

Boat Harbour Sludge Thickness Mapping and Volume Calculations



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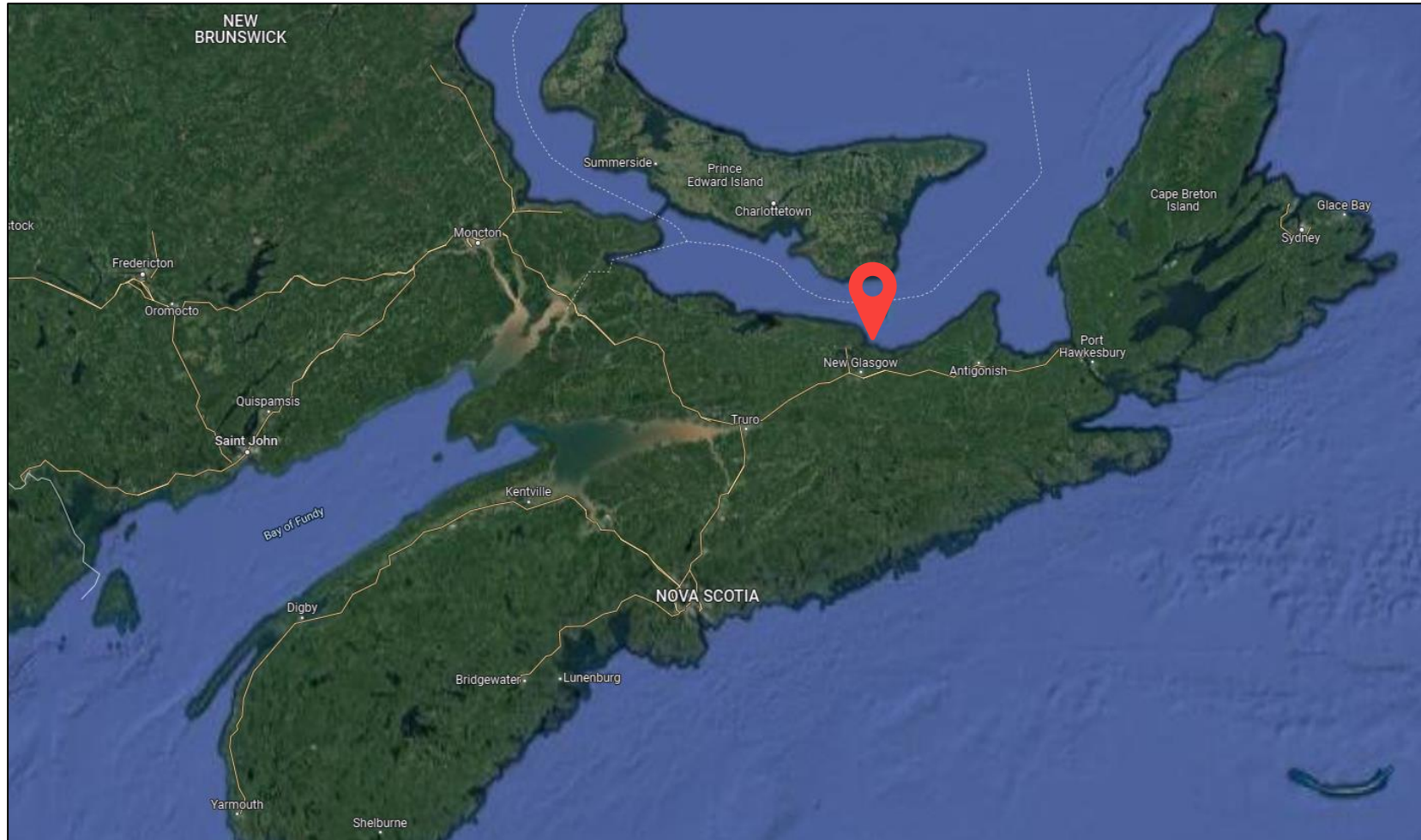
RemTech East
June 1, 2022



Project Location



Project Location



Land Acknowledgement

Nova Scotia is located in Mi'kma'ki, the ancestral and unceded territory of Mi'kmaq.



Project History

Before 1967, Boat Harbour was a natural tidal estuary that spread over about 142 hectares (350 acres). The estuary was connected to the Northumberland Strait by a narrow passage just east of Pictou Landing First Nation Community.

Project History



Boat Harbour contamination: 1967 - 2020

Contaminants identified in sludge

- Cadmium
- Dioxins
- Furans
- Mercury
- Polycyclic aromatic hydrocarbons (PAHs)
- Petroleum hydrocarbons
- Zinc





1967

Wastewater is discharged to Boat Harbour

- Mill begins discharging effluent to Boat Harbour
- Aquatic life begins to die

2015

Boat Harbour Act (Provincial Legislation)

- Protests by the First Nation prompts the Province of NS to pass the “Boat Harbour Act”
- The Act states Boat Harbour will cease to receive and treat mill effluent on January 31, 2020

2017

Start of Boat Harbour Remediation Environmental Assessment and Design

- GHD & WSP contracted for Environmental Assessment and Remediation Design of Boat Harbour

2020

Discharge of wastewater to Boat Harbour ends

- Pulp & Paper Mill stops discharging pulp waste to Boat Harbour

Remediation Design Background Information

Contaminated sludge

To be dredged.



142 Hectares of water

To be returned to tidal.



Remedial costs

Project risk because of sludge volume uncertainty.



Sludge volume

Sludge volume estimates based on limited information.

High level of uncertainty for remedial design.

Technical Problem

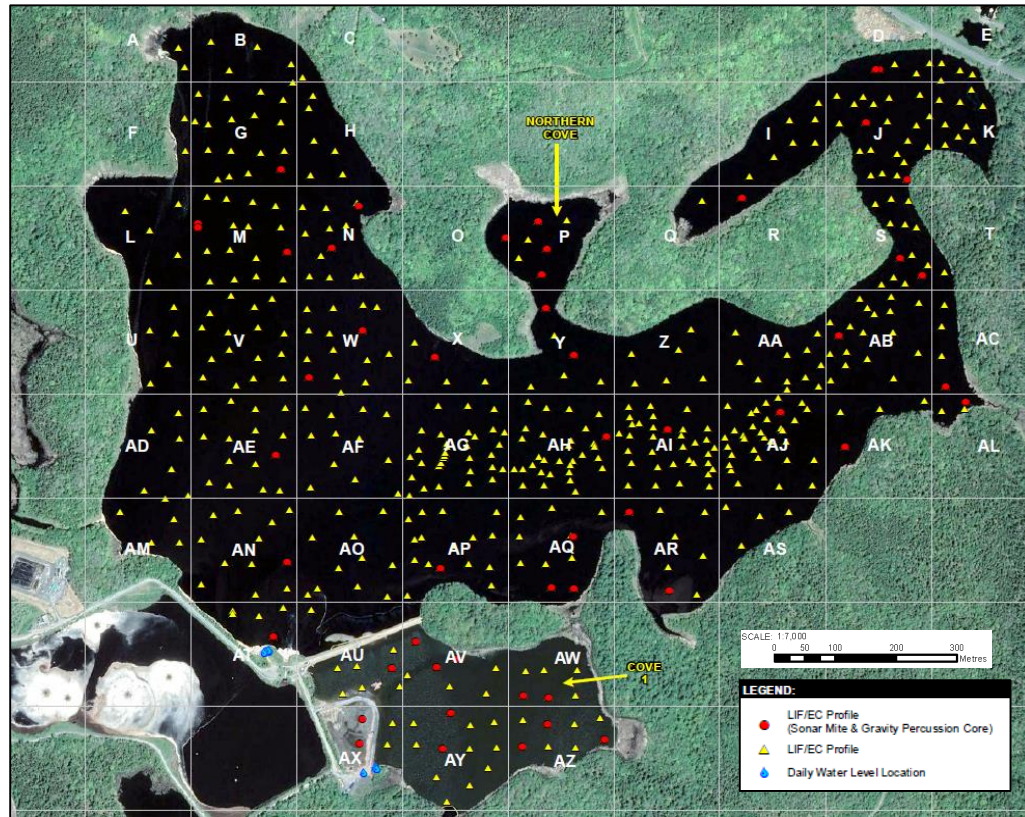
What is the volume of contaminated material?

Informs remedial design, permitting and costs.

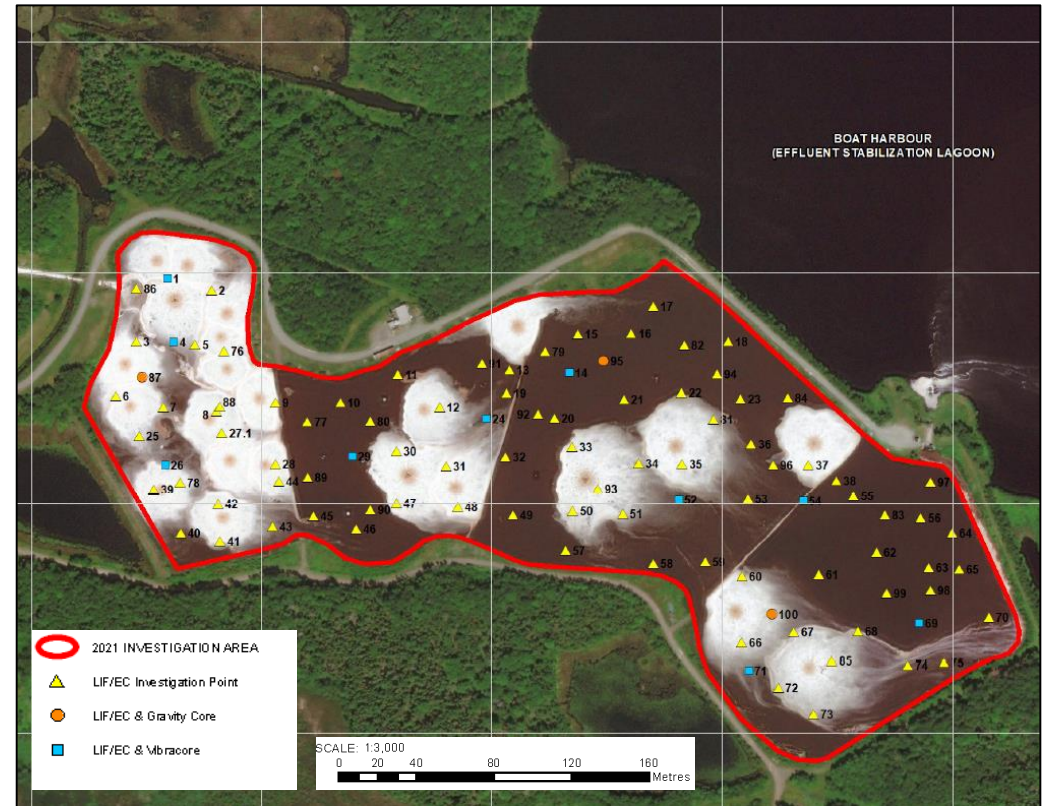


Field Investigations

Boat Harbour: October – December 2019



*Aerated Stabilization Basin (ASB):
September – October 2021*



Keys to Success

Safety

Site and water access



Existing infrastructure



Working over water



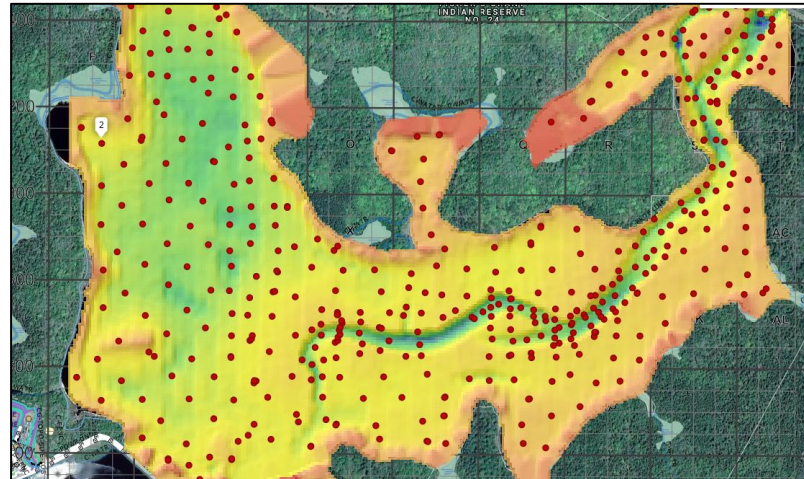
Keys to Success

Technical Solutions

In-situ sludge measurements



Bathymetry



Digital field data collection



Keys to Success

Collaboration



WSP Sectors

Environment: Project management, field coordination, HSE, field staff, data management, reporting

ERI: bathymetry

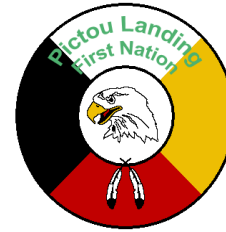
Geomatics: survey control



Client team

NS Lands

GHD



Pictou Landing First Nation

Field support: Health and safety support, site preparation, security



SCG Industries

Development of in-situ measurement methods.

Construction of barges

Processing and interpretation of LIF/EC data

In-situ sludge thickness measurements

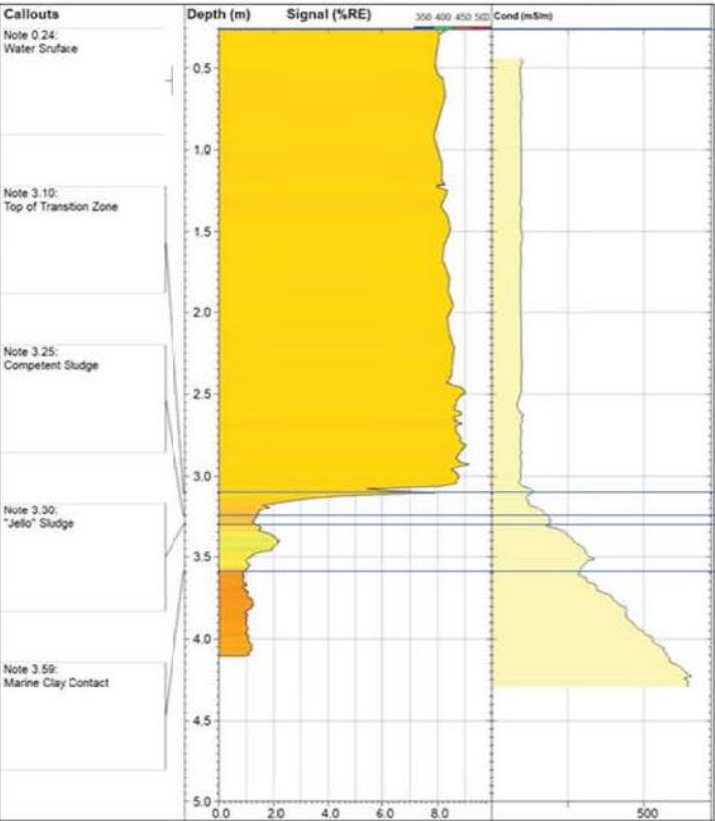
SCG Industries application

- Laser Induced Fluorescence and Electrical Conductivity (LIF/EC)
- Applications for high resolution site characterization of petroleum hydrocarbon and PAH impacted sites
- Methods adapted to detect top of sludge and sludge/marine sediment interface
- Pilot programs 2018/2019
- Full scale application in 2019

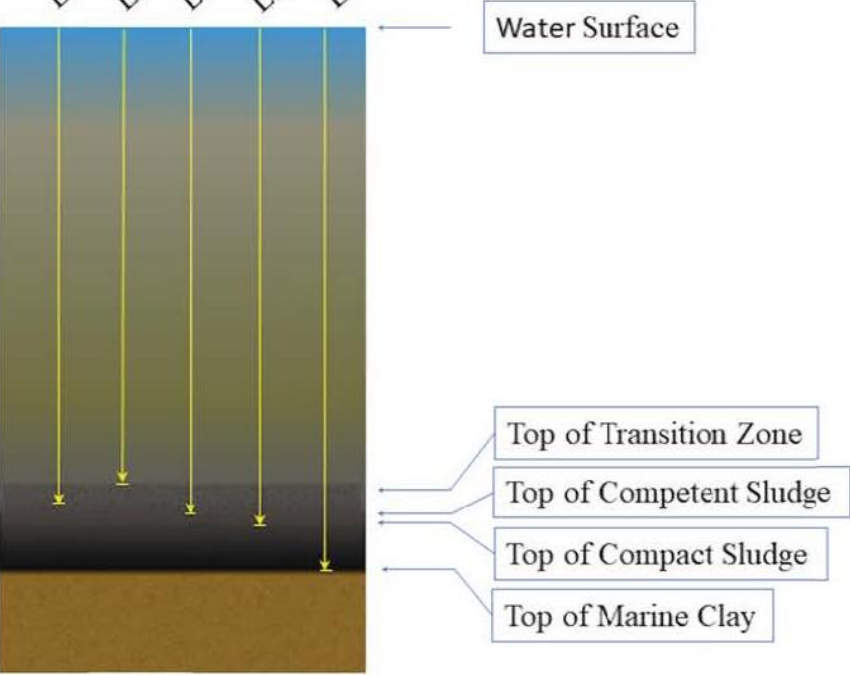


Example LIF/EC log

V-10		UVOST® By Dakota www.dakotatechnologies.com
Site: Boat Harbour	Y Coord (Lat-N) / System: Unavailable / NA	Final depth: / Altered data 4.11 m / B-
Client / Job: WSP / 191-12720	X Coord (Lng-E) / Fix: Unavailable / NA	Max signal: 9.1 %RE @ 2.93 m
Operator / Unit: B. Drummond / UVOST194	Elevation: Unavailable	Date & Time: 2019-12-06 11:00 AST



Bathymetric Surface (SBES and MBES)
 LIF/EC – Top of Transition Zone
 LIF/EC Top of Competent Sludge
 LIF/EC – Top of Compact Sludge
 LIF/EC – Top of Marine Clay



Sediment and Sludge Sampling

Gravity Core



Vibra-core



Percussion Core





Sludge Observations: Transition Zone

- Increasing solids content with depth.
- Low degree of cohesiveness
- Dynamic
- Thickness: Non-detect - 1 m



Sludge Observations: Competent Sludge

- Consolidated relative to the transition zone
- Increase in thickness observed with increase in location depth
- Thickness: Non-detect - >1 m



Sludge Observations: Compact Sludge

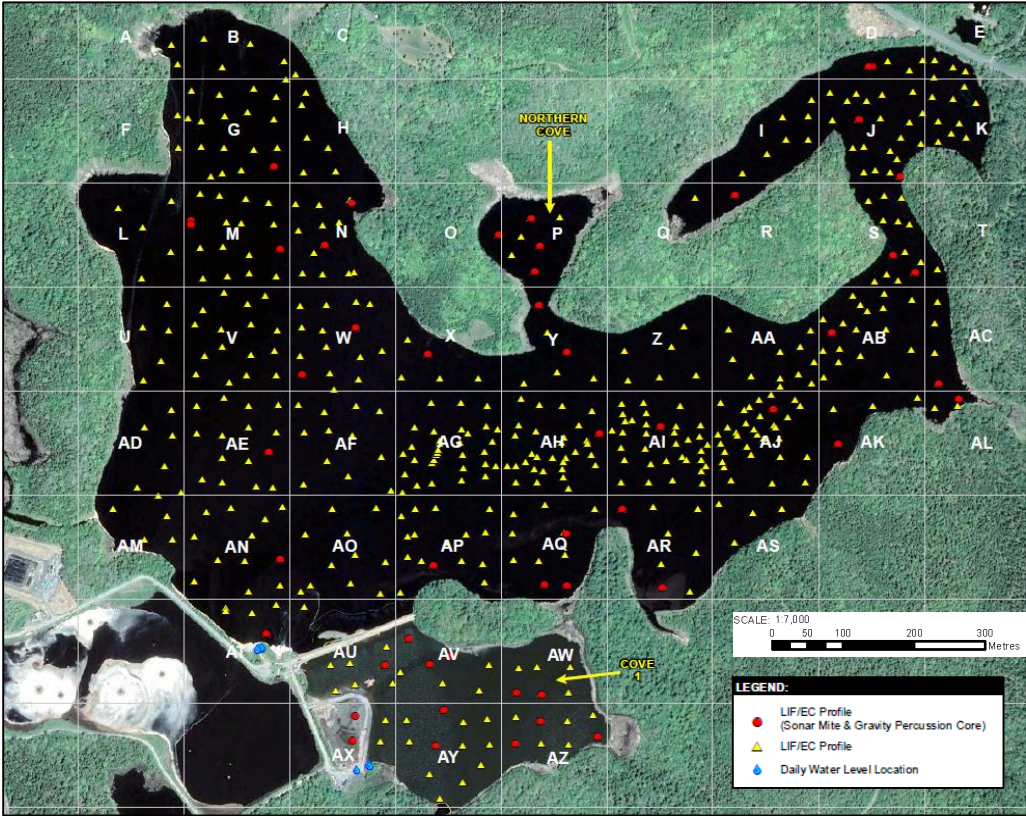
- Approximately ½ of the competent sludge layer
- Cohesive gel or jelly like material
- Uncertain if the properties of this layer are a result of historic differences in effluent or in-situ changes to sludge properties

Sludge Observations: Marine Clay

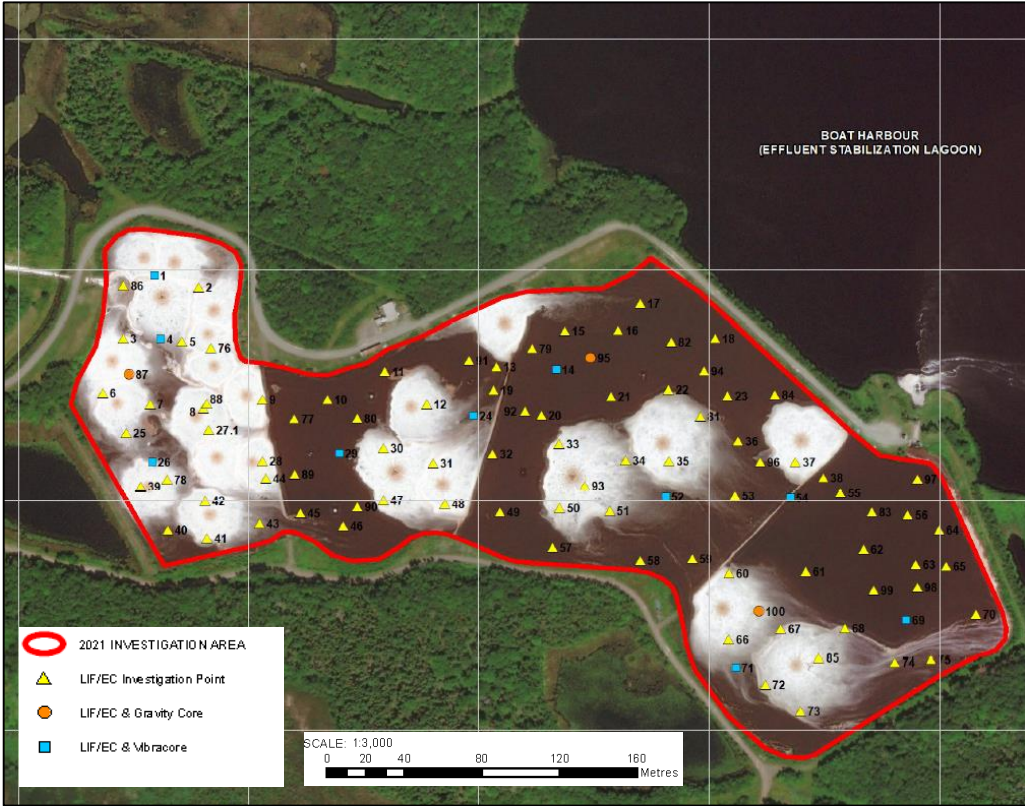
- Native sediments of the Boat Harbour marine estuary
- Holocene (post last glaciation) marine deposits

Field Investigations

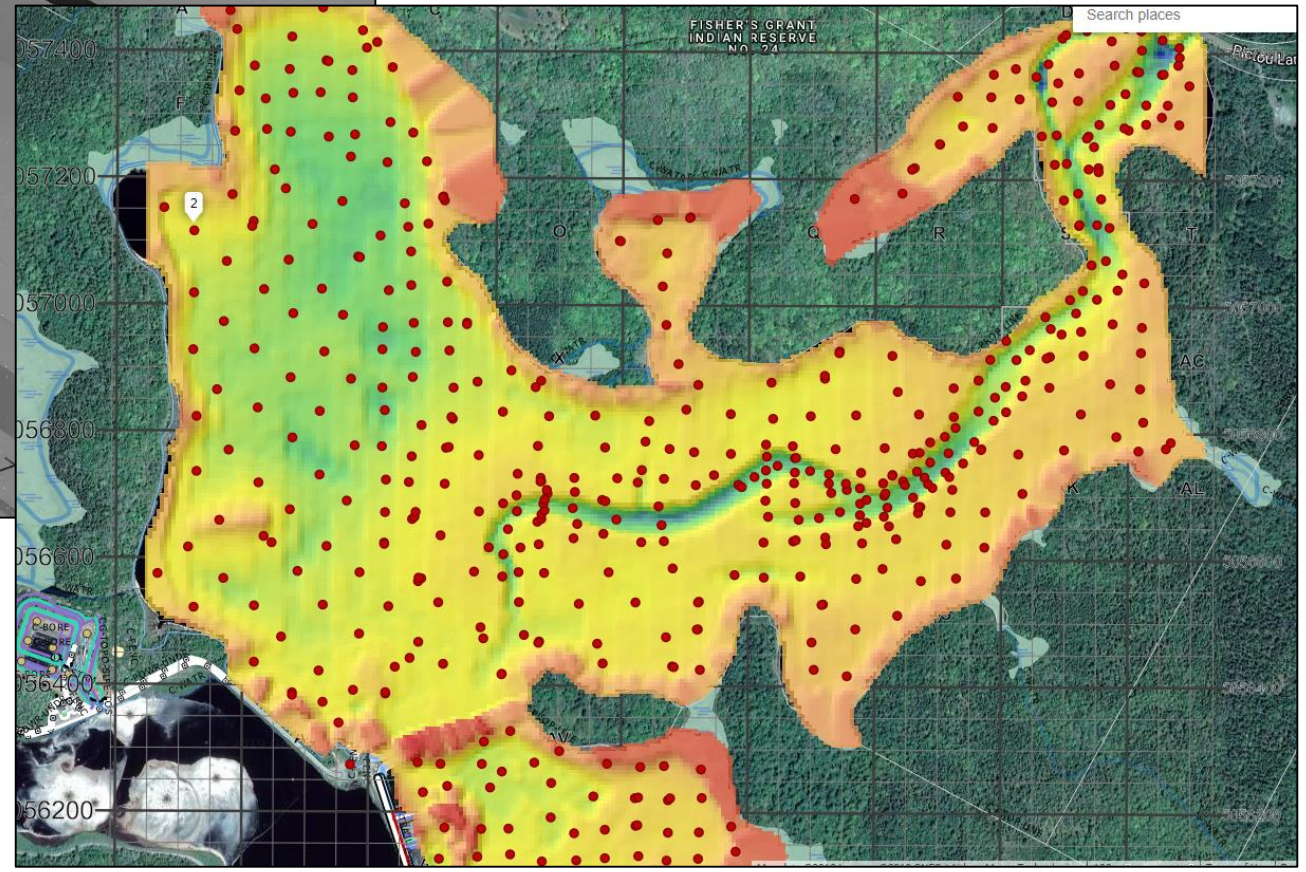
Boat Harbour 2019



Aerated Stabilization Basin (ASB) 2021



Data Entry into Fulcrum



Bathymetric Surveys

Single beam data collection



Multibeam data collection



Survey control



Data Processing

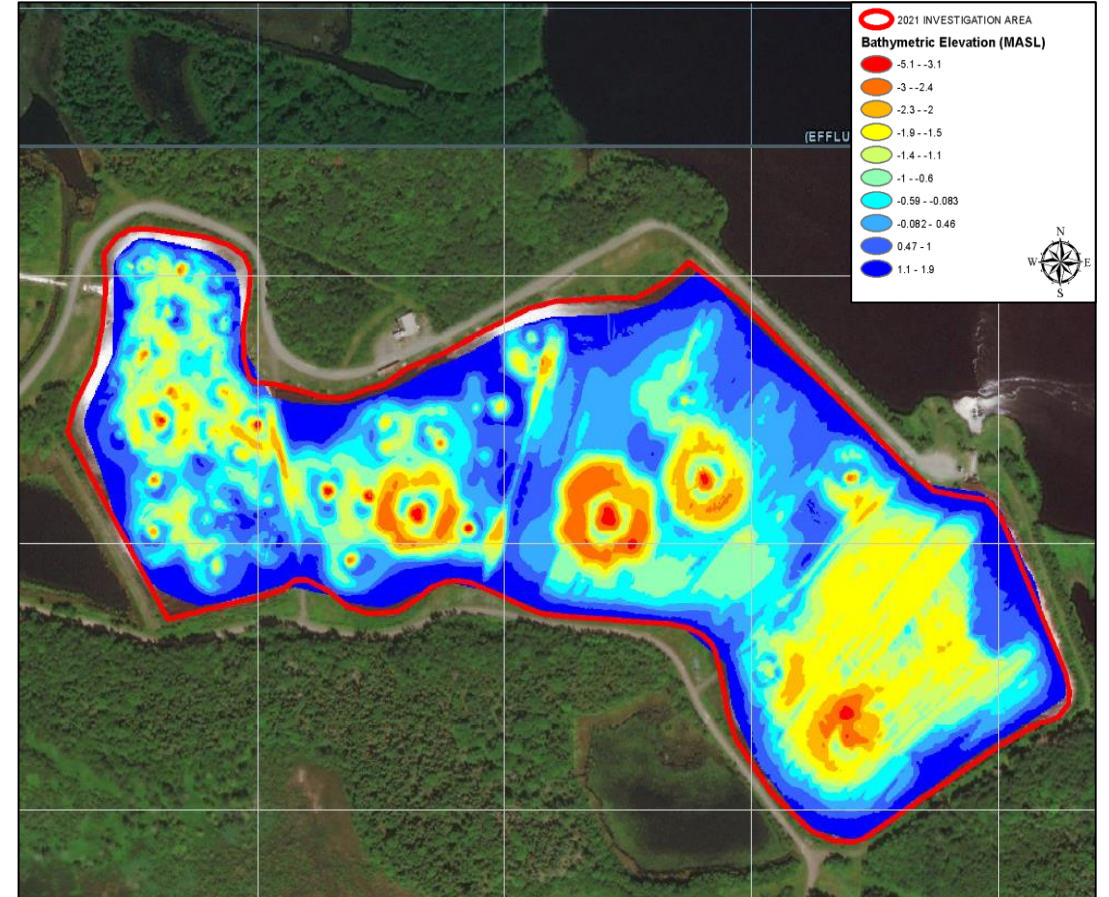
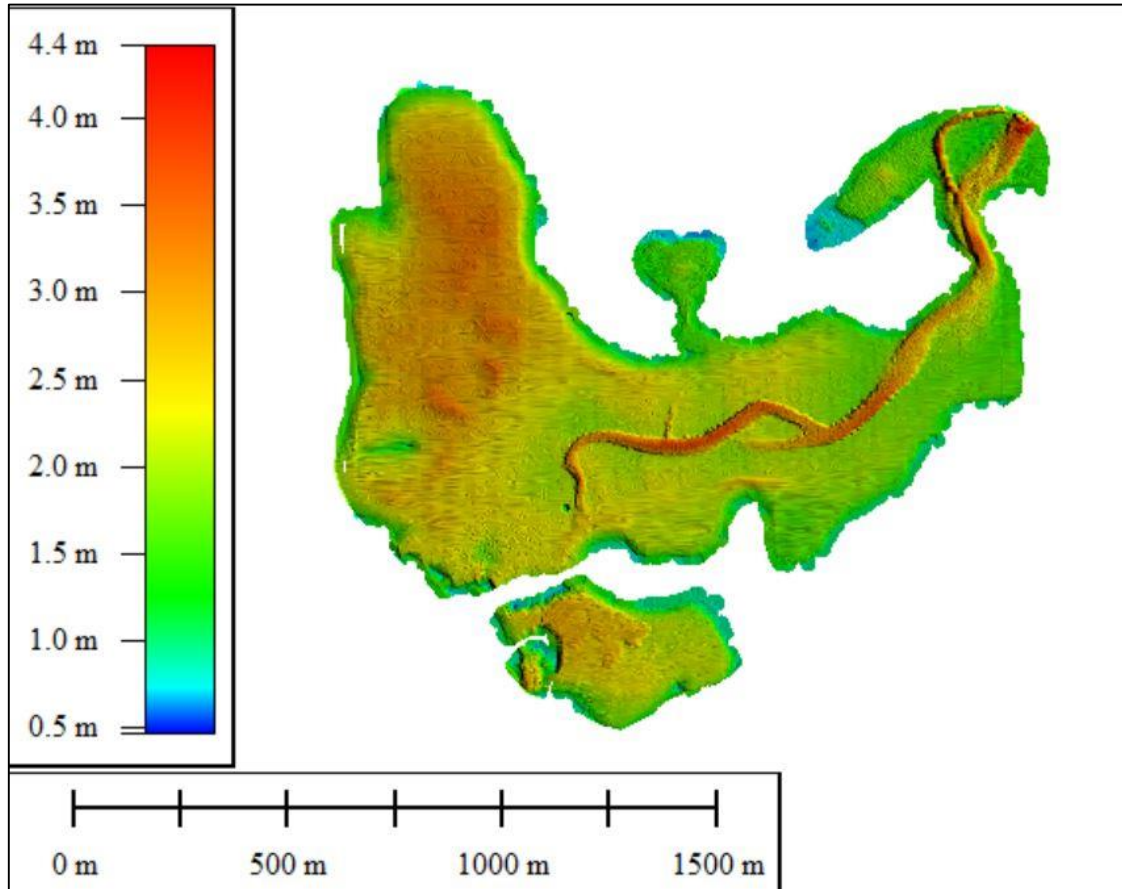
LIF/EC Data

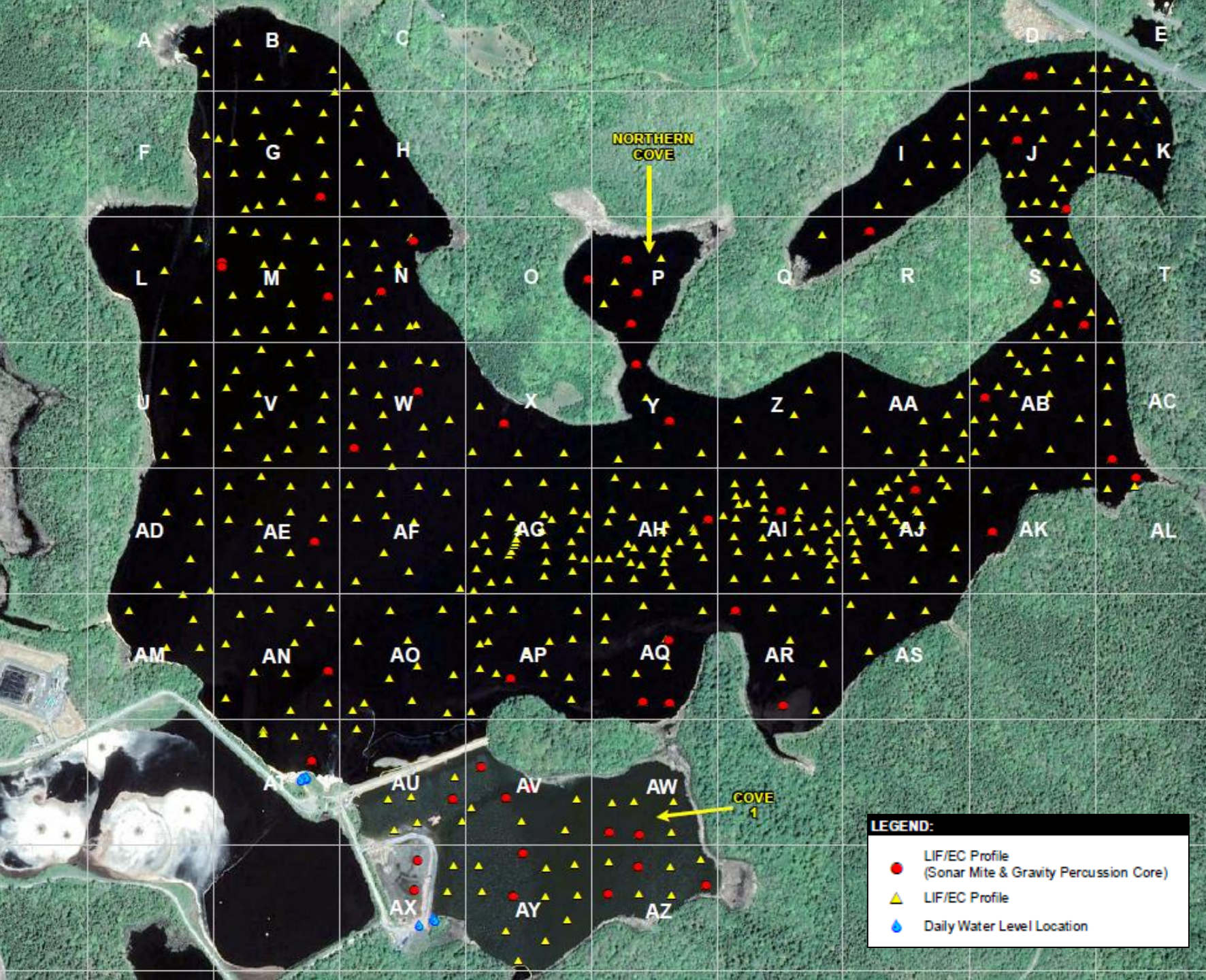
- Field interpretation of logs
- Post field interpretation of logs
- Interface depths converted to elevations
- Validation during the iterative surface generation

Bathymetric

- SBES & MBES data points combined
- Data set subsampled for ease of processing
- 1% of data points used for surface generation

Bathymetric Surveys





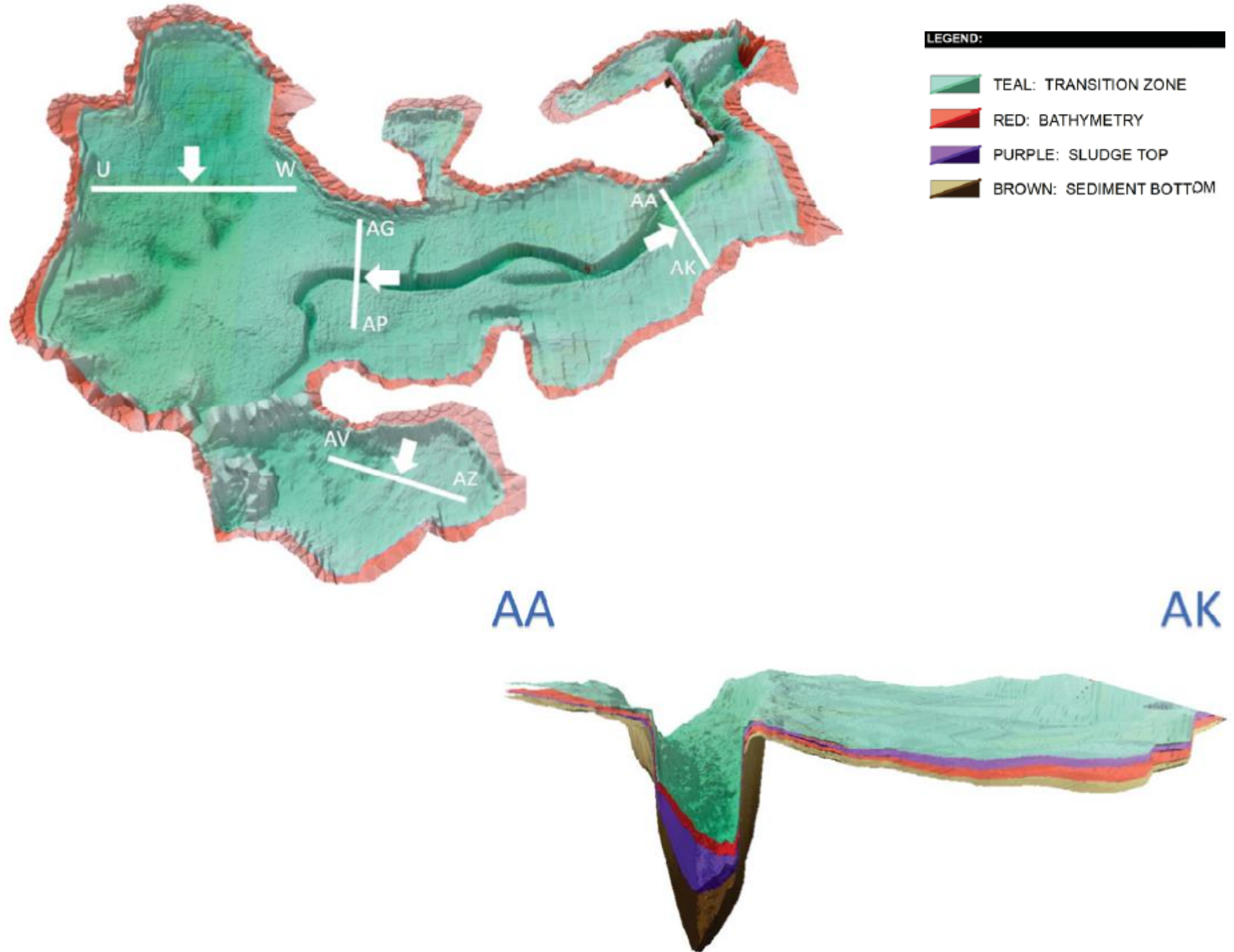
Sludge thickness

- Convert sludge thickness profiles into surfaces and sludge volume estimates

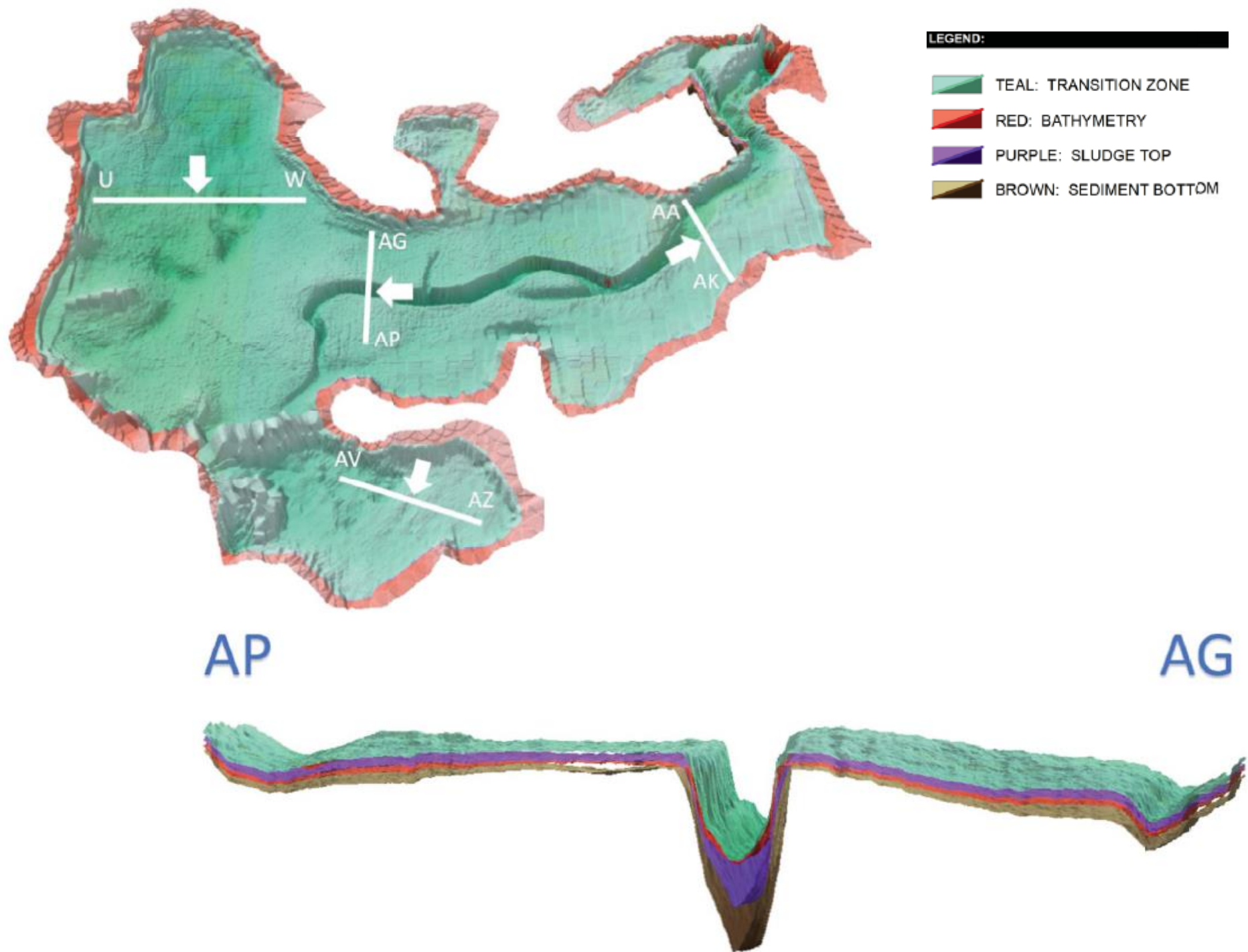
LEGEND:

- LIF/EC Profile (Sonar Mite & Gravity Percussion Core)
- ▲ LIF/EC Profile
- Daily Water Level Location

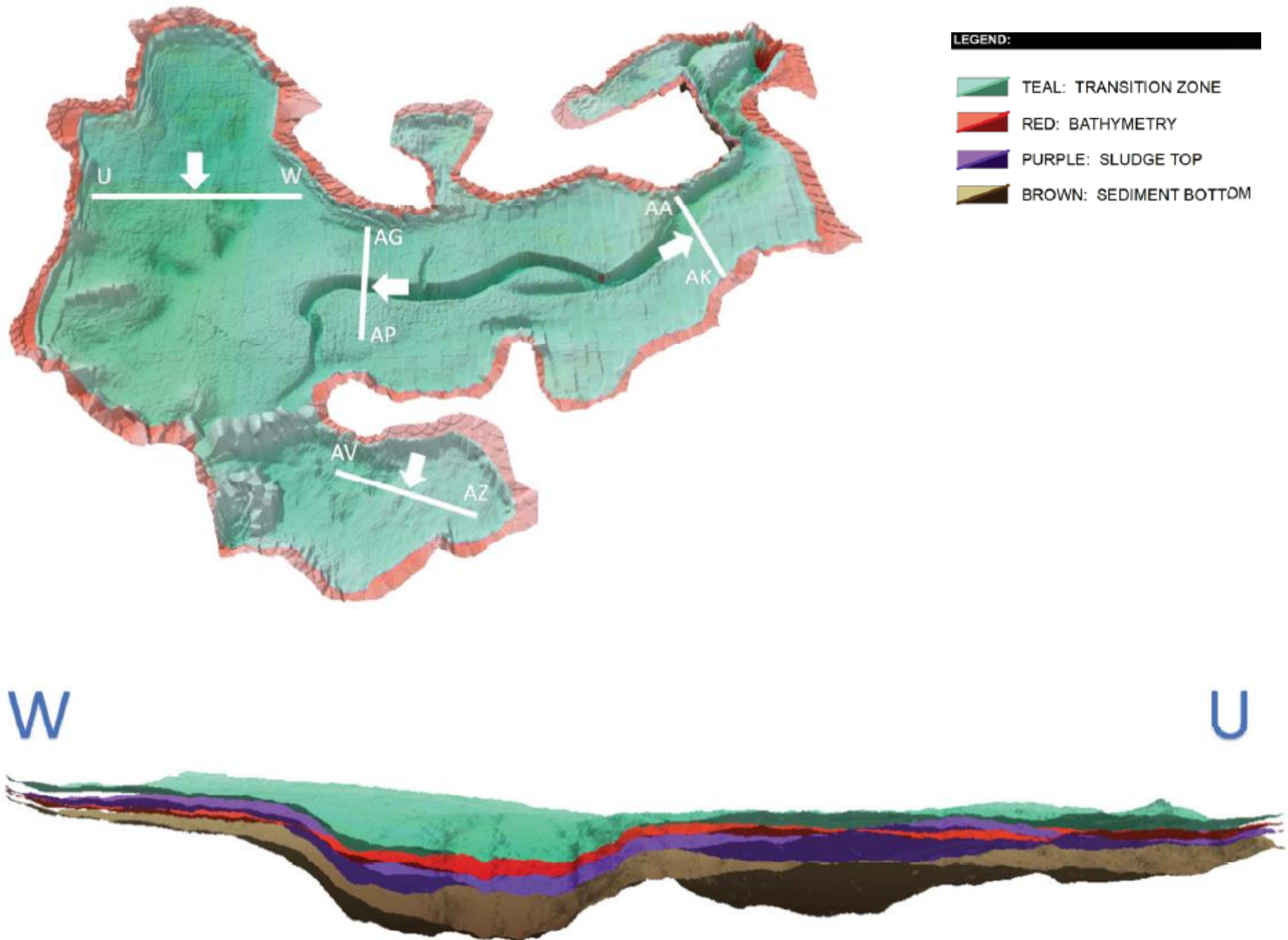
Channel



Channel

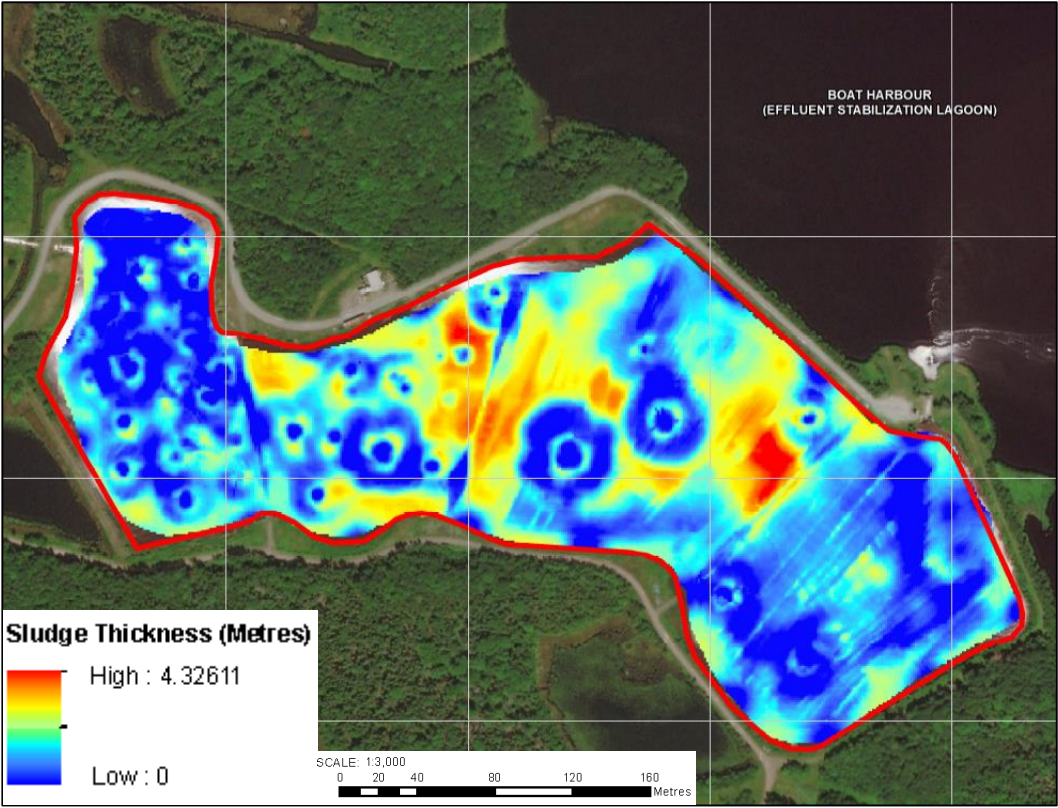


Western Basin

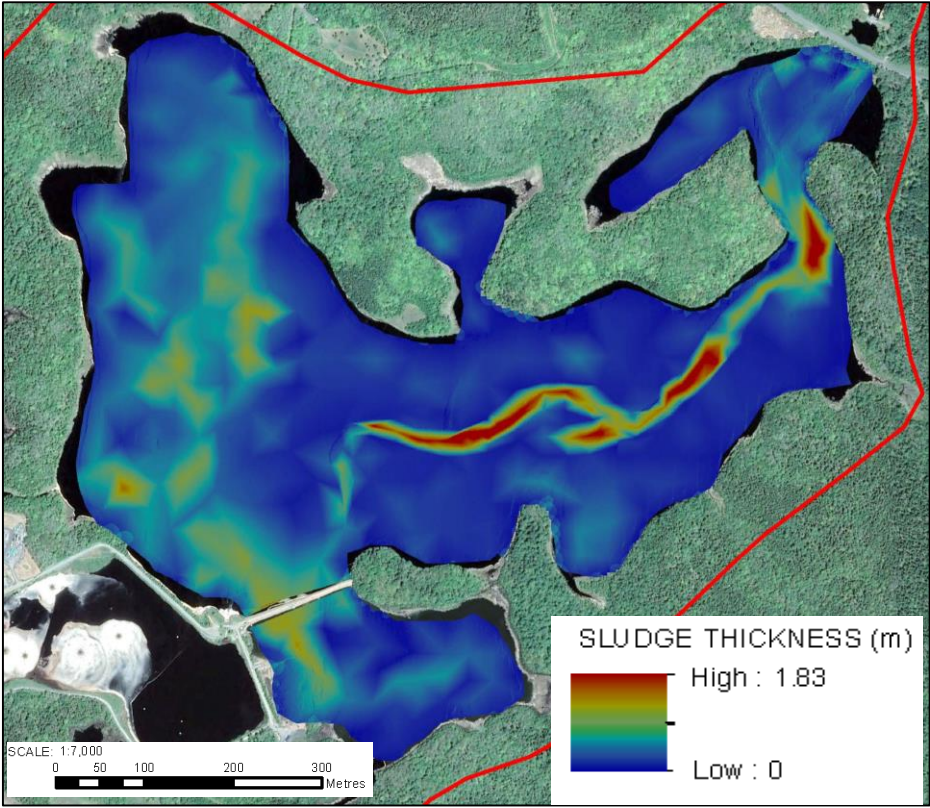


Sludge Thickness Mapping

ASB



Boat Harbour



Sludge Volume

- Competent sludge: 271,000 m³
- Competent sludge + transition zone: 400,500 m³

Challenges and Solutions

Safety:

- Planning and team work.
- Improved design.

Technical:

- LIF/EC is an effective tool to precisely measure sludge thickness.
- Rapid data processing to refine interpretations.
- Survey control.

Logistics:

- Digital and cloud-based data management.
- Refining equipment.



Future applications

Boat Harbour remediation:

- LIF/EC profiling after dredging to identify areas of sludge/sediment mixing and identifying 'hot spots' where sludge remains;
- Couple LIF/EC with chemical analyses to provide semi-quantitative interpretation;
- LIF/EC profiling following dredging to quantify the settling of suspended sediment;

Applications beyond Boat Harbour:

- Novel approach to sludge characterization and quantifying;
- Waste water treatment systems;
- Ports and marine facilities.





Summary

- Field programs designed to address challenges of the season and site with up to 15 staff on site daily.
- Collaborative team effort.
- Data collection:
 - >600 LIF/EC investigation points; >60 core samples;
 - Single beam and multibeam surveys;
 - All measurements surveyed to convert to elevations.
- Data management
 - Real time upload of data;
 - Data validation and interpretation;
- Bottom of sludge surface defined for remedial design.
- Sludge volume estimates calculated.



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Thank you to:

SCG Industries

NS Lands

Pictou Landing First Nation Fisheries and Community Members

WSP Project Team