



# Vertical Accuracy Report

Wisconsin WROC - 3DEP 2020

Menominee County Lidar

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# Vertical Accuracy Report

## Project Information

Prepared By: Ayres

Project Name: Wisconsin WROC – 3DEP Menominee County Lidar 2020

Sensor Info: Leica ALS80 SN 8239

Required Nominal Pulse Spacing: 0.7

Consultant Name: Ayres primary and Quantum Spatial (now NV5 Geospatial) as lidar acquisition partner

Units: U.S. Survey Feet

Date of Acquisition: Start: 4/25/2020 | Finish: 4/30/2020

## Report Information

This report documents the absolute vertical accuracy of the lidar data collected for the Menominee County, WI, QL2 lidar project. Independent vertical checkpoints were collected by land surveyors using Trimble GNSS equipment connected to WISCRS base stations. The checkpoints were collected from April 15 to April 20, 2020.

The checkpoints were collected under various land cover types that are predominant in the County. Each land cover type falls into either the Non-vegetated Vertical Accuracy (NVA) or the Vegetated Vertical Accuracy (VVA) group. For this project, 25 NVA points and 21 VVA points were collected throughout the County.

The following report shows the final statistics for the NVA checkpoints compared against the raw swath point cloud and the bare earth DEM, and the VVA statistics compared against the DEM. Statistics are reported for LAS and DEM by NVA and VVA categories.

Vertical Accuracy Specifications per USGS QL2 level:

### LAS:

NVA equates to 10 cm RMSEz, or 19.6 cm (0.64 ft) at the 95% confidence level.

### DEM:

NVA equates to 10 cm RMSEz, or 19.6 cm (0.64 ft) at the 95% confidence level.

VVA equates to 29.4 cm (0.96 ft) at the 95th percentile.

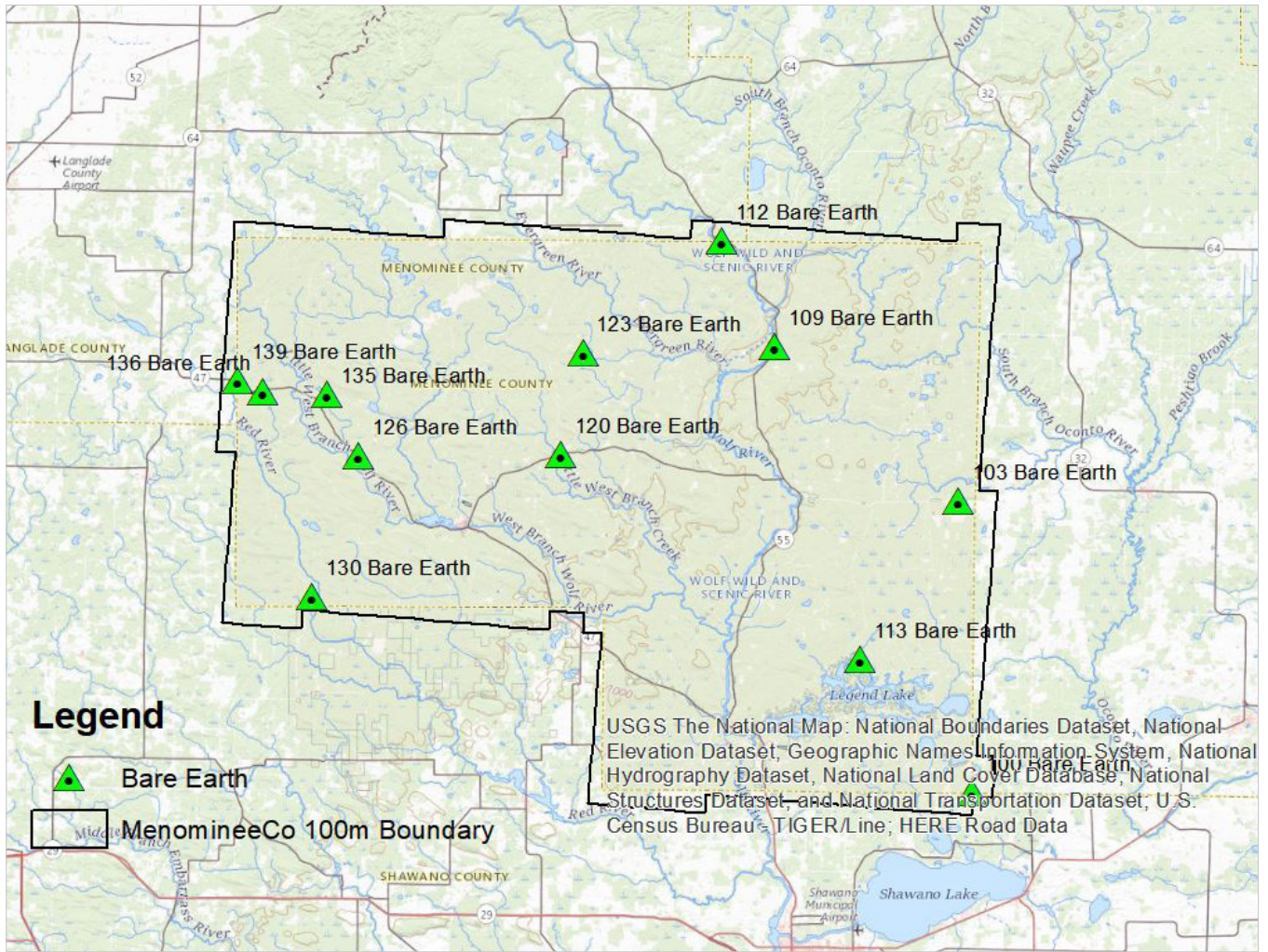
The NVA and VVA statistics for this project are within the above stated specifications.

## Lidar Accuracy Assessment Summary

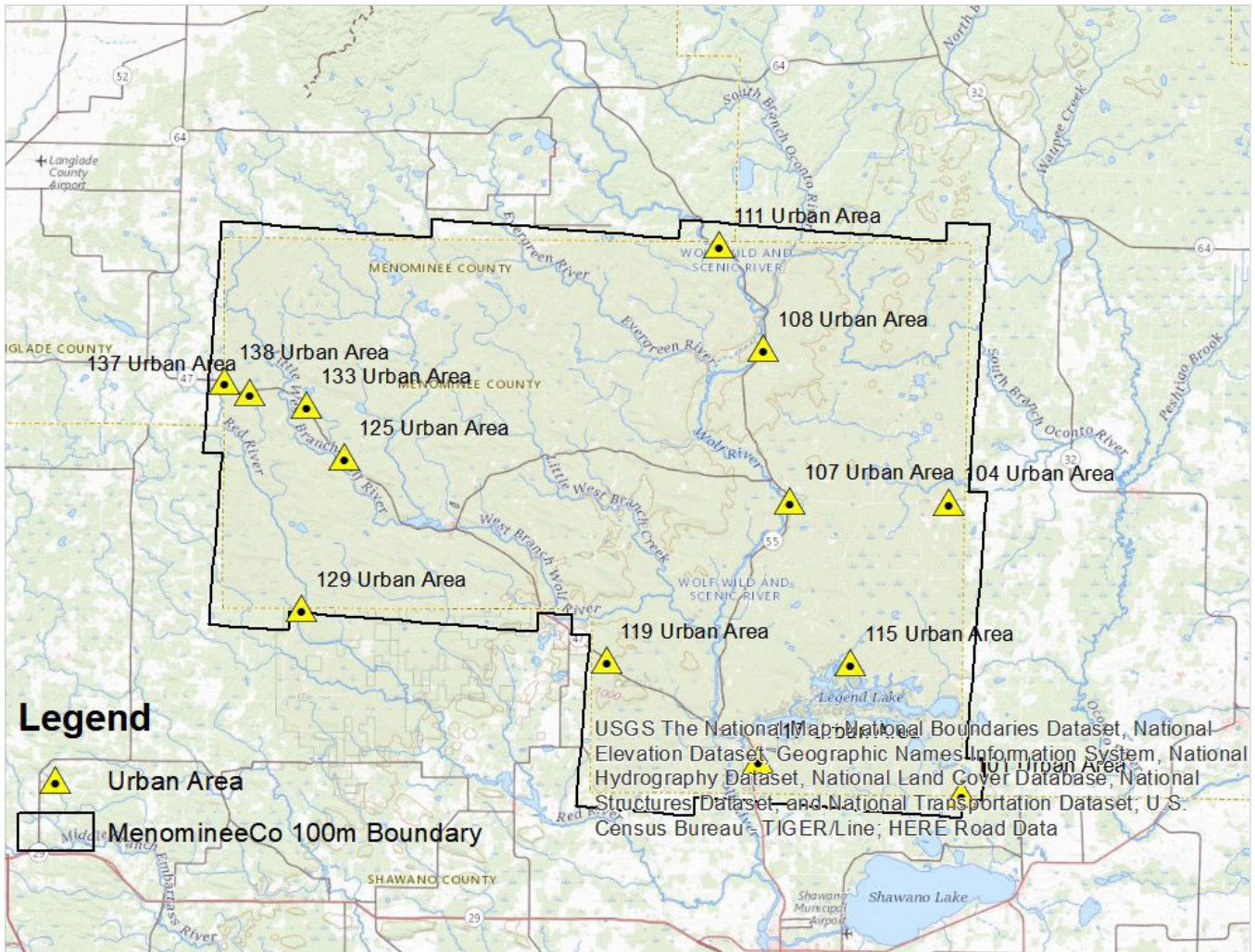
LAND COVER TYPE	# OF POINTS	NVA	VVA
<b>LAS</b>		<b>95% confidence</b>	
Bare Earth	12	0.320	N/A
Urban Area	13	0.172	N/A
Forest	16	N/A	N/A
Tall Weeds	5	N/A	N/A
<b>Total</b>	<b>46</b>	<b>0.254</b>	<b>N/A</b>
<b>DEM</b>		<b>95% confidence</b>	<b>95th percentile</b>
Bare Earth	12	0.221	N/A
Urban Area	13	0.253	N/A
Forest	16	N/A	0.495
Tall Weeds	5	N/A	0.796
<b>Total</b>	<b>46</b>	<b>0.238</b>	<b>0.685</b>

Units: U.S. Survey Feet

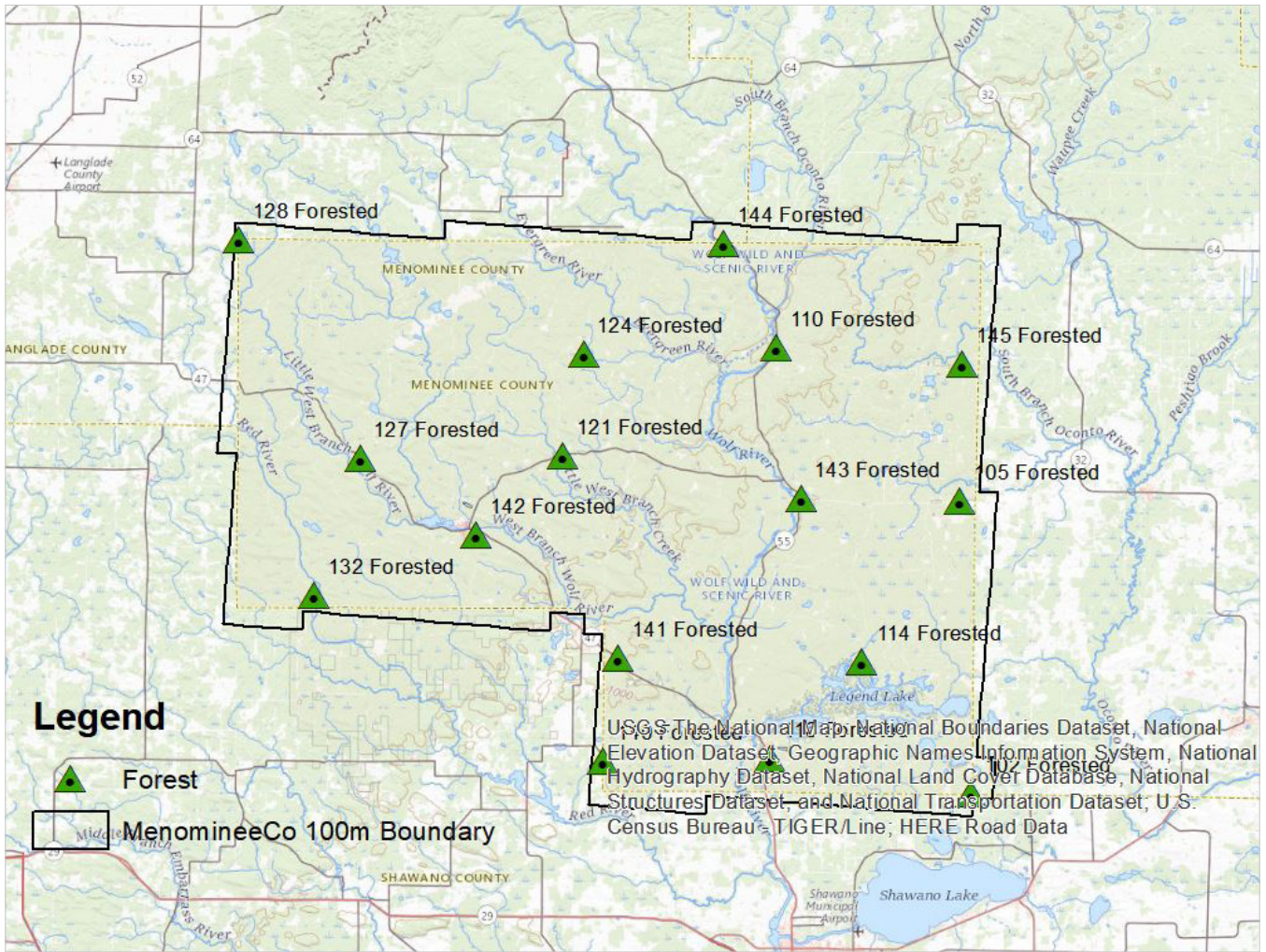
# Map of NVA Checkpoint Locations - Bare Earth



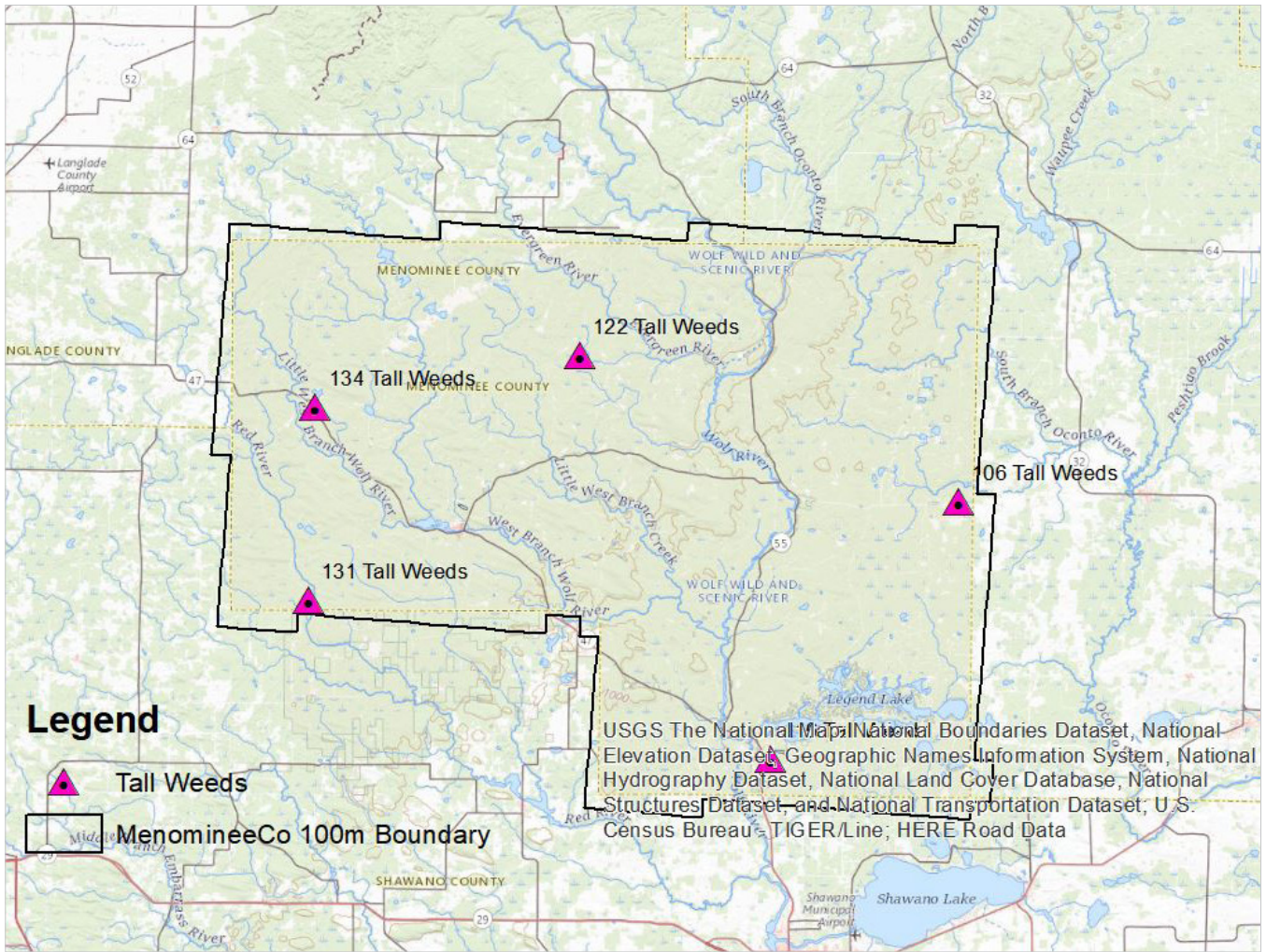
# Map of NVA Checkpoint Locations - Urban Areas



## Map of NVA Checkpoint Locations - Forested Areas



## Map of NVA Checkpoint Locations - Tall Weeds



## LAS

NONVEGETATED VERTICAL ACCURACY – OVERALL	
LAND COVER TYPE	BARE EARTH, URBAN AREA
Minimum DZ	-0.267
Maximum DZ	0.251
Mean DZ	-0.04
Mean Magnitude DZ	0.32
Number Observations	25
Standard Deviation DZ	0.126
RMSE Z	0.13
95% Confidence Level Z	0.254
Units	U.S. Survey Feet

## DEM

NONVEGETATED VERTICAL ACCURACY	
LAND COVER TYPE	BARE EARTH, URBAN AREA
Minimum DZ	-0.313
Maximum DZ	0.221
Mean DZ	-0.002
Mean Magnitude DZ	0.309
Number Observations	25
Standard Deviation DZ	0.124
RMSE Z	0.121
95% Confidence Level Z	0.238
Units	U.S. Survey Feet



## DEM (Continued)

VEGETATED VERTICAL ACCURACY	
LAND COVER TYPE	FOREST
Minimum DZ	0.113
Maximum DZ	0.574
Mean DZ	0.334
Mean Magnitude DZ	0.578
Number Observations	16
Standard Deviation DZ	0.127
RMSE Z	0.356
95th percentile	0.495
Units	U.S. Survey Feet

VEGETATED VERTICAL ACCURACY	
LAND COVER TYPE	TALL WEEDS
Minimum DZ	0.057
Maximum DZ	0.796
Mean DZ	0.374
Mean Magnitude DZ	0.612
Number Observations	5
Standard Deviation DZ	0.312
RMSE Z	0.467
95th percentile	0.796
Units	U.S. Survey Feet

## Point: 100 Bare Earth

Survey X: 327145.73, Survey Y: 50712.2, Z1: 853.58, Z DEM: 853.69, Z LAS: 853.75, ΔZ DEM: 0.1, ΔZ LAS: 0.17



**North**



**South**



**East**



**West**

## Point: 101 Urban Area

Survey X: 327114.68, Survey Y: 51003.46, Z1: 857.84, Z DEM: 857.86, Z LAS: 857.81, ΔZ DEM: 0.02, ΔZ LAS: -0.04



North



South



East



West

# Point: 102 Forested

Survey X: 327011.84, Survey Y: 50845.21, Z1: 856.99, Z DEM: 857.13, Z LAS: 857.14, ΔZ DEM: 0.14, ΔZ LAS: 0.15



**North**



**South**



**East**



**West**

## Point: 103 Bare Earth

Survey X: 324895.85, Survey Y: 101277.47, Z1: 903.3, Z DEM: 903.48, Z LAS: 903.55, ΔZ DEM: 0.18, ΔZ LAS: 0.25



North



South



East



West

## Point: 104 Urban Area

Survey X: 325065.52, Survey Y: 101333.8, Z1: 904.26, Z DEM: 904.17, Z LAS: 904.19, ΔZ DEM: -0.08, ΔZ LAS: -0.06



North



South



East



West

# Point: 105 Forested

Survey X: 325100.9, Survey Y: 101398.99, Z1: 907.05, Z DEM: 907.42, Z LAS: 907.56, ΔZ DEM: 0.37, ΔZ LAS: 0.52



North



South



East



West

## Point: 106 Tall Weeds

Survey X: 325132.2, Survey Y: 101587.71, Z1: 909.59, Z DEM: 910.39, Z LAS: 910.11, ΔZ DEM: 0.8, ΔZ LAS: 0.52



North



South



East



West



# Point: 107 Urban Area

Survey X: 297488.27, Survey Y: 101367.37, Z1: 899.73, Z DEM: 899.85, Z LAS: 899.76, ΔZ DEM: 0.12, ΔZ LAS: 0.03



North



South



East



West

## Point: 108 Urban Area

Survey X: 293029.18, Survey Y: 127823.81, Z1: 995.16, Z DEM: 994.97, Z LAS: 995.11,  $\Delta Z$  DEM: -0.19,  $\Delta Z$  LAS: -0.05



North



South



East



West

## Point: 109 Bare Earth

Survey X: 293108.17, Survey Y: 128027.68, Z1: 999.88, Z DEM: 1000.1, Z LAS: 999.69, ΔZ DEM: 0.22, ΔZ LAS: -0.19



North



South



East



West

# Point: 110 Forested

Survey X: 293191.39, Survey Y: 127931.71, Z1: 996.23, Z DEM: 996.48, Z LAS: 996.34, ΔZ DEM: 0.25, ΔZ LAS: 0.12



North



South



East



West

# Point: 111 Urban Area

Survey X: 285306.96, Survey Y: 145661.09, Z1: 1080.21, Z DEM: 1080.04, Z LAS: 1080.12, ΔZ DEM: -0.17, ΔZ LAS: -0.09



North



South



East



West

## Point: 112 Bare Earth

Survey X: 283918.61, Survey Y: 146245.17, Z1: 1086.84, Z DEM: 1086.71, Z LAS: 1086.57, ΔZ DEM: -0.12, ΔZ LAS: -0.27



North



South



East



West

## Point: 113 Bare Earth

Survey X: 307790.75, Survey Y: 73827.23, Z1: 853.32, Z DEM: 853.32, Z LAS: 853.26, ΔZ DEM: 0, ΔZ LAS: -0.05



North



South



East



West

## Point: 114 Forested

Survey X: 308128.02, Survey Y: 73603.06, Z1: 851.8, Z DEM: 852.17, Z LAS: 852.15, ΔZ DEM: 0.38, ΔZ LAS: 0.35



North



South



East



West



## Point: 115 Urban Area

Survey X: 308044.7, Survey Y: 73503.5, Z1: 856.76, Z DEM: 856.85, Z LAS: 856.78,  $\Delta Z$  DEM: 0.1,  $\Delta Z$  LAS: 0.02



North



South



East



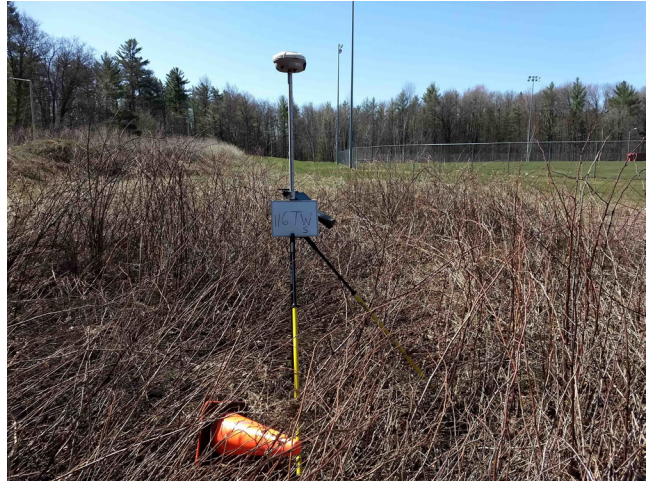
West

## Point: 116 Tall Weeds

Survey X: 292887.21, Survey Y: 57262.7, Z1: 887.55, Z DEM: 887.95, Z LAS: 887.97, ΔZ DEM: 0.4, ΔZ LAS: 0.43



North



South



East



West

# Point: 117 Urban Area

Survey X: 292099.19, Survey Y: 56930.45, Z1: 886.33, Z DEM: 886.4, Z LAS: 886.36, ΔZ DEM: 0.07, ΔZ LAS: 0.03



North



South



East



West

## Point: 118 Forested

Survey X: 292061.01, Survey Y: 56807.7, Z1: 884.49, Z DEM: 884.81, Z LAS: 884.93, ΔZ DEM: 0.33, ΔZ LAS: 0.44



North



South



East



West

## Point: 119 Urban Area

Survey X: 265942.18, Survey Y: 74076.43, Z1: 1033.29, Z DEM: 1033.37, Z LAS: 1033.33, ΔZ DEM: 0.09, ΔZ LAS: 0.05



North



South



East



West

## Point: 120 Bare Earth

Survey X: 255997.69, Survey Y: 109233.04, Z1: 1086.26, Z DEM: 1086.29, Z LAS: 1086.26, ΔZ DEM: 0.04, ΔZ LAS: 0.01



North



South



East



West

## Point: 121 Forested

Survey X: 256189.72, Survey Y: 109285.81, Z1: 1084.6, Z DEM: 1085.05, Z LAS: 1085.04, ΔZ DEM: 0.45, ΔZ LAS: 0.45



North



South



East



West

## Point: 122 Tall Weeds

Survey X: 259816.85, Survey Y: 126852.22, Z1: 1133.71, Z DEM: 1133.76, Z LAS: 1133.83,  $\Delta Z$  DEM: 0.06,  $\Delta Z$  LAS: 0.13



North



South



East



West



# Point: 123 Bare Earth

Survey X: 259812.08, Survey Y: 127020.87, Z1: 1141.8, Z DEM: 1141.72, Z LAS: 1141.65, ΔZ DEM: -0.08, ΔZ LAS: -0.15



North



South



East



West

## Point: 124 Forested

Survey X: 259864.18, Survey Y: 127017.79, Z1: 1142.05, Z DEM: 1142.16, Z LAS: 1142.11,  $\Delta Z$  DEM: 0.11,  $\Delta Z$  LAS: 0.07



North



South



East



West

## Point: 125 Urban Area

Survey X: 220764.9, Survey Y: 109167.05, Z1: 1211.91, Z DEM: 1211.96, Z LAS: 1211.97, ΔZ DEM: 0.05, ΔZ LAS: 0.07



**North**



**South**



**East**



**West**

# Point: 126 Bare Earth

Survey X: 221041.28, Survey Y: 109056.66, Z1: 1214.79, Z DEM: 1214.79, Z LAS: 1214.83,  $\Delta Z$  DEM: 0,  $\Delta Z$  LAS: 0.04



North



South



East



West

## Point: 127 Forested

Survey X: 221080.09, Survey Y: 108948.28, Z1: 1214.65, Z DEM: 1214.96, Z LAS: 1214.82, ΔZ DEM: 0.31, ΔZ LAS: 0.17



North



South



East



West

## Point: 128 Forested

Survey X: 200071.35, Survey Y: 146759.6, Z1: 1433.79, Z DEM: 1434.07, Z LAS: 1434.19,  $\Delta Z$  DEM: 0.29,  $\Delta Z$  LAS: 0.41



North



South



East



West

# Point: 129 Urban Area

Survey X: 213225.05, Survey Y: 82952.07, Z1: 1129.66, Z DEM: 1129.64, Z LAS: 1129.5, ΔZ DEM: -0.02, ΔZ LAS: -0.16



North



South



East



West

## Point: 130 Bare Earth

Survey X: 212987.44, Survey Y: 84604.93, Z1: 1140.1, Z DEM: 1140.04, Z LAS: 1140.03, ΔZ DEM: -0.06, ΔZ LAS: -0.08



North



South



East



West



# Point: 131 Tall Weeds

Survey X: 213061.94, Survey Y: 84674.8, Z1: 1138.41, Z DEM: 1138.94, Z LAS: 1138.92, ΔZ DEM: 0.53, ΔZ LAS: 0.5



**North**



**South**



**East**



**West**

# Point: 132 Forested

Survey X: 213167.98, Survey Y: 85110.26, Z1: 1140.91, Z DEM: 1141.3, Z LAS: 1141.12, ΔZ DEM: 0.39, ΔZ LAS: 0.21



North



South



East



West

# Point: 133 Urban Area

Survey X: 214218.48, Survey Y: 117902.83, Z1: 1248.93, Z DEM: 1248.61, Z LAS: 1248.71, ΔZ DEM: -0.31, ΔZ LAS: -0.22



North



South



East



West

## Point: 134 Tall Weeds

Survey X: 214308.58, Survey Y: 117980.34, Z1: 1244.87, Z DEM: 1244.95, Z LAS: 1245.04, ΔZ DEM: 0.08, ΔZ LAS: 0.17



North



South



East



West

# Point: 135 Bare Earth

Survey X: 215565.16, Survey Y: 119654.74, Z1: 1242.65, Z DEM: 1242.66, Z LAS: 1242.52, ΔZ DEM: 0.01, ΔZ LAS: -0.13



North



South



East



West

## Point: 136 Bare Earth

Survey X: 204373.09, Survey Y: 120139.97, Z1: 1255.29, Z DEM: 1255.11, Z LAS: 1255.04, ΔZ DEM: -0.18, ΔZ LAS: -0.25



**North**



**South**



**East**



**West**

# Point: 137 Urban Area

Survey X: 204328.72, Survey Y: 120274.7, Z1: 1255.47, Z DEM: 1255.49, Z LAS: 1255.43, ΔZ DEM: 0.02, ΔZ LAS: -0.05



North



South



East



West

## Point: 138 Urban Area

Survey X: 199973.05, Survey Y: 122212.94, Z1: 1285.97, Z DEM: 1286.05, Z LAS: 1285.99, ΔZ DEM: 0.08, ΔZ LAS: 0.02



North



South



East



West



# Point: 139 Bare Earth

Survey X: 200100.58, Survey Y: 122124.61, Z1: 1284.25, Z DEM: 1284.31, Z LAS: 1284.34, ΔZ DEM: 0.06, ΔZ LAS: 0.1



North



South



East



West

# Point: 140 Forested

Survey X: 263260.53, Survey Y: 56460.15, Z1: 909.86, Z DEM: 910.23, Z LAS: 910.16, ΔZ DEM: 0.37, ΔZ LAS: 0.3



North



South



East



West

# Point: 141 Forested

Survey X: 265894.26, Survey Y: 74244.98, Z1: 1032.01, Z DEM: 1032.43, Z LAS: 1032.21, ΔZ DEM: 0.42, ΔZ LAS: 0.2



North



South



East



West

# Point: 142 Forested

Survey X: 241171.09, Survey Y: 95605.07, Z1: 1062.41, Z DEM: 1062.99, Z LAS: 1063.01, ΔZ DEM: 0.57, ΔZ LAS: 0.6



North



South



East



West

# Point: 143 Forested

Survey X: 297532.43, Survey Y: 101988, Z1: 916.95, Z DEM: 917.45, Z LAS: 917.66, ΔZ DEM: 0.5, ΔZ LAS: 0.71



North



South



East



West

## Point: 144 Forested

Survey X: 284097.59, Survey Y: 146111.92, Z1: 1078.25, Z DEM: 1078.41, Z LAS: 1078.4, ΔZ DEM: 0.16, ΔZ LAS: 0.15



North



South



East



West

# Point: 145 Forested

Survey X: 325489.01, Survey Y: 125142.6, Z1: 901.73, Z DEM: 902.04, Z LAS: 901.9, ΔZ DEM: 0.32, ΔZ LAS: 0.18



North



South



East



West