boundary. Deepest void is very large.
CLDS-Other	Site	09	C	Small tubes at SWI. Open voids above and below aRPD boundary. Deepest void is very large.
CLDS-Other	Site	10	A	Small tubes at SWI. Open voids above and below aRPD boundary. Good example of stage 3 voids.
CLDS-Other	Site	10	B	Small tubes at SWI. Open burrow above aRPD boundary. Infilled and open voids beneath aRPD boundary.
CLDS-Other	Site	10	C	Evidence of bioturbation near aRPD boundary and void at depth.
CLDS-Other	Site	11	A	Small tubes at SWI. Burrowing and open voids beneath aRPD boundary.
CLDS-Other	Site	11	B	Small tubes at SWI. Infilled burrows and an infilled void beneath aRPD boundary.
CLDS-Other	Site	11	C	Small tubes and a large clast at SWI. Very large, infilled burrow with associated voids throughout sediment beneath aRPD boundary.
CLDS-Other	Site	12	A	Infilled void beneath aRPD boundary and large, open burrow with associated voids at depth.
CLDS-Other	Site	12	B	Small tubes at SWI. A lot of bioturbation beneath aRPD boundary including many infilled voids.
CLDS-Other	Site	12	C	Small tubes at SWI. Infilled and open voids beneath aRPD boundary all the way to depth.
CLDS-Other	Site	13	B	Small tubes at SWI. Distinct layering of sediments. Two methane bubbles at aRPD boundary. An open burrow with small worm and associated void beneath aRPD boundary. Large, partially infilled burrow at depth.
CLDS-Other	Site	13	C	Small burrows present beginning near SWI and continuing beyond aRPD boundary. No evidence of stage 3 organisms. Distinct layering of sediments
CLDS-Other	Site	13	D	A small tube at SWI. Small burrows near SWI and continuing to aRPD boundary. Few pass aRPD boundary. Methane bubbles at depth. Distinct layering of sediment.
CLDS-Other	Site	14	A	Shallow aRPD boundary. Large burrow beneath aRPD boundary and open voids at depth. PV images show tubes at sediment surface.
CLDS-Other	Site	14	B	Shallow aRPD boundary with some small burrows around aRPD boundary. PV images show tubes at sediment surface.
CLDS-Other	Site	14	C	Small tubes at SWI. Shallow aRPD boundary with some small burrows around aRPD boundary. PV images show tubes at sediment surface.
CLDS-Other	Site	15	A	Many small tubes at SWI. Collapsed voids begin at aRPD boundary and continue beneath. Large, open void beneath aRPD boundary.
CLDS-Other	Site	15	B	Very small tubes at SWI. Shallow aRPD with small burrows above aRPD boundary.
CLDS-Other	Site	15	C	Evidence of bioturbation moving aRPD boundary deeper but no visible tubes or burrows.
CLDS-Other	Site	16	A	Evidence of bioturbation moving aRPD boundary deeper but no visible tubes. A few small burrows near aRPD boundary.

Area	Location	StationID	Replicate	Comment
CLDS-Other	Site	16	B	SWI appears to have been recently disturbed. A tube visible at SWI. Shallow aRPD boundary with infilled void beneath.
CLDS-Other	Site	16	C	Shallow aRPD boundary with many very small tubes at SWI. Open void just beneath aRPD boundary.
CLDS-Other	Site	17	A	Evidence of bioturbation moving aRPD boundary deeper but no visible voids. Many methane bubbles of various sizes beneath aRPD boundary. PV images show many small tubes at sediment surface.
CLDS-Other	Site	17	B	Evidence of bioturbation moving aRPD boundary deeper. Open and infilled voids at depth. PV images show many small tubes at sediment surface.
CLDS-Other	Site	17	C	Very shallow aRPD boundary with evidence of bioturbation moving the boundary deeper. Large, open burrow with associated voids at depth. PV images show many small tubes at sediment surface.
Reference	2500W	2500W-01	A	Small tubes at SWI. Evidence of bioturbation moving the aRPD boundary deeper. Open and collapsed voids beneath aRPD boundary continue to depth.
Reference	2500W	2500W-01	B	Evidence of bioturbation moving the aRPD boundary deeper with small burrows extending beneath.
Reference	2500W	2500W-01	C	Evidence of bioturbation moving the aRPD boundary deeper with large, infilling burrow at depth.
Reference	2500W	2500W-02	A	Evidence of bioturbation moving the aRPD boundary deeper with infilled burrows and an open void at depth.
Reference	2500W	2500W-02	B	Evidence of bioturbation moving the aRPD boundary deeper with many small worms and tubes at SWI. Open void at depth.
Reference	2500W	2500W-02	C	Evidence of bioturbation moving the aRPD boundary deeper. Small worms at SWI. Open void beneath aRPD boundary.
Reference	2500W	2500W-03	A	Evidence of bioturbation moving the aRPD boundary deeper with large, infilled burrow at depth.
Reference	2500W	2500W-03	B	Unable to determine aRPD boundary. Large, open voids and burrows begin a few cms deep and continue.
Reference	2500W	2500W-03	C	Disturbance at SWI makes aRPD determination difficult. A tube visible at SWI. Infilled voids nearing depth.
Reference	2500W	2500W-04	A	Small tubes at SWI. Open voids begin in upper cms of sediment and continue all the way to depth. Open burrows with visible worms also present.
Reference	2500W	2500W-04	B	Small worms at SWI. Infilled voids beneath aRPD boundary. Large, open burrow just in image at depth.
Reference	2500W	2500W-04	C	Evidence of bioturbation moving the aRPD boundary deeper with infilled voids and burrows beneath that continue to depth.
Reference	2500W	2500W-05	A	Infilled and open voids and burrows begin beneath aRPD boundary and continue to depth.
Reference	2500W	2500W-05	B	Evidence of bioturbation moving the aRPD boundary deeper with many open voids and open burrows beginning beneath aRPD boundary and continuing to depth.
Reference	2500W	2500W-05	C	Open burrow with visible worm in upper few cms of sediment. Infilled burrows at depth.
Reference	4500E	4500E-01	A	A few small tubes at SWI with evidence of bioturbation moving the aRPD boundary deeper. Open burrows and infilled burrows beneath aRPD boundary.
Reference	4500E	4500E-01	B	A few small tubes at SWI with evidence of bioturbation moving the aRPD boundary deeper. Infilled burrows beneath aRPD boundary.
Reference	4500E	4500E-01	C	Evidence of bioturbation moving the aRPD boundary deeper with very large, open void and open burrow at depth.
Reference	4500E	4500E-02	A	Evidence of bioturbation moving the aRPD boundary deeper with small, open voids just beneath.
Reference	4500E	4500E-02	B	Evidence of bioturbation moving the aRPD boundary deeper with a few small tubes at SWI. Infilled burrows beneath aRPD boundary.
Reference	4500E	4500E-02	C	Evidence of bioturbation moving the aRPD boundary deeper with many small burrows and voids at depth.
Reference	4500E	4500E-03	A	Small tubes at SWI. Evidence of bioturbation moving the aRPD boundary deeper with a large, partially infilled burrow with associated void beneath.
Reference	4500E	4500E-03	B	Infilled burrows beneath aRPD boundary.
Reference	4500E	4500E-03	C	Very large disturbance at SWI has made aRPD and successional stage determination difficult. Good example of physical boundary roughness
Reference	4500E	4500E-04	A	Small worms at SWI. Evidence of bioturbation moving aRPD boundary deeper.
Reference	4500E	4500E-04	B	Small tubes at SWI. Evidence of bioturbation moving aRPD boundary deeper. Open and infilled void at depth.
Reference	4500E	4500E-04	C	Small tubes at SWI. Evidence of bioturbation moving aRPD boundary deeper. Two open voids beneath aRPD boundary..
Reference	4500E	4500E-05	A	Shallow aRPD boundary with infilled burrows present beneath aRPD boundary.
Reference	4500E	4500E-05	B	Open and infilled voids begin at aRPD boundary and continue throughout sediment to depth.
Reference	4500E	4500E-05	C	Evidence of bioturbation moving the aRPD boundary deeper. A couple infilled burrows and two collapsed voids beneath aRPD boundary.
Reference	CLIS-REF	CLIS-REF-01	A	Evidence of bioturbation moving the aRPD boundary deeper. A large, open void just beneath aRPD boundary. A few infilled burrows at depth.
Reference	CLIS-REF	CLIS-REF-01	B	Small tubes at SWI. Evidence of bioturbation moving the aRPD boundary deeper. A infilled burrows beneath aRPD boundary.
Reference	CLIS-REF	CLIS-REF-01	C	Evidence of bioturbation moving aRPD boundary deeper. Infilled burrow beneath aRPD boundary.
Reference	CLIS-REF	CLIS-REF-02	A	Small burrows above aRPD boundary. An infilled burrow just beneath aRPD boundary.
Reference	CLIS-REF	CLIS-REF-02	B	Evidence of bioturbation moving aRPD boundary deeper. Many open and infilled voids begin beneath aRPD boundary and continue throughout sediment to depth.
Reference	CLIS-REF	CLIS-REF-02	C	Definite disturbance of sediment. Possibly due to heavy bioturbation. Partially filled void beneath aRPD boundary.
Reference	CLIS-REF	CLIS-REF-03	A	Very small tubes at SWI. Many infillled and open voids begin just beneath aRPD boundary and continue to depth.
Reference	CLIS-REF	CLIS-REF-03	B	Very shallow aRPD boundary with an open burrow containing a visible worm and associated void beneath aRPD boundary.
Reference	CLIS-REF	CLIS-REF-03	C	Open voids beneath aRPD boundary.

Area	Location	StationID	Replicate	Comment
Reference	CLIS-REF	CLIS-REF-04	A	Evidence of bioturbation moving aRPD boundary deeper. Open voids and infilled burrows begin beneath aRPD boundary and move to depth.
Reference	CLIS-REF	CLIS-REF-04	B	Evidence of bioturbation moving aRPD boundary deeper. Infilled burrows beneath aRPD boundary. Large, open burrow just in the frame at depth.
Reference	CLIS-REF	CLIS-REF-04	C	Visible burrows above aRPD boundary. Open voids begin just beneath aRPD boundary and continue to depth.
Reference	CLIS-REF	CLIS-REF-05	A	Visible burrows above aRPD boundary. Open void just beneath aRPD boundary and large, infilled void a few cms deeper.
Reference	CLIS-REF	CLIS-REF-05	B	Evidence of bioturbation moving the aRPD boundary deeper. Large, infilled burrow at depth.
Reference	CLIS-REF	CLIS-REF-05	C	Open void just beneath aRPD boundary. Burrow with large, visible worm beneath and another large, open void at depth.
Historical Mound	CS-1	CS-1-01	A	Many small worms at SWI. Infilled burrows begin beneath aRPD boundary and continue to depth. A few burrows have associated, open voids.
Historical Mound	CS-1	CS-1-01	B	Evidence of bioturbation moving aRPD boundary deeper. Open voids beneath aRPD boundary.
Historical Mound	CS-1	CS-1-01	C	A few small worms at SWI. Evidence of bioturbation moving aRPD boundary deeper. Infilled burrows beneath aRPD boundary.
Historical Mound	CS-1	CS-1-02	A	Many small worms at SWI. Open voids begin just beneath SWI and continue to depth.
Historical Mound	CS-1	CS-1-02	B	No visible worms or tubes. Infilled void at aRPD boundary.
Historical Mound	CS-1	CS-1-02	C	Open void beneath aRPD boundary. Small burrows visible beginning beneath SWI and continuing to depth.
Historical Mound	CS-1	CS-1-03	A	Many small burrows above aRPD boundary. No visible biology at SWI.
Historical Mound	CS-1	CS-1-03	B	A worm at SWI. Open void at depth. Infilled burrows evident beneath aRPD boundary.
Historical Mound	CS-1	CS-1-03	C	A few small tubes at SWI. Small burrows begin beneath SWI and continue to depth. Large, infilled burrows beneath aRPD boundary.
Historical Mound	CS-1	CS-1-04	A	Small worms at SWI. Infilled and open burrows beneath aRPD boundary. Open voids near depth.
Historical Mound	CS-1	CS-1-04	B	Large, open burrow throughout image. Open void beneath aRPD boundary.
Historical Mound	CS-1	CS-1-04	C	Small tube at SWI. Open and infilled burrows begin beneath aRPD boundary and continue to depth.
Historical Mound	CS-1	CS-1-05	A	Small, open void at depth.
Historical Mound	CS-1	CS-1-05	B	Many small worms at SWI. Large, open burrow with associated open voids beneath aRPD boundary.
Historical Mound	CS-1	CS-1-05	C	Small burrows above aRPD boundary. An infilled burrow near depth.
Historical Mound	CS-1	CS-1-06	A	Small worms at SWI. Partially infilled void just beneath aRPD boundary.
Historical Mound	CS-1	CS-1-06	B	A few large mudclasts at SWI. One has been drug down by penetration to mix with upper layer of sediment. A few small tubes at SWI. Open burrows and voids at depth.
Historical Mound	CS-1	CS-1-06	C	Burrow begins at SWI and continues to large, open void beneath aRPD boundary. Infilled burrows and a collapsed void at depth.
Historical Mound	CS-2	CS-2-01	A	Large, open void at depth. Infilled burrows beneath aRPD boundary.
Historical Mound	CS-2	CS-2-01	B	Open voids above and just beneath aRPD boundary. Infilled voids at depth.
Historical Mound	CS-2	CS-2-01	C	A few mudclasts appear to have been drug down into upper sediment by prism. They may have been attached to prism before this replicate. Stage 2 bivalves above aRPD boundary.
Historical Mound	CS-2	CS-2-02	A	Open void just beneath aRPD boundary and at depth. Shell fragments in deep sediment. Fecal piles visible at sediment surface in PV images.
Historical Mound	CS-2	CS-2-02	B	Tubes and small worms at SWI. Open burrows with large worms and an associated open void beneath aRPD boundary. Lower sediment layer contains many shell fragments. Fecal piles visible at sediment surface in PV images.
Historical Mound	CS-2	CS-2-02	C	Burrow with void just beneath aRPD boundary. Small burrows beneath aRPd boundary. Lower sediment layer contains shell fragments. Fecal piles visible at sediment surface in PV images.
Historical Mound	CS-2	CS-2-03	A	Many small worms at SWI. Infilled burrows beneath aRPD boundary with a small, open void and a very large, open void at depth.
Historical Mound	CS-2	CS-2-03	B	Small tube at SWI. Open voids beneath aRPD boundary. Example of stage 3 voids.
Historical Mound	CS-2	CS-2-03	C	Small tubes at SWI. Open void beneath aRPD boundary. Small burrows throughout sediment.
Historical Mound	CS-2	CS-2-04	B	Small tubes and worms in background of SWI. Very dark mud clasts at SWI. Small burrows above aRPD boundary.
Historical Mound	CS-2	CS-2-04	C	Small worms at SWI. Fecal mound at SWI. No visible stage 3 organisms but fecal mound and large burrow penetrating beyond aRPD boundary suggest their presence.
Historical Mound	CS-2	CS-2-04	D	Open void at aRPD boundary. Lower sediment layer contains shell fragments.
Historical Mound	CS-2	CS-2-05	A	A couple tubes in background of SWI.
Historical Mound	CS-2	CS-2-05	B	A few small tubes and a large clast at SWI. Evidence of bioturbation pushing aRPD boundary deeper into sediment.
Historical Mound	CS-2	CS-2-05	C	Open burrow with associated void above aRPD boundary.
Historical Mound	CS-2	CS-2-06	A	Thin aRPD with some evidence of shallow burrows. Burrows visible in PV images.
Historical Mound	CS-2	CS-2-06	B	Open burrow with visible worm beneath aRPD boundary. No voids visible. Burrows visible in PV images.
Historical Mound	CS-2	CS-2-06	C	Small tubes and worms at SWI. Infilled burrow beneath aRPD boundary. Burrows visible in PV images.
Historical Mound	CS-2	CS-2-07	A	Burrows moving beneath aRPD boundary and an infilled void at depth.
Historical Mound	CS-2	CS-2-07	B	Small burrows with visible worms above aRPD boundary. Large, open burrow at depth.
Historical Mound	CS-2	CS-2-07	C	Small tubes at SWI. Large, open void beneath aRPD boundary. Infilled burrows beneath aRPD boundary.
Historical Mound	FVP	FVP-01	A	Small tubes at SWI. Open void just above aRPD boundary. No evidence of stage 3 organisms beneath aRPD boundary.
Historical Mound	FVP	FVP-01	B	Small tubes and a crab at SWI. Small burrows throughout sediment. Very large burrow with visible organism and associated void at depth.

Area	Location	StationID	Replicate	Comment
Historical Mound	FVP	FVP-01	C	Small tubes at SWI. Two large, open voids beneath aRPD boundary. Example of large burrows.
Historical Mound	FVP	FVP-02	A	Unknown object/organism at SWI. Evidence of bioturbulation moving aRPD boundary deeper into sediment. Infilled burrows and void at depth.
Historical Mound	FVP	FVP-02	B	Unknown objects in background of SWI. Open burrows and void at depth.
Historical Mound	FVP	FVP-02	C	Small worms at SWI. Evidence of bioturbation moving aRPD boundary deeper. Large, infilled burrow at depth.
Historical Mound	FVP	FVP-03	A	Small worms visible at SWI. Open burrow with associated open voids beneath aRPD boudary nearing depth.
Historical Mound	FVP	FVP-03	B	Many small worms at SWI. Infilled void at depth.
Historical Mound	FVP	FVP-03	C	Unable to determine aRPD boundary. Infilled void and large, open burrow with open void at depth.
Historical Mound	FVP	FVP-04	A	Tubes in background of SWI. Shell fragment at SWI. Coarse sediment makes aRPD determination difficult. No visible evidence of stage 3 organisms.
Historical Mound	FVP	FVP-04	B	Tubes at SWI and open and infilled voids in sediment. No visible aRPD boundary because of coarse sediment.
Historical Mound	FVP	FVP-04	C	Small tubes visible at SWI. No visible evidence of stage 3 organisms present.
Historical Mound	FVP	FVP-05	A	Small worms at SWI. Thin aRPD boundary.
Historical Mound	FVP	FVP-05	B	Evidence of bioturbation moving aRPD boundary deeper into sediment. Open void at depth.
Historical Mound	FVP	FVP-05	C	Unable to determine aRPD boundary because of coarse sediment. Large, open burrows at depth.
Historical Mound	FVP	FVP-06	A	Small worms and tubes at SWI. Open void just beneath aRPD boundary. Large, open burrow at depth.
Historical Mound	FVP	FVP-06	B	Shallow aRPD boundary but evidence of bioturbation moving it deeper into sediment. Small burrows beneath aRPD boundary.
Historical Mound	FVP	FVP-06	C	Tubes and a hermit crab at SWI. Unable to determine aRPD boundary. Infilled void in sediment.
Historical Mound	FVP	FVP-07	A	Small tubes at SWI. Infilled and open voids beneath aRPD boundary.
Historical Mound	FVP	FVP-07	B	Small worms at SWI. Infilled void beneath aRPD boundary.
Historical Mound	FVP	FVP-07	C	A tube at SWI. Thin aRPD boundary with an open void and infilled burrow beneath.
Historical Mound	MQR	MQR-01	A	Small burrows throughout sediment. Two collapsed voids beneath aRPD boundary.
Historical Mound	MQR	MQR-01	B	Small burrows throughout sediment. No visible evidence of stage 3 organisms.
Historical Mound	MQR	MQR-01	C	Small tube visible in background at SWI. Small burrows throughout sediment. Partially filled void beneath aRPD boundary.
Historical Mound	MQR	MQR-02	A	Small tubes at SWI. Open and infilled voids beneath aRPD boundary.
Historical Mound	MQR	MQR-02	B	Small worms at SWI. Infilled void just beneath aRPD boundary.
Historical Mound	MQR	MQR-02	C	Small burrows throughout sediment. Large, infilled burrows at depth.
Historical Mound	MQR	MQR-03	A	A tube at SWI. Small burrows throughout sediment but no visible evidence of stage 3 organisms.
Historical Mound	MQR	MQR-03	B	Small tubes at SWI. Burrows with visible worms in sediment and collapsed void beneath aRPD boundary.
Historical Mound	MQR	MQR-03	C	Large burrow beginning at SI and continueing to depth with large, open void associated. Other burrows with visible worms present.
Historical Mound	MQR	MQR-04	A	A small tube at SWI. Open burrows and open voids begin beneath aRPD boundary and continue to depth. Some burrows have visible worms.
Historical Mound	MQR	MQR-04	B	Thin aRPD boundary with infilled burrows and open void beneath.
Historical Mound	MQR	MQR-04	C	Thin aRPD boundary. Open and infilled burrows, some containing visible worms beneath aRPD boundary.
Historical Mound	MQR	MQR-05	A	Small worms at SWI. Open voids above and below aRPD boundary.
Historical Mound	MQR	MQR-05	B	Thin aRPD boundary with methane bubble just beneath. Many small, open burrows containing visible worms beneath aRPD boundary and an infilled void at depth.
Historical Mound	MQR	MQR-05	C	Large, open void in upper cms of sediment. Evidence of burrowing deepr in sediment.
Historical Mound	MQR	MQR-06	A	Major disturbance of something (possibly organism) at SWI in right of image. Open voids at depth.
Historical Mound	MQR	MQR-06	B	Small tube in background of SWI. Many small burrows above and just below aRPD boundary. No visible evidence of the presence of stage 3 organisms.
Historical Mound	MQR	MQR-06	C	Small burrows in upper cms of sediment. No visible evidence of stage 3 organisms present.
Historical Mound	MQR	MQR-07	A	Tubes and small worms at SWI. Open void beneath aRPD boundary. Open and infilled burrows throughout sediment.
Historical Mound	MQR	MQR-07	B	Small worms at SWI. Small burrows throughout sediment and a collapsed void at depth.
Historical Mound	MQR	MQR-07	C	Small burrows near and below aRPD boundary, some containing visible worms.

Area	Location	StationID	Replicate	Date	Time	Image Width (cm)	Image Height (cm)	Field of View (m^2)	Sediment Type	Surface Oxidation	Beggiatoa Present?	Beggiatoa Type/Extent	Dredged Material Present?	Dredged Material Notes
NHAV14	Site	01	A	9/28/2016	14:52:45	48.51	32.34	0.16	sand/silt	ox	No			
NHAV14	Site	01	B	9/28/2016	14:53:33	38.88	25.92	0.10	sand/silt	ox	No			
NHAV14	Site	02	A	9/28/2016	14:58:41	40.75	27.17	0.11	sand/silt	ox	No			
NHAV14	Site	02	B	9/28/2016	14:59:27	46.59	31.06	0.14	sand/silt	ox	No			
NHAV14	Site	03	A	9/28/2016	15:04:13	36.38	24.25	0.09	sand/silt	ox	No			
NHAV14	Site	03	B	9/28/2016	15:05:34	46.43	30.95	0.14	sand/silt	ox	No			
NHAV14	Site	03	C	9/28/2016	15:06:17	IND	IND	IND	sand/silt	ox	No			
NHAV14	Site	04	A	9/28/2016	15:11:29	38.05	25.37	0.10	sand/silt	ox	No			
NHAV14	Site	04	B	9/28/2016	15:12:38	IND	IND	IND	sand/silt	ox	No			
NHAV14	Site	04	C	9/28/2016	15:14:10	39.12	26.08	0.10	sand/silt	ox	No			
NHAV14	Site	05	A	9/28/2016	15:20:32	38.31	25.54	0.10	sand/silt	ox	No			
NHAV14	Site	05	B	9/28/2016	15:21:41	43.62	29.08	0.13	sand/silt	ox	No			
NHAV14	Site	05	C	9/28/2016	15:22:30	36.01	24.01	0.09	sand/silt	ox	No			
NHAV14	Site	06	A	9/28/2016	15:28:25	40.29	26.86	0.11	sand/silt	ox	No			
NHAV14	Site	06	B	9/28/2016	15:29:11	36.55	24.37	0.09	sand/silt	ox	No			
NHAV14	Site	06	C	9/28/2016	15:29:57	45.56	30.37	0.14	sand/silt	ox	No			
NHAV14	Site	07	A	9/28/2016	15:39:45	49.81	33.21	0.17	sand/silt	ox	No			
NHAV14	Site	07	B	9/28/2016	15:40:56	44.62	29.75	0.13	sand/silt	ox	No			
NHAV14	Site	07	C	9/28/2016	15:42:09	33.36	22.24	0.07	sand/silt	ox	No			
NHAV14	Site	08	A	9/28/2016	15:34:13	39.59	26.40	0.10	sand/silt	ox	No			
NHAV14	Site	08	B	9/28/2016	15:35:14	36.83	24.55	0.09	sand/silt	ox	No			
NHAV14	Site	08	C	9/28/2016	15:36:01	44.02	29.35	0.13	sand/silt	ox	No			
CLDS-Other	Site	09	A	9/28/2016	15:49:55	38.84	25.90	0.10	sand/silt	ox	No			
CLDS-Other	Site	09	B	9/28/2016	15:50:58	32.26	21.51	0.07	sand/silt	ox	No			
CLDS-Other	Site	09	C	9/28/2016	15:51:55	29.95	19.97	0.06	sand/silt	ox	No			
CLDS-Other	Site	11	A	9/28/2016	16:07:44	46.88	31.25	0.15	sand/silt	ox	No			
CLDS-Other	Site	11	B	9/28/2016	16:08:44	37.79	25.19	0.10	sand/silt	ox	No			
CLDS-Other	Site	11	C	9/28/2016	16:09:55	42.72	28.48	0.12	sand/silt	ox	No			
CLDS-Other	Site	12	A	9/28/2016	16:13:26	35.20	23.47	0.08	sand/silt	ox	No			
CLDS-Other	Site	12	B	9/28/2016	16:14:54	44.37	29.58	0.13	sand/silt	ox	No			
CLDS-Other	Site	12	C	9/28/2016	16:15:50	46.65	31.10	0.15	sand/silt	ox	No			
CLDS-Other	Site	13	A	9/28/2016	13:29:21	35.52	23.68	0.08	sand/silt	ox	No			
CLDS-Other	Site	13	D	9/28/2016	13:31:53	37.97	25.32	0.10	sand/silt	ox	No			
CLDS-Other	Site	14	B	9/28/2016	13:24:26	35.14	23.42	0.08	sand/silt	ox	No			
CLDS-Other	Site	14	C	9/28/2016	13:25:14	34.48	22.99	0.08	sand/silt	ox	No			
CLDS-Other	Site	16	A	9/28/2016	13:10:13	33.39	22.26	0.07	sand/silt	ox	No			
CLDS-Other	Site	16	C	9/28/2016	13:12:00	33.56	22.38	0.08	sand/silt	ox	No			
CLDS-Other	Site	16	D	9/28/2016	13:12:49	40.21	26.80	0.11	sand/silt	ox	No			
CLDS-Other	Site	17	A	9/28/2016	13:15:47	37.32	24.88	0.09	sand/silt	ox	No			
CLDS-Other	Site	17	B	9/28/2016	13:16:54	IND	IND	IND	sand/silt	ox	No			
CLDS-Other	Site	17	C	9/28/2016	13:17:41	41.94	27.96	0.12	sand/silt	ox	No			
Reference	2500W	2500W-01	A	10/2/2016	11:50:58	56.52	37.68	0.21	sand/silt	ox	No			

Area	Location	StationID	Replicate	Date	Time	Image Width (cm)	Image Height (cm)	Field of View (m^2)	Sediment Type	Surface Oxidation	Beggiatoa Present?	Beggiatoa Type/Extent	Dredged Material Present?	Dredged Material Notes
Reference	2500W	2500W-02	A	10/2/2016	11:46:33	45.09	30.06	0.14	sand/silt	ox	No			
Reference	2500W	2500W-02	B	10/2/2016	11:47:21	42.30	28.20	0.12	sand/silt	ox	No			
Reference	2500W	2500W-02	C	10/2/2016	11:48:01	IND	IND	IND	sand/silt	ox	No			
Reference	2500W	2500W-03	A	10/2/2016	12:05:39	42.44	28.29	0.12	sand/silt	ox	No			
Reference	2500W	2500W-03	B	10/2/2016	12:06:22	46.99	31.33	0.15	sand/silt	ox	No			
Reference	2500W	2500W-03	D	10/2/2016	12:07:40	IND	IND	IND	sand/silt	ox	No			
Reference	2500W	2500W-04	A	10/2/2016	12:00:01	46.26	30.84	0.14	sand/silt	ox	No			
Reference	2500W	2500W-04	B	10/2/2016	12:00:50	42.62	28.42	0.12	sand/silt	ox	No			
Reference	2500W	2500W-04	C	10/2/2016	12:01:29	39.80	26.53	0.11	sand/silt	ox	No			
Reference	2500W	2500W-05	A	10/2/2016	12:12:15	31.94	21.29	0.07	sand/silt	ox	No			
Reference	2500W	2500W-05	B	10/2/2016	12:13:02	47.97	31.98	0.15	sand/silt	ox	No			
Reference	2500W	2500W-05	C	10/2/2016	12:14:18	51.18	34.12	0.17	sand/silt	ox	No			
Reference	4500E	4500E-01	A	10/2/2016	9:38:37	39.39	26.26	0.10	sand/silt	ox	No			
Reference	4500E	4500E-02	A	10/2/2016	9:32:13	51.52	34.35	0.18	sand/silt	ox	No			
Reference	4500E	4500E-03	A	10/2/2016	9:11:15	42.90	28.60	0.12	sand/silt	ox	No			
Reference	4500E	4500E-03	B	10/2/2016	9:12:07	43.19	28.79	0.12	sand/silt	ox	No			
Reference	4500E	4500E-04	A	10/2/2016	9:27:06	48.99	32.66	0.16	sand/silt	ox	No			
Reference	4500E	4500E-04	B	10/2/2016	9:27:51	49.94	33.29	0.17	sand/silt	ox	No			
Reference	4500E	4500E-05	A	10/2/2016	9:19:40	39.84	26.56	0.11	sand/silt	ox	No			
Reference	4500E	4500E-05	C	10/2/2016	9:21:30	45.24	30.16	0.14	sand/silt	ox	No			
Reference	4500E	4500E-05	D	10/2/2016	9:22:17	41.85	27.90	0.12	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-01	A	10/2/2016	11:06:12	42.67	28.45	0.12	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-01	B	10/2/2016	11:06:59	51.86	34.57	0.18	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-01	C	10/2/2016	11:07:42	43.72	29.15	0.13	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-02	A	10/2/2016	10:59:44	45.40	30.27	0.14	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-02	B	10/2/2016	11:00:41	IND	IND	IND	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-02	C	10/2/2016	11:01:29	51.52	34.35	0.18	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-03	A	10/2/2016	10:43:35	51.72	34.48	0.18	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-03	B	10/2/2016	10:44:28	53.50	35.67	0.19	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-03	C	10/2/2016	10:45:26	45.40	30.27	0.14	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-04	A	10/2/2016	10:52:16	42.90	28.60	0.12	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-04	D	10/2/2016	10:54:28	48.63	32.42	0.16	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-05	A	10/2/2016	10:35:55	50.06	33.38	0.17	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-05	B	10/2/2016	10:36:40	40.41	26.94	0.11	sand/silt	ox	No			
Reference	CLIS-REF	CLIS-REF-05	C	10/2/2016	10:37:32	50.52	33.68	0.17	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-01	A	9/28/2016	12:13:03	37.25	24.83	0.09	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-01	B	9/28/2016	12:14:06	36.31	24.21	0.09	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-01	C	9/28/2016	12:15:00	35.39	23.59	0.08	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-02	A	9/28/2016	12:22:19	33.19	22.13	0.07	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-02	B	9/28/2016	12:23:13	54.17	36.11	0.20	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-02	C	9/28/2016	12:24:02	46.43	30.95	0.14	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-03	A	9/28/2016	12:17:40	48.57	32.38	0.16	sand/silt	ox	No			

Area	Location	StationID	Replicate	Date	Time	Image Width (cm)	Image Height (cm)	Field of View (m^2)	Sediment Type	Surface Oxidation	Beggiatoa Present?	Beggiatoa Type/Extent	Dredged Material Present?	Dredged Material Notes
Historical Mound	CS-1	CS-1-03	C	9/28/2016	12:19:58	39.35	26.24	0.10	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-03	D	9/28/2016	12:20:52	44.27	29.51	0.13	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-04	A	9/28/2016	12:26:53	34.98	23.32	0.08	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-04	B	9/28/2016	12:27:47	37.07	24.71	0.09	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-04	C	9/28/2016	12:28:37	48.45	32.30	0.16	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-05	A	9/28/2016	12:33:48	40.41	26.94	0.11	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-05	B	9/28/2016	12:34:34	39.43	26.29	0.10	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-05	C	9/28/2016	12:35:25	43.33	28.89	0.13	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-06	A	9/28/2016	12:37:26	36.35	24.23	0.09	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-06	B	9/28/2016	12:38:16	40.08	26.72	0.11	sand/silt	ox	No			
Historical Mound	CS-1	CS-1-06	D	9/28/2016	12:40:29	31.76	21.17	0.07	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-01	A	9/28/2016	11:32:56	26.48	17.65	0.05	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-02	A	9/28/2016	11:05:19	34.09	22.73	0.08	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-02	B	9/28/2016	11:06:44	34.95	23.30	0.08	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-03	A	9/28/2016	11:40:13	35.75	23.83	0.09	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-03	B	9/28/2016	11:41:08	43.05	28.70	0.12	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-03	D	9/28/2016	11:43:14	48.03	32.02	0.15	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-04	A	9/28/2016	11:46:09	33.53	22.36	0.07	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-04	B	9/28/2016	11:47:20	37.32	24.88	0.09	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-04	C	9/28/2016	11:48:06	IND	IND	IND	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-05	C	9/28/2016	11:53:13	51.18	34.12	0.17	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-05	D	9/28/2016	11:54:02	57.44	38.29	0.22	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-06	A	9/28/2016	11:56:37	43.43	28.95	0.13	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-06	B	9/28/2016	11:57:26	34.57	23.05	0.08	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-06	C	9/28/2016	11:58:12	35.52	23.68	0.08	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-07	A	9/28/2016	12:03:42	35.26	23.51	0.08	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-07	B	9/28/2016	12:04:32	37.28	24.86	0.09	sand/silt	ox	No			
Historical Mound	CS-2	CS-2-07	C	9/28/2016	12:05:35	53.21	35.47	0.19	sand/silt	ox	No			
Historical Mound	FVP	FVP-01	A	10/2/2016	8:24:54	50.26	33.51	0.17	sand/silt	ox	No			
Historical Mound	FVP	FVP-01	B	10/2/2016	8:25:48	44.98	29.99	0.13	sand/silt	ox	No			
Historical Mound	FVP	FVP-01	C	10/2/2016	8:26:29	52.00	34.67	0.18	sand/silt	ox	No			
Historical Mound	FVP	FVP-02	A	10/2/2016	8:06:06	44.98	29.99	0.13	sand/silt	ox	No			
Historical Mound	FVP	FVP-02	B	10/2/2016	8:06:50	46.99	31.33	0.15	sand/silt	ox	No			
Historical Mound	FVP	FVP-02	C	10/2/2016	8:07:44	35.55	23.70	0.08	sand/silt	ox	No			
Historical Mound	FVP	FVP-03	A	10/2/2016	8:30:25	50.39	33.59	0.17	sand/silt	ox	No			
Historical Mound	FVP	FVP-03	C	10/2/2016	8:32:27	53.42	35.62	0.19	sand/silt	ox	No			
Historical Mound	FVP	FVP-04	A	10/2/2016	8:41:39	58.91	39.27	0.23	sand/silt	ox	No			
Historical Mound	FVP	FVP-04	B	10/2/2016	8:43:01	60.84	40.56	0.25	sand/silt	ox	No			
Historical Mound	FVP	FVP-04	C	10/2/2016	8:44:05	41.10	27.40	0.11	sand/silt	ox	No			
Historical Mound	FVP	FVP-05	A	10/2/2016	8:46:51	43.19	28.79	0.12	sand/silt	ox	No			
Historical Mound	FVP	FVP-05	D	10/2/2016	8:49:08	47.97	31.98	0.15	sand/silt	ox	No			
Historical Mound	FVP	FVP-06	A	10/2/2016	8:36:32	57.27	38.18	0.22	sand/silt	ox	No			

Area	Location	StationID	Replicate	Date	Time	Image Width (cm)	Image Height (cm)	Field of View (m^2)	Sediment Type	Surface Oxidation	Beggiatoa Present?	Beggiatoa Type/Extent	Dredged Material Present?	Dredged Material Notes
Historical Mound	FVP	FVP-06	B	10/2/2016	8:37:23	59.27	39.51	0.23	sand/silt	ox	No			
Historical Mound	FVP	FVP-06	C	10/2/2016	8:38:11	59.63	39.76	0.24	sand/silt	ox	No			
Historical Mound	FVP	FVP-07	A	10/2/2016	8:52:44	47.85	31.90	0.15	sand/silt	ox	No			
Historical Mound	FVP	FVP-07	B	10/2/2016	8:53:36	50.32	33.55	0.17	sand/silt	ox	No			
Historical Mound	FVP	FVP-07	C	10/2/2016	8:54:39	42.03	28.02	0.12	sand/silt	ox	No			
Historical Mound	MQR	MQR-01	B	9/28/2016	13:52:05	IND	IND	IND	sand/silt	ox	No			
Historical Mound	MQR	MQR-01	C	9/28/2016	13:52:54	32.99	22.00	0.07	sand/silt	ox	No			
Historical Mound	MQR	MQR-02	A	9/28/2016	13:45:07	28.97	19.32	0.06	sand/silt	ox	No			
Historical Mound	MQR	MQR-02	D	9/28/2016	13:48:09	46.04	30.70	0.14	sand/silt	ox	No			
Historical Mound	MQR	MQR-03	B	9/28/2016	14:05:35	IND	IND	IND	sand/silt	ox	No			
Historical Mound	MQR	MQR-04	A	9/28/2016	13:55:35	35.39	23.59	0.08	sand/silt	ox	No			
Historical Mound	MQR	MQR-04	B	9/28/2016	13:56:26	30.98	20.65	0.06	sand/silt	ox	No			
Historical Mound	MQR	MQR-04	D	9/28/2016	13:58:17	40.88	27.25	0.11	sand/silt	ox	No			
Historical Mound	MQR	MQR-05	B	9/28/2016	13:42:00	34.03	22.69	0.08	sand/silt	ox	No			
Historical Mound	MQR	MQR-06	A	9/28/2016	14:00:19	31.15	20.77	0.06	sand/silt	ox	No			
Historical Mound	MQR	MQR-06	B	9/28/2016	14:01:11	33.39	22.26	0.07	sand/silt	ox	No			
Historical Mound	MQR	MQR-06	C	9/28/2016	14:02:14	37.43	24.95	0.09	sand/silt	ox	No			
Historical Mound	MQR	MQR-07	A	9/28/2016	13:35:07	47.22	31.48	0.15	sand/silt	ox	No			
Historical Mound	MQR	MQR-07	B	9/28/2016	13:36:15	33.85	22.57	0.08	sand/silt	ox	No			

Area	Location	StationID	Replicate	Debris	Bedforms	Tubes	Burrows	Tracks	Epifauna	Flora	Number of Fish
NHAV14	Site	01	A			None	Sparse (<10%)	None			
NHAV14	Site	01	B			Sparse (<10%)	Sparse (<10%)	None			
NHAV14	Site	02	A			None	Sparse (<10%)	None			
NHAV14	Site	02	B			Sparse (<10%)	None	None			
NHAV14	Site	03	A			Sparse (<10%)	None	None			
NHAV14	Site	03	B			None	None	None			
NHAV14	Site	03	C	shell		Sparse (<10%)	None	None			
NHAV14	Site	04	A			None	Sparse (<10%)	None			
NHAV14	Site	04	B			None	Sparse (<10%)	None			
NHAV14	Site	04	C			Abundant (25-75%)	Sparse (<10%)	None			
NHAV14	Site	05	A			Sparse (<10%)	Sparse (<10%)	None			
NHAV14	Site	05	B		cobble	None	Sparse (<10%)	None			
NHAV14	Site	05	C			Sparse (<10%)	Sparse (<10%)	None			
NHAV14	Site	06	A	shell		Sparse (<10%)	Sparse (<10%)	None			
NHAV14	Site	06	B			Sparse (<10%)	Sparse (<10%)	None			
NHAV14	Site	06	C			Sparse (<10%)	Sparse (<10%)	None			
NHAV14	Site	07	A			Sparse (<10%)	Sparse (<10%)	None			
NHAV14	Site	07	B	shell		Sparse (<10%)	None	None			
NHAV14	Site	07	C			Sparse (<10%)	Sparse (<10%)	None			
NHAV14	Site	08	A		cobble	None	None	None	unknown orange organism		
NHAV14	Site	08	B			None	None	None			
NHAV14	Site	08	C			Sparse (<10%)	None	None			
CLDS-Other	Site	09	A			Sparse (<10%)	Sparse (<10%)	None			
CLDS-Other	Site	09	B	shell		Sparse (<10%)	Sparse (<10%)	None			
CLDS-Other	Site	09	C	shell		None	None	None			
CLDS-Other	Site	11	A			None	None	None			
CLDS-Other	Site	11	B		cobble	None	None	Sparse (<10%)	hydroids		
CLDS-Other	Site	11	C		cobble	None	None	Sparse (<10%)			
CLDS-Other	Site	12	A			None	None	Sparse (<10%)			
CLDS-Other	Site	12	B		cobble	None	None	None			
CLDS-Other	Site	12	C		cobble	None	None	None			
CLDS-Other	Site	13	A			None	None	None			
CLDS-Other	Site	13	D			None	None	None			
CLDS-Other	Site	14	B			Abundant (25-75%)	Sparse (<10%)	None			
CLDS-Other	Site	14	C			Abundant (25-75%)	Sparse (<10%)	None			
CLDS-Other	Site	16	A			Sparse (<10%)	None	None			
CLDS-Other	Site	16	C			Sparse (<10%)	Sparse (<10%)	None			
CLDS-Other	Site	16	D			Present (10-25%)	Sparse (<10%)	None			
CLDS-Other	Site	17	A			Sparse (<10%)	Sparse (<10%)	None			
CLDS-Other	Site	17	B			Present (10-25%)	Sparse (<10%)	None			
CLDS-Other	Site	17	C	shell		Abundant (25-75%)	Sparse (<10%)	None			
Reference	2500W	2500W-01	A	shell		Present (10-25%)	Sparse (<10%)	None			

Area	Location	StationID	Replicate	Debris	Bedforms	Tubes	Burrows	Tracks	Epifauna	Flora	Number of Fish
Reference	2500W	2500W-02	A		cobble	Sparse (<10%)	Sparse (<10%)	None			
Reference	2500W	2500W-02	B			Present (10-25%)	Sparse (<10%)	None			
Reference	2500W	2500W-02	C			Sparse (<10%)	Sparse (<10%)	None			
Reference	2500W	2500W-03	A			Sparse (<10%)	Sparse (<10%)	None			
Reference	2500W	2500W-03	B	shell		Sparse (<10%)	Sparse (<10%)	None			
Reference	2500W	2500W-03	D			Sparse (<10%)	None	Sparse (<10%)			
Reference	2500W	2500W-04	A		cobble	Present (10-25%)	Sparse (<10%)	None			
Reference	2500W	2500W-04	B			Present (10-25%)	Sparse (<10%)	None			
Reference	2500W	2500W-04	C		cobble	Sparse (<10%)	Sparse (<10%)	None			
Reference	2500W	2500W-05	A			Sparse (<10%)	Sparse (<10%)	None			
Reference	2500W	2500W-05	B			None	Sparse (<10%)	None			
Reference	2500W	2500W-05	C			Sparse (<10%)	None	Sparse (<10%)			
Reference	4500E	4500E-01	A			Sparse (<10%)	Sparse (<10%)	None			
Reference	4500E	4500E-02	A			Sparse (<10%)	Sparse (<10%)	None			
Reference	4500E	4500E-03	A		cobble	Sparse (<10%)	Sparse (<10%)	None			
Reference	4500E	4500E-03	B			Sparse (<10%)	Sparse (<10%)	None			
Reference	4500E	4500E-04	A			None	Sparse (<10%)	None			
Reference	4500E	4500E-04	B		cobble	None	Sparse (<10%)	None			
Reference	4500E	4500E-05	A	shell		None	Sparse (<10%)	None			
Reference	4500E	4500E-05	C	shell	cobble	Present (10-25%)	Sparse (<10%)	None			
Reference	4500E	4500E-05	D		cobble	Sparse (<10%)	Sparse (<10%)	None			
Reference	CLIS-REF	CLIS-REF-01	A			None	Sparse (<10%)	Sparse (<10%)			
Reference	CLIS-REF	CLIS-REF-01	B	shell		Sparse (<10%)	Sparse (<10%)	None			
Reference	CLIS-REF	CLIS-REF-01	C		cobble	Sparse (<10%)	Sparse (<10%)	None			
Reference	CLIS-REF	CLIS-REF-02	A	shell	cobble	Sparse (<10%)	Sparse (<10%)	None			
Reference	CLIS-REF	CLIS-REF-02	B	shell		Sparse (<10%)	Sparse (<10%)	None			
Reference	CLIS-REF	CLIS-REF-02	C	shell	cobble	Sparse (<10%)	Sparse (<10%)	None			
Reference	CLIS-REF	CLIS-REF-03	A			Sparse (<10%)	Sparse (<10%)	None			
Reference	CLIS-REF	CLIS-REF-03	B			None	Sparse (<10%)	None			
Reference	CLIS-REF	CLIS-REF-03	C			None	None	None			
Reference	CLIS-REF	CLIS-REF-04	A			None	None	None			
Reference	CLIS-REF	CLIS-REF-04	D			None	None	None			
Reference	CLIS-REF	CLIS-REF-05	A			Sparse (<10%)	Sparse (<10%)	None			
Reference	CLIS-REF	CLIS-REF-05	B		cobble	Sparse (<10%)	Sparse (<10%)	None			
Reference	CLIS-REF	CLIS-REF-05	C		cobble	None	Sparse (<10%)	None			
Historical Mound	CS-1	CS-1-01	A			Sparse (<10%)	None	None			
Historical Mound	CS-1	CS-1-01	B			None	None	None			
Historical Mound	CS-1	CS-1-01	C			None	None	None			
Historical Mound	CS-1	CS-1-02	A			None	None	None			
Historical Mound	CS-1	CS-1-02	B		cobble	Sparse (<10%)	Sparse (<10%)	None			
Historical Mound	CS-1	CS-1-02	C	shell		None	None	None			
Historical Mound	CS-1	CS-1-03	A			None	None	None			

Area	Location	StationID	Replicate	Debris	Bedforms	Tubes	Burrows	Tracks	Epifauna	Flora	Number of Fish
Historical Mound	CS-1	CS-1-03	C			None	None	Sparse (<10%)			
Historical Mound	CS-1	CS-1-03	D		cobble	None	None	None			
Historical Mound	CS-1	CS-1-04	A	shell		None	None	None			
Historical Mound	CS-1	CS-1-04	B	shell		Sparse (<10%)	None	None			
Historical Mound	CS-1	CS-1-04	C			None	None	None			
Historical Mound	CS-1	CS-1-05	A			None	Sparse (<10%)	None			
Historical Mound	CS-1	CS-1-05	B			Sparse (<10%)	None	None			
Historical Mound	CS-1	CS-1-05	C			None	None	None			
Historical Mound	CS-1	CS-1-06	A			None	None	None			
Historical Mound	CS-1	CS-1-06	B		cobble	None	None	None			
Historical Mound	CS-1	CS-1-06	D			None	None	None			
Historical Mound	CS-2	CS-2-01	A	shell		None	None	None			
Historical Mound	CS-2	CS-2-02	A	shell		None	Present (10-25%)	Sparse (<10%)			
Historical Mound	CS-2	CS-2-02	B			None	Sparse (<10%)	None			
Historical Mound	CS-2	CS-2-03	A			None	Sparse (<10%)	None			
Historical Mound	CS-2	CS-2-03	B			None	Sparse (<10%)	None			
Historical Mound	CS-2	CS-2-03	D	shell	cobble	None	None	None			
Historical Mound	CS-2	CS-2-04	A	shell		None	None	None			
Historical Mound	CS-2	CS-2-04	B			None	None	None			
Historical Mound	CS-2	CS-2-04	C		cobble	None	None	None			
Historical Mound	CS-2	CS-2-05	C			None	Sparse (<10%)	None			
Historical Mound	CS-2	CS-2-05	D	shell	cobble	Sparse (<10%)	Sparse (<10%)	None			
Historical Mound	CS-2	CS-2-06	A	shell		None	Sparse (<10%)	None			
Historical Mound	CS-2	CS-2-06	B	shell		Sparse (<10%)	None	None			
Historical Mound	CS-2	CS-2-06	C			None	None	None			
Historical Mound	CS-2	CS-2-07	A	shell		Sparse (<10%)	None	None			
Historical Mound	CS-2	CS-2-07	B	shell		None	None	None			
Historical Mound	CS-2	CS-2-07	C	shell	cobble	None	None	None			
Historical Mound	FVP	FVP-01	A			Sparse (<10%)	Sparse (<10%)	Sparse (<10%)	gastropod		
Historical Mound	FVP	FVP-01	B	shell		None	Sparse (<10%)	Sparse (<10%)			
Historical Mound	FVP	FVP-01	C	shell		Sparse (<10%)	Sparse (<10%)	None			
Historical Mound	FVP	FVP-02	A			None	None	Abundant (25-75%)	gastropods		
Historical Mound	FVP	FVP-02	B	shell		Sparse (<10%)	None	None	hydroids		
Historical Mound	FVP	FVP-02	C			Sparse (<10%)	Sparse (<10%)	Sparse (<10%)			
Historical Mound	FVP	FVP-03	A			None	Sparse (<10%)	None			
Historical Mound	FVP	FVP-03	C			None	Sparse (<10%)	None			
Historical Mound	FVP	FVP-04	A			Present (10-25%)	Sparse (<10%)	None	unknown orange organisms, hydroids		
Historical Mound	FVP	FVP-04	B	shell		Sparse (<10%)	Present (10-25%)	None	unknown orange organism		
Historical Mound	FVP	FVP-04	C	shell		Sparse (<10%)	Sparse (<10%)	Sparse (<10%)	unknown orange organism, hydroids		
Historical Mound	FVP	FVP-05	A			None	Sparse (<10%)	None			
Historical Mound	FVP	FVP-05	D	shell		Sparse (<10%)	Sparse (<10%)	None	hydroids		
Historical Mound	FVP	FVP-06	A	shell		Sparse (<10%)	Sparse (<10%)	None			

Area	Location	StationID	Replicate	Debris	Bedforms	Tubes	Burrows	Tracks	Epifauna	Flora	Number of Fish
Historical Mound	FVP	FVP-06	B	shell	cobble	Sparse (<10%)	Sparse (<10%)	Sparse (<10%)	gastropod		
Historical Mound	FVP	FVP-06	C	shell		Sparse (<10%)	Sparse (<10%)	None	unknown orange organism, hydroids		
Historical Mound	FVP	FVP-07	A	shell	cobble	None	Sparse (<10%)	None			
Historical Mound	FVP	FVP-07	B			None	None	None			
Historical Mound	FVP	FVP-07	C	shell	cobble	None	None	None			
Historical Mound	MQR	MQR-01	B			None	None	None			
Historical Mound	MQR	MQR-01	C	shell		None	None	None			
Historical Mound	MQR	MQR-02	A			None	None	None			
Historical Mound	MQR	MQR-02	D	shell		None	None	None			
Historical Mound	MQR	MQR-03	B	shell		None	None	None			
Historical Mound	MQR	MQR-04	A			Sparse (<10%)	None	None			
Historical Mound	MQR	MQR-04	B	shell		Sparse (<10%)	None	None			
Historical Mound	MQR	MQR-04	D	shell		Sparse (<10%)	Sparse (<10%)	None	unknown orange organism		
Historical Mound	MQR	MQR-05	B			None	None	None			
Historical Mound	MQR	MQR-06	A	shell		None	None	None			
Historical Mound	MQR	MQR-06	B	shell		Sparse (<10%)	None	None			
Historical Mound	MQR	MQR-06	C	shell		Sparse (<10%)	None	None			
Historical Mound	MQR	MQR-07	A	shell		Sparse (<10%)	Sparse (<10%)	None			
Historical Mound	MQR	MQR-07	B	shell		Sparse (<10%)	None	None			

Area	Location	StationID	Replicate	Comments
NHAV14	Site	01	A	A lot of debris in water column makes image difficult to see seafloor features.
NHAV14	Site	01	B	Some shell/small pebbles on sediment surface.
NHAV14	Site	02	A	Mostly uniform sediment surface with one or two small burrows visible.
NHAV14	Site	02	B	Mostly uniform sediment surface.A couple small tubes visible.
NHAV14	Site	03	A	A few small tubes visible.
NHAV14	Site	03	B	Image somewhat distorted. No visible tubes or burrows.
NHAV14	Site	03	C	A few small tubes in image. Shell fragments scattered across sediment surface.
NHAV14	Site	04	A	Coarse sediment surface with small burrows visible.
NHAV14	Site	04	B	Coarse sediment surface with small burrows visible. Half of image obscured by sediment cloud, unable to locate second laser.
NHAV14	Site	04	C	Coarse sediment surface with many small tubes visible across entire image.
NHAV14	Site	05	A	Coarse sediment surface with small tubes and small burrows visible.
NHAV14	Site	05	B	Most of image is cobble with some sediment visible.
NHAV14	Site	05	C	Coarse sediment with a few small tubes and burrows.
NHAV14	Site	06	A	Coarse sediment surface with a few shell fragments. A couple small tubes and burrows.
NHAV14	Site	06	B	Coarse sediment surface with a few small tubes and burrows.
NHAV14	Site	06	C	Coarse sediment surface with a few small tubes and burrows.
NHAV14	Site	07	A	Coarse sediment surface contains a few small tubes and some burrows.
NHAV14	Site	07	B	Coarse sediment surface with some scattered shell throughout image.
NHAV14	Site	07	C	Coarse sediment surface with a few medium sized burrows and a small tube or two.
NHAV14	Site	08	A	Coarse sediment surface with an unknown orange organism in lower right corner of image. Some cobble scattered about sediment surface.
NHAV14	Site	08	B	Coarse sediment surface.
NHAV14	Site	08	C	Coarse sediment surface. A couple long tubes in image.
CLDS-Other	Site	09	A	Coarse sediment surface. Small tubes throughout and a few larger burrows in image.
CLDS-Other	Site	09	B	Coarse sediment with some shell fragments resting on surface. A couple medium to large burrows present in image.
CLDS-Other	Site	09	C	Coarse sediment surface containing shell fragments.
CLDS-Other	Site	11	A	Coarse sediment surface. No visible tubes, burrows, or tracks.
CLDS-Other	Site	11	B	Coarse sediment with a couple tracks running through center of image. An object, possibly cobble with hydroids attached in image.
CLDS-Other	Site	11	C	Coarse sediment with some cobble resting on suface. A track running through image.
CLDS-Other	Site	12	A	Coarse sediment surface with a few small tracks visible.
CLDS-Other	Site	12	B	Coarse sediment surface with a lot of cobble resting on top.
CLDS-Other	Site	12	C	Coarse sediment surface with a few scattered cobble partially buried.
CLDS-Other	Site	13	A	Uniform sediment surface.
CLDS-Other	Site	13	D	Uniform sediment surface.
CLDS-Other	Site	14	B	Small tubes present in the majority of the image.
CLDS-Other	Site	14	C	Many tubes of various sizes, some with worms sticking out of them into the water column.
CLDS-Other	Site	16	A	Coarse sediment surface with a few small tubes.
CLDS-Other	Site	16	C	Coarse sediment surface with a few small tubes and burrows.
CLDS-Other	Site	16	D	Corase sediment surface with small tubes scattered throughout and a few small burrows.
CLDS-Other	Site	17	A	Coarse sediment surface with a few small tubes and burrows.
CLDS-Other	Site	17	B	Could not locate second laser. Tubes visible scattered throughout image.
CLDS-Other	Site	17	C	Small tubes present throughout the image. Some shell fragments scattered on sediment surface.
Reference	2500W	2500W-01	A	Scattered shell fragments on sediment surface. Small tubes and burrows in image.

Area	Location	StationID	Replicate	Comments
Reference	2500W	2500W-02	A	Small tubes and a large burrow in image. Partially buried cobble visible.
Reference	2500W	2500W-02	B	Many tubes visible in sediment.
Reference	2500W	2500W-02	C	Sediment cloud obscures lasers. A large burrow visible in center of image.
Reference	2500W	2500W-03	A	Coarse sediment surface with a few tubes and a large burrow.
Reference	2500W	2500W-03	B	Coarse sediment surface with a few small tubes and a large burrow just in frame.
Reference	2500W	2500W-03	D	Coarse sediment surface with a few small tubes and a very large track. Sediment cloud covering half of image makes determining laser distance difficult.
Reference	2500W	2500W-04	A	Coarse sediment with many small tubes and a partially buried cobble.
Reference	2500W	2500W-04	B	Coarse sediment with many small tubes and a few small burrows.
Reference	2500W	2500W-04	C	Coarse sediment surface with a few large burrows, some small tubes, and a piece or two of cobble.
Reference	2500W	2500W-05	A	Coarse sediment surface with a tube and burrow visible.
Reference	2500W	2500W-05	B	Coarse sediment surface with a few burrows visible.
Reference	2500W	2500W-05	C	A large tube in center of image with a track running across right side of image.
Reference	4500E	4500E-01	A	A few tubes vsiible in sediment.
Reference	4500E	4500E-02	A	A few tubes visible in sediment. A few small burrows and one very large burrow visible.
Reference	4500E	4500E-03	A	A few medium sized burrows visible. Small tubes, some with worms reaching out visible. Strong current appears to be revealing a few chunks of cobble in bottom right of image.
Reference	4500E	4500E-03	B	A few small tubes and small burrows in uniform sediment surface.
Reference	4500E	4500E-04	A	Large burrow visible but rest of image is too scattered by objects in water column to make out.
Reference	4500E	4500E-04	B	A large chunk of cobble and some smaller pieces of cobble scattered throughout image. Large burrow and a few smaller burrows present.
Reference	4500E	4500E-05	A	Mostly uniform sediment surface with a few small burrows and a shell fragment.
Reference	4500E	4500E-05	C	A lot of cobble intermixed with many tubes and a few small burrows.
Reference	4500E	4500E-05	D	Sediment surface contains a few small tubes and burrows as well as a few smaller pieces of cobble.
Reference	CLIS-REF	CLIS-REF-01	A	Coarse sediment surface with a track running along top of image and two large burrows in center of image.
Reference	CLIS-REF	CLIS-REF-01	B	A couple tubes and medium sized burrows present along sediment surface containing a few shell fragments.
Reference	CLIS-REF	CLIS-REF-01	C	Chunks of cobble resting on sediment surface with a couple of small tubes and small burrows also present.
Reference	CLIS-REF	CLIS-REF-02	A	Piece of cobble partially buried. Large burrow visible just in image to right. Some scattered shell fragments.
Reference	CLIS-REF	CLIS-REF-02	B	Some small burrows and tubes in sediment with scattered shell fragments.
Reference	CLIS-REF	CLIS-REF-02	C	Cobble and pebbles scattered throughout image with a few shell fragments.
Reference	CLIS-REF	CLIS-REF-03	A	One or two small tubes and burrows.
Reference	CLIS-REF	CLIS-REF-03	B	One very large burrow in bottom of image.
Reference	CLIS-REF	CLIS-REF-03	C	Coarse sediment surface.
Reference	CLIS-REF	CLIS-REF-04	A	Coarse sediment surface.
Reference	CLIS-REF	CLIS-REF-04	D	Coarse sediment surface.
Reference	CLIS-REF	CLIS-REF-05	A	A small tube and some small burrows.
Reference	CLIS-REF	CLIS-REF-05	B	Partially buried chunk of cobble with a few large burrows and a tube or two present.
Reference	CLIS-REF	CLIS-REF-05	C	Small pieces of cobble scattered about sediment surface with a few small burrows intermixed
Historical Mound	CS-1	CS-1-01	A	Very coarse sediment surface with a few visible tubes.
Historical Mound	CS-1	CS-1-01	B	Very coarse sediment surface. Almost appears to have some sort of flora cover.
Historical Mound	CS-1	CS-1-01	C	Very coarse sediment surface. Almost appears to have some sort of flora cover.
Historical Mound	CS-1	CS-1-02	A	Very coarse sediment surface. Almost appears to have some sort of flora cover.
Historical Mound	CS-1	CS-1-02	B	Coarse sediment surface with a gathering of cobble. Large burrows also present.
Historical Mound	CS-1	CS-1-02	C	Coarse sediment surface with scattered shell fragments.
Historical Mound	CS-1	CS-1-03	A	Coarse sediment surface with a lot of interference from turbidity in water column.

Area	Location	StationID	Replicate	Comments
Historical Mound	CS-1	CS-1-03	C	Coarse sediment surface with a lot of interference from turbidity in water column.
Historical Mound	CS-1	CS-1-03	D	Coarse sediment surface with a lot of interference from turbidity in water column. Chunks of cobble visible.
Historical Mound	CS-1	CS-1-04	A	Coarse sediment surface with scattered shell fragments.
Historical Mound	CS-1	CS-1-04	B	Coarse sediment surface with scattered shell fragments and a tube or two.
Historical Mound	CS-1	CS-1-04	C	Coarse sediment surface.
Historical Mound	CS-1	CS-1-05	A	Coarse sediment surface with a medium sized burrow visible.
Historical Mound	CS-1	CS-1-05	B	Coarse sediment surface with one or two small tubes.
Historical Mound	CS-1	CS-1-05	C	Coarse sediment surface.
Historical Mound	CS-1	CS-1-06	A	Coarse sediment surface.
Historical Mound	CS-1	CS-1-06	B	Coarse sediment surface with a couple pieces of cobble partially buried.
Historical Mound	CS-1	CS-1-06	D	Coarse sediment surface.
Historical Mound	CS-2	CS-2-01	A	Coarse sediment surface with a few scattered shell fragments.
Historical Mound	CS-2	CS-2-02	A	Many small to medium sized burrows with some scattered shell fragments. Fecal piles near burrows.
Historical Mound	CS-2	CS-2-02	B	Coarse sediment surface with a few burrows and many fecal piles associated with burrows.
Historical Mound	CS-2	CS-2-03	A	Coarse sediment with a large burrow in upper left of image.
Historical Mound	CS-2	CS-2-03	B	Coarse sediment surface with a couple burrows.
Historical Mound	CS-2	CS-2-03	D	Sediment surface covered in shell fragments and pebbles/small cobble.
Historical Mound	CS-2	CS-2-04	A	Coarse sediment surface with a couple fragments of shell.
Historical Mound	CS-2	CS-2-04	B	Coarse sediment surface with a lot of disturbance, most likely a strong current.
Historical Mound	CS-2	CS-2-04	C	Partially buried cobble visible in image.
Historical Mound	CS-2	CS-2-05	C	A medium sized burrow visible.
Historical Mound	CS-2	CS-2-05	D	Large slab of cobble takes up most of image. Small tubes visible in cracks of cobble.
Historical Mound	CS-2	CS-2-06	A	A couple of large burrows with fecal piles associated with them.
Historical Mound	CS-2	CS-2-06	B	Coarse sediment surface with a couple small tubes and fecal piles.
Historical Mound	CS-2	CS-2-06	C	Coarse sediment surface.
Historical Mound	CS-2	CS-2-07	A	A couple small tubes and scattered shell fragments.
Historical Mound	CS-2	CS-2-07	B	Sediment surface contains scattered shell fragments.
Historical Mound	CS-2	CS-2-07	C	Sediment surface covered in shell fragments and cobble of all sizes.
Historical Mound	FVP	FVP-01	A	Sediment contains small burrows and tubes, as well as a gastropod.
Historical Mound	FVP	FVP-01	B	Small burrows and shell fragments scattered across sediment surface.
Historical Mound	FVP	FVP-01	C	Small tubes and a large burrow in image. A few shell fragments on sediment surface.
Historical Mound	FVP	FVP-02	A	Tracks throughout image with three visible gastropods.
Historical Mound	FVP	FVP-02	B	Groupings of hydroids attached to some sort of structures in sediment.
Historical Mound	FVP	FVP-02	C	Small tubes, a burrow, and a track in image.
Historical Mound	FVP	FVP-03	A	Large burrow in mostly uniform sediment surface.
Historical Mound	FVP	FVP-03	C	A couple small burrows in a mostly uniform sediment surface.
Historical Mound	FVP	FVP-04	A	Many partially buried orange organisms, some with attached hydroids. Possibly sponges? Small tubes and burrows throughout image.
Historical Mound	FVP	FVP-04	B	Many burrows and a few tubes. Unknown orange organism and some scattered shell fragments also in image.
Historical Mound	FVP	FVP-04	C	A couple partially buried orange organisms with attached hydroids. Small tubes and burrows and a few tracks in image.
Historical Mound	FVP	FVP-05	A	Mostly uniform sediment surface with a large burrow.
Historical Mound	FVP	FVP-05	D	Shell fragments throughout image as well as some hydroids attached to an object/organism buried in sediment.
Historical Mound	FVP	FVP-06	A	A few small tubes and burrows visible.

Area	Location	StationID	Replicate	Comments
Historical Mound	FVP	FVP-06	B	Smal tubes, tracks, burrows, and a gastropiod around a cobble structure.
Historical Mound	FVP	FVP-06	C	Many shell fragments at sediment surface with an orange organism and attached hydroids in image.
Historical Mound	FVP	FVP-07	A	A few chunks of partially covered cobble and a large burrow.
Historical Mound	FVP	FVP-07	B	Mostly uniform sediment surface.
Historical Mound	FVP	FVP-07	C	Scattered shell fragments on sediment surface.
Historical Mound	MQR	MQR-01	B	Very coarse sediment surface. Unable to locate lasers.
Historical Mound	MQR	MQR-01	C	Very coarse sediment surface with some shell fragments.
Historical Mound	MQR	MQR-02	A	Very coarse sediment surface.
Historical Mound	MQR	MQR-02	D	Very coarse sediment surface with a couple of shell fragments.
Historical Mound	MQR	MQR-03	B	Very coarse sediment surface with a couple of shell fragments. Only one laser is in frame because image was taken quite close to sediment surface.
Historical Mound	MQR	MQR-04	A	Many worms and fecal piles visible.
Historical Mound	MQR	MQR-04	B	Many shell fragments and a few small tubes in image.
Historical Mound	MQR	MQR-04	D	Many shell fragments. Unknown orange organism.
Historical Mound	MQR	MQR-05	B	Coarse sediment surface.
Historical Mound	MQR	MQR-06	A	Coarse sediment surface with shell fragments.
Historical Mound	MQR	MQR-06	B	Coarse sediment with one or two small tubes and shell fragments.
Historical Mound	MQR	MQR-06	C	Coarse sediment with one or two small tubes and shell fragments.
Historical Mound	MQR	MQR-07	A	Small tubes and a couple large burrows present among many scattered shell fragments.
Historical Mound	MQR	MQR-07	B	Small tubes among scattered shell fragments.

APPENDIX F

GRAIN SIZE SCALE FOR SEDIMENTS

APPENDIX F

GRAIN SIZE SCALE FOR SEDIMENTS

Phi (Φ) Size	Size Range (mm)	Size Class (Wentworth Class)
<-1	>2	Gravel
0 to –1	1 to 2	Very coarse sand
1 to 0	0.5 to 1	Coarse sand
2 to 1	0.25 to 0.5	Medium sand
3 to 2	0.125 to 0.25	Fine sand
4 to 3	0.0625 to 0.125	Very fine sand
>4	<0.0625	Silt/clay

APPENDIX G

DEVELOPMENT OF CENTRAL LONG ISLAND SOUND
AMBIENT THRESHOLD VALUES

HISTORICAL LONG ISLAND SOUND DATA ANALYSIS AND STUDY DESIGN: METHODOLOGY AND RESULTS

Development of Central Long Island Sound Ambient Threshold Values

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1.0 INTRODUCTION

Dredged material disposal in Long Island Sound (LIS) has been occurring since the early 1970s, and continues today. In that time, many monitoring studies and assessments have been conducted to inform a variety of research questions and management approaches, and to support site designations. As management approaches evolve and public interest in dredged material management increases, the need for expanded research is emerging. Existing data from a variety of studies can provide valuable insight into historical patterns in the Sound and support assessments of current conditions. However, many of these studies were conducted in isolation, by different groups, and the utility of that data is compromised by the disparate nature of the work. The objectives of this project were to compile and evaluate historical sediment chemistry data from Long Island Sound (LIS) dredged material disposal sites and surrounding areas to support ongoing assessments and inform an evaluation of existing management approaches.

There are four active open water disposal sites in LIS: Central Long Island Sound (CLDS), Cornfield Shoals (CSDS), New London (NLDS) and Western Long Island Sound (WLDS) Disposal Sites. Designation of an additional site in Eastern Long Island Sound is under consideration (USEPA 2016). This document focuses on the work conducted in Central Long Island Sound. First, sources of historical and recent sediment chemistry and bioassay data were identified, compiled, and evaluated for usability based on specific criteria as described in Section 2.

Once the usable data were compiled and standardized, the database was used to develop a Central Long Island Sound ambient sediment dataset sufficiently robust to develop ambient threshold values (Section 3). Results of this analysis are provided in Section 4. Additional disposal site analyses is provided in the complete project report (Battelle 2017)[1].

[1] Note that UTL values have been updated for CLDS since publication of the Battelle report.

2.0 DATABASE PREPARATION

2.1 Database Compilation and Standardization

The first objective of this project was to compile sediment chemistry and toxicity data from a variety of studies conducted between 1971 and the present (Table 1) and to standardize these data to be compatible with the existing sediment chemistry database for the New England District's Disposal Area Monitoring System (DAMOS). This section includes a brief description of the DAMOS database application; a description of the studies evaluated for inclusion into the database; and a summary of the standardization steps required to ensure compatibility of the data.

The existing DAMOS database and application that stores sediment chemistry associated with sediment testing is called the Regulatory and Environmental Effects Database Application (REEDA 2016). The database was designed to automate import of standard electronic data deliverables (EDDS); a data selection tool to allow the user to filter and download data; and a tool to allow the user to compare dredge site sediment chemistry results with DAMOS reference site data.

A variety of database sources were identified and reviewed. The primary criteria used to evaluate the data were that the data contained stations within the basin of Long Island Sound; later in the project this spatial buffer was constrained to within one kilometer of the DAMOS Disposal Sites (Section 3). The data sources that were identified for incorporation into the database are summarized in Table 1. Only one data source (CT DEP SQUID database) was excluded entirely. Three databases were included that contained toxicity data (Table 1). During the analysis phase (Section 3), the bioassay data were excluded from the database due to a) too little data to be of use to the analysis and b) no existing database structure in the current DAMOS database.

A series of data standardization steps were required for each data source to ensure consistency between the database and the REEDA format included:

- Generate a study-level record for each database;
- Ensure every sample had a distinct StationID with available and accurate coordinates[2];
- Ensure every sample had a distinct SampleID (key field) with critical sample fields including date and sampling depth.
- Attempt to document whether the sample was collected from a core or grab device;
- Standardize chemical names, units, and measuring basis to match those of the REEDA database.

[2] One set of samples in the USGS database appeared to have been collected from the FVP disposal mound at CLDS but had inaccurate coordinates; these samples were flagged in the database.

Table 1. List of Projects Assessed for Long Island Sound Data Analyses

Project Name	Sample Count	Source File(s)	Comments
Long Island Sound Sediment Quality Triad Report 2000	80	xf02f3.pdf, xt02f4.pdf (OCR from ENSR report)	Only sediment chemistry data included in final database
USGS Long Island Sound Database 1971-1995	262	LISNYBDB.xls (USGS Website)	All sediment chemistry data.
EPA National Coastal Assessment Program 1993-2006	10	NOAA Query Manager National Database	Bioassay data excluded from final database
DAMOS Long Island Sound Reference Areas 1991-1998	95	DMSmart	All sediment chemistry data.
DAMOS CLDS Capped Mound Core Data 1990	5	DAMOS Database/Reports compiled from historical studies	All sediment chemistry data.
DAMOS FVP Chemistry Data 2005	9	DAMOS Database/Reports compiled from historical studies	All sediment chemistry data.
DAMOS NLDS Seawolf Chem Data Surface 2006, 2010	29	DAMOS Database/Reports compiled from historical studies	All sediment chemistry data.
Battelle LIS Water Column Survey 2002	30	OldNED_ref_station_and_LIS_data.xls (Battelle)	Retained in database although many stations not within defined
Eastern LIS Environmental Impact Statement 2002	42	elis_dseis_appendix_g.pdf (OCR from UCONN/Berger report)	All sediment chemistry data.
DAMOS CLDS Sed/Tissue Investigation 2016	60	DAMOS2016_CLDS for Pmyre_18Jan2017.xlsx (Battelle)	All sediment chemistry data.
DAMOS NLDS Studies at Seawolf 1997-2001	32	DMSmart/Reports compiled from historical studies	All sediment chemistry data.
Connecticut DEP SQUID (Sediment Quality Information Database)	na	DMSmart/Reports compiled from historical studies	Exluded from final database - no data within defined spatial criteria

Modifications to the structure of the LIS database (distinct from the REEDA database) were necessary to: a) accurately describe stations from the disposal sites and nearby references areas (as opposed to testing areas); b) add station grouping fields; and c) create table formats for bioassay and tissue data[3].

After all of the data sources were standardized and appended into the main LIS database, a comprehensive review of the entire database was conducted prior to conducting analyses. This review included:

- Evaluate duplicate samples and remove the set of lesser quality[4];
- Conduct statistical range analyses to evaluate for outlier concentrations/detection limits to spot check for potential errors;
- Create a chemical synonym list relating source chemical names to the final REEDA name;
- Assign each sample to the nearest DAMOS Disposal site;
- Append values to Station Type lookup list for additional offshore station categories;
- Import sediment quality guideline tables to support follow-up analyses.

[3] The final analysis database excluded toxicity data; tissue data were included in an ancillary table to enable draft BSAF analyses.
[4] The USGS database contained historical data from DAMOS, but the quality of these data were of lower quality than those from DMSmart or other DAMOS-related sources.

2.2 Database Pre-Processing

Following database compilation and standardization, a variety of pre-processing steps were conducted to support data analyses (Section 3). First, the data were evaluated to establish a standard method for the treatment of non-detected results. Following this analysis, standard sums were calculated using the selected replacement value for these non-detects. Finally, because there were so many disparate sample designs compiled over many studies and many years, a standard method of processing field replicates was generated.

Data Reported as Below Detection

The method by which data reported as below detection are handled quantitatively in the calculation of sums (e.g., Total PCBs) can have great impact on the results (Table 2). An analysis was conducted to a) determine what chemicals were reported in sufficient quantity to include in data analyses; and b) determine the optimum method for including data below detection in sums.

Table 2. Options for Dealing with Non-Detects in Calculation of Sums

Method	PRO	CON
Substitution at full DL	Confident that this is an upper bound.	May be an exceedingly high upper bound, especially if some DLs are high and/or there are many NDs.
Substitution at 0 DL	Confident that this is a lower bound.	Potentially underestimates true total, especially if some DLs are high.
Substitution at 0.5 DL	Easy to do and splits the difference between the other two easy substitution options. Tends to be relatively close (within 10%) of the Kaplan-Meier estimate under some circumstances (<50% NDs and NDs are below all detects).	Uncertain as to how these estimates relate to the true value.
Kaplan-Meier with Efron's bias correction	Confident that this is an upper bound. The positive bias is smaller than substitution at full DL when multiple detection limits are present.	May not be readily accessible to all (though it can be calculated in commercial software, including R freeware, or with a macro in Excel). Is known to be slightly biased high. When all DLs are identical, result is equivalent to substitution at full DL. Generally not recommended when more than 50% NDs are present.

Metals - The metals with the highest number of non-detects were cadmium (Cd) and mercury (Hg), though the percentage of non-detects was still less than 10%. The detection limits (DLs) for the samples that were below detection were less than most of the DLs for the detected values. Thus, the metals database was considered robust enough to produce meaningful statistical calculations.

PAHs - The rate of detection was evaluated for total polyaromatic hydrocarbons (PAHs), as well as high (HPAH) and low (LPAH) molecular weight PAH sums. HPAHs were dominated by detected values (90% of the samples had less than 20% non-detected HPAH chemicals within the sample) so the choice of how NDs were treated was not particularly influential to the final outcome. LPAHs had a higher rate of NDs (only 54% of the samples have <20% non-detected LPAH chemicals). For consistency with DAMOS Program methods, the total PAH concentration was simply estimated using one-half DL for all values below detection. The number of individual PAHs included in each sum is included in the qualifier field for each summed record.

PCBs - The database of polychlorinated biphenyl (PCB) Aroclors was dominated by non-detects. For 60 samples with measured Aroclors, only 10 samples had >1 reported Aroclor, and all Aroclors were below detection. For the 50 remaining samples, only Aroclor 1254 was reported with 38 detections and 12 non-detects. Thus, for the purposes of data analysis, Aroclors were excluded from the dataset.

For PCB congeners, 65% of the samples had over 50% of their individual congeners reported as below detection. For the samples with fewer than 20% of the congeners below detection, the detected congeners dominated the total PCB sum and the treatment of non-detects would have little bearing on the outcome: e.g., the sum of detected congeners represented, on average, 98% of the sum of all congeners using substitution of one-half DL. However, when greater than 75% of the congeners within a sample were below detection, the detected congeners represented only 9%, on average, of the total calculated using substitution at one-half DL. Clearly, with so many non-detected PCB congeners in the dataset, there is no way to accurately estimate total concentration. For consistency with DAMOS Program methods the total PCB concentration was simply estimated using one-half DL for all values below detection; the qualifier was used to flag the number of congeners used in the sum. Subsequent evaluation of PCB sums could include an analysis of the effect of detection limits on the sum.

In summary:

- Metals had high detection frequency (>90%) and thus were included in statistical calculations.
- PCB Aroclors had very low detection frequencies; Aroclors were excluded from further data analysis. Total PCB congeners were calculated using one-half DL for values reported as below detection.

- PAHs had relatively high detection frequency for HPAHs, slightly lower for LPAHS. Total PAHs were calculated using one-half DL for values reported as below detection, and were included in further data analyses.

Standard Sums

Total HPAH, LPAH, and total PAHs were calculated, as well as total PCB congeners. In the summing routine, non-detected values were replaced with one-half of the reported detection limit. The number of detected chemicals used in the sum was included in the qualifier code. Total HPAHs included the following chemicals if reported: Pyrene, Indeno(1,2,3-cd)pyrene, Fluoranthene, Dibenz(a,h)anthracene, Chrysene, Benzo(k)fluoranthene, Benzo(g,h,i)perylene, Benzo(b)fluoranthene, Benzo(a)pyrene, Benzo(a)anthracene. Total LPAHs included the following chemicals if reported: Phenanthrene, Naphthalene, Fluorene, Anthracene, Acenaphthylene, Acenaphthene. Finally, total PCB congeners was calculated as a sum of the NOAA Status and Trends Program 18 congeners, and then multiplied by 2 (PCB 8, 18, 28, 44, 52, 66, 101, 105, 118, 128, 138, 153, 170, 180, 187, 195, 206, and 209).

Field Replicates

Within some of the studies (USGS; Long Island Sound Sediment Quality Triad report; most of the DAMOS reference area data), results were included from multiple field replicates (generally 3 replicates, but some data had up to 8). Field replicates were noted in the database with the Sample Purpose code ("FD"). Field replicates are useful for measuring both analytical variability and small-scale spatial variability within a dataset. A variance partitioning approach was used to compare the variability within the field replicates relative to the variability between stations. The results indicated that the small-scale variability could be very high. This information is useful for planning future sampling efforts, suggesting that when sampling to characterize area-wide concentrations a more statistically efficient sampling design would use composite samples (multiple grabs physically combined into a single analytical sample) instead of individual field samples. The high variability among field replicates suggests some independence among these samples, however, it was decided to not treat them as independent samples to avoid biasing results towards the areas that had higher sampling density. Thus, the field replicate values within a station were averaged for the final statistical analyses.

3.0 PRELIMINARY ANALYSES AND METHOD DEVELOPMENT

Various methods of comparing the statistical distribution of contaminant concentrations within the disposal sites relative to the surrounding area were considered. Generally, DAMOS studies include comparison of site chemistry to reference values (results from official DAMOS reference sites), and less frequently, use of sediment quality guidelines (e.g., Long and Morgan 1990). In addition to these, an approach recently used by dredged material evaluators in San Francisco Bay and the state of Washington was applied. For example, in San Francisco, the regulators chose to include comparison to ambient San Francisco Bay contaminant concentrations (Yee et al. 2015). *"In 2011, the LTMS agencies agreed upon a statistically robust definition of ambient Bay sediment contaminant concentrations that is relevant for dredged material regulatory use, while remaining based on data collected routinely by the RMP. Ambient sediment concentrations were defined as: the 90% upper confidence limit of the 90th percentile concentrations using the most recent 10 years of data from the RMP's randomized Bay-wide sediment sampling stations, after removal of statistical outliers due to highly contaminated samples."*

The Upper Tolerance Limit (UTL) values were calculated as the 90% upper confidence limit of the 90th percentile (90/90 UTL) for LIS ambient dataset as a "proof-of-concept" to use for analyzing disposal site chemical concentrations. The 90/90 UTL can be interpreted as the threshold below which 90% of the ambient (outside of the disposal site) population is expected to fall, 90% of the time. Thus, any individual samples that exceed this threshold are flagged as different from ambient.

A subset of the database was selected for the UTL analysis to represent ambient surface sediment typical of sediment from Central Long Island Sound. As a first step, the database was filtered for stations located within one kilometer of the CLDS boundary. This spatial restriction was applied in order to exclude stations closer to possible land-based sources of contamination. Surface sediment was defined to include samples with an upper water depth reported at the sediment/water interface; no lower depth criterion was enforced.

The distribution of the ambient dataset was then evaluated to ensure that it contained independent observations representing ambient sediment of Central Long Island Sound. Outliers were evaluated, resulting in the decision to exclude some data in the analysis. Much of the data from the 1970s were problematic due to a) high detection limits (especially with organic contaminants) and b) errors and discrepancies found in the coordinates, dates, and other field-related information[5]. Therefore, the data from the 1970s (and as a corollary, data with no sample date) were excluded from the final UTL dataset.

The 90/90 UTL for each chemical was calculated. The 90/90 UTL was based on a parametric distribution (i.e., normal, lognormal, or gamma) if the data appeared to adequately represent one of these distributions. Otherwise, a non-parametric approach was used to estimate the UTL. Using the tools in ProUCL v5.0 (USEPA 2013), the best fitting

[5] For example, one sample from 1977 apparently falling outside of the disposal site was labeled "Dump NH1" suggesting it was actually collected from active dredged material disposal.

distribution for each ambient chemical dataset was evaluated using correlation coefficients and visual inspection of the probability plots, and a formal goodness-of-fit test (e.g., Shapiro-Wilk's). If the goodness-of-fit tests for multiple distributions were not rejected, the distribution with the highest correlation coefficient was used.[6] If outliers were apparent in the probability plots, these were tested using a formal outlier test (Dixon's or Rosner's test, both of which assume an underlying Normal distribution, so an appropriate transformation to normality was required). If all three tested distributions were rejected using the goodness-of-fit tests, a non-parametric BCA bootstrap approach was used.

When non-detects were present for the individual metals, censored data methods were used to estimate population parameters. The sums were treated as estimated, uncensored values.

Following calculation of the 90/90 UTL, these values were compared with selected sediment quality guidelines [Effects Range -Low (ER-L) and -Medium (ER-M), Long and Morgan 1990], and regional LIS summary concentrations (Mitch and Anisfeld 2010; USEPA 2015).

[6] In situations where more than one distribution was a good fit to the data, the calculated UTL values for the different distributions were nearly identical.

4.0 RESULTS OF THE DATA ANALYSES

This summary provides the results of quantification of contaminant concentrations from the CLDS relative to regional LIS data. All observations about distributional characteristics, outliers, mixtures, or the influence of detection limits are noted for each chemical or sum in the detailed summary table (Appendix A). If outliers were apparent, results are reported both with and without the outliers so their influence can be assessed.

When a data set is a good fit to a particular parametric distribution, the probability plot is smooth, with no breaks or irregularities, and the data follow a straight line. Deviations from a straight line pattern, even if the correlation coefficient is high, can indicate that the data set is actually a mixture of two or more overlapping distributions. An initial investigation of how temporal or spatial variables (year of sampling, or reference area sampled) may influence the concentration distributions did not identify any strong signals from these variables. When the data represent a mixture, rather than a single population, the UTLs presented may not be interpretable as an upper probability bound for central LIS, in general. Typically, a UTL estimated from a mixture of distributions will be higher than from a single population because of the effect of the higher variance estimate for the mixture.

Final reported UTL values are compared to standard sediment quality guidelines (ER-L/ER-M, Long and Morgan 1990) as well as basin-specific regional calculated values (Mitch and Anisfeld 2010) in Table 3. Some specific observations about each chemical endpoint follows.

- The distributions for all three PAH sums and the total PCB sum appeared to be a mixture of multiple sub-populations. Because these sums use ½ the detection limit for non-detects, these results may be strongly influenced by the limit of detection, which has substantially changed over the 34 years represented in this collated dataset. The final reported UTL values for PAH sums (Table 3) report the BCA bootstrap value, acknowledging that the ambient sediment surrounding the CLDS is likely to have sub-populations due to historical dredged material disposal as well as other localized contaminant influences.

- For total PCBs, high detection limits strongly influenced the six samples with estimated sums at the high end of this distribution. The samples affected by high detection limits were from sampling years 2000 and 2001; in these samples most congeners were below detection and the estimated sum is derived primarily as a sum of (one-half) detection limits. If only the 2016 survey data were used (n=15), the UTL result is 17 µg/kg, dw (compared to 95 µg/kg, dw using all data available, n=22).

- Antimony, selenium, and silver had no UTL values estimated. The concentration distributions for these metals did not follow a particular parametric distribution, and there were issues with high detection limits in some of the samples. Due to detection limit issues and the small sample sizes ($n \leq 12$), no UTL values were estimated.

- Aluminum did not follow any particular parametric distribution; the small sample size (n=12) resulted in a preliminary UTL estimated based on a non-parametric bootstrap. As aluminum is not a typical monitored contaminant, it was not included in the final UTL table.

- Chromium, lead and zinc did not follow any particular parametric distribution, and the probability plots suggested that these data may represent a mixture data set. The older data (2006 and earlier) tended to have higher concentrations than those observed in the most recent 2016 survey. Bootstrapped estimates were calculated based on all the data ($n \geq 31$); if only the most recent 2016 survey was used (n=15), the UTLs would be lower.

- Arsenic, cadmium, mercury, and nickel all showed good fits to one or more of the parametric distributions tested. For these metals, the choice of parametric distribution had little to no effect on the estimated UTL value, indicating a fairly robust UTL estimate for these metals. The higher Cd value was selected, based on the dataset which excluded only the record with the high detection limit (Appendix A).

- In the copper data set, there were two influential, high concentration samples (from stations EMAP-12795 and EMAP-12796, both with concentrations of 75 mg/kg). For the full data set, both the lognormal and gamma distributions were a reasonable fit; if a normal distribution was assumed, the two highest values were identified as potential outliers. The UTLs calculated under these two different assumptions were 63 mg/kg (gamma approximation, all data) and 55 mg/kg (normal approximation, excluding the two highest values). The higher UTL was reported in the final UTL value table (Table 3) as these values could not be excluded for any quality control reason, and likely represent actual variability of Cu values in the sediments outside of the disposal site.

Table 3. CLDS Ambient 90/90 UTL and Comparison Values

Analyte (dry weight)	90/90 UTL[1]	ERL	ERM	CLIS-M[2]	CLIS-90[2]
Arsenic mg/kg	8.1	8.2	70	5.69	10.56
Cadmium mg/kg	0.25	1.2	9.6	0.92	2.16
Chromium mg/kg	79	81	370	62	109
Copper mg/kg	63	34	270	83.8	185
Lead mg/kg	60	46.7	218	45.6	85.9
Mercury mg/kg	0.21	0.15	0.71	0.21	0.47
Nickel mg/kg	28	20.9	51.6	22.5	37
Zinc mg/kg	160	150	410	137	221
Total High Molecular Weight PAHs ug/kg	2,200	1700	9600	N/A	N/A
Total Low Molecular Weight PAHs ug/kg	410	552	3160	N/A	N/A
Total Molecular Weight PAHs ug/kg	2,700	4,022	44,792	2,860	10,900
Total PCB congeners ug/kg	95	22.7	180	32.6	35.3

[1]Results rounded to 2 significant figures.
[2]Mean and 90th percentile values for Central Long Island Sound (Mitch and Anisfeld 2010)

Some cautionary notes on the usage of these values. The characterization using the UTL was simplified, i.e., temporal strata in the data were not considered, and it was assumed that all the data were derived from the same statistical population, having the same mean and variance. A more thorough evaluation of the Ambient data might yield slightly different UTL results. A temporal analysis of the data also would be useful to put the LIS database into context of regional changes to chemical input into LIS, although other factors (e.g., different chemical methods, improvement of detection limits) would have to be part of the analysis.

5.0 SUMMARY AND CONCLUSIONS

5.1 Summary

- A database was generated with historic sediment (and limited toxicity) data from on and near (within 1 km) the DAMOS Long Island Sound disposal sites.

- A variety of database processing steps were conducted to ensure consistency of the data for follow-on analyses.

- A method of determining ambient concentrations of contaminants was developed based on calculation of the 90/90 UTL calculated from the ambient data.

- Preliminary results at CLDS indicated the presence of several contaminants at values greater than the 90/90 UTL within the disposal site as well as in the surrounding sediment.

- As a final step, a combination metric that included both the 90/90 UTL distribution, as well as a comparison to a toxicity-based effect was defined as an Effects-Based UTL to indicate values that are different from ambient (>UTL), but are also associated with potential ecological impact; results are published elsewhere (Battelle 2017)[7].

5.2 Conclusions and Recommendations

Although the 90/90 UTL method is useful in determining differences between the disposal sites and the surrounding area, it is not, by itself, useful as a metric to determine potential ecological impact because there is no link to effects. Use of published sediment quality guidelines aids in the ability to make this assessment, but these guidelines are not based on sediments in Long Island Sound, and thus have limited use in evaluating potential biological effects from the disposal of dredged material in LIS.

At CLDS, there is a strong background signal from contaminants that vary over time. Consequently, interpretation of the potential signal of contaminants from dredged material needs careful consideration of time-related changes of general contaminant input into Central LIS.

In conclusion, the data collected for this project could be used to:

- Support further work on developing Long Island Sound-based guidelines for both assessing contaminant concentrations at the disposal sites, as well as for suitability decisions.

- Assess whether there is variability of contaminant concentrations over time, especially at well-represented locations such as CLIS-REF.

[7] CLDS EB-UTL values have not yet been updated with the values presented in this document.

6.0 REFERENCES

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Appendix A: Summary of Central Long Island Sound ambient data and estimated 90/90 Upper Tolerance Limit (UTL)

Analyte or Sum	Sample Size	# of NDs	Potential outliers	Distribution	90/90 UTL[1]	Units	Method and Comments
LPAH	35	-	1 low	possible mixture[2]	410	ug/kg, dw	BCA bootstrap on all data; when low-end outlier was omitted, data were not different from lognormal distribution.
LPAH	34	-	0	lognormal	370	ug/kg, dw	Lognormal UTL; this result excludes one low-end outlier at 4.2 ug/kg.
HPAH	35	-	1 low	possible mixture	2,200	ug/kg, dw	BCA bootstrap on all data; when low-end outlier was omitted, data were not different from lognormal distribution.
HPAH	34	-	0	lognormal	2,000	ug/kg, dw	Lognormal UTL; this result excludes one low-end outlier at 6.0 ug/kg.
Total PAH	35	-	1 low	possible mixture	2,700	ug/kg, dw	BCA bootstrap on all data; when low-end outlier was omitted, data were not different from lognormal distribution.
Total PAH	34	-	0	lognormal	2,400	ug/kg, dw	Lognormal UTL; this result excludes one low-end outlier at 6.0 ug/kg.
Total PCBs	22	-	1 high	possible mixture	95	ug/kg, dw	BCA bootstrap excluding the one high-end outlier at 1,974 ug/kg. Several other high samples (field rep averaged values) were affected by high DLs. This UTL value is only preliminary and may not be representative of results derived using current analytical methods.
arsenic	29	0	0	gamma	8.1	mg/kg, dw	Gamma Approximation. Both gamma and lognormal distributions had comparable fits to the data, and identical UTL results.
cadmium	37	1	2 high	non-parametric	0.25	mg/kg, dw	BCA bootstrap on dataset after excluding the ND (n=36) which had a DL that is 2x the next highest detected value (with this high DL, this data point provides very little information).
cadmium	34	0	0	gamma	0.23	mg/kg, dw	Gamma approximation. All 3 distributions were a good fit, and UTL results were comparable.
chromium	36	0	0	possible mixture	79	mg/kg, dw	BCA bootstrap on all data.
copper	36	0	2 high	gamma	63	mg/kg, dw	Gamma Approximation. Both gamma and lognormal distributions had comparable fits to the data, and similar UTL results.
copper	34	0	0	normal	55	mg/kg, dw	Normal approximation, after excluding the 2 potential outliers.
lead	31	0	0	possible mixture	60	mg/kg, dw	BCA bootstrap on all data.
mercury	29	0	0	gamma	0.21	mg/kg, dw	Gamma Approximation. Both gamma and lognormal distributions had comparable fits to the data, and identical UTL results.
nickel	29	0	0	gamma	28	mg/kg, dw	Gamma Approximation. Both gamma and lognormal distributions had comparable fits to the data, and identical UTL results.
zinc	32	0	0	possible mixture	160	mg/kg, dw	BCA bootstrap on all data

[1] Results rounded to 2 significant figures.

[2] The data set was significantly different from all 3 parametric distributions tested, and appears to be a mixture of two or more sub-populations. The make-up of this mixture should be investigated. The UTLs presented may be representative of the collated dataset, but if there are concentration patterns that align with spatial or temporal indicators, then the UTL may not be interpretable as an upper probability bound for central LIS in general.

APPENDIX H

SEDIMENT CHEMISTRY LAB RESULTS

(Provided as stand-alone electronic document in Technical Support Notebook)

APPENDIX I

TISSUE CHEMISTRY LAB RESULTS

(Provided as stand-alone electronic document in Technical Support Notebook)

APPENDIX J

BENTHIC COMMUNITY ANALYSIS RESULTS

Total Abundance of Benthic Infauna (LPIL) Collected in 2016 DAMOS Samples Across all Areas					
Phylum	**Class**	**Order**	**Family**	**ID**	**Number**
Mollusca	Bivalvia	Nuculoida	Nuculidae	*Nucula proxima*	1745
Mollusca	Gastropoda	Cephalaspidea	Scaphandridae	*Acteocina canaliculata*	1668
Annelida	Polychaeta	Phyllodocida	Pilargidae	*Sigambra tentaculata*	572
Annelida	Polychaeta	Spionida	Spionidae	*Spionidae (LPIL)*	419
Annelida	Polychaeta	Scolecida	Paraonidae	*Levinsenia gracilis*	406
Mollusca	Bivalvia	Veneroida	Tellinidae	*Tellinidae (LPIL)*	290
Annelida	Polychaeta	Terebellida	Ampharetidae	*Melinna maculata*	266
Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys incisa*	251
Mollusca	Gastropoda	Pyramidelloida	Pyramidellidae	*Pyramidellidae (LPIL)*	247
Annelida	Polychaeta	Terebellida	Pectinariidae	*Pectinaria gouldi*	212
Annelida	Polychaeta	Scolecida	Capitellidae	*Mediomastus (LPIL)*	190
Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtyidae (LPIL)*	159
Hemichordata	Enteropneusta		Ptychoderidae	*Balanoglossus (LPIL)*	157
Sipuncula	Sipunculidea	Golfingiida	Phascolionidae	*Phascolion strombus*	110
Mollusca	Bivalvia	Veneroida	Tellinidae	*Macoma tenta*	109
Nemertea	Anopla	Paleonemertea	Tubulanidae	*Tubulanus (LPIL)*	106
Mollusca	Gastropoda	Neogastropoda	Nassariidae	*Nassarius trivittatus*	93
Annelida	Polychaeta	Oweniida	Oweniidae	*Owenia fusiformis*	78
Annelida	Oligochaeta	Tubificida	Naididae	*Naididae (LPIL)*	74
Mollusca	Bivalvia	Venerida	Veneridae	*Pitar morrhuanus*	71
Mollusca	Gastropoda	Mesogastropoda	Calyptraeidae	*Crepidula plana*	68
Sipuncula				*Sipuncula (LPIL)*	58
Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	*Ampelisca vadorum*	49
Mollusca	Bivalvia	Veneroida	Lasaeidae	*Pythinella cuneata*	46
Annelida	Polychaeta	Scolecida	Maldanidae	*Maldanidae (LPIL)*	39
Annelida	Polychaeta	Spionida	Chaetopteridae	*Spiochaetopterus oculatus*	36
Mollusca	Gastropoda	Cephalaspidea	Haminoeidae	*Haminoea solitaria*	34
Mollusca	Bivalvia	Nuculoida	Yoldiidae	*Yoldia limatula*	32
Nemertea				*Nemertea (LPIL)*	30
Mollusca	Bivalvia			*Bivalvia (LPIL)*	29
Mollusca	Gastropoda	Neotaenioglossa	Naticidae	*Euspira heros*	29
Annelida	Polychaeta	Terebellida	Cirratulidae	*Cirratulidae (LPIL)*	19
Annelida	Polychaeta	Spionida	Spionidae	*Prionospio (LPIL)*	19
Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	*Ampelisca (LPIL)*	18
Annelida	Polychaeta	Terebellida	Ampharetidae	*Ampharetidae (LPIL)*	17
Annelida	Polychaeta	Terebellida	Terebellidae	*Loimia viridis*	16
Platyhelminthes				*Platyhelminthes (LPIL)*	16
Annelida	Polychaeta	Terebellida	Cirratulidae	*Tharyx acutus*	16
Mollusca	Gastropoda	Cephalaspidea	Acteonidae	*Acteonidae (LPIL)*	15
Mollusca	Bivalvia	Arcoida	Arcidae	*Anadara transversa*	15
Annelida	Polychaeta	Cossurida	Cossuridae	*Cossura soyeri*	13
Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys ciliata*	13
Mollusca	Gastropoda	Neogastropoda	Mangeliidae	*Propebela (LPIL)*	13
Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	*Amphiuridae (LPIL)*	12

Total Abundance of Benthic Infauna (LPIL) Collected in 2016 DAMOS Samples Across all Areas					
Mollusca	Gastropoda	Heterostropha	Pyramidellidae	*Odostomia (LPIL)*	11
Mollusca	Bivalvia	Pholadomyoida	Lyonsiidae	*Lyonsia hyalina*	9
Arthropoda	Malacostraca	Isopoda	Idoteidae	*Edotia triloba*	8
Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodoce arenae*	8
Mollusca	Gastropoda	Nudibranchia		*Nudibranchia (LPIL)*	7
Annelida	Polychaeta	Terebellida	Ampharetidae	*Ampharete finmarchica*	6
Mollusca	Gastropoda	Heterostropha	Acteonidae	*Japonactaeon punctostriatus*	6
Arthropoda	Malacostraca	Decapoda	Paguridae	*Pagurus (LPIL)*	6
Arthropoda	Malacostraca	Decapoda	Xanthidae	*Panopeus herbstii*	6
Mollusca	Gastropoda	Heterostropha	Pyramidellidae	*Turbonilla (LPIL)*	6
Cnidaria	Hydrozoa			*Hydrozoa (LPIL)*	5
Arthropoda	Malacostraca	Mysida	Mysidae	*Neomysis (LPIL)*	5
Arthropoda	Malacostraca	Cumacea	Diastylidae	*Oxyurostylis smithi*	5
Mollusca	Gastropoda			*Gastropoda (LPIL)*	4
Arthropoda	Malacostraca	Mysida	Mysidae	*Neomysis americana*	4
Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glyceridae (LPIL)*	3
Nemertea	Anopla	Heteronemertea	Lineidae	*Lineidae (LPIL)*	3
Annelida	Polychaeta	Eunicida	Lumbrineridae	*Ninoe nigripes*	3
Mollusca	Bivalvia	Pholadomyoida	Pandoridae	*Pandora gouldiana*	3
Annelida	Polychaeta	Spionida	Spionidae	*Paraprionospio pinnata*	3
Arthropoda	Malacostraca	Decapoda	Pinnotheridae	*Pinnixa (LPIL)*	3
Annelida	Polychaeta	Scolecida	Paraonidae	*Aricidea (LPIL)*	2
Mollusca	Gastropoda	Neogastropoda	Columbellidae	*Astyris lunata*	2
Annelida	Polychaeta	Scolecida	Paraonidae	*Cirrophorus lyra*	2
Annelida	Polychaeta	Phyllodocida	Nereididae	*Nereididae (LPIL)*	2
Annelida	Polychaeta	Spionida	Spionidae	*Polydora cornuta*	2
Mollusca	Gastropoda	Neogastropoda	Mangeliidae	*Propebela (LPIL)*	2
Annelida	Polychaeta	Spionida	Spionidae	*Streblospio benedicti*	2
Mollusca	Gastropoda	Neogastropoda	Turridae	*Turridae (LPIL)*	2
Mollusca	Gastropoda	Neogastropoda	Turridae	*Turridae (LPIL)*	2
Arthropoda	Malacostraca	Amphipoda	Caprellidae	*Aeginina longicornis*	1
Mollusca	Bivalvia	Arcoida	Arcidae	*Arcidae (LPIL)*	1
Annelida	Polychaeta	Scolecida	Paraonidae	*Aricidea quadrilobata*	1
Mollusca	Bivalvia	Veneroida	Astartidae	*Astarte undata*	1
Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	*Cerapus tubularis*	1
Annelida	Polychaeta	Spionida	Chaetopteridae	*Chaetopteridae (LPIL)*	1
Arthropoda	Malacostraca	Decapoda	Crangonidae	*Crangon septemspinosa*	1
Arthropoda	Malacostraca	Cumacea		*Cumacea (LPIL)*	1
Echinodermata				*Echinodermata (LPIL)*	1
Mollusca	Bivalvia	Venerida	Veneridae	*Gemma gemma*	1
Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera (LPIL)*	1
Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera americana*	1
Annelida	Polychaeta	Phyllodocida	Goniadidae	*Goniadidae (LPIL)*	1
Annelida	Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus sublevis*	1
Annelida	Polychaeta	Terebellida	Terebellidae	*Loimia medusa*	1

Total Abundance of Benthic Infauna (LPIL) Collected in 2016 DAMOS Samples Across all Areas					
Arthropoda	Malacostraca	Amphipoda	Stenothoidae	*Metopella angusta*	1
Arthropoda	Malacostraca	Decapoda	Paguridae	*Pagurus pollicaris*	1
Arthropoda	Malacostraca	Amphipoda	Stenothoidae	*Parametopella cypris*	1
Phoronida			Phoronidae	*Phoronis (LPIL)*	1
Annelida	Polychaeta	Phyllodocida	Pilargidae	*Pilargidae (LPIL)*	1
Arthropoda	Malacostraca	Decapoda	Porcellanidae	*Polyonyx gibbesi*	1
Annelida	Polychaeta	Spionida	Spionidae	*Prionospio steenstrupi*	1
Arthropoda	Malacostraca	Stomatopoda	Squillidae	*Squilla empusa*	1
Mollusca	Bivalvia	Veneroida	Tellinidae	*Tellina agilis*	1
Annelida	Polychaeta	Terebellida	Terebellidae	*Terebellidae (LPIL)*	1
Annelida	Polychaeta	Terebellida	Trichobranchidae	*Terebellides stroemi*	1
Mollusca	Bivalvia	Venerida	Veneridae	*Veneridae (LPIL)*	1