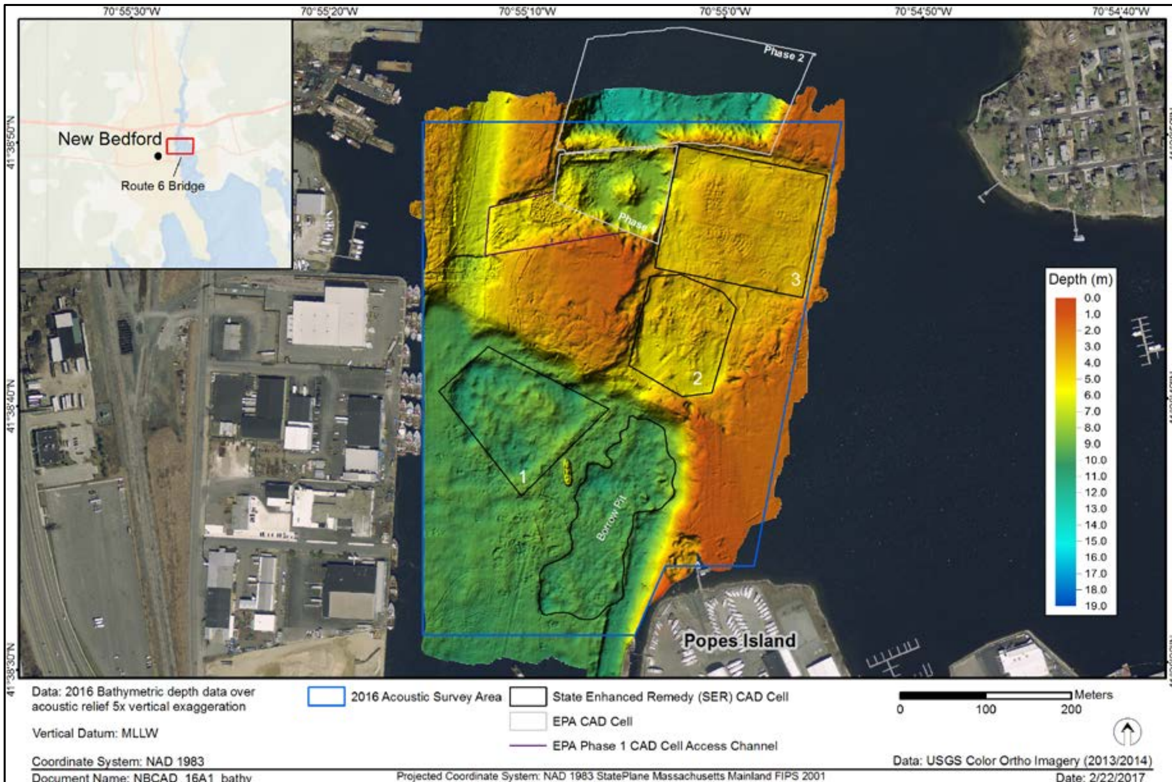
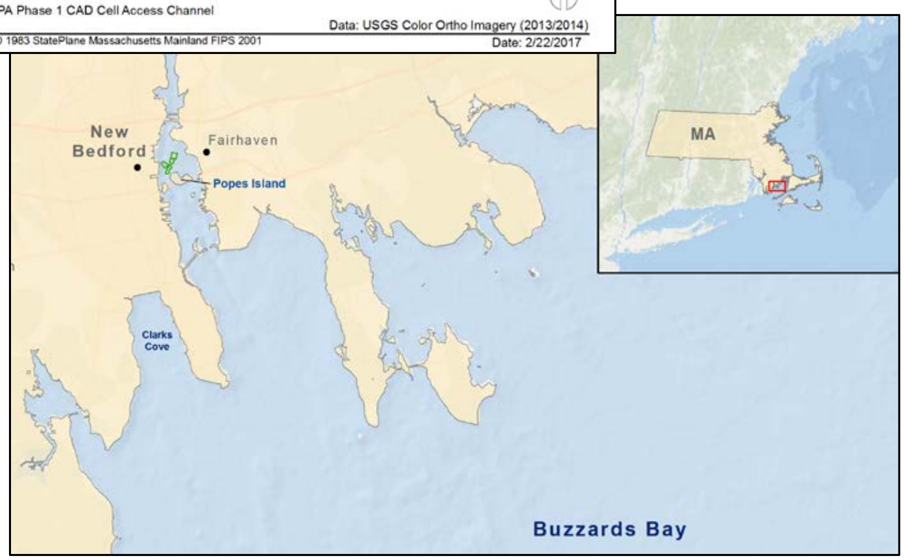
# Data Summary Report for the Baseline Monitoring Survey at the New Bedford Harbor Confined Aquatic Disposal Cell Site – November 2016

# Disposal Area Monitoring System DAMOS




D A M O S

DISPOSAL AREA MONITORING SYSTEM

Data Summary Report

DR 2016-02

October 2017

US Army Corps of Engineers®

New England District

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***<u>Note on units of this report</u>***: 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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| | |
|---|---|
| ASCII | American Standard Code for Information Interchange |
| CAD | Confined Aquatic Disposal |
| CCOM | Center for Coastal and Ocean Mapping |
| DAMOS | Disposal Area Monitoring System |
| FIPS | Federal Information Processing Standard |
| GIS | Graphic information system |
| GPS | Global positioning system |
| MBES | Multibeam echo sounder |
| MLLW | Mean lower low water |
| NAE | New England District |
| NBCAD | New Bedford CAD Cell Site |
| NOAA | National Oceanic and Atmospheric Administration |
| NOS | National Ocean Service |
| NTRIP | Network transport of RTCM data over IP |
| PV | Plan-view |
| RTCM | Radio Technical Commission for Maritime Services |
| RTK | Real time kinematic GPS |
| SER | State Enhanced Remedy |
| SHP | Shapefile or geospatial data file |
| SOP | Standard Operating Procedures |
| SPI | Sediment-profile Imaging |
| TIF | Tagged image file |
| TIN | Triangulated irregular network |
| USACE | U.S. Army Corps of Engineers |

# 1.0 INTRODUCTION

A monitoring survey was conducted at the New Bedford Harbor Confined Aquatic Disposal (NBCAD) Cell Site in November 2016 as part of the U.S. Army Corps of Engineers (USACE) New England District (NAE) Disposal Area Monitoring System (DAMOS) Program. DAMOS is a comprehensive monitoring and management program designed and conducted to address environmental concerns surrounding the placement of dredged material at aquatic disposal sites throughout the New England region. An overview of the DAMOS Program and the NBCAD Cell Site is provided below.

## 1.1 Overview of the DAMOS Program

The DAMOS Program features a tiered management protocol 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 39 years, the DAMOS Program has collected and evaluated 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 (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 management questions in determining the next step in the disposal site management process to guide the management of disposal activities at existing sites, plan for use of future sites, and evaluate the long-term status of historic sites.

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 often 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 inactive or historical disposal sites and contribute to the development of dredged material placement 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 subbottom profiling, towed video, sediment coring, or grab sampling.

The objective of the 2016 NBCAD Cell Site investigation was considered part of a focused study to track long-term stability of the confined aquatic disposal (CAD) cells given their location within a working harbor and as a baseline for the State Enhanced Remedy (SER) CAD cells (Cells 1, 2, and 3) and the initial Superfund cell (Phase 1 Cell).

## 1.2 Introduction to the New Bedford Harbor Confined Aquatic Disposal Cell Site

The NBCAD Cell Site is one of several CAD Cell Sites in New England. The site is a series of six CAD cells in New Bedford Harbor, New Bedford, Massachusetts (Figure 1-1).

The site includes four CAD cells (Borrow Pit, 1, 2, 3) in the New Bedford Harbor that are part of the State's remediation/development of the harbor and two CAD cells (Phase 1 and Phase 2) that are part of the Superfund remediation. The cells have been surveyed at various times during construction and operation by the contractor supporting the City of New Bedford, but there has not been a DAMOS survey prior to this study.

The construction of CAD cells began in New Bedford Harbor in 1989 to support efforts in cleaning up the harbor after discovery of contamination from electrical transformer manufacturing industries that moved to the area in the 1940s and operated until the 1970s. Sediment samples conducted towards the end of the industries' waterfront operations revealed significant concentrations of metals and Polychlorinated Biphenyls (PCBs). This led to the signing of the Record of Decision (ROD) for the New Bedford Harbor Superfund Site by the USEPA in 1998 in an effort to remedy the pollution (APEX 2016).

In 1989 a shallow CAD cell was constructed in New Bedford Harbor as part of a pilot study for the New Bedford Harbor Superfund project. The CAD cell, located in Pierce Mill Cove, was constructed to contain contaminated sediment dredged from the surrounding area and to evaluate in-water disposal methods. The CAD cell was subsequently capped with clean parent material and is located north of the NBCAD Cell Site (USACE 2012).

The Borrow Pit and CAD cells 1, 2 and 3 were used in New Bedford Harbor beginning in 2005, associated with improvements to the harbor requiring removal of material that was outside of the area being remediated as part of the Superfund project (Figure 1-2). The first cell used was a historic borrow pit created from past sand mining activities. Once that borrow pit site was filled, approximately 65,000 $m^3$ of sand was dredged from an area north of Popes Island in constructing the three additional CAD cells. The newly completed Phase 1 and Phase 2 CAD cells were not completed under the State Enhanced Remedy, however, they were constructed in conjunction with and under the same protocols and oversight as other SER projects (APEX 2016).

## 1.3 New Bedford Harbor CAD Cell Construction Sequence

CAD cell construction began in June 2005 with the creation of CAD Cell 1 and the initial filling of the CAD Borrow Pit. In June 2008 construction of CAD Cell 2 began followed by CAD Cell

3 in April 2013. Phase 1 Cell construction started in November 2013 and Phase 2 Cell construction started in December 2014 (Table 1-1).

## 1.4 Previous Monitoring Events at New Bedford Harbor CAD Cell Site

The November 2016 survey is a baseline study under the DAMOS Program. No previous monitoring surveys were conducted under the DAMOS Program at the NBCAD Cell Site. As-built (final CAD cell construction) acoustic surveys were completed outside of the DAMOS program in prior years. Figures of the as-built excavated cell bathymetry data for the three SER CAD cells and the Phase 1 cell are included in this report (Figures 1-3 through 1-6).

## 1.5 2016 Survey Objectives

The 2016 survey was designed as a focused survey to provide baseline data and track long-term stability of CAD Cells 1, 2, 3, and of the Phase 1 Cell. The objectives of the survey were to:

- Characterize the harbor topography and surficial features over the 4 existing cells (1, 2, 3, and Phase 1) by completing a multibeam bathymetric survey, and
- Using the baseline multibeam data, calculate any remaining capacity of the cells assuming they would be filled to within 1 m (~3 ft) of the surrounding harbor bottom

**Table 1-1.** New Bedford Harbor CAD Cell Construction Sequence and As-Built Survey Dates

| Cell ID | Construction Start[a] | "As-Built" Survey Date[b] |
|---|---|---|
| Borrow Pit | Existing depression | Not applicable |
| 1 | June 2005 | July 27, 2005 |
| 2 | June 2008 | October 16, 2008 |
| 3 | April 2013 | September 13, 2013 |
| Phase 1 | November 2013 | July 2014 |
| Phase 2 | December 2014 | Not provided |

[a] Personal communication, USACE, Feb. 2017
[b] Data provided by USACE, Feb. 2017

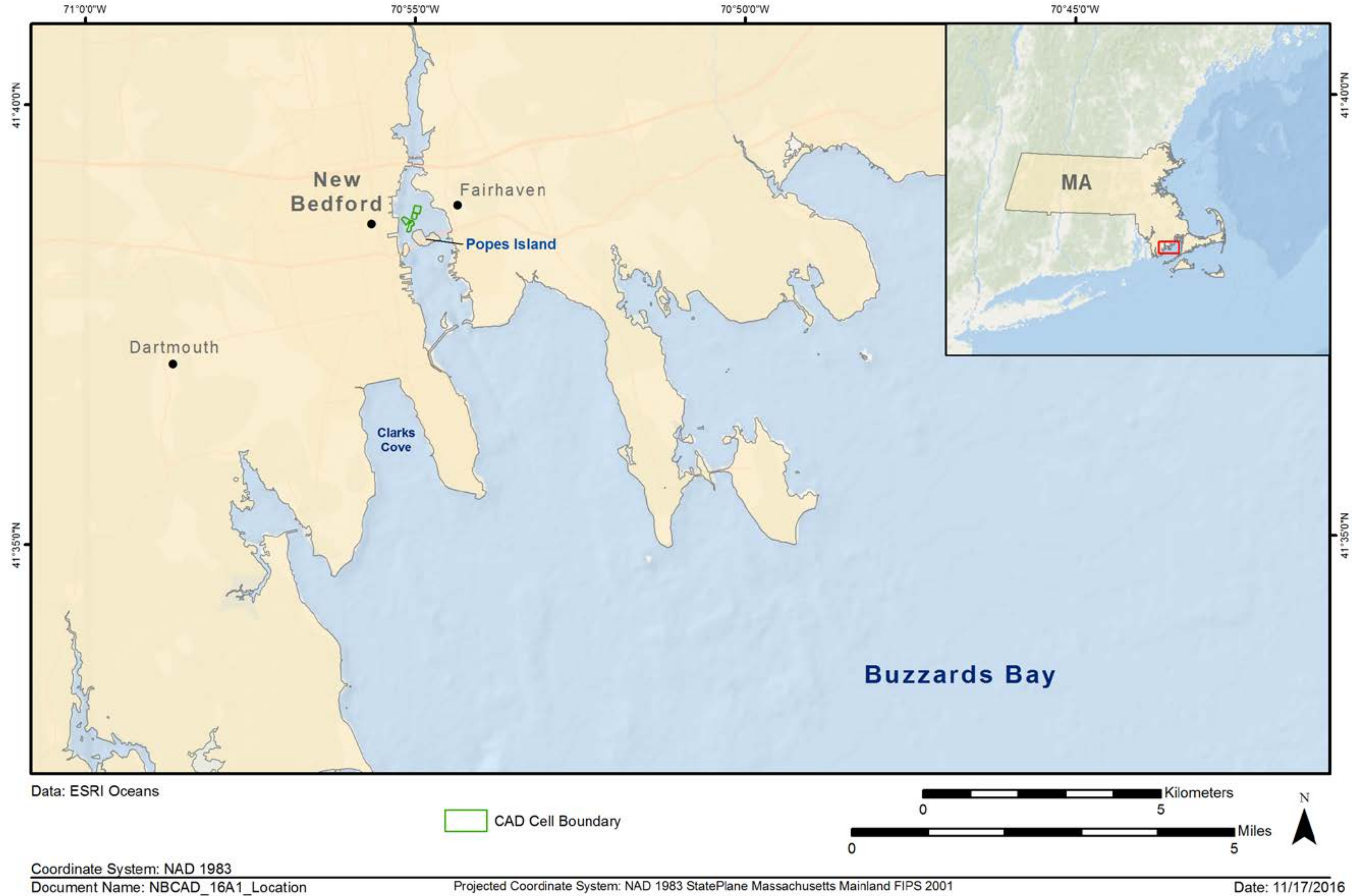



**Figure 1-1.** Location of the New Bedford Harbor CAD Cell Site (NBCAD)

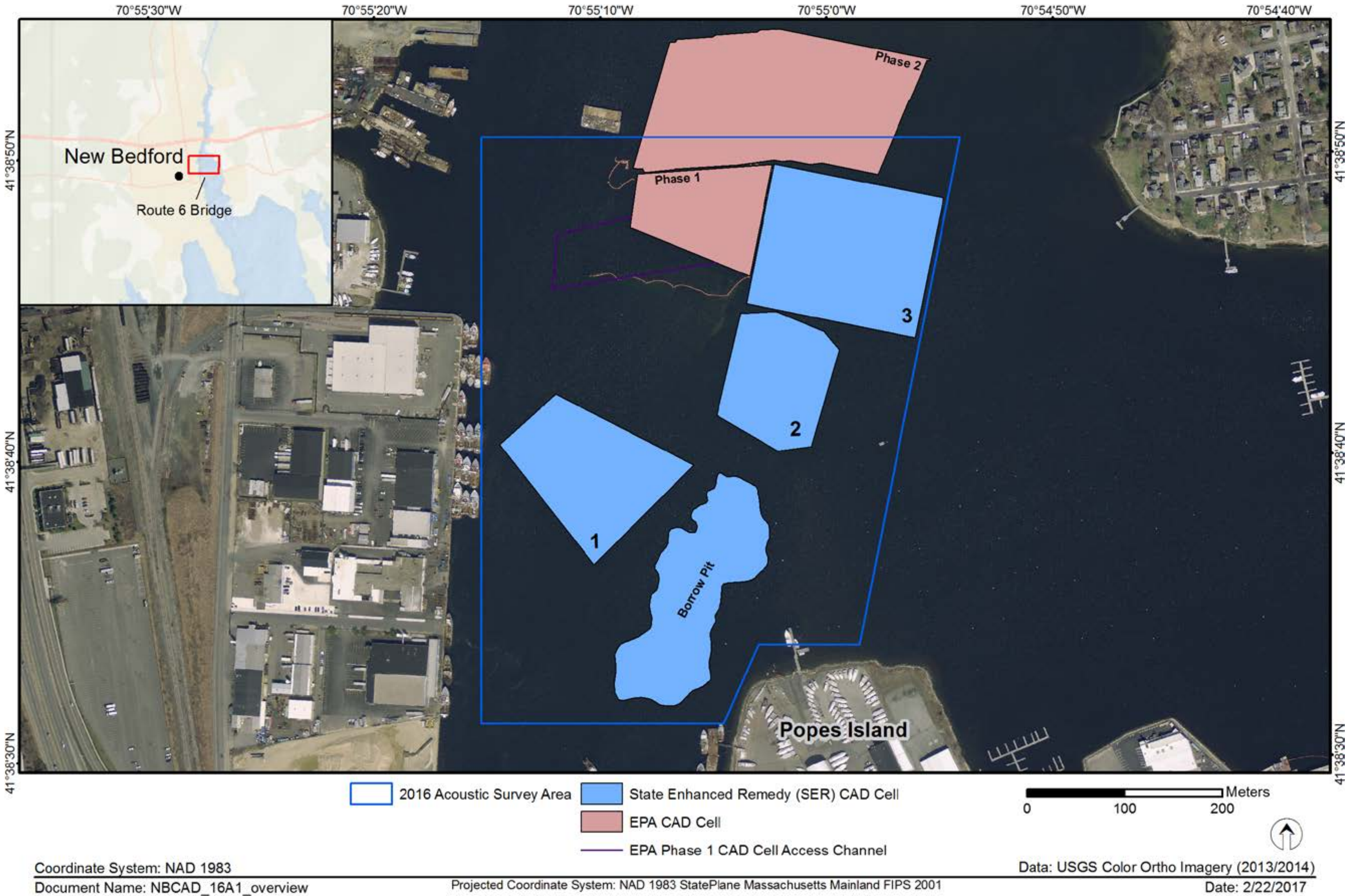



**Figure 1-2.** Overview and NBCAD 2016 acoustic survey area

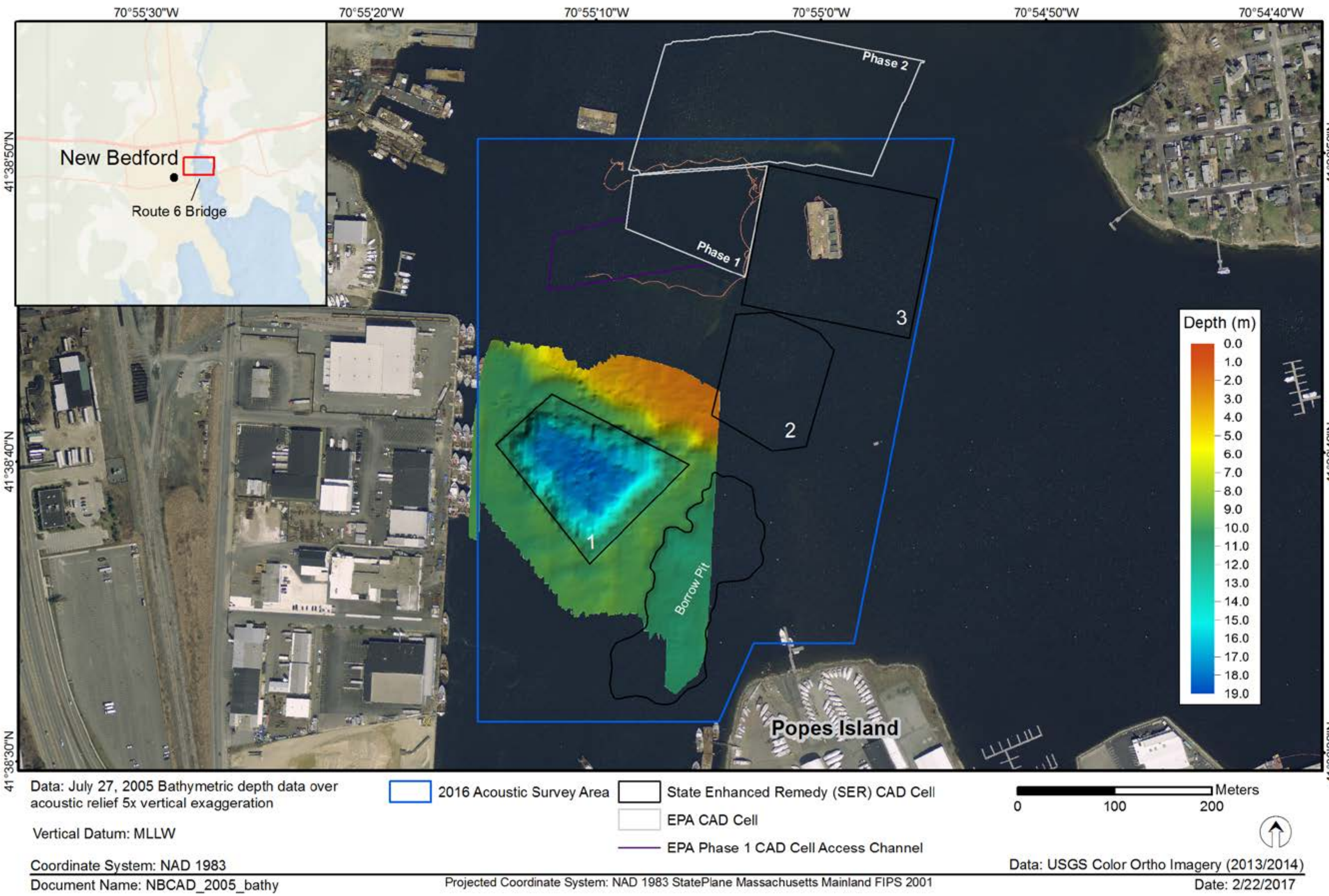



**Figure 1-3.** As-built bathymetry data of SER CAD Cell 1 – July 27, 2005

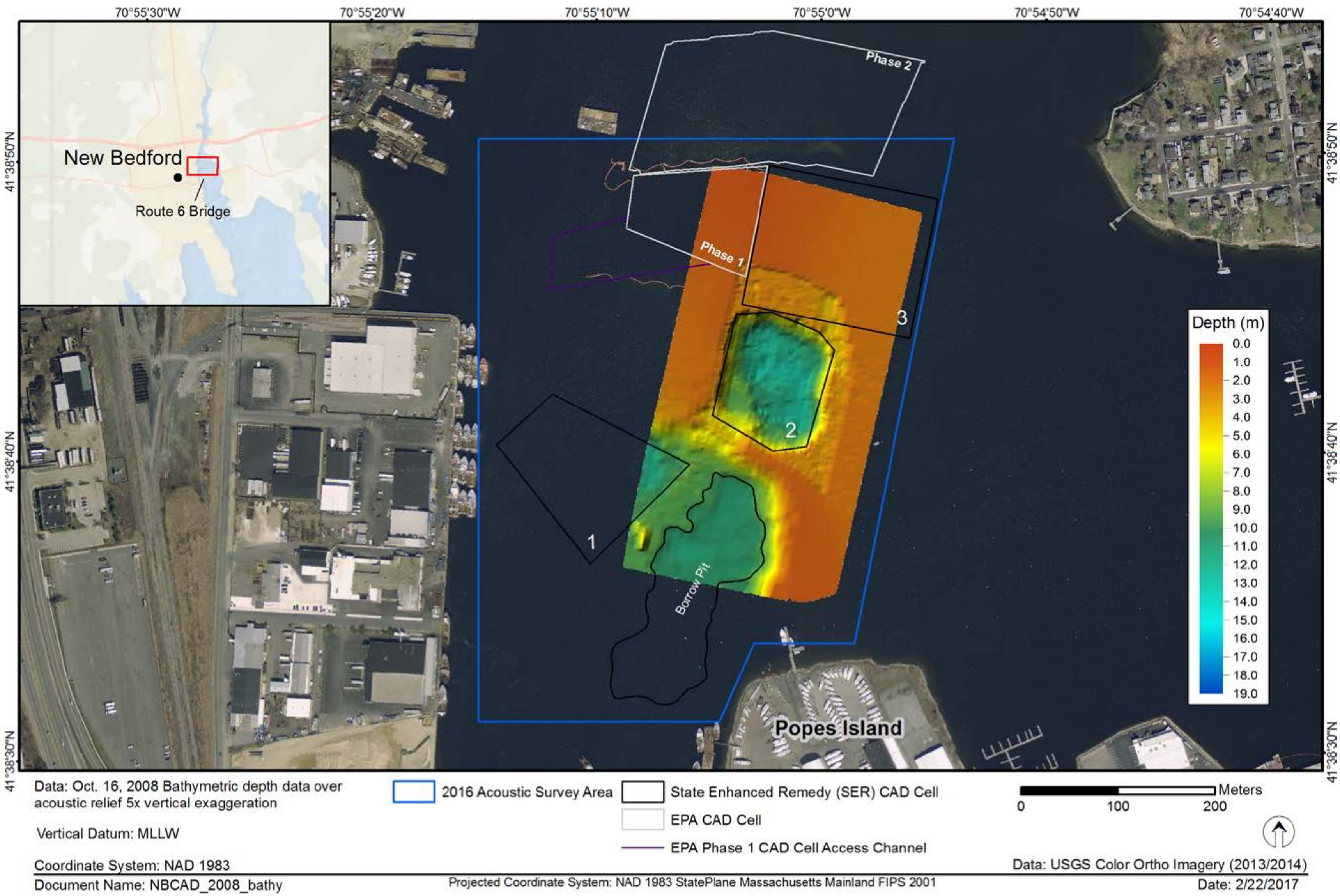



**Figure 1-4.** As-built bathymetry data of SER CAD Cell 2 – October 16, 2008

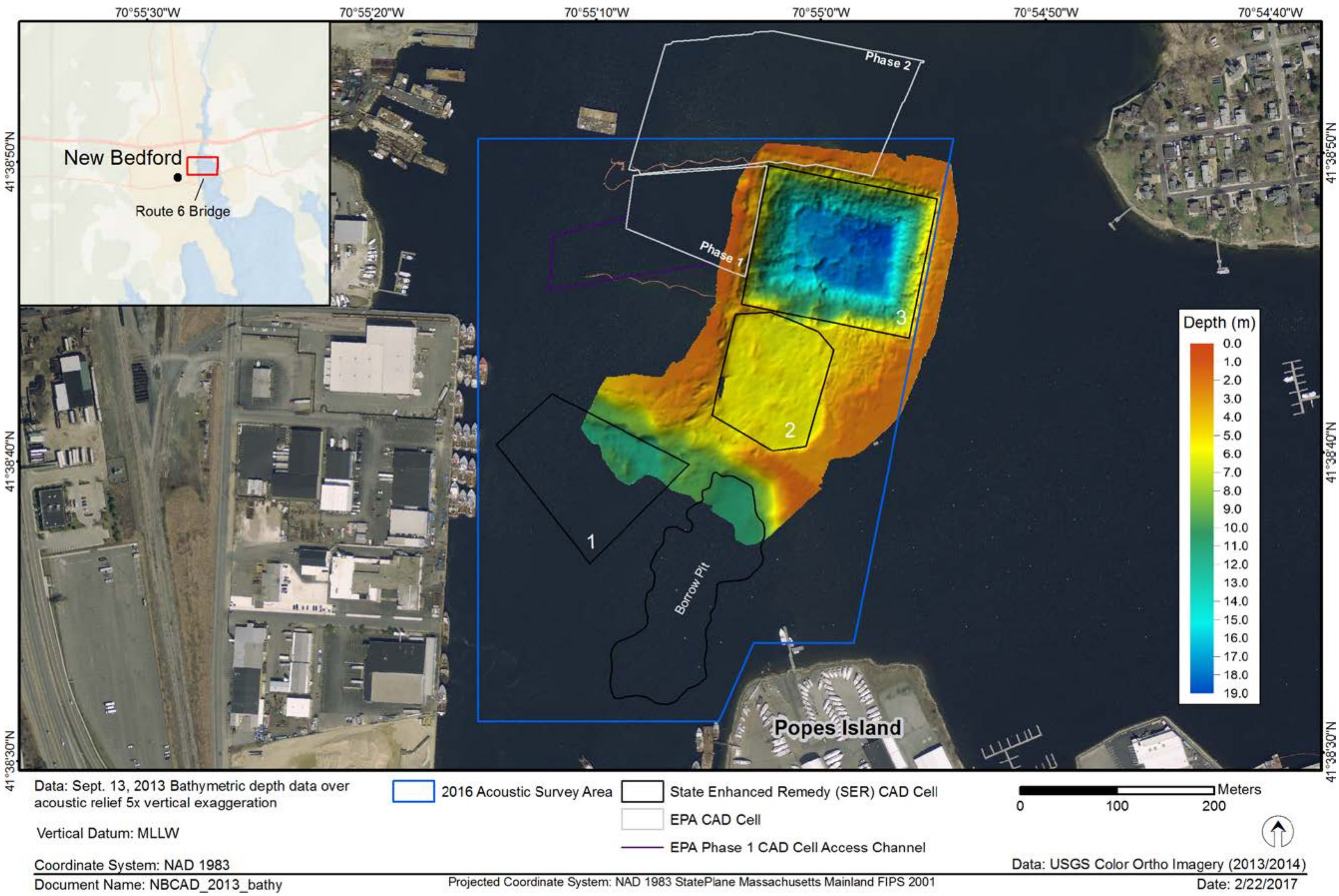



**Figure 1-5.** As-built bathymetry data of SER CAD Cell 3 – September 13, 2013

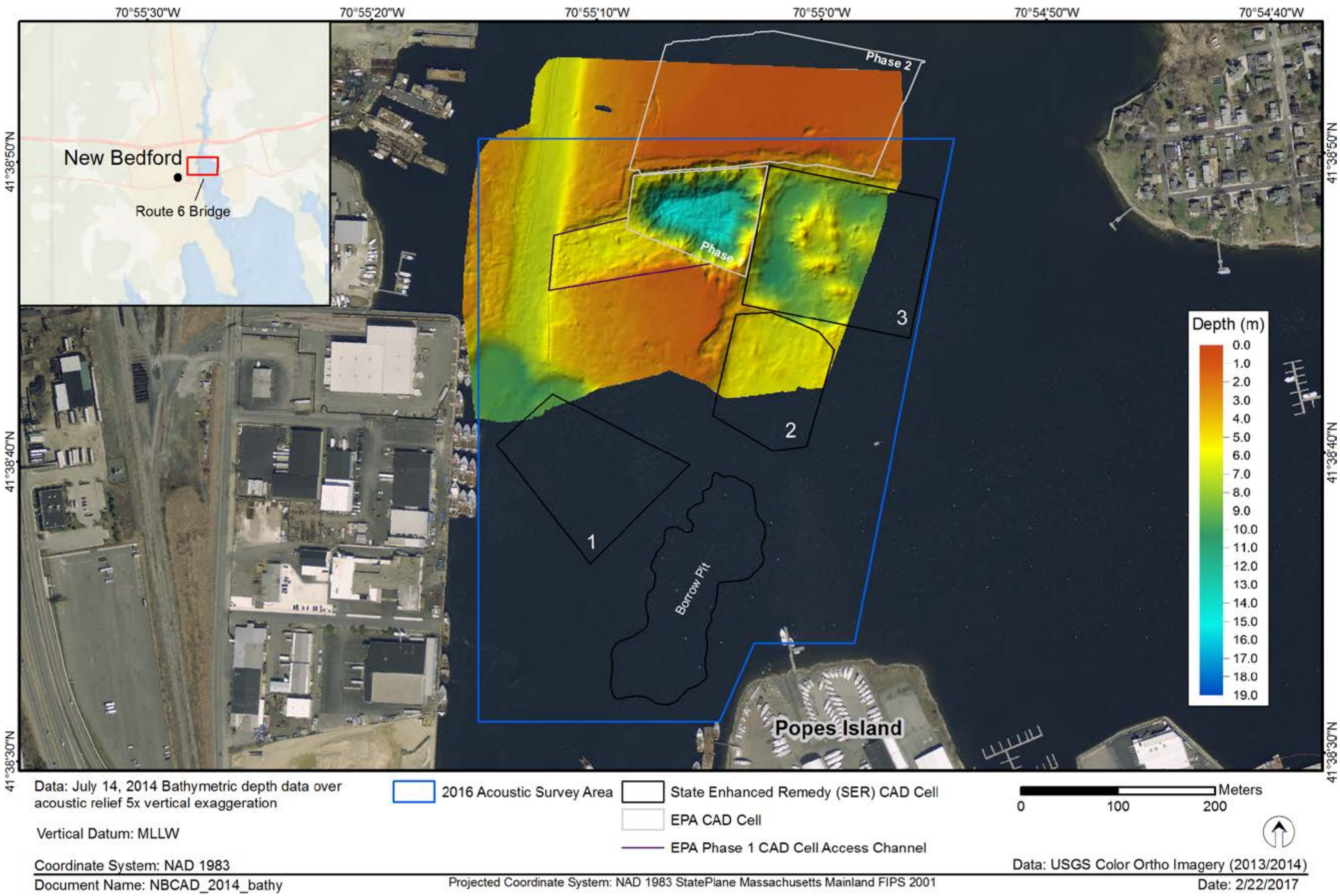



**Figure 1-6.** As-built bathymetry data of EPA CAD Cell Phase 1 – July 14, 2014

# 2.0 METHODS

The November 2016 survey at the NBCAD Cell Site was conducted by a team of investigators from INSPIRE Environmental including certified hydrographer Christopher Wright aboard the 25-foot *R/V Cyprinodon*. The acoustic survey was conducted 2-3 November 2016. An overview of the methods used to collect, process, and analyze the survey data is provided below. Detailed Standard Operating Procedures (SOPs) for data collection and processing are available in the Quality Assurance Project Plan for the DAMOS Program (Battelle 2015).

## 2.1 Navigation and On-Board Data Acquisition

Navigation for the acoustic survey was accomplished using a Hemisphere VS-330 RTK GPS which received base station correction through the Keynet NTRIP broadcast. Horizontal position accuracy in fixed RTK mode was approximately 1 cm, vertical (tidal) accuracy was approximately 2 cm. The GPS system was interfaced to a laptop computer running HYPACK MAX® hydrographic survey software. HYPACK MAX® 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.

On the *Cyprinodon*, vessel heading measurements were provided by an IxBlue Octans III fiber optic gyrocompass. A dual-antenna Hemisphere VS-110 Crescent Digital compass was mobilized as a backup.

## 2.2 Acoustic Survey

The acoustic survey included multibeam 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 the characterization of surface sediment texture and roughness. Each of these acoustic data types is useful for assessing dredged material placement and surface sediment features.

### 2.2.1 Acoustic Survey Planning

The acoustic survey area at the NBCAD Cell Site (Figure 1-2) had water depths ranging from 2 m to 13 m. The acoustic survey featured a high spatial resolution survey of 4 CAD cells (Cells 1, 2, 3, and Phase 1) and covered an approximate 600 × 600 m area in New Bedford Harbor (Figure 1-2).

INSPIRE hydrographers obtained site coordinates, imported them to graphic information system (GIS) software, and created maps to aid planning. Base bathymetric data from previous surveys were used to calculate 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 15-20 m apart and cross-lines spaced 100-150 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

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 1-2° beams (frequency dependent) distributed equiangularly or equidistantly across a 10 - 160° swath. The MBES system was operated using a transmit frequency of 200 kHz to facilitate comparisons with previous survey data while maximizing bathymetric resolution. 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 on 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 the 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 each survey day using an AML, Inc. Minos-X profiling instrument.

### 2.2.3 Bathymetric Data Processing

Bathymetric data were processed by the certified hydrographer 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. Water surface elevations derived using RTK were adjusted to Mean Lower Low Water (MLLW) elevations using NOAA’s VDATUM Model. Processed RTK tide data were successfully ground-truthed against a data series acquired using a digital water level recorder installed at a surveyed control point established by USACE for bathymetric surveys.

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 remained in the bathymetric surface model at a relatively fine scale (generally less than 5 cm) relative to the survey depth.

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 a mean depth of 6 m and a maximum beam angle of 60°, the maximum diameter of the beam footprint was calculated at approximately 0.4 × 0.8 m (0.35 $m^2$). Mid-swath data would have a resolution of 0.07 $m^2$. Data were reduced to a cell (grid) size of 0.5 × 0.5 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 $95^{th}$ percentile confidence interval (95% CI) of 0.27 m at the maximum site depth (13.6 m) and 0.25 m at the average site depth (6.1 m).

Reduced data were exported in ASCII text format with fields for Easting, Northing, and MLLW Elevation (meters). All data were projected to the Massachusetts State Plane FIPS 2001, NAD83 (metric). A variety of data visualizations were generated using a combination of ESRI ArcMap (V.10.1) and Golden Software Surfer (V.13). Visualizations and data products included:

- ASCII data files of all processed soundings including MLLW depths and elevations
- Contours of seabed elevation (25-cm, 50-cm and 1.0-m intervals) in a geospatial data file (SHP) 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 5× vertical exaggeration, delivered in georeferenced TIF format.

### 2.2.4 Backscatter Data Processing

Backscatter data were extracted from cleaned MBES TruePix formatted files 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). Seamless mosaics of unfiltered backscatter data were 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 exported to an 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. Seamless mosaics of side-scan sonar data were developed and exported in grayscale TIF format using a resolution of 0.3 m per pixel.

#### 2.2.6 Acoustic Data Analysis

Bathymetric contour lines and acoustic relief models were generated from grids 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 Remaining Cell Capacity Calculation

CAD cell volumes and remaining capacities were calculated by constructing triangulated irregular network (TIN) surface models for each cell using processed ASCII point data (binned as described in Section 2.2.3), then computing the volumes and planar areas above and below discreet 20-cm elevation intervals within vertical prisms. Prism geometry was defined by digital polygons provided by USACE and, where applicable, alternate boundaries digitized based on the observed footprint of each cell's excavation. TIN-based volume calculations are recommended by EM 1110-2-1003 (30 Nov 13, 10-30(d)).

TIN models honor each sounding solution without introducing minor uncertainties associated with grid interpolations. A TIN model consists of a series of triangles constructed between corrected sounding points that exactly honors the elevation and position of each point.

**Table 2-1.** Accuracy and Uncertainty Analysis of Bathymetric Data

| | | Results (m) | | | | |
|---|---|---|---|---|---|---|
| **Survey Date** | **Quality Control Metric** | **Mean** | **95% Uncertainty** | **Range** | | |
| 11/2-3/2016 | Cross-Line Swath Comparisons | 0.00 | 0.11 | | | |
| | Within Cell Uncertainty | 0.04 | 0.10 | 0.00 | - | 4.53 (wreck) |
| | Beam Angle Uncertainty (0 – 60 d) | 0.00 | 0.09 | 0.08 | - | 0.14 |

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 0.5 m x 0.5 m cell averages. These analyses do not exclude sounding variability associated with terrain slopes and objects (e.g., wrecks, pilings).

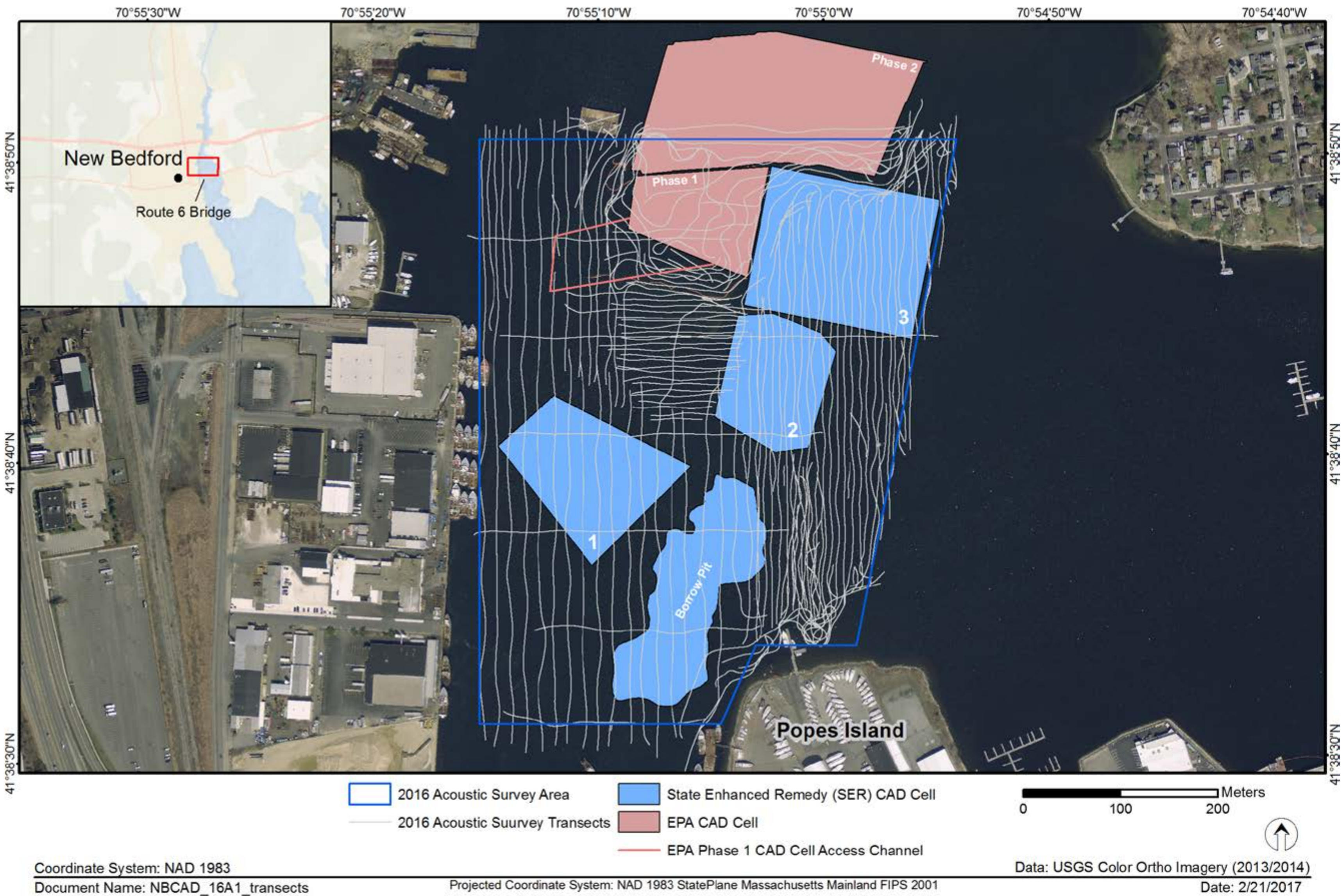



**Figure 2-1.** NBCAD 2016 acoustic survey area and tracklines

# 3.0 ACOUSTIC RESULTS

The results of the acoustic survey conducted in November 2016 to characterize seafloor topography and sediment surface features over the NBCAD Cell Site are presented in this section.

## 3.1 Bathymetry

The November 2016 New Bedford CAD survey covered an approximately 600 x 600 m area north of Popes Island. Survey tracklines were run over the Borrow Pit, CAD Cell 1, CAD Cell 2, CAD Cell 3, and Phase 1 Cell (Figure 2-1). Depths over the entire survey area ranged from 0.49 to 13.6 m below MLLW (Figure 3-1). The deepest areas were found in the southwest quadrant of the survey area, which includes CAD Cell 1 and the Borrow Pit, with depths of 8 to 10 m below MLLW. CAD Cells 2 and 3 had depths ranging from 3 to 5 m below MLLW. A noticeably shallow area was west of CAD Cell 2 and south of Phase 1 Cell that was 2 m deep. Depths in the Phase 1 cell ranged from 2 to 8 m below MLLW. Multibeam bathymetric data rendered as an acoustic relief model provided a more detailed representation of the fine-scale topography of the cells and of the entire site consistent with material placement (Figure 3-2).

Multibeam bathymetric data rendered as a color scale by elevation over an acoustic relief model (grayscale with hill-shading) provided additional representation of cell topographic lows and of the entire site (Figure 3-3). A distinct small oval shaped deposit was observed between CAD Cell 1 and the Borrow Pit. Two approximately 6-m deep channels were apparent, one covering the EPA Phase 1 CAD Cell Access Channel and the other running along the navigational channel on the western survey boundary. A large circular-shaped depression with a central mound ranged from a low of -8 m MLLW to a high of -6 m MLLW in the Phase 1 Cell (Figure 3-3). The western side of the Borrow Pit had three features resembling deposits of dredged material.

## 3.2 Backscatter and Side-Scan Sonar

A mosaic of unfiltered backscatter data for the NBCAD Cell Site (Figure 3-4) generally revealed finer surfaces having a weaker acoustic return (darker gray) in the south west of the survey area. Coarse sediment with a stronger acoustic return (lighter gray) was found throughout the rest of the survey area except for in CAD Cell 2, CAD Cell 3, and Phase 1 Cell. CAD Cells 2 and 3 had nearly homogenous medium acoustic returns. Phase 1 CAD Cell had a mixture of strong and weak acoustic returns with distinct weaker returns indicative of finer sediment in the southeast of the cell.

Filtered backscatter results were processed into a grid file and presented in a quantitative form where backscatter intensity values were assigned a color (Figure 3-5). In this filtered and gridded display, the finer-scale details were less visible, but the relative intensity of backscatter returns were easier to discern. Side-scan sonar results provided a high-resolution acoustic representation of the seafloor surface in a mosaic of the site and revealed three deposit features on the western margin of the Borrow Pit (Figure 3-6).

### 3.3 Comparison with Previous Bathymetry

As this is a baseline DAMOS survey, there is no suitable previous bathymetric data for comparison.

### 3.4 Cell Capacity

The NBCAD cells have remaining capacity of approximately 56,545 $m^3$ (Table 3-1) if filled to within one meter of the surrounding harbor bottom. A complete capacity report is presented in Appendix B.

**Table 3-1.** Remaining Capacity of New Bedford Harbor CAD Cells

| CAD Cell Area | Cell ID | Depth of Surrounding Harbor Bottom (m) below MLLW | Remaining Capacity if Filled to within 1 m of Surrounding Harbor Bottom ($m^3$) |
|---|---|---|---|
| State Cell | 1 | 7.8 | 11,572 |
| | 2 | 3.4 | 3,983 |
| | 3 | 3.4 | 2,043 |
| EPA | Phase 1 | 2.4 | 38,947 |

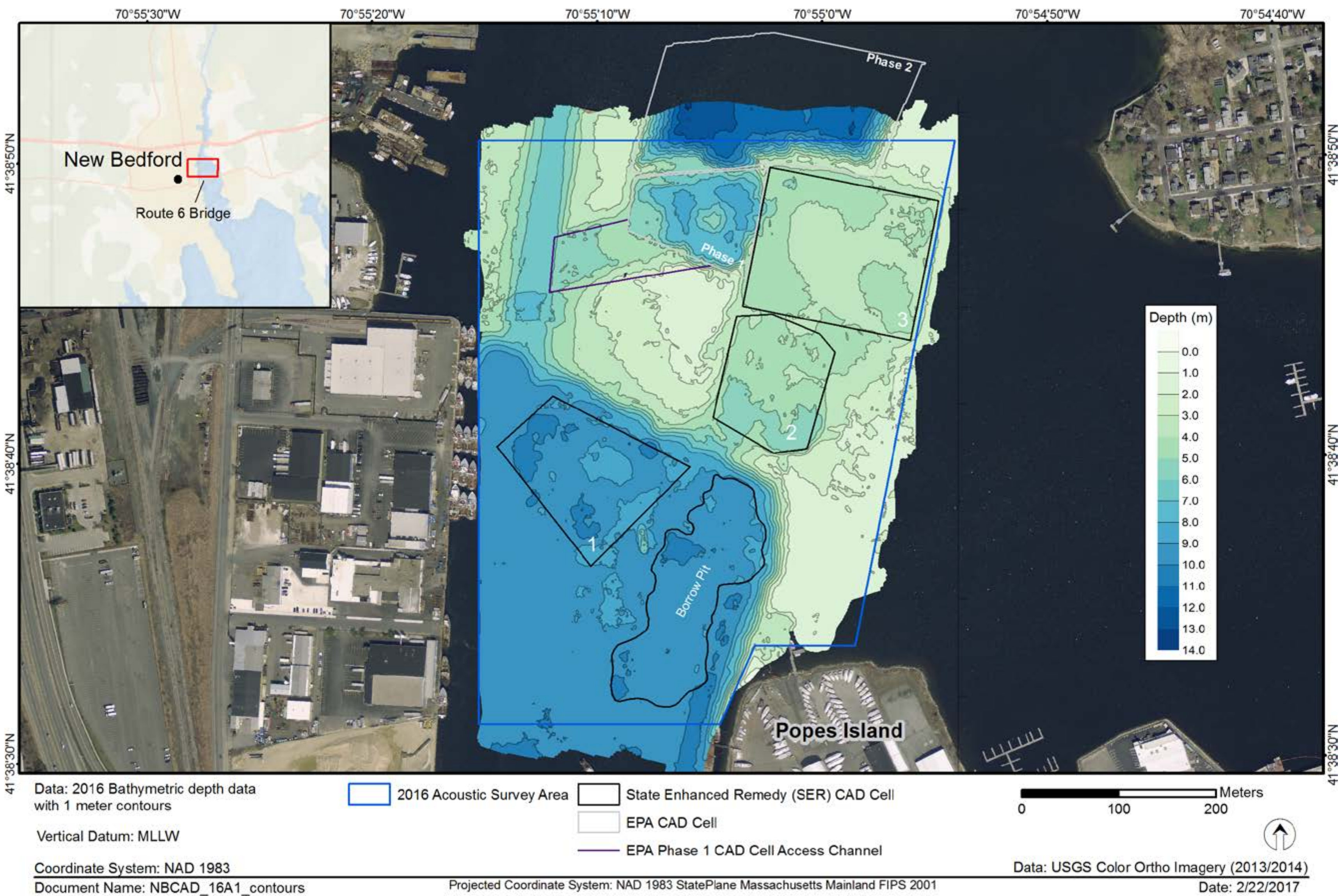



**Figure 3-1.** Bathymetric contour map of NBCAD Cell Site – November 2016

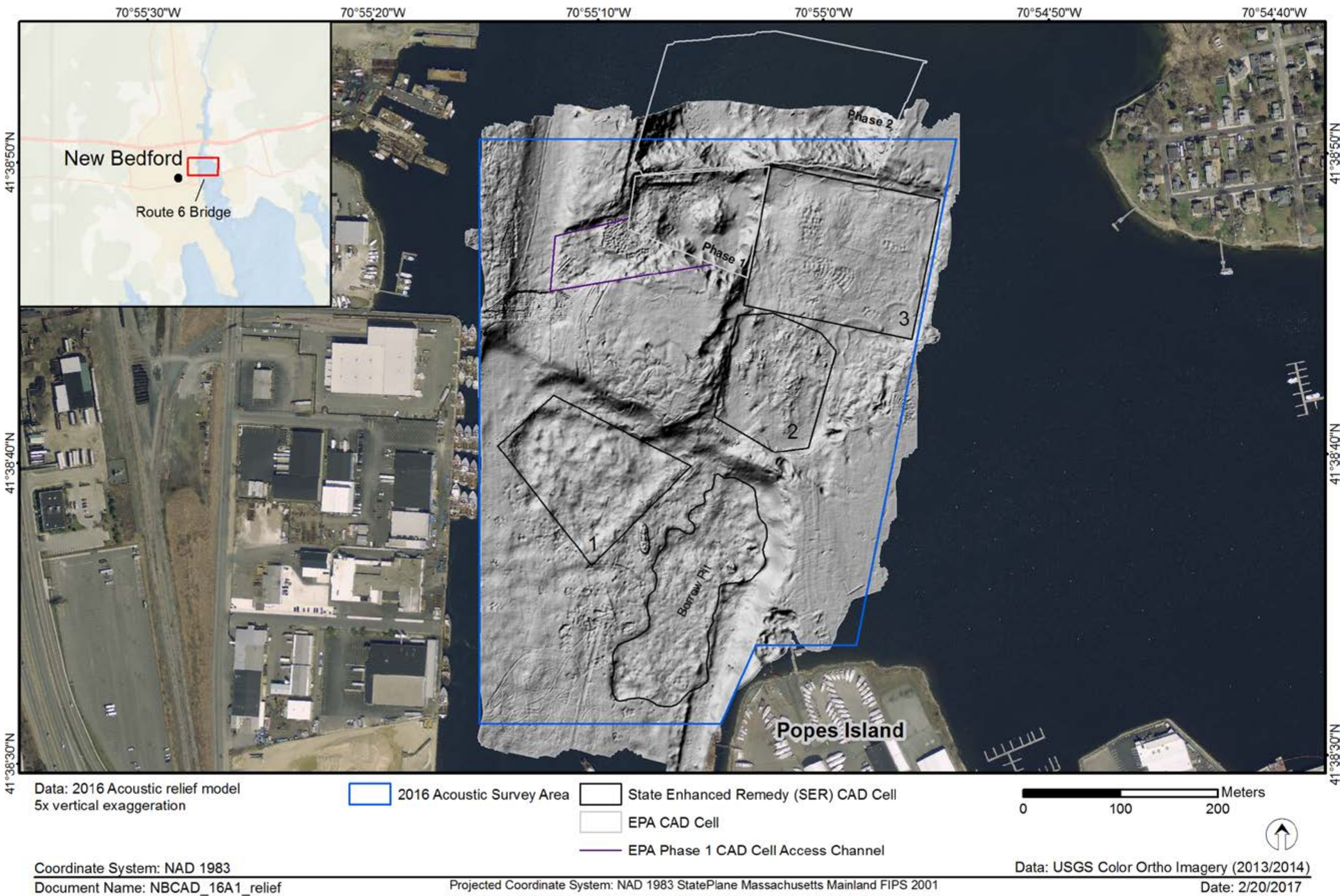



**Figure 3-2.** Acoustic relief map (hill-shaded) of NBCAD Cell Site – November 2016

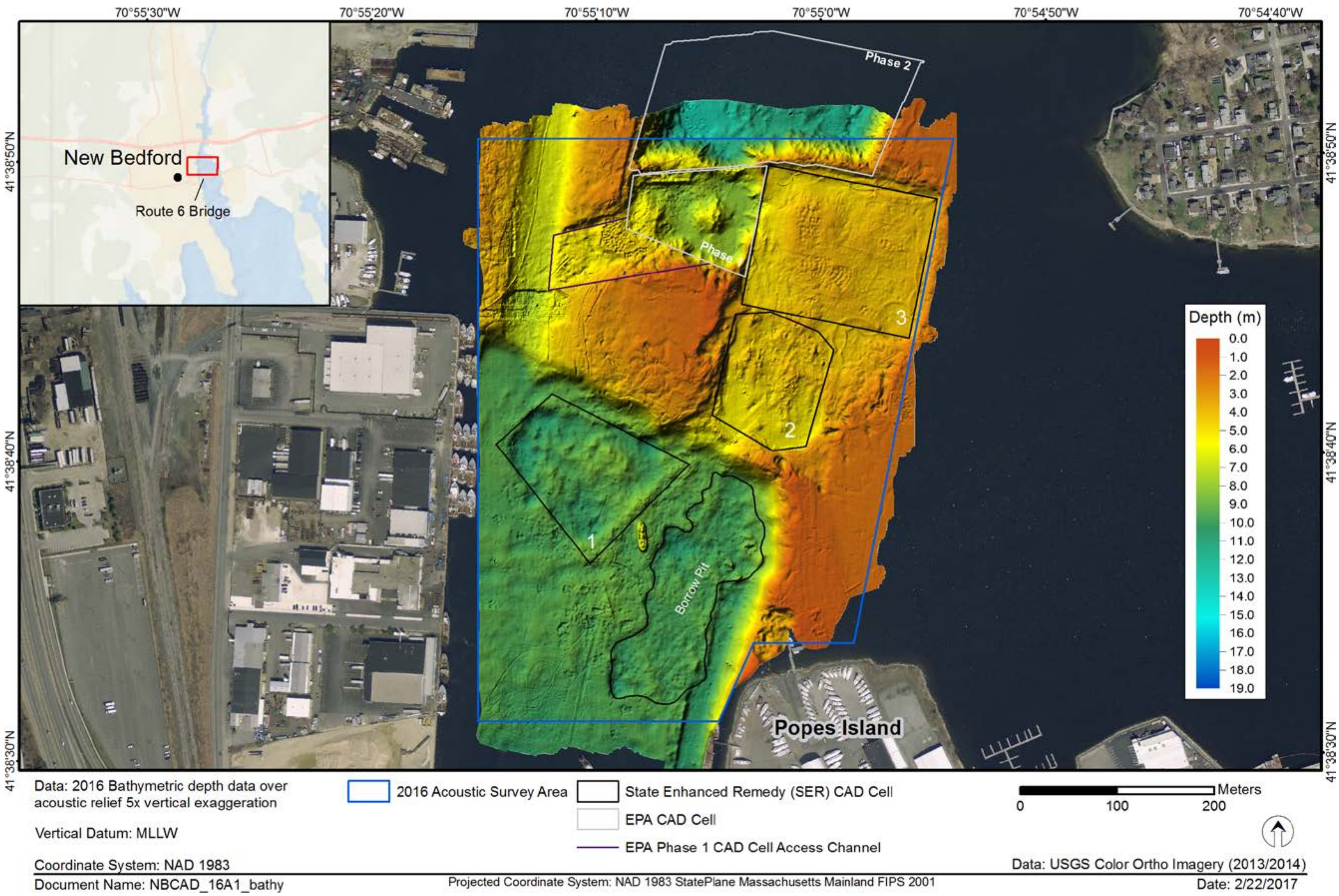



**Figure 3-3.** Bathymetric depth data over acoustic relief model of NBCAD Cell Site – November 2016

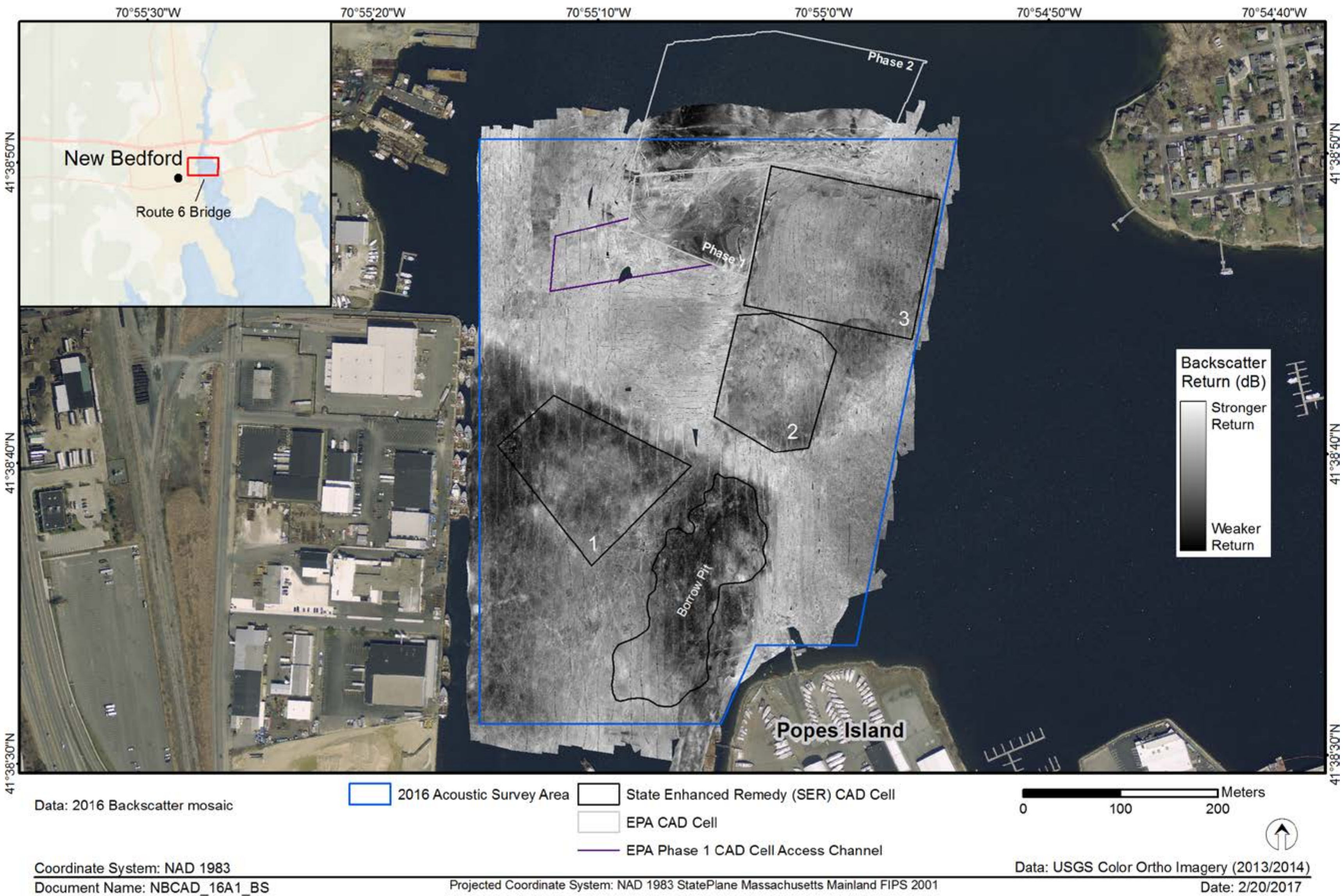



**Figure 3-4.** Mosaic of unfiltered backscatter data of NBCAD Cell Site – November 2016

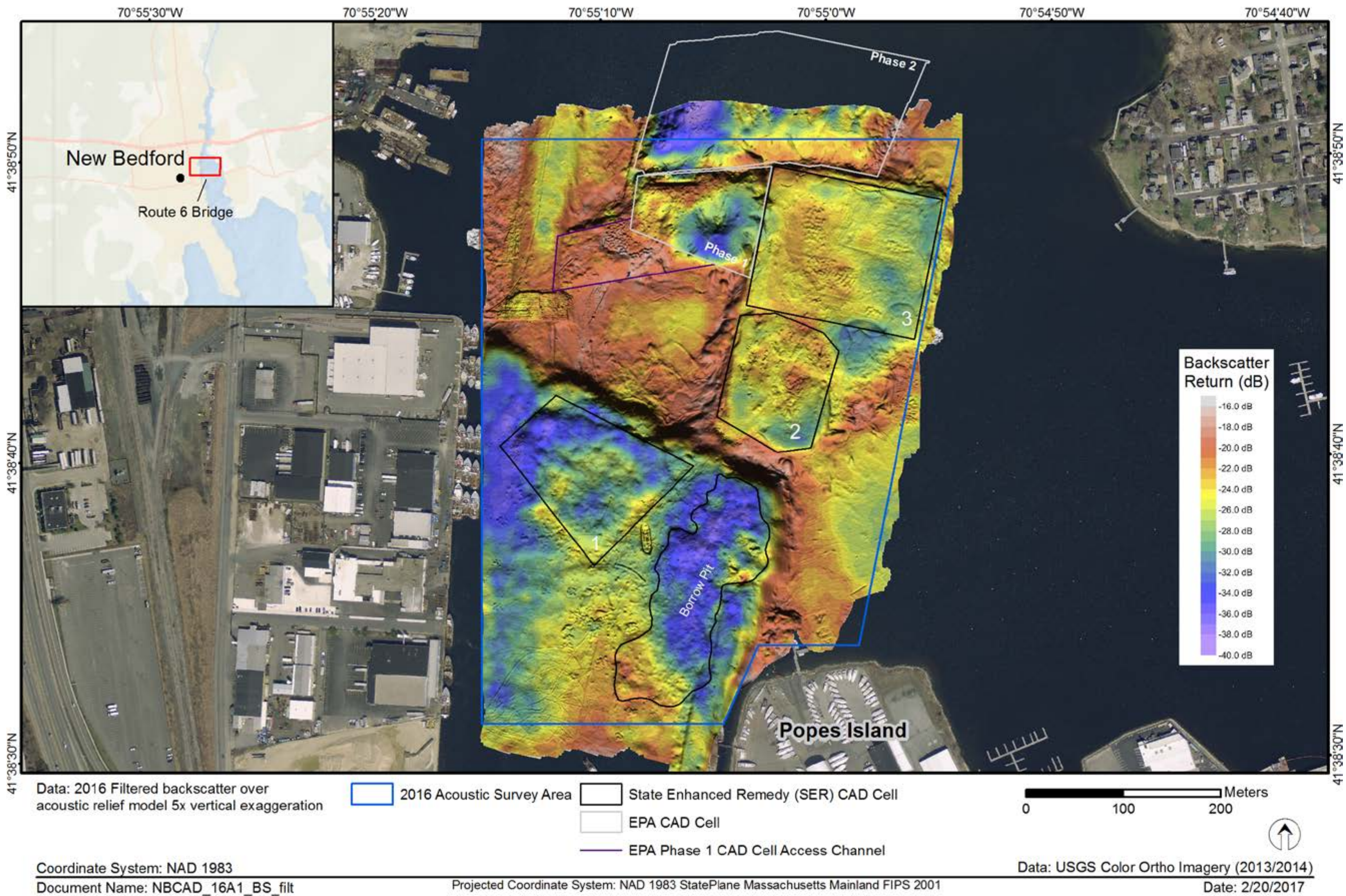



**Figure 3-5.** Filtered backscatter over acoustic relief model of NBCAD Cell Site – November 2016

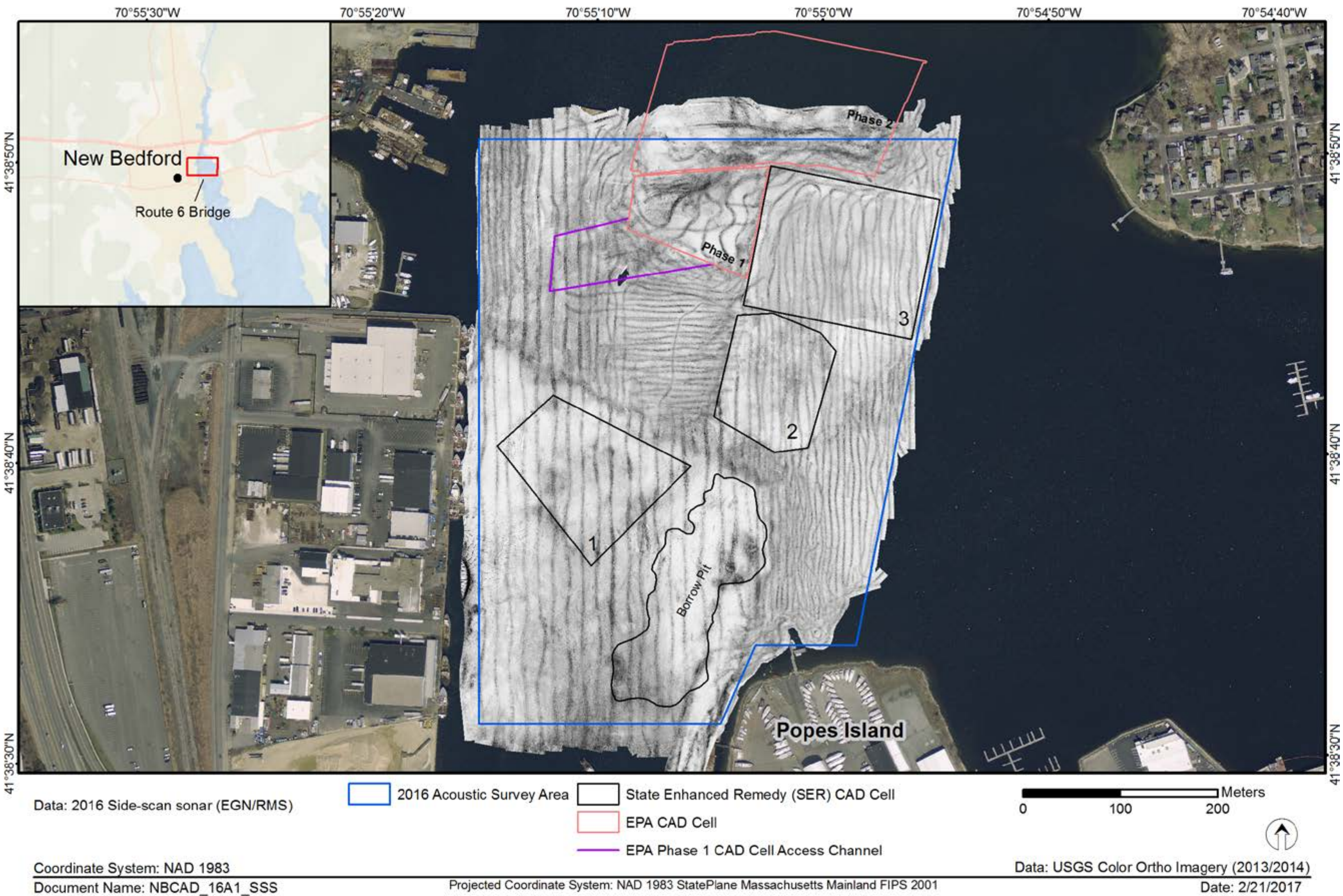



**Figure 3-6.** Side-scan mosaic of NBCAD Cell Site – November 2016

## 4.0 SUMMARY

The objectives of the survey were to:

- Characterize the harbor topography and surficial features over the 4 existing cells (1, 2, 3, and Phase 1) by completing a multibeam bathymetric survey, and
- Using the baseline multibeam data, calculate any remaining capacity of the cells assuming they would be filled to within 1 m (~3 ft) of the surrounding harbor bottom

Observed surficial features in the survey areas were consistent with excavation of CAD cells with dredging equipment (arcuate scars or parallel marks) and filling of the cells with bottom release barges (smooth surfaces and circular depressions).

The NBCAD cells have remaining capacity of approximately 56,545 m³ (Table 3-1) if filled to within one meter of the surrounding harbor bottom.

State CAD Cell 1

- CAD Cell 1 had depths of 8 to 10 m below MLLW
- The State CAD cell 1 has a remaining capacity of approximately 11,572 m³ if filled to within one meter of the surrounding harbor bottom.

State CAD Cell 2

- CAD Cell 2 had depths ranging from 3 to 5 m below MLLW.
- CAD cell 2 has a remaining capacity of approximately 3,983 m³ if filled to within one meter of the surrounding harbor bottom.

State CAD Cell 3

- CAD Cell 3 had depths ranging from 3 to 5 m below MLLW.
- CAD cell 3 has a remaining capacity of approximately 2,043 m³ if filled to within one meter of the surrounding harbor bottom.

Phase 1 CAD Cell

- Depths in the Phase 1 cell ranged from 2 to 8 m below MLLW.
- The EPA Phase 1 CAD cell has a remaining capacity of approximately 38,947 m³ if filled to within one meter of the surrounding harbor bottom.

## 5.0 DATA TRANSMITTAL

Data transmittal to support this data report will be provided as a separate deliverable for inclusion in a Technical Support Notebook. The data submittal will include:

- Scope of Work
- Raw and processed acoustic survey data
- Survey field logs
- Report figures and associated files, including an ArcGIS geo-database
- Electronic copies of all data and final products

# 6.0 REFERENCES

APEX. 2016. After Action Report, Lower Harbor CAD Cell Dredging Project. Prepared by APEX Companies, LLC, Boston, MA. Submitted to the New Bedford Harbor Development Commission, New Bedford, MA and the U.S. Environmental Protection Agency, Boston, MA, 20 pp.

Battelle. 2015. Quality Assurance Project Plan (QAPP) for the Disposal Area Monitoring Study (DAMOS) Program. Prepared by Battelle, Norwell, MA. Submitted to U.S. Army Corps of Engineers, New England District, Concord, MA, 50 pp.

Fredette, T. J.; French, G. T. 2004. Understanding the physical and environmental consequences of dredged material disposal: history in New England and current perspectives. Mar. Pollut. Bull. 49:93–102.

Germano, J. D.; Rhoads, D. C.; Lunz, J. D. 1994. An Integrated, Tiered Approach to Monitoring and Management of Dredged Material Disposal Sites in the New England Regions. DAMOS Contribution No. 87. U.S. Army Corps of Engineers, New England Division, Waltham, MA, 67 pp.

National Oceanic and Atmospheric Administration (NOAA). 2015. NOS Hydrographic Surveys Specifications and Deliverables. May 2015.

USACE. 2012. Monitoring Surveys of New England CAD Cells, October 2009. DAMOS Contribution No. 185. U.S. Army Corps of Engineers, New England District, Concord, MA, 151 pp.

USACE. 2013. Engineering and Design Hydrographic Surveying. EM1110-2-1003.

# APPENDIX A

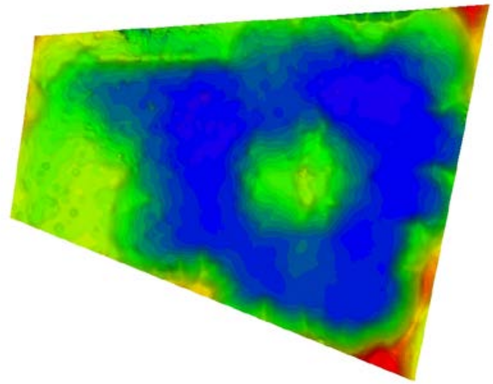
## TABLE OF COMMON CONVERSIONS

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

# APPENDIX B

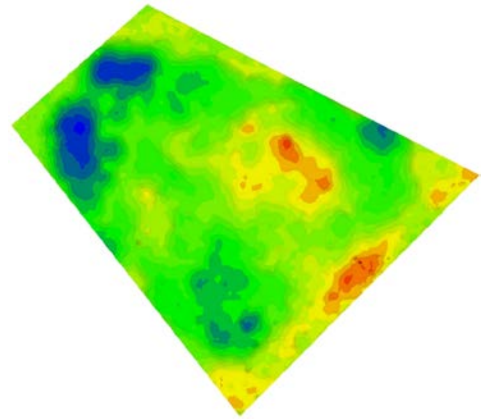
## CAPACITY REPORTS FOR NEW BEDFORD CAD CELL SITE

**New Bedford Harbor**
**CAD Cell Capacity Report**
**CAD Cell: EPA Phase 1**
Level unit: Meter
Volume unit: Cubic Meter
TIN vs Level Volume Totals



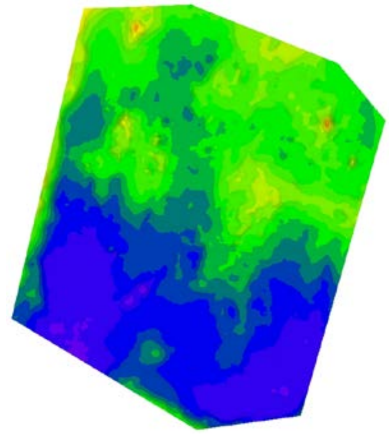
| Level (MLLW) | Volume Above | Area Above | Volume Below | Area Below |
|---|---|---|---|---|
| -2.4 | 0 | 2 | 50,229 | 11,318 |
| -2.6 | 1 | 10 | 47,966 | 11,310 |
| -2.8 | 4 | 20 | 45,705 | 11,301 |
| -3.0 | 11 | 48 | 43,448 | 11,272 |
| -3.2 | 23 | 69 | 41,195 | 11,252 |
| -3.4 | 39 | 92 | **38,947** | 11,229 |
| -3.6 | 60 | 122 | 36,704 | 11,199 |
| -3.8 | 88 | 162 | 34,468 | 11,158 |
| -4.0 | 125 | 211 | 32,242 | 11,109 |
| -4.2 | 173 | 268 | 30,025 | 11,053 |
| -4.4 | 235 | 354 | 27,823 | 10,966 |
| -4.6 | 315 | 450 | 25,639 | 10,870 |
| -4.8 | 417 | 577 | 23,477 | 10,743 |
| -5.0 | 549 | 759 | 21,345 | 10,562 |
| -5.2 | 742 | 1,220 | 19,274 | 10,100 |
| -5.4 | 1,030 | 1,666 | 17,298 | 9,654 |
| -5.6 | 1,407 | 2,078 | 15,411 | 9,242 |
| -5.8 | 1,857 | 2,418 | 13,596 | 8,902 |
| -6.0 | 2,381 | 2,837 | 11,857 | 8,484 |
| -6.2 | 2,990 | 3,267 | 10,202 | 8,053 |
| -6.4 | 3,690 | 3,737 | 8,638 | 7,583 |
| -6.6 | 4,490 | 4,255 | 7,174 | 7,066 |
| -6.8 | 5,387 | 4,717 | 5,806 | 6,603 |
| -7.0 | 6,381 | 5,225 | 4,536 | 6,095 |
| -7.2 | 7,481 | 5,778 | 3,372 | 5,543 |
| -7.4 | 8,695 | 6,388 | 2,322 | 4,933 |
| -7.6 | 10,053 | 7,219 | 1,416 | 4,101 |
| -7.8 | 11,602 | 8,294 | 701 | 3,026 |
| -8.0 | 13,388 | 9,669 | 223 | 1,651 |
| -8.2 | 15,447 | 10,920 | 18 | 400 |
| -8.4 | 17,693 | 11,315 | 0 | 6 |

**New Bedford Harbor**
**CAD Cell Capacity Report**
**State CAD Cell: 1**
Level unit: Meter
Volume unit: Cubic Meter
TIN vs Level Volume Totals



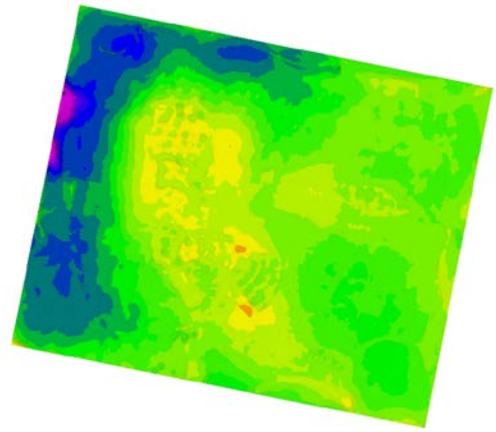
| Level (MLLW) | Volume Above | Area Above | Volume Below | Area Below |
|---|---|---|---|---|
| -7.8 | 0 | 0 | 28,183 | 17,032 |
| -8.0 | 0 | 1 | 24,776 | 17,031 |
| -8.2 | 1 | 26 | 21,371 | 17,006 |
| -8.4 | 26 | 260 | 17,990 | 16,772 |
| -8.6 | 129 | 848 | 14,687 | 16,184 |
| -8.8 | 421 | 2,098 | **11,572** | 14,934 |
| -9.0 | 985 | 3,725 | 8,730 | 13,307 |
| -9.2 | 1,938 | 5,792 | 6,276 | 11,240 |
| -9.4 | 3,307 | 7,836 | 4,239 | 9,196 |
| -9.6 | 5,092 | 10,118 | 2,618 | 6,914 |
| -9.8 | 7,346 | 12,348 | 1,465 | 4,684 |
| -10.0 | 10,011 | 14,314 | 724 | 2,718 |
| -10.2 | 13,026 | 15,686 | 332 | 1,346 |
| -10.4 | 16,233 | 16,329 | 133 | 703 |
| -10.6 | 19,536 | 16,694 | 30 | 338 |
| -10.8 | 22,913 | 17,012 | 1 | 20 |

**New Bedford Harbor**
**CAD Cell Capacity Report**
**Stat CAD Cell: 2**
Level unit: Meter
Volume unit: Cubic Meter
TIN vs Level Volume Totals



| Level (MLLW) | Volume Above | Area Above | Volume Below | Area Below |
|---|---|---|---|---|
| -3.4 | 0 | 5 | 15,463 | 12,871 |
| -3.6 | 5 | 44 | 12,892 | 12,833 |
| -3.8 | 36 | 344 | 10,348 | 12,533 |
| -4.0 | 180 | 1,234 | 7,917 | 11,643 |
| -4.2 | 581 | 2,902 | 5,743 | 9,975 |
| -4.4 | 1,397 | 5,147 | **3,983** | 7,730 |
| -4.6 | 2,597 | 6,879 | 2,608 | 5,998 |
| -4.8 | 4,108 | 8,054 | 1,544 | 4,823 |
| -5.0 | 5,856 | 9,457 | 716 | 3,420 |
| -5.2 | 7,913 | 11,082 | 197 | 1,794 |
| -5.4 | 10,292 | 12,795 | 1 | 81 |

**New Bedford Harbor**
**CAD Cell Capacity Report**
**State CAD Cell: 3**
Level unit: Meter
Volume unit: Cubic Meter
TIN vs Level Volume Totals



| Level (MLLW) | Volume Above | Area Above | Volume Below | Area Below |
|---|---|---|---|---|
| -3.4 | 1 | 32 | 18,544 | 25,742 |
| -3.6 | 87 | 1,360 | 13,475 | 24,414 |
| -3.8 | 766 | 5,792 | 9,000 | 19,983 |
| -4.0 | 2,550 | 12,208 | 5,629 | 13,566 |
| -4.2 | 5,537 | 17,345 | 3,462 | 8,429 |
| -4.4 | 9,274 | 19,681 | **2,043** | 6,093 |
| -4.6 | 13,387 | 21,544 | 1,002 | 4,230 |
| -4.8 | 17,941 | 23,999 | 401 | 1,775 |
| -5.0 | 22,892 | 25,298 | 197 | 476 |
| -5.2 | 27,985 | 25,548 | 135 | 226 |
| -5.4 | 33,102 | 25,613 | 97 | 161 |
| -5.6 | 38,229 | 25,650 | 69 | 124 |
| -5.8 | 43,361 | 25,677 | 47 | 97 |
| -6.0 | 48,500 | 25,704 | 30 | 70 |
| -6.2 | 53,642 | 25,725 | 19 | 49 |
| -6.4 | 58,789 | 25,741 | 10 | 33 |
| -6.6 | 63,939 | 25,753 | 5 | 21 |
| -6.8 | 69,090 | 25,762 | 2 | 12 |
| -7.0 | 74,243 | 25,770 | 0 | 4 |