OHIO UNIVERSITY

Drone Surveying Stream and Wetland Restoration Projects

Liliana Kijek, Cassidy Mollick, Sebastian Teas, Dr. Natalie Kruse Daniels, Nora Sullivan

Ohio University, Athens OH, USA

Overview

- Introduction to stream & wetland restoration projects in Ohio & Pennsylvania
- Process of drone surveying & 3D elevation model creation
- Displaying drone footage & model outputs
- Working through challenges with drone & software
- Future work associated with drone models

Introduction

Functional stream and wetland restoration projects rely on key aspects:

- **Floodplain connection**
- **Wetland inundation**

Periods of inundation can be used as a metric of successful wetland restoration, but detailed topographic surveys can be time consuming and challenging given the terrain, access, and saturation of sites

Microtopography, or the study of surface level features and patterns, of restoration projects can support **development of diverse plant, macroinvertebrate, and amphibian communities** as well as **assess the overall productivity** of the restored streams and wetlands in **mitigating high-intensity flood events and improving water quality**

Introduction Cont.

Surveying stream and wetland restoration sites using drone equipment to create topographic digital elevation models (DEMs) allows for surveillance and analysis of:

- Surface level erosion rates
- Flood levels
- Hydrological connectivity and flow regime
- Succession of physical terrain post-stream construction
- Wetland inundation

Approach

We deployed a Skydio 2+ Construction Drone, designed for construction mapping and inspection, with 6 on board cameras, to map several stream and wetland restoration sites during the leaf-off winter season

Challenges of Drone Surveying:

- Weather (unusable in rain, fog, high winds, etc.)
- Terrain (challenging with dense wooded coverage even in leaf off season)
- Limited drone battery life
- Access and saturation of sites
- Cellular service and phone battery life

Model Creation and Importing

Our models were created using the collected images, coordinates, and elevation points stitched together using **Bentley Reality and Spatial Modeling Software (iTwin Capture Modeler Master)** and imported into **Arc Geographical Information System**

Bentley®

→

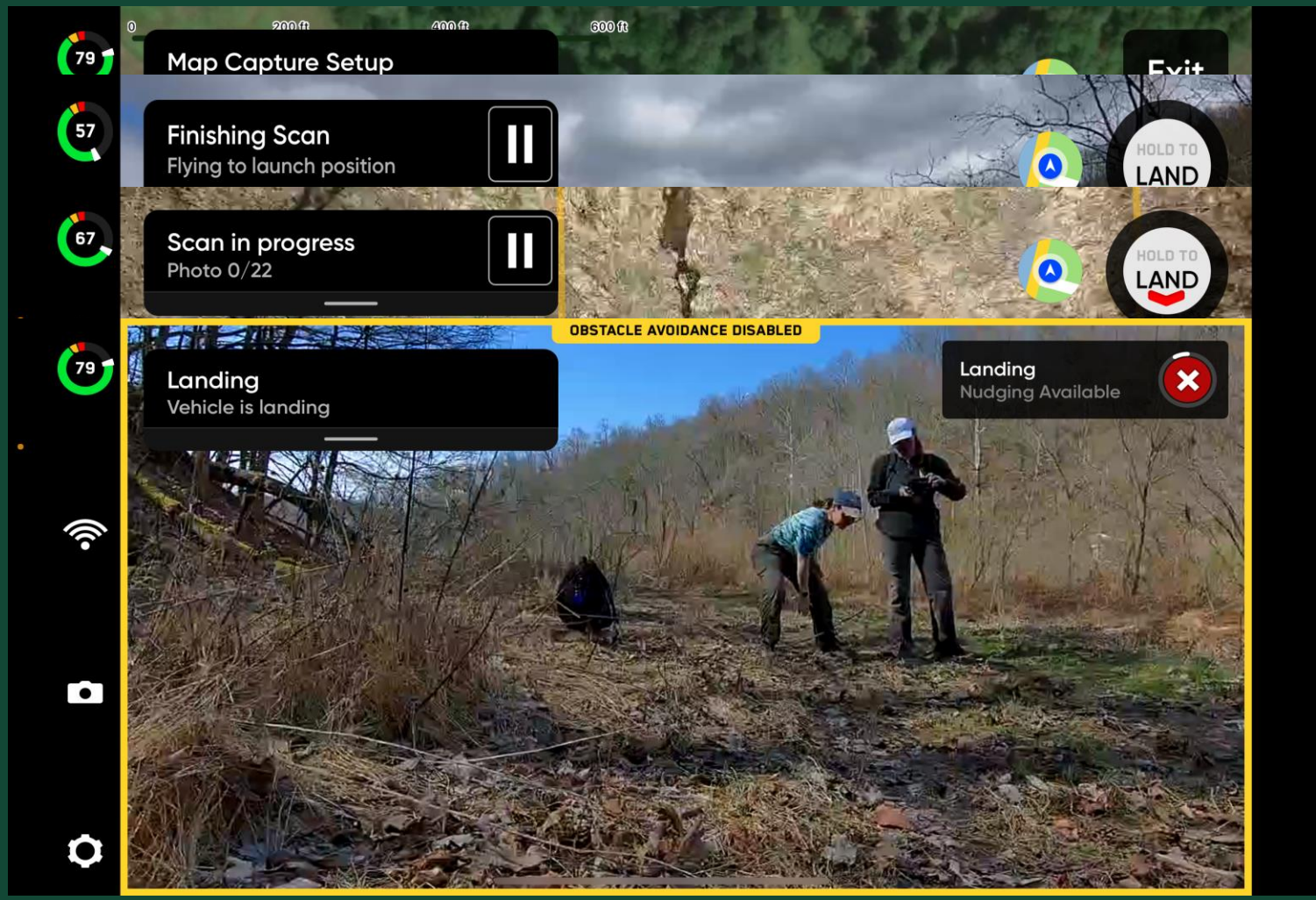
ArcGIS

Surveyed Sites

- Bloody Run, an 80-acre former agricultural field turned restored wetland by the Streams and Wetlands Foundation, approximately 1.5 hrs from OU campus
- Robinson Fork Restoration Project, Resource Environmental Solutions LLC, approximately 3 hrs from campus
  - Trip 1
    - Molinari and Molinari Tributary
  - Trip 2
    - Wallace
  - Trip 3
    - McCully and Beham
  - Trip 4
    - Lebanik and Unit 4D

Step-by-Step

- Skydio Enterprise mobile app
- Choose 3D Model Capture
- Set your chosen site boundaries
- Set elevation and picture overlap
- Begin flight
- Watch scan progress
- Land drone
- Celebrate a successful flight!



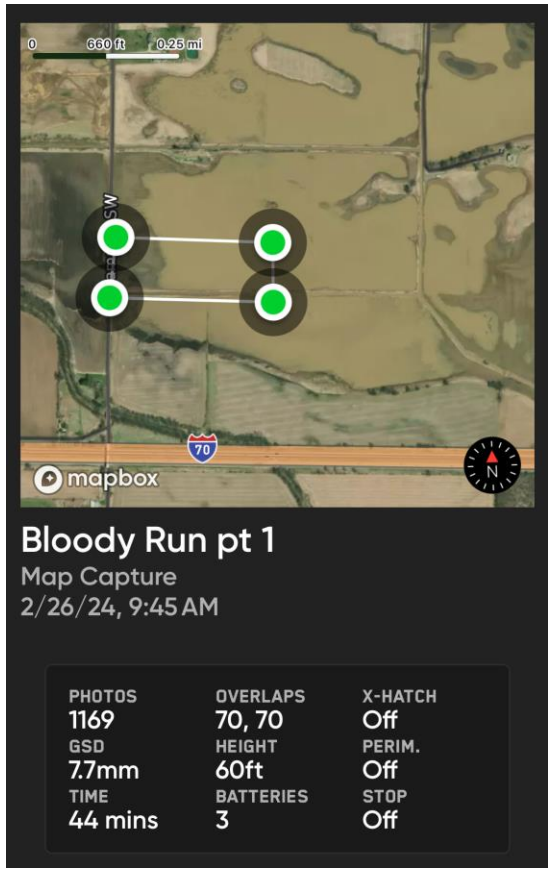
Bloody Run

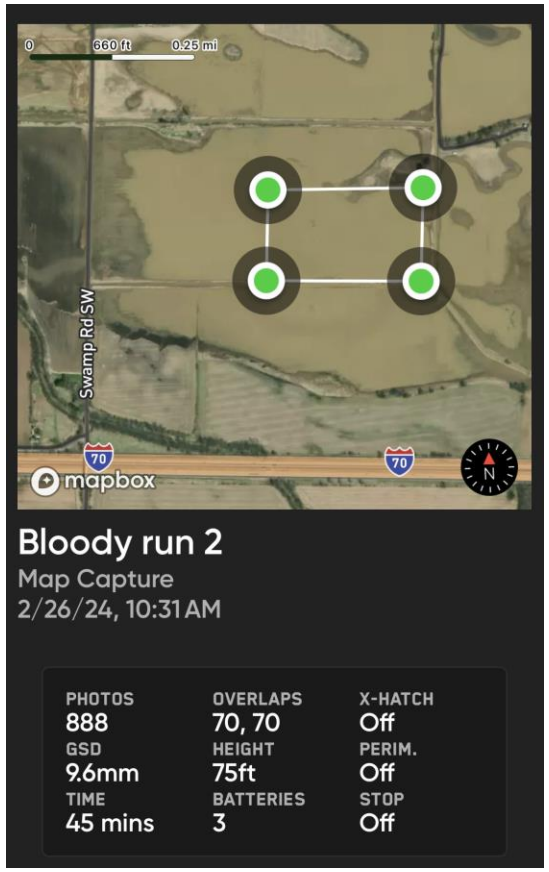
- First real field day utilizing Skydio 2+ drone
  - Assistance from OU engineering team, lots of trial and error with mechanism
  - High intensity wind required a second visit to finish scanning the 80-acre restored wetland

- The second trip out revealed the battery limitations preventing us from completing scans of entire site
  - We were able to order several new batteries in preparation for the upcoming Pennsylvania trips

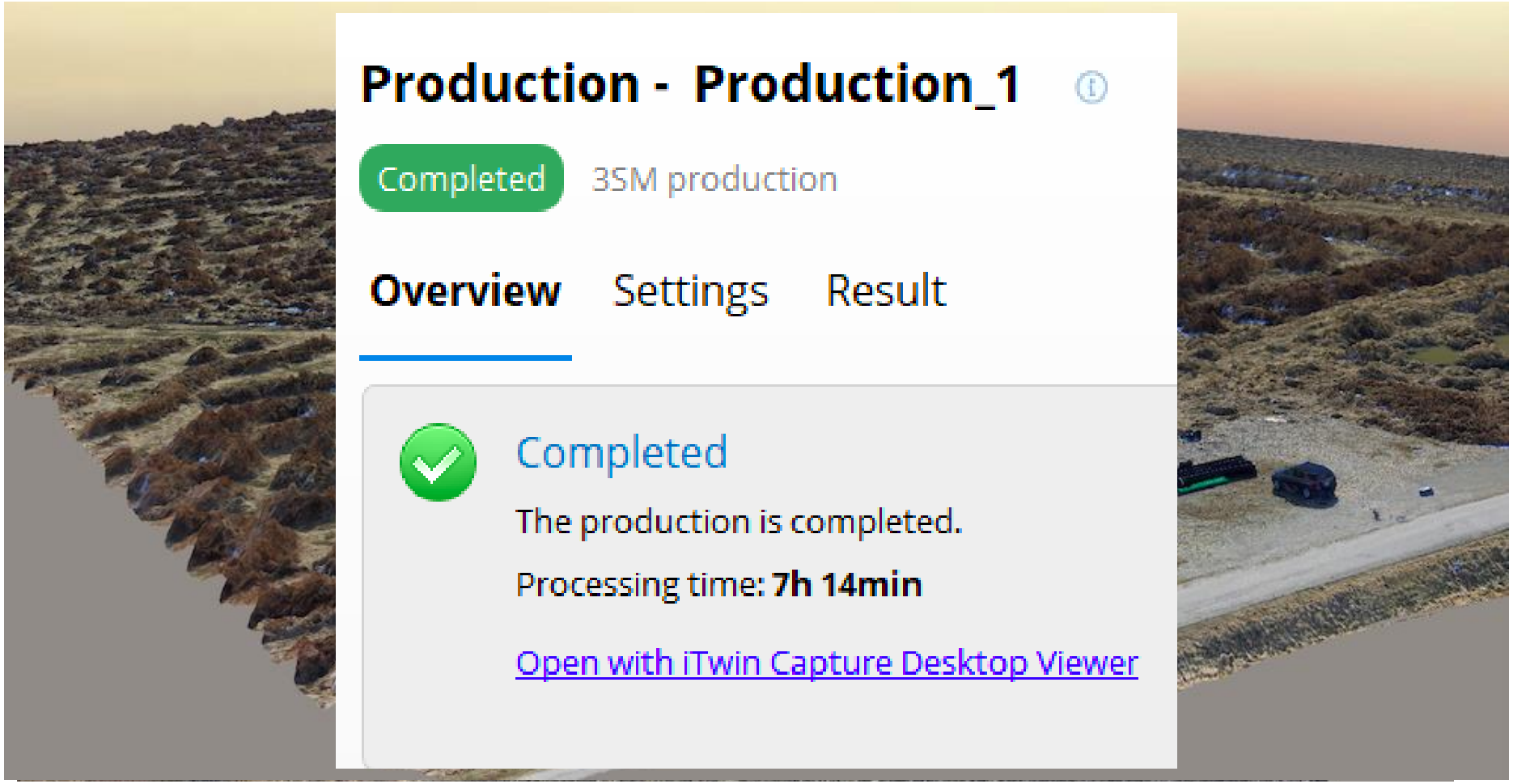
OHIO UNIVERSITY

Setting the Survey Area: Bloody Run





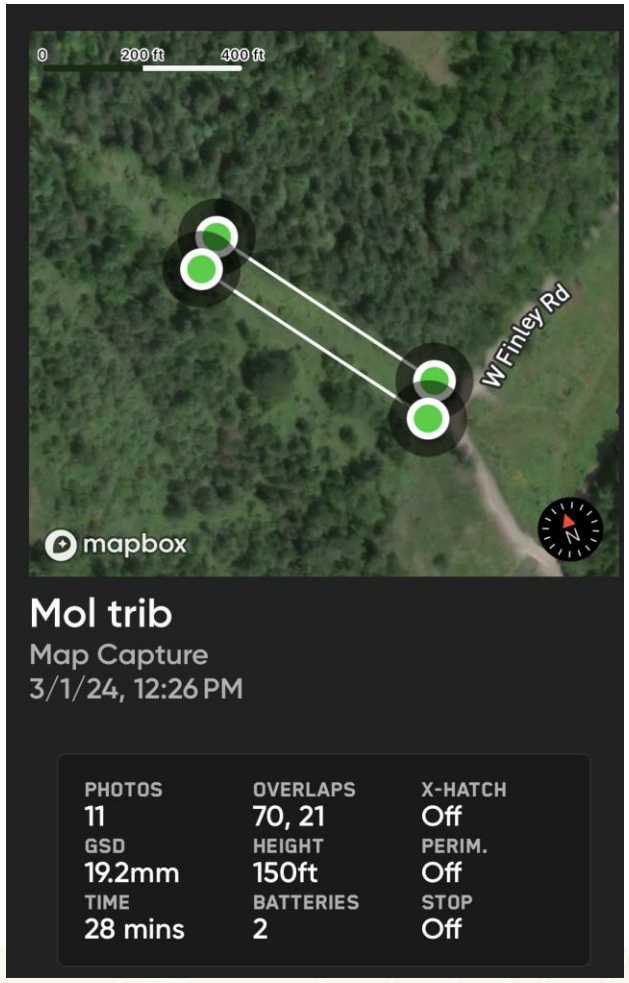
Bloody Run Partially Completed Model

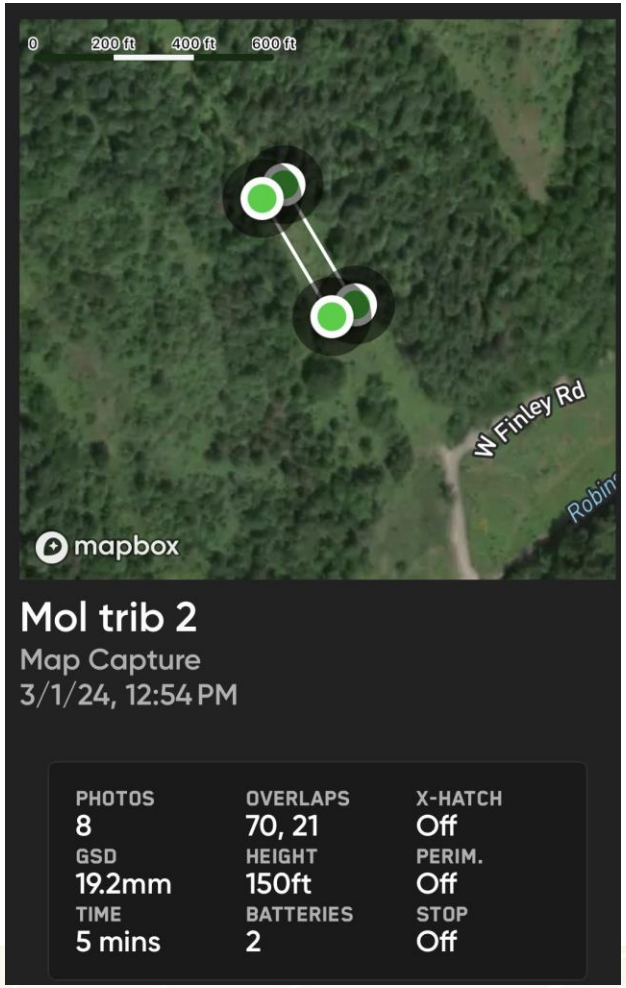


Molinari Tributary

- First Pennsylvania restoration site visited
  - Extremely narrow
  - Drastic elevation change
  - Dangerous terrain
- First several flights were unsuccessful, requiring a higher elevation to safely maneuver the terrain
  - First ever in-field surgery on drone propellor after losing service and crashing into a tree
- Successful flight at 150 ft
  - Much higher than other surveys

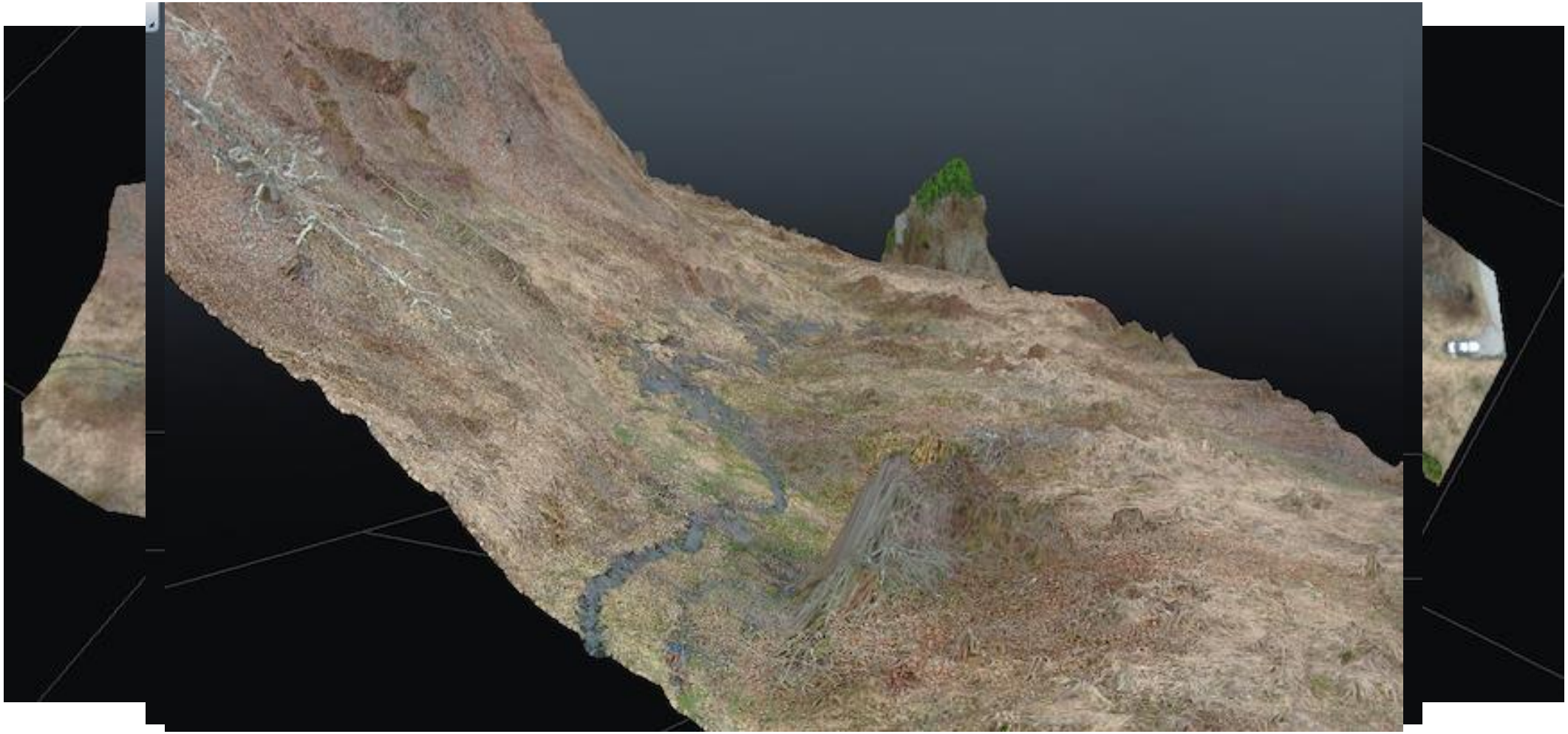
Setting the Survey Area: Molinari Tributary





OHIO UNIVERSITY

Molinari Tributary Model



OHIO UNIVERSITY

Molinari (mainstem)

OHIO UNIVERSITY

Setting the Survey Area: Molinari

Molinari 1
Map Capture
3/1/24, 1:01 PM

PHOTOS	OVERLAPS	X-HATCH
27	70, 21	Off
GSD	HEIGHT	PERIM.
19.2mm	150ft	Off
TIME	BATTERIES	STOP
33 mins	2	Off

Molinari 2
Map Capture
3/1/24, 1:43 PM

PHOTOS	OVERLAPS	X-HATCH
31	70, 21	Off
GSD	HEIGHT	PERIM.
19.2mm	150ft	Off
TIME	BATTERIES	STOP
8 mins	2	Off

Molinari 3 4/19
Map Capture
4/19/24, 11:21 AM

PHOTOS	OVERLAPS	X-HATCH
63	70, 70	Off
GSD	HEIGHT	PERIM.
9.0mm	70ft	Off
TIME	BATTERIES	STOP
13 mins	2	Off

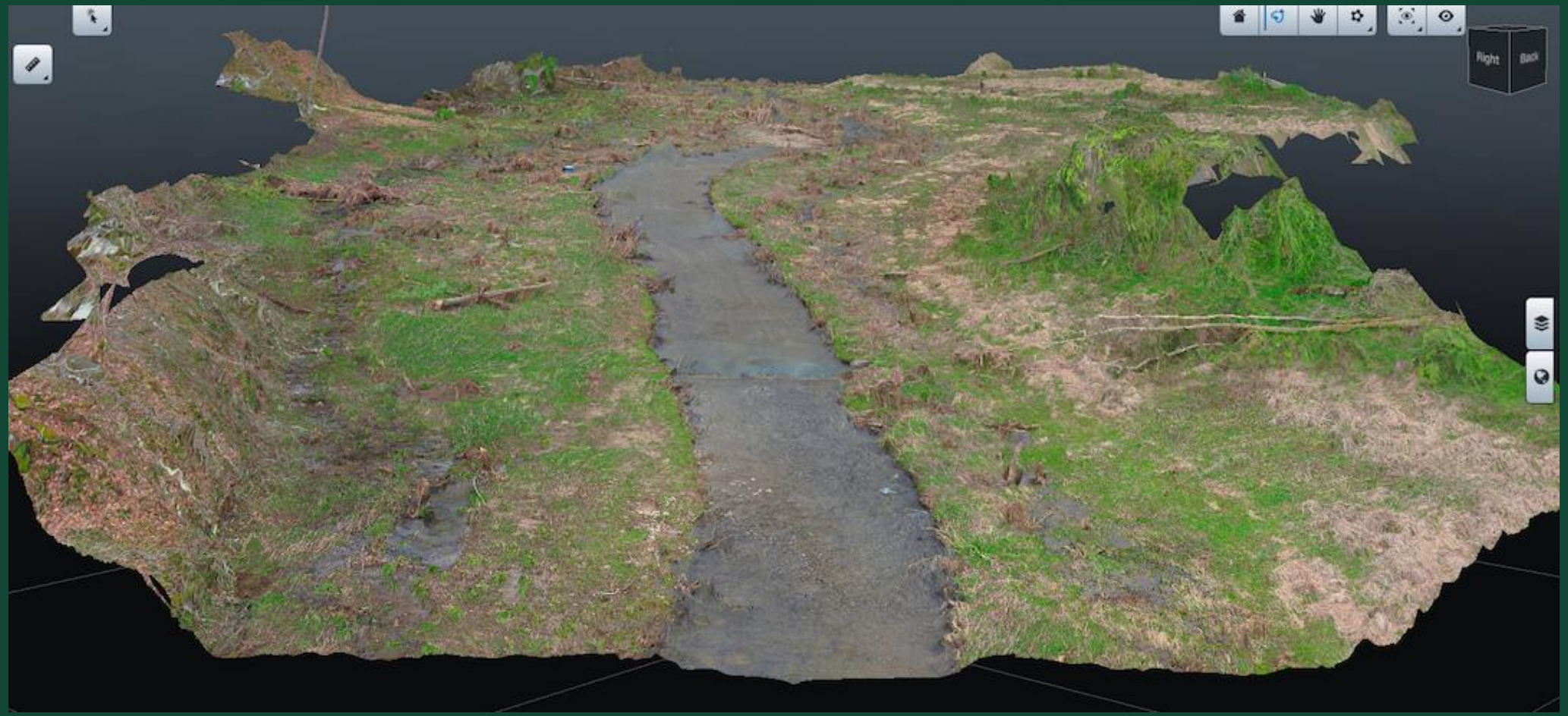
Molinari4 4/19
Map Capture
4/19/24, 11:40 AM

PHOTOS	OVERLAPS	X-HATCH
26	70, 70	Off
GSD	HEIGHT	PERIM.
9.0mm	70ft	Off
TIME	BATTERIES	STOP
4 mins	2	Off

Molinari5 4/19
Map Capture
4/19/24, 11:54 AM

PHOTOS	OVERLAPS	X-HATCH
180	70, 70	Off
GSD	HEIGHT	PERIM.
9.0mm	70ft	Off
TIME	BATTERIES	STOP
15 mins	2	Off

Molinari Model

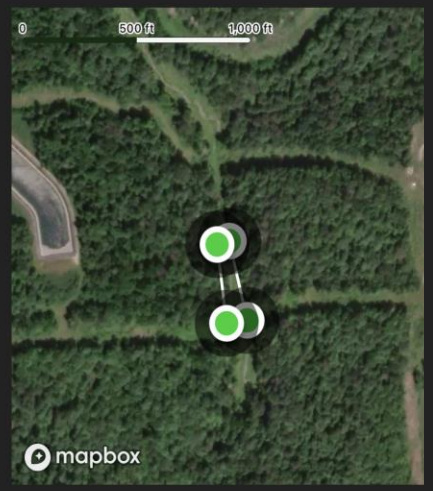


OHIO UNIVERSITY

Wallace

OHIO UNIVERSITY

Setting the Survey Area: Wallace



Wallace 1

Map Capture
3/29/24, 10:43 AM

PHOTOS	OVERLAPS	X-HATCH
13	70, 21	Off
GSD	HEIGHT	PERIM.
9.6mm	75ft	Off
TIME	BATTERIES	STOP
9 mins	2	Off

Wallace 2

Map Capture
3/29/24, 10:54 AM

PHOTOS	OVERLAPS	X-HATCH
4	70, 21	Off
GSD	HEIGHT	PERIM.
9.6mm	75ft	Off
TIME	BATTERIES	STOP
8 mins	2	Off

Wallace 3

Map Capture
3/29/24, 11:24 AM

PHOTOS	OVERLAPS	X-HATCH
9	70, 21	Off
GSD	HEIGHT	PERIM.
11.5mm	90ft	Off
TIME	BATTERIES	STOP
6 mins	2	Off

Wallace 4

Map Capture
3/29/24, 11:47 AM

PHOTOS	OVERLAPS	X-HATCH
27	70, 70	Off
GSD	HEIGHT	PERIM.
11.5mm	90ft	Off
TIME	BATTERIES	STOP
6 mins	2	Off

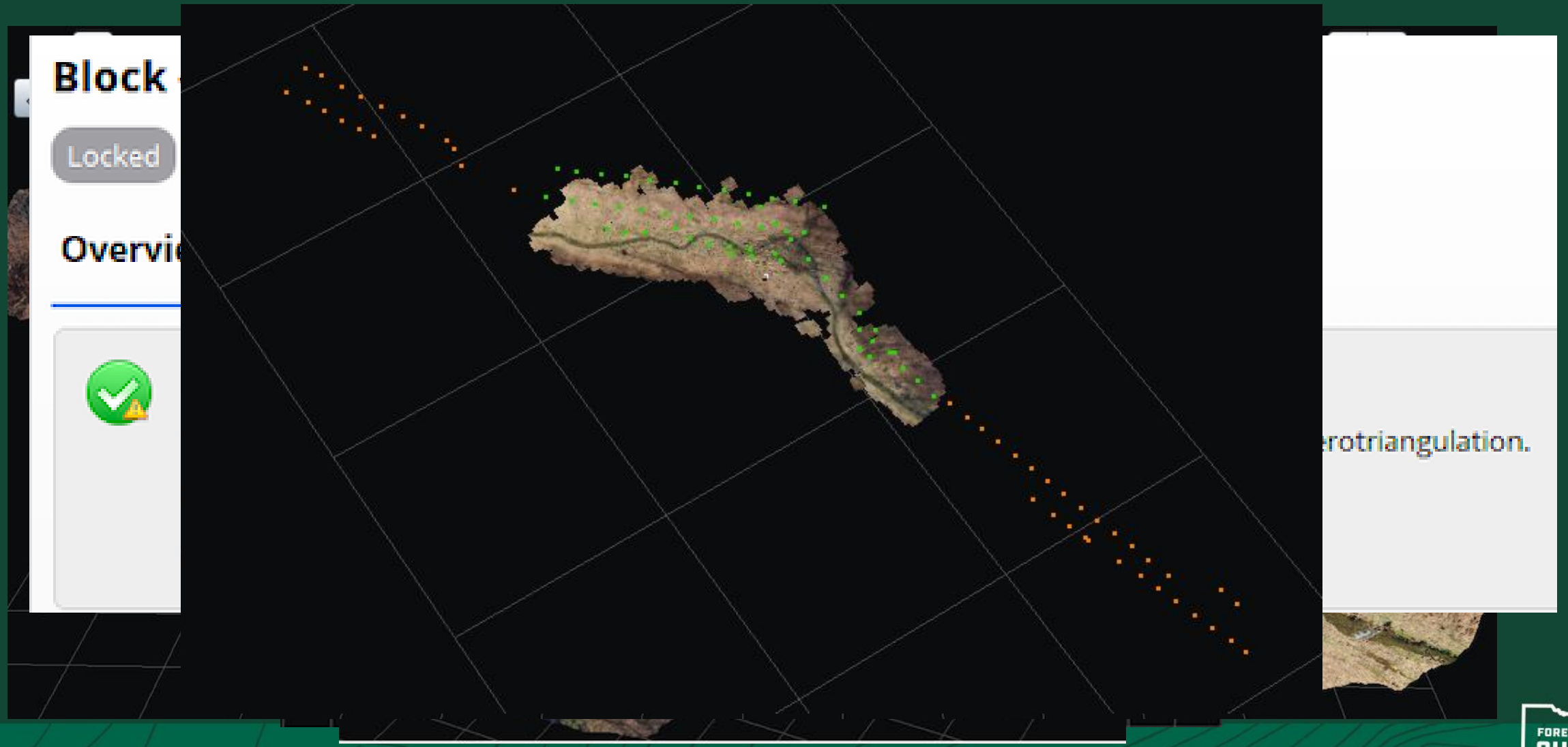
Wallace 5

Map Capture
3/29/24, 12:02 PM

PHOTOS	OVERLAPS	X-HATCH
14	70, 70	Off
GSD	HEIGHT	PERIM.
11.5mm	90ft	Off
TIME	BATTERIES	STOP
4 mins	2	Off

OHIO UNIVERSITY

Wallace Model



OHIO UNIVERSITY

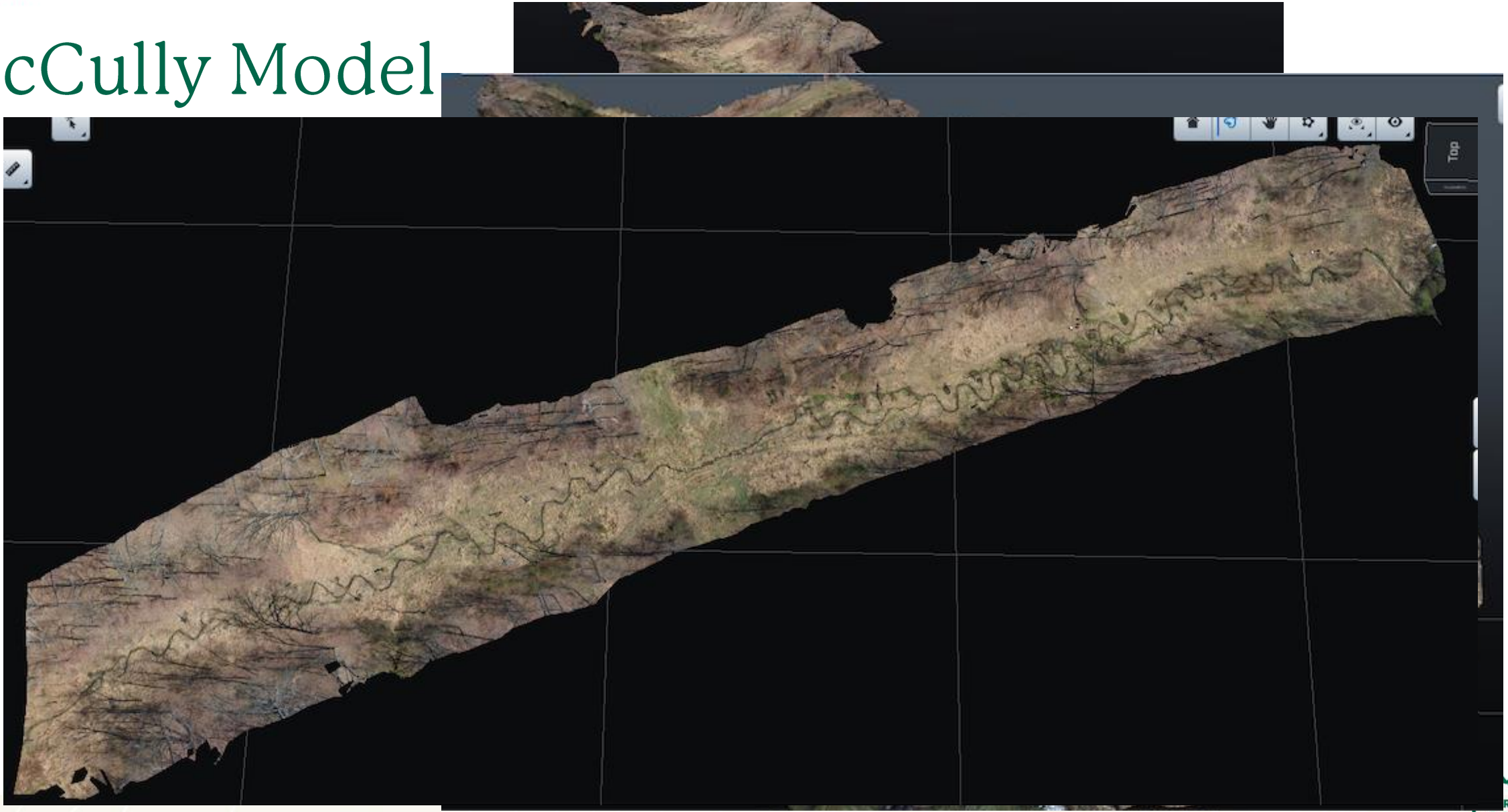
McCully

OHIO UNIVERSITY

Setting the Survey Area: McCully

OHIO UNIVERSITY

McCully Model



Beham

Setting the Survey Area: Beham

Beham 4/19
Map Capture
4/19/24, 1:55 PM

PHOTOS	OVERLAPS	X-HATCH
36	70, 70	Off
GSD	**HEIGHT**	**PERIM.**
9.0mm	70ft	Off
TIME	**BATTERIES**	**STOP**
7 mins	2	Off

Beham2 4/19
Map Capture
4/19/24, 2:12 PM

PHOTOS	OVERLAPS	X-HATCH
45	70, 70	Off
GSD	**HEIGHT**	**PERIM.**
9.0mm	70ft	Off
TIME	**BATTERIES**	**STOP**
6 mins	2	Off

Beham5 4/19
Map Capture
4/19/24, 2:33 PM

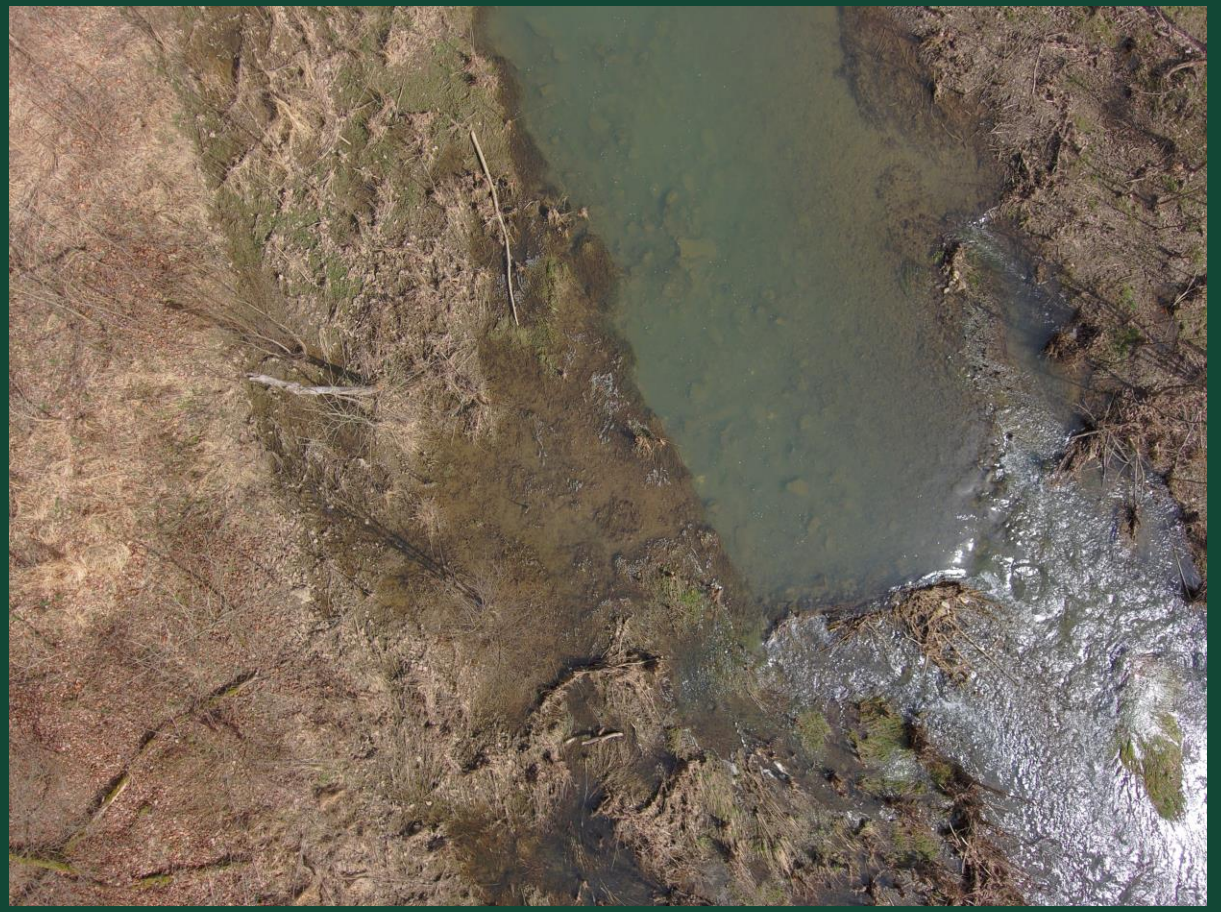
PHOTOS	OVERLAPS	X-HATCH
65	70, 70	Off
GSD	**HEIGHT**	**PERIM.**
9.0mm	70ft	Off
TIME	**BATTERIES**	**STOP**
13 mins	2	Off

OHIO
UNIVERSITY

Beham Model

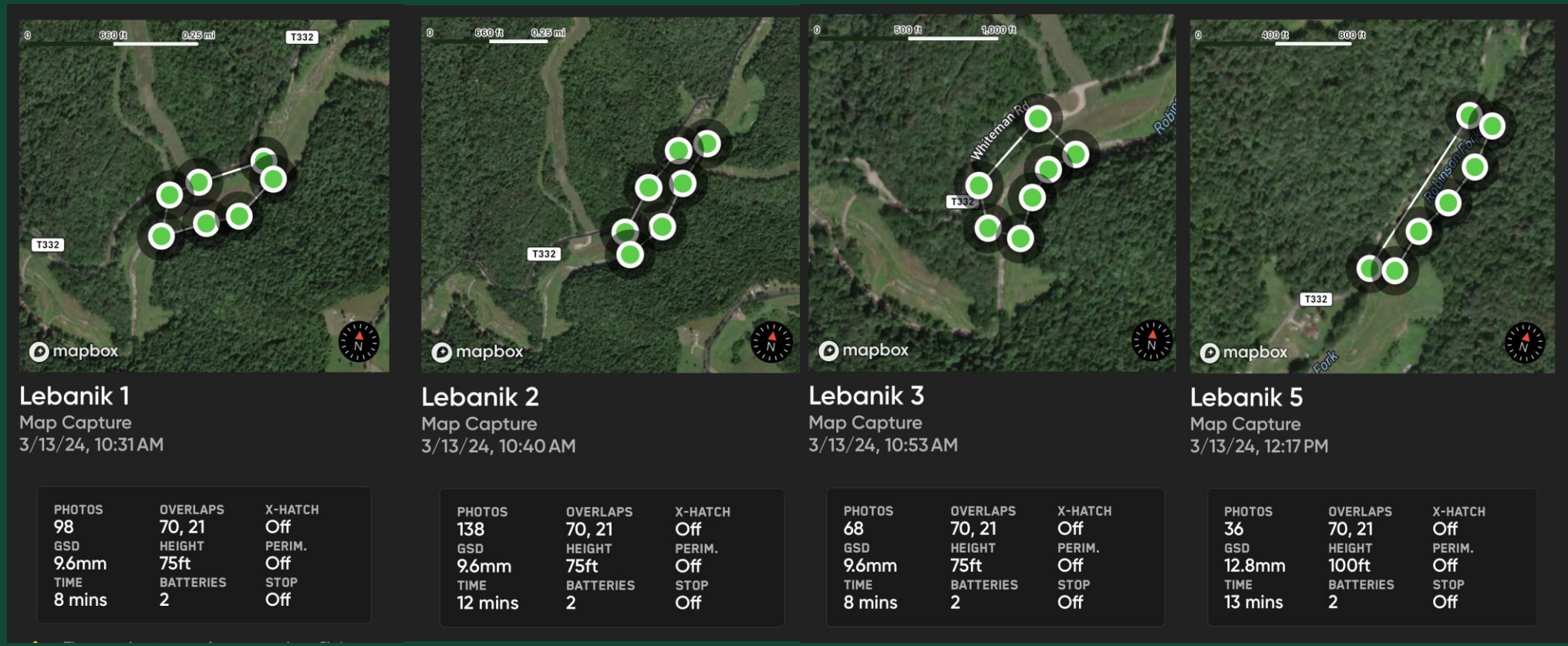
OHIO UNIVERSITY

Lebanik



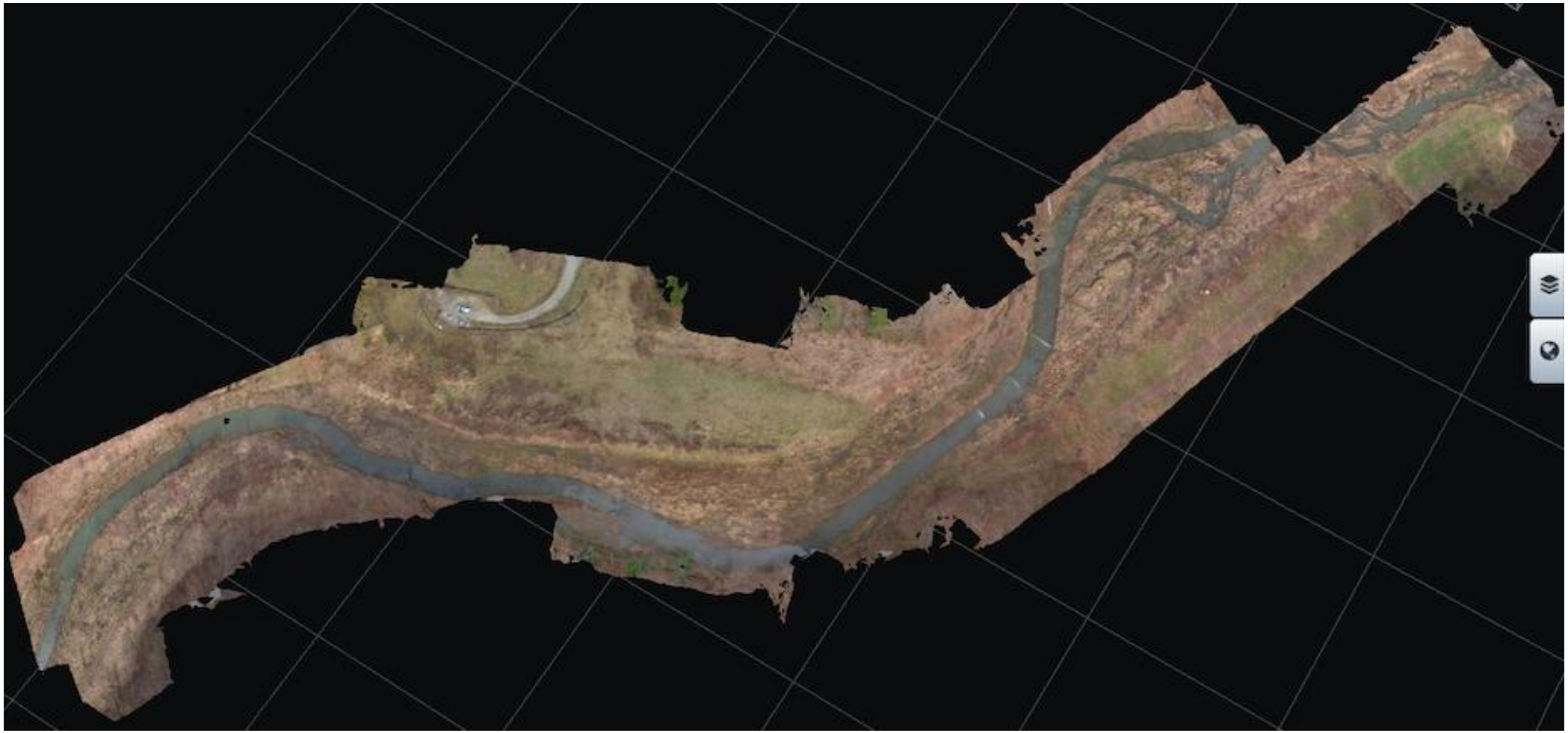
OHIO UNIVERSITY

Setting the Survey Area: Lebanik

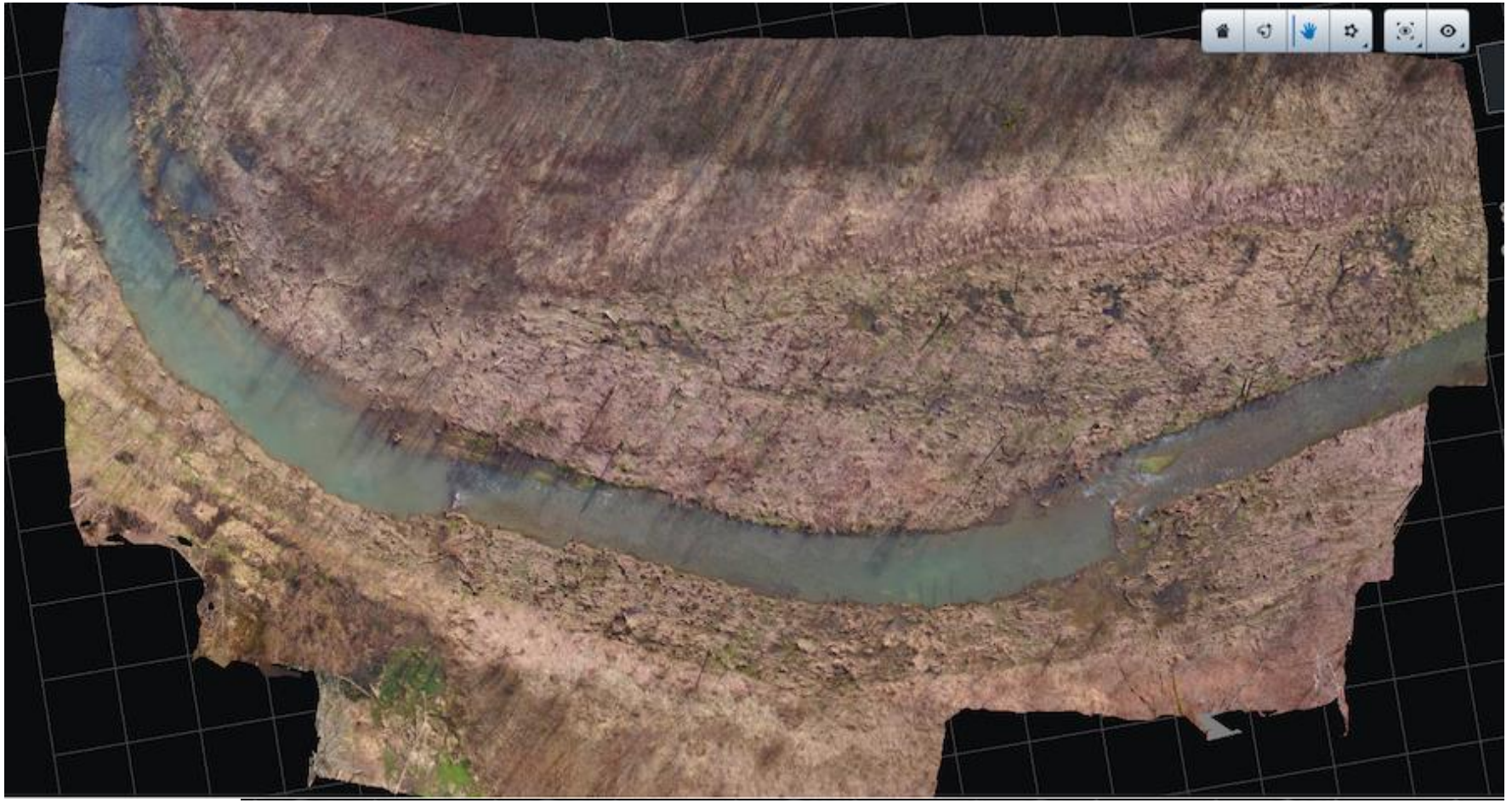


OHIO UNIVERSITY

Lebanik Model



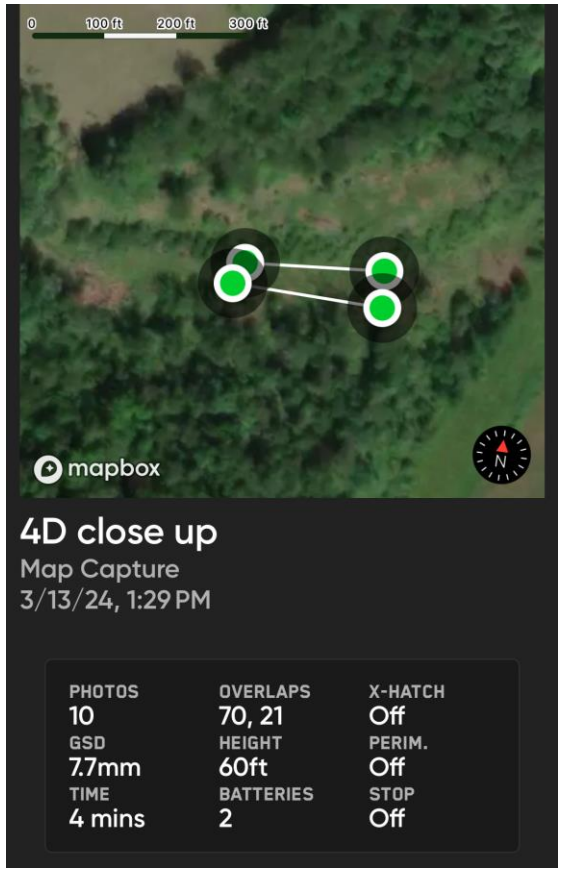
Lebanik Model (up close)

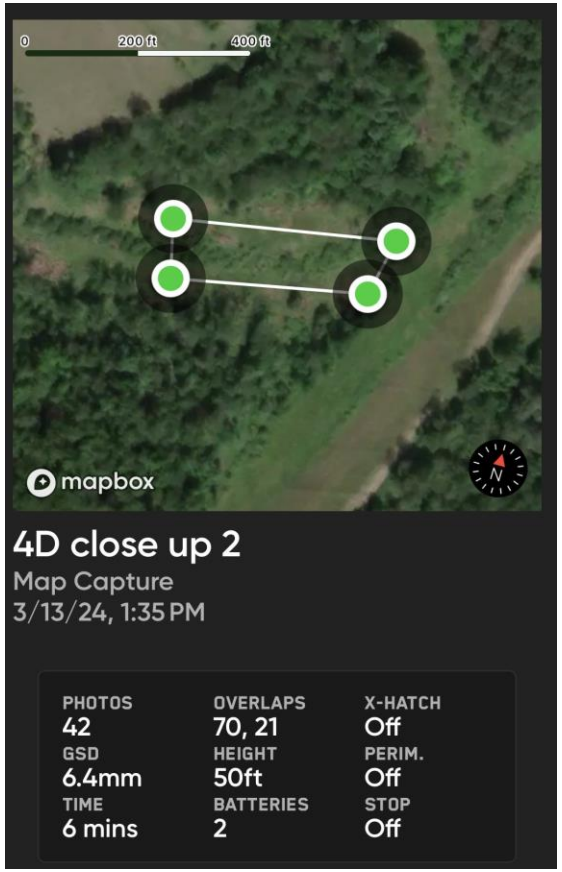


OHIO UNIVERSITY

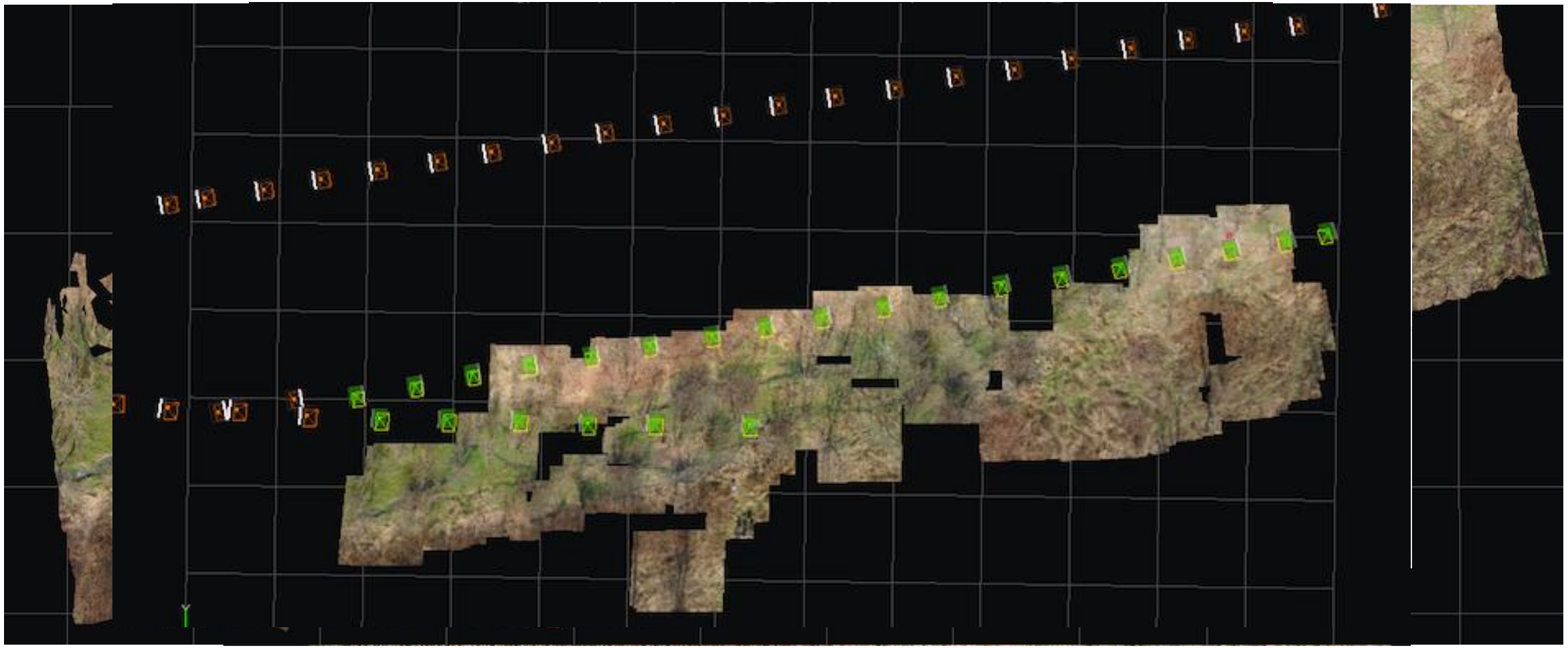
Unit 4D

Setting the Survey Area: Unit 4D





Unit 4D Model



Step by Step Bentley Processing

- Name your new project and set its location
- Give the software the entire folder containing the imagery and geolocation points from the survey
- Submit the aero triangulation process, which organizes and stitches the imagery together
- Wait for service to complete the model (the number of photos will affect the length of time)
- Submit production to create the 3D model out of the stitched photos, using the elevation data to create the topographic DEM
- Produce an ESRI file to import into ArcGIS

Challenges with Bentley Software

- Learning the process of creating the models (trial and error)
- Light reflection off water can affect photo quality, making it unusable by software ("incomplete photos" error message frequently appeared during model processing)
- Elevation differences in separate scans
- Uncommon software
- Not generally used for surveying environmental restoration projects (used for civil engineering projects)
- Larger scans/models taking many hours to process & requires much computing power
- Pricey software (between $2,000 to over $4,000)

Next Steps

- Standardizing the elevation throughout the surveying process
- Fixing errors/artifacts in the produced models
- Producing point cloud files to convert to raster to analyze data points in ArcGIS
- Fix the photos/models → run output as point cloud file → convert to raster → import to ArcGIS

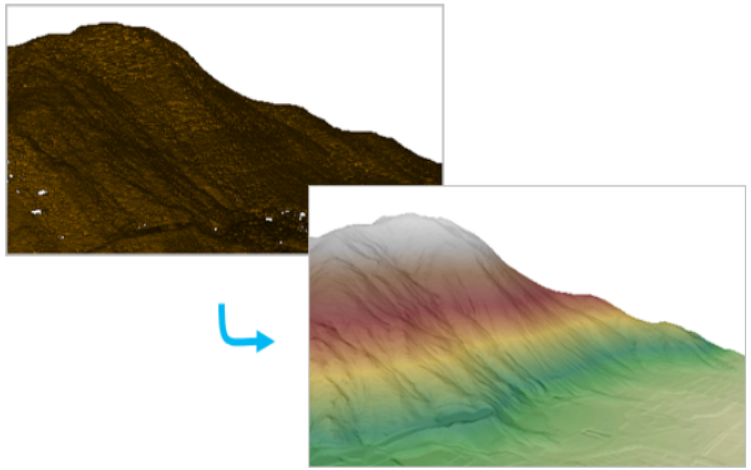
Point Cloud To Raster (Conversion)

ArcGIS Pro 3.3 | Other versions | Help archive

Summary

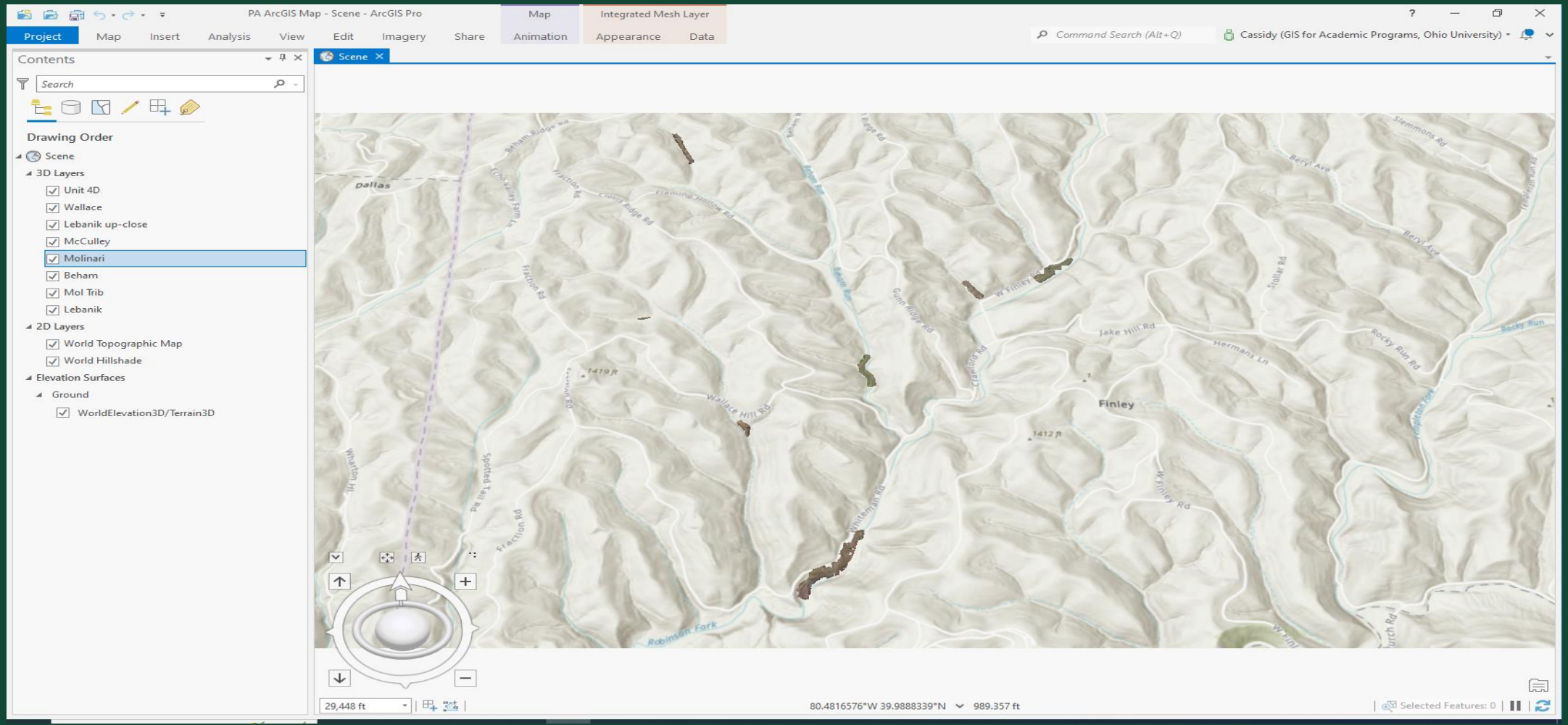
Creates a raster surface from height values in a point cloud scene layer package file (`*.slpk`).

Illustration



OHIO UNIVERSITY

Bentley Models into ArcGIS

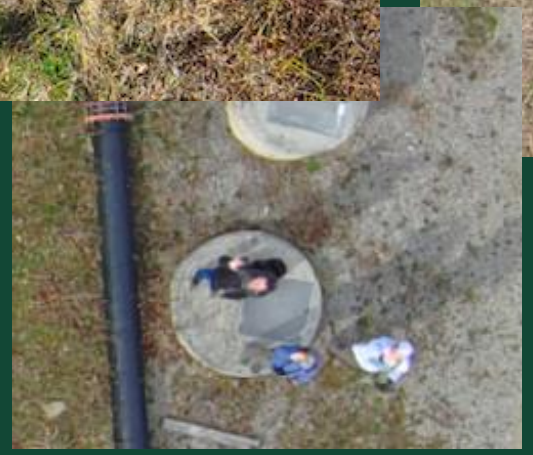


FOREVER OHIO

Acknowledgements

- Dr. Natalie Kruse-Daniels
- Sebastian Teas
- Nora Sullivan
- OU Engineering Team, Issam Khoury
- Aliching Marma (emotional support)

OHIO UNIVERSITY



Thank you! Questions?

Liliana Kijek

lk053923@ohio.edu

Cassidy Mollick

cm368014@ohio.edu

FOREVER OHIO