Ground Control Report

WISCONSIN WROC – 3DEP | CALUMET COUNTY LIDAR 2018

1.1 GROUND CONTROL DESIGN AND METHODOLOGY

The ground control network and design used for the Calumet County lidar acquisition was made up of calibration points, GPS base stations, NGS base stations, and independent check points from the vertical accuracy ground control survey. This report will focus on the lidar calibration points that were collected at 12 locations in and around the Calumet County project area. The control points are used for QC checks and calibration of the raw point cloud and for additional vertical checks against the processed bare earth surface.

The ground control calibration survey was done in Wisconsin County Coordinate System-Calumet County, NAD83 (2011), US survey feet; NAVD88 (Geoid 12B), US survey feet. The field work was conducted by Ayres Associates surveyors. All field work was completed between May 31, 2018, and October 29, 2018.

CONTROL SUMMARY AND METHODOLOGY

Control Summary

Horizontal Datum:	NAD83 (2011)
Vertical Datum:	NAVD88 (2012), Wisconsin GEOID12B
Rectangular Coordinate System:	WCCS-Calumet County
Used NGS Control?	☒ Yes ☐ No
List any NGS control points used:	See field notes.
Summary of control checks and calibration (if applicable):	(See Field Notes for control checks on NGS monuments – No calibration was needed)
Survey Methods Used:	RTK-GPS using WISCORS Network through VRS connection were used for direct observations and to set control pairs for Robotic Total Station shots under canopy, etc
Equipment Used:	GPS Trimble R8-3 GNSS S/N 5004413097 – (Ayres #74.58) Total station Trimble S 6 S/N 93410182 – (Ayres #75.38) Data Collector Trimble TSC 3 S/N RSONC10841 (Ayres #75.20)

Crew Chief Notes

Set PK nails or spikes at control points used for total station measurements and for calibration points. Recorded appropriate: NVA (Bare Earth & Urban) and VVA (Forested, Swamp/Wetland, Tall Weed/Crop). Took (4) pictures of each point – one from each cardinal direction.

Survey Methods (continued)

All work was performed in and referenced to NAD83 (2011), NAVD 88(2012), Geoid 12B, Wisconsin County Coordinate System-Calumet County in US Survey Feet.

Established horizontal and vertical coordinate values on the points by a minimum of two – 90 epoch observations with separate initializations using RTK GPS and the WISCORS network. The resultant coordinates and elevations provided in the deliverables are an average of the two observations.

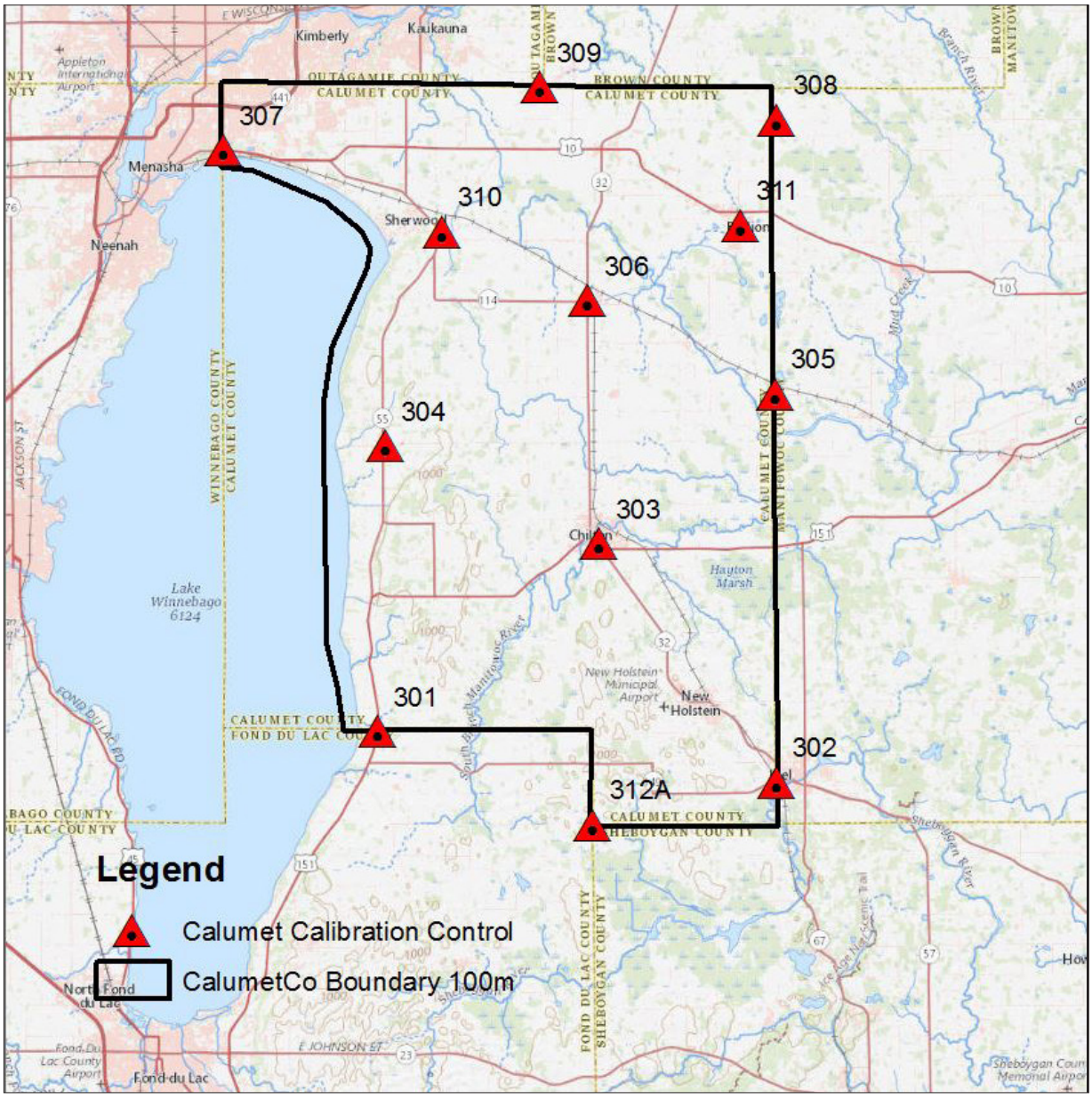
Check shots were taken on numerous NGS control points (see field notes) to verify that the values obtained are consistent with the datum/adjustment as described herein and meet the ±3 centimeter vertical accuracy requirement at the 95% confidence level.

Points not able to be directly occupied by GPS means were measured using Total Station methods from control point pairs set utilizing GPS methods outlined above.

1.1.2 CONTROL LAYOUT

The locations were selected around the outer geometry of the project boundary and on major roads within the project area. This layout design is preferred when the calibration points will be used to check different areas across a large flight block. The control survey was conducted with a Trimble R-8 GPS receiver and a VRS connection with a TSC3 data collector.

1.1.2.1 MAP OF CALUMET COUNTY CALIBRATION POINTS



1.1.3 CALUMET COUNTY LIDAR, CALIBRATION POINT STATISTICS

The final step in using the calibration points is to run a statistical comparison against the bare earth ground surface to confirm that the vertical accuracy is within specification. The follow results indicate that the overall RMSEz of the calibration points is 0.096'. This is a separate check as compared to the Vertical Accuracy Survey QA/QC report. These points are used in the calibration of the raw point cloud, and therefore are not an independent set of checkpoints like those used in the vertical accuracy testing.

1.1.3.1 STATISTICAL REPORT FOR CALIBRATION POINTS

Number	Easting	Northing	Known Z	Laser Z	Dz
301	854882.536	443569.536	801.043	801.170	+0.127
302	923851.618	434856.625	910.175	910.170	-0.005
303	893254.144	476102.967	909.209	909.000	-0.209
304	856167.984	493019.396	829.127	829.080	-0.047
305	923667.010	502007.741	832.992	832.910	-0.082
306	891257.432	518230.125	837.224	837.270	+0.046
307	828153.385	544284.323	751.255	751.350	+0.095
308	923990.790	549465.507	944.088	944.200	+0.112
309	883027.792	555194.580	799.551	799.480	-0.071
310	866001.758	530057.903	889.702	889.710	+0.008
311	917642.088	531233.675	827.073	827.160	+0.087
312A	892108.463	427422.071	950.643	950.570	-0.073

Average Dz	-0.001 ft
Minimum Dz	-0.209 ft
Maximum Dz	0.127 ft
Root Mean Square	0.096 ft
Std Deviation	0.100 ft

1.1.4 FIELD NOTES

CURVE FORMULAS

$T = R \tan \frac{1}{2} I$

$T = \frac{50 \tan \frac{1}{2} I}{\text{Sin. } \frac{1}{2} D}$

$\text{Sin. } \frac{1}{2}D = \frac{50}{R}$

$\text{Sin. } \frac{1}{2}D = \frac{50 \tan \frac{1}{2} I}{T}$

$R = T \cot \frac{1}{2} I$

$R = \frac{50}{\text{Sin. } \frac{1}{2} D}$

$E = R \text{ ex. sec } \frac{1}{2} I$

$E = T \tan \frac{1}{4} I$

$\text{Chord def.} = \frac{\text{chord}^2}{R}$

$\text{No. chords} = \frac{I}{D}$

$\text{Tan. def.} = \frac{1}{2} \text{ chord def.}$

The square of any distance, divided by twice the radius, will equal the distance from tangent to curve, very nearly.

To find angle for a given distance and deflection.

Rule 1. Multiply the given distance by .01745 (def. for 1° for 1 ft.) and divide given deflection by the product.

Rule 2. Multiply given deflection by 57.3, and divide the product by the given distance.

To find deflection for a given angle and distance. Multiply the angle by .01745, and the product by the distance.

GENERAL DATA

Right Angle Triangles. Square the altitude, divide by twice the base. Add quotient to base for hypotenuse.

Given Base 100, Alt. $10.10^2 \div 200 = .5$. $100 + .5 = 100.5$ hyp.

Given Hyp. 100, Alt. $25.25^2 \div 200 = 3.125$. $100 - 3.125 = 96.875$=Base.

Error in first example, .002; in last, .045.

To find Tons of Rail in one mile of track: multiply weight per yard by 11, and divide by 7.

Leveling. The correction for curvature and refraction, in feet and decimals of feet is equal to $0.574\ d^2$, where d is the distance in miles. The correction for curvature alone is closely, $\frac{2}{3}d^2$. The combined correction is negative.

Probable Error. If d_1, d_2, d_3, etc. are the discrepancies of various results from the mean, and if Σd^2=the sum of the squares of these differences and n=the number of observations, then the probable error of the mean= $\pm 0.6745 \sqrt{\frac{\Sigma d^2}{n(n-1)}}$

MINUTES IN DECIMALS OF A DEGREE

1′	.0167	11′	.1833	21′	.3500	31′	.5167	41′	.6833	51′	.8500
2	.0333	12	.2000	22	.3667	32	.5333	42	.7000	52	.8667
3	.0500	13	.2167	23	.3833	33	.5500	43	.7167	53	.8833
4	.0667	14	.2333	24	.4000	34	.5667	44	.7333	54	.9000
5	.0833	15	.2500	25	.4167	35	.5833	45	.7500	55	.9167
6	.1000	16	.2667	26	.4333	36	.6000	46	.7667	56	.9333
7	.1167	17	.2833	27	.4500	37	.6167	47	.7833	57	.9500
8	.1333	18	.3000	28	.4667	38	.6333	48	.8000	58	.9667
9	.1500	19	.3167	29	.4833	39	.6500	49	.8167	59	.9833
10	.1667	20	.3333	30	.5000	40	.6667	50	.8333	60	1.0000

INCHES IN DECIMALS OF A FOOT

1/16	3/32	1/8	3/16	1/4	5/16	3/8	1/2	5/8	3/4	7/8
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729

1	2	3	4	5	6	7	8	9	10	11
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

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CALUMET CO GROUND TRUTHING
72-023710
WCCS - CALUMET CO.

EQUIPMENT:
GPS: TRIMBLE R8 S/N: 5004413097 (74 58)
TS:
DC: TRIMBLE TSC3 S/N: ES77025148

PT#	NGS MONUMENT	ΔN	ΔE	ΔZ
510	KAUKAUNA GPS	-0.007	-0.029	-0.067
511	BROTHERTOWN GPS	0.008	0.019	-0.013
512	CHARLESTOWN WGB	0.022	-0.010	+0.028
513	BRILLION S GPS	-0.003	-0.012	—
514	4K16	—	—	-0.064
515	MAPLE GROVE WGB	0.020	-0.025	—

307	PID	2M	TIP, N, S	
309	PID	2M	TIP, N, W	

- CENTER OF 19" MANHOLE EAST OF 19" ORANGE MANHOLE ON EASTERN SIDE OF KWIK TRIP PARKING LOT.
- SW CORNER OF CONCRETE OF DRIVEWAY FOR HOUSE W/ H2 CTH KK

1.1.4 FIELD NOTES (CONTINUED)

CREW: TIM SCHROEDER
DATE: 05-31-2018
WEATHER: AM- 77°F, PARTLY CLOUDY
PM- 83°F, PARTLY CLOUDY, BREEZEY

PT#	CODE	HEIGHT	PHOTOS
310	PID	2M	TIP,N,S
304	PID	2M	TIP,N,E
301	PID	2M	TIP,N,W
312A	PID	2M	TIP,N,W
302	PID	2M	TIP,N,E
303	PID	2M	TIP,N,W

DESCRIPTION
- SE CORNER OF SS INLET ON MILITARY RD TO THE SE OF POST OFFICE
- EAST CORNER OF SS INLET ON SOUTH SIDE OF LAKE ST NEAR INTERSECTION OF LAKE ST AND CHURCH ST.
- NE CORNER OF SS INLET ON SOUTH SIDE OF CTH HHH EAST OF STH 151
- SW CORNER OF NORTHERN FOG LINE ON CTH Q EAST OF DORN RD.
- CENTER OF MANHOLE ON WASHINGTON ST. WEST OF 8TH ST.
- CENTER OF MANHOLE ON OAK ST, 1ST MANHOLE EAST OF PARK ST.

PT#	CODE	HEIGHT	PHOTOS
305	PID	2M	TIP,N,E

CREW: TIM SCHROEDER
DATE: 06-01-2018
WEATHER: AM- 57°F, OVERCAST

PT#	CODE	HEIGHT	PHOTOS
306	PID	2M	TIP,N,W
311	PID	2M	TIP,N,S
308	PID	2M	TIP,N,E

DESCRIPTION
- SE CORNER OF SOUTHERN FOG LINE ON CTH JJ WEST OF WELLS RD.

DESCRIPTION
- CENTER OF MANHOLE ON CEDAR ST. EAST OF 8TH ST.
- SE CORNER OF SS INLET ON WEST SIDE OF CLEVELAND ST NORTH OF E WATER ST.
- NE CORNER OF DASHED CENTERLINE ON CTH K, NORTH OF FIELD ENTERANCE AND WEST OF HOUSE 24204

1.15 FIELD PHOTOS

Point 301

Point 302

Point 303

Point 304

Point 305

Point 306

FIELD PHOTOS (CONTINUED)

Point 307

Point 308

Point 309

Point 310

Point 311

Point 312A