

Barron County Wisconsin LIDAR PROJECT

ACCURACY ASSESSMENT REPORT

PROCESS DESCRIPTION

Raw LIDAR range, GPS and IMU data was imported into Applanix Posproc software and Optech's REALM software and processed to final first return and last return x y z i point files in UTM NAD 83 (97), zone 15, ellipsoid meters . The ASCII point files were converted to Wisconsin County Coordinate system Barron County-9503 State Plane NAD83 (97), NAVD88 US Survey Feet and GRS80,US Survey Feet using GEIOD03 in WIScon V2.2. Removal of vegetation and other above ground features was completed in Terrascan software V005. The LIDAR x y z i data was compared to ground control points and LIDAR flight lines that crossed said control points were vertically adjusted to best fit said points and called control lines. The remaining flight lines were then vertically adjusted to seamlessly match the control lines. Any remaining noise was removed from the LIDAR x y z bald earth point files to create a surface model of irregularly spaced points.

QUALITY CONTROL AND ACCURACY ASSESSMENT PROCEDURES

AREA COVERAGE

All LIDAR elevation measurements were imported into the project area polygon and checked and verified to be free of data voids or gaps, except in the bald earth surface model where voids or gaps were created by vegetation, buildings, water or other removed features.

AVERAGE RAW POINT DENSITY

No deviation was made from the planned survey parameters calculated to meet the required LIDAR average raw point density, therefore the average raw point spacing will be approximately the same as our planned flight as set forth below:

LIDAR Flight Parameters

Laser Firing Rate: 25000
Altitude (ft. AGL): 2800
Swath Overlap (%): 50
Approx. Ground Speed (mph): 150
Scan Rate (Hz): 28.0
Scan Angle ($^{\circ}\pm$): 19.0
Computed Along Track Spacing (ft): 4.2
Computed Cross track Spacing (ft.): 4.2
Average Raw Point Spacing (ft.) 3.0
Computed Swath Width (ft.): 1928
Number of Lines Req'd: 178
Line Spacing (ft.) 964

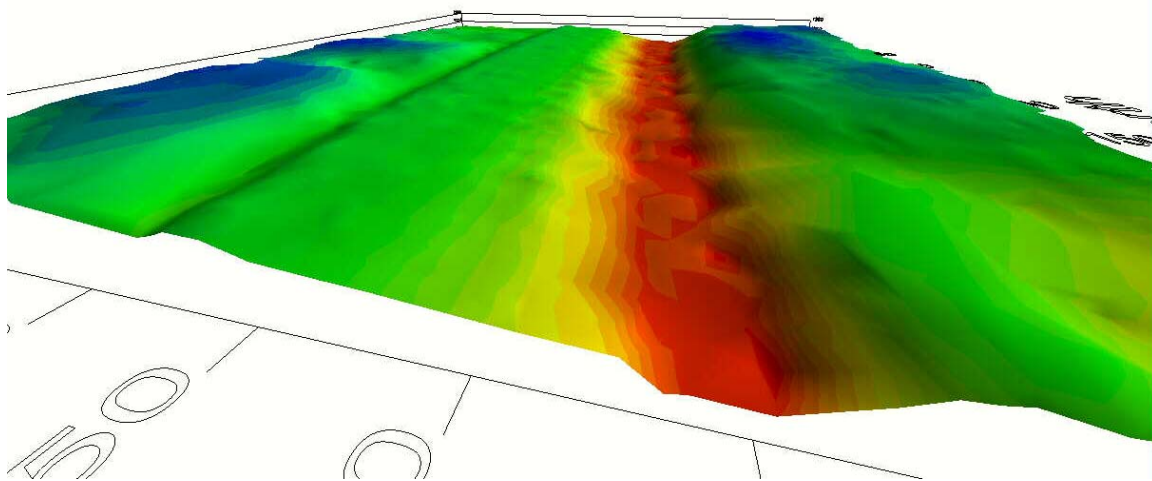
VERTICAL POSITIONAL ACCURACY

The LIDAR data was collected, processed and mapped under the direct supervision of professional land surveyors. Airborne GPS trajectories were carefully processed and analyzed with proprietary methods to produce long baseline solutions in the few centimeter range. Proprietary data analysis and adjustment methods were then utilized to form a LIDAR DTM model of both the first and last return surfaces that were best fit into static GPS ground control points that had been set to both control and validate the LIDAR survey. The vertical accuracy of the LIDAR DTM surface was then determined by comparing the best fit of the LIDAR DTM to the ground control points. Since the LIDAR DTM surface model was totally intact relative to the airborne trajectory, any point falling inside the DTM point coverage relative

to the GPS ground control network will produce similar vertical accuracies. Ground truth points were also collected by Barron County throughout the typical vegetation classifications around the county as shown on the attached spread sheet. The overall project RMSE based upon the ground truth surveys was 0.29'.

HORIZONTAL POSITIONAL ACCURACY

The horizontal accuracy of a LIDAR DTM surface is more difficult to validate than the vertical DTM comparisons to ground control, however, we have utilized the technique set forth hereafter and have successfully produced high accuracy LIDAR surveys for over 8 years that have been used for engineering planning and design. The LIDAR data was collected and processed as described above. Then the horizontal accuracy was analyzed by comparing data from opposing LIDAR flight lines having a 50% sidelap in flight coverage to the adjoining flight line. This gives a comparison of terrain features contiguous to one flight line overlapped and overlaid on top of the adjoining flight line. This produces millions of check points from each line as compared to the adjoining line. The overlapped data is carefully compared for alignment of features and checked for the clarity and consistency of said features. Specific sloping features are selected along the flight trajectory and at perpendicular angles. If there is any shift in the horizontal alignment of the LIDAR data from the adjoining line, it will appear as noise along the perpendicular sloped features. Shown below is a graphic used only to demonstrate this technique using all last return shots.



The above graphic is two overlapping flight lines along a perpendicular road surface with relatively steep side slopes. The color bands on the graphic are at 1 foot increments. You can see that small terrain relief features visible on the side slope of the road are almost in perfect alignment with very little noise. This indicates a very close alignment horizontally between the two flight lines. Using this method, we can determine that the horizontal accuracy of the LIDAR DTM is easily sub foot. A shift of 1 foot or more horizontally would have produced a very apparent roughness in the sides of the slopes along the road surface.

BARRON COUNTY WISCONSIN LIDAR QUALITY ASSURANCE DATA

PROJECT ACCURACY STATISTICS

Total # shots =
166 - 5%
outliers = 158

Coefficient
of Skew 0.37

RMSE (ft.)
Mean 0.13

Std Deviation 0.27

Median 0.10

Bare Earth - Low Grass	High Grass, Weeds & Crops	Brush Lands & Low Trees	Forested, fully covered in Trees	Urban Area
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RMSE by
Category

0.17	0.32	0.47	0.40	0.14
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Ground
Truth
Points

Easting	Northing	Elevation	LIDAR Points	Δ	TILE #	GROUND CATEGORY
236850.32	38348.84	1199.53	1199.18	-0.35	38_236	Bare Earth - Low Grass
236838.72	38290.19	1196.27	1196.18	-0.09	38_236	Bare Earth - Low Grass
236844.69	38228.91	1194.82	1194.53	-0.29	38_236	Bare Earth - Low Grass
236845.61	38142.33	1194.77	1194.61	-0.16	38_236	Bare Earth - Low Grass
236945.74	38123.33	1204.22	1203.93	-0.29	38_236	Bare Earth - Low Grass
236996.71	38157.33	1204.82	1204.64	-0.18	38_236	Bare Earth - Low Grass
237056.52	38170.38	1203.17	1203.06	-0.11	38_236	Bare Earth - Low Grass
237071.86	38335.28	1205.95	1205.81	-0.14	38_236	Bare Earth - Low Grass
233911.40	38341.68	1142.26	1142.22	-0.04	38_232	Bare Earth - Low Grass
233916.00	38265.11	1140.55	1140.70	0.15	38_232	Bare Earth - Low Grass
233953.38	38116.74	1141.40	1141.46	0.06	38_232	Bare Earth - Low Grass
233999.41	38109.94	1141.45	1141.56	0.11	38_232	Bare Earth - Low Grass
234057.15	38106.92	1141.78	1141.78	0.00	38_232	Bare Earth - Low Grass
234133.40	38106.94	1141.58	1141.58	0.00	38_232	Bare Earth - Low Grass
234231.18	38111.07	1141.51	1141.43	-0.08	38_232	Bare Earth - Low Grass
234350.66	38083.15	1140.69	1140.58	-0.11	38_232	Bare Earth - Low Grass
234265.96	38170.71	1141.01	1141.04	0.03	38_232	Bare Earth - Low Grass
234201.83	38187.21	1141.24	1141.14	-0.10	38_232	Bare Earth - Low Grass
234124.48	38207.31	1141.25	1141.26	0.01	38_232	Bare Earth - Low Grass
234032.17	38222.17	1141.14	1141.14	0.00	38_232	Bare Earth - Low Grass
234014.85	38307.91	1141.95	1141.95	0.00	38_232	Bare Earth - Low Grass
234104.03	38309.27	1141.65	1141.53	-0.12	38_232	Bare Earth - Low Grass
234164.70	38313.88	1141.58	1141.55	-0.03	38_232	Bare Earth - Low Grass
234221.33	38327.82	1141.51	1141.48	-0.03	38_232	Bare Earth - Low Grass
234053.57	38363.25	1141.95	1141.90	-0.05	38_232	Bare Earth - Low Grass

233837.74	38329.83	1141.43	1141.22	-0.21	38_232	Bare Earth - Low Grass
233768.16	38326.97	1140.57	1140.22	-0.35	38_232	Bare Earth - Low Grass
233642.57	38333.35	1138.58	1138.38	-0.20	38_232	Bare Earth - Low Grass
233607.36	38373.91	1139.79	1139.52	-0.27	38_232	Bare Earth - Low Grass
233536.05	38343.20	1139.07	1138.83	-0.24	38_232	Bare Earth - Low Grass
233637.28	38260.72	1137.58	1137.37	-0.21	38_232	Bare Earth - Low Grass
233636.41	38170.40	1138.28	1138.05	-0.23	38_232	Bare Earth - Low Grass
379656.09	36427.56	1142.67	1143.02	0.35	34_376	High Grass, Weeds & Crops
379645.53	36370.78	1142.22	1142.68	0.46	34_376	High Grass, Weeds & Crops
379620.59	36321.90	1141.31	1141.80	0.49	34_376	High Grass, Weeds & Crops
379570.13	36290.45	1139.39	1140.01	0.62	34_376	High Grass, Weeds & Crops
379449.32	36288.14	1136.11	1136.68	0.57	34_376	High Grass, Weeds & Crops
379438.52	36341.61	1135.53	1136.02	0.49	34_376	High Grass, Weeds & Crops
379399.58	36424.89	1134.39	1134.42	0.03	34_376	High Grass, Weeds & Crops
379305.14	36451.48	1132.03	1132.21	0.18	34_376	High Grass, Weeds & Crops
379215.21	36523.97	1131.07	1131.35	0.28	34_376	High Grass, Weeds & Crops
379105.91	36593.98	1130.07	1130.56	0.49	34_376	High Grass, Weeds & Crops
379053.46	36664.28	1130.93	1131.36	0.43	34_376	High Grass, Weeds & Crops
378983.12	36676.39	1131.39	1131.68	0.29	34_376	High Grass, Weeds & Crops
378940.82	36665.31	1131.32	1131.62	0.30	34_376	High Grass, Weeds & Crops
373629.71	45190.71	1072.74	1072.95	0.21	42_372	High Grass, Weeds & Crops
373618.08	45167.43	1071.84	1072.18	0.34	42_372	High Grass, Weeds & Crops
373657.60	45133.69	1071.52	1072.07	0.55	42_372	High Grass, Weeds & Crops
373682.23	45043.41	1070.77	1070.90	0.13	42_372	High Grass, Weeds & Crops
373740.46	45097.95	1070.69	1070.80	0.11	42_372	High Grass, Weeds & Crops
373776.28	45149.73	1072.22	1072.74	0.52	42_372	High Grass, Weeds & Crops
373805.73	45182.23	1074.17	1074.28	0.11	42_372	High Grass, Weeds & Crops
373826.57	45131.41	1072.90	1073.07	0.17	42_372	High Grass, Weeds & Crops
373920.69	45090.81	1074.20	1074.27	0.07	42_372	High Grass, Weeds & Crops
373969.90	45087.35	1074.16	1074.12	-0.04	42_372	High Grass, Weeds & Crops
373995.62	45105.11	1073.38	1073.21	-0.17	42_372	High Grass, Weeds & Crops
374039.52	45182.95	1074.28	1074.35	0.07	42_372	High Grass, Weeds & Crops
374083.95	45217.58	1073.71	1073.67	-0.04	42_372	High Grass, Weeds & Crops
374139.16	45253.16	1075.51	1075.42	-0.09	42_372	High Grass, Weeds & Crops
374153.50	45270.97	1075.26	1075.36	0.10	42_372	High Grass, Weeds & Crops
374204.77	45218.75	1077.15	1077.32	0.17	42_372	High Grass, Weeds & Crops
374256.46	45176.98	1078.40	1078.67	0.27	42_372	High Grass, Weeds & Crops
374244.52	45133.28	1078.92	1079.03	0.11	42_372	High Grass, Weeds & Crops
232398.77	122461.47	1235.60	1236.14	0.54	122_232	Brush Lands & Low Trees
232372.77	122462.54	1235.74	1235.99	0.25	122_232	Brush Lands & Low Trees
232312.47	122496.29	1235.56	1235.67	0.11	122_232	Brush Lands & Low Trees
232239.93	122489.36	1235.80	1236.37	0.57	122_232	Brush Lands & Low Trees
232414.00	122709.85	1234.88	1235.27	0.39	122_232	Brush Lands & Low Trees
232386.60	122750.88	1235.20	1235.72	0.52	122_232	Brush Lands & Low Trees
232360.97	122784.15	1235.45	1236.10	0.65	122_232	Brush Lands & Low Trees
232252.50	123445.35	1234.41	1234.79	0.38	122_232	Brush Lands & Low Trees

232149.66	123488.56	1234.09	1234.44	0.35	122_232	Brush Lands & Low Trees
232436.28	123884.03	1231.04	1231.50	0.46	122_232	Brush Lands & Low Trees
232379.96	123890.66	1230.29	1230.88	0.59	122_232	Brush Lands & Low Trees
232314.09	123896.35	1229.96	1230.05	0.09	122_232	Brush Lands & Low Trees
232248.12	123929.03	1229.39	1229.74	0.35	122_232	Brush Lands & Low Trees
232233.76	124037.11	1229.28	1229.64	0.36	122_232	Brush Lands & Low Trees
232231.51	124082.25	1229.23	1229.38	0.15	122_232	Brush Lands & Low Trees
232264.38	124172.15	1228.49	1228.70	0.21	122_232	Brush Lands & Low Trees
232271.36	124208.02	1228.50	1228.88	0.38	122_232	Brush Lands & Low Trees
232221.85	124272.00	1228.83	1229.25	0.42	122_232	Brush Lands & Low Trees
232211.72	124359.88	1229.17	1229.66	0.49	122_232	Brush Lands & Low Trees
232250.49	124518.69	1227.45	1227.74	0.29	122_232	Brush Lands & Low Trees
232198.15	124692.16	1226.71	1226.73	0.02	122_232	Brush Lands & Low Trees
232243.76	124779.64	1225.38	1225.76	0.38	122_232	Brush Lands & Low Trees
232441.59	124856.70	1224.63	1225.04	0.41	122_232	Brush Lands & Low Trees
232553.27	124114.20	1228.88	1229.62	0.74	122_232	Brush Lands & Low Trees
232567.37	124040.94	1229.58	1230.33	0.75	122_232	Brush Lands & Low Trees
232594.23	123974.95	1230.84	1231.60	0.76	122_232	Brush Lands & Low Trees
232575.12	123923.50	1231.44	1232.09	0.65	122_232	Brush Lands & Low Trees
232619.79	125925.13	1225.55	1225.69	0.14	122_232	Brush Lands & Low Trees
232657.76	125898.45	1225.10	1225.84	0.74	122_232	Brush Lands & Low Trees
353677.51	184228.92	1232.51	1232.37	-0.14	182_352	Forested, fully covered in Trees
353694.92	184229.71	1232.90	1233.18	0.28	182_352	Forested, fully covered in Trees
353719.18	184223.49	1233.60	1233.55	-0.05	182_352	Forested, fully covered in Trees
353749.06	184228.16	1235.10	1234.69	-0.41	182_352	Forested, fully covered in Trees
353763.08	184227.29	1235.75	1235.56	-0.19	182_352	Forested, fully covered in Trees
353789.64	184228.19	1236.29	1236.32	0.03	182_352	Forested, fully covered in Trees
353807.00	184201.30	1235.85	1235.94	0.09	182_352	Forested, fully covered in Trees
353786.84	184204.12	1236.29	1236.42	0.13	182_352	Forested, fully covered in Trees
353741.52	184200.59	1234.69	1234.41	-0.28	182_352	Forested, fully covered in Trees
353700.39	184194.37	1233.58	1233.43	-0.15	182_352	Forested, fully covered in Trees
353704.64	184128.85	1232.61	1232.74	0.13	182_352	Forested, fully covered in Trees
353742.02	184123.27	1233.05	1232.73	-0.32	182_352	Forested, fully covered in Trees
353786.86	184115.68	1232.79	1232.88	0.09	182_352	Forested, fully covered in Trees
353674.14	184726.02	1233.76	1233.87	0.11	182_352	Forested, fully covered in Trees
353667.13	184767.42	1233.47	1233.46	-0.01	182_352	Forested, fully covered in Trees
353714.05	184786.36	1233.86	1234.11	0.25	182_352	Forested, fully covered in Trees
353673.99	184819.27	1233.93	1234.23	0.30	182_352	Forested, fully covered in Trees
353668.06	184882.09	1235.27	1235.36	0.09	182_352	Forested, fully covered in Trees
353688.57	184918.62	1235.54	1235.82	0.28	182_352	Forested, fully covered in Trees
363987.74	164103.75	1207.36	1207.68	0.32	162_360	Forested, fully covered in Trees
363970.10	164109.03	1207.33	1207.83	0.50	162_360	Forested, fully covered in Trees
363985.82	164132.17	1208.98	1209.28	0.30	162_360	Forested, fully covered in Trees
364175.38	164222.10	1211.60	1211.91	0.31	162_364	Forested, fully covered in Trees
364183.34	164239.87	1210.74	1211.21	0.47	162_364	Forested, fully covered in Trees
364336.86	163942.97	1213.38	1213.86	0.48	162_364	Forested, fully covered in Trees

364307.83	163918.53	1214.61	1214.87	0.26	162_364	Forested, fully covered in Trees
364324.33	163909.75	1215.65	1215.99	0.34	162_364	Forested, fully covered in Trees
364323.25	163891.23	1216.37	1216.53	0.16	162_364	Forested, fully covered in Trees
364344.66	163876.52	1218.48	1219.13	0.65	162_364	Forested, fully covered in Trees
364347.59	163822.12	1214.45	1214.65	0.20	162_364	Forested, fully covered in Trees
364324.59	163792.22	1212.86	1213.14	0.28	162_364	Forested, fully covered in Trees
306066.88	98715.51	1115.34	1115.24	-0.10	98_304	Urban Area
306160.41	98632.54	1115.06	1114.82	-0.24	98_304	Urban Area
306240.70	98642.10	1115.23	1115.33	0.10	98_304	Urban Area
306307.86	98629.23	1115.10	1115.34	0.24	98_304	Urban Area
306428.36	98685.66	1114.83	1114.96	0.13	98_304	Urban Area
306608.57	98861.92	1113.53	1113.66	0.13	98_304	Urban Area
306682.37	98858.55	1112.90	1112.91	0.01	98_304	Urban Area
306741.18	98863.49	1113.03	1112.93	-0.10	98_304	Urban Area
306622.16	98604.09	1113.42	1113.55	0.13	98_304	Urban Area
306316.29	98493.57	1113.69	1113.75	0.06	98_304	Urban Area
306460.38	98514.97	1113.75	1113.86	0.11	98_304	Urban Area
306242.28	98494.72	1113.76	1113.85	0.09	98_304	Urban Area
306078.99	98490.43	1114.26	1114.05	-0.21	98_304	Urban Area
305883.29	98656.12	1114.34	1114.34	0.00	98_304	Urban Area
305856.58	98620.49	1114.74	1114.67	-0.07	98_304	Urban Area
305819.46	96778.43	1113.78	1113.70	-0.08	94_304	Urban Area
305731.77	96773.46	1114.14	1114.34	0.20	94_304	Urban Area
305666.34	96784.66	1114.02	1113.86	-0.16	94_304	Urban Area
305656.84	96858.70	1116.51	1116.32	-0.19	94_304	Urban Area
305655.73	96915.75	1117.63	1117.47	-0.16	94_304	Urban Area
305547.91	96783.69	1114.04	1114.06	0.02	94_304	Urban Area
305450.73	96777.86	1116.11	1116.07	-0.04	94_304	Urban Area
305334.06	96784.80	1117.54	1117.67	0.13	94_304	Urban Area
305064.85	97064.22	1123.00	1122.76	-0.24	94_304	Urban Area
305123.39	97059.40	1122.39	1122.43	0.04	94_304	Urban Area
304962.80	96946.01	1129.75	1129.76	0.01	94_304	Urban Area
304980.42	96891.14	1129.25	1129.15	-0.10	94_304	Urban Area
304864.64	96914.17	1135.96	1135.87	-0.09	94_304	Urban Area
304865.33	96893.02	1135.56	1135.58	0.02	94_304	Urban Area
304843.58	97392.09	1119.58	1119.58	0.00	94_304	Urban Area
304774.59	97365.32	1119.91	1119.66	-0.25	94_304	Urban Area
304736.51	97430.78	1120.20	1120.25	0.05	94_304	Urban Area
304664.25	97429.05	1120.39	1120.43	0.04	94_304	Urban Area
304610.02	96773.99	1121.93	1121.97	0.04	94_304	Urban Area
304832.36	96772.31	1123.95	1123.64	-0.31	94_304	Urban Area