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Mapping Disposed Dredged Material and a Sand Cap Using Sediment Profile Imaging (SPI) and a Semi-automated Image Processing System

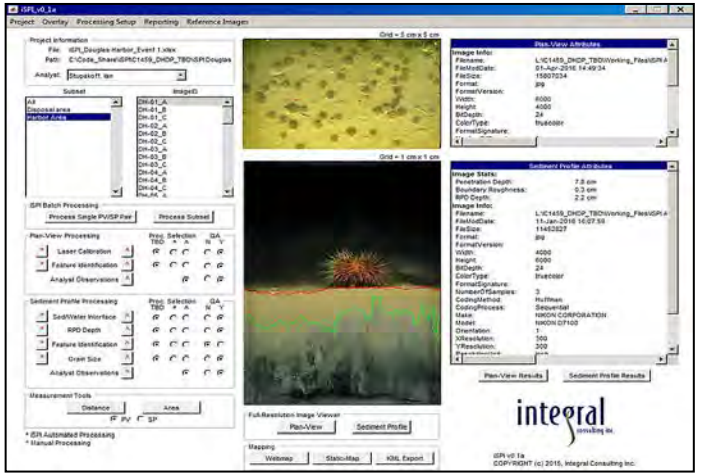
Gene Revelas
Brandon Sackmann, Ph.D
Ian Stupakoff

June 27, 2017

Presentation Outline

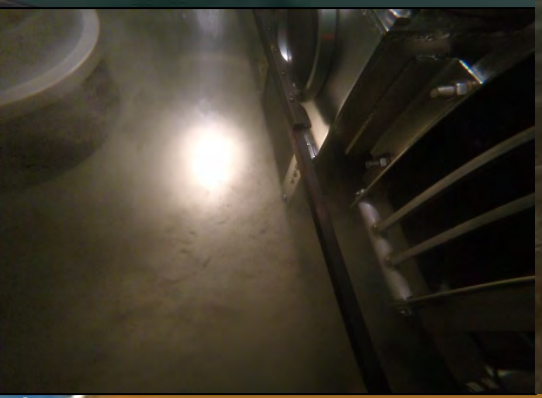
1. SPI/PV Image Collection

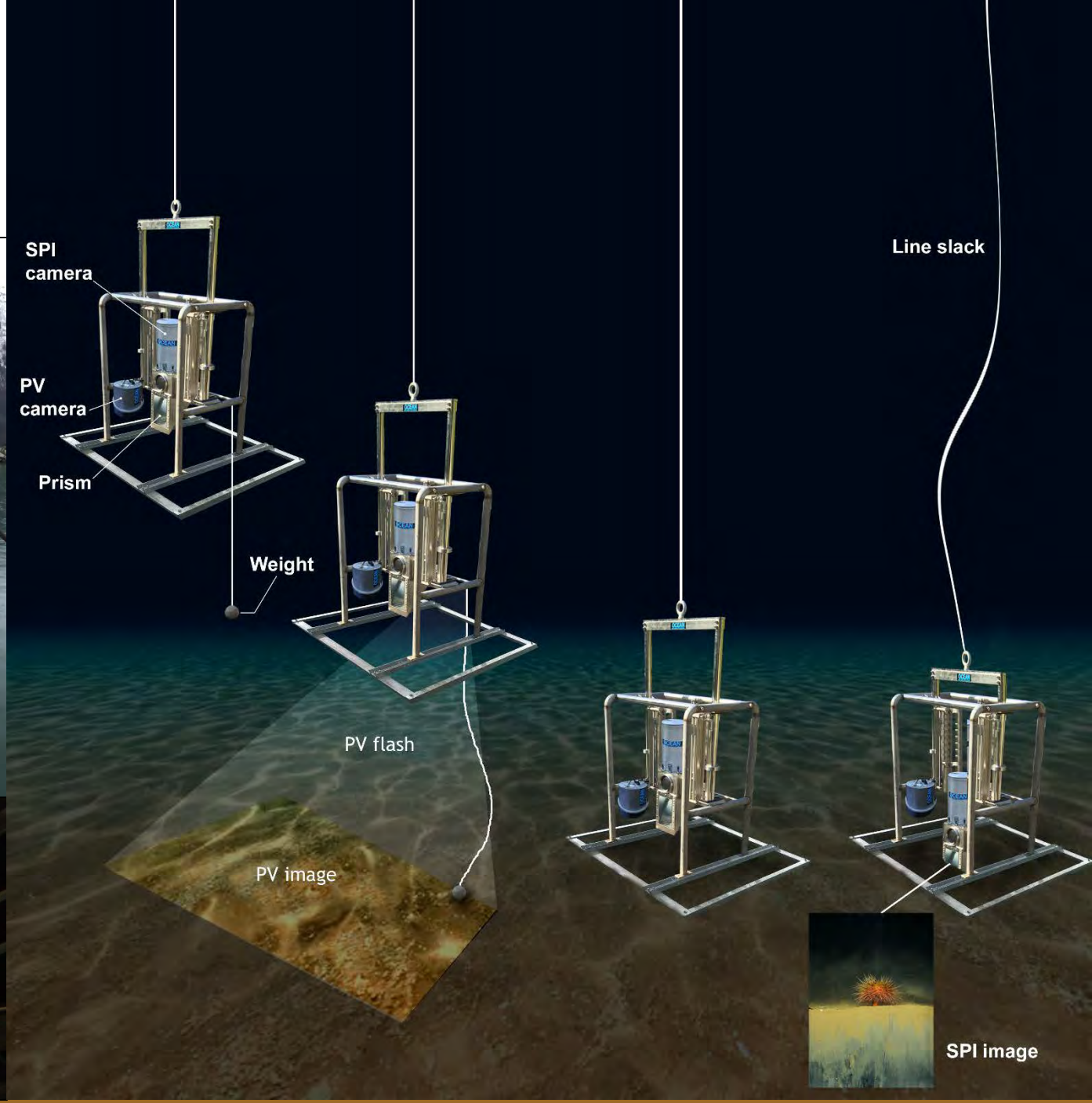
2. Image Analysis and Automated Data Generation

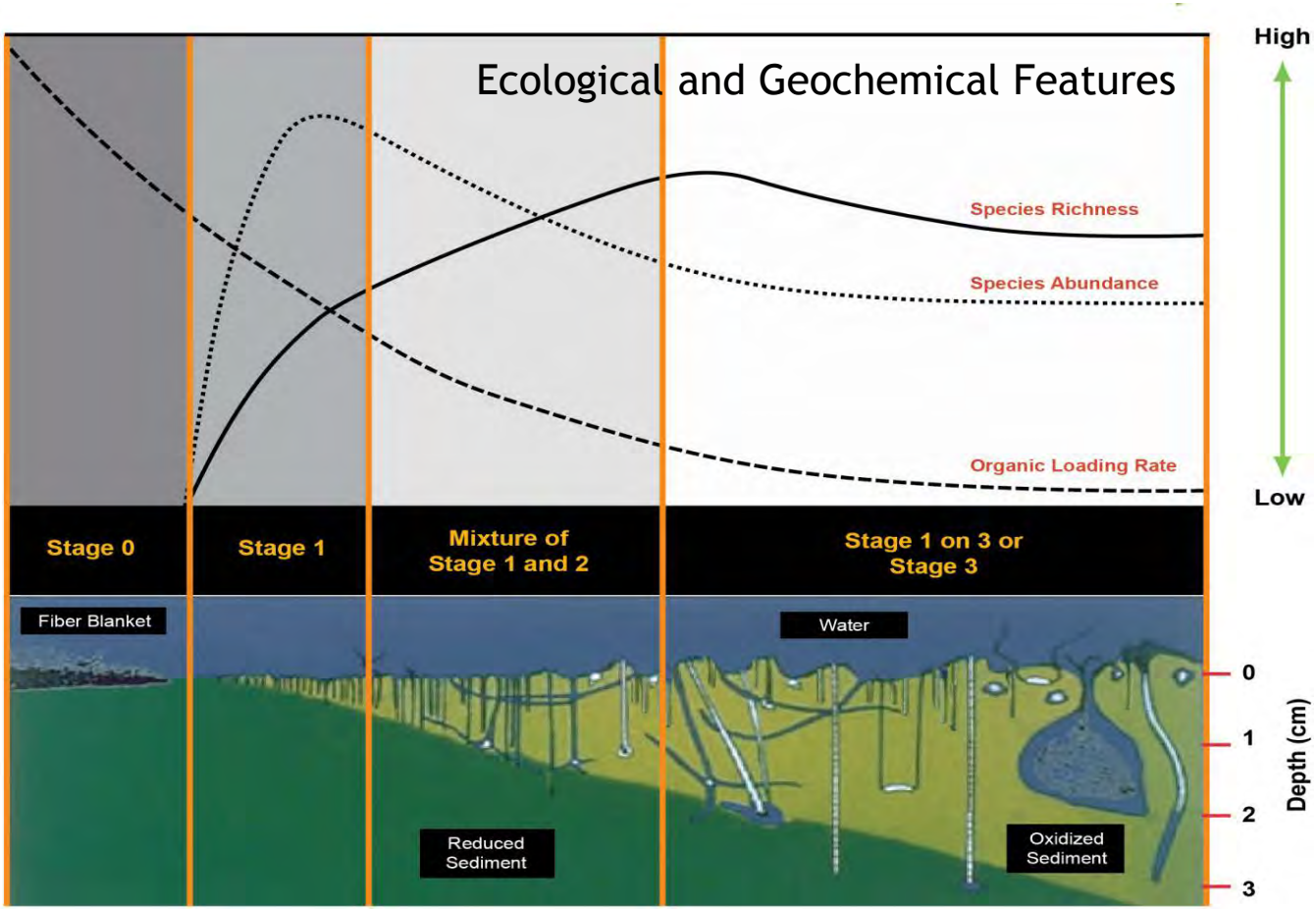


3. Mapping of Dredged Material and a Sand Cap, Douglas Harbor, Alaska

SPI/PV Image Collection

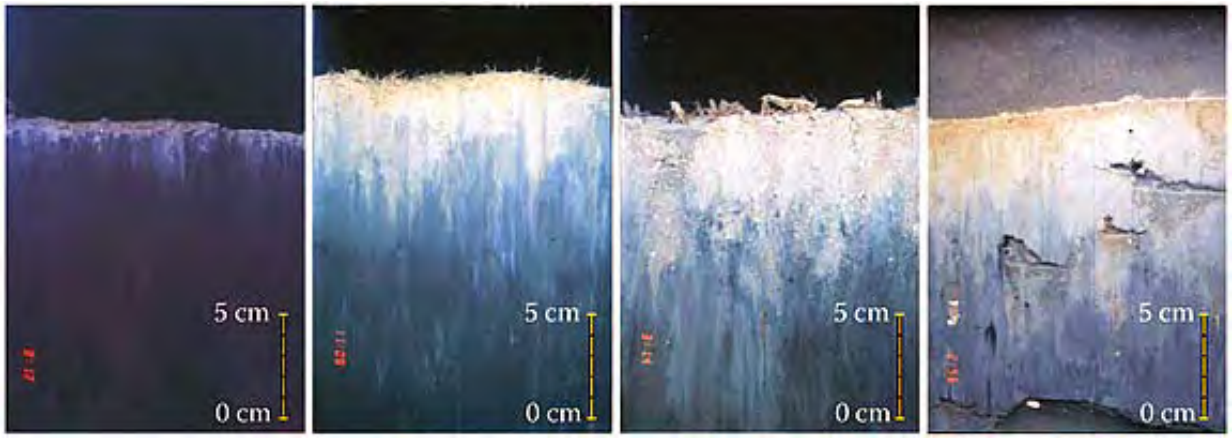


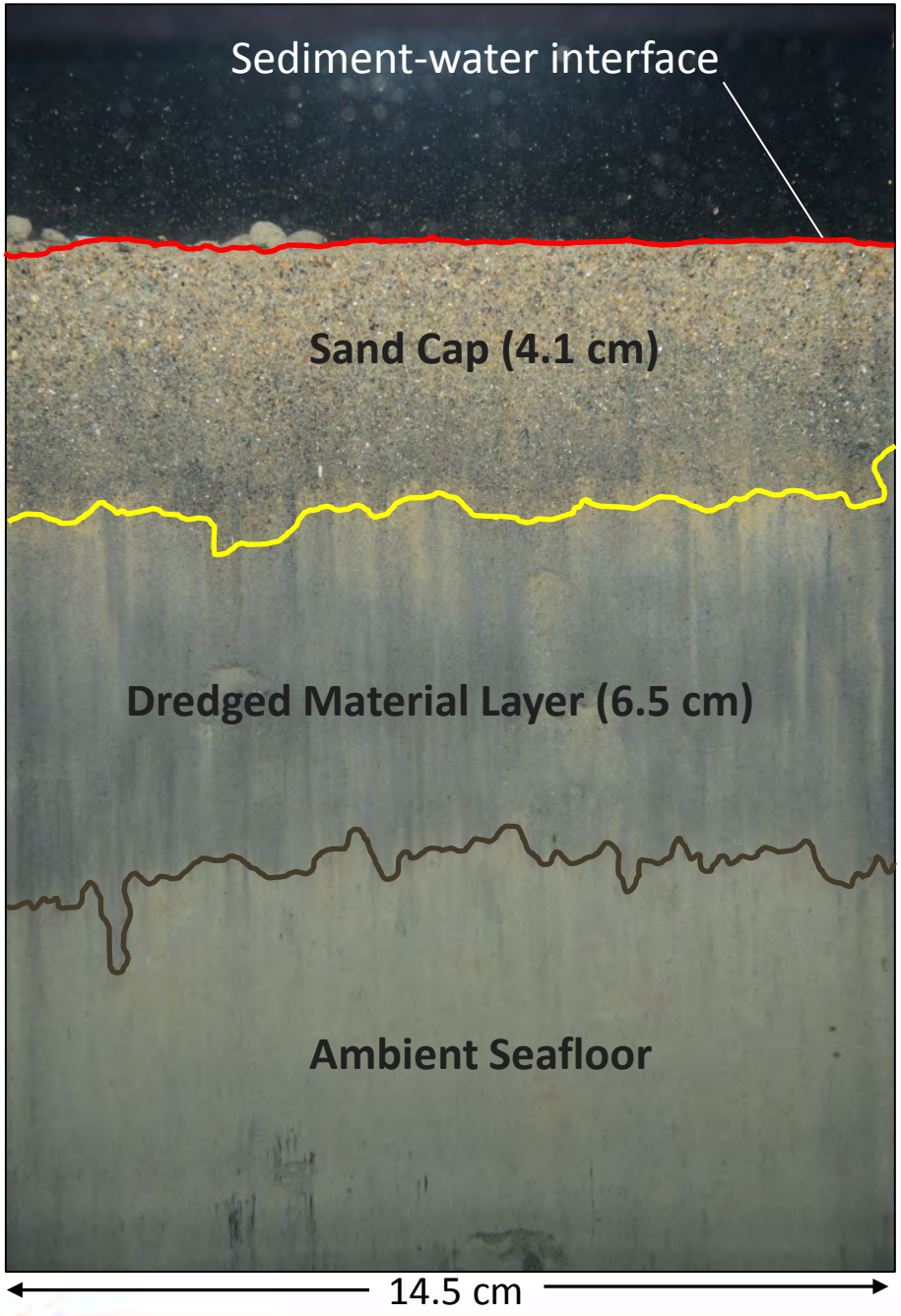


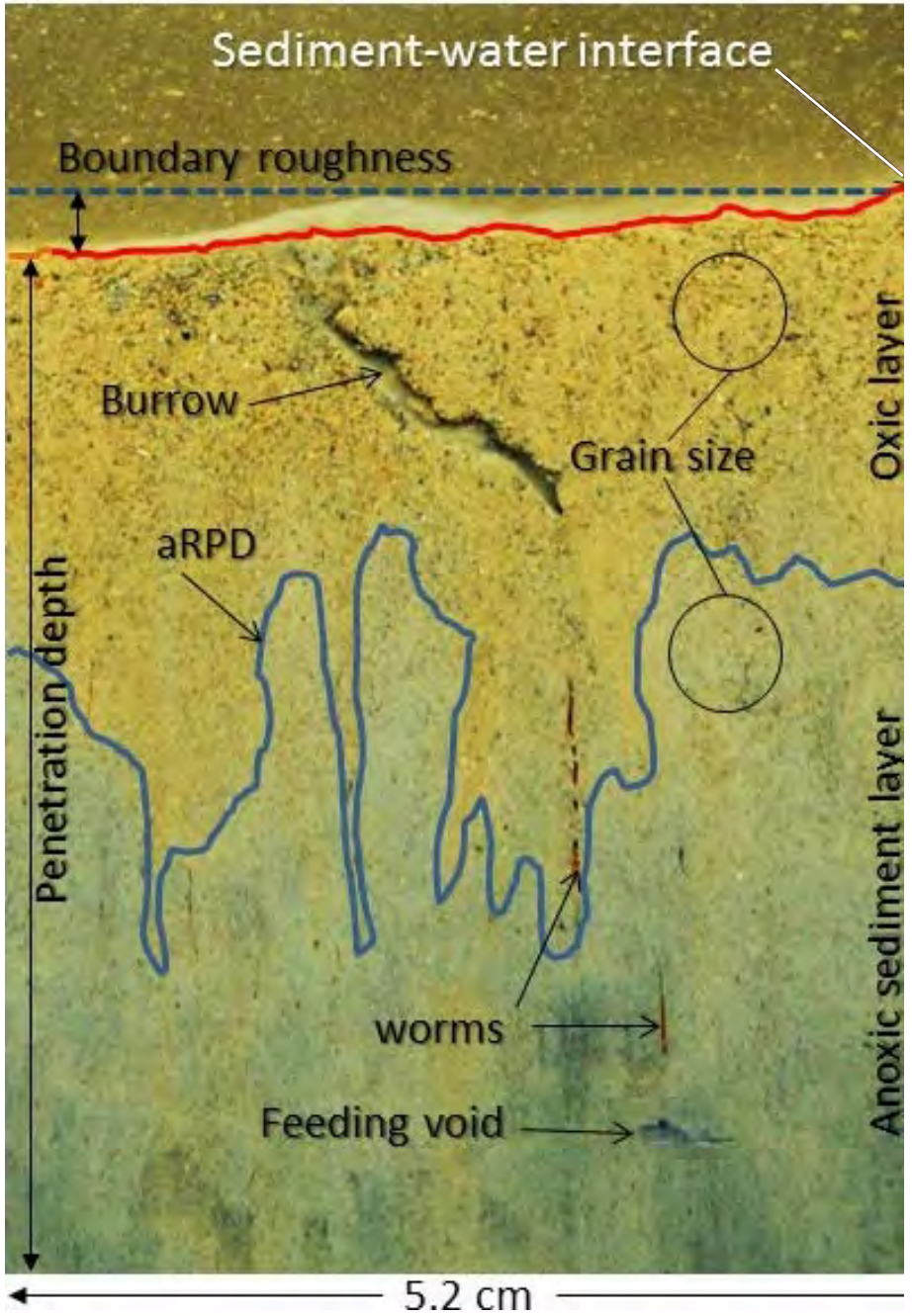


Physical Features

14.5 cm




Sediment-water interface
Sand Cap (4.1 cm)
Dredged Material Layer (6.5 cm)
Ambient Seafloor
14.5 cm


Sediment-water interface
Boundary roughness
Burrow
Grain size
Oxic layer
aRPD
Penetration depth
Anoxic sediment layer
worms
Feeding void
5.2 cm

*i*SPI Framework

Field Form

- Standardized MS Excel workbook
- Survey details, equipment configuration, image metadata (e.g., station ID, lat., long., date/time)

iSPI Analysis

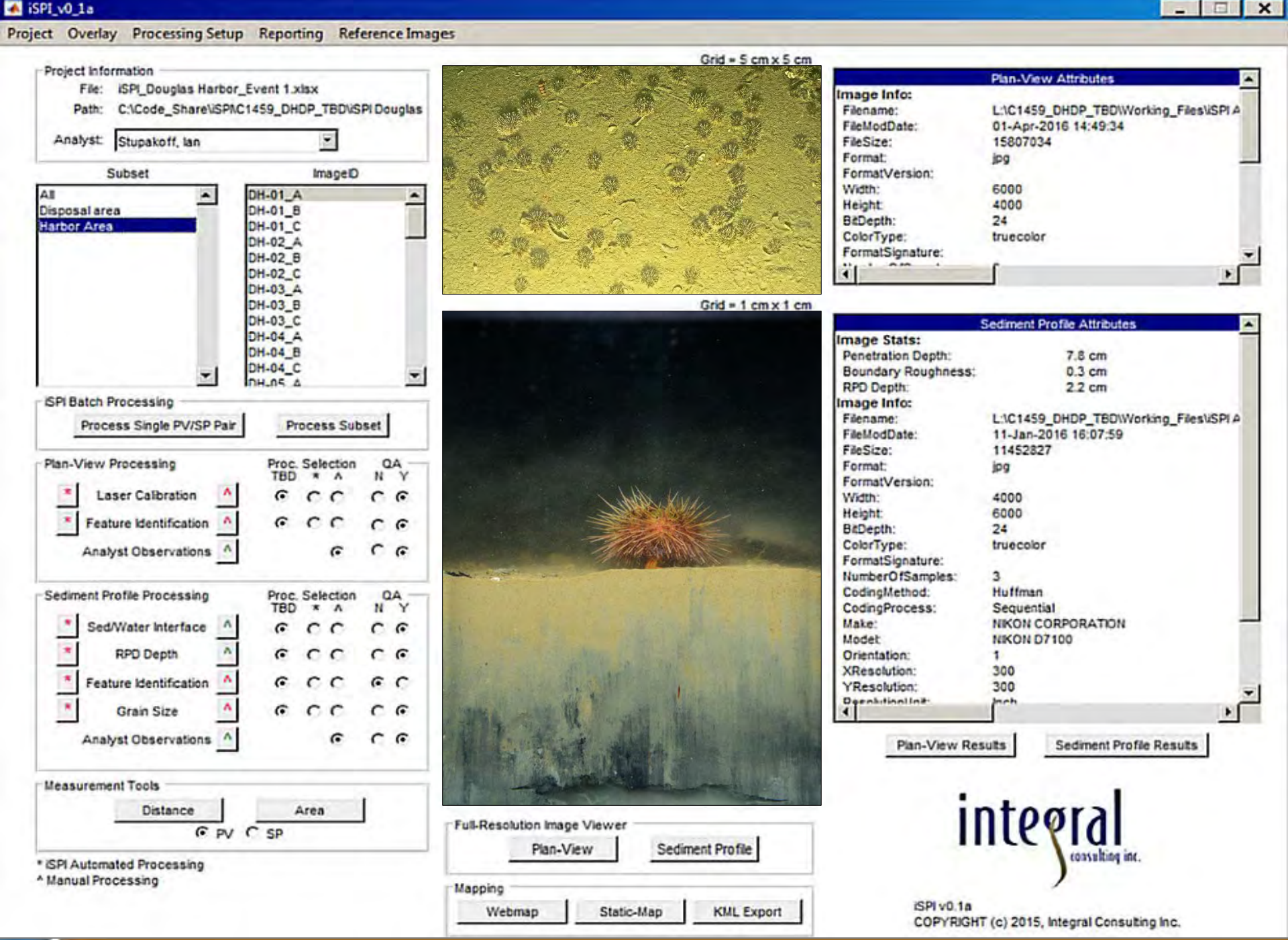
- MATLAB GUI
  - Image Processing + Computer Vision Toolboxes
  - Third-party CV routines (e.g., ImageJ and OpenCV)
- Define/identify SWI, RPD depth, features of interest (e.g., feeding voids), analyst observations
- Statistics (e.g., penetration depth, boundary roughness) calculated automatically

iSPI QA

- Standardized interface to facilitate senior technical review/QA
  - Analyst inputs
  - Derived calculations

iSPI Reporting

- Publication ready tables, figures, and maps
- GIS integration
- MS Word report templates (MATLAB Report Generator)


iSPI_v0_1a
Project
Overlay
Processing Setup
Reporting
Reference Images
Project Information
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Path: C:\Code_Share\iSPI\C1459_DHDP_TBD\iSPI Douglas
Analyst: Stupakoff, Ian
Subset
All
Disposal area
Harbor Area
ImageID
DH-01_A
DH-01_B
DH-01_C
DH-02_A
DH-02_B
DH-02_C
DH-03_A
DH-03_B
DH-03_C
DH-04_A
DH-04_B
DH-04_C
iSPI Batch Processing
Process Single PV/SP Pair
Process Subset
Plan-View Processing
Proc. Selection
TBD * ^
QA
N Y
Laser Calibration
Feature Identification
Analyst Observations
Sediment Profile Processing
Proc. Selection
TBD * ^
QA
N Y
Sed/Water Interface
RPD Depth
Feature Identification
Grain Size
Analyst Observations
Measurement Tools
Distance
Area
PV
SP
* iSPI Automated Processing
^ Manual Processing
Grid = 5 cm x 5 cm
Grid = 1 cm x 1 cm
Full-Resolution Image Viewer
Plan-View
Sediment Profile
Mapping
Webmap
Static-Map
KML Export
Plan-View Attributes
Image Info:
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FileSize: 15807034
Format: jpg
FormatVersion:
Width: 6000
Height: 4000
BitDepth: 24
ColorType: truecolor
FormatSignature:
Sediment Profile Attributes
Image Stats:
Penetration Depth: 7.8 cm
Boundary Roughness: 0.3 cm
RPD Depth: 2.2 cm
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ColorType: truecolor
FormatSignature:
NumberOfSamples: 3
CodingMethod: Huffman
CodingProcess: Sequential
Make: NIKON CORPORATION
Model: NIKON D7100
Orientation: 1
XResolution: 300
YResolution: 300
Plan-View Results
Sediment Profile Results
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iSPI v0.1a
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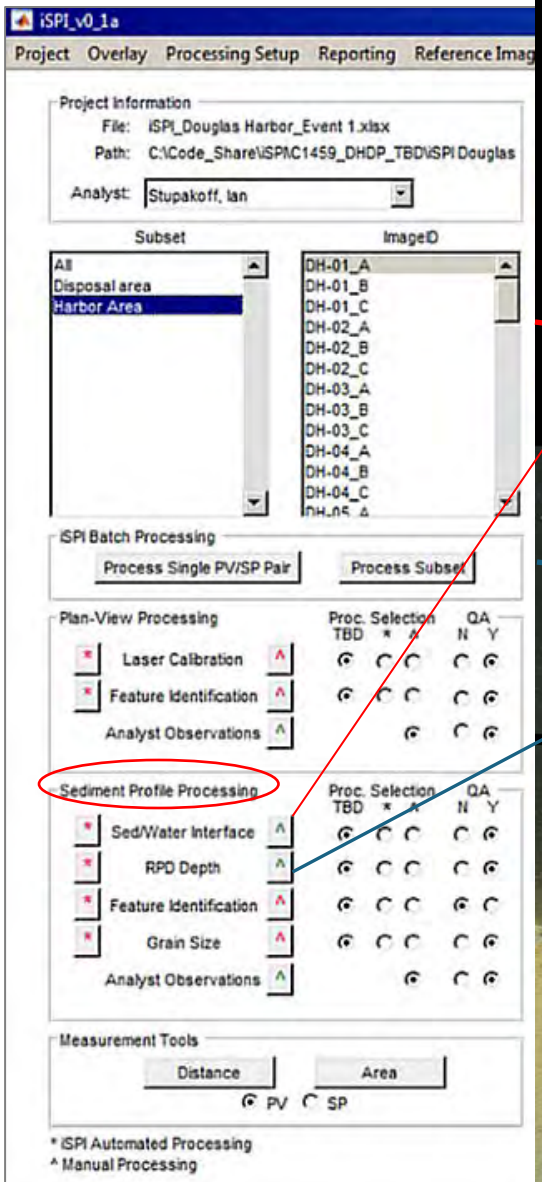
*i*SPI


iSPI_v0_1a
Project Overlay Processing Setup Reporting Reference Imag
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Measurement Tools
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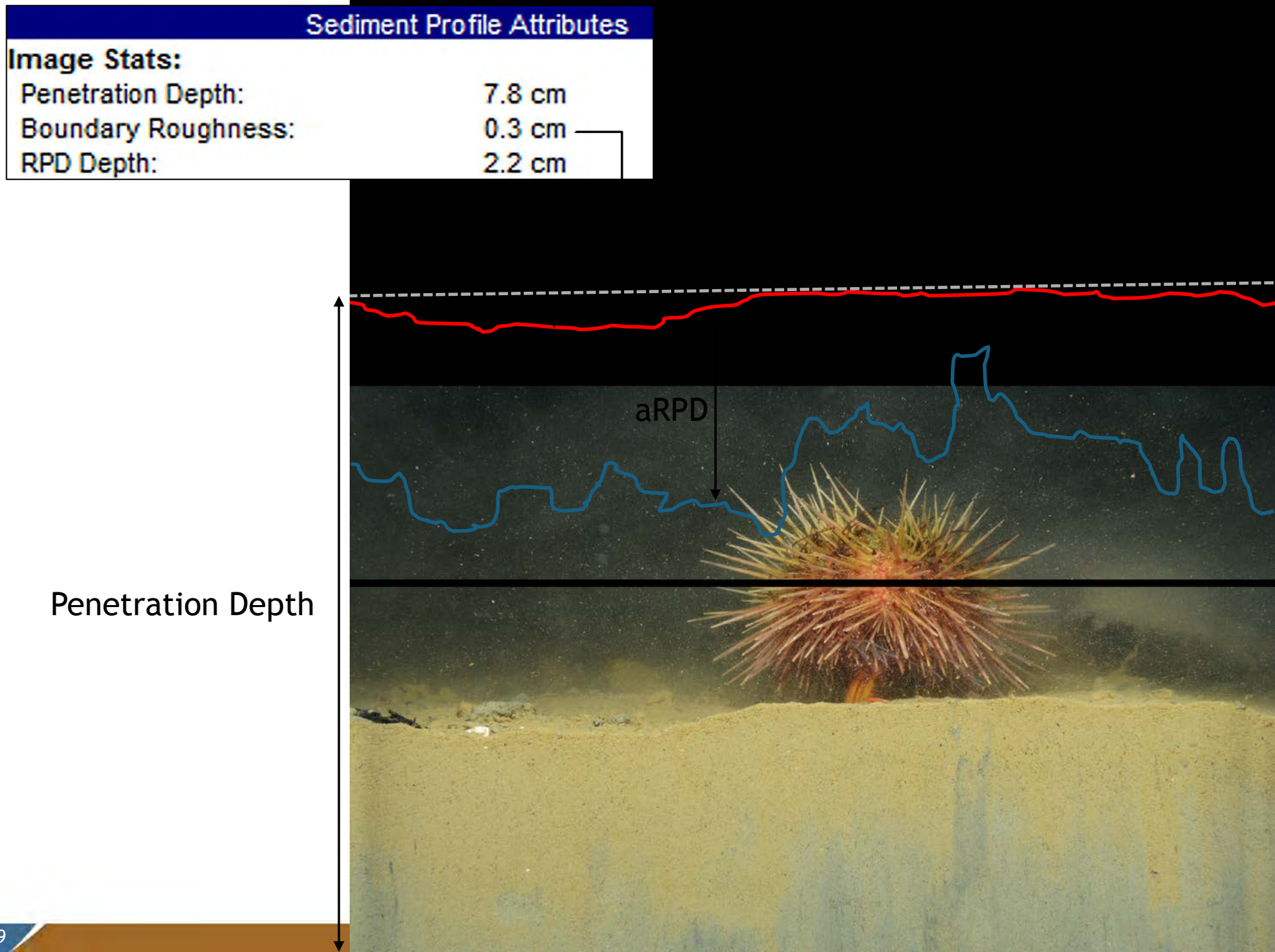
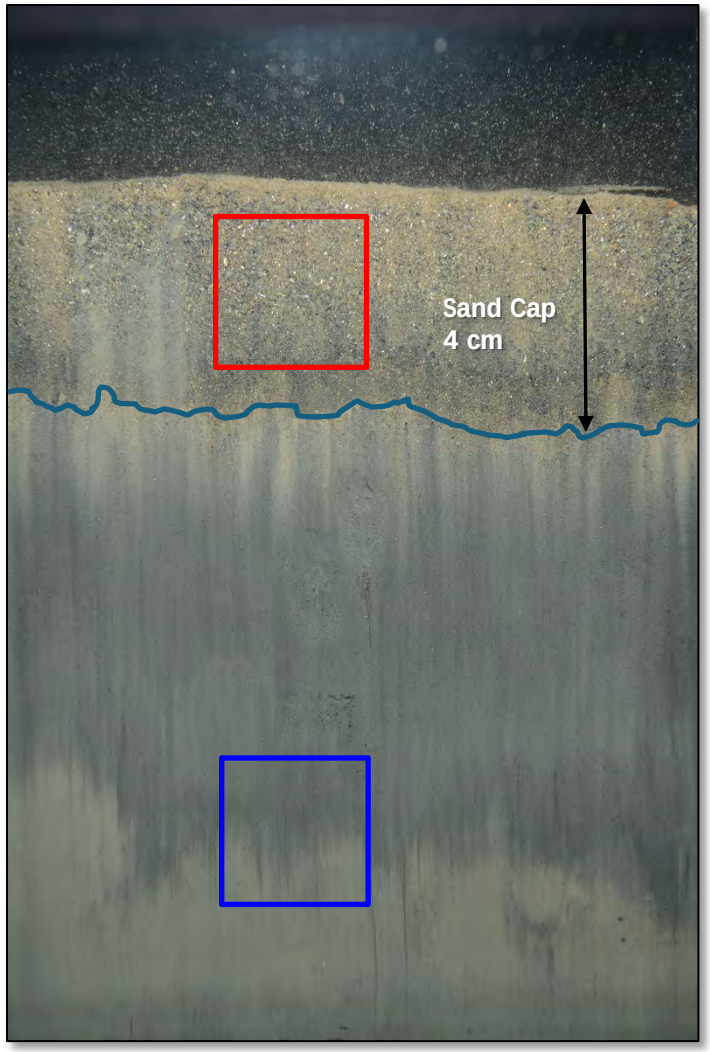
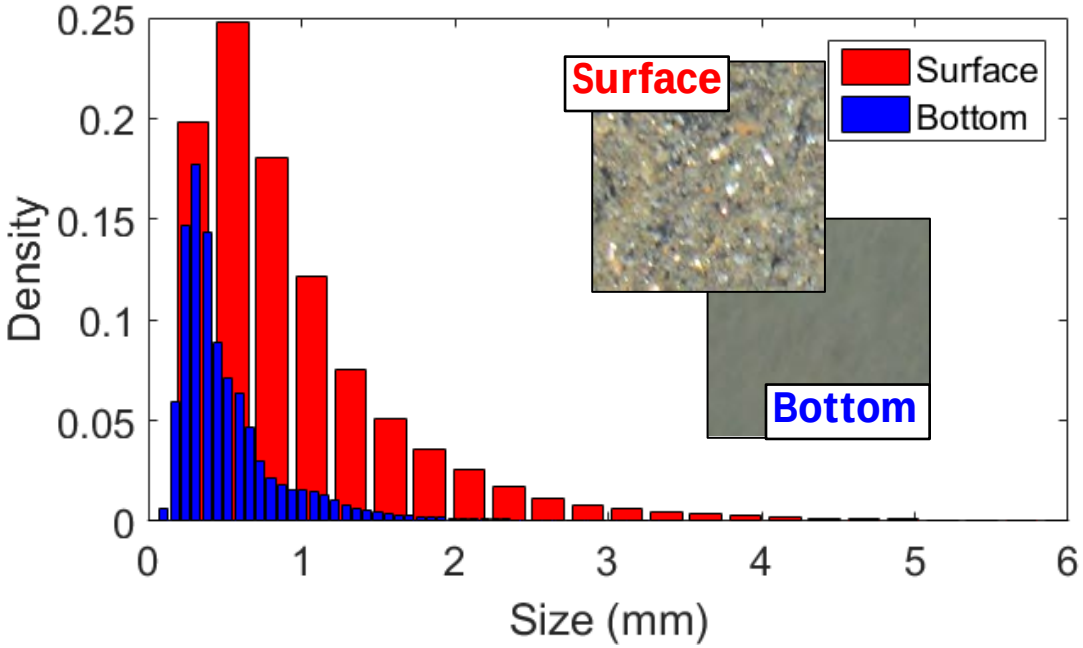
* iSPI Automated Processing
^ Manual Processing


Sediment Profile Attributes
Image Stats:
Penetration Depth: 7.8 cm
Boundary Roughness: 0.3 cm
RPD Depth: 2.2 cm
aRPD
Penetration Depth

Grain Size Analysis[1]

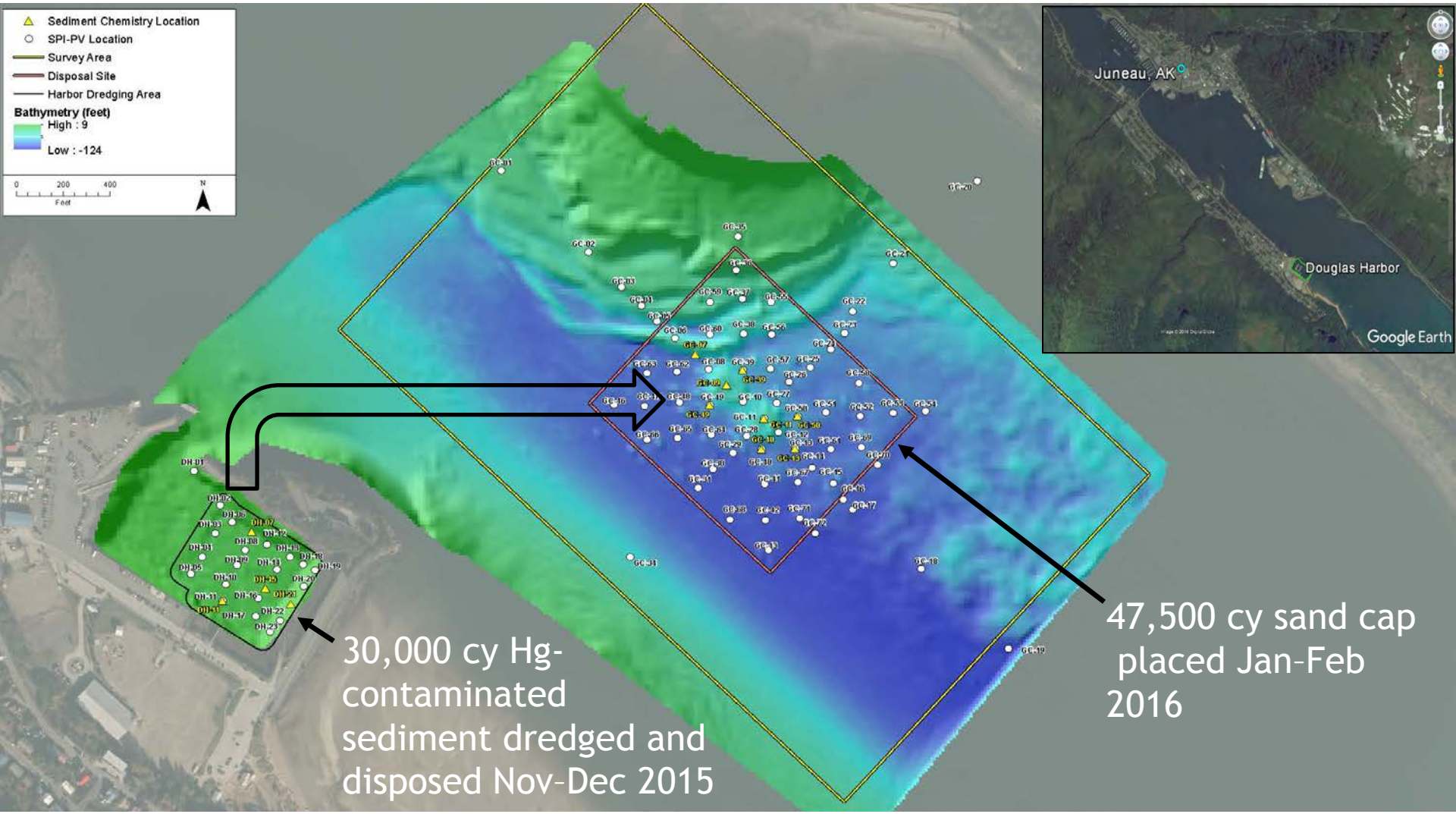




[1]Buscombe, D. 2013. Transferable wavelet method for grain-size distribution from images of sediment surface and thin sections, and other natural granular patterns. *Sedimentology* 60:1709–1732. http://dbuscombe-usgs.github.io/DGS_Project/

Douglas Harbor Remedial Dredging and Capping

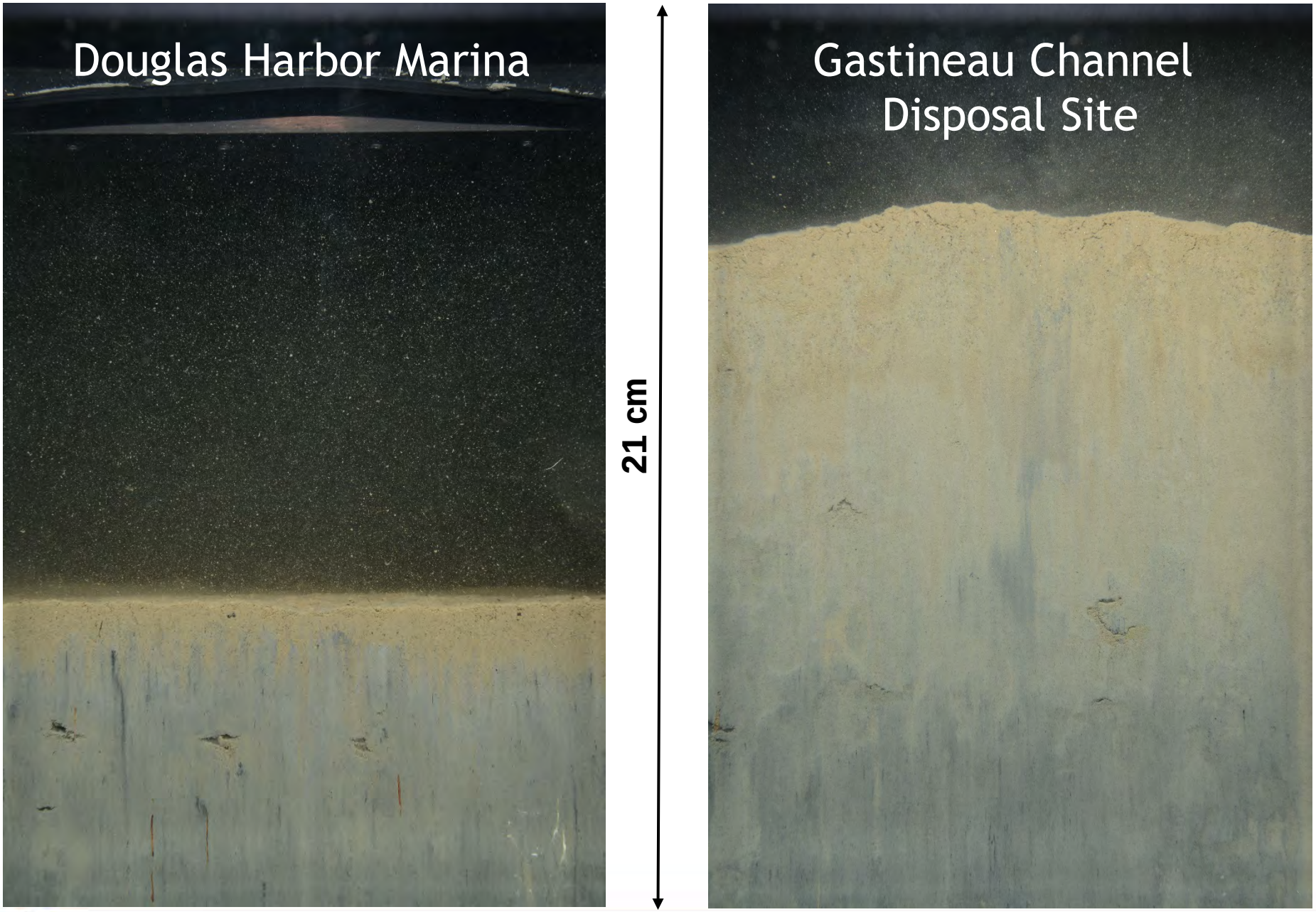
Douglas Harbor, Juneau, Alaska—Dredging Project



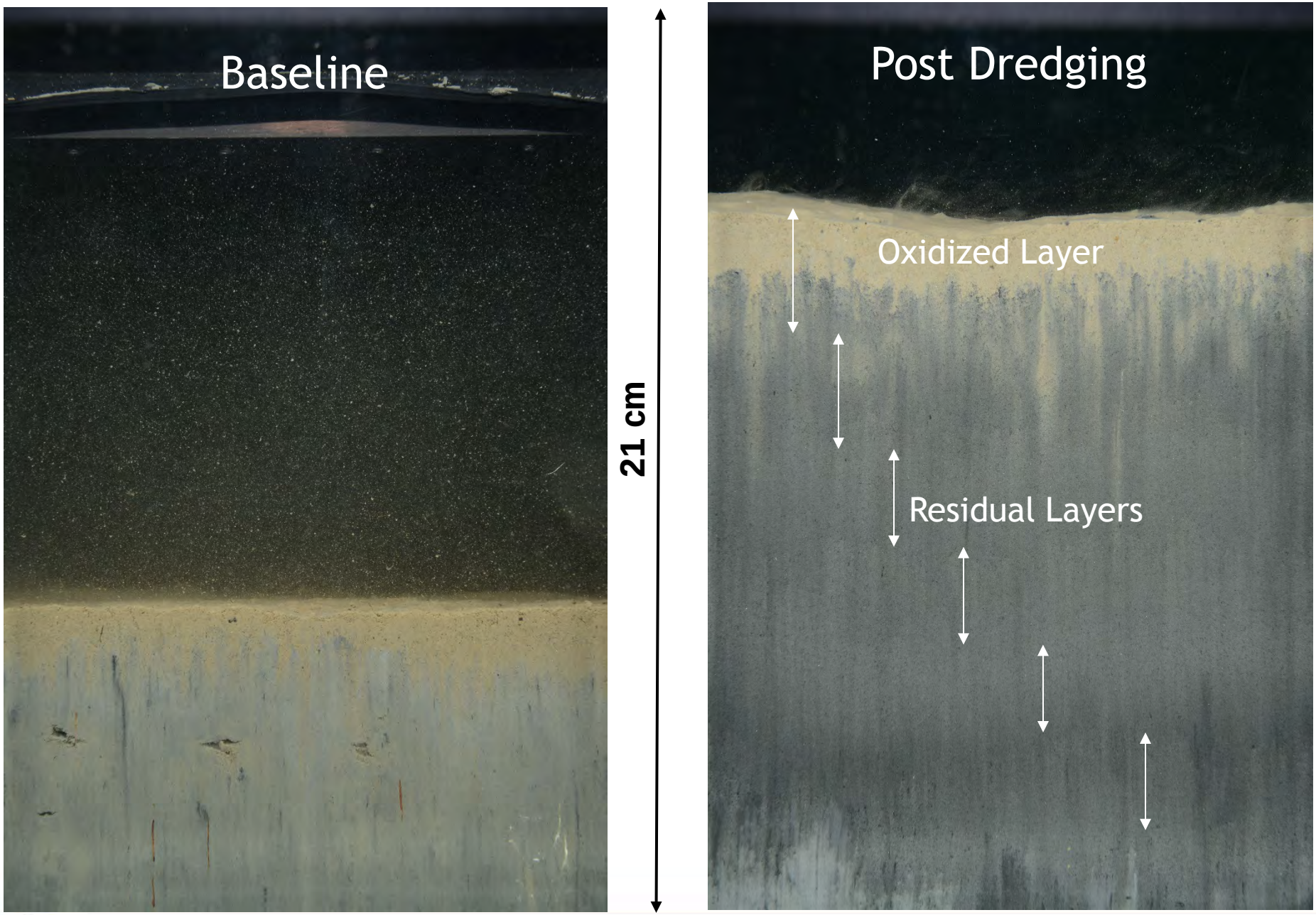
SPI/PV Surveys and Objectives

1. **Baseline:** Map benthic conditions in Douglas Harbor and at Gastineau Channel disposal site — October 2015
2. **Post Dredged Material Disposal:** Map benthic conditions and dredged material footprint at disposal site — January 2016
3. **Interim Sand Cap Placement Survey:** Map interim extent and thickness of sand cover at the disposal site — February 2016
4. **Post-construction Survey:** Map benthic conditions and the final extent and thickness of sand cap in the harbor and at the disposal site — March 2016
5. **One-year Post-construction Survey:** Map cap integrity and benthic recovery — March 2017

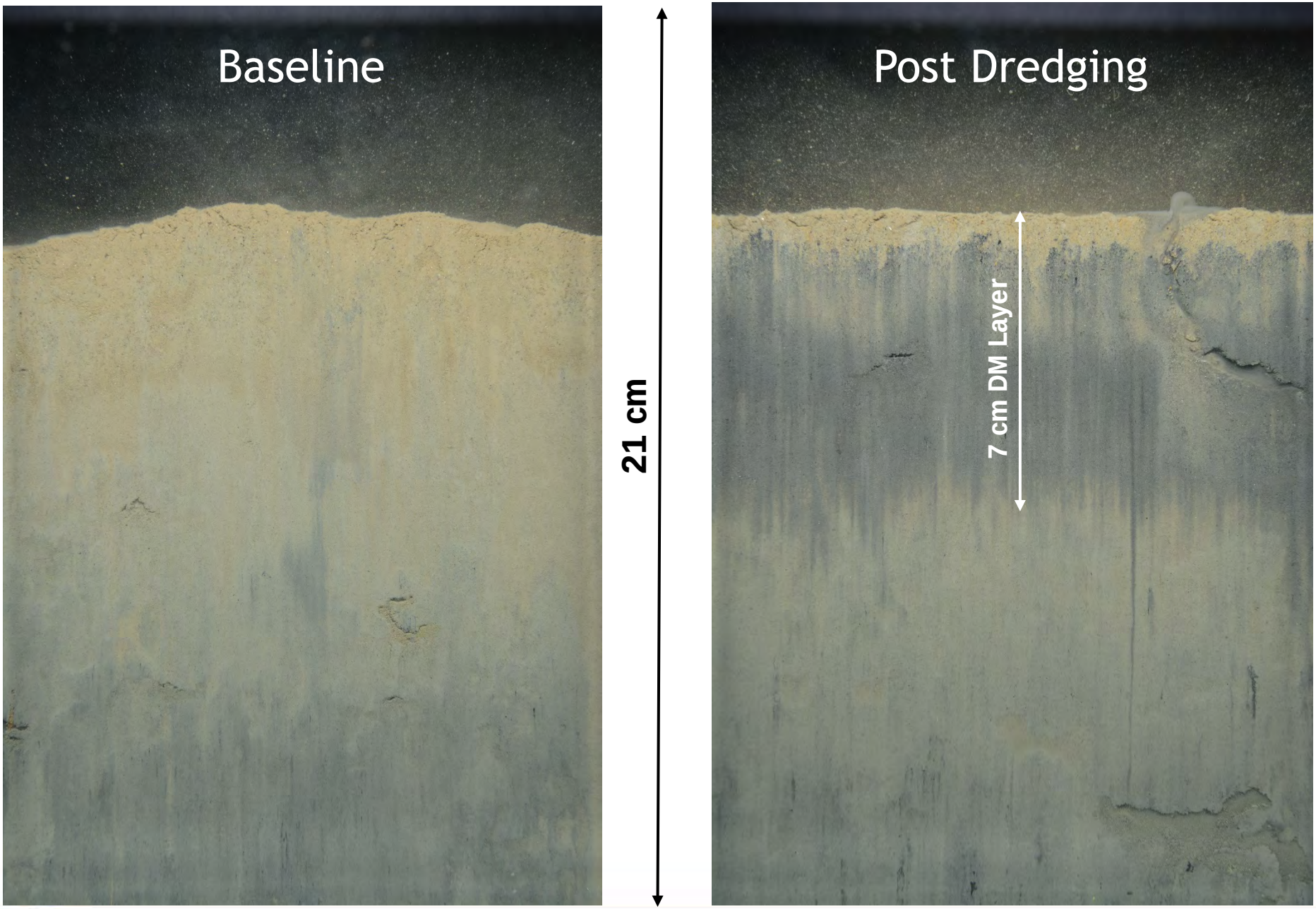
Baseline Conditions



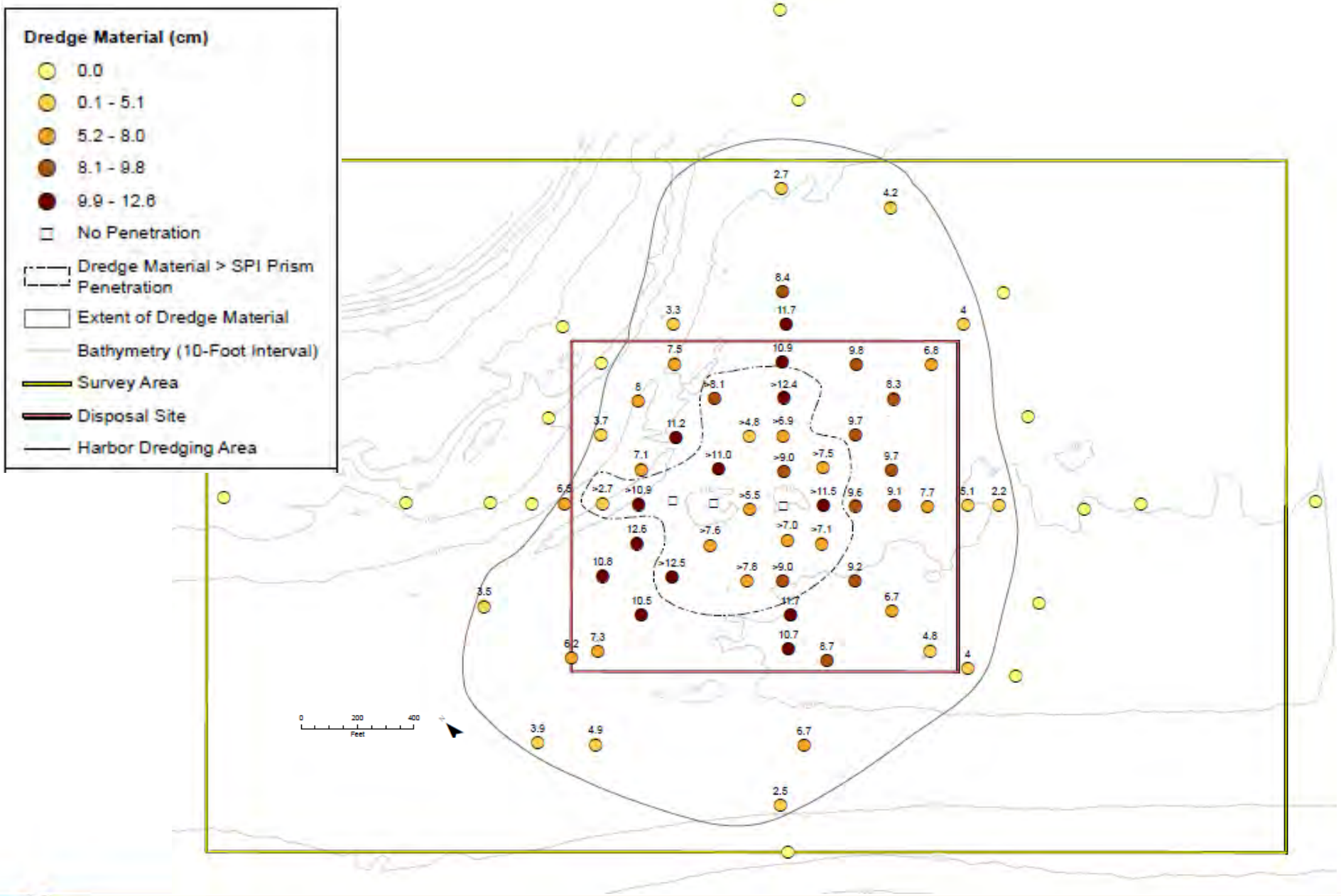
Douglas Harbor—Post-dredge Survey



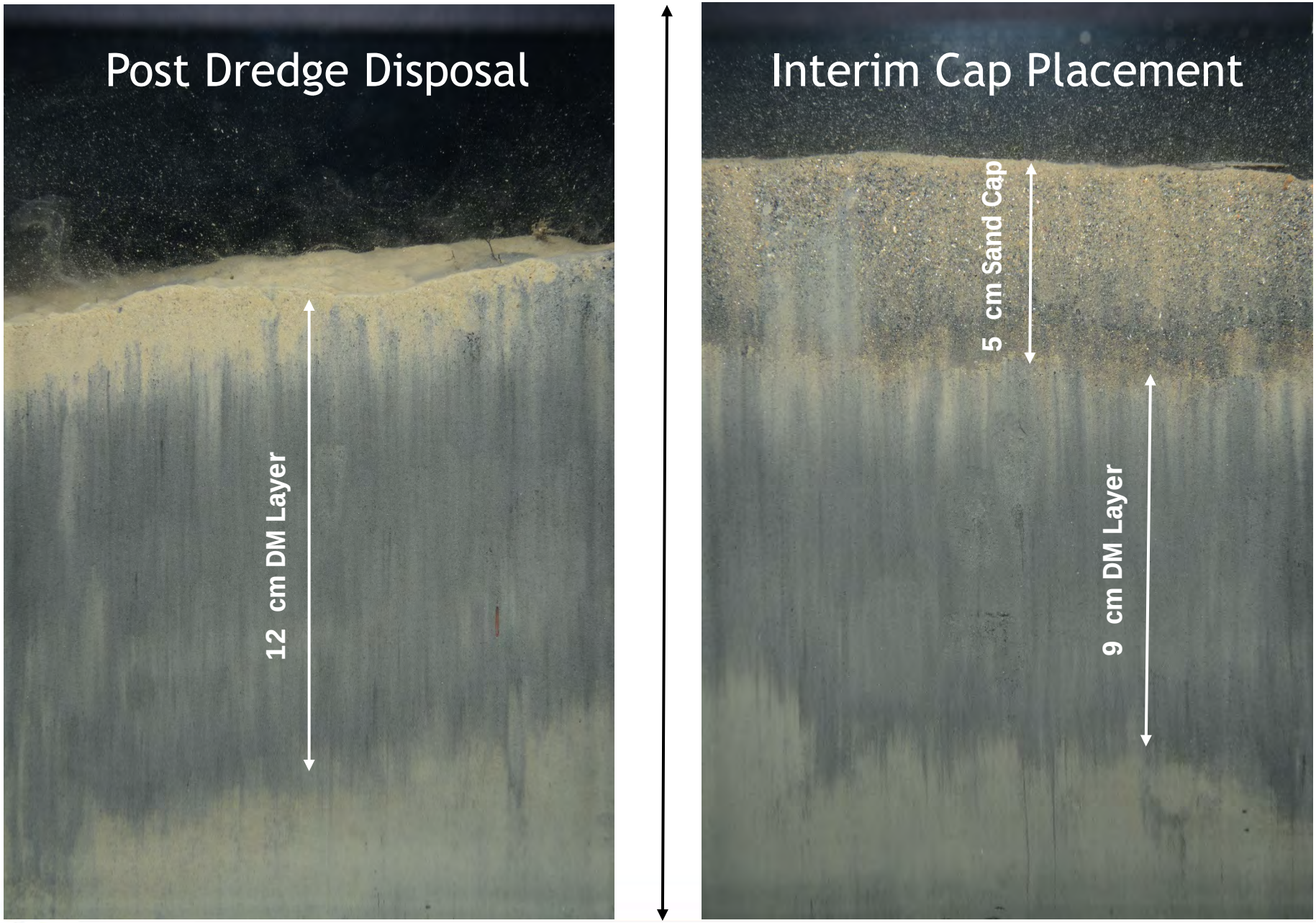
Disposal Site—Post-dredge Survey



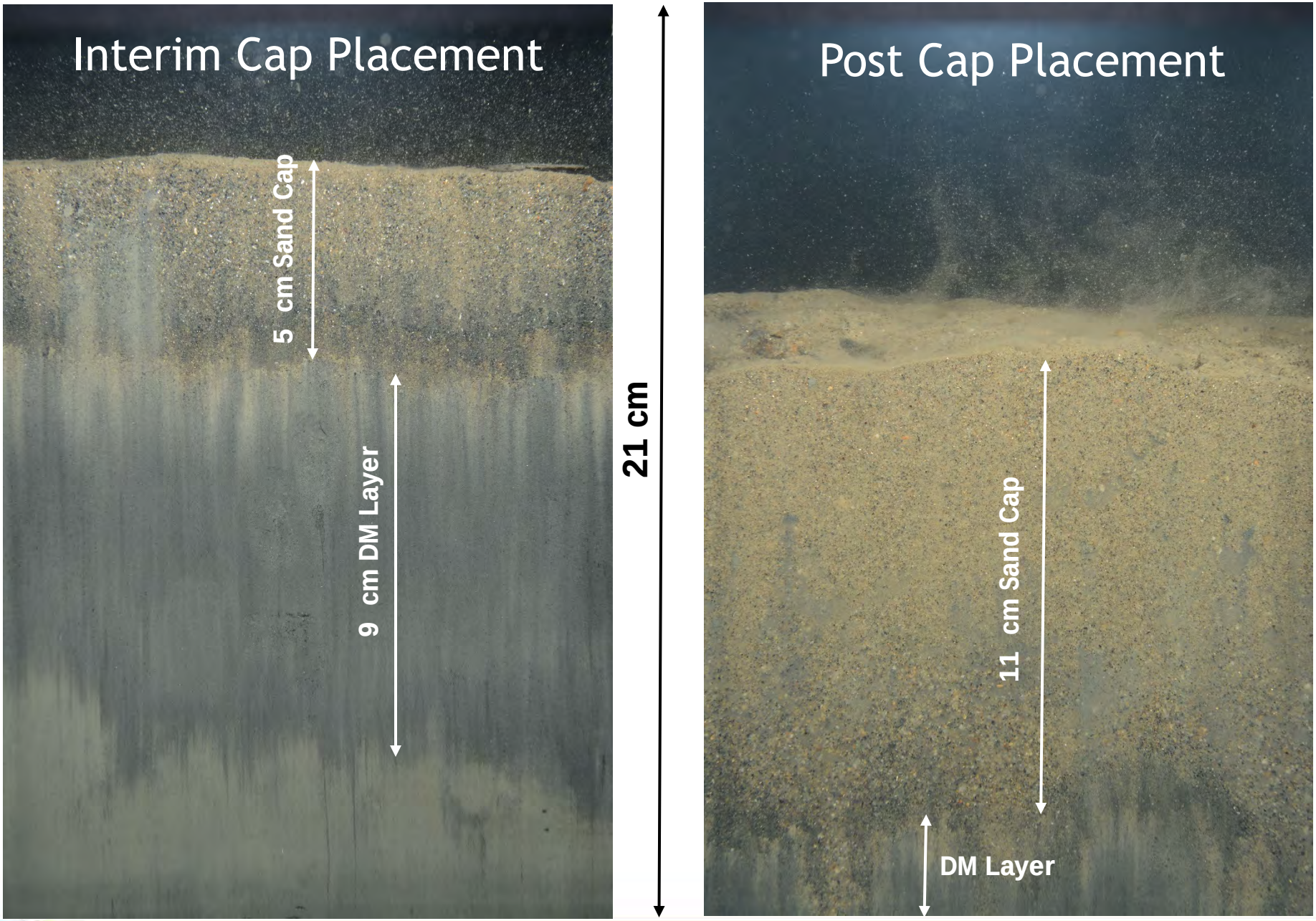
Disposed Dredged Material Footprint



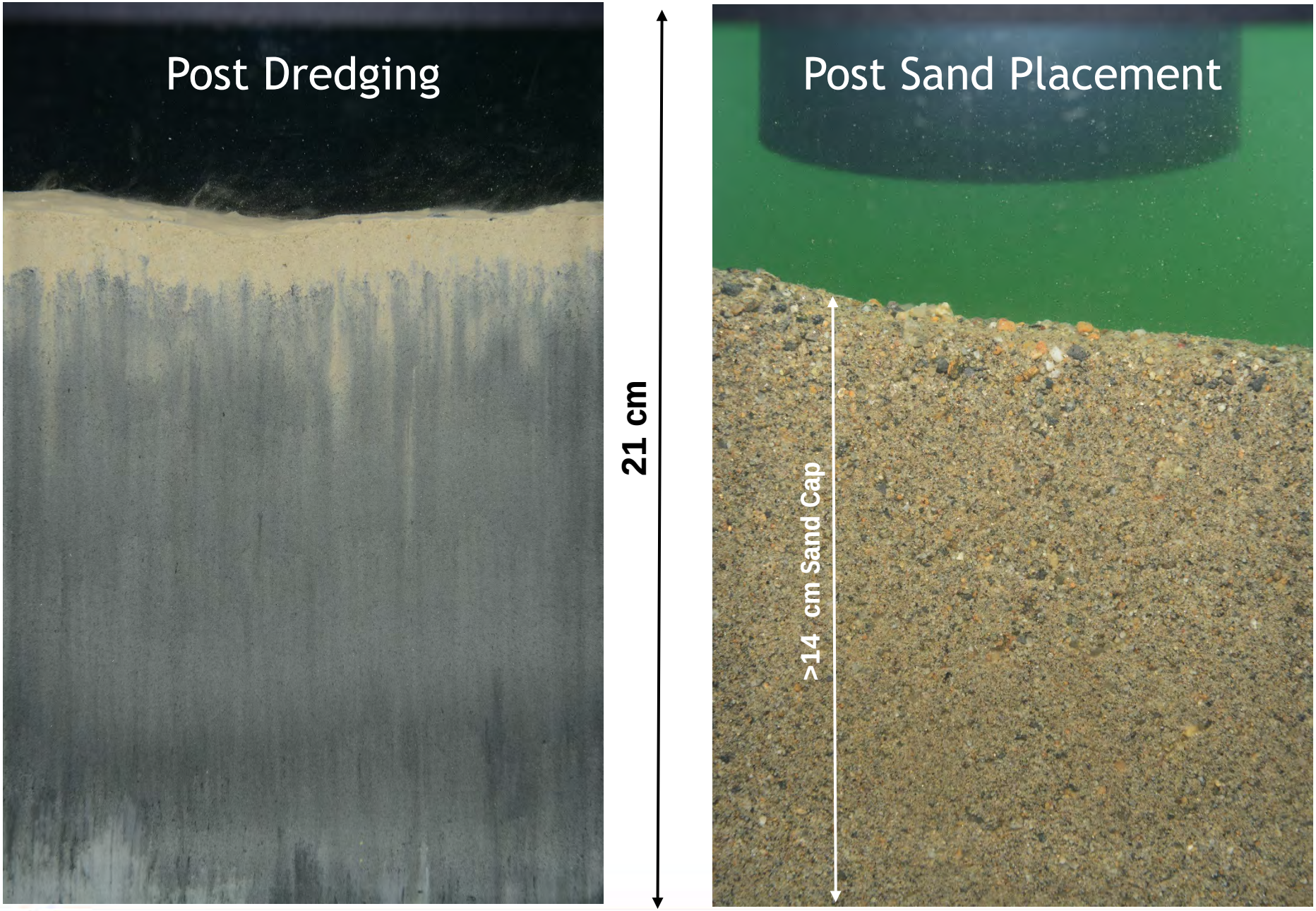
Disposal Site—Interim Cap Survey



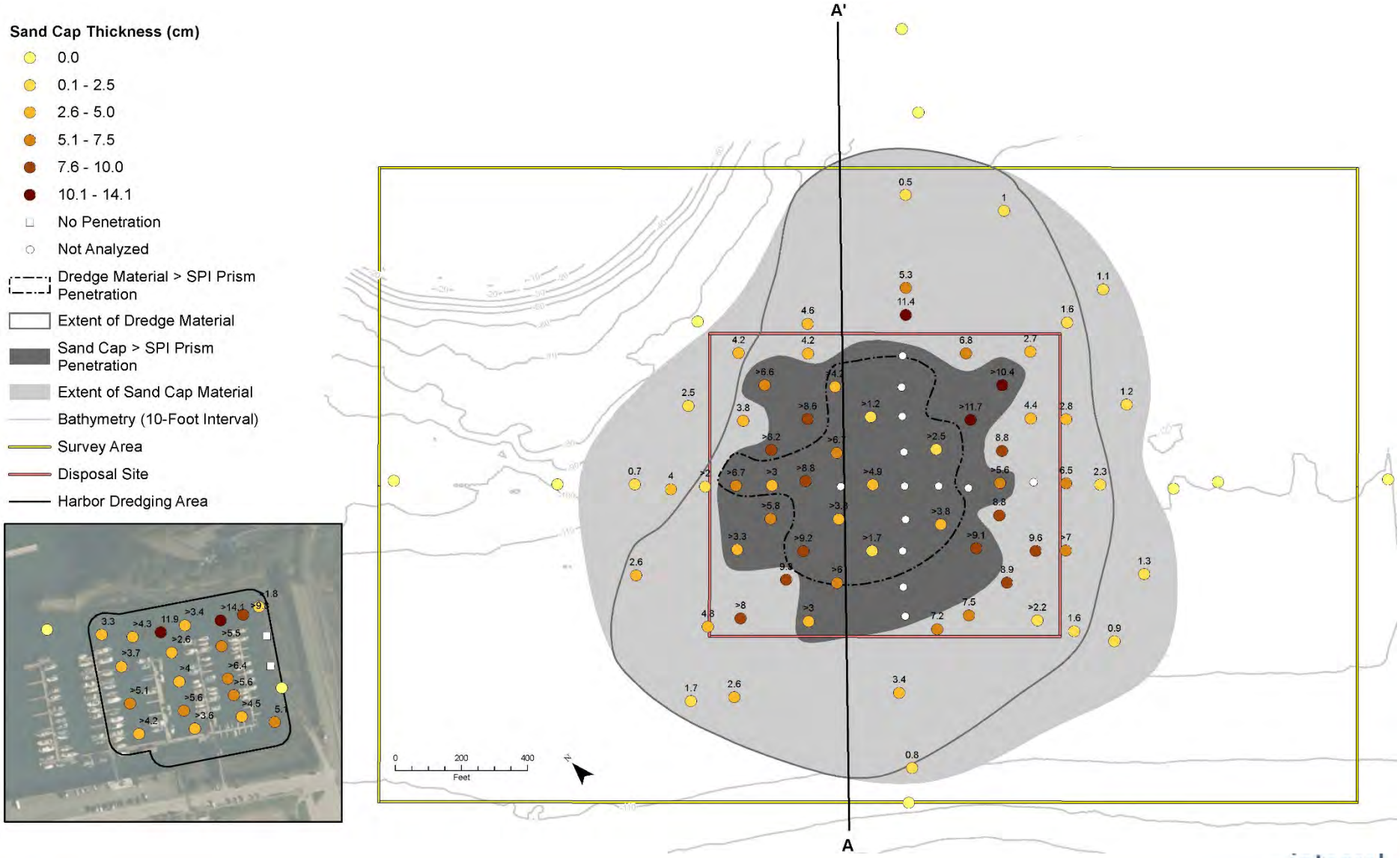
Disposal Site—Post-capping Survey



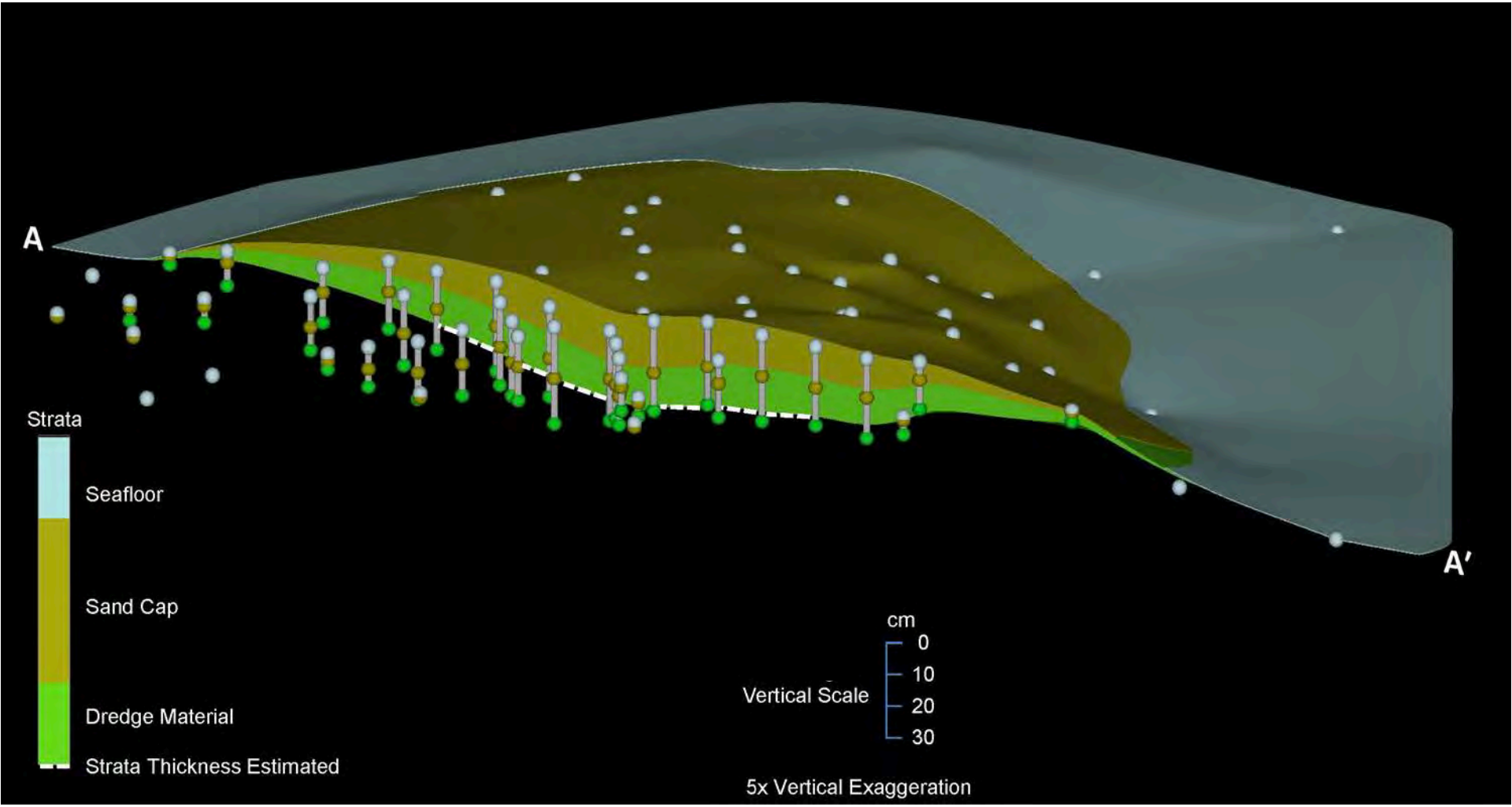
Douglas Harbor—Post-capping Survey



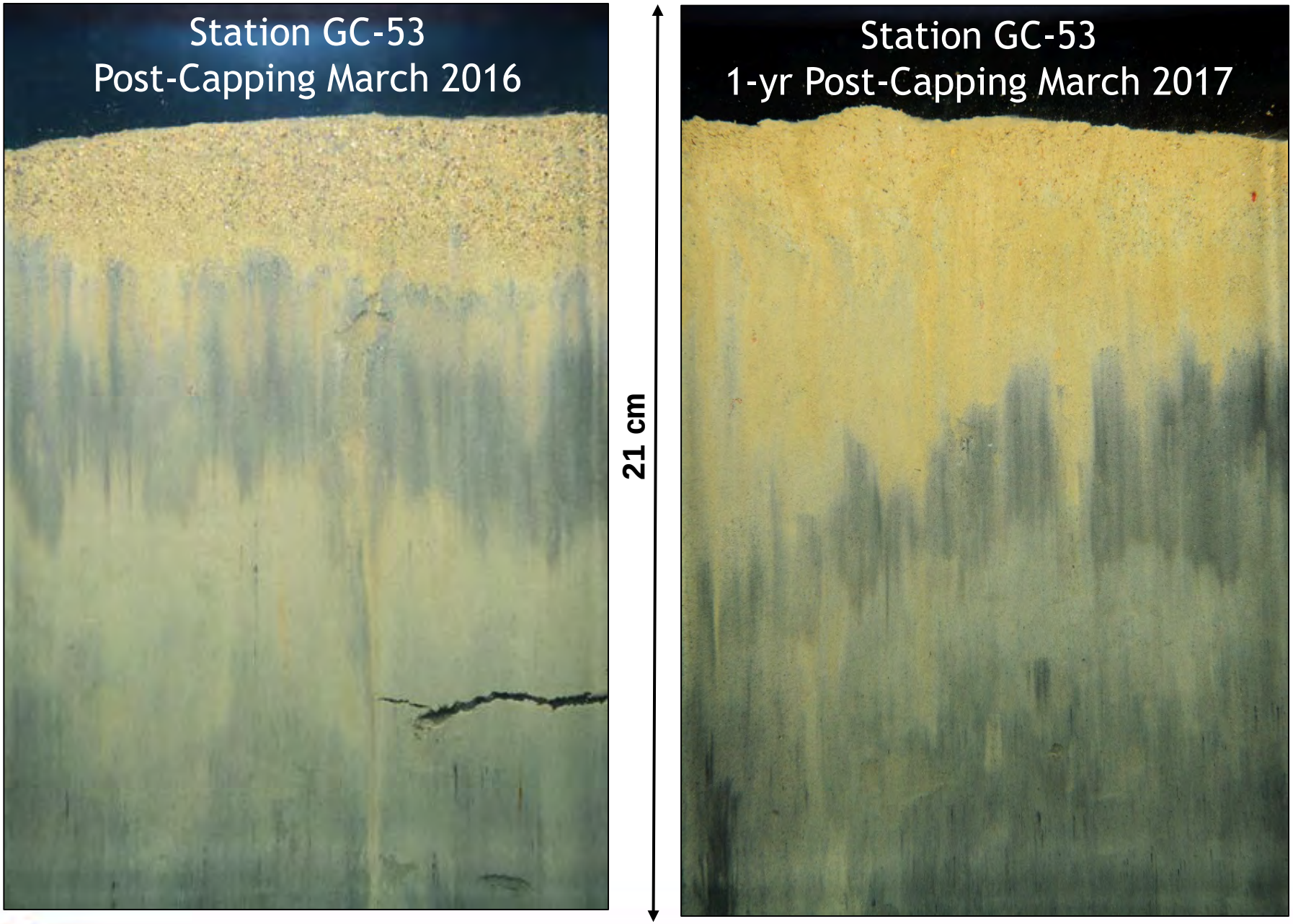
Post Sand Cap Survey—Disposal Site



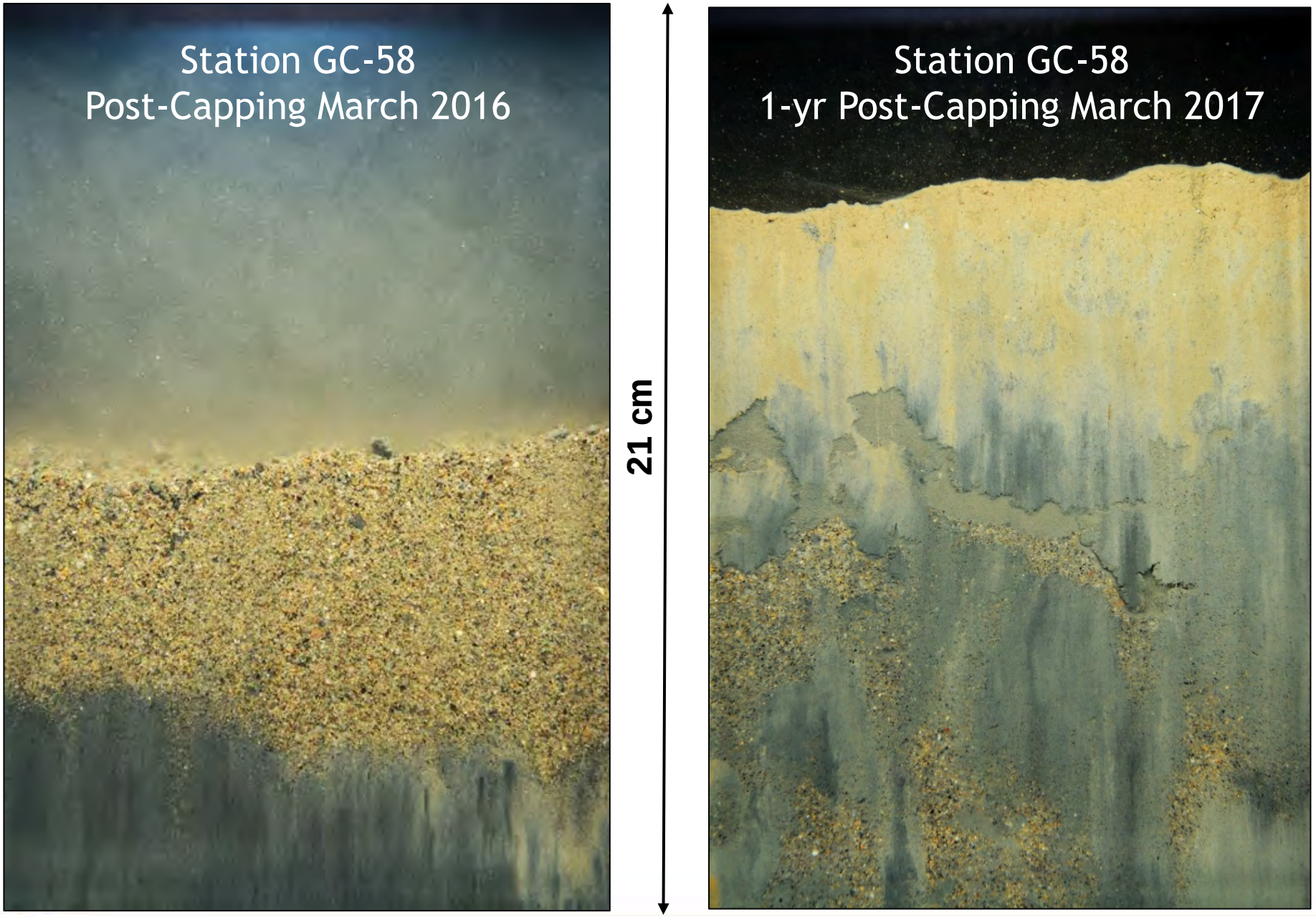
Post Sand Cap Survey, A-A′ Cross Section



Douglas Harbor—1-year Post-capping Survey



Douglas Harbor—1-year Post-capping Survey



Summary

- SPI provides unique information on surface sediment layering and biological and physical mixing processes that cannot be obtained in any other way
- SPI can provide “real-time” information on dredged residuals and disposed dredged and cap material footprints.
- This information can be use to optimize the design of other sampling efforts and enhances the interpretation of other data sets
- Our goals in developing iSPI are to:
  - Streamline data generation by semi-automating the measurement of basic features in the images
  - Standardize data quality and improve data management and analytical capabilities
  - Make the technology more transparent and accessible

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