

DPH-11 Report on Absolute Vertical Accuracy

The USGS Lidar Base Specification Version 2.1 states: "Absolute vertical accuracy of the lidar data and the derived DEM will be assessed and reported in accordance with ASPRS (2014). Vegetated and nonvegetated land cover types shall be assessed for absolute vertical accuracy.

Three absolute accuracy values shall be assessed and reported:

1. NVA for the point data
2. VVA for the point data
3. NVA for the DEM
4. VVA for the DEM

The minimum NVA and VVA requirements for all data, using the ASPRS methodology, are listed in table 4. Both the NVA and VVA required values shall be met. NVA for the point data shall be assessed by comparing check points surveyed for NVA assessment to a triangulated irregular network (TIN) constructed from ground-classified lidar points in those areas. VVA for the point data shall be assessed by comparing check points surveyed for VVA assessment to a triangulated irregular network (TIN) constructed from ground-classified lidar points in those areas. NVA and VVA for the DEM are assessed by comparing check points to the final bare-earth surface. The minimum required thresholds for absolute and relative accuracy may be increased by the USGS–NGP when any of the following conditions are met:

- A demonstrable, substantial, and prohibitive increase in cost is needed to obtain this accuracy, which is often the case in heavily vegetated project areas.
- An alternate specification is needed to conform to previously contracted phases of a single larger overall collection effort such as for multiyear statewide collections
- The USGS–NGP agrees that the use of an alternate specification is reasonable and in the best interest of all stakeholders."

Table 4. Absolute vertical accuracy for light detection and ranging data and digital elevation models.

[QL, quality level, $RMSE_z$, root mean square error in the z direction; NVA, nonvegetated vertical accuracy; VVA, vegetated vertical accuracy; m, meter; \leq , less than or equal to]

Quality level	$RMSE_z$ (nonvegetated) (m)	NVA at the 95-percent confidence level (m)	VVA at the 95th percentile (m)
QL0	≤ 0.050	≤ 0.098	≤ 0.15
QL1	≤ 0.100	≤ 0.196	≤ 0.30
QL2	≤ 0.100	≤ 0.196	≤ 0.30
QL3	≤ 0.200	≤ 0.392	≤ 0.60

The purpose of this section is to report on the absolute vertical accuracy of the lidar data and DEMs generated from it by testing for NVA (Nonvegetated Vertical Accuracy) and VVA (Vegetated Vertical Accuracy) against surveyed ground check points.

DPH-11 Report on Absolute Vertical Accuracy - continued

[Data Source - Y:\Mapping\Projects\65220554_NE_Northeast\Production\Final_Client_Deliverables\Block3_Surdex\metadata\shapefiles\USGS_NE_Northeast_Block3_29NVA_24VVA.shp](#)

Units: Meter (/Feet)

Vertical Accuracy Class tested: 10-cm

Check Points in defined project area (DPA):	53
Check Points with Lidar Coverage	53
Check Points with Lidar Coverage (NVA)	29
Check Points with Lidar Coverage (VVA)	24
Average Z Error (NVA)	-0.007/-0.023
Maximum Z Error (NVA)	0.046/0.151
Median Z Error (NVA)	-0.007/-0.022
Minimum Z Error (NVA)	-0.059/-0.194
Standard deviation of Vertical Error (NVA)	0.026/0.084
Skewness of Vertical Error (NVA)	0.041
Kurtosis of Vertical Error (NVA)	-0.060
Non-vegetated Vertical Accuracy (NVA) RMSE(z) ¹	0.026/0.086 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level +/- ¹	0.051/0.169 PASS
FGDC/NSSDA Vertical Accuracy at the 95% Confidence Level +/-	0.051/0.169
Non-vegetated Vertical Accuracy (NVA) RMSE(z) (DEM) ²	0.030/0.098 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level (DEM) +/- ²	0.058/0.191 PASS
Vegetated Vertical Accuracy (VVA) at the 95th Percentile (TIN) +/- ¹	0.150/0.492 PASS
Vegetated Vertical Accuracy (VVA) at the 95th Percentile (DEM) +/- ²	0.159/0.523 PASS

This data set was tested to meet ASPRS Positional Accuracy Standard for Digital Geospatial Data (2014) for a 10-cm RMSEz Vertical Accuracy Class. Actual NVA accuracy was found to be RMSEz = 2.6cm, equating to +/- 5.1cm at the 95% confidence level. Actual VVA accuracy was found to be +/- 15.9cm at the 95th percentile.

¹ This value is calculated from TIN-based testing of the lidar point cloud data.

² This value is calculated from RAM-based grid testing of the lidar data. The grid cells are sized according to the Quality Level selected, and are defined in the USGS NGP Lidar Base Specification Version 2.1 (Table 6).

DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to report the results of measuring the lidar point cloud data against surveyed ground NVA (nonvegetated vertical accuracy) check points. All XY coordinates and Z values reported are in the selected data units.

NVA (lidar data)

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Minimum Z	Median Z	Maximum Z	Intensity	Scan Angle Rank	Returns	Description	Comments
NVA6022	630329.495	4736738.017	Yes	421.309	421.343	0.034	421.33	421.335	421.358	16805	-1235	1,1,1		
NVA6025	629058.235	4722239.805	Yes	475.084	475.088	0.004	475.081	475.091	475.094	17728	396	1,1,1		
NVA6027	647333.71	4708037.675	Yes	472.168	472.182	0.014	472.165	472.169	472.195	11592	2533	1,1,1		
NVA6029	635064.105	4693369.323	Yes	509.06	509.046	-0.014	509.039	509.054	509.087	16005	2155	1,1,1		
NVA6036	647844.927	4653438.342	Yes	510.484	510.469	-0.015	510.46	510.479	510.49	18101	-2911	1,1,1		
NVA6038	633048.768	4677231.251	Yes	551.852	551.841	-0.011	551.835	551.84	551.848	22015	-622	1,1,1		
NVA6039	630457.468	4641716.093	Yes	508.825	508.805	-0.020	508.803	508.806	508.827	18755	1687	1,1,1		
NVA6050	642632.573	4677389.175	Yes	521.227	521.22	-0.007	521.205	521.236	521.258	23722	1344	1,1,1		
NVA6056	644072.247	4645206.018	Yes	453.037	453.002	-0.035	452.992	452.994	453.02	22085	54	1,1,1		
NVA6061	648266.183	4636491.991	Yes	505.297	505.312	0.015	505.284	505.315	505.318	23765	-2076	1,1,1		
NVA6068	643827.42	4719302.245	Yes	412.067	412.113	0.046	412.086	412.09	412.133	15886	1361	1,1,1		
NVA6077	629398.82	4702907.432	Yes	571.088	571.052	-0.036	571.027	571.055	571.061	23741	-467	1,1,1		
NVA6091	627748.026	4622394.631	Yes	515.197	515.197	0.000	515.195	515.2	515.235	18154	2400	1,1,1		
NVA6094	629692.119	4686776.43	Yes	519.274	519.241	-0.033	519.223	519.241	519.26	18059	87	1,1,1		
NVA6110	647776.193	4663000.385	Yes	503.632	503.619	-0.013	503.6	503.644	503.666	14394	-2510	1,1,1		
NVA6121	650384.675	4671107.778	Yes	484.012	484.01	-0.002	483.992	484.008	484.024	12604	972	1,1,1		
NVA6123	640114.194	4663404.328	Yes	514.382	514.323	-0.059	514.278	514.319	514.347	12021	2370	1,1,1		
NVA6127	635954.025	4748831.836	Yes	357.136	357.145	0.009	357.125	357.125	357.152	8152	-2952	1,1,1		
NVA6127alt	635958.173	4748887.539	Yes	356.667	356.709	0.042	356.707	356.711	356.712	12270	-2477	1,1,1		
NVA6133	648518.059	4622984.56	Yes	504.413	504.41	-0.003	504.394	504.404	504.419	15067	-1525	1,1,1		
NVA6139	648845.457	4687162.194	Yes	510.17	510.131	-0.039	510.117	510.133	510.133	18337	-1261	1,1,1		
NVA6140	641696.318	4732109.742	Yes	397.225	397.236	0.011	397.229	397.237	397.239	17903	-29	1,1,1		
NVA6142	629176.135	4654600.196	Yes	480.101	480.097	-0.004	480.094	480.096	480.147	16234	-2224	1,1,1		
NVA6148	645134.085	4632400.817	Yes	519.013	518.992	-0.021	518.975	518.982	519.001	20787	-1993	1,1,1		
NVA6149	624565.095	4668983.91	Yes	478.948	478.943	-0.005	478.929	478.931	478.958	19452	-1762	1,1,1		
NVA6159	651339.214	4741584.115	Yes	353.442	353.426	-0.016	353.417	353.422	353.43	16420	-983	1,1,1		
NVA6164	648639.896	4697596.033	Yes	469.453	469.395	-0.058	469.389	469.405	469.407	12786	-1232	1,1,1		
NVA6169	629146.197	4714197.561	Yes	485.748	485.765	0.017	485.752	485.761	485.776	19719	209	1,1,1		
NVA6172	629594.941	4631935.558	Yes	481.798	481.789	-0.009	481.756	481.768	481.822	15248	-1311	1,1,1		

DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to report the results of measuring the lidar point cloud data against surveyed ground VVA (vegetated vertical accuracy) check points. All XY coordinates and Z values reported are in the selected data units.

VVA (lidar data)

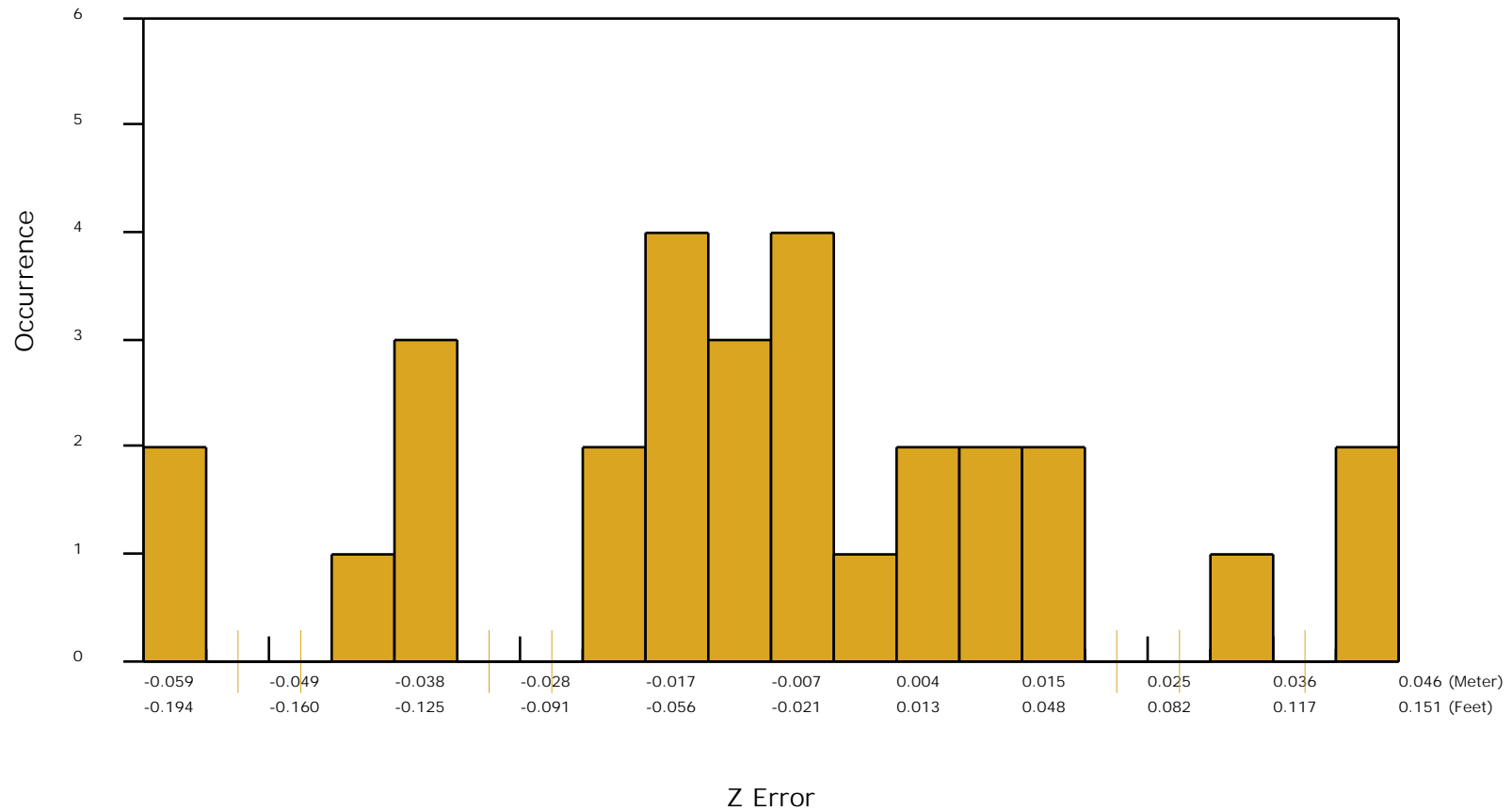
ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Minimum Z	Median Z	Maximum Z	Intensity	Scan Angle Rank	Returns	Description	Comments
VVA7022	630693.753	4736684.582	Yes	412.55	412.619	0.069	412.615	412.627	412.63	9284	-43	1,1,1		
VVA7025	629754.941	4722264.064	Yes	479.437	479.46	0.023	479.421	479.433	479.47	12808	-1940	2,2,1		
VVA7025alt	630040.999	4722372.116	Yes	485.898	485.832	-0.066	485.817	485.832	485.857	20857	-2631	1,1,1		
VVA7027	647428.465	4708029.886	Yes	469.522	469.556	0.034	469.54	469.543	469.569	25395	2403	1,1,1		
VVA7027alt	647407.962	4708029.208	Yes	469.819	469.824	0.005	469.778	469.828	469.838	13182	2536	1,2,1		
VVA7029	635463.795	4692875.553	Yes	503.293	503.255	-0.038	503.232	503.238	503.265	30283	756	1,1,1		
VVA7036	648063.571	4653416.784	Yes	503.39	503.464	0.074	503.455	503.457	503.492	30339	-2789	1,1,1		
VVA7038	633061.186	4677509.661	Yes	537.172	537.356	0.184	537.348	537.358	537.375	18660	-689	1,1,1		
VVA7039	630456.6	4641674.581	Yes	508.656	508.748	0.092	508.743	508.752	508.78	26739	1699	1,1,1		
VVA7050	642885.7	4677350.814	Yes	516.891	516.94	0.049	516.909	516.955	516.963	24164	2412	1,1,1		
VVA7050alt	642766.024	4677347.683	Yes	517.448	517.362	-0.086	517.339	517.358	517.381	13350	1779	1,2,1		
VVA7056	644514.75	4645094.447	Yes	451.974	451.995	0.021	451.986	451.993	451.998	31890	-1394	1,1,1		
VVA7061	649079.256	4636526.135	Yes	477.845	478.001	0.156	477.992	478.001	478.017	29033	579	1,1,1		
VVA7068	643635.947	4719330.773	Yes	409.608	409.715	0.107	409.69	409.707	409.73	10395	739	1,1,1		
VVA7068alt	643625.541	4719302.72	Yes	410.299	410.413	0.114	410.41	410.41	410.446	20522	717	1,1,1		
VVA7077	627440.501	4702854.793	Yes	566.563	566.625	0.062	566.59	566.635	566.64	28454	-1046	1,1,1		
VVA7079	652693.892	4711382.443	Yes	476.706	476.726	0.020	476.694	476.719	476.728	26062	-669	1,1,1		
VVA7091	627595.907	4623968.951	Yes	523.648	523.725	0.077	523.714	523.738	523.747	23892	2233	1,1,1		
VVA7094	629628.842	4688705.544	Yes	515.703	515.78	0.077	515.757	515.772	515.786	27005	-169	1,1,1		
VVA7110	646965.432	4662968.745	Yes	509.645	509.716	0.071	509.714	509.715	509.726	26625	462	1,1,1		
VVA7121	651062.714	4671141.175	Yes	490.99	491.036	0.046	491.019	491.044	491.054	21502	2736	1,1,1		
VVA7123	639770.265	4663484.693	Yes	508.237	508.216	-0.021	508.196	508.217	508.254	23055	1766	1,1,1		
VVA7123alt	639857.859	4664035.411	Yes	508.567	508.543	-0.024	508.535	508.537	508.55	11880	2016	1,1,1		
VVA7127	632756.736	4749252.325	Yes	361.544	361.518	-0.026	361.494	361.501	361.526	23654	-1880	1,1,1		

DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to show a frequency distribution chart of the non-vegetated vertical accuracy (NVA) of the lidar point cloud data measured against surveyed ground check points.

[Data Source - Y:\Mapping\Projects\65220554_NE_Northeast\Production\Final_Client_Deliverables\Block3_Surdex\point_cloud\tilecls](#)

NVA (lidar data)

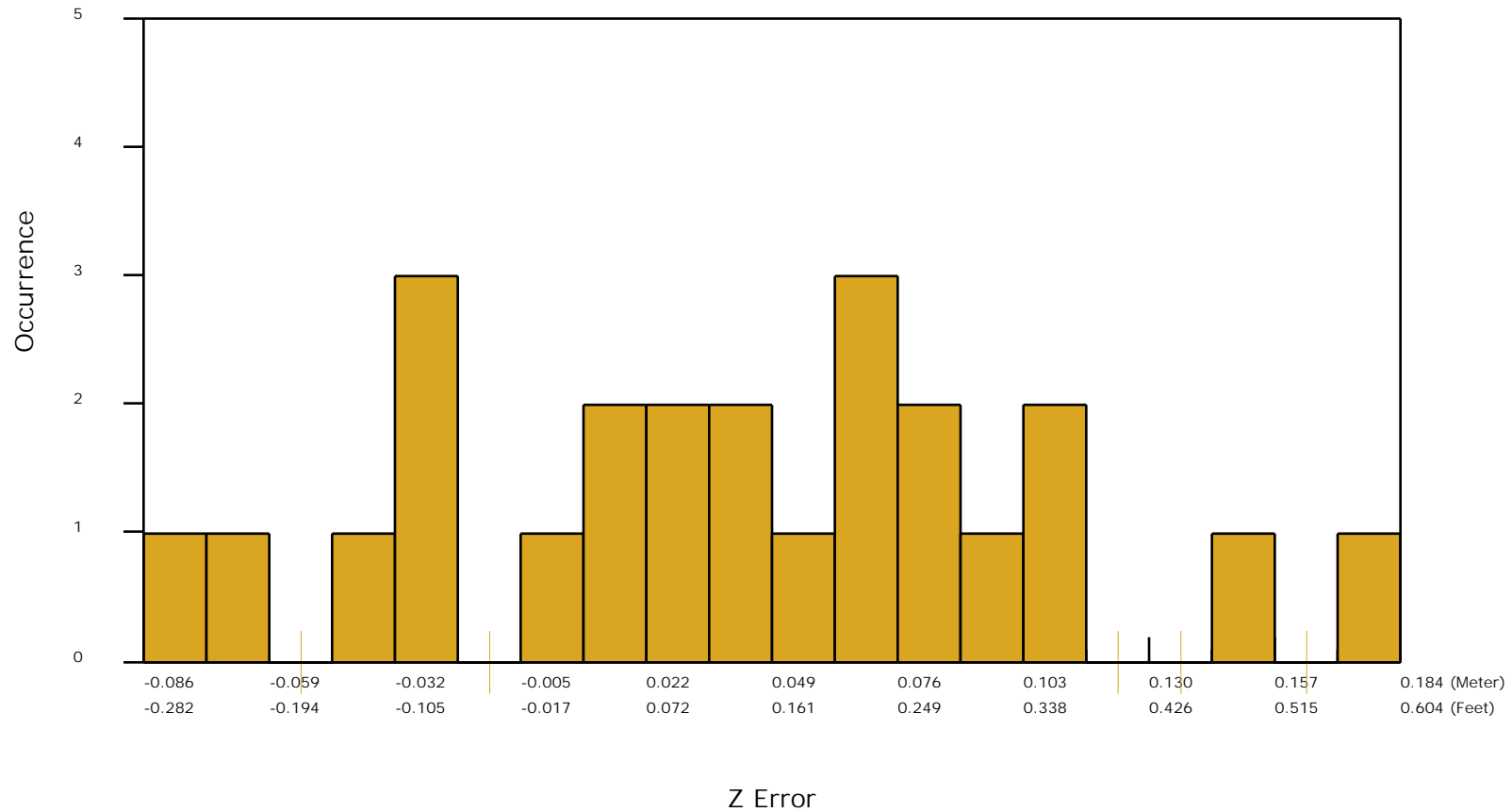


DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to show a frequency distribution chart of the vegetated vertical accuracy (VVA) of the lidar point cloud data measured against surveyed ground check points.

[Data Source - Y:\Mapping\Projects\65220554_NE_Northeast\Production\Final_Client_Deliverables\Block3_Surdex\point_cloud\tilecls](#)

VVA (lidar data)



DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to report the results of measuring the DEM data against surveyed ground NVA (nonvegetated vertical accuracy) check points. All XY coordinates and Z values reported are in the selected data units.

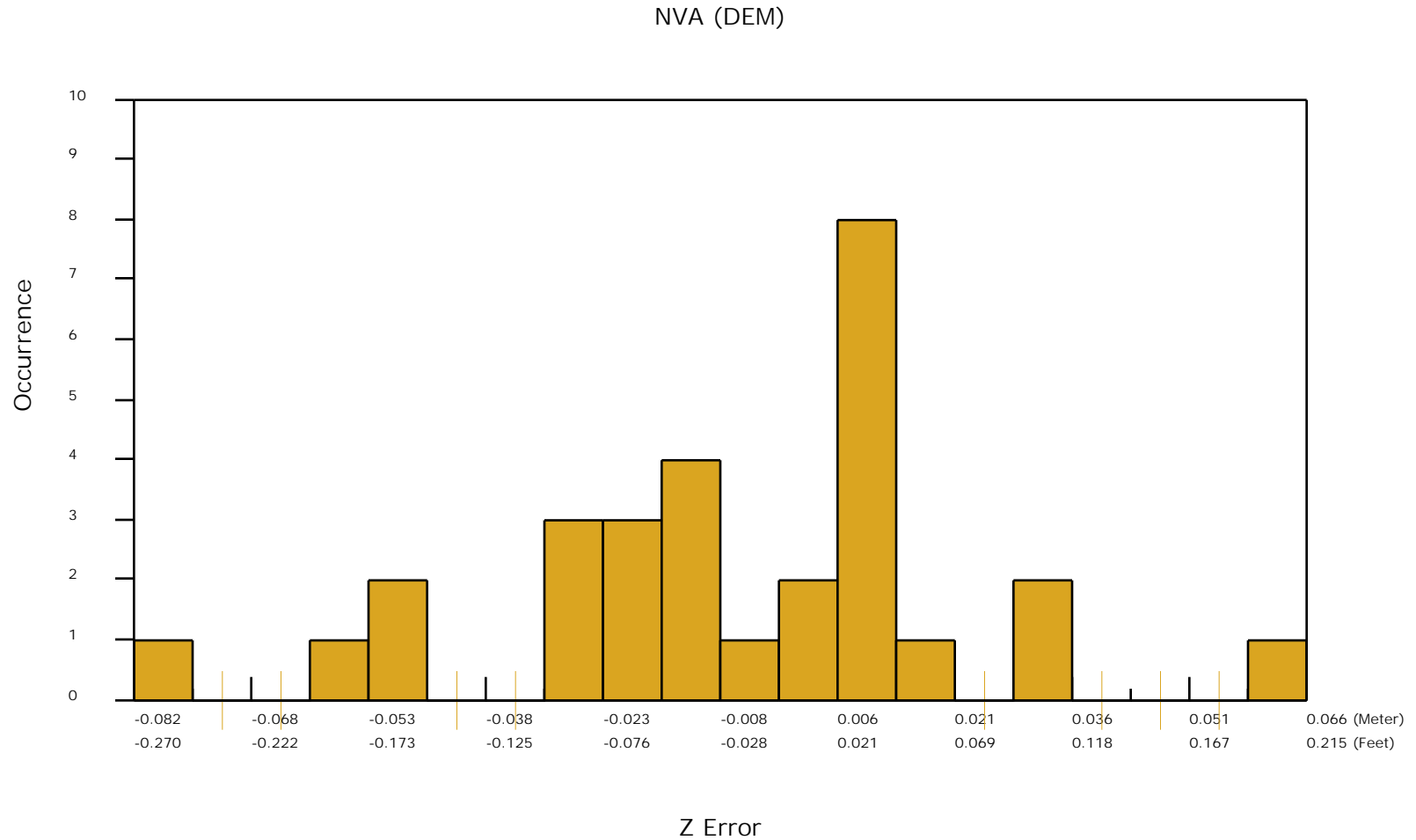
NVA (DEM)

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
NVA6022	630329.495	4736738.017	Yes	421.309	421.340	0.031		
NVA6025	629058.235	4722239.805	Yes	475.084	475.092	0.008		
NVA6027	647333.71	4708037.675	Yes	472.168	472.176	0.008		
NVA6029	635064.105	4693369.323	Yes	509.06	509.041	-0.019		
NVA6036	647844.927	4653438.342	Yes	510.484	510.460	-0.024		
NVA6038	633048.768	4677231.251	Yes	551.852	551.838	-0.014		
NVA6039	630457.468	4641716.093	Yes	508.825	508.794	-0.031		
NVA6050	642632.573	4677389.175	Yes	521.227	521.237	0.010		
NVA6056	644072.247	4645206.018	Yes	453.037	452.991	-0.046		
NVA6061	648266.183	4636491.991	Yes	505.297	505.314	0.017		
NVA6068	643827.42	4719302.245	Yes	412.067	412.133	0.066		
NVA6077	629398.82	4702907.432	Yes	571.088	571.061	-0.027		
NVA6091	627748.026	4622394.631	Yes	515.197	515.203	0.006		
NVA6094	629692.119	4686776.43	Yes	519.274	519.259	-0.015		
NVA6110	647776.193	4663000.385	Yes	503.632	503.630	-0.002		
NVA6121	650384.675	4671107.778	Yes	484.012	484.020	0.008		
NVA6123	640114.194	4663404.328	Yes	514.382	514.326	-0.056		
NVA6127	635954.025	4748831.836	Yes	357.136	357.143	0.007		
NVA6127alt	635958.173	4748887.539	Yes	356.667	356.701	0.034		
NVA6133	648518.059	4622984.56	Yes	504.413	504.404	-0.009		
NVA6139	648845.457	4687162.194	Yes	510.17	510.123	-0.047		
NVA6140	641696.318	4732109.742	Yes	397.225	397.231	0.006		
NVA6142	629176.135	4654600.196	Yes	480.101	480.103	0.002		
NVA6148	645134.085	4632400.817	Yes	519.013	518.994	-0.019		
NVA6149	624565.095	4668983.91	Yes	478.948	478.957	0.009		
NVA6159	651339.214	4741584.115	Yes	353.442	353.421	-0.021		
NVA6164	648639.896	4697596.033	Yes	469.453	469.371	-0.082		
NVA6169	629146.197	4714197.561	Yes	485.748	485.760	0.012		
NVA6172	629594.941	4631935.558	Yes	481.798	481.788	-0.010		

DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to show a frequency distribution chart of the non-vegetated vertical accuracy (NVA) of the DEM data measured against surveyed ground check points.

[Data Source - Y:\Mapping\Projects\65220554_NE_Northeast\Production\Final_Client_Deliverables\Block3_Surdex\point_cloud\tilecls](#)



DPH-11 Report on Absolute Vertical Accuracy - continued

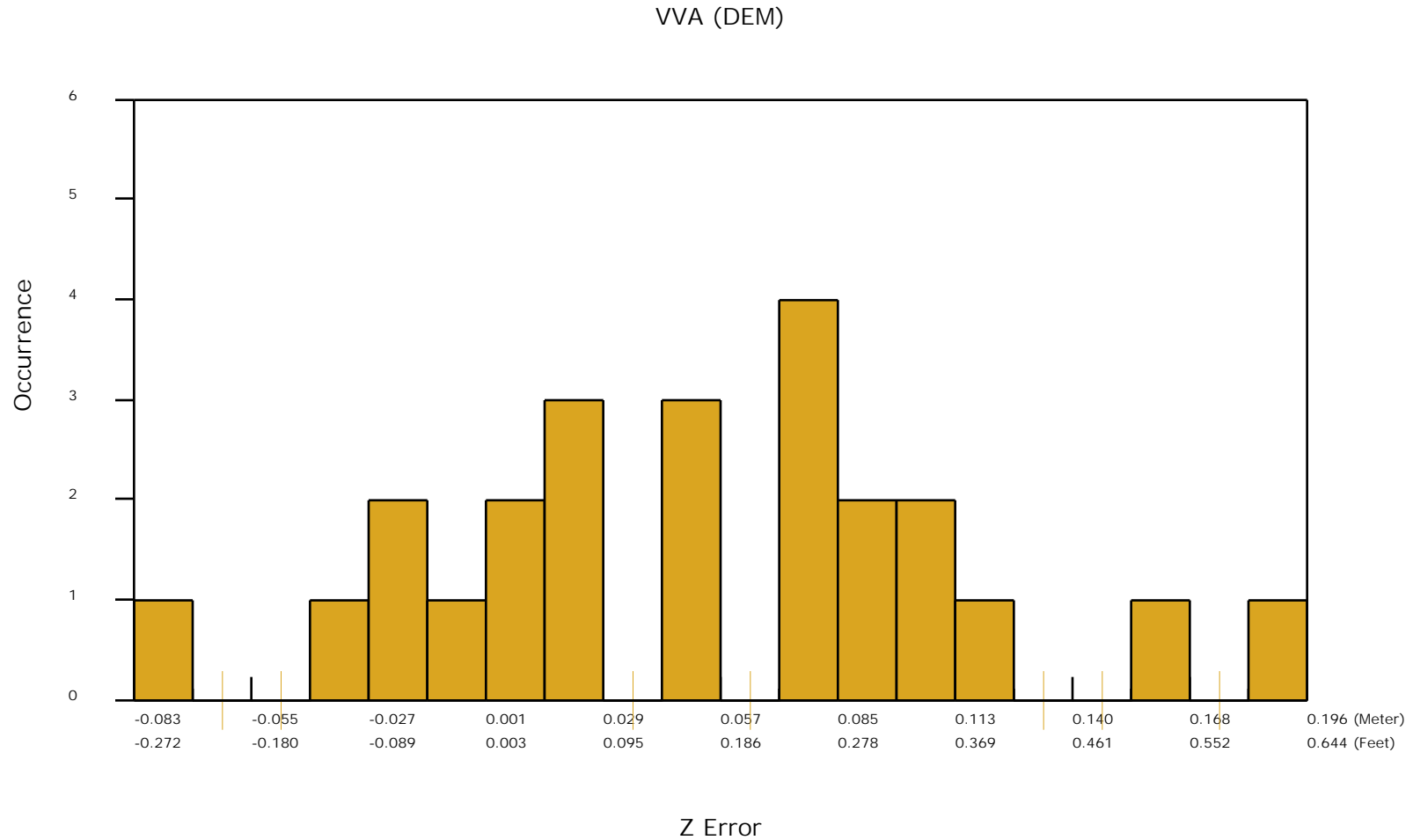
The purpose of this section is to report the results of measuring the DEM data against surveyed ground VVA (vegetated vertical accuracy) check points. All XY coordinates and Z values reported are in the selected data units.

VVA (DEM)								
ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
VVA7022	630693.753	4736684.582	Yes	412.55	412.627	0.077		
VVA7025	629754.941	4722264.064	Yes	479.437	479.483	0.046		
VVA7025alt	630040.999	4722372.116	Yes	485.898	485.871	-0.027		
VVA7027	647428.465	4708029.886	Yes	469.522	469.545	0.023		
VVA7027alt	647407.962	4708029.208	Yes	469.819	469.841	0.022		
VVA7029	635463.795	4692875.553	Yes	503.293	503.265	-0.028		
VVA7036	648063.571	4653416.784	Yes	503.39	503.502	0.112		
VVA7038	633061.186	4677509.661	Yes	537.172	537.368	0.196		
VVA7039	630456.6	4641674.581	Yes	508.656	508.748	0.092		
VVA7050	642885.7	4677350.814	Yes	516.891	516.946	0.055		
VVA7050alt	642766.024	4677347.683	Yes	517.448	517.365	-0.083		
VVA7056	644514.75	4645094.447	Yes	451.974	451.994	0.020		
VVA7061	649079.256	4636526.135	Yes	477.845	478.011	0.166		
VVA7068	643635.947	4719330.773	Yes	409.608	409.692	0.084		
VVA7068alt	643625.541	4719302.72	Yes	410.299	410.421	0.122		
VVA7077	627440.501	4702854.793	Yes	566.563	566.643	0.080		
VVA7079	652693.892	4711382.443	Yes	476.706	476.719	0.013		
VVA7091	627595.907	4623968.951	Yes	523.648	523.755	0.107		
VVA7094	629628.842	4688705.544	Yes	515.703	515.788	0.085		
VVA7110	646965.432	4662968.745	Yes	509.645	509.723	0.078		
VVA7121	651062.714	4671141.175	Yes	490.99	491.042	0.052		
VVA7123	639770.265	4663484.693	Yes	508.237	508.227	-0.010		
VVA7123alt	639857.859	4664035.411	Yes	508.567	508.569	0.002		
VVA7127	632756.736	4749252.325	Yes	361.544	361.517	-0.027		

DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to show a frequency distribution chart of the vegetated vertical accuracy (VVA) of the DEM data measured against surveyed ground check points.

[Data Source - Y:\Mapping\Projects\65220554_NE_Northeast\Production\Final_Client_Deliverables\Block3_Surdex\point_cloud\tilecls](#)

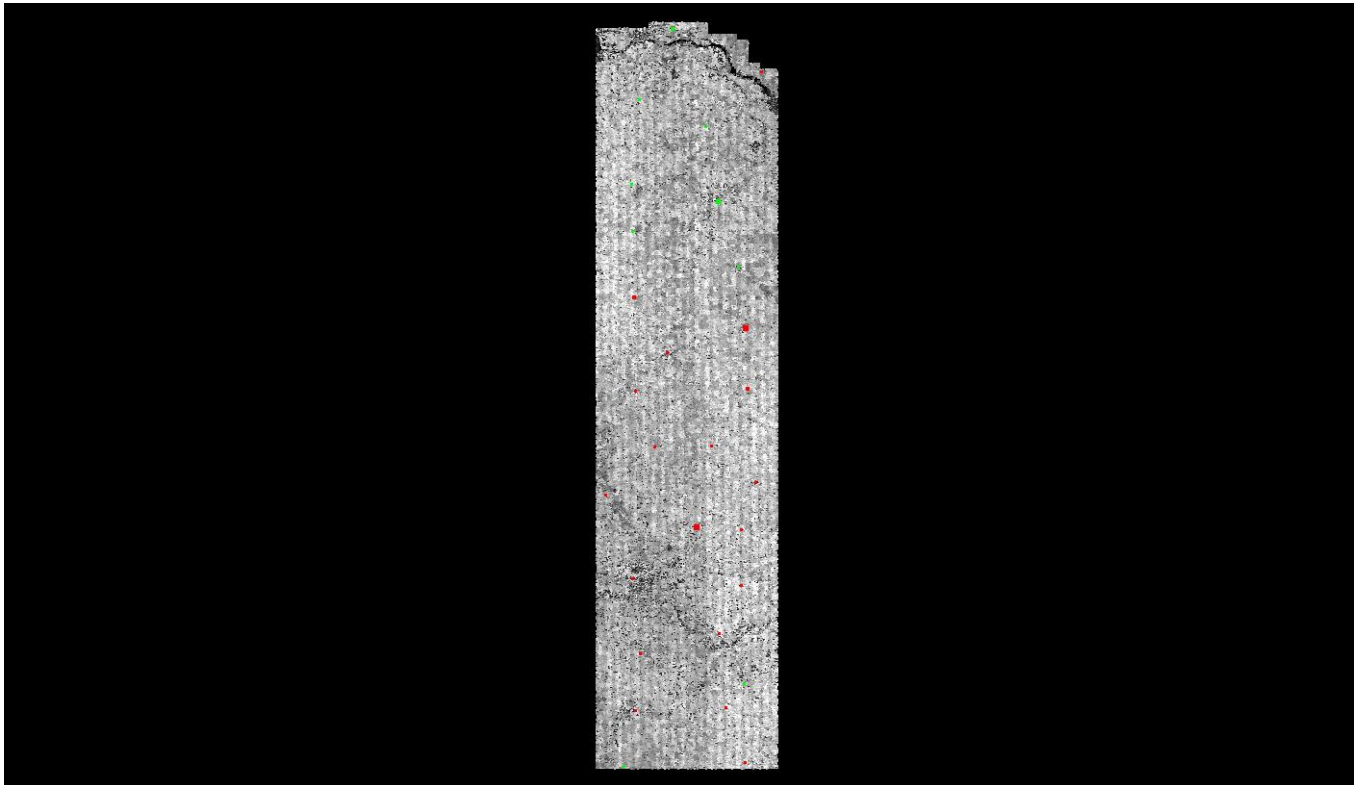


DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to show a graphic of lidar data points colored by intensity with NVA check points rendered "thematically" showing the green and red squares sized by Z error.

[Data Source - Y:\Mapping\Projects\65220554_NE_Northeast\Production\Final_Client_Deliverables\Block3_Surdex\point_cloud\tilecls](Y:\Mapping\Projects\65220554_NE_Northeast\Production\Final_Client_Deliverables\Block3_Surdex\point_cloud\tilecls)

[Result Path - D:\00_NE_Nebraska\Block3\DPH_11\ColorByIntensity_CheckPoints_NVA.jpg](D:\00_NE_Nebraska\Block3\DPH_11\ColorByIntensity_CheckPoints_NVA.jpg)



■ Green represents where the lidar surface is above the check point (positive elevation error).

■ Red represents where the lidar surface is below the check point (negative elevation error).

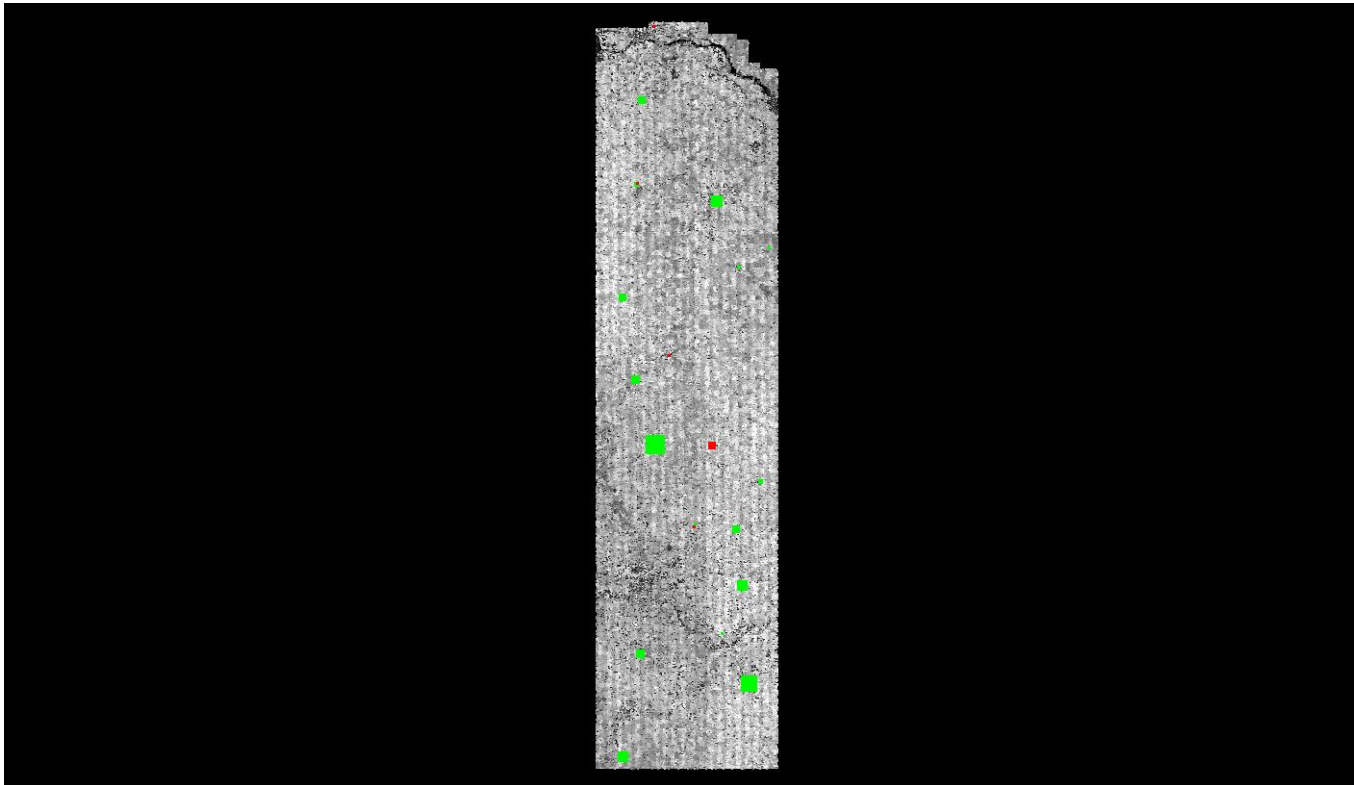
The size of the square symbol represents the absolute value magnitude of error.

DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to show a graphic of lidar data points colored by intensity with VVA check points rendered "thematically" showing the green and red squares sized by Z error.

[Data Source - Y:\Mapping\Projects\65220554_NE_Northeast\Production\Final_Client_Deliverables\Block3_Surdex\point_cloud\tilecls](Y:\Mapping\Projects\65220554_NE_Northeast\Production\Final_Client_Deliverables\Block3_Surdex\point_cloud\tilecls)

[Result Path - D:\00_NE_Nebraska\Block3\DPH_11\ColorByIntensity_CheckPoints_VVA.jpg](D:\00_NE_Nebraska\Block3\DPH_11\ColorByIntensity_CheckPoints_VVA.jpg)



■ Green represents where a DEM of the lidar surface is above the check point (positive elevation error).

■ Red represents where a DEM of the lidar surface is below the check point (negative elevation error).

The size of the square symbol represents the absolute value magnitude of error.