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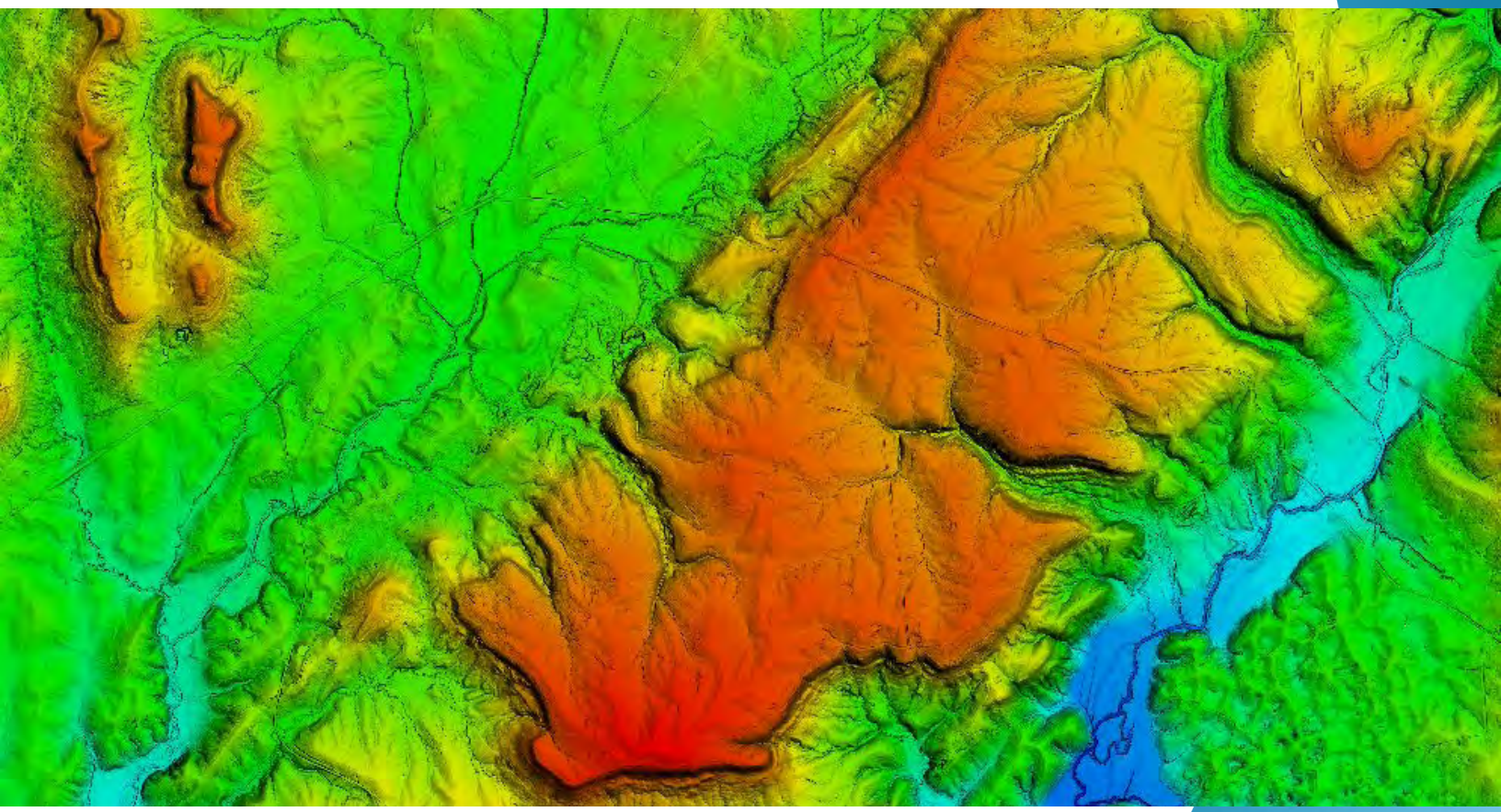

FLUORSPAR DISTRICT 2019 D19 LIDAR PROJECT REPORT

2020

Work Package ID: 182969
Work Unit ID: 182966

Submitted: September 16, 2020

Prepared for:

USGS
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1. Summary / Scope

1.1. Summary

This report contains a summary of the Fluorspar District 2019 D19, Work Unit 182966 LiDAR acquisition task order, issued by USGS under their Contract G16PC00016 on August 20, 2019. The task order yielded a project area covering 3,770 square miles over Kentucky. The intent of this document is only to provide specific validation information for the data acquisition/collection, processing, and production of deliverables completed as specified in the task order.

1.2. Scope

Aerial topographic LiDAR was acquired using state of the art technology along with the necessary surveyed ground control points (GCPs) and airborne GPS and inertial navigation systems. The aerial data collection was designed with the following specifications listed in Table 1 below.

Table 1. Originally Planned LiDAR Specifications

Average Point Density	Flight Altitude (AGL)	Field of View	Minimum Side Overlap	RMSEz
2 pts / m^2	2300 m	58.5°	20%	≤ 10 cm

1.3. Coverage

The project boundary covers approximately 3,770 square miles over 25 counties in Kentucky. A buffer of 100 meters was created to meet task order specifications. Project extents are shown in Figure 1.

1.4. Duration

LiDAR data was acquired from December 5, 2019 to February 8, 2020 in 12 total lifts. See "Section: 2.4. Time Period" for more details.

1.5. Issues

There were no major issues to report for this project.

Fluorspar District 2019 D19 Work Unit 182966 Projected Coordinate System: UTM Zone 16N Horizontal Datum: NAD 1983 (2011) Vertical Datum: NAVD88 (GEOID 12b) Units: Meters	
Lidar Point Cloud	Classified Point Cloud in .LAS 1.4 format
Rasters	• 1 meter Hydro-flattened Bare Earth Digital Elevation Model (DEM) in GeoTIFF format • 1 meter Intensity images in GeoTIFF format
Vectors	Shapefiles (*.shp) • Project Boundary • LiDAR Tile Index • Calibration and QC Checkpoints (NVA/VVA) Geodatabase (*.gdb) • Continuous Hydro-flattened Breaklines
Reports	Reports in PDF format • Focus on Delivery • Focus on Accuracy • Survey Report • Project Report
Metadata	XML Files (*.xml) • Breaklines • Classified Point Cloud • DEM • Intensity Imagery

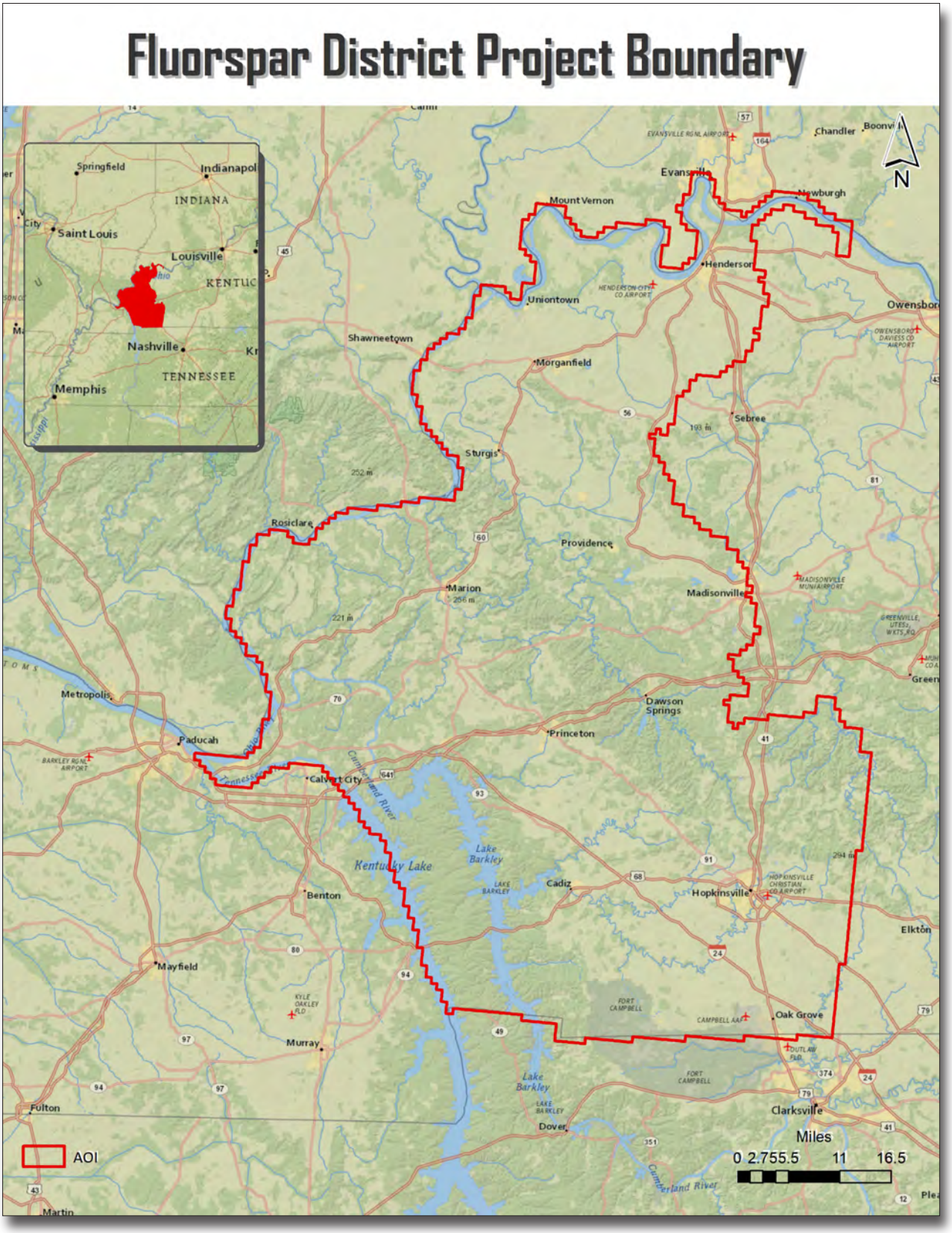

Figure 1. Project Boundary

2. Planning / Equipment

2.1. Flight Planning

Flight planning was based on the unique project requirements and characteristics of the project site. The basis of planning included: required accuracies, type of development, amount / type of vegetation within project area, required data posting, and potential altitude restrictions for flights in project vicinity.

Detailed project flight planning calculations were performed for the project using RiPARAMETER planning software. The entire target area was comprised of 132 planned flight lines (Figure 2).

2.2. LiDAR Sensor

Quantum Spatial utilized a Riegl VQ1560i LiDAR sensor(Figure 3), serial numbers 3061, 4040, 4046, for data collection.

The Riegl 1560i system has a laser pulse repetition rate of up to 2 MHz resulting in more than 1.3 million measurements per second. The system utilizes a Multi-Pulse in the Air option (MPIA). The sensor is also equipped with the ability to measure up to an unlimited number of targets per pulse from the laser.

A brief summary of the aerial acquisition parameters for the project are shown in the LiDAR System Specifications in Table 2.

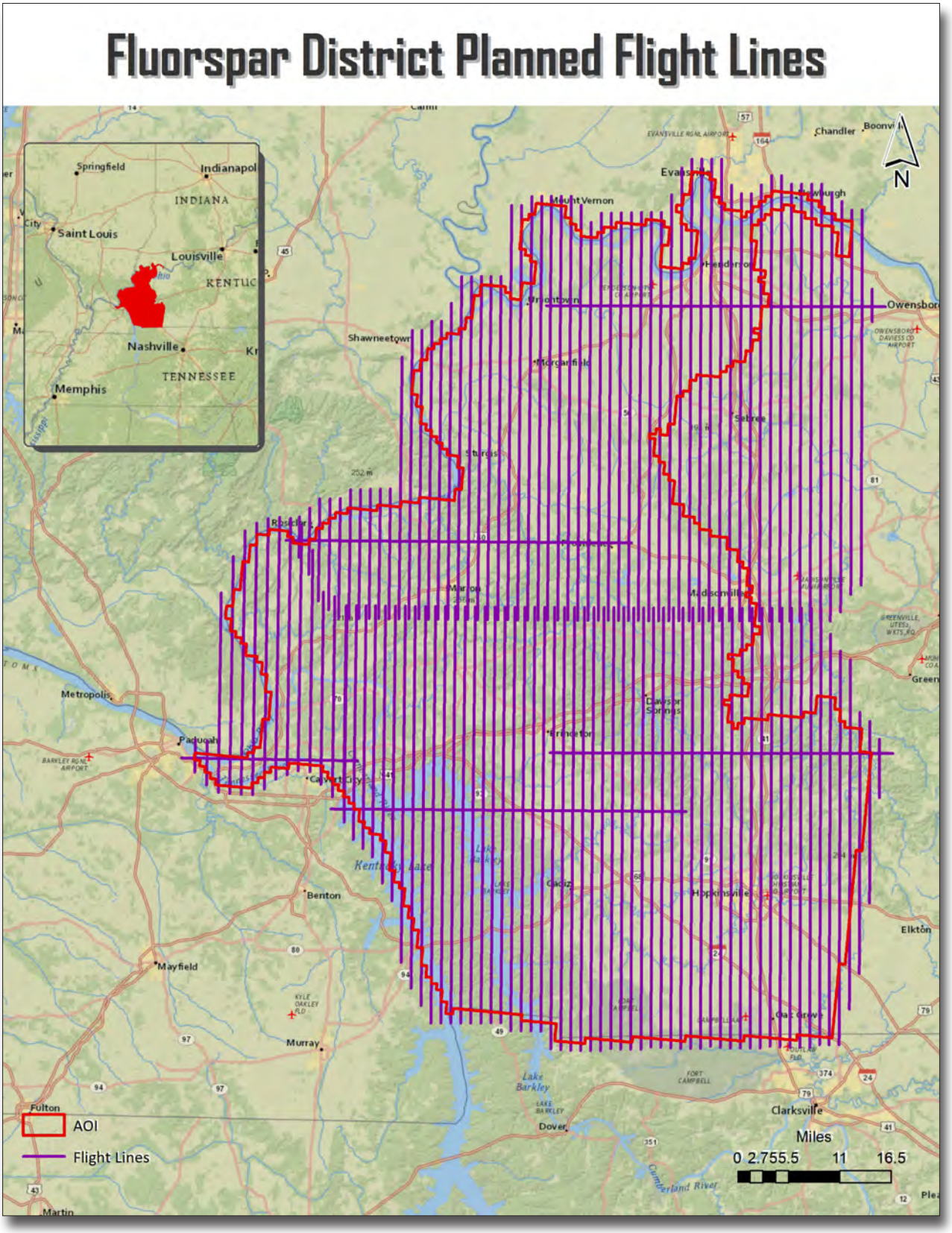

Figure 2. Planned Flight Lines

Table 2. LiDAR System Specifications

		Riegl V1560i
Terrain and Aircraft Scanner	Flying Height	2300 m
	Recommended Ground Speed	140 kts
Scanner	Field of View	58.5°
	Scan Rate Setting Used	160 Hz
Laser	Laser Pulse Rate Used	350 kHz
	Multi Pulse in Air Mode	yes
Coverage	Full Swath Width	2577 m
	Line Distance	0.438 m
Point Spacing and Density	Average Point Spacing	0.71 m
	Average Point Density	2 pts / m^2

Figure 3. Riegl VQ1560i LiDAR Sensors

2.3. Aircraft

All flights for the project were accomplished through the use of customized planes. Plane type and tail numbers are listed below.

LiDAR Collection Planes

- Piper Navajo, Tail Numbers: N73TM, N22GE
- Cessna Caravan, Tail Number: N208NR

These aircraft provided an ideal, stable aerial base for LiDAR acquisition. These aerial platforms have relatively fast cruise speeds, which are beneficial for project mobilization/demobilization while maintaining relatively slow stall speeds, proving ideal for collection of high-density, consistent data posting using a state-of-the-art Riegl VQ1560i LiDAR system. Some of Quantum Spatial's operating aircraft can be seen in Figure 4 below.

Figure 4. Some of Quantum Spatial's Planes

2.4. Time Period

Project specific flights were conducted between December 5, 2019 and February 8, 2020. Twelve aircraft lifts were completed. Accomplished lifts are listed below.

- 12052019A (SN4040,N208NR)
- 12072019A (SN4040,N208NR)
- 12102019A (SN4040,N208NR)
- 12112019A (SN4040,N208NR)
- 12112019A (SN4046,N22GE)
- 12112019B (SN4046,N22GE)
- 12122019A (SN4040,N208NR)
- 12212019A (SN4040,N208NR)
- 12222019A (SN4040,N208NR)
- 01012020B (SN3061,N73TM)
- 01052020A (SN3061,N73TM)
- 02082020A (SN3061,N22GE)

3. Processing Summary

3.1. Flight Logs

Flight logs were completed by LIDAR sensor technicians for each mission during acquisition. These logs depict a variety of information, including:

- Job / Project #
- Flight Date / Lift Number
- FOV (Field of View)
- Scan Rate (HZ)
- Pulse Rate Frequency (Hz)
- Ground Speed
- Altitude
- Base Station
- PDOP avoidance times
- Flight Line #
- Flight Line Start and Stop Times
- Flight Line Altitude (AMSL)
- Heading
- Speed
- Returns
- Crab

Notes: (Visibility, winds, ride, weather, temperature, dew point, pressure, etc).

3.2. LiDAR Processing

Applanix + POSPac software was used for post-processing of airborne GPS and inertial data (IMU), which is critical to the positioning and orientation of the LiDAR sensor during all flights. Applanix POSPac combines aircraft raw trajectory data with stationary GPS base station data yielding a “Smoothed Best Estimate Trajectory” (SBET) necessary for additional post processing software to develop the resulting geo-referenced point cloud from the LiDAR missions.

During the sensor trajectory processing (combining GPS & IMU datasets) certain statistical graphs and tables are generated within the Applanix POSPac processing environment which are commonly used as indicators of processing stability and accuracy. This data for analysis include: max horizontal / vertical GPS variance, separation plot, altitude plot, PDOP plot, base station baseline length, processing mode, number of satellite vehicles, and mission trajectory.

Point clouds were created using RiPROCESS software. The generated point cloud is the mathematical three dimensional composite of all returns from all laser pulses as determined from the aerial mission. The point cloud is imported into GeoCue distributive processing software. Imported data is tiled and then calibrated using TerraMatch and proprietary software. Using TerraScan, the vertical accuracy of the surveyed ground control is tested and any bias is removed from the data. TerraScan and TerraModeler software packages are then used for automated data classification and manual cleanup. The data are manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler.

DEMs and Intensity Images are then generated using proprietary software. In the bare earth surface model, above-ground features are excluded from the data set. Global Mapper is used as a final check of the bare earth dataset.

Finally, proprietary software is used to perform statistical analysis of the LAS files.

Software	Version
Applanix + POSPac	8.4
RiPROCESS	1.8.6
GeoCue	2017.1.14.1
Global Mapper	19.1;20.1
TerraModeler	20.004
TerraScan	20.011
TerraMatch	20.004

3.3. LAS Classification Scheme

The classification classes are determined by the USGS Version 1.3 specifications and are an industry standard for the classification of LIDAR point clouds. All data starts the process as Class 1 (Unclassified), and then through automated classification routines, the classifications are determined using TerraScan macro processing.

The classes used in the dataset are as follows and have the following descriptions:

Table 3. LAS Classifications

	Classification Name	Description
1	Processed, but Unclassified	Laser returns that are not included in the ground class, or any other project classification
2	Bare earth	Laser returns that are determined to be ground using automated and manual cleaning algorithms
7	Low Noise	Laser returns that are often associated with scaterring from reflective surfaces, or artificial points below the ground surface
9	Water	Laser returns that are found inside of hydro features
17	Bridge Deck	Laser returns falling on bridge decks
18	High Noise	Laser returns that are often associated with birds or artificial points above the ground surface
20	Ignored Ground	Ground points that fall within the given threshold of a collected hydro feature.
22	Temporal Exclusion	Points that are excluded due to differences in collection dates

3.4. Classified LAS Processing

The bare earth surface is then manually reviewed to ensure correct classification on the Class 2 (Ground) points. After the bare- earth surface is finalized; it is then used to generate all hydro-breaklines through heads-up digitization.

All ground (ASPRS Class 2) LiDAR data inside of the Lake Pond and Double Line Drain hydro flattening breaklines were then classified to water (ASPRS Class 9) using TerraScan macro functionality. A buffer of 3 feet was also used around each hydro flattened feature to classify these ground (ASPRS Class 2) points to Ignored ground (ASPRS Class 20). All Lake Pond Island and Double Line Drain Island features were checked to ensure that the ground (ASPRS Class 2) points were reclassified to the correct classification after the automated classification was completed.

All overlap data was processed through automated functionality provided by TerraScan to

classify the overlapping flight line data to approved classes by USGS. The overlap data was identified using the Overlap Flag, per LAS 1.4 specifications.

All data was manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler. Global Mapper is used as a final check of the bare earth dataset. GeoCue was then used to create the deliverable industry-standard LAS files for all point cloud data. Quantum Spatial's proprietary software was used to perform final statistical analysis of the classes in the LAS files, on a per tile level to verify final classification metrics and full LAS header information.

3.5. Hydro-Flattened Breakline Processing

Class 2 LiDAR was used to create a bare earth surface model. The surface model was then used to heads-up digitize 2D breaklines of Inland Streams and Rivers with a 100 foot nominal width and Inland Ponds and Lakes of 2 acres or greater surface area.

Elevation values were assigned to all Inland Ponds and Lakes, Inland Pond and Lake Islands, Inland Streams and Rivers and Inland Stream and River Islands using TerraModeler functionality.

Elevation values were assigned to all Inland streams and rivers using Quantum Spatial's proprietary software.

All ground (ASPRS Class 2) LiDAR data inside of the collected inland breaklines were then classified to water (ASPRS Class 9) using TerraScan macro functionality. A buffer of 1 meter was also used around each hydro flattened feature. These points were moved from ground (ASPRS Class 2) to Ignored Ground (ASPRS Class 20).

The breakline files were then translated to Esri file geodatabase format using Esri conversion tools.

Breaklines are reviewed against lidar intensity imagery to verify completeness of capture. All breaklines are then compared to TINs (triangular irregular networks) created from ground only points prior to water classification. The horizontal placement of breaklines is compared to terrain features and the breakline elevations are compared to lidar elevations to ensure all breaklines match the lidar within acceptable tolerances. Some deviation is expected between breakline and lidar elevations due to monotonicity, connectivity, and flattening rules that are enforced on the breaklines. Once completeness, horizontal placement, and vertical variance is reviewed, all breaklines are reviewed for topological consistency and data integrity using a combination of Esri Data Reviewer tools and proprietary tools.

3.6. Hydro-Flattened Raster DEM Processing

Class 2 LiDAR in conjunction with the hydro breaklines were used to create a 1-meter Raster DEM. Using automated scripting routines within proprietary software, a GeoTIFF file was created for each tile. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations found within the surface.

3.7. Intensity Image Processing

GeoCue software was used to create the deliverable intensity images. All overlap classes were ignored during this process. This helps to ensure a more aesthetically pleasing image. The GeoCue software was then used to verify full project coverage as well. GeoTIFF files with a cell size of 1-meter were then provided as the deliverable for this dataset requirement.

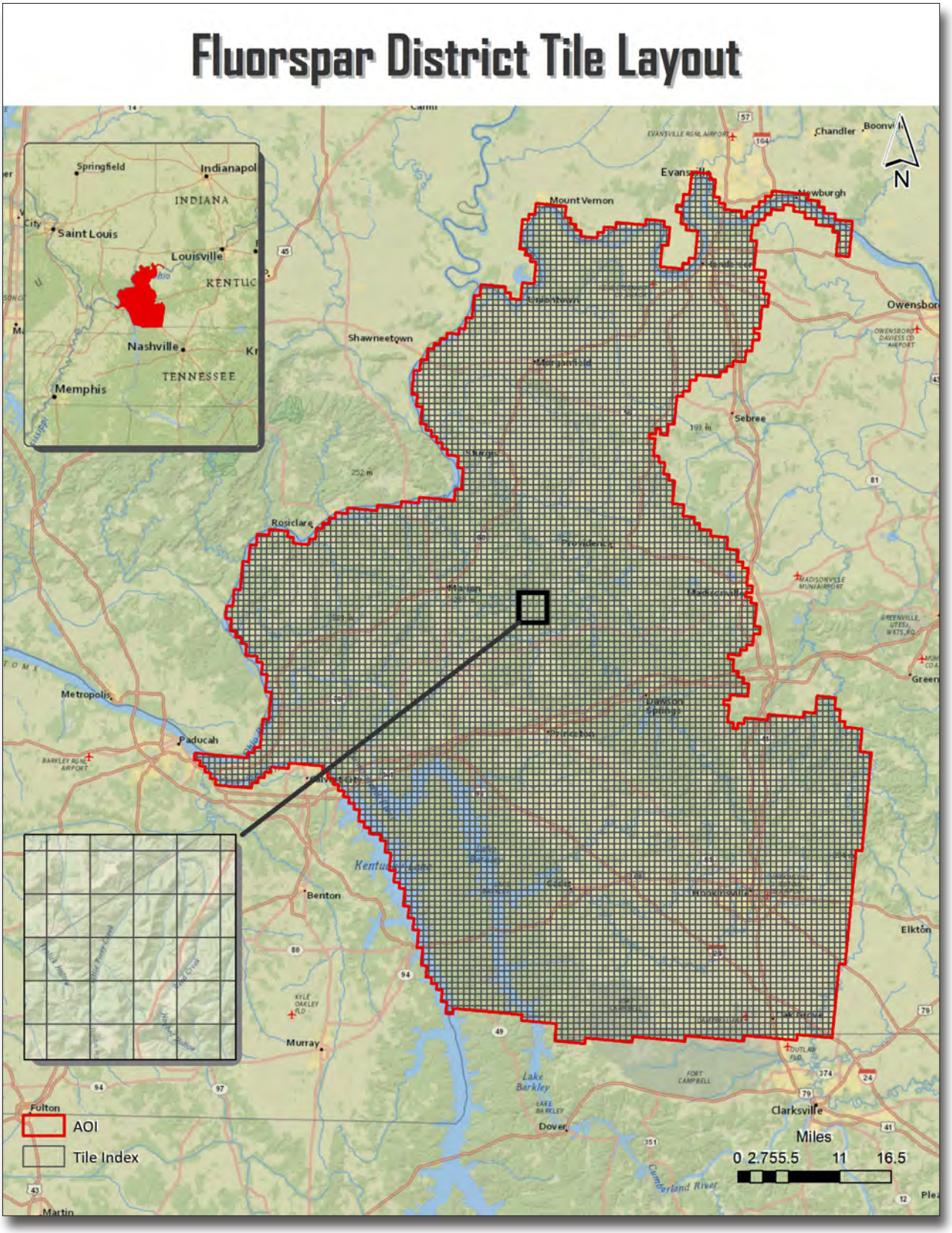

Figure 5. LiDAR Tile Layout

4. Project Coverage Verification

Coverage verification was performed by comparing coverage of processed .LAS files captured during project collection to generate project shape files depicting boundaries of specified project areas. Please refer to Figure 6.

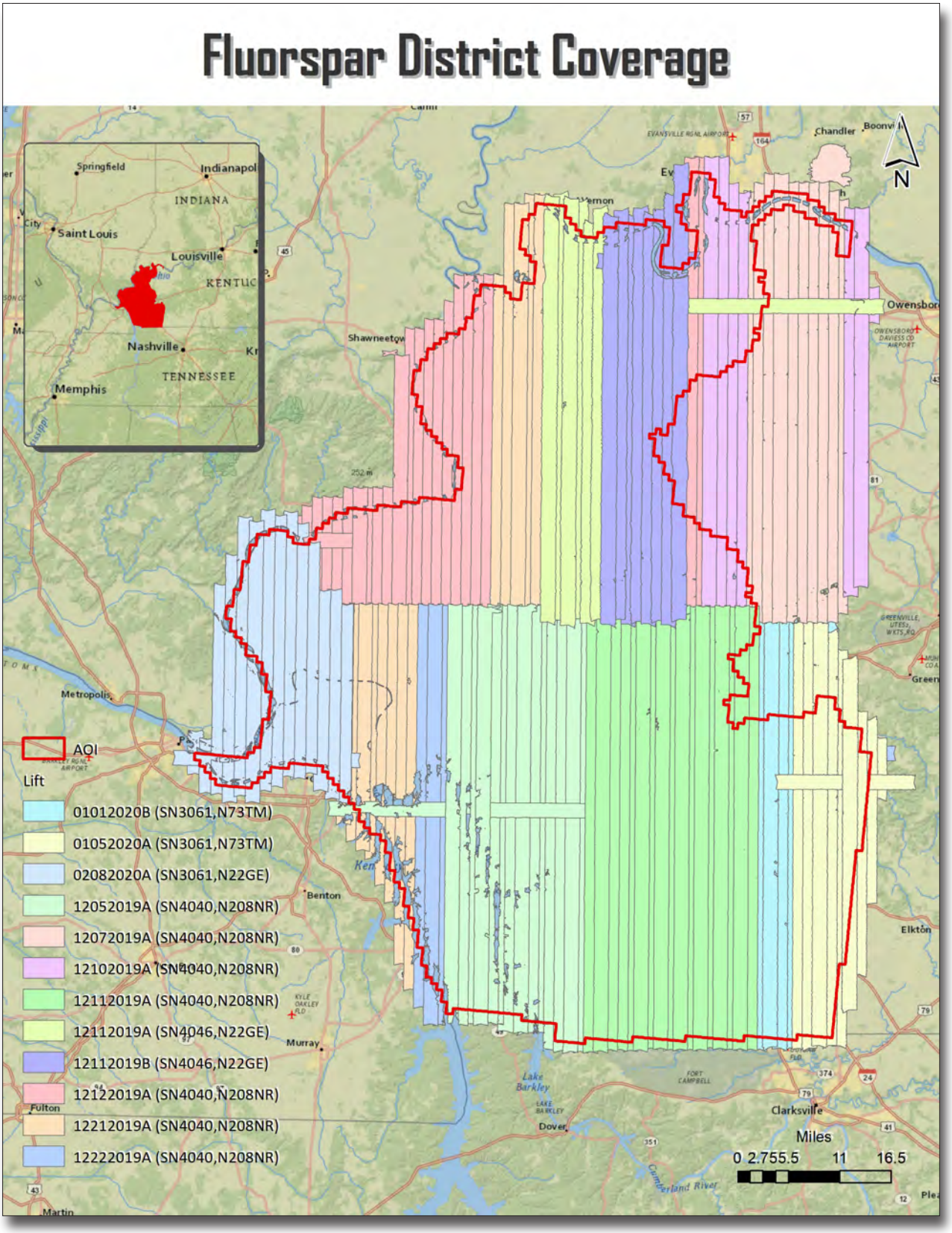

Figure 6. LiDAR Flight Line Coverage

5. Ground Control and Check Point Collection

NV5 and Platinum Geomatics completed the field surveys for this project.

A combination of precise GPS surveying methods, including static and RTK observations were used to establish the 3D position of ground calibration points and QA points for the point classes above. GPS was not an appropriate methodology for surveying in the forested areas during the leaf-on conditions for the actual field survey (which was accomplished after the LiDAR acquisition). Therefore the 3D positions for the forested points were acquired using a GPS-derived offset point located out in the open near the forested area, and using precise offset surveying techniques to derive the 3D position of the forested point from the open control point. The explicit goal for these surveys was to develop 3D positions that were three times greater than the accuracy requirement for the elevation surface. In this case of the blind QA points the goal was a positional accuracy of 5 cm in terms of the RMSE.

For more information, see the Survey Reports in Appendix A.

The required accuracy testing was performed on the LiDAR dataset (both the LiDAR point cloud and derived DEM's) according to the USGS LiDAR Base Specification Version 1.3.

5.1. Calibration Control Point Testing

Figure 7 shows the location of each bare earth calibration point for the project area. TerraScan was used to perform a quality assurance check using the LiDAR bare earth calibration points. The results of the surface calibration are **not an independent assessment of the accuracy of these project deliverables, but the statistical results do provide additional feedback as to the overall quality of the elevation surface.**

5.2. Point Cloud Testing

The project specifications require that only Non-Vegetated Vertical Accuracy (NVA) be computed for the raw lidar point cloud. The required accuracy (ACCz) is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 10 cm in the "bare earth" and "urban" land cover classes. The NVA was tested with 96 checkpoints located in bare earth and urban (non-vegetated) areas. These check points were not used in the calibration or post processing of the lidar point cloud data. The checkpoints were distributed throughout the project area and were surveyed using GPS techniques. See survey report for additional survey methodologies.

Elevations from the unclassified lidar surface were measured for the x,y location of each check point. Elevations interpolated from the lidar surface were then compared to the elevation values of the surveyed control points. AccuracyZ has been tested to meet 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using RMSE(z) x 1.9600 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASRPS Guidelines.

5.3. Digital Elevation Model (DEM) Testing

The project specifications require the accuracy (ACCz) of the derived DEM be calculated and reported in two ways:

1. The required NVA is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 10 cm in the "bare earth" and "urban" land cover classes. This is a required accuracy. The NVA was tested with 96 checkpoints located in bare earth and urban (non-vegetated) areas. See Figure 8.

2. Vegetated Vertical Accuracy (VVA): VVA shall be reported for "brushlands/low trees" and "tall weeds/crops" land cover classes. The target VVA is: 29.4 cm at the 95th percentile, derived according to ASPRS Guidelines, Vertical Accuracy Reporting for Lidar Data, i.e., based on the 95th percentile error in all vegetated land cover classes combined. This is a target accuracy. The VVA was tested with 72 checkpoints located in tall weeds/ crops and brushlands/low trees (vegetated) areas. The checkpoints were distributed throughout the project area and were surveyed using GPS techniques. See Figure 9.

AccuracyZ has been tested to meet 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using RMSE(z) x 1.9600 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ ASRPS Guidelines.

A brief summary of results are listed below.

	Target	Measured	Point Count
Raw NVA	0.196	.0429 m	96
NVA	0.196	.0423 m	96
VVA	0.294	.1524 m	72

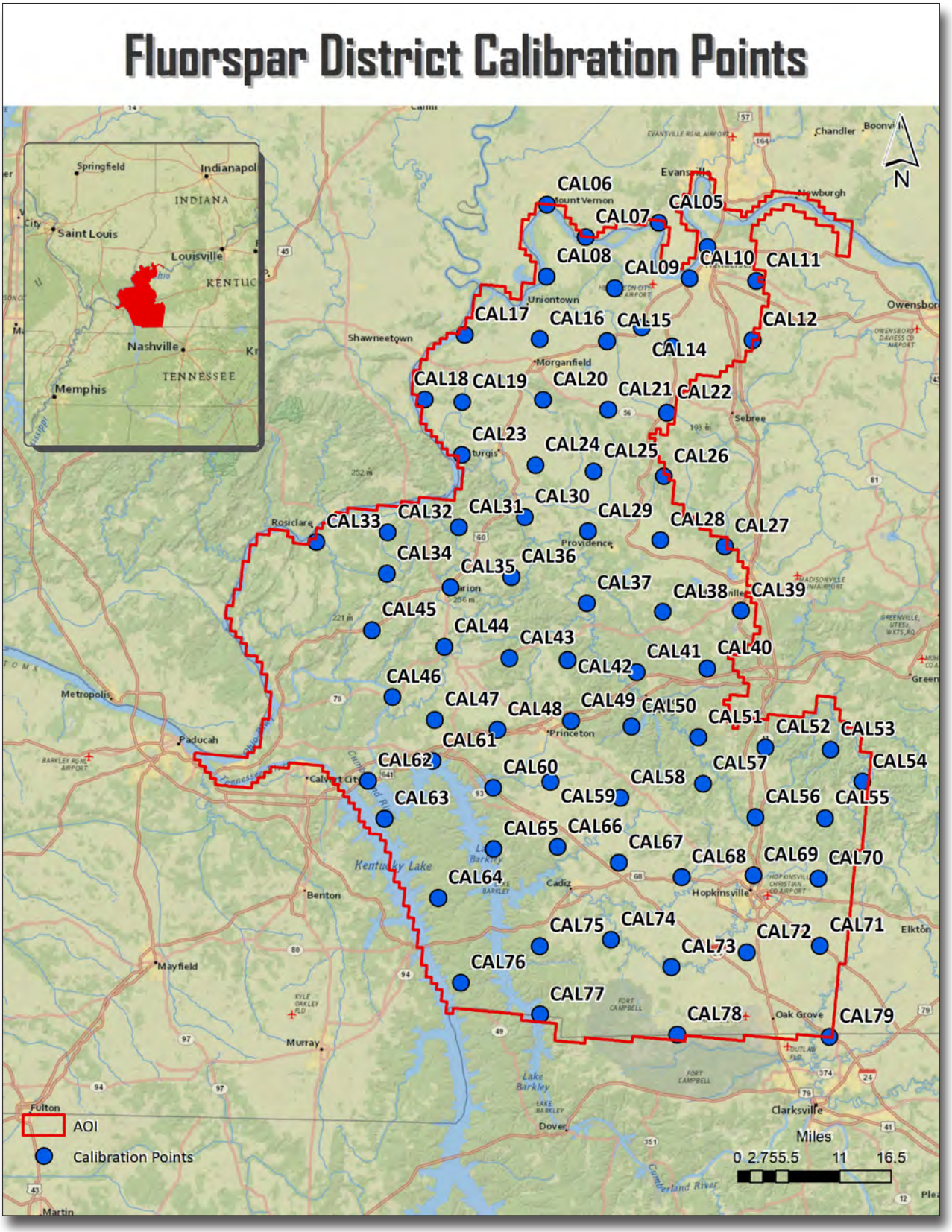

Figure 7. Calibration Control Point Locations

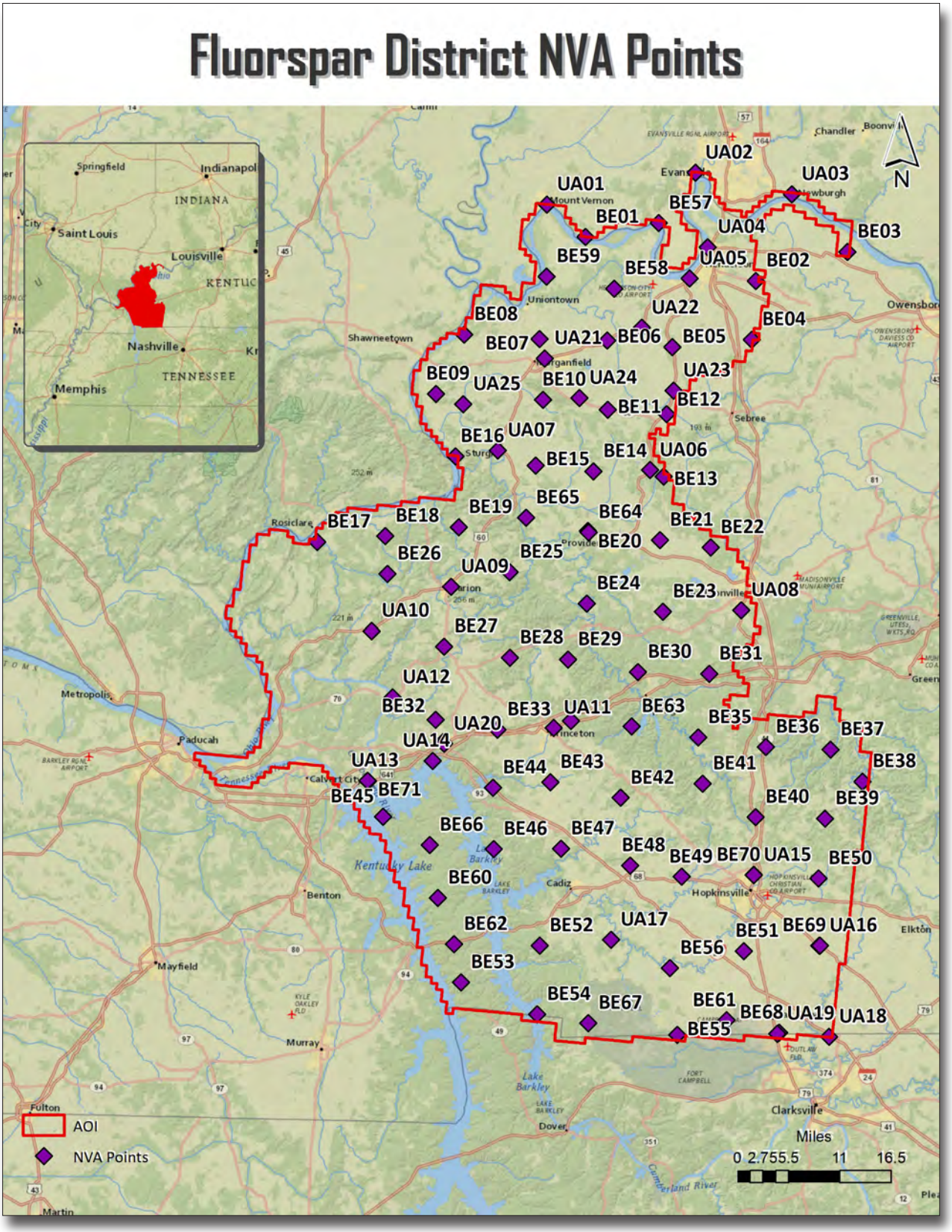

Figure 8. QC Checkpoint Locations - NVA

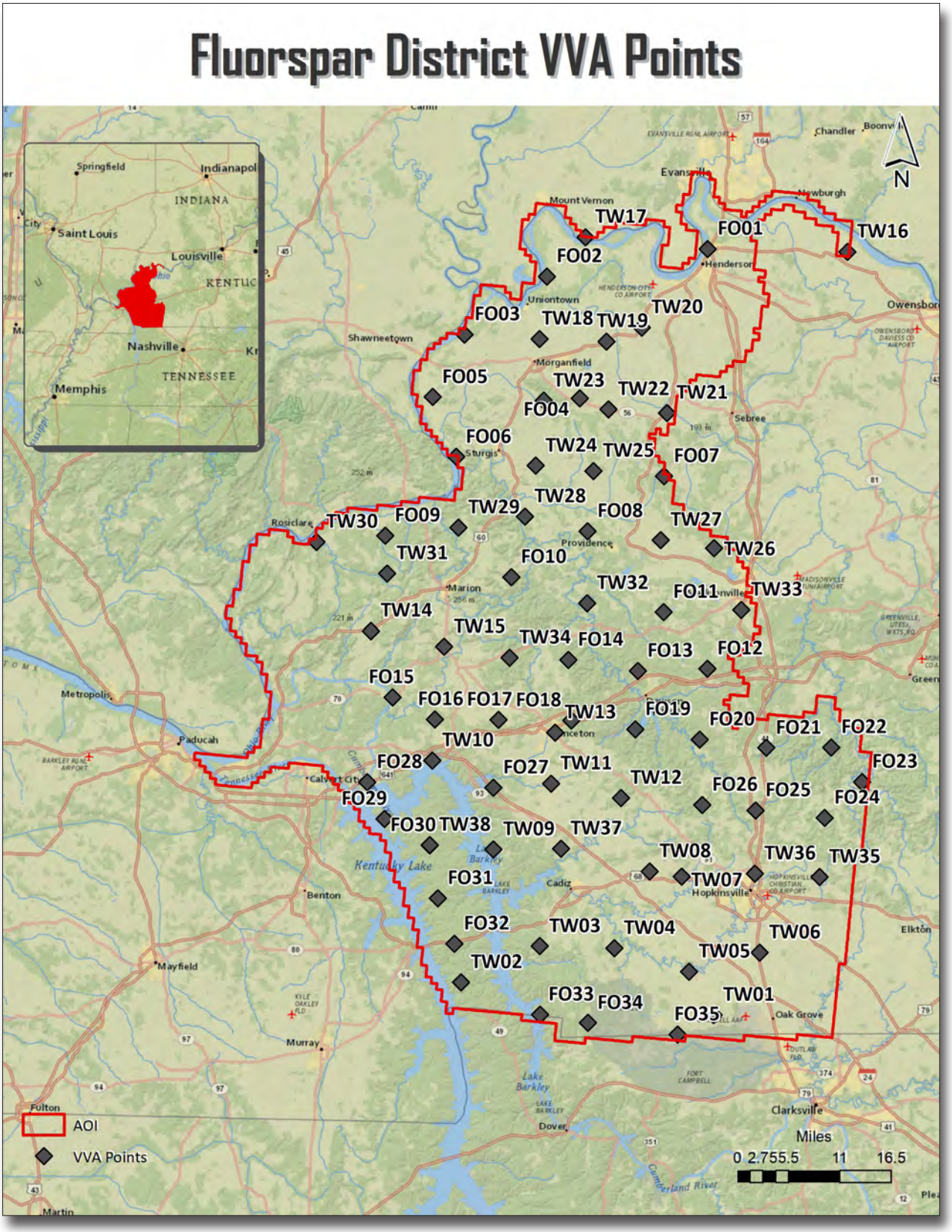

Figure 9. QC Checkpoint Locations - VVA

Project Report Appendices

The following section contains the appendices as listed in the Fluorspar District 2019 D19 LiDAR Project Report.

Appendix A

Survey Reports

Platinum Geomatics

PROJECT NO. 1001-005
SURVEY REPORT OF LIDAR
CALIBRATION AND VERTICAL
ASSESSMENT POINTS IN WESTERN
KENTUCKY - DECEMBER 27, 2019

PLATINUM GEOMATICS

Contract Information

PROJECT NO. 35832
PROJECT NAME: KYSW FLIORSPAR
DISTRICT
PHASE#/TASK#: 1301/2
ACCOUNT#: 63230
PO#/MSA#: 3650/68-1

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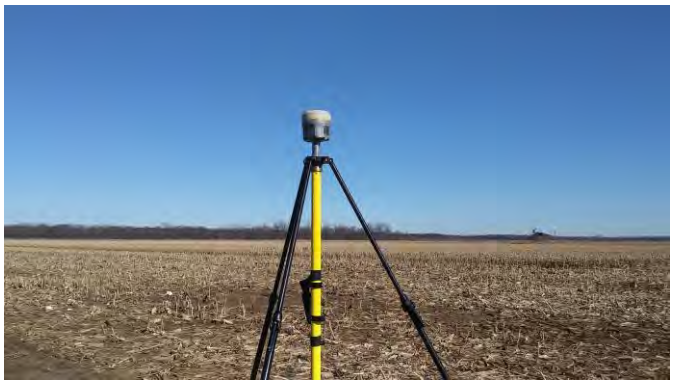
PROJECT INTRODUCTION

Platinum Geomatics, LLC entered into a contract with Quantum Spatial, Inc to collect calibration and vertical assessment points for LiDAR mapping in western Kentucky. This report describes the methodology used, includes the calculated accuracy of the survey, and lists the final coordinates derived from the survey by Platinum Geomatics, LLC.



EQUIPMENT USED

Trimble R8-3 & R10 GNSS Receivers were used for this survey.

PROCEDURES USED

The Kentucky Real Time Reference Network was utilized to obtain real-time GNSS corrections for the points. KYCORS observations consisted of a minimum of 180 1-second epochs and point tolerances were set to record within 0.049ft horizontal and 0.066ft vertical accuracies. Points were observed twice, separated by several hours so that different satellite constellations would be factored into each solution. An adjustment was performed constraining to the applicable KYCORS base stations.

POINT CLASSIFICATIONS & QUANTITIES

Point Description	Quantity
Non-vegetated Vertical Assessment	97
Vegetated Vertical Assessment	73
Ground Control Calibration Points	79
Total	249

COORDINATE LISTING

The coordinates below are reported in meters and are relative to NAD83 (2011) UTM 16 North and orthometric heights were determined using Geoid 12b.

Bare Earth

Point	Northing	Easting	Elevation		Point	Northing	Easting	Elevation
Be01	4192809.116	428005.598	109.142		**Be21**	4140396.681	440829.104	123.962
Be02	4185229.538	457456.451	132.413		**Be22**	4139096.46	449616.597	142.075
Be03	4190247.095	473237.449	116.953		**Be23**	4127998.883	441368.853	135.475
Be04	4175072.894	456765.406	145.619		**Be24**	4129426.768	428235.193	129.439
Be05	4173779.371	443001.483	140.597		**Be25**	4134846.623	414913.821	179.223
Be06	4174927.917	431791.925	113.542		**Be26**	4134547.044	393792.721	161.525
Be07	4175198.013	420067.911	114.953		**Be27**	4122032.042	403614.905	168.854
Be08	4175931.548	407077.184	106.619		**Be28**	4120126.159	414925.69	143.279
Be09	4165640.493	402187.492	108.245		**Be29**	4119820.29	424960.636	185.765
Be10	4164640.964	420653.267	145.085		**Be30**	4117683.85	437052.24	123.545
Be11	4162932.312	431850.597	135.411		**Be31**	4117333.028	449381.775	145.27
Be12	4162136.584	442026.512	130.678		**Be32**	4109426.998	402117.907	138.212
Be13	4151394.701	441514.151	170.602		**Be33**	4107666.696	412804.004	196.343
Be14	4152247.146	429349.138	130.949		**Be34**	4109229.509	425480.364	131.253
Be15	4153278.729	419415.847	110.243		**Be35**	4106371.161	447474.581	137.646
Be16	4154849.461	405561.5	107.272		**Be36**	4104686.228	459138.992	192.171
Be17	4140096.98	381663.095	106.656		**Be37**	4104282.902	470324.376	144.072
Be18	4141094.228	393442.623	120.678		**Be38**	4098734.049	475860.736	167.563
Be19	4142596.814	406093.526	180.561		**Be39**	4092348.433	469395.108	183.167
Be20	4141949.603	428411.164	121.546		**Be40**	4092585.619	457386.037	207.007

Point	Northing	Easting	Elevation		Point	Northing	Easting	Elevation
Be41	4098358.883	448245.184	201.861		**Be57**	4195225.022	440670.397	110.661
Be42	4095906.188	434074.638	165.418		**Be58**	4183902.246	433009.352	123.556
Be43	4098630.035	421914.041	143.047		**Be59**	4186004.631	421315.357	106.915
Be44	4097631.301	412041.659	163.852		**Be60**	4078591.834	402526.163	151.988
Be45	4092662.958	393073.316	147.913		**Be61**	4057429.049	452337.459	163.985
Be46	4087038.154	412172.445	121.412		**Be62**	4070592.26	405292.524	193.363
Be47	4087108.674	423766.289	154.256		**Be63**	4108270.261	435945.282	168.344
Be48	4084168.707	435709.955	160.615		**Be64**	4141699.616	428557.659	128.449
Be49	4082257.299	444592.856	154.037		**Be65**	4144240.605	417716.1	111.583
Be50	4081947.82	468234.606	183.805		**Be66**	4087754.709	401107.618	164.225
Be51	4069404.241	455325.693	174.042		**Be67**	4056937.105	428507.534	192.897
Be52	4070344.071	420080.106	133.681		**Be68**	4055274.098	461464.339	168.392
Be53	4063997.958	406518.562	177.457		**Be69**	4070343.742	468380.606	181.271
Be54	4058454.534	419658.016	155.608		**Be70**	4082572.867	457030.741	169.649
Be55	4054945.181	443846.085	168.156		**Be71**	4098803.32	390420.234	110.169
Be56	4066498.718	442605.096	153.185		**Be72**	4105504.246	403424.112	143.014

Calibration

Point	Northing	Easting	Elevation		Point	Northing	Easting	Elevation
Cal01	4203925.841	446975.5	117.345		**Cal32**	4141734.188	393839.638	134.792
Cal02	4200209.991	463625.281	119.509		**Cal33**	4140078.051	381557.391	106.937
Cal03	4190239.985	473246.515	116.822		**Cal34**	4134578.87	393731.955	157.96
Cal04	4191038.001	449139.299	117.2		**Cal35**	4132278.3	404699.515	173.775
Cal05	4195232.045	440658.138	111.217		**Cal36**	4134055.251	415197.547	188.33
Cal06	4198446.359	421392.589	117.527		**Cal37**	4129451.66	428249.543	129.652
Cal07	4192790.336	428007.487	109.137		**Cal38**	4127977.483	441393.713	133.287
Cal08	4185998.661	421310.628	106.879		**Cal39**	4128221.28	454859.484	129.019
Cal09	4183952.543	433036.917	123.698		**Cal40**	4118310.922	449072.714	143.408
Cal10	4185631.847	445993.586	117.359		**Cal41**	4117674.763	436860.376	129.14
Cal11	4185245	457470.981	132.678		**Cal42**	4119778.063	424943.811	184.61
Cal12	4175018.096	456885.903	146.458		**Cal43**	4120098.384	414918.332	142.295
Cal13	4173836.97	442938.992	141.918		**Cal44**	4122020.023	403626.868	168.558
Cal14	4177135.029	437719.786	137.008		**Cal45**	4124810.57	391128.32	136.027
Cal15	4174807.807	431701.145	114.813		**Cal46**	4113310.145	394697.31	104.953
Cal16	4175191.539	420077.769	115.11		**Cal47**	4109395.308	401968.011	134.995
Cal17	4175906.418	407150.075	108.221		**Cal48**	4107683.202	412823.747	197.158
Cal18	4164715.475	400291.704	104.357		**Cal49**	4109209.074	425500.425	134.141
Cal19	4164248.444	406743.892	114.702		**Cal50**	4108240.196	435972.859	167.746
Cal20	4164622.729	420688.342	143.579		**Cal51**	4106388.163	447470.583	138.027
Cal21	4162961.498	431880.258	135.281		**Cal52**	4104653.916	459113.707	192.028
Cal22	4162399.158	442064.222	134.063		**Cal53**	4104272.015	470303.051	145.937
Cal23	4155105.887	406714.636	154.302		**Cal54**	4098700.113	475841.155	167.636
Cal24	4153319.32	419378.218	109.951		**Cal55**	4092403.291	469381.154	184.245
Cal25	4152261.955	429399.986	131.037		**Cal56**	4092566.916	457379.561	206.818
Cal26	4151409.558	441566.199	168.857		**Cal57**	4098354.31	448268.247	201.457
Cal27	4139312.036	452025.879	179.243		**Cal58**	4095936.048	434090.59	165.408
Cal28	4140399.338	440894.873	123.316		**Cal59**	4098651.267	421966.654	143.634
Cal29	4141905.492	428400.862	122.44		**Cal60**	4097663.953	412093.352	162.285
Cal30	4144419.371	417524.738	110.972		**Cal61**	4102311.52	401548.593	113.902
Cal31	4142640.901	406120.339	175.908		**Cal62**	4098848.79	390427.836	111.208

Point	Northing	Easting	Elevation		Point	Northing	Easting	Elevation
Cal63	4092347.905	393266.249	131.647		**Cal72**	4069195.814	455850.833	170.938
Cal64	4078588.189	402548.28	151.771		**Cal73**	4066674.844	442825.203	136.104
Cal65	4087043.732	412167.69	121.668		**Cal74**	4071374.263	432392.597	167.596
Cal66	4087418.016	423186.269	157.651		**Cal75**	4070270.062	420073.654	132.454
Cal67	4084707.53	433725.419	163.86		**Cal76**	4063942.465	406494.016	172.706
Cal68	4082248.414	444615.127	154.194		**Cal77**	4058442.43	420135.454	168.379
Cal69	4082545.207	457076.281	168.804		**Cal78**	4054970.384	443857.81	168.089
Cal70	4081952.163	468238.755	184.044		**Cal79**	4054597.473	470110.741	159.659
Cal71	4070344.779	468507.51	181.361					

Forested

Point	Northing	Easting	Elevation		Point	Northing	Easting	Elevation
Fo01	4190764.688	449133.806	117.88		**Fo19**	4107759.356	436604.341	142.277
Fo02	4185992.913	421353.911	107.447		**Fo20**	4105996.851	447707.159	144.172
Fo03	4175962.532	407156.391	106.915		**Fo21**	4104543.819	459187.601	179.112
Fo04	4164911.901	426999.784	136.893		**Fo22**	4104668.003	470477.187	142.733
Fo05	4165125.981	401603.816	104.224		**Fo23**	4098679.197	475797.085	168.04
Fo06	4154772.839	405675.225	106.221		**Fo24**	4092444.626	469284.678	174.11
Fo07	4151423.929	441586.621	166.711		**Fo25**	4093695.635	457376.697	228.342
Fo08	4141889.615	428368.864	123.99		**Fo26**	4094665.705	448173.949	214.509
Fo09	4141123.053	393404.533	118.09		**Fo27**	4097671.483	412121.393	162.098
Fo10	4133970.064	415199.857	180.127		**Fo28**	4098593.721	390290.973	102.583
Fo11	4127951.053	441472.561	128.656		**Fo29**	4092263.44	393269.999	124.763
Fo12	4118239.651	449077.378	140.512		**Fo30**	4087671.463	401081.779	175.813
Fo13	4117836.577	437024.104	127.885		**Fo31**	4078556.151	402521.979	147.145
Fo14	4119751.174	425032.904	180.991		**Fo32**	4070644.818	405336.243	189.006
Fo15	4113281.392	394706.424	106.66		**Fo33**	4058408.804	420161.027	172.087
Fo16	4109455.743	401975.395	132.814		**Fo34**	4056985.142	428382.925	194.982
Fo17	4109401.732	413005.488	162.865		**Fo35**	4055010.852	443902.138	166.953
Fo18	4109249.041	425566.501	133.533					

Tall Weeds

Point	Northing	Easting	Elevation		Point	Northing	Easting	Elevation
Tw1	4058369.554	450100.776	173.147		**Tw18**	4175210.676	420073.452	114.623
Tw2	4064027.103	406526.496	177.934		**Tw19**	4174770.172	431670.31	113.7
Tw3	4070251.599	420066.737	131.91		**Tw20**	4177139.057	437737.052	136.799
Tw4	4069933.457	432970.722	135.866		**Tw21**	4162364.603	442053.815	134.059
Tw5	4065854.341	445895.579	164.881		**Tw22**	4162980.478	431958.152	131.344
Tw6	4069155.669	458052.135	172.924		**Tw23**	4164486.176	420767.591	133.067
Tw7	4082279.886	444583.023	153.523		**Tw24**	4153249.635	419411.984	110.385
Tw8	4083196.619	439104.941	152.616		**Tw25**	4152299.879	429339.252	131.528
Tw9	4086968.383	412101.426	123.383		**Tw26**	4139017.484	450208.193	130.594
Tw10	4102356.544	401554.775	112.759		**Tw27**	4140376.976	440986.091	122.25
Tw11	4098338.663	422045.934	143.522		**Tw28**	4144477.359	417546.454	108.951
Tw12	4095901.522	434111.431	166.731		**Tw29**	4142570.542	406091.87	180.635
Tw13	4107191.478	422745.225	155.79		**Tw30**	4140076.092	381571.781	106.448
Tw14	4124727.521	390951.772	131.004		**Tw31**	4134600.853	393732.838	158.902
Tw15	4122005.441	403595.906	168.418		**Tw32**	4129468.17	428291.397	128.082
Tw16	4190242.839	473231.224	116.907		**Tw33**	4128304.918	454921.054	126.868
Tw17	4192770.249	428018.962	108.982		**Tw34**	4120131.184	414887.979	144.726

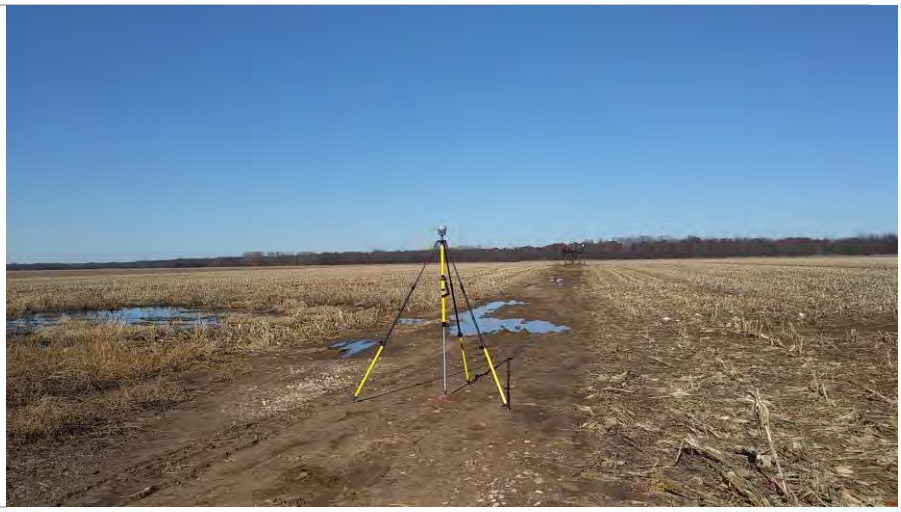
Point	Northing	Easting	Elevation		Point	Northing	Easting	Elevation
Tw35	4082249.483	468412.055	192.768		**Tw37**	4087124.248	423769.012	154.923
Tw36	4082814.913	457219.21	173.586		**Tw38**	4087772.947	401099.716	163.508

Urban Areas

Point	Northing	Easting	Elevation		Point	Northing	Easting	Elevation
Ua01	4198440.086	421388.52	117.482		**Ua14**	4102299.345	401588.94	113.675
Ua02	4203921.374	446998.243	117.277		**Ua15**	4082544.284	457053.281	168.827
Ua03	4200220.621	463624.347	119.616		**Ua16**	4070363.568	468468.064	181.337
Ua04	4191049.139	449141.61	117.14		**Ua17**	4071365.819	432385.946	167.748
Ua05	4185634.231	445996.809	117.348		**Ua18**	4054584.956	470067.533	161.294
Ua06	4152486.609	439129.648	158.513		**Ua19**	4055080.484	461092.525	167.723
Ua07	4155900.923	412861.137	113.258		**Ua20**	4105242.332	403555.811	140.59
Ua08	4128257.552	454905.056	128.539		**Ua21**	4171845.13	420972.394	118.934
Ua09	4132300.926	404789.697	177.09		**Ua22**	4177125.122	437722.571	137.156
Ua10	4124726.801	391098.77	135.702		**Ua23**	4166229.59	443187.976	147.952
Ua11	4108009.958	422523.072	162.781		**Ua24**	4164947.783	426956.125	137.263
Ua12	4113300.058	394707.976	105.526		**Ua25**	4163880.488	406899.373	112.025
Ua13	4098833.68	390404.546	111.116					

INDIVIDUAL POINT REPORT

Point ID	Be01
Northing	4192809.12
Easting	428005.60
Elevation	109.14



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Easting	457456.45
Elevation	132.41

Point ID	Be03
Northing	4190247.10
Easting	473237.45
Elevation	116.95

Point ID	Be04
Northing	4175072.89
Easting	456765.41
Elevation	145.62

Point ID	Be05
Northing	4173779.37
Easting	443001.48
Elevation	140.60

Point ID	Be06
Northing	4174927.92
Easting	431791.93
Elevation	113.54

Point ID	Be07
Northing	4175198.01
Easting	420067.91
Elevation	114.95

Point ID	Be08
Northing	4175931.55
Easting	407077.18
Elevation	106.62

Point ID	Be09
Northing	4165640.49
Easting	402187.49
Elevation	108.25

Point ID	Be10
Northing	4164640.96
Easting	420653.27
Elevation	145.09

Point ID	Be11
Northing	4162932.31
Easting	431850.60
Elevation	135.41

Point ID	Be12
Northing	4162136.58
Easting	442026.51
Elevation	130.68

Point ID	Be13
Northing	4151394.70
Easting	441514.15
Elevation	170.60

Point ID	Be14
Northing	4152247.15
Easting	429349.14
Elevation	130.95

Point ID	Be15
Northing	4153278.73
Easting	419415.85
Elevation	110.24

Point ID	Be16
Northing	4154849.46
Easting	405561.50
Elevation	107.27

Point ID	Be17
Northing	4140096.98
Easting	381663.10
Elevation	106.66

Point ID	Be18
Northing	4141094.23
Easting	393442.62
Elevation	120.68

Point ID	Be19
Northing	4142596.81
Easting	406093.53
Elevation	180.56

Point ID	Be20
Northing	4141949.60
Easting	428411.16
Elevation	121.55

Point ID	Be21
Northing	4140396.68
Easting	440829.10
Elevation	123.96

Point ID	Be22
Northing	4139096.46
Easting	449616.60
Elevation	142.08

Point ID	Be23
Northing	4127998.88
Easting	441368.85
Elevation	135.48

Point ID	Be24
Northing	4129426.77
Easting	428235.19
Elevation	129.44

Point ID	Be25
Northing	4134846.62
Easting	414913.82
Elevation	179.22

Point ID	Be26
Northing	4134547.04
Easting	393792.72
Elevation	161.53

Point ID	Be27
Northing	4122032.04
Easting	403614.91
Elevation	168.85

Point ID	Be28
Northing	4120126.16
Easting	414925.69
Elevation	143.28

Point ID	Be29
Northing	4119820.29
Easting	424960.64
Elevation	185.77

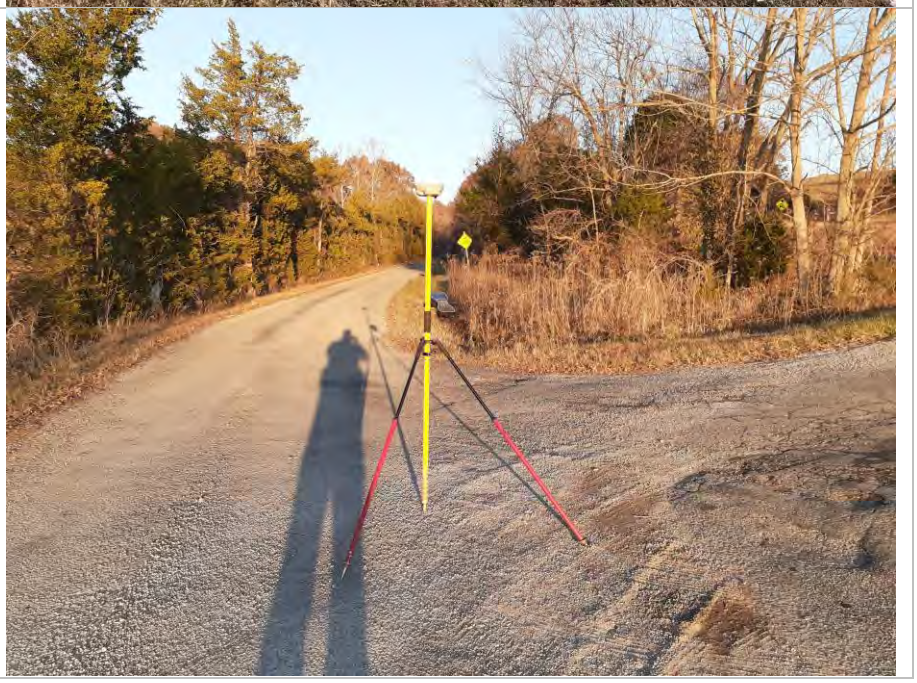
Point ID	Be30
Northing	4117683.85
Easting	437052.24
Elevation	123.55

Point ID	Be31
Northing	4117333.03
Easting	449381.78
Elevation	145.27

Point ID	Be32
Northing	4109427.00
Easting	402117.91
Elevation	138.21

Point ID	Be33
Northing	4107666.70
Easting	412804.00
Elevation	196.34

Point ID	Be34
Northing	4109229.51
Easting	425480.36
Elevation	131.25



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Point ID	Be36
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Easting	459138.99
Elevation	192.17

Point ID	Be37
Northing	4104282.90
Easting	470324.38
Elevation	144.07

Point ID	Be38
Northing	4098734.05
Easting	475860.74
Elevation	167.56

Point ID	Be39
Northing	4092348.43
Easting	469395.11
Elevation	183.17

Point ID	Be40
Northing	4092585.62
Easting	457386.04
Elevation	207.01

Point ID	Be41
Northing	4098358.88
Easting	448245.18
Elevation	201.86

Point ID	Be42
Northing	4095906.19
Easting	434074.64
Elevation	165.42

Point ID	Be43
Northing	4098630.04
Easting	421914.04
Elevation	143.05

Point ID	Be44
Northing	4097631.30
Easting	412041.66
Elevation	163.85

Point ID	Be45
Northing	4092662.96
Easting	393073.32
Elevation	147.91

Point ID	Be46
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Easting	412172.45
Elevation	121.41

Point ID	Be47
Northing	4087108.67
Easting	423766.29
Elevation	154.26

Point ID	Be48
Northing	4084168.71
Easting	435709.96
Elevation	160.62

Point ID	Be49
Northing	4082257.30
Easting	444592.86
Elevation	154.04

Point ID	Be50
Northing	4081947.82
Easting	468234.61
Elevation	183.81

Point ID	Be51
Northing	4069404.24
Easting	455325.69
Elevation	174.04

Point ID	Be52
Northing	4070344.07
Easting	420080.11
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Point ID	Be53
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Point ID	Be54
Northing	4058454.53
Easting	419658.02
Elevation	155.61

Point ID	Be55
Northing	4054945.18
Easting	443846.09
Elevation	168.16

Point ID	Be56
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Easting	442605.10
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Point ID	Be57
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Easting	440670.40
Elevation	110.66

Point ID	Be58
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Point ID	Be59
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Easting	421315.36
Elevation	106.92

Point ID	Be60
Northing	4078591.83
Easting	402526.16
Elevation	151.99

Point ID	Be61
Northing	4057429.05
Easting	452337.46
Elevation	163.99

Point ID	Be62
Northing	4070592.26
Easting	405292.52
Elevation	193.36

Point ID	Be63
Northing	4108270.26
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Elevation	168.34

Point ID	Be64
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Easting	428557.66
Elevation	128.45

Point ID	Be65
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Easting	417716.10
Elevation	111.58

Point ID	Be66
Northing	4087754.71
Easting	401107.62
Elevation	164.23

Point ID	Be67
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Easting	428507.53
Elevation	192.90

Point ID	Be68
Northing	4055274.10
Easting	461464.34
Elevation	168.39

Point ID	Be69
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Easting	468380.61
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Point ID	Be70
Northing	4082572.87
Easting	457030.74
Elevation	169.65

Point ID	Be71
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Easting	390420.23
Elevation	110.17

Point ID	Be72
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Point ID	Cal01
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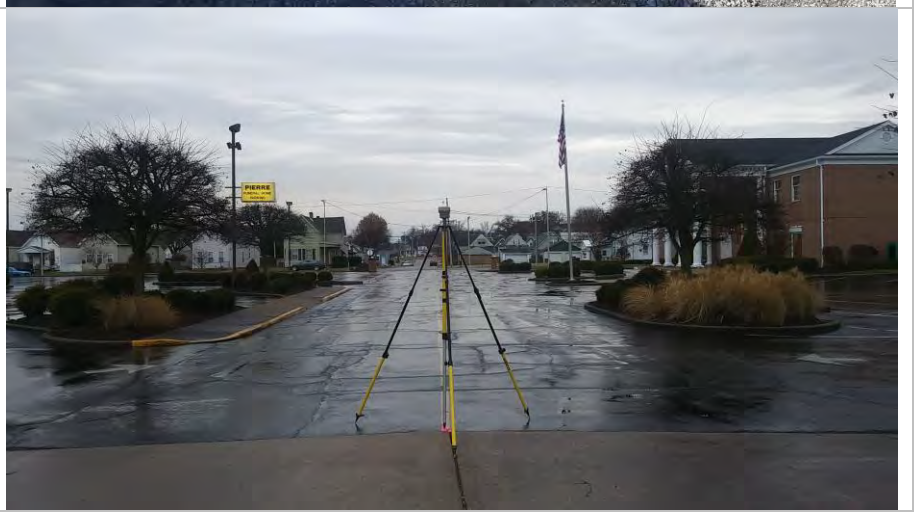

Point ID	Cal02
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Easting	463625.28
Elevation	119.51

Point ID	Cal03
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Point ID	Cal04
Northing	4191038.00
Easting	449139.30
Elevation	117.20

Point ID	Cal05
Northing	4195232.05
Easting	440658.14
Elevation	111.22

Point ID	Cal06
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Elevation	117.53

Point ID	Cal07
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Point ID	Cal08
Northing	4185998.66
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Elevation	106.88

Point ID	Cal09
Northing	4183952.54
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Point ID	Cal10
Northing	4185631.85
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Point ID	Cal11
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Point ID	Cal12
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Point ID	Cal13
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Easting	442938.99
Elevation	141.92

Point ID	Cal14
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Easting	437719.79
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Point ID	Cal15
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Point ID	Cal16
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Easting	420077.77
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Point ID	Cal17
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Easting	407150.08
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Point ID	Cal18
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Easting	400291.70
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Point ID	Cal19
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Point ID	Cal23
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Easting	419378.22
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Point ID	Cal26
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Easting	441566.20
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Point ID	Cal27
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Easting	452025.88
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Point ID	Cal28
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Easting	440894.87
Elevation	123.32

Point ID	Cal29
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Easting	428400.86
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Point ID	Cal30
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Easting	417524.74
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Point ID	Cal31
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Point ID	Cal37
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Easting	428249.54
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Easting	441393.71
Elevation	133.29

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Elevation	129.02

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Easting	449072.71
Elevation	143.41

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Easting	436860.38
Elevation	129.14

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Easting	424943.81
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Elevation	142.30

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Elevation	136.03

Point ID	Cal46
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Easting	394697.31
Elevation	104.95

Point ID	Cal47
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Easting	401968.01
Elevation	135.00

Point ID	Cal48
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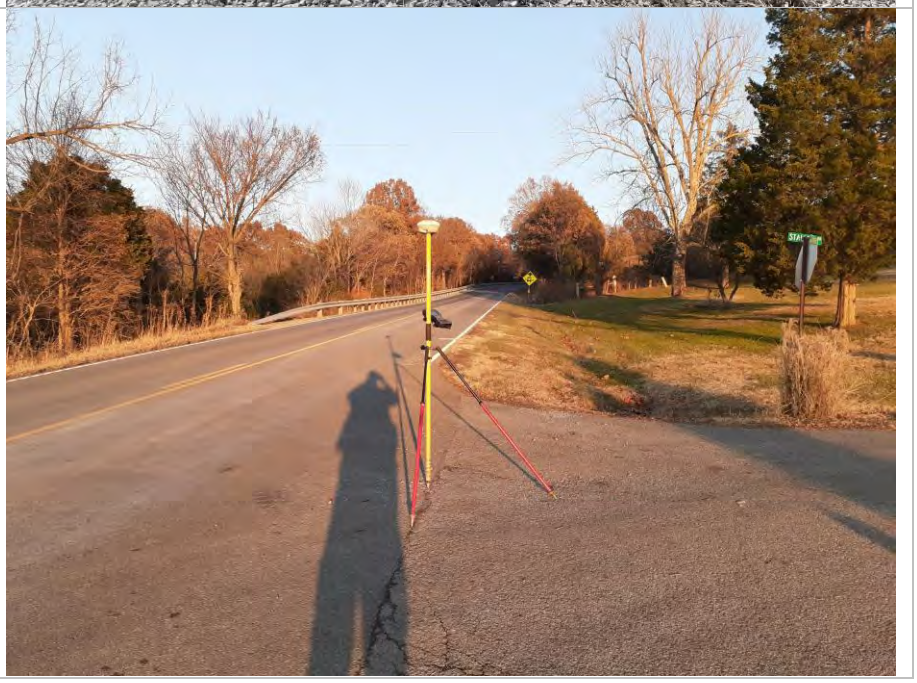
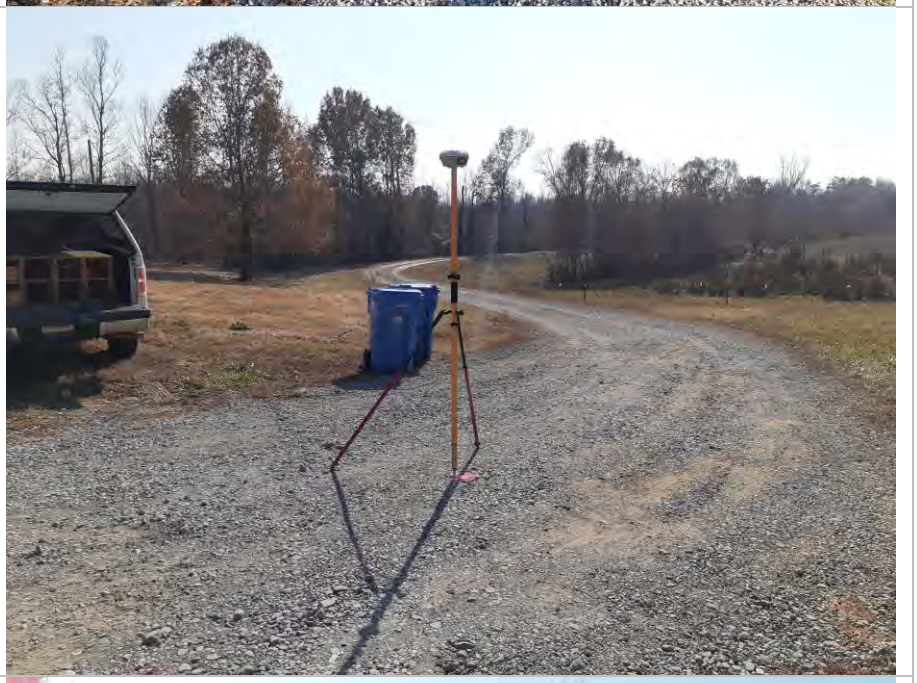
Elevation	197.16

Point ID	Cal49
Northing	4109209.07
Easting	425500.43
Elevation	134.14



Point ID	Cal50
Northing	4108240.20
Easting	435972.86
Elevation	167.75

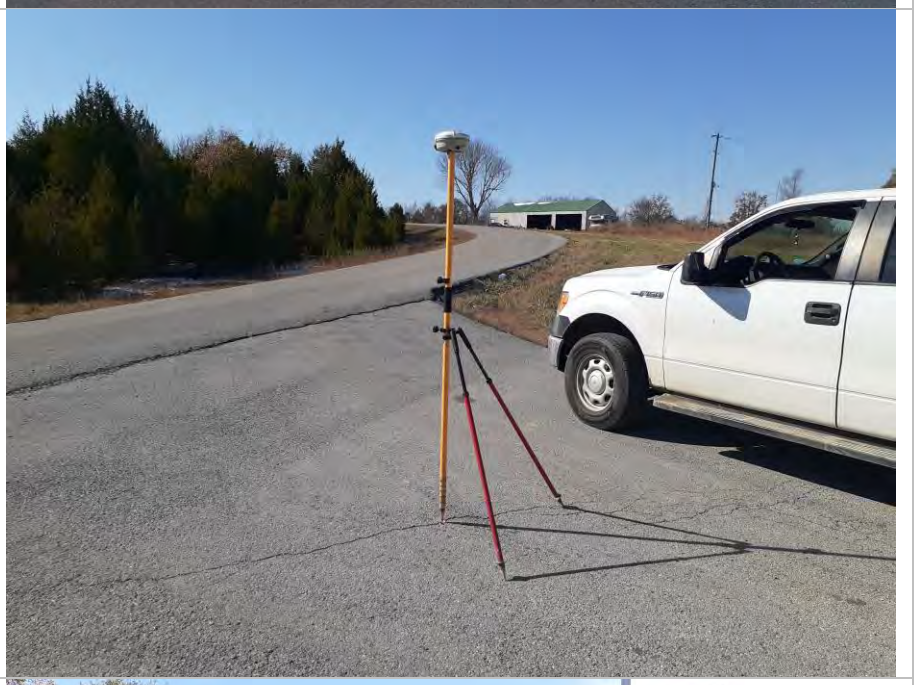
Point ID	Cal51
Northing	4106388.16
Easting	447470.58
Elevation	138.03



Point ID	Cal52
Northing	4104653.92
Easting	459113.71
Elevation	192.03

Point ID	Cal53
Northing	4104272.02
Easting	470303.05
Elevation	145.94

Point ID	Cal54
Northing	4098700.11
Easting	475841.16
Elevation	167.64



Point ID	Cal55
Northing	4092403.29
Easting	469381.15
Elevation	184.25

Point ID	Cal56
Northing	4092566.92
Easting	457379.56
Elevation	206.82

Point ID	Cal57
Northing	4098354.31
Easting	448268.25
Elevation	201.46

Point ID	Cal58
Northing	4095936.05
Easting	434090.59
Elevation	165.41

Point ID	Cal59
Northing	4098651.27
Easting	421966.65
Elevation	143.63

Point ID	Cal60
Northing	4097663.95
Easting	412093.35
Elevation	162.29

Point ID	Cal61
Northing	4102311.52
Easting	401548.59
Elevation	113.90

Point ID	Cal62
Northing	4098848.79
Easting	390427.84
Elevation	111.21

Point ID	Cal63
Northing	4092347.91
Easting	393266.25
Elevation	131.65

Point ID	Cal64
Northing	4078588.19
Easting	402548.28
Elevation	151.77

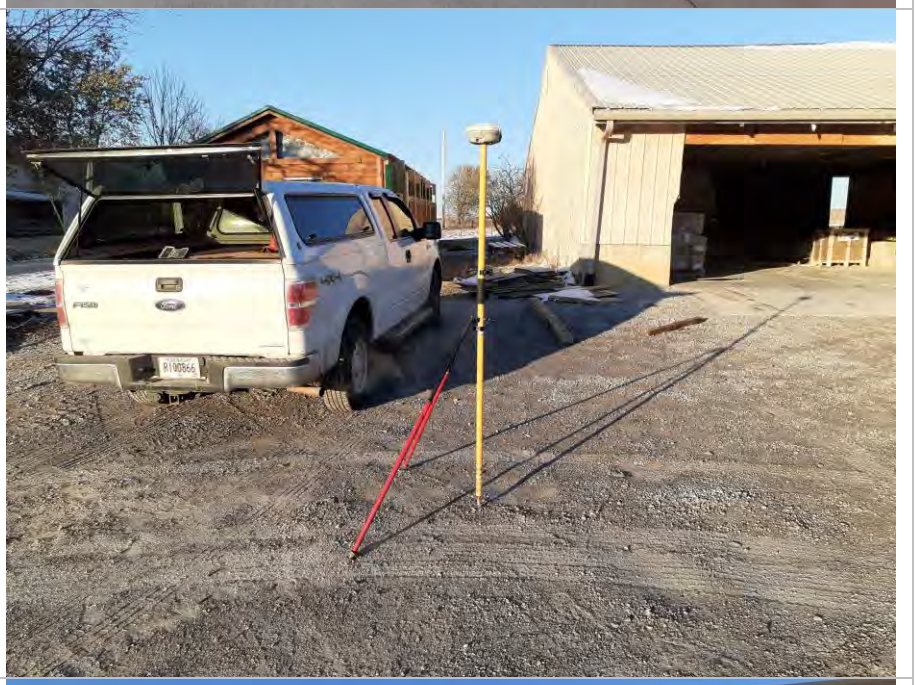
Point ID	Cal65
Northing	4087043.73
Easting	412167.69
Elevation	121.67

Point ID	Cal66
Northing	4087418.02
Easting	423186.27
Elevation	157.65

Point ID	Cal67
Northing	4084707.53
Easting	433725.42
Elevation	163.86
Point ID	Cal68
Northing	4082248.41
Easting	444615.13
Elevation	154.19

Point ID	Cal69
Northing	4082545.21
Easting	457076.28
Elevation	168.80

Point ID	Cal70
Northing	4081952.16
Easting	468238.76
Elevation	184.04



Point ID	Cal71
Northing	4070344.78
Easting	468507.51
Elevation	181.36

Point ID	Cal72
Northing	4069195.81
Easting	455850.83
Elevation	170.94

Point ID	Cal73
Northing	4066674.84
Easting	442825.20
Elevation	136.10

Point ID	Cal74
Northing	4071374.26
Easting	432392.60
Elevation	167.60

Point ID	Cal75
Northing	4070270.06
Easting	420073.65
Elevation	132.45

Point ID	Cal76
Northing	4063942.47
Easting	406494.02
Elevation	172.71

Point ID	Cal77
Northing	4058442.43
Easting	420135.45
Elevation	168.38

Point ID	Cal78
Northing	4054970.38
Easting	443857.81
Elevation	168.09

Point ID	Cal79
Northing	4054597.47
Easting	470110.74
Elevation	159.66

Point ID	Fo01
Northing	4190764.69
Easting	449133.81
Elevation	117.88

Point ID	Fo02
Northing	4185992.91
Easting	421353.91
Elevation	107.45

Point ID	Fo03
Northing	4175962.53
Easting	407156.39
Elevation	106.92

Point ID	Fo04
Northing	4164911.90
Easting	426999.78
Elevation	136.89

Point ID	Fo05
Northing	4165125.98
Easting	401603.82
Elevation	104.22

Point ID	Fo06
Northing	4154772.84
Easting	405675.23
Elevation	106.22

Point ID	Fo07
Northing	4151423.93
Easting	441586.62
Elevation	166.71

Point ID	Fo08
Northing	4141889.62
Easting	428368.86
Elevation	123.99

Point ID	Fo09
Northing	4141123.05
Easting	393404.53
Elevation	118.09

Point ID	Fo10
Northing	4133970.06
Easting	415199.86
Elevation	180.13

Point ID	Fo11
Northing	4127951.05
Easting	441472.56
Elevation	128.66

Point ID	Fo12
Northing	4118239.65
Easting	449077.38
Elevation	140.51

Point ID	Fo13
Northing	4117836.58
Easting	437024.10
Elevation	127.89

Point ID	Fo14
Northing	4119751.17
Easting	425032.90
Elevation	180.99
Point ID	Fo15
Northing	4113281.39
Easting	394706.42
Elevation	106.66

Point ID	Fo16
Northing	4109455.74
Easting	401975.40
Elevation	132.81

Point ID	Fo17
Northing	4109401.73
Easting	413005.49
Elevation	162.87

Point ID	Fo18
Northing	4109249.04
Easting	425566.50
Elevation	133.53

Point ID	Fo19
Northing	4107759.36
Easting	436604.34
Elevation	142.28

Point ID	Fo20
Northing	4105996.85
Easting	447707.16
Elevation	144.17

Point ID	Fo21
Northing	4104543.82
Easting	459187.60
Elevation	179.11

Point ID	Fo22
Northing	4104668.00
Easting	470477.19
Elevation	142.73

Point ID	Fo23
Northing	4098679.20
Easting	475797.09
Elevation	168.04

Point ID	Fo24
Northing	4092444.63
Easting	469284.68
Elevation	174.11

Point ID	Fo25
Northing	4093695.64
Easting	457376.70
Elevation	228.34

Point ID	Fo26
Northing	4094665.71
Easting	448173.95
Elevation	214.51

Point ID	Fo27
Northing	4097671.48
Easting	412121.39
Elevation	162.10

Point ID	Fo28
Northing	4098593.72
Easting	390290.97
Elevation	102.58

Point ID	Fo29
Northing	4092263.44
Easting	393270.00
Elevation	124.76

Point ID	Fo30
Northing	4087671.46
Easting	401081.78
Elevation	175.81

Point ID	Fo31
Northing	4078556.15
Easting	402521.98
Elevation	147.15

Point ID	Fo32
Northing	4070644.82
Easting	405336.24
Elevation	189.01

Point ID	Fo33
Northing	4058408.80
Easting	420161.03
Elevation	172.09

Point ID	Fo34
Northing	4056985.14
Easting	428382.93
Elevation	194.98

Point ID	Fo35
Northing	4055010.85
Easting	443902.14
Elevation	166.95

Point ID	Tw1
Northing	4058369.55
Easting	450100.78
Elevation	173.15

Point ID	Tw2
Northing	4064027.10
Easting	406526.50
Elevation	177.93

Point ID	Tw3
Northing	4070251.60
Easting	420066.74
Elevation	131.91

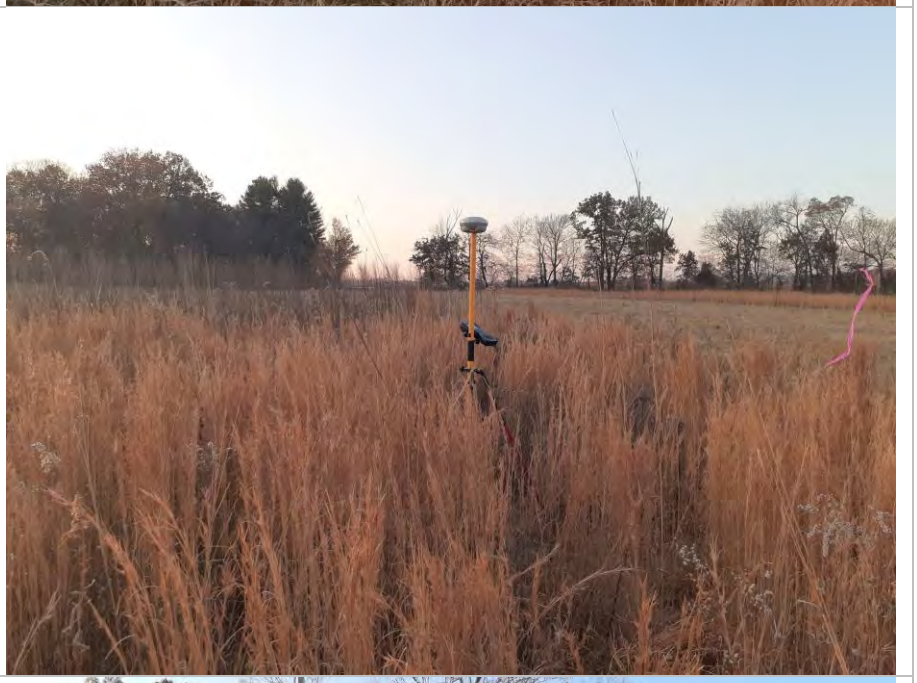
Point ID	Tw4
Northing	4069933.46
Easting	432970.72
Elevation	135.87

Point ID	Tw5
Northing	4065854.34
Easting	445895.58
Elevation	164.88

Point ID	Tw6
Northing	4069155.67
Easting	458052.14
Elevation	172.92

Point ID	Tw7
Northing	4082279.89
Easting	444583.02
Elevation	153.52

Point ID	Tw8
Northing	4083196.62
Easting	439104.94
Elevation	152.62



Point ID	Tw9
Northing	4086968.38
Easting	412101.43
Elevation	123.38

Point ID	Tw10
Northing	4102356.54
Easting	401554.78
Elevation	112.76

Point ID	Tw11
Northing	4098338.66
Easting	422045.93
Elevation	143.52

Point ID	Tw12
Northing	4095901.52
Easting	434111.43
Elevation	166.73

Point ID	Tw13
Northing	4107191.48
Easting	422745.23
Elevation	155.79

Point ID	Tw14
Northing	4124727.52
Easting	390951.77
Elevation	131.00

Point ID	Tw15
Northing	4122005.44
Easting	403595.91
Elevation	168.42

Point ID	Tw16
Northing	4190242.84
Easting	473231.22
Elevation	116.91

Point ID	Tw17
Northing	4192770.25
Easting	428018.96
Elevation	108.98

Point ID	Tw18
Northing	4175210.68
Easting	420073.45
Elevation	114.62

Point ID	Tw19
Northing	4174770.17
Easting	431670.31
Elevation	113.70

Point ID	Tw20
Northing	4177139.06
Easting	437737.05
Elevation	136.80

Point ID	Tw21
Northing	4162364.60
Easting	442053.82
Elevation	134.06

Point ID	Tw22
Northing	4162980.48
Easting	431958.15
Elevation	131.34

Point ID	Tw23
Northing	4164486.18
Easting	420767.59
Elevation	133.07

Point ID	Tw24
Northing	4153249.64
Easting	419411.98
Elevation	110.39

Point ID	Tw25
Northing	4152299.88
Easting	429339.25
Elevation	131.53

Point ID	Tw26
Northing	4139017.48
Easting	450208.19
Elevation	130.59

Point ID	Tw27
Northing	4140376.98
Easting	440986.09
Elevation	122.25

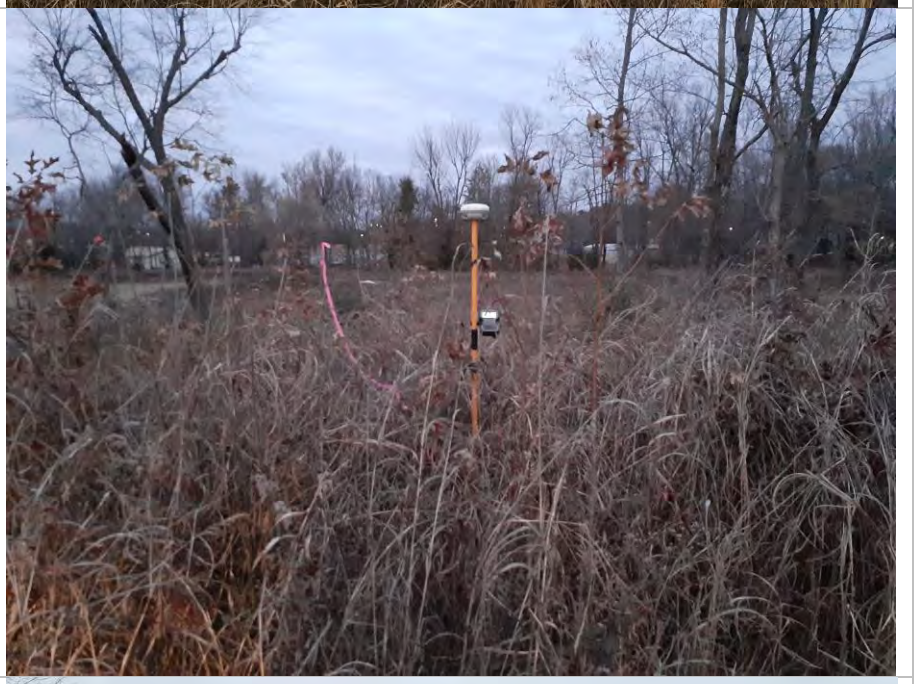
Point ID	Tw28
Northing	4144477.36
Easting	417546.45
Elevation	108.95

Point ID	Tw29
Northing	4142570.54
Easting	406091.87
Elevation	180.64

Point ID	Tw30
Northing	4140076.09
Easting	381571.78
Elevation	106.45

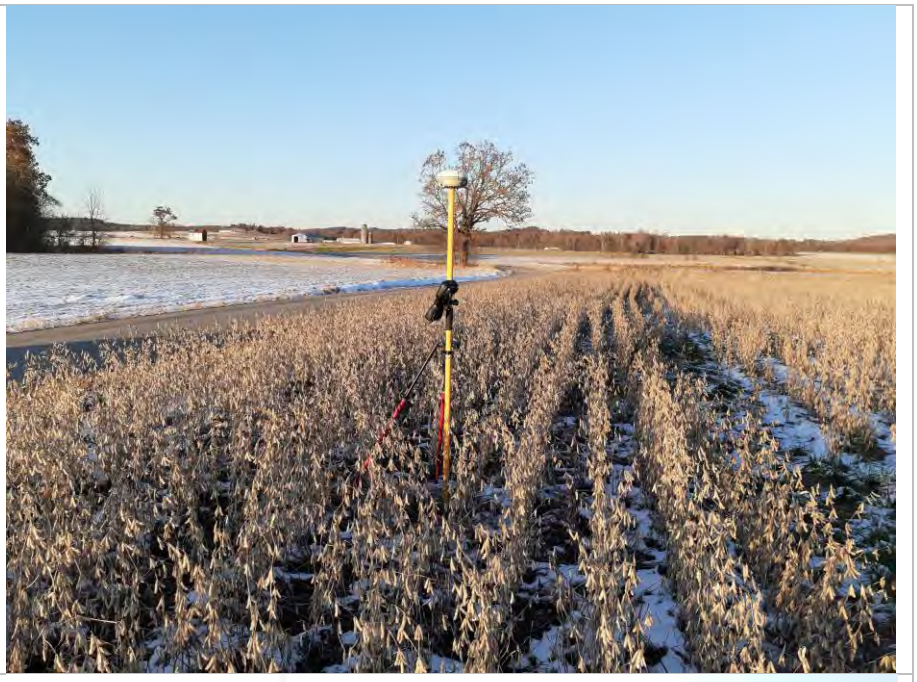
Point ID	Tw31
Northing	4134600.85
Easting	393732.84
Elevation	158.90
Point ID	Tw32
Northing	4129468.17
Easting	428291.40
Elevation	128.08

Point ID	Tw33
Northing	4128304.92
Easting	454921.05
Elevation	126.87



Point ID	Tw34
Northing	4120131.18
Easting	414887.98
Elevation	144.73

Point ID	Tw35
Northing	4082249.48
Easting	468412.06
Elevation	192.77



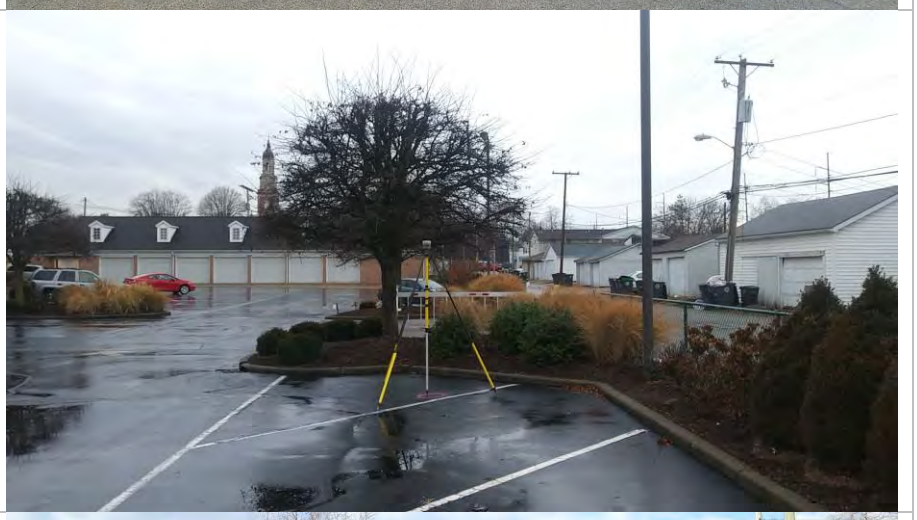
Point ID	Tw36
Northing	4082814.91
Easting	457219.21
Elevation	173.59

Point ID	Tw37
Northing	4087124.25
Easting	423769.01
Elevation	154.92

Point ID	Tw38
Northing	4087772.95
Easting	401099.72
Elevation	163.51

Point ID	Ua01
Northing	4198440.09
Easting	421388.52
Elevation	117.48

Point ID	Ua02
Northing	4203921.37
Easting	446998.24
Elevation	117.28



Point ID	Ua03
Northing	4200220.62
Easting	463624.35
Elevation	119.62

Point ID	Ua04
Northing	4191049.14
Easting	449141.61
Elevation	117.14

Point ID	Ua05
Northing	4185634.23
Easting	445996.81
Elevation	117.35

Point ID	Ua06
Northing	4152486.61
Easting	439129.65
Elevation	158.51

Point ID	Ua07
Northing	4155900.92
Easting	412861.14
Elevation	113.26

Point ID	Ua08
Northing	4128257.55
Easting	454905.06
Elevation	128.54

Point ID	Ua09
Northing	4132300.93
Easting	404789.70
Elevation	177.09

Point ID	Ua10
Northing	4124726.80
Easting	391098.77
Elevation	135.70

Point ID	Ua11
Northing	4108009.96
Easting	422523.07
Elevation	162.78

Point ID	Ua12
Northing	4113300.06
Easting	394707.98
Elevation	105.53

Point ID	Ua13
Northing	4098833.68
Easting	390404.55
Elevation	111.12

Point ID	Ua14
Northing	4102299.35
Easting	401588.94
Elevation	113.68

Point ID	Ua15
Northing	4082544.28
Easting	457053.28
Elevation	168.83

Point ID	Ua16
Northing	4070363.57
Easting	468468.06
Elevation	181.34

Point ID	Ua17
Northing	4071365.82
Easting	432385.95
Elevation	167.75

Point ID	Ua18
Northing	4054584.96
Easting	470067.53
Elevation	161.29

Point ID	Ua19
Northing	4055080.48
Easting	461092.53
Elevation	167.72

Point ID	Ua20
Northing	4105242.33
Easting	403555.81
Elevation	140.59

Point ID	Ua21
Northing	4171845.13
Easting	420972.39
Elevation	118.93

Point ID	Ua22
Northing	4177125.12
Easting	437722.57
Elevation	137.16

Point ID	Ua23
Northing	4166229.59
Easting	443187.98
Elevation	147.95

Point ID	Ua24
Northing	4164947.78
Easting	426956.13
Elevation	137.26

Point ID	Ua25
Northing	4163880.49
Easting	406899.37
Elevation	112.03

NV5

Survey Report
35832
KYSW Flourspar - MOD

GPS Field Collection

Mode: RTK

Corrections Source: Kentucky CORS (KYCORS) RTN via VRS network

Occupation Method: Each location recorded consisted of a minimum of two occupations, with a minimum of 3 minutes (180 epochs) per occupation, then a second occupation for at least 3 minutes (180 epochs). If the difference between the two occupations exceeded 0.01 feet horizontal or vertical, a third occupation was performed for a minimum of 3 minutes (180 epochs). Initialization (FIX) was broken and re-initialized between all occupations. The same point ID was used for all occupations at each location.

No static observations were necessary.

Equipment:
GPS Receiver: Trimble R10
Data Collector: Trimble TSC3
Field Software: Trimble Access
Office Software: Trimble Business Center

Conventional Field Collection

Occupation Method: Two temporary points were established according the GPS Field Collection Occupation Method. A robotic total station was used to occupy one of these temporary points, while back sighting the other. A single angle observation was then taken to record the target location.

Equipment:
Total Station: Trimble S8
Prism: Trimble MT1000
Data Collector: Trimble TSC3
Field Software: Trimble Access
Office Software: Trimble Business Center

Processing Method

Field data (Trimble Access .job files) was imported into Trimble Business Center (TBC). TBC settings were configured to flag any point with accuracies greater than 2cm (0.0656 ft) @ 95% confidence. Because all occupations on common locations were recorded using the same point ID, TBC automatically derived an averaged point location for each location. Vectors exceeding the

accuracies of 2cm (0.0656 ft) @ 95% confidence were then analyzed to determine their effect on the derived point's accuracy, and whether those vectors would remain enabled as part of the derived point's solution. Individual vectors that possessed a residual being out of tolerance of the mean vector for its location were also disabled.

I, John C. Hendrix, PLS# 5342 do certify that the dataset described above, being surveyed on March 5, 2020, was completed utilizing the above mentioned methods and does meet or exceed the accuracies stated.

John C. Hendrix, PLS

Point ID	Cal80
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Livingston
Quad	Golconda

	Aerial Target
X	LiDAR Ground Control
	LiDAR QC Point
	New Control
	Photo ID
	Published Control

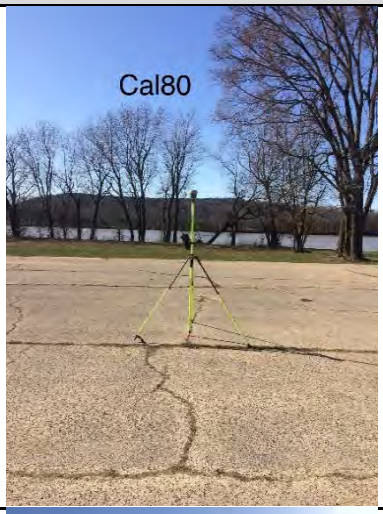
Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

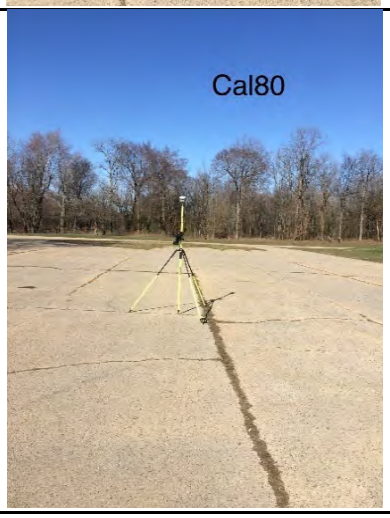
Northing	Easting	Elevation
4137242.108	370119.279	104.39

Operator	Scott Leonard
Receiver Model	Trimble R10
Receiver S/N	5841470384
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.006
RMSE Z	0.011
GPS Method	VRS

PHOTOS:





Point ID	Cal81
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Livingston
Quad	Lola

	Aerial Target
X	LiDAR Ground Control
	LiDAR QC Point
	New Control
	Photo ID
	Published Control

Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

Northing	Easting	Elevation
4133665.187	381746.143	134.162

Operator	Scott Leonard
Receiver Model	Trimble R10
Receiver S/N	5841470384
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.005
RMSE Z	0.011
GPS Method	VRS

PHOTOS:

Point ID	Cal82
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Livingston
Quad	Burna

	Aerial Target
X	LiDAR Ground Control
	LiDAR QC Point
	New Control
	Photo ID
	Published Control

Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

Northing	Easting	Elevation
4122854.305	379153.685	168.287

Operator	Scott Leonard
Receiver Model	Trimble R10
Receiver S/N	5841470384
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.007
RMSE Z	0.013
GPS Method	VRS

PHOTOS:

Point ID	Cal83
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Livingston
Quad	Smithland

	Aerial Target
X	LiDAR Ground Control
	LiDAR QC Point
	New Control
	Photo ID
	Published Control

Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

Northing	Easting	Elevation
4123125.568	369089.728	105.25

Operator	Ollie Jermane
Receiver Model	Trimble R10
Receiver S/N	5841470385
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.005
RMSE Z	0.010
GPS Method	VRS

PHOTOS:

Point ID	Cal84
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Livingston
Quad	SmithlandB

	Aerial Target
X	LiDAR Ground Control
	LiDAR QC Point
	New Control
	Photo ID
	Published Control

Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

Northing	Easting	Elevation
4111339.427	375226.455	104.082

Operator	Ollie Jermane
Receiver Model	Trimble R10
Receiver S/N	5841470385
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.005
RMSE Z	0.008
GPS Method	VRS

PHOTOS:

Point ID	Cal85
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Livingston
Quad	Burna

	Aerial Target
X	LiDAR Ground Control
	LiDAR QC Point
	New Control
	Photo ID
	Published Control

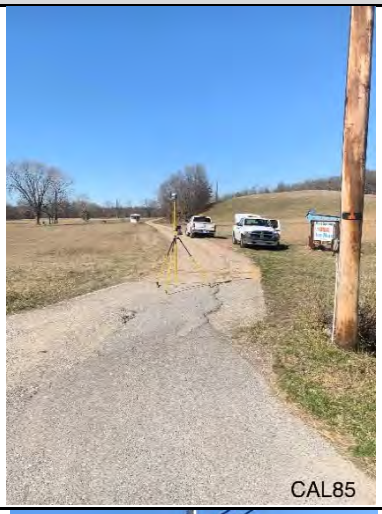
Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

Northing	Easting	Elevation
4112677.936	384784.485	106.292

Operator	Ollie Jermane
Receiver Model	Trimble R10
Receiver S/N	5841470385
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.005
RMSE Z	0.010
GPS Method	VRS

PHOTOS:



Point ID	Cal86
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Marshall
Quad	Calvert City

	Aerial Target
X	LiDAR Ground Control
	LiDAR QC Point
	New Control
	Photo ID
	Published Control

Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

Northing	Easting	Elevation
4097330.006	386019.593	106.783

Operator	Greg Comer
Receiver Model	Trimble R10
Receiver S/N	5841470387
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.006
RMSE Z	0.011
GPS Method	VRS

PHOTOS:

Point ID	Cal87
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Marshall
Quad	Calvert City

	Aerial Target
X	LiDAR Ground Control
	LiDAR QC Point
	New Control
	Photo ID
	Published Control

Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

Northing	Easting	Elevation
4101766.877	379694.603	106.436

Operator	Greg Comer
Receiver Model	Trimble R10
Receiver S/N	5841470387
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.005
RMSE Z	0.007
GPS Method	VRS

PHOTOS:

Point ID	Cal88
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	McCraken
Quad	Paducah East

		Coordinate System
	Aerial Target	NAD83(2011)
X	LiDAR Ground Control	UTM Zone 16N
	LiDAR QC Point	NAVD88
	New Control	GEOID12B
	Photo ID	Meters
	Published Control	

Northing	Easting	Elevation
4099653.988	363547.057	121.485

Operator	Greg Comer
Receiver Model	Trimble R10
Receiver S/N	5841470387
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.002
RMSE Z	0.004
GPS Method	VRS

PHOTOS:

Point ID	Be73
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Livingston
Quad	Burna

	Aerial Target
	LiDAR Ground Control
X	LiDAR QC Point
	New Control
	Photo ID
	Published Control

Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

Northing	Easting	Elevation
4122872.958	379143.41	168.284

Operator	Scott Leonard
Receiver Model	Trimble R10
Receiver S/N	5841470384
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.006
RMSE Z	0.011
GPS Method	VRS

PHOTOS:

Point ID	Be74
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Livingston
Quad	Burna

	Aerial Target	Coordinate System
	LiDAR Ground Control	NAD83(2011)
X	LiDAR QC Point	UTM Zone 16N
	New Control	NAVD88
	Photo ID	GEOID12B
	Published Control	Meters

Northing	Easting	Elevation
4112686.012	384772.349	105.755

Operator	Ollie Jermane
Receiver Model	Trimble R10
Receiver S/N	5841470385
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.005
RMSE Z	0.010
GPS Method	VRS

PHOTOS:

Point ID	Be75
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	McCracken
Quad	Paducah East

	Aerial Target
	LiDAR Ground Control
X	LiDAR QC Point
	New Control
	Photo ID
	Published Control

Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

Northing	Easting	Elevation
4099699.438	363571.252	120.685

Operator	Greg Comer
Receiver Model	Trimble R10
Receiver S/N	5841470387
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.002
RMSE Z	0.004
GPS Method	VRS

PHOTOS:

Point ID	Be76
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Marshall
Quad	Calvert City

	Aerial Target
	LiDAR Ground Control
X	LiDAR QC Point
	New Control
	Photo ID
	Published Control

Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

Northing	Easting	Elevation
4097327.226	386043.394	107.031

Operator	Greg Comer
Receiver Model	Trimble R10
Receiver S/N	5841470387
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.006
RMSE Z	0.011
GPS Method	VRS

PHOTOS:

Point ID	Ua26
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Livingston
Quad	Smithland

	Aerial Target
X	LiDAR Ground Control
	LiDAR QC Point
	New Control
	Photo ID
	Published Control

Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

Northing	Easting	Elevation
4111334.994	375226.878	104.17

Operator	Ollie Jermane
Receiver Model	Trimble R10
Receiver S/N	5841470385
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.005
RMSE Z	0.008
GPS Method	VRS

PHOTOS:

Point ID	Tw39
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Livingston
Quad	Golconda

	Aerial Target
	LiDAR Ground Control
X	LiDAR QC Point
	New Control
	Photo ID
	Published Control

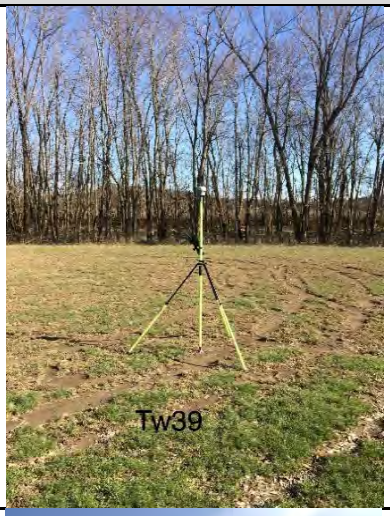
Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

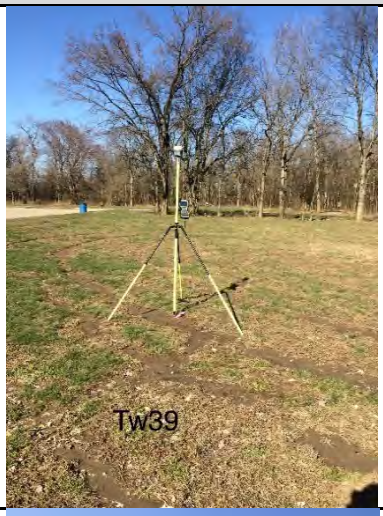
Northing	Easting	Elevation
4137217.528	370131.758	104.211

Operator	Scott Leonard
Receiver Model	Trimble R10
Receiver S/N	5841470384
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.007
RMSE Z	0.011
GPS Method	VRS

PHOTOS:





Point ID	Fo36
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Marshall
Quad	Calvert City

	Aerial Target
	LiDAR Ground Control
X	LiDAR QC Point
	New Control
	Photo ID
	Published Control

Coordinate System
NAD83(2011)
UTM Zone 16N
NAVD88
GEOID12B
Meters

Northing	Easting	Elevation
4097355.292	386048.037	106.758

Operator	Greg Comer
Receiver Model	Trimble R10
Receiver S/N	5841470387
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.019
RMSE Z	0.025
GPS Method	VRS/Conventional

PHOTOS:

Point ID	Fo37
Project No.	35832
Project Name	KYSW Fluorspar - MOD
State	Kentucky
County	Livingston
Quad	Lola

	Aerial Target	Coordinate System
	LiDAR Ground Control	NAD83(2011)
X	LiDAR QC Point	UTM Zone 16N
	New Control	NAVD88
	Photo ID	GEOID12B
	Published Control	Meters

Northing	Easting	Elevation
4133638.165	381745.599	132.834

Operator	Scott Leonard
Receiver Model	Trimble R10
Receiver S/N	5841470384
Antenna Height	2.000 Meters

Date (MM-DD-YYYY)	3/5/2020
RMSE Hz	0.019
RMSE Z	0.026
GPS Method	VRS/Conventional

PHOTOS: