

**New York State
Airborne LiDAR Processing & Accuracy Report**

For

Erie, Genesee, and Livingston Counties

Prepared For



**New York State
Office of Information Technology Services
GIS Program Office
10B Airline Drive,
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Section 2: Introduction

The New York State Office of Information Technology Services, GIS Program Office requested delivery of three-dimensional classified point cloud and terrain data derived from LiDAR (Light Detection and Ranging) technology for the New York LiDAR project area covering Erie, Genesee, and Livingston Counties, in West New York State. The project area covered approximately 2,188 square miles.

This project was completed to meet USGS 3D Elevation Program (3DEP) requirements including USGS publication “LiDAR Base Specification”, ver. 1.3. 3DEP Quality Level 2 LiDAR data was processed and projected to Conus Albers, referenced to the North American Datum 1983 (NAD83) (2011), in units of meters. The vertical datum used for the project was the North American Vertical Datum 1988 (NAVD88) with units expressed in meters. Orthometric heights were referenced to Geoid 12B.

This document explains the process and procedures used to create and verify the calibration and accuracy of georeferenced LiDAR swath data. The two previous reports were delivered under separate cover and are listed below for reference:

- 1) For a more detailed report on the LiDAR acquisition, see the report entitled: “*New York State Airborne LiDAR Acquisition Report; Erie-Genesee-Livingston Counties; Axis Project 13367-1916*”. Dated August 2019.
- 2) A thorough review of the survey techniques and parameters surrounding the field work and processing of the ground control and check points can be found in a report entitled: “*GNSS Survey Report: New York Statewide LiDAR Acquisition Lot 19; 2019 Lot 19 LiDAR Ground Control and Check Point Survey Report*”. Dated 8-22-2019.

The data tested in this report include:

- 1) The Relative Accuracy assessment of the LiDAR swaths;
- 2) A comparison of the adjusted LiDAR swath data with the surveyed coordinates of the project Ground Control Points

Section 3: Summary of Swath Data Results

A brief summary of the accuracy assessments performed with the swath data is discussed below.

The first assessment measures the relative match of the LiDAR points in the overlap areas of the acquisition swaths. The second assessment provides an analysis of the adjusted LiDAR points with the surveyed ground control points.

An initial analysis of the swath data involves comparing the elevation values of points from one swath to the points from a neighboring swath. Points within the overlapping swath areas are observed and compared. Swaths are adjusted with the intent of reducing the elevation differences between points within the overlapping swaths.

USGS publication “LiDAR Base Specification”, ver. 1.3, Page 23, Table 2 identifies that QL2 data will have a swath overlap difference of ≤ 8 cm. For this dataset, the RMSEz of the relative adjustment is 1.9 cm and the maximum difference between points observed is 16.9 cm. (one point from 11.75 million section lines)

A second analysis provides a statistical measure of how well the adjusted swath point cloud data have been merged and adjusted to ground control points whose coordinates have been surveyed. Forty-Eight (48) control points were utilized. For this dataset, the average difference of the LiDAR data with the ground control points is +0.2 cm, with a standard deviation of 3.2 cm and an RMSEz of 3.9 cm.

Section 4: Merging Swaths

Generation and Calibration of Laser Points

The initial step of calibration is to verify availability and status of all needed GPS and Laser data against field notes and compile any data if not complete. Subsequently, the mission points are output using Riegl’s RiProcess software. The initial point generation for each mission calibration is completed within TerraSolid using TerraMatch. Using LASTools, a Z-difference intensity ortho is created to verify relative swath to swath adjustments. If a calibration error greater than specification is observed within the mission, the roll, pitch and scanner scale corrections that need to be applied are re-calculated.

The NY19 Erie-Genesee-Livingston LiDAR Actual Flight Line Alignment is displayed below (Figure 1). 230 flight lines were acquired for completing the NY19 Erie-Genesee-Livingston LiDAR project area. This includes:

- 227 swaths were delivered—Two (2) reflights and one (1) Cross-Tie from 5/1 were not processed or delivered due to high percentage of unusable data.
- Two hundred (207) of the acquired lines were mission lines;
 - Seven (7) of these lines were re-flown (includes 2 lines flown on 5-1 but not processed)
- Twenty-two (23) Cross-Tie lines were acquired;
 - Includes 1 Cross-Tie line flown on 5-1 but not processed
 - Includes Cross-Tie 87 flown on 4-29 which was processed but not imported for production

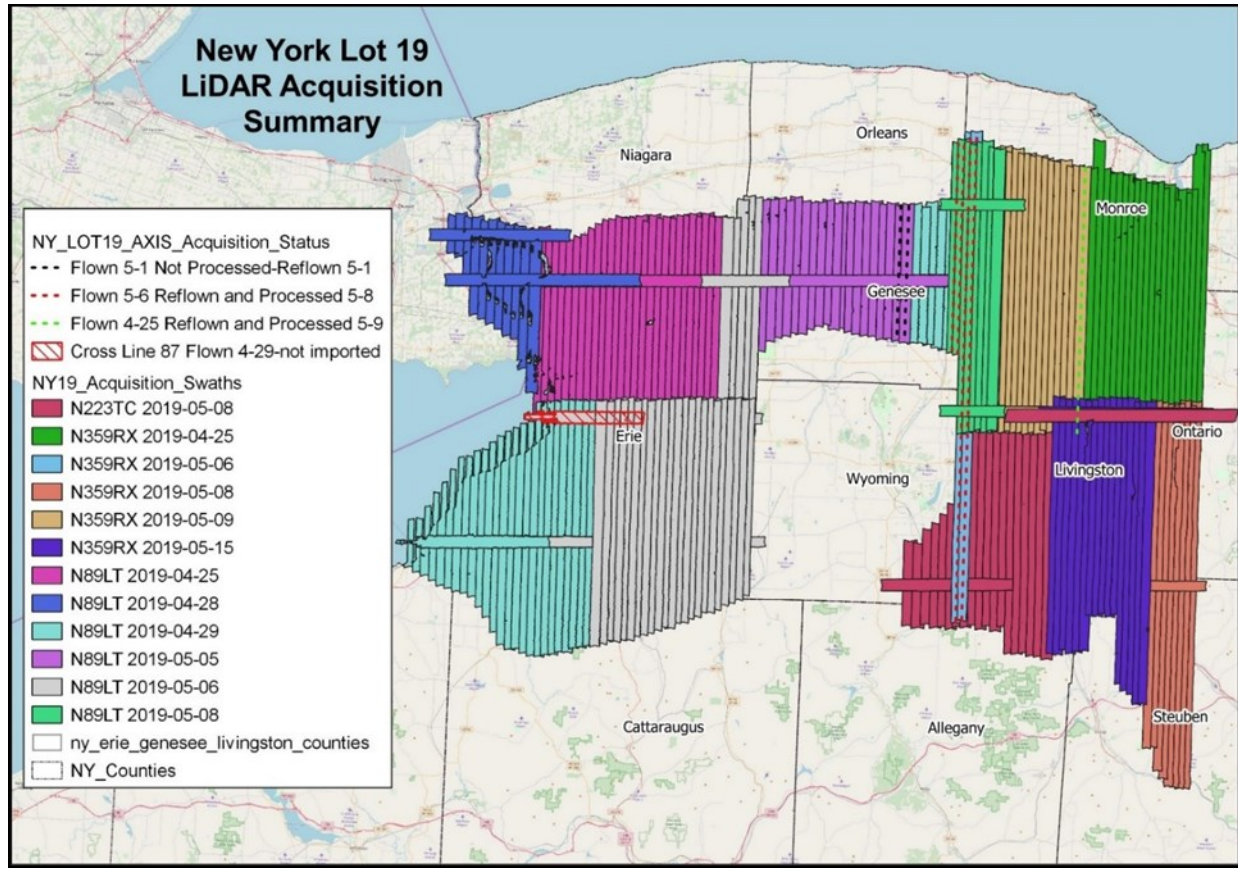


Figure 1: Erie, Genesee, Livingston Actual Flight Lines Acquired (Spring 2019 Acquisition)

The Aggregate Nominal Pulse Spacing for the NY19 LiDAR project is 0.40 m with an Aggregate Nominal Pulse Density of 3.17 pts/m².

Table 1: Point Cloud Statistics	
Total Points	97,694,882,622
Aggregate Nominal Pulse Spacing (m)	.38m
Aggregate Nominal Pulse Density (pts/m ²)	6.95ppsm

Relative Accuracy Assessment

For effective data management, each imported mission is tiled out in TerraScan to a project specific tile scheme or index. Relative accuracy and internal quality are then checked using several carefully selected tiles in which points from all lines are loaded and inspected. Vertical differences between ground surfaces of each line are displayed by the generation of Z-Difference colored intensity orthos in TerraScan. The color scale of these orthos are adjusted so that errors greater than the specifications are flagged. Cross sections are visually inspected across each block to validate point to point, flight line to flight line and mission to mission alignment. When available, surveyed control points are used to supplement and verify the calibration of the data.

The Relative and Absolute Adjustment Workflows are summarized below:

- a. Search for Tie Lines for Relative Adjustments –To find the difference between flightlines, Axis utilizes a function in TerraMatch called Search Tie Line. The automatic tie line search provides a statistical report of the average mismatch between flightlines.
- b. Find Tie Line Match & Generate Correction Values - Find Tie Line Match tool analyzes the mismatch in the tie lines and provides correction values.
- c. Apply Correction Values to the LiDAR – Utilizing the correction values that were calculated, a macro applies the corrections.
- d. Analyze and Fit Data to Control for Absolute Adjustment –For the absolute adjustments, the LiDAR data is adjusted to known control points. LiDAR is adjusted using average Dz mismatches to the control.
- e. Gather Intensity Images of Horizontal Alignment of Control – Axis generates intensity imagery to check the horizontal accuracy of the LiDAR.
- f. Create a Report of Relative and Absolute Adjustments – Terrascan provides:
 - i. Tie-line Output Report – Average Z mismatch between each strip.
 - ii. Output Control Report – Match between the control and the LiDAR.

Relative Adjustment Accuracy Results

An overall statistical assessment of the relative accuracy, using TerraMatch Tie Line Report between LiDAR swaths, can be found in Table 2 below. The values provided are in Meters.

Table 2: Average Magnitude per line (m)

Line	Z	Line	Z	Line	Z
1	0.017	77	0.015	165	0.017
2	0.02	78	0.015	166	0.015
3	0.015	79	0.015	167	0.017
4	0.015	80	0.015	168	0.018
5	0.015	81	0.016	169	0.014
6	0.016	82	0.015	200	0.019
7	0.015	83	0.017	201	0.019
8	0.015	84	0.02	202	0.022
9	0.015	85	0.019	203	0.02
10	0.016	86	0.017	204	0.021
11	0.02	87	0.017	205	0.02
12	0.024	88	0.017	206	0.023
13	0.023	89	0.018	207	0.021
14	0.019	90	0.017	208	0.022
15	0.017	91	0.018	209	0.021
16	0.019	92	0.017	210	0.023
17	0.018	93	0.017	211	0.022
18	0.017	94	0.017	212	0.021
19	0.017	95	0.017	213	0.021

Line	Z	Line	Z	Line	Z
20	0.017	96	0.018	214	0.02
21	0.017	97	0.017	215	0.021
22	0.017	98	0.018	216	0.021
23	0.017	99	0.018	217	0.021
24	0.019	100	0.017	218	0.02
25	0.02	101	0.017	219	0.016
26	0.019	102	0.015	220	0.013
27	0.017	103	0.017	221	0.013
28	0.018	104	0.017	222	0.015
29	0.016	105	0.017	223	0.016
30	0.018	106	0.017	224	0.016
31	0.016	107	0.019	225	0.016
32	0.018	108	0.018	226	0.015
33	0.016	109	0.017	227	0.013
34	0.018	110	0.016	228	0.014
35	0.019	111	0.016	229	0.014
36	0.018	112	0.016	230	0.016
37	0.015	113	0.016	231	0.014
38	0.018	114	0.016	232	0.014
39	0.019	115	0.013	233	0.014
40	0.015	128	0.016	234	0.015
41	0.016	129	0.019	235	0.013
42	0.015	130	0.016	236	0.012
43	0.017	131	0.019	237	0.012
44	0.016	132	0.016	238	0.012
45	0.015	133	0.016	239	0.012
46	0.015	134	0.016	240	0.012
47	0.015	135	0.015	241	0.013
48	0.015	136	0.014	242	0.015
49	0.015	137	0.016	408	0.02
50	0.015	138	0.016	5000	0.02
51	0.015	139	0.015	5008	0.035
52	0.016	140	0.014	5009	0.017
53	0.016	141	0.012	5010	0.025
54	0.013	142	0.013	5011	0.022
55	0.014	143	0.015	5012	0.015
56	0.013	144	0.015	5014	0.018

Line	Z	Line	Z	Line	Z
57	0.014	145	0.014	5015	0.026
58	0.014	146	0.014	5016	0.019
59	0.014	147	0.015	5017	0.015
60	0.012	148	0.015	5018	0.015
61	0.013	149	0.021	5023	0.014
62	0.013	150	0.019	5024	0.019
63	0.016	151	0.016	5027	0.015
64	0.015	152	0.016	5028	0.016
65	0.017	153	0.015	5029	0.016
66	0.016	154	0.017	5030	0.018
67	0.018	155	0.017	5031	0.018
68	0.014	156	0.019	5045	0.019
69	0.014	157	0.017	5058	0.026
70	0.015	158	0.019	10128	0.017
71	0.015	159	0.015	10129	0.018
72	0.015	160	0.015	10130	0.016
73	0.016	161	0.016	10131	0.017
74	0.016	162	0.015	10149	0.022
75	0.016	163	0.015		
76	0.015	164	0.017		

Table 3: Overall Relative Accuracy (m)	
Category	Mismatch
Average 3D Mismatch	.01885
Average Z Mismatch	.01885

Table 4: Internal Observation Statistics (m)			
Category	X	Y	Z
Average Magnitude	0.0	0.0	.019
RMS Values	0.0	0.0	.027
Maximum Values	0.0	0.0	.276
Observation Weight	0.0	0.0	50769738.0

Table 5: TerraMatch Tie Lines	
Category	Observations
Surface Lines	15281425

Absolute Adjustment Accuracy Results

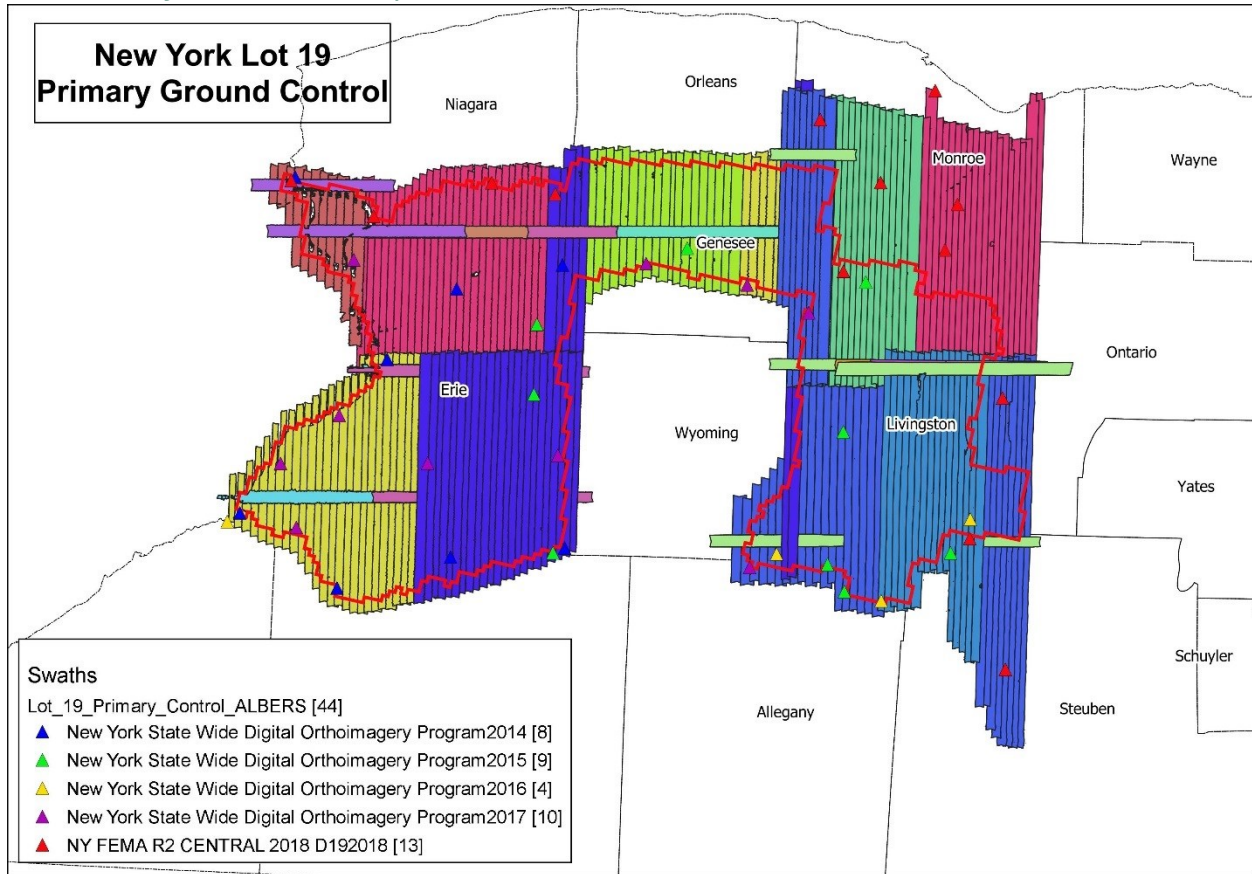


Figure 2: Forty-Four (44) Ground Control Locations

A vertical accuracy assessment of the forty-four (44) control points against the LiDAR swath surface can be found in the table below. The coordinates provided are in NAD83 (2011), Conus Albers, NAVD88 (Geoid12B), Meters.

Table 6: Ground Control Point Assessment (Swath) (m)

Number	Easting	Northing	Known Z	Laser Z	Delta Z	Description
040_2017	1373670.747	2305531.811	181.162	181.250	0.088	Mag nail set in corner of sidewalk
042_2017	1398423.089	2311261.877	277.033	277.100	0.067	Cor of Tennis Court Paint Line
043_2017	1378032.600	2343051.354	177.867	177.990	0.123	Mag nail set in asphalt
044_2017	1381664.065	2315990.380	214.474	214.500	0.026	Mag nail set in corner of sidewalk
10_2015	1473600.718	2305466.074	402.992	403.030	0.038	CAPPED SPIKE CORNER SIDEWALK
18_2015	1467203.111	2332674.439	173.715	173.750	0.035	MAG NAIL POINT OF ARROW
20_2015	1413627.530	2327110.101	274.153	274.210	0.057	MAG NAIL CORNER OF SIDEWALK
21_2015	1411400.356	2339146.928	261.242	261.300	0.058	MAG NAIL SE CORNER OF CONCRETE DRIVEWAY

Number	Easting	Northing	Known Z	Laser Z	Delta Z	Description
33_2016	1366975.672	2293540.840	198.939	198.870	-0.069	6" Mag Hub @ SLY inside corner of SW
4_2014	1368778.204	2295490.354	176.175	176.380	0.205	MAG HUB AT THE INTERSECTION OF CONCRETE DRIVE WITH ASPHALT APRON
45_2015	1423009.941	2300847.346	433.036	433.120	0.084	MAG NAIL POINT OF DIRECTIONAL
5_2014	1388045.639	2286489.083	254.895	254.990	0.095	MAG NAIL AT THE NORTH CORNER OF CONCRETE SURROUND FOR CATCH BASIN
51_2015	1433753.184	2357963.530	270.946	270.970	0.024	MAG NAIL CORNER OF SIDEWALK
52_2015	1465151.393	2359107.721	204.881	204.930	0.049	MAG NAIL CORNER OF SIDEWALK
6_2014	1424797.862	2302130.971	444.748	444.890	0.142	MAG HUB AT THE INTERSECTION OF CONCRETE WALK WITH ASPHALT PARKING LOT
6_2015	1469710.322	2309437.132	402.760	402.790	0.030	MAG NAIL CENTER END OF WHITE PAINT LINE
7_2014	1413376.265	2350282.953	249.364	249.470	0.106	MAG NAIL AT THE INTERSECTION OF CONCRETE DRIVE WITH ROAD PAVEMENT
8_2014	1364930.610	2354859.033	182.305	182.430	0.125	MAG HUB AT THE INTERSECTION OF CONCRETE APRON WITH CONCRETE WALK
8_2015	1489995.312	2316159.856	426.578	426.530	-0.048	MAG NAIL CORNER CONCRETE DRIVE
80_2014	1396493.183	2342108.620	214.090	214.180	0.090	MAG HUB AT THE INTERSECTION OF CONCRETE DRIVE WITH CONCRETE SIDEWALK
82_2014	1405936.572	2296153.835	419.360	419.430	0.070	MAG NAIL AT THE INTERSECTION OF CONCRETE WALK WITH CONCRETE APRON
9_2014	1387546.187	2327398.227	177.857	177.960	0.103	MAG NAIL AT THE INTERSECTION OF CONCRETE WALKS
GC01_2016	1460722.272	2309285.660	483.967	484.050	0.083	Mag Nail @ center of end of white paint stripe
GC01_2017	1427422.491	2353752.506	271.982	272.020	0.038	Mag nail set in asphalt
GC02_2016	1480156.804	2305329.070	402.847	402.850	0.003	Mag Nail @ center of end of yellow paint stripe
GC02_2017	1445284.105	2354003.822	282.041	282.110	0.069	Mag nail set in asphalt
GC03_2017	1456743.866	2351664.083	280.668	280.640	-0.028	Mag nail set corner of stop bar
GC04_2016	1491996.266	2322679.207	431.111	431.130	0.019	Mag Nail @ center of end of white paint stripe
GC07_2017	1420047.955	2317625.620	420.368	420.390	0.022	Nail set in gravel parking lot
GC11_2017	1456696.568	2305967.942	352.311	352.290	-0.021	Mag nail set in asphalt
GC21_2017	1378833.291	2295239.139	193.221	193.260	0.039	Mag nail set in asphalt
GCP-003	1409392.744	2362087.812	186.593	186.630	0.037	Point @ end of double yellow road line
GCP-004	1364380.301	2354100.789	170.080	170.260	0.180	Point @ corner of hashed parking isle
GCP-009	1460965.068	2360072.696	215.118	215.030	-0.088	Point @ end paint stripe
GCP-010	1477604.847	2375877.134	160.227	160.190	-0.037	Shot center end of yellow parking stripe

Number	Easting	Northing	Known Z	Laser Z	Delta Z	Description
GCP-016	1492663.942	2319378.704	418.349	418.260	-0.089	Point @ end of paint line
GCP-031	1451156.107	2385023.804	158.982	158.990	0.008	Point @ end of paint stripe
GCP-035	1379667.045	2351231.887	175.191	175.230	0.039	Point @ end of paint stripe
GCP-039	1398239.153	2361512.810	180.503	180.460	-0.043	Point @ corner of hased area
GCP-040	1469418.444	2394412.873	82.545	82.570	0.025	Shot corner of conc. inlet
GCP-044	1503743.574	2298404.523	502.644	502.640	-0.004	Point @ end of paint line
GCP-046	1492710.042	2344603.068	286.480	286.450	-0.030	Point @ end of paint line
GCP-049	1463790.916	2376644.735	177.554	177.540	-0.014	Point @ end of paint stripe
GCP-051	1477266.346	2367620.497	207.422	207.300	-0.122	Point @ end of paint stripe

An overall statistical assessment summary of the control points can be found in Table 7 below. The coordinates provided are in NAD83(2011), Conus Albers, NAVD88 (Geoid12B), Meters.

Category	# of Points	Min (m)	Max (m)	Mean (m)	Std Dev (m)	RMSE _Z (m)
Control Points	44	-0.122	+0.205	+0.036	.069	.078

Section 5: Swath NVA QA/QC

Using TerraScan, Non-Vegetated Vertical Accuracy (NVA) Check Points were compared to the swath data and checked for consistency and compliance with project specifications.

TerraScan:

- 1) Generates relative and absolute adjustment reports;
 - a) The Check Points are loaded into Terrascan using a function called "Output Control Report". Using the ground class, a control report is generated and examined to determine whether the Dz is within tolerance of the specifications.
- 2) Calculating the NVA Report

The NVA points and the swath data are loaded into TerraScan to run a statistical report of the elevation differences between features. The elevation difference between the QA points and the swath data is calculated and embedded, via attribute, to the NVA file.

LP360 and LASTools

- 1) LP360 is used to check completeness of data;
 - a) Provides additional details in the header to validate project parameters. If an error is discovered, then changes can be made
- 2) Using LasToLas in "LAS-Tools" data are converted to LAS version 1.4.
 - a) LasToLas is used to convert the LAS v1.2 files to LAS v1.4. The data is exported with the Point Data Record Format (PDRF) changed for each file from 1 to 6 for the file to be converted correctly. Changing the PDRF to 6 is necessary because it supports added elements such as "Overlap" bit flags, Coordinate Reference Systems (CRS) and Well-Known Text (WKT). The new version number is also specified in the line of code in order to export tiles whose headers read "1.4".

- 3) Overlap Points flagged to adhere to specifications.
 - a) "lasoverage" is used to create "Overlap" bit flags along the edges of crossing flightlines.

Global Mapper

- 1) Overlap points checked for correct classification flag
 - a. Swath data is loaded into Global Mapper and points are tag/selected in overlap regions in order to see in the attribute table that the Overlap bit read "Y" for "Yes".

A summary of the vertical accuracy assessment of the Non-Vegetated Vertical Accuracy (NVA) check points against the swath surface can be found in Table 8 below. The coordinates provided are in NAD83 (2011), Albers Equal Area, NAVD88 (Geoid12B), Meters. Overall, the results proved to be satisfactory. The overall RMSE_z for the NVA checkpoints was 5.2 cm and compared favorably to the USGS specification of ≤ 10 cm, (USGS "LIDAR Base Specification, Version 1.3", Page 24, Table 4;). The NVA at the 95% confidence level was 10.37 cm which is less than the USGS specification of ≤ 19.6 cm. (USGS "LIDAR Base Specification, Version 1.3", Page 24, Table 4;).

Table 8: NVA Check Point Error Statistics (m)						
Category	# of Points	Min (m)	Max (m)	Mean (m)	Std Dev (m)	RMSE _z (m)
Check Points	111	-0.124	0.120	-0.012	0.052	0.053

For a complete listing of the NVA points, see Table 9.

Table 9: NVA Check Point Assessment (swath surface) (m)

ID	Easting	Northing	Known_Z	Laser_Z	Delta_Z	Description
NVA 01	1378912.027	2344187.225	183.096	183.182	-0.086	CONCRETE SIDEWALK
NVA 02	1475970.929	2319579.402	365.289	365.305	-0.016	CONCRETE/GRAVEL PARKING LOT
NVA 04	1488035.322	2357448.485	228.304	228.255	0.049	CONCRETE/SHORT GRASS
NVA 05	1484573.777	2306651.576	382.469	382.356	0.113	CONCRETE/SHORT GRASS
NVA 06	1484566.426	2306650.058	382.342	382.216	0.126	CONCRETE/SHORT GRASS
NVA 07	1433432.671	2356791.148	279.290	279.329	-0.039	CONCRETE/SHORT GRASS
NVA 08	1417916.121	2307019.074	456.615	456.646	-0.031	GRAVEL DRIVEWAY
NVA 09	1373946.587	2299508.137	200.575	200.643	-0.068	GRAVEL DRIVEWAY
NVA 10	1397868.527	2308604.41	427.823	427.866	-0.043	GRAVEL DRIVEWAY
NVA 11	1394298.719	2355834.05	177.701	177.723	-0.022	GRAVEL DRIVEWAY
NVA 12	1394323.899	2355829.337	177.656	177.657	-0.001	GRAVEL DRIVEWAY
NVA 13	1487475.371	2332642.79	581.204	581.126	0.078	GRAVEL DRIVEWAY
NVA 14	1484607.255	2306670.689	384.589	384.561	0.028	GRAVEL DRIVEWAY
NVA 15	1466500.201	2362382.895	200.610	200.585	0.025	GRAVEL ROAD
NVA 16	1466490.924	2362427.38	201.313	201.282	0.031	GRAVEL ROAD

ID	Easting	Northing	Known_Z	Laser_Z	Delta_Z	Description
NVA 17	1414961.779	2328492.44	358.806	358.810	-0.004	GRAVEL SHOULDER
NVA 18	1387297.609	2324894.662	177.377	177.479	-0.102	GRAVEL/GRASS ISLAND
NVA 19	1387308.377	2324861.457	177.472	177.547	-0.075	GRAVEL/GRASS ISLAND
NVA 20	1388534.892	2286484.872	241.576	241.687	-0.111	MH LID
NVA 21	1388549.54	2286506.232	242.153	242.191	-0.038	MH LID
NVA 22	1373887.629	2299474.862	200.299	200.367	-0.068	MH LID
NVA 23	1379021.064	2344207.826	182.371	182.452	-0.081	MH LID
NVA 24	1371142.226	2351866.27	175.823	175.782	0.041	MH LID
NVA 25	1373876.395	2299480.223	200.686	200.716	-0.030	PAVED DRIVEWAY
NVA 26	1374051.443	2299510.577	200.532	200.582	-0.050	PAVED DRIVEWAY
NVA 27	1394312.985	2355870.827	177.710	177.680	0.030	PAVED DRIVEWAY
NVA 28	1414926.882	2328439.058	362.946	362.963	-0.017	PAVED DRIVEWAY
NVA 29	1406118.086	2293484.289	397.749	397.803	-0.054	PAVED PARKING LOT
NVA 30	1388491.048	2286465.591	241.347	241.471	-0.124	PAVED PARKING LOT
NVA 31	1388472.731	2286484.076	241.876	242.008	-0.132	PAVED PARKING LOT
NVA 32	1378937.13	2344216.081	182.755	182.806	-0.051	PAVED PARKING LOT
NVA 33	1378939.139	2344227.305	182.587	182.645	-0.058	PAVED PARKING LOT
NVA 34	1395319.023	2340858.909	205.295	205.369	-0.074	PAVED PARKING LOT
NVA 35	1395300.56	2340864.57	205.273	205.273	0.000	PAVED PARKING LOT
NVA 36	1395276.624	2340855.977	205.277	205.343	-0.066	PAVED PARKING LOT
NVA 37	1395330.042	2340803.688	204.649	204.703	-0.054	PAVED PARKING LOT
NVA 38	1470004.722	2342954.55	223.558	223.549	0.009	PAVED PARKING LOT
NVA 39	1470016.051	2342941.294	223.663	223.692	-0.029	PAVED PARKING LOT
NVA 40	1470048.941	2342953.196	224.520	224.513	0.007	PAVED PARKING LOT
NVA 41	1462930.422	2331829.512	280.392	280.402	-0.010	PAVED PARKING LOT
NVA 42	1462879.71	2331822.775	279.410	279.415	-0.005	PAVED PARKING LOT
NVA 43	1462882.955	2331811.717	279.477	279.467	0.010	PAVED PARKING LOT
NVA 46	1378957.144	2344195.06	182.768	182.847	-0.079	PAVED PATH
NVA 47	1371138.951	2351811.442	175.505	175.539	-0.034	PAVED PATH
NVA 48	1417977.053	2307025.199	454.838	454.885	-0.047	PAVED ROAD
NVA 49	1417903.237	2307009.752	457.269	457.315	-0.046	PAVED ROAD
NVA 50	1406114.538	2293402.179	398.066	398.099	-0.033	PAVED ROAD
NVA 51	1397810.2	2308584.925	430.070	430.131	-0.061	PAVED ROAD
NVA 52	1397838.736	2308590.11	429.025	429.080	-0.055	PAVED ROAD
NVA 53	1387288.428	2324909.34	177.437	177.510	-0.073	PAVED ROAD
NVA 54	1387324.157	2324796.672	177.429	177.502	-0.073	PAVED ROAD
NVA 55	1387336.314	2324733.905	177.129	177.208	-0.079	PAVED ROAD
NVA 56	1371083.056	2351816.639	175.956	176.048	-0.092	PAVED ROAD
NVA 57	1413732.366	2348312.625	255.037	255.066	-0.029	PAVED ROAD
NVA 58	1413738.998	2348275.747	255.345	255.415	-0.070	PAVED ROAD

ID	Easting	Northing	Known_Z	Laser_Z	Delta_Z	Description
NVA 59	1413742.001	2348299.009	255.174	255.260	-0.086	PAVED ROAD
NVA 60	1414935.25	2328430.312	362.696	362.702	-0.006	PAVED ROAD
NVA 61	1414952.031	2328472.673	360.942	360.929	0.013	PAVED ROAD
NVA 62	1500022.462	2322007.194	492.283	492.264	0.019	PAVED ROAD
NVA 63	1500056.696	2321963.718	492.810	492.782	0.028	PAVED ROAD
NVA 64	1500060.913	2321967.709	492.864	492.852	0.012	PAVED ROAD
NVA 65	1500029.829	2321998.289	492.486	492.432	0.054	PAVED ROAD
NVA 66	1487476.733	2332655.94	581.398	581.336	0.062	PAVED ROAD
NVA 67	1487496.045	2332619.863	581.559	581.463	0.096	PAVED ROAD
NVA 68	1475985.821	2319669.749	358.919	358.886	0.033	PAVED ROAD
NVA 69	1475966.018	2319593.561	365.123	365.123	0.000	PAVED ROAD
NVA 70	1484603.896	2306734.393	385.940	385.913	0.027	PAVED ROAD
NVA 71	1461700.962	2355031.597	232.406	232.402	0.004	PAVED ROAD
NVA 72	1461734.882	2355038.538	231.288	231.276	0.012	PAVED ROAD
NVA 73	1461755.503	2355032.179	231.435	231.430	0.005	PAVED ROAD
NVA 74	1461752.146	2355055.318	230.448	230.451	-0.003	PAVED ROAD
NVA 75	1433455.753	2356779.788	279.009	279.046	-0.037	PAVED ROAD
NVA 76	1433163.088	2370268.028	202.936	202.926	0.010	PAVED ROAD
NVA 77	1433140.524	2370264.305	202.528	202.519	0.009	PAVED ROAD
NVA 78	1433126.383	2370249.2	202.965	202.966	-0.001	PAVED ROAD
NVA 79	1453144.089	2374818.458	183.022	183.034	-0.012	PAVED ROAD
NVA 80	1453186.563	2374822.828	182.903	182.879	0.024	PAVED ROAD
NVA 81	1453195.062	2374836.636	183.020	183.019	0.001	PAVED ROAD
NVA 82	1466506.313	2362437.331	201.213	201.165	0.048	PAVED ROAD
NVA 83	1466477.335	2362431.757	201.965	201.927	0.038	PAVED ROAD
NVA 84	1488030.4	2357501.254	227.970	227.885	0.085	PAVED ROAD
NVA 85	1488041.574	2357427.787	229.022	228.948	0.074	PAVEDROAD
NVA 86	1433435.633	2356777.824	278.952	278.984	-0.032	PAVED ROAD
NVA 87	1371150.253	2351899.005	175.211	175.282	-0.071	PAVED SHOULDER
NVA 89	1417962.303	2307028.362	454.826	454.860	-0.034	SHORT GRASS
NVA 90	1417934.573	2307024.211	455.905	455.971	-0.066	SHORT GRASS
NVA 91	1406108.587	2293466.278	397.897	397.949	-0.052	SHORT GRASS
NVA 92	1406116.983	2293425.942	397.934	397.976	-0.042	SHORT GRASS
NVA 93	1373911.882	2299480.808	200.270	200.332	-0.062	SHORT GRASS
NVA 94	1394317.782	2355858.593	177.823	177.839	-0.016	SHORT GRASS
NVA 95	1395363.149	2340823.954	204.744	204.816	-0.072	SHORT GRASS
NVA 96	1487458.291	2332669.088	581.132	581.051	0.081	SHORT GRASS
NVA 97	1475989.182	2319642.546	360.741	360.697	0.044	SHORT GRASS
NVA 98	1461767.183	2354931.074	233.504	233.534	-0.030	SHORT GRASS
NVA 99	1433415.238	2356780.861	278.952	278.982	-0.030	SHORT GRASS

ID	Easting	Northing	Known_Z	Laser_Z	Delta_Z	Description
NVA 100	1433178.214	2370264.667	203.183	203.204	-0.021	SHORT GRASS
NVA 101	1453174.86	2374837.843	182.726	182.738	-0.012	SHORT GRASS
NVA 102	1453176.605	2374846.868	182.840	182.824	0.016	SHORT GRASS
NVA 103	1488042.247	2357503.844	228.561	228.525	0.036	SHORT GRASS
NVA 104	1470061.351	2342978.701	225.802	225.814	-0.012	SHORT GRASS
NVA 105	1462929.909	2331773.403	279.907	279.918	-0.011	SHORT GRASS
NVA 106	1397798.22	2308588.654	430.283	430.321	-0.038	UNPAVED DRIVEWAY
NVA 107	1412101.145	2366596.144	186.544	186.597	-0.053	UNPAVED ROAD
NVA 108	1412085.649	2366595.206	186.531	186.600	-0.069	UNPAVED ROAD
NVA 109	1500046.482	2321984.597	492.710	492.675	0.035	UNPAVED SHOULDER
NVA 110	1500046.318	2321984.894	492.708	492.688	0.020	UNPAVED SHOULDER
NVA 111	1413720.561	2348295.985	254.452	254.410	0.042	VALVE LID
NVA 44	1456621.863	2331765.696	351.579	351.551	0.028	PAVED PARKING LOT
NVA 45	1456632.042	2331773.403	351.559	351.558	0.001	PAVED PARKING LOT
NVA 88	1456645.992	2306198.065	351.725	351.738	-0.013	PAVED SHOULDER/CONCRETE
NVA 3	1456642.955	2306215.987	351.672	351.624	0.048	CONCRETE/GRAVEL

Section 6: Summary of Classified LAS and DEM Results

A brief summary of accuracy assessments performed with the classified LiDAR data and hydro-flattened DEM is provided below.

Non-Vegetated Vertical Accuracy (NVA) Check Points and Vegetated Vertical Accuracy (VVA) Check Points were also independently surveyed and compared to the DEM data. For the NVA checkpoints, the overall RMSEz is 5.4 centimeters. This compares favorably to the USGS specification of < 10 cm. (USGS “*LIDAR Base Specification, Version 1.3*”, Page 24, Table 4;). The NVA at the 95% confidence level is 10.51 centimeters which is within the USGS specification of < 19.6 cm. (USGS “*LIDAR Base Specification, Version 1.3*”, Page 24, Table 4;)

Vegetated Vertical Accuracy (VVA) Check Point RMSEz is 8.7 centimeters and the VVA at the 95th percentile is 16.4 centimeters. The USGS specification for VVA at the 95th percentile is < 30.0 cm. (USGS “*LIDAR Base Specification Version 1.3*”, Page 24, Table 4;)

Section 7: Classification

Classification was conducted in accordance with USGS publication “*LIDAR Base Specification*”, Version 1.3 February 2018;

Table 5. “*Minimum classified point cloud classification scheme*”; Page 24.

Code	Description
1	Processed, but unclassified.

- 2 Bare earth.
- 7 Low noise.
- 9 Water
- 17 Bridge decks.
- 18 High noise
- 20 Ignored Ground
- 21 Snow
- 22 Temporal Exclusion

The calibrated dataset, omitting any crosslines used in the calibration process, was used to create the classification point cloud dataset. The classification point cloud was produced with TerraScan in LAS file format with attributes for each return including but not limited to time, easting, northing, elevation, intensity, return number, and return classification. Utilizing both automated and manual methods, the point cloud was filtered to identify bare-earth surface points removing above ground features and erroneous noise.

The TerraSolid suite of software packages were used for the automated method of macro based bare-earth filtering. Multiple iterations of automated filtering were utilized to address the ever-changing terrain while retaining a homogenous surface. After automated filtering, manual editing was completed using TerraScan and TerraModeler in MicroStation. Editing was performed to ensure that 100% of the identified bare-earth surface was visually inspected for errors, completeness, and accuracy. In addition, hydro features were classified but not verified against vector features.

Bridge decks were also classified. Points floating above or positioned below the bare earth surface were designated as low noise and high noise.

Breaklines for hydrography and underneath bridges were compiled for this project. Hydro breaklines were compiled for rivers and streams over 30 m wide and for lakes and ponds greater than 2 acres in area and utilized to generate hydro-flattened water features for the DEMs. The bridge terrain breaklines were captured at the bridge deck level and below along the ground beneath to allow proper flow of hydro through bridges per USGS "LIDAR Base Specification, Version 1.3". All breaklines were delivered as 3D ESRI shapefiles with attribution for feature types.

Section 8: Final Classified LAS and DEM QA/QC

Both automated and manual procedures were utilized to check the final products prior to delivery. Using TerraScan and LP360, the completeness, classification, headers, and attributes were checked for consistency and compliance with project specifications. GeoCue and Global Mapper were used for a final bare earth surface review.

TerraScan:

- 3) Generates relative and absolute adjustment reports;
- b) The Ground Control and/or Check Points are loaded into Terrascan using a function called "Output Control Report". Using the ground class, a control report is generated and examined to determine whether the Dz is within tolerance of the specifications.

LP 360

- 1) Check header format;

- a) Files are loaded into LP360 and the header information displayed. The data is checked to validate correctness and consistency.
- 2) Check version numbers;
- 3) Review the project parameters in the header;

LASTools

- 4) LAS Info used to check completeness of data;
 - b) LASinfo provides additional details in the header to validate project parameters. If an error is discovered, then changes can be made
- 5) Validate project classifications;
 - a) "LASinfo" creates text files that are reviewed to check that only project classifications are populated.
- 6) Using Las-to-Las in "LAS-Tools" data are converted to LAS version 1.4.
 - b) "Las-to-Las" is used to convert the LAS v1.2 files to LAS v1.4. The data is exported with the Point Data Record Format (PDRF) changed for each file from 1 to 6 for the file to be converted correctly. Changing the PDRF to 6 is necessary because it supports added elements such as "Overlap" bit flags, Coordinate Reference Systems (CRS) and Well-Known Text (WKT). The new version number is also specified in the line of code in order to export tiles whose headers read "1.4".
- 7) Overlap Points flagged to adhere to specifications.
 - b) "lasoverage" is used to create "Overlap" bit flags along the edges of crossing flightlines.

Global Mapper

- 2) Final DEMs checked for edge-matching, geo-referencing and data voids
 - a. Map catalog is created to load all the data at one time and then is examined using traditional QC/QA methods to validate correctness.
- 3) Overlap points checked for correct classification flag
 - a. LiDAR tiles are loaded into global mapper and points are tag/selected in overlap regions in order to see in the attribute table that the Overlap bit read "Y" for "Yes".
- 4) Tile names checked to coincide with tile index.
 - a. A tile grid is loaded with labels of the "Photohead" turned on and the corresponding tile is then loaded. If the lidar tile appears in the correct tile, then the tile is named in accordance with the tile grid.
- 5) Calculating NVA and VVA Reports
 - a. The NVA, VVA and Final DEMs of the LiDAR are loaded into Global Mapper to run a statistical report of the elevation differences between features. The elevation difference between the QA points and the DEMs is calculated and embedded, via attribute, to both the NVA and VVA files. These files are then exported from Global Mapper and statistics are calculated.

A summary of the vertical accuracy assessment of the Non-Vegetated Vertical Accuracy (NVA) check points against the final DEM surface can be found in Table 10 below. The coordinates provided are in NAD83 (2011), Albers Equal Area, NAVD88 (Geoid12B), Meters. Overall, the results proved to be satisfactory. The overall RMSE_z for the NVA checkpoints was 5.4 cm and compared favorably to the USGS specification of < 10 cm, (USGS "LIDAR Base Specification, Version 1.3", Page 24, Table 4;). The NVA at the 95% confidence level was 10.51 cm which is less than the USGS specification of < 19.6 cm. ("LIDAR

Base Specification, Version 1.3", Page 24, Table 4;).

For a complete listing of the NVA points, see Table 10.

Table 10: NVA Check Point Error Statistics (m)						
Category	# of Points	Min (m)	Max (m)	Mean (m)	Std Dev (m)	RMSE _z (m)
Check Points	107	-0.124	0.120	-0.013	0.052	0.054

Code	Easting	Northing	Known_Z	DEM_Z	Delta_Z	Description
NVA 01	1378912.03	2344187.22	183.096	183.191	-0.095	CONCRETE SIDEWALK
NVA 10	1397868.53	2308604.41	427.823	427.854	-0.031	GRAVEL DRIVEWAY
NVA 100	1433178.21	2370264.67	203.183	203.21	-0.027	SHORT GRASS
NVA 101	1453174.86	2374837.84	182.726	182.728	-0.002	SHORT GRASS
NVA 102	1453176.60	2374846.87	182.840	182.815	0.025	SHORT GRASS
NVA 103	1488042.25	2357503.84	228.561	228.499	0.062	SHORT GRASS
NVA 104	1470061.35	2342978.70	225.802	225.816	-0.014	SHORT GRASS
NVA 106	1397798.22	2308588.65	430.283	430.302	-0.019	UNPAVED DRIVEWAY
NVA 107	1412101.14	2366596.14	186.544	186.622	-0.078	UNPAVED ROAD
NVA 108	1412085.65	2366595.21	186.531	186.605	-0.074	UNPAVED ROAD
NVA 109	1500046.48	2321984.60	492.710	492.686	0.024	UNPAVED SHOULDER
NVA 11	1394298.72	2355834.05	177.701	177.706	-0.005	GRAVEL DRIVEWAY
NVA 110	1500046.32	2321984.89	492.708	492.698	0.010	UNPAVED SHOULDER
NVA 111	1413720.56	2348295.99	254.452	254.382	0.070	VALVE LID
NVA 12	1394323.90	2355829.34	177.656	177.63	0.026	GRAVEL DRIVEWAY
NVA 13	1487475.37	2332642.79	581.204	581.127	0.077	GRAVEL DRIVEWAY
NVA 14	1484607.25	2306670.69	384.589	384.568	0.021	GRAVEL DRIVEWAY
NVA 15	1466500.20	2362382.89	200.610	200.569	0.041	GRAVEL ROAD
NVA 16	1466490.92	2362427.38	201.313	201.294	0.019	GRAVEL ROAD
NVA 17	1414961.78	2328492.44	358.806	358.812	-0.006	GRAVEL SHOULDER
NVA 18	1387297.61	2324894.66	177.377	177.462	-0.085	GRAVEL/GRASS ISLAND
NVA 19	1387308.38	2324861.46	177.472	177.548	-0.076	GRAVEL/GRASS ISLAND
NVA 02	1475970.93	2319579.40	365.289	365.288	0.001	CONCRETE/GRAVEL PARKING LOT
NVA 20	1388534.89	2286484.87	241.576	241.682	-0.106	MH LID
NVA 21	1388549.54	2286506.23	242.153	242.208	-0.055	MH LID
NVA 22	1373887.63	2299474.86	200.299	200.332	-0.033	MH LID
NVA 23	1379021.06	2344207.83	182.371	182.486	-0.115	MH LID
NVA 24	1371142.23	2351866.27	175.823	175.762	0.061	MH LID
NVA 25	1373876.40	2299480.22	200.686	200.718	-0.032	PAVED DRIVEWAY
NVA 26	1374051.44	2299510.58	200.532	200.57	-0.038	PAVED DRIVEWAY
NVA 27	1394312.99	2355870.83	177.710	177.694	0.016	PAVED DRIVEWAY
NVA 28	1414926.88	2328439.06	362.946	362.964	-0.018	PAVED DRIVEWAY

Code	Easting	Northing	Known_Z	DEM_Z	Delta_Z	Description
NVA 29	1406118.09	2293484.29	397.749	397.797	-0.048	PAVED PARKING LOT
NVA 30	1388491.05	2286465.59	241.347	241.471	-0.124	PAVED PARKING LOT
NVA 31	1388472.73	2286484.08	241.876	241.997	-0.121	PAVED PARKING LOT
NVA 32	1378937.13	2344216.08	182.755	182.836	-0.081	PAVED PARKING LOT
NVA 33	1378939.14	2344227.30	182.587	182.648	-0.061	PAVED PARKING LOT
NVA 34	1395319.02	2340858.91	205.295	205.332	-0.037	PAVED PARKING LOT
NVA 35	1395300.56	2340864.57	205.273	205.286	-0.013	PAVED PARKING LOT
NVA 36	1395276.62	2340855.98	205.277	205.343	-0.066	PAVED PARKING LOT
NVA 37	1395330.04	2340803.69	204.649	204.702	-0.053	PAVED PARKING LOT
NVA 38	1470004.72	2342954.55	223.558	223.567	-0.009	PAVED PARKING LOT
NVA 39	1470016.05	2342941.29	223.663	223.656	0.007	PAVED PARKING LOT
NVA 04	1488035.32	2357448.48	228.304	228.248	0.056	CONCRETE/SHORT GRASS
NVA 40	1470048.94	2342953.20	224.520	224.515	0.005	PAVED PARKING LOT
NVA 41	1462930.42	2331829.51	280.392	280.386	0.006	PAVED PARKING LOT
NVA 42	1462879.71	2331822.77	279.410	279.419	-0.009	PAVED PARKING LOT
NVA 43	1462882.95	2331811.72	279.477	279.476	0.001	PAVED PARKING LOT
NVA 46	1378957.14	2344195.06	182.768	182.84	-0.072	PAVED PATH
NVA 47	1371138.95	2351811.44	175.505	175.57	-0.065	PAVED PATH
NVA 48	1417977.05	2307025.20	454.838	454.854	-0.016	PAVED ROAD
NVA 49	1417903.24	2307009.75	457.269	457.277	-0.008	PAVED ROAD
NVA 05	1484573.78	2306651.58	382.469	382.349	0.120	CONCRETE/SHORT GRASS
NVA 50	1406114.54	2293402.18	398.066	398.089	-0.023	PAVED ROAD
NVA 51	1397810.20	2308584.93	430.070	430.106	-0.036	PAVED ROAD
NVA 52	1397838.74	2308590.11	429.025	429.058	-0.033	PAVED ROAD
NVA 53	1387288.43	2324909.34	177.437	177.509	-0.072	PAVED ROAD
NVA 54	1387324.16	2324796.67	177.429	177.489	-0.060	PAVED ROAD
NVA 55	1387336.31	2324733.90	177.129	177.212	-0.083	PAVED ROAD
NVA 56	1371083.06	2351816.64	175.956	176.033	-0.077	PAVED ROAD
NVA 57	1413732.37	2348312.62	255.037	255.093	-0.056	PAVED ROAD
NVA 58	1413739.00	2348275.75	255.345	255.44	-0.095	PAVED ROAD
NVA 59	1413742.00	2348299.01	255.174	255.267	-0.093	PAVED ROAD
NVA 06	1484566.43	2306650.06	382.342	382.224	0.118	CONCRETE/SHORT GRASS
NVA 60	1414935.25	2328430.31	362.696	362.692	0.004	PAVED ROAD
NVA 61	1414952.03	2328472.67	360.942	360.901	0.041	PAVED ROAD
NVA 62	1500022.46	2322007.19	492.283	492.238	0.045	PAVED ROAD
NVA 63	1500056.70	2321963.72	492.810	492.787	0.023	PAVED ROAD
NVA 64	1500060.91	2321967.71	492.864	492.847	0.017	PAVED ROAD
NVA 65	1500029.83	2321998.29	492.486	492.431	0.055	PAVED ROAD
NVA 66	1487476.73	2332655.94	581.398	581.318	0.080	PAVED ROAD
NVA 67	1487496.04	2332619.86	581.559	581.469	0.090	PAVED ROAD

Code	Easting	Northing	Known_Z	DEM_Z	Delta_Z	Description
NVA 68	1475985.82	2319669.75	358.919	358.892	0.027	PAVED ROAD
NVA 69	1475966.02	2319593.56	365.123	365.104	0.019	PAVED ROAD
NVA 07	1433432.67	2356791.15	279.290	279.272	0.018	CONCRETE/SHORT GRASS
NVA 70	1484603.90	2306734.39	385.940	385.904	0.036	PAVED ROAD
NVA 71	1461700.96	2355031.60	232.406	232.383	0.023	PAVED ROAD
NVA 72	1461734.88	2355038.54	231.288	231.278	0.010	PAVED ROAD
NVA 73	1461755.50	2355032.18	231.435	231.435	0.000	PAVED ROAD
NVA 74	1461752.15	2355055.32	230.448	230.433	0.015	PAVED ROAD
NVA 75	1433455.75	2356779.79	279.009	279.013	-0.004	PAVED ROAD
NVA 76	1433163.09	2370268.03	202.936	202.954	-0.018	PAVED ROAD
NVA 77	1433140.52	2370264.31	202.528	202.504	0.024	PAVED ROAD
NVA 78	1433126.38	2370249.20	202.965	202.98	-0.015	PAVED ROAD
NVA 79	1453144.09	2374818.46	183.022	183.018	0.004	PAVED ROAD
NVA 08	1417916.12	2307019.07	456.615	456.646	-0.031	GRAVEL DRIVEWAY
NVA 80	1453186.56	2374822.83	182.903	182.876	0.027	PAVED ROAD
NVA 81	1453195.06	2374836.64	183.020	183.011	0.009	PAVED ROAD
NVA 82	1466506.31	2362437.33	201.213	201.192	0.021	PAVED ROAD
NVA 83	1466477.34	2362431.76	201.965	201.945	0.020	PAVED ROAD
NVA 84	1488030.40	2357501.25	227.970	227.893	0.077	PAVED ROAD
NVA 85	1488041.57	2357427.79	229.022	228.957	0.065	PAVEDROAD
NVA 86	1433435.63	2356777.82	278.952	279.003	-0.051	PAVED ROAD/CONCRETE
NVA 87	1371150.25	2351899.00	175.211	175.267	-0.056	PAVED SHOULDER
NVA 89	1417962.30	2307028.36	454.826	454.871	-0.045	SHORT GRASS
NVA 09	1373946.59	2299508.14	200.575	200.646	-0.071	GRAVEL DRIVEWAY
NVA 90	1417934.57	2307024.21	455.905	455.968	-0.063	SHORT GRASS
NVA 91	1406108.59	2293466.28	397.897	397.954	-0.057	SHORT GRASS
NVA 92	1406116.98	2293425.94	397.934	397.978	-0.044	SHORT GRASS
NVA 93	1373911.88	2299480.81	200.270	200.327	-0.057	SHORT GRASS
NVA 94	1394317.78	2355858.59	177.823	177.849	-0.026	SHORT GRASS
NVA 95	1395363.15	2340823.95	204.744	204.813	-0.069	SHORT GRASS
NVA 96	1487458.29	2332669.09	581.132	581.055	0.077	SHORT GRASS
NVA 97	1475989.18	2319642.55	360.741	360.726	0.015	SHORT GRASS
NVA 98	1461767.18	2354931.07	233.504	233.531	-0.027	SHORT GRASS
NVA 99	1433415.24	2356780.86	278.952	278.995	-0.043	SHORT GRASS
NVA 105	1462929.91	2331773.40	279.907	279.908	-0.001	SHORT GRASS

A summary of the vertical accuracy assessment of the Vegetated Vertical Accuracy (VVA) check points against the final DEM surface can be found in Table 11, below. The coordinates provided are in NAD83 (2011), Albers Equal Area, NAVD88 (Geoid12B), Meters. Overall, the results proved to be satisfactory. The

overall RMSE_z for the VVA checkpoints was 8.7 cm and the VVA at the 95th Percentile was 16.4 cm. The USGS specification for the VVA at the 95th Percentile is < 30 cm. (USGS “*LIDAR Base Specification, Version 1.3*”, Page 24, Table 4;).

For a complete listing of the VVA points, see Table 11.

Table 11: VVA Check Point Error Statistics (m)						
Category	# of Points	Min (m)	Max (m)	Mean (m)	Std Dev (m)	RMSE _z (m)
Check Points	103	-0.280	0.139	-0.050	0.071	0.087

ID	Easting	Northing	Known_Z	DEM_Z	Delta_Z	Description
VVA 1	1371104.31	2351869.50	174.952	175.084	-0.132	TALL BRUSH
VVA 10	1388399.01	2286474.37	241.671	241.829	-0.158	TALL GRASS/TREES
VVA 100	1500076.13	2321962.66	493.849	493.851	-0.002	WOODS
VVA 101	1475938.69	2319621.27	362.172	362.191	-0.019	WOODS
VVA 102	1461746.48	2354911.21	235.535	235.57	-0.035	WOODS
VVA 103	1433406.24	2356742.73	278.637	278.751	-0.114	WOODS
VVA 11	1388396.78	2286459.87	241.983	242.131	-0.148	TALL GRASS/TREES
VVA 12	1388420.21	2286440.01	242.294	242.437	-0.143	TALL GRASS/TREES
VVA 13	1397875.84	2308610.28	427.435	427.546	-0.111	TALL GRASS/TREES
VVA 14	1397825.28	2308603.61	429.250	429.303	-0.053	TALL GRASS/TREES
VVA 15	1397837.31	2308575.17	429.483	429.536	-0.053	TALL GRASS/TREES
VVA 16	1397793.86	2308590.31	430.314	430.426	-0.112	TALL GRASS/TREES
VVA 17	1394314.52	2355887.12	177.635	177.678	-0.043	TALL GRASS/TREES
VVA 18	1394282.18	2355879.16	177.428	177.496	-0.068	TALL GRASS/TREES
VVA 19	1394286.75	2355841.80	177.465	177.527	-0.062	TALL GRASS/TREES
VVA 2	1394287.40	2355796.61	177.814	177.871	-0.057	TALL BRUSH
VVA 20	1413766.06	2348298.00	255.442	255.509	-0.067	TALL GRASS/TREES
VVA 21	1413782.42	2348301.13	256.422	256.483	-0.061	TALL GRASS/TREES
VVA 22	1413769.16	2348315.76	254.744	254.969	-0.225	TALL GRASS/TREES
VVA 23	1414953.74	2328438.74	361.516	361.541	-0.025	TALL GRASS/TREES
VVA 24	1500036.90	2321983.30	492.820	492.776	0.044	TALL GRASS/TREES
VVA 25	1487530.52	2332582.26	580.802	580.766	0.036	TALL GRASS/TREES
VVA 26	1475996.50	2319617.29	361.947	361.91	0.037	TALL GRASS/TREES
VVA 27	1484639.11	2306624.98	384.739	384.698	0.041	TALL GRASS/TREES
VVA 28	1433402.27	2356769.24	278.772	278.851	-0.079	TALL GRASS/TREES
VVA 29	1470086.02	2342998.84	226.043	226.145	-0.102	TALL GRASS/TREES
VVA 3	1415006.70	2328476.78	358.773	358.634	0.139	TALL BRUSH
VVA 30	1470064.59	2342999.24	224.928	225.018	-0.090	TALL GRASS/TREES
VVA 31	1470043.83	2342997.91	224.094	224.125	-0.031	TALL GRASS/TREES
VVA 32	1417972.64	2307018.89	454.556	454.625	-0.069	TREES
VVA 33	1417980.25	2307021.95	454.630	454.601	0.029	TREES

VVA 34	1417923.58	2307023.89	456.070	456.103	-0.033	TREES
VVA 35	1417901.85	2307004.01	456.837	456.894	-0.057	TREES
VVA 36	1406152.35	2293463.94	397.682	397.721	-0.039	TREES
VVA 37	1406138.20	2293463.46	397.750	397.815	-0.065	TREES
VVA 38	1374044.69	2299502.26	200.708	200.759	-0.051	TREES
VVA 39	1397859.48	2308612.34	428.084	428.151	-0.067	TREES
VVA 4	1414972.50	2328488.81	359.264	359.204	0.060	TALL BRUSH
VVA 40	1387286.27	2324869.95	175.876	175.972	-0.096	TREES
VVA 41	1387325.63	2324749.43	177.134	177.414	-0.280	TREES
VVA 42	1378943.52	2344244.09	182.731	182.917	-0.186	TREES
VVA 43	1378946.98	2344227.72	182.715	182.903	-0.188	TREES
VVA 44	1378950.94	2344211.72	182.898	182.983	-0.085	TREES
VVA 45	1378967.74	2344213.27	182.710	182.833	-0.123	TREES
VVA 46	1371160.80	2351877.94	175.153	175.195	-0.042	TREES
VVA 47	1413787.02	2348281.34	256.824	256.939	-0.115	TREES
VVA 48	1413793.26	2348262.94	257.538	257.669	-0.131	TREES
VVA 49	1395405.55	2340824.67	204.930	205.013	-0.083	TREES
VVA 5	1487506.81	2332628.60	580.523	580.499	0.024	TALL BRUSH
VVA 50	1395390.64	2340821.77	204.921	205	-0.079	TREES
VVA 51	1395368.53	2340816.75	204.815	204.899	-0.084	TREES
VVA 52	1395359.16	2340863.13	205.304	205.362	-0.058	TREES
VVA 53	1500085.10	2321932.65	491.287	491.261	0.026	TREES
VVA 54	1475994.78	2319595.37	364.183	364.231	-0.048	TREES
VVA 55	1475951.52	2319631.77	361.688	361.709	-0.021	TREES
VVA 56	1484595.40	2306731.70	384.800	384.798	0.002	TREES
VVA 57	1484640.91	2306642.68	386.107	386.155	-0.048	TREES
VVA 58	1484639.38	2306609.62	383.768	383.807	-0.039	TREES
VVA 59	1461773.60	2354910.72	234.404	234.394	0.010	TREES
VVA 6	1487495.33	2332648.18	580.493	580.491	0.002	TALL BRUSH
VVA 60	1461762.68	2354908.15	234.913	234.902	0.011	TREES
VVA 61	1461761.02	2354894.25	235.722	235.756	-0.034	TREES
VVA 62	1433411.75	2356803.62	279.035	279.069	-0.034	TREES
VVA 63	1433404.39	2356785.06	279.247	279.251	-0.004	TREES
VVA 64	1433207.60	2370296.61	202.882	202.974	-0.092	TREES
VVA 65	1433192.34	2370270.74	203.301	203.348	-0.047	TREES
VVA 66	1433169.88	2370260.21	203.330	203.388	-0.058	TREES
VVA 67	1433154.47	2370231.49	205.254	205.261	-0.007	TREES
VVA 68	1453176.28	2374862.28	183.185	183.179	0.006	TREES
VVA 69	1453159.67	2374837.26	182.763	182.805	-0.042	TREES
VVA 7	1487454.75	2332677.61	581.054	581.027	0.027	TALL BRUSH
VVA 70	1453148.42	2374841.18	182.893	182.898	-0.005	TREES

VVA 71	1466495.92	2362378.70	200.239	200.346	-0.107	TREES
VVA 72	1466505.53	2362414.77	200.712	200.69	0.022	TREES
VVA 73	1466505.65	2362426.25	200.778	200.781	-0.003	TREES
VVA 74	1466525.67	2362433.60	200.778	200.769	0.009	TREES
VVA 75	1488052.20	2357507.20	229.166	229.07	0.096	TREES
VVA 76	1488054.47	2357491.78	228.969	228.921	0.048	TREES
VVA 77	1488044.78	2357482.63	228.434	228.375	0.059	TREES
VVA 78	1488051.76	2357465.56	228.587	228.565	0.022	TREES
VVA 79	1470097.19	2342990.84	227.006	227.057	-0.051	TREES
VVA 8	1412116.23	2366607.62	186.520	186.652	-0.132	TALL GRASS
VVA 80	1462862.53	2331805.58	279.397	279.433	-0.036	TREES
VVA 81	1462848.61	2331799.62	278.996	279.01	-0.014	TREES
VVA 82	1462854.27	2331780.34	279.035	279.014	0.021	TREES
VVA 83	1462870.30	2331792.62	279.502	279.456	0.046	TREES
VVA 84	1462875.38	2331777.13	279.482	279.485	-0.003	TREES
VVA 85	1462897.19	2331771.90	280.065	280.048	0.017	TREES
VVA 86	1462912.05	2331782.12	280.096	280.1	-0.004	TREES
VVA 87	1462914.36	2331765.70	279.848	279.859	-0.011	TREES
VVA 88	1406126.43	2293389.25	398.157	398.241	-0.084	WOODS
VVA 89	1406125.53	2293384.17	398.205	398.253	-0.048	WOODS
VVA 9	1388414.70	2286489.96	242.134	242.258	-0.124	TALL GRASS/TREES
VVA 90	1373941.70	2299482.93	200.141	200.305	-0.164	WOODS
VVA 91	1373951.04	2299487.85	200.488	200.579	-0.091	WOODS
VVA 92	1373969.73	2299490.37	200.358	200.603	-0.245	WOODS
VVA 93	1387318.15	2324777.18	176.922	177.086	-0.164	WOODS
VVA 94	1371160.45	2351851.50	175.171	175.299	-0.128	WOODS
VVA 95	1371119.37	2351883.05	174.890	174.982	-0.092	WOODS
VVA 96	1394295.85	2355783.14	178.238	178.24	-0.002	WOODS
VVA 97	1414941.93	2328484.99	359.999	360.063	-0.064	WOODS
VVA 98	1414931.63	2328457.91	362.642	362.709	-0.067	WOODS
VVA 99	1500087.30	2321951.82	493.618	493.61	0.008	WOODS