



2013 KYTC Partnering Conference

Practical LiDAR Solutions for Transportation Projects

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Woolpert

September 10, 2013



Agenda

- + LiDAR Technology
- + LiDAR Technology Accuracy
- + Case Studies
 - Mobile LiDAR for Transportation Asset Management
 - Mobile LiDAR for Highway Design - Breckinridge County
 - Mobile LiDAR for Highway Safety Improvement - Meade County
 - Airborne LiDAR for Highway Design - Clay County



LiDAR Technology



Terrestrial Scanner



Mobile Mapping System



Airborne LiDAR



LiDAR Accuracy



Vertical Accuracy Comparisons

Fixed Wing Aerial LiDAR

- $\pm 6''$ Vertical Accuracy

Fixed Wing Aerial Mapping

- $\pm 4''$ Vertical Accuracy
(Low and Slow)

Mobile Mapping Systems

- $\pm \frac{1}{2}'' - 1''$ Vertical Accuracy

Terrestrial Surveying (GPS)

- $\pm \frac{1}{2}'' - 1''$ Vertical Accuracy

Tripod Mounted Laser Scanning

- $\pm \frac{1}{4}'' - \frac{1}{2}''$ Vertical Accuracy

Terrestrial Surveying (TS/Differential Leveling)

- $\leq \frac{1}{2}''$ Vertical Accuracy



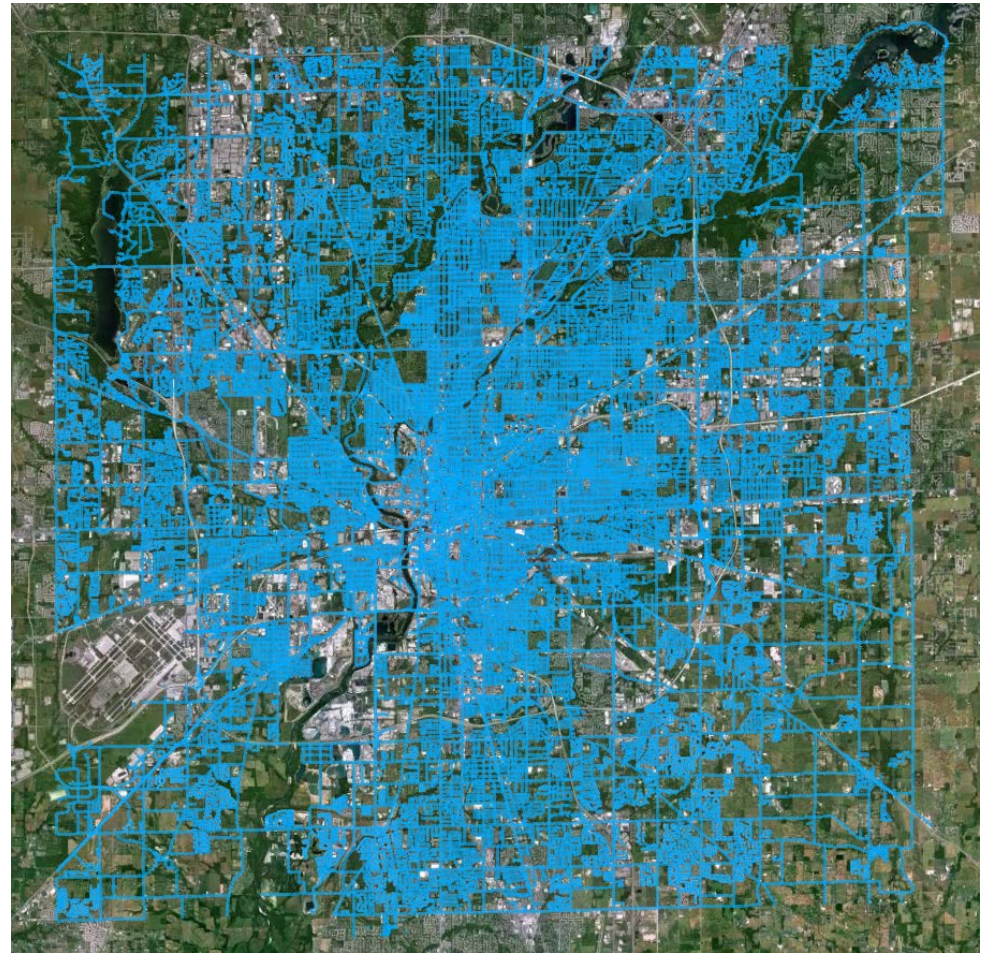
LiDAR Case Studies

- + Mobile LiDAR for Transportation Asset Management
- + Mobile LiDAR for Highway Design - Breckinridge County
- + Mobile LiDAR for Highway Safety Improvement - Meade County
- + Airborne LiDAR for Highway Design - Clay County



Mobile LiDAR - Asset Management

- 400 square mile area
- 3200 drive miles
- Acquisition
 - LiDAR
 - Imagery



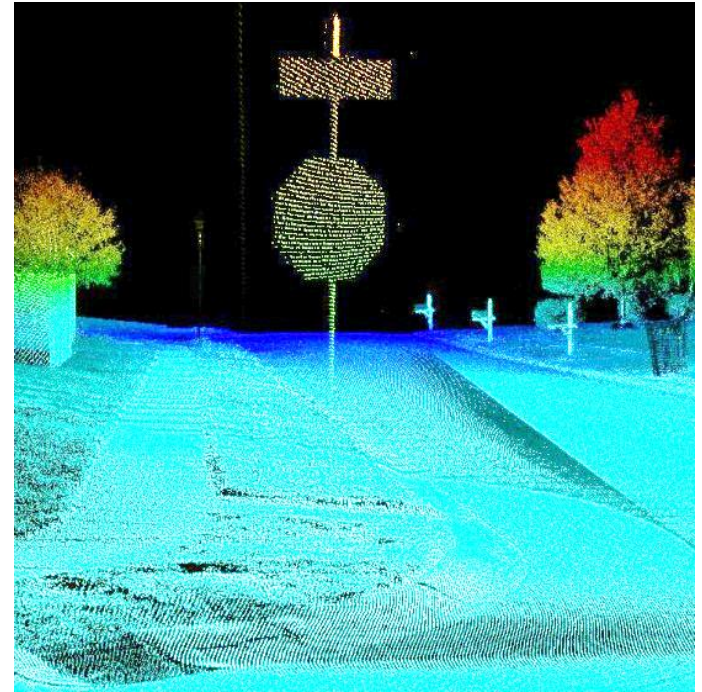
Required Metadata Fields in Geodatabase

- + Positional Coordinates within +/- .25'
- + Size
- + Orientation (cardinal direction)
- + Position (overhead, center, left or right of road)
- + Date and time of capture
- + MUTCD sign type
- + Mounting type
- + Sign photo
- + Condition



Woolpert's Smart Feature Extraction Tool

- + LiDAR (Spatial Information)
 - Sign Position/Location
 - Sign Dimensions
 - Cardinal Direction
 - Mounting Type



Woolpert's Smart Feature Extraction Tool

+ Imagery (Visual Information)

- Sign Color
- Sign Text
- Condition
 - Functional
 - Needs Attention
 - Needs Replacement



Woolpert's Smart Feature Extraction Tool

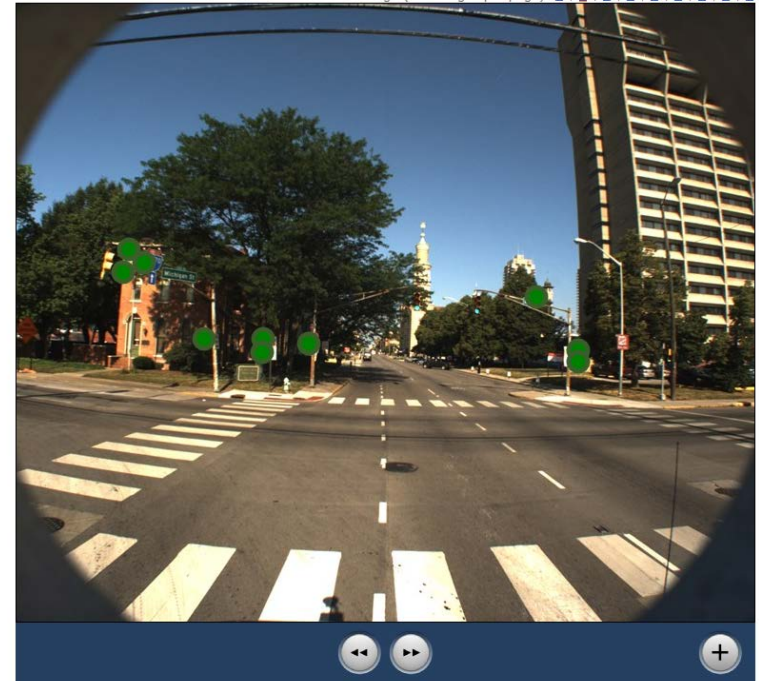
- + Software learned the MUTCD library
- + Collects approximately 95% of all signs
- + Woolpert's QC managers manually review working tiles prior to delivery

woolpert_labs serious
geospatial.



QC Via the Web

- + Online QC Tool for Feature Extraction Data
- + A user controlled Ortho-rectified Video from MMS
- + QC features
 - Signs, ADA ramps, hydrants, poles, etc.
- + If feature missing, etc., stop video and able to provide heads-up digitizing for editing/redlining



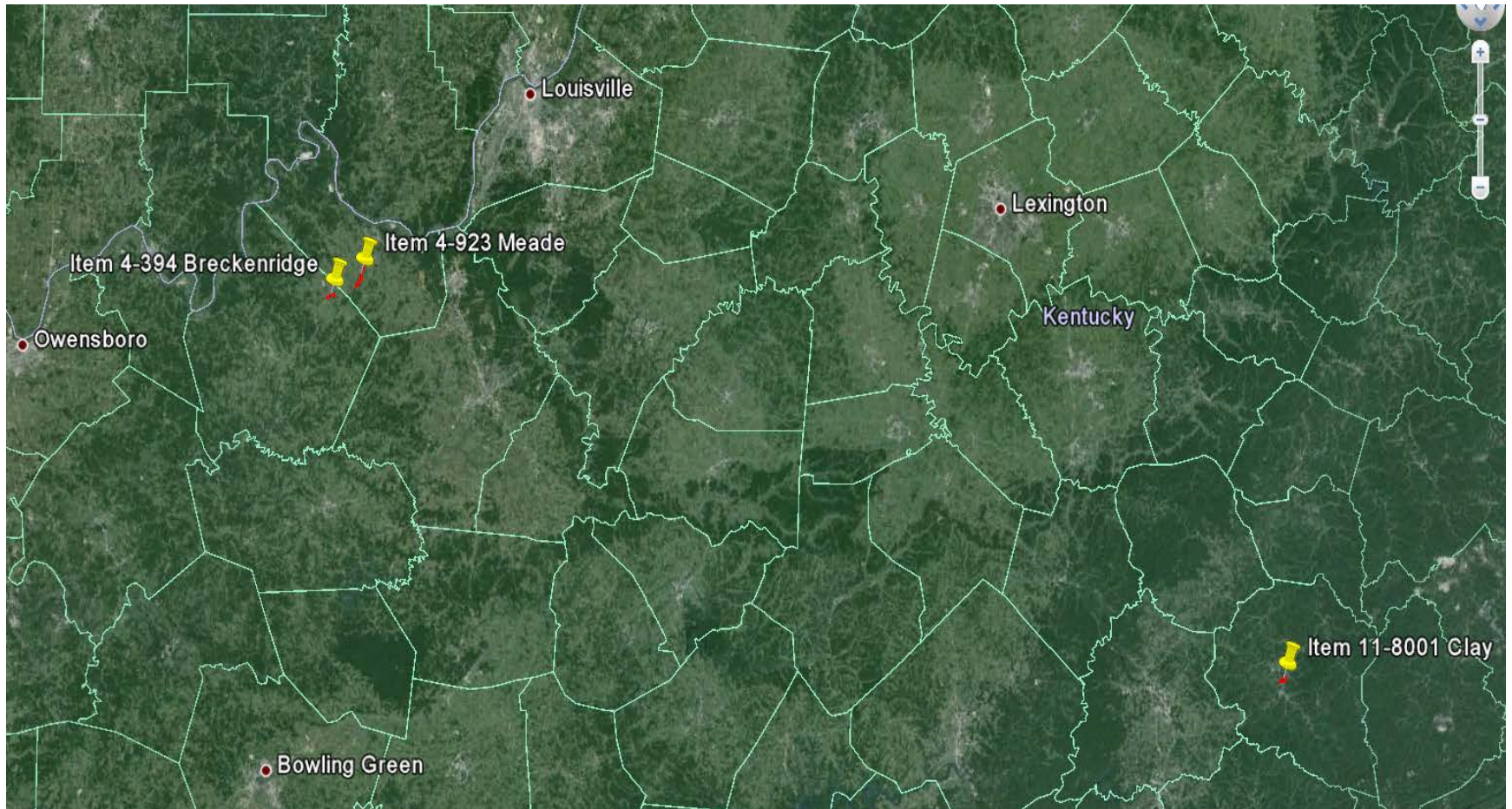
Mobile LiDAR - Asset Management

+ Cost Savings & Efficiencies

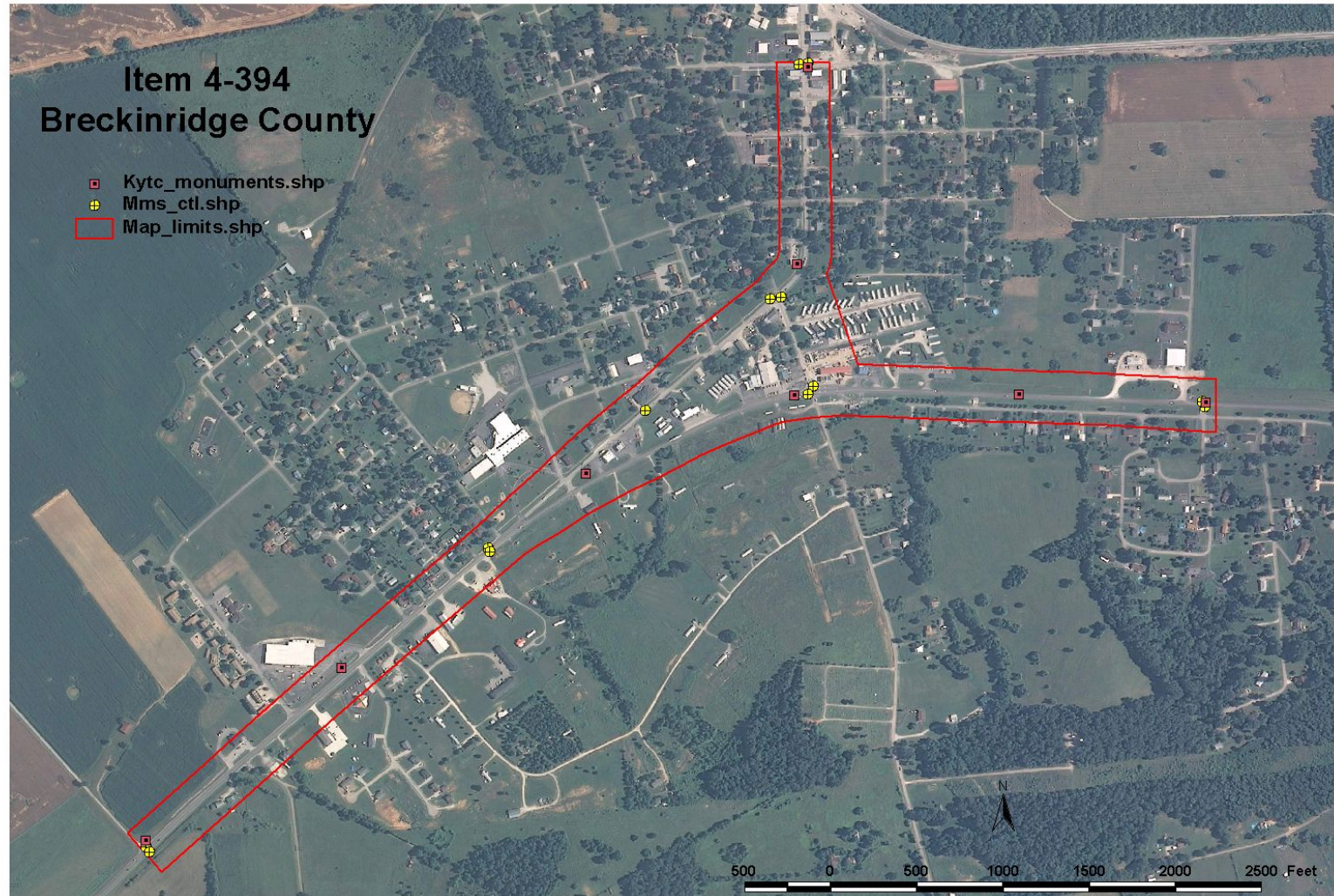
- High Resolution LiDAR acquired at roadway speed
- Dual collection of LiDAR and Photos
- Multiple Use Data Set
 - Engineering Design
 - Pavement quality assessment
 - Countywide asset inventory
 - + Road signs
 - + ADA ramps
 - + Guardrails



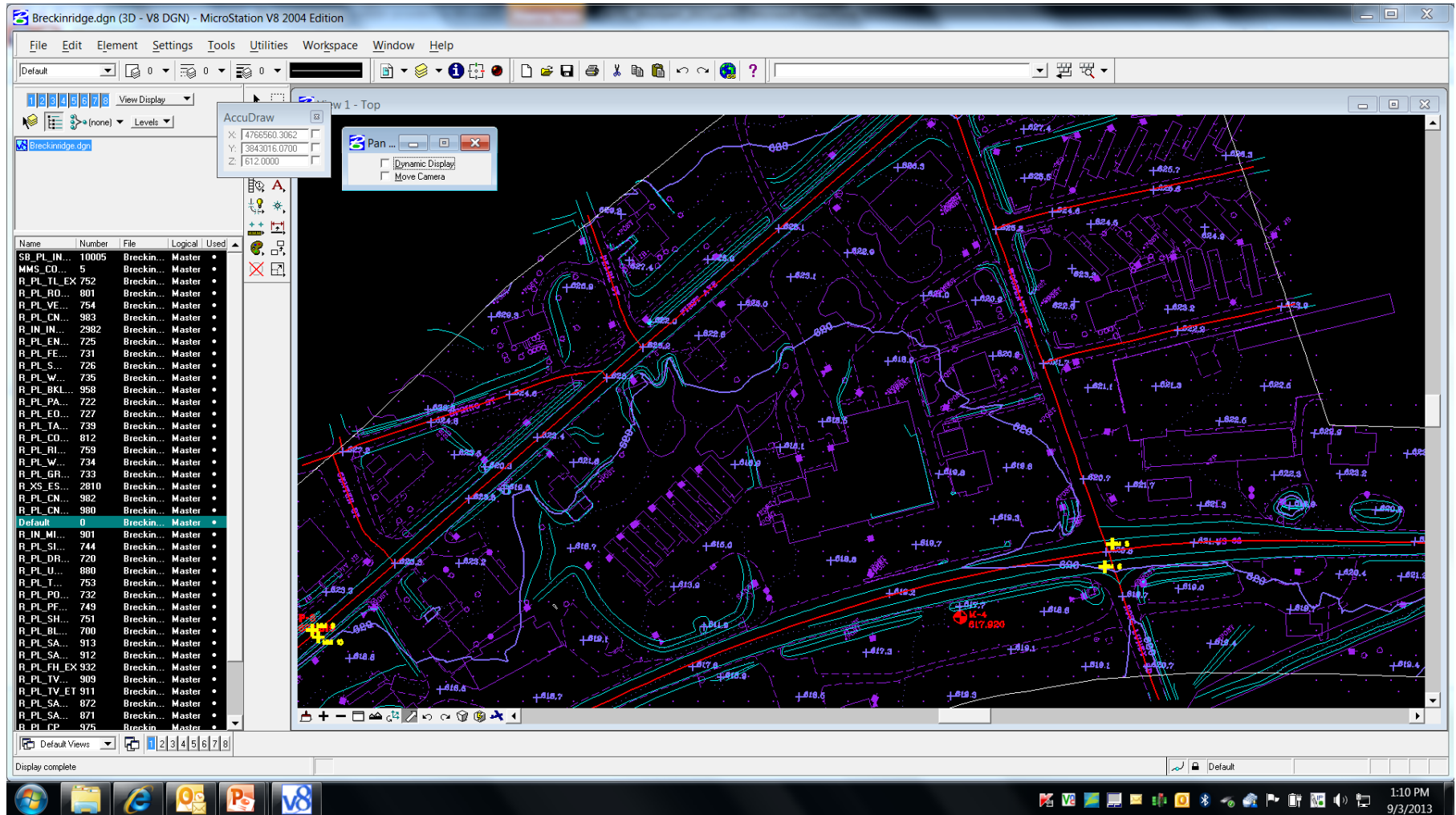
KTC Projects using LiDAR Technology



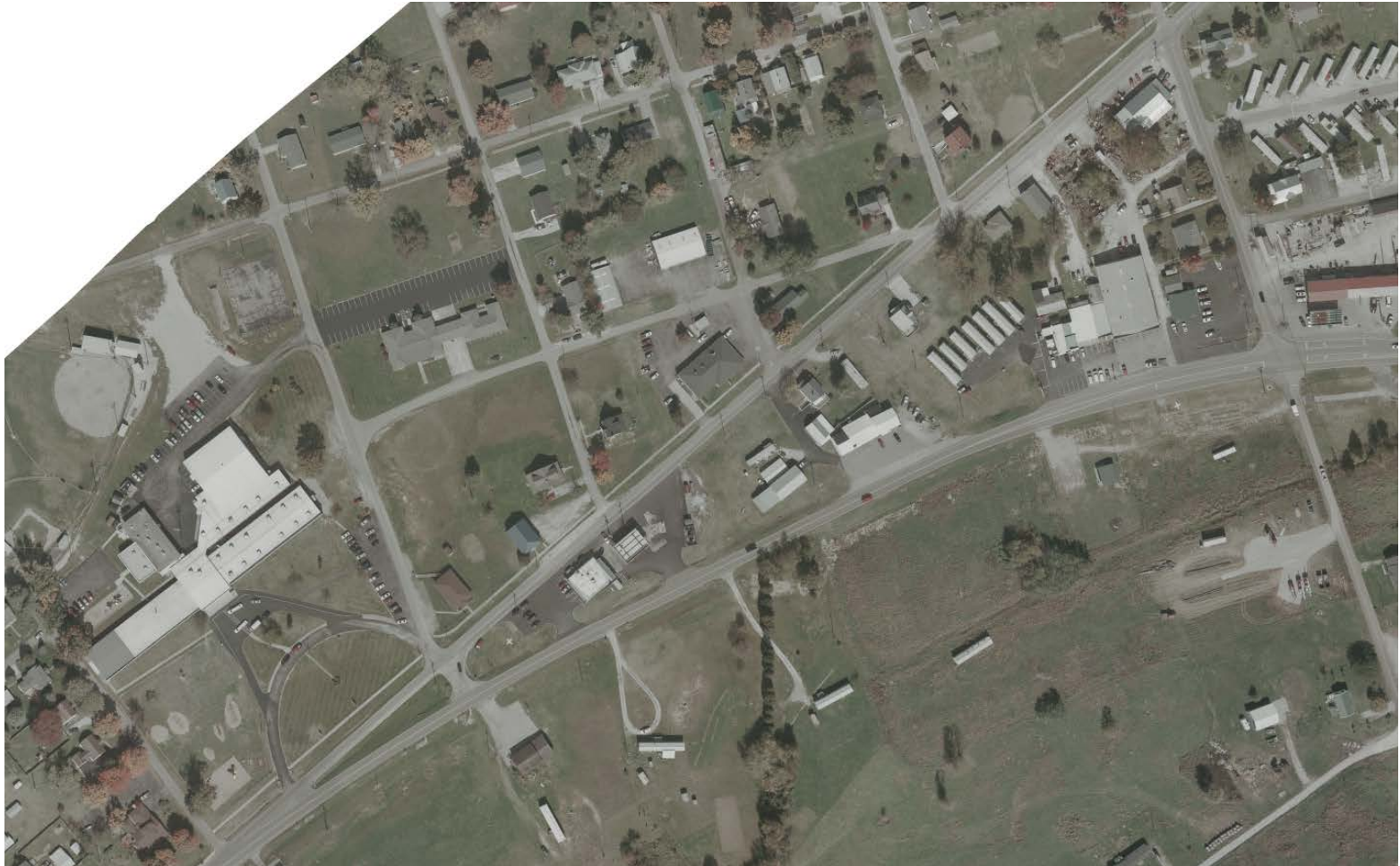
Mobile LiDAR - Breckinridge County



Item 4-394 Breckinridge - Design File



Item 4-394 Breckinridge - Orthophoto



Item 4-394 Breckinridge - MMS Control



G:\GS\Projects\072826_KYTC_Irvington_Kentucky\Carto\DGN\MM-control.txt

Number	Easting	Northing	Known Z	Surface	Dz
MM1	4763367.477	3840431.247	634.780	634.717	-0.063
MM10	4766242.667	3842929.615	622.020	621.976	-0.044
MM11	4766988.600	3843596.112	631.160	631.102	-0.058
MM12	4767011.821	3843600.440	631.750	631.725	-0.025
MM13	4767125.575	3844957.248	618.600	618.512	-0.088
MM14	4767154.570	3844958.844	618.470	618.413	-0.057
MM2	4763387.451	3840411.011	634.290	634.221	-0.069
MM3	4765319.568	3842137.774	605.350	605.278	-0.072
MM4	4765341.465	3842114.481	604.590	604.547	-0.043
MM5	4767195.278	3843041.715	621.180	621.115	-0.065
MM6	4767186.284	3843014.534	620.190	620.148	-0.042
MM7	4769515.830	3842970.173	651.120	651.259	+0.139
MM8	4769515.437	3842959.003	651.140	651.254	+0.114
MM9	4766235.644	3842938.020	622.150	622.101	-0.049

Average dz -0.030
Minimum dz -0.088
Maximum dz +0.139
Average magnitude 0.066
Root mean square 0.072
Std deviation 0.068



Mobile LiDAR - Breckinridge County

+ Cost Savings & Efficiencies

- Low Altitude color aerial photography for digital mapping and orthophotography
- Monuments, photo control and MMS control in a single mobilization
- MMS survey limited to pavement surfaces at field survey accuracy
- Photogrammetric mapping from outside of pavement to project limits

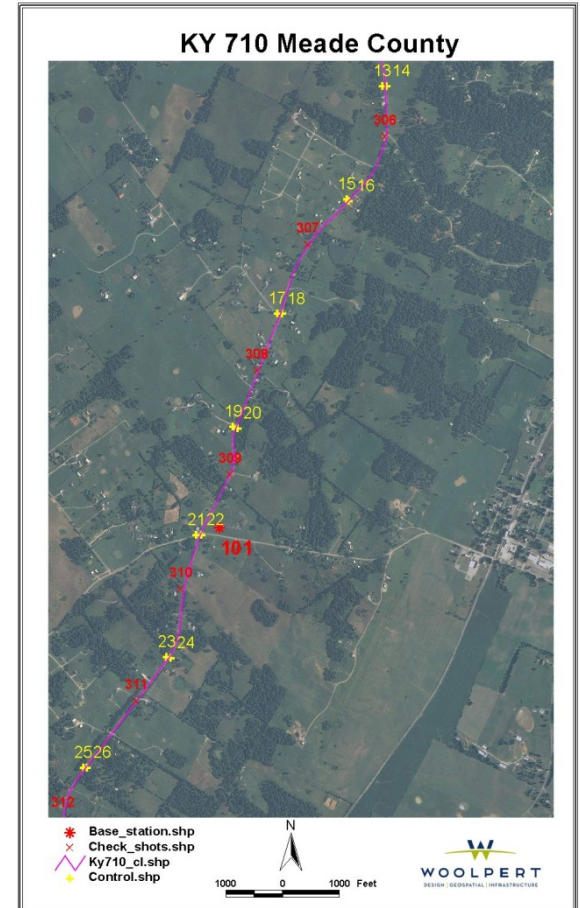
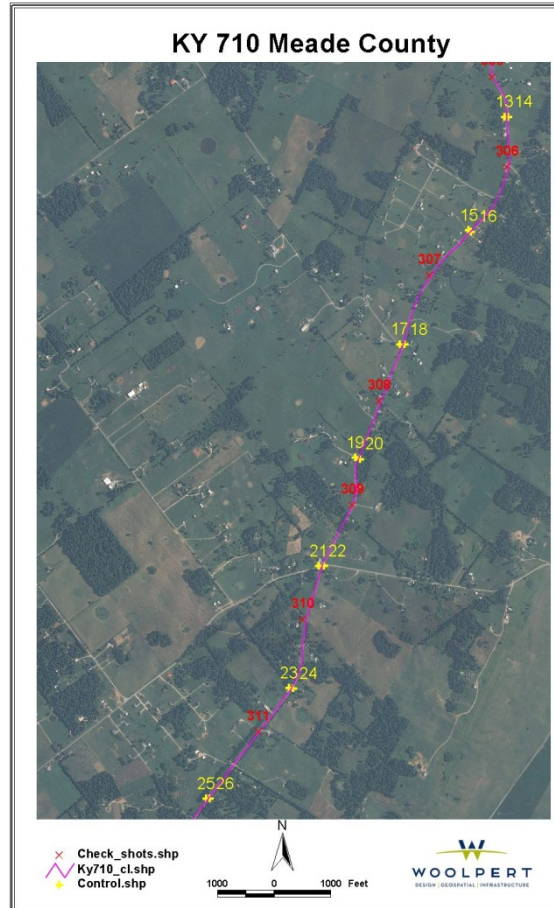
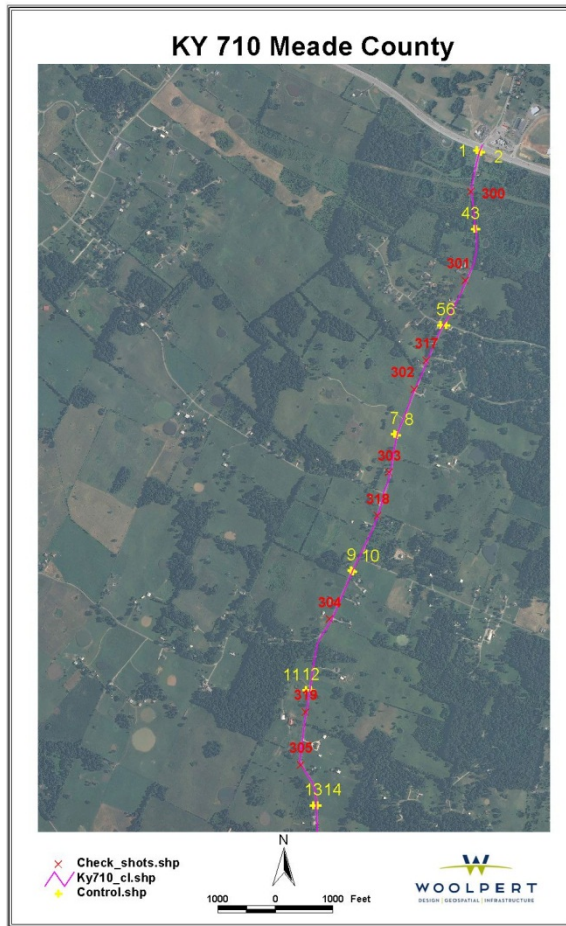


Mobile LiDAR - Meade County

North

Central

South



KY 710 - Highway Safety Improvement Project

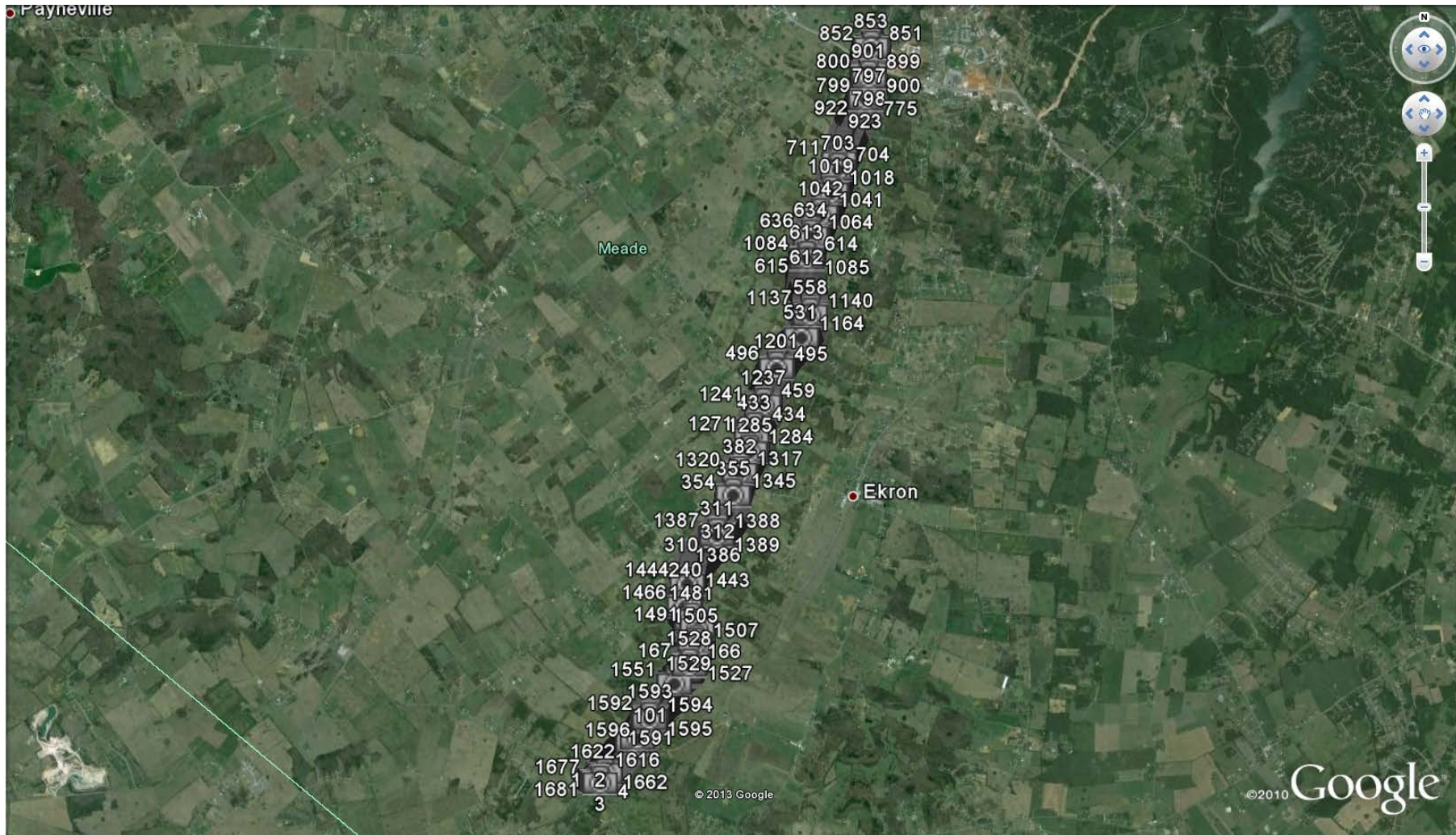
- + HSIP/planning project
 - slope flattening
 - pipe extensions



KY 710 - MMS Control Points



MMS - Digital Photo Library



KY 710 - Photo Library



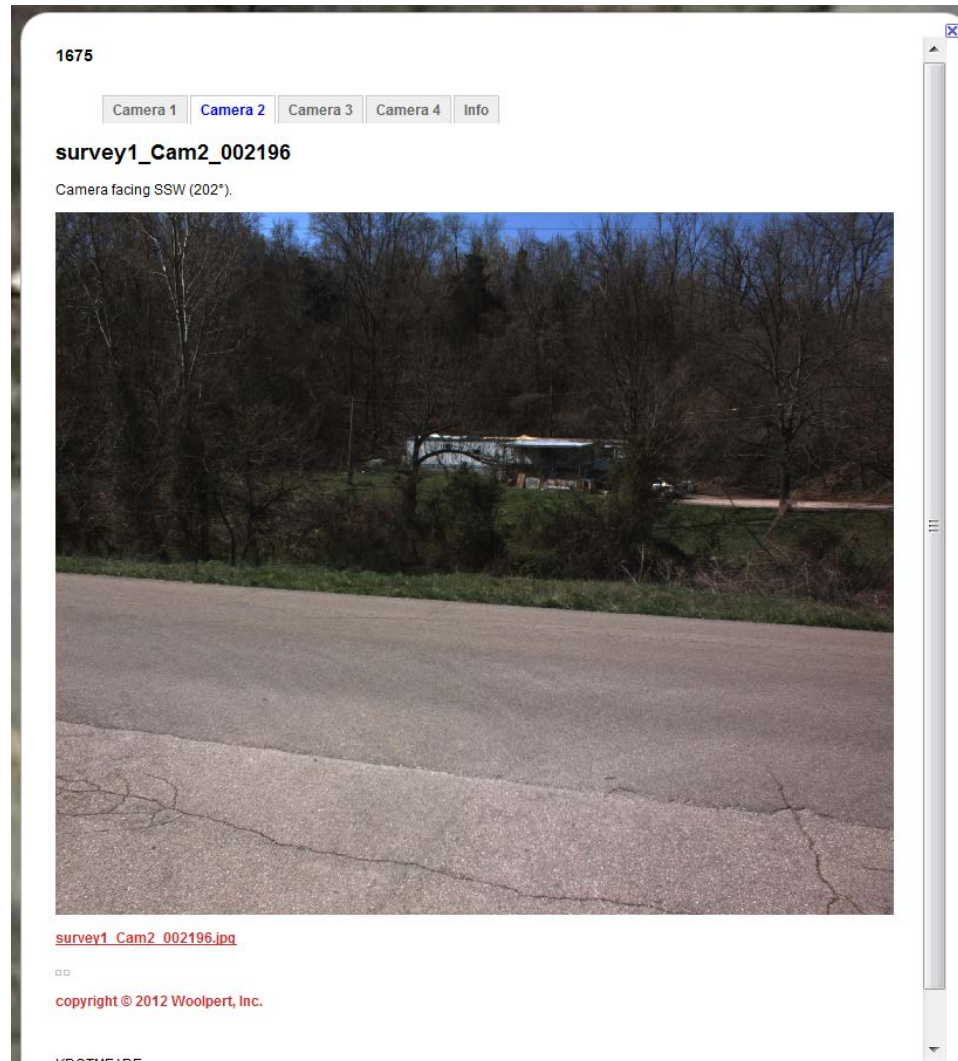
KY 710 - Camera Station 1675

Ahead
WSW 245°



KY 710 – Camera Station 1675

Left
SSW 202°



KY 710 - Camera Station 1675


Rear
ENE 68°

1675

Camera 1 Camera 2 **Camera 3** Camera 4 Info

survey1_Cam3_002202

Camera facing ENE (68°).



[survey1_Cam3_002202.jpg](#)

□□

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KY 710 - Camera Station 1675

Right
WSW 285°



KY 710 - Feature Extraction



MMS Control Results

C:\SCANNER\KDOT\73250\CONTROL\CONTROL_4_TERRA.csv

Number	Easting	Northing	Known Z	Laser Z	Dz
1	4798267.782	3881808.512	625.317	625.314	-0.003
2	4798330.866	3881796.651	624.948	624.961	+0.013
3	4798167.118	3880918.571	620.365	620.353	-0.012
4	4798147.035	3880940.613	620.026	620.054	+0.028
5	4797668.375	3878794.150	615.033	615.028	-0.005
6	4797693.871	3878787.406	615.190	615.196	+0.006
7	4796569.020	3875646.109	611.384	611.396	+0.012
8	4796613.947	3875726.532	607.014	607.007	-0.007
9	4796056.911	3874468.074	619.098	619.104	+0.006
10	4796042.340	3874392.379	617.876	617.858	-0.018
11	4795351.135	3872532.476	625.035	625.035	+0.000
12	4795361.238	3872468.902	624.780	624.779	-0.001
13	4795450.876	3870444.640	627.831	627.830	-0.001
14	4795471.384	3870408.812	627.942	627.954	+0.012
15	4794400.426	3868028.222	641.418	641.413	-0.005
16	4794387.068	3867987.597	642.626	642.633	+0.007
17	4793603.729	3866428.680	619.531	619.541	+0.010
18	4793630.340	3866435.191	620.248	620.235	-0.013
19	4792844.940	3864469.544	647.377	647.382	+0.005
20	4792864.821	3864470.050	647.297	647.285	-0.012
21	4792164.993	3862438.071	663.707	663.706	-0.001
22	4792247.888	3862653.620	663.348	663.348	+0.000
23	4791576.695	3860297.651	672.747	672.742	-0.005
24	4791584.179	3860277.865	673.547	673.546	-0.001
25	4790180.931	3858461.633	683.119	683.118	-0.001
26	4790187.800	3858437.474	683.223	683.225	+0.002
27	4789681.807	3856376.212	684.337	684.332	-0.005
28	4789706.385	3856359.350	682.427	682.415	-0.012
29	4790038.263	3854384.241	682.919	682.910	-0.009
30	4790059.146	3854380.300	682.790	682.788	-0.002
31	4789149.509	3852745.154	682.136	682.110	-0.026
32	4789171.726	3852781.763	681.965	681.974	+0.009
33	4787854.463	3851068.841	695.283	695.274	-0.009
34	4787860.645	3851041.641	695.202	695.205	+0.003
35	4785682.915	3848601.358	683.015	683.015	+0.000
36	4785747.618	3848554.532	682.054	682.061	+0.007

300	4798157.600	3881267.300	622.651	622.670	+0.019
301	4798114.631	3879636.527	616.910	616.899	-0.011
302	4797308.648	3877990.508	594.659	594.652	-0.007
303	4796470.877	3875339.759	610.974	610.967	-0.007
304	4795656.898	3873572.413	620.370	620.373	+0.003
305	4795252.009	3871061.476	625.272	625.286	+0.014
306	4795498.625	3869616.772	634.666	634.651	-0.015
307	4793793.372	3867055.075	640.394	640.383	-0.011
308	4793006.899	3864835.065	655.017	655.031	+0.014
309	4792747.088	3863642.032	648.843	648.862	+0.019
310	4791857.943	3861139.754	677.740	677.739	-0.001
311	4790677.682	3859084.504	680.829	680.826	-0.003
312	4789727.374	3857087.501	686.511	686.505	-0.006
313	4790288.363	3855371.875	684.204	684.227	+0.023
314	4788587.565	3852072.392	664.609	664.604	-0.005
314A	4789547.403	3853390.105	694.453	694.473	+0.020
315	4787659.933	3850741.245	693.105	693.094	-0.011
316	4786400.088	3849404.462	688.642	688.649	+0.007
317	4797424.606	3878223.573	595.767	595.767	+0.000
318	4796203.043	3874718.802	598.880	598.851	-0.029
319	4795224.717	3871569.655	628.917	628.905	-0.012

Average dz	-0.000
Minimum dz	-0.029
Maximum dz	+0.028
Average magnitude	0.009
Root mean square	0.011
Std deviation	0.011

Vertical check results on hard surfaces:

36 Primary Control Points
 21 Target Check Shots
 57 Combined Check Shots
 Compared to DTM
0.011' Vertical Accuracy
@ 1σ- 68%



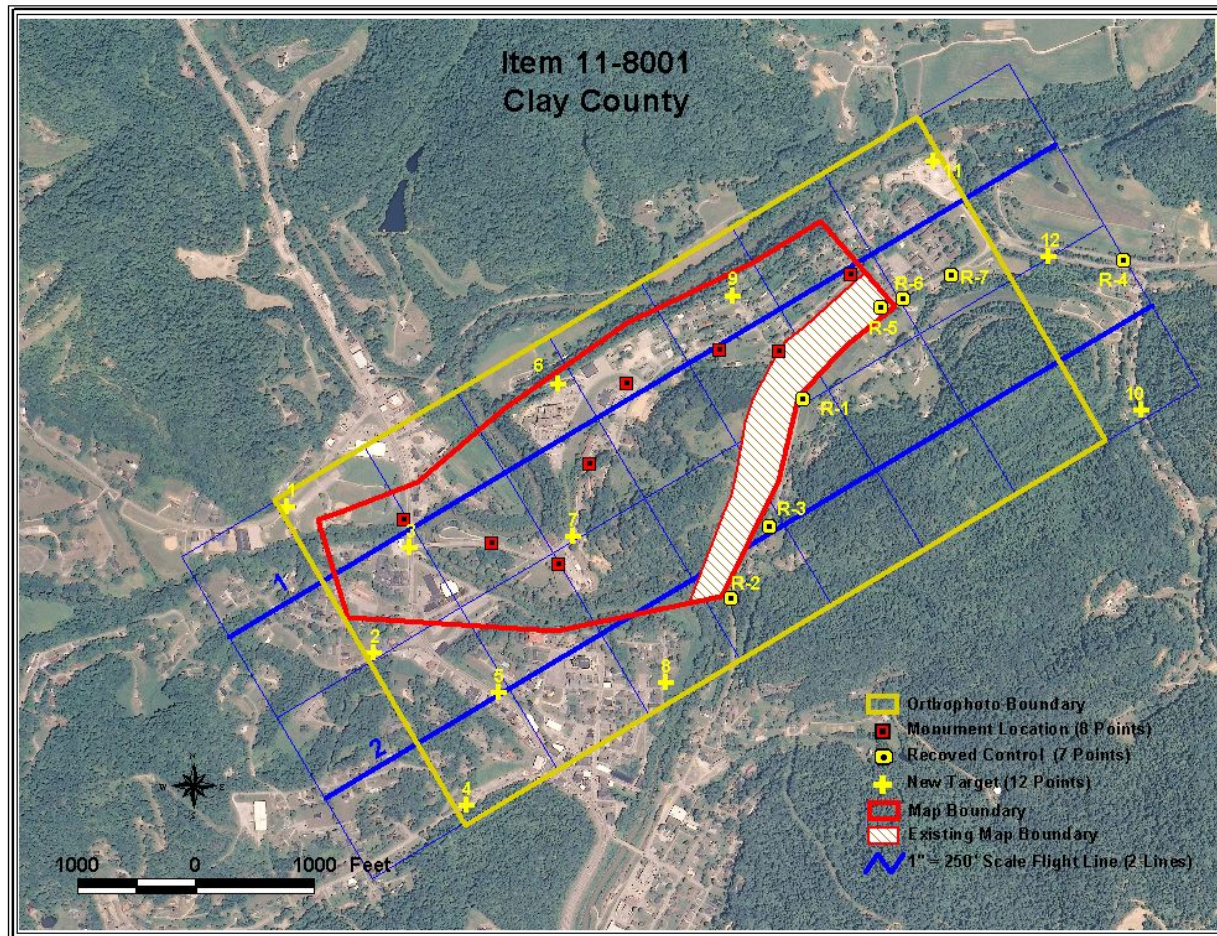
Mobile LiDAR - Meade County

+ Cost Savings & Efficiencies

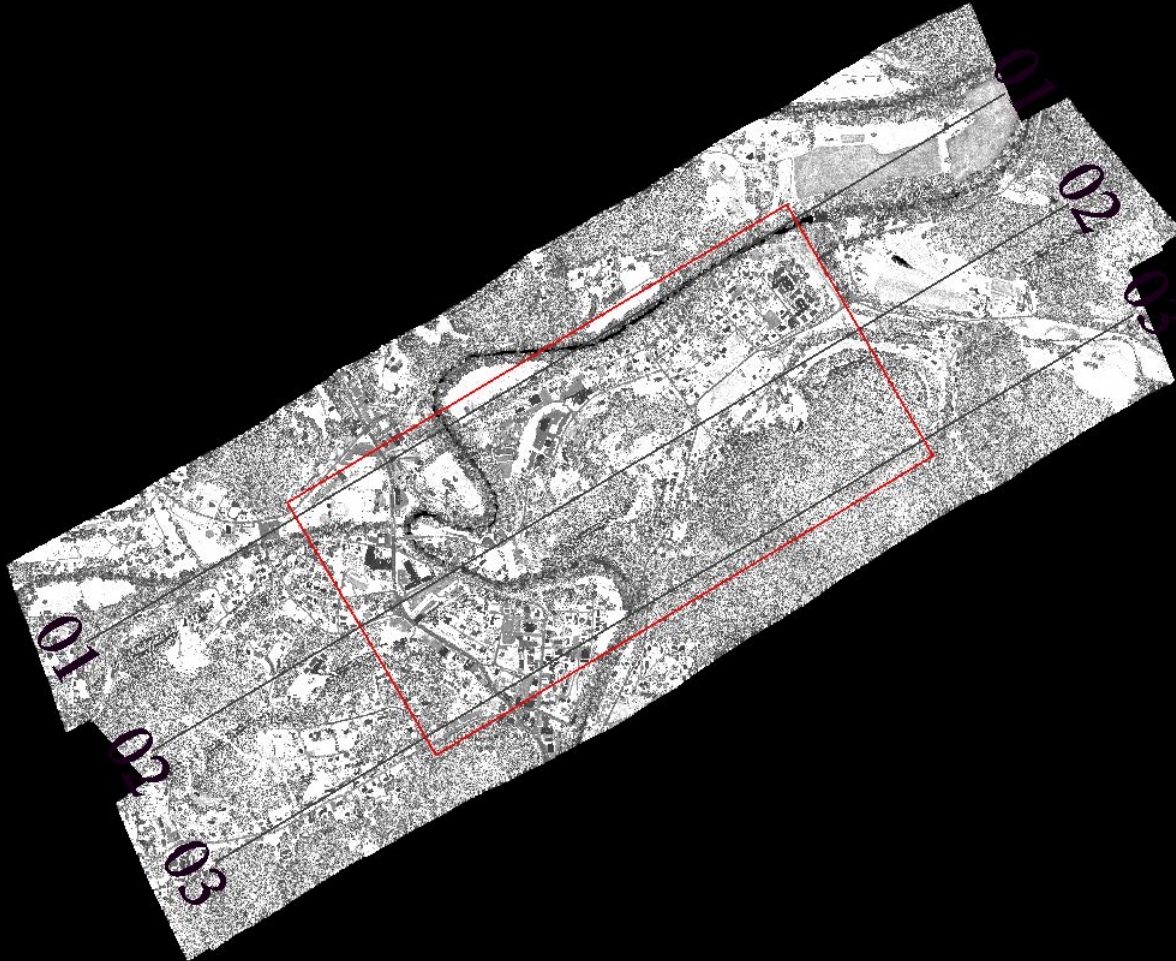
- Minimal width corridor acquired without aerial acquisition and associated control outside right-of-way
- MMS targeting and control in single mobilization
- Distributed “Cloud” processing and data hosting for LiDAR processing and feature extraction
- Geo-referenced digital photo library as a derivative service



Airborne LiDAR - Clay County



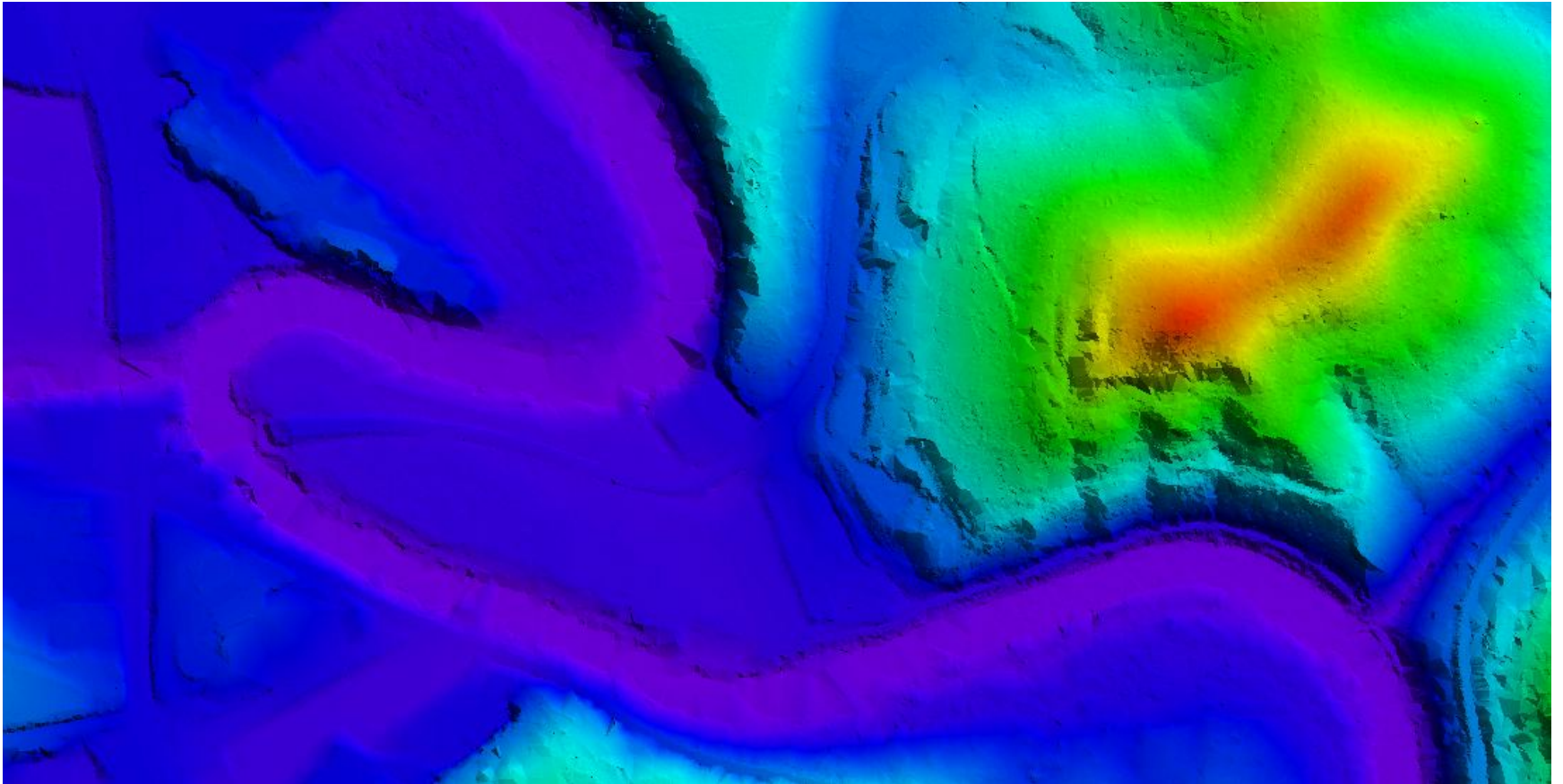
Airborne LiDAR - Coverage



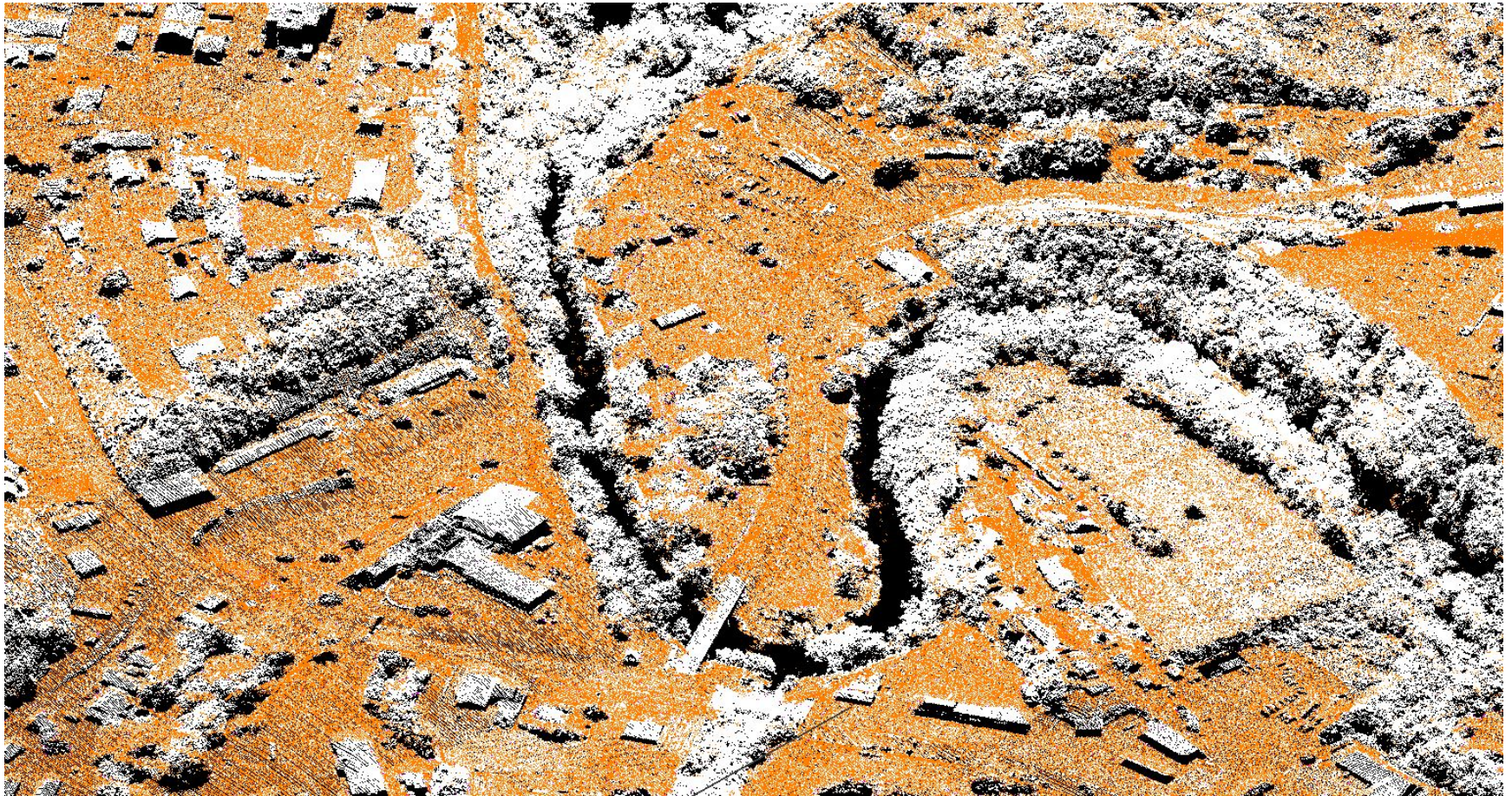
Airborne LiDAR



Airborne LiDAR



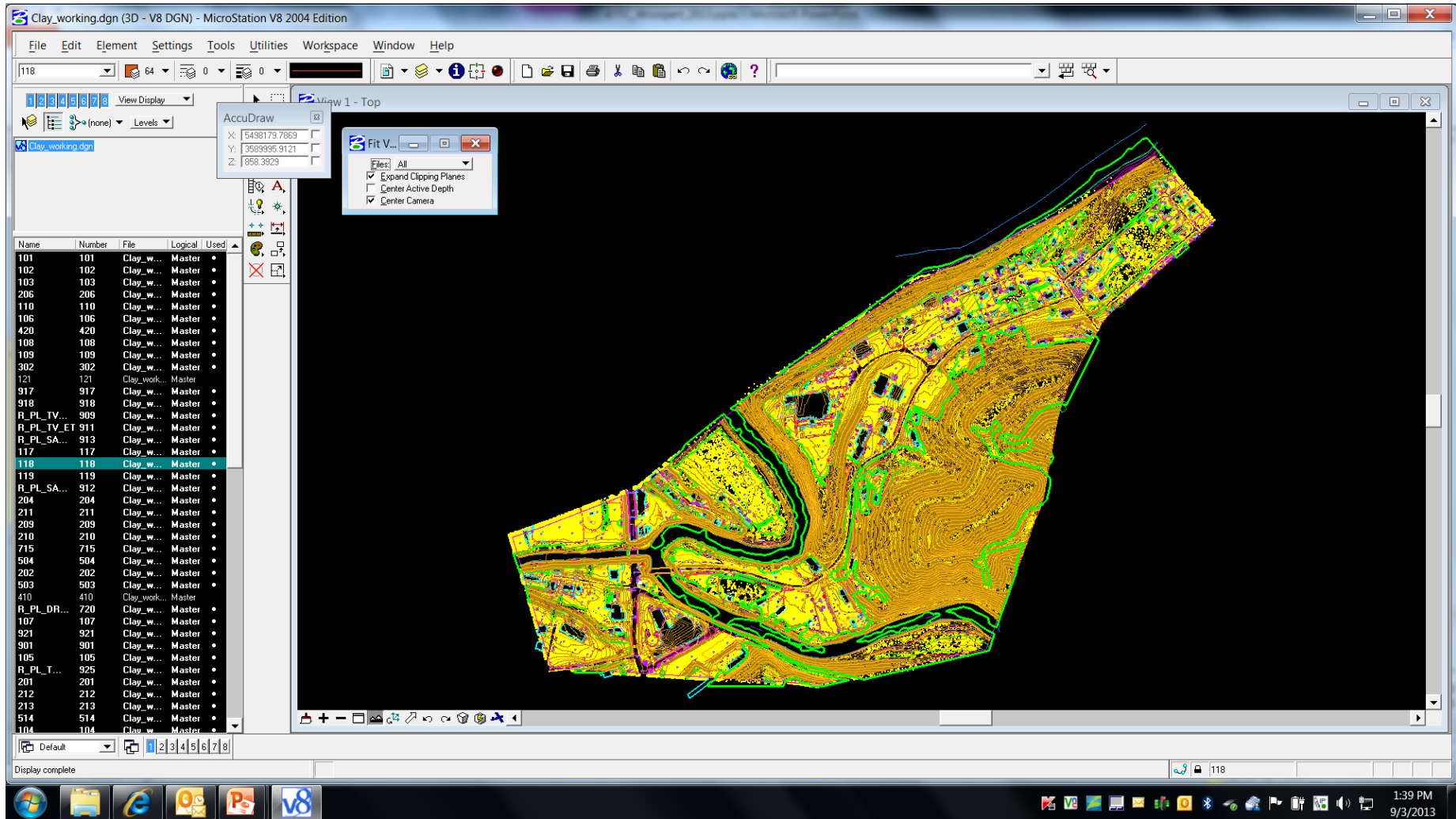
Airborne LiDAR



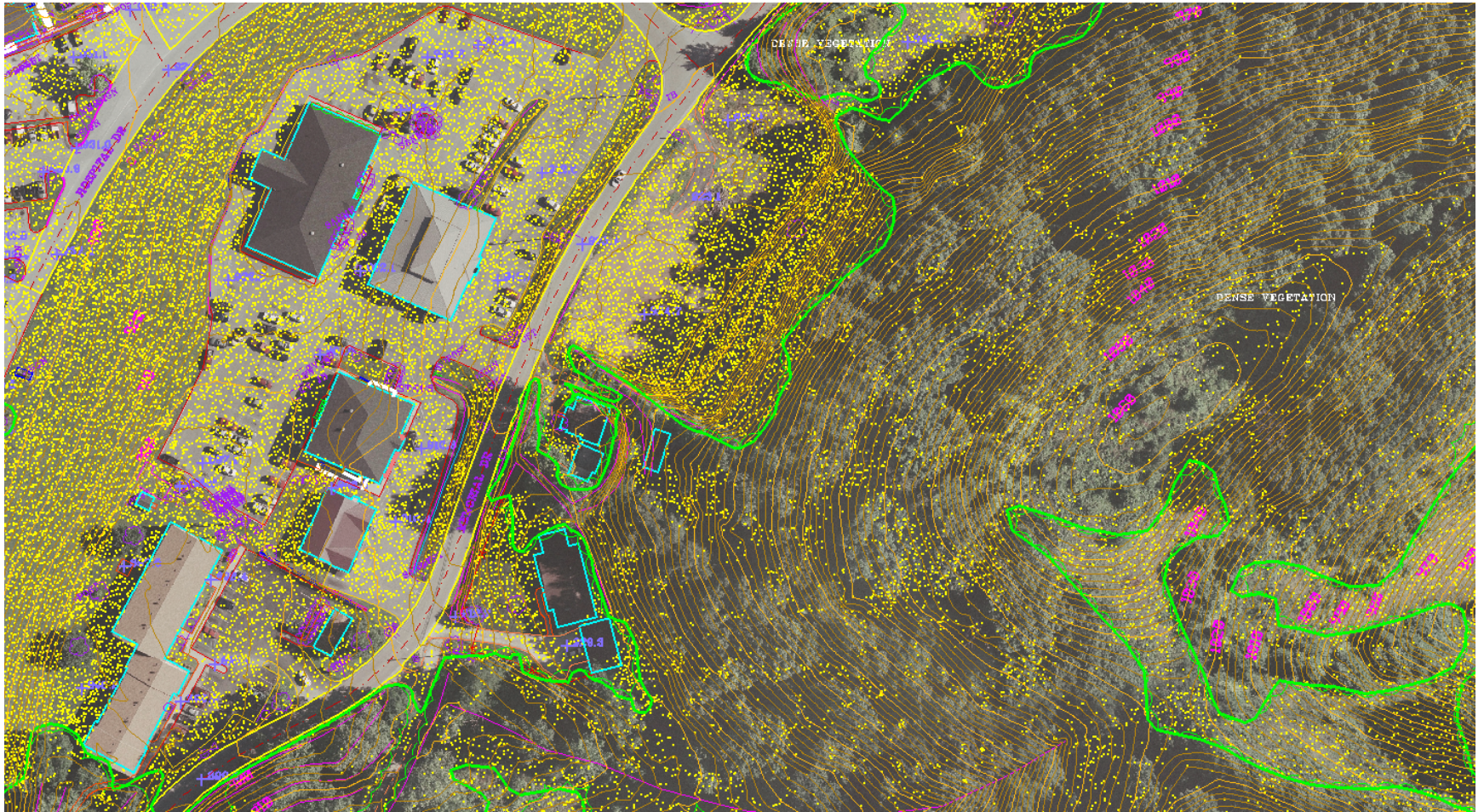
Airborne LiDAR - Oblique River Perspective



Item 11-8001 Clay - MicroStation File



Item 11-8001 Clay - Orthophoto



Airborne LiDAR - Clay County

+ Cost Savings & Efficiencies

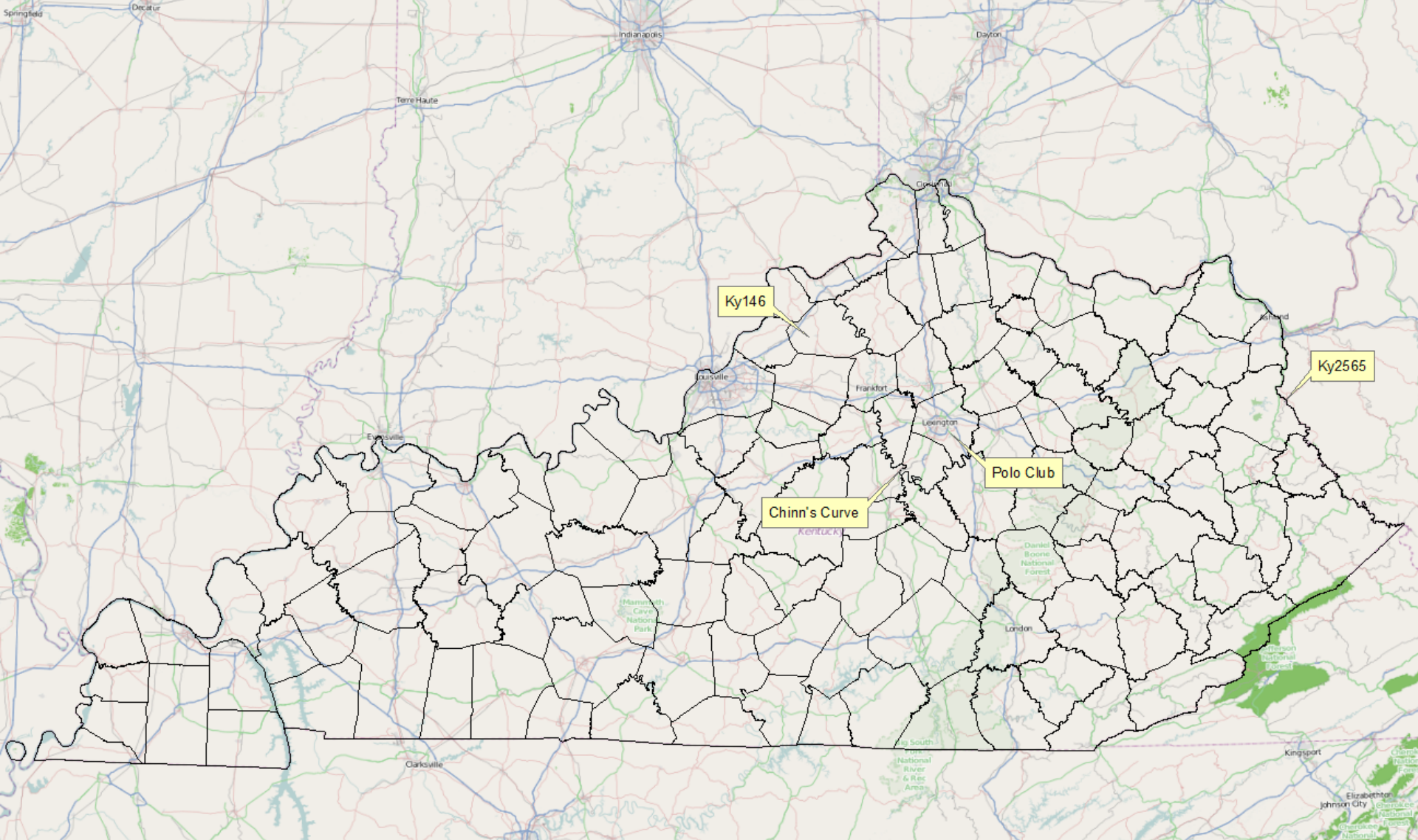
- Aerial photography and airborne LiDAR in single mobilization
- Airborne LiDAR supports digital mapping and DEM for orthophotography
- Ground line in deciduous tree cover derived from airborne LiDAR processing
- Utilized some existing control to extend and tie existing design mapping



Blending of Aerial, Terrestrial Scans, and Field Surveys

1. Field Surveys
 - a) Monumentation
 - b) Place Aerial Targets
 - c) Survey Terrestrial Control
 - d) Complete Additional surveys, such as utilities
2. Aerial Workflow
 - a) Collect new LiDAR data or Download Statewide Data
 - a) Adjust to Surveyed Control
 - b) Extract Bare Ground Surface
 - b) Collect Aerial Photography
 - a) Complete Aerial Triangulation
 - b) Compile Topography and Planimetrics
3. STLS/MTLS Workflow
 - a) Scan Data in Field
 - b) Register to Surveyed Control
 - c) Extract Features
4. Blended Workflow
 - a) Use Highest Accuracy Data
 - a) Supplement Aerial Photography with LiDAR or TLS
 - b) Supplement Aerial LiDAR with TLS
 - c) Supplement TLS with Field Survey





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www.grwinc.com





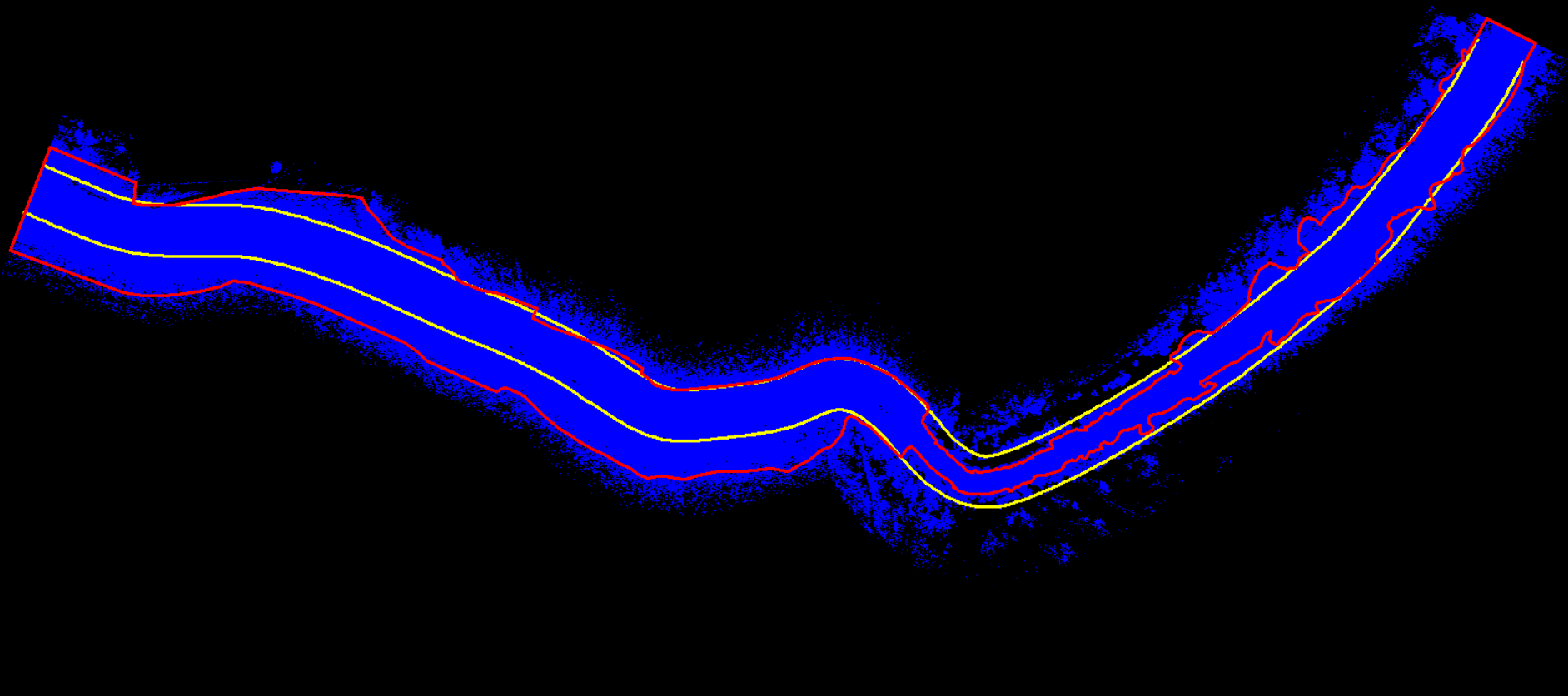
Yellow line 75ft offset from center line

Red line mobile scan data limits



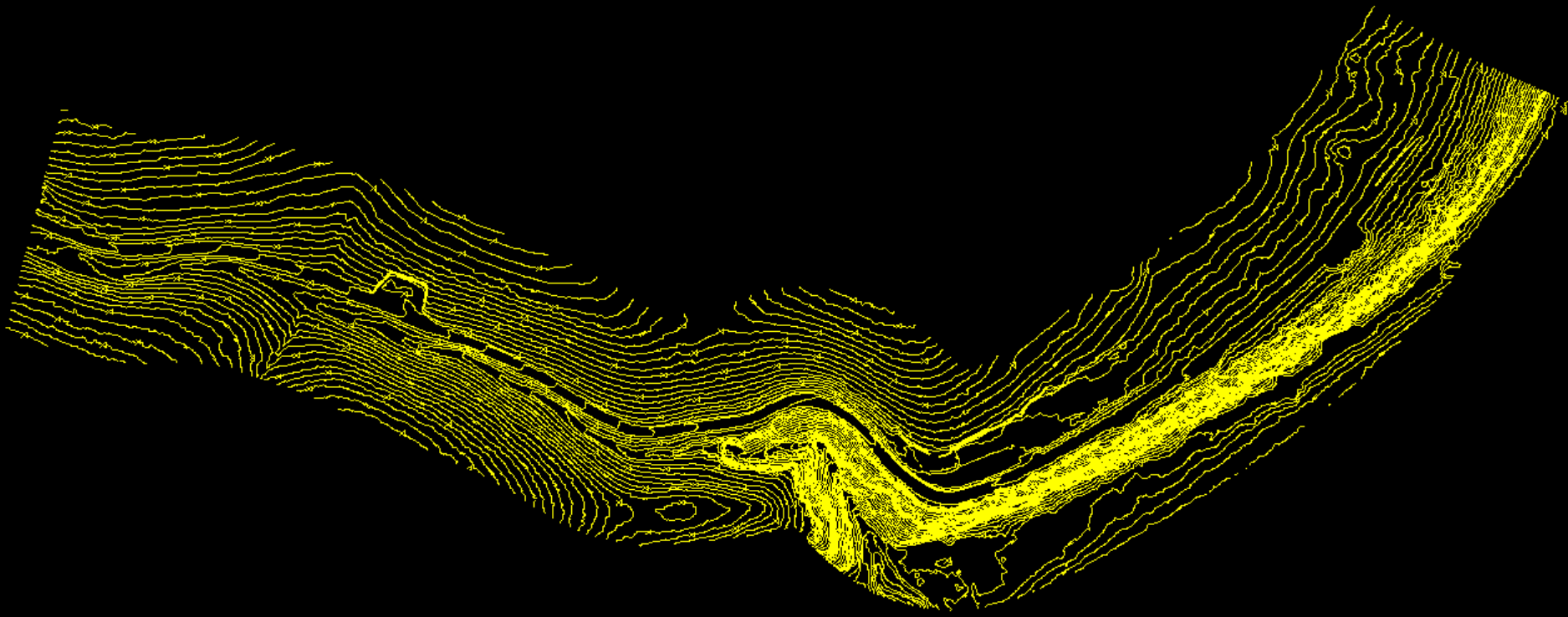
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- US68 in Jessamine County
- Blend of Technologies
 - Aerial LiDAR (statewide)
 - Field Surveys
 - MTLs

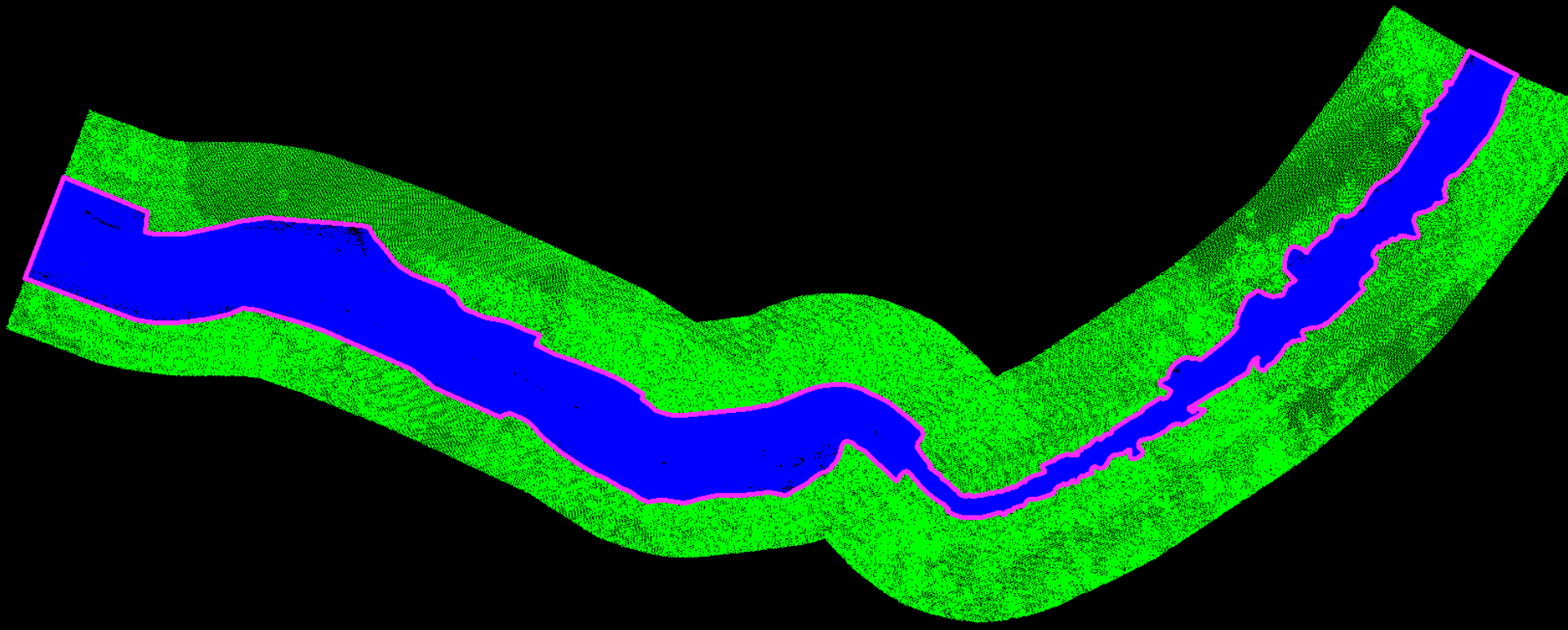


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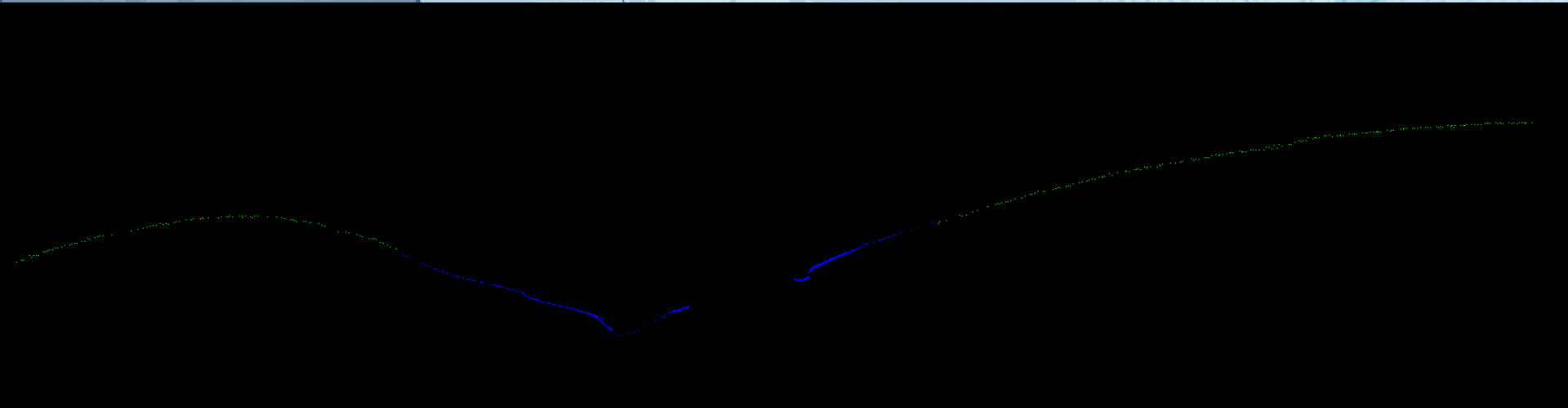
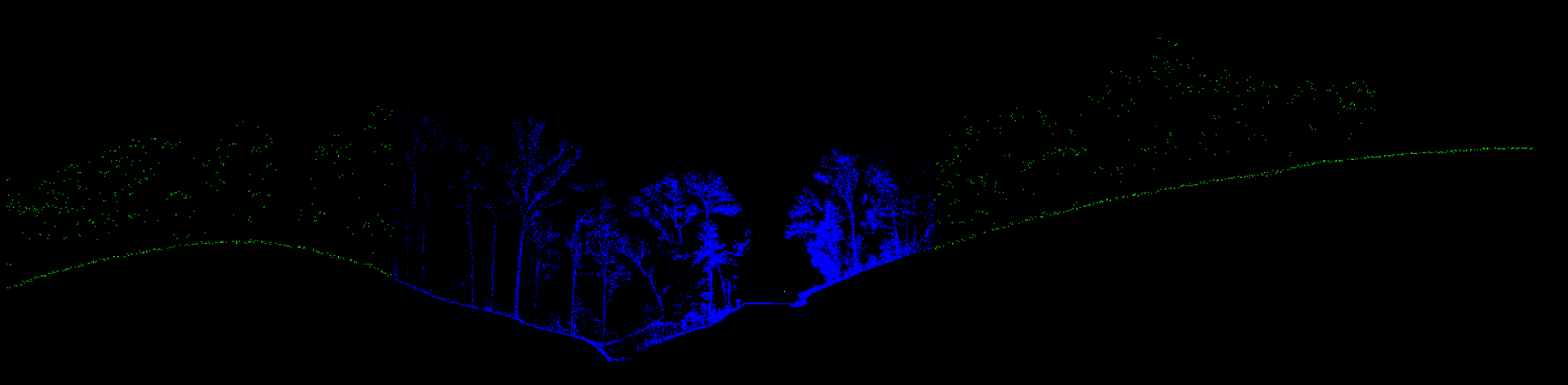


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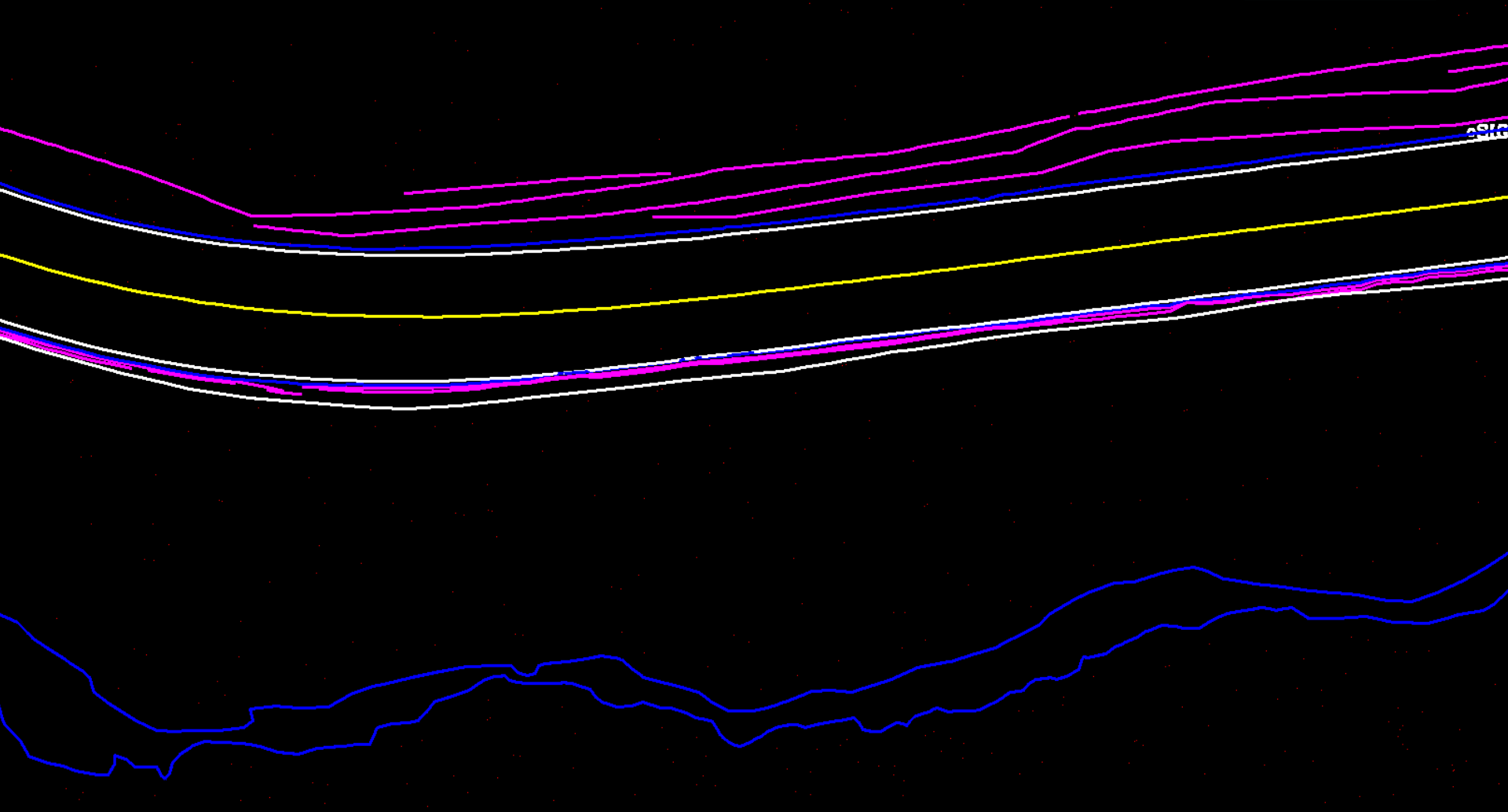
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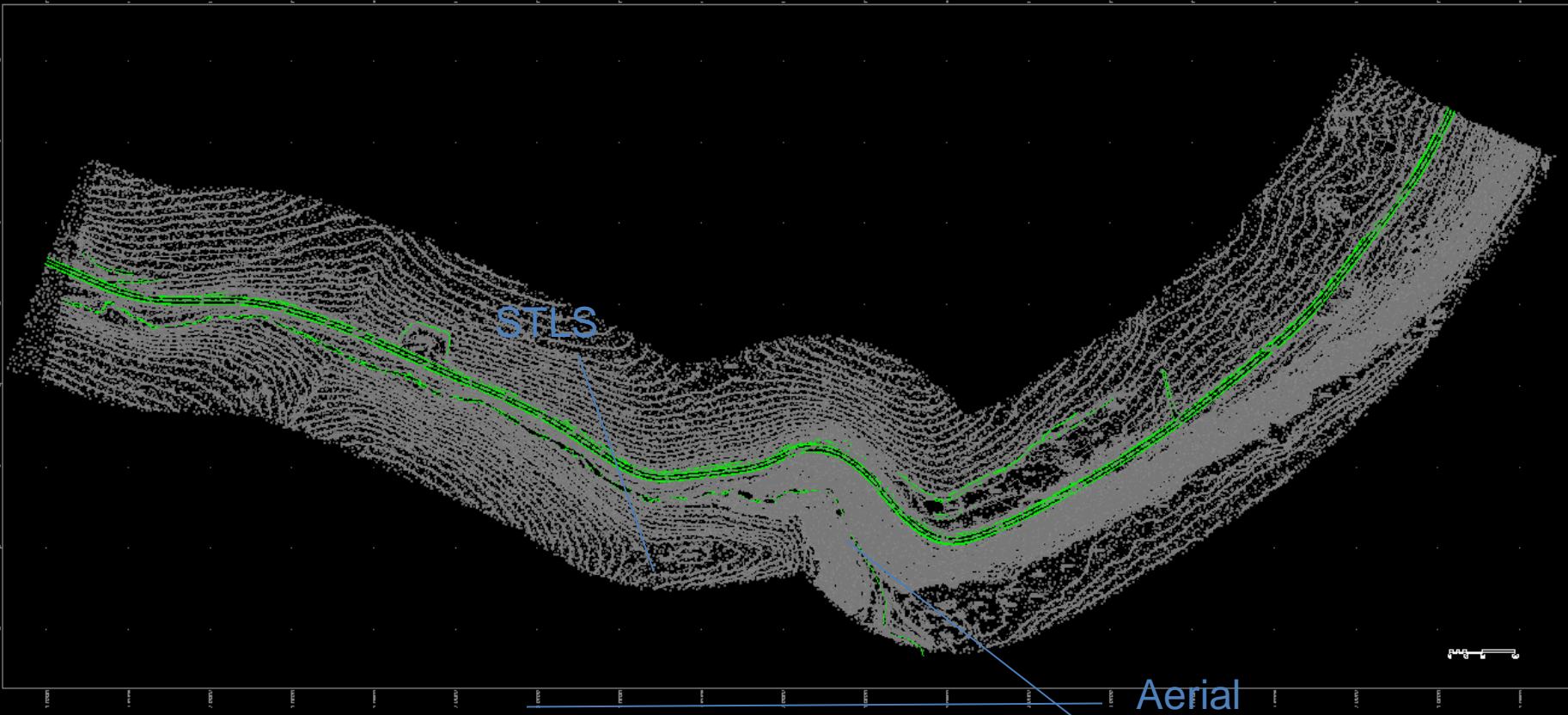
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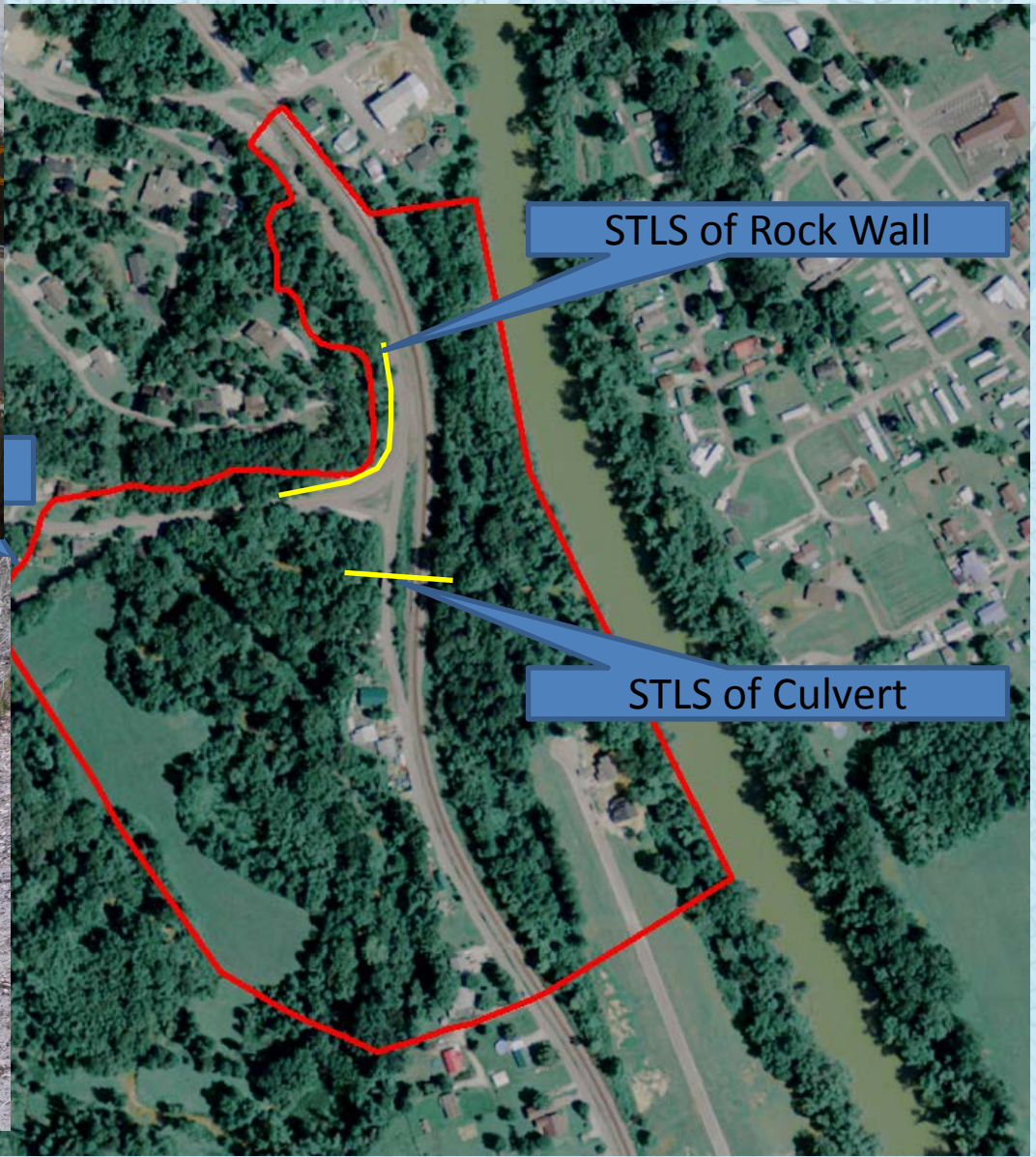




Aerial



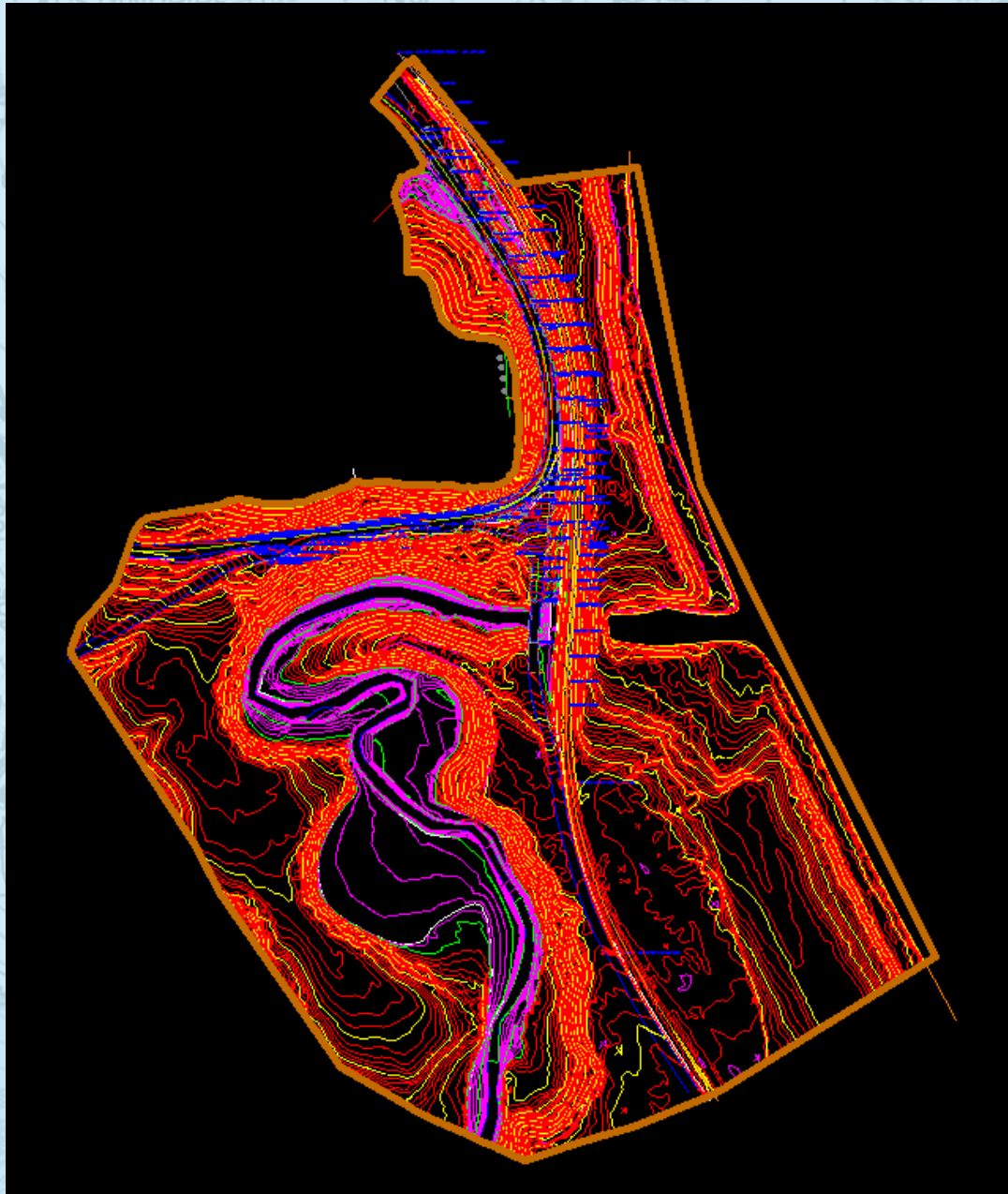
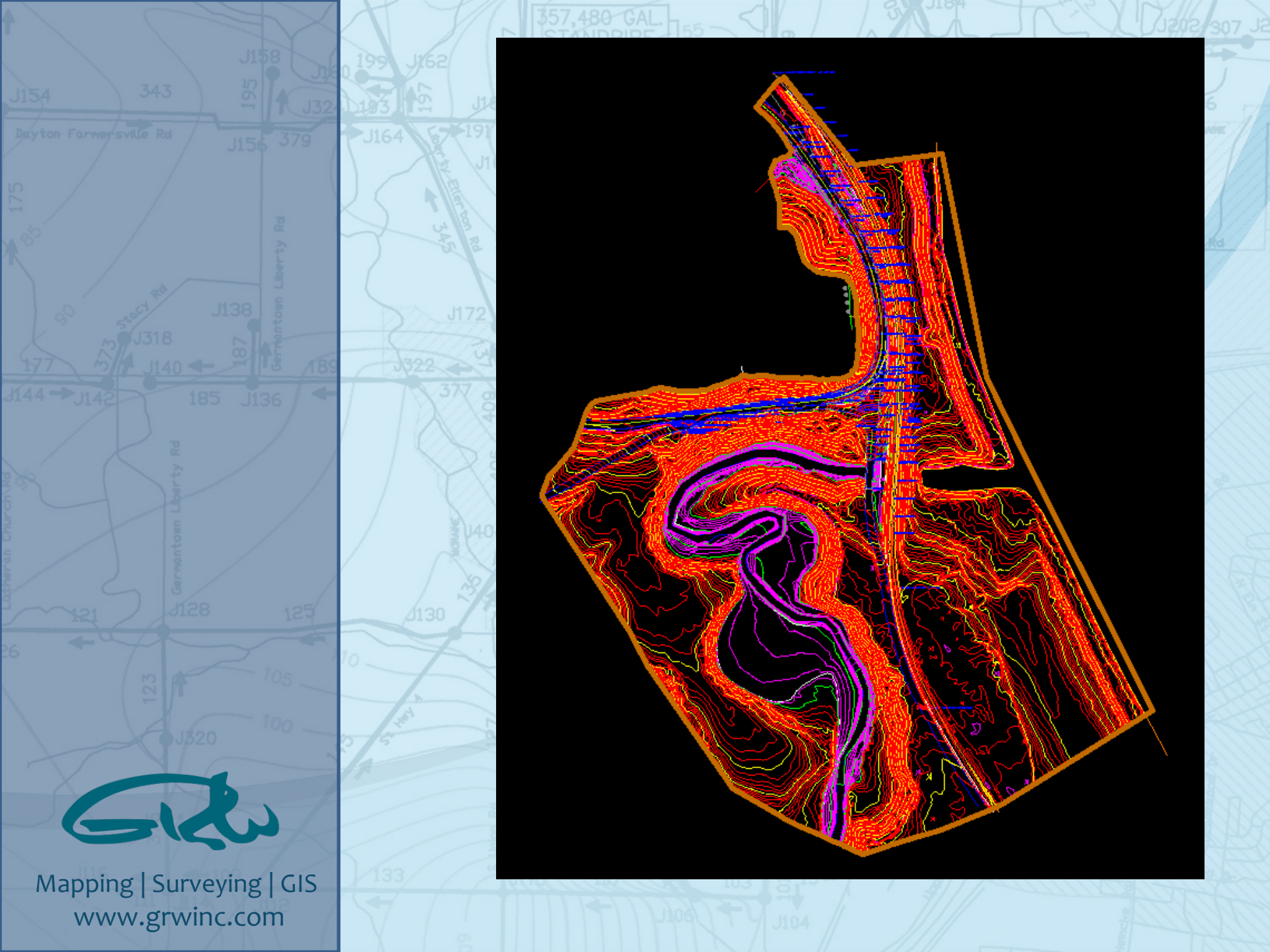
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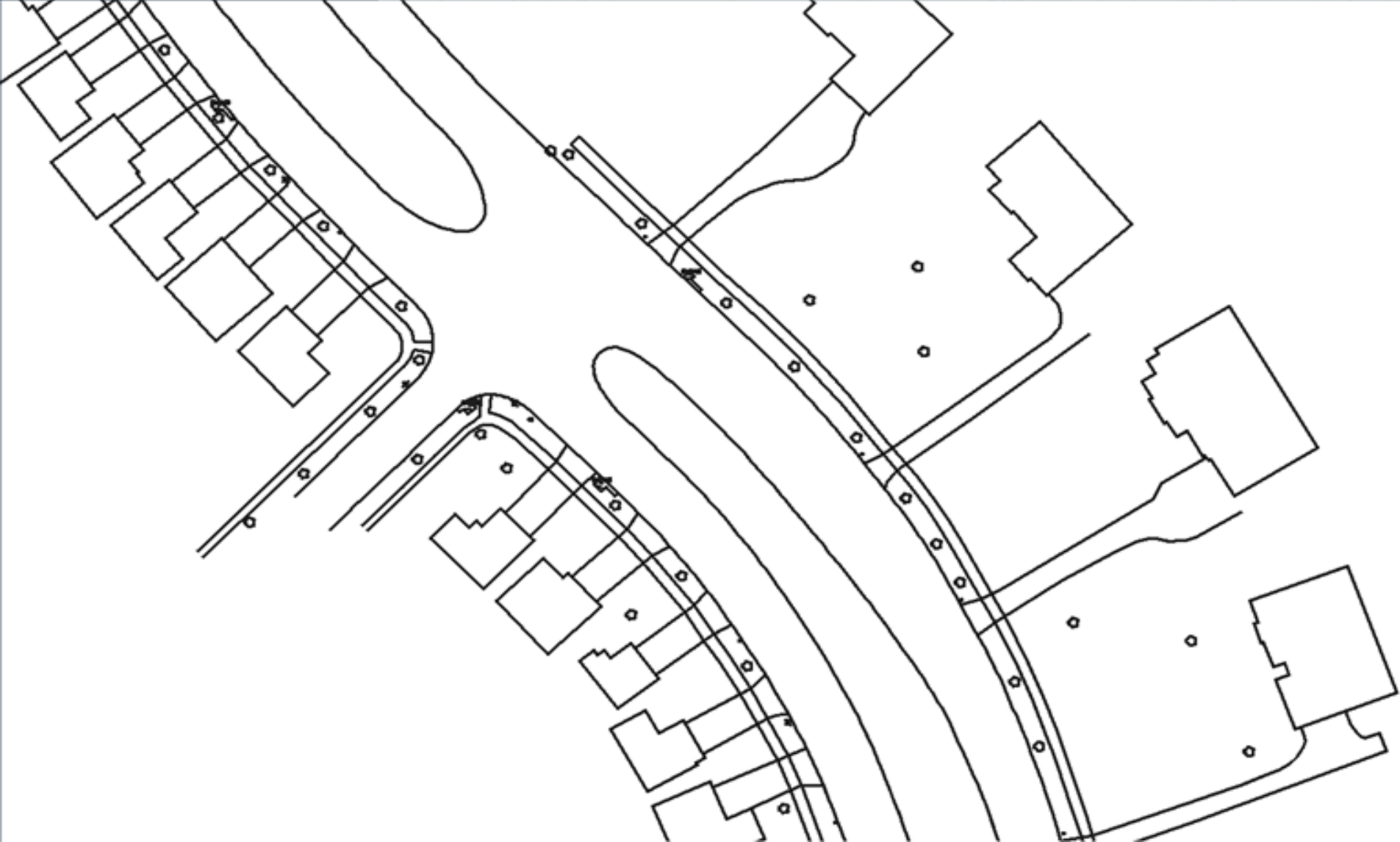


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- Polo Club, Lexington
- Blend of Technologies
 - Field Surveys
 - STLS



The background is a complex, abstract composition of overlapping lines and shapes. A prominent, thick green line curves from the top left towards the bottom center. Another thick green line runs diagonally from the top center towards the bottom right. Several horizontal yellow lines are scattered across the upper and middle sections. The background is filled with a dense, textured pattern of smaller lines and dots in various colors, including purple, red, and brown, creating a rich, multi-layered visual effect.

Questions?