LiDAR PROJECT REPORT

Utah 2020 LiDAR – QL2 UTM11 & UTM12

Project Name:	**UT_StatewideNCentral_2020_A20**
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Contract #:	**AV2406**
PTS Work Unit #s:	**QL2 UTM 11N: 211412 QL2 UTM 12N: 211415**

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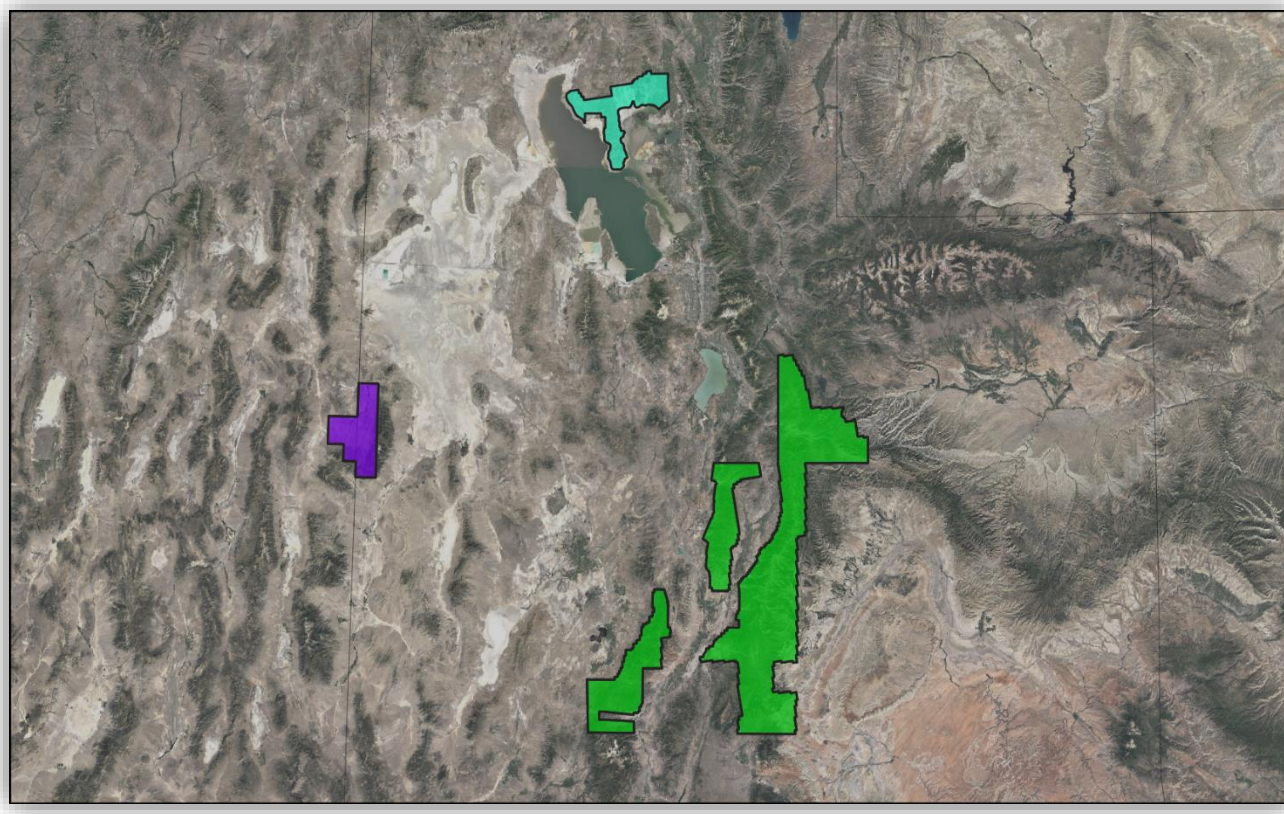

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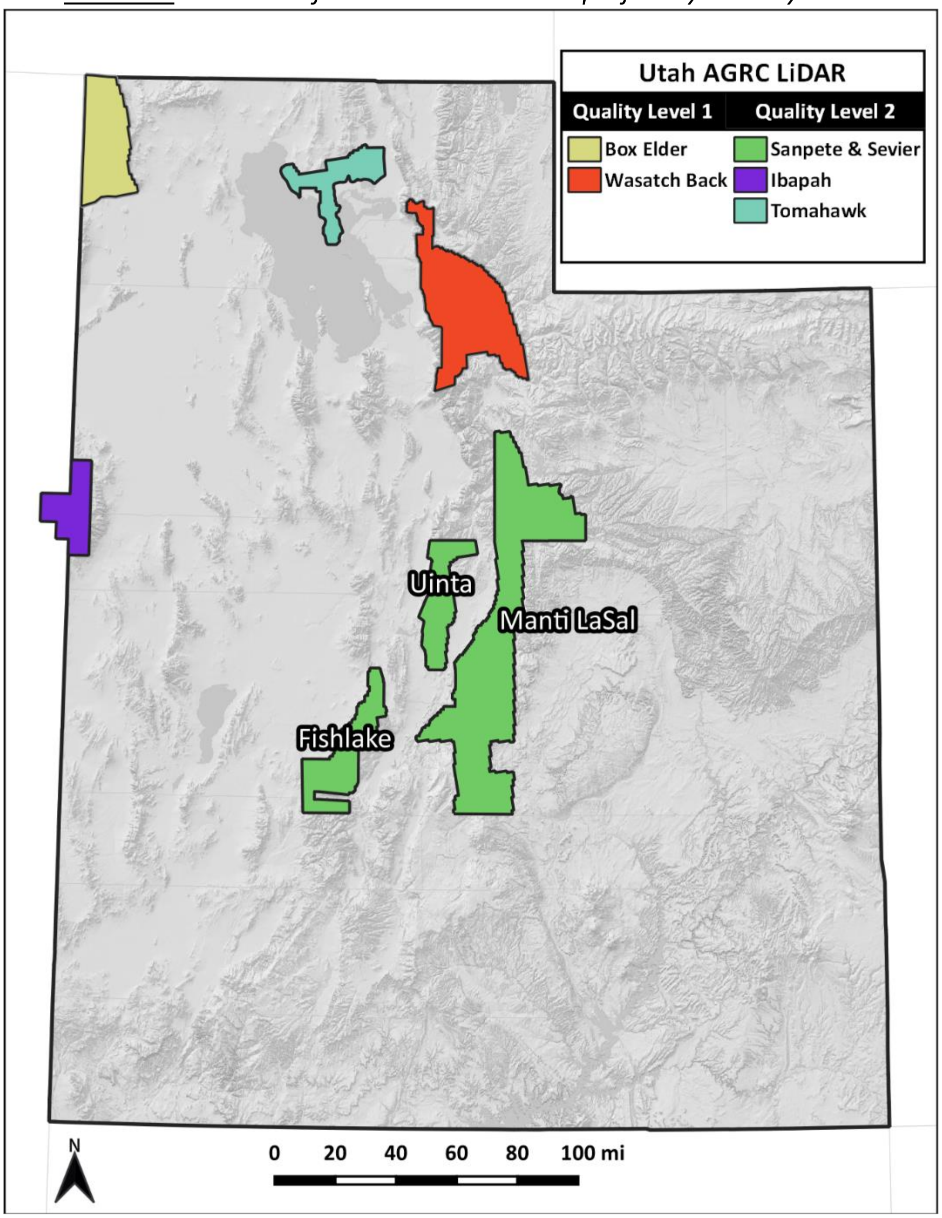
1. INTRODUCTION

1.1 PROJECT OVERVIEW

Aero-Graphics, Inc., a full-service geospatial firm located in Salt Lake City, Utah, was contracted by the State of Utah, Department of Technology Services, Division of Integrated Technology, Automated Geographic Reference Center (AGRC) and partners to acquire, process, and deliver aerial LiDAR data and derivative products that adhere to U.S. Geological Survey (USGS) National Geospatial Program (NGP) Lidar Base Specification Version 2.1 (2019). The assigned project areas cover portions of Utah totaling approximately 5,182 mi^2.

Exhibit 1: Overview of the Utah 2020 LiDAR project by delivery areas.

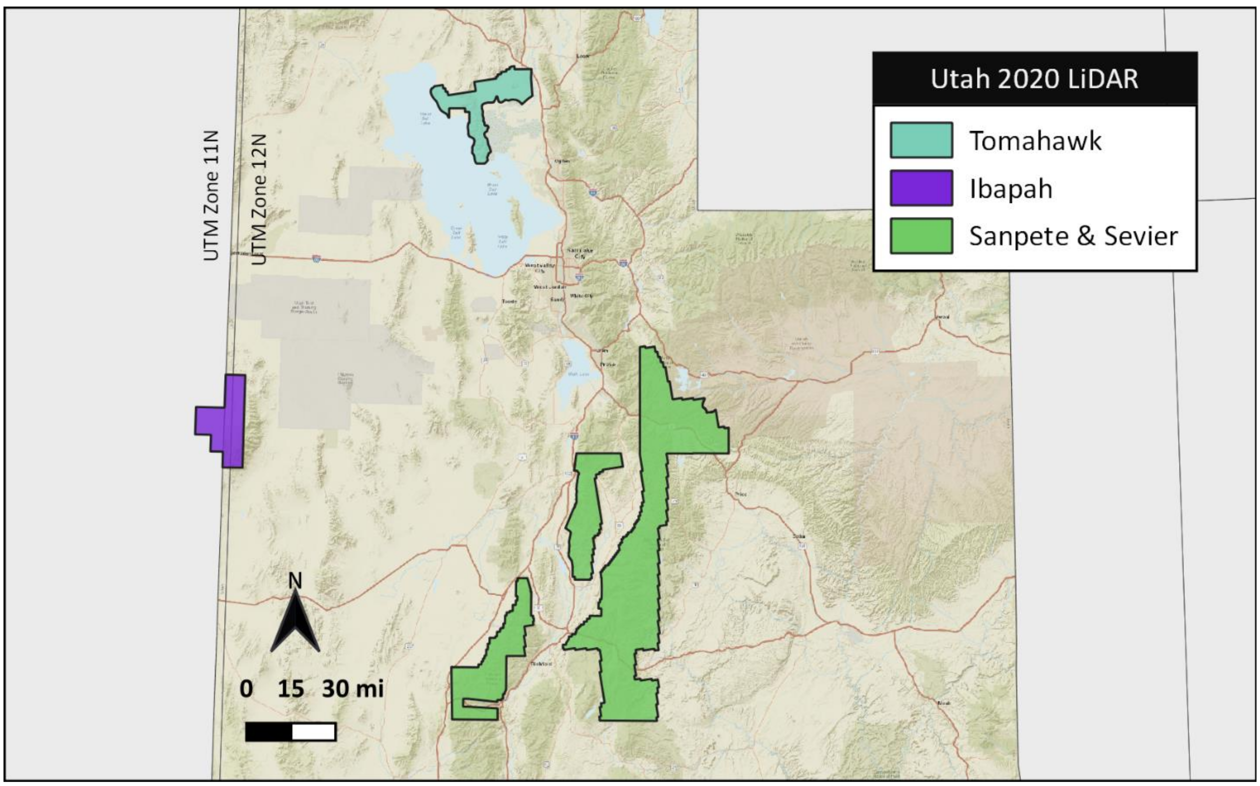


1.2 Project Area Description

As described in the Scope of Work (SOW), the Utah 2020 LiDAR project was separated into two (2) delivery areas: QL1 (Box Elder and Wasatch Back), and QL2 (Tomahawk, Ibapah, and Sanpete and Sevier). This report focuses on the QL2 AOIs, which cover 2931.67 mi^2 of the total project area.

QL2 Project Areas	
AOI Name	**Area (mi^2)**
Tomahawk QL2	351.24
Ibapah QL2	315.05
Sanpete and Sevier QL2	2266.38

Exhibit 2: *Overview of the Tomahawk, Ibapah, and Sanpete and Sevier QL2 project areas.*



2. LiDAR Acquisition

2.1 Flight Planning

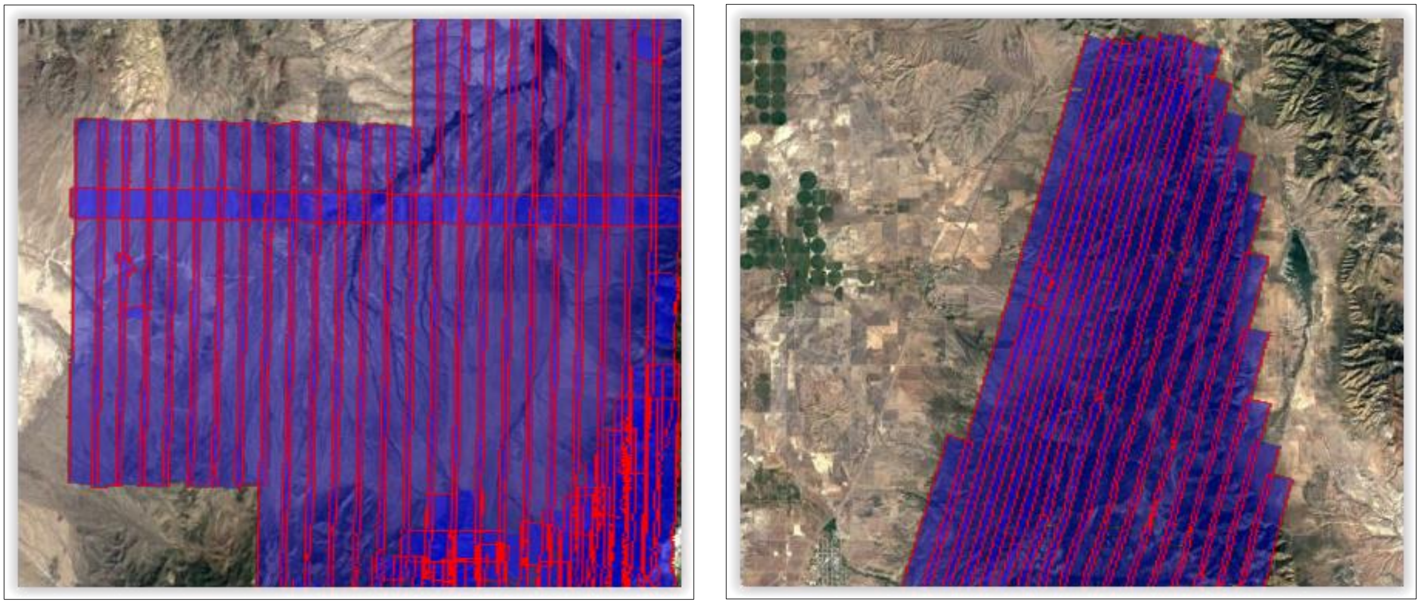
Specialized flight plans were developed by Aero-Graphics' Aerial Department to ensure complete coverage and that all contract specifications were met. Prior to mobilizing to the acquisition sites, Aero-Graphics' staff monitored all site conditions and potential weather hazards including wind, rain, snow, and blowing dust. In addition, Aero-Graphics ensured that all airspace clearances were secured by the proper officials before acquisition occurred.

The table below contains the planned settings for the Tomahawk, Ibapah, and Sanpete and Sevier QL2 AOIs.

Planned Specs	Tomahawk QL2	Ibapah QL2	Sanpete & Sevier QL2
	Optech Galaxy Prime	Optech Galaxy Prime	Optech Galaxy Prime
Altitude (m)	1600	1600	1600
Speed (kts)	120	120	120
PRF (kHz)	300	300	300
Scan Freq (Hz)	55.6	55.6	55.6
Scan Angle (°)	46	46	46
Swath Width (m)	1358	1358	1358
NPS (m)	0.56	0.56	0.56
Average Point Density (ppm^2)	3.24	3.24	3.24
Overlap (%)	20	20-30	20-30

AGI utilizes Optech's Airborne Mission Manager (AMM) software to plan flight lines and sensor settings. AMM is the most advanced and versatile flight planning software available and allows the aerial department to simulate the effects of the different sensors, mounts, and settings, thus ensuring the flight plan meets the needs of the project while being as efficient as possible. To complement the flight planning process, the Galaxy Prime and T2000 are equipped with FMS NAV software, which ensures accurate and consistent acquisition with its real-time quality assurance. The system operator monitored the point density and swath during the mission to confirm there was adequate coverage of each AOI. Exhibit 3 shows the coverage of the acquired swaths in portions of each AOI.

Exhibit 3: *Swath data for the project was recorded and viewed real-time by the sensor operator. Left: the western section of the Ibapah AOI. Right: the northern section of the Fish Lake AOI.*



2.2 LiDAR Sensors

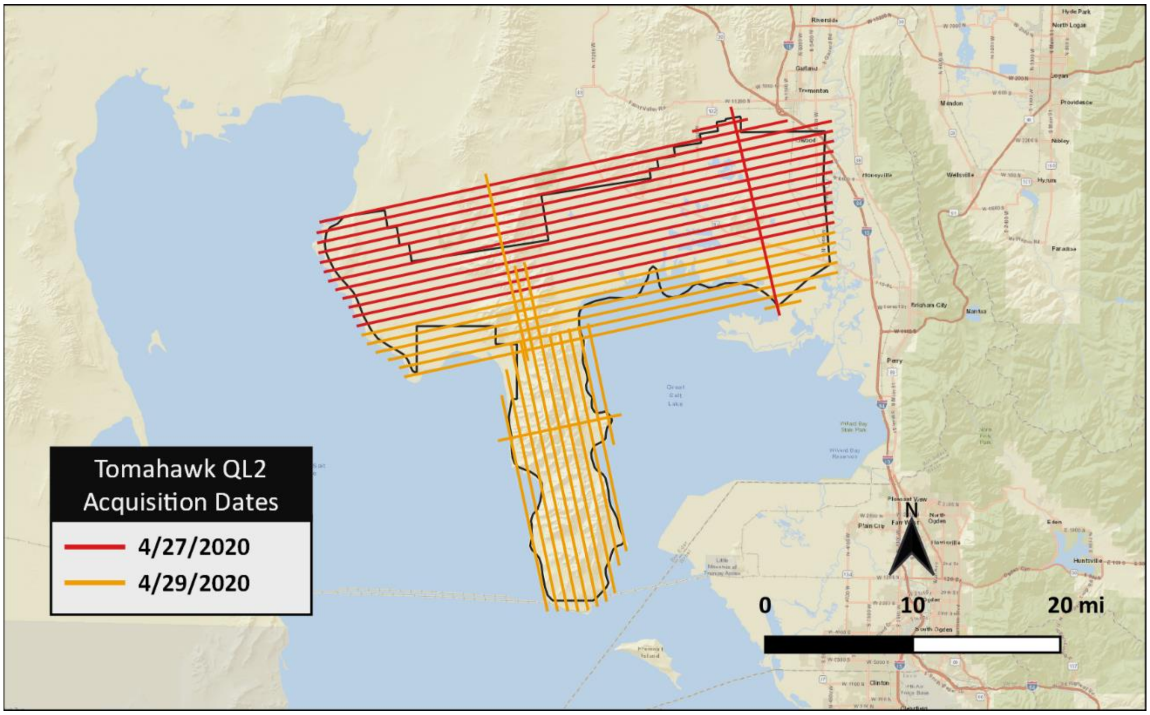
Optech Galaxy PRIME and T2000

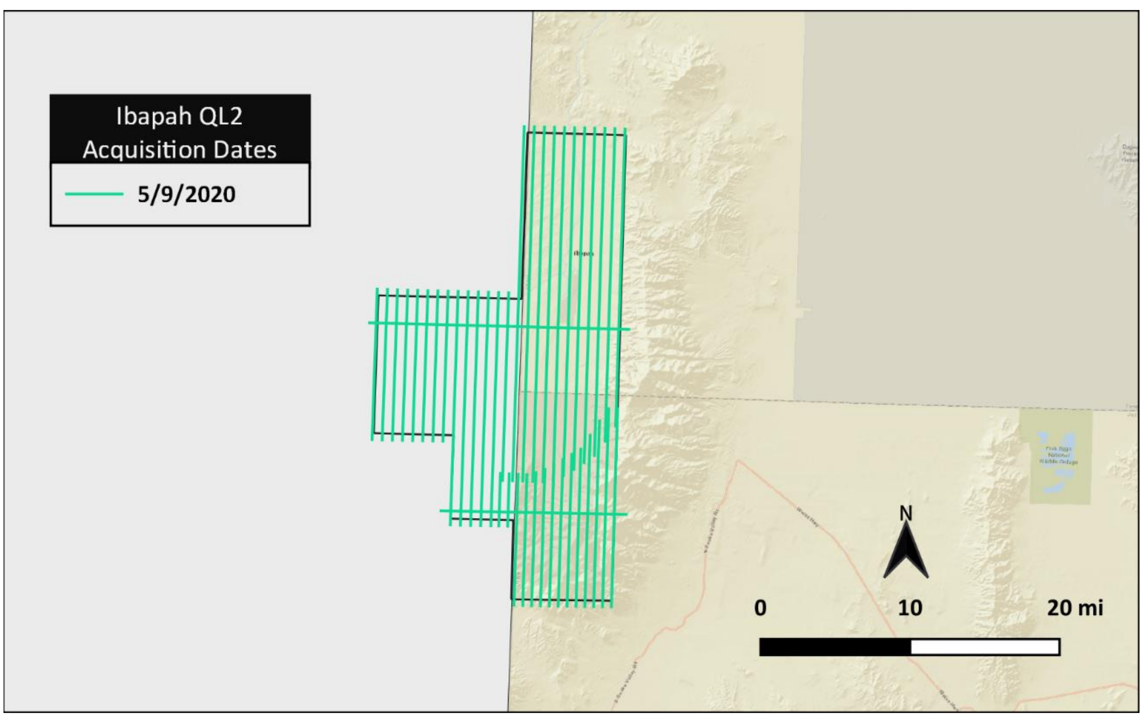
The Optech Galaxy PRIME and T2000 are currently two of the most productive sensors available in the industry. These sensors feature SwathTRAK technology, which dynamically adjusts the scan FOV in real time during data acquisition. The Prime and T2000 also feature a 1MHz and 2MHz effective pulse rate, respectively, providing on-the-ground point density and efficiency formerly reserved for dual-beam sensors. Up to 8 returns per pulse are possible for increased vertical resolution of complex targets without the need for full waveform recording and processing. Industry-leading data precision and accuracy (<5cm $RMSE_z$) results in the highest-quality datasets possible.

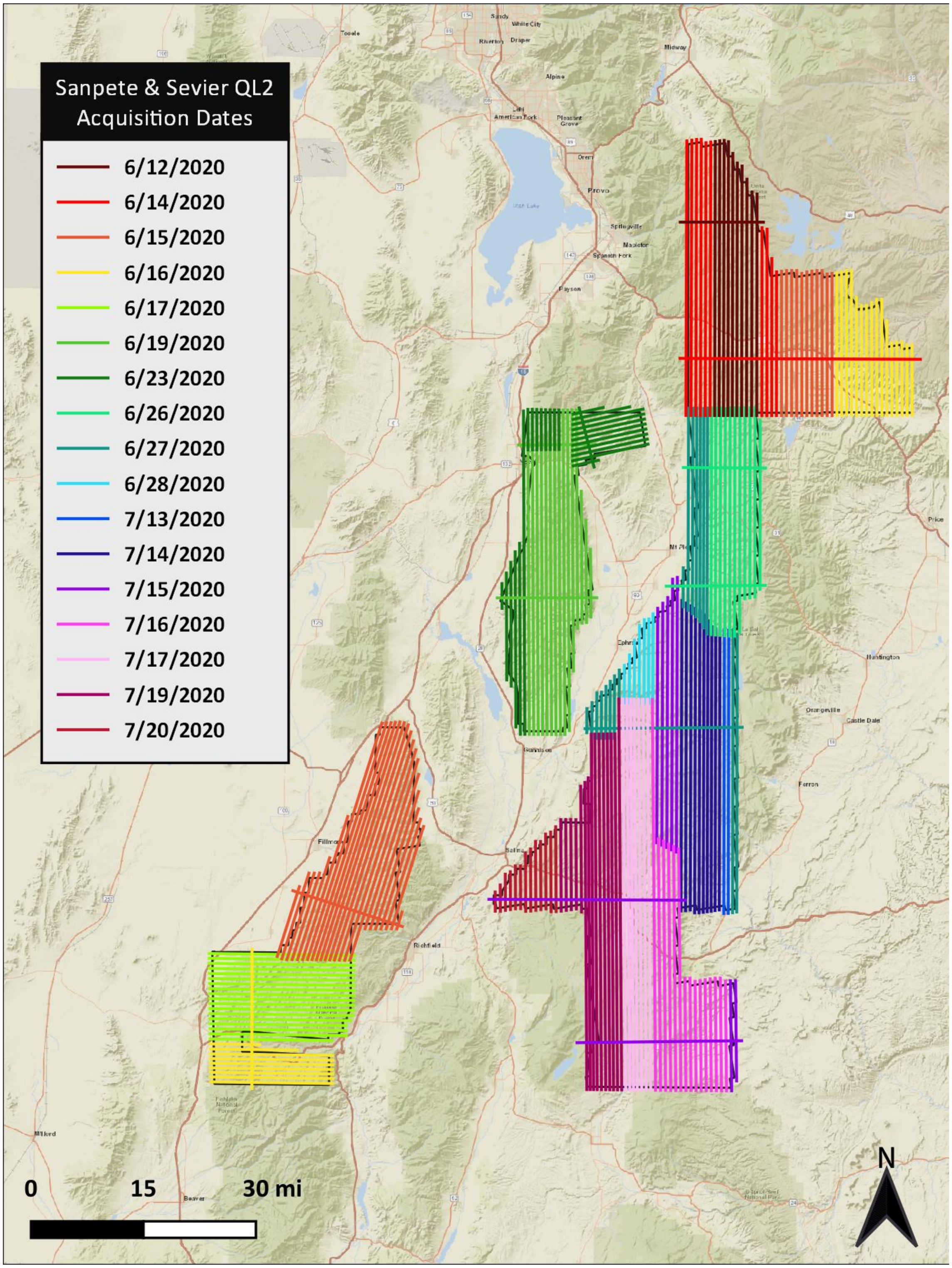
2.3 Acquisition Summary

Acquisition for the QL2 AOIs occurred between April 27 and August 4, 2020. These flights took place when ground conditions were free of snow, ice, and standing water. A total of 28 lifts were required to complete lidar acquisition for the assigned Tomahawk, Ibapah, and Sanpete and Sevier QL2 AOIs.

Exhibit 4: *Flightlines organized by day of acquisition*






Sanpete & Sevier QL2 Acquisition Dates
6/12/2020
6/14/2020
6/15/2020
6/16/2020
6/17/2020
6/19/2020
6/23/2020
6/26/2020
6/27/2020
6/28/2020
7/13/2020
7/14/2020
7/15/2020
7/16/2020
7/17/2020
7/19/2020
7/20/2020
0
15
30 mi
N

2.4 Flight Logs

Flight dates are listed in the tables below along with the AOI, sensor name, sensor number, and aircraft tail number for each lift. Reflights are sometimes necessary in order to fill gaps in the LiDAR coverage due to clouds, extreme terrain, sensor malfunctions, or other issues that can't be resolved during flight.

QL2 Flight Logs				
Flight Date	**AOI Covered**	**Sensor Name**	**Sensor Number**	**Aircraft Tail Number**
4/27/2020	Tomahawk	Optech Galaxy Prime	5060430	N65474
4/29/2020	Tomahawk	Optech Galaxy Prime	5060430	N65474
5/9/2020	Ibapah	Optech Galaxy Prime	5060410	N7269T
6/12/2020	Sanpete & Sevier	Optech Galaxy Prime	5060430	N27DV
6/14/2020	Sanpete & Sevier	Optech Galaxy Prime	5060430	N27DV
6/15/2020*	Sanpete & Sevier	Optech Galaxy Prime	5060410	N7269T
	Sanpete & Sevier	Optech Galaxy Prime	5060430	N27DV
6/16/2020	Sanpete & Sevier	Optech Galaxy Prime	5060410	N7269T
	Sanpete & Sevier	Optech Galaxy Prime	5060430	N27DV
6/17/2020	Sanpete & Sevier	Optech Galaxy Prime	5060410	N7269T
6/19/2020	Sanpete & Sevier	Optech Galaxy Prime	5060410	N7269T
6/23/2020*	Tomahawk	Optech Galaxy Prime	5060410	N7269T
	Sanpete & Sevier	Optech Galaxy Prime	5060410	N7269T
6/26/2020	Sanpete & Sevier	Optech Galaxy Prime	5060430	N27DV
6/27/2020	Sanpete & Sevier	Optech Galaxy Prime	5060430	N27DV
6/28/2020	Sanpete & Sevier	Optech Galaxy Prime	5060430	N27DV
7/3/2020*	Ibapah	Optech Galaxy Prime	5060430	N27DV
7/11/2020*	Sanpete & Sevier	Optech Galaxy Prime	5060410	N27DV
7/12/2020*	Sanpete & Sevier	Optech Galaxy Prime	5060410	N27DV
	Sanpete & Sevier	Optech Galaxy Prime	5060410	N27DV
7/13/2020*	Sanpete & Sevier	Optech Galaxy Prime	5060410	N27DV
7/14/2020	Sanpete & Sevier	Optech Galaxy Prime	5060410	N27DV
7/15/2020*	Sanpete & Sevier	Optech Galaxy Prime	5060410	N27DV
7/16/2020	Sanpete & Sevier	Optech Galaxy Prime	5060410	N27DV
7/17/2020	Sanpete & Sevier	Optech Galaxy Prime	5060410	N27DV
7/19/2020	Sanpete & Sevier	Optech Galaxy Prime	5060410	N27DV
7/20/2020*	Sanpete & Sevier	Optech Galaxy Prime	5060410	N27DV
8/4/2020	Sanpete & Sevier	Optech Galaxy Prime	5060410	N27DV

**Flight included reflights*

3. LiDAR Processing Workflow

a. **Absolute Sensor Calibration.** Our absolute sensor calibration adjusted for the difference in roll, pitch, heading, and scale between the raw laser point cloud from the sensor and surveyed control points on the ground.

b. **Kinematic Air Point Processing.** Used Applanix' industry-leading POSPac MMS GNSS Inertial software (PP-RTX) to post-process the 1-second airborne GPS positions; combined and refined the GPS positions with 1/200-second IMU (roll-pitch-yaw) data through development of a smoothed best estimate of trajectory (SBET).

c. **Raw LiDAR Point Processing (Calibration).** Combined SBET with raw LiDAR range data; solved real-world position for each laser point; produced point cloud data by flight strip in ASPRS v1.4 .LAS format; output in NAD83 (2011) UTM Zone 12 and UTM Zone 11, meters.

d. **Relative Calibration.** Performed relative calibration by correcting for roll, pitch, heading, and scale discrepancies between adjacent flightlines; tested resulting relative accuracy.

e. **Vertical Accuracy Assessment.** Performed comparative tests that showed Z-differences between surveyed points and the laser point surface.

f. **Tiling & Long/Short Filtering.** Cut data into project-specified tiles and filtered out grossly long and short returns.

g. **Classified LAS Processing.** The point classification is performed as described below. 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-flattened 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 to classify these ground (ASPRS Class 2) points to Ignored ground (ASPRS Class 10). All bridge decks were classified to Class 17. All overlap data was processed using TerraScan macro functionality to set the overlap bit flag on overlapping flight line data.

   All data was manually reviewed and any remaining artifacts were removed using functionality provided by TerraScan. LP360 was used as a final check of the bare earth dataset. LP360 was then used to create the deliverable industry-standard LAS files. Aero-Graphics, Inc. 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.

USGS Version 1.3 minimum point cloud classification scheme		
CLASS #	**CLASS NAME**	**DESCRIPTION**
1	Processed, but unclassified	Points that do not fit any other classes
2	Bare earth	Bare earth surface
7	Low noise	Low points identified below surface
9	Water	Points inside of lakes/ponds
17	Bridge decks	Points on bridge decks
18	High noise	High points identified above surface
20	Ignored ground	Points near breakline features; ignored in DEM creation process

h. **Hydro-Flattened Breakline Creation.** Class 2 (ground) LiDAR points were 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 Stream and River Islands, using LP360 functionality. Elevation values were assigned to all inland streams and rivers using Aero-Graphics, Inc. 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 shapefile 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 horizontal placement, vertical variance is reviewed, all breaklines are reviewed for topological consistency and data integrity using a combination of ESRI ArcMap tools and proprietary tools.

i. **Hydro-Flattened Raster DEM Creation.** Class 2 (Ground) LiDAR points in conjunction with the hydro breaklines were used to create 1 meter (QL2) hydro-flattened raster DEMs. Using LP360 along with automated scripting routines within ArcMap, a GeoTIFF was created for each tile. Each surface is reviewed using ESRI ArcMap and ArcScene to check for any surface anomalies or incorrect elevations found within the surface.

Breaklines were collected at bridges but not culverts. The distinction between bridges and culverts was based on the following guidelines: Bridges are structures carrying a road, path, railroad, canal, aircraft taxiway, or any other transit between two locations of higher elevation over an area of lower elevation. A bridge may traverse a river, ravine, road, railroad, or other obstacle. "Bridge" also includes but is not limited to aqueduct, drawbridge, flyover, footbridge, overpass, span, trestle, and viaduct. In mapping, the term "bridge" is distinguished from a roadway over a culvert in that a bridge is an elevated deck that is not underlain with earth or soil. Culverts are a tunnel carrying a stream or open drainage under a road or railroad or through another type of obstruction to natural drainage. Typically constructed of formed concrete or corrugated metal and surrounded on all sides, top, and bottom by earth or soil.

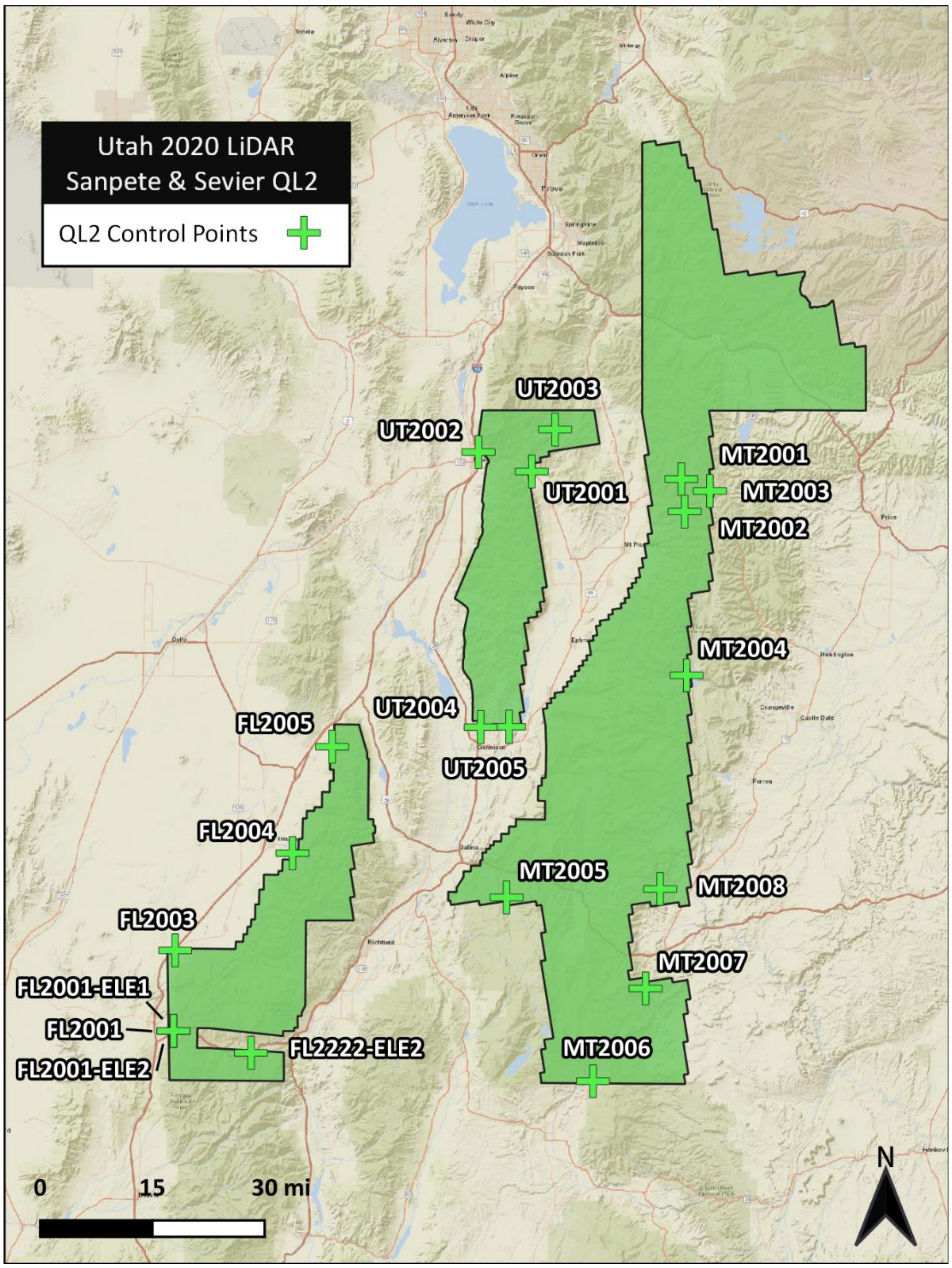
j. **First Return Raster DSM Creation.** First return LiDAR points were used to create 1 meter (QL2) first-return raster DEMs. Using LP360 along with automated scripting routines within ArcMap, a GeoTIFF file was created for each tile. Each surface is reviewed using ESRI ArcMap and ArcScene to check for any surface anomalies or incorrect elevations found within the surface.

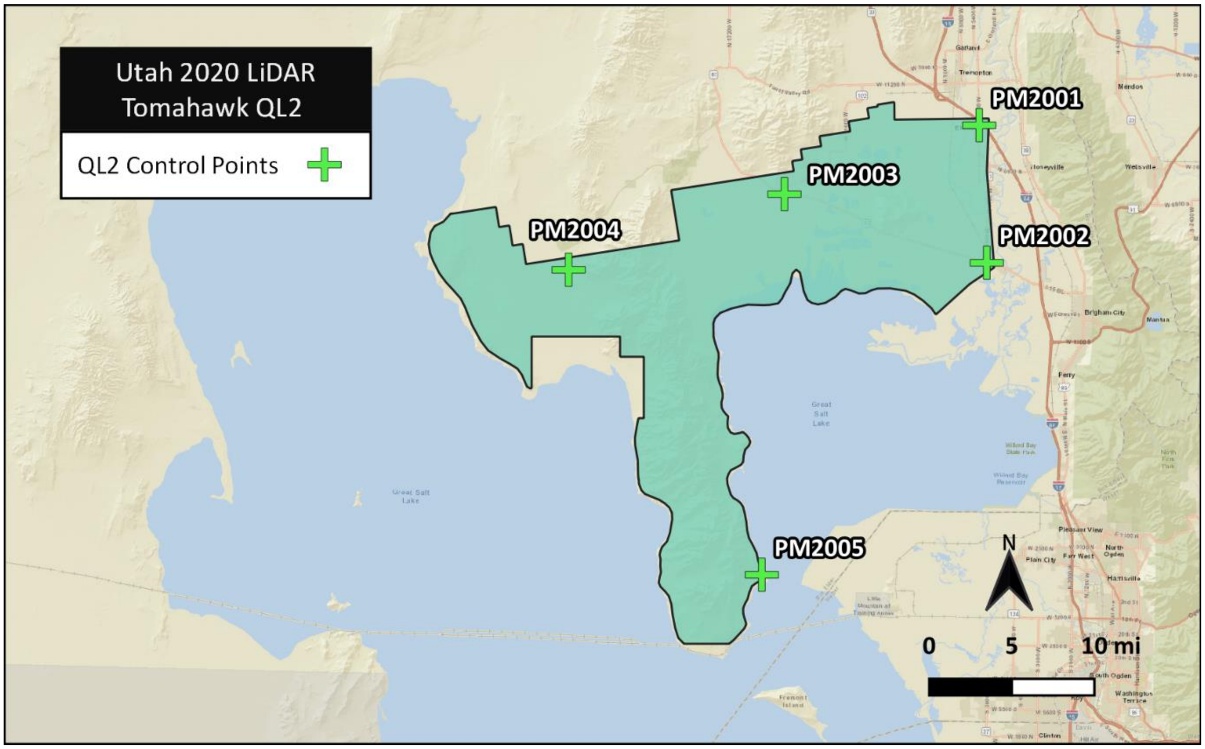
k. **Intensity Image Creation.** TerraScan software was used to create the deliverable Intensity Images. All overlap classes were ignored during this process as it helps to ensure a more aesthetically pleasing image. ESRI ArcMap software was then used to verify full project coverage. GeoTIFF files were provided as the deliverable for this dataset requirement.

4. Ground Control and Check Point Survey

Aero-Graphics' professional land surveyor identified, targeted, and surveyed 29 ground control points for use in data calibration as well as 165 QC check points in Vegetated and Non-Vegetated land cover classifications as an independent test of accuracy 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 QC check points. Calibration control point and QC check point coordinates are included in the deliverable ESRI shapefiles.

Exhibit 5: *Locations and names for each ground control point throughout the project areas*




Utah 2020 LiDAR
Tomahawk QL2
QL2 Control Points
PM2001
PM2003
PM2004
PM2002
PM2005
N
0
5
10 mi

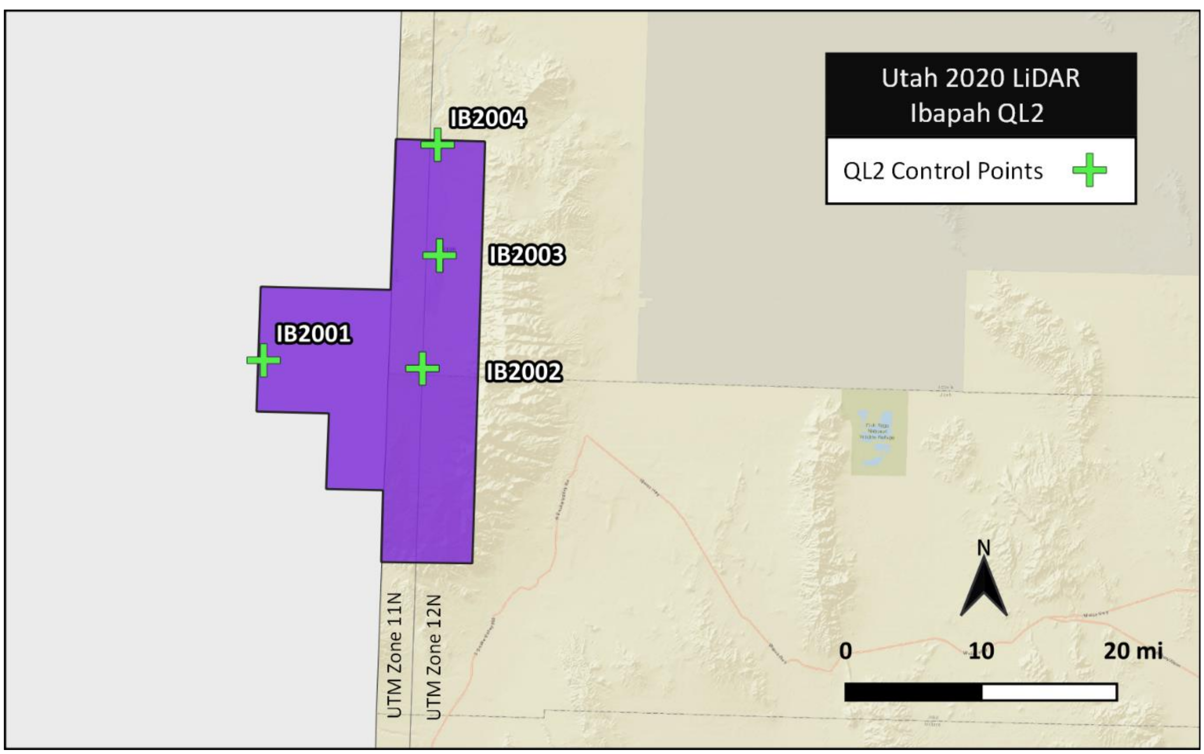
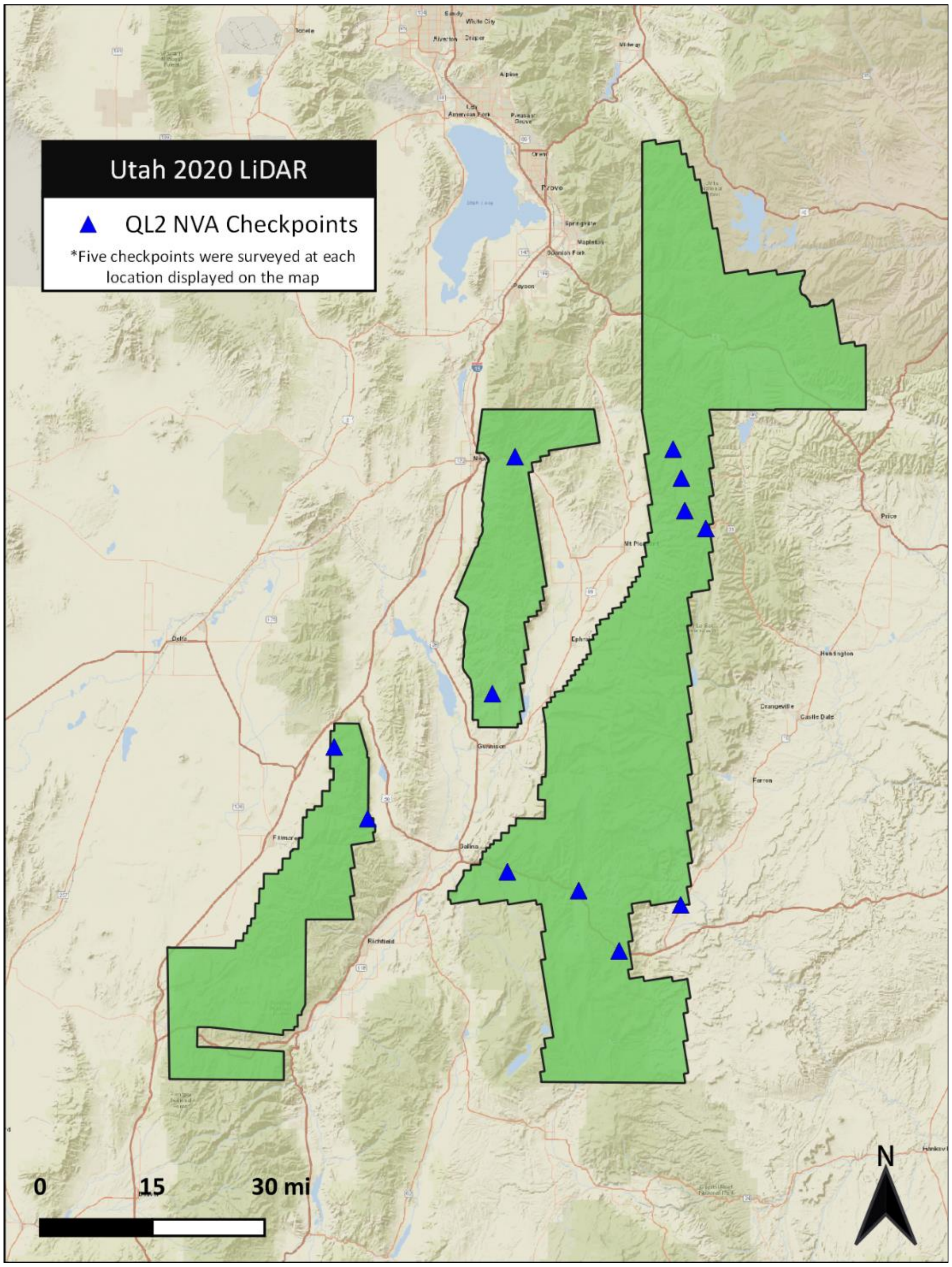
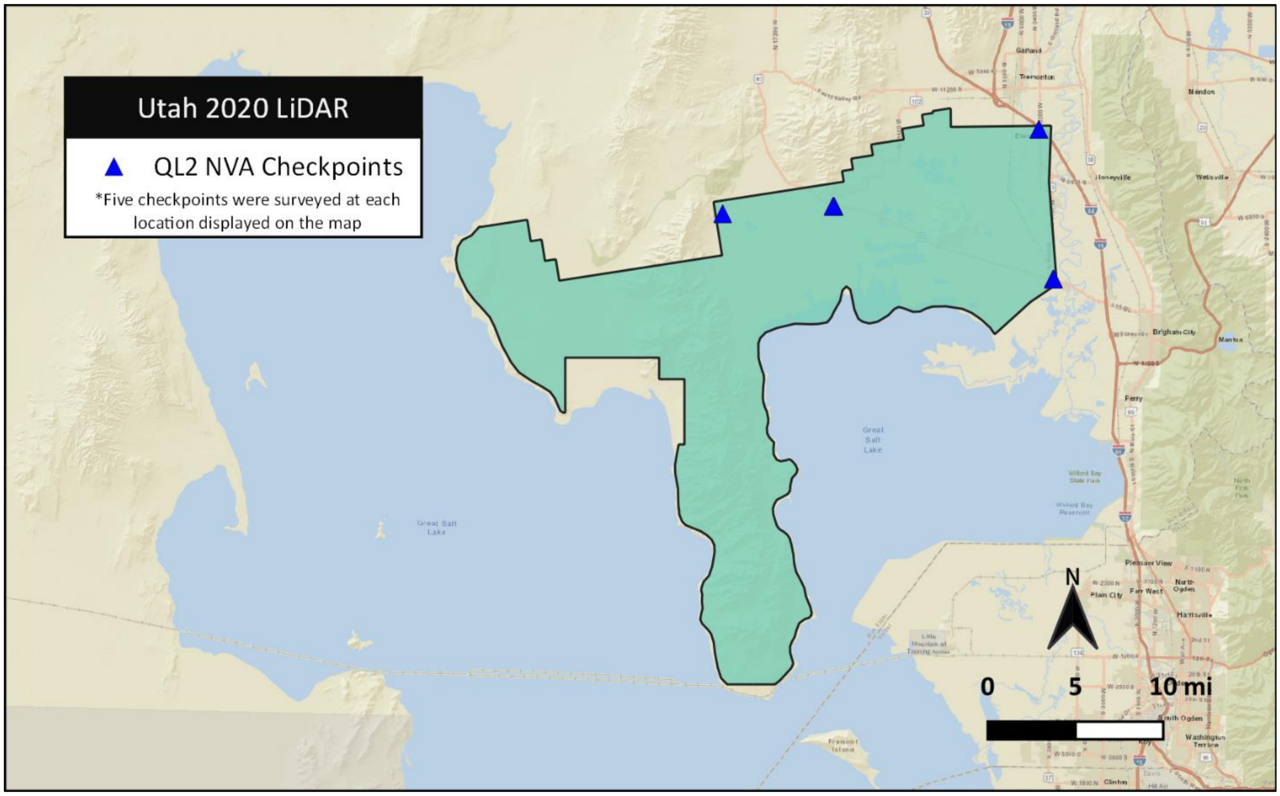
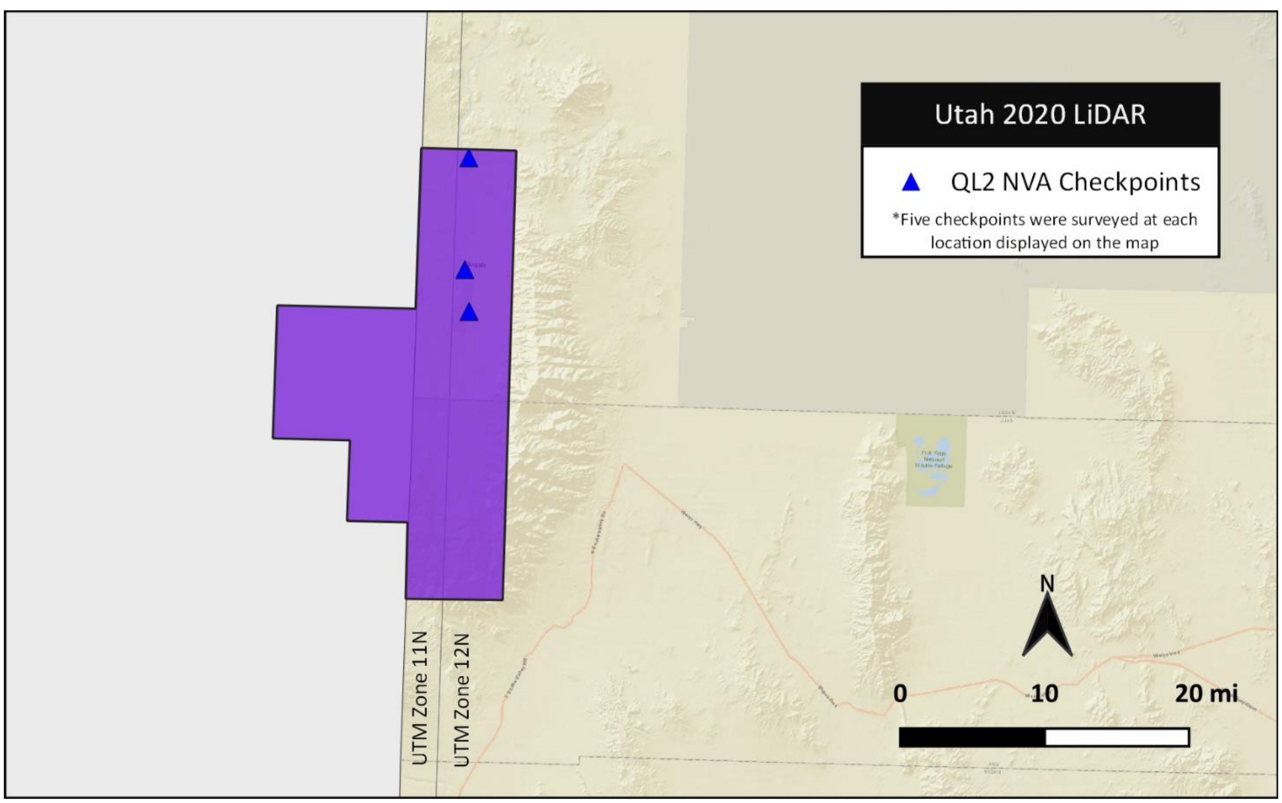

Utah 2020 LiDAR
Ibapah QL2
QL2 Control Points
IB2004
IB2003
IB2001
IB2002
UTM Zone 11N
UTM Zone 12N
N
0
10
20 mi

Exhibit 6: *Locations of NVA checkpoints throughout the project area*



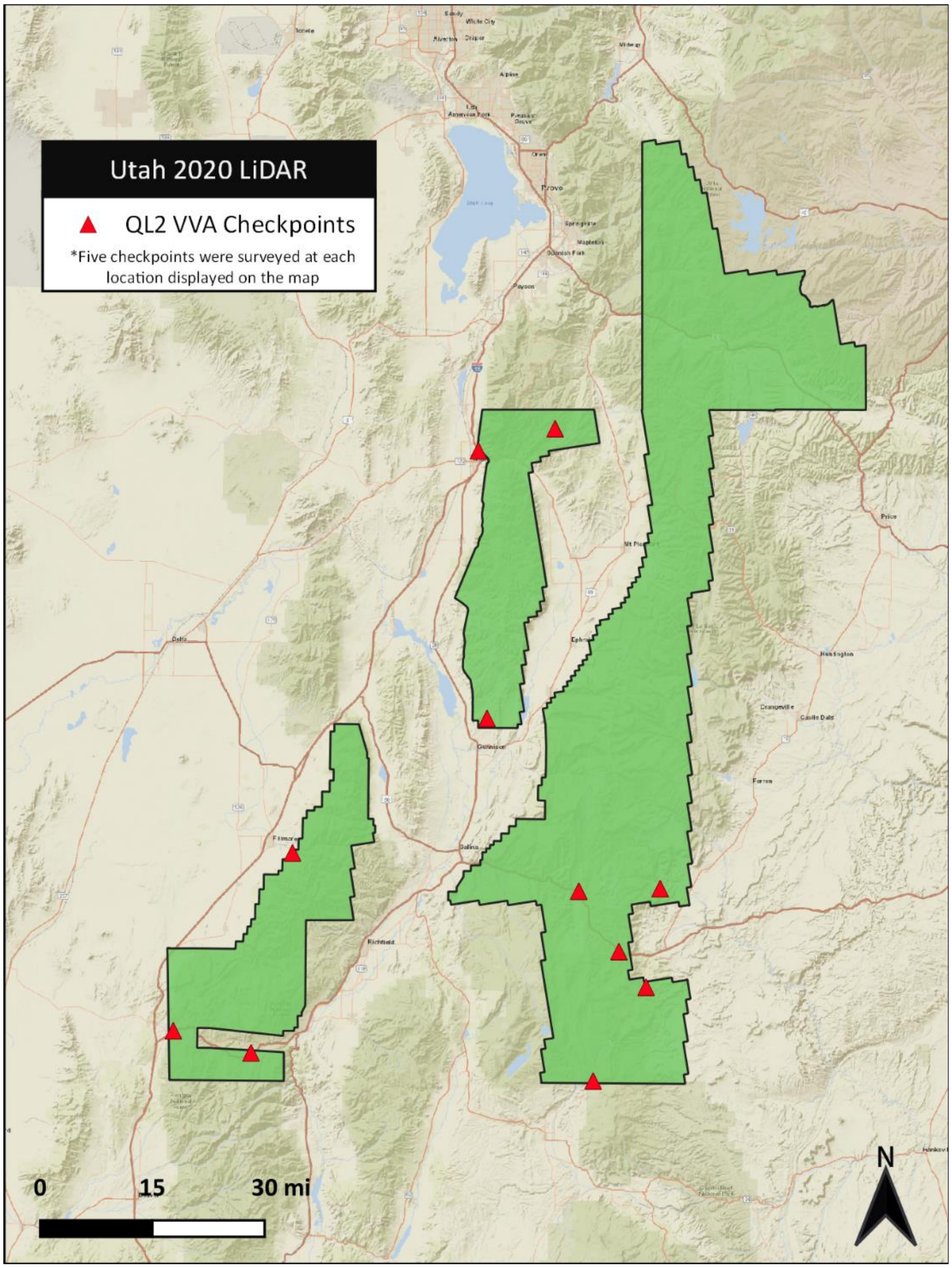


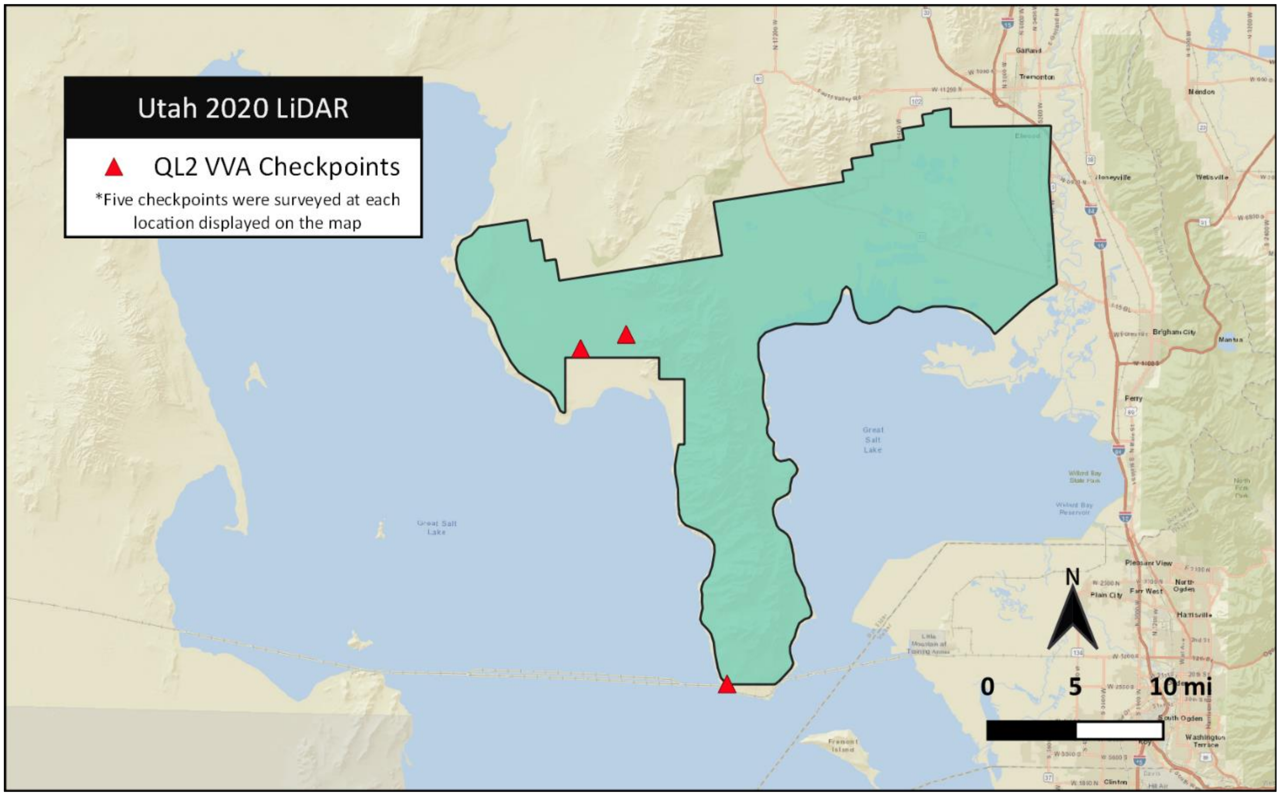
Utah 2020 LiDAR
QL2 NVA Checkpoints
*Five checkpoints were surveyed at each location displayed on the map
N
0
5
10 mi

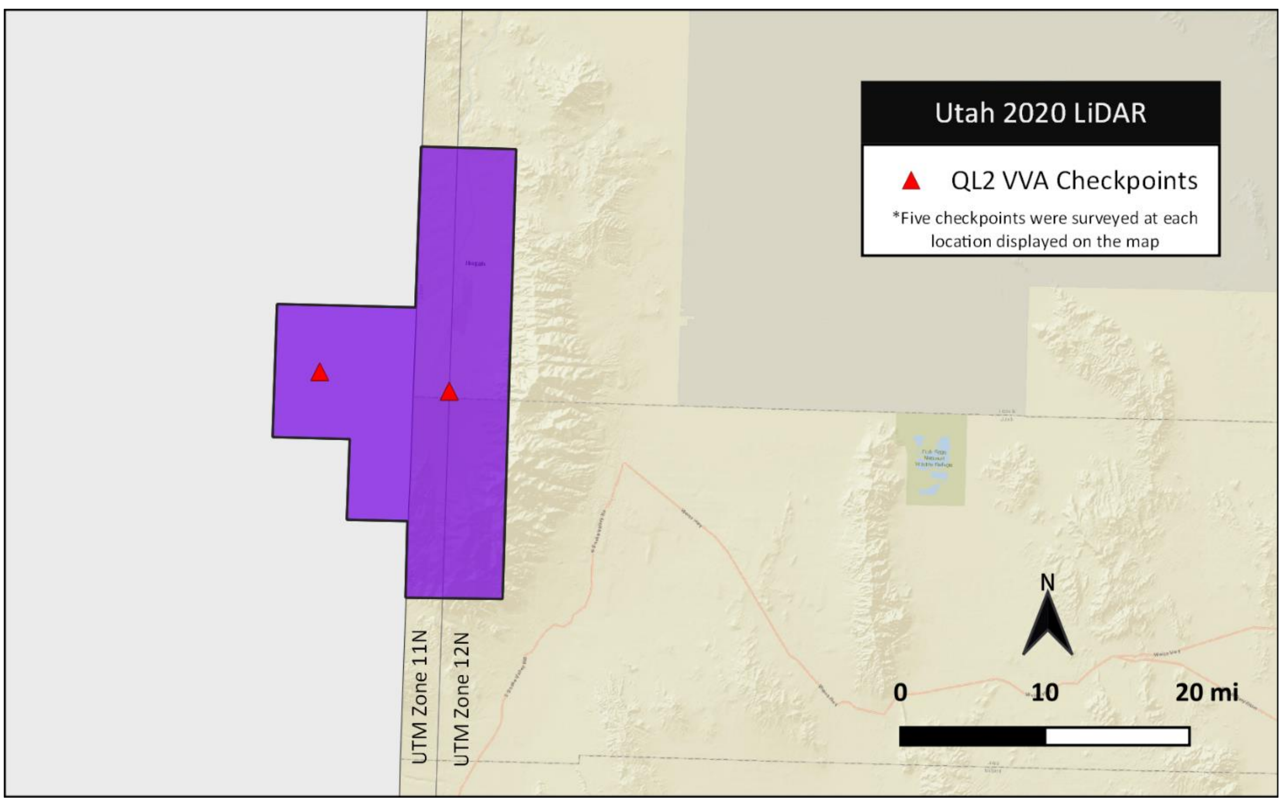


Utah 2020 LiDAR
QL2 NVA Checkpoints
*Five checkpoints were surveyed at each location displayed on the map
UTM Zone 11N
UTM Zone 12N
N
0
10
20 mi

Exhibit 7: *Locations of VVA checkpoints throughout the project area*




Utah 2020 LiDAR
QL2 VVA Checkpoints
*Five checkpoints were surveyed at each location displayed on the map
N
0
5
10 mi


Utah 2020 LiDAR
QL2 VVA Checkpoints
*Five checkpoints were surveyed at each location displayed on the map
UTM Zone 11N
UTM Zone 12N
N
0
10
20 mi

5. Accuracy Testing and Results

5.1 Relative Calibration Accuracy Results

Between-swath relative accuracy is defined as the elevation difference in overlapping areas between a given set of two adjacent flightlines. During the calibration process coincident tie-lines are created in the overlapping regions of each swath. The elevation difference between these tie lines was used to measure the between-swath relative accuracy of the dataset. During calibration, this process is carried out to verify consistency from swath to swath but as a quality assurance measure it can point toward the internal consistency of the overall dataset. The results are based on the comparison of the flightlines and points for each area. The results below include any reflights that were completed over each area, increasing the number of flightlines from what was originally planned.

QL2 project areas: (396 flightlines, > 31 billion points)

- Between-swath relative accuracy **average** of 0.050 meters

5.2 Calibration Control Point Testing

Calibration Control Point reports were generated as a quality assurance check by testing 0.109 meters at 95 percent confidence level in all open and non-vegetated land cover categories combined using RMSEz x 1.96. Note that the results are not an independent assessment of the accuracy of the project deliverables, but rather an additional indication of the overall accuracy of the dataset. The location of each control point is displayed on pages 12 and 13.

Calibration Control Accuracy$_z$: UTMz11N (Ibapah QL2)	
Average Error = -0.022 m	RMSE = 0.028 m
Minimum Error = -0.040 m	σ = 0.019 m
Maximum Error = +0.005 m	Average Magnitude = 0.022 m
Survey Sample Size: n = 4	

Calibration Control Accuracy$_z$: UTMz12N (Tomahawk QL2, Ibapah QL2, Sanpete & Sevier QL2)	
Average Error = -0.001 m	RMSE = 0.046 m
Minimum Error = -0.076 m	σ = 0.046 m
Maximum Error = +0.086 m	Average Magnitude = 0.038 m
Survey Sample Size: n = 28	

5.3 Point Cloud Testing

The project specifications require that only Non-Vegetated Vertical Accuracy (NVA) be computed for raw LiDAR point cloud swath files. NVA is defined as the elevation difference between the LiDAR surface and ground surveyed static points collected in open terrain (bare soil, sand, rocks, and short grass) as well as urban terrain (asphalt and concrete surfaces). The NVA for this project was tested with 92 check points (15 in UTMz11 and 92 in UTMz12). These check points were not used in the calibration or post processing of the LiDAR point cloud data. Elevations from the unclassified LiDAR surface were measured for the xy location of each check point. Elevations interpolated from the LiDAR surface were then compared to the elevation values of the surveyed control points.

Raw Non-vegetated Vertical Accuracy (Raw NVA): The tested Raw NVA for this dataset was found to be 0.036 meters in UTMz11 and 0.048 meters in UTMz12, in terms of the RMSEz. The resulting NVA stated as the 95% confidence level (RMSEz x 1.96) is 0.071 meters in UTMz11 and 0.094 meters in UTMz12. Therefore, this dataset meets the required NVA of 0.196 meters at the 95% confidence level as defined by the National Standards for Spatial Data Accuracy (NSSDA).

5.4 Digital Elevation Model (DEM) Testing

The project specifications require the accuracy of the derived DEM be calculated and reported in two ways: (1) Non-Vegetated Vertical Accuracy (NVA) calculated at a 95% confidence level in "bare earth" and "urban" land cover classes and (2) Vegetated Vertical Accuracy (VVA) in all vegetated land cover classes combined calculated based on the 95th percentile error. The NVA for this project was tested with 92 check points (15 in UTMz11 and 92 in UTMz12). The VVA was tested with 78 check points (10 in UTMz11 and 73 in UTMz12).

The tested Non-Vegetated Vertical Accuracy (NVA) for this dataset captured from the DEM using bi-linear interpolation to derive the DEM elevations was found to be 0.032 meters in UTMz11 and 0.048 meters in UTMz12 in terms of the RMSEz. The resulting accuracy stated as the 95% confidence level (RMSEz x 1.96) is 0.063 meters in UTMz11 and 0.093 meters in UTMz12. Therefore, this dataset meets the required NVA of 0.196 meters at the 95% confidence level.

The tested Vegetated Vertical Accuracy (VVA) for this dataset captured from the DEM using bi-linear interpolation for all classes was found to be 0.046 meters in UTMz11 and 0.212 meters in UTMz12. Therefore this dataset meets the required VVA of 0.294 meters based on the 95th percentile error.

5.5 Data Accuracy Summary

Accuracy has been tested to meet 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using RMSEz x 1.96 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation (NDEP)/ASPRS Guidelines.

Area	Raw Point Cloud NVA (m)	DEM NVA (m)	DEM VVA (m)	Points Tested NVA	Points Tested VVA
UTMz11	0.071	0.063	0.046	15	10
UTMz12	0.094	0.093	0.212	92	73

5.6 Data Density

In order to fulfill USGS LBS 1.3 QL2 density requirements, the density of the point cloud must be greater than or equal to 2 points per meter^2. Average density per tile for Tomahawk, Ibapah, and Sanpete and Sevier project areas was calculated based on first returns only. Exhibits 8-11 illustrate that the acquisition met or exceeded the required density except in areas where bodies of water impeded the collection of data or tiles contained a proportionally significant area outside of the project boundaries. The QL2 project achieved and average per tile density of 3.2 points per meter^2 for first returns in UTMz11 and 3.2 points per meter^2 for first returns in UTMz12.

Exhibit 8: *Laser point density of first returns by tile, point/m^2 (Tomahawk QL2)*

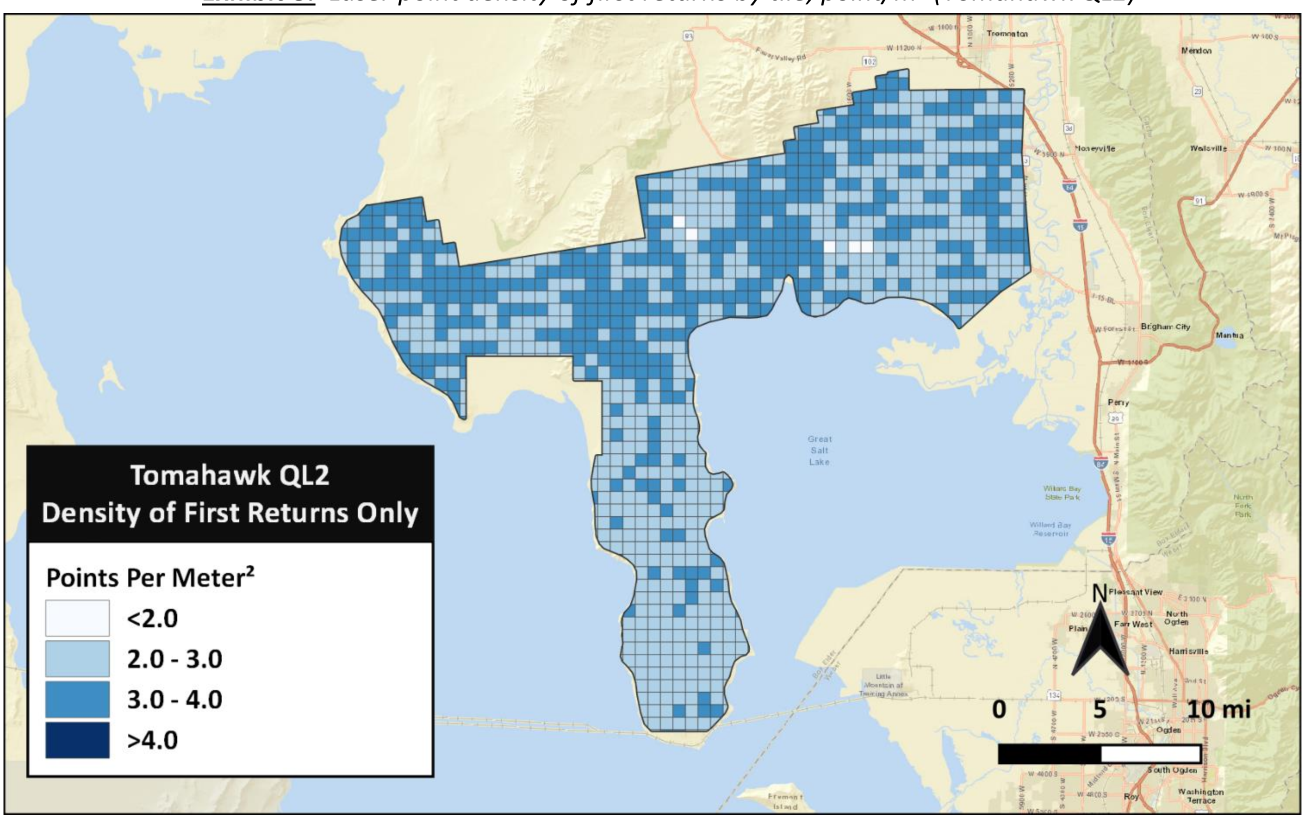


Exhibit 9: *Laser point density of first returns by tile, point/m² (Ibapah UTMz11)*

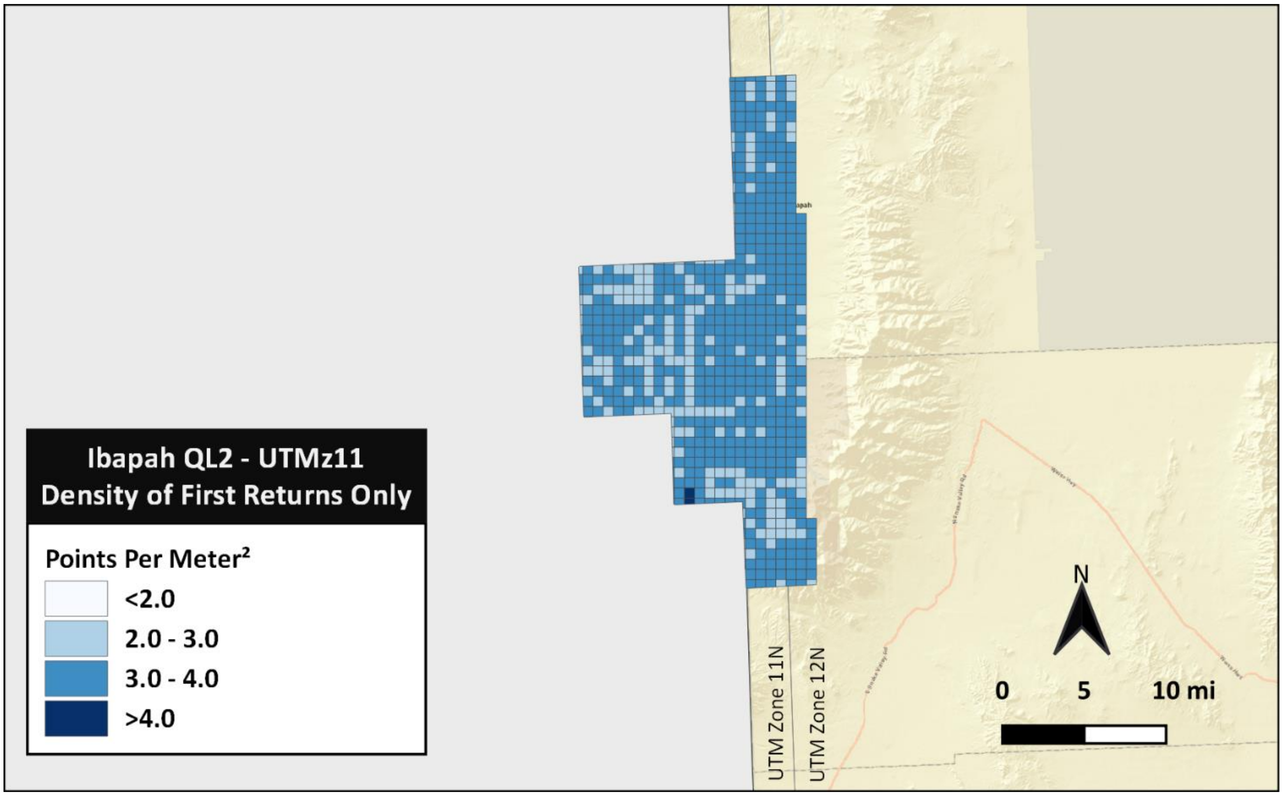


Exhibit 10: *Laser point density of first returns by tile, point/m² (Ibapah UTMz12)*

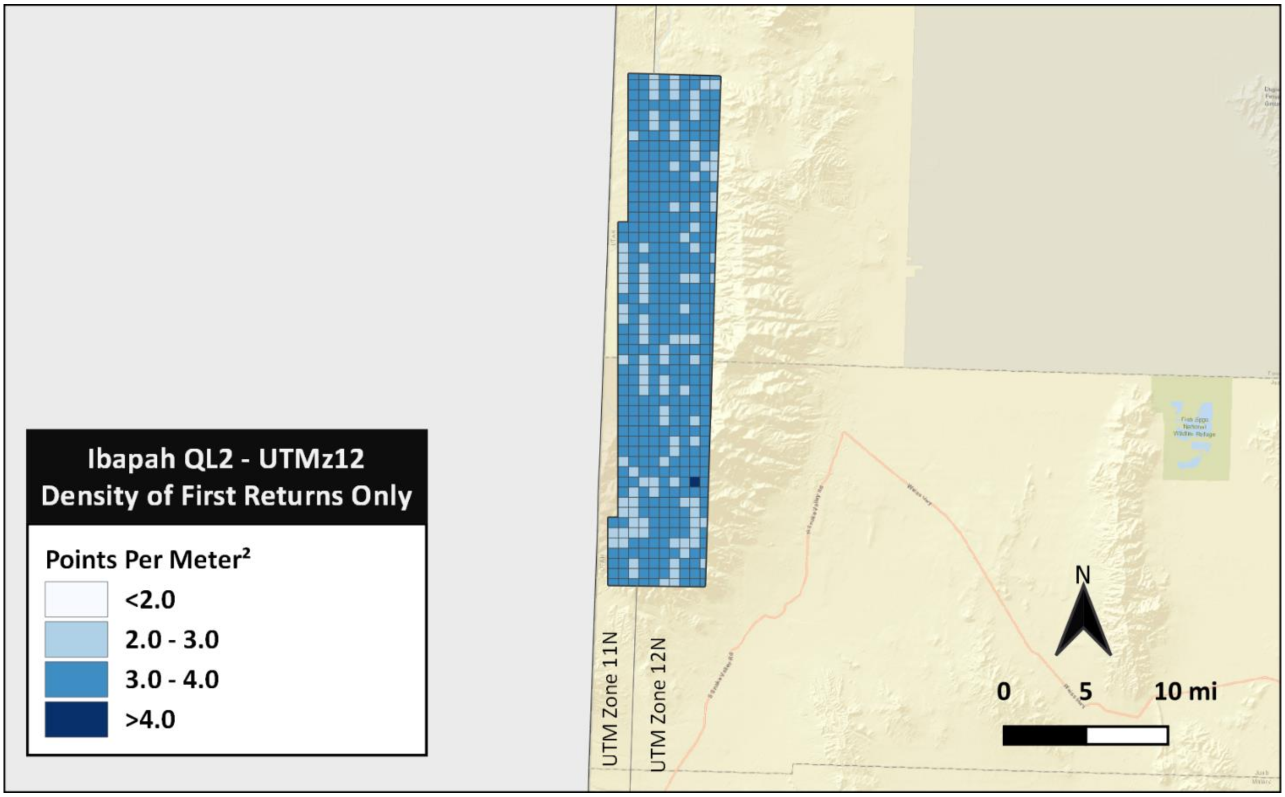
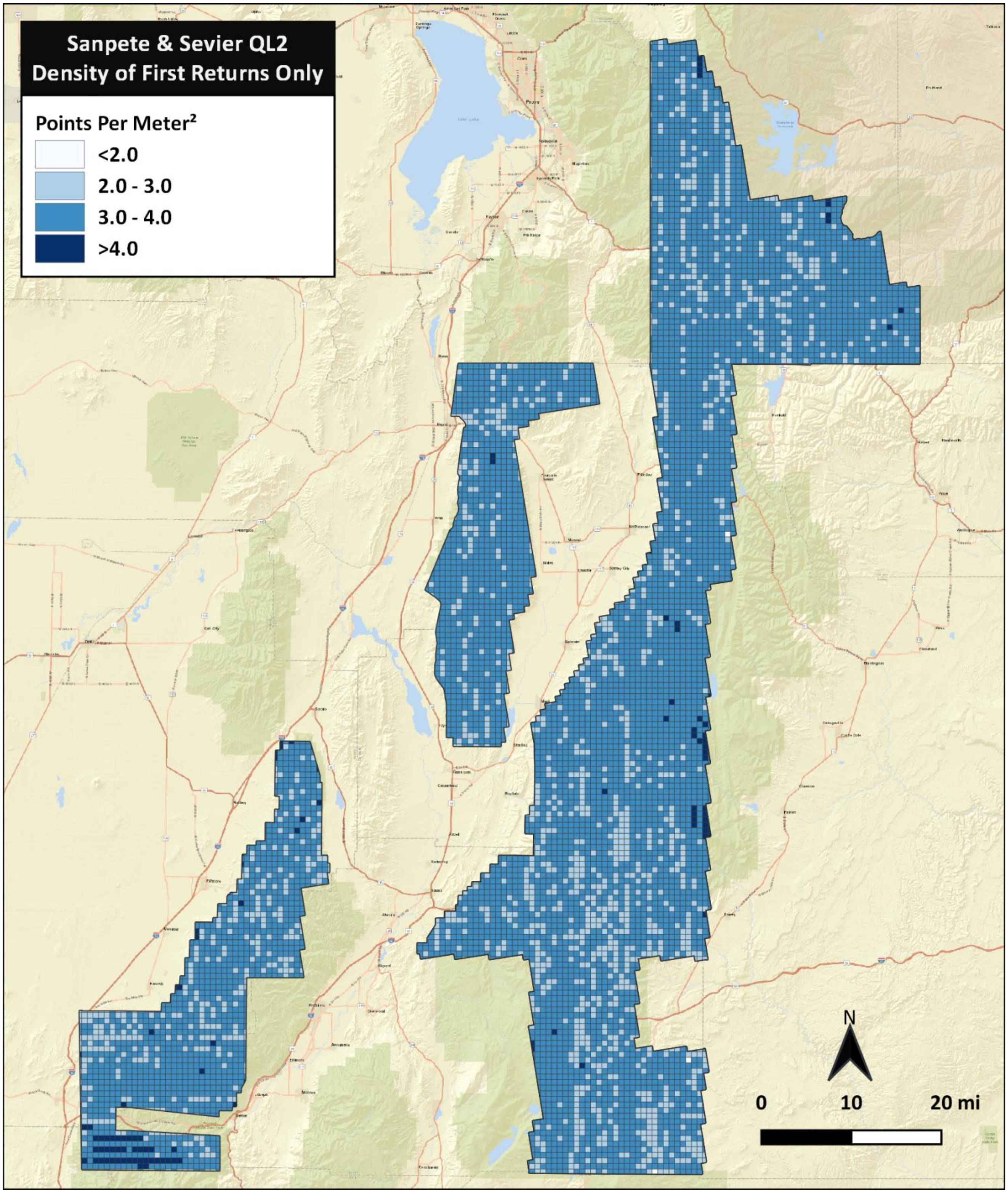


Exhibit 11: *Laser point density of first returns by tile, point/m² (Sanpete and Sevier)*



6. Project Coordinate Systems

Projection:		**UTM Zone 12 & UTM Zone 11**
Datum	**Vertical:**	**NAVD88 (Geoid12B)**
	Horizontal:	**NAD83 (2011) / HARN**
Units:		**Meters**
EPSG:		**6341 & 6340**

7. Project Deliverables

All required project deliverables and file formats are listed in the table below.

LiDAR Data:	• **Raw and classified point clouds in LAS v1.4 format**
Raster Data:	• **Bare-earth and first return DEMs with a cell size of 1 meter in .TIFF format** • **Intensity images at a 1 meter resolution in GeoTIFF format**
Vector Data:	• **Breaklines in SHP format**
Report of Survey:	• **Reports and metadata as described in SOW**

*Tiling for the LiDAR deliverables is based on the U.S. National Grid System. Tile names are based on the SW corner of the tile. All .LAS and Raster tiles are 1,000 meters x 1,000 meters.

Appendix A

Control Point Coordinates

UTMz11N (Ibapah QL2)			
Survey Point	NAD83 (2011) / HARN		
	Northing	Easting	Elev (m) - Geoid 12B
IB2001	737545.689	4422084.313	1744.815
IB2002	756427.946	4422384.165	1794.658
IB2003	757555.695	4435912.640	1615.750
IB2004	756435.433	4449007.076	1565.517

UTMz12N (Tomahawk QL2, Ibapah QL2, Sanpete & Sevier QL2)			
Survey Point	NAD83 (2011) / HARN		
	Northing	Easting	Elev (m) - Geoid 12B
UT2005	436104.527	4338945.991	1634.702
UT2004	429997.926	4338857.737	1678.595
UT2002	429540.249	4398019.098	1622.899
UT2001	441012.985	4393826.762	1910.647
UT2003	446009.796	4402864.302	2278.579
PM2001	405069.235	4614419.985	1305.559
PM2002	405800.518	4601018.139	1291.731
PM2003	386089.874	4607704.635	1296.220
PM2004	365063.495	4600334.468	1373.544
PM2005	383889.507	4570624.810	1304.424
MT2005	435578.019	4302228.975	1934.434
MT2008	468609.522	4304040.014	2137.294
MT2007	465474.182	4282660.674	2357.186
MT2006	454164.810	4262701.280	2487.843
MT2003	479305.637	4389641.758	2624.930
MT2001	473174.039	4392200.718	2697.713
MT2002	473886.978	4385221.200	2952.068
MT2004	474304.826	4349996.687	2190.910
IB2002	243576.722	4422384.008	1794.641
IB2003	245611.837	4435805.858	1615.752
IB2004	245377.063	4448945.825	1565.503
FL2005	398047.936	4334662.276	1818.618
FL2004	389521.413	4311750.505	1742.295
FL2003	364295.415	4290838.397	1522.259
FL2001	363927.595	4273519.175	1867.916
FL2001-ELE1	363931.296	4273519.698	1867.928
FL2001-ELE2	363923.528	4273518.633	1867.784
FL2222-ELE2	380599.681	4268799.132	1877.722

APPENDIX B

While every effort has been made to meet the requirements of the latest LBS2.1 Rev. A specification, it should be noted that the Rev. A spec was released well after the inception of this project. Most notably, the following parts of the Rev. A spec have not been met:

- The data supplied is in Geoid12B (as per the task order)
- Photographs have not been captured from all four cardinal points (North, South, East, and West)
- We have NOT supplied Swath Separation Images