

DPH-11 Report on Absolute Vertical Accuracy

The USGS Lidar Base Specification Version 1.3 states: "Absolute vertical accuracy of the lidar data and the derived DEM will be assessed and reported in accordance with the ASPRS (2014). Two broad land cover types shall be assessed: vegetated and nonvegetated. Three absolute accuracy values shall be assessed and reported: (1) NVA for the point data, (2) NVA for the DEM, and (3) 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."

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\65220171_USGS-TX_West_Texas\Production\Final_Client_Deliverables\Lot6_utm13\metadata\shapefiles\TX_WestTexas_Lot6_38NVA_33VVA_pts_u13.shp](#)

Units: Meter (/Feet)

Vertical Accuracy Class tested: 10-cm

Check Points in defined project area (DPA):	71
Check Points with Lidar Coverage	71
Check Points with Lidar Coverage (NVA)	38
Check Points with Lidar Coverage (VVA)	33
Average Z Error (NVA)	-0.021/-0.069
Maximum Z Error (NVA)	0.048/0.159
Median Z Error (NVA)	-0.014/-0.046
Minimum Z Error (NVA)	-0.286/-0.939
Standard deviation of Vertical Error (NVA)	0.061/0.200
Skewness of Vertical Error (NVA)	-2.810
Kurtosis of Vertical Error (NVA)	8.775
Non-vegetated Vertical Accuracy (NVA) RMSE(z) ¹	0.064/0.209 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level +/- ¹	0.125/0.410 PASS
FGDC/NSSDA Vertical Accuracy at the 95% Confidence Level +/-	0.125/0.410
Non-vegetated Vertical Accuracy (NVA) RMSE(z) (DEM) ²	0.062/0.203 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level (DEM) +/- ²	0.121/0.397 PASS
Vegetated Vertical Accuracy (VVA) at the 95th Percentile (DEM) +/- ²	0.185/0.607 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 = 6.4cm, equating to +/- 12.5cm at the 95% confidence level. Actual VVA accuracy was found to be +/- 18.5cm 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 1.3 (page 24, 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
1005	514166.264	3453819.876	Yes	1284.739	1284.764	0.025	1284.747	1284.76	1284.772	5746	-64	1,1,1		
1012	550201.363	3468718.797	Yes	1376.291	1376.271	-0.020	1376.261	1376.282	1376.29	10492	172	1,1,1		
1014	547366.288	3436515.439	Yes	1240.417	1240.131	-0.286	1240.101	1240.147	1240.149	2776	-119	1,1,1		
1016	553107.04	3504037.13	Yes	1260.284	1260.266	-0.018	1260.257	1260.266	1260.267	7851	1049	1,1,1		
1017	516151.043	3433742.063	Yes	1230.286	1230.306	0.020	1230.29	1230.293	1230.316	5911	-1444	1,1,1		
1035	521171.998	3414493.45	Yes	1208.988	1208.973	-0.015	1208.966	1208.968	1209.006	3751	2187	1,1,1		
1054	512945.913	3506946.026	Yes	1188.343	1188.336	-0.007	1188.325	1188.334	1188.358	6097	-1745	1,1,1		
1058	533892.665	3435302.341	Yes	1179.52	1179.396	-0.124	1179.391	1179.396	1179.411	3288	443	1,1,1		
1060	501426.104	3427796.576	Yes	1291.036	1291.01	-0.026	1291.004	1291.016	1291.022	4124	-565	1,1,1		
1064	553520.243	3481281.739	Yes	1246.863	1246.863	0.000	1246.849	1246.861	1246.868	6973	295	1,1,1		
1067	501512.414	3535425.54	Yes	1110.368	1110.355	-0.013	1110.353	1110.355	1110.36	7734	1282	1,1,1		
1068	517098.085	3468658.842	Yes	1116.189	1116.201	0.012	1116.178	1116.193	1116.221	4630	-1363	1,1,1		
1070	534278.559	3486436.81	Yes	1482.177	1482.142	-0.035	1482.134	1482.146	1482.15	5601	-1308	1,1,1		
1073	516964.479	3525059.104	Yes	1652.886	1652.849	-0.037	1652.842	1652.843	1652.859	5344	-1393	1,1,1		
1076	514478.664	3477105.755	Yes	1104.232	1104.267	0.035	1104.242	1104.252	1104.278	6814	902	1,1,1		
1078	513541.34	3497311.206	Yes	1111.482	1111.482	0.000	1111.477	1111.482	1111.493	2464	-1399	1,1,1		
1089	548883.329	3525558.876	Yes	1131.739	1131.719	-0.020	1131.703	1131.726	1131.768	2814	1896	1,1,1		
1105	554356.674	3531891.271	Yes	1118.996	1119.012	0.016	1118.998	1119.01	1119.013	5502	-1777	1,1,1		
1147	540449.664	3462418.766	Yes	1239.894	1239.904	0.010	1239.888	1239.907	1239.911	6668	-1338	1,1,1		
1148	517963.447	3404121.73	Yes	1279.567	1279.594	0.027	1279.581	1279.594	1279.614	7075	1380	1,1,1		
1150	506674.007	3435107.514	Yes	1363.944	1363.957	0.013	1363.953	1363.956	1363.974	4446	951	1,1,1		
1164	547454.559	3529308.676	Yes	1171.029	1171.022	-0.007	1171	1171.034	1171.075	7484	-2047	1,1,1		
1167	539348.088	3508791.369	Yes	1336.682	1336.724	0.042	1336.7	1336.731	1336.76	7610	1089	1,1,1		
1181	534119.404	3442268.921	Yes	1153.411	1153.383	-0.028	1153.371	1153.387	1153.397	2986	1167	1,1,1		
1189	538184.527	3452980.331	Yes	1154.379	1154.391	0.012	1154.366	1154.392	1154.403	3773	-337	1,1,1		
1199	503530.259	3513661.302	Yes	1115.49	1115.463	-0.027	1115.462	1115.468	1115.471	6026	-548	1,1,1		
1246A	502456.527	3443902.573	Yes	1465.529	1465.517	-0.012	1465.51	1465.515	1465.523	4391	-1392	1,1,1		
1252	526694.695	3452828.327	Yes	1129.772	1129.82	0.048	1129.814	1129.821	1129.848	7004	-1214	1,1,1		
1261	534858.817	3537231.812	Yes	1347.886	1347.864	-0.022	1347.849	1347.865	1347.886	8397	1216	1,1,1		
1264	542241.191	3436121.054	Yes	1204.275	1204.09	-0.185	1204.057	1204.057	1204.109	3096	141	1,1,1		

Check Points Vertical Accuracy - continued

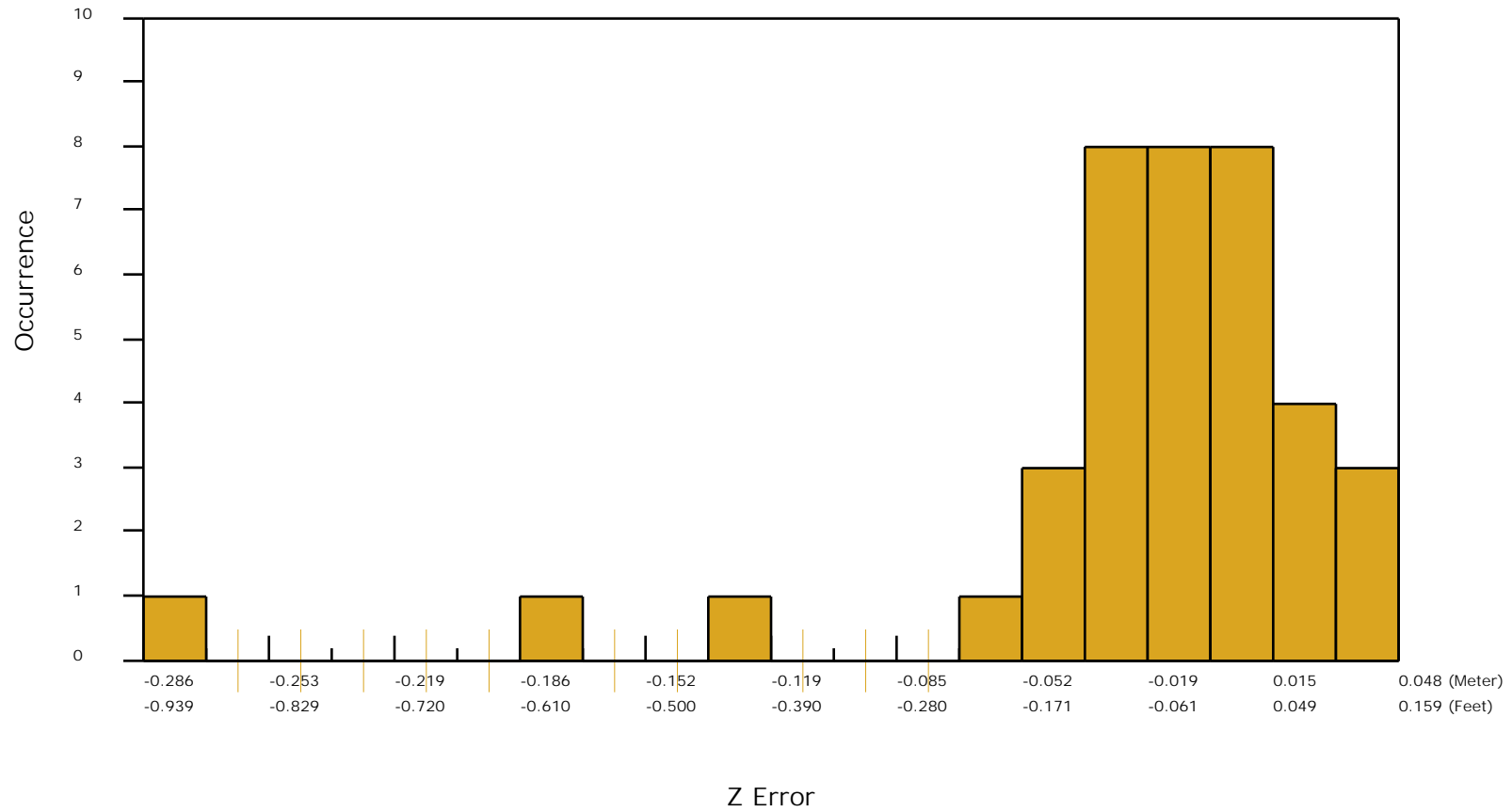
ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Minimum Z	Median Z	Maximum Z	Intensity	Scan Angle Rank	Returns	Description	Comments
1290	520372.722	3407005.277	Yes	1231.846	1231.806	-0.040	1231.773	1231.815	1231.826	4933	625	1,1,1		
1339	522118.081	3418564.937	Yes	1202.848	1202.861	0.013	1202.855	1202.86	1202.865	5855	-880	1,1,1		
941003	547515.835	3439694.61	Yes	1259.662	1259.646	-0.016	1259.616	1259.661	1259.678	8173	347	1,1,1		
951002	513991.785	3492821.998	Yes	1104.565	1104.565	0.000	1104.559	1104.56	1104.57	7471	-244	1,1,1		
951004	523987.901	3531851.115	Yes	1482.487	1482.458	-0.029	1482.451	1482.453	1482.489	4853	-712	1,1,1		
951006	523431.914	3537882.28	Yes	1526.94	1526.879	-0.061	1526.856	1526.876	1526.906	4033	-2343	1,1,1		
951009	527243.35	3533813.3	Yes	1429.618	1429.587	-0.031	1429.584	1429.589	1429.592	4140	-1165	1,1,1		
981002	546023.013	3486099.263	Yes	1378.371	1378.356	-0.015	1378.332	1378.346	1378.357	6830	2037	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.

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NVA (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
1005	514166.264	3453819.876	Yes	1284.739	1284.768	0.029		
1012	550201.363	3468718.797	Yes	1376.291	1376.261	-0.030		
1014	547366.288	3436515.439	Yes	1240.417	1240.147	-0.270		
1016	553107.04	3504037.13	Yes	1260.284	1260.262	-0.022		
1017	516151.043	3433742.063	Yes	1230.286	1230.266	-0.020		
1035	521171.998	3414493.45	Yes	1208.988	1208.962	-0.026		
1054	512945.913	3506946.026	Yes	1188.343	1188.349	0.006		
1058	533892.665	3435302.341	Yes	1179.52	1179.399	-0.121		
1060	501426.104	3427796.576	Yes	1291.036	1291.009	-0.027		
1064	553520.243	3481281.739	Yes	1246.863	1246.865	0.002		
1067	501512.414	3535425.54	Yes	1110.368	1110.355	-0.013		
1068	517098.085	3468658.842	Yes	1116.189	1116.192	0.003		
1070	534278.559	3486436.81	Yes	1482.177	1482.135	-0.042		
1073	516964.479	3525059.104	Yes	1652.886	1652.864	-0.022		
1076	514478.664	3477105.755	Yes	1104.232	1104.273	0.041		
1078	513541.34	3497311.206	Yes	1111.482	1111.495	0.013		
1089	548883.329	3525558.876	Yes	1131.739	1131.745	0.006		
1105	554356.674	3531891.271	Yes	1118.996	1119.018	0.022		
1147	540449.664	3462418.766	Yes	1239.894	1239.906	0.012		
1148	517963.447	3404121.73	Yes	1279.567	1279.598	0.031		
1150	506674.007	3435107.514	Yes	1363.944	1363.953	0.009		
1164	547454.559	3529308.676	Yes	1171.029	1171.019	-0.010		
1167	539348.088	3508791.369	Yes	1336.682	1336.731	0.049		
1181	534119.404	3442268.921	Yes	1153.411	1153.365	-0.046		
1189	538184.527	3452980.331	Yes	1154.379	1154.394	0.015		
1199	503530.259	3513661.302	Yes	1115.49	1115.466	-0.024		
1246A	502456.527	3443902.573	Yes	1465.529	1465.518	-0.011		
1252	526694.695	3452828.327	Yes	1129.772	1129.828	0.056		
1261	534858.817	3537231.812	Yes	1347.886	1347.873	-0.013		
1264	542241.191	3436121.054	Yes	1204.275	1204.095	-0.180		

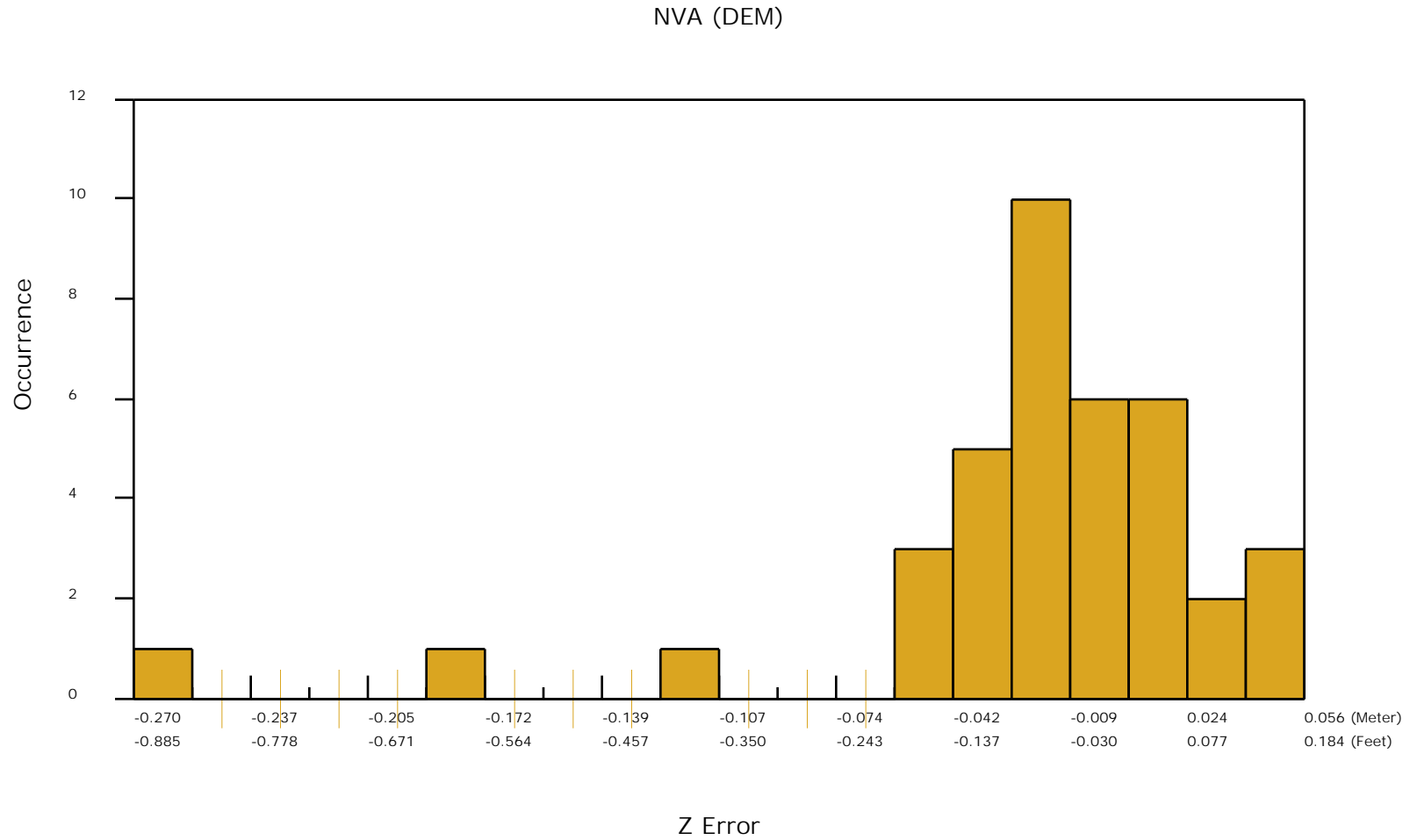
Check Points Vertical Accuracy - continued

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
1290	520372.722	3407005.277	Yes	1231.846	1231.796	-0.050		
1339	522118.081	3418564.937	Yes	1202.848	1202.861	0.013		
941003	547515.835	3439694.61	Yes	1259.662	1259.662	0.000		
951002	513991.785	3492821.998	Yes	1104.565	1104.571	0.006		
951004	523987.901	3531851.115	Yes	1482.487	1482.475	-0.012		
951006	523431.914	3537882.28	Yes	1526.94	1526.891	-0.049		
951009	527243.35	3533813.3	Yes	1429.618	1429.590	-0.028		
981002	546023.013	3486099.263	Yes	1378.371	1378.359	-0.012		

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\65220171_USGS-TX_West_Texas\Production\Final_Client_Deliverables\Lot6_utm13\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
2004	514160.892	3453791.536	Yes	1285.343	1285.395	0.052		
2011	550231.409	3468713.218	Yes	1376.005	1376.073	0.068		
2013	547366.217	3436486.424	Yes	1239.741	1239.503	-0.238		
2015	553095.936	3504037.786	Yes	1260.385	1260.412	0.027		
2016	516265.153	3433770.169	Yes	1229.892	1229.919	0.027		
2034	521080.312	3414674.132	Yes	1207.95	1208.123	0.173		
2051	512954.594	3506945.772	Yes	1188.178	1188.153	-0.025		
2055	533880.679	3435320.745	Yes	1178.434	1178.373	-0.061		
2058	501389.874	3427833.438	Yes	1291.477	1291.502	0.025		
2060	553522.296	3481303.863	Yes	1246.609	1246.634	0.025		
2063	501545.354	3535447.68	Yes	1110.78	1110.807	0.027		
2064	517082.707	3468797.304	Yes	1117.102	1117.077	-0.025		
2066	534283.547	3486427.499	Yes	1482.561	1482.574	0.013		
2069	517008.764	3525050.87	Yes	1650.658	1650.687	0.029		
2071	514486.779	3477126.598	Yes	1103.72	1103.768	0.048		
2073	513528.518	3497302.185	Yes	1110.954	1111.056	0.102		
2084	548872.395	3525550.676	Yes	1131.432	1131.464	0.032		
2100	554384.067	3531860.067	Yes	1118.904	1118.939	0.035		
2142	540439.279	3462431.491	Yes	1239.787	1239.874	0.087		
2143	517975.18	3404093.069	Yes	1280.195	1280.233	0.038		
2158	539362.447	3508787.675	Yes	1337.964	1338.069	0.105		
2171	534116.262	3442252.671	Yes	1153.242	1153.445	0.203		
2178	538197.02	3452981.848	Yes	1154.129	1154.081	-0.048		
2188	503525.975	3513672.369	Yes	1115.032	1115.083	0.051		
2228	534847.251	3537223.907	Yes	1347.822	1347.870	0.048		
2230	502333.92	3444865.92	Yes	1487.975	1488.040	0.065		
931004	506737.462	3435133.399	Yes	1361.883	1361.965	0.082		
941002	547525.025	3439706.285	Yes	1259.598	1259.672	0.074		
951003	513911.971	3493274.391	Yes	1104.257	1104.332	0.075		
951007	523611.718	3537841.685	Yes	1519.837	1519.802	-0.035		

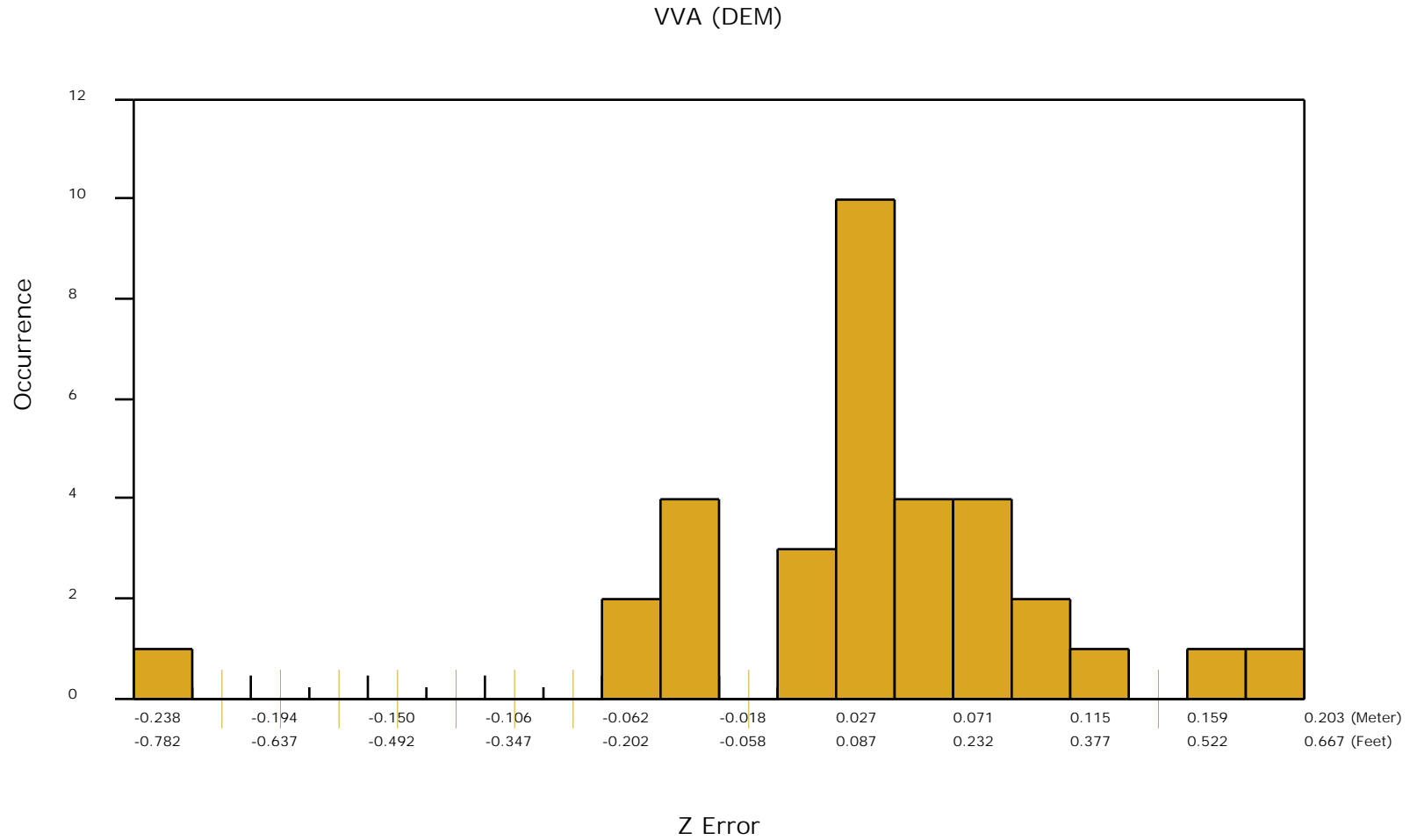
Check Points Vertical Accuracy - continued

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
971002	522093.922	3418546.407	Yes	1202.623	1202.739	0.116		
971004	520345.692	3406992.271	Yes	1232.074	1232.056	-0.018		
981001	545999.866	3486113.356	Yes	1378.047	1378.089	0.042		

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\65220171_USGS-TX_West_Texas\Production\Final_Client_Deliverables\Lot6_utm13\point_cloud\tilecls](#)

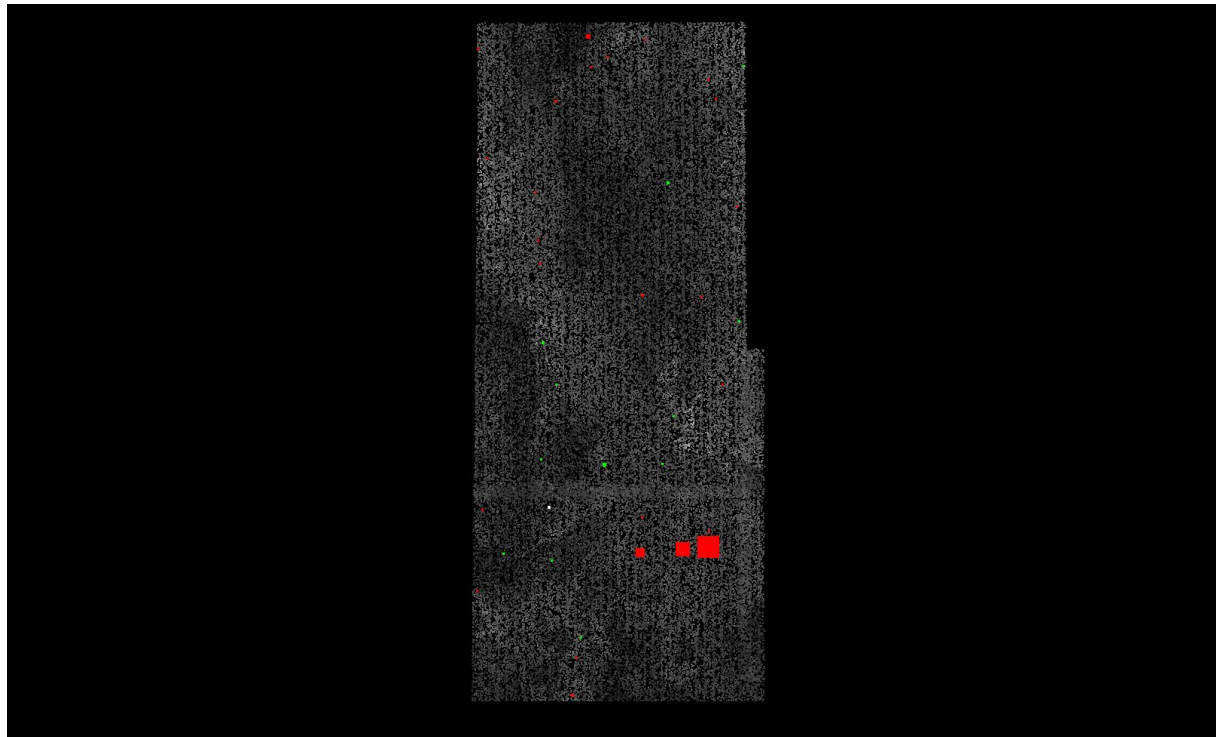


DPH-11 Report on Absolute Vertical Accuracy - continued

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\65220171_USGS-TX_West_Texas\Production\Final_Client_Deliverables\Lot6_utm13\point_cloud\tilecls](Y:\Mapping\Projects\65220171_USGS-TX_West_Texas\Production\Final_Client_Deliverables\Lot6_utm13\point_cloud\tilecls)

[Result Path - Y:\Mapping\Projects\65220171_USGS-TX_West_Texas\Admin\QA_OC\Lot6\DPH_11\ColorByIntensity_CheckPoints_NVA.jpg](Y:\Mapping\Projects\65220171_USGS-TX_West_Texas\Admin\QA_OC\Lot6\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).

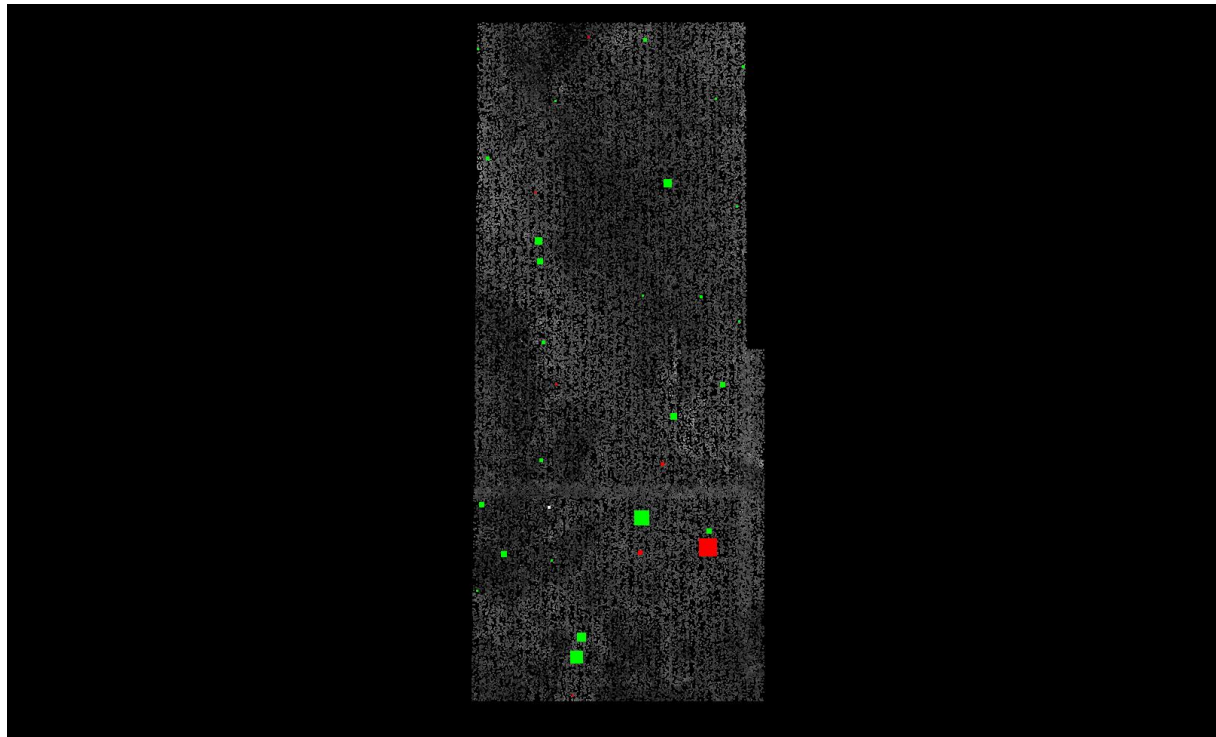
The size of the square symbol represents the absolute value magnitude of error.

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\65220171_USGS-TX_West_Texas\Production\Final_Client_Deliverables\Lot6_utm13\point_cloud\tilecls](Y:\Mapping\Projects\65220171_USGS-TX_West_Texas\Production\Final_Client_Deliverables\Lot6_utm13\point_cloud\tilecls)

[Result Path - Y:\Mapping\Projects\65220171_USGS-TX_West_Texas\Admin\OA_OC\Lot6\DPH_11\ColorByIntensity_CheckPoints_VVA.jpg](Y:\Mapping\Projects\65220171_USGS-TX_West_Texas\Admin\OA_OC\Lot6\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.