



atlantic

Project Report

TASK ORDER NAME: AZ_CoconinoUSFS_2019_B19

TASK ORDER NUMBER: 140G0219F0247

CONTRACT NUMBER: G16PC00042

ATLANTIC PROJECT NUMBER: 19049

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SECTION 1: PROJECT OVERVIEW & PURPOSE

1.1 Aerial LiDAR Project

1.1.1 Project Overview

USGS NGTOC task order 140G0219F0247 required summer 2019 leaf-on LiDAR surveys to be collected over 1,107 square miles covering parts of Coconino and Mohave counties in Arizona. Aerial LiDAR data for this task order was planned, acquired, processed and produced at an aggregate nominal pulse spacing (ANPS) of .35 meters and in compliance with USGS National Geospatial Program LiDAR Base Specification version 1.3.



Figure 1: Aerial LiDAR Project Overview – Defined Project Area (DPA)

1.1.2 Project Purpose

This task order is for planning, acquisition, processing, and derivative products of lidar data to be collected at an aggregate nominal pulse spacing of ≤ 0.35 meters, including overlap and an aggregate nominal pulse density of no less than 8 points per square meter. Lidar data and derivative products produced in compliance with this task order are based on the “National Geospatial Program Lidar Base Specification Version 1.3”. This project will support the Kaibab National Forest goal of acquiring high quality lidar throughout the forest and the 3DEP mission.

1.1.3 Client Contact Information

Client Contact Information	
Name of Contact	Robert Haselwander
Organization	USGS/NGTOC
Position	MS 662
Telephone	573.308.3642
E-Mail Address	rhaselwander@usgs.gov
Mailing Address	1400 Independence Road
City	Rolla
State or Province	MO
Postal Code	65401

Table 1: Aerial LiDAR Client Contact Information

1.1.4 Contract Deliverables

Item	Specification/Format
Classified Point Cloud	LAS, version 1.4, Point Record Format 6
Bare Earth Surface (Raster DEM) - Hydro	32Bit, floating point, TIF, 0.5M cell size
Bare Earth Surface (Raster DEM) - Non-Hydro	32Bit, floating point, TIF, 0.5M cell size
First Return Surface (DSM) - Non-Hydro	32Bit, floating point, TIF, 0.5M cell size
Hydro Breaklines	ESRI file geodatabase (polylineZ and polygonZ feature classes)
Intensity Image	8-bit, 256 color gray scale, TIF, 0.5M cell size
Product Metadata	XML, FGDC compliant
Flight Index	ESRI file geodatabase
Swath Data	ESRI file geodatabase
Dataset Extents	ESRI shapefile
Project Report	PDF (Acquisition, Survey, Processing, QA/QC)
Tile Scheme	Albers Tiling Scheme, 1000M x 1000M
Tile Naming	US National Grid Conventions
Spatial Reference System	Alberts Equal Area, Meters; NAVD88, Meters, latest Geoid model, EPSG code 6350

Table 2: Aerial LiDAR Contract Deliverables Lots 5 and 6

Item	Specification/Format
Classified Point Cloud	LAS, version 1.4, Point Record Format 6
Bare Earth Surface (Raster DEM) - Hydro	32Bit, floating point, TIF, 0.5M cell size
Bare Earth Surface (Raster DEM) - Non-Hydro	32Bit, floating point, TIF, 0.5M cell size
First Return Surface (DSM) - Non-Hydro	32Bit, floating point, TIF, 0.5M cell size
Hydro Breaklines	ESRI file geodatabase (polylineZ and polygonZ feature classes)
Intensity Image	8-bit, 256 color gray scale, TIF, 0.5M cell size
Product Metadata	XML, FGDC compliant 2 sets, one for each projection delivered
Flight Index	ESRI file geodatabase

Item	Specification/Format
Swath Data	ESRI file geodatabase
Dataset Extents	ESRI shapefile
Project Report	PDF (Acquisition, Survey, Processing, QA/QC)
Tile Scheme	U.S. Forest Service Tiling Scheme, Tiles for the classified LAS consist of 1/100th USGS 7.5 minute quadrangles (0.75 minute x 0.75 minute). Tiles for all raster files consist of 1/4th USGS 7.5-minute quadrangles (3.75 minute x 3.75 minute).
Tile Naming	Per C.1.e.(i)(e) of Task Order
Spatial Reference System	<p>1.) 2 drives with all data referenced to NAD83 (2011), Universal Transverse Mercator (UTM) Zone 12 North, meters; NAVD88 (using the latest Geoid model), Meters. Horizontal and vertical units shall be Meters.</p> <p>2.) 1 drive with all data referenced to NAD 1983 (2011) – State Plane, Arizona Central (FIPS 0202), international feet; NAVD88 (using the latest Geoid model), international feet.</p>

Table 3: Aerial LiDAR Contract Deliverables Lot 7

SECTION 2: FIELD OPERATIONS

2.1 Aerial LiDAR Project – Aerial Acquisition

2.1.1 Aircraft & Sensor Information

Atlantic operated a PACVX (N750VX), (750DV) outfitted with an Optech Galaxy Prime LiDAR system during the collection of the project.

Parameter	Specification
Model	Galaxy Prime
Manufacturer	Optech
Performance Envelope	150 – 4700 m AGL, nominal
Absolute Horizontal Accuracy	1/10,000 x altitude
Absolute Elevation Accuracy	< 0.03 – 0.20 m RMSE from 150 – 4700 m AGL
Topographic Laser	1064-nm near-infrared
Laser Classification	Class IV
Pulse Repetition Frequency (Effective)	Programmable, 50 – 1000 kHz
Beam Divergence	0.25 mrad (1/e)
Laser Range Precision	< 0.008 m
Minimum Target Separation Distance	< 0.7 m (discrete)
Range Capture	Up to 8 range measurements, including last
Intensity Capture	Up to 8 intensity measurements, including last (12-bit)
Scan Angle (Fov)	10 – 60°
Swath Width	10 – 115% of altitude AGL
Scan Frequency	0 – 120 Hz advertised (0 – 240 scan lines/sec)
Scan Product	2000 maximum
Roll Compensation	±5° minimum
Data Storage	Internal solid-state drive (SSD)
Power Requirements	28 V; 300 W
Dimensions and Weight	Sensor: 0.34 x 0.34 x 0.25 m, 27 kg PDU: 0.42 x 0.33 x 0.10 m, 6.5 kg
Operation Temperature	0 to +35°C

Table 4: System Specifications – Galaxy Prime

2.1.2 Sensor Acquisition Information

The following table illustrates project specific system parameters for LiDAR acquisition on this project:

Parameter	Specification
System	Optech Galaxy Prime
Nominal Pulse Spacing (m)	0.35
Nominal Pulse Density (pls/m²)	4.45
Nominal Flight Height (AGL meters)	1800
Nominal Flight Speed (kts)	140
Pass Heading (°)	VARIABLES
Sensor Scan Angle (°)	38
Scan Frequency (Hz)	75
Pulse Rate of Scanner (kHz)	500
Line Spacing (m)	800
Central Wavelength of Sensor Laser (nm)	1064
Sensor Operated with Multiple Pulses	7
Beam Divergence (mrad)	0.25
Nominal Swath Width (m)	1308
Nominal Swath Overlap (%)	56
Scan Pattern	TRIANGLE

Table 5: Aerial LiDAR Sensor Acquisition Parameters

2.1.3 Flight Plan Execution

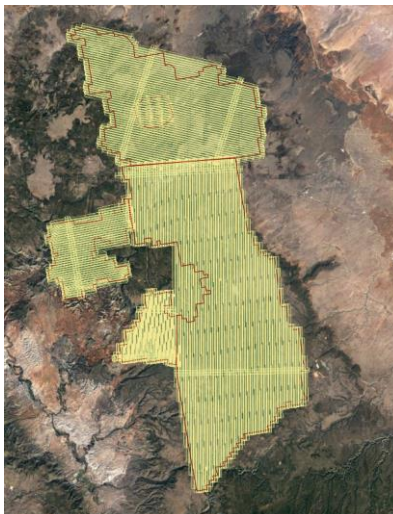


Figure 2: Orientation of Executed Flight-lines and LiDAR DPA

2.1.4 GNSS Reference Stations

Seven (7) Continuously Operating Reference Stations (CORS) were used to control the LiDAR acquisition for the defined project area. The coordinates provided in below are in NAD83 (2011), Geographic Coordinate System, Ellipsoid, Meters.

Designation	Type	PID	Latitude (N)	Longitude (W)	Elevation
AZUP	CORS	AZUP	N33°28'51.32767"	W111°37'12.04589"	591.584
FERN	CORS	FERN	N35°20'30.73513"	W112°27'17.06047"	1767.895
GCES	CORS	GCES	N36°02'52.81011"	W112°07'44.95882"	2110.961
P004	CORS	P004	N34°47'03.77121"	W112°09'07.13781"	1791.754
P008	CORS	P008	N36°08'34.15227"	W111°07'48.17860"	1522.032
P015	CORS	P015	N34°15'49.71492"	W110°00'34.15309"	1930.185
AZSV	CORS	AZSV	N34°15'53.97993"	W111°14'25.86061"	1465.248

Table 6: GNSS Reference Stations

2.2 Aerial LiDAR Project – Ground Acquisition

2.2.1 Ground Control Survey

A total of 110 ground survey points were collected in support of this project, including 12 LiDAR Control Points (LCP), 61 Non-vegetated Vertical Accuracy (NVA) and 50 Vegetated Vertical Accuracy (VVA).

Point cloud data accuracy was tested against a Triangulated Irregular Network (TIN) constructed from LiDAR points in clear and open areas. A clear and open area can be characterized with respect to topographic and ground cover variation such that a minimum of five (5) times the Nominal Pulse Spacing (NPS) exists with less than 1/3 of the RMSEZ deviation from a low-slope plane. Slopes that exceed ten (10) percent were avoided.

Each land cover type representing ten (10) percent or more of the total project area were tested and reported with a VVA. In land cover categories other than dense urban areas, the tested points did not have obstructions forty-five (45) degrees above the horizon to ensure a satisfactory TIN surface. The VVA value is provided as a target. It is understood that in areas of dense vegetation, swamps, or extremely difficult terrain, this value may be exceeded.

The NVA value is a requirement that must be met, regardless of any allowed “busts” in the VVA(s) for individual land cover types within the project. Checkpoints for each assessment (NVA & VVA) are required to be well-distributed throughout the land cover type, for the entire project area.

The following tables and figures outline the coordinate values and distribution of LCP, NVA and VVA points collected in support of this project:

ID	Easting	Northing	Elevation
LCP101	444089.4	3898131	2160.337
LCP102	453941.8	3894910	2015.494
LCP103	462135.1	3900721	1885.235
LCP104	455202.2	3905874	2010.089
LCP105	449497.3	3914450	2128.293
LCP106	428581	3925270	2271.902
LCP107	431331.8	3917889	2406.405
LCP108	432244.1	3904058	2280.18
LCP109	439445.2	3917795	2415.349

ID	Easting	Northing	Elevation
LCP110	435335.7	3909782	2834.265
LCP111	432169	3900920	2238.407
LCP112	462191	3874717	2182.337
LCP113	455269.4	3859448	2224.748
LCP501	467640.5	3858236	2229.048
LCP502	471968	3848278	2132.808
LCP503	470555.2	3840624	2106.593
LCP701	425535.4	3883766	2185.993
XLCP101	457406.7	3890478	2007.956
XLCP102	450805.1	3904997	2050.52
XLCP103	447763.2	3918132	2089.16
XLCP104	441662.9	3900009	2206.139
XLCP105	457829.2	3879424	2105.829
XLCP106	445418.9	3914052	2371.28
XLCP107	442304.5	3894830	2095.433
XLCP501	461066.7	3845871	2311.011
XLCP502	453404.3	3840424	2000.399
XLCP503	451527.3	3819623	1924.445
XLCP701	433864.9	3885033	2113.91
XLCP702	434422.4	3895624	2192.641

Table 7: LiDAR Control Point Coordinates

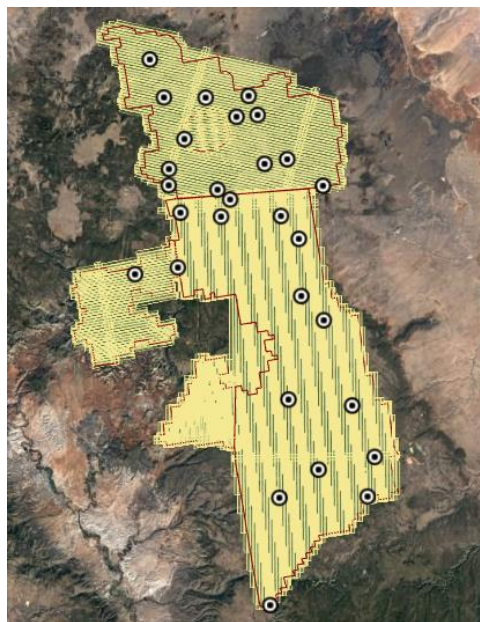


Figure 3: LiDAR Control Point Distribution

ID	Easting	Northing	Elevation
BE01	424143.5	3930740	2111.005
BE02	452046.3	3862443	2231.153
BE03	435889.1	3902661	2248.105
BE04	448030.8	3906854	2154.678
BE05	434402.1	3858975	1507.873
BE06	457412.8	3890492	2007.737
BE07	455456.2	3829018	1894.659
BE08	450812.2	3905004	2050.194
BE09	453853.3	3912321	2146.508
BE10	453403.6	3840431	2000.638
BE12	428875.3	3930387	2182.438
BE13	459496.2	3886853	1985.101
BE14	467815.7	3859630	2219.64
BE15	446772.6	3904206	2222.656
BE16	466866.8	3866569	2212.465
BE17	473125.2	3848821	2127.871
BE18	425778.6	3922600	2356.733
BE19	449206.8	3882253	2094.009
BE20	428182.9	3913987	2442.1
OT01	431987.3	3923539	2324.533
OT02	464208.6	3903365	1899.009
OT03	429794	3923473	2299.489
OT04	455172.8	3867214	2181.466
OT05	461341.4	3884174	2024.758
OT06	429755	3905109	2330.529
OT07	439327.4	3923055	2228.023
OT08	438511.2	3900507	2199.918
OT09	449375.6	3900318	2075.491
OT10	435189.8	3920188	2383.703
OT11	451430.8	3887721	2177.17
OT11	459008.9	3888853	1996.204
OT12	441382.8	3920950	2158.408
OT13	450110.9	3910240	2084.778
OT14	447742.7	3918135	2089.387
OT15	452671.6	3921568	1968.951
OT16	449609.1	3916554	2243.041
OT17	454006.9	3914226	2147.218
OT18	464122	3901751	1860.098

ID	Easting	Northing	Elevation
OT19	434604.8	3897238	2302.495
OT20	432715.6	3890059	2187.357
UR01	448651.3	3914835	2189.388
UR02	448710.2	3911685	2154.884
UR03	450658.1	3907756	2044.553
UR04	450381.5	3902913	2042.912
UR05	451790.1	3897323	2043.657
UR06	458534	3895612	1956.323
UR07	445593.8	3897023	2086.686
UR08	442317	3894824	2095.175
UR09	458798.6	3872015	2207.96
UR10	457367.6	3863288	2171.382
UR11	440284.4	3866687	1969.543
UR12	429905.8	3851817	1321.601
UR13	439447.6	3892673	2098.371
UR14	442011.6	3859417	1945.958
UR15	445318.7	3851501	1941.392
UR16	460142.6	3853488	2275.772
UR17	464409.6	3841732	2234.202
UR18	466417.2	3833371	2076.782
UR19	451524.1	3819636	1924.829
UR20	438464	3890414	2119.457
XNVA101	453520.3	3892832	2047.577
XNVA102	460794.9	3916441	1888.74
XNVA103	426877	3927212	2225.405
XNVA104	429557.4	3911802	2484.142
XNVA105	452122.7	3881413	2086.803
XNVA501	459349.5	3849754	2242.194
XNVA502	449732.1	3847739	1955.146
XNVA503	449859.6	3820703	1909.917
XNVA701	427859.4	3880267	2173.314
XNVA702	437747.6	3883121	2057.019
XNVA703	445742.1	3886177	2081.584

Table 8: Non-Vegetated Vertical Accuracy (NVA) Point Coordinates

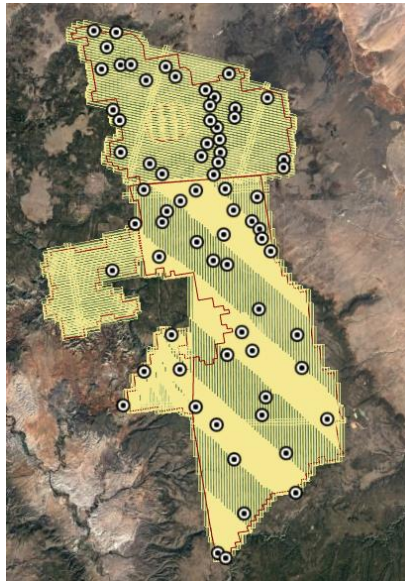


Figure 4: Non-Vegetated Vertical Accuracy (NVA) Point Distribution

ID	Easting	Northing	Elevation
BR01	428567.6	3925264	2271.414
BR02	455241.1	3859440	2223.06
BR03	425531.9	3883781	2185.824
BR04	431327.8	3917863	2405.165
BR05	462208	3874703	2182.101
BR06	439417.1	3917766	2418.897
BR07	449489.9	3914427	2127.38
BR08	467646.6	3858154	2230.102
BR09	471973.7	3848275	2132.697
BR10	432288.3	3904070	2278.721
BR11	435331.3	3909821	2834.154
BR12	455211.8	3905878	2010.413
BR13	462144.4	3900727	1885.262
BR14	444078.7	3898124	2159.954
BR15	432115.1	3900934	2236.15
BR16	470563.7	3840620	2106.68
BR17	453962.4	3894921	2017.016
HG01	439954.7	3890658	2109.117
HG02	433879.6	3885003	2112.475
HG03	427885.5	3880256	2173.303
HG04	445748.4	3886167	2080.589
HG05	434440.8	3895601	2192.216

ID	Easting	Northing	Elevation
HG06	436253.5	3894347	2154.591
HG07	437732.4	3883144	2056.318
HG08	446543.5	3885571	2076.809
HG09	457818.7	3879417	2104.195
HG10	458806.6	3874379	2116.17
HG11	455945.1	3869634	2192.305
HG12	455661.6	3865177	2175.914
HG13	459905.1	3861930	2219.951
HG14	459348.1	3849723	2242.346
HG15	462521.7	3844604	2284.593
HG16	449866.5	3820712	1910.792
HG17	460786.4	3916426	1889.509
TR01	441258.1	3863508	1977.574
TR02	445404.7	3914069	2373.438
TR03	437563.6	3916181	2567.662
TR04	429567.3	3911787	2484.703
TR05	444809.3	3856574	1978.351
TR06	461065	3845892	2309.337
TR07	452115.9	3881413	2086.528
TR08	428116.5	3918155	2413.274
TR09	449756.2	3847776	1956.676
TR10	448824.3	3881692	2095.684
TR11	424512.3	3929231	2185.31
TR12	453529.5	3892825	2047.253
TR13	426893.1	3927191	2225.294
TR14	437196.6	3923778	2229.719
TR15	430722.3	3921379	2350.093
TR16	441662.6	3900021	2206.78
TR17	438181.4	3885278	2063.764
XVVA101	445604.5	3897019	2086.325
XVVA102	458526.2	3895622	1956.231
XVVA103	449568	3916582	2237.054
XVVA104	435895.7	3902646	2248.19
XVVA105	449194.3	3882249	2093.928
XVVA106	466889.5	3866562	2212.213
XVVA107	439461.4	3892674	2098.587
XVVA501	460156.8	3853500	2274.997
XVVA502	467802.7	3859616	2219.901

ID	Easting	Northing	Elevation
XVVA503	455459.2	3829009	1894.801
XVVA701	429903.7	3851807	1321.81
XVVA702	432714.8	3890048	2187.574
XVVA703	439959.4	3890686	2109.686

Table 9: Vegetated Vertical Accuracy (VVA) Point Coordinates

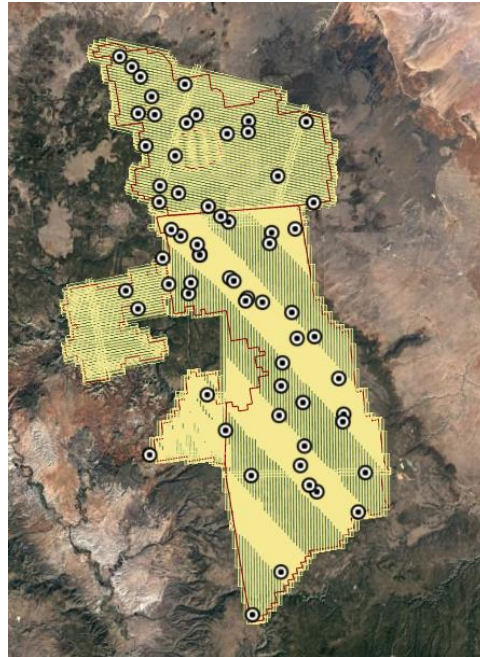


Figure 5: Vegetated Vertical Accuracy (VVA) Point Distribution

SECTION 3: DATA PRODUCTION

3.1 Aerial LiDAR Project – Calibration/Classification

3.1.1 LiDAR Point Cloud Generation

Atlantic used Leica software products to download the IPAS ABGNSS/IMU data and raw laser scan files from the airborne system. Waypoint Inertial Explorer is used to extract the raw IPAS ABGNSS/IMU data, which is further processed in combination with controlled base stations to provide the final Smoothed Best Estimate Trajectory (SBET) for each mission. The SBETs are combined with the raw laser scan files to export the LiDAR ASCII Standard (*.las) formatted swath point clouds.

3.1.2 Coordinate Reference System

Parameter	Specification
Horizontal Datum	NAD83 (NSRS2011)
Coordinate System	Albers Conic
Vertical Datum	NAVD88
Geoid Model	12B
EPSG Code	6350
Units of Reference	Meter

Table 10: Coordinate Reference System

3.1.3 LiDAR Point Cloud Statistics

Category	Value
Total Points	64,062,923,404
Nominal Pulse Spacing (m)	0.3664
Nominal Pulse Density (pls/m ²)	7.4483
Nominal Pulse Spacing (ft)	1.2021
Nominal Pulse Density (pls/ft ²)	0.6920
Aggregate Total Points	61,742,064,677
Aggregate Nominal Pulse Spacing (m)	0.2481
Aggregate Nominal Pulse Density (pls/m ²)	16.2399
Aggregate Nominal Pulse Spacing (ft)	0.8141
Aggregate Nominal Pulse Density (pls/ft ²)	1.5087

Table 11: LiDAR Point Cloud Statistics

3.1.4 Smooth Surface Repeatability (Interswath)

Departures from planarity of first returns within single swaths in non-vegetated areas were assessed at multiple locations with hard surface areas (parking lots or large rooftops) inside the project area. Each area was evaluated using signed difference rasters (maximum elevation – minimum elevation) at a cell size equal to 2 x ANPS, rounded to the next integer. The following figure depicts a sample of the assessment.

3.1.5 LiDAR Calibration

Using a combination of GeoCue, TerraScan and TerraMatch; overlapping swath point clouds are corrected for any orientation or linear deviations to obtain the best fit swath-to-swath calibration. Relative calibration was evaluated using advanced plane-matching analysis and parameter corrections derived. This process was repeated interactively until residual errors between overlapping swaths, across all project missions, was reduced to $\leq 2\text{cm}$. A final analysis of the calibrated lidar is preformed using a TerraMatch tie line report for an overall statistical model of the project area. Individual control point assessments for this project can be found in Section VI of this report.

Upon completion of the data calibration, a complete set of elevation difference intensity rasters (dZ Orthos) are produced. A user-defined color ramp is applied depicting the offsets between overlapping swaths based on project specifications. The dZ orthos provide an opportunity to review the data calibration in a qualitative manner. Atlantic assigns green to all offset values that fall below the required RMSDz requirement of the project. A yellow color is assigned for offsets that fall between the RMSDz value and 1.5x of that value. Finally, red values are assigned to all values that fall beyond 1.5x of the RMSDz requirements of the project.

3.1.6 LiDAR Classification

Multiple automated filtering routines are applied to the calibrated LiDAR point cloud identifying and extracting bare-earth and above ground features. GeoCue, TerraScan, and TerraModeler software was used for the initial batch processing, visual inspection and any manual editing of the LiDAR point clouds. Atlantic utilized collected breakline data to preform classification for class 9 (Water).

Code	Description
1	Unclassified
2	Bare-earth Ground
7	Low Noise
9	Water
17	Bridge Deck
18	High Noise
20	Ignored Ground (Breakline Proximity)
21	Snow (If present and identifiable)
22	Temporal Exclusions

Table 12: LiDAR Point Classification Codes and Descriptions

3.1.7 LiDAR Intensity Imagery

LiDAR intensity imagery was created from the final calibrated and classified lidar point cloud. Intensity images were produced from all classified points and posted to a 0.5-meter cell size. Intensity images were cut to match the tile index and its corresponding tile names and delivered in .img format.

3.1.8 Hydro-line Collection/Conflation

Hydro breaklines were compiled using LiDAR intensity data and surface terrain models of the entire project area. After the collection, all delineated hydro features were validated for monotonicity and

vertical variance. This procedure ensures that no points were floating above ground. Hydro-lines were then encoded into the LiDAR surface and used to hydro-enforce/flatten all significant water bodies. These final hydro-lines were then used in the production of bare Earth digital models to hydro flatten significant water bodies. This product was delivered as an ESRI geodatabase for the entire project area.

3.1.9 Bare-Earth Surface – Digital Elevation Model (DEM)

Bare earth Digital Elevation Models (DEMs) were derived using the hydro-lines and bare earth (ground) LiDAR points. All DEMs were created with a grid spacing of 0.5 meter. DEMs for this project were cut to match the tile index and its corresponding tile names and delivered in 32-bit floating point .img format.

3.1.10 Surface-Digital Elevation Model (DSM)

Surface digital elevation models (DSMs) were derived using all first return LiDAR points, excluding LiDAR points classified as high or low noise. All DSMs were created with a grid spacing of 0.5 meter. DSMs for this project were cut to match the tile index and its corresponding tile names and delivered in 32-bit floating point .img format.

SECTION 4: ACCURACY ASSESSMENT

4.1 Aerial LiDAR Project – Vertical Accuracy Assessment

4.1.1 Requirements

Per the table below, the Vertical Accuracy Assessment utilized the required parameters for Vertical Data Accuracy Class IV.

Vertical Data Accuracy Class	RMSEz in Non-Vegetated Terrain (cm)	Non-Vegetated Vertical Accuracy (NVA) at 95% Confidence Level (cm)	Vegetated Vertical Accuracy (VVA) at 95th Percentile (cm)
I	1.0	2.0	2.9
II	2.5	4.9	7.4
III	5.0	9.8	14.7
IV	10.0	19.6	29.4
V	12.5	24.5	36.8
VI	20.0	39.2	58.8
VII	33.3	65.3	98.0
VIII	66.7	130.7	196.0
IX	100.0	196.0	294.0
X	333.3	653.3	980.0

Table 13: Vertical Accuracy Standards, Source: ASPRS Positional Accuracy Standards for Digital Geospatial Data v1.0 (2014)

*The terms NVA and VVA are from the American Society for Photogrammetry and Remote Sensing (ASPRS) Positional Accuracy Standards for Digital Geospatial Data v1.0 (2014). The term NVA refers to assessments in clear, open areas (which typically produce only single LiDAR returns); the term VVA refers to assessments in vegetated areas (typically characterized by multiple return LiDAR).

4.1.2 Results

An overall statistical assessment of the check points can be found in the following two tables (values provided in meters):

Broad Land Cover Type	# of Points	RMSEz	95% Confidence Level	95th Percentile
NVA of Point Cloud	68	0.0570	0.1118	0.1152
NVA of DEM	68	0.0569	0.1116	0.1143
VVA of Point Cloud	62	0.0909	0.1782	0.1695
VVA of DEM	62	0.0893	0.1750	0.1651

Table 14: NVA/VVA Accuracies

SECTION 5: CERTIFICATION STATEMENTS

5.1 Aerial LiDAR Project

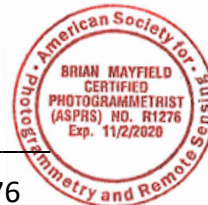
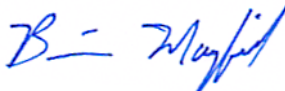
This accuracy assessment confirms that the data may be used for the intended applications stated in Section I of this document. This dataset may also be used as a topographic input for other applications, but the user should be aware that this LiDAR dataset was designed with a specific purpose and was not intended to meet specifications and/or requirements of users outside of the United States Geological Survey.

It should also be noted that LiDAR points do not represent a continuous surface model. LiDAR points are discrete measurements of the surface and any values derived within a triangle of three LiDAR points are interpolated. As such, the user should not use the resultant LiDAR dataset for vertical placement of a planimetric feature such as a headwall, building footprint or any other planimetric feature unless there is an associated LiDAR point that can be reasonably located on this structure.

Consideration should be given by the end user of this dataset to the fact that this LiDAR dataset was developed differently and separately than previous LiDAR datasets that may be available for this geographic location. It is likely that the data in this project was created using different geodetic control, a different Geoid, newer LiDAR technology and more up-to-date processing techniques. As such, any direct comparative analysis performed between this dataset and previous datasets could result in misleading or inaccurate results. Users are encouraged to proceed with caution while performing this type of comparative analysis and to completely understand the variables that make each of these datasets unique and not corollary.

It is encouraged that the user refers to the full FGDC Metadata and project reports for a complete understanding on the content of this dataset.

I, hereby, certify to the extent of my knowledge that the statements and statistics represented in this document are true and factual.



Brian J. Mayfield, ASPRS Certified Photogrammetrist #R1276

SECTION 6: CONTROL POINT ASSESSMENTS

6.1 Aerial LiDAR Project

6.1.1 Point Cloud Check Point Assessment

Point ID	Easting	Northing	KnownZ	LaserZ	Description	DeltaZ
BE01	-1417253.079	1503061.368	2,111.0050	2,111.0950	BARE EARTH	0.0900
BE02	-1400786.877	1430653.401	2,231.1530	2,231.1360	BARE EARTH	(0.0170)
BE03	-1410218.152	1473246.109	2,248.1050	2,248.0830	BARE EARTH	(0.0220)
BE04	-1397660.702	1475529.767	2,154.6780	2,154.7300	BARE EARTH	0.0520
BE05	-1418623.302	1429953.858	1,507.8730	1,507.8970	BARE EARTH	0.0240
BE06	-1391072.691	1457761.133	2,007.7370	2,007.7160	BARE EARTH	(0.0210)
BE07	-1402757.874	1396826.947	1,894.6590	1,894.6810	BARE EARTH	0.0220
BE08	-1395230.899	1473252.096	2,050.1940	2,050.2370	BARE EARTH	0.0430
BE09	-1391089.660	1480070.087	2,146.5080	2,146.4590	BARE EARTH	(0.0490)
BE10	-1402955.504	1408514.193	2,000.6380	2,000.7460	BARE EARTH	0.1080
BE12	-1412676.082	1501971.242	2,182.4380	2,182.6280	BARE EARTH	0.1900
BE13	-1389610.279	1453810.428	1,985.1010	1,985.1380	BARE EARTH	0.0370
BE14	-1385785.077	1425389.297	2,219.6400	2,219.5990	BARE EARTH	(0.0410)
BE15	-1399313.835	1473087.419	2,222.6560	2,222.6120	BARE EARTH	(0.0440)
BE16	-1385612.569	1432450.935	2,212.4650	2,212.3780	BARE EARTH	(0.0870)
BE17	-1382299.507	1413793.473	2,127.8710	2,127.8800	BARE EARTH	0.0090
BE18	-1416947.197	1494693.279	2,356.7330	2,356.7110	BARE EARTH	(0.0220)
BE19	-1400419.555	1450832.946	2,094.0090	2,093.9690	BARE EARTH	(0.0400)
BE20	-1415963.214	1485734.786	2,442.1000	2,442.0820	BARE EARTH	(0.0180)
OT01	-1410718.340	1494660.432	2,324.5330	2,324.5360	OPEN TERRAIN	0.0030
OT02	-1382371.417	1469529.386	1,899.0090	1,899.0560	OPEN TERRAIN	0.0470
OT03	-1412876.489	1494937.242	2,299.4890	2,299.4310	OPEN TERRAIN	(0.0580)
OT04	-1396965.832	1434918.392	2,181.4660	2,181.5100	OPEN TERRAIN	0.0440
OT05	-1388228.520	1450853.119	2,024.7580	2,024.7790	OPEN TERRAIN	0.0210
OT06	-1415836.065	1476642.439	2,330.5290	2,330.4620	OPEN TERRAIN	(0.0670)
OT07	-1403607.812	1493033.316	2,228.0230	2,228.0670	OPEN TERRAIN	0.0440
OT08	-1407992.924	1470690.198	2,199.9180	2,199.8690	OPEN TERRAIN	(0.0490)
OT09	-1397382.680	1468806.909	2,075.4910	2,075.4800	OPEN TERRAIN	(0.0110)
OT10	-1408115.427	1490821.072	2,383.7030	2,383.6510	OPEN TERRAIN	(0.0520)
OT11	-1397372.085	1455934.282	2,177.1700	2,177.1910	OPEN TERRAIN	0.0210
OT11	-1389769.717	1455879.269	1,996.2040	2,177.1910	OPEN TERRAIN	0.0210
OT12	-1401929.941	1490614.411	2,158.4080	2,158.3580	OPEN TERRAIN	(0.0500)
OT13	-1395085.452	1478579.278	2,084.7780	2,084.7810	OPEN TERRAIN	0.0030
OT14	-1396149.542	1486817.339	2,089.3870	2,089.3380	OPEN TERRAIN	(0.0490)

Point ID	Easting	Northing	KnownZ	LaserZ	Description	DeltaZ
OT15	-1390777.235	1489469.588	1,968.9510	1,969.0700	OPEN TERRAIN	0.1190
OT16	-1394573.096	1484950.711	2,243.0410	2,243.0620	OPEN TERRAIN	0.0210
OT17	-1390636.561	1481944.139	2,147.2180	2,147.3600	OPEN TERRAIN	0.1420
OT18	-1382712.760	1467933.804	1,860.0980	1,860.1040	OPEN TERRAIN	0.0060
OT19	-1412338.505	1468042.593	2,302.4950	2,302.4460	OPEN TERRAIN	(0.0490)
UR01	-1395784.430	1483386.443	2,189.3880	2,189.3640	URBAN TERRAIN	(0.0240)
UR02	-1396227.410	1480238.197	2,154.8840	2,154.8940	URBAN TERRAIN	0.0100
UR03	-1394944.377	1476018.786	2,044.5530	2,044.5810	URBAN TERRAIN	0.0280
UR04	-1395985.010	1471236.291	2,042.9120	2,042.8960	URBAN TERRAIN	(0.0160)
UR05	-1395494.013	1465445.489	2,043.6570	2,043.6000	URBAN TERRAIN	(0.0570)
UR06	-1389160.945	1462688.032	1,956.3230	1,956.3580	URBAN TERRAIN	0.0350
UR07	-1401610.282	1466113.952	2,086.6860	2,086.6280	URBAN TERRAIN	(0.0580)
UR08	-1405169.223	1464433.611	2,095.1750	2,095.1260	URBAN TERRAIN	(0.0490)
UR09	-1392651.248	1439135.043	2,207.9600	2,208.0150	URBAN TERRAIN	0.0550
UR10	-1395439.577	1430664.671	2,171.3820	2,171.5260	URBAN TERRAIN	0.1440
UR11	-1411634.429	1436717.255	1,969.5430	1,969.5620	URBAN TERRAIN	0.0190
UR13	-1408321.603	1462738.056	2,098.3710	2,098.3390	URBAN TERRAIN	(0.0320)
UR14	-1411098.421	1429205.486	1,945.9580	1,945.9120	URBAN TERRAIN	(0.0460)
UR15	-1409117.124	1420804.015	1,941.3920	1,941.3390	URBAN TERRAIN	(0.0530)
UR16	-1394278.068	1420468.477	2,275.7720	2,275.6590	URBAN TERRAIN	(0.1130)
UR17	-1391964.962	1408091.713	2,234.2020	2,234.2060	URBAN TERRAIN	0.0040
UR19	-1408102.002	1388097.983	1,924.8290	1,924.7700	URBAN TERRAIN	(0.0590)
UR20	-1409644.180	1460640.864	2,119.4570	2,119.4280	URBAN TERRAIN	(0.0290)
XNVA101	-1394513.245	1460700.585	2,047.5770	2,047.5560	BARE EARTH	(0.0210)
XNVA102	-1383637.111	1483093.286	1,888.7400	1,888.7930	BARE EARTH	0.0530
XNVA103	-1415137.911	1499118.488	2,225.4050	2,225.4590	BARE EARTH	0.0540
XNVA104	-1414964.748	1483343.457	2,484.1420	2,484.2230	BARE EARTH	0.0810
XNVA105	-1397697.021	1449540.581	2,086.8030	2,086.8270	BARE EARTH	0.0240
XNVA501	-1395648.313	1416872.990	2,242.1940	2,242.1870	BARE EARTH	(0.0070)
XNVA502	-1405391.189	1416367.497	1,955.1460	1,955.1950	BARE EARTH	0.0490
XNVA503	-1409563.567	1389420.361	1,909.9170	1,909.9340	BARE EARTH	0.0170
XNVA701	-1421644.967	1452186.308	2,173.3140	2,173.2790	BARE EARTH	(0.0350)
XNVA702	-1411505.713	1453486.019	2,057.0190	2,056.9850	BARE EARTH	(0.0340)
XNVA703	-1403189.374	1455283.772	2,081.5840	2,081.6140	BARE EARTH	0.0300
BR01	-1413792.334	1496913.817	2,271.4140	2,271.2490	BRUSH	(0.1650)
BR02	-1398134.326	1427162.702	2,223.0600	2,223.1280	BRUSH	0.0680
BR03	-1423365.478	1456050.897	2,185.8240	2,185.7900	BRUSH	(0.0340)
BR04	-1412266.939	1489107.051	2,405.1650	2,405.2600	BRUSH	0.0950

Point ID	Easting	Northing	KnownZ	LaserZ	Description	DeltaZ
BR05	-1388884.409	1441280.960	2,182.1010	2,182.2050	BRUSH	0.1040
BR06	-1404360.987	1487748.367	2,418.8970	2,418.9100	BRUSH	0.0130
BR07	-1395027.919	1482849.609	2,127.3800	2,127.5210	BRUSH	0.1410
BR08	-1386185.162	1423945.167	2,230.1020	2,230.0920	BRUSH	(0.0100)
BR09	-1383514.520	1413428.362	2,132.6970	2,132.7430	BRUSH	0.0460
BR10	-1413520.517	1475211.726	2,278.7210	2,278.6940	BRUSH	(0.0270)
BR11	-1409625.548	1480468.524	2,834.1540	2,834.4060	BRUSH	0.2520
BR12	-1390783.267	1473437.054	2,010.4130	2,010.4690	BRUSH	0.0560
BR13	-1384812.210	1467222.226	1,885.2620	1,885.3900	BRUSH	0.1280
BR14	-1402919.141	1467447.110	2,159.9540	2,159.9640	BRUSH	0.0100
BR15	-1414188.947	1472114.183	2,236.1500	2,235.9620	BRUSH	(0.1880)
BR16	-1386111.394	1406024.121	2,106.6800	2,106.6550	BRUSH	(0.0250)
BR17	-1393748.315	1462712.694	2,017.0160	2,017.0320	BRUSH	0.0160
HG01	-1408145.385	1460651.072	2,109.1170	2,109.1740	HIGH GRASS	0.0570
HG02	-1414994.924	1455965.391	2,112.4750	2,112.4390	HIGH GRASS	(0.0360)
HG03	-1421621.113	1452171.454	2,173.3030	2,173.2560	HIGH GRASS	(0.0470)
HG04	-1403184.888	1455272.176	2,080.5890	2,080.8300	HIGH GRASS	0.2410
HG05	-1412759.523	1466437.154	2,192.2160	2,192.1210	HIGH GRASS	(0.0950)
HG06	-1411183.574	1464905.222	2,154.5910	2,154.5670	HIGH GRASS	(0.0240)
HG07	-1411516.949	1453511.758	2,056.3180	2,056.3180	HIGH GRASS	-
HG08	-1402500.833	1454554.295	2,076.8090	2,076.8070	HIGH GRASS	(0.0020)
HG09	-1392434.942	1446662.625	2,104.1950	2,104.2540	HIGH GRASS	0.0590
HG10	-1392267.662	1441489.705	2,116.1700	2,116.3110	HIGH GRASS	0.1410
HG11	-1395824.819	1437208.196	2,192.3050	2,192.3810	HIGH GRASS	0.0760
HG12	-1396810.750	1432812.280	2,175.9140	2,175.9190	HIGH GRASS	0.0050
HG13	-1393169.567	1428915.510	2,219.9510	2,220.0790	HIGH GRASS	0.1280
HG14	-1395654.663	1416841.987	2,242.3460	2,242.2840	HIGH GRASS	(0.0620)
HG15	-1393358.534	1411247.031	2,284.5930	2,284.7320	HIGH GRASS	0.1390
HG16	-1409555.394	1389428.555	1,910.7920	1,910.8080	HIGH GRASS	0.0160
HG17	-1383647.898	1483078.993	1,889.5090	1,889.7460	HIGH GRASS	0.2370
TR01	-1411186.035	1433398.498	1,977.5740	1,977.6020	TREE	0.0280
TR02	-1399085.396	1483129.821	2,373.4380	2,373.5400	TREE	0.1020
TR03	-1406428.096	1486457.915	2,567.6620	2,567.6760	TREE	0.0140
TR04	-1414957.397	1483327.031	2,484.7030	2,484.6650	TREE	(0.0380)
TR05	-1408809.619	1425936.990	1,978.3510	1,978.3070	TREE	(0.0440)
TR06	-1394581.209	1412757.601	2,309.3370	2,309.3410	TREE	0.0040
TR07	-1397703.649	1449542.307	2,086.5280	2,086.5610	TREE	0.0330
TR08	-1415365.056	1489899.471	2,413.2740	2,413.2520	TREE	(0.0220)

Point ID	Easting	Northing	KnownZ	LaserZ	Description	DeltaZ
TR09	-1405361.644	1416400.635	1,956.6760	1,956.7200	TREE	0.0440
TR10	-1400883.530	1450333.340	2,095.6840	2,095.6380	TREE	(0.0460)
TR11	-1417132.057	1501499.526	2,185.3100	2,185.3360	TREE	0.0260
TR12	-1394505.263	1460692.627	2,047.2530	2,047.2080	TREE	(0.0450)
TR13	-1415125.463	1499094.929	2,225.2940	2,225.4650	TREE	0.1710
TR14	-1405579.349	1494086.480	2,229.7190	2,229.6420	TREE	(0.0770)
TR15	-1412300.510	1492705.608	2,350.0930	2,349.9680	TREE	(0.1250)
TR16	-1404983.693	1469714.881	2,206.7800	2,206.7340	TREE	(0.0460)
TR17	-1410737.722	1455568.117	2,063.7640	2,063.8490	TREE	0.0850
XVVA101	-1401600.526	1466107.922	2,086.3250	2,086.3770	BRUSH	0.0520
XVVA102	-1389167.012	1462699.375	1,956.2310	1,956.3010	BRUSH	0.0700
XVVA103	-1394608.889	1484985.126	2,237.0540	2,237.1430	BRUSH	0.0890
XVVA104	-1410214.142	1473230.294	2,248.1900	2,248.1540	BRUSH	(0.0360)
XVVA105	-1400432.527	1450830.764	2,093.9280	2,093.8890	BRUSH	(0.0390)
XVVA106	-1385591.531	1432439.787	2,212.2130	2,212.1390	BRUSH	(0.0740)
XVVA107	-1408307.871	1462737.347	2,098.5870	2,098.5540	BRUSH	(0.0330)
XVVA501	-1394262.294	1420478.142	2,274.9970	2,274.9450	BRUSH	(0.0520)
XVVA502	-1385799.944	1425377.820	2,219.9010	2,219.8580	BRUSH	(0.0430)
XVVA503	-1402756.296	1396817.756	1,894.8010	1,894.8450	BRUSH	0.0440
XVVA703	-1408136.267	1460678.754	2,109.6860	2,109.7390	BRUSH	0.0530

Table 15: Point Cloud Check Point Assessment

6.1.2 Digital Elevation Model (DEM) Check Point Assessment

Point ID	Easting	Northing	KnownZ	DEMZ	Description	DeltaZ
BE01	-1417253.079	1503061.368	2,111.0050	2,111.0980	BARE EARTH	0.0931
BE02	-1400786.877	1430653.401	2,231.1530	2,231.1294	BARE EARTH	(0.0237)
BE03	-1410218.152	1473246.109	2,248.1050	2,248.0769	BARE EARTH	(0.0281)
BE04	-1397660.702	1475529.767	2,154.6780	2,154.7294	BARE EARTH	0.0514
BE05	-1418623.302	1429953.858	1,507.8730	1,507.8942	BARE EARTH	0.0212
BE06	-1391072.691	1457761.133	2,007.7370	2,007.7172	BARE EARTH	(0.0199)
BE07	-1402757.874	1396826.947	1,894.6590	1,894.6760	BARE EARTH	0.0169
BE08	-1395230.899	1473252.096	2,050.1940	2,050.2419	BARE EARTH	0.0478
BE09	-1391089.660	1480070.087	2,146.5080	2,146.4551	BARE EARTH	(0.0530)
BE10	-1402955.504	1408514.193	2,000.6380	2,000.7456	BARE EARTH	0.1077
BE12	-1412676.082	1501971.242	2,182.4380	2,182.6229	BARE EARTH	0.1849
BE13	-1389610.279	1453810.428	1,985.1010	1,985.1424	BARE EARTH	0.0414
BE14	-1385785.077	1425389.297	2,219.6400	2,219.5965	BARE EARTH	(0.0434)
BE15	-1399313.835	1473087.419	2,222.6560	2,222.6111	BARE EARTH	(0.0449)
BE16	-1385612.569	1432450.935	2,212.4650	2,212.3843	BARE EARTH	(0.0808)

BE17	-1382299.507	1413793.473	2,127.8710	2,127.8742	BARE EARTH	0.0031
BE18	-1416947.197	1494693.279	2,356.7330	2,356.7161	BARE EARTH	(0.0168)
BE19	-1400419.555	1450832.946	2,094.0090	2,093.9836	BARE EARTH	(0.0254)
BE20	-1415963.214	1485734.786	2,442.1000	2,442.0827	BARE EARTH	(0.0174)
OT01	-1410718.340	1494660.432	2,324.5330	2,324.5301	OPEN TERRAIN	(0.0029)
OT02	-1382371.417	1469529.386	1,899.0090	1,899.0570	OPEN TERRAIN	0.0480
OT03	-1412876.489	1494937.242	2,299.4890	2,299.4349	OPEN TERRAIN	(0.0541)
OT04	-1396965.832	1434918.392	2,181.4660	2,181.5068	OPEN TERRAIN	0.0407
OT05	-1388228.520	1450853.119	2,024.7580	2,024.7761	OPEN TERRAIN	0.0180
OT06	-1415836.065	1476642.439	2,330.5290	2,330.4651	OPEN TERRAIN	(0.0640)
OT07	-1403607.812	1493033.316	2,228.0230	2,228.0672	OPEN TERRAIN	0.0443
OT08	-1407992.924	1470690.198	2,199.9180	2,199.8700	OPEN TERRAIN	(0.0480)
OT09	-1397382.680	1468806.909	2,075.4910	2,075.4803	OPEN TERRAIN	(0.0107)
OT10	-1408115.427	1490821.072	2,383.7030	2,383.6509	OPEN TERRAIN	(0.0520)
OT11	-1397372.085	1455934.282	2,177.1700	2,177.1975	OPEN TERRAIN	0.0276
OT11	-1389769.717	1455879.269	1,996.2040	2,177.1975	OPEN TERRAIN	0.0276
OT12	-1401929.941	1490614.411	2,158.4080	2,158.3586	OPEN TERRAIN	(0.0494)
OT13	-1395085.452	1478579.278	2,084.7780	2,084.7777	OPEN TERRAIN	(0.0004)
OT14	-1396149.542	1486817.339	2,089.3870	2,089.3367	OPEN TERRAIN	(0.0503)
OT15	-1390777.235	1489469.588	1,968.9510	1,969.0690	OPEN TERRAIN	0.1180
OT16	-1394573.096	1484950.711	2,243.0410	2,243.0560	OPEN TERRAIN	0.0150
OT17	-1390636.561	1481944.139	2,147.2180	2,147.3674	OPEN TERRAIN	0.1494
OT18	-1382712.760	1467933.804	1,860.0980	1,860.1060	OPEN TERRAIN	0.0080
OT19	-1412338.505	1468042.593	2,302.4950	2,302.4483	OPEN TERRAIN	(0.0468)
UR01	-1395784.430	1483386.443	2,189.3880	2,189.3632	URBAN TERRAIN	(0.0247)
UR02	-1396227.410	1480238.197	2,154.8840	2,154.8974	URBAN TERRAIN	0.0134
UR03	-1394944.377	1476018.786	2,044.5530	2,044.5790	URBAN TERRAIN	0.0260
UR04	-1395985.010	1471236.291	2,042.9120	2,042.9005	URBAN TERRAIN	(0.0115)
UR05	-1395494.013	1465445.489	2,043.6570	2,043.5989	URBAN TERRAIN	(0.0581)
UR06	-1389160.945	1462688.032	1,956.3230	1,956.3471	URBAN TERRAIN	0.0241
UR07	-1401610.282	1466113.952	2,086.6860	2,086.6260	URBAN TERRAIN	(0.0600)
UR08	-1405169.223	1464433.611	2,095.1750	2,095.1318	URBAN TERRAIN	(0.0432)
UR09	-1392651.248	1439135.043	2,207.9600	2,208.0126	URBAN TERRAIN	0.0526
UR10	-1395439.577	1430664.671	2,171.3820	2,171.5264	URBAN TERRAIN	0.1443
UR11	-1411634.429	1436717.255	1,969.5430	1,969.5739	URBAN TERRAIN	0.0309
UR13	-1408321.603	1462738.056	2,098.3710	2,098.3385	URBAN TERRAIN	(0.0326)
UR14	-1411098.421	1429205.486	1,945.9580	1,945.9066	URBAN TERRAIN	(0.0514)
UR15	-1409117.124	1420804.015	1,941.3920	1,941.3440	URBAN TERRAIN	(0.0480)
UR16	-1394278.068	1420468.477	2,275.7720	2,275.6660	URBAN TERRAIN	(0.1060)

UR17	-1391964.962	1408091.713	2,234.2020	2,234.2017	URBAN TERRAIN	(0.0002)
UR19	-1408102.002	1388097.983	1,924.8290	1,924.7798	URBAN TERRAIN	(0.0492)
UR20	-1409644.180	1460640.864	2,119.4570	2,119.4284	URBAN TERRAIN	(0.0286)
XNVA101	-1394513.245	1460700.585	2,047.5770	2,047.5562	BARE EARTH	(0.0208)
XNVA102	-1383637.111	1483093.286	1,888.7400	1,888.7972	BARE EARTH	0.0572
XNVA103	-1415137.911	1499118.488	2,225.4050	2,225.4585	BARE EARTH	0.0535
XNVA104	-1414964.748	1483343.457	2,484.1420	2,484.2297	BARE EARTH	0.0876
XNVA105	-1397697.021	1449540.581	2,086.8030	2,086.8277	BARE EARTH	0.0247
XNVA501	-1395648.313	1416872.990	2,242.1940	2,242.1837	BARE EARTH	(0.0104)
XNVA502	-1405391.189	1416367.497	1,955.1460	1,955.1980	BARE EARTH	0.0520
XNVA503	-1409563.567	1389420.361	1,909.9170	1,909.9422	BARE EARTH	0.0252
XNVA701	-1421644.967	1452186.308	2,173.3140	2,173.2761	BARE EARTH	(0.0379)
XNVA702	-1411505.713	1453486.019	2,057.0190	2,056.9728	BARE EARTH	(0.0462)
XNVA703	-1403189.374	1455283.772	2,081.5840	2,081.6138	BARE EARTH	0.0298
BR01	-1413792.334	1496913.817	2,271.4140	2,271.2536	BRUSH	(0.1605)
BR02	-1398134.326	1427162.702	2,223.0600	2,223.1273	BRUSH	0.0672
BR03	-1423365.478	1456050.897	2,185.8240	2,185.7884	BRUSH	(0.0356)
BR04	-1412266.939	1489107.051	2,405.1650	2,405.2597	BRUSH	0.0947
BR05	-1388884.409	1441280.960	2,182.1010	2,182.1716	BRUSH	0.0705
BR06	-1404360.987	1487748.367	2,418.8970	2,418.9123	BRUSH	0.0153
BR07	-1395027.919	1482849.609	2,127.3800	2,127.5171	BRUSH	0.1372
BR08	-1386185.162	1423945.167	2,230.1020	2,230.0936	BRUSH	(0.0085)
BR09	-1383514.520	1413428.362	2,132.6970	2,132.7524	BRUSH	0.0554
BR10	-1413520.517	1475211.726	2,278.7210	2,278.6931	BRUSH	(0.0278)
BR11	-1409625.548	1480468.524	2,834.1540	2,834.3760	BRUSH	0.2219
BR12	-1390783.267	1473437.054	2,010.4130	2,010.4808	BRUSH	0.0678
BR13	-1384812.210	1467222.226	1,885.2620	1,885.3898	BRUSH	0.1278
BR14	-1402919.141	1467447.110	2,159.9540	2,159.9660	BRUSH	0.0119
BR15	-1414188.947	1472114.183	2,236.1500	2,235.9616	BRUSH	(0.1883)
BR16	-1386111.394	1406024.121	2,106.6800	2,106.6814	BRUSH	0.0015
BR17	-1393748.315	1462712.694	2,017.0160	2,017.0311	BRUSH	0.0151
HG01	-1408145.385	1460651.072	2,109.1170	2,109.1663	HIGH GRASS	0.0494
HG02	-1414994.924	1455965.391	2,112.4750	2,112.4384	HIGH GRASS	(0.0367)
HG03	-1421621.113	1452171.454	2,173.3030	2,173.2508	HIGH GRASS	(0.0522)
HG04	-1403184.888	1455272.176	2,080.5890	2,080.8325	HIGH GRASS	0.2434
HG05	-1412759.523	1466437.154	2,192.2160	2,192.1411	HIGH GRASS	(0.0750)
HG06	-1411183.574	1464905.222	2,154.5910	2,154.5645	HIGH GRASS	(0.0266)
HG07	-1411516.949	1453511.758	2,056.3180	2,056.3177	HIGH GRASS	(0.0004)
HG08	-1402500.833	1454554.295	2,076.8090	2,076.8046	HIGH GRASS	(0.0045)

HG09	-1392434.942	1446662.625	2,104.1950	2,104.2594	HIGH GRASS	0.0643
HG10	-1392267.662	1441489.705	2,116.1700	2,116.3203	HIGH GRASS	0.1504
HG11	-1395824.819	1437208.196	2,192.3050	2,192.3807	HIGH GRASS	0.0758
HG12	-1396810.750	1432812.280	2,175.9140	2,175.9173	HIGH GRASS	0.0032
HG13	-1393169.567	1428915.510	2,219.9510	2,220.0801	HIGH GRASS	0.1292
HG14	-1395654.663	1416841.987	2,242.3460	2,242.2871	HIGH GRASS	(0.0588)
HG15	-1393358.534	1411247.031	2,284.5930	2,284.7275	HIGH GRASS	0.1345
HG16	-1409555.394	1389428.555	1,910.7920	1,910.8075	HIGH GRASS	0.0155
HG17	-1383647.898	1483078.993	1,889.5090	1,889.7525	HIGH GRASS	0.2435
TR01	-1411186.035	1433398.498	1,977.5740	1,977.6043	TREE	0.0303
TR02	-1399085.396	1483129.821	2,373.4380	2,373.5381	TREE	0.1001
TR03	-1406428.096	1486457.915	2,567.6620	2,567.6764	TREE	0.0143
TR04	-1414957.397	1483327.031	2,484.7030	2,484.6628	TREE	(0.0401)
TR05	-1408809.619	1425936.990	1,978.3510	1,978.3128	TREE	(0.0382)
TR06	-1394581.209	1412757.601	2,309.3370	2,309.3329	TREE	(0.0040)
TR07	-1397703.649	1449542.307	2,086.5280	2,086.5618	TREE	0.0337
TR08	-1415365.056	1489899.471	2,413.2740	2,413.2573	TREE	(0.0166)
TR09	-1405361.644	1416400.635	1,956.6760	1,956.7394	TREE	0.0634
TR10	-1400883.530	1450333.340	2,095.6840	2,095.6380	TREE	(0.0461)
TR11	-1417132.057	1501499.526	2,185.3100	2,185.3418	TREE	0.0317
TR12	-1394505.263	1460692.627	2,047.2530	2,047.2133	TREE	(0.0398)
TR13	-1415125.463	1499094.929	2,225.2940	2,225.4598	TREE	0.1659
TR14	-1405579.349	1494086.480	2,229.7190	2,229.6560	TREE	(0.0630)
TR15	-1412300.510	1492705.608	2,350.0930	2,349.9627	TREE	(0.1303)
TR16	-1404983.693	1469714.881	2,206.7800	2,206.7384	TREE	(0.0416)
TR17	-1410737.722	1455568.117	2,063.7640	2,063.8544	TREE	0.0905
XVVA101	-1401600.526	1466107.922	2,086.3250	2,086.3699	BRUSH	0.0449
XVVA102	-1389167.012	1462699.375	1,956.2310	1,956.3001	BRUSH	0.0691
XVVA103	-1394608.889	1484985.126	2,237.0540	2,237.1431	BRUSH	0.0891
XVVA104	-1410214.142	1473230.294	2,248.1900	2,248.1512	BRUSH	(0.0387)
XVVA105	-1400432.527	1450830.764	2,093.9280	2,093.8874	BRUSH	(0.0406)
XVVA106	-1385591.531	1432439.787	2,212.2130	2,212.1367	BRUSH	(0.0762)
XVVA107	-1408307.871	1462737.347	2,098.5870	2,098.5492	BRUSH	(0.0377)
XVVA501	-1394262.294	1420478.142	2,274.9970	2,274.9444	BRUSH	(0.0527)
XVVA502	-1385799.944	1425377.820	2,219.9010	2,219.8518	BRUSH	(0.0491)
XVVA503	-1402756.296	1396817.756	1,894.8010	1,894.8444	BRUSH	0.0434
XVVA703	-1408136.267	1460678.754	2,109.6860	2,109.7366	BRUSH	0.0506

Table 16: DEM Check Point Assessment