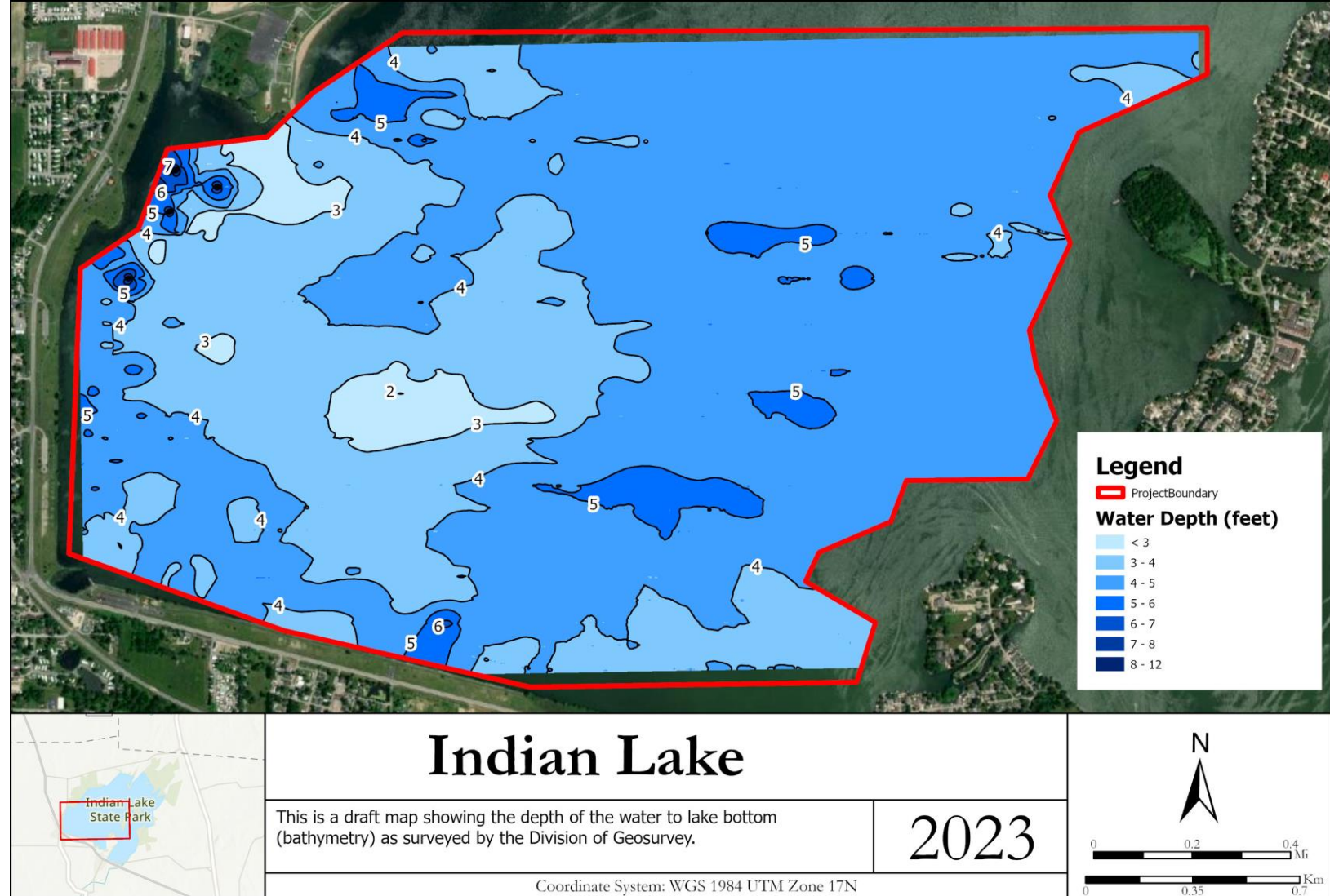


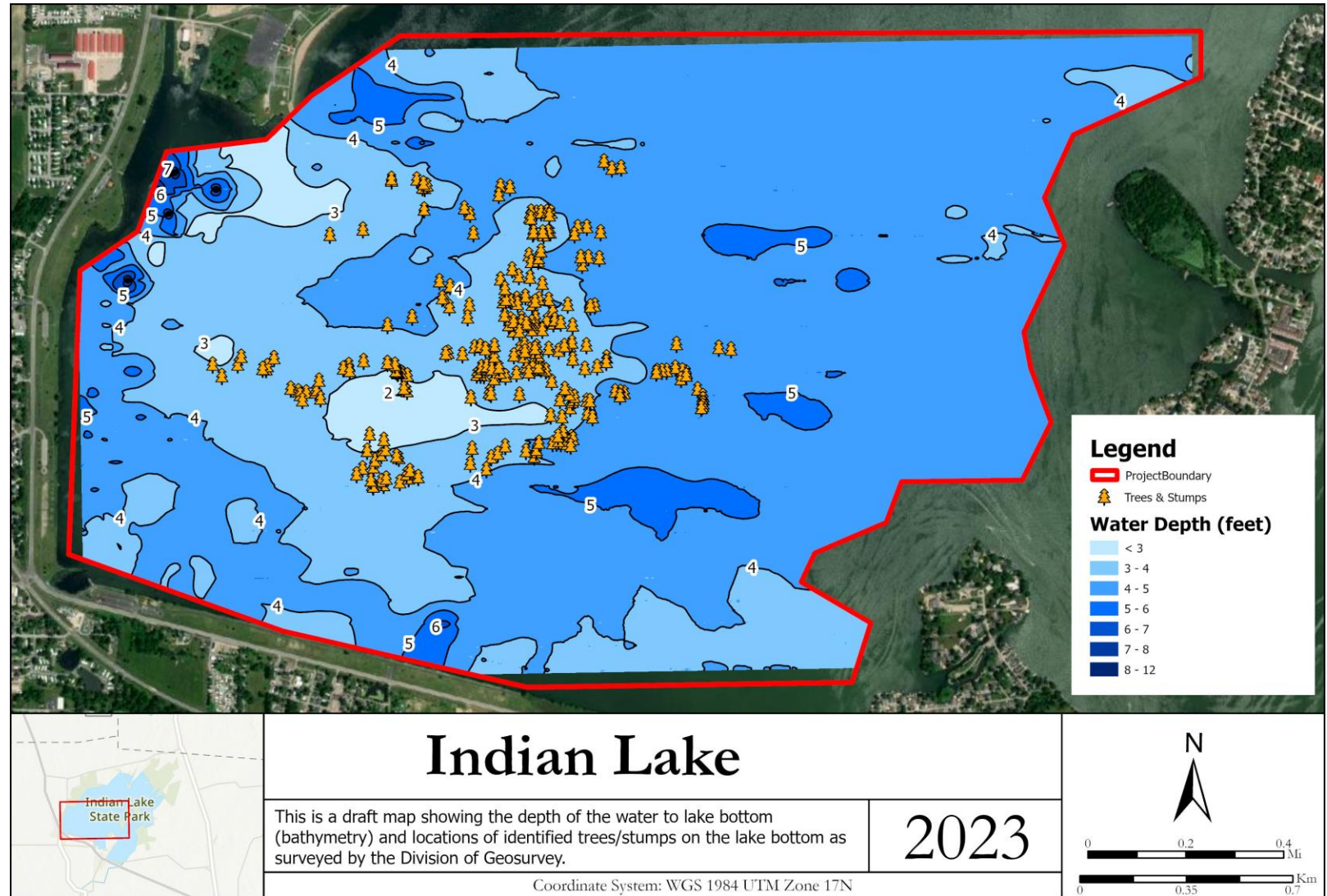
# WATER DEPTH – BATHYMETRY (1 FOOT INTERVAL)

- Water depth of Indian Lake – to the lake bottom/top of the mud.
- Darker = deeper
- Lighter = shallower



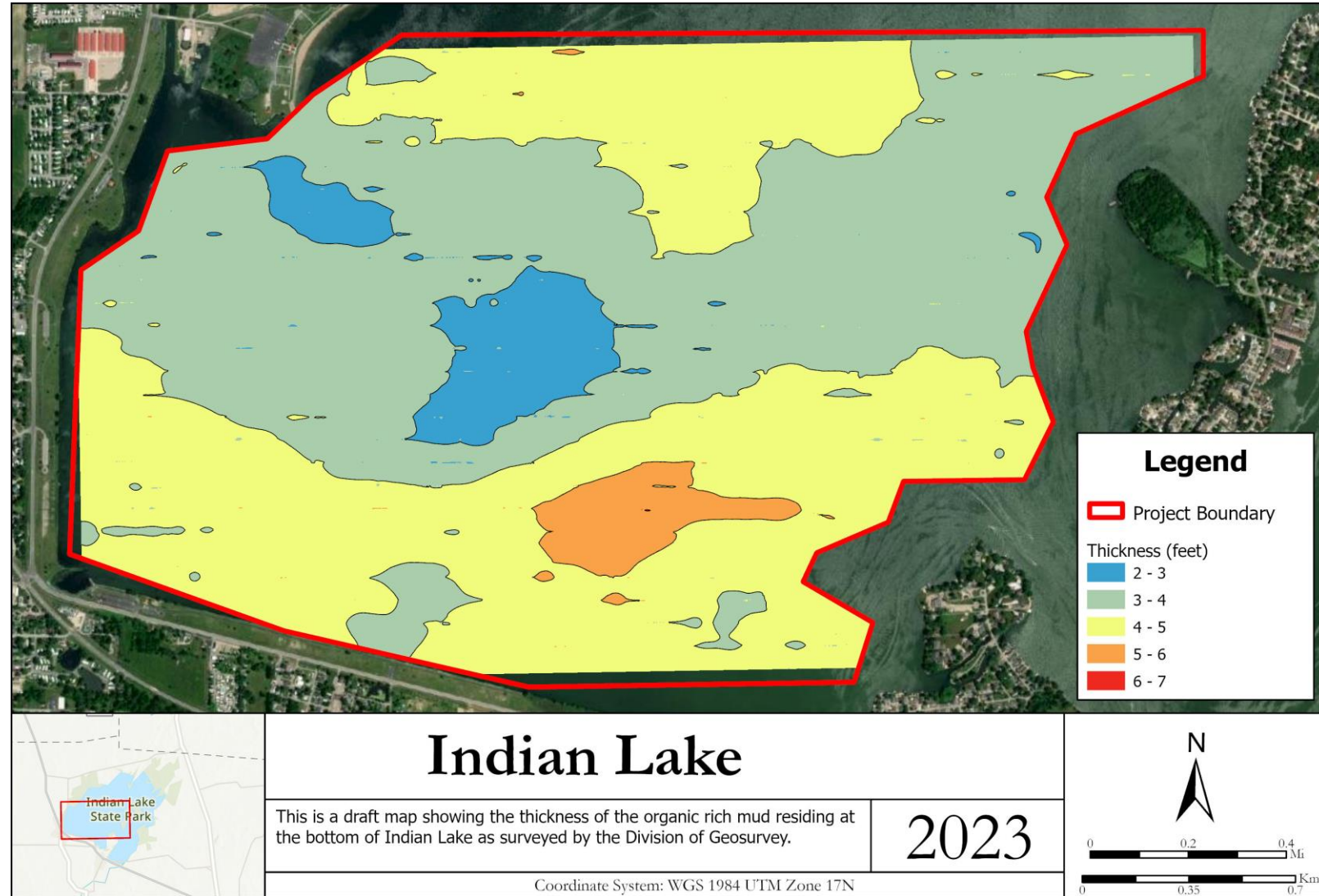
# WATER DEPTH & TREES

- Water depth of Indian Lake
- Darker = deeper
- Lighter = shallower
- Locations of identified trees/stumps on lake bottom



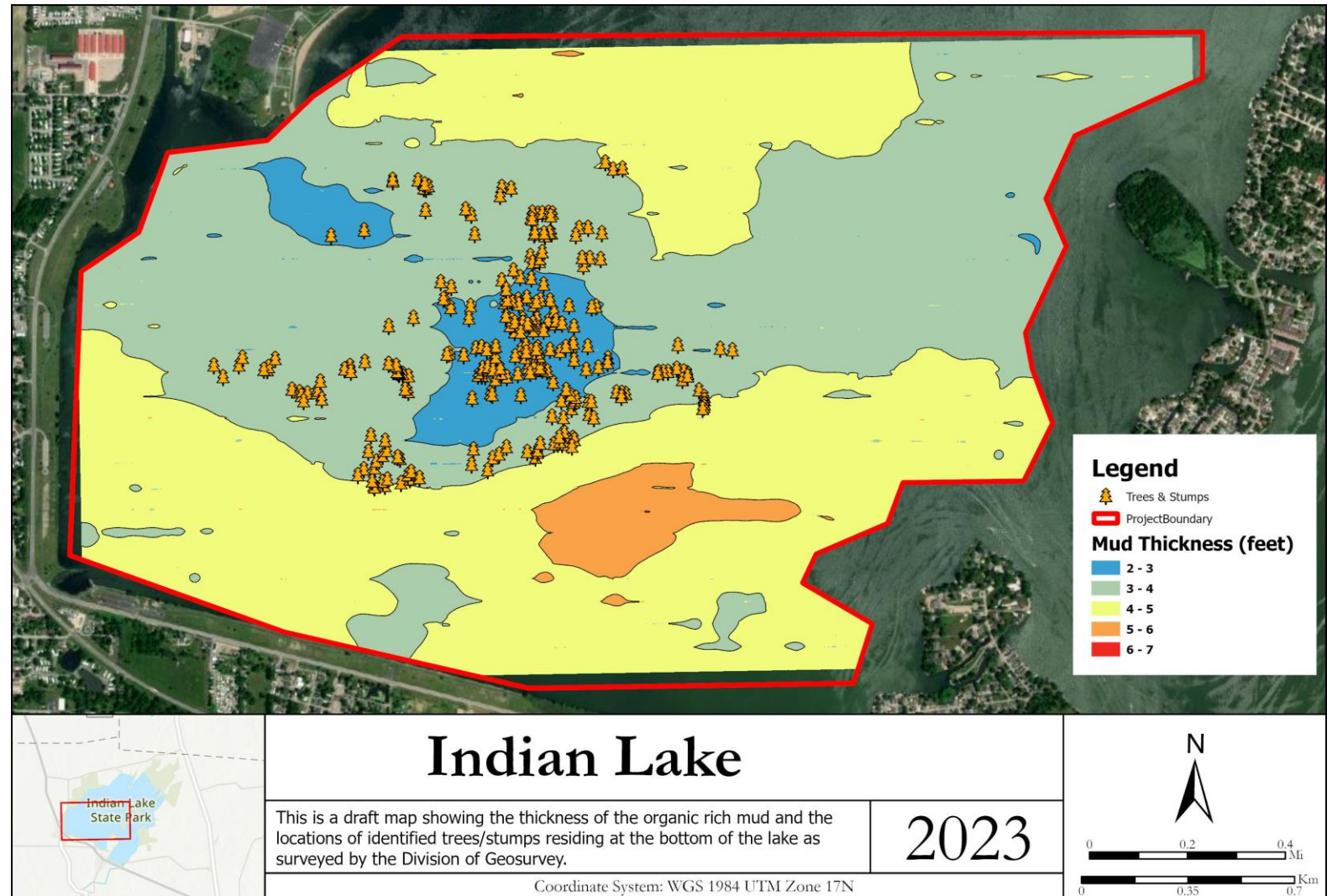
# MUD THICKNESS MAP (1 FOOT INTERVAL)

- The average mud thickness is 3.93 feet.
- The thickest mud is found in the southeast part of the study area (orange area).
- The thinnest mud is in the central part of the study area (blue area).
- Map = Model of the data



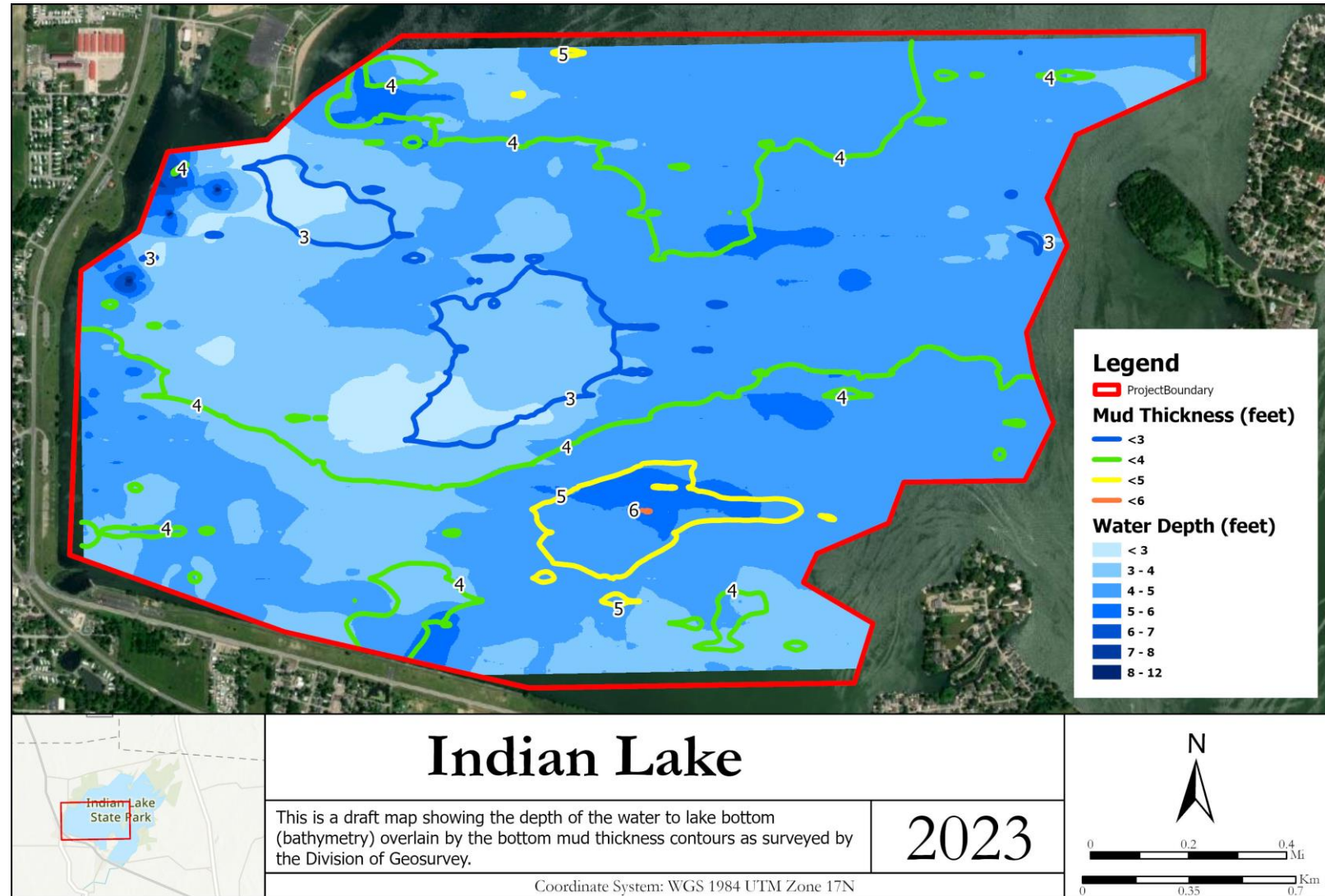
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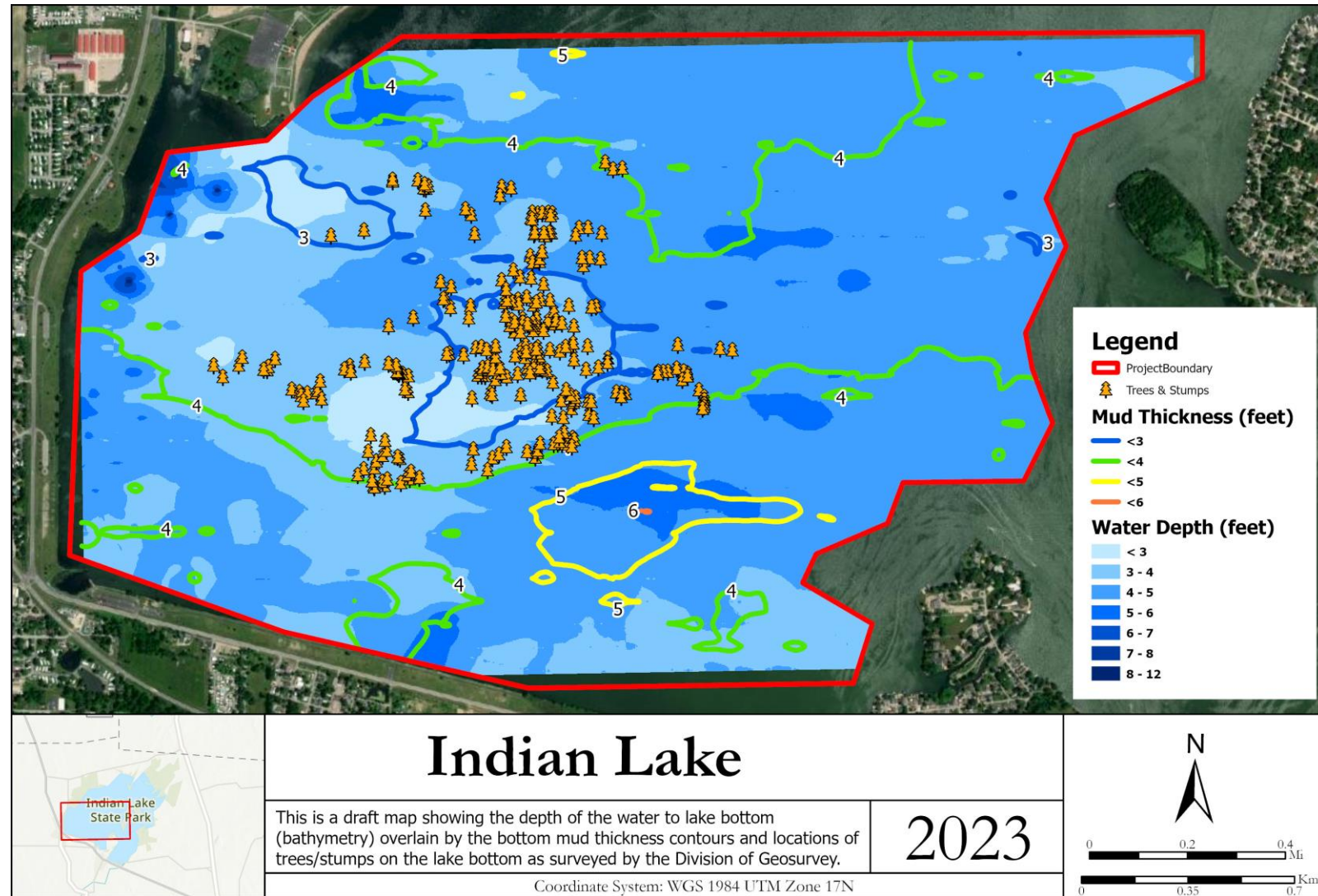
# WATER DEPTH & MUD THICKNESS (1 FOOT INTERVAL)

- Water depth of Indian Lake overlain by contours of mud thickness
- Darker = deeper
- Lighter = shallower
- One foot mud thickness contours



# WATER DEPTH, MUD THICKNESS, & TREES

- Water depth of Indian Lake overlain by contours of mud thickness
- Darker = deeper
- Lighter = shallower
- One foot mud thickness contours
- Locations of identified trees/stumps on lake bottom



# MAPPING THE MUD THICKNESS AT INDIAN LAKE

The Ohio Geological Survey used side-scan sonar to image and sub-bottom profiles to determine the thickness and amount of mud deposited on the bottom of Indian Lake.

**MINDY THOMAS & DANIEL BLAKE**

Geologists

Presentation for the ODNR Division of Parks & Watercraft

January 6, 2023



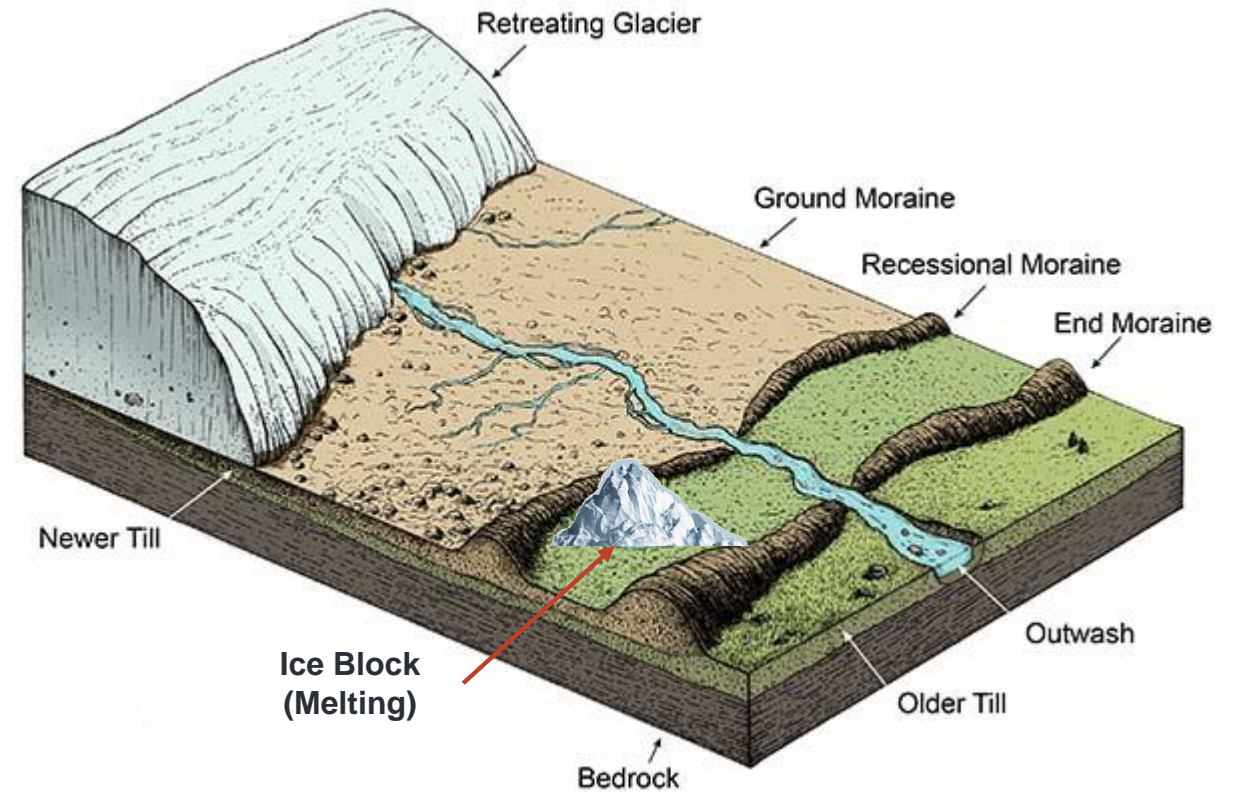
# OVERVIEW

- Brief History of Indian Lake
- Data Collection
  - Side-Scan Sonar Data
  - Sub-Bottom Profiler Data
- Thickness Maps
- Volumetric Calculations



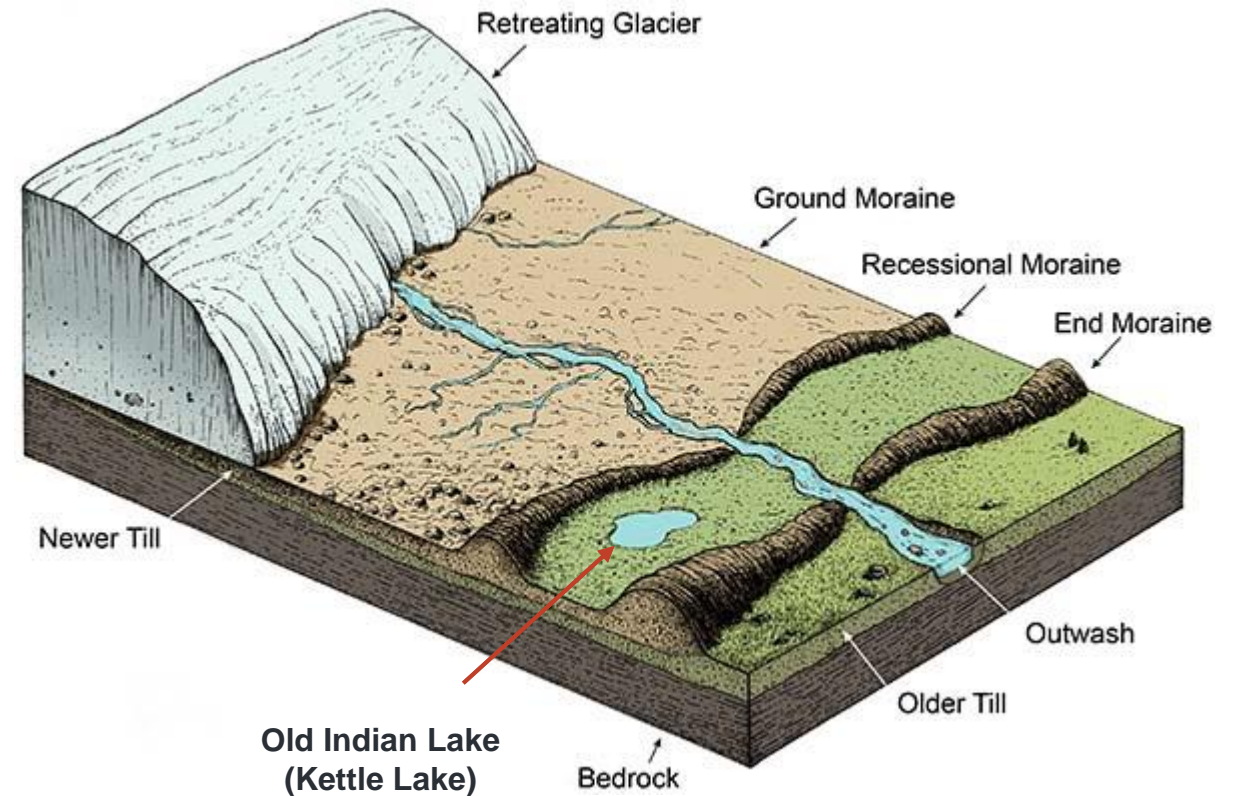
# GEOLOGIC HISTORY OF INDIAN LAKE

- Old Indian Lake was originally a kettle lake, which was created during the last Ice Age.
- A massive block of ice that broke off from the glacier remained in place and melted forming the original lake.



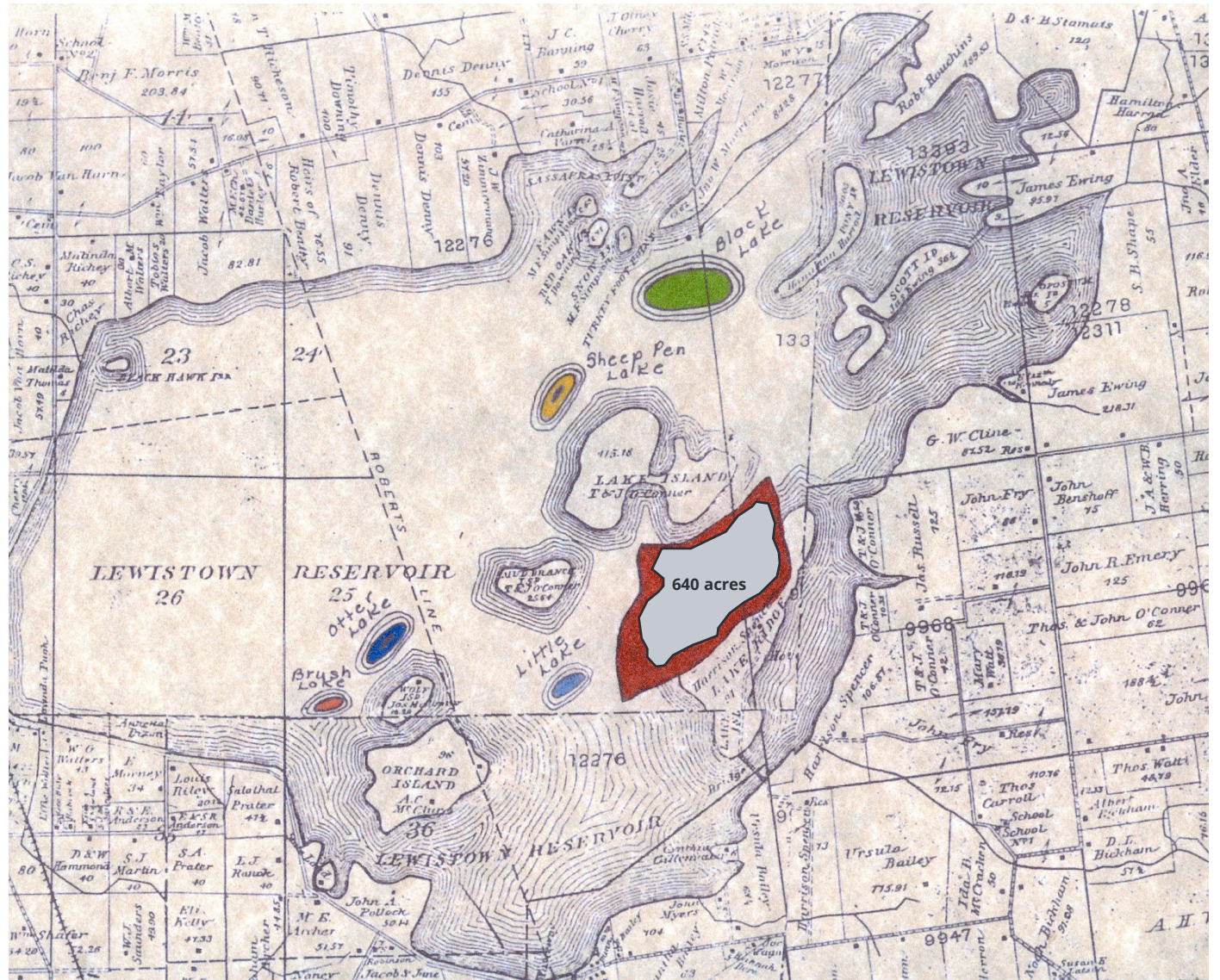
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# HISTORY OF INDIAN LAKE

- Indian Lake began as Old Indian Lake or Indian Miami Lake. Originally formed by a glacier, the **640-acre kettle lake** was expanded to a 1,000 acre in 1851 and renamed the Lewistown Reservoir.
- In 1856 the lake was enlarged again to a size of 6,334 acres, and work was completed in 1860. The lake was built to serve as a feeder lake for the Miami and Erie Canal. (Current size ~5,100 acres.)
- In 1898 the State of Ohio made the Lewistown Reservoir into a state park and renamed it Indian Lake.

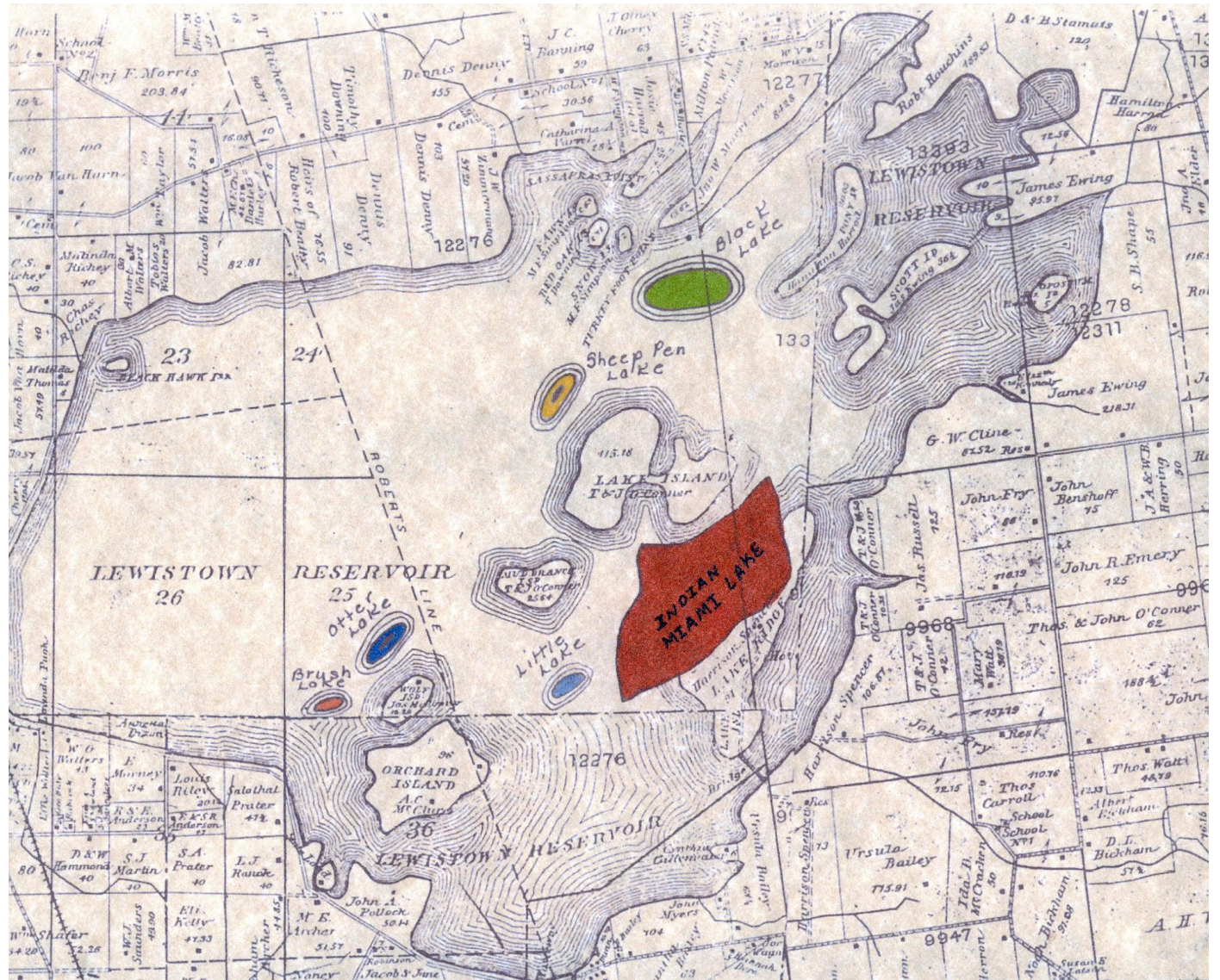


Source: Logan County Historical Society.



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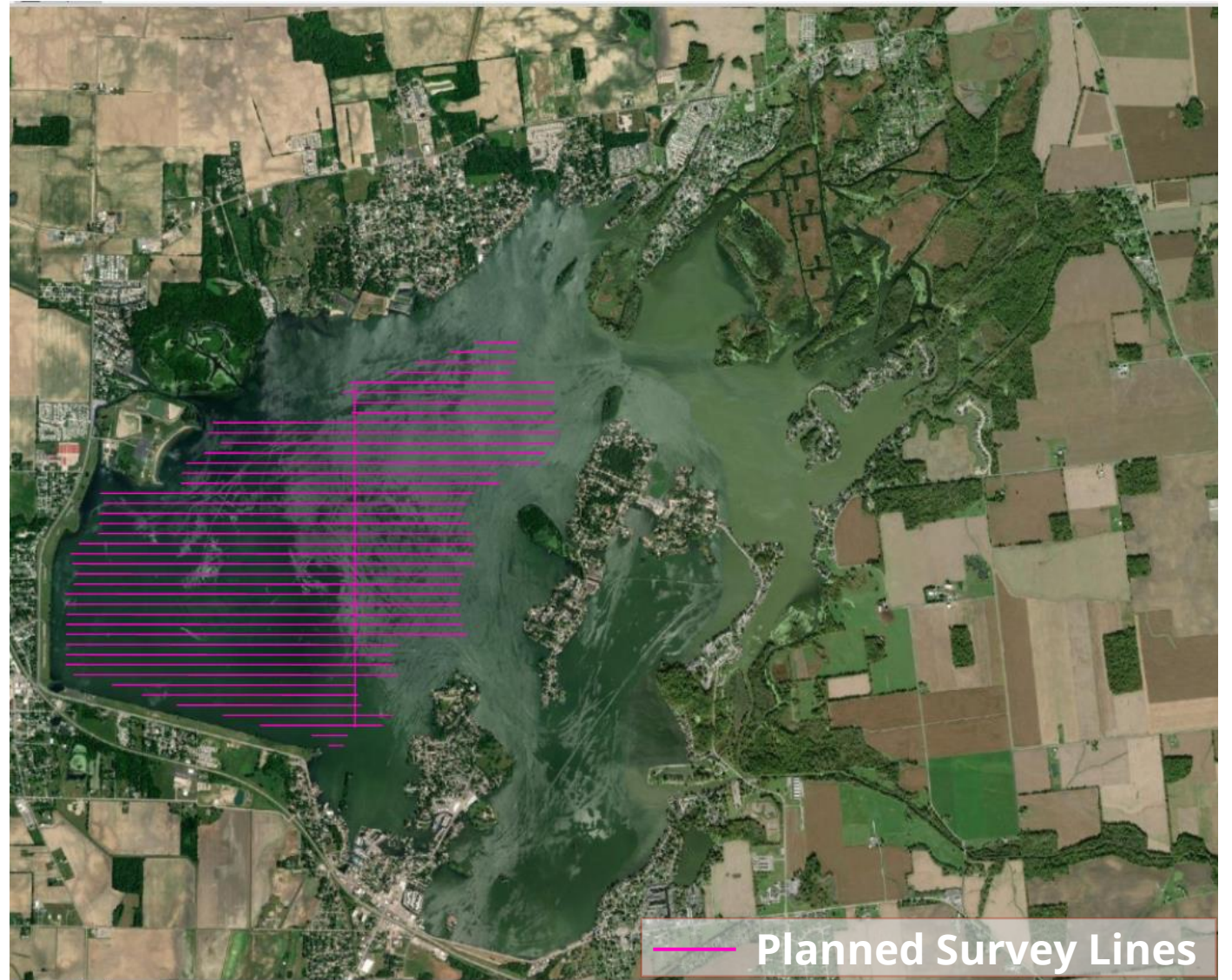


Source: Logan County Historical Society.



# DATA COLLECTION

- Over a period of two days in November of 2022, the Ohio Geological Survey collected data on Indian Lake.
  - Side Scan Sonar
  - Sub Bottom Profiler
- The boat could only safely operate in parts of the lake that were deeper than 4 feet due to the equipment installed on the boat.



# DATA COLLECTION

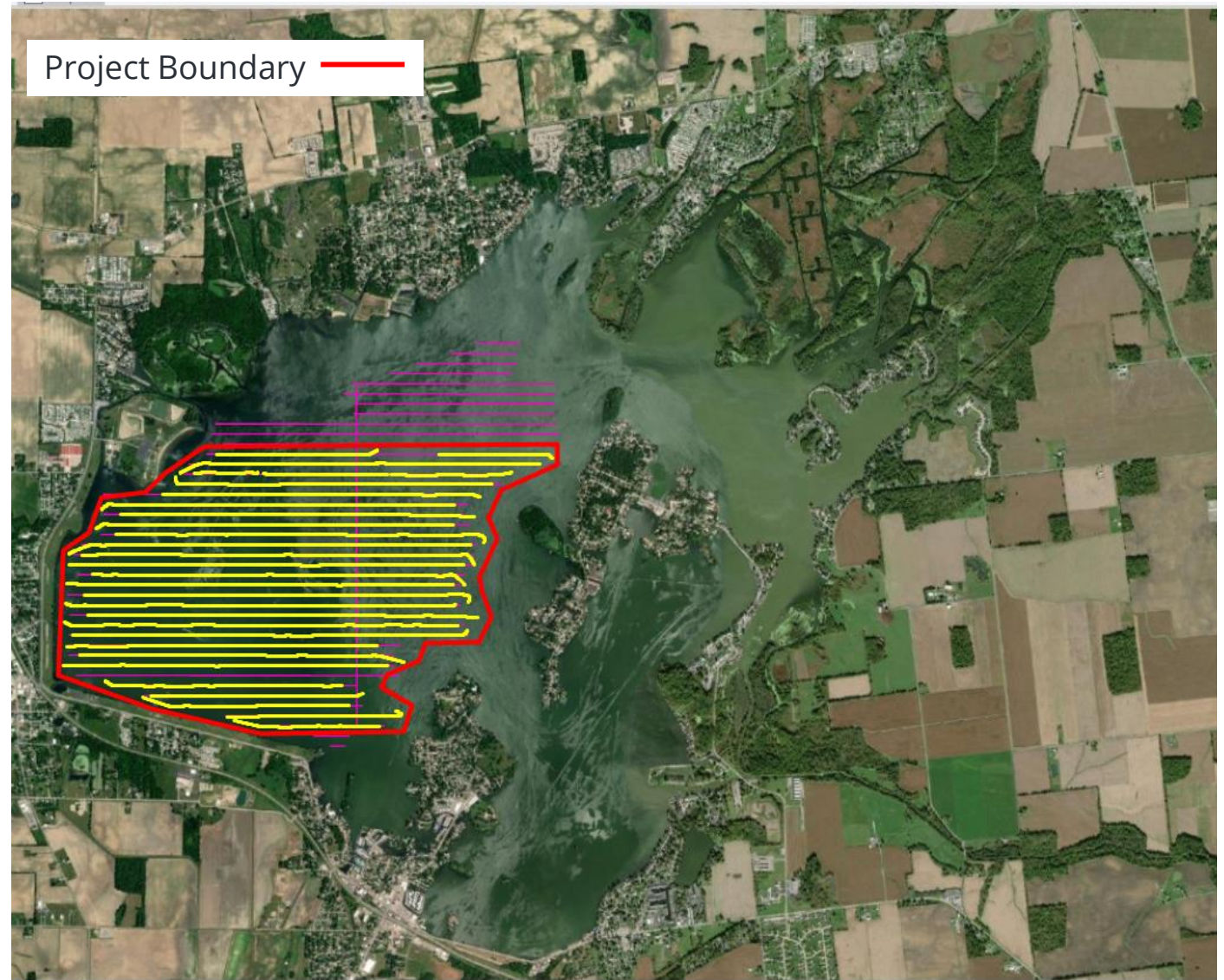
- The yellow lines show the areas where we were able to collect data.
- Outside of the project boundary we were unable to collect data due to vegetation gathering heavily on the equipment
- The Ohio Geological Survey collected approximately 42 miles of data, which recorded over 32K unique data points.



Sub-Bottom Profiler



Side-scan Sonar Fish



# DATA COLLECTION

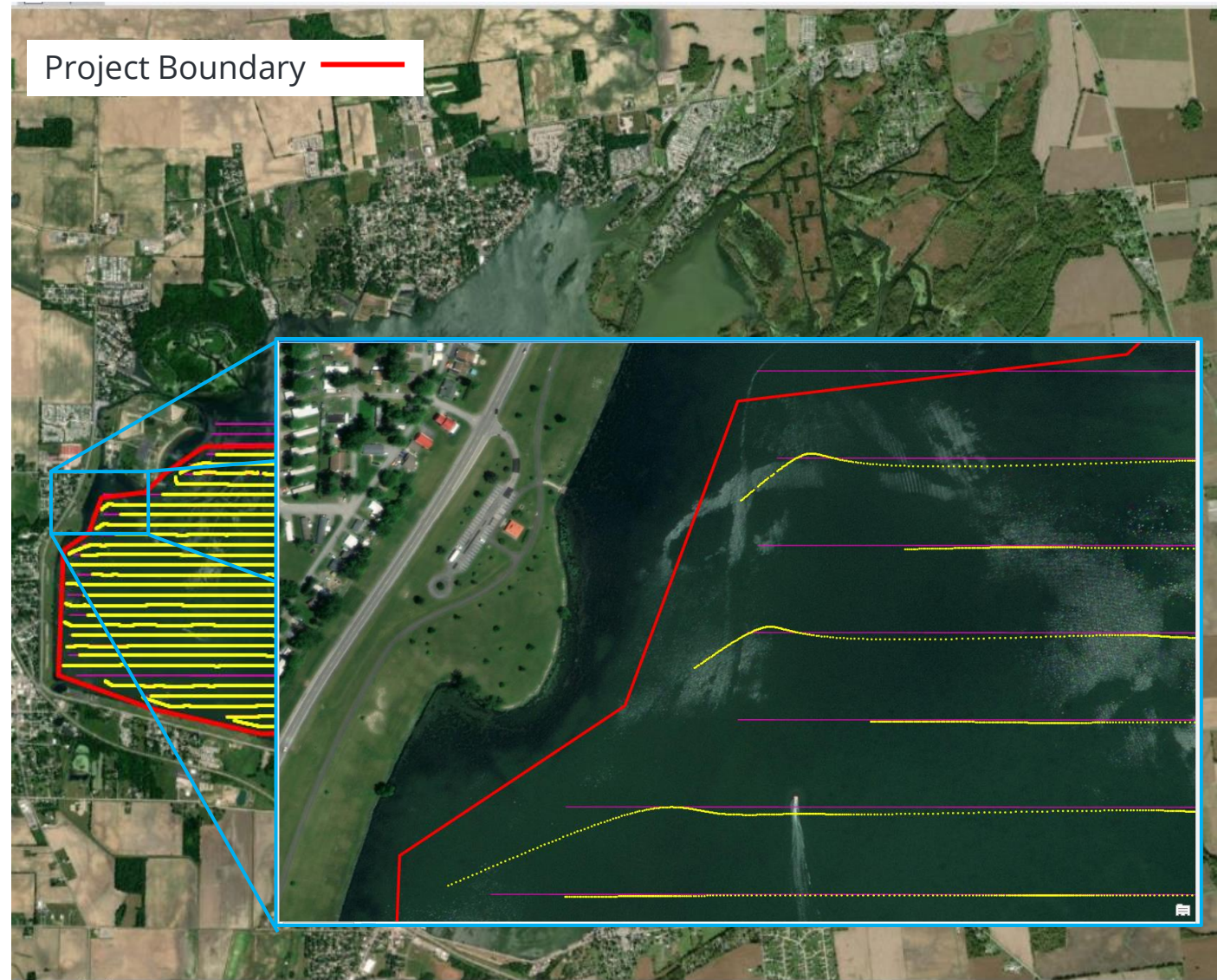
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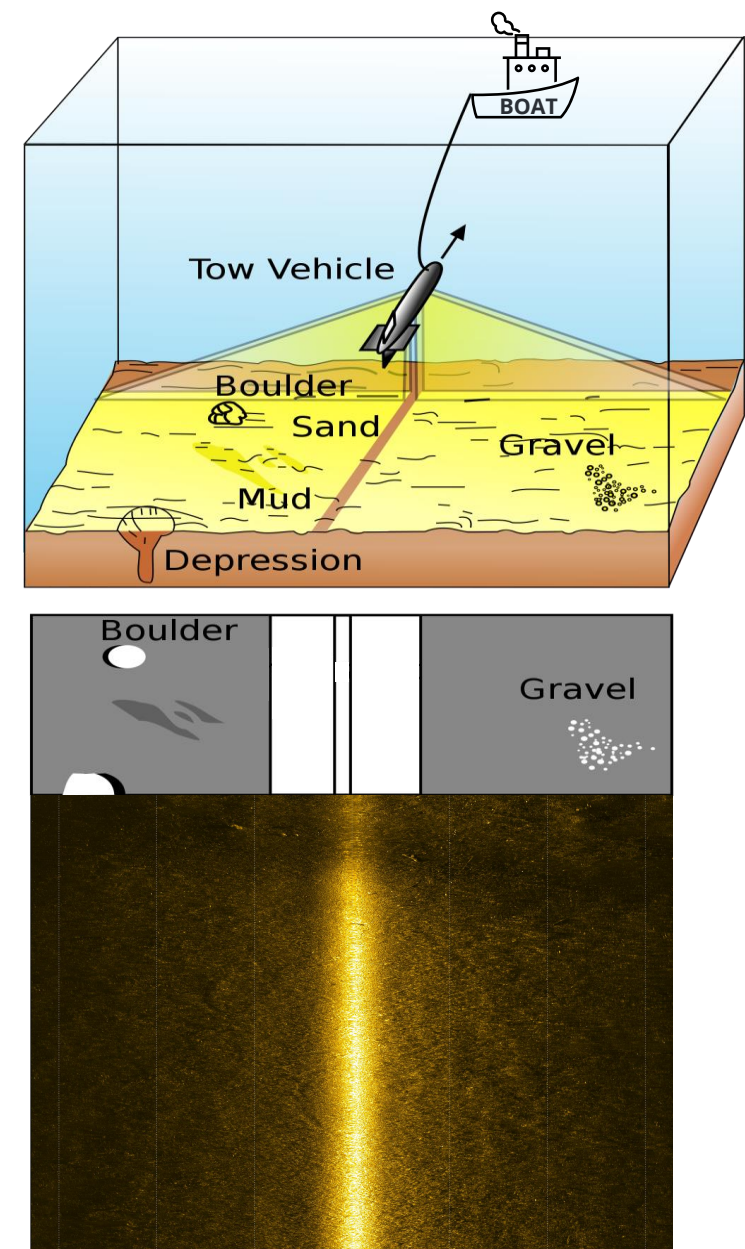


# SIDE-SCAN SONAR



Side-Scan Sonar takes a picture of the bottom of the lake as if you were looking directly down.

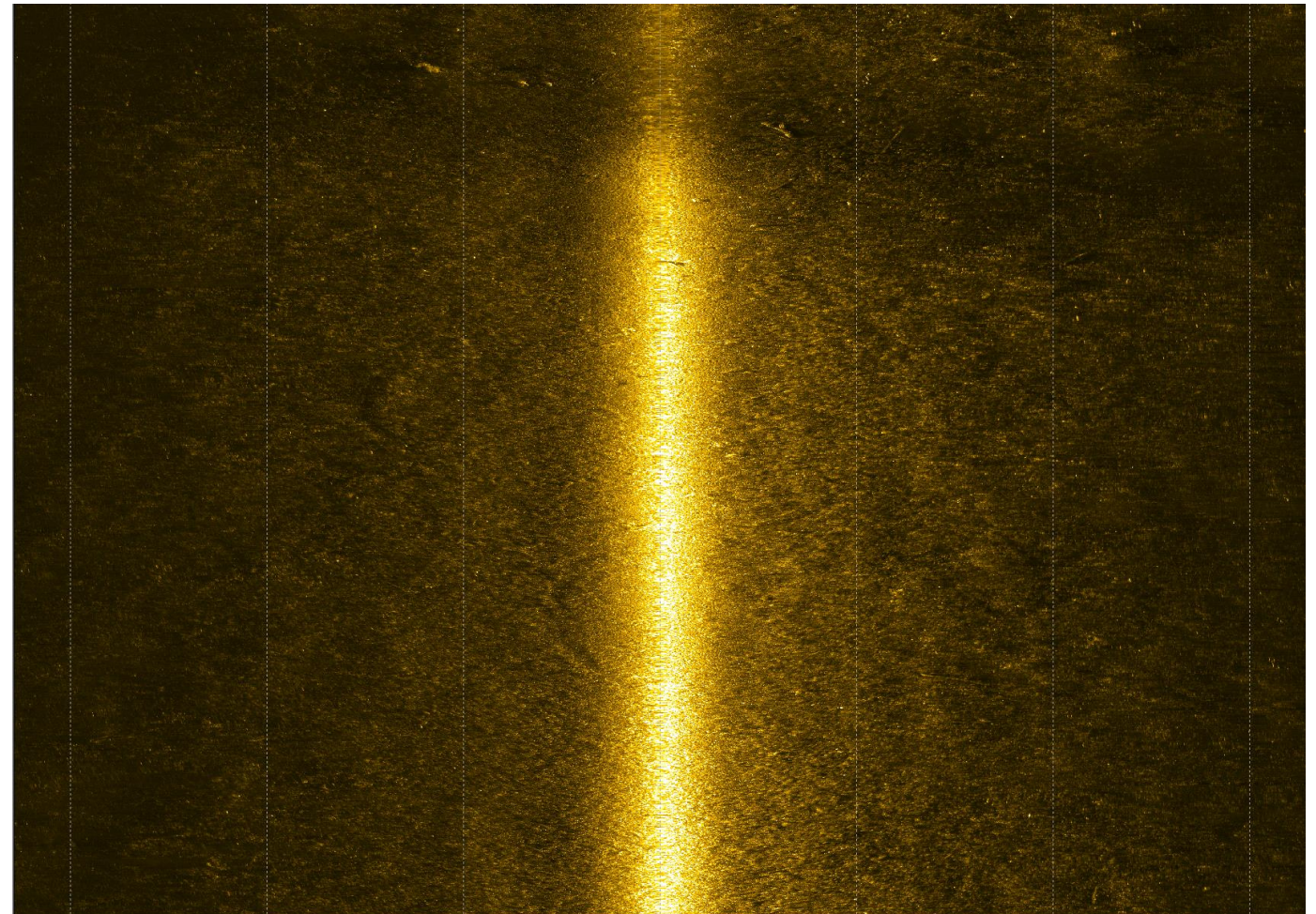
- Darker colors are from softer sediments like mud.
- Brighter colors are from harder sediments (sand, clay, rock, etc.).
- The bright line on this image is due to high amounts of energy being transmitted in shallow water.



# SIDE-SCAN SONAR

## RECORD OF A MUDDY BOTTOM

- The dark brown color is indicative of a muddy bottom. The signal from the sonar system is absorbed into the mud and causes it to look dark.

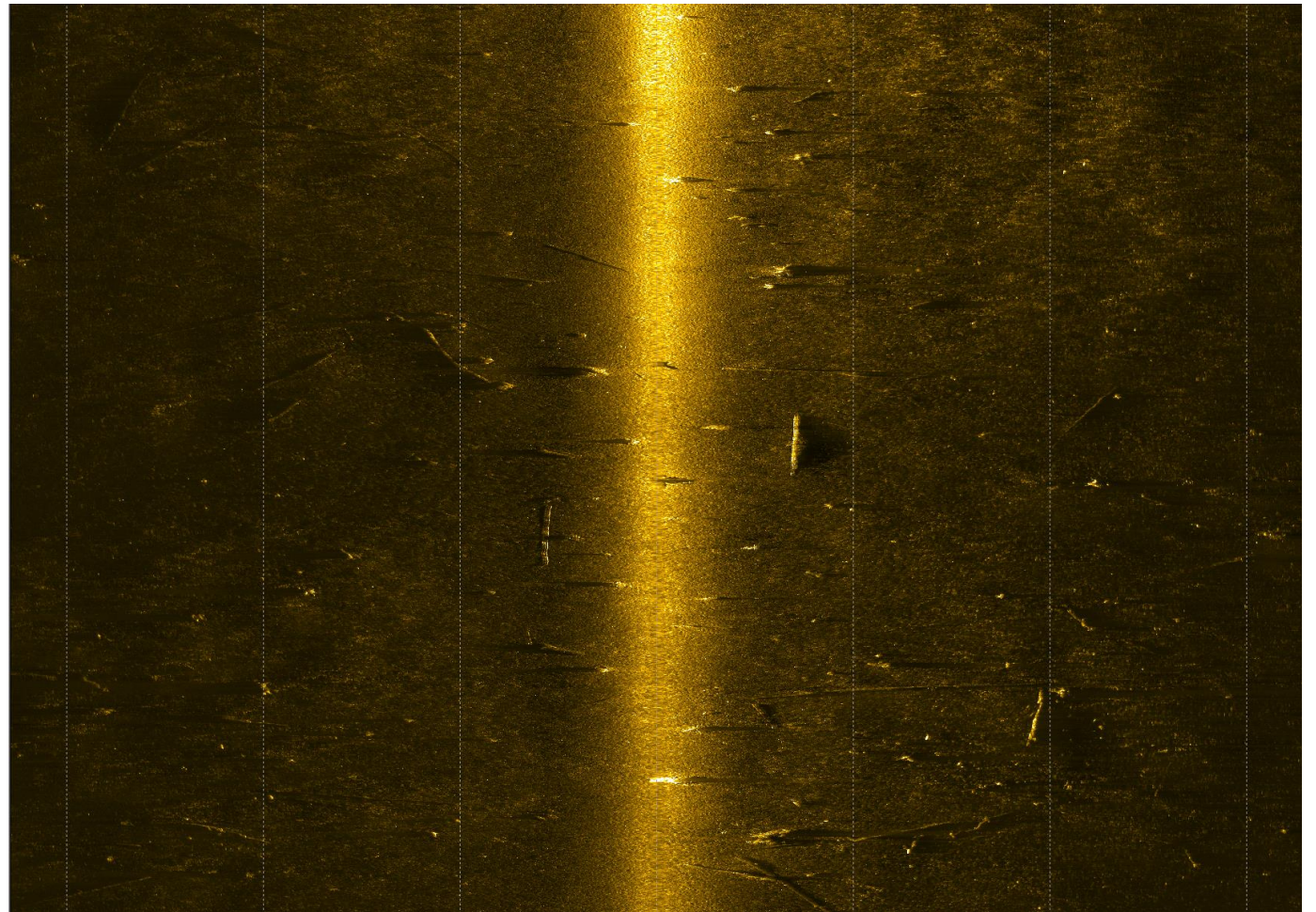


164 feet



# SIDE-SCAN SONAR WITH SUBMERGED TREES AND STUMPS

- The trees and stumps on the bottom of the lake show up as bright objects in the image.

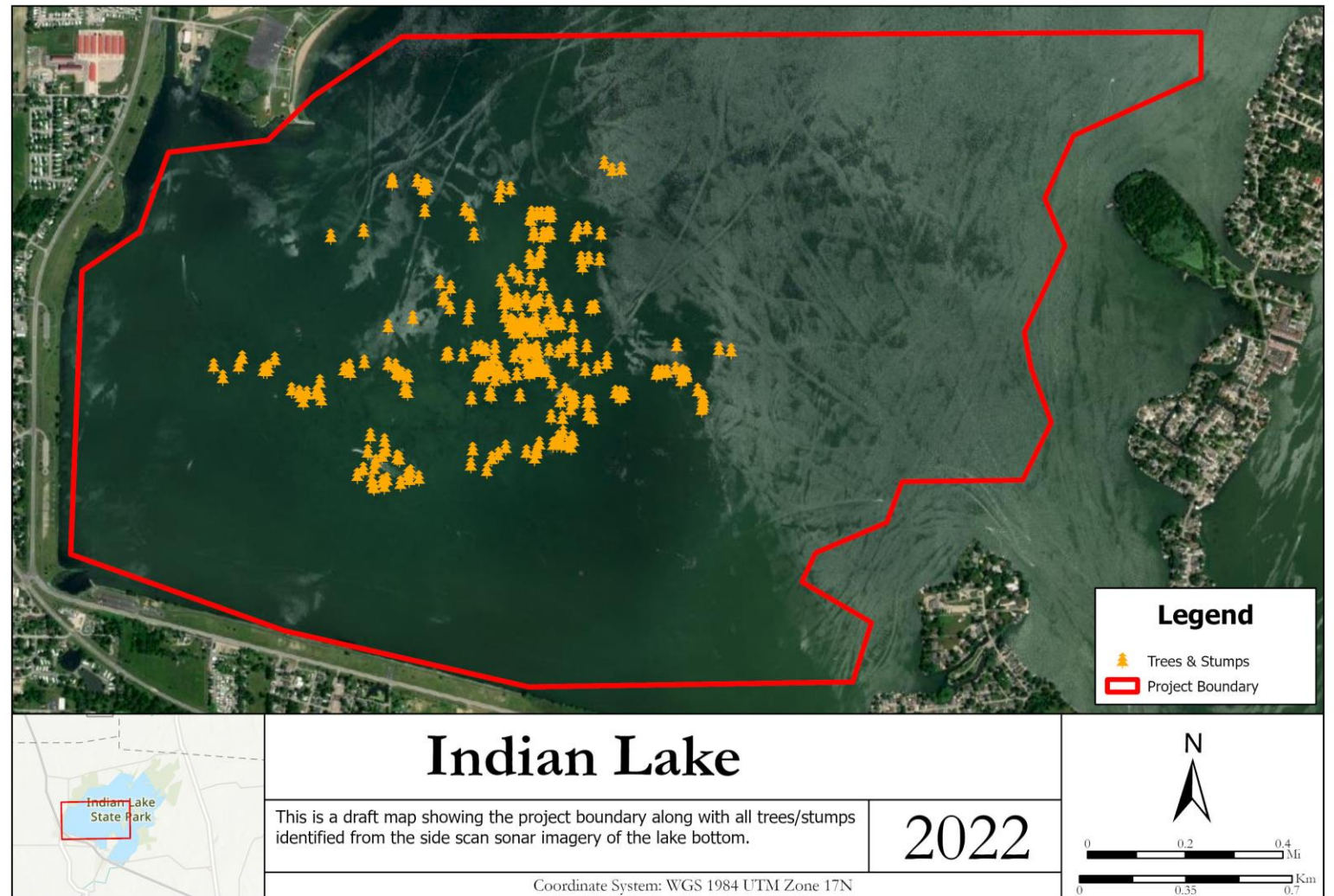


164 feet



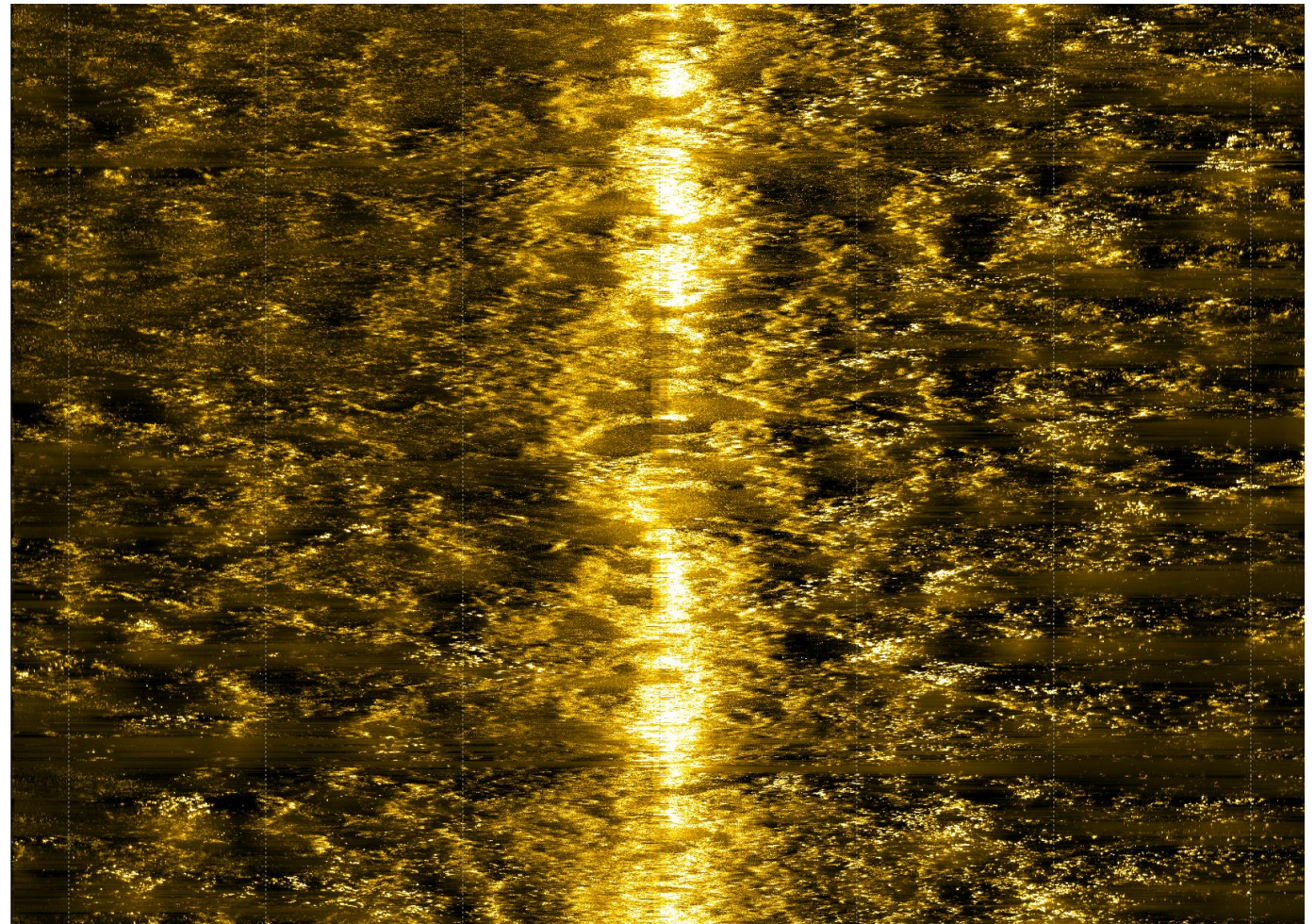
# LOCATION OF SUBMERGED TREES AND STUMPS

- Trees and stumps were identified on the lake bottom as seen on the side-scan sonar imagery



# SIDE-SCAN SONAR RECORD OF AQUATIC VEGETATION

- The aquatic vegetation shows up as a wavy signal in the data.




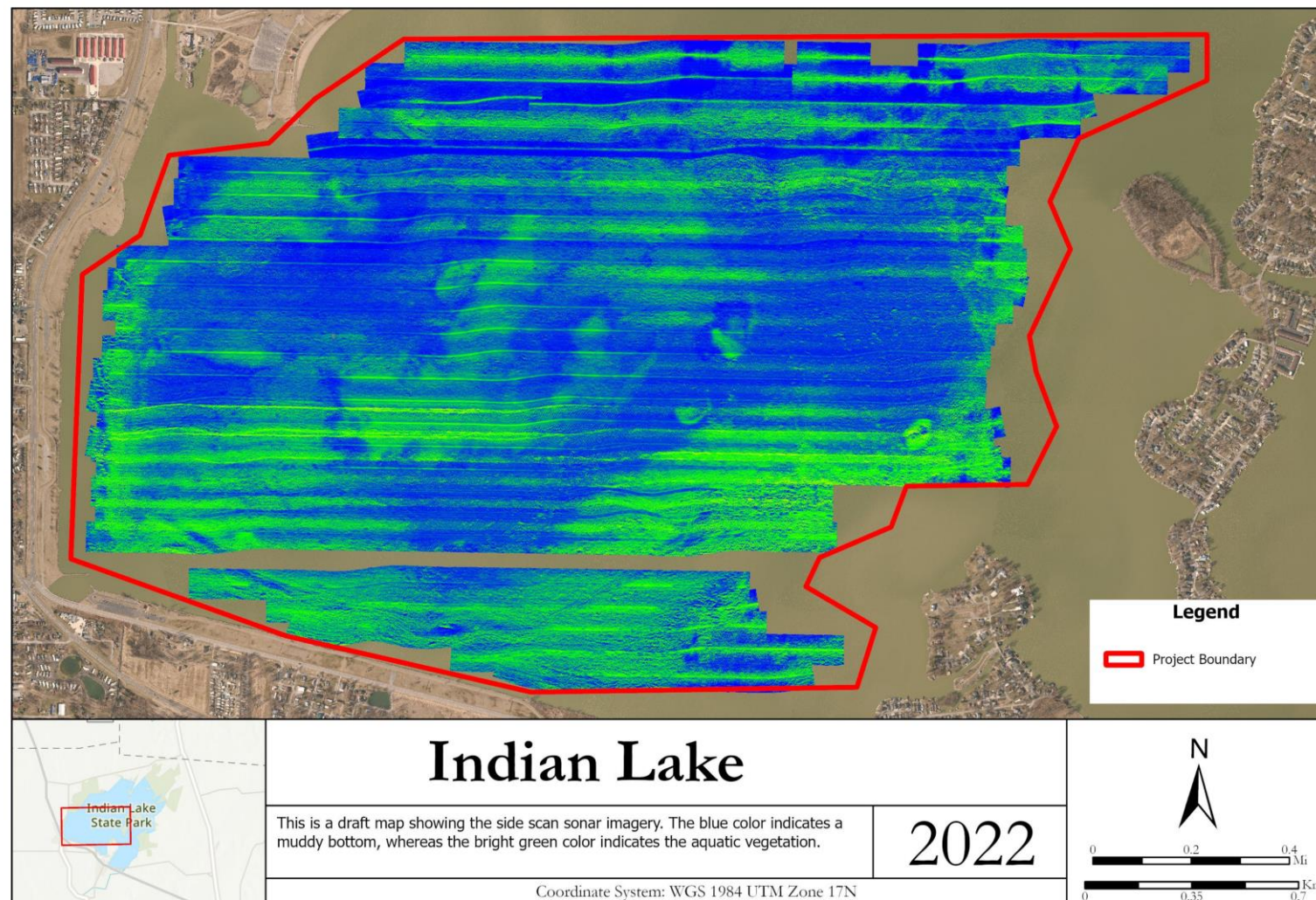
164 feet



# LAKE BOTTOM IMAGERY


 The blue color is indicative of a muddy bottom.

 The green color is indicative of aquatic vegetation or very shallow water.

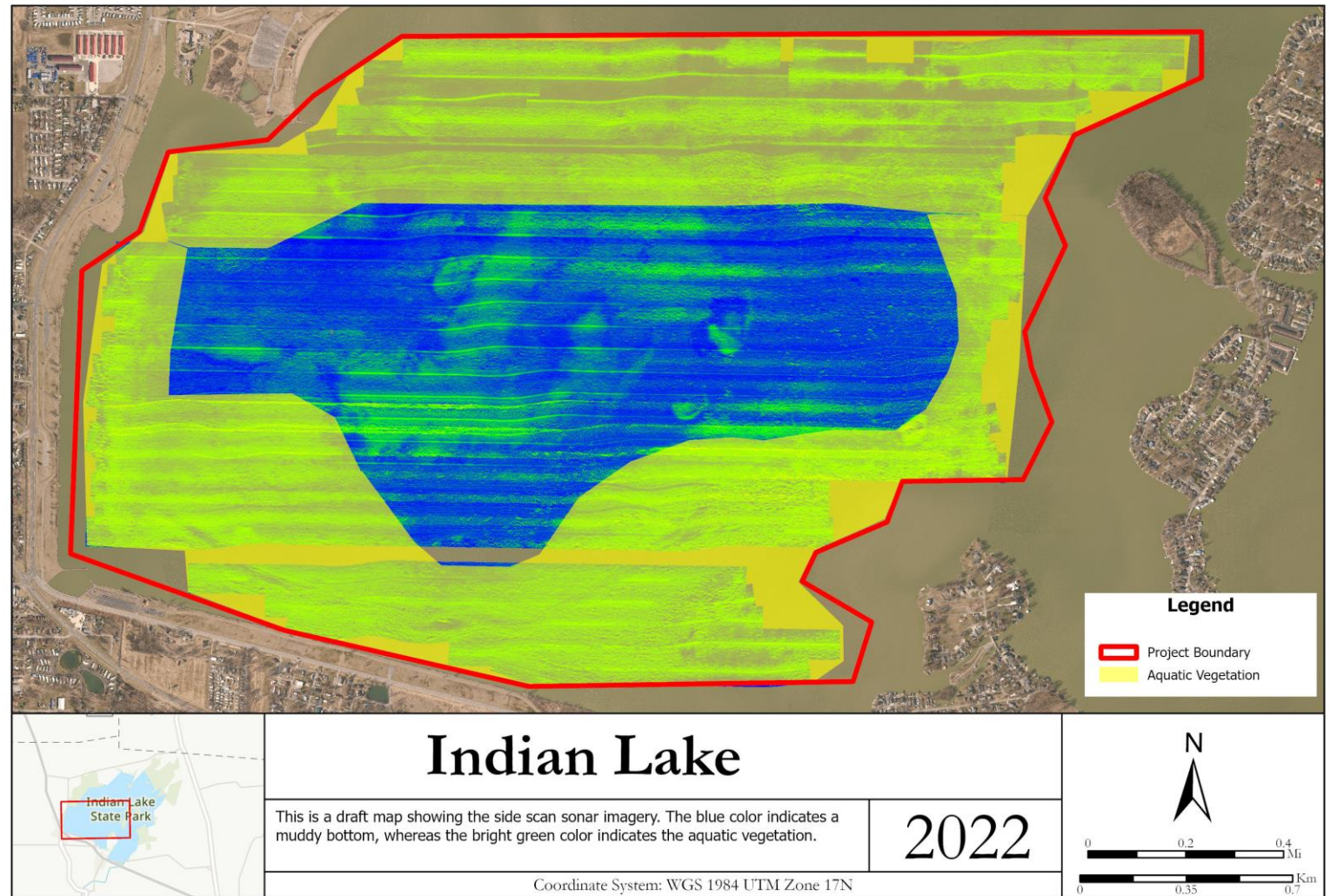


# LAKE BOTTOM IMAGERY

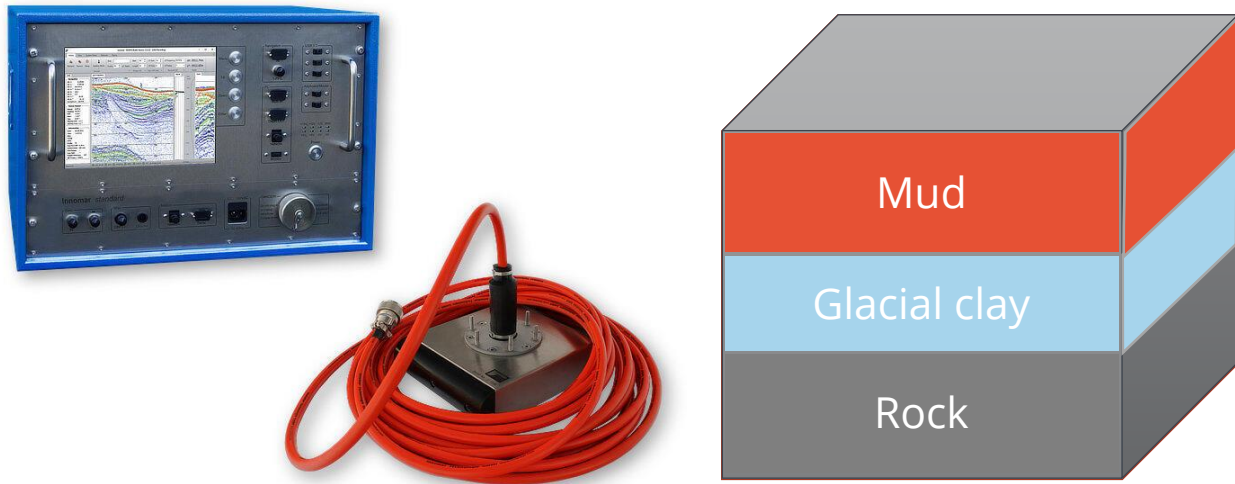
 The blue color is indicative of a muddy bottom.

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The highlighted area show where aquatic vegetation was imaged in November of 2022.

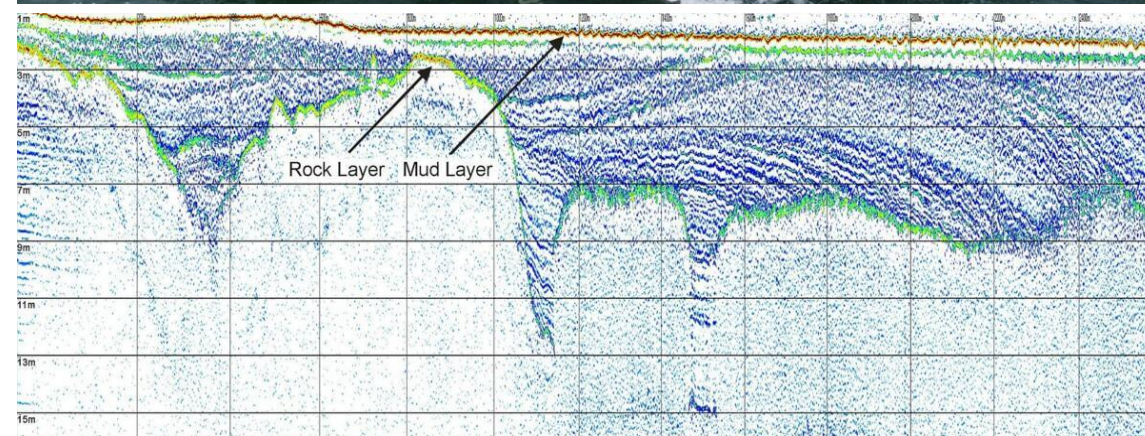
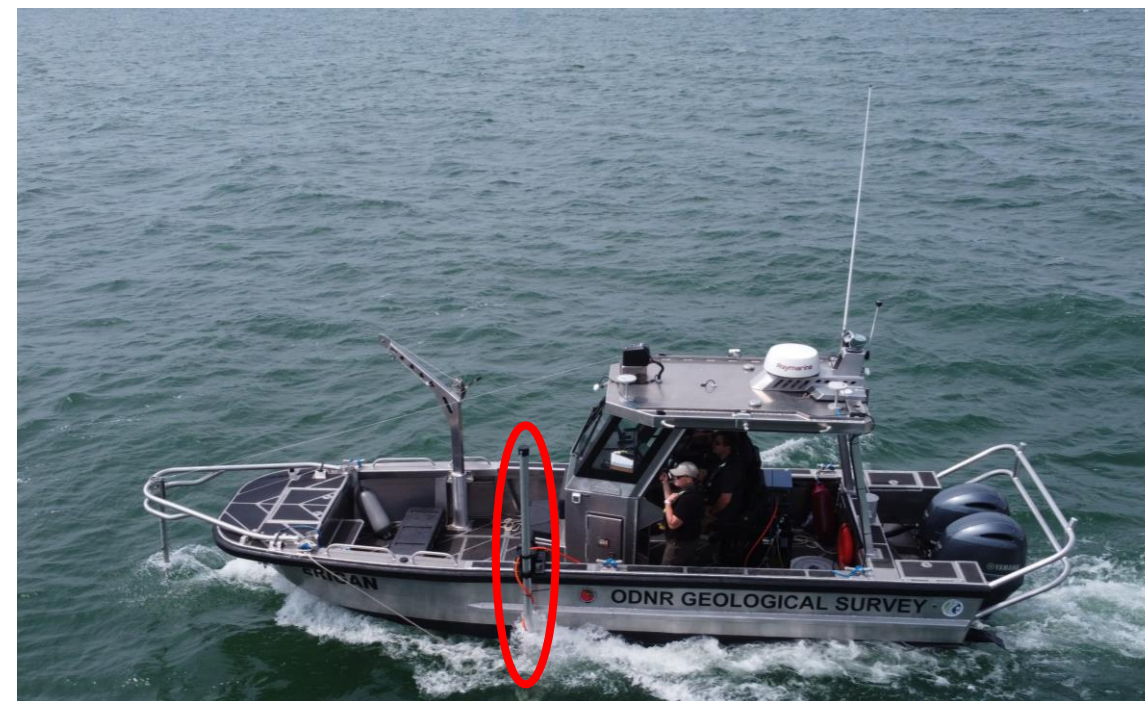


# SUB-BOTTOM PROFILER



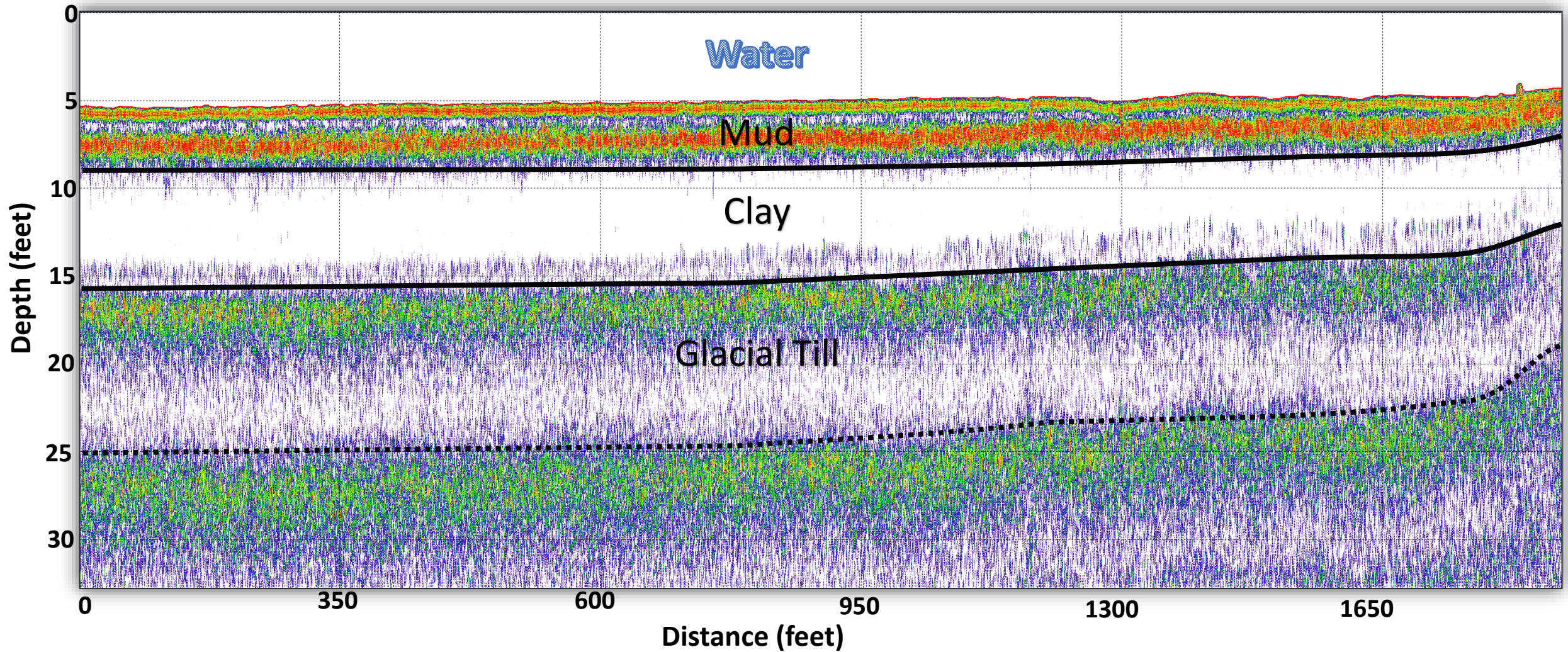
The Sub-Bottom Profiler takes picture of the sediments below the lake surface. This is like a slice of pie into the earth.

- Mud is difficult to push seismic energy through
- Glacial Clay is easy to push seismic energy through
- Rock is very hard to push seismic energy through



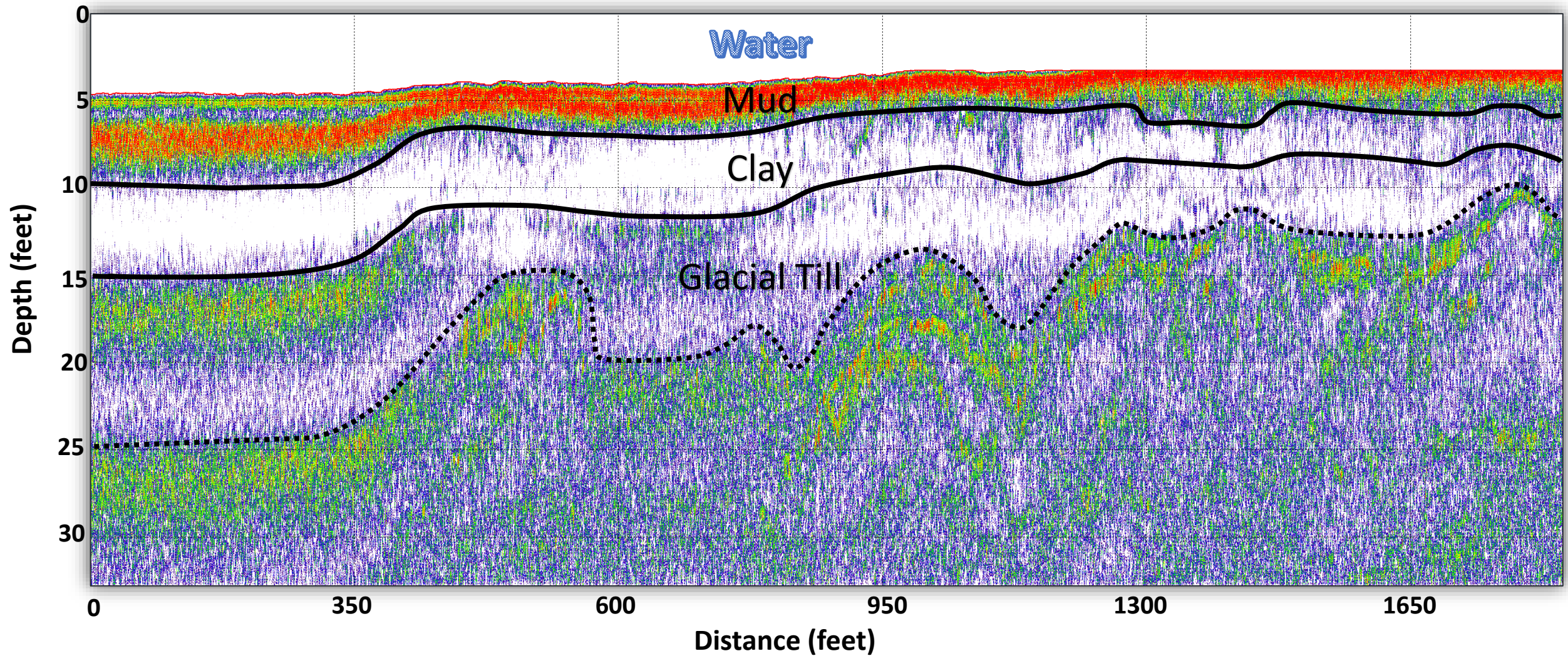
# SUB-BOTTOM PROFILE DATA

## SIMPLE MODEL OF INDIAN LAKE GEOLOGY



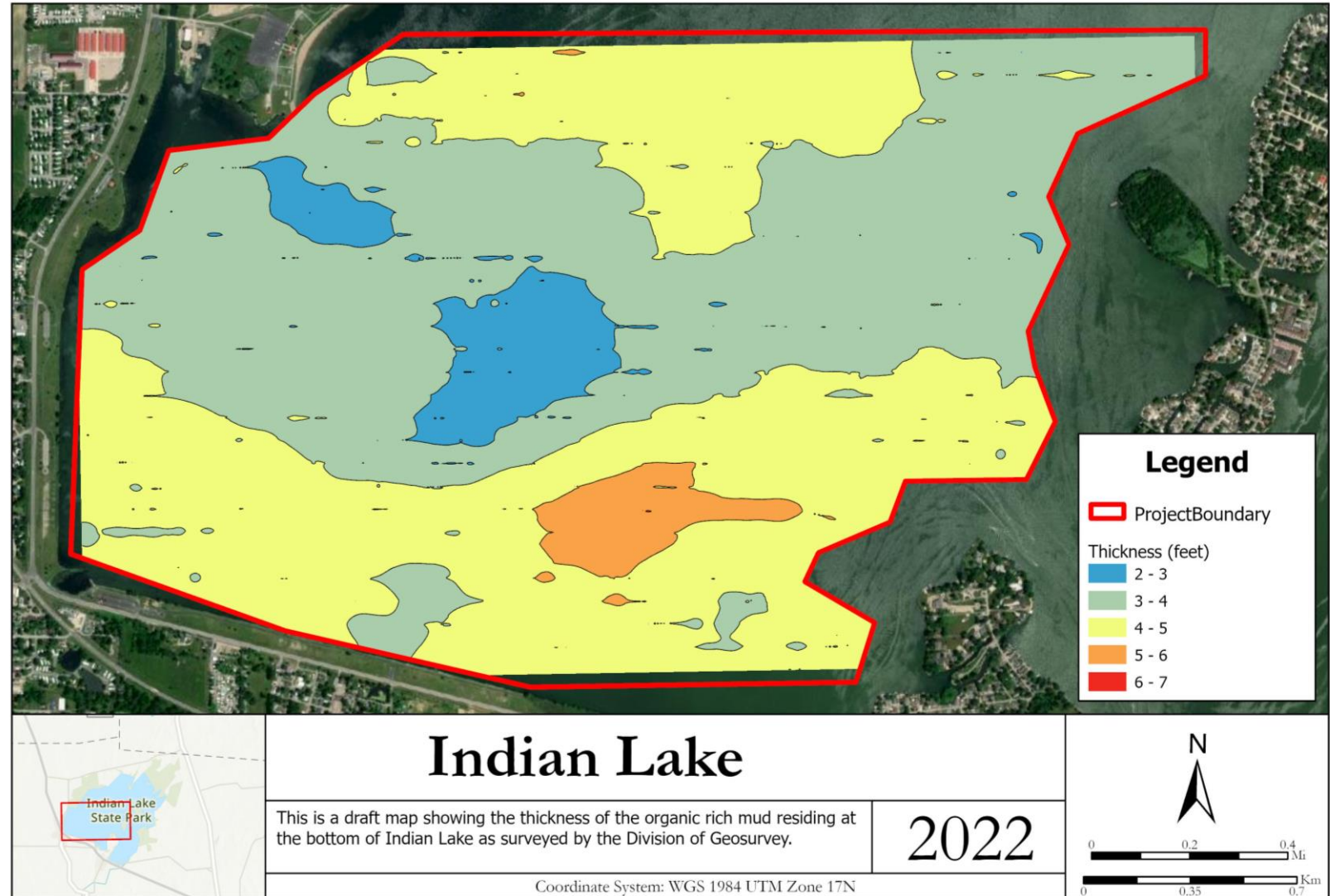
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# MUD THICKNESS MAP (1 FOOT INTERVAL)

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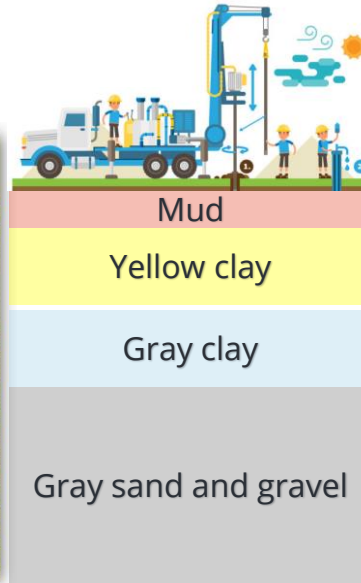
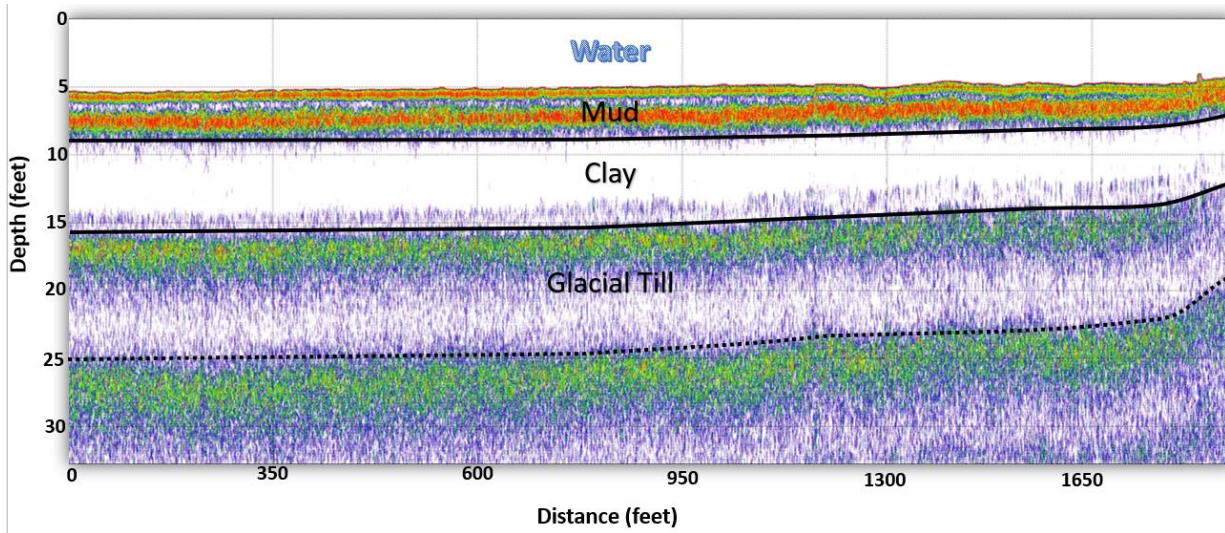




# NEARBY WATER WELL LOGS

- The sediment layers recorded in the drilling reports match the geophysical data collected by the sub-bottom profiler in Indian Lake.

## SUB-BOTTOM PROFILER DATA



| DRILLING LOG*  |         |                      |      |    |
|--|---------|----------------------|------|----|
| FORMATIONS INCLUDE DEPTH(S) AT WHICH WATER IS ENCOUNTERED. |         |                      |      |    |
| Color  | Texture | Formation            | From | To |
| YELLOW   | SOFT    | CLAY                 | 0    | 8  |
| GRAY   | SOFT    | CLAY                 | 8    | 32 |
| GRAY   | COARSE  | SAND AND GRAVEL      | 32   | 52 |
|  |         | Water Encountered At | 32   | 52 |

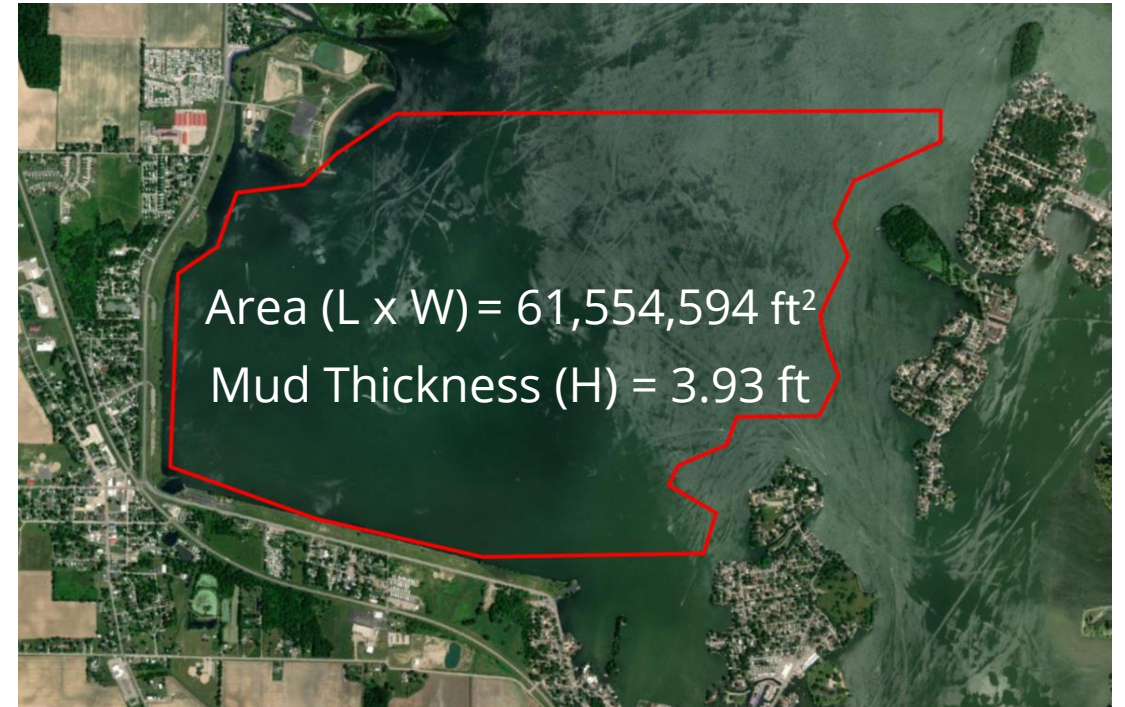


# VOLUMETRIC MUD CALCULATIONS – SIMPLE

Simple Model Volume = **L** x **W** x **H**

Used the **study area acreage**  
(**L x W**) and the **average thickness of the mud** (**H**) to calculate mud volume:

61.5 million ft<sup>2</sup> x 3.93 ft = **242 million ft<sup>3</sup>**  
**or 9 million yd<sup>3</sup>**



Average thickness of the mud was calculated from the sub-bottom data points.



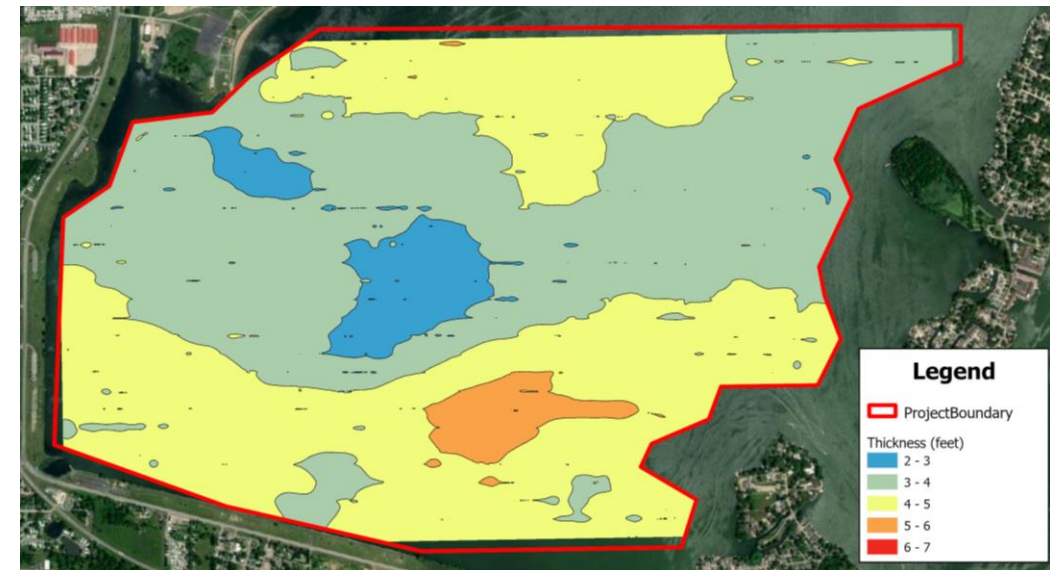
# VOLUMETRIC MUD CALCULATIONS – COMPLEX

Complex Model Volume = **L** x **W** x **H**

Used the **thickness of each cell (H)** and the **area of each cell (L x W)** for all cells in the grid to calculate mud volume:

10' x 10' x 2.4 million = **242 million ft<sup>3</sup>**  
**or 9 million yd<sup>3</sup>**

- This method is more precise because the mud thickness varies over the study area.



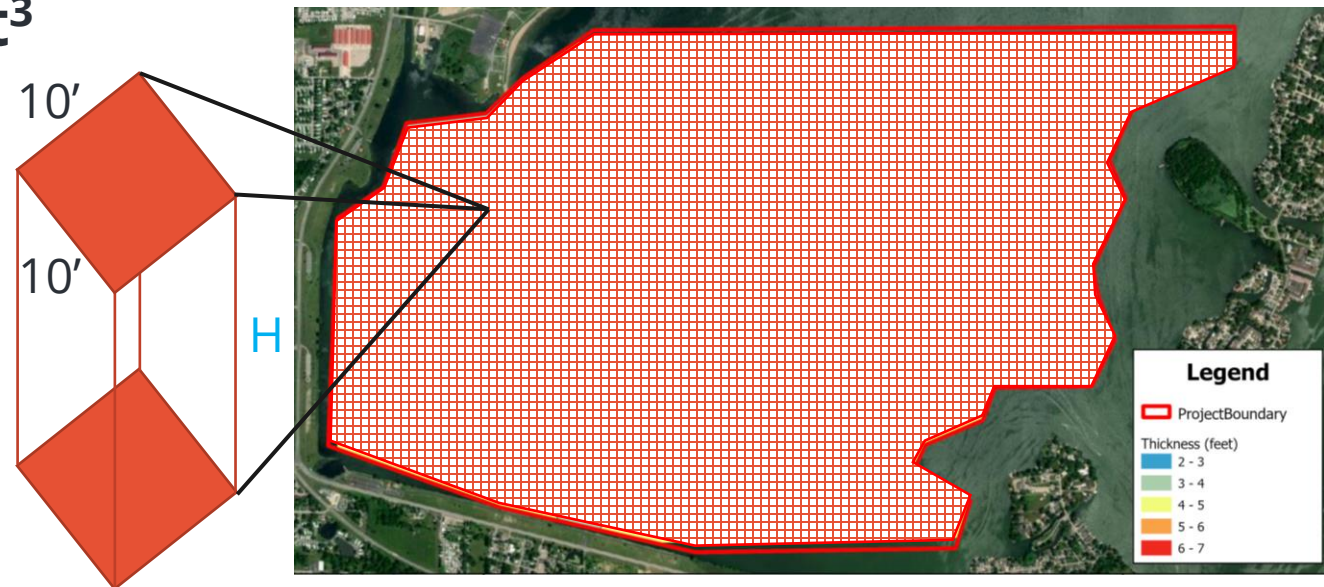
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**or 9 million yd<sup>3</sup>**

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# COMPARISON OF THE TWO MODELS

- The simple model had a mud volume that is 1% less than the complex model.

- 8,959,613 yd<sup>3</sup>      Simple
- 8,960,681 yd<sup>3</sup>      Complex

- **What does this tell us?**

The simple model should be close to our complex model, so that we know our geoprocessing is accurate and correct.

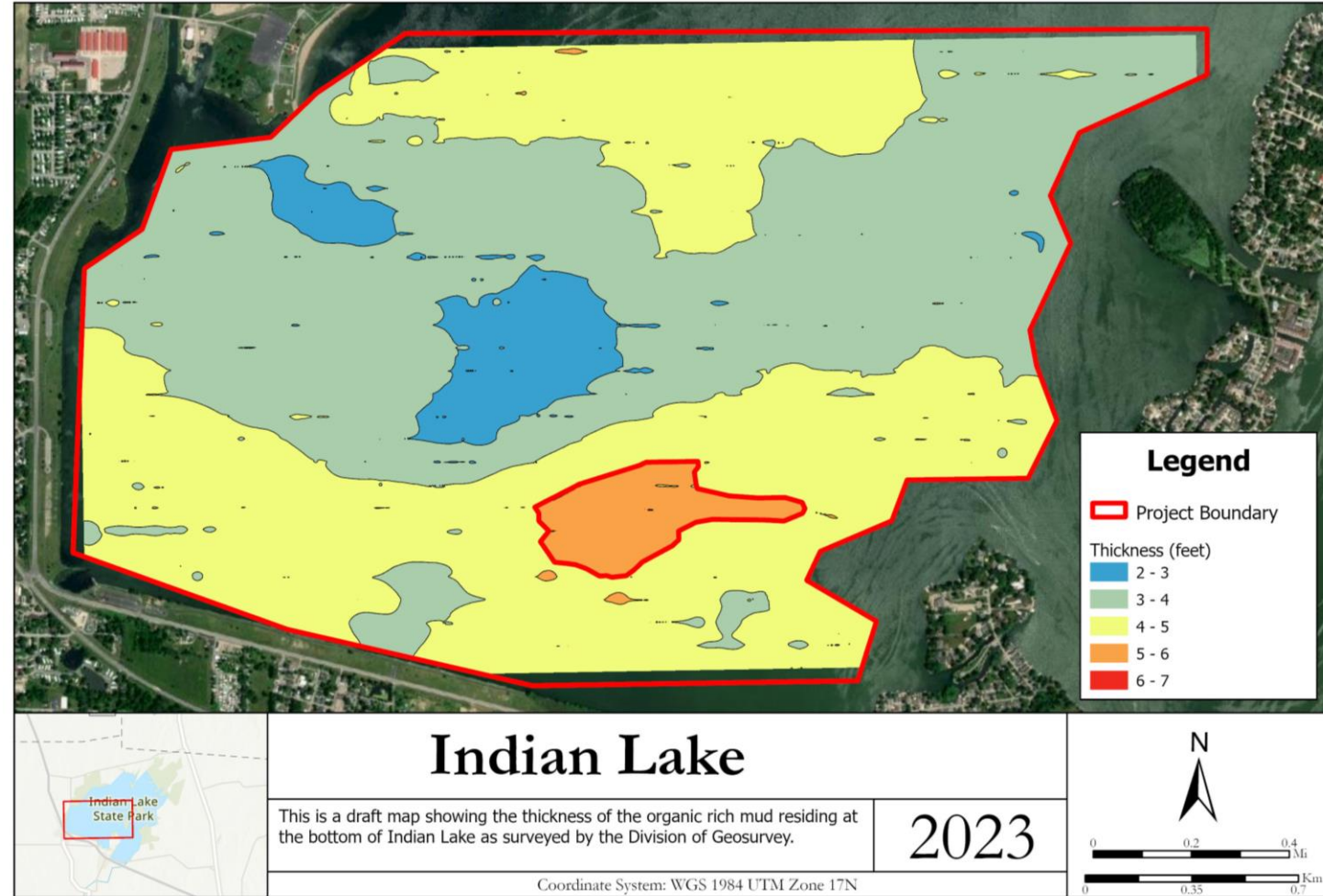


# HOW DO WE USE THIS DATA AND RESULTS?

## EXAMPLE - SELECTED VOLUME OF MUD

- For any unique polygon within the survey area, we can determine the volume of mud present. If they have a dredge area in mind, we can calculate the volume of mud to be removed.
- Example: How much volume of mud is in the orange polygon, the thickest of the mud deposits?

Calculated Volume: 9,131,700 ft<sup>3</sup>  
= 338,211 yd<sup>3</sup>





**OHIO  
GEOLOGICAL  
SURVEY**  
DEPARTMENT OF NATURAL RESOURCES