

## Ground Control Report St Louis River LiDAR mission, October 2015

### 1.1 Ground Control Design

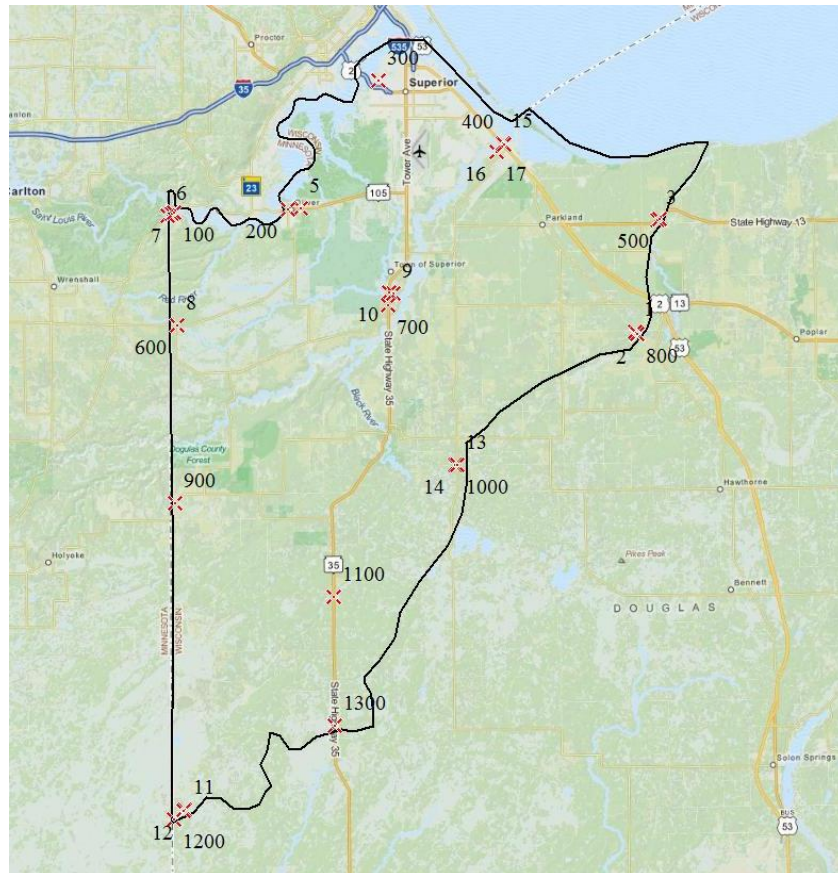
The ground control network and design used for the St. Louis River LiDAR acquisition was made up of calibration points, GPS base stations, NGS monuments, and check points from the vertical accuracy ground control survey. This report will focus on the calibration points that were collected at 29 locations in and around the Douglas 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 UTM NAD83, Zone 15 N, NAVD88 (Geoid 12A), meters. The field work was conducted by Ayres Associates surveyors in November 2015.

#### 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-10 receiver using a WISCORS connection via Verizon wireless.

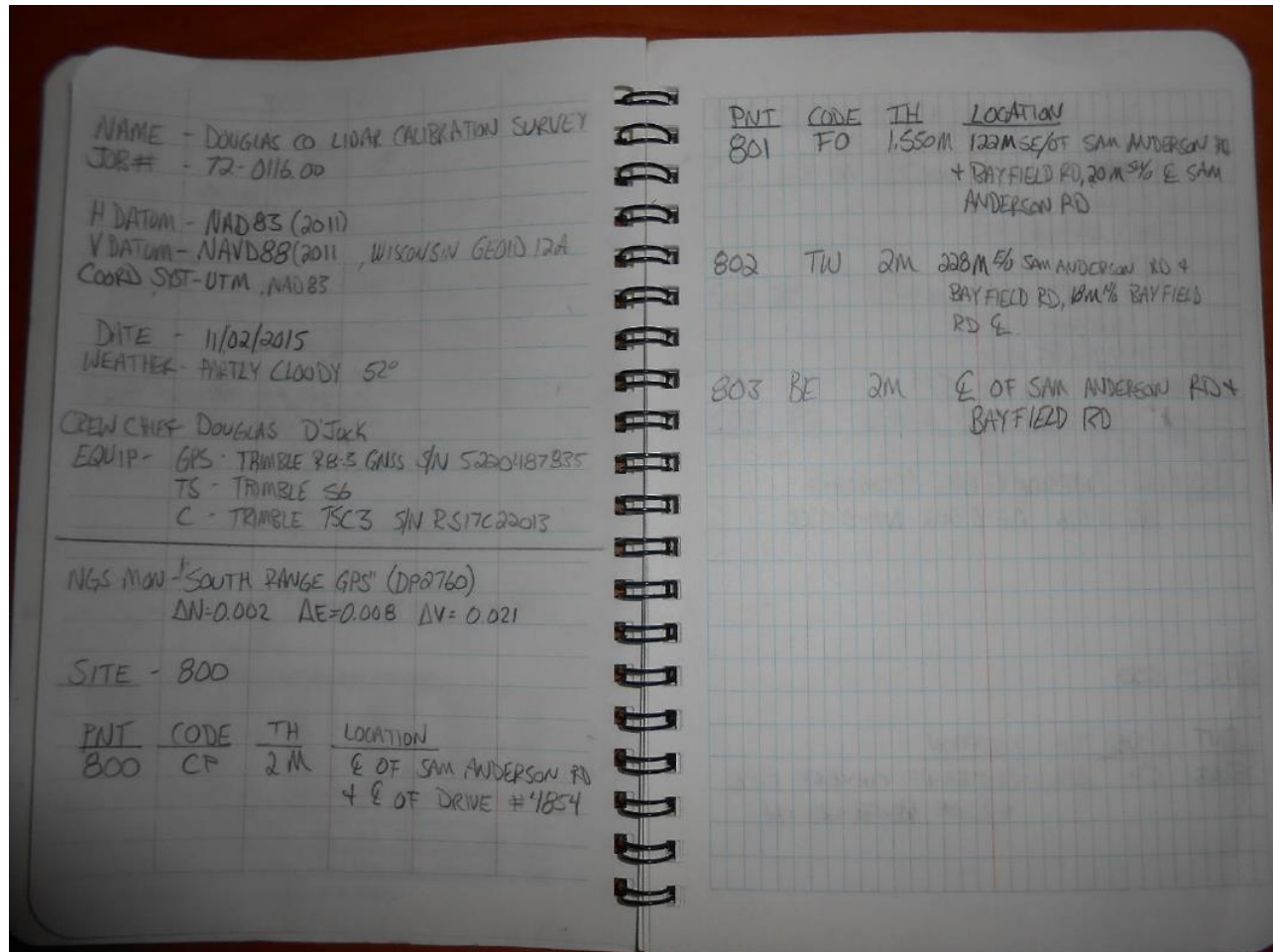
##### 1.1.2.1 Map of calibration points



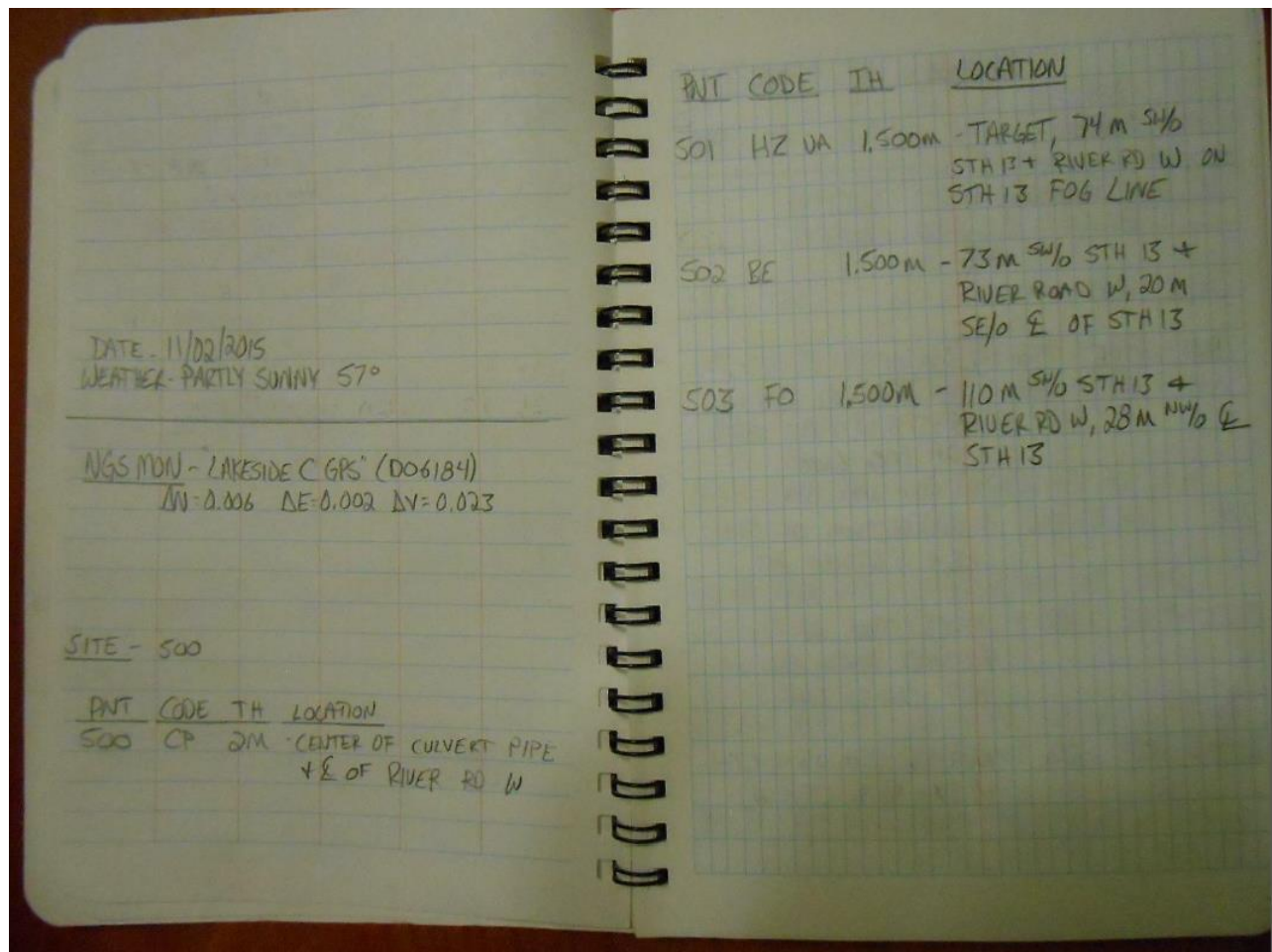
1.1.2.2 St Louis River calibration points, UTM NAD83, Zone 15 N, Meters

Point ID	X	Y	Z
1	5160052.133	582257.073	322.259
2	5159870.955	582418.300	318.905
3	5166818.645	583630.634	221.302
5	5167493.818	562165.890	199.976
6	5167038.198	554135.044	194.49
7	5167196.474	554411.946	190.156
8	5160430.814	554683.888	266.754
9	5162398.803	567754.284	210.449
10	5162414.419	567442.014	211.301
11	5131246.210	555124.457	390.046
12	5131207.726	555099.573	389.714
13	5152026.136	571569.501	349.189
2914	5152020.418	571445.098	349.406
15	5171440.003	574355.807	192.591
16	5170874.308	573944.813	194.269
17	5170913.181	573951.553	194.109
100	5167234.693	554514.397	189.591
200	5167441.676	561371.406	197.782
300	5175213.832	566807.903	192.43
400	5171361.675	574420.835	193.045
500	5166875.205	583734.342	221.254
600	5160434.208	554717.759	266.665
700	5161645.824	567432.882	211.771
800	5159908.922	582379.811	319.667
900	5149703.720	554594.123	282.356
1000	5152034.272	571577.005	349.123
1100	5144080.658	564137.207	357.868
1200	5130695.576	554481.918	389.232
1300	5136342.007	564213.462	389.331

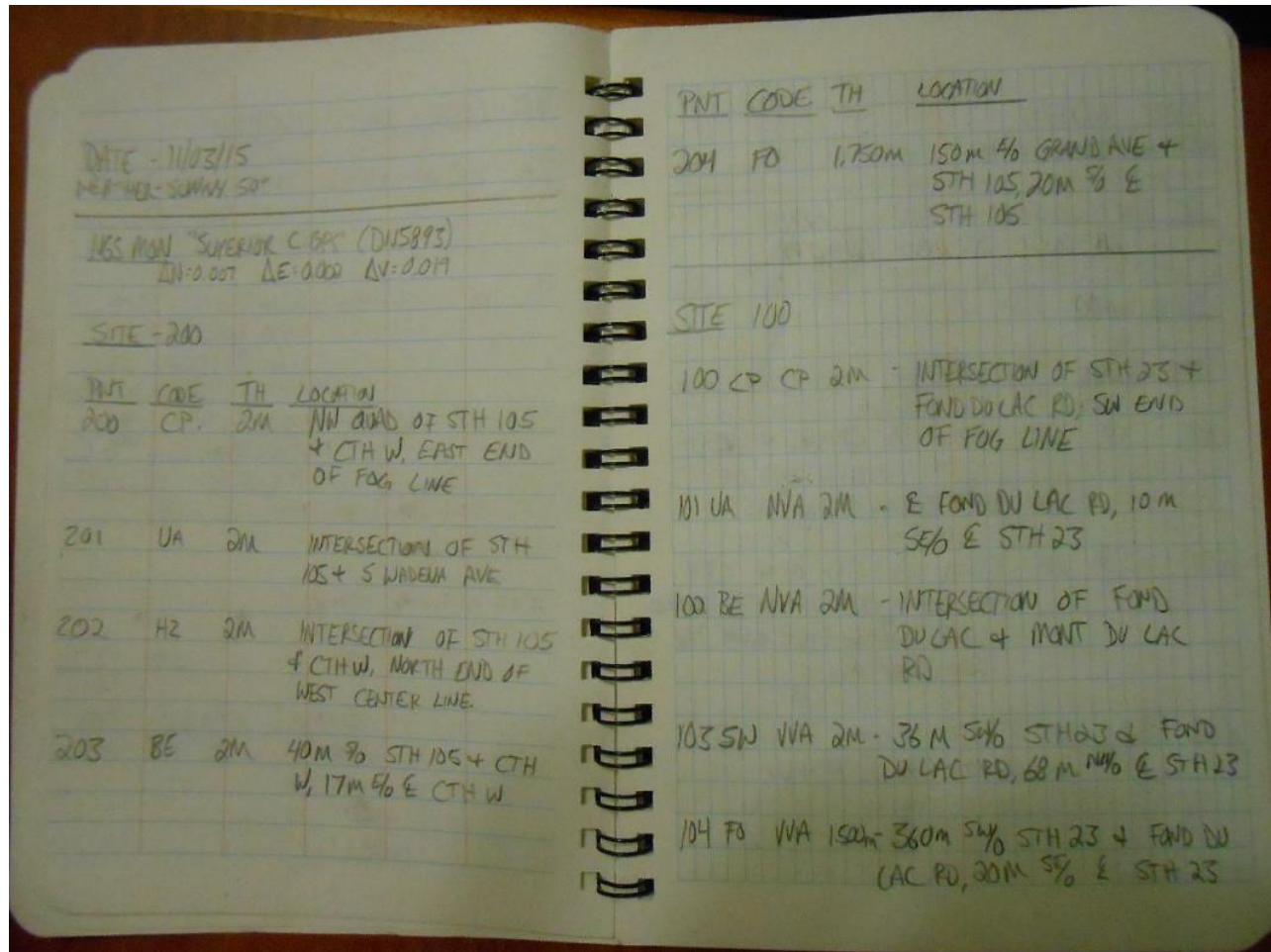
1.1.3 Field Notes



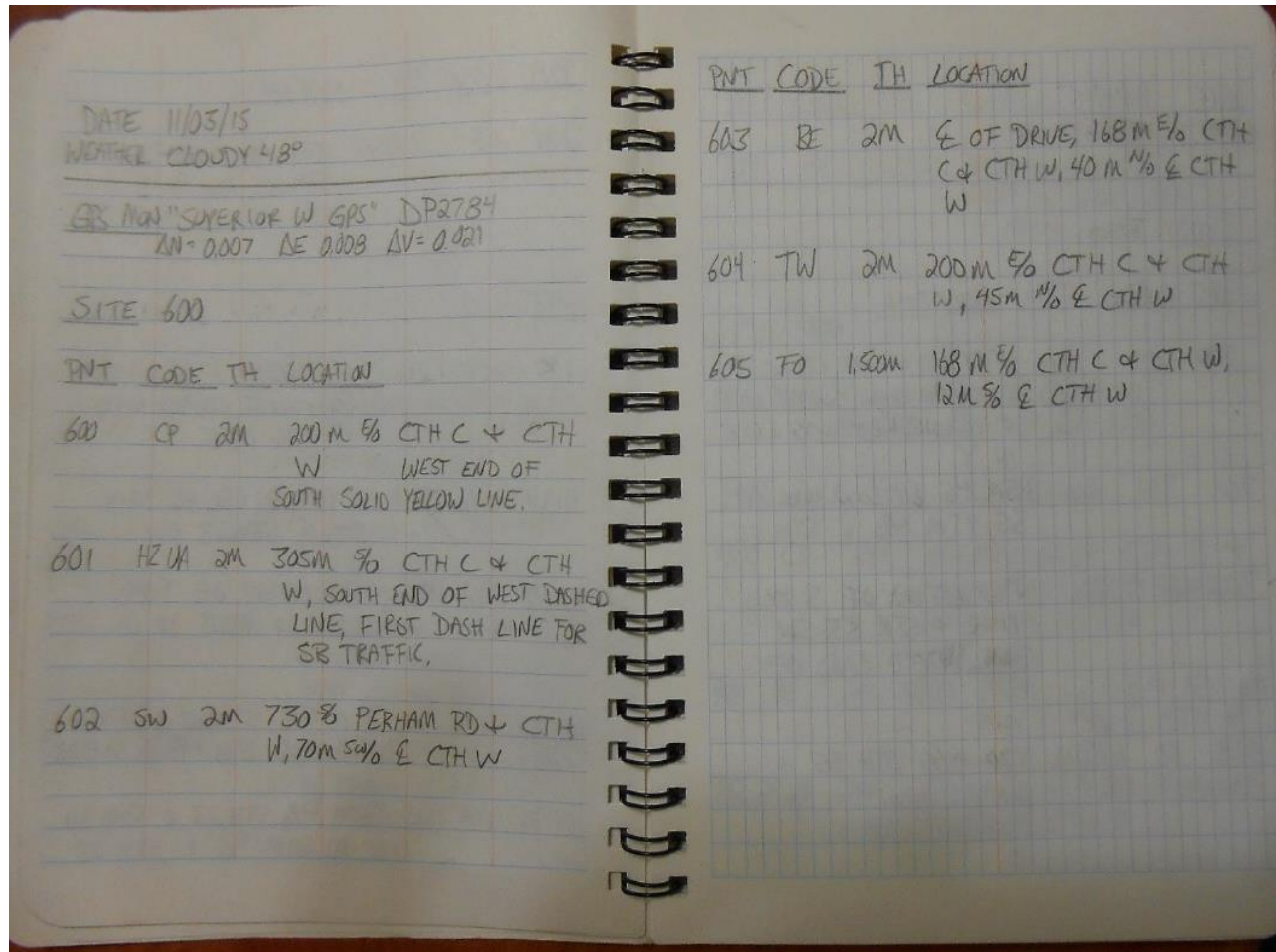
1.1.3 Field Notes (continued)



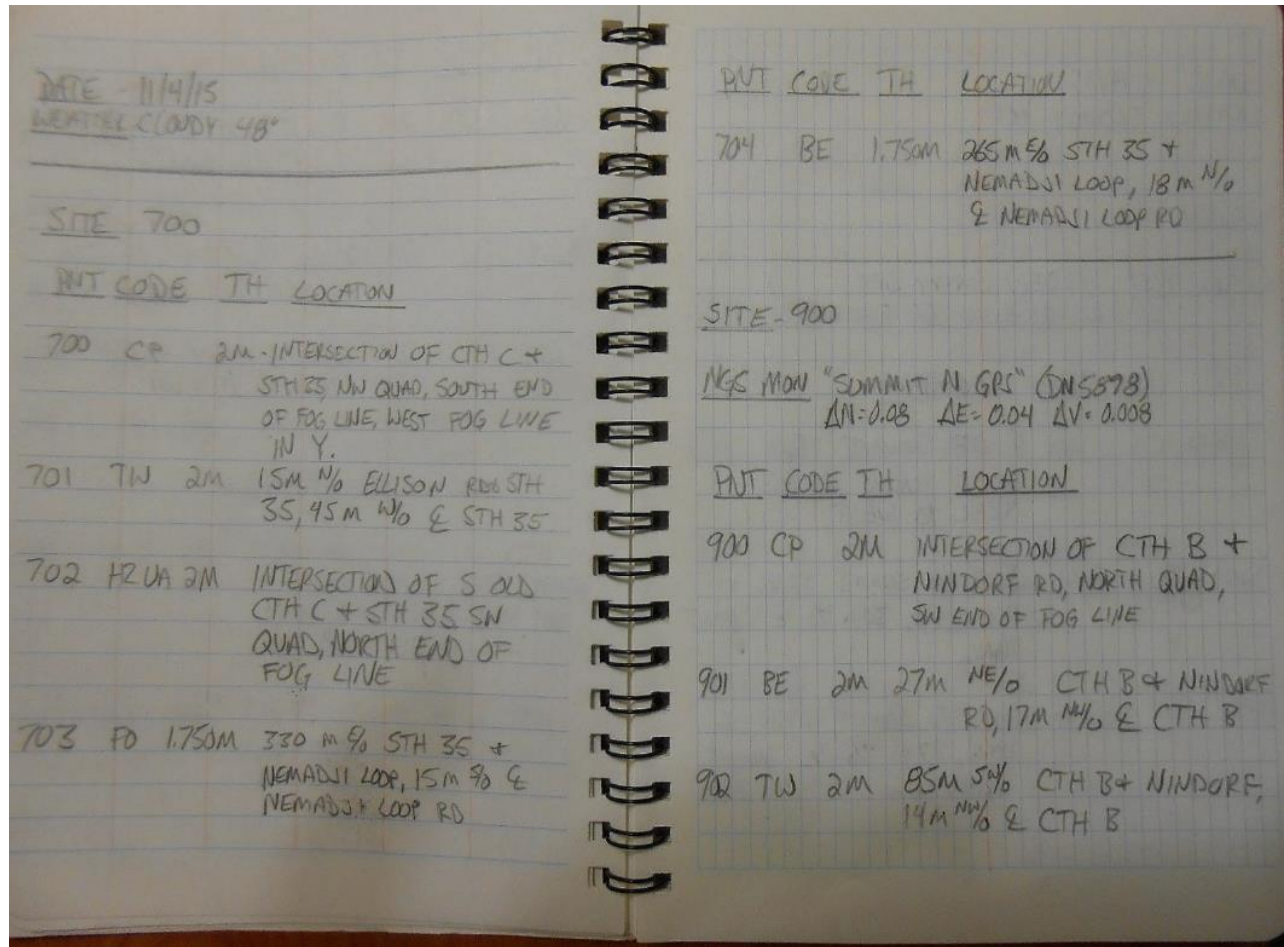
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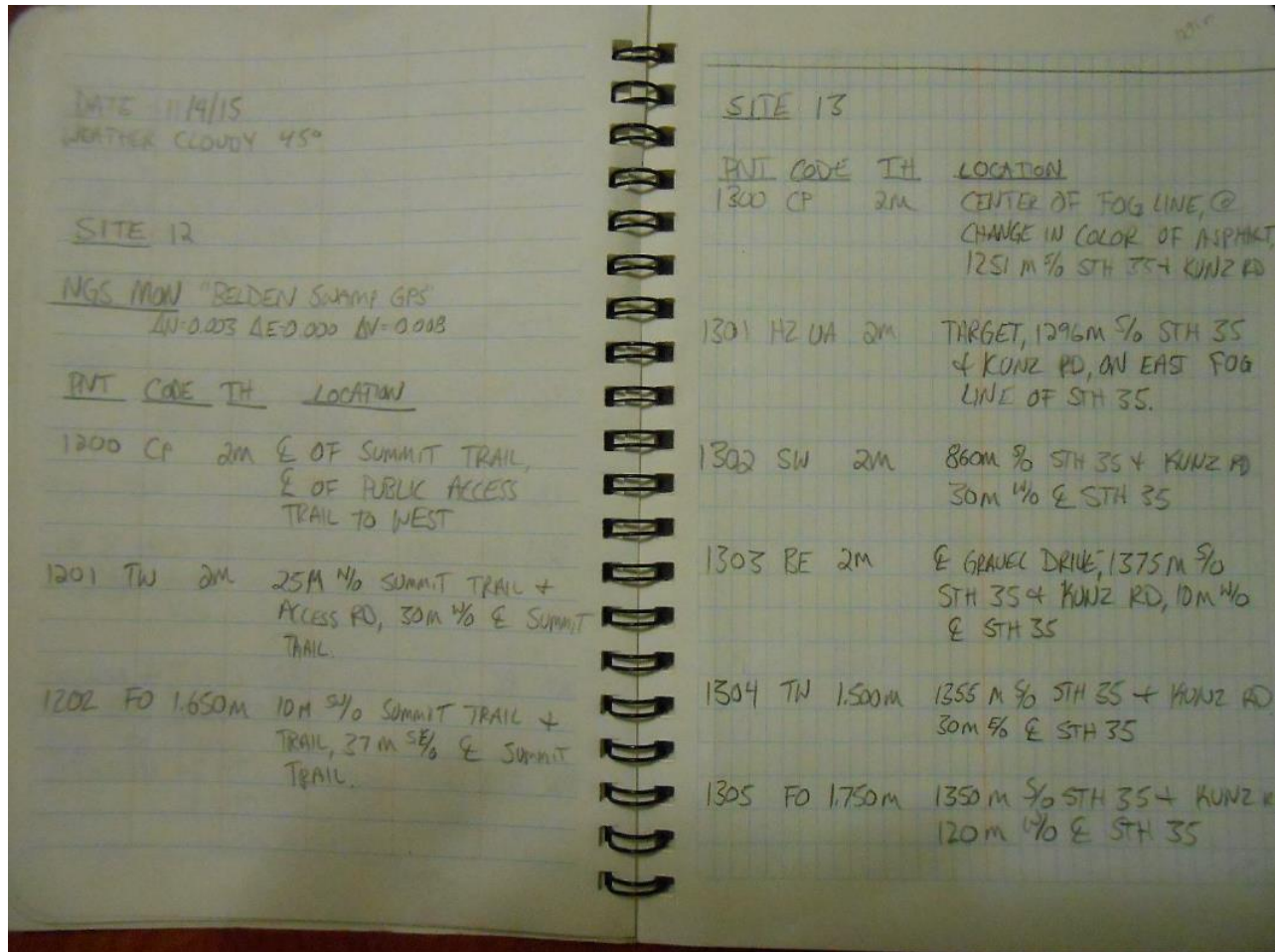
1.1.3 Field Notes (continued)



1.1.3 Field Notes (continued)

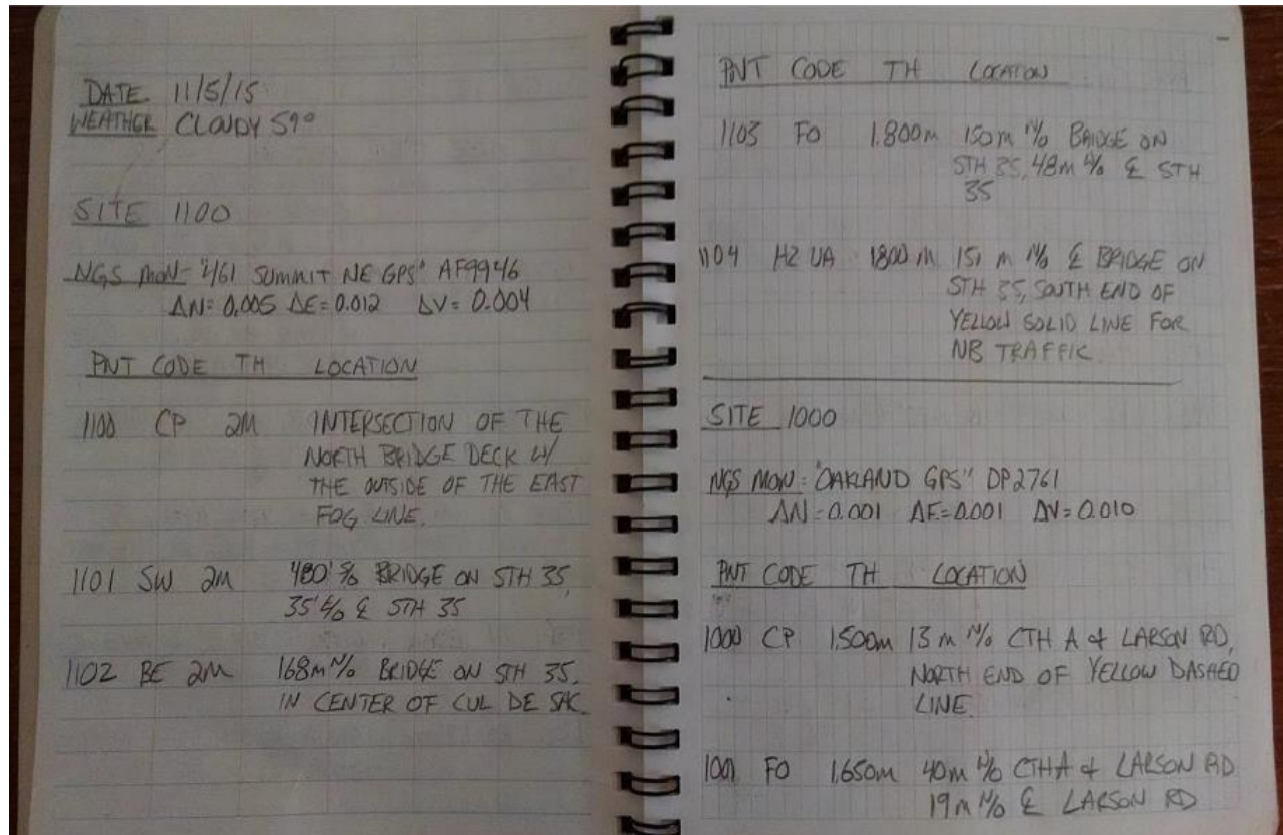


1.1.3 Field Notes (continued)

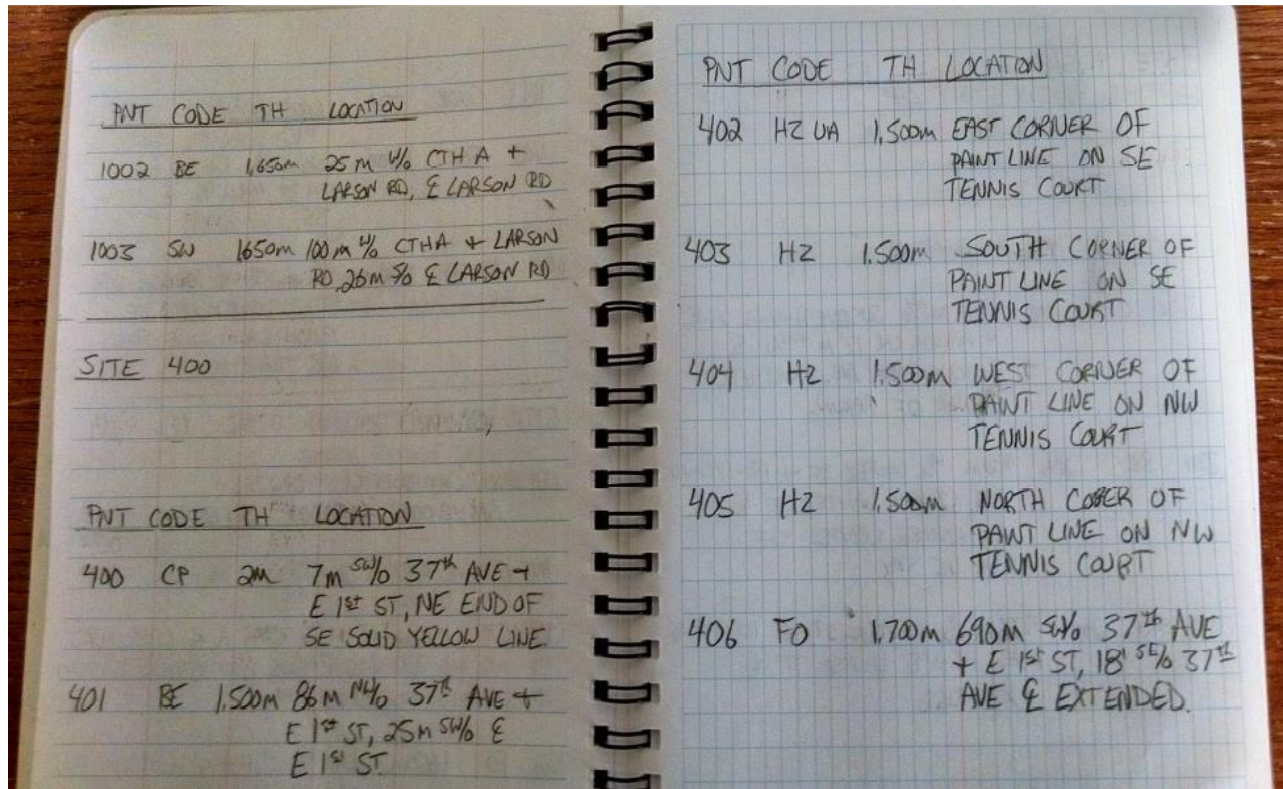




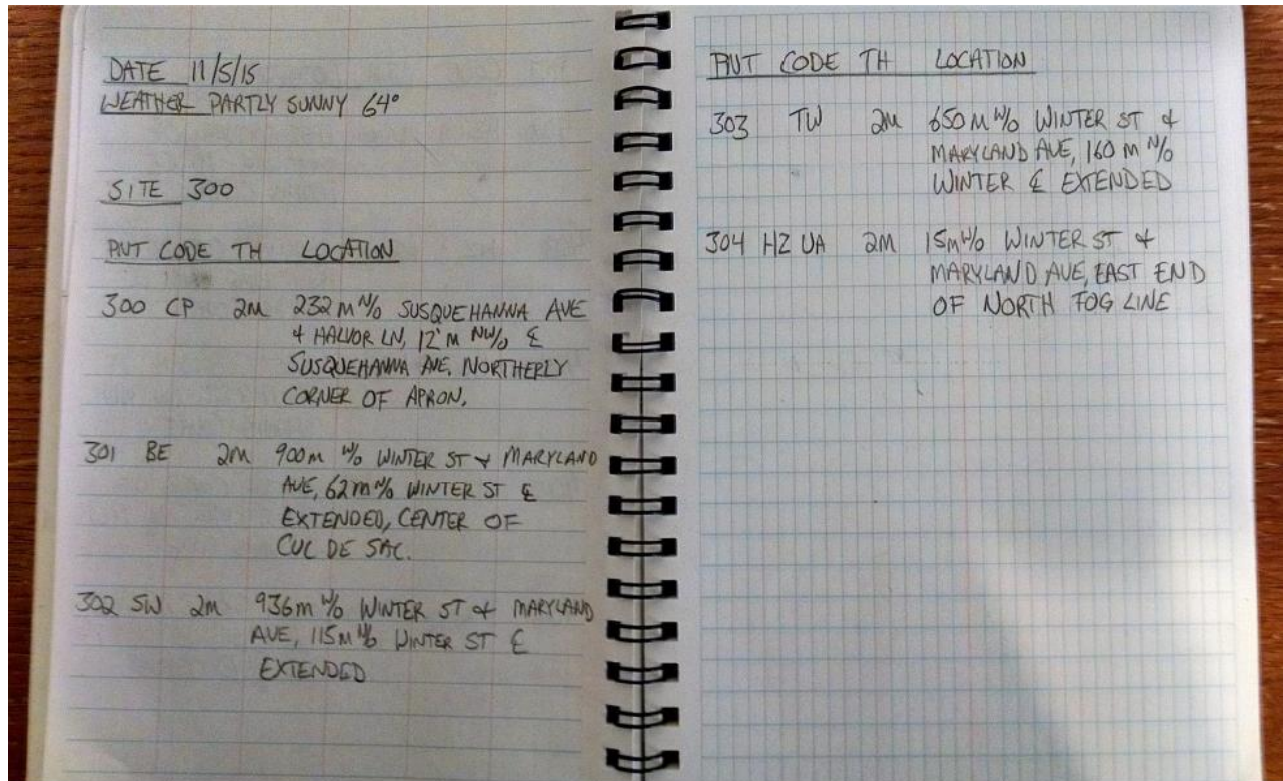
1.1.3 Field Notes (continued)



1.1.3 Field Notes (continued)



1.1.3 Field Notes (continued)



### 1.1.4 St. Louis River 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 0.046'. 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.

#### 1.1.4.1 Statistical Report for calibration points

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Control Point Report (LP360, QCoherent Software, LLC)
----- Report Summary -----
Vertical Error Mean *:          0.015
Vertical Error Range:         [-0.107,0.143]
Vertical Skew:                0.104
Vertical RMSE:                0.046
Vertical NMAS/VMAS Accuracy (90% CI): ±0.075
Vertical ASPRS/NSSDA Accuracy (95% CI): ±0.090
Vertical Accuracy Class:      0.05
Vertical Min Contour Interval: 0.15

Point Counts
Horizontal Measured: 0
Vertical Measured: 29
withheld: 0 of 29

----- End Report Summary -----

----- Surface Definition -----
Surface Method: Triangulation (TIN)
Classification Filter Used:
-ALL classification values used in filter
Return Combination Filter Used:
-ALL return combinations used in filter

----- End Surface Definition -----

----- Control Points -----
Name Description Type Control X Control Y Control Surface Z Delta Z
1 Calibration Point 582257.073 5160052.133 322.259 322.239 0.020
2 Calibration Point 582418.300 5159870.955 318.905 318.866 0.039
3 Calibration Point 583630.634 5166818.645 221.302 221.409 -0.107
5 Calibration Point 562165.890 5167493.818 199.976 199.937 0.039
6 Calibration Point 554135.044 5167038.198 194.490 194.500 -0.010
7 Calibration Point 554411.946 5167196.474 190.156 190.150 0.006
8 Calibration Point 554683.888 5160430.814 266.754 266.710 0.044
9 Calibration Point 567754.284 5162398.803 210.449 210.462 -0.013
10 Calibration Point 567442.014 5162414.419 211.301 211.351 -0.050
11 Calibration Point 555124.457 5131246.210 390.046 390.018 0.028
12 Calibration Point 555099.573 5131207.726 389.714 389.678 0.036
13 Calibration Point 571569.501 5152026.136 349.189 349.176 0.013
14 Calibration Point 571445.098 5152020.418 349.406 349.412 -0.006
15 Calibration Point 574355.807 5171440.003 192.591 192.600 -0.009
16 Calibration Point 573944.813 5170874.308 194.269 194.215 0.054
17 Calibration Point 573951.553 5170913.181 194.109 194.061 0.048
100 Calibration Point 554514.397 5167234.693 189.591 189.621 -0.030
200 Calibration Point 561371.406 5167441.676 197.782 197.794 -0.012
300 Calibration Point 566807.903 5175213.832 192.430 192.362 0.068
400 Calibration Point 574420.835 5171361.675 193.045 193.040 0.005
500 Calibration Point 583734.342 5166875.205 221.254 221.265 -0.011
600 Calibration Point 554594.123 5160434.208 266.665 266.626 0.039
700 Calibration Point 567432.882 5161645.824 211.771 211.739 0.032
800 Calibration Point 582379.811 5159908.922 319.667 319.601 0.066
900 Calibration Point 554594.123 5149703.720 282.356 282.339 0.017
1000 Calibration Point 571577.005 5152034.272 349.123 349.126 -0.003
1100 Calibration Point 564137.207 5144080.658 357.868 357.725 0.143
1200 Calibration Point 554481.918 5130695.576 389.232 389.238 -0.006
1300 Calibration Point 564213.462 5136342.007 389.331 389.331 -0.000
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