TRAIL PLANNING TECHNOLOGY

A DIGITAL TOOLBOX

International TRAILS SUMMIT
AMERICAN TRAILS PTBA

TONY BOONE TRAILS

chinook LANDSCAPE ARCHITECTURE

Jon Altschuld, *PLA, PTBA*
Tony Boone, *M. Ed, PTBA*

Tony Boone

Tony Boone Trails, Timberline Trailcraft

- Trailbuilder since 1987
- PTBA member since 1995
- Trained over 3,000 students

Jon Altschuld, PLA, ASLA

Chinook Landscape Architecture

- Landscape Architect (CO, CA)
- FAA Remote Pilot
- Author, presenter
- 3D data collection and visualization

PIX4D Pix4D Ambassador

Professional TrailBuilders Association

SketchUp Visiting Professionals

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Courtesy: Highline Earthworks

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Landscape Architecture

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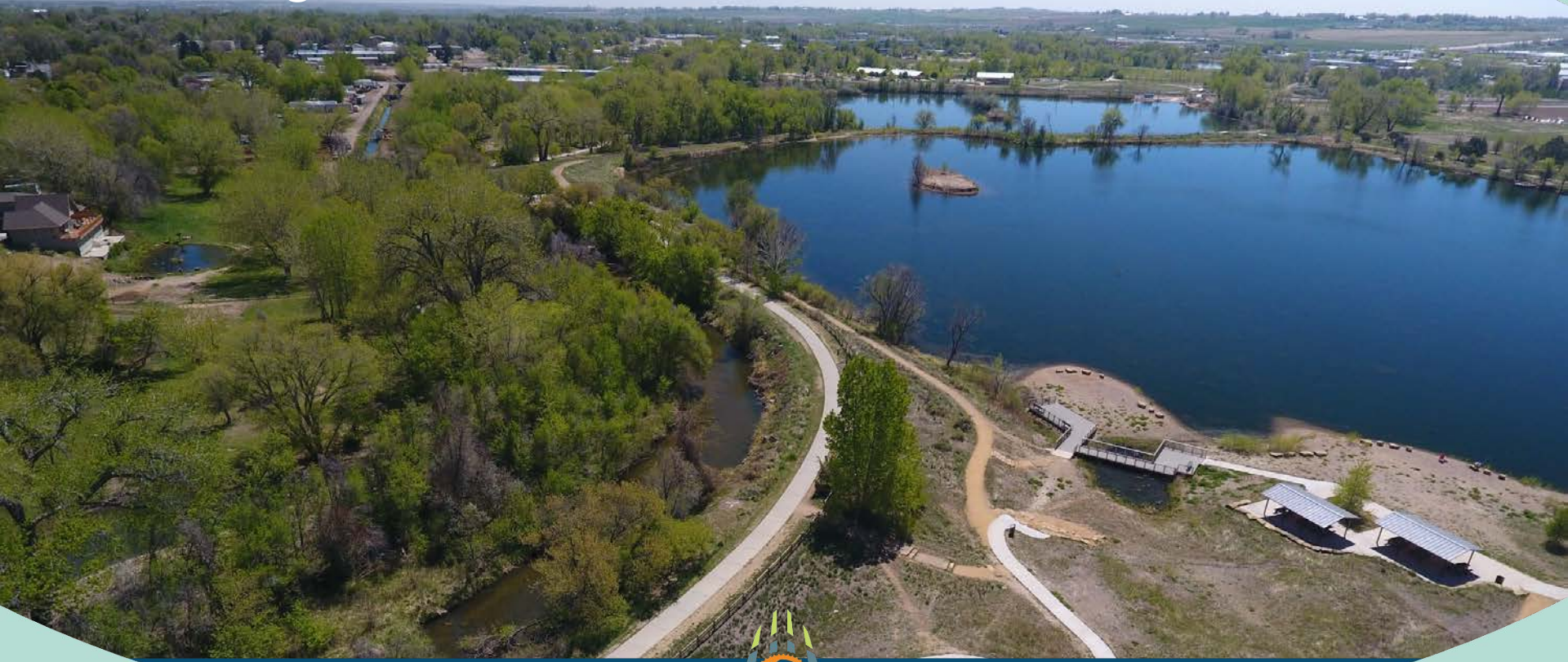
Ecological Restoration and Outdoor Recreation



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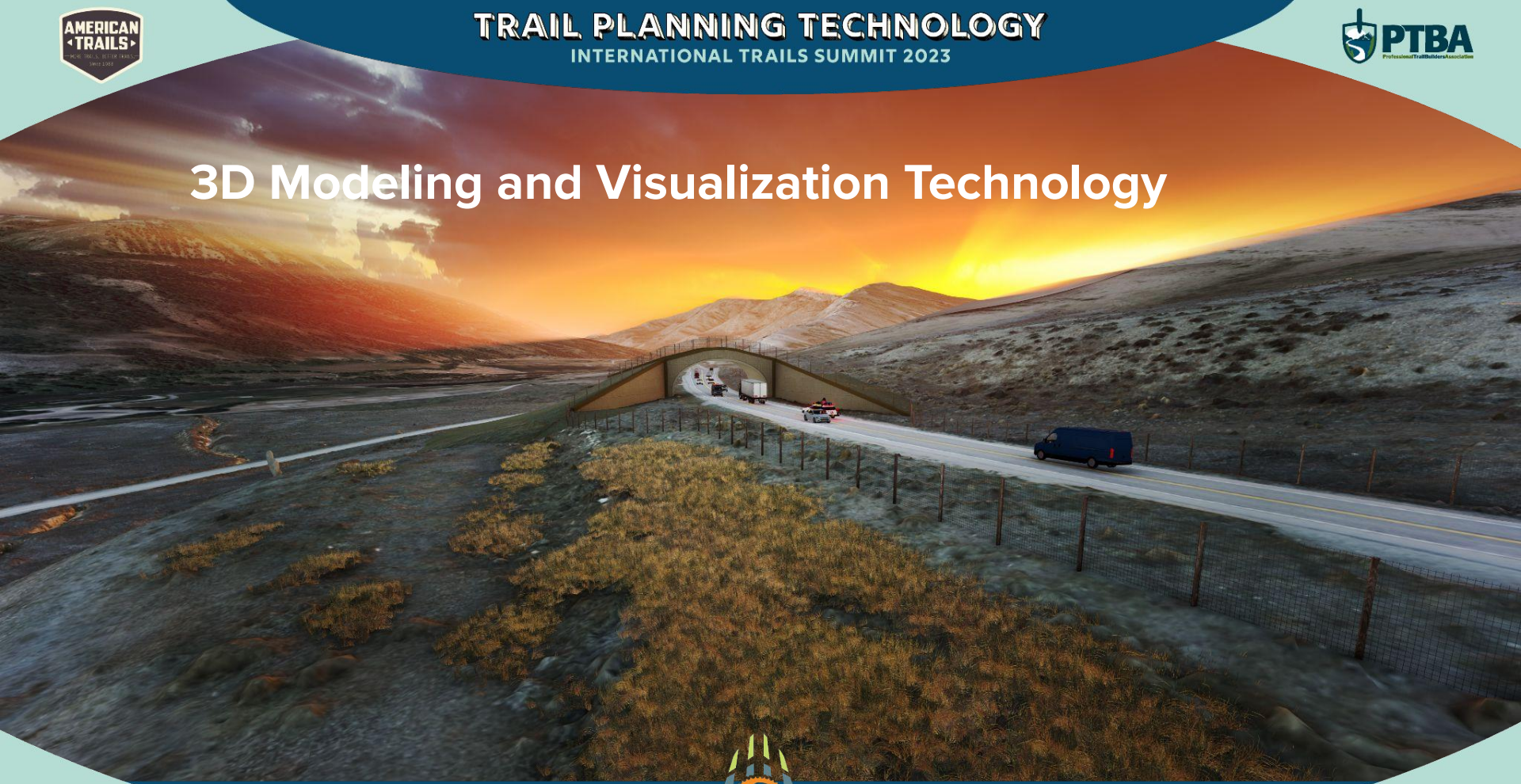
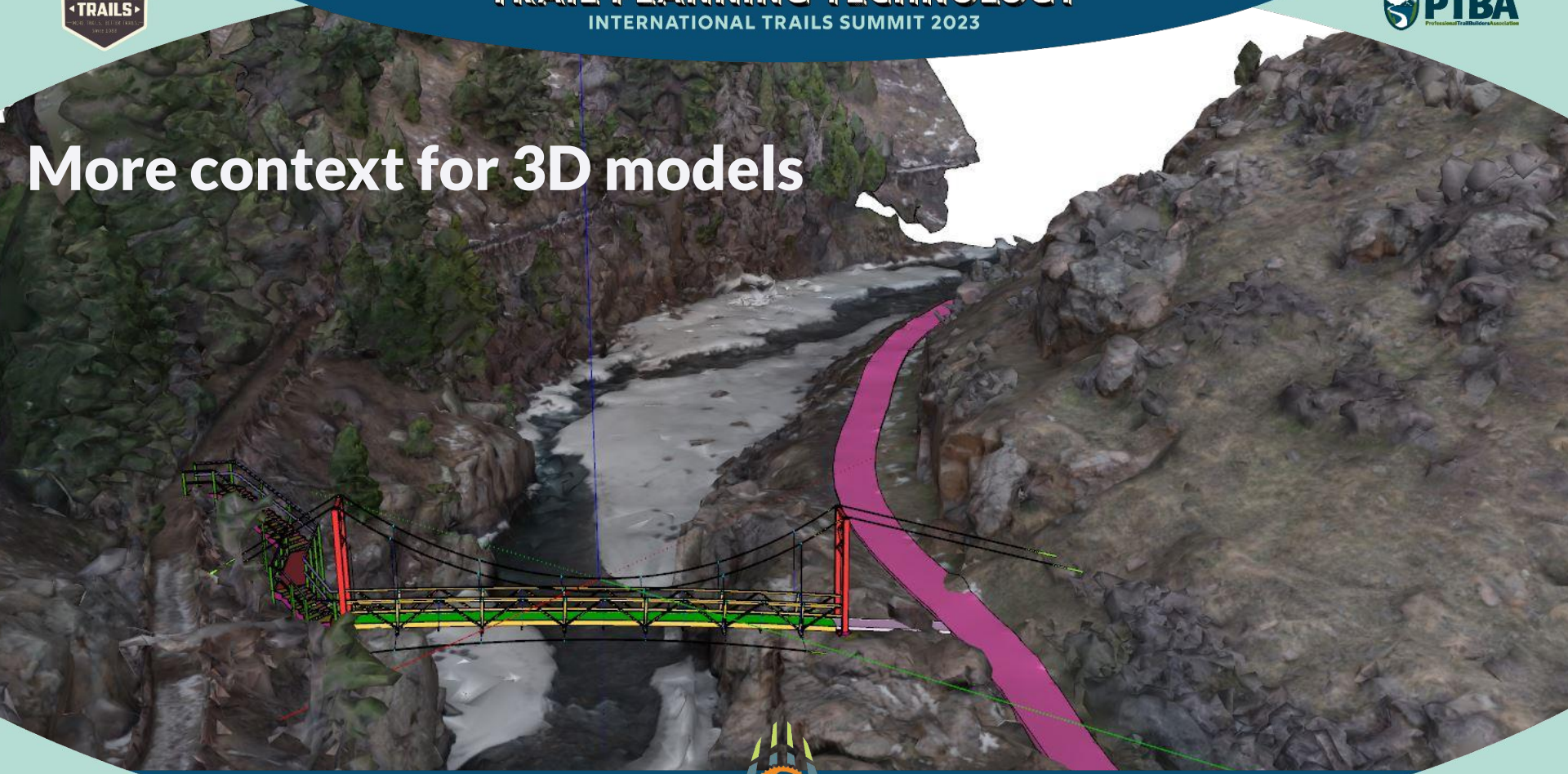
3D Modeling and Visualization Technology

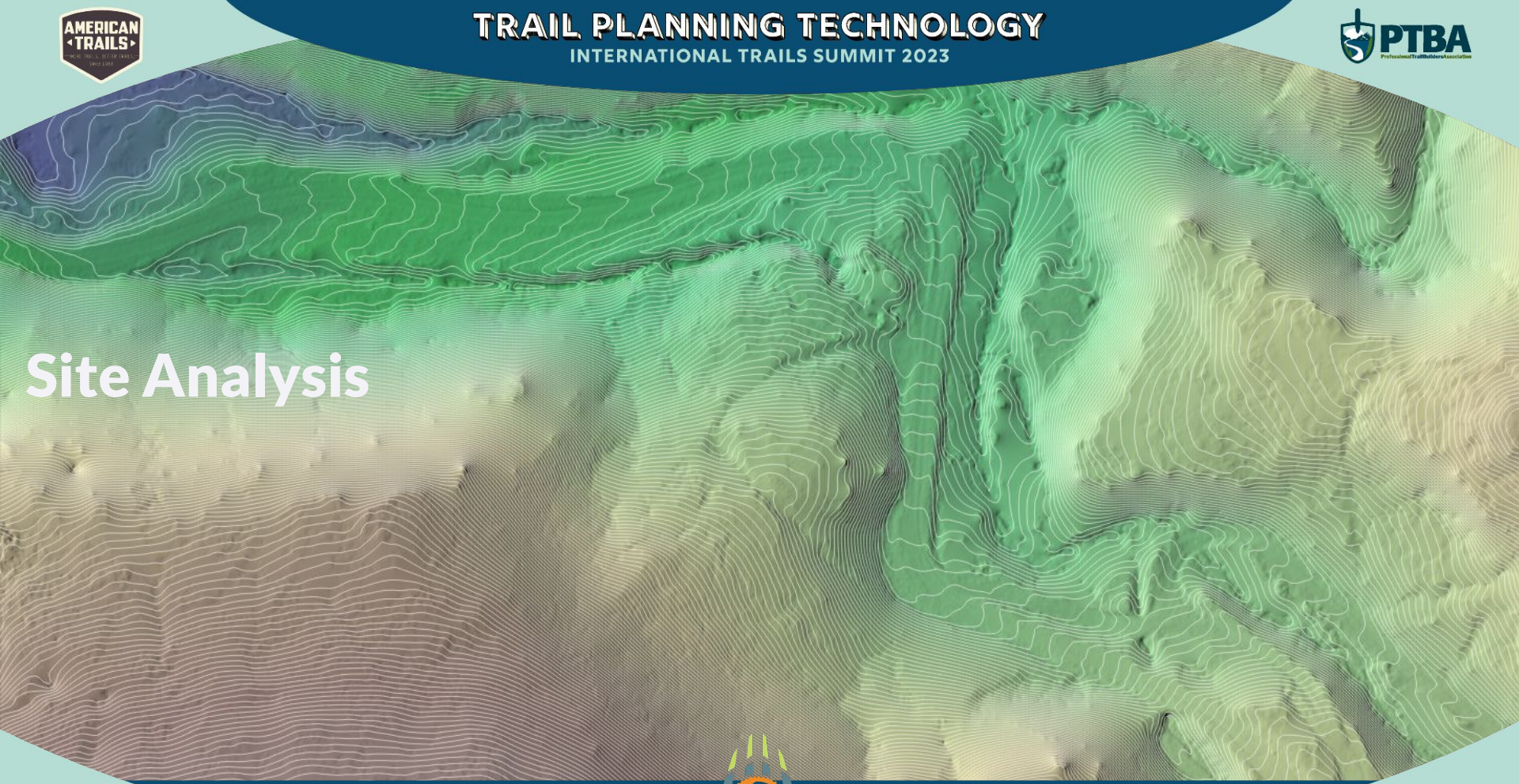


...led to integrating drones

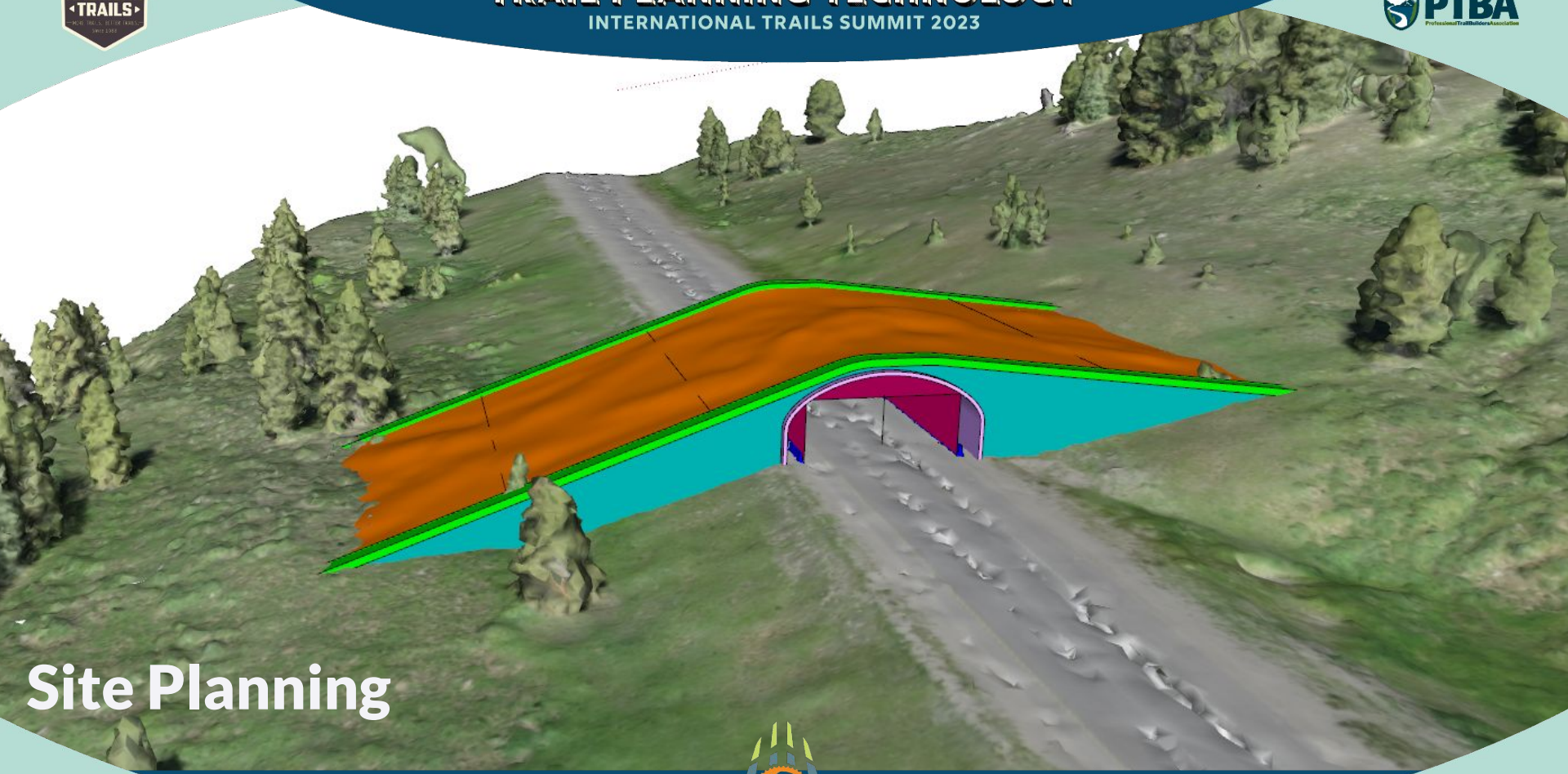
More context for 3D models



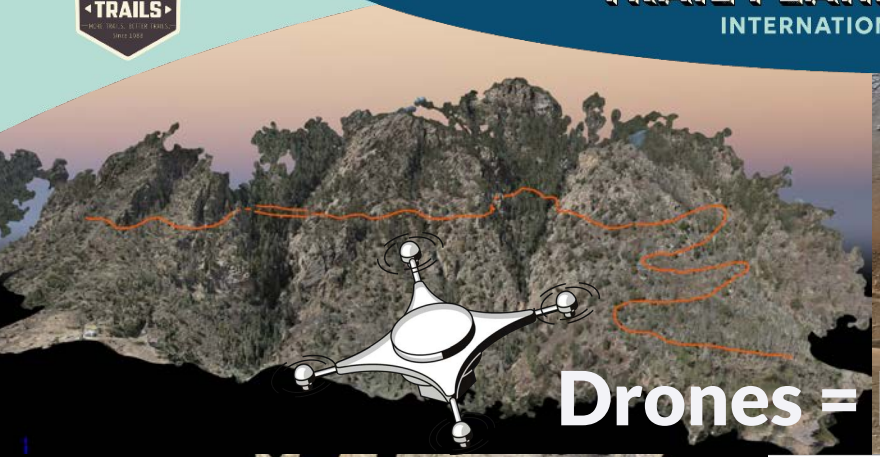
Site Analysis



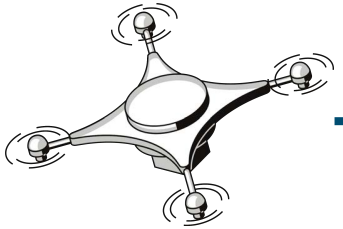
Key Feature Inventory



Site Planning



Drones = Multi-use tools



Technology Toolbox

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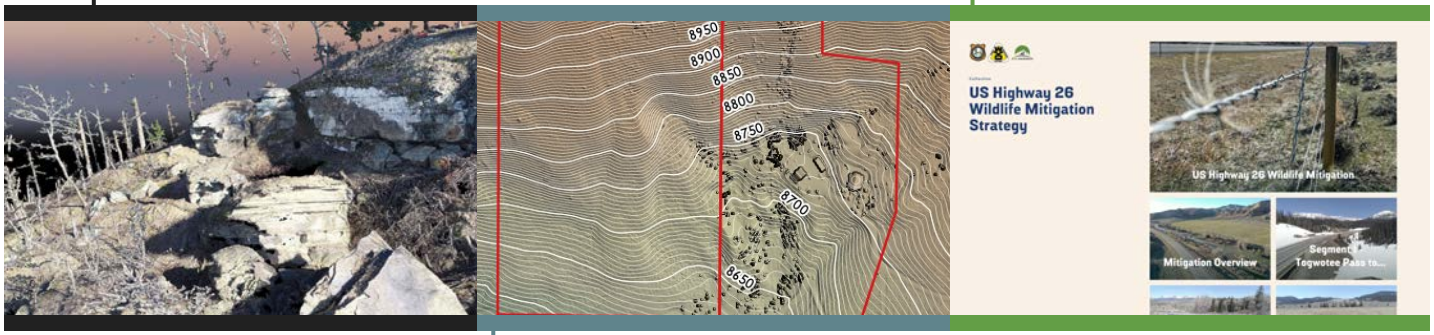
Categories of Tech Tools

Data Collection

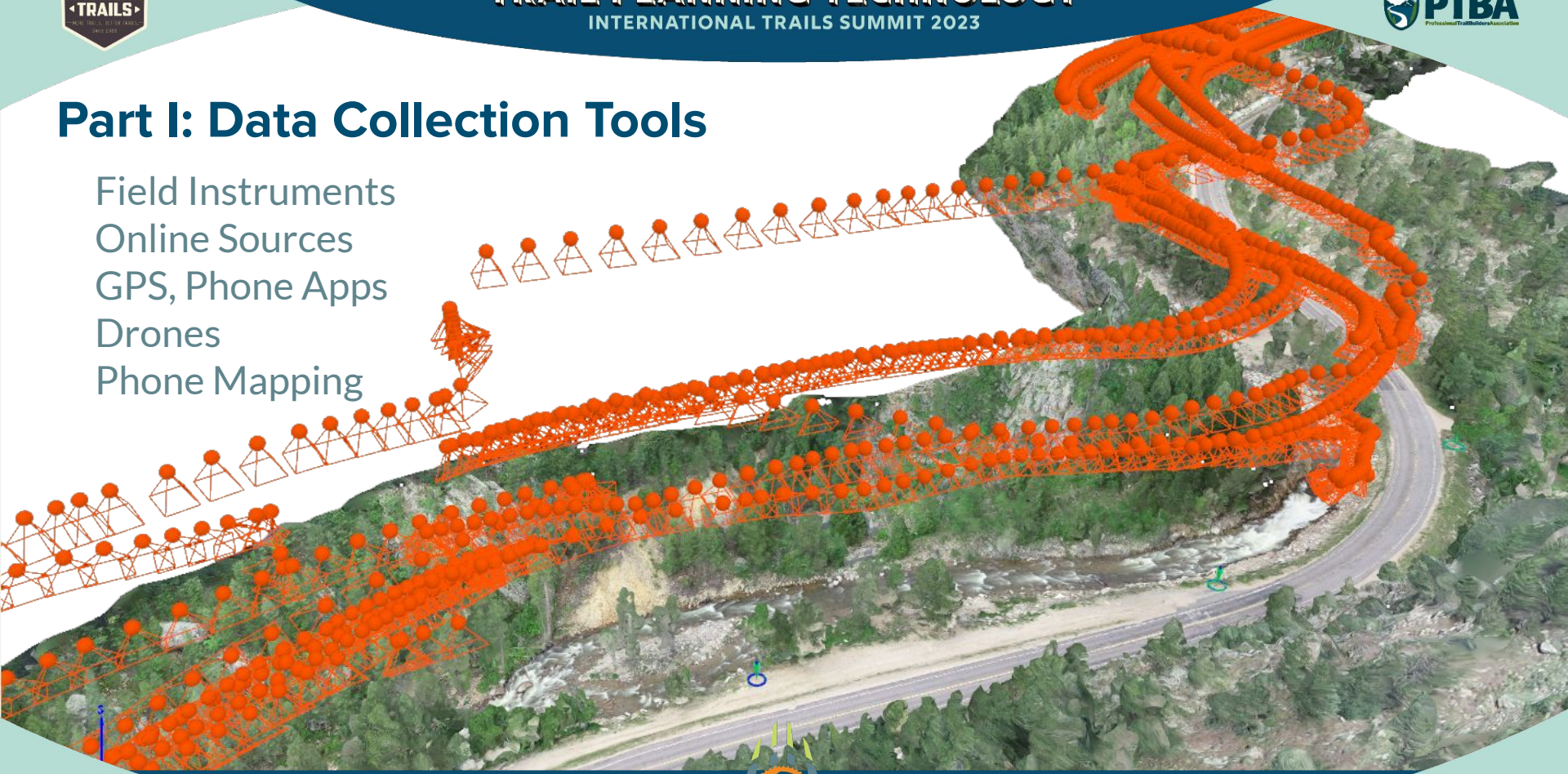
Presentation and Sharing



Design and Mapping

Part I: Data Collection Tools

- Field Instruments
- Online Sources
- GPS, Phone Apps
- Drones
- Phone Mapping



Field Instruments

Clinometer*

- Measures slope/grade
- Key for assessing, planning, and flagging trails

*Don't trust a trail builder/planner who doesn't use a clino!

Field Instruments

Digital Angle Gauge, Tape Measure

- Great for Technical Trail Features (TTFs)

Field Instruments

Laser Rangefinder, Handheld GPS

GPS and Phone Apps

- Decent accuracy
- Easy to use
- Phone apps have largely replaced handheld GPS units
- OnX, ArcGIS Collector, Survey123

ON X HUNT

Map Layers

Offline Maps

My Content

My Account & Settings

My Account

Settings

Elite Benefits

Invite Friends

Print

Chip Updater

Pride Rock

06/12/21, 1:26 PM

Overview | Wind Calendar

Lat/Long 39.55893, -105.39765 Copy

Hide on map

Waypoint Tools

Wind Direction
See the current wind direction over this waypoint.

Waypoint Radius
Set a range around this waypoint by choosing a distance.

Photos

Share | Edit | Add to Folder | Delete

ON X HUNT

ARAPAHO NATL FOREST

TODD ANDREW R

GRAFF MICHELLE LEE

MUNNS ELIZABETH

DAVID L GIES TRUST

WHITE ROBERT C

ASHBAUGH CHRISTOPHER

ARAPAHO NATL FOREST

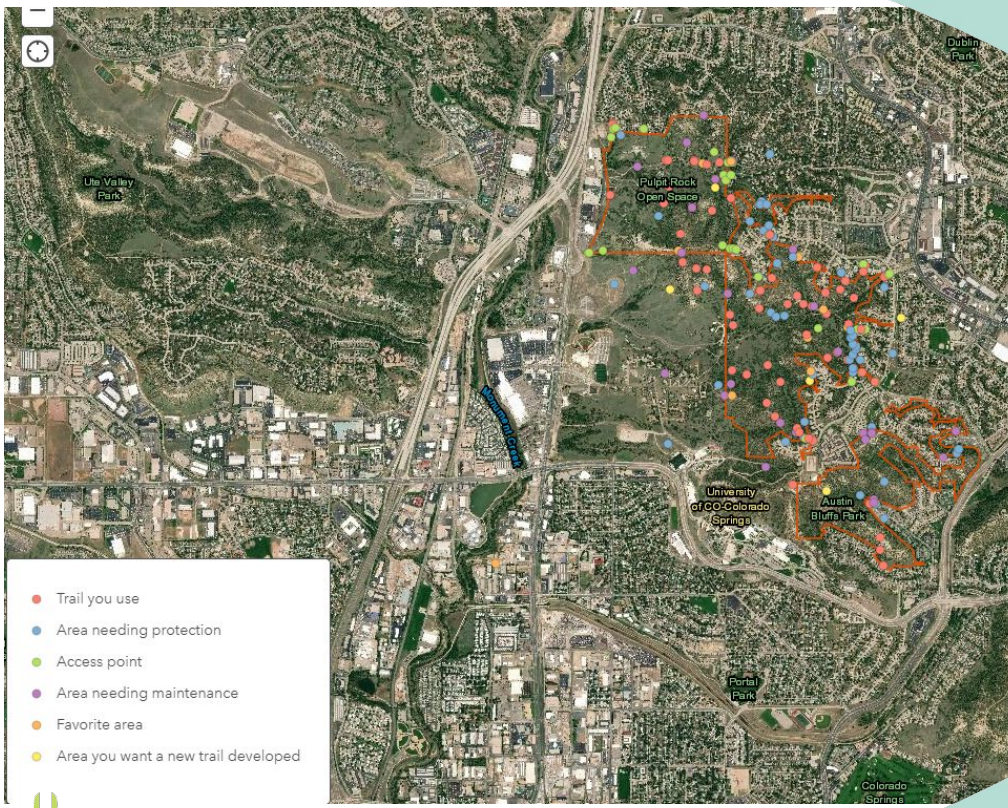
LICHEN STEVEN R

FLANIGAN GREGORY S

Mapbox

Phone/Tablet Applications

ArcGIS Collector, Survey123, Fulcrum, Avenza



Online Data Sources

GIS Data

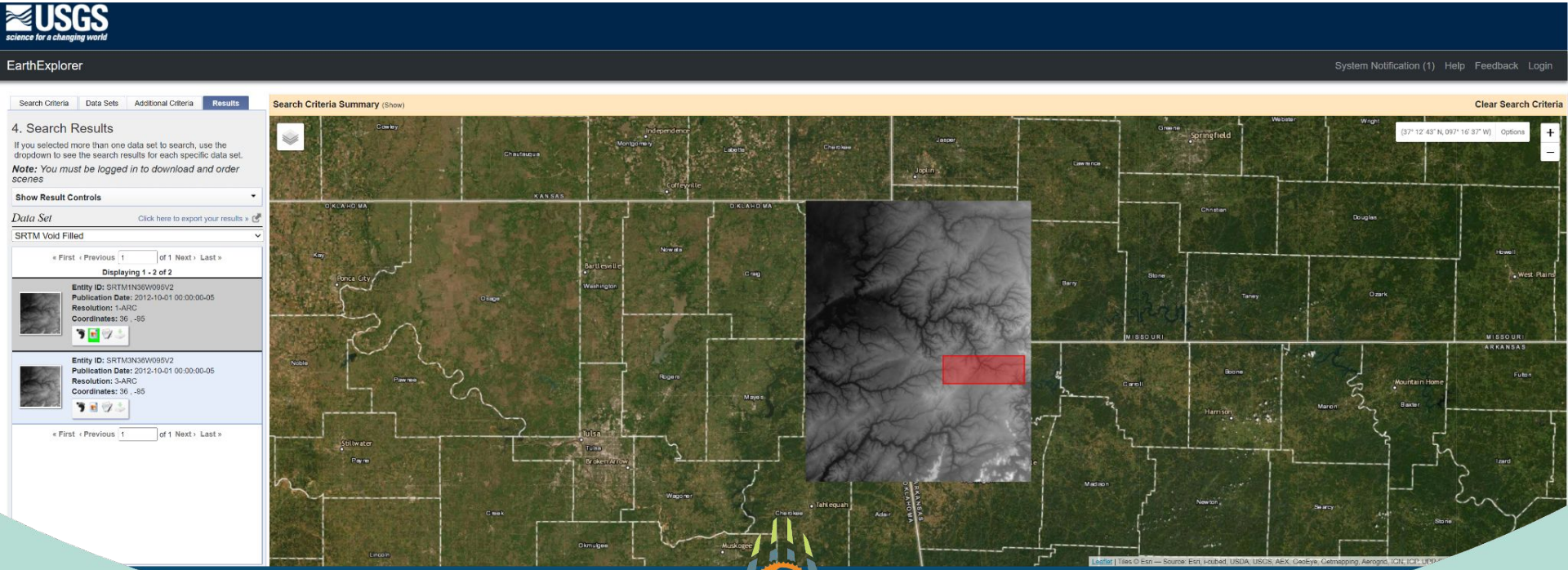
- Can be used in QGIS, ArcGIS, Google Earth, others
- Base mapping
- Before site visits

Goals:

1. Understand a site enough to prepare scope and fees for a planning project
2. Jump start the planning process before visiting the site

Online Data Sources

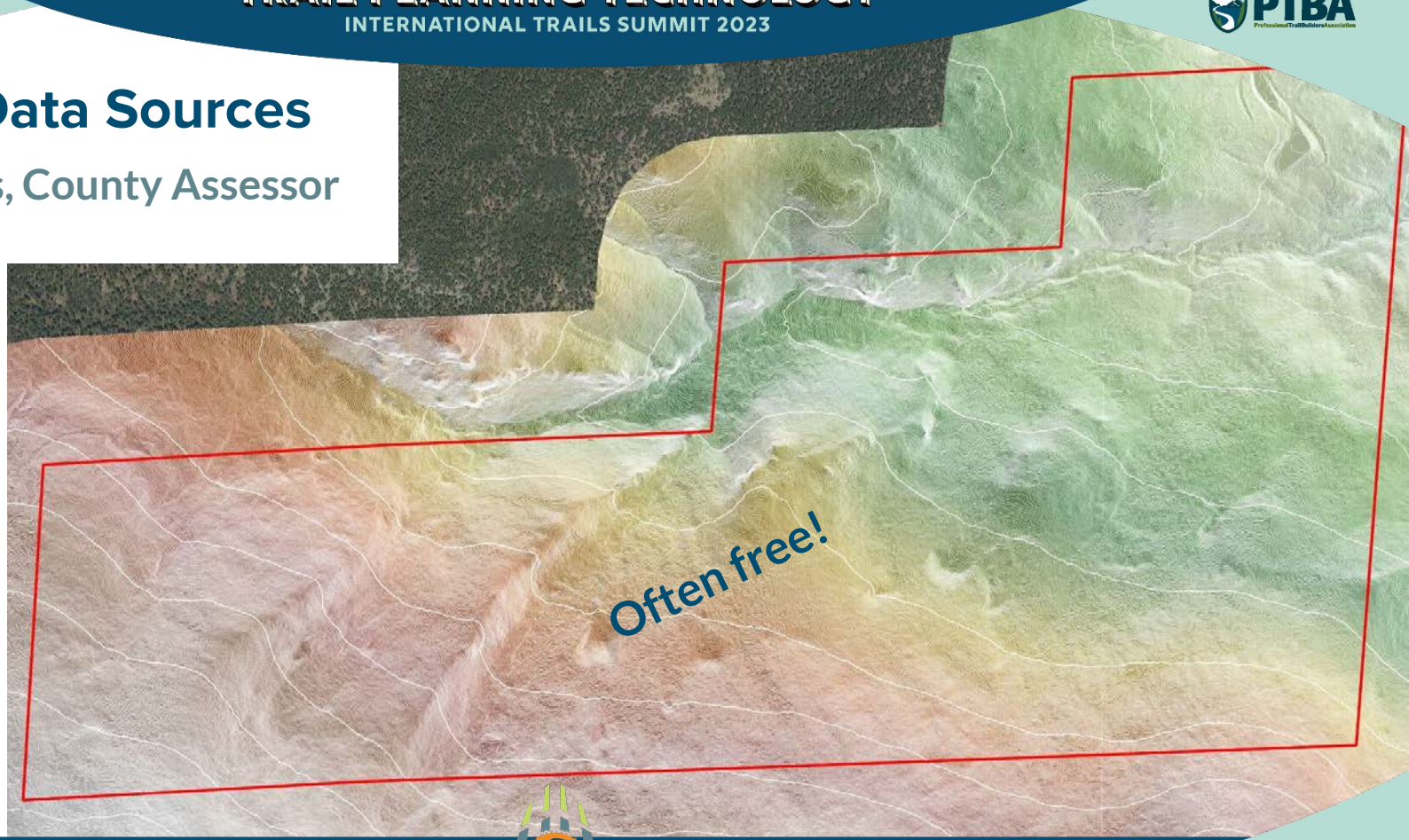
Earth Explorer

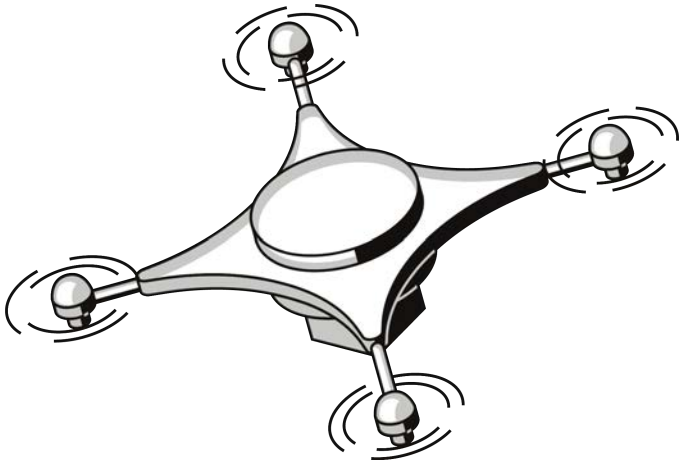


Online Data Sources

Local COGs, County Assessor

Property lines
Elevation
Roads
Trails
Buildings





Why do we use drones in our practices?

Different Reasons on Each Project

Generally:

- Reduce cost
- Expedite schedule
- Minimize footprint on sensitive habitats
- Increase data accuracy
- Increase contextual awareness
- Increase types of available data
- Increase use of collected data across disciplines

How do we use drones in our practices?

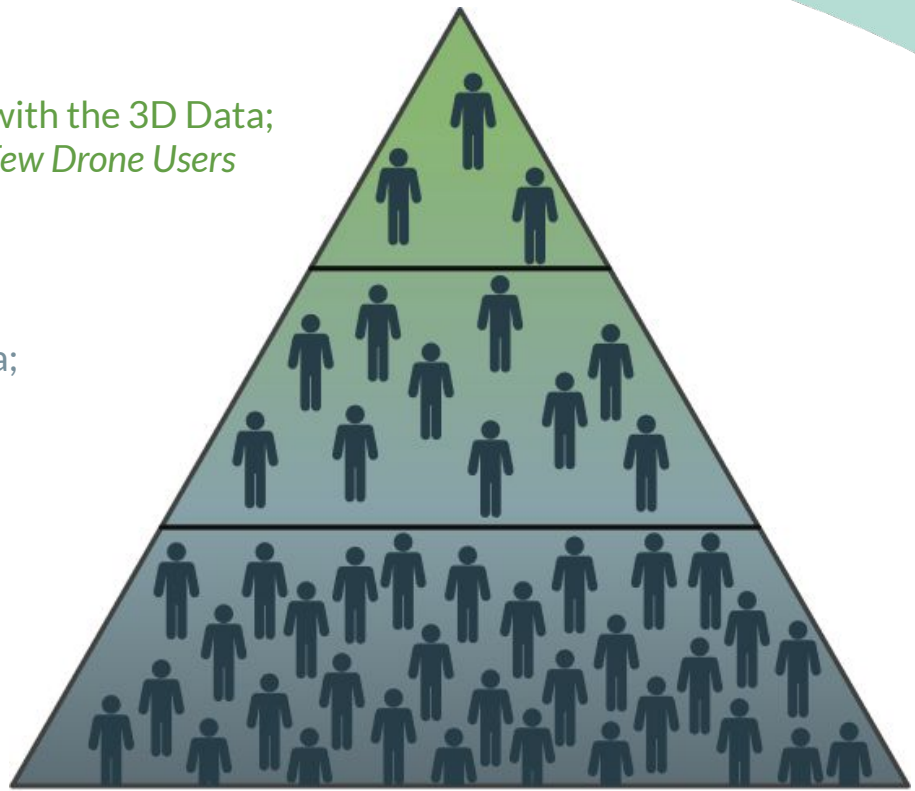
Types of Drone Users

3 Main Tiers/Categories

Working with the 3D Data;
Only a Few Drone Users

Collecting 3D Data;
Less Drone Users

Collecting Photos and Videos;
Many Drone Users



Tier 1: Photographs and Videos

Most common and basic type of drone use

- Photos and videos are geotagged
- Cover a lot of ground quickly
- Gain a better overall perspective of the site

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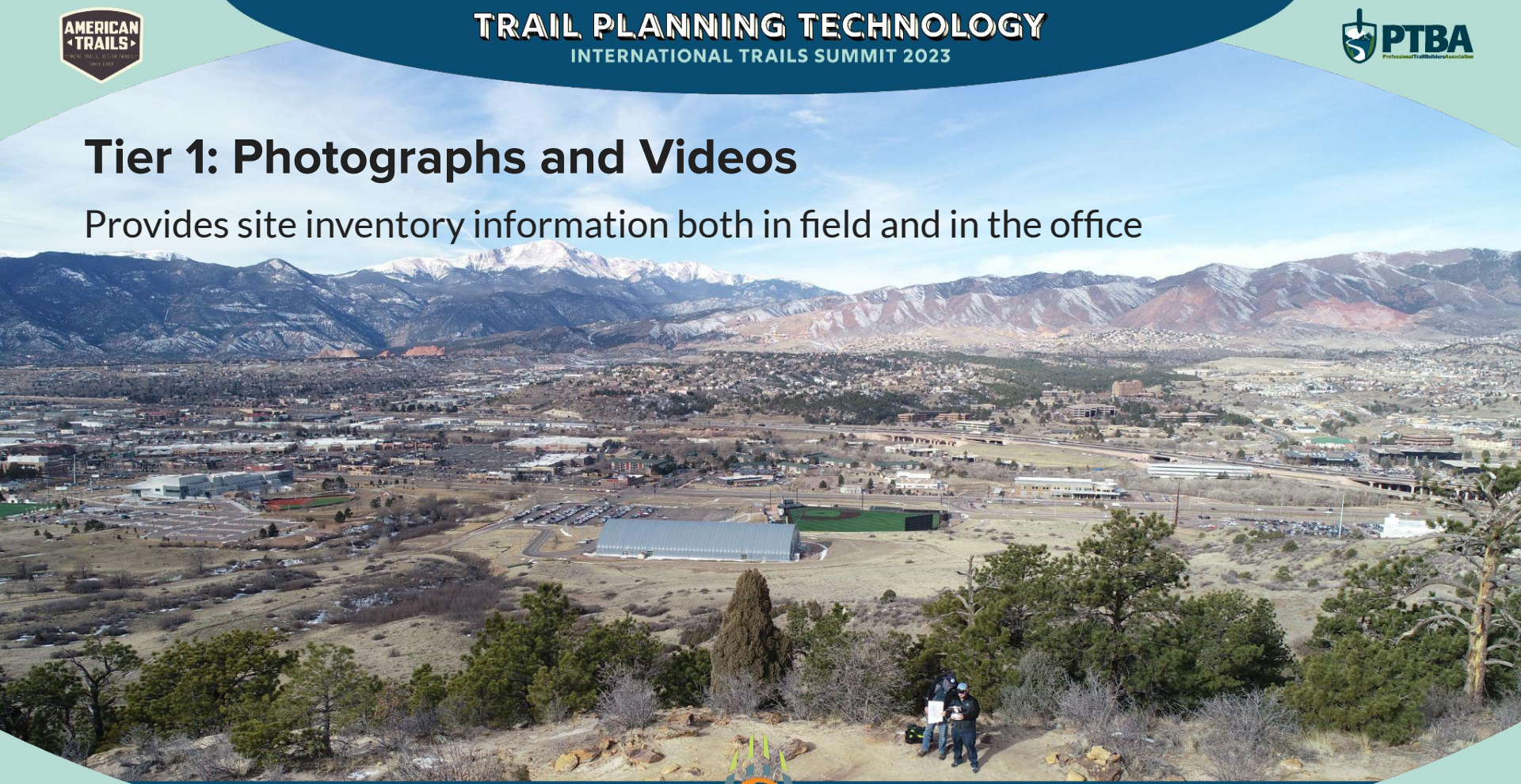
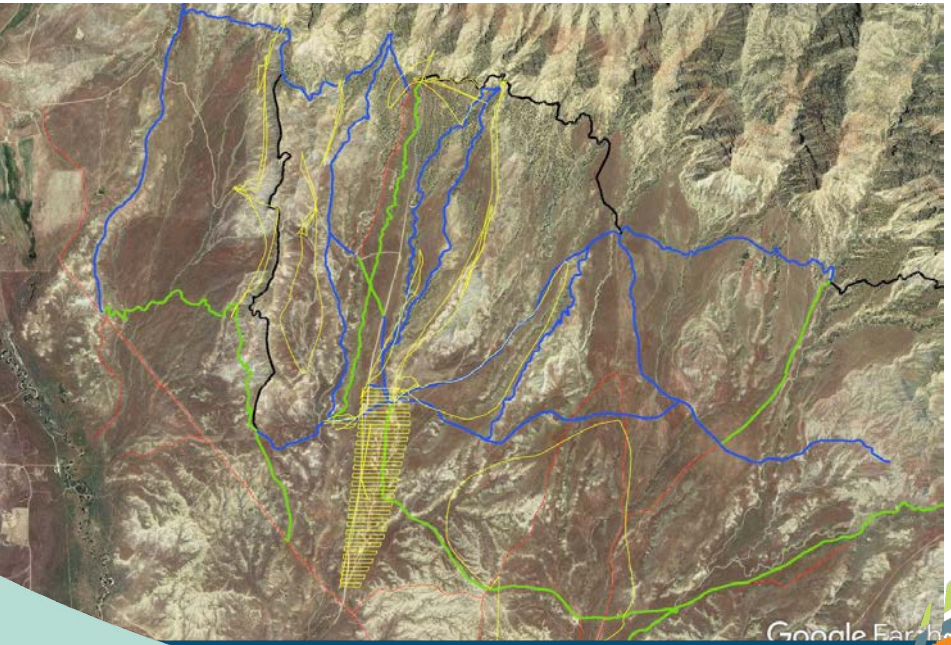
Tier 1: Photographs and Videos

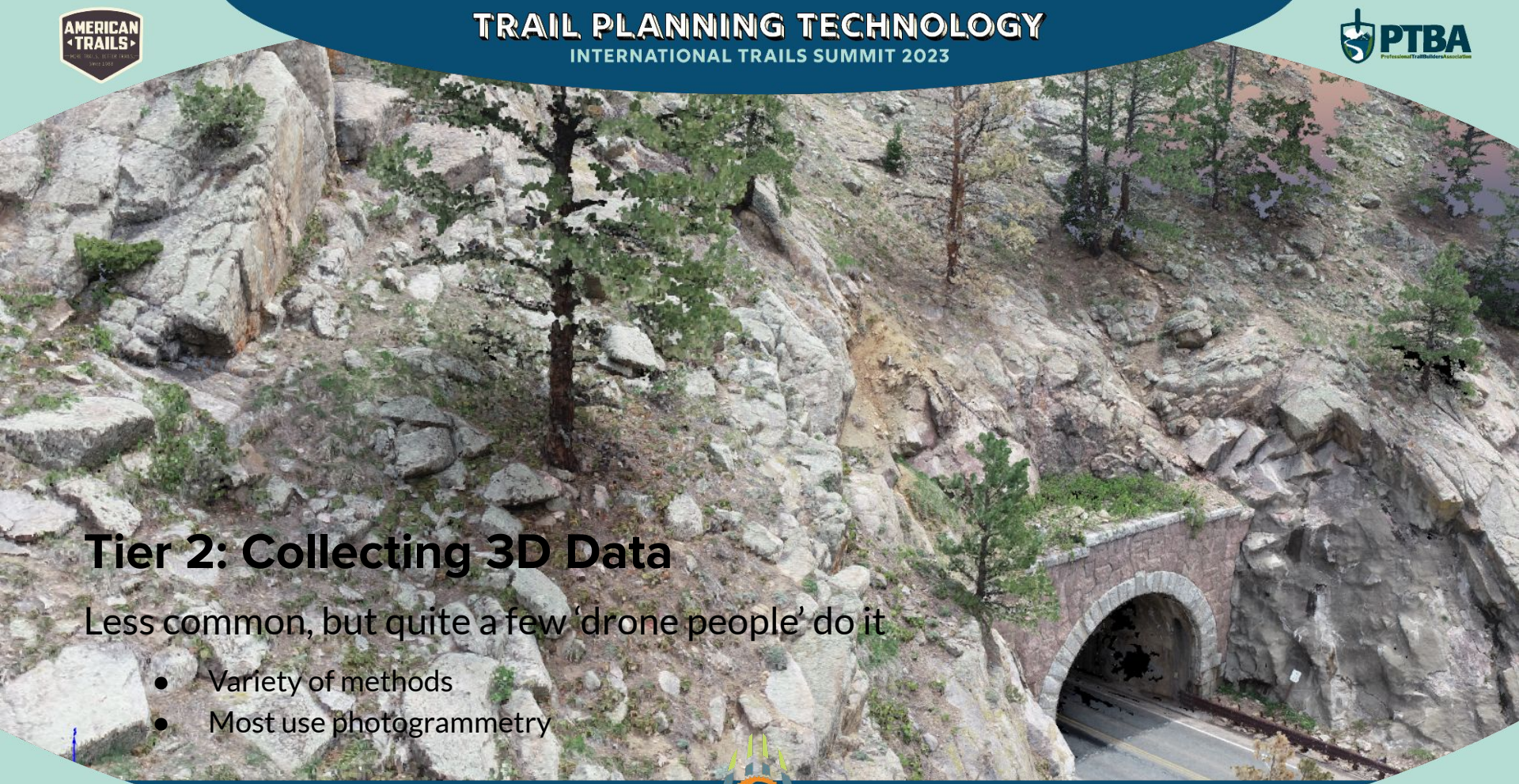
Provides site inventory information both in field and in the office



Tier 1: Photographs and Videos

Geotagged videos and photos





Tier 2: Collecting 3D Data

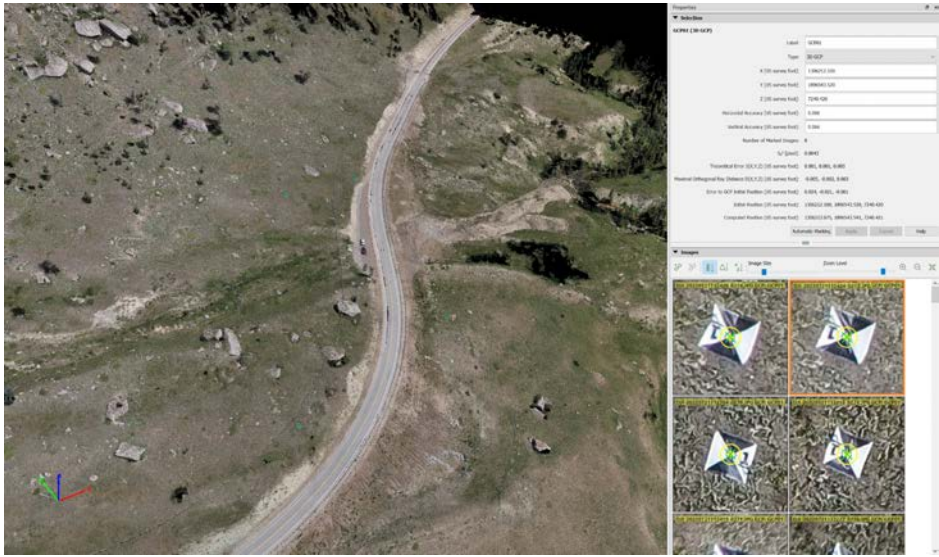
Less common, but quite a few 'drone people' do it

- Variety of methods
- Most use photogrammetry

Tier 2: Collecting 3D Data

Photogrammetry

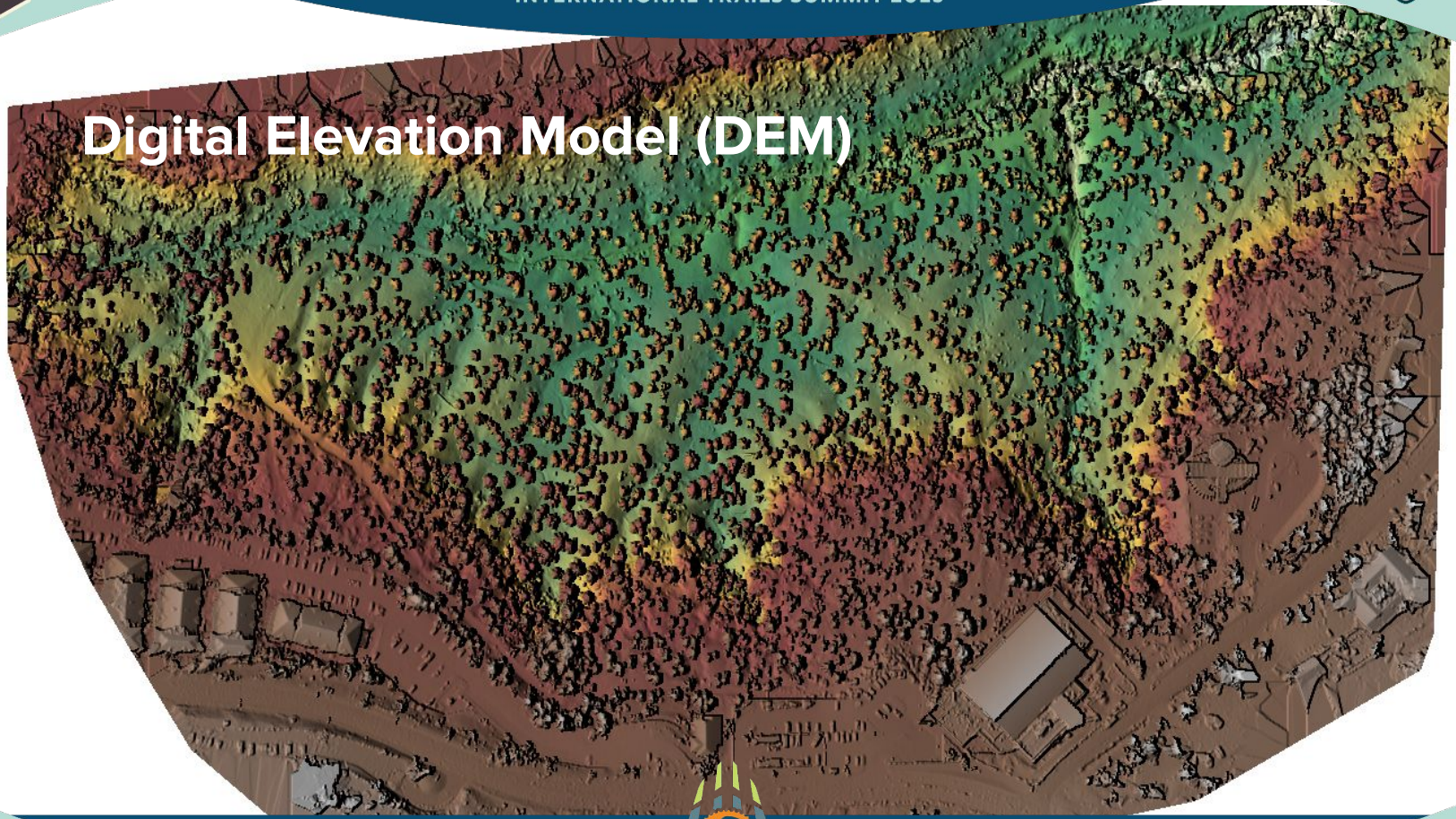
- Uses a series of overlapping photographs
- Creates a 3D model (point cloud and mesh)
- Accuracy heavily relies on:
  - Photograph overlap
  - Angle of images (flight pattern)
  - Distance to subject
  - Ground Control Points (GCPs)



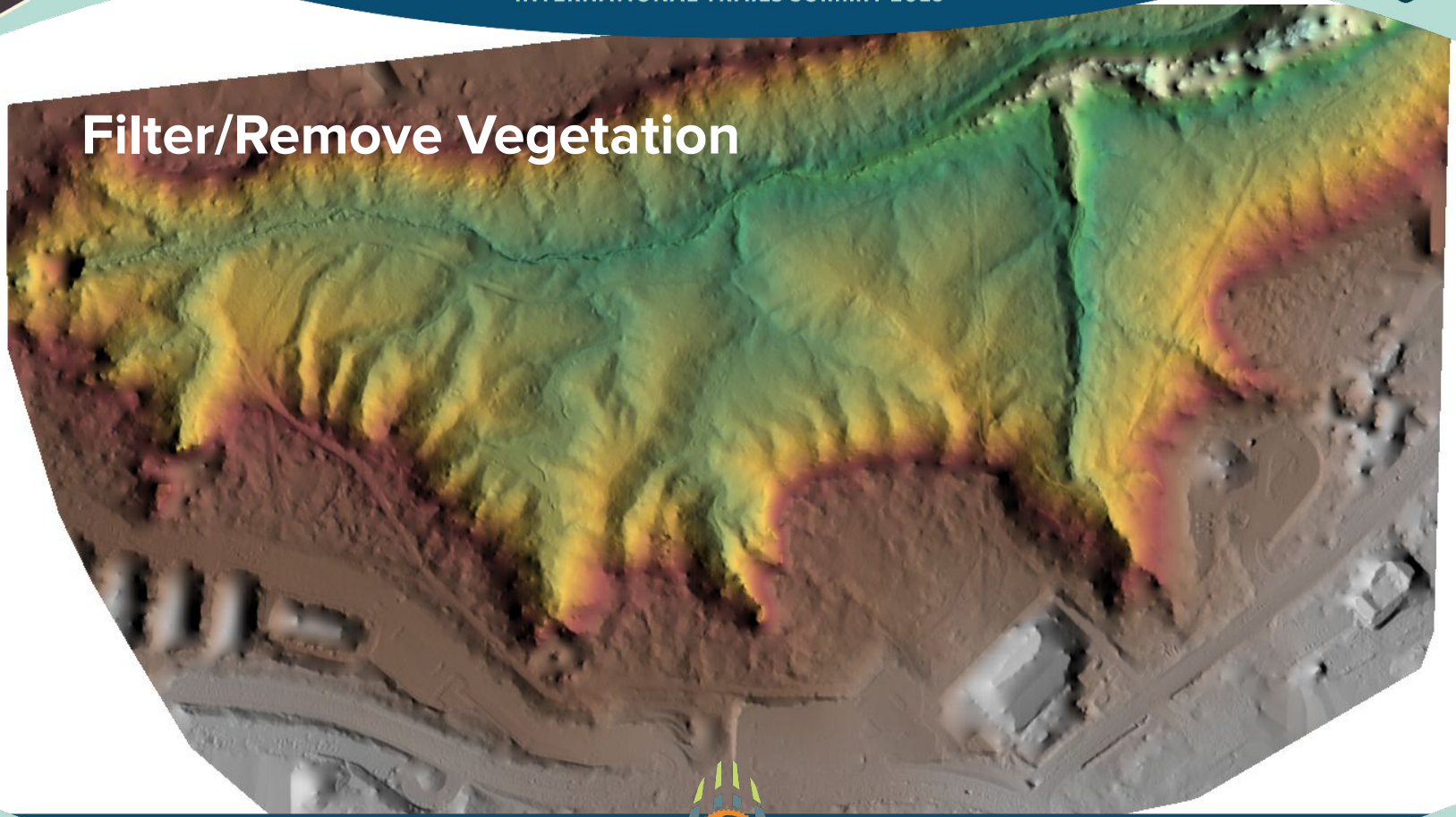
What can we get out of photogrammetry?

Orthorectified High Resolution Imagery

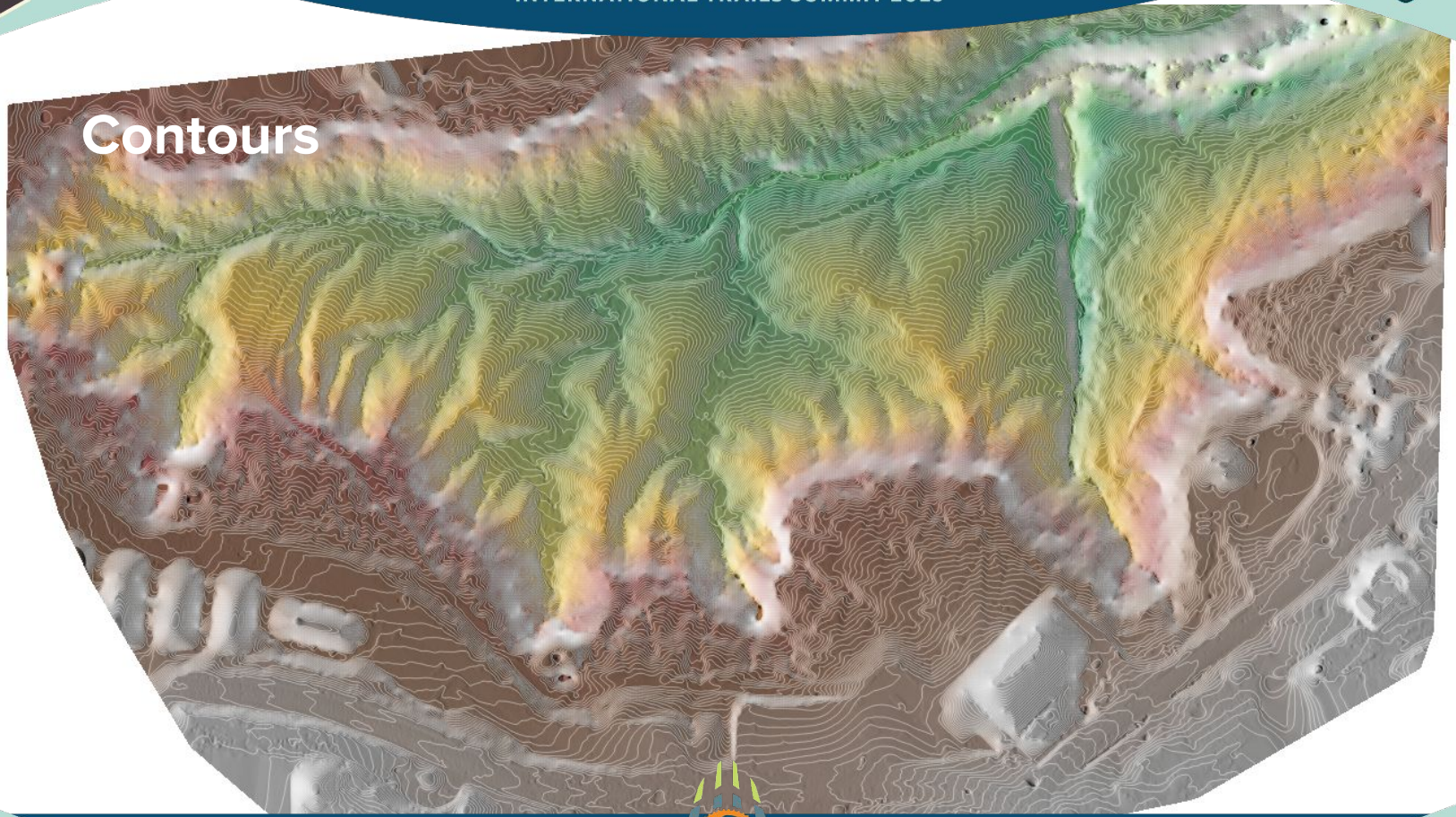
Digital Elevation Model (DEM)



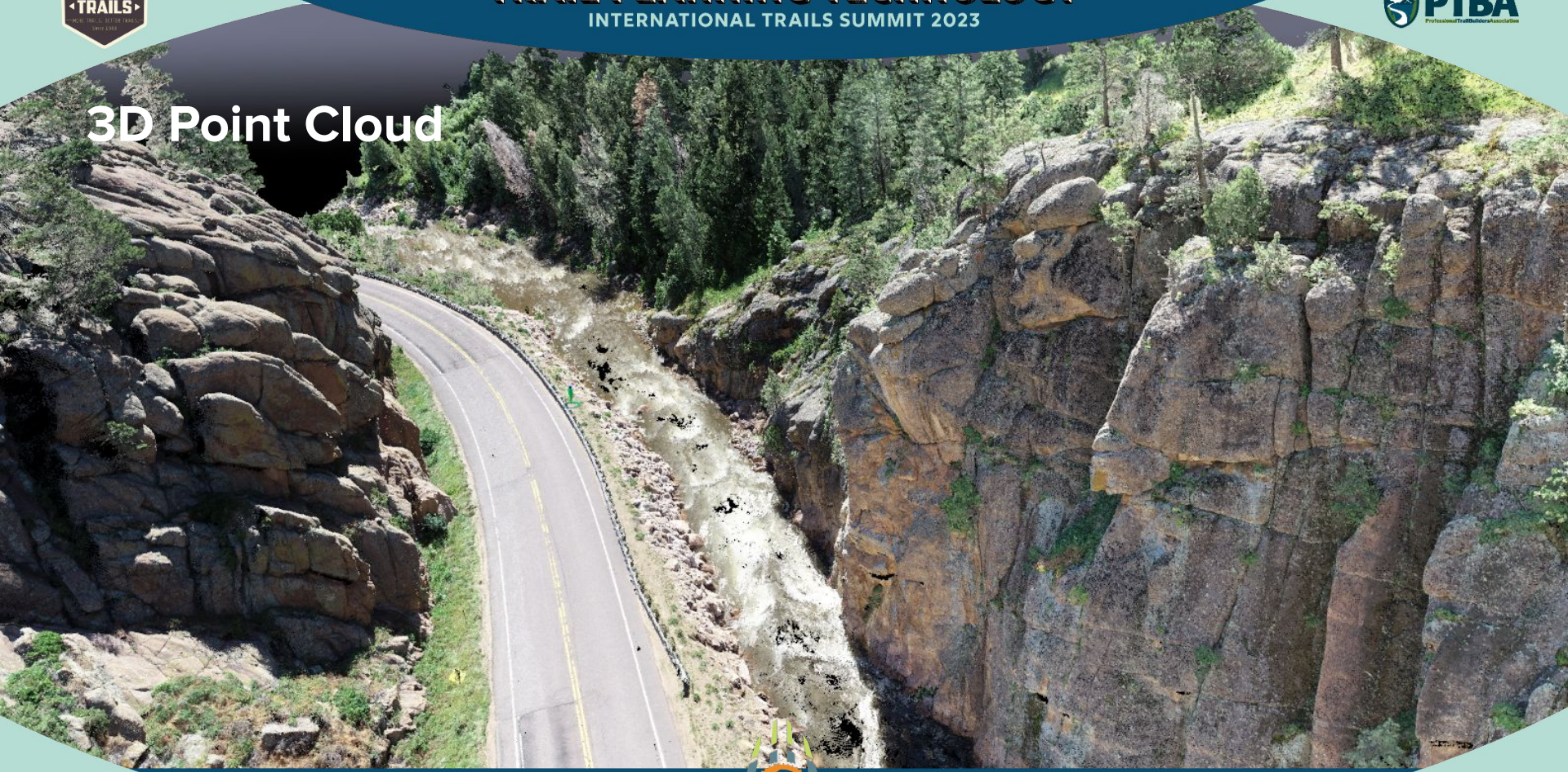
Filter/Remove Vegetation



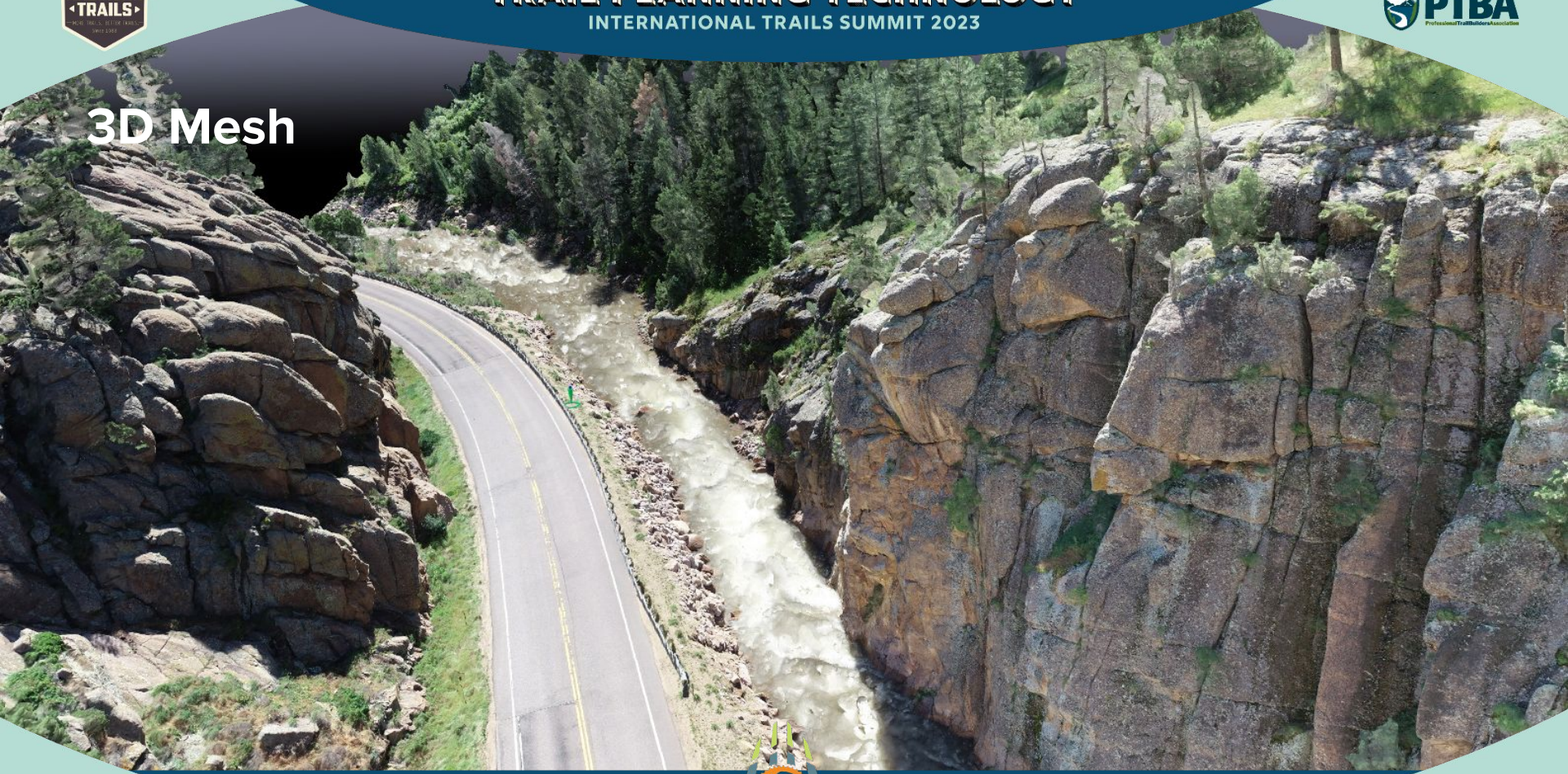
Contours



3D Point Cloud

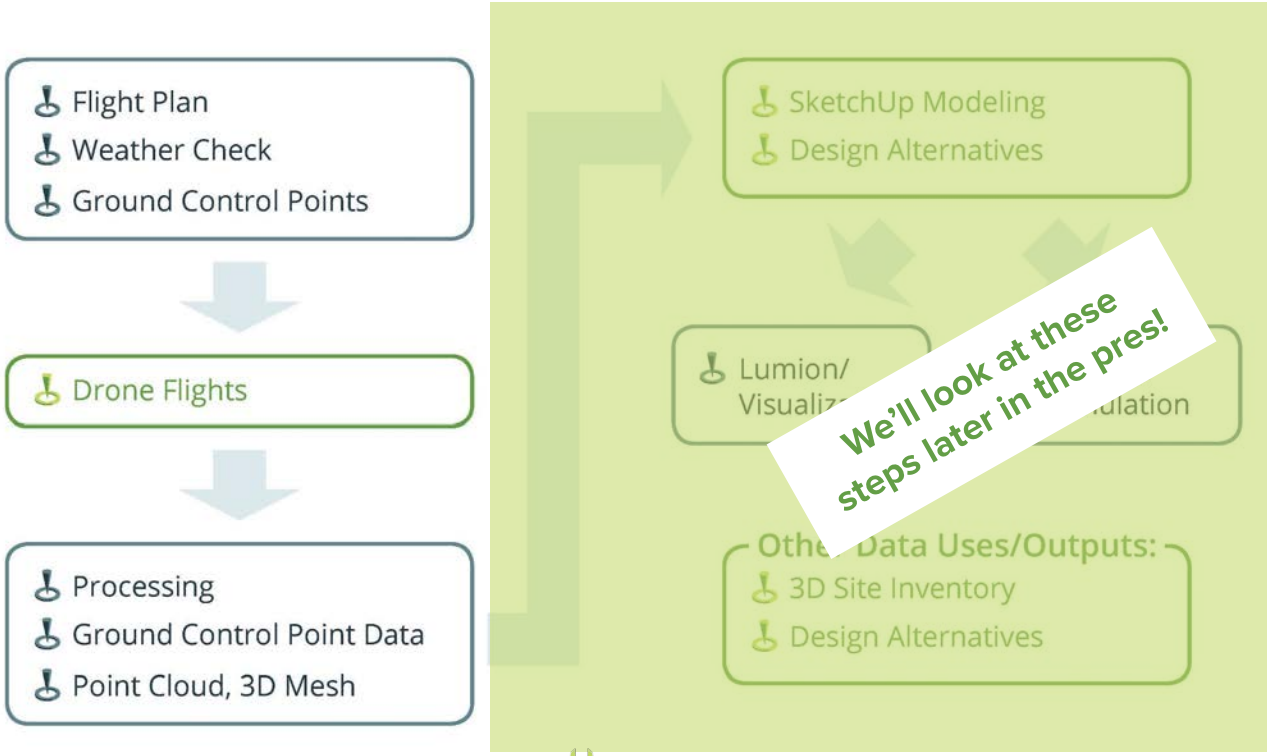


3D Mesh



3D Site Inventory

What does this process look like?

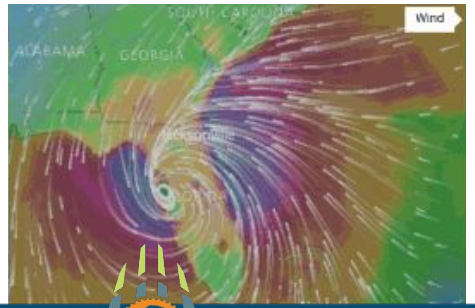

Flight Plan
Weather Check
Ground Control Points
Drone Flights
Processing
Ground Control Point Data
Point Cloud, 3D Mesh
SketchUp Modeling
Design Alternatives
Lumion/
We'll look at these steps later in the pres!
Data Uses/Outputs:
3D Site Inventory
Design Alternatives

Flight Plan
Weather Check
Ground Control Points
Drone Flights
Processing
Ground Control Point Data
Point Cloud, 3D Mesh
SketchUp Modeling
Design Alternatives
Lumion/ Visualization
Rockfall Simulation
Other Data Uses/Outputs:
3D Site Inventory
Design Alternatives

Flight Planning

Crucial to success of the mission

- Flight areas
- Battery times
- Operator areas
- FAA regulations
- Weather
- GCPs
- Traffic control



Ground Control Points

Required for accurate results

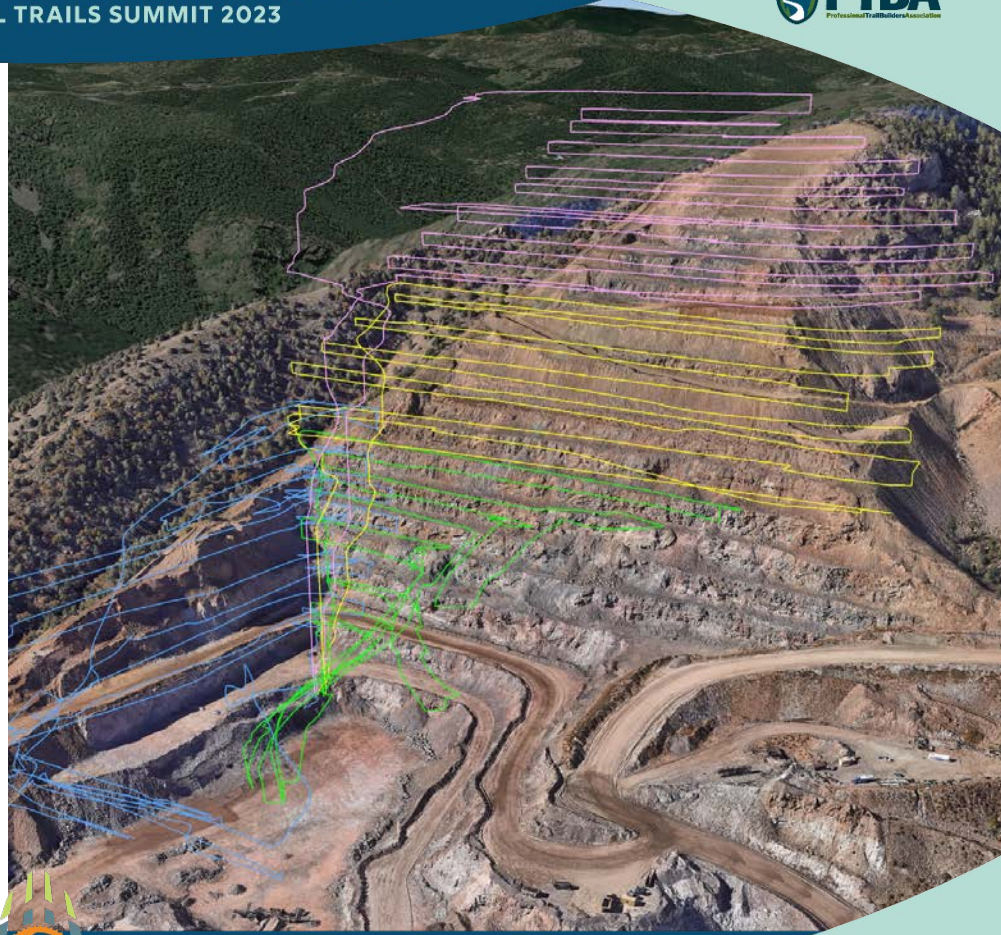
Absolute accuracy
vs.
Relative accuracy

Flight Pattern Options

How much overlap?

How far from the subject?

What type of flight pattern/grid?



Nadir Flight Grid

Most common

Nadir = looking straight down

Horizontal, automated grid

Consistent height above ground (subject)

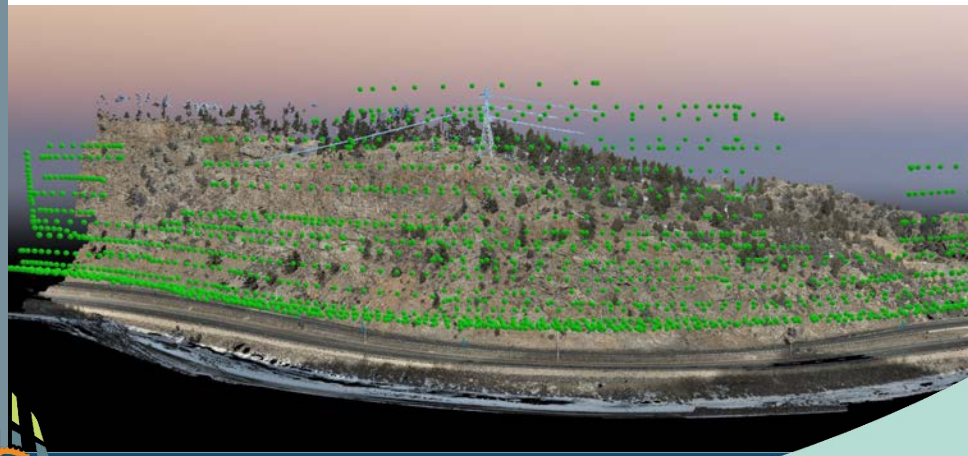
Oblique Flight Grid

Least common

Oblique = at an angle

Fly ‘around’ the subject

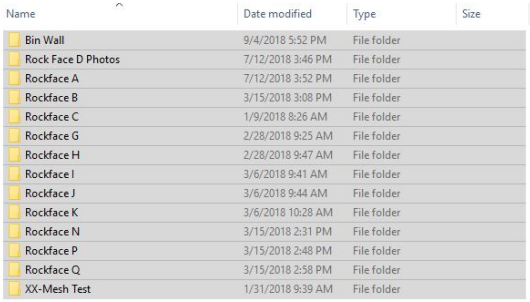
Requires move overlap



Flight Operations

Back to the Office - Post Flight Processing

Download photos



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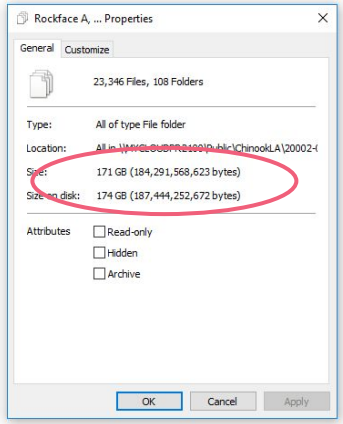
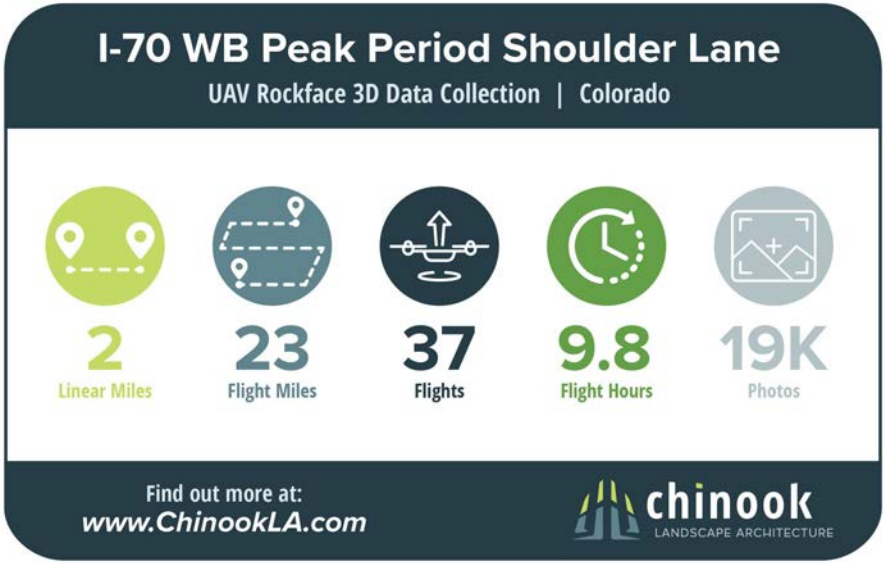
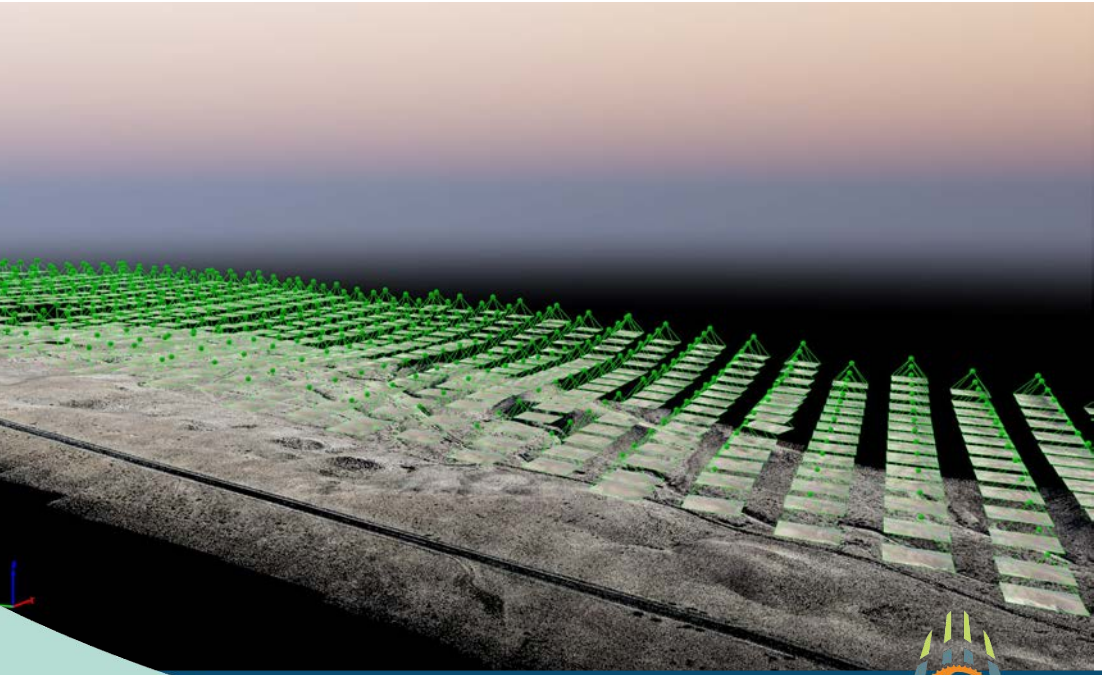
Rock Face D Photos	7/12/2018 3:46 PM	File folder	
Rockface A	7/12/2018 3:52 PM	File folder	
Rockface B	3/15/2018 3:08 PM	File folder	
Rockface C	1/9/2018 8:26 AM	File folder	
Rockface G	2/28/2018 9:25 AM	File folder	
Rockface H	2/28/2018 9:47 AM	File folder	
Rockface I	3/6/2018 9:41 AM	File folder	
Rockface J	3/6/2018 9:44 AM	File folder	
Rockface K	3/6/2018 10:28 AM	File folder	
Rockface N	3/15/2018 2:31 PM	File folder	
Rockface P	3/15/2018 2:48 PM	File folder	
Rockface Q	3/15/2018 2:58 PM	File folder	
XX-Mesh Test	1/31/2018 9:39 AM	File folder	

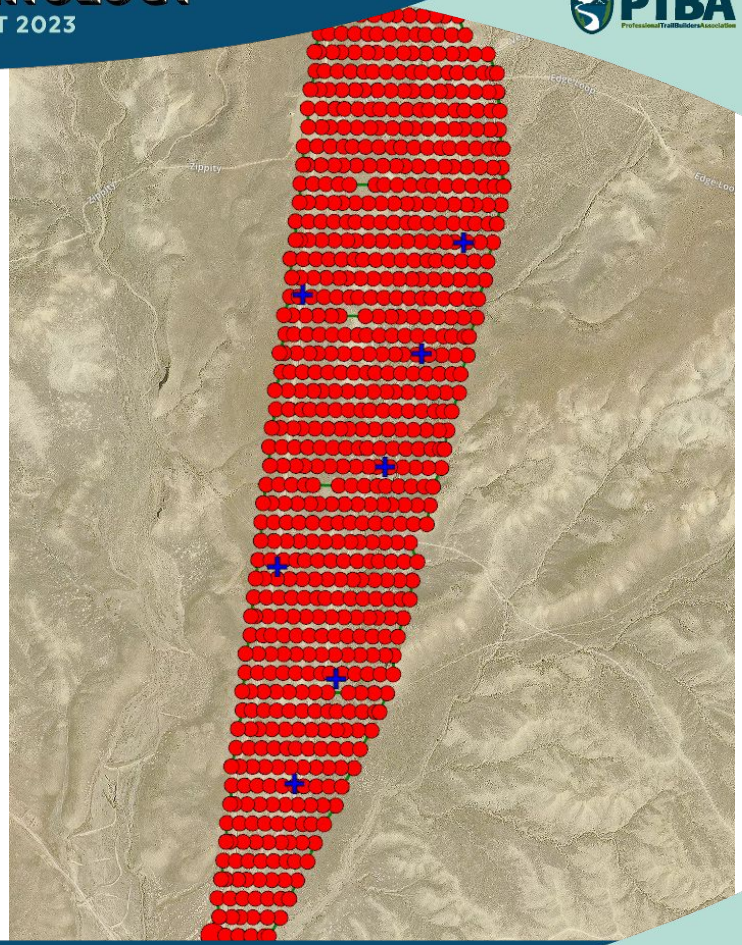




Process. GCPs. Process.

Process with photogrammetry software





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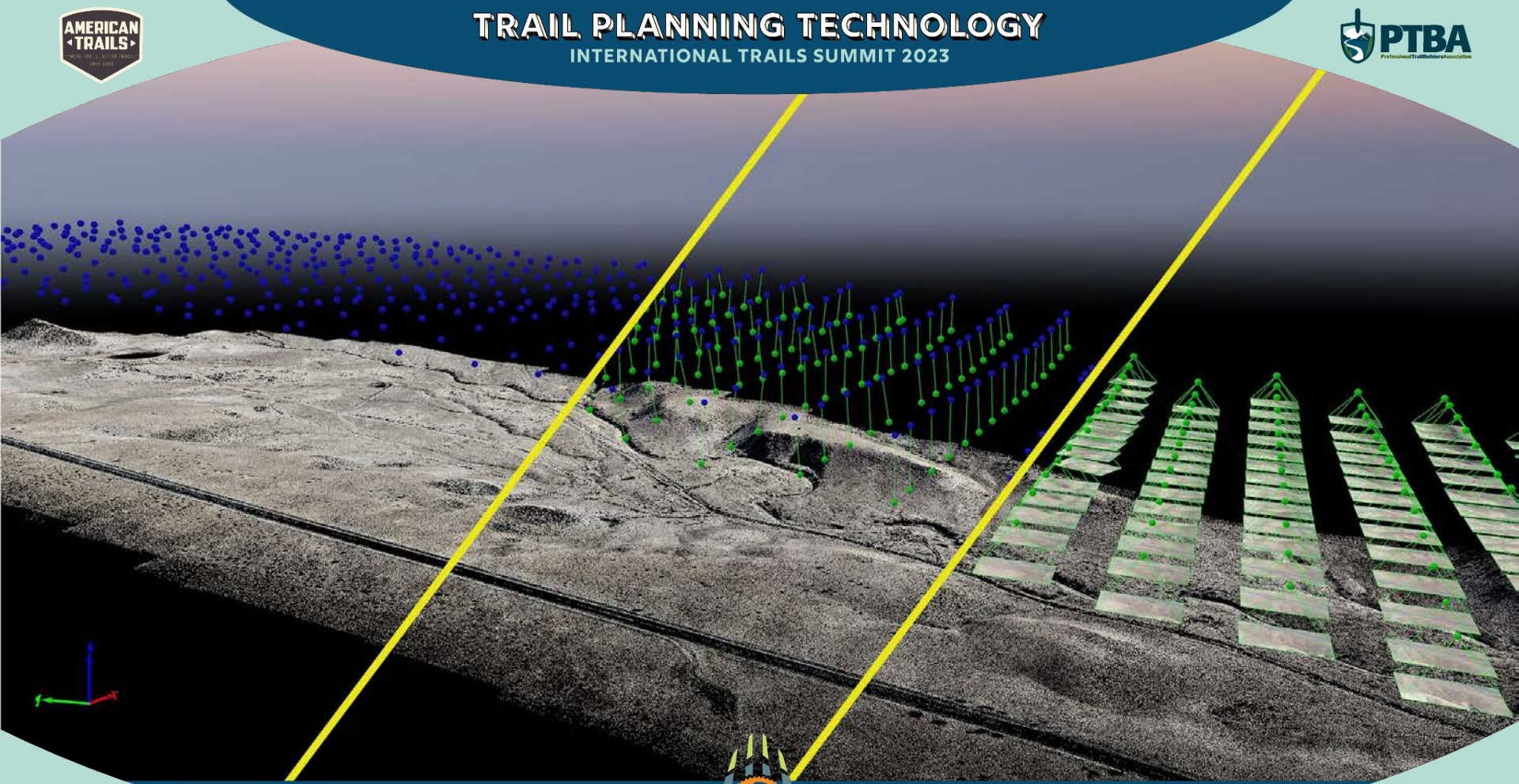

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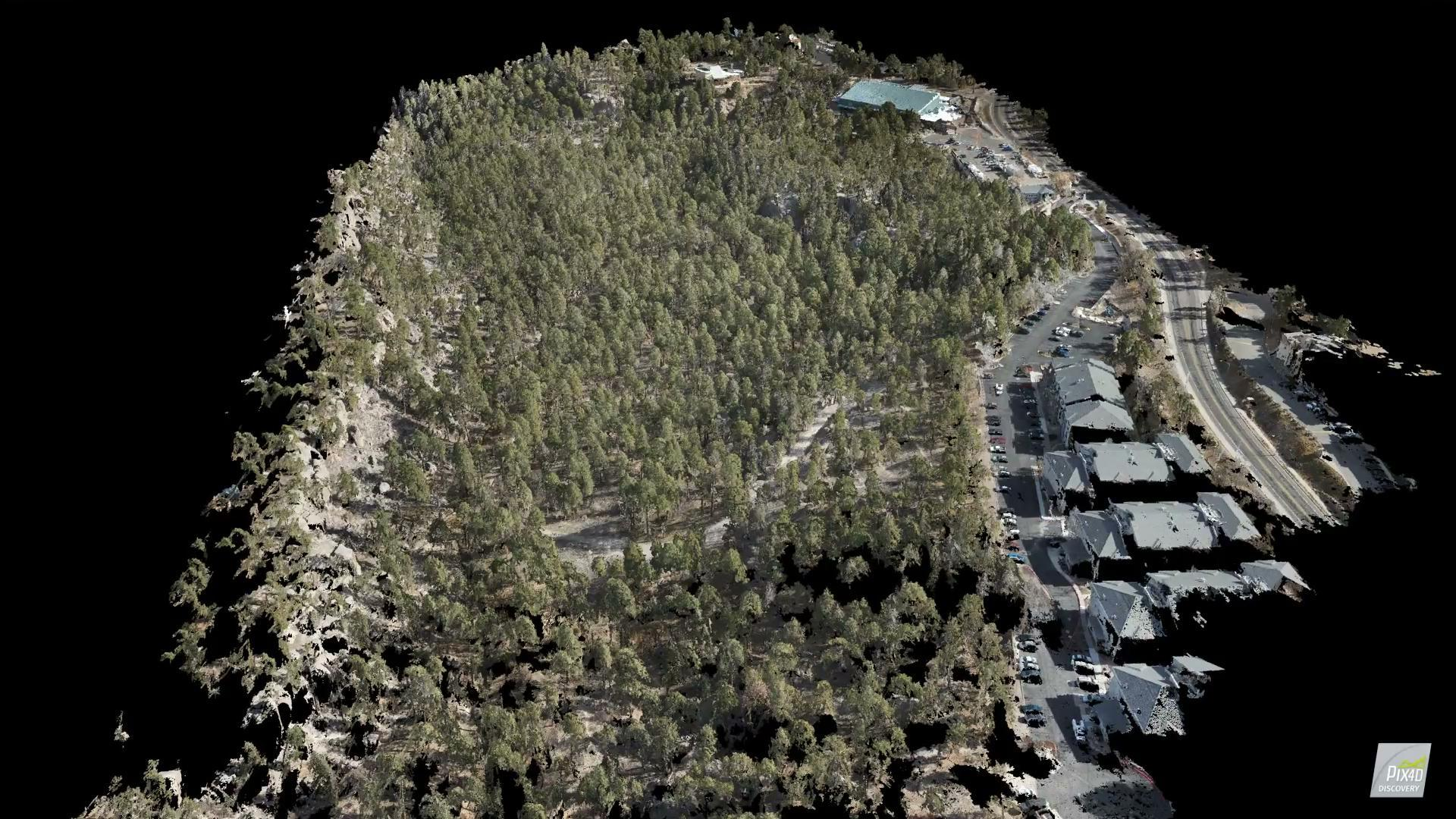
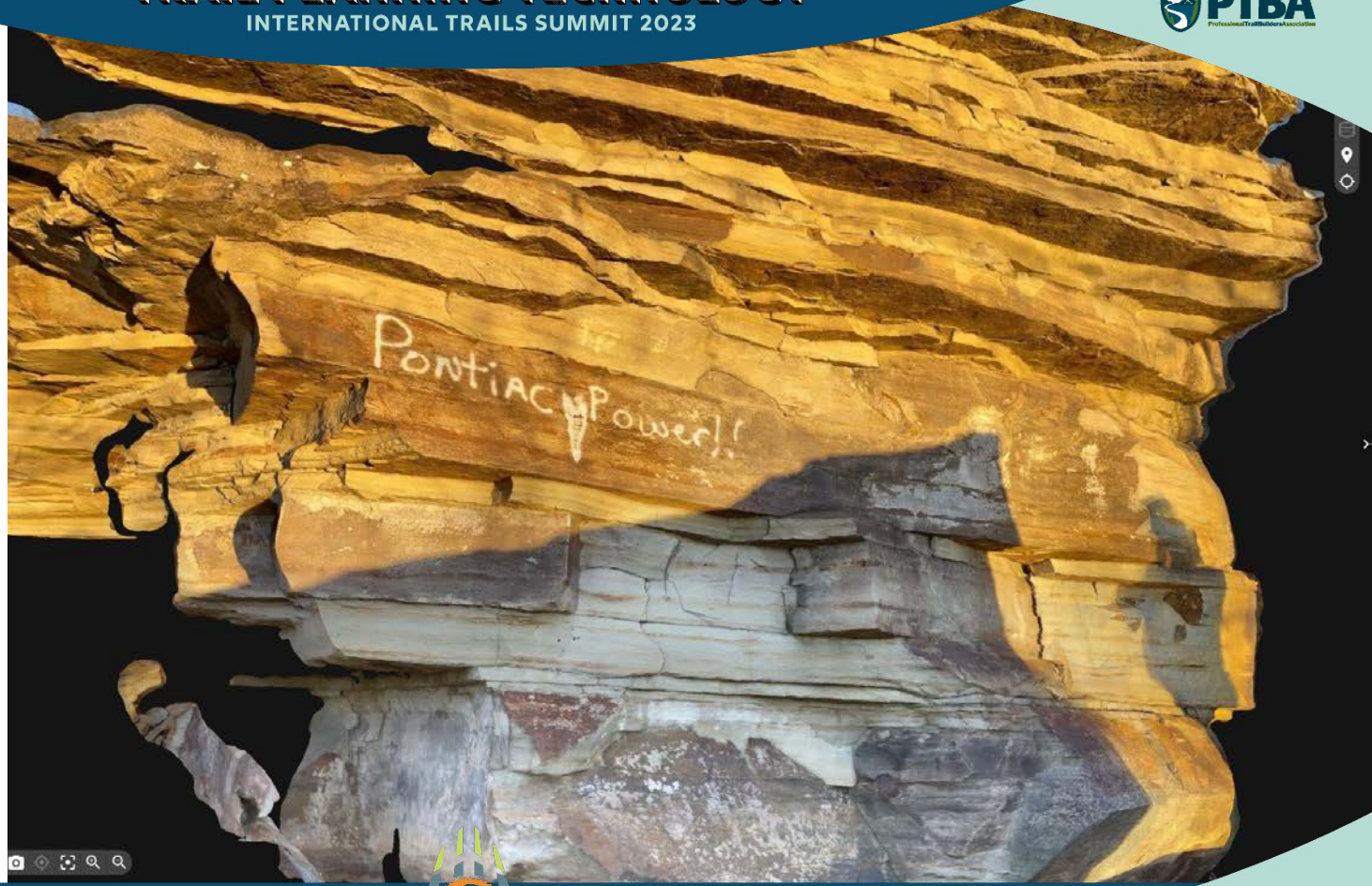

PIX4D
DISCOVERY

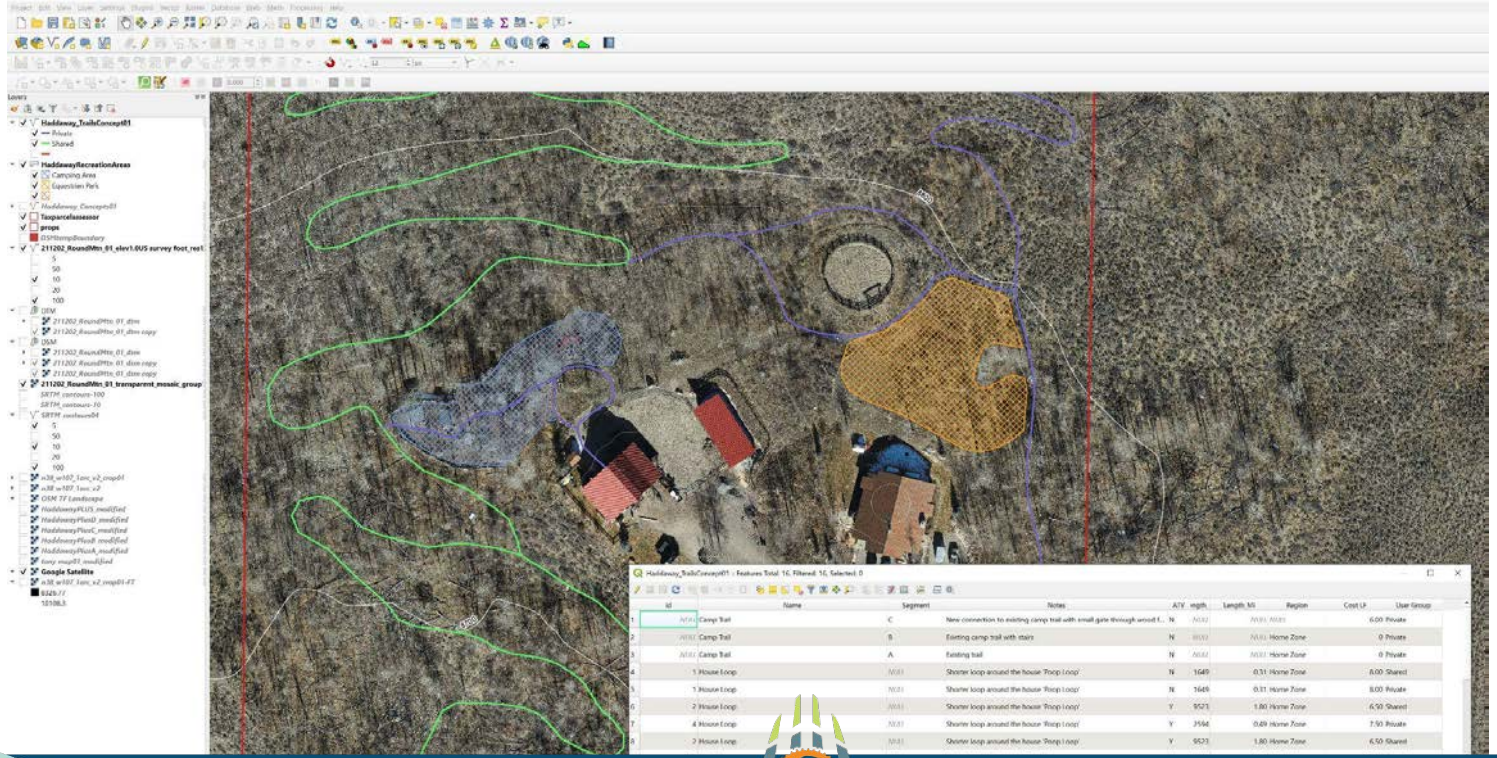
Phone Mapping

Similar to drone mapping, but handheld

- Often, combination of photogrammetry and LiDAR
- Best for smaller areas

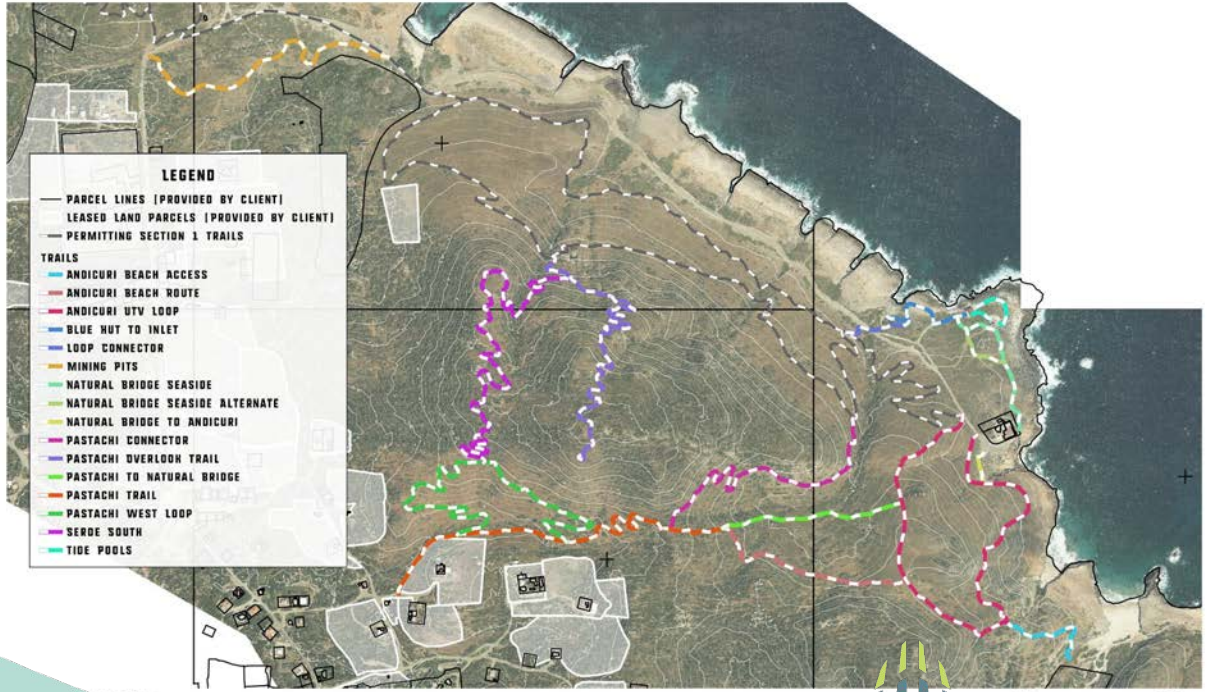


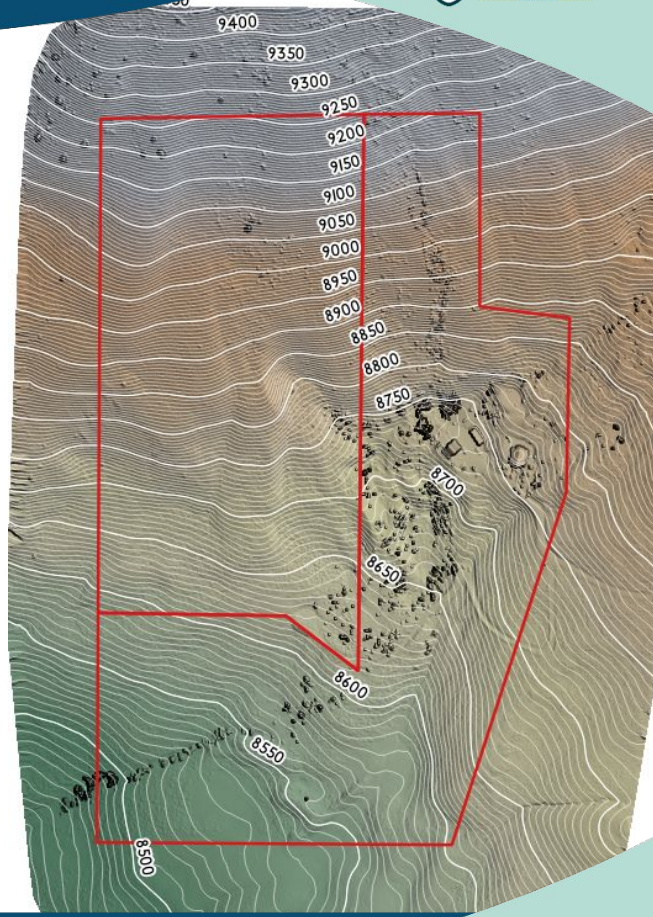
Part II: Design and Planning Tools

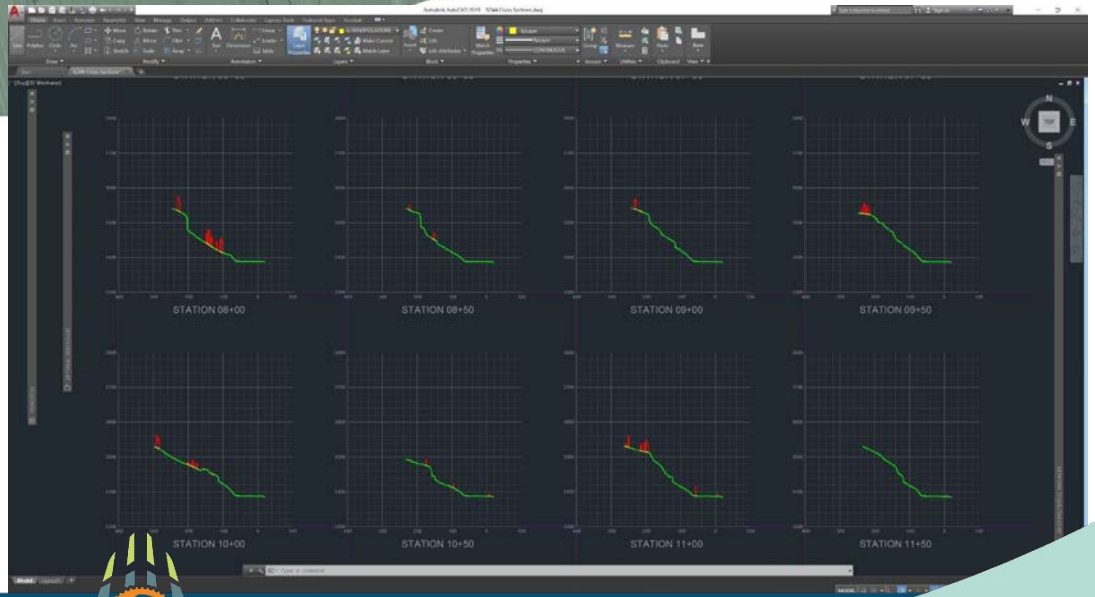


GIS Applications

QGIS and ArcGIS (ESRI)



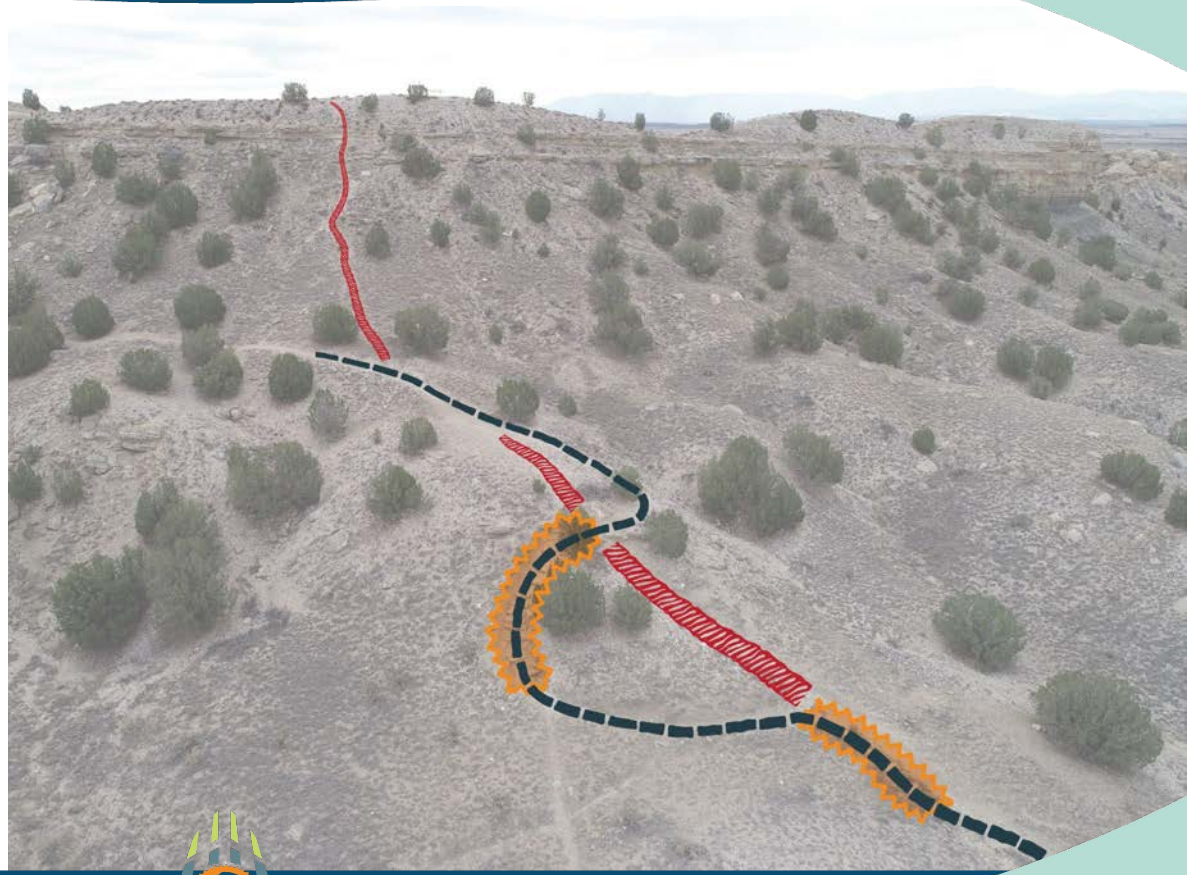


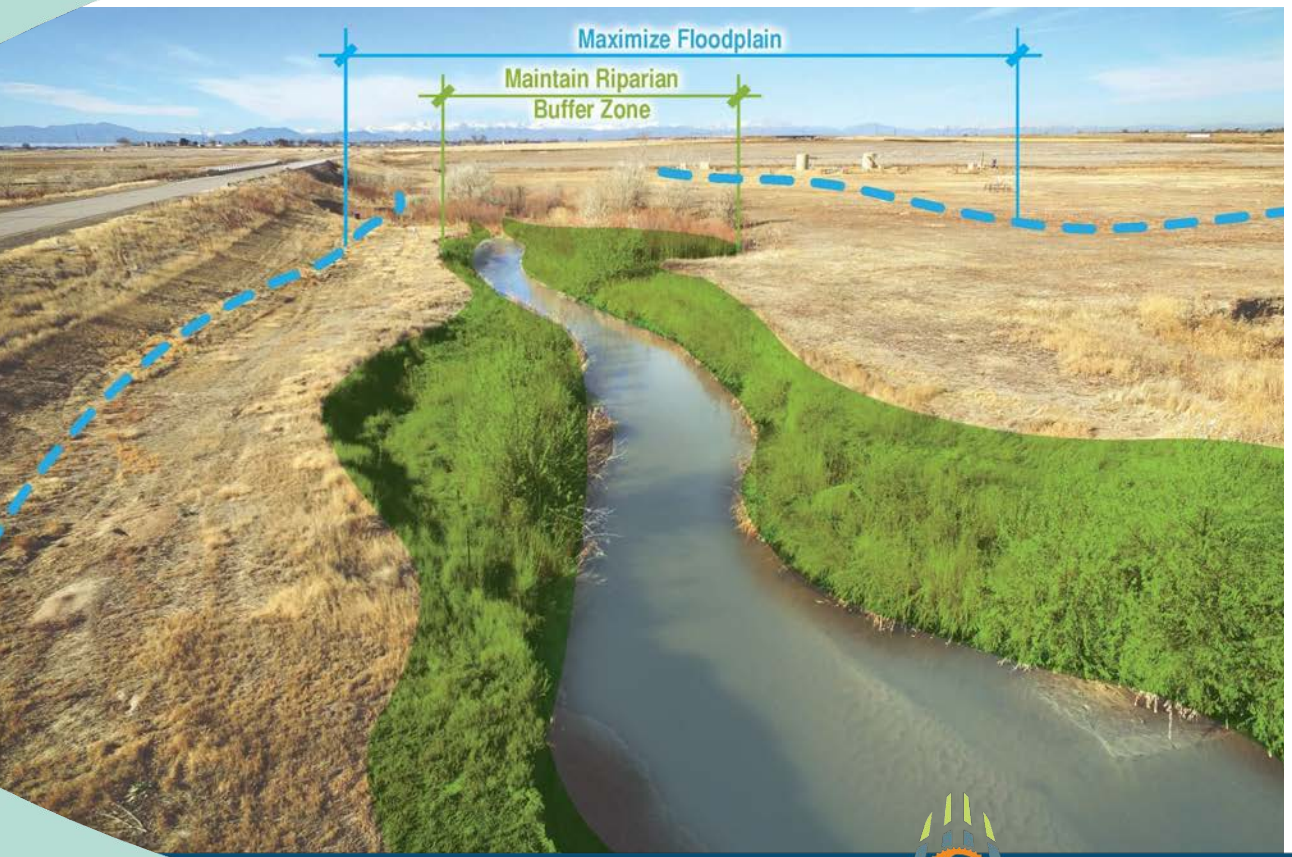


CAD Software

Adobe Products

Photoshop, Illustrator, InDesign, Premiere




Maximize Floodplain
Maintain Riparian
Buffer Zone

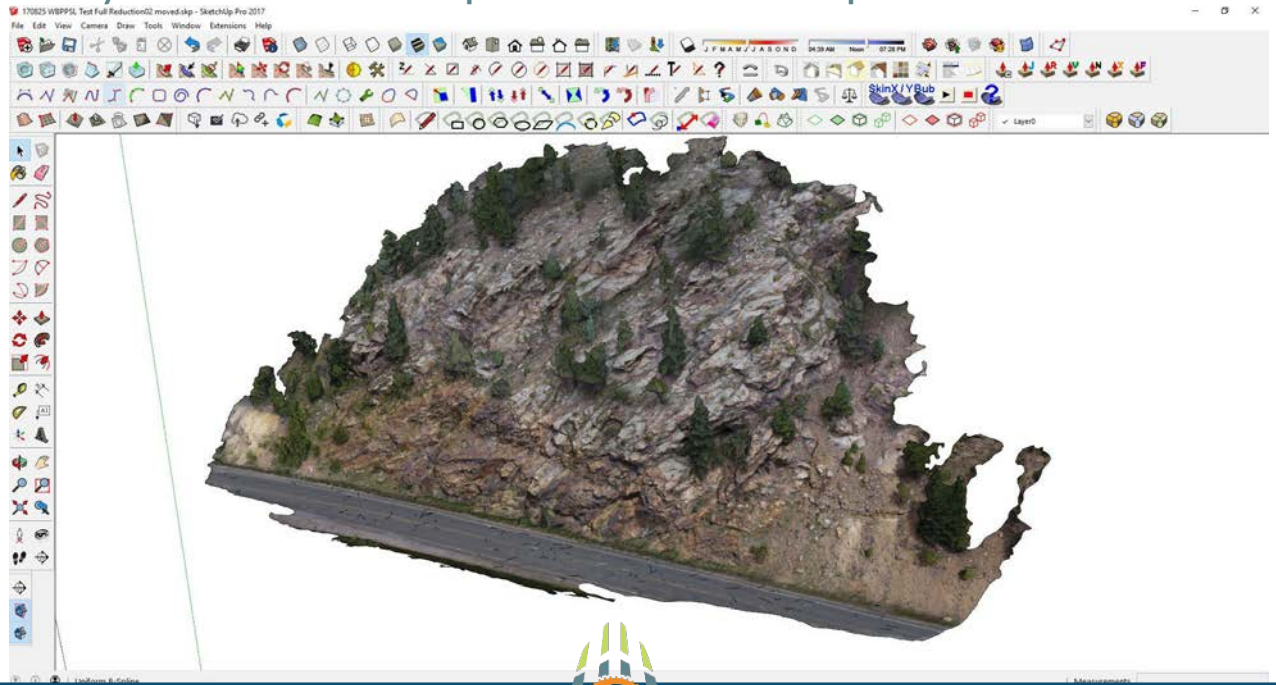
Toland Property (Big Thompson River)
N County Road 31D
Scale
0 75 150 Feet
E
D
C
B
A
Highway 34/Big Thompson Road
A Handy Ditch Diversion
B Revegetate Riparian Bench
C Add Channel Complexity
D Bank Revegetation
E Monitor Downstream Bridge

3D Modeling

SketchUp and Lumion

3D Modeling - SketchUp, Lumion, Photoshop

Photogrammetry model can be exported to SketchUp



TRAIL PLANNING TECHNOLOGY

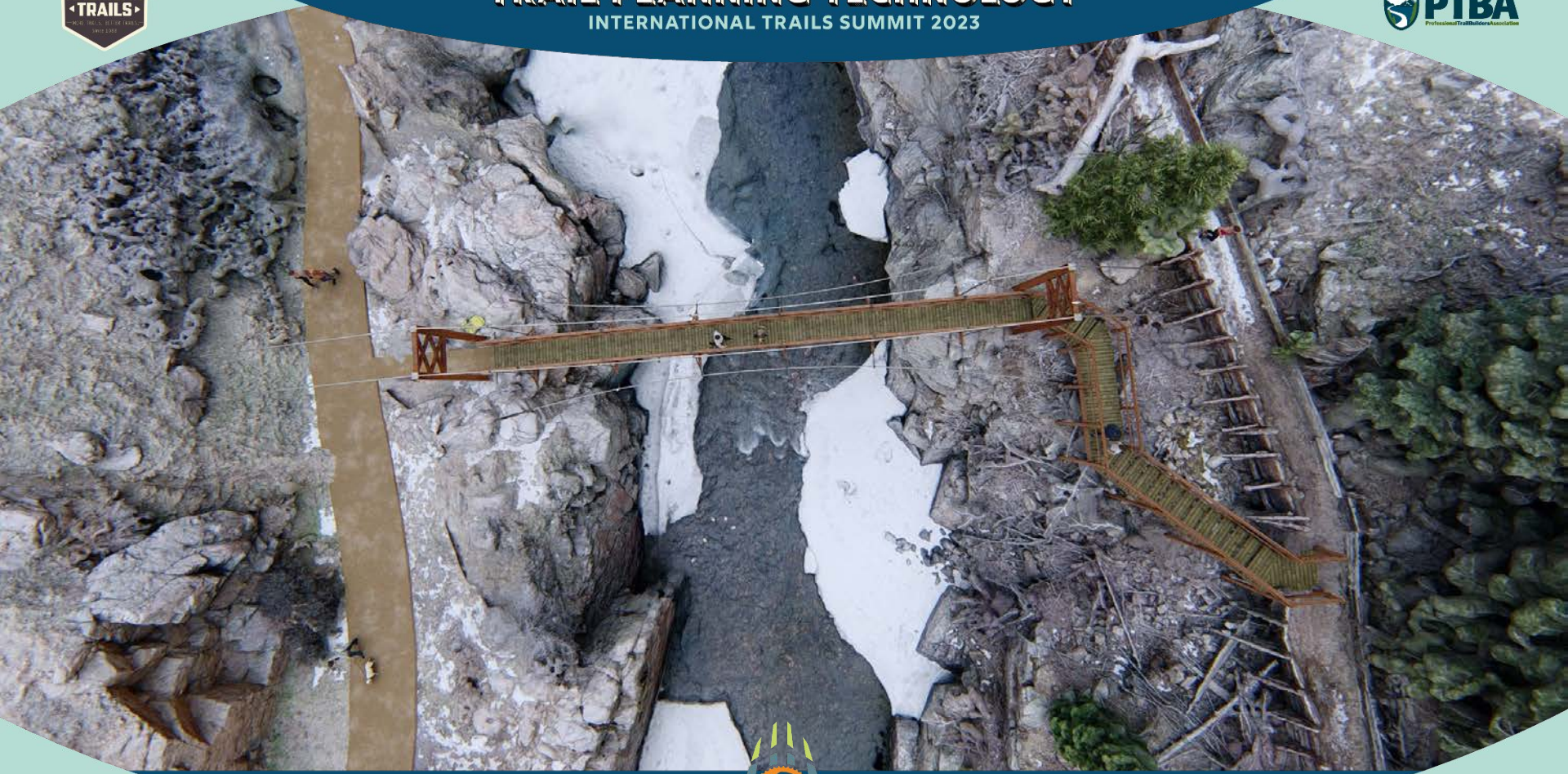
INTERNATIONAL TRAILS SUMMIT 2023

TONY BOONE TRAILS

chinook LANDSCAPE ARCHITECTURE

TRAIL PLANNING TECHNOLOGY

INTERNATIONAL TRAILS SUMMIT 2023



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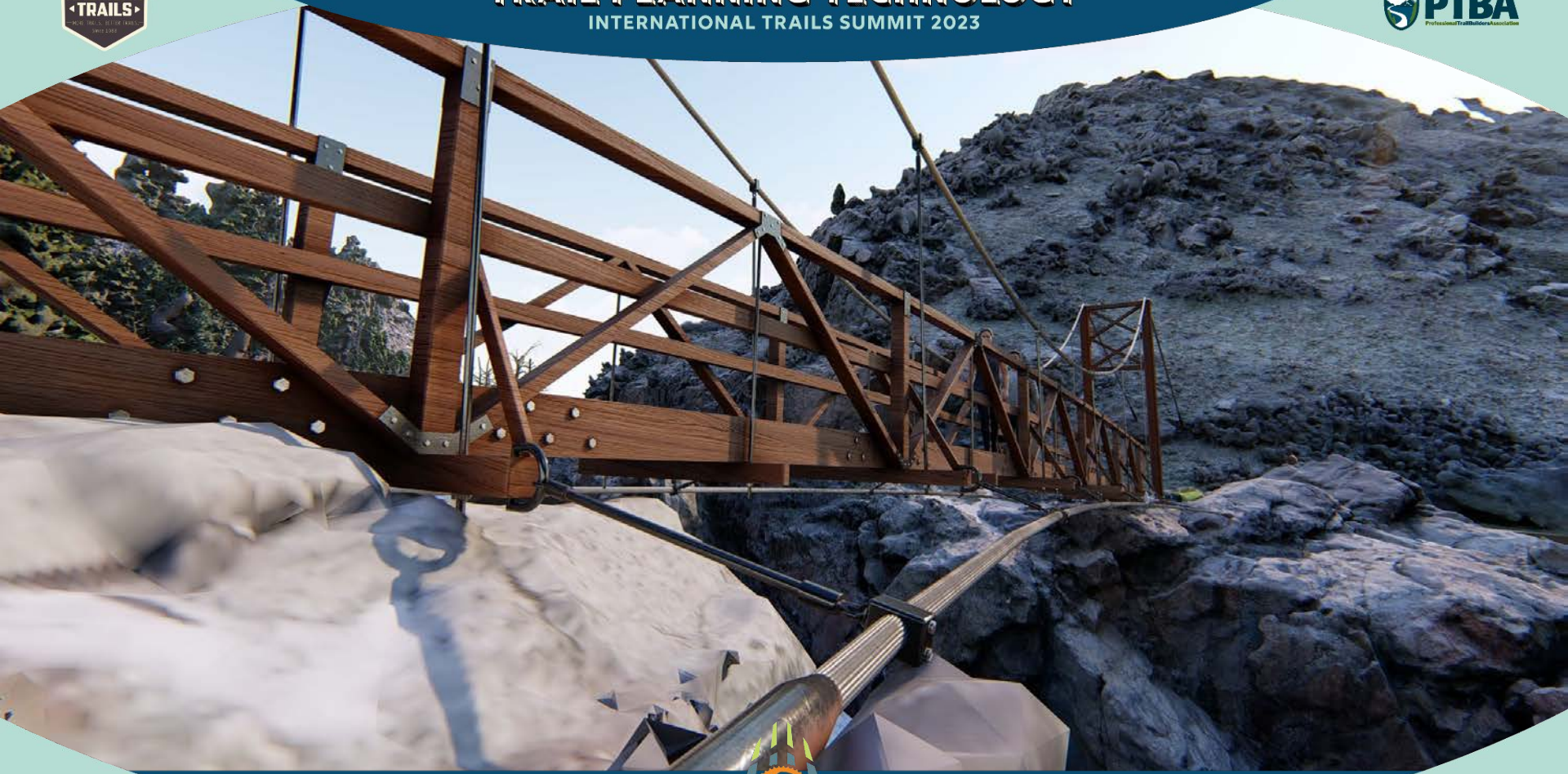

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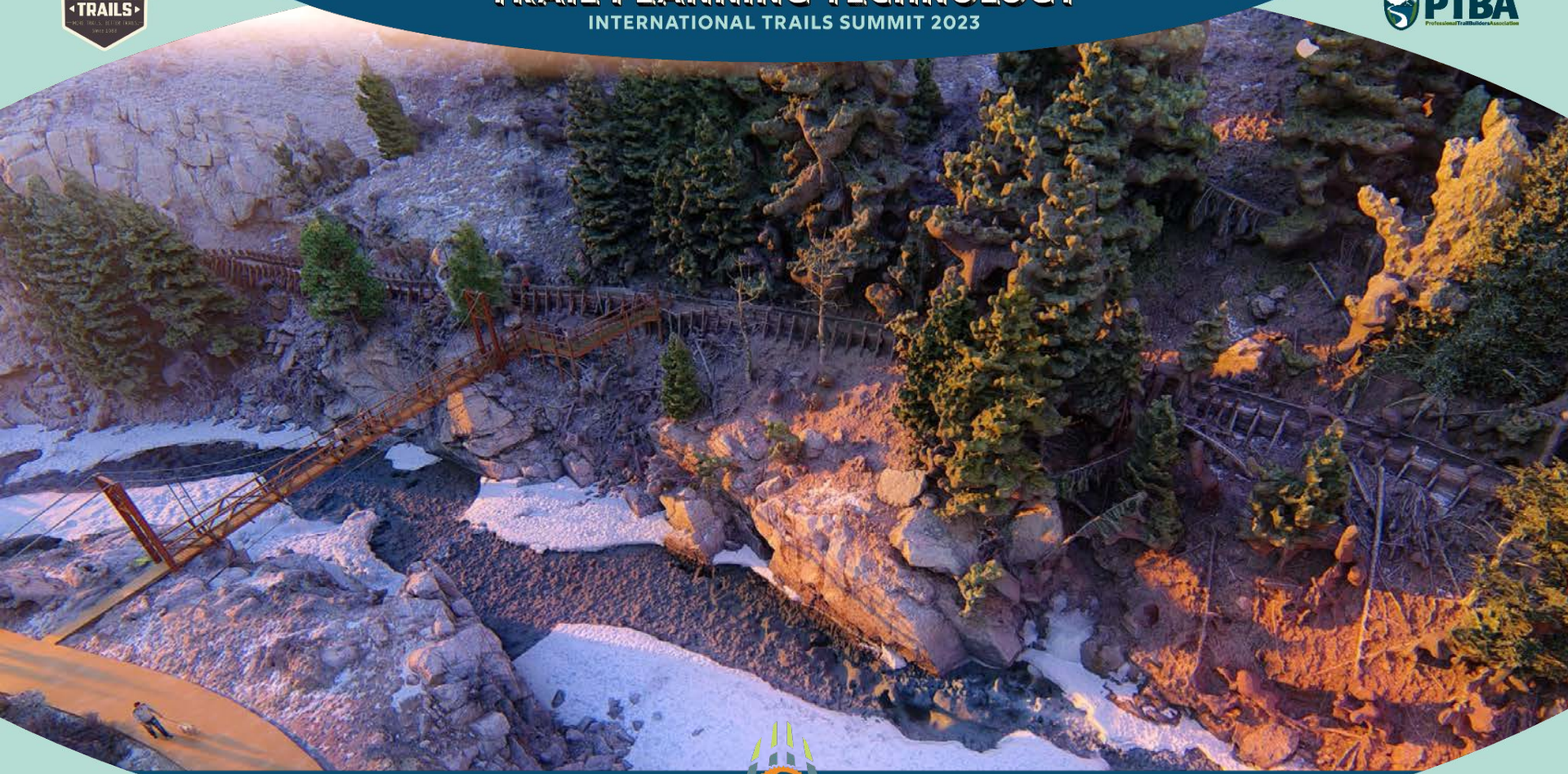

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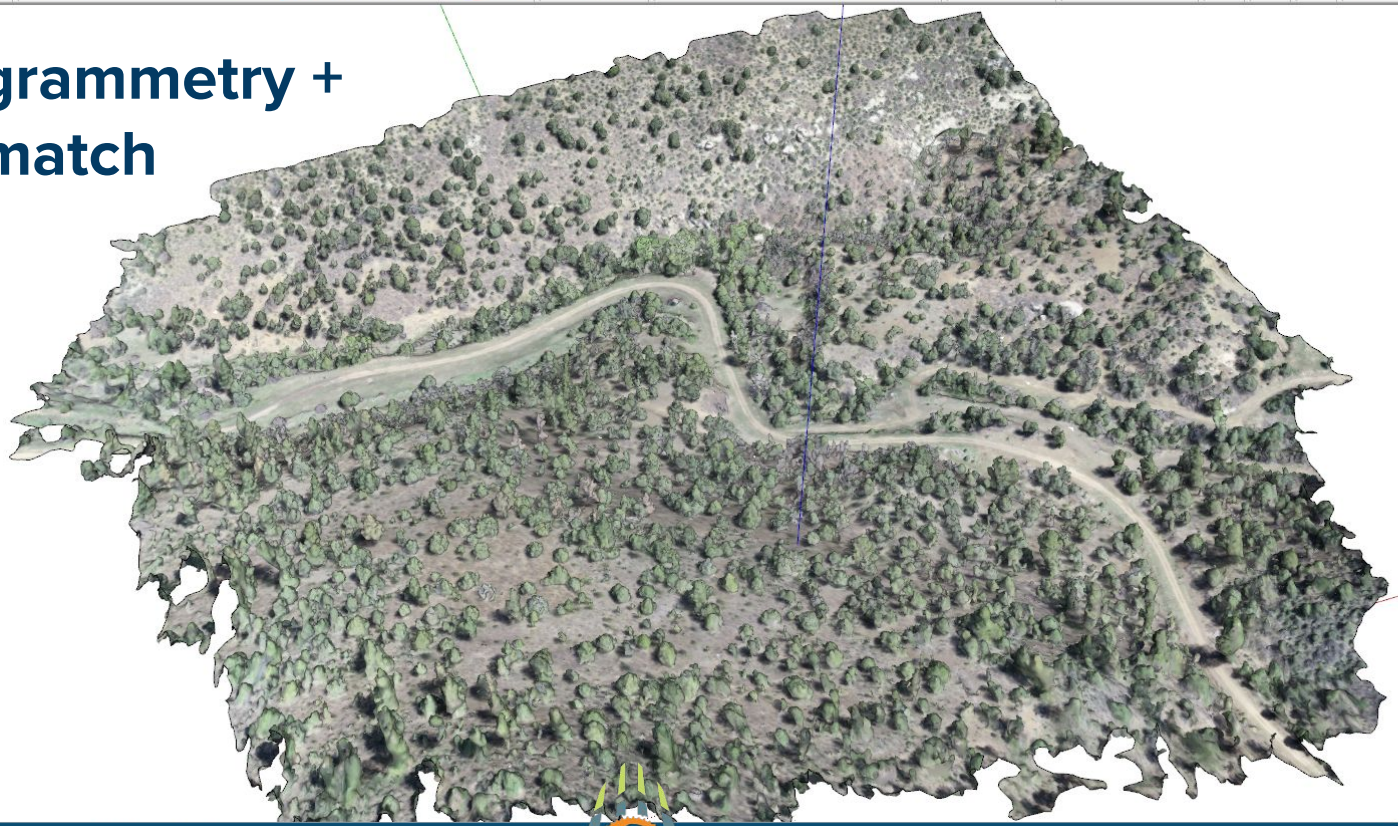
Time investment

- Drone flights - 3 hours with travel (~1 hour flight time)
- Processing - 1 hour
- 3D modeling - 10-12 hours
- Lumion rendering - 2 hours

Total time - ~16-18 hours

Photogrammetry + Photomatch



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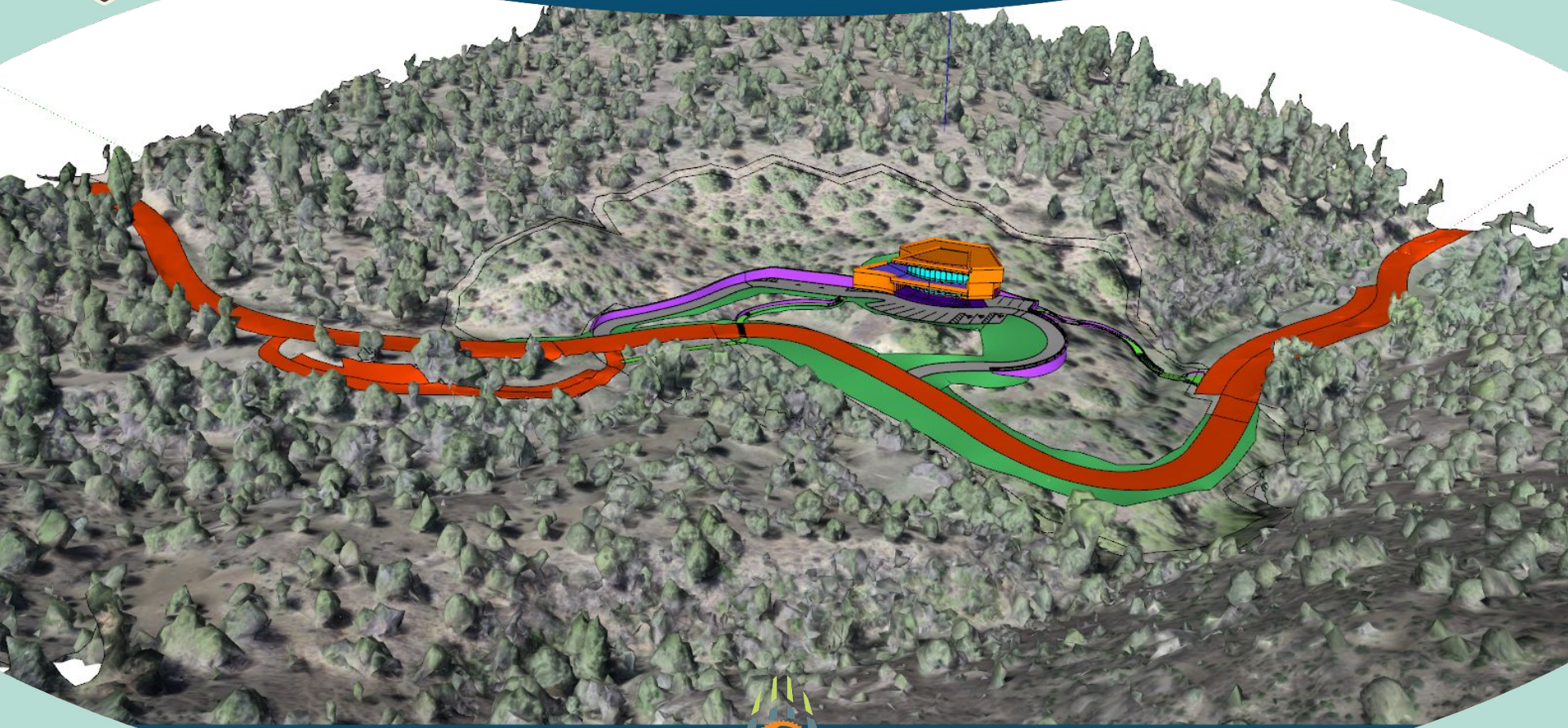

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Drone Photo

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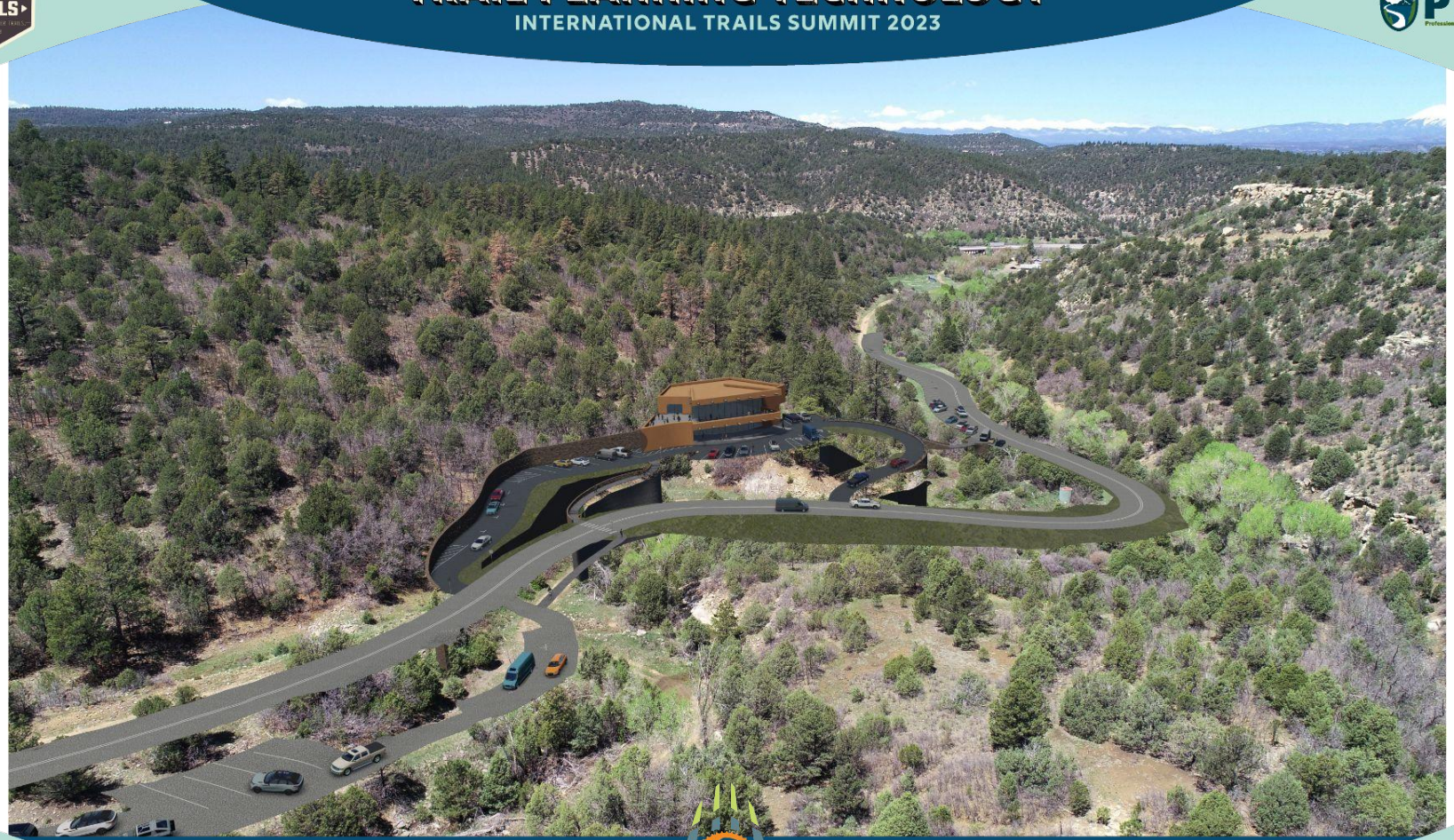

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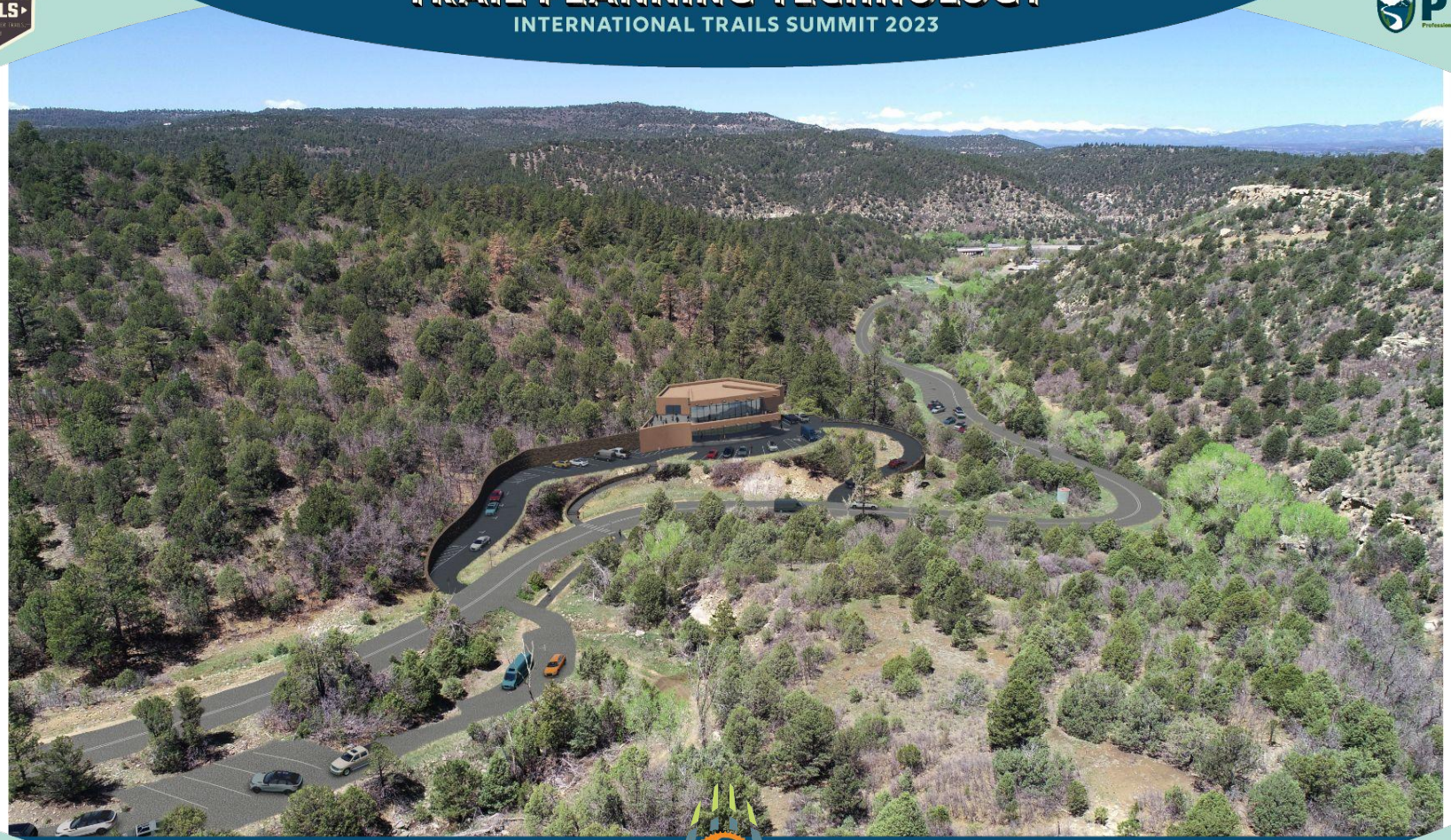

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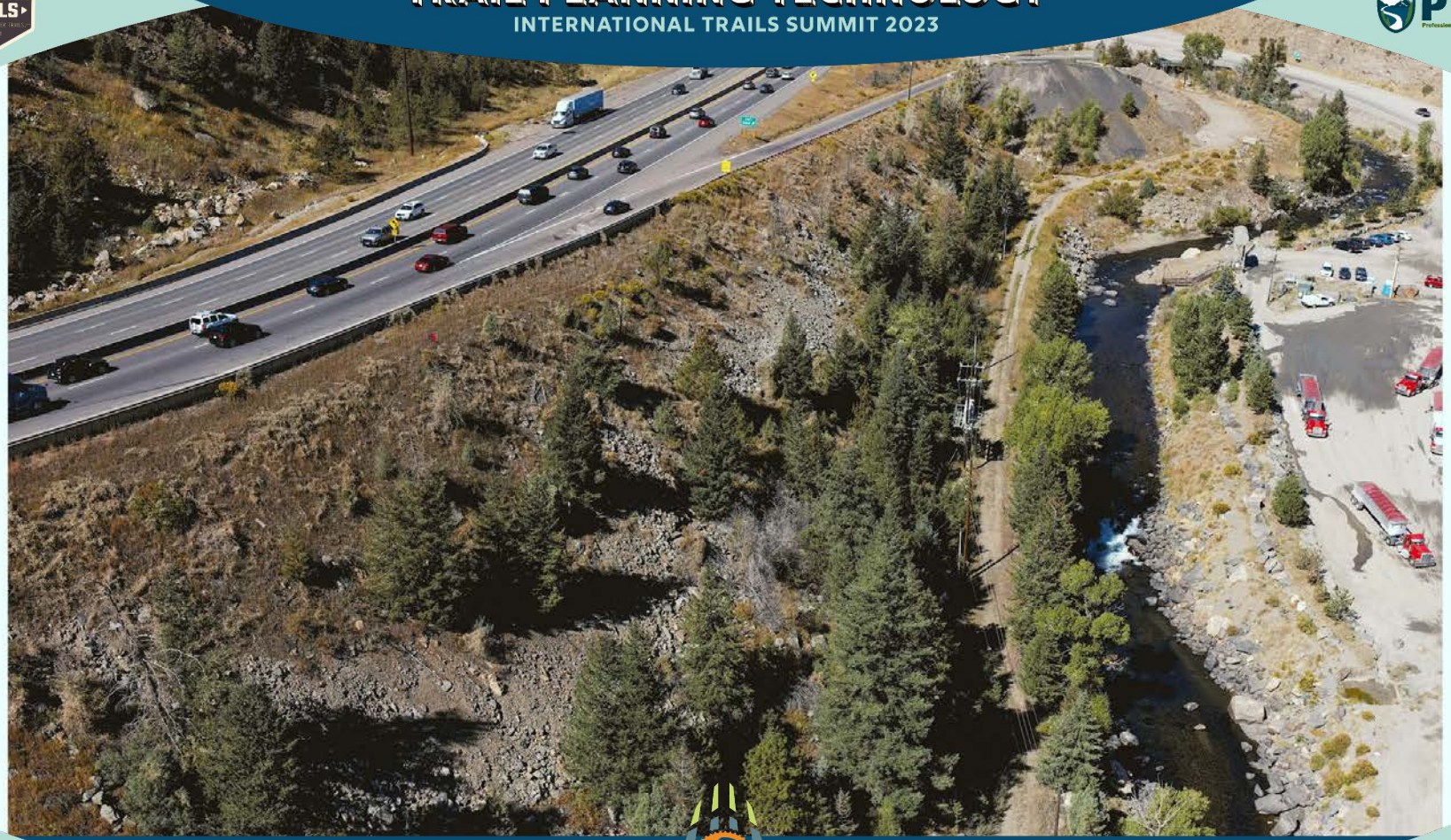

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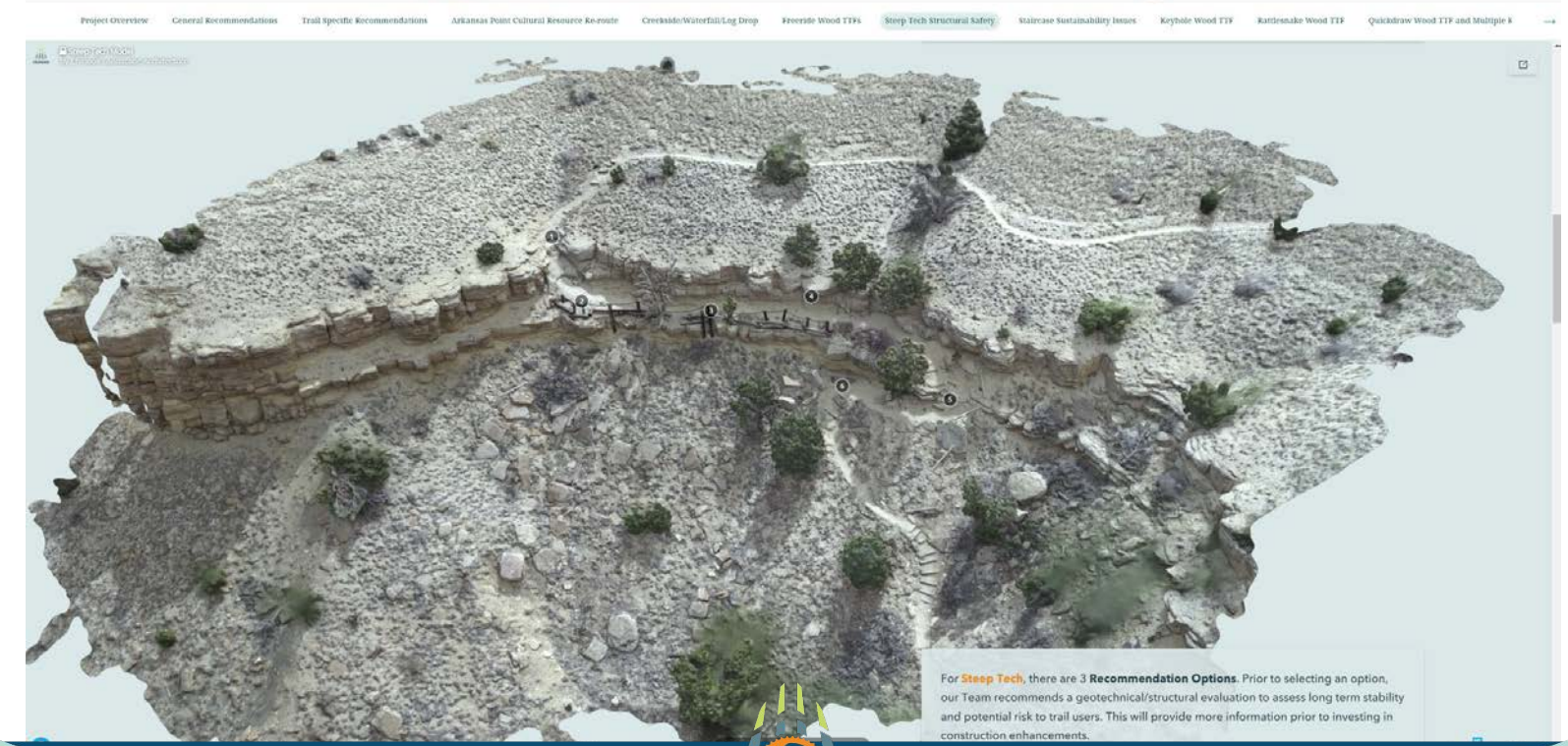
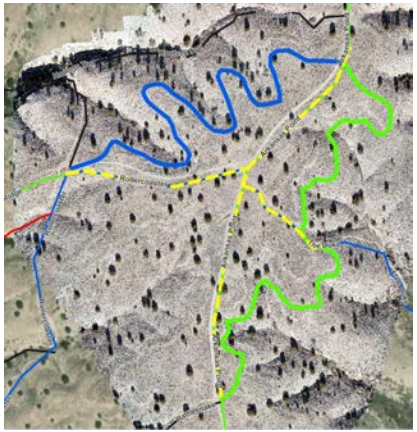
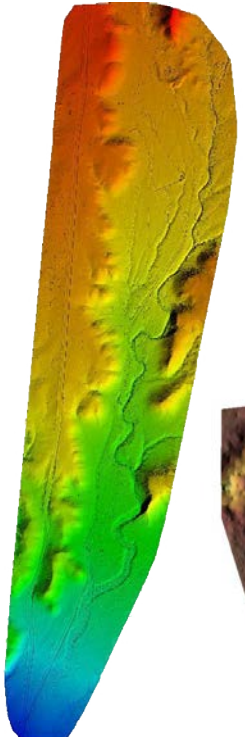
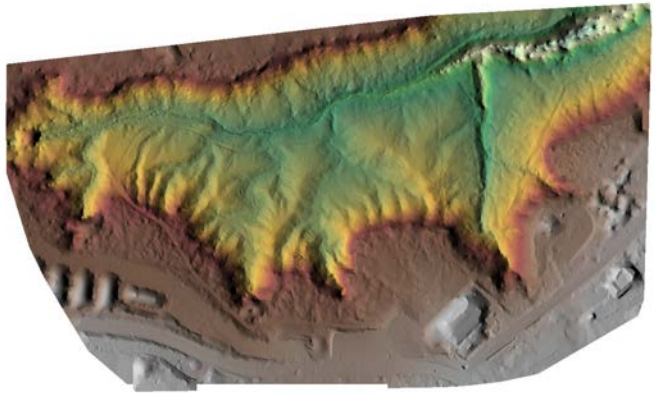
Part III: Presentation and Sharing Tools



Tons of Graphics...







...how do we share them with clients?

PDFs

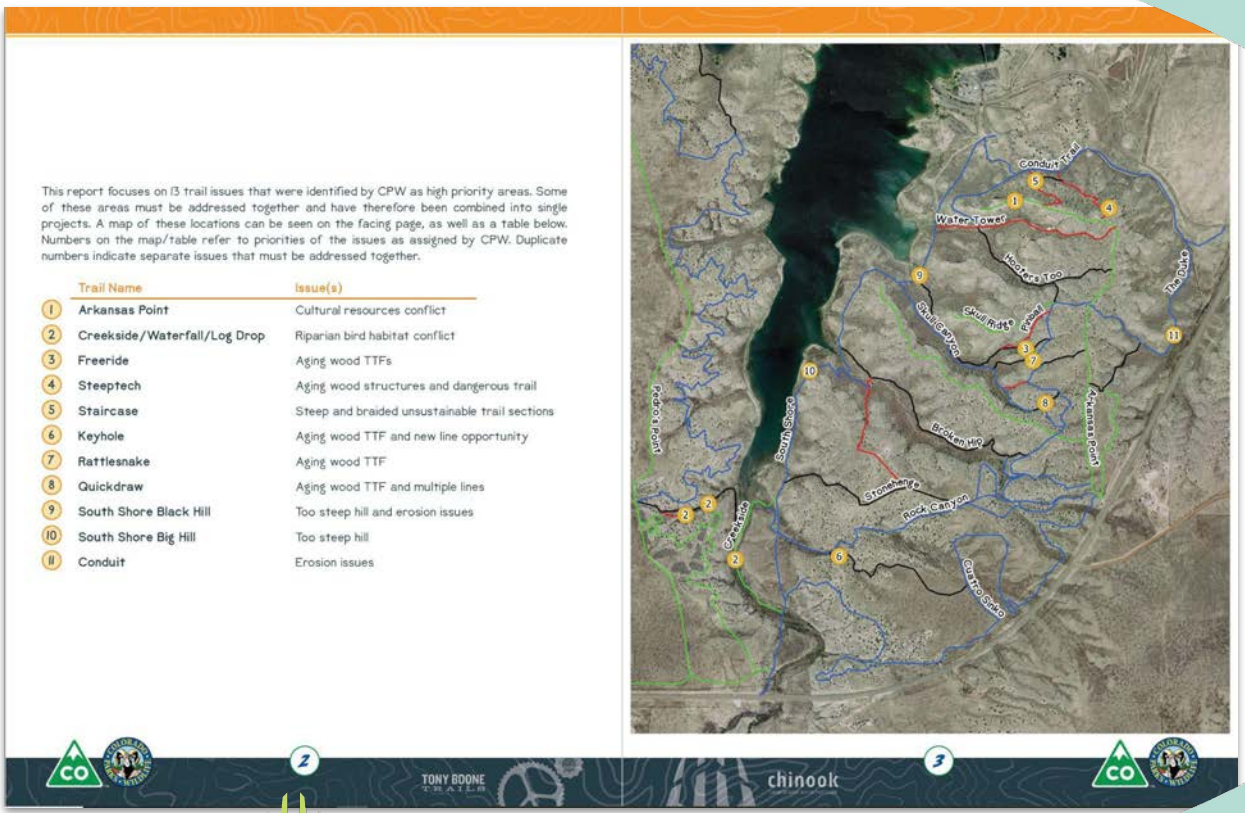
InDesign to dress them up

TTF Inspection and Routine Maintenance Schedule

Several trails at Lake Pueblo State Park include Technical Trail Features (TTFs), many of which are deteriorating wood and do not meet Best Management Practices. These aging TTFs urgently need to be removed and/or replaced. All TTFs, but especially wood ones, require regular documented maintenance inspections and repairs (based on industry standards) to effectively minimize injuries and manage risk. Understanding, inspecting, maintaining, and documenting the TTFs on the property is crucial to avoiding trail user injuries and property manager liability.

General Recommendation #3 is to develop a routine safety inspections and a maintenance schedule for all TTFs in the Park. International Mountain Bicycling Association (IMBA) guides and the Resort Municipality of Whistler's Trail Standards for Environmental and Technical Trail Features are both good resources for creating such a schedule.

These documents are commonly accepted as Best Management Practices and are frequently used in both construction and litigation as industry standards.

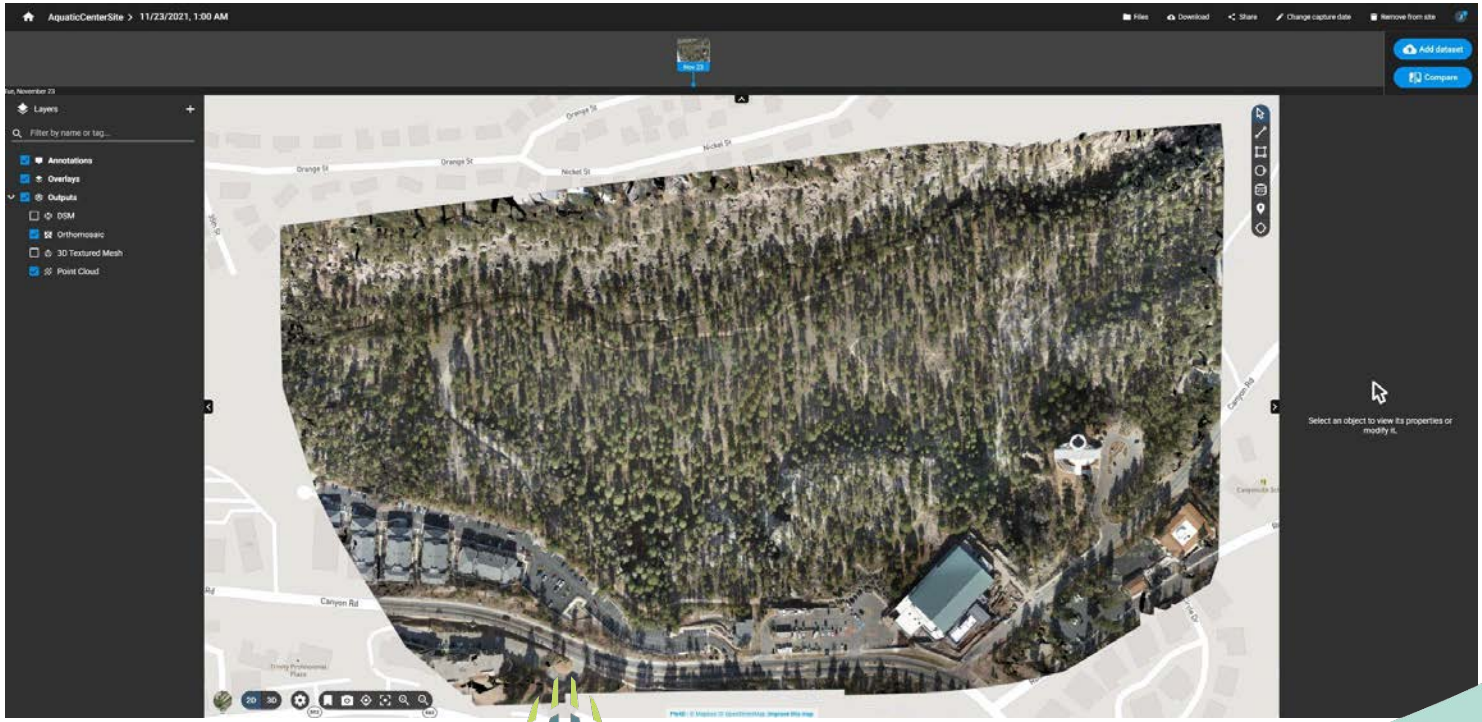


This report focuses on 13 trail issues that were identified by CPW as high priority areas. Some of these areas must be addressed together and have therefore been combined into single projects. A map of these locations can be seen on the facing page, as well as a table below. Numbers on the map/table refer to priorities of the issues as assigned by CPW. Duplicate numbers indicate separate issues that must be addressed together.

	Trail Name	Issue(s)
1	Arkansas Point	Cultural resources conflict
2	Creekside/Waterfall/Log Drop	Riparian bird habitat conflict
3	Freeride	Aging wood TTFs
4	Steeptech	Aging wood structures and dangerous trail
5	Staircase	Steep and braided unsustainable trail sections
6	Keyhole	Aging wood TTF and new line opportunity
7	Rattlesnake	Aging wood TTF
8	Quickdraw	Aging wood TTF and multiple lines
9	South Shore Black Hill	Too steep hill and erosion issues
10	South Shore Big Hill	Too steep hill
11	Conduit	Erosion issues

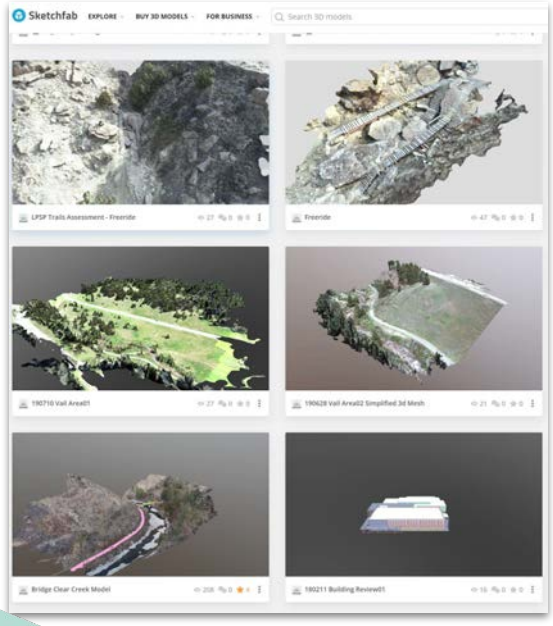
Sharing Photogrammetry Data

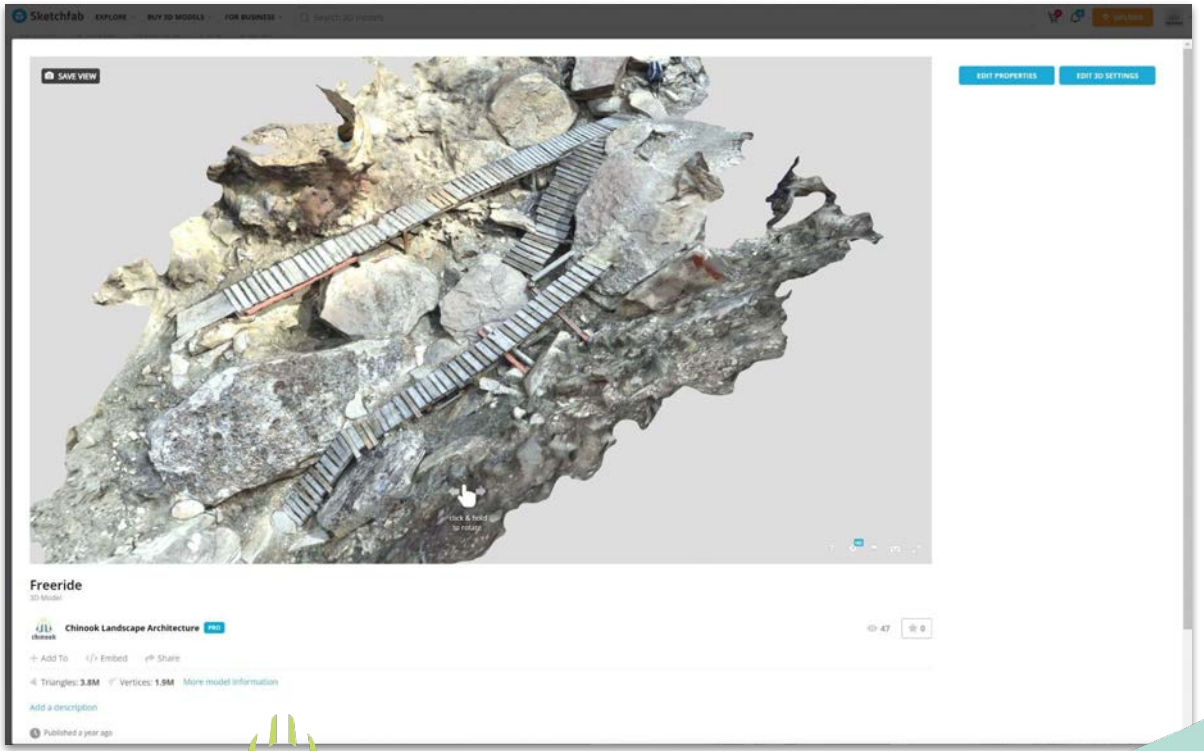
[Pix4D Cloud]



Sharing 3D Models

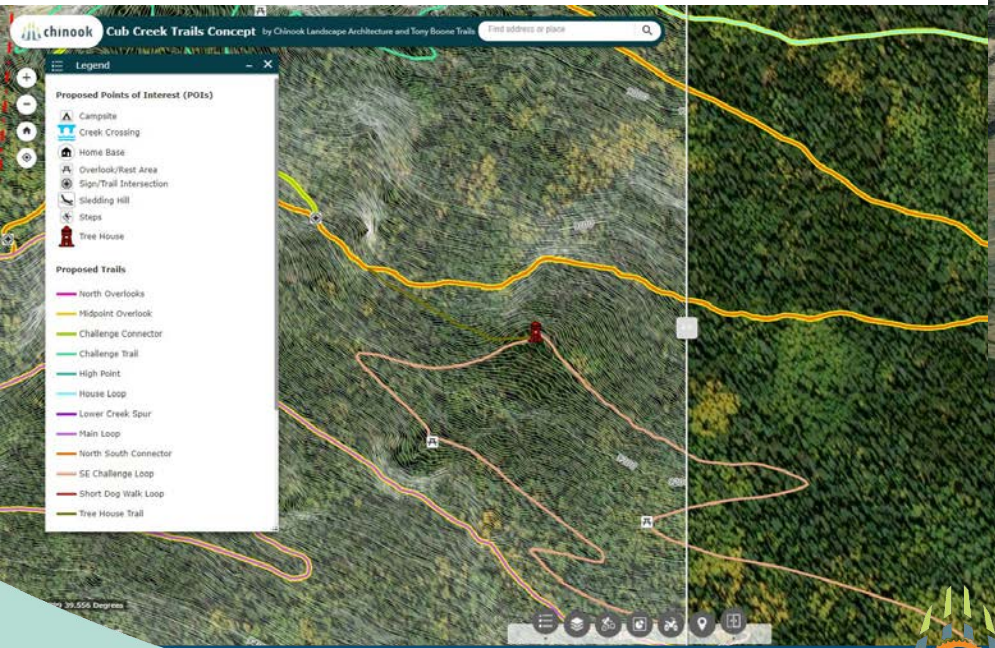
Sketchfab





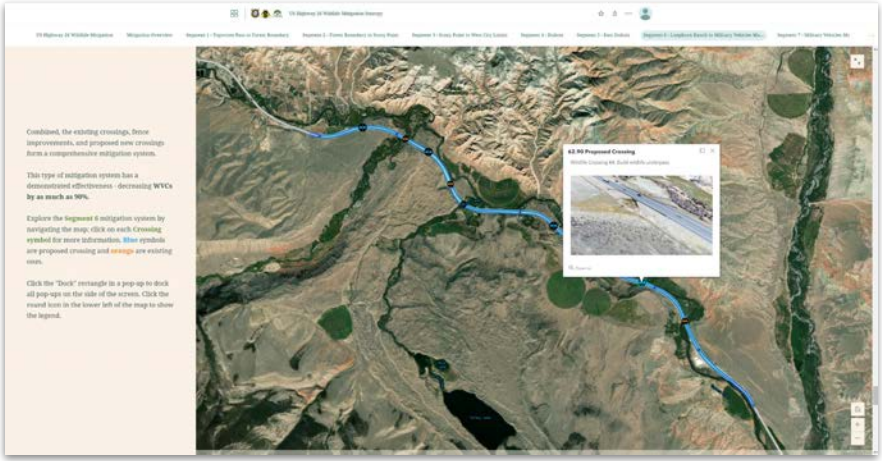
Sharing Maps ArcGIS Online

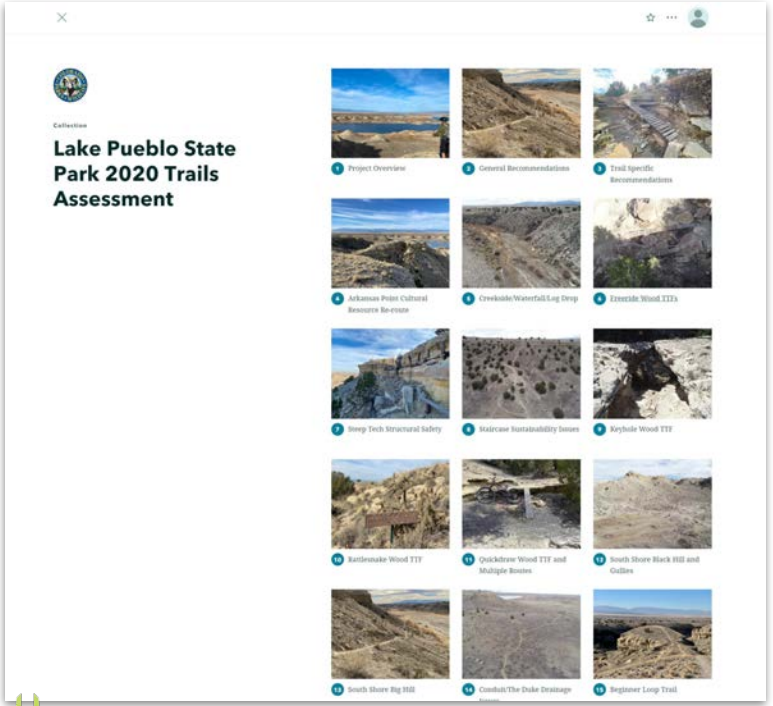
[WebMaps and WebApps]



Sharing an Entire Project and Narrative

[StoryMaps]





Technology Toolbox

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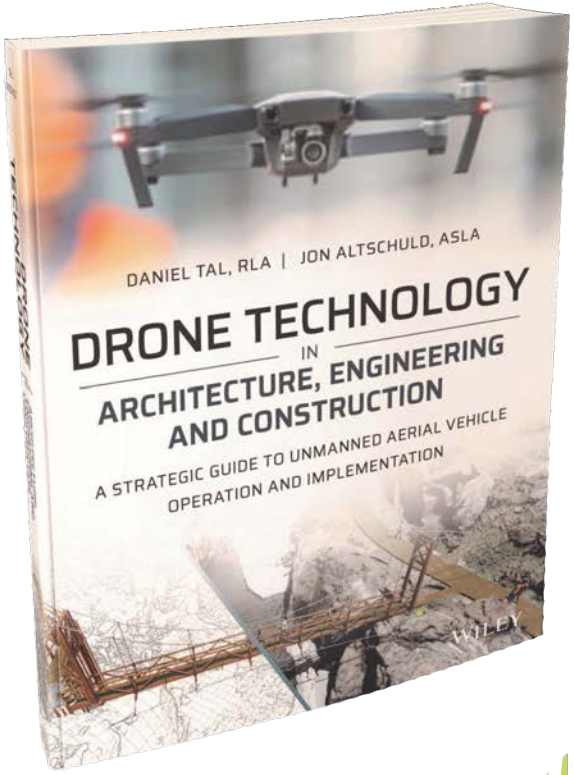

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