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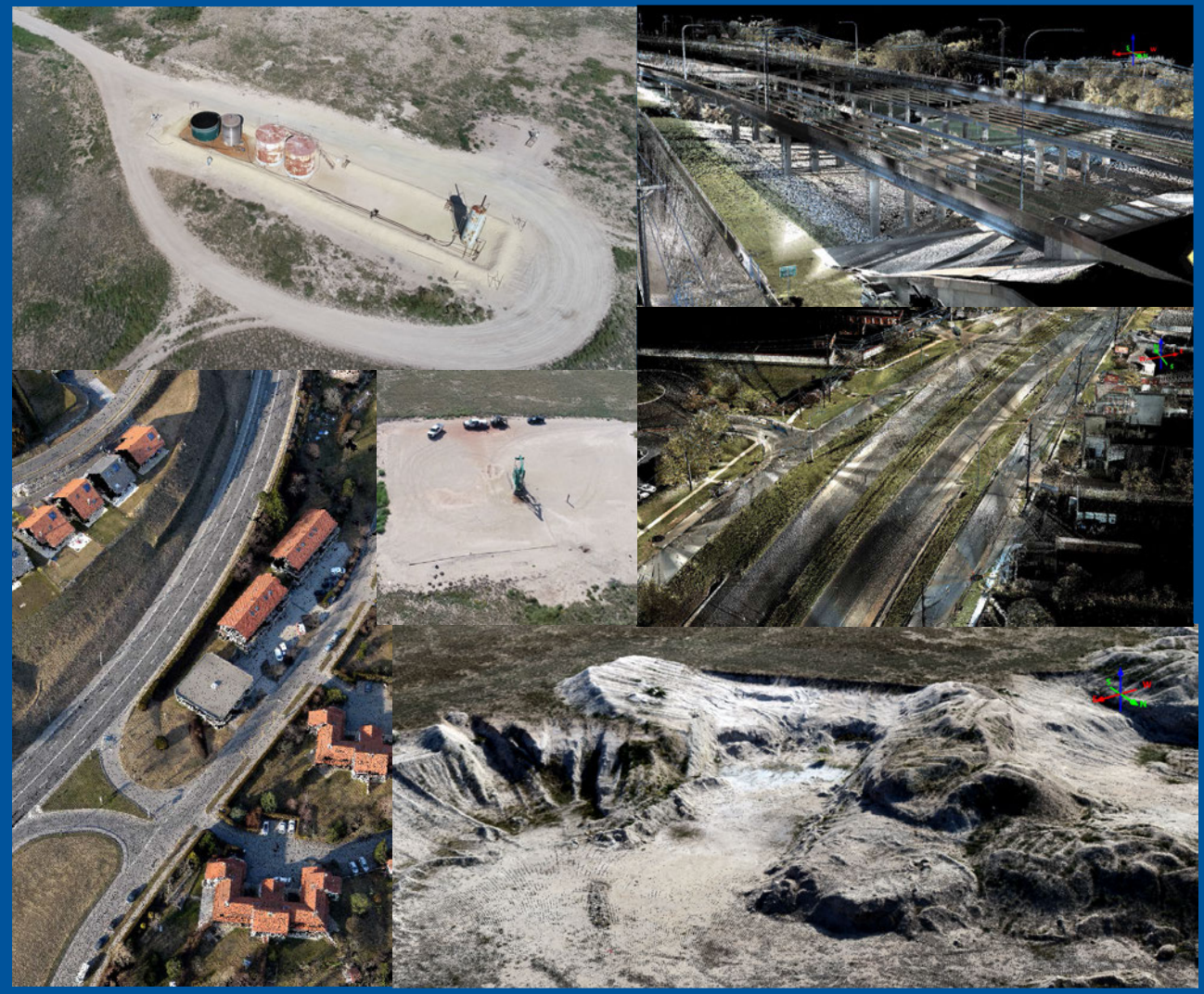
DRONES: A POSITIVE SOLUTION IN A MUNICIPAL SCENARIO

20TH ANNUAL PUBLIC WORKS ROUNDUP
MAY 21,2019



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TODAY'S PRESENTER:

RUSTY STEEL

"CORRODED METAL"

YES, THAT IS MY REAL NAME

OCTOBER 16, 2018

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UAS INFORMATION

What are we doing now?

- Planning
  - Safety
  - Project Planning
- General Survey
  - PointClouds
  - Current, Hi-Res Aerial Imagery/Orthos
  - DTM's/TIN's/3D Models
  - Quantities and Volumes
  - Video
- SfM vs. LiDAR

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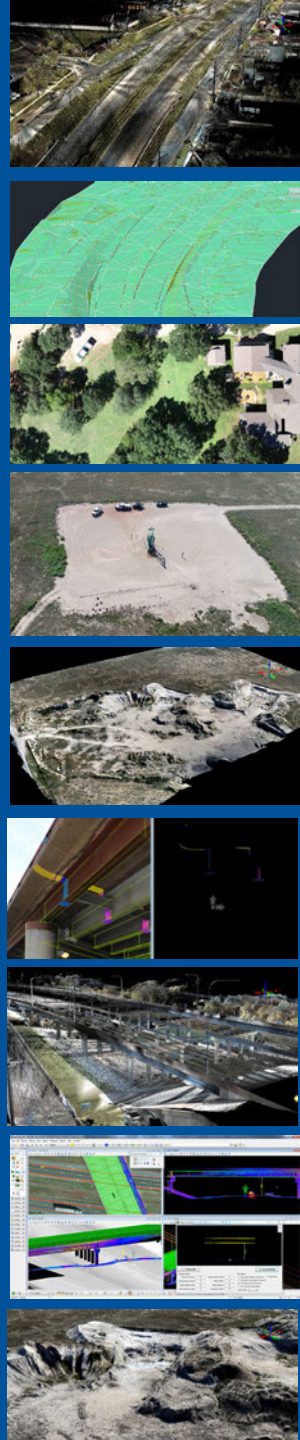
TODAY'S AGENDA:

UAS AND UTILITIES

What are we doing now?

- Underground Utilities Marking
  - Digitizing and Asset Assignments
- LiDAR Processing and Analysis
  - Extraction of detailed CAD Survey's
  - 3D Model any Infrastructure item to +/- 4mm accuracy (Walls, Floors, Pipes, Tanks, Bridges, Corridors, etc..)
- Inspection Videos, FLIR, Zoom, etc..
- Vegetation Impact Analysis, Encroachment Buffers
- Many tools in the toolbox



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TODAY'S AGENDA:

DRONES IN THE UTILITY MARKETPLACE

+ Mission Planning - "Safety"
+ Data Validation - "Quality"
+ Capabilities – "Innovation"

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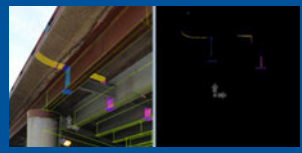

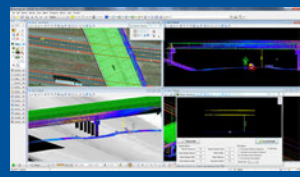


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WHAT ARE WE DOING NOW?

General Survey

- What's the SfM Process?
  - KMZ job scope scenarios
  - Airspace limitations
    - +LAANC (skyward)
    - +Sectionals
    - +MOA and other specific zones
  - Owner/Property/R-O-W
    - +Insurance, Policies, etc.
  - Mission Plan, Battery Plan Calcs, GSD Calcs, Day Plan Calcs

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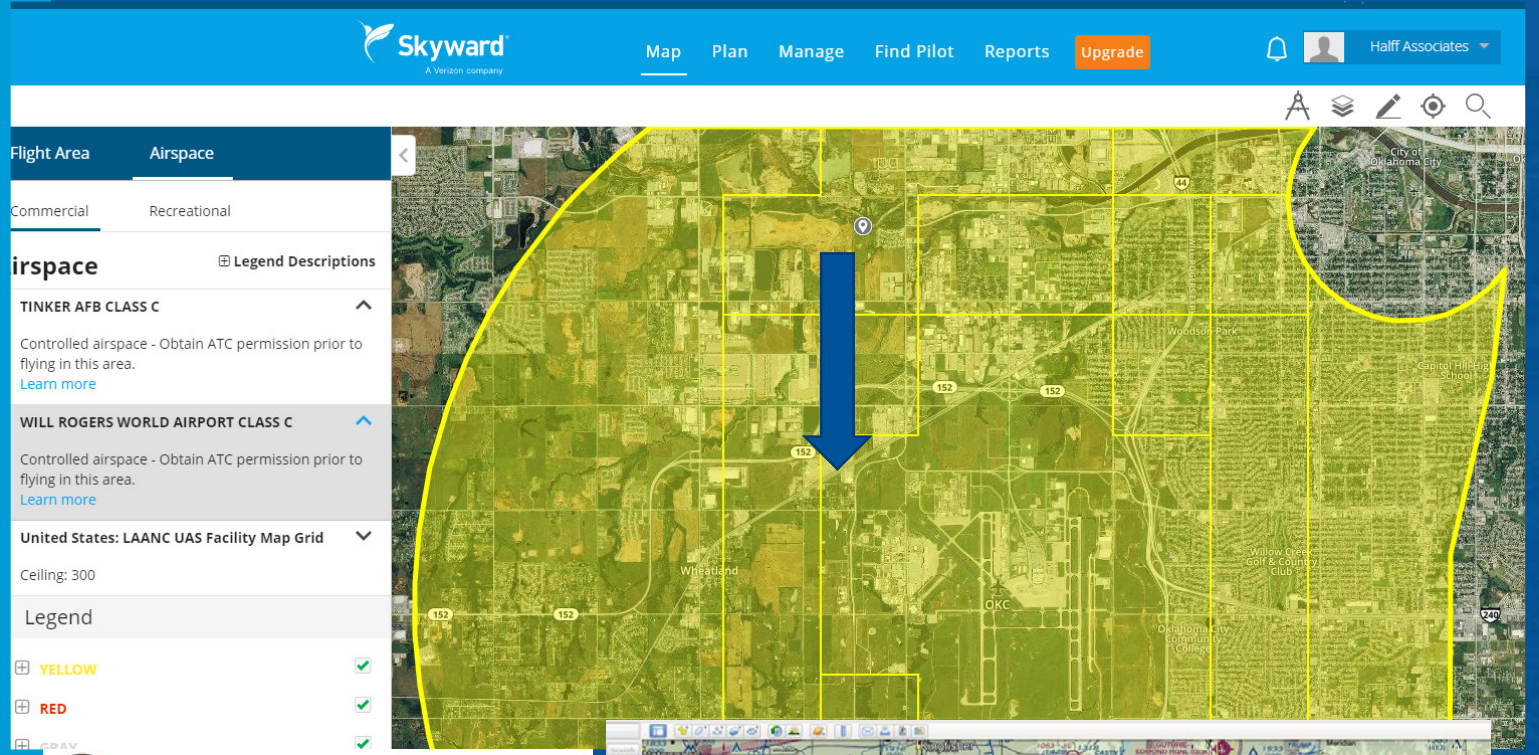
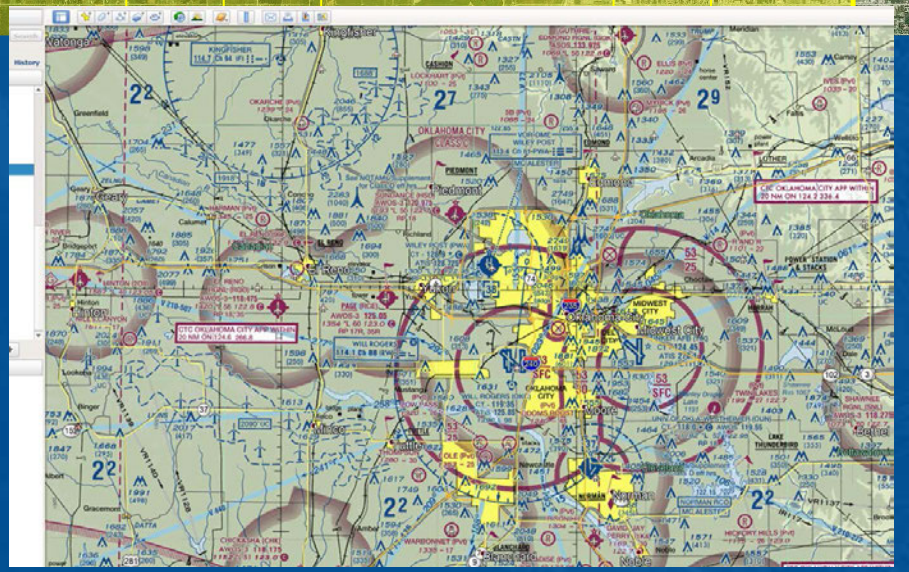
SKYWARD | LAANC





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UAS Operational Check List

MISSION DATE: _____ LOCATION: _____

PILOT NAME / ID: _____ JOB NAME / NUMBER: _____

AIRCRAFT ID: _____ CURRENT WEATHER: _____

MISSION SCOPE (IN OFFICE)

- ☐ Check for any restrictions
- ☐ Ensure Site Boundary has been confirmed
- ☐ Check for Potential Obstructions (lines, lights, trees)
- ☐ Check KMZ / SECTIONAL CHART / SKYWARD / DJI GO
- ☐ Flight Restriction (ATC?)
- ☐ Obtain Authorization if Flight Restriction (60 DAYS)
- ☐ Weather Forcast (monitor until complete)
- ☐ Plan Drone Deploy Missions on PC
- ☐ Print maps for control/mission layout

SITE - PRE FLIGHT INSPECTION

- ☐ site inspection, obsticals, activity
- ☐ notify all non participants in the area
- ☐ check flight area for trees, powerlines, etc.
- ☐ identify take off / landing zone
- ☐ check wind speed, temp, visibility

PACKING CHECK LIST

- ☐ aircraft
- ☐ tablet
- ☐ controller
- ☐ flight batteries (charged night before)
- ☐ quick equipment inspection
- ☐ memory cards
- ☐ propellers
- ☐ tablet & cables
- ☐ Maps & Checklists

AIRCRAFT INSPECTION

- ☐ air frame
- ☐ propellers
- ☐ controller antenna / extended and connections
- ☐ motors
- ☐ camera and gimble

SEE BACK SIDE FOR BATTERY LOG

- ☐ log flight times, battery id, mission # picture count

BEFORE EVERY FLIGHT

- ☐ Contact ATC
- ☐ Start battery log sheet & Maps
- ☐ Discuss flight plan with ALL participants
- ☐ Inspect Batteries
- ☐ Make sure SD card is in place
- ☐ Record Battery ID w/ Mission ID
- ☐ Power on Aircraft, Controller, Tablet
- ☐ Check Controller Settings - set to P
- ☐ Open DJI GO APP
- ☐ Check return to home altitude
- ☐ Check overall status / green bar
- ☐ Check that clear to fly has been indicated
- ☐ Open Drone Deploy in tablet
- ☐ Select Project / Mission
- ☐ Ensure Flight Altitude is adequate
- ☐ Ensure location on map is correct
- ☐ Upload mission to aircraft
- ☐ Begin automated Flights

AFTER MISSION

- ☐ Ensure all flights have been logged properly
- ☐ Download and Save Photos to proper storage device
- ☐ Unpack equipement on a clean surface
- ☐ Wipe down EVERYTHING
- ☐ Use canned air and GENTLY blow any dust from motors

DO NOT CLEAN WITH RAG IT WILL REMOVE FACTORY LUBRICANT

DO NOT SPRAY ANY LIQUID DIRECTLY ONTHE DRONE, APPLY TO CLOTH

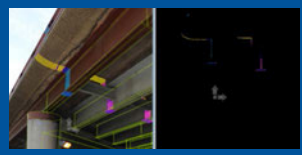
- ☐ Charge Batteries and controller
- ☐ Inspect all working components of aircraft
- ☐ Properly pack all equipment in itsplace

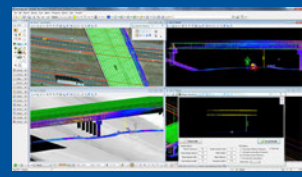
SITE CONTROL

- ☐ set targets
- ☐ locate targets (before picking them up)
- ☐ shoot ground truthing





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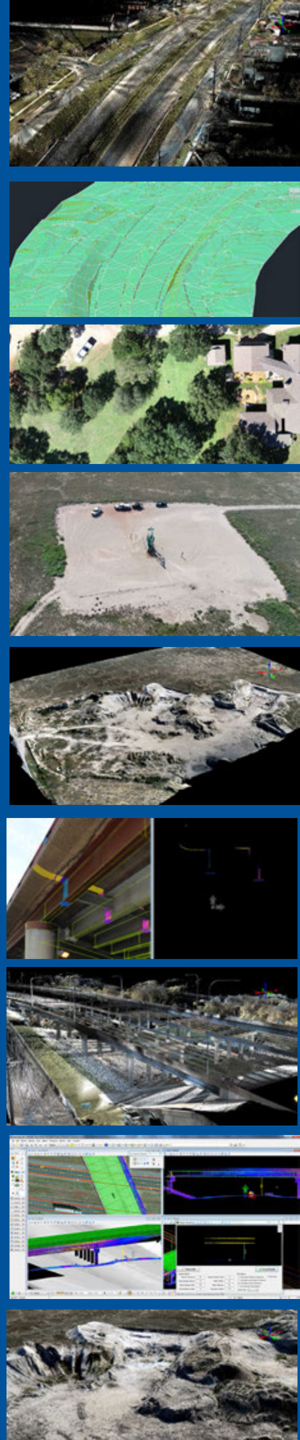
UAS BATTERY FLIGHT LOG

TAKE OFF TIME	BATTERY NUMBER	MISSION NUMBER	LANDING TIME	ALTITUDE	PICTURE COUNT	STRUCTURE MODE



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WHAT ARE WE DOING NOW?

General Survey

- What's the SfM Process?
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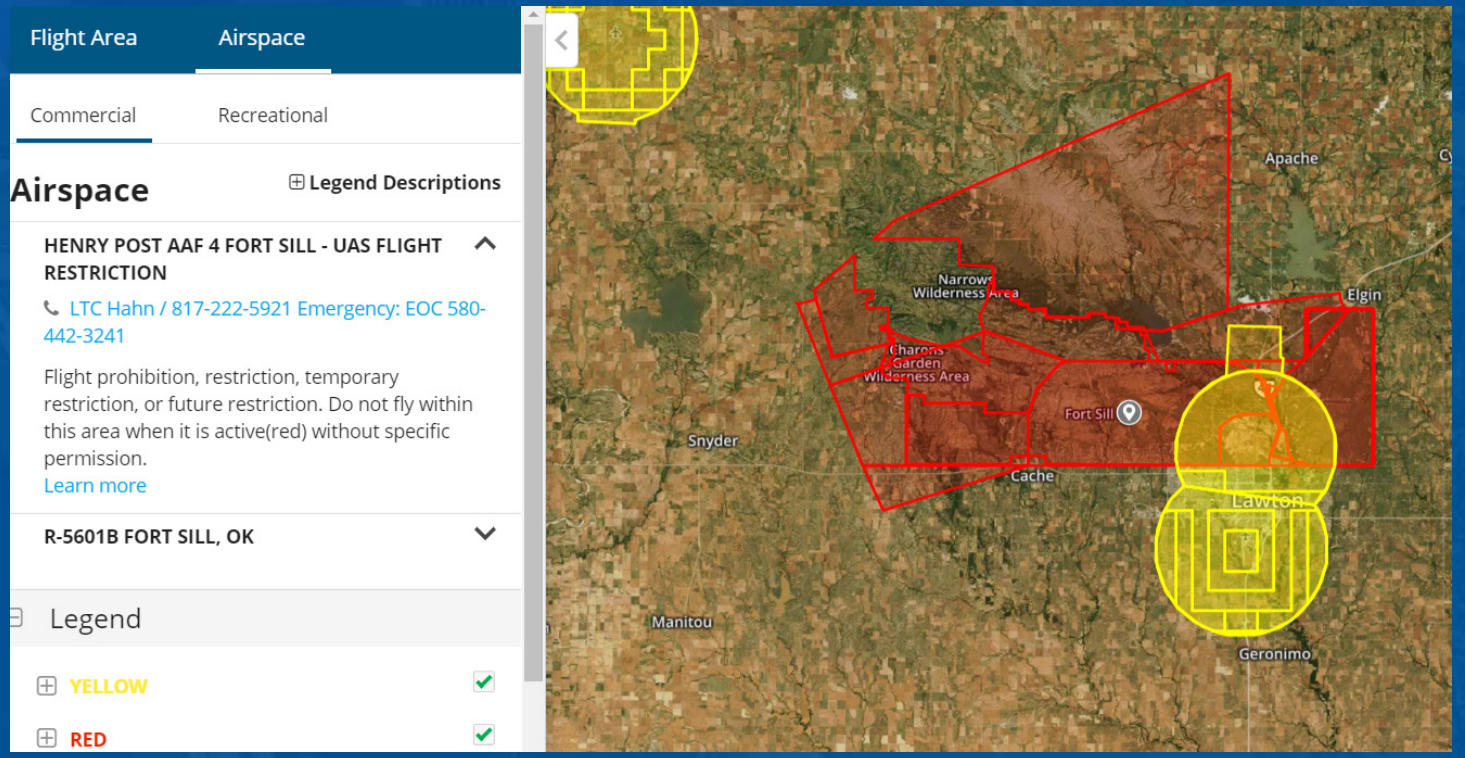
SKYWARD | LAANC



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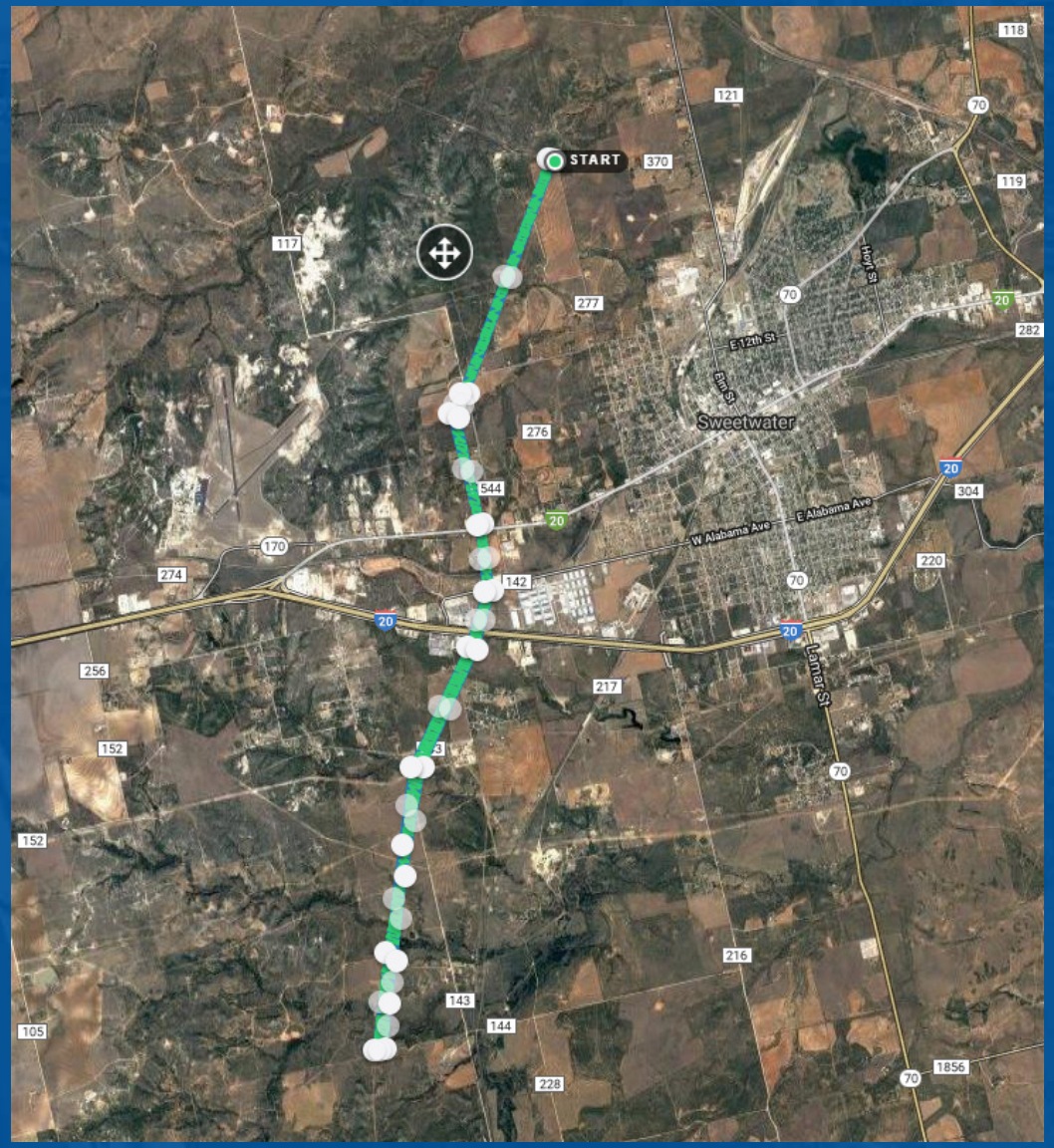
SFM | MISSION PLANNING



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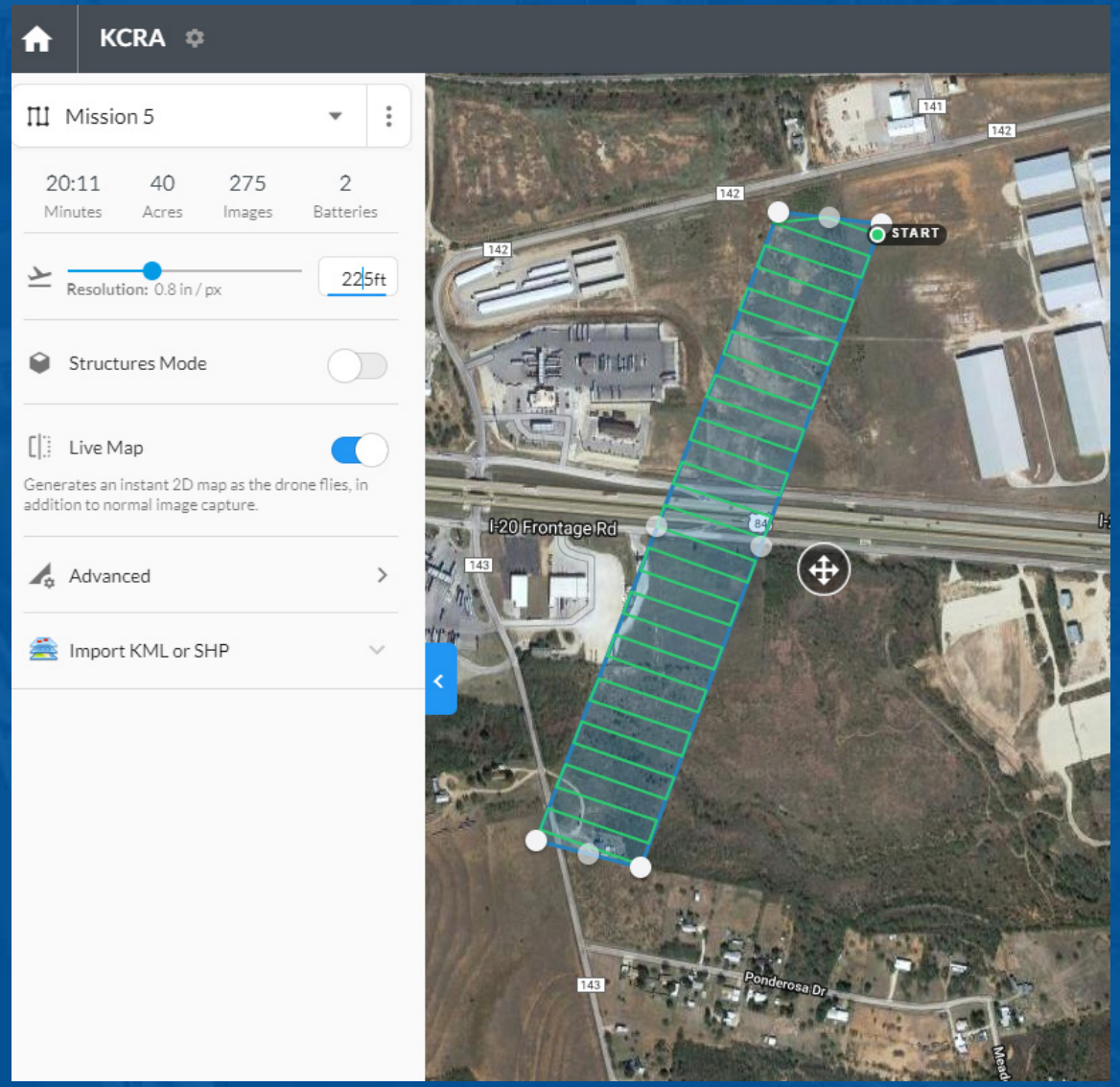

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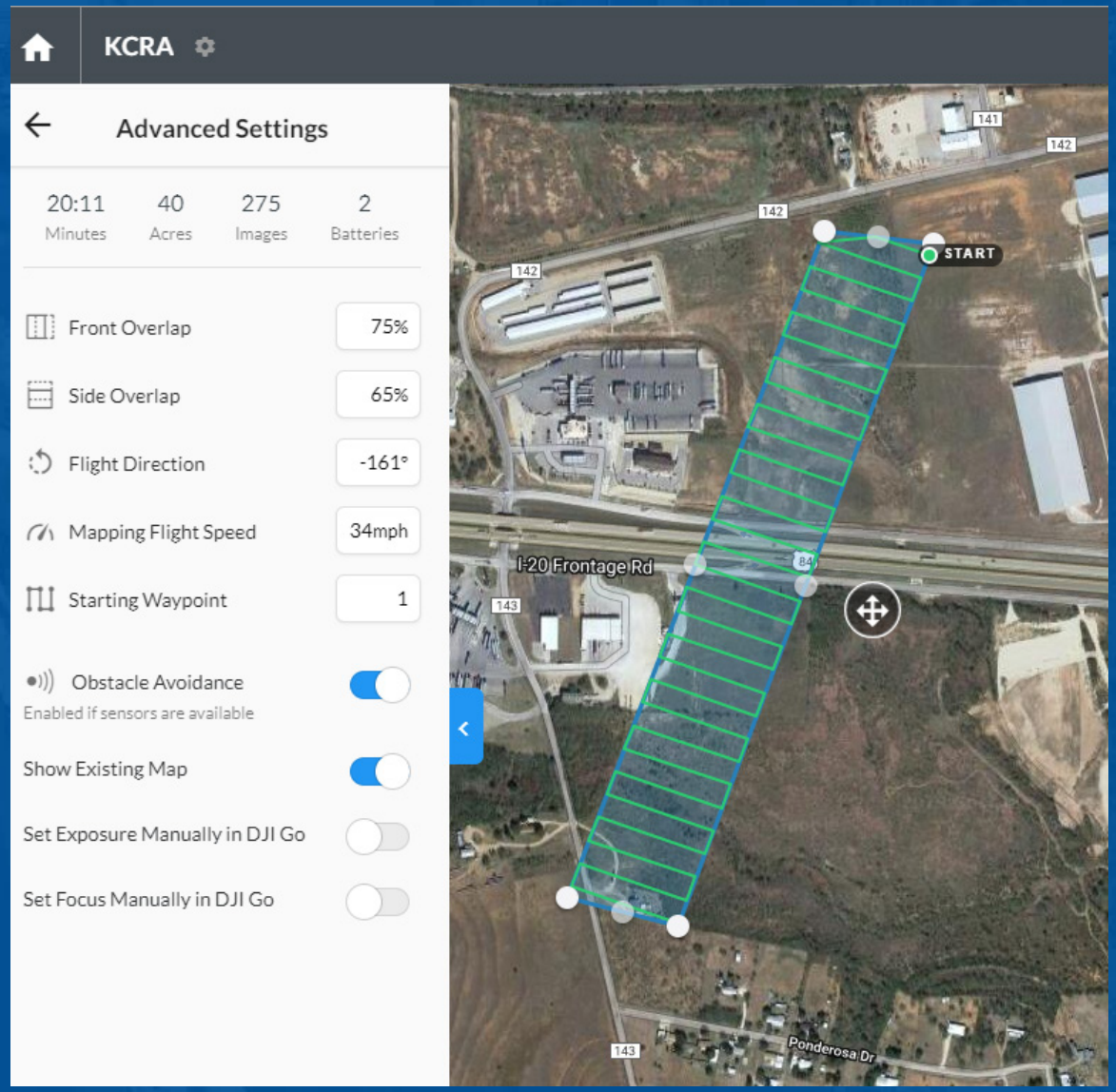

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SFM | BATTERY PLAN CALCS

Simple Battery Calculator			
	# of Batteries used	Battery Bank	3 Batteries 80 minutes
8:00 AM	3	20	
9:00 AM	3	17	
10:00 AM	3	14	3
11:00 AM	3	14	
12:00 PM	3	11	3
1:00 PM	3	11	
2:00 PM	3	8	3
3:00 PM	3	8	
4:00 PM	3	5	3
5:00 PM	3	5	
Day 1			
Detailed Battery Calculator			
	# of Batteries used	Battery Bank	3 Batteries 80 minutes
8:00 AM	5	22	
9:12 AM	5	19	2
10:24 AM	5	16	2
11:36 AM	7	13	3
1:15 PM	4	9	2
2:18 PM	6	7	3
3:40 PM	5	4	2
Day 2			
Detailed Battery Calculator			
	# of Batteries used	Battery Bank	3 Batteries 80 minutes
8:00 AM	5	22	
9:15 AM	6	20	3
10:37 AM	6	17	3
11:57 AM	5	14	3
1:16 PM	5	12	3
2:31 PM	6	10	3

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SFM | DAY PLAN CALCS

	Mission	Batteries	Flight Time	Acres	Lines	Photos	Length		
800	1	5	72	183	7	553	54917		
912	2	5	72	169	7	530	44771		
1024	3	5	72	170	6	485	45300		
1136	4	6	80	203	7	602	49700		
1315	5	4	63	164	6	480	39193		
1418	6	6	82	206	7	623	50605		
1540	7	5	79	187	6	542	50599		Day ends at 4:59
	Day 1 Summary	36	520	1282	46	3815	335085		
			8.66666667						
800	8	5	75	154	7	499	46136		
915	9	6	82	167	7	553	52514		
1037	10	6	80	196	7	603	49465		
1157	11	5	79	200	6	600	48557		
1316	12	5	75	187	6	570	46127		
1431	13	6	83	182	7	578	52435		Day ends at 3:54
	Day 2 Summary	33	482.666667	1086	40	3403	295234		
			8.04444444						
800	Video Mission (14)	7	104				85668		
944									
	Overall Totals	69	1002.66667	2368	86	7218	630319		
	Avg's	5.307692	76.4615385	182.1538	6.615385	555.2308	48486.08		

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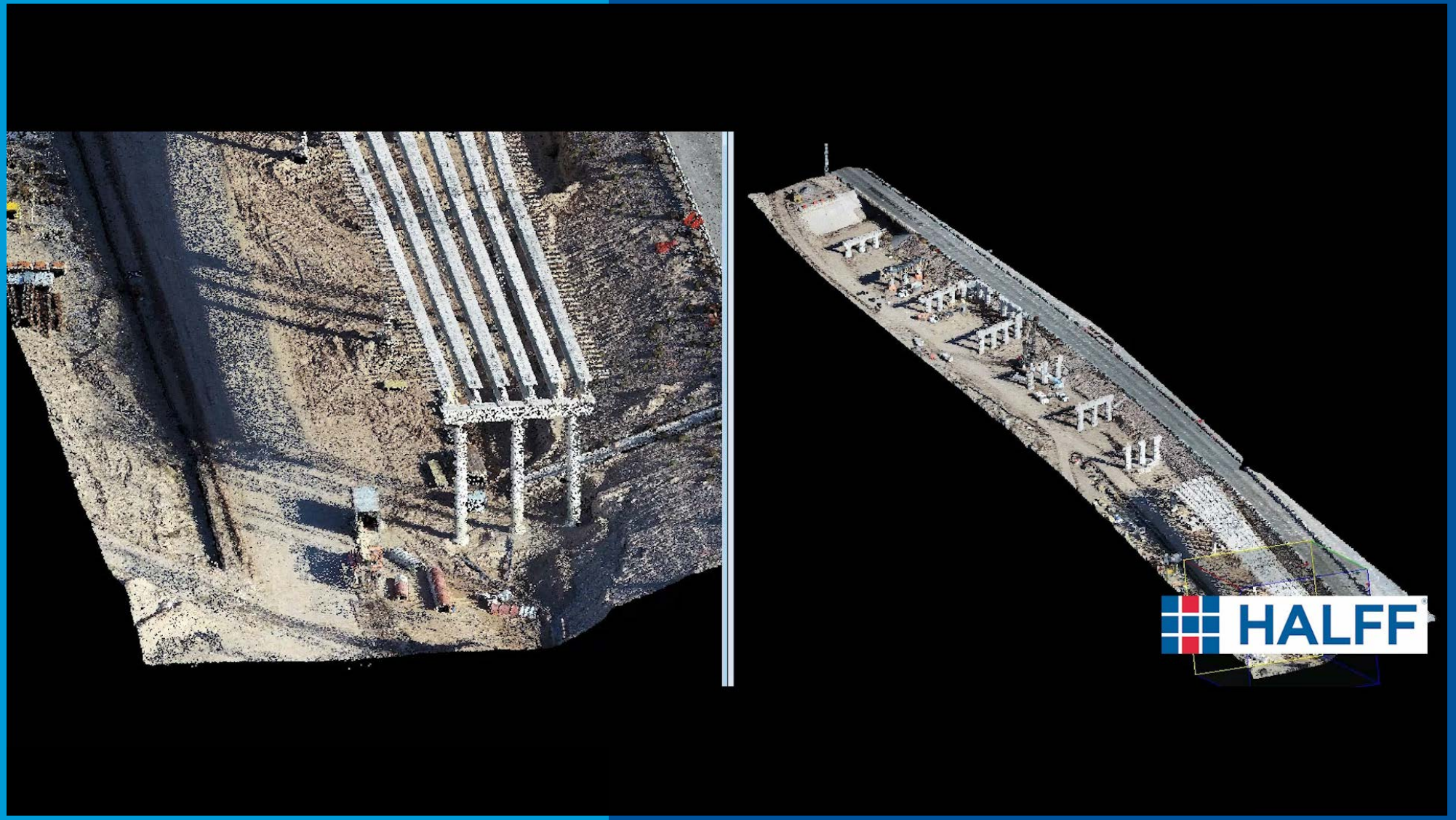
POP QUIZ… WHAT IS THIS CALLED?



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POP QUIZ… WHAT IS THIS CALLED?

POINTILLISM?

POINTCLOUDS

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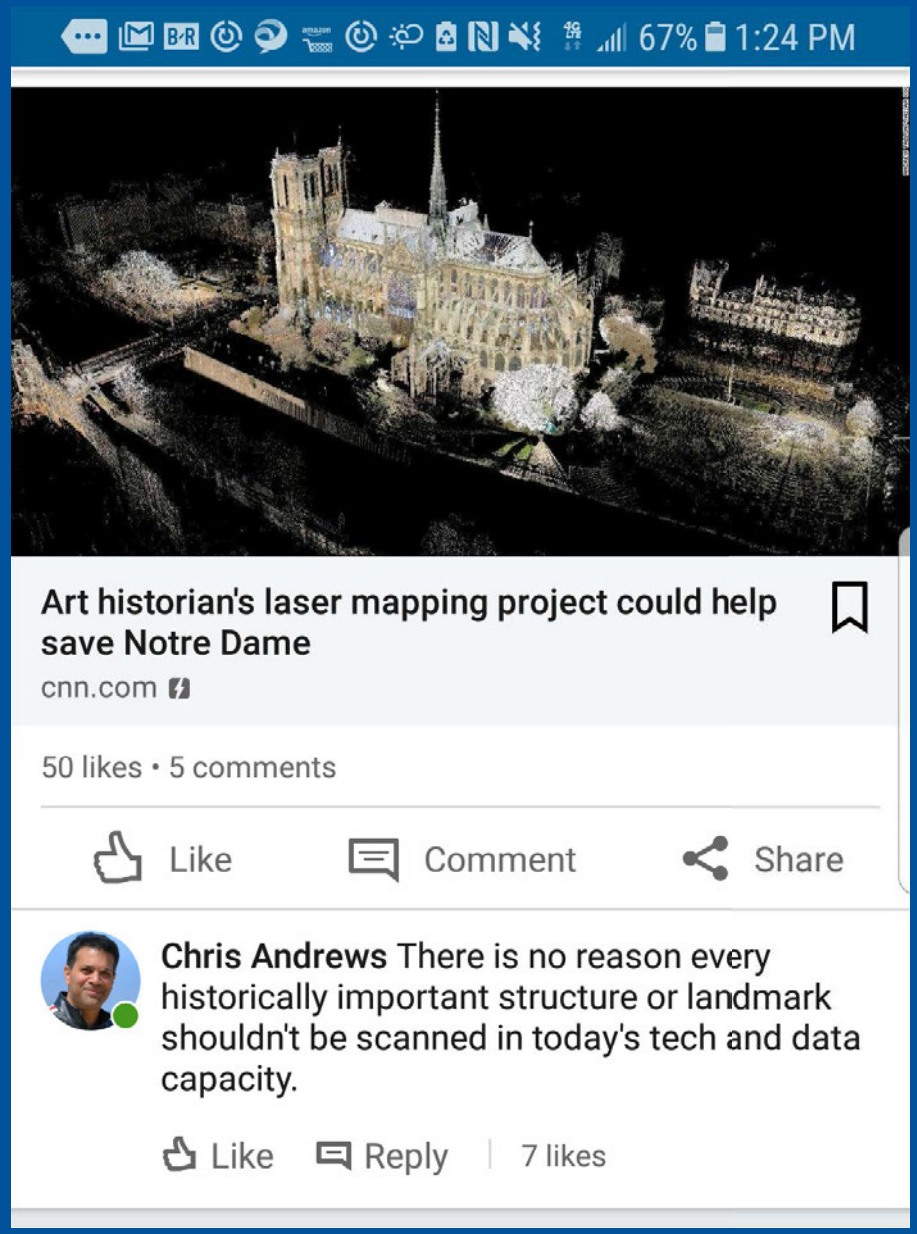






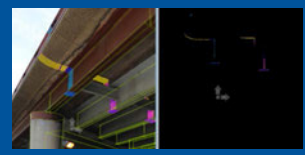

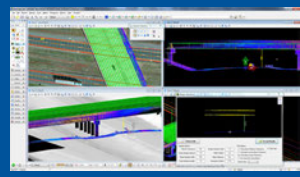


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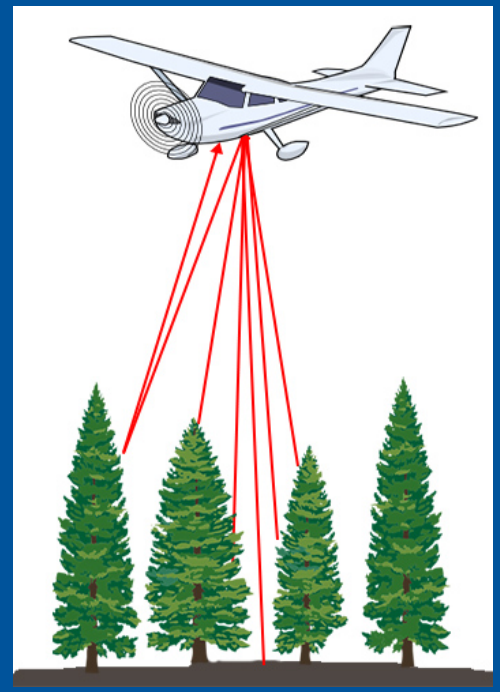
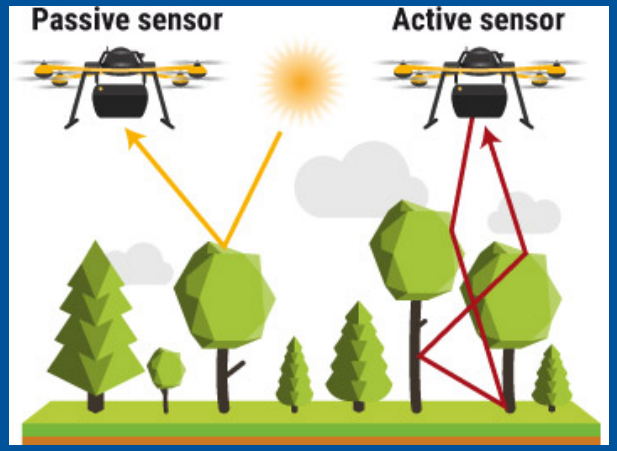
INTRODUCE LIDAR AND SFM

- DATA COLLECTION
- SURVEY CONTROL
- DATA ANALYSIS





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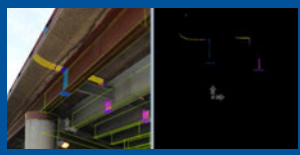
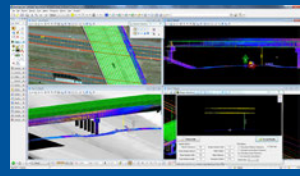
WHY LIDAR?

- Vegetation Penetration
- “True” location laser returns
- Lighting not an Issue

- More Accurate Point Clouds
- Better Defined Point Clouds





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WHAT ARE WE DOING NOW?

General Survey

- SfM Accuracy Expectations
  - – Vegetation?
    - + H=0.2’ V=0.3’ Confidence
    - + After Bare earth filters
    - +After Ground Truthing
  - – Little to no Vegetation?
    - + H=0.05’ V=0.07’ Confidence
    - + After Bare earth filters
    - +After Ground Truthing

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SFM | POINTCLOUD

- Lidar Accuracy Expectations
  - – Vegetation?
    - + H= 0.05’ V=0.07’ Confidence
    - + After Bare earth filters
    - +After Ground Truthing
  - – Little to no Vegetation?
    - + H=0.03’ V=0.05’ Confidence
    - + After Bare earth filters
    - +After Ground Truthing

Credit: Pix4D

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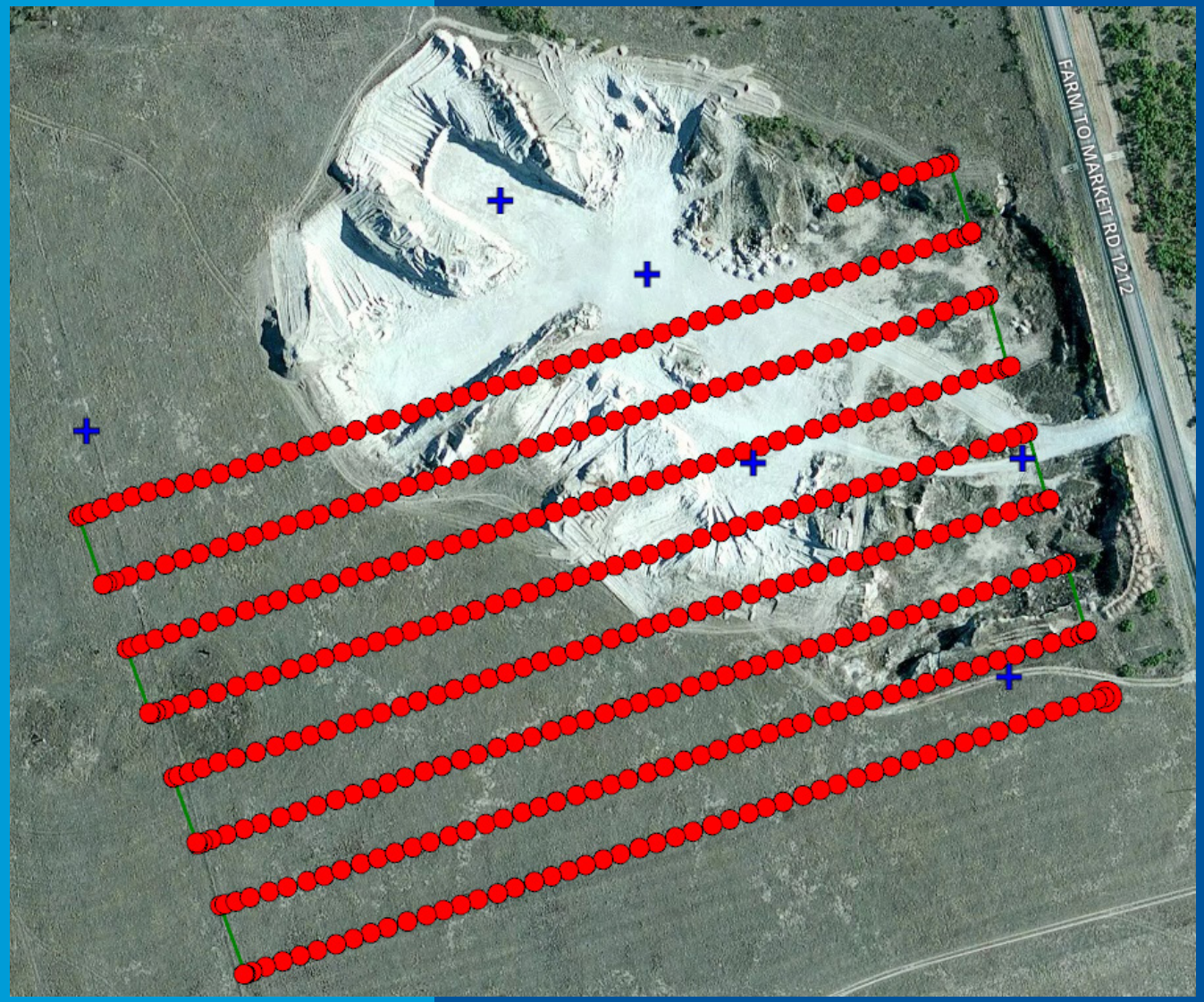
DTM'S | DETAILED TERRAIN MODELS



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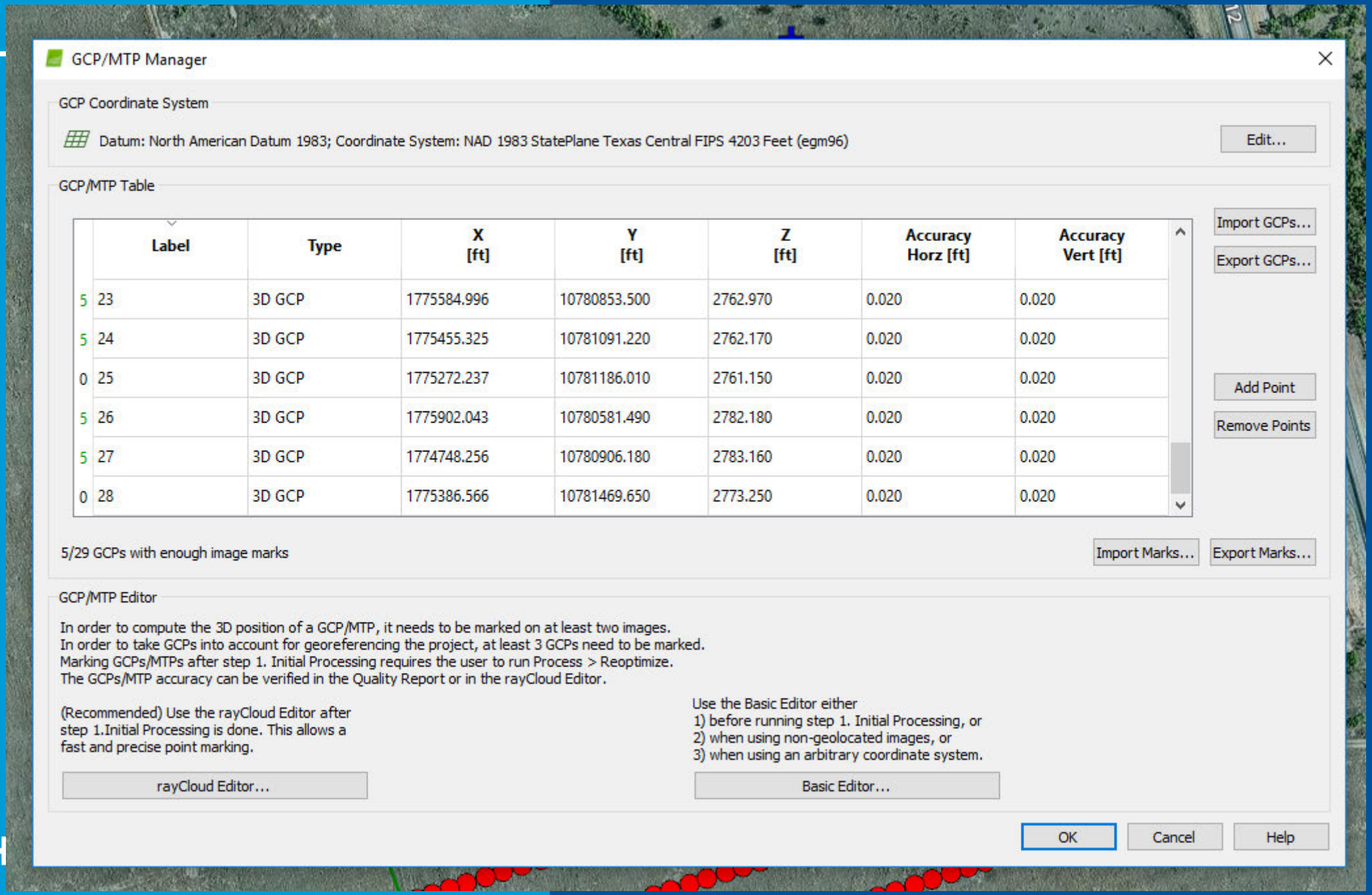

GCP/MTP Manager

GCP Coordinate System

Datum: North American Datum 1983; Coordinate System: NAD 1983 StatePlane Texas Central FIPS 4203 Feet (egm96)

Edit...

GCP/MTP Table

	Label	Type	X [ft]	Y [ft]	Z [ft]	Accuracy Horz [ft]	Accuracy Vert [ft]
5	23	3D GCP	1775584.996	10780853.500	2762.970	0.020	0.020
5	24	3D GCP	1775455.325	10781091.220	2762.170	0.020	0.020
0	25	3D GCP	1775272.237	10781186.010	2761.150	0.020	0.020
5	26	3D GCP	1775902.043	10780581.490	2782.180	0.020	0.020
5	27	3D GCP	1774748.256	10780906.180	2783.160	0.020	0.020
0	28	3D GCP	1775386.566	10781469.650	2773.250	0.020	0.020

Import GCPs...

Export GCPs...

Add Point

Remove Points

5/29 GCPs with enough image marks

Import Marks...

Export Marks...

GCP/MTP Editor

In order to compute the 3D position of a GCP/MTP, it needs to be marked on at least two images.
In order to take GCPs into account for georeferencing the project, at least 3 GCPs need to be marked.
Marking GCPs/MTPs after step 1. Initial Processing requires the user to run Process > Reoptimize.
The GCPs/MTP accuracy can be verified in the Quality Report or in the rayCloud Editor.

(Recommended) Use the rayCloud Editor after step 1.Initial Processing is done. This allows a fast and precise point marking.

rayCloud Editor...

Use the Basic Editor either
1) before running step 1. Initial Processing, or
2) when using non-geolocated images, or
3) when using an arbitrary coordinate system.

Basic Editor...

OK

Cancel

Help

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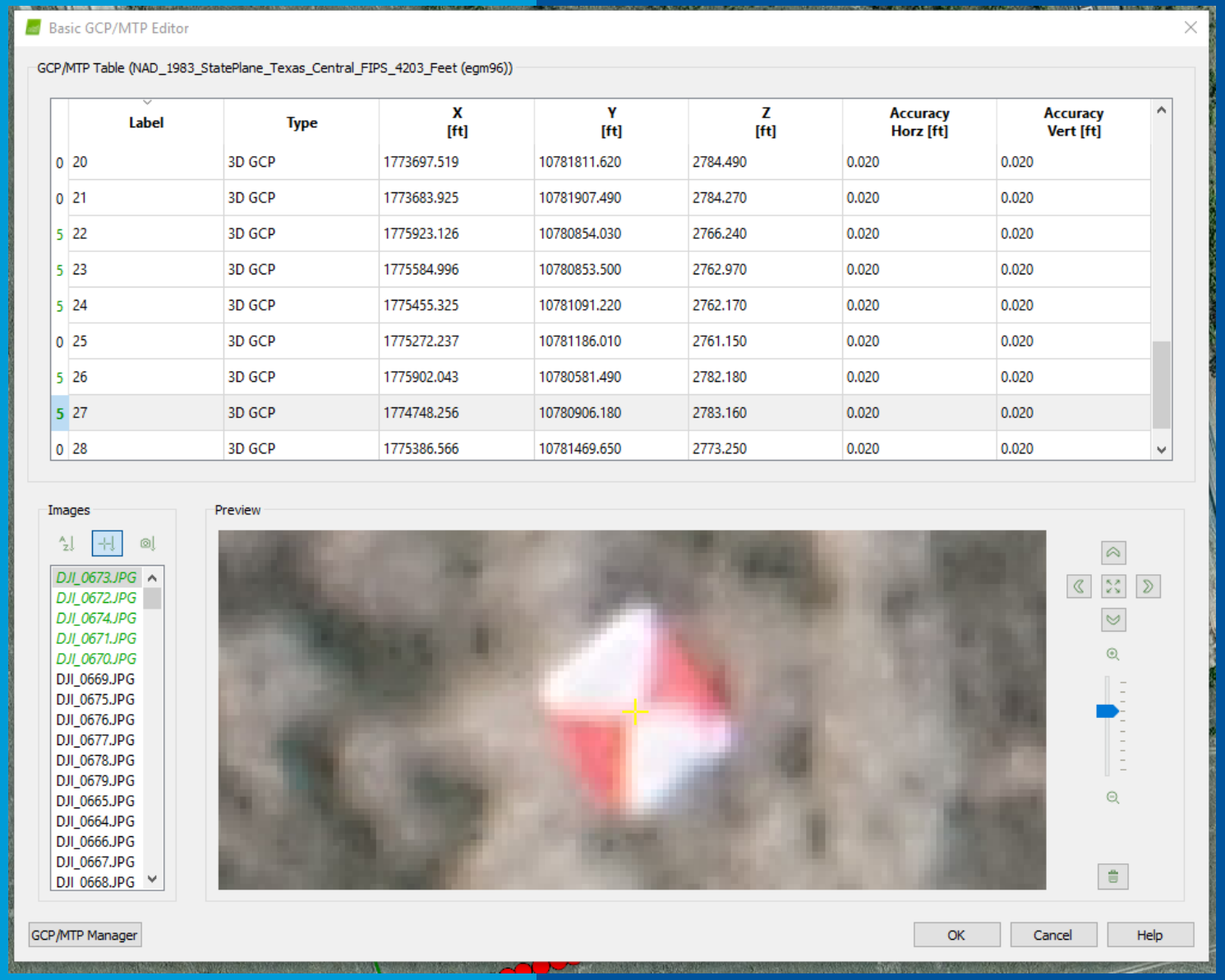
DTM'S | DETAILED TERRAIN MODELS



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WHAT ARE WE DOING NOW?

General Survey

- Current Aerials
- Orthomosaics
- Hi-Res Imagery
  - 1/8” at (120’) to 3/4” at (375’) per pixel
  - Based on flight altitude
  - 20 MP Camera

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AERIALS | ORTHOMOSAICS

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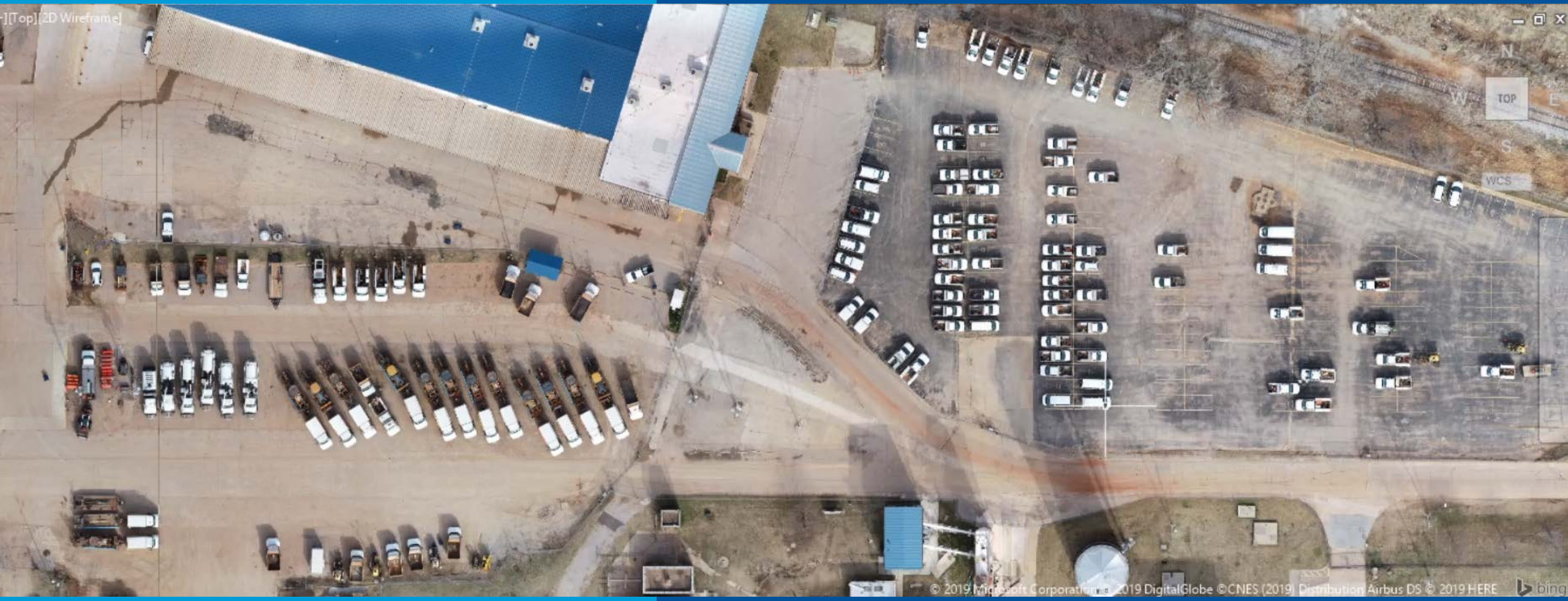
HIGH-RES IMAGERY



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HIGH-RES IMAGERY

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HIGH-RES IMAGERY

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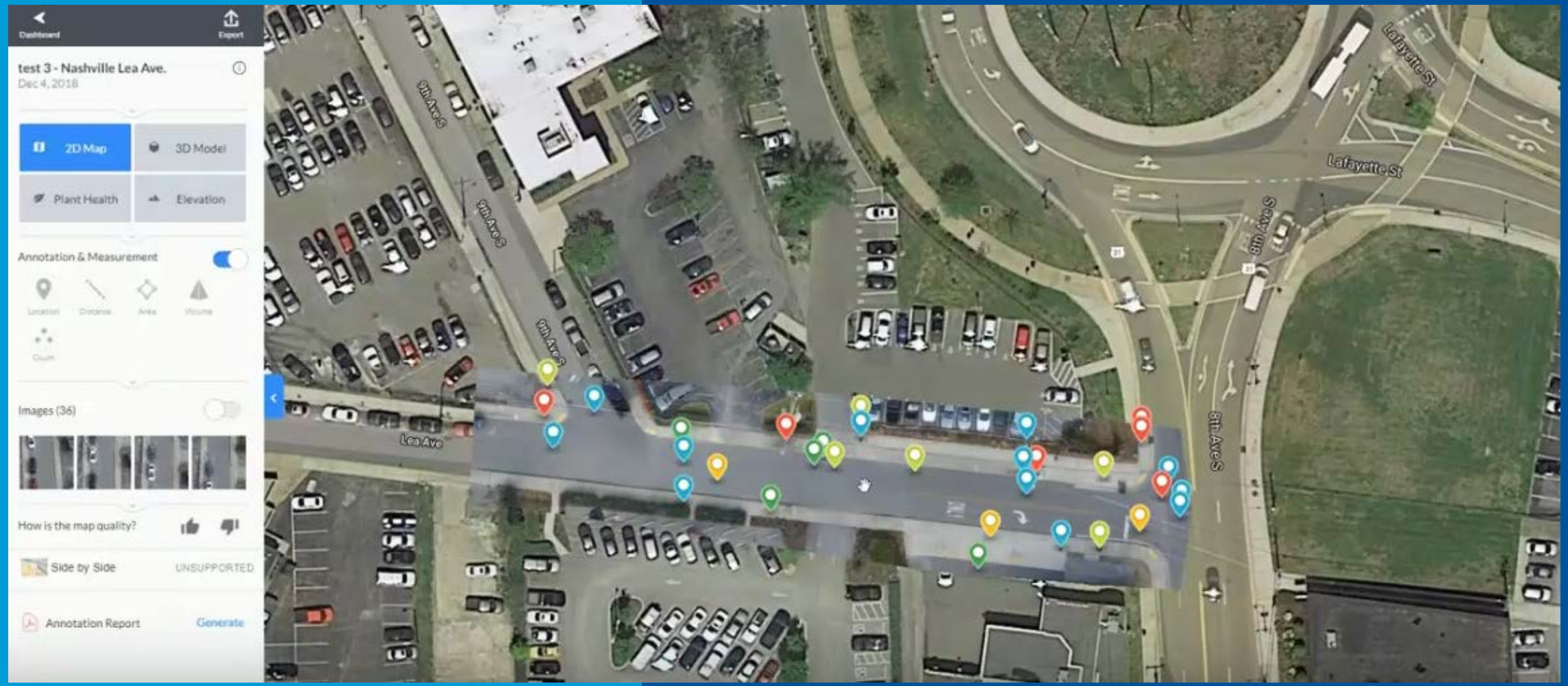
ASSET IDENTIFICATION



Credit: U. S. Aerial Analytics
Drone Deploy

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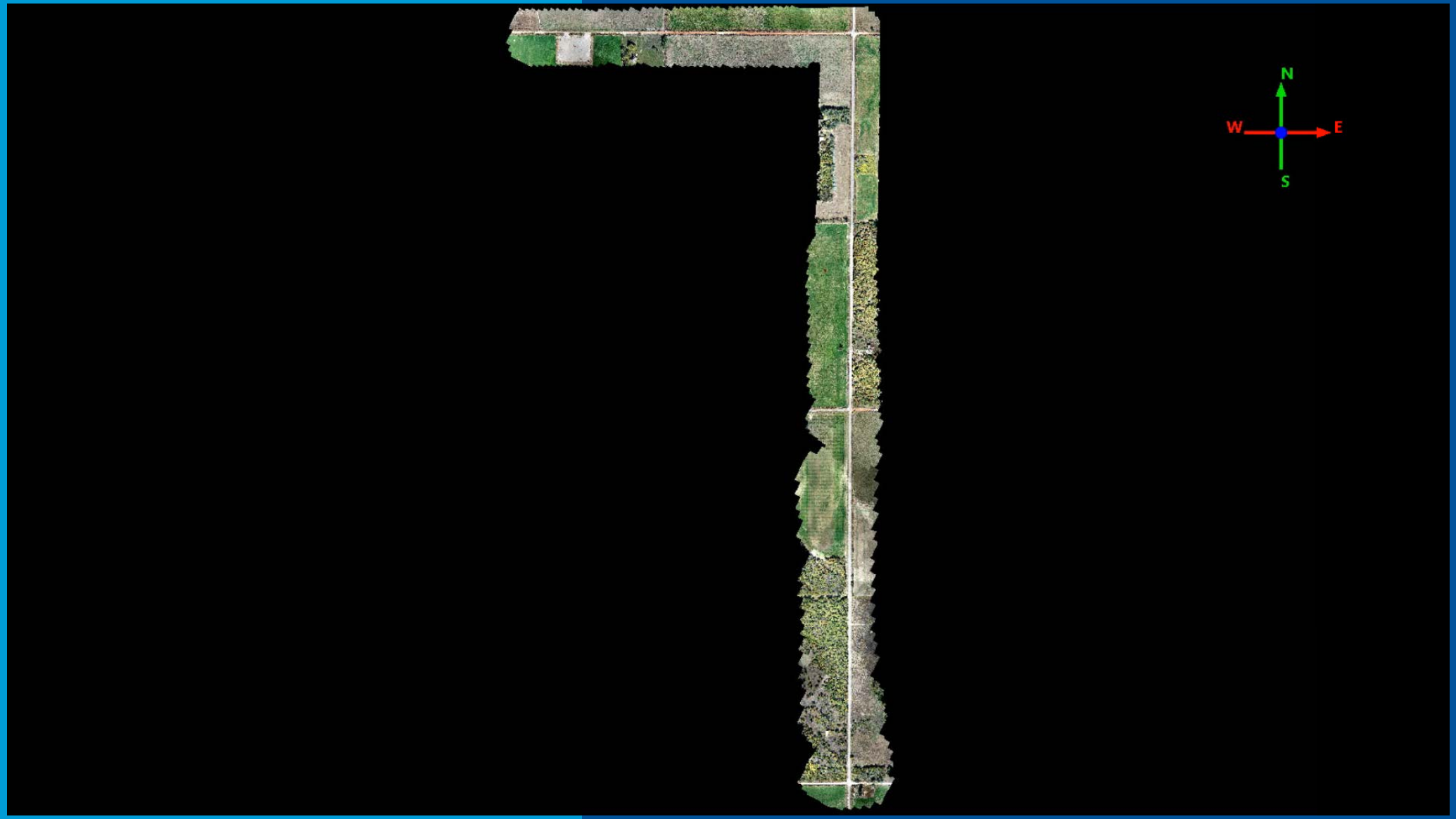
POINTCLOUDS??



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POINTCLOUDS??

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PROJECT FLYTHROUGHS

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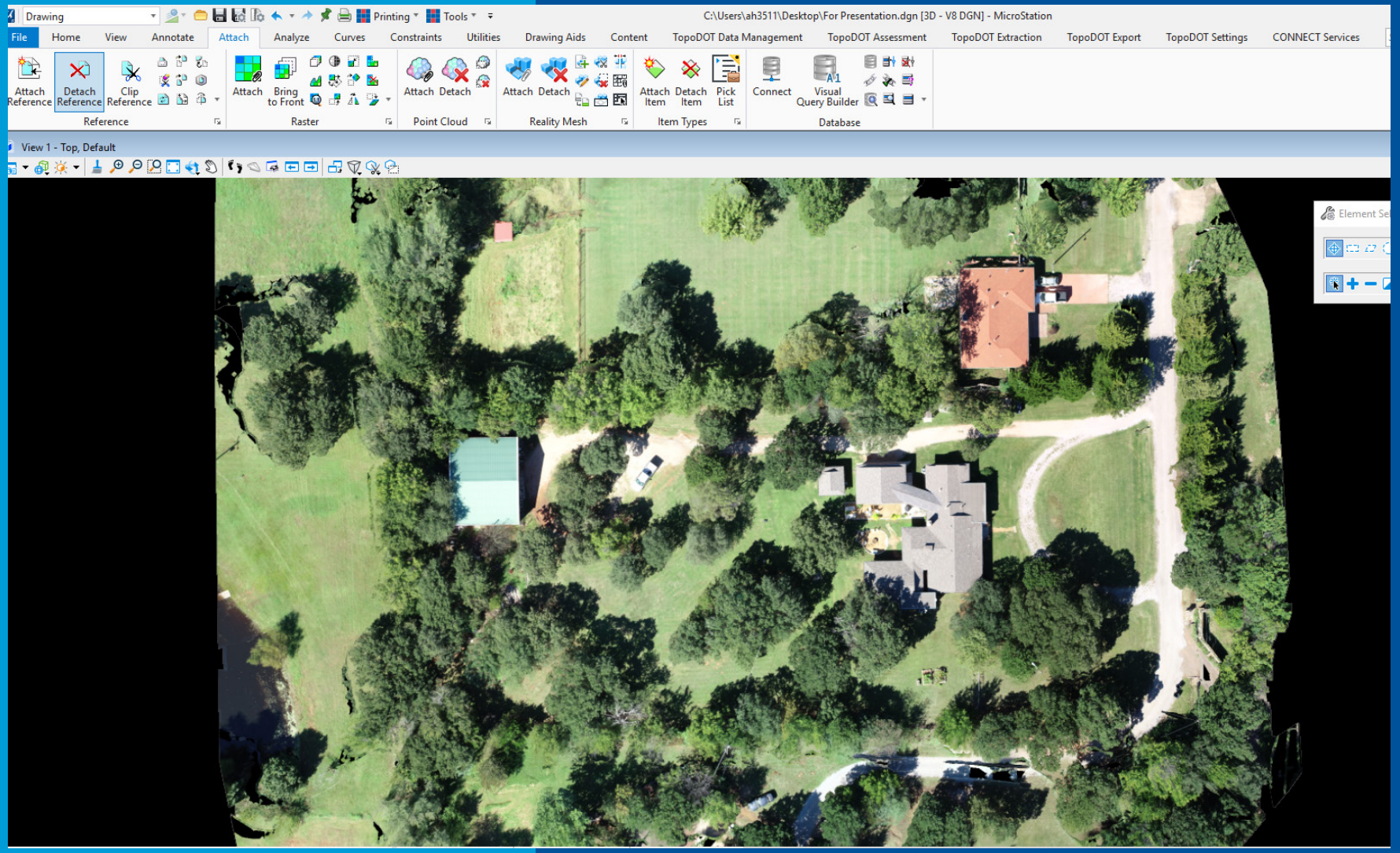
DTM'S | DETAILED TERRAIN MODELS



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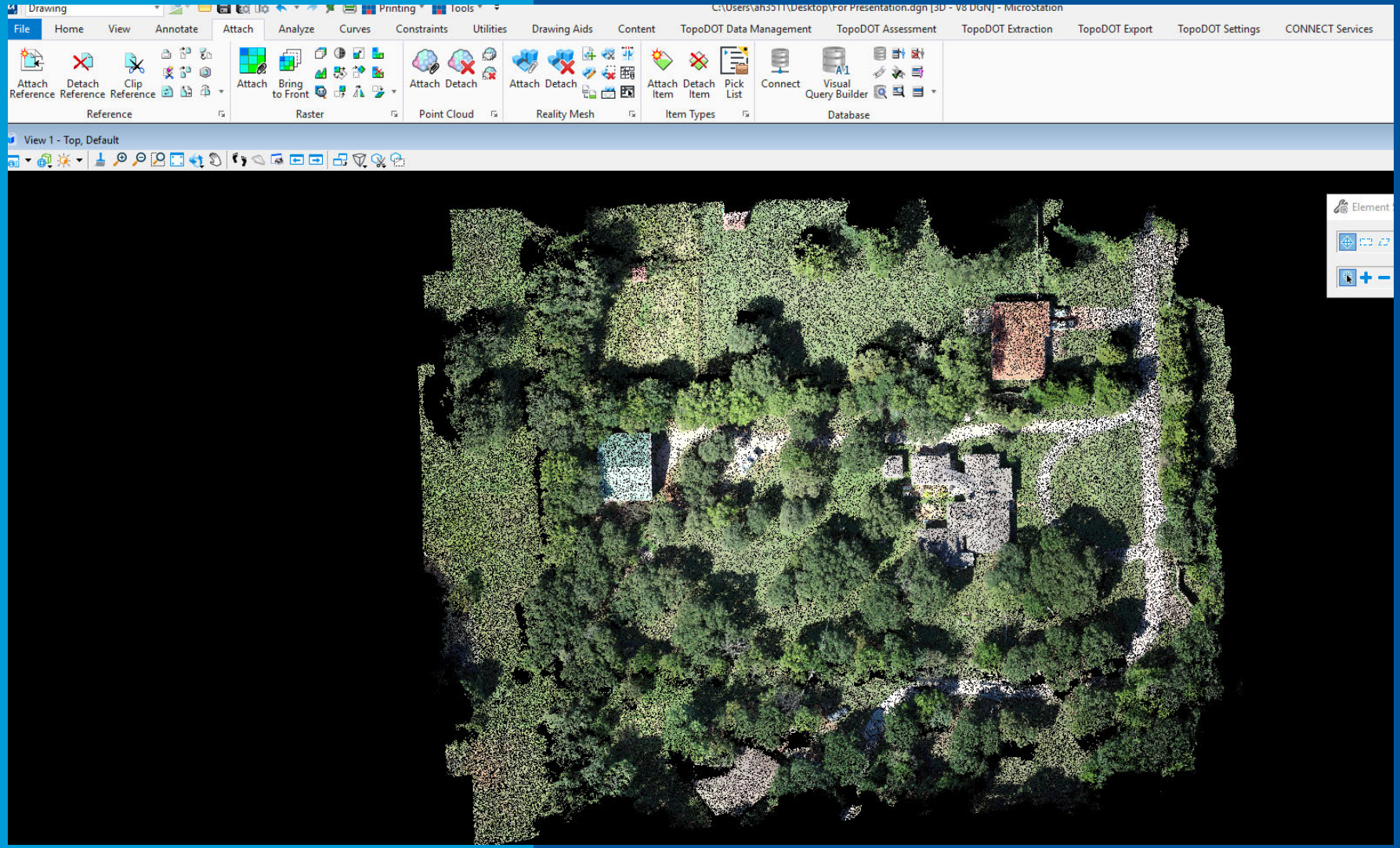
DTM'S | DETAILED TERRAIN MODELS



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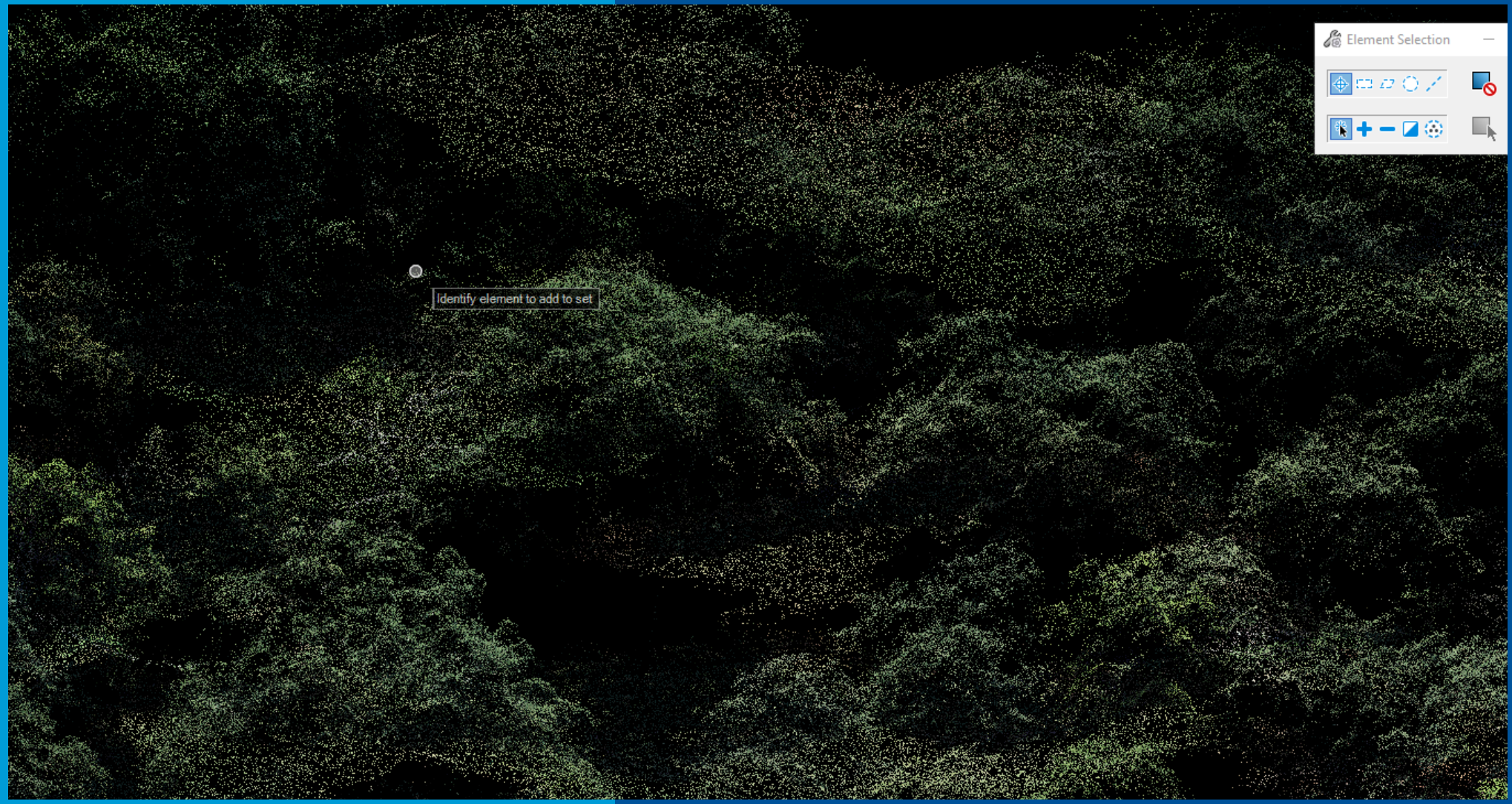
DTM'S | DETAILED TERRAIN MODELS



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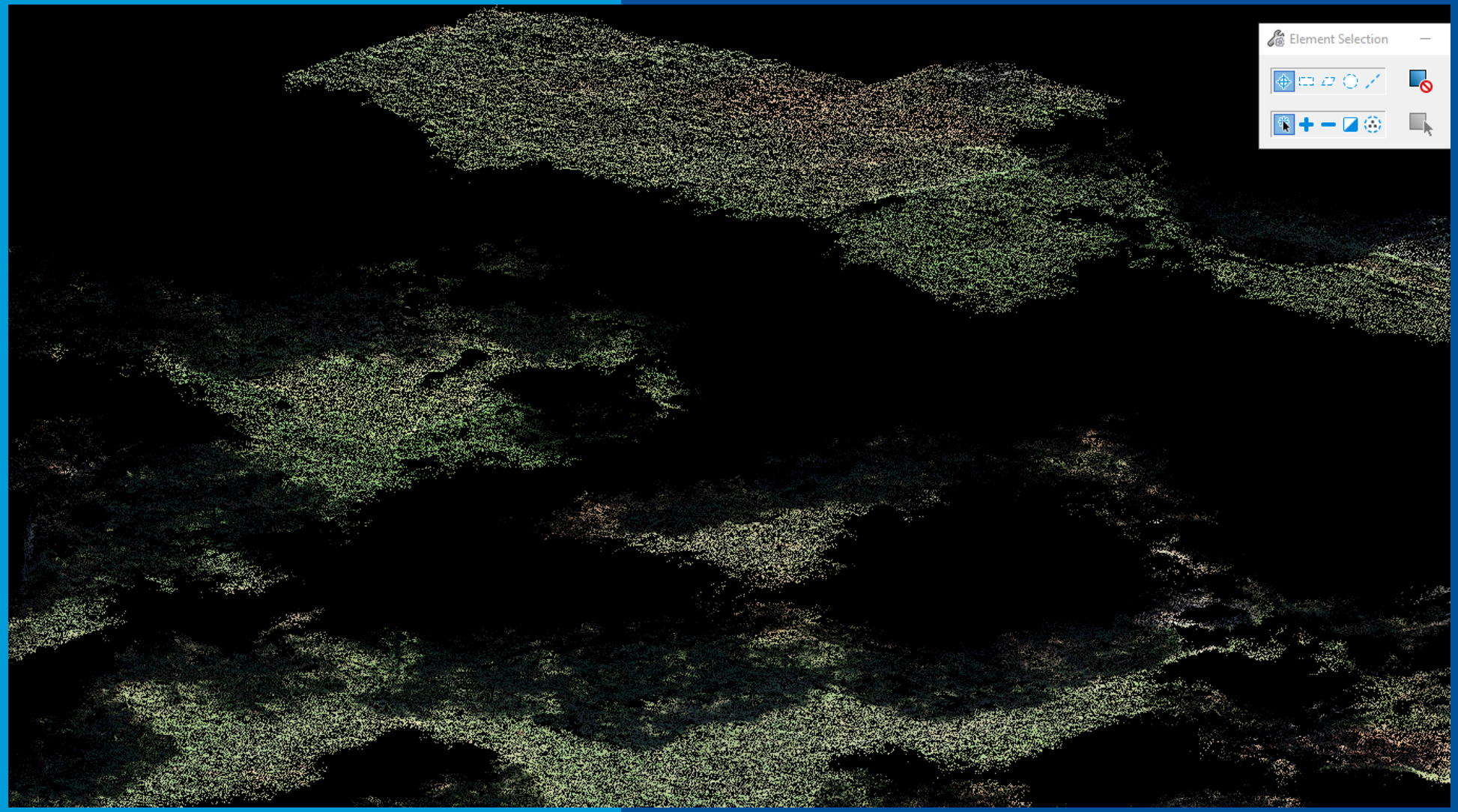
DTM'S | DETAILED TERRAIN MODELS



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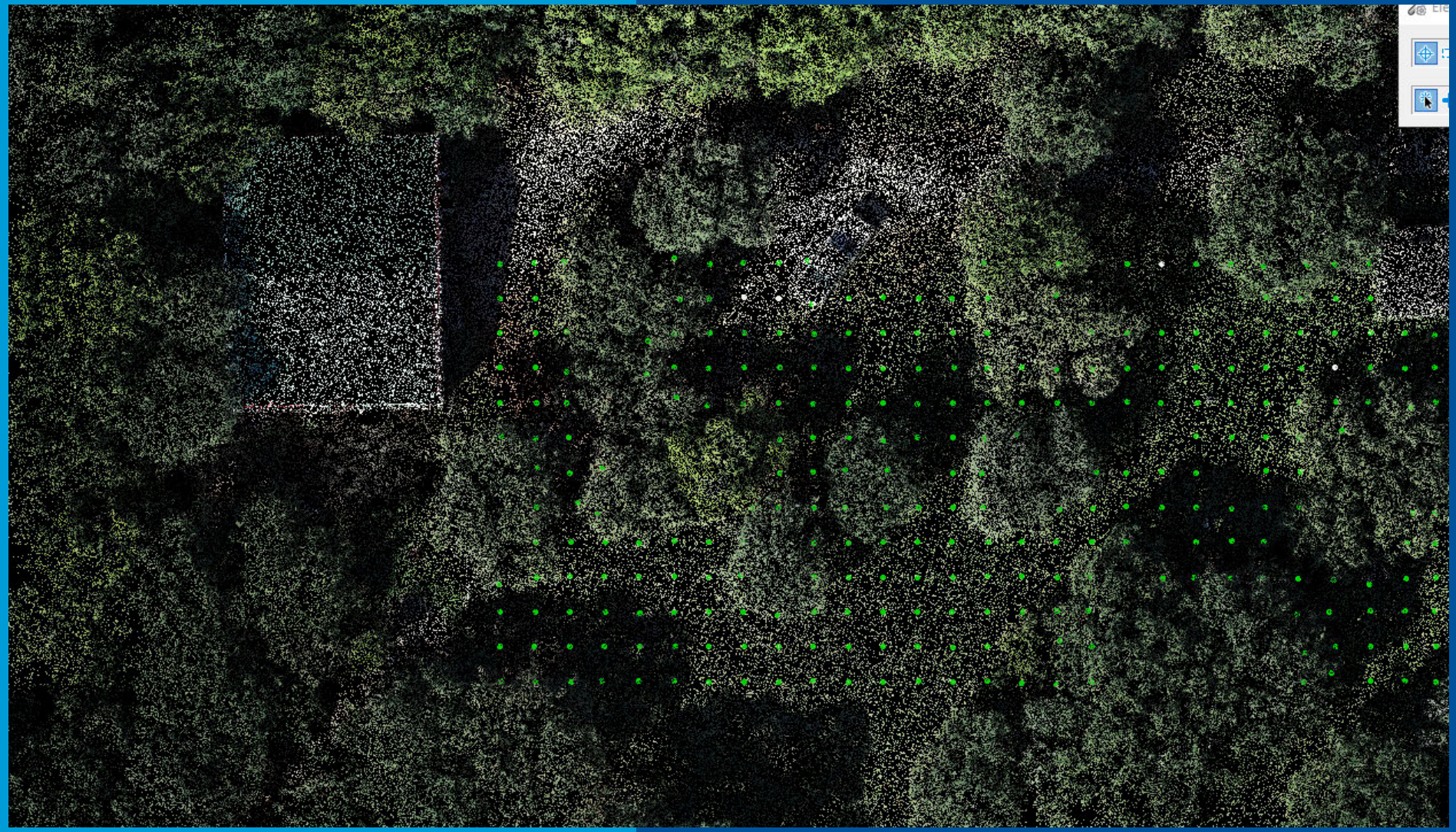
DTM'S | DETAILED TERRAIN MODELS



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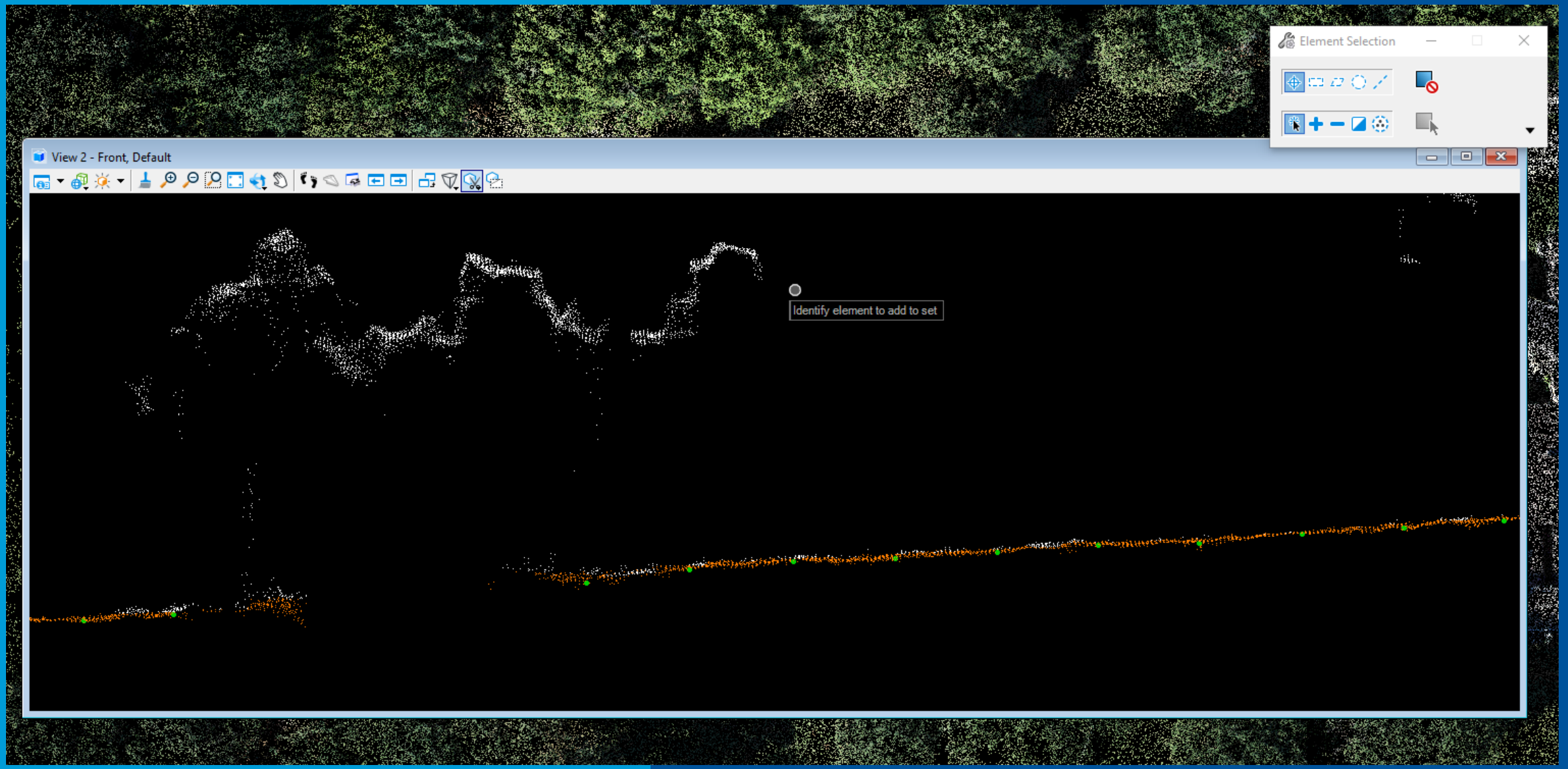
DTM'S | DETAILED TERRAIN MODELS



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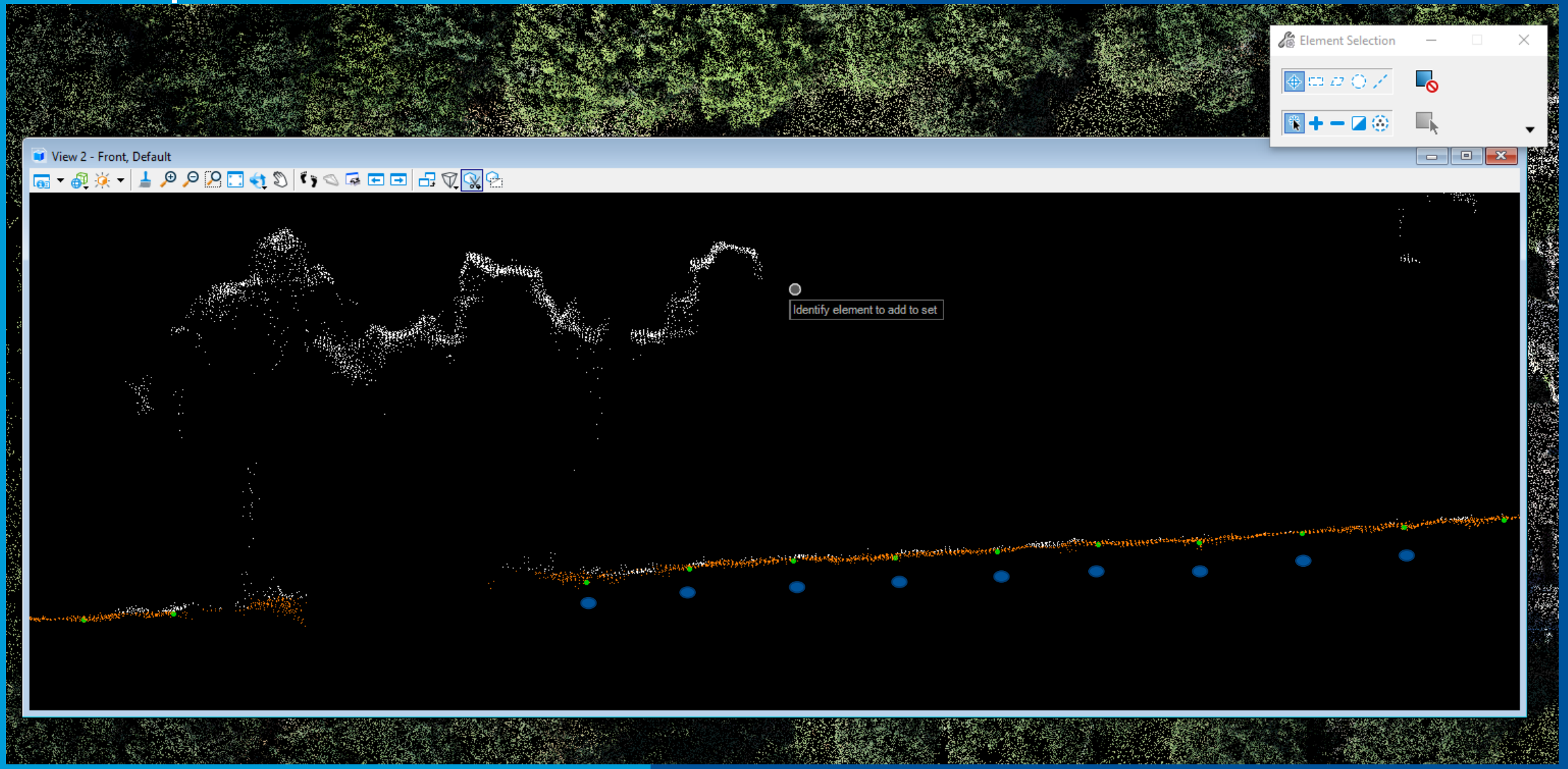
DTM'S | DETAILED TERRAIN MODELS



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DTM’S | DETAILED TERRAIN MODELS

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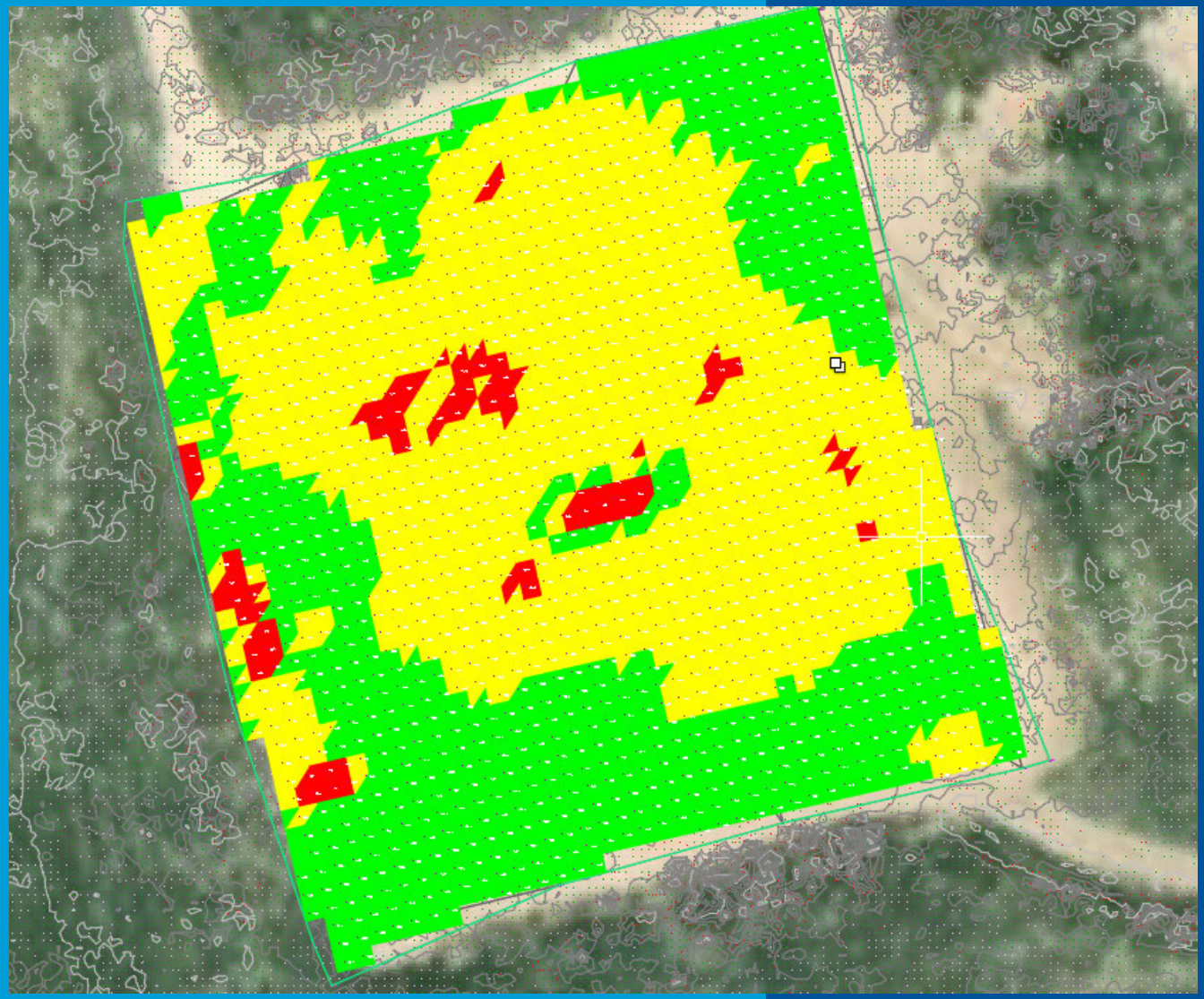
DTM'S | DETAILED TERRAIN MODELS



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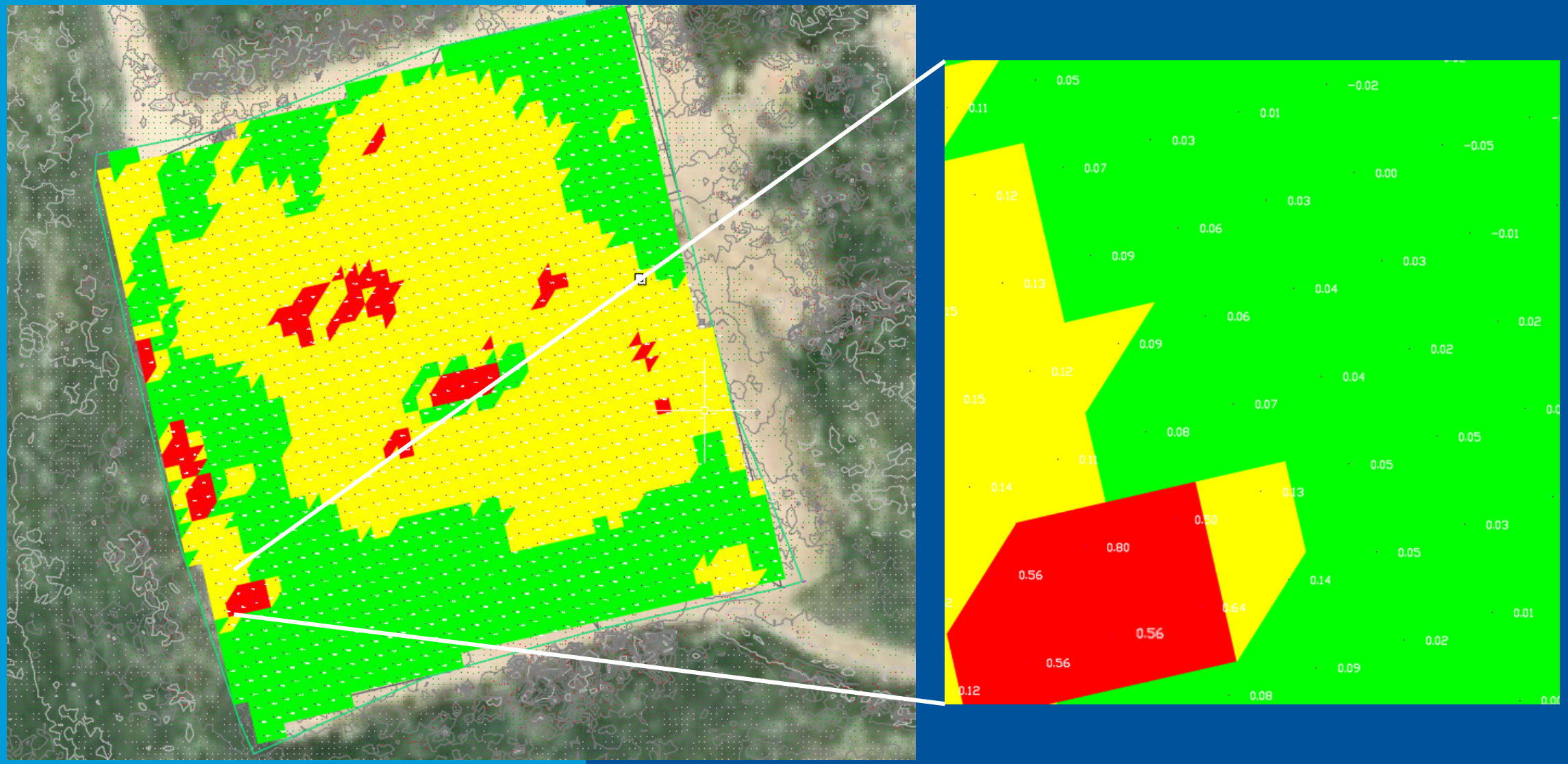
DTM'S | DETAILED TERRAIN MODELS



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DTM'S | DETAILED TERRAIN MODELS

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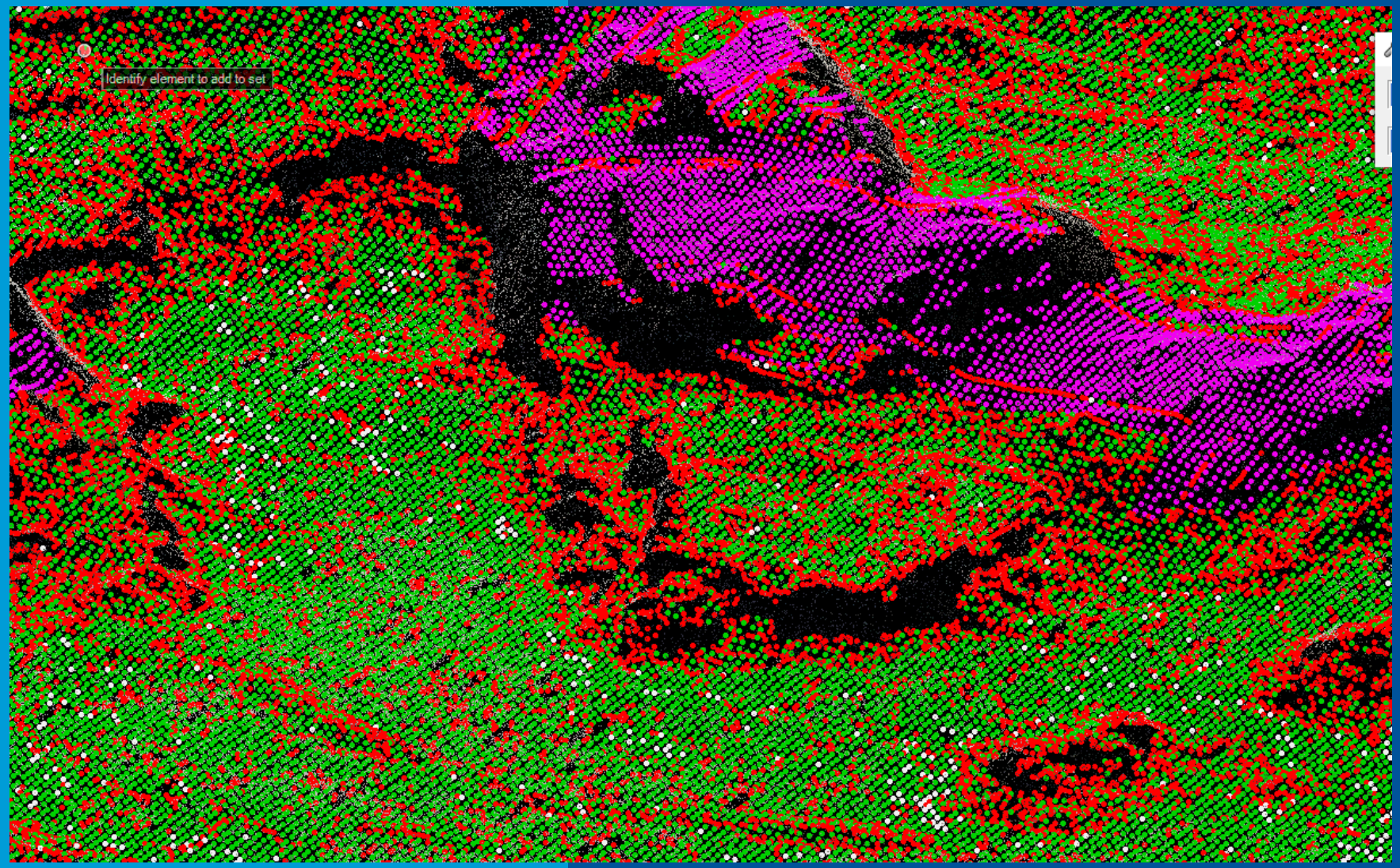

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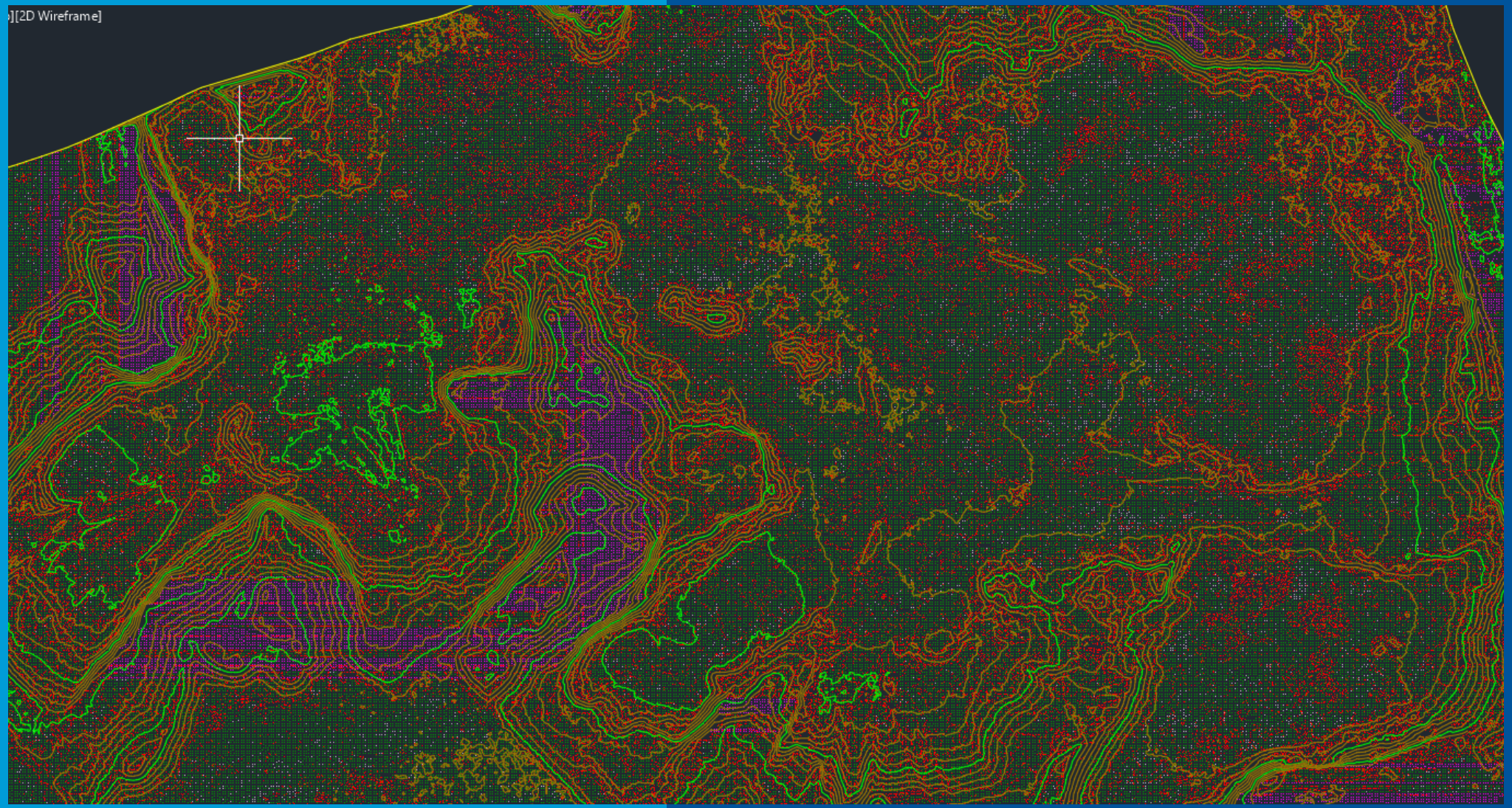
DTM'S | DETAILED TERRAIN MODELS



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DTM’S | DETAILED TERRAIN MODELS

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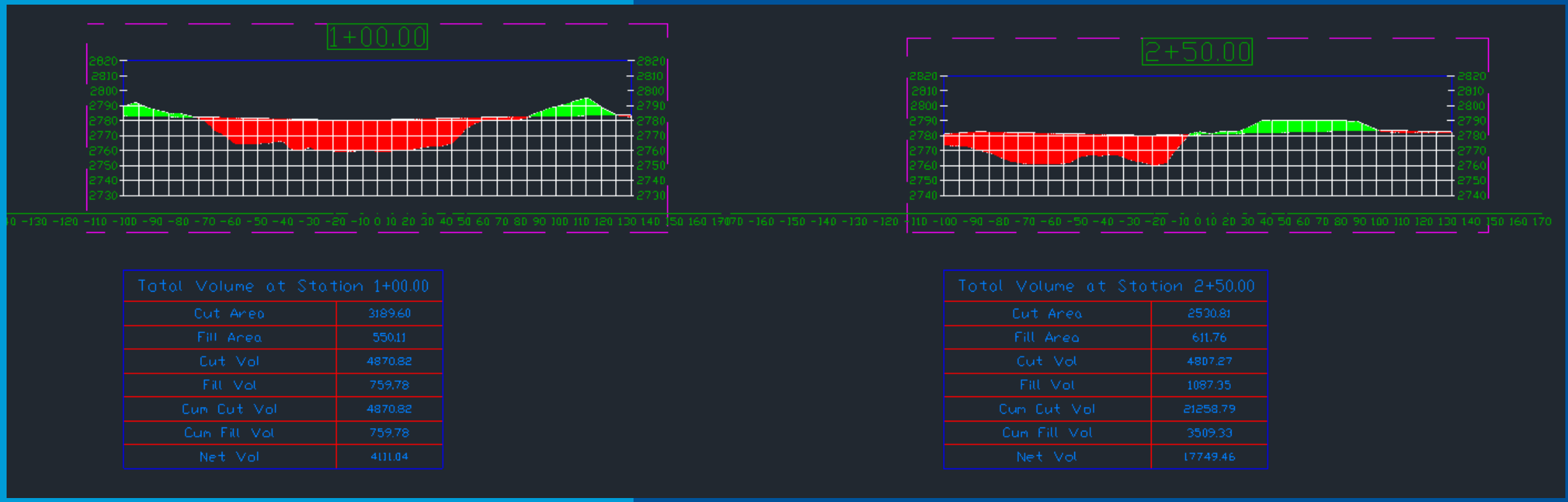
QUANTITIES | END AREA SECTIONS



Total Volume at Station 1+00.00	
Cut Area	3189.60
Fill Area	550.11
Cut Vol	4870.82
Fill Vol	759.78
Cum Cut Vol	4870.82
Cum Fill Vol	759.78
Net Vol	4111.04

Total Volume at Station 2+50.00	
Cut Area	2530.81
Fill Area	611.76
Cut Vol	4807.27
Fill Vol	1087.35
Cum Cut Vol	21258.79
Cum Fill Vol	3509.33
Net Vol	17749.46

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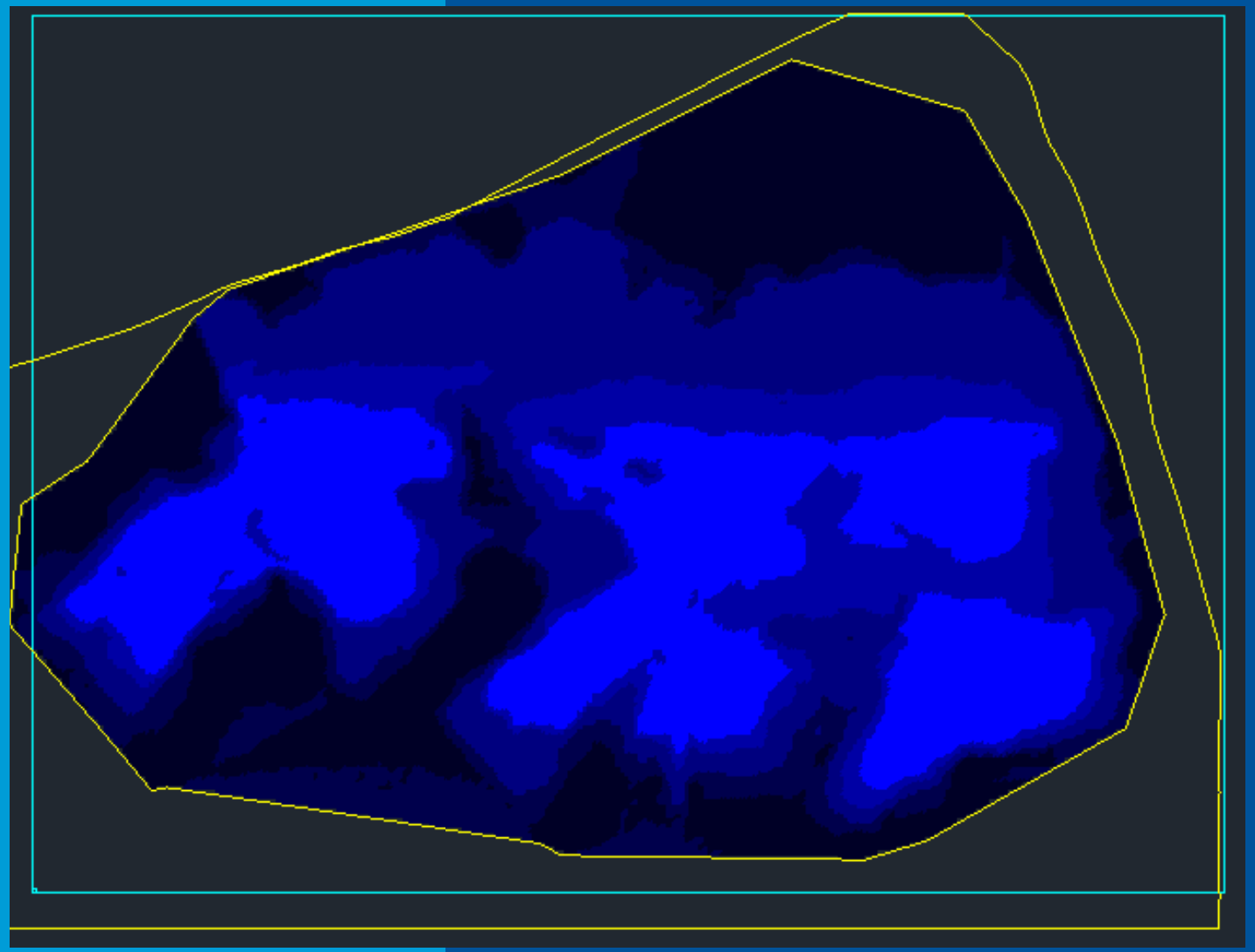
QUANTITIES | PRISMOIDAL HEAT MAP



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QUANTITIES | REPORTS

Station	Cut Area (Sq.ft.)	Cut Volume (Cu.yd.)	Reusable Volume (Cu.yd.)	Fill Area (Sq.ft.)	Fill Volume (Cu.yd.)	Cum. Cut Vol. (Cu.yd.)	Cum. Reusable Vol. (Cu.yd.)	Cum. Fill Vol. (Cu.yd.)	Cum. Net Vol. (Cu.yd.)
0+50.000	2070.89	0.00	0.00	270.45	0.00	0.00	0.00	0.00	0.00
1+00.000	3189.60	4870.82	4870.82	550.11	759.78	4870.82	4870.82	759.78	4111.04
1+50.000	3328.26	6035.05	6035.05	341.24	825.33	10905.87	10905.87	1585.11	9320.77
2+00.000	2661.04	5545.65	5545.65	562.58	836.88	16451.52	16451.52	2421.98	14029.54
2+50.000	2530.81	4807.27	4807.27	611.76	1087.35	21258.79	21258.79	3509.33	17749.46
3+00.000	5248.16	7202.75	7202.75	0.75	567.13	28461.55	28461.55	4076.47	24385.08
3+50.000	5299.50	9766.35	9766.35	56.87	53.34	38227.90	38227.90	4129.81	34098.09
4+00.000	4649.99	9212.49	9212.49	384.67	408.83	47440.39	47440.39	4538.64	42901.75
4+50.000	3114.84	7189.67	7189.67	539.10	855.34	54630.05	54630.05	5393.98	49236.08
5+00.000	1580.16	4347.23	4347.23	363.10	835.38	58977.28	58977.28	6229.35	52747.93
5+50.000	4105.14	5264.17	5264.17	0.00	336.21	64241.45	64241.45	6565.56	57675.89
6+00.000	4702.40	8155.12	8155.12	0.00	0.00	72396.57	72396.57	6565.56	65831.01
6+50.000	5429.38	9381.27	9381.27	0.00	0.00	81777.84	81777.84	6565.56	75212.28
7+00.000	5393.42	10021.11	10021.11	0.00	0.00	91798.95	91798.95	6565.56	85233.39

Cut/Fill Report

Generated: 2018-10-15 09:04:09

By user: ah3511

Drawing: C:\Users\ah3511\Desktop\C:\Users\ah3511\Desktop\For Presentation Grid_KeyPts_HeatMap.dwg

Volume Summary

Name	Type	Cut Factor	Fill Factor	2d Area (Sq. Ft.)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Surface3	full	1.000	1.000	754893.67	262407.82	25018.48	237389.35<Cut>

Totals

	2d Area (Sq. Ft.)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Total	754893.67	262407.82	25018.48	237389.35<Cut>

* Value adjusted by cut or fill factor other than 1.0

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ENVIRONMENTAL & GIS

- Current, possibly more affordable Imagery and Terrain Models
  - Flood assessments
  - River assessments
  - Change monitoring and detection
  - Coastal information
  - Forest information (health or inventory)
  - Plant information (multi or hyper spectral sensors)*

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WHERE CAN WE GROW?

ARCHITECTURE & LANDSCAPE ARCHITECTURE

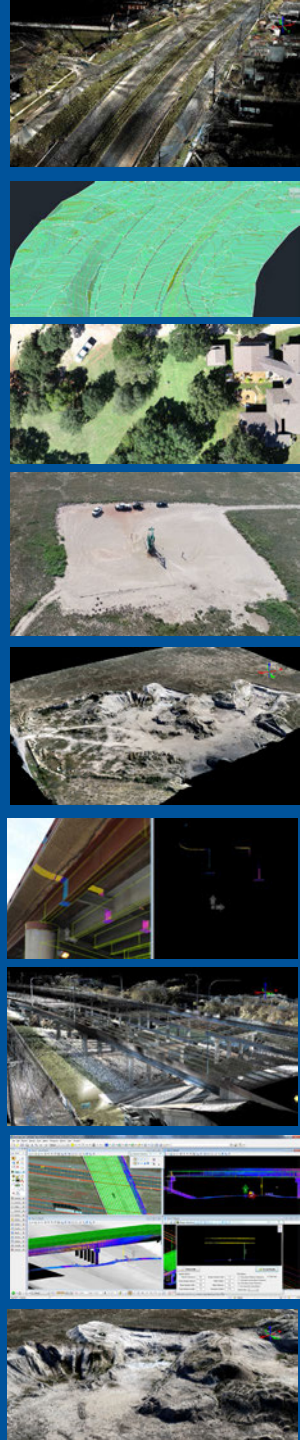
- Significant time/cost reduction on site documentation for Aerial Imagery, Terrain Models (Irrigation), and 3d modeling of buildings

TRAFFIC STUDIES

- “Overhead” flight video mapping highly congested traffic areas for study purposes

CONSTRUCTION INSPECTION

- Verification, inspection, Stockpile or any type of quantities



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MINING AND QUARRIES

- Best way to map quarries for precise, current information

AGRICULTURE

- Crop inspection for yield information, irrigation information*

ENERGY

- Thermal imagery for Solar Fam Panel inspections, Wind Farm Turbine inspection (30x zoom camera)*

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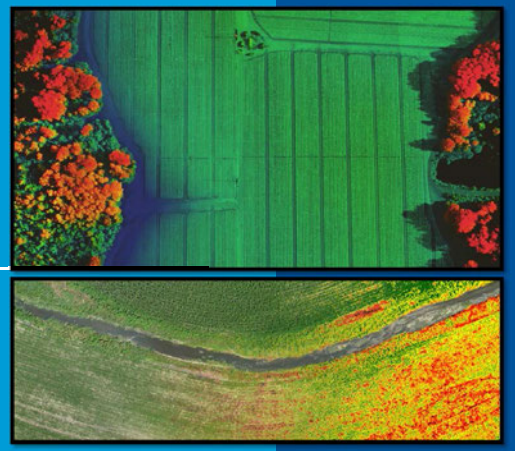
WHERE CAN WE GROW?

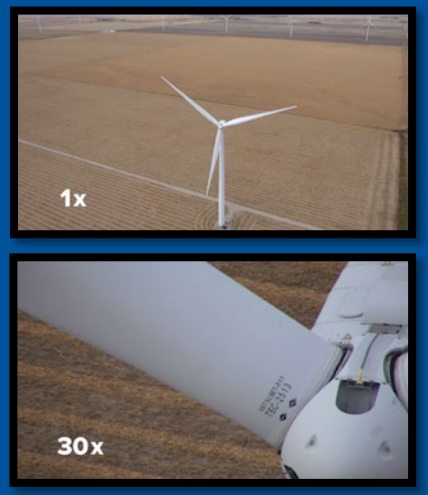
POWER

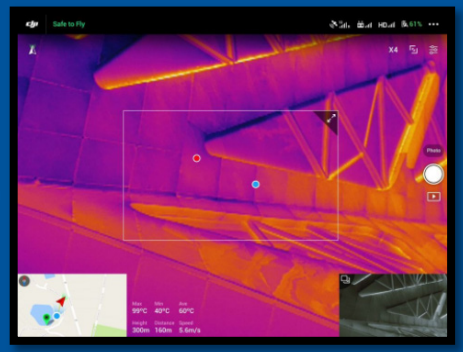
- Thermal imagery of Electrical Equipment, General storm assessment flights (Live streaming information)*

PUBLIC SAFETY

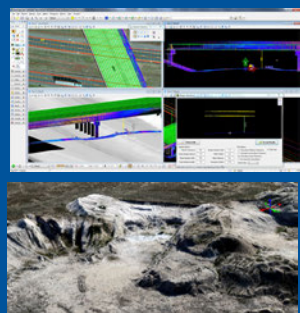
- Applications for Firefighting, law enforcement, disaster management, search & rescue, etc







Credit: DJI



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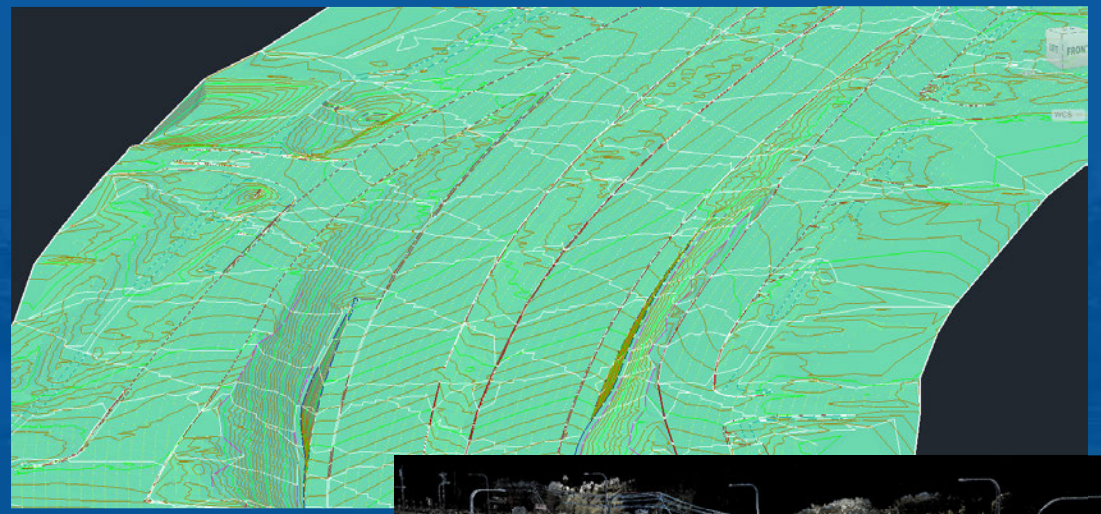
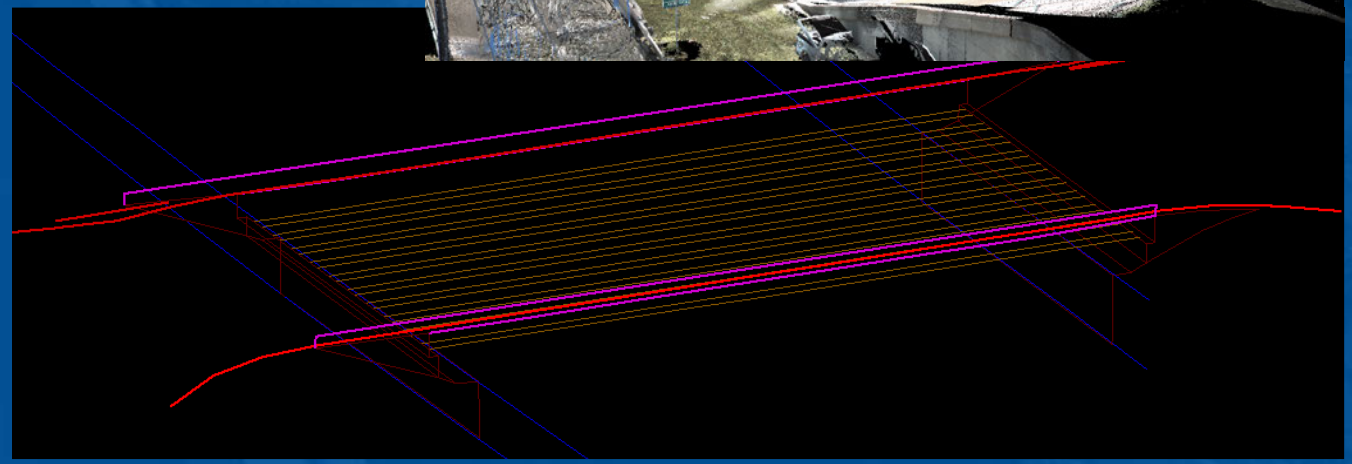
LIDAR MODELING

What are we doing now?

- Corridor 3D Modeling
- Bridge 3D Modeling
- Detailed Terrain Modeling





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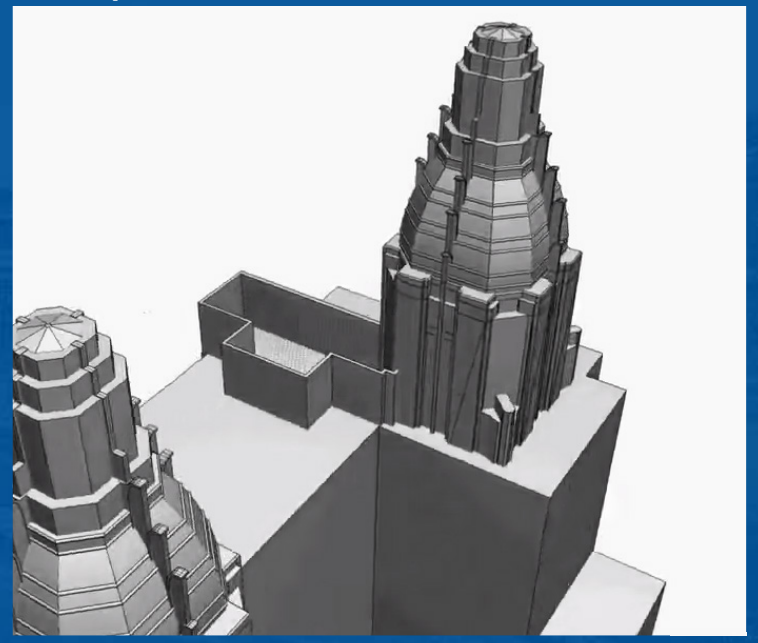
LIDAR MODELING AND ANALYSIS

What are we capable of?

- 3D Building Modeling (BIM)
- Railroad Modeling
- Pipe Modeling
- Tank and attachment modeling
- Bridge modeling
- Pavement Condition Analysis
- Floor Flatness and Levelness
- Super Elevation and ADA Grade Checks
- Horizontal and Vertical Clearances
- Buffer Clearances
- Powerline Modeling

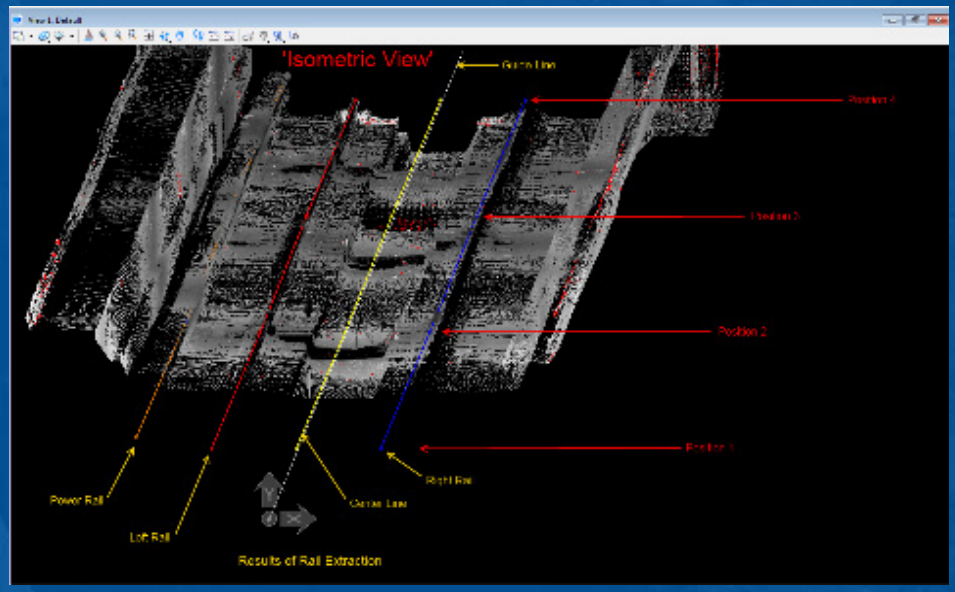
HALFF

3D BUILDING MODELING | BIM



Credit: TopoDOT

RAILROAD SURVEY | MODELING



Credit: TopoDOT

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LIDAR MODELING AND ANALYSIS

What are we capable of?

- 3D Building Modeling (BIM), Bridge modeling
- Railroad Modeling
- Pipe Modeling
- Tank and attachment modeling
- Wall/Structure Monitoring
- Pavement Condition Analysis
- Floor Flatness and Levelness
- Super Elevation and ADA Grade Checks
- Horizontal and Vertical Clearances
- Buffer Clearances
- Powerline Modeling

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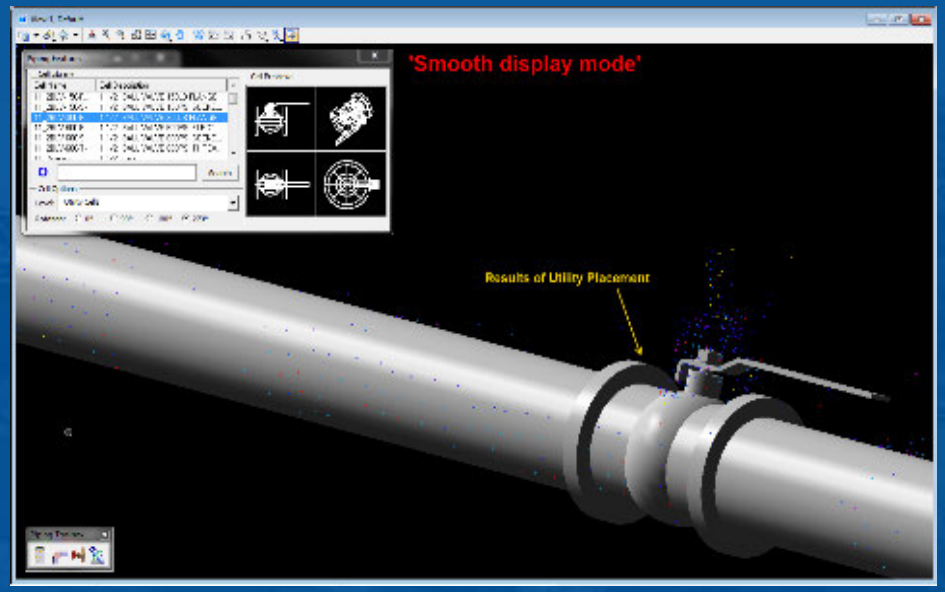
PIPE MODELING | TANKS AND ATTACHMENTS



Credit: TopoDOT

PIPE MODELING | TANKS AND ATTACHMENTS

Credit: TopoDOT

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LIDAR MODELING AND ANALYSIS

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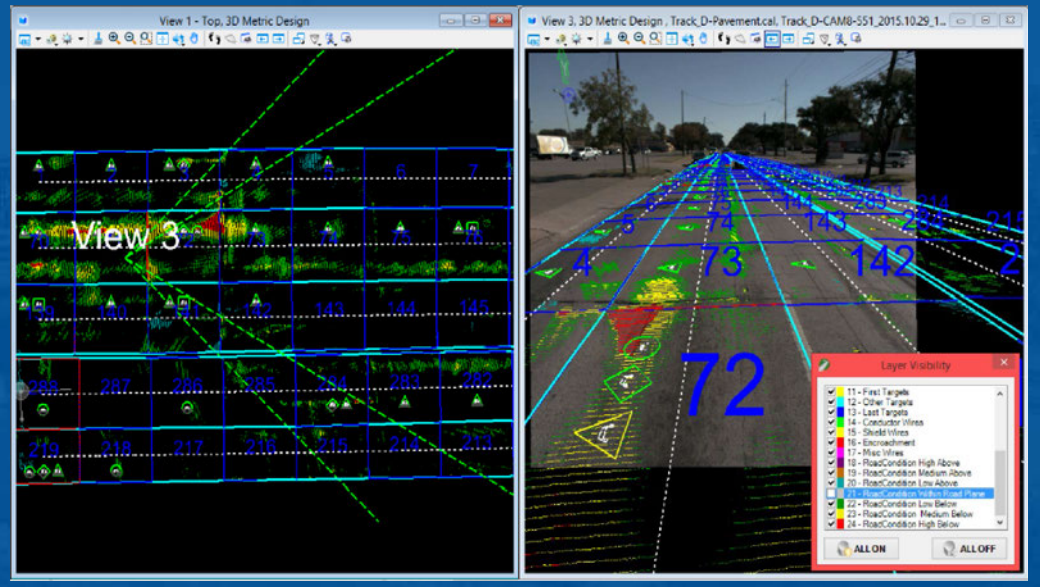
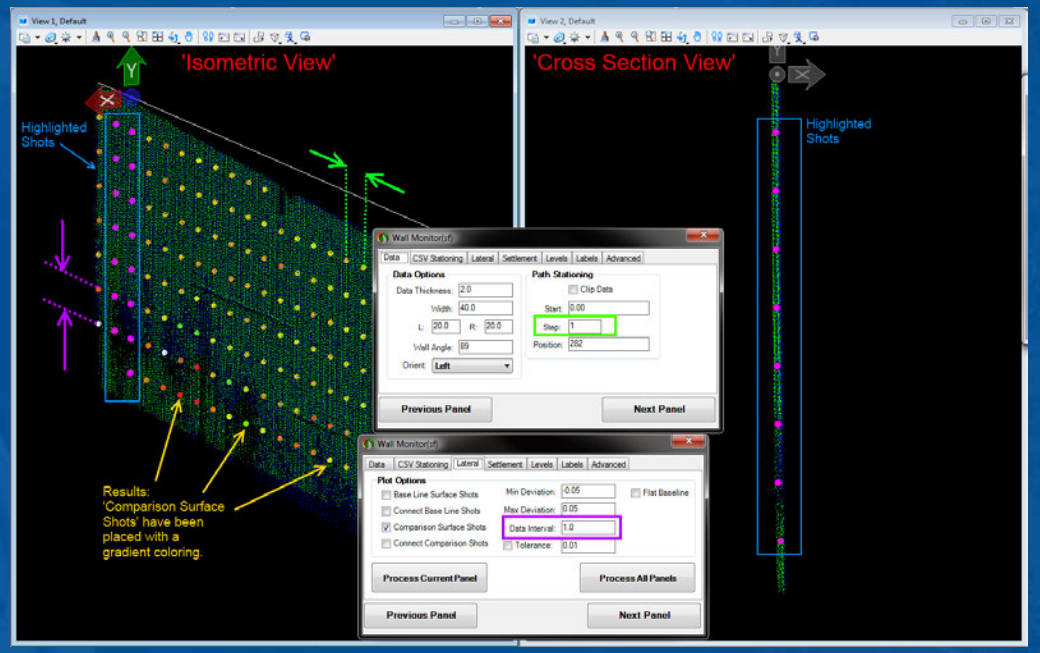
PAVEMENT CONDITION | CHANGE DETECTION



Credit: TopoDOT

WALL MONITORING | PLANE DETECTION



Credit: TopoDOT

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LIDAR MODELING AND ANALYSIS

What are we capable of?

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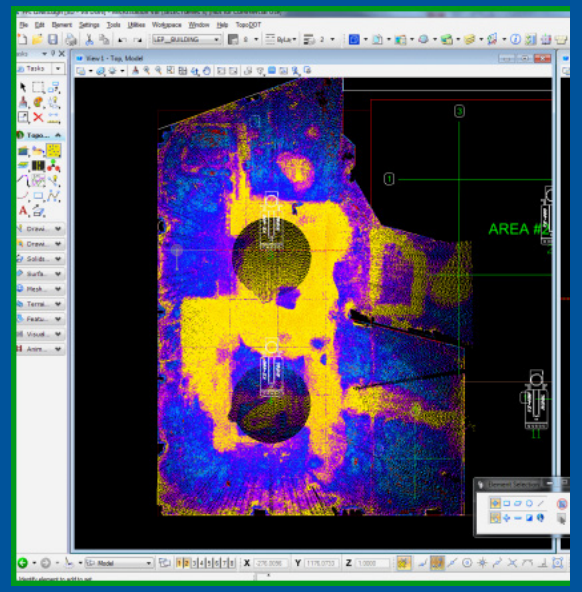
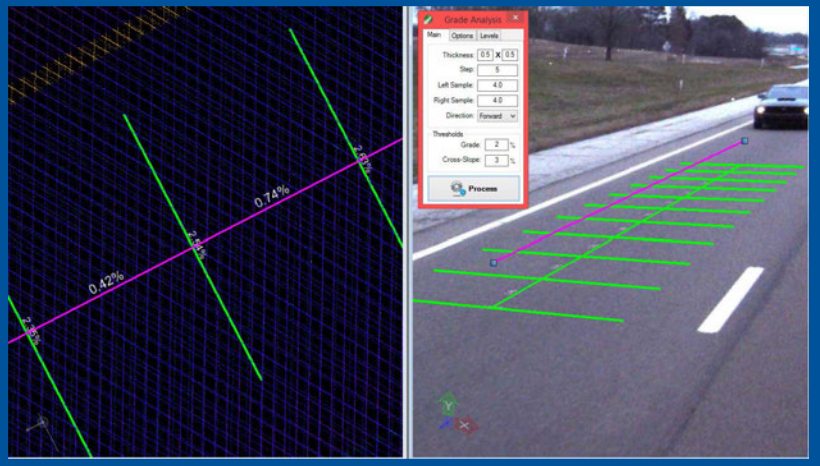
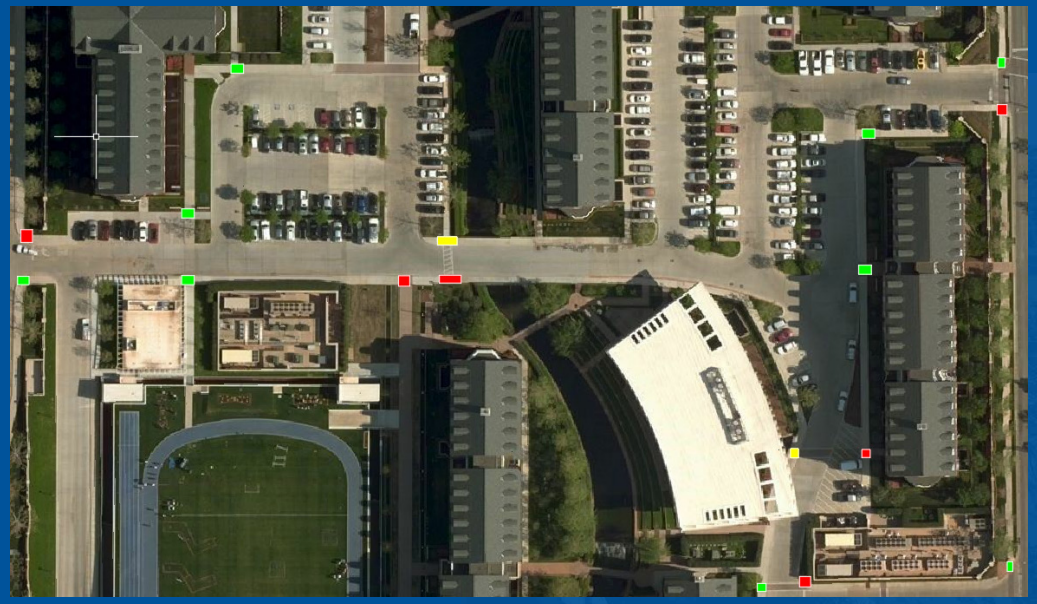
FLOOR FLATNESS| SUPER ELEVATION ANALYSIS





Credit: TopoDOT

GRADE CHECKS | ADA COMPLIANCE



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LIDAR MODELING AND ANALYSIS

What are we capable of?

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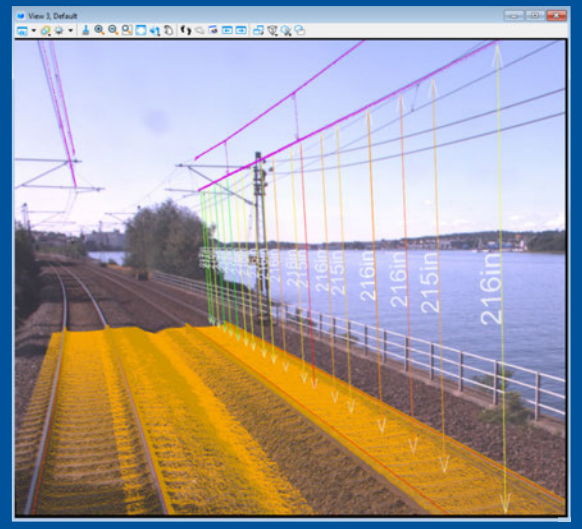
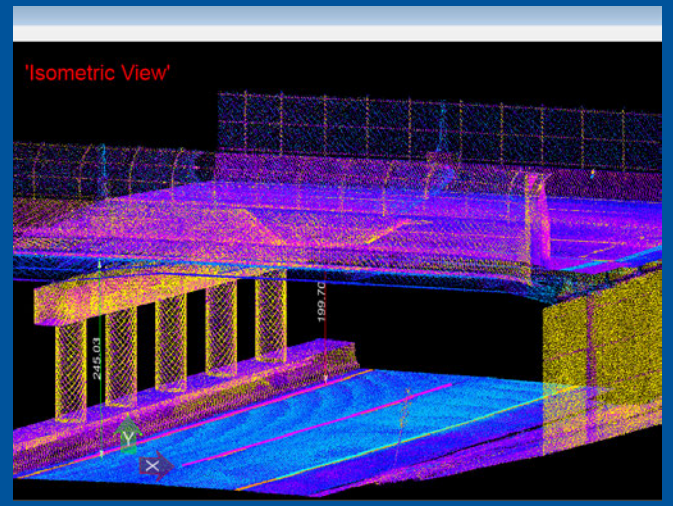
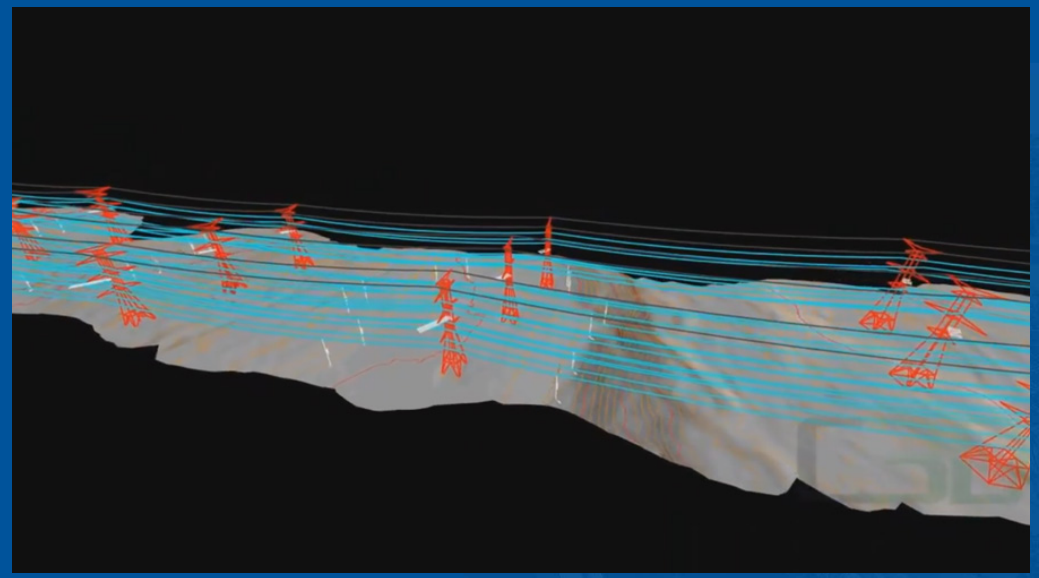
HORIZONTAL CLEARANCES | VERTICAL CLEARANCES





Credit: TopoDOT

POWERLINE MODELING | BUFFER CLEARANCES



Credit: TopoDOT

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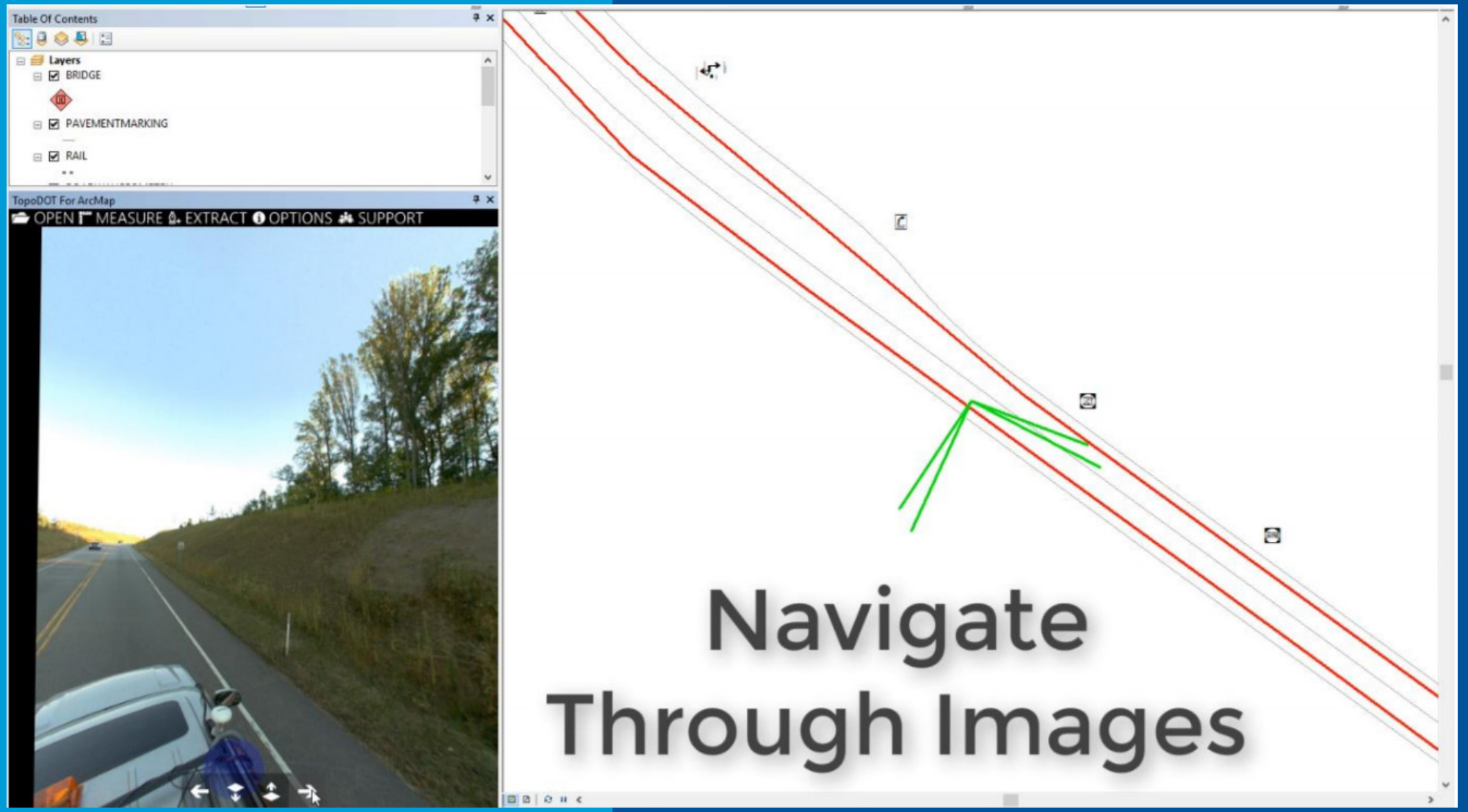
GIS | TOPODOT – ESRI INTEGRATION



Credit: TopoDOT

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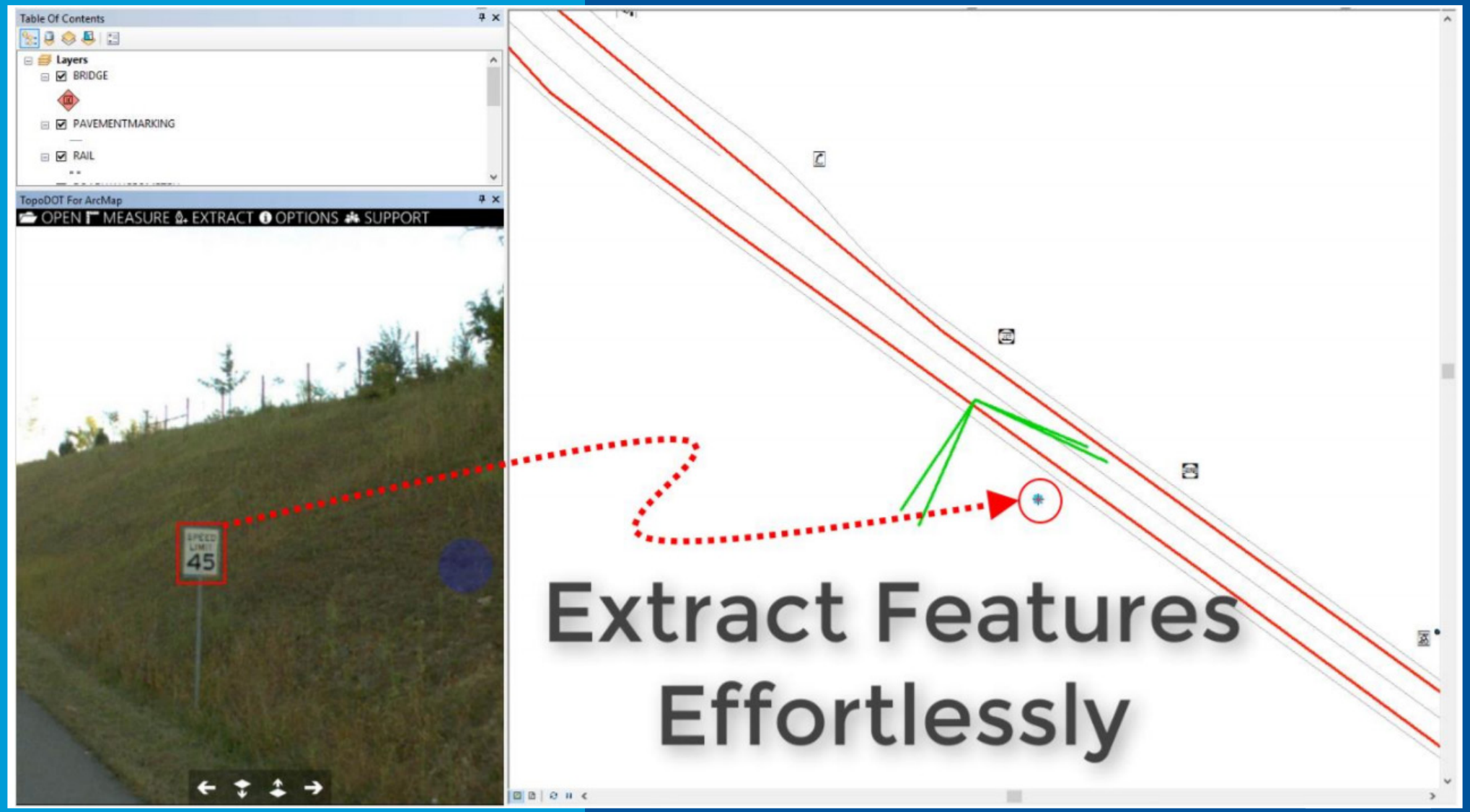
GIS | TOPODOT – ESRI INTEGRATION



Credit: TopoDOT

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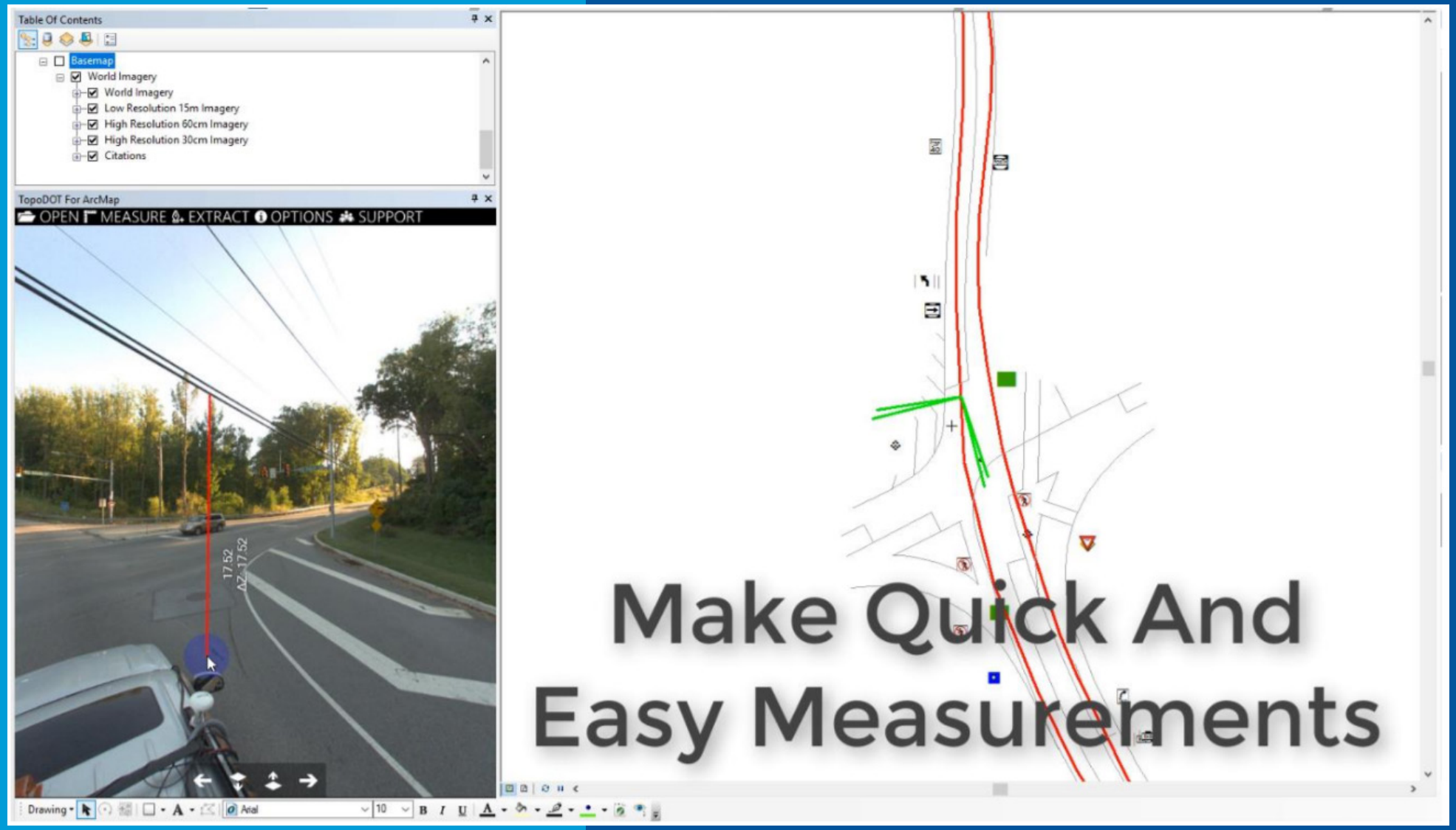
GIS | TOPODOT – ESRI INTEGRATION



Credit: TopoDOT

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FLYING IN TEXAS/ OKLAHOMA

- TXDOT has some great early policies and best practices (to be continued)
- Texas State Senate Bill 840 (revised 9/1/17) originally Chapter 423 of the Texas Government Code titled “Use of Unmanned Aircraft,”
  - Operating as Licensed Surveyors and Licensed Engineers we are permitted to fly
  - if the image is captured by or for an electric or natural gas utility or a telecommunications provider
- Oklahoma House Bill 2599 signed into law by Governor Fallin permits those Authorized by FAA to conduct operations over “critical infrastructure”

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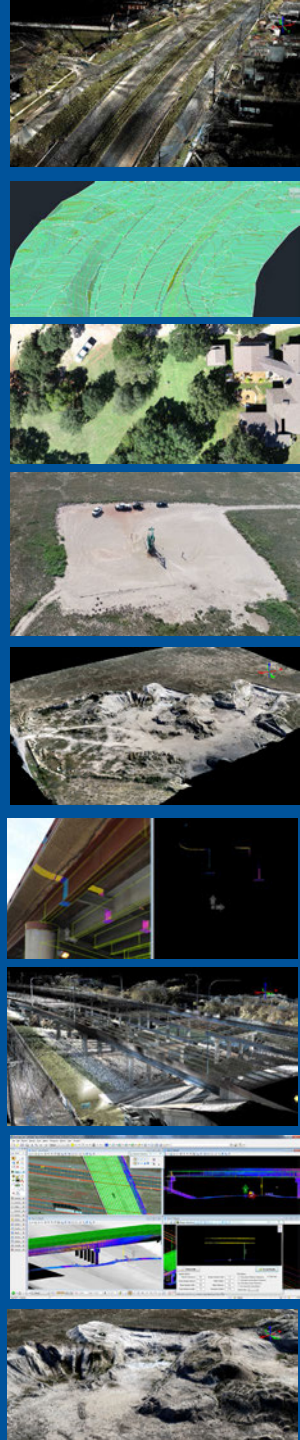
SOME COMMON QUESTIONS

PRIVATE PROPERTY

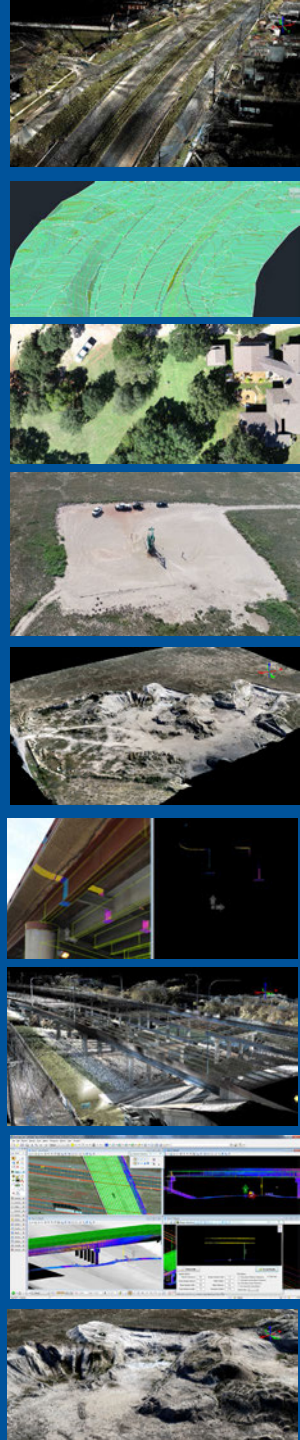
- FAA owns the aerospace, individuals cannot claim ownership.
- Don’t cause a nuisance (fly plenty high)
- Don’t fly recklessly
- Don’t violate local privacy laws
- Avoid unnecessary collection of private property
- Don’t take off, land, or operate on private property
- During post processing remove any over collection or unneeded private property data
- Notify private owner when possible



SOME COMMON QUESTIONS

“CRITICAL INFRASTRUCTURE”

Fallin says FAA-approved drone pilots are “already held to federal standards that are more rigorous than those for hobbyists or recreational flyers and are also subject to a federal permitting process.” Thus, she says, “more regulation is not needed to protect the public interest.” Forcing these operators to comply with a separate set of rules, she adds, “would not only be inconsistent with FAA regulation, but also could force commercial operators to seek the written consent of the facility owner or operator prior to flight – a task so logistically difficult as to functionally disallow commercial [unmanned aircraft] operations in Oklahoma.”



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SOME COMMON QUESTIONS

TXDOT UAS MANUAL

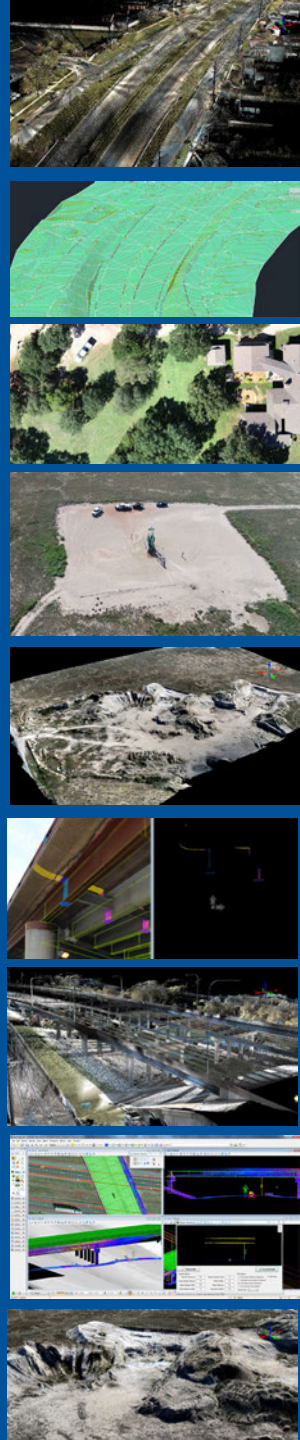
Any persons collecting data using UAS must be familiar with Chapter 423 of the Texas Government Code titled “Use of Unmanned Aircraft,” which concerns the legality of using a UAS to capture images of people or private property.

In light of the current legal environment, TxDOT will operate UAS under the following privacy requirements:

- Data will only be collected for use that is consistent and relevant to mission of the agency.
- Flight crews will make every attempt to limit coincidental collection of data outside of the project area.
- Coincidental data collected outside of the project area will be deleted if that data could reasonably be considered to be an invasion of an individual’s privacy.
- UAS data collection will be performed in a manner consistent with federal and state laws and with any local ordinances.

For any project in which privacy issues are a concern, pre-approval from the TxDOT UAS Coordinator is required. The privacy issue shall be submitted to the UAS Coordinator using the UAS Flight Pre-Approval Form provided in Appendix B along with the flight plan. The form will be e-mailed to TxDOT-UASFlightPlan@txdot.gov.

HALFF



QUESTIONS?

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