



Ground Control Report

Goodhue County 3DEP Lidar 2020

Goodhue County, Minnesota

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1.1 Ground Control Design and Methodology

The ground control network and design used for the Goodhue 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 43 locations in and around the Goodhue 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 Goodhue County Coordinates, NAD83 (HARN), US survey feet; NAVD88 (Geoid 12B), US survey feet. The field work was conducted by Goodhue County surveyors. All field work was completed between April 30, 2020, and May 12, 2020.

Control Summary and Methodology

Control Summary

Horizontal Datum:	NAD83 (HARN)
Vertical Datum:	NAVD88 (2012), GEOID12B (CONUS)
Rectangular Coordinate System:	Goodhue County Coordinates
Used NGS Control?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
List any NGS control points used:	PP0257, PP2405, DK3529, DG8450, AC4934
Summary of control checks and calibration (if applicable):	(See Crew Chief Notes for control checks on NGS monuments – No calibration was needed)
Survey Methods Used:	RTK-GPS via the MNCORS Network through a VRS connection was used for direct observations. Redundancy checked with RTK-GPS via LEICA SMARTNET through a VRS connection.
Equipment Used:	GPS LEICA GS16 GNSS S/N's 3248252 & 3248280 Data Collector LEICA CS20 S/N's 2491270 & 2491276

Survey Methods (continued)

All work was performed in and referenced to NAD83 (2011), NAVD 88(2012), Geoid 12B (CONUS), Goodhue County Coordinate System.

Established horizontal and vertical coordinate values on the points with a minimum of two – 20 epoch observations with separate initializations using RTK GPS and the MNCORS VRS network. A redundancy check was also included in the average with a minimum of one 10 epoch observation from the LEICA SmartNet VRS Network. The resultant coordinates and elevations provided in the deliverables are an average of the three observations.

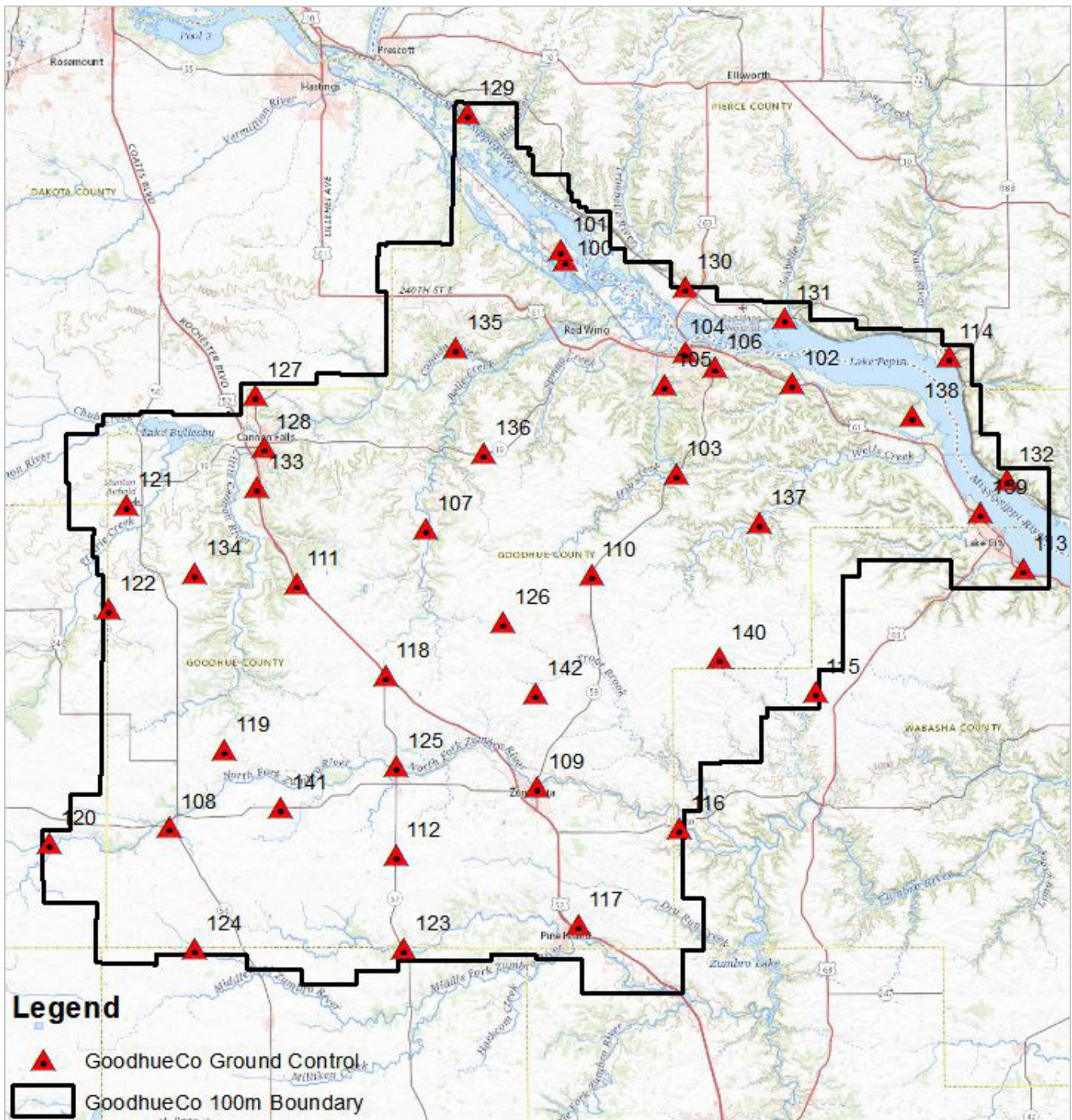
Check shots were taken on several NGS control points (see above) to verify that the values obtained are consistent with the datum/adjustment as described herein and meet the ± 1.7 centimeter vertical accuracy requirement at the 95% confidence level.

All points were observed with RTK GPS.

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 LEICA CS20 GPS receiver and a VRS connection with a data collector.

1.1.2.1 Map of Goodhue County Calibration Points



1.1.3 Goodhue 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 following results indicate that the overall RMSEz of the calibration points is 0.059'. 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
100	627902.992	256452.856	695.589	695.52	-0.069
101	626735.716	258835.733	691.074	691.17	0.096
102	679074.225	228385.929	720.254	720.22	-0.034
103	652847.645	207963.376	826.953	826.91	-0.043
104	655133.22	235424.481	711.697	711.71	0.013
105	650219.892	228093.57	815.155	815.13	-0.025
106	661692.195	232035.999	831.506	831.5	-0.006
107	596436.154	195649.358	942.095	942.22	0.125
108	538197.269	128169.16	1151.481	1151.55	0.069
109	621572.55	137213.741	977.493	977.45	-0.043
110	633781.076	185107.136	1111.618	1111.64	0.022
111	566981.528	183173.205	1187.339	1187.35	0.011
112	589612.814	121891.874	1244.124	1244.16	0.036
113	731569.381	186524.766	695.817	695.73	-0.087
114	714683.896	234519.654	688.688	688.85	0.162
115	684483.178	158799.708	1112.215	1112.22	0.005
116	653768.354	127815.662	936.172	936.3	0.128
117	630727.603	105922.28	1096.559	1096.57	0.011
118	587128.136	162290.97	1191.883	1191.88	-0.003
119	550807.238	145510.786	1190.202	1190.18	-0.022
120	511003.609	124516.483	1119.447	1119.53	0.083
121	528648.722	201057.047	923.667	923.7	0.033
122	524588.26	177412.377	969.014	969.06	0.046
123	591152.436	100770.804	1087.003	1087.02	0.017
124	543845.275	100614.485	1225.213	1225.26	0.047
125	589649.247	141737.646	1021.282	1021.3	0.018
126	613762.731	174555.772	1199.762	1199.81	0.048
127	557852.211	225793.741	871.543	871.57	0.027

1.1.3.1 Statistical Report for Calibration Points (Continued)

NUMBER	EASTING	NORTHING	KNOWN Z	LASER Z	DZ
128	559804.297	213925.322	848.878	848.78	-0.098
129	605579.608	289583.835	785.249	785.23	-0.019
130	655003.816	250184.763	716.912	716.91	-0.002
131	677639.4	243260.472	688.928	689.04	0.112
132	727972.56	206614.586	755.382	755.35	-0.032
133	558001.812	205099.038	931.508	931.58	0.072
134	543809.038	185443.206	1086.122	1086.1	-0.022
135	602912.682	236409.44	720.257	720.27	0.013
136	609428.394	212800.768	1079.26	1079.3	0.04
137	671800.601	197081.603	848.086	848.06	-0.026
138	706300.083	221162.489	795.624	795.58	-0.044
139	721698.728	199186.058	680.995	680.94	-0.055
140	662646.214	166238.178	1113.561	1113.55	-0.011
141	563288.409	132582.91	1178.997	1179	0.003
142	621111.444	158382.393	1140.049	1139.97	-0.079

Average Dz	0.012
Minimum Dz	-0.098
Maximum Dz	0.162
Average Magnitude	0.046
Root Mean Square	0.059
Std Deviation	0.059

1.1.4 Field Notes

PT#	CODE	ROD-H	PIC
100	END PAINT	6.562	✓ ✓
NW CORNER HELIPAD MARKER NEAR PRARIE ISLAND NUCLEAR PLANT WELCH, MN			

PT#	CODE	ROD-H	PIC
104	CTR-MH	6.562	✓ ✓
CENTER SANITARY MH @ NORTH QUADRANT MAIN ST & DAKOTA ST. RED WING MN			

PT#	CODE	ROD-H	PIC
101	END STOP	6.562	✓ ✓
N.W. CORNER STOP SIGN BAR @ INTERSECTION STURBEAN LAKE RD & EDOKA ST. WELCH MN - CASINO			

PT#	CODE	ROD-H	PIC
105	END PAINT	6.562	✓ ✓
SW CORNER PAINT LINE IN APT. COMPLEX ALONG BERLICH AVE. RED WING MN			

PT#	CODE	ROD-H	PIC
102	END FOG L	6.562	✓ ✓
END FOG LINE NE SIDE RR TRACK XING @ HWY 61 & CO ROAD 21 WACOUTA, MN			

PT#	CODE	ROD-H	PIC
106	END STOP	6.562	✓ ✓
NE CORNER STOP SIGN BAR @ INTERSECTION BUSH ST AND 21 ST ST. RED WING, MN			

PT#	CODE	ROD-H	PIC
103	END FOG	6.562	✓ ✓
END OF FOG LINE ON NW SIDE HWY 50 & HAY CREEK TRAIL INT. HAY CREEK MN			

PT# 107 SW CORNER OF STORM INLET PHOTOS FACING			
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1.1.4 Field Notes (Continued)

PT# 108
 CODE: MH
 ROD HT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY LOOKING N
 (2) 20 FT AWAY " W
 LOCATION: CENTER OF MANHOLE
 IN W SIDE OF FOREST ST IN
 KENYON, ON S SIDE OF INT
 W/ T.H. 60

PT # 109
 SE COR STORM INLET
 PHOTOS FACING NW

PT # 110
 CODE: FOG LINE
 ROD HEIGHT: 6.562 FT (2M)
 PHOTOS (1) 4 FT AWAY FACING EAST
 (2) 4 FT AWAY FACING NE
 LOCATION: SOUTH END OF FOG LINE
 ON SOUTHBOUND T.H. 58 2 MILES
 N OF GOODHUE

PT# 111
 CODE: FOG LINE
 ROD HT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY FACING N
 (2) 20 " " " "
 LOCATION: S END R TURN LANE
 STRIPE ON SB TH 52
 BY MAPLE LANE

PT # 112
 CODE: FOG LINE
 ROD HT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY FACING S
 (2) 20 FT " " "
 LOCATION: END OF FOG LINE ON
 NORTHBOUND T.H. 57 JUST S OF
 INT. W/ 480TH ST

PT#	CODE	ROD-H	PIC
113	CTR-MH	6.562	✓
			✓

CENTER SANITARY MH @
 INTERSECTION CAMP LAKEVIEW DR
 & TERRACE RD.
 LAKE CITY, MN

PT#	CODE	ROD-H	PIC
114	COR PAD	6.562	✓
			✓

LOCATION: NE CORNER PAD
 RAMP PAD HWY 35
 MAIDEN ROCK WI

PT # 115
 CODE: DRIVEWAY
 ROD HEIGHT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY FACING W
 (2) 4 FT AWAY FACING N
 (3) 20 FT AWAY FACING N
 LOCATION: WEST EDGE OF CONCRETE
 DRIVEWAY AT ANGLE POINT WHERE
 DRIVEWAY FLARES OUT, ~6' N OF
 S END OF DRIVEWAY
 NOTE: CHOSE THIS SPOT BECAUSE
 S END OF DRIVEWAY WAS
 COVERED WITH MUD/GRAVEL

1.1.4 Field Notes (Continued)

PT # 116
 CODE: SIDEWALK
 ROD HEIGHT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT FACING E
 (2) 20 FT " "
 LOCATION: INTERSECTION OF
 SOUTH EDGE E-W SIDEWALK &
 EAST EDGE N-S SIDEWALK

PT # 117
 CENTER OF MANHOLE
 PHOTOS FACING N

PT # 118
 SW CORNER OF STOP BAR
 PHOTOS FACING W & NW

PT # 119
 CODE: FOG LINE
 ROD HT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY FACING SW
 (2) 20 FT " " "
 LOCATION: END OF FOG LINE ON
 WB CTY 30 ON S SIDE OF
 INT W/ 50TH AVE

PT # 120 Z
 CODE: CL GRAVEL
 ROD HT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY FACING NW
 (2) 20 FT " " " N
 LOCATION: APPROX CL OF
 GRAVEL RD IN RICE CTY
 S OF BRIDGE

PT # 121
 CODE: FOG LINE
 ROD HT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY FACING SW
 (2) 20 FT " " " "
 LOCATION: END OF FOG LINE ON
 WB TH 19 AT INT. W 10TH AVE

PT # 122
 CODE: MH
 ROD HT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY FACING N
 (2) 20 FT " " " "
 LOCATION: MANHOLE ON S SIDE
 OF CSAH 9 E OF 1ST AVE
 IN DENNISON - SHOT CENTER
 OF MH

PT # 123
 CODE: FOG LINE
 ROD HT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY FACING S
 (2) 20 FT " " "
 (3) CLOSE-UP OF FOG
 LINE SHOWING IT IS
 DEGRADING
 LOCATION: NORTH END OF FOG
 LINE ON NORTH BOUND T.H. 57
 ON S SIDE OF INT W/ 520TH ST

1.1.4 Field Notes (Continued)

PT# 124
 CODE: FOG LINE
 ROD HT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY FACING SE
 (2) 20 " " " "
 LOCATION: END OF FOG LINE
 ON WB 520TH ST AT INT
 W/ 140TH AVE ON
 GOODHUE/ODDGE CTY LINE
 NOTE: PT 1245 WAS 1/2 MILE
 WEST BUT FOG LINE WAS
 FADED BADLY

PT# 125
 NW COR OF MOST NORTHERLY
 STEEL COVER
 PHOTOS FACING E & NE
 SHOT GEODETIC SURVEY
 MARKER 2509 K ON TH 57
 NEAR HADER

PT# 126
 CODE: FOG LINE
 ROD HT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY FACING E
 (2) 20 FT AWAY FACING E
 LOCATION: WEST END OF FOG LINE
 ON WESTBOUND CSAH 9 BY
 171 ST AVE

PT#	CODE	ROD-H	PIG
127	CTR.MH	6.562	✓ ✓

CENTER SANITARY WITH COVER
 @ CANNON IND. BLVD & N. PARK DR
 CANNON FALLS MN

PT#	CODE	ROD-H	PIG
128	COR.WALK	6.562	✓ ✓

NE CORNER SIDEWALK @
 INTERSECTION HWY 19 & 3RD S.
 CANNON FALLS, MN

PT#	CODE	ROD-H	PIG
129	CORN PAD	6.562	✓ ✓

NE CORNER CONC DRIVEWAY PAD @
 END OF 1208 ST. N4759
 NEAR PRESCOTT WI

PT#	CODE	ROD-H	PIG
130	E-FOG LN	6.562	✓ ✓

LOCATION: END FOG LINE
 WI STATE HWY 35 & Co. NV
 HAGAR CITY WI

PT#	CODE	ROD-H	PIG
131	CTR.MH	6.562	✓ ✓

LOCATION: CENTER FUEL TANK
 FILL COVER MH. GAS STA.
 BAY CITY WI

PT#	CODE	ROD-H	PIG
132	CORNER DRIVE	6.562	✓ ✓

LOCATION: NE CORNER CONC DRIVE
 IN ALLEY
 STOCKHOLM WI

1.1.4 Field Notes (Continued)

PT#	CODE	ROD-H	PIC
133	CORWALK	6.562	✓ ✓
NW COR STEEL PED RAMP INSERT @ ROUNDABOUT CO. RD 24 & 64 AVE AVE EXIT CANNON FALLS, MN			

PT#	CODE	ROD-H	PIC
136	ENDFOGL	6.562	✓ ✓
END FOG LINE FOR TURN LANE @ EAST SIDE INTERSECTION HWY 19 & NORELIVS RD VASA, MN.			

PT # 134			
CODE: FOG LINE			
ROD HT: 6.562 FT (2M)			
PHOTOS: (1) 4 FT AWAY FACING W (2) 20 FT " " "			
LOCATION: END OF FOG LINE ON WB CSAH 24 AT INT. W CTY 54 - PAINT STRIPE IS NARROW AND FADED AT END			

PT#	CODE	ROD-H	PIC
137	ENDFOGL	6.562	✓ ✓
END FOG LINE NW SIDE INTERSECTION CO RD 2 & CO RD 45			

PT#	CODE	ROD-H	PIC
135	CTR MH	6.562	✓ ✓
CENTER SANITARY MH COVER WEST SIDE COUNTY ROAD #7 WELCH, MN			

PT#	CODE	ROD-H	PIC
138	ENDPOINT LN	6.562	✓ ✓
SE CORNER PAINTED TRIANGLE NEAR VISITOR CENTER STATE PARK. FRONTENAC, MN			

1.1.4 Field Notes (Continued)

PT#	CODE	ROD-H	PIG
139	COR PAD	6.562	✓ ✓
NW CORNER CONC. DRIVE PAD ON CENTRAL POINT RD LAKE CITY, MN			

PT# 140 VOID SHOT
 CODE: STORM GRATE
 ROD HEIGHT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY FACING W
 (2) " " " N
 (3) 20 FT " " W
 LOCATION: EAST EDGE OF STORM
 GRATE, CENTERED N-S

PT# 141
 CODE: FOG LINE
 ROD HT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY FACING S
 (2) 20 FT AWAY FACING SE
 LOCATION: W END OF FOG LINE
 ON WB TH 60 AT 70TH AVE
 IN BOMBAY

PT# 142
 CODE: FOG LINE
 ROD HT: 6.562 FT (2M)
 PHOTOS: (1) 4 FT AWAY FACING E
 (2) 20 FT AWAY FACING S
 LOCATION: NORTH END OF FOG LINE
 ON SOUTHBOUND CSAH 6 S OF
 INT. WITH 410TH ST.

1.1.5 Field Photos



Point 100



Point 101



Point 102



Point 103



Point 104



Point 105

1.1.5 Field Photos (Continued)



Point 106



Point 107



Point 108



Point 109

1.1.5 Field Photos (Continued)



Point 110



Point 111

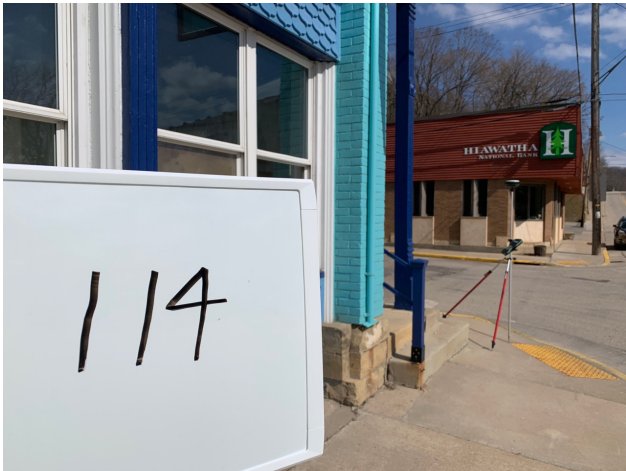


Point 112



Point 113

1.1.5 Field Photos (Continued)



Point 114



Point 115



Point 116



Point 117

1.1.5 Field Photos (Continued)



Point 118



Point 119



Point 120



Point 121

1.1.5 Field Photos (Continued)



Point 122



Point 123



Point 124



Point 125

1.1.5 Field Photos (Continued)



Point 126



Point 127



Point 128



Point 129



Point 130

1.1.5 Field Photos (Continued)



Point 131



Point 132



Point 133



Point 134

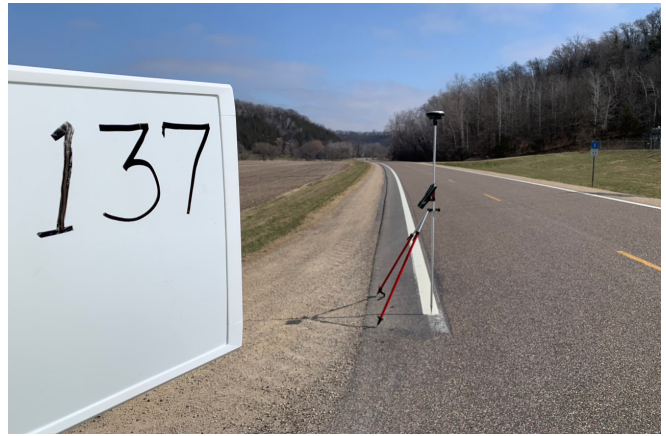


Point 135

1.1.5 Field Photos (Continued)



Point 136



Point 137



Point 138



Point 139

1.1.5 Field Photos (Continued)



Point 140



Point 141



Point 142