

The logo graphic consists of three curved, parallel yellow lines that sweep from the left side towards the right, positioned above the word "atlantic".

atlantic

Project Report

TASK ORDER NAME: Mid-Region Council of Governments (MRCOG) – New Mexico
ATLANTIC PROJECT NUMBER: 18001

TABLE OF CONTENTS

SECTION I: PROJECT OVERVIEW & PURPOSE	3
1. Aerial LiDAR Project.....	3
<i>a. Project Overview.....</i>	3
<i>b. Client Contact Information.....</i>	3
<i>c. Contract Deliverables</i>	4
SECTION II: FIELD OPERATIONS.....	5
1. Aerial LiDAR Project – Aerial Acquisition.....	5
<i>a. Aircraft & Sensor Information</i>	5
<i>b. Sensor Acquisition Information</i>	5
<i>c. Flight Plan Execution</i>	6
<i>d. GNSS Reference Stations.....</i>	7
2. Aerial LiDAR Project – Ground Acquisition.....	8
<i>a. Ground Control Survey.....</i>	8
SECTION III: DATA PRODUCTION	14
3. Aerial LiDAR Project – Calibration/Classification	14
<i>a. LiDAR Point Cloud Generation.....</i>	14
<i>b. Coordinate Reference System</i>	14
<i>c. LiDAR Point Cloud Statistics.....</i>	14
<i>d. Smooth Surface Repeatability (Interswath).....</i>	14
<i>e. LiDAR Calibration.....</i>	14
<i>f. LiDAR Classification</i>	15
<i>g. Hydro-line Collection/Conflation.....</i>	15
<i>h. Bare-Earth Surface – Digital Elevation Model (DEM).....</i>	15
SECTION IV: ACCURACY ASSESSMENT	16
1. Aerial LiDAR Project – Vertical Accuracy Assessment.....	16
<i>a. Requirements</i>	16
<i>b. Results.....</i>	16
SECTION V: CERTIFICATION STATEMENTS	17
1. Aerial LiDAR Project.....	17
SECTION VI: CONTROL POINT ASSESSMENTS.....	18
1. Aerial LiDAR Project.....	18
<i>a. Point Cloud Check Point Assessment</i>	18
<i>b. Digital Elevation Model (DEM) Check Point Assessment.....</i>	21

SECTION I: PROJECT OVERVIEW & PURPOSE

1. Aerial LiDAR Project

a. Project Overview

The Mid-Region Council of Governments – New Mexico (MRCOG) is coordinating a project with public and private entities to acquire Light Detection and Ranging (LiDAR) data and derivatives that meet USGS QL2 specifications or better (spatial resolution: 2 ft. or better and vertical accuracy: 3.9 in or better). The metropolitan area includes urban, suburban and rural landscapes in Bernalillo, Sandoval, Torrance, and Valencia Counties. Terrain varies across the area, with river valleys, sloping mesas, rugged foothills, and mountainous areas reaching over 10,000 feet in elevation.

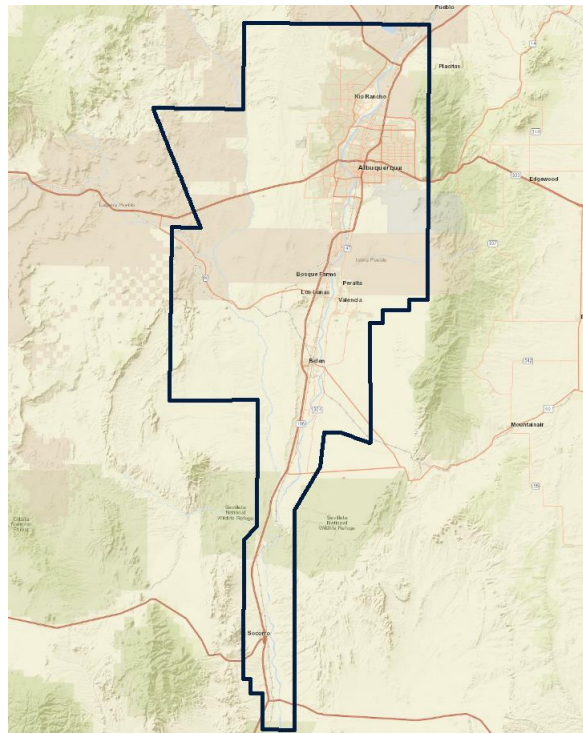


Figure 1: Aerial LiDAR Project Overview – Defined Project Area (DPA) and Associated Areas of Interest (AOIs)

b. Client Contact Information

Client Contact Information	
Name of Contact	Forest B. Replogle
Telephone	(505) 843-1711
E-Mail Address	FReplogle@mrcog-nm.gov
Mailing Address	809 Copper Ave NW
City	Albuquerque
State or Province	New Mexico
Postal Code	87102

Table 1: Aerial LiDAR Client Contact Information

c. Contract Deliverables

Item	Specification/Format
LAS Swaths	.las
LAS Tiles	.las
DEMs	.tif
Hydrolines	.shp
Control Point Shapefile	.shp
Check Point Shapefile	.shp
Survey Report	.pdf
LiDAR Report	.pdf
FGDC Metadata	.xml

Table 2: Aerial LiDAR Contract Deliverables

SECTION II: FIELD OPERATIONS

1. Aerial LiDAR Project – Aerial Acquisition

a. Aircraft & Sensor Information

Atlantic operated a Cessna (N732JE) outfitted with a Leica ALS70-HP LiDAR system during the collection of the project area. The specifications of this system are presented in the following table:

Parameter	Specification
Model	ALS70-HP
Manufacturer	Leica
Platform	Fixed-Wing
Scan Pattern	Sine, Triangle, Raster
Maximum Scan Rate (Hz)	Sine: 200 Triangle: 158 Raster: 120
Field of View (°)	0 – 75 (Full Angle, User Adjustable)
Maximum Pulse Rate (kHz)	500
Maximum Flying Height (m AGL)	3500
Number of Returns	Unlimited
Number of Intensity Measurements	3 (First, Second, Third)
Roll Stabilization (Automatic Adaptive, °)	75 - Active FOV
Storage Media	Removable 500 GB SSD
Storage Capacity (Hours @ Max Pulse Rate)	6
Size (cm)	Scanner: 37 W x 68 L x 26 H Control Electronics: 45 W x 47 D x 36 H
Weight (kg)	Scanner: 43 Control Electronics: 45
Operation Temperature (°C)	0 – 40
Flight Management	FCMS
Power Consumption	927 @ 22.0 – 30.3 VDC

Table3: System Specifications – ALS70-HP

b. Sensor Acquisition Information

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

Parameter	Specification
System	Leica ALS70-HP
Nominal Pulse Spacing (m)	0.66
Nominal Pulse Density (pls/m²)	2.2
Nominal Flight Height (AGL meters)	2,255
Nominal Flight Speed (kts)	130
Pass Heading (°)	Varies
Sensor Scan Angle (°)	40-30
Scan Frequency (Hz)	34.7
Pulse Rate of Scanner (kHz)	249.2

Parameter	Specification
Line Spacing (m)	1,185
Pulse Duration of Scanner (ns)	4
Pulse Width of Scanner (m)	0.48
Central Wavelength of Sensor Laser (nm)	1064
Sensor Operated with Multiple Pulses	Yes
Beam Divergence (mrad)	0.22
Nominal Swath Width (m)	1,061
Nominal Swath Overlap (%)	20
Scan Pattern	Triangle

Table 4: Aerial LiDAR Sensor Acquisition Parameters

c. Flight Plan Execution

Atlantic acquired 133 passes of the AOI as a series of perpendicular and/or adjacent flight-lines executed in 19 flight missions completed on April 9th, 2018. Onboard differential Global Navigation Satellite System (GNSS) unit(s) recorded sample aircraft positions at 2 hertz (Hz) or more frequency. LiDAR data was only acquired when a minimum of six (6) satellites were in view.

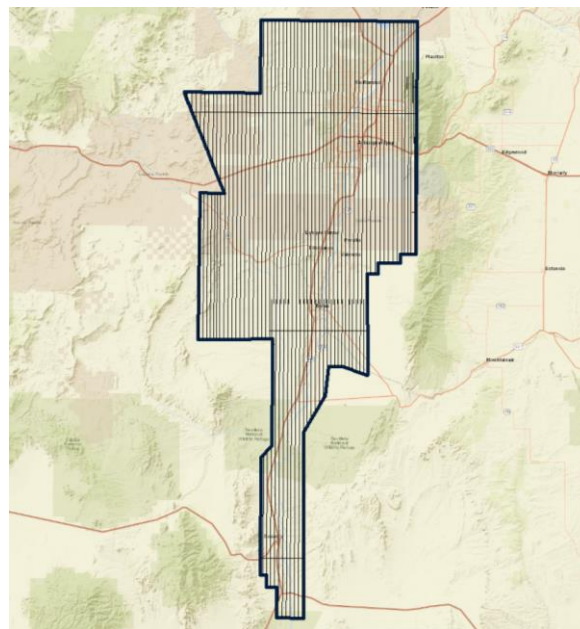


Figure 2: Orientation of Executed Flight-lines and LiDAR DPA

d. GNSS Reference Stations

Four (4) 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
NMSF	CORS	DF4369	35 40 25.62398	105 57 30.93089	2097.239
NMGR	CORS	DI0438	35 12 59.64999	107 55 48.36832	2021.631
ZAB1	CORS	DE6386	35 10 24.85464	106 34 02.41357	1620.623
ZAB2	CORS	DE6388	35 10 24.85235	106 34 02.19263	1620.690

Table 5: GNSS Reference Stations

2. Aerial LiDAR Project – Ground Acquisition

a. Ground Control Survey

A total of 152 ground survey points were collected in support of this project, including 19 LiDAR Control Points (LCP), 72 Non-vegetated Vertical Accuracy (NVA) and 61 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:

<u>ID</u>	<u>Easting</u>	<u>Northing</u>	<u>Elevation</u>	<u>Description</u>
LCP11	1517690.202	1443159.160	4980.675	CONTROL
LCP14	1484597.271	1363829.100	4829.230	CONTROL
LCP04	1499856.014	1554937.731	5750.416	CONTROL
PID25	1480008.696	1319829.644	4814.909	CONTROL
PID05	1461186.070	1217135.876	4733.341	CONTROL
PID07	1530867.144	1273344.784	5183.796	CONTROL
PID06	1541761.675	1268614.504	5270.815	CONTROL
LCP17	1486132.788	1285005.823	4790.122	CONTROL
PID03	1452107.276	1051444.583	4535.320	CONTROL
PID08	1486693.045	1392689.350	4976.060	CONTROL
LCP21	1452525.477	1060308.546	4557.679	CONTROL
LCP12	1573271.214	1419254.548	5790.562	CONTROL
LCP22	1422451.030	1465353.356	5513.226	CONTROL
PID16	1560368.436	1471131.963	5495.848	CONTROL
PID27	1523998.985	1606223.883	5385.654	CONTROL
PID01	1427149.101	1375951.089	5120.607	CONTROL
LCP19	1441148.577	1171407.225	4658.457	CONTROL
PID32	1518094.955	1298295.000	5075.129	CONTROL

<u>ID</u>	<u>Easting</u>	<u>Northing</u>	<u>Elevation</u>	<u>Description</u>
PID11	1531246.804	1495873.989	5088.053	CONTROL
PID13	1531246.769	1495873.975	5088.045	CONTROL
PID12	1531246.770	1495873.958	5088.039	CONTROL
LCP08	1409579.542	1479091.391	5622.887	CONTROL
LCP20	1457632.815	1097535.190	4636.343	CONTROL
LCP03	1386565.297	1471426.399	5617.090	CONTROL
BE19	1432127.594	1375709.326	5142.181	NVA
BE08	1556260.903	1475607.775	5476.427	NVA
OT08	1416286.237	1490374.684	5465.932	NVA
OT26	1512269.433	1485968.865	4952.283	NVA
UR26	1518060.647	1298290.078	5075.645	NVA
BE17	1457165.230	1053473.005	4539.378	NVA
UR22	1388319.839	1421867.527	5345.615	NVA
OT10	1458427.278	1442428.551	5594.245	NVA
UR24	1555121.388	1367689.723	5470.585	NVA
BE14	1446599.825	1163380.872	4659.144	NVA
OT02	1395287.430	1414816.319	5301.526	NVA
OT01	1376918.037	1431325.346	5446.475	NVA
OT15	1536482.687	1532554.168	5009.103	NVA
UR19	1461119.581	1236991.327	4735.637	NVA
BE09	1556048.050	1422394.646	5483.361	NVA
BE01	1445209.433	1323615.082	4902.931	NVA
BE13	1460420.682	1216369.060	4726.052	NVA
OT09	1401180.409	1394627.647	5134.026	NVA
BE12	1490941.386	1294263.781	4867.786	NVA
UR08	1530988.167	1485263.095	5183.155	NVA
UR10	1463953.419	1374039.410	5286.817	NVA
OT11	1518664.997	1545231.547	5317.038	NVA
UR20	1469483.310	1535978.614	5903.875	NVA
UR13	1455194.794	1504354.642	6002.252	NVA
UR06	1520826.887	1424482.240	5246.661	NVA
BE04	1458674.842	1543786.971	6142.186	NVA
OT23	1447136.478	1202135.905	4812.139	NVA
UR04	1453785.882	1124841.215	4622.291	NVA
UR15	1542148.464	1386666.516	5271.570	NVA
UR25	1517233.816	1341338.660	5014.380	NVA
OT22	1447201.698	1085679.332	4594.936	NVA
UR21	1434107.201	1477511.795	5303.083	NVA
BE10	1519700.296	1381899.123	5041.944	NVA

<u>ID</u>	<u>Easting</u>	<u>Northing</u>	<u>Elevation</u>	<u>Description</u>
UR02	1457355.421	1070039.360	4554.534	NVA
OT05	1443491.325	1153849.230	4629.540	NVA
OT06	1462686.952	1286959.042	5092.354	NVA
BE24	1456956.975	1338252.192	5198.326	NVA
BE18	1445198.171	1128701.435	4626.072	NVA
OT13	1469197.450	1508556.969	5864.396	NVA
OT04	1438002.384	1487945.955	5358.011	NVA
OT21	1442338.522	1184523.321	4662.949	NVA
BE25	1520909.668	1323649.182	5041.988	NVA
OT07	1465497.050	1389045.978	5329.046	NVA
BE15	1457588.312	1097563.888	4636.014	NVA
PID02	1386598.400	1471439.132	5616.209	NVA
LCP24	1406472.161	1506265.361	5638.418	NVA
OT25	1468643.680	1457369.861	5650.010	NVA
UR16	1498062.949	1509029.375	5323.261	NVA
UR23	1371946.366	1518056.607	6394.645	NVA
LCP01	1427107.605	1375848.852	5121.957	NVA
LCP07	1458405.512	1475104.295	5864.843	NVA
PID19	1497658.382	1532751.921	5414.296	NVA
PID28	1549953.542	1384231.336	5402.478	NVA
LCP16	1464709.146	1301941.646	5176.017	NVA
UR14	1566923.872	1477799.190	5551.646	NVA
BE03	1405259.322	1513606.978	5768.032	NVA
UR11	1506981.602	1396465.650	4862.101	NVA
UR07	1500096.628	1446468.825	4909.069	NVA
BE16	1468508.633	1253579.764	4737.779	NVA
BE26	1559138.304	1579684.440	5088.198	NVA
UR12	1550481.760	1565906.562	5050.585	NVA
BE02	1386463.962	1468723.859	5635.641	NVA
BE20	1439024.611	1416765.196	5622.291	NVA
PID18	1497658.377	1532751.950	5414.225	NVA
BE22	1482129.225	1416394.566	5087.511	NVA
BE07	1536819.012	1512018.880	5128.285	NVA
LCP06	1526469.203	1472110.519	5155.712	NVA
PID20	1548855.299	1522446.337	5429.781	NVA
OT24	1481807.410	1344741.015	4816.471	NVA
OT12	1491183.857	1524260.896	5545.916	NVA
UR17	1520810.125	1299872.668	5051.902	NVA
OT03	1386469.866	1468752.882	5635.619	NVA

<u>ID</u>	<u>Easting</u>	<u>Northing</u>	<u>Elevation</u>	<u>Description</u>
LCP09	1431980.046	1420584.512	5632.975	NVA
PID35	1402723.126	1391985.545	5134.627	NVA
OT17	1460085.867	1422140.413	5471.382	NVA
OT14	1479572.672	1581587.507	6066.825	NVA
BE06	1529769.723	1556509.551	5169.921	NVA
PID33	1416618.246	1382042.535	5058.016	NVA
OT20	1476523.031	1316643.847	4896.761	NVA
BR13	1463481.504	1319751.492	5188.035	VVA
HG11	1514210.707	1416945.462	4883.956	VVA
HG04	1442746.742	1140967.151	4667.607	VVA
HG09	1576105.245	1477779.301	5788.150	VVA
BR16	1451178.226	1044657.521	4532.850	VVA
TR15	1519786.318	1502337.386	4971.810	VVA
TR16	1519800.116	1502337.079	4971.803	VVA
TR04	1456529.349	1077022.831	4558.186	VVA
HG10	1555327.132	1380216.172	5515.021	VVA
TR03	1450556.640	1135727.979	4613.995	VVA
TR14	1545882.665	1490057.260	5290.325	VVA
BR09	1458478.431	1532655.058	6126.222	VVA
TR07	1486550.380	1388656.370	4963.761	VVA
TR12	1491344.961	1572873.267	5856.167	VVA
HG05	1442871.222	1189845.702	4680.075	VVA
BR20	1546011.696	1577324.741	5157.690	VVA
HG13	1488146.351	1585458.329	5980.660	VVA
BR02	1406170.441	1387292.583	5108.255	VVA
HG02	1403628.348	1458532.251	5491.615	VVA
HG21	1454480.934	1366299.000	5299.598	VVA
HG16	1431729.244	1466043.550	5275.823	VVA
TR10	1433912.246	1412951.441	5582.384	VVA
HG12	1517480.859	1518682.714	4986.335	VVA
HG08	1386340.687	1517249.069	5775.518	VVA
HG01	1376858.933	1431335.424	5445.181	VVA
BR17	1455646.639	1106878.754	4627.486	VVA
TR05	1458512.176	1241130.902	4741.154	VVA
BR10	1546242.480	1556423.186	5034.815	VVA
HG07	1464162.031	1417065.878	5443.682	VVA
HG03	1438060.488	1487917.067	5358.768	VVA
TR09	1556116.499	1474542.088	5470.328	VVA
TR13	1538577.528	1567130.499	5198.560	VVA

<u>ID</u>	<u>Easting</u>	<u>Northing</u>	<u>Elevation</u>	<u>Description</u>
TR19	1490867.645	1329924.229	4805.968	VVA
TR01	1406097.043	1387356.774	5105.213	VVA
BR06	1466902.426	1568948.693	6179.257	VVA
BR04	1537609.602	1426253.007	5234.245	VVA
HG17	1399255.692	1399571.640	5231.761	VVA
HG20	1478665.136	1501263.049	5799.698	VVA
HG18	1515441.581	1369451.862	5016.724	VVA
BR07	1528635.231	1386755.587	5127.320	VVA
TR11	1459090.292	1466566.127	5787.677	VVA
BR03	1502066.751	1374316.583	4841.343	VVA
BR01	1445112.287	1323625.934	4902.375	VVA
BR05	1495780.200	1420554.219	5022.986	VVA
TR18	1496236.546	1396622.029	4863.324	VVA
HG14	1463614.144	1552132.169	6116.910	VVA
HG22	1460005.838	1558854.341	6251.003	VVA
TR17	1491553.316	1463644.763	5148.081	VVA
TR08	1403267.766	1391064.521	5130.762	VVA
BR14	1449313.204	1386129.092	5353.150	VVA
TR06	1478985.951	1302033.160	4795.599	VVA
BR19	1496555.890	1482641.544	5125.675	VVA
HG19	1555734.560	1528854.207	5643.769	VVA
HG15	1506354.995	1542562.748	5390.882	VVA
TR02	1403620.815	1458489.509	5491.523	VVA
BR11	1553010.656	1506309.965	5498.097	VVA
BR18	1471438.035	1263256.197	4763.901	VVA
BR15	1460948.776	1211476.666	4717.781	VVA
HG06	1473276.740	1274051.814	4757.063	VVA
BR08	1388182.576	1487008.847	5590.751	VVA
BR12	1525206.323	1460667.437	5194.093	VVA

Table 6: LiDAR Control Point Coordinates

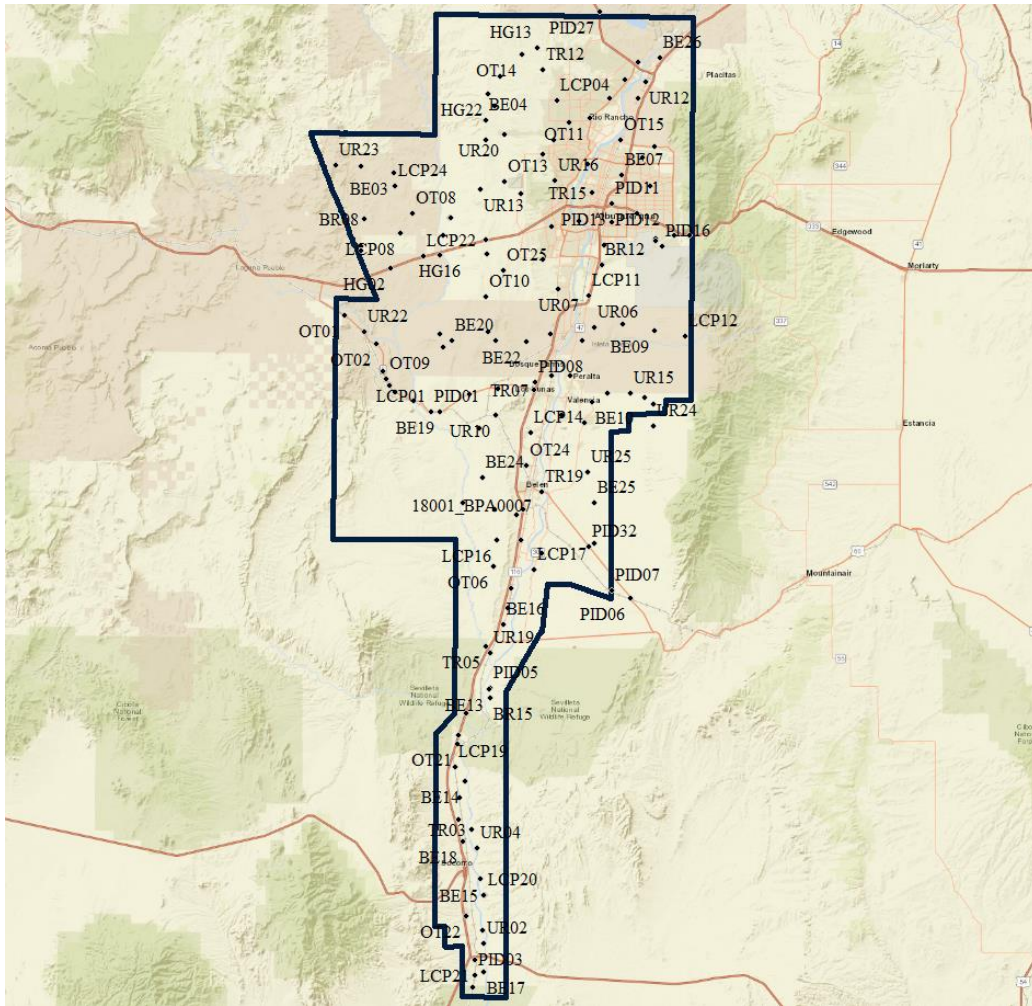


Figure 3: LiDAR Control Point Distribution

SECTION III: DATA PRODUCTION

3. Aerial LiDAR Project – Calibration/Classification

a. 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.

b. Coordinate Reference System

Horizontal Datum: North American Datum of 1983 HARN (1992)
Coordinate System: State Plane New Mexico Central
Vertical Datum: NAVD88
Geoid Model: 12B
Units of Reference: US Feet

c. LiDAR Point Cloud Statistics

Category	Value
Total Points	25,092,268,912
Nominal Pulse Spacing (m)	1.6162
Nominal Pulse Density (pls/m²)	0.3828
Nominal Pulse Spacing (ft)	5.3026
Nominal Pulse Density (pls/ft²)	0.0356
Aggregate Total Points	21,650,815,789
Aggregate Nominal Pulse Spacing (m)	0.4604
Aggregate Nominal Pulse Density (pls/m²)	4.7186
Aggregate Nominal Pulse Spacing (ft)	1.5104
Aggregate Nominal Pulse Density (pls/ft²)	0.4384

Table 7: LiDAR Point Cloud Statistics

d. 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.

e. 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 ≤ 2 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.

f. 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 classes 9 (Water) and 10 (Ignored Ground).

Code	Description
1	Unclassified
2	Ground
3	Low Vegetation
4	Medium Vegetation
5	High Vegetation
6	Building
7	Low Point (Noise)
9	Water
10	Ignored Ground
17	Bridges
18	High Point (Noise)
Flags	Overlap & Withheld

Table 8: LiDAR Point Classification Codes and Descriptions

g. 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.

h. 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 2 feet. DEMs for this project were cut to match the tile index and its corresponding tile names and delivered in 32-bit floating point .tif format.

SECTION IV: ACCURACY ASSESSMENT

1. Aerial LiDAR Project – Vertical Accuracy Assessment

a. 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 95 th 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 9: 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).

b. Results

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

Broad Land Cover Type	# of Points	RMSEz	95% Confidence Level	95th Percentile
NVA of Point Cloud	79	0.2950	0.5782	0.4444
VVA of Point Cloud	61	0.4500	0.8821	0.9890
NVA of DEM	79	0.2937	0.5757	0.4478
VVA of DEM	61	0.4479	0.8778	0.9629

Table 10: NVA/VVA Accuracies

SECTION V: CERTIFICATION STATEMENTS

1. Aerial LiDAR Project

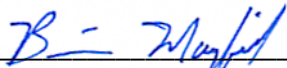
This accuracy assessment confirms that the data may be used for the intended applications stated in Section I of this document. This dataset may also be used as a topographic input for other applications, but the user should be aware that this LiDAR dataset was designed with a specific purpose and was 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 VI: CONTROL POINT ASSESSMENTS

1. Aerial LiDAR Project

a. Point Cloud Check Point Assessment

Point ID	Easting	Northing	KnownZ	LaserZ	Description	DeltaZ
BE19	1432127.594	1375709.326	5,142.1810	5,142.1800	BARE EARTH	(0.0010)
BE08	1556260.903	1475607.775	5,476.4270	5,476.4300	BARE EARTH	0.0030
OT08	1416286.237	1490374.684	5,465.9320	5,465.9400	OPEN TERRAIN	0.0080
OT26	1512269.433	1485968.865	4,952.2830	4,952.2600	OPEN TERRAIN	(0.0230)
UR26	1518060.647	1298290.078	5,075.6450	5,075.6100	URBAN TERRAIN	(0.0350)
BE17	1457165.230	1053473.005	4,539.3780	4,539.4200	BARE EARTH	0.0420
UR22	1388319.839	1421867.527	5,345.6150	5,345.6600	URBAN TERRAIN	0.0450
OT10	1458427.278	1442428.551	5,594.2450	5,594.1900	OPEN TERRAIN	(0.0550)
UR24	1555121.388	1367689.723	5,470.5850	5,470.5300	URBAN TERRAIN	(0.0550)
BE14	1446599.825	1163380.872	4,659.1440	4,659.2100	BARE EARTH	0.0660
OT02	1395287.430	1414816.319	5,301.5260	5,301.6000	OPEN TERRAIN	0.0740
OT01	1376918.037	1431325.346	5,446.4750	5,446.5500	OPEN TERRAIN	0.0750
OT15	1536482.687	1532554.168	5,009.1030	5,009.1800	OPEN TERRAIN	0.0770
UR19	1461119.581	1236991.327	4,735.6370	4,735.5600	URBAN TERRAIN	(0.0770)
BE09	1556048.050	1422394.646	5,483.3610	5,483.4600	BARE EARTH	0.0990
BE01	1445209.433	1323615.082	4,902.9310	4,902.8300	BARE EARTH	(0.1010)
BE13	1460420.682	1216369.060	4,726.0520	4,725.9500	BARE EARTH	(0.1020)
OT09	1401180.409	1394627.647	5,134.0260	5,134.1400	OPEN TERRAIN	0.1140
BE12	1490941.386	1294263.781	4,867.7860	4,867.9100	BARE EARTH	0.1240
UR08	1530988.167	1485263.095	5,183.1550	5,183.2900	URBAN TERRAIN	0.1350
UR10	1463953.419	1374039.410	5,286.8170	5,286.9600	URBAN TERRAIN	0.1430
OT11	1518664.997	1545231.547	5,317.0380	5,317.1900	OPEN TERRAIN	0.1520
UR20	1469483.310	1535978.614	5,903.8750	5,904.0300	URBAN TERRAIN	0.1550
UR13	1455194.794	1504354.642	6,002.2520	6,002.0900	URBAN TERRAIN	(0.1620)
UR06	1520826.887	1424482.240	5,246.6610	5,246.4900	URBAN TERRAIN	(0.1710)
BE04	1458674.842	1543786.971	6,142.1860	6,142.0100	BARE EARTH	(0.1760)
OT23	1447136.478	1202135.905	4,812.1390	4,811.9600	OPEN TERRAIN	(0.1790)
UR04	1453785.882	1124841.215	4,622.2910	4,622.1100	URBAN TERRAIN	(0.1810)
UR15	1542148.464	1386666.516	5,271.5700	5,271.7600	URBAN TERRAIN	0.1900
UR25	1517233.816	1341338.660	5,014.3800	5,014.5700	URBAN TERRAIN	0.1900
OT22	1447201.698	1085679.332	4,594.9360	4,594.7400	OPEN TERRAIN	(0.1960)
UR21	1434107.201	1477511.795	5,303.0830	5,302.8800	URBAN TERRAIN	(0.2030)
BE10	1519700.296	1381899.123	5,041.9440	5,042.1500	BARE EARTH	0.2060
UR02	1457355.421	1070039.360	4,554.5340	4,554.3200	URBAN TERRAIN	(0.2140)
OT05	1443491.325	1153849.230	4,629.5400	4,629.3200	OPEN TERRAIN	(0.2200)

Point ID	Easting	Northing	KnownZ	LaserZ	Description	DeltaZ
OT06	1462686.952	1286959.042	5,092.3540	5,092.5900	OPEN TERRAIN	0.2360
BE24	1456956.975	1338252.192	5,198.3260	5,198.0800	BARE EARTH	(0.2460)
BE18	1445198.171	1128701.435	4,626.0720	4,625.8100	BARE EARTH	(0.2620)
OT13	1469197.450	1508556.969	5,864.3960	5,864.6600	OPEN TERRAIN	0.2640
OT04	1438002.384	1487945.955	5,358.0110	5,357.7400	OPEN TERRAIN	(0.2710)
OT21	1442338.522	1184523.321	4,662.9490	4,662.6700	OPEN TERRAIN	(0.2790)
BE25	1520909.668	1323649.182	5,041.9880	5,042.2700	BARE EARTH	0.2820
OT07	1465497.050	1389045.978	5,329.0460	5,329.3300	OPEN TERRAIN	0.2840
BE15	1457588.312	1097563.888	4,636.0140	4,636.3100	BARE EARTH	0.2960
PID02	1386598.400	1471439.132	5,616.2090	5,615.9100	BARE EARTH	(0.2990)
LCP24	1406472.161	1506265.361	5,638.4180	5,638.1100	BARE EARTH	(0.3080)
OT25	1468643.680	1457369.861	5,650.0100	5,650.3200	OPEN TERRAIN	0.3100
UR16	1498062.949	1509029.375	5,323.2610	5,323.5800	URBAN TERRAIN	0.3190
UR23	1371946.366	1518056.607	6,394.6450	6,394.3200	URBAN TERRAIN	(0.3250)
LCP01	1427107.605	1375848.852	5,121.9570	5,121.6300	BARE EARTH	(0.3270)
LCP07	1458405.512	1475104.295	5,864.8430	5,864.5100	BARE EARTH	(0.3330)
PID19	1497658.382	1532751.921	5,414.2960	5,414.6300	BARE EARTH	0.3340
PID28	1549953.542	1384231.336	5,402.4780	5,402.1400	BARE EARTH	(0.3380)
LCP16	1464709.146	1301941.646	5,176.0170	5,176.3600	BARE EARTH	0.3430
UR14	1566923.872	1477799.190	5,551.6460	5,551.9900	URBAN TERRAIN	0.3440
BE03	1405259.322	1513606.978	5,768.0320	5,767.6800	BARE EARTH	(0.3520)
UR11	1506981.602	1396465.650	4,862.1010	4,861.7400	URBAN TERRAIN	(0.3610)
UR07	1500096.628	1446468.825	4,909.0690	4,908.7000	URBAN TERRAIN	(0.3690)
BE16	1468508.633	1253579.764	4,737.7790	4,738.1500	BARE EARTH	0.3710
BE26	1559138.304	1579684.440	5,088.1980	5,088.5700	BARE EARTH	0.3720
UR12	1550481.760	1565906.562	5,050.5850	5,050.2100	URBAN TERRAIN	(0.3750)
BE02	1386463.962	1468723.859	5,635.6410	5,635.2600	BARE EARTH	(0.3810)
BE20	1439024.611	1416765.196	5,622.2910	5,621.8900	BARE EARTH	(0.4010)
PID18	1497658.377	1532751.950	5,414.2250	5,414.6300	BARE EARTH	0.4050
BE22	1482129.225	1416394.566	5,087.5110	5,087.1000	BARE EARTH	(0.4110)
BE07	1536819.012	1512018.880	5,128.2850	5,127.8500	BARE EARTH	(0.4350)
LCP06	1526469.203	1472110.519	5,155.7120	5,156.1500	BARE EARTH	0.4380
PID20	1548855.299	1522446.337	5,429.7810	5,430.2200	BARE EARTH	0.4390
OT24	1481807.410	1344741.015	4,816.4710	4,816.0300	OPEN TERRAIN	(0.4410)
OT12	1491183.857	1524260.896	5,545.9160	5,546.3600	OPEN TERRAIN	0.4440
UR17	1520810.125	1299872.668	5,051.9020	5,052.3500	URBAN TERRAIN	0.4480
OT03	1386469.866	1468752.882	5,635.6190	5,635.1700	OPEN TERRAIN	(0.4490)
LCP09	1431980.046	1420584.512	5,632.9750	5,632.5200	BARE EARTH	(0.4550)
PID35	1402723.126	1391985.545	5,134.6270	5,134.1600	BARE EARTH	(0.4670)

Point ID	Easting	Northing	KnownZ	LaserZ	Description	DeltaZ
OT17	1460085.867	1422140.413	5,471.3820	5,470.9100	OPEN TERRAIN	(0.4720)
OT14	1479572.672	1581587.507	6,066.8250	6,067.3100	OPEN TERRAIN	0.4850
BE06	1529769.723	1556509.551	5,169.9210	5,170.4100	BARE EARTH	0.4890
PID33	1416618.246	1382042.535	5,058.0160	5,057.5200	BARE EARTH	(0.4960)
OT20	1476523.031	1316643.847	4,896.7610	4,897.2600	OPEN TERRAIN	0.4990
BR13	1463481.504	1319751.492	5,188.0350	5,188.0500	BRUSH	0.0150
HG11	1514210.707	1416945.462	4,883.9560	4,883.9300	HIGH GRASS	(0.0260)
HG04	1442746.742	1140967.151	4,667.6070	4,667.5800	HIGH GRASS	(0.0270)
HG09	1576105.245	1477779.301	5,788.1500	5,788.1200	HIGH GRASS	(0.0300)
BR16	1451178.226	1044657.521	4,532.8500	4,532.8000	BRUSH	(0.0500)
TR15	1519786.318	1502337.386	4,971.8100	4,971.8600	TREE	0.0500
TR16	1519800.116	1502337.079	4,971.8030	4,971.8600	TREE	0.0570
TR04	1456529.349	1077022.831	4,558.1860	4,558.2500	TREE	0.0640
HG10	1555327.132	1380216.172	5,515.0210	5,515.0900	HIGH GRASS	0.0690
TR03	1450556.640	1135727.979	4,613.9950	4,614.0700	TREE	0.0750
TR14	1545882.665	1490057.260	5,290.3250	5,290.4000	TREE	0.0750
BR09	1458478.431	1532655.058	6,126.2220	6,126.3000	BRUSH	0.0780
TR07	1486550.380	1388656.370	4,963.7610	4,963.8400	TREE	0.0790
TR12	1491344.961	1572873.267	5,856.1670	5,856.2500	TREE	0.0830
HG05	1442871.222	1189845.702	4,680.0750	4,680.1600	HIGH GRASS	0.0850
BR20	1546011.696	1577324.741	5,157.6900	5,157.7800	BRUSH	0.0900
HG13	1488146.351	1585458.329	5,980.6600	5,980.7600	HIGH GRASS	0.1000
BR02	1406170.441	1387292.583	5,108.2550	5,108.1500	BRUSH	(0.1050)
HG02	1403628.348	1458532.251	5,491.6150	5,491.5100	HIGH GRASS	(0.1050)
HG21	1454480.934	1366299.000	5,299.5980	5,299.7200	HIGH GRASS	0.1220
HG16	1431729.244	1466043.550	5,275.8230	5,275.7000	HIGH GRASS	(0.1230)
TR10	1433912.246	1412951.441	5,582.3840	5,582.2500	TREE	(0.1340)
HG12	1517480.859	1518682.714	4,986.3350	4,986.1800	HIGH GRASS	(0.1550)
HG08	1386340.687	1517249.069	5,775.5180	5,775.3300	HIGH GRASS	(0.1880)
HG01	1376858.933	1431335.424	5,445.1810	5,445.3700	HIGH GRASS	0.1890
BR17	1455646.639	1106878.754	4,627.4860	4,627.2900	BRUSH	(0.1960)
TR05	1458512.176	1241130.902	4,741.1540	4,741.3500	TREE	0.1960
BR10	1546242.480	1556423.186	5,034.8150	5,035.0200	BRUSH	0.2050
HG07	1464162.031	1417065.878	5,443.6820	5,443.9000	HIGH GRASS	0.2180
HG03	1438060.488	1487917.067	5,358.7680	5,358.5400	HIGH GRASS	(0.2280)
TR09	1556116.499	1474542.088	5,470.3280	5,470.0900	TREE	(0.2380)
TR13	1538577.528	1567130.499	5,198.5600	5,198.8200	TREE	0.2600
TR19	1490867.645	1329924.229	4,805.9680	4,806.2300	TREE	0.2620
TR01	1406097.043	1387356.774	5,105.2130	5,104.9400	TREE	(0.2730)

Point ID	Easting	Northing	KnownZ	LaserZ	Description	DeltaZ
BR06	1466902.426	1568948.693	6,179.2570	6,178.9700	BRUSH	(0.2870)
BR04	1537609.602	1426253.007	5,234.2450	5,234.5400	BRUSH	0.2950
HG17	1399255.692	1399571.640	5,231.7610	5,232.0700	HIGH GRASS	0.3090
HG20	1478665.136	1501263.049	5,799.6980	5,800.0200	HIGH GRASS	0.3220
HG18	1515441.581	1369451.862	5,016.7240	5,016.4000	HIGH GRASS	(0.3240)
BR07	1528635.231	1386755.587	5,127.3200	5,127.6500	BRUSH	0.3300
TR11	1459090.292	1466566.127	5,787.6770	5,787.3300	TREE	(0.3470)
BR03	1502066.751	1374316.583	4,841.3430	4,840.9800	BRUSH	(0.3630)
BR01	1445112.287	1323625.934	4,902.3750	4,901.9900	BRUSH	(0.3850)
BR05	1495780.200	1420554.219	5,022.9860	5,023.3800	BRUSH	0.3940
TR18	1496236.546	1396622.029	4,863.3240	4,863.7200	TREE	0.3960
HG14	1463614.144	1552132.169	6,116.9100	6,116.4900	HIGH GRASS	(0.4200)
HG22	1460005.838	1558854.341	6,251.0030	6,250.5400	HIGH GRASS	(0.4630)
TR17	1491553.316	1463644.763	5,148.0810	5,148.5600	TREE	0.4790
TR08	1403267.766	1391064.521	5,130.7620	5,130.2800	TREE	(0.4820)
BR14	1449313.204	1386129.092	5,353.1500	5,352.6500	BRUSH	(0.5000)
TR06	1478985.951	1302033.160	4,795.5990	4,796.1300	TREE	0.5320
BR19	1496555.890	1482641.544	5,125.6750	5,126.2200	BRUSH	0.5450
HG19	1555734.560	1528854.207	5,643.7690	5,643.1800	HIGH GRASS	(0.5890)
HG15	1506354.995	1542562.748	5,390.8820	5,390.2800	HIGH GRASS	(0.6020)
TR02	1403620.815	1458489.509	5,491.5230	5,490.9200	TREE	(0.6030)
BR11	1553010.656	1506309.965	5,498.0970	5,497.4900	BRUSH	(0.6070)
BR18	1471438.035	1263256.197	4,763.9010	4,764.8200	BRUSH	0.9190
BR15	1460948.776	1211476.666	4,717.7810	4,718.7700	BRUSH	0.9890
HG06	1473276.740	1274051.814	4,757.0630	4,758.2600	HIGH GRASS	1.1970
BR08	1388182.576	1487008.847	5,590.7510	5,592.0600	BRUSH	1.3090
BR12	1525206.323	1460667.437	5,194.0930	5,195.5900	BRUSH	1.4970

Table 11: Point Cloud Check Point Assessment

b. Digital Elevation Model (DEM) Check Point Assessment

Point ID	Easting	Northing	KnownZ	DEMZ	Description	DeltaZ
BE01	1445209.433	1323615.082	4,902.9310	4,902.8158	BARE EARTH	(0.1154)
BE02	1386463.962	1468723.859	5,635.6410	5,635.2494	BARE EARTH	(0.3918)
BE03	1405259.322	1513606.978	5,768.0320	5,767.7284	BARE EARTH	(0.3038)
BE04	1458674.842	1543786.971	6,142.1860	6,141.9951	BARE EARTH	(0.1910)
BE06	1529769.723	1556509.551	5,169.9210	5,170.4002	BARE EARTH	0.4793
BE07	1536819.012	1512018.880	5,128.2850	5,127.8626	BARE EARTH	(0.4226)
BE08	1556260.903	1475607.775	5,476.4270	5,476.4239	BARE EARTH	(0.0029)
BE09	1556048.050	1422394.646	5,483.3610	5,483.4288	BARE EARTH	0.0680

Point ID	Easting	Northing	KnownZ	DEMZ	Description	DeltaZ
BE10	1519700.296	1381899.123	5,041.9440	5,042.1541	BARE EARTH	0.2102
BE12	1490941.386	1294263.781	4,867.7860	4,867.9520	BARE EARTH	0.1659
BE13	1460420.682	1216369.060	4,726.0520	4,725.9359	BARE EARTH	(0.1159)
BE14	1446599.825	1163380.872	4,659.1440	4,659.2211	BARE EARTH	0.0771
BE15	1457588.312	1097563.888	4,636.0140	4,636.3140	BARE EARTH	0.2999
BE16	1468508.633	1253579.764	4,737.7790	4,738.1763	BARE EARTH	0.3975
BE17	1457165.230	1053473.005	4,539.3780	4,539.4094	BARE EARTH	0.0314
BE18	1445198.171	1128701.435	4,626.0720	4,625.7704	BARE EARTH	(0.3014)
BE19	1432127.594	1375709.326	5,142.1810	5,142.1522	BARE EARTH	(0.0289)
BE20	1439024.611	1416765.196	5,622.2910	5,621.8777	BARE EARTH	(0.4133)
BE22	1482129.225	1416394.566	5,087.5110	5,087.0946	BARE EARTH	(0.4166)
BE24	1456956.975	1338252.192	5,198.3260	5,198.0855	BARE EARTH	(0.2406)
BE25	1520909.668	1323649.182	5,041.9880	5,042.2850	BARE EARTH	0.2972
BE26	1559138.304	1579684.440	5,088.1980	5,088.5382	BARE EARTH	0.3399
LCP01	1427107.605	1375848.852	5,121.9570	5,121.5752	BARE EARTH	(0.3818)
LCP06	1526469.203	1472110.519	5,155.7120	5,156.1575	BARE EARTH	0.4456
LCP07	1458405.512	1475104.295	5,864.8430	5,864.4986	BARE EARTH	(0.3442)
LCP09	1431980.046	1420584.512	5,632.9750	5,632.4984	BARE EARTH	(0.4767)
LCP16	1464709.146	1301941.646	5,176.0170	5,176.3320	BARE EARTH	0.3149
LCP24	1406472.161	1506265.361	5,638.4180	5,638.1198	BARE EARTH	(0.2982)
OT01	1376918.037	1431325.346	5,446.4750	5,446.5821	OPEN TERRAIN	0.1070
OT02	1395287.430	1414816.319	5,301.5260	5,301.5610	OPEN TERRAIN	0.0352
OT03	1386469.866	1468752.882	5,635.6190	5,635.2891	OPEN TERRAIN	(0.3301)
OT04	1438002.384	1487945.955	5,358.0110	5,357.7860	OPEN TERRAIN	(0.2252)
OT05	1443491.325	1153849.230	4,629.5400	4,629.3288	OPEN TERRAIN	(0.2112)
OT06	1462686.952	1286959.042	5,092.3540	5,092.5857	OPEN TERRAIN	0.2317
OT07	1465497.050	1389045.978	5,329.0460	5,329.3336	OPEN TERRAIN	0.2877
OT08	1416286.237	1490374.684	5,465.9320	5,465.9757	OPEN TERRAIN	0.0436
OT09	1401180.409	1394627.647	5,134.0260	5,134.0909	OPEN TERRAIN	0.0650
OT10	1458427.278	1442428.551	5,594.2450	5,594.1668	OPEN TERRAIN	(0.0784)
OT11	1518664.997	1545231.547	5,317.0380	5,317.1985	OPEN TERRAIN	0.1604
OT12	1491183.857	1524260.896	5,545.9160	5,546.3053	OPEN TERRAIN	0.3893
OT13	1469197.450	1508556.969	5,864.3960	5,864.6610	OPEN TERRAIN	0.2650
OT14	1479572.672	1581587.507	6,066.8250	6,067.3056	OPEN TERRAIN	0.4804
OT15	1536482.687	1532554.168	5,009.1030	5,009.1784	OPEN TERRAIN	0.0754
OT17	1460085.867	1422140.413	5,471.3820	5,470.9219	OPEN TERRAIN	(0.4599)
OT20	1476523.031	1316643.847	4,896.7610	4,897.2544	OPEN TERRAIN	0.4932
OT21	1442338.522	1184523.321	4,662.9490	4,662.6804	OPEN TERRAIN	(0.2688)
OT22	1447201.698	1085679.332	4,594.9360	4,594.7482	OPEN TERRAIN	(0.1879)

Point ID	Easting	Northing	KnownZ	DEMZ	Description	DeltaZ
OT23	1447136.478	1202135.905	4,812.1390	4,811.9078	OPEN TERRAIN	(0.2313)
OT24	1481807.410	1344741.015	4,816.4710	4,816.0368	OPEN TERRAIN	(0.4344)
OT25	1468643.680	1457369.861	5,650.0100	5,650.3346	OPEN TERRAIN	0.3249
OT26	1512269.433	1485968.865	4,952.2830	4,952.2717	OPEN TERRAIN	(0.0115)
PID02	1386598.400	1471439.132	5,616.2090	5,615.9102	BARE EARTH	(0.2988)
PID18	1497658.377	1532751.950	5,414.2250	5,414.6570	BARE EARTH	0.4319
PID19	1497658.382	1532751.921	5,414.2960	5,414.6576	BARE EARTH	0.3617
PID20	1548855.299	1522446.337	5,429.7810	5,430.2088	BARE EARTH	0.4280
PID28	1549953.542	1384231.336	5,402.4780	5,402.1360	BARE EARTH	(0.3420)
PID33	1416618.246	1382042.535	5,058.0160	5,057.6170	BARE EARTH	(0.3991)
PID35	1402723.126	1391985.545	5,134.6270	5,134.1559	BARE EARTH	(0.4711)
UR02	1457355.421	1070039.360	4,554.5340	4,554.3536	URBAN TERRAIN	(0.1806)
UR04	1453785.882	1124841.215	4,622.2910	4,622.0959	URBAN TERRAIN	(0.1951)
UR06	1520826.887	1424482.240	5,246.6610	5,246.5625	URBAN TERRAIN	(0.0987)
UR07	1500096.628	1446468.825	4,909.0690	4,908.7341	URBAN TERRAIN	(0.3348)
UR08	1530988.167	1485263.095	5,183.1550	5,183.2667	URBAN TERRAIN	0.1119
UR10	1463953.419	1374039.410	5,286.8170	5,286.9751	URBAN TERRAIN	0.1582
UR11	1506981.602	1396465.650	4,862.1010	4,861.6846	URBAN TERRAIN	(0.4164)
UR12	1550481.760	1565906.562	5,050.5850	5,050.2243	URBAN TERRAIN	(0.3607)
UR13	1455194.794	1504354.642	6,002.2520	6,002.0701	URBAN TERRAIN	(0.1818)
UR14	1566923.872	1477799.190	5,551.6460	5,552.0025	URBAN TERRAIN	0.3565
UR15	1542148.464	1386666.516	5,271.5700	5,271.7931	URBAN TERRAIN	0.2232
UR16	1498062.949	1509029.375	5,323.2610	5,323.5672	URBAN TERRAIN	0.3060
UR17	1520810.125	1299872.668	5,051.9020	5,052.3624	URBAN TERRAIN	0.4605
UR19	1461119.581	1236991.327	4,735.6370	4,735.5989	URBAN TERRAIN	(0.0383)
UR20	1469483.310	1535978.614	5,903.8750	5,904.1304	URBAN TERRAIN	0.2554
UR21	1434107.201	1477511.795	5,303.0830	5,302.9216	URBAN TERRAIN	(0.1614)
UR22	1388319.839	1421867.527	5,345.6150	5,345.6623	URBAN TERRAIN	0.0471
UR23	1371946.366	1518056.607	6,394.6450	6,394.3555	URBAN TERRAIN	(0.2896)
UR24	1555121.388	1367689.723	5,470.5850	-	Outside	-
UR25	1517233.816	1341338.660	5,014.3800	5,014.5465	URBAN TERRAIN	0.1666
UR26	1518060.647	1298290.078	5,075.6450	5,075.6199	URBAN TERRAIN	(0.0251)
BR01	1445112.287	1323625.934	4,902.3750	4,901.9936	BRUSH	(0.3814)
BR02	1406170.441	1387292.583	5,108.2550	5,108.1182	BRUSH	(0.1367)
BR03	1502066.751	1374316.583	4,841.3430	4,840.9547	BRUSH	(0.3881)
BR04	1537609.602	1426253.007	5,234.2450	5,234.5385	BRUSH	0.2934
BR05	1495780.200	1420554.219	5,022.9860	5,023.3897	BRUSH	0.4039
BR06	1466902.426	1568948.693	6,179.2570	6,178.9783	BRUSH	(0.2786)
BR07	1528635.231	1386755.587	5,127.3200	5,127.6405	BRUSH	0.3206

Point ID	Easting	Northing	KnownZ	DEMZ	Description	DeltaZ
BR08	1388182.576	1487008.847	5,590.7510	5,591.9814	BRUSH	1.2304
BR09	1458478.431	1532655.058	6,126.2220	6,126.3035	BRUSH	0.0813
BR10	1546242.480	1556423.186	5,034.8150	5,035.0219	BRUSH	0.2069
BR11	1553010.656	1506309.965	5,498.0970	5,497.5069	BRUSH	(0.5903)
BR12	1525206.323	1460667.437	5,194.0930	5,195.6006	BRUSH	1.5079
BR13	1463481.504	1319751.492	5,188.0350	5,187.9842	BRUSH	(0.0510)
BR14	1449313.204	1386129.092	5,353.1500	5,352.6456	BRUSH	(0.5043)
BR15	1460948.776	1211476.666	4,717.7810	4,718.7436	BRUSH	0.9629
BR16	1451178.226	1044657.521	4,532.8500	4,532.8356	BRUSH	(0.0145)
BR17	1455646.639	1106878.754	4,627.4860	4,627.2734	BRUSH	(0.2125)
BR18	1471438.035	1263256.197	4,763.9010	4,764.8164	BRUSH	0.9155
BR19	1496555.890	1482641.544	5,125.6750	5,126.1707	BRUSH	0.4958
BR20	1546011.696	1577324.741	5,157.6900	5,157.7155	BRUSH	0.0256
HG01	1376858.933	1431335.424	5,445.1810	5,445.3803	HIGH GRASS	0.1992
HG02	1403628.348	1458532.251	5,491.6150	5,491.5065	HIGH GRASS	(0.1087)
HG03	1438060.488	1487917.067	5,358.7680	5,358.5406	HIGH GRASS	(0.2275)
HG04	1442746.742	1140967.151	4,667.6070	4,667.5715	HIGH GRASS	(0.0354)
HG05	1442871.222	1189845.702	4,680.0750	4,680.1876	HIGH GRASS	0.1124
HG06	1473276.740	1274051.814	4,757.0630	4,758.2987	HIGH GRASS	1.2357
HG07	1464162.031	1417065.878	5,443.6820	5,443.8774	HIGH GRASS	0.1952
HG08	1386340.687	1517249.069	5,775.5180	5,775.5063	HIGH GRASS	(0.0118)
HG09	1576105.245	1477779.301	5,788.1500	5,788.0604	HIGH GRASS	(0.0895)
HG10	1555327.132	1380216.172	5,515.0210	5,515.0928	HIGH GRASS	0.0718
HG11	1514210.707	1416945.462	4,883.9560	4,883.8923	HIGH GRASS	(0.0638)
HG12	1517480.859	1518682.714	4,986.3350	4,986.1808	HIGH GRASS	(0.1542)
HG13	1488146.351	1585458.329	5,980.6600	5,980.7657	HIGH GRASS	0.1056
HG14	1463614.144	1552132.169	6,116.9100	6,116.5512	HIGH GRASS	(0.3589)
HG15	1506354.995	1542562.748	5,390.8820	5,390.2827	HIGH GRASS	(0.5992)
HG16	1431729.244	1466043.550	5,275.8230	5,275.7160	HIGH GRASS	(0.1073)
HG17	1399255.692	1399571.640	5,231.7610	5,232.0536	HIGH GRASS	0.2924
HG18	1515441.581	1369451.862	5,016.7240	5,016.3618	HIGH GRASS	(0.3623)
HG19	1555734.560	1528854.207	5,643.7690	5,643.0285	HIGH GRASS	(0.7405)
HG20	1478665.136	1501263.049	5,799.6980	5,800.0387	HIGH GRASS	0.3405
HG21	1454480.934	1366299.000	5,299.5980	5,299.7195	HIGH GRASS	0.1214
HG22	1460005.838	1558854.341	6,251.0030	6,250.5119	HIGH GRASS	(0.4910)
TR01	1406097.043	1387356.774	5,105.2130	5,104.9423	TREE	(0.2705)
TR02	1403620.815	1458489.509	5,491.5230	5,490.9491	TREE	(0.5738)
TR03	1450556.640	1135727.979	4,613.9950	4,614.0411	TREE	0.0460
TR04	1456529.349	1077022.831	4,558.1860	4,558.2591	TREE	0.0730

Point ID	Easting	Northing	KnownZ	DEMZ	Description	DeltaZ
TR05	1458512.176	1241130.902	4,741.1540	4,741.3506	TREE	0.1967
TR06	1478985.951	1302033.160	4,795.5990	4,796.0650	TREE	0.4659
TR07	1486550.380	1388656.370	4,963.7610	4,963.8406	TREE	0.0794
TR08	1403267.766	1391064.521	5,130.7620	5,130.2806	TREE	(0.4817)
TR09	1556116.499	1474542.088	5,470.3280	5,470.0768	TREE	(0.2513)
TR10	1433912.246	1412951.441	5,582.3840	5,582.2905	TREE	(0.0933)
TR11	1459090.292	1466566.127	5,787.6770	5,787.2599	TREE	(0.4169)
TR12	1491344.961	1572873.267	5,856.1670	5,856.2171	TREE	0.0501
TR13	1538577.528	1567130.499	5,198.5600	5,198.7991	TREE	0.2391
TR14	1545882.665	1490057.260	5,290.3250	5,290.3987	TREE	0.0735
TR15	1519786.318	1502337.386	4,971.8100	4,971.8685	TREE	0.0584
TR16	1519800.116	1502337.079	4,971.8030	4,971.8652	TREE	0.0620
TR17	1491553.316	1463644.763	5,148.0810	5,148.5597	TREE	0.4787
TR18	1496236.546	1396622.029	4,863.3240	4,863.6879	TREE	0.3637
TR19	1490867.645	1329924.229	4,805.9680	4,806.1598	TREE	0.1920

Table 12: DEM Check Point Assessment