LiDAR Accuracy Assessment



Wayne County, Indiana for

LiDAR Acquired Spring 2017

Prepared by

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August 31, 2017

**Summary**

GRW was contracted in the Spring of 2017 to develop elevation data to support 2’ contours for Wayne County, Indiana. The project included the acquisition of LiDAR data utilizing an Optech Gemini sensor. Data was acquired Spring 2017.

Control points were field surveyed to be used in the calibration and adjustment of the LiDAR dataset as part of the original project. Validation points to be used in the reporting of RMSEz, Supplemental, NVA and VVA Accuracies were surveyed in March 2017. The validation points surveyed in March 2017 serve as the basis for the accuracy assessment contained in this report.

The charts and statistics on the following pages were derived by comparing the final project DEM (generated from bare earth LiDAR) to the surveyed XYZ position of each point. Comparisons were made using the TerraModel software, comparing the surveyed position to the TIN generated from the DEM.

**The project was delivered to the client in NGVD88 vertical datum, US Survey Foot. All XYZ coordinates reported herein are based on NAD88 Indiana East horizontal and NGVD88 vertical datums.**

**Accuracy Statements**

Tested 6.94944 cm **RMSEz** open terrain using urban and ground control validation points.

Tested 13.80 cm **Non-Vegetated Accuracy** at 95th percentile in open terrain using urban and ground control points with RMSEz \* 1.9600.

Tested 0.65072 feet **supplemental vertical accuracy** at 95th percentile in Bare Earth category.

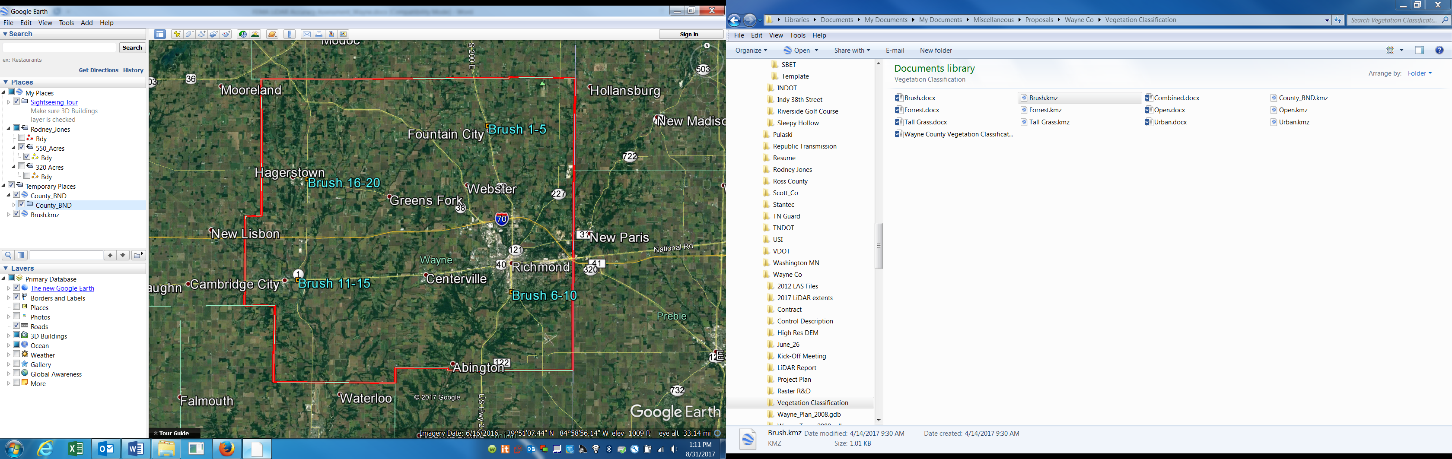
Tested 0.46844 feet **supplemental vertical accuracy** at 95th percentile in Urban category.

Tested 1.3426 feet **supplemental vertical accuracy** at 95th percentile in Brush category.

Tested 1.39552 feet **supplemental vertical accuracy** at 95th percentile in Forested Area category.

Tested 1.00156 feet **supplemental vertical accuracy** at 95th percentile in High Grass category.

Tested 38.23 cm **vegetated vertical accuracy** at 95th percentile in vegetated areas including Forested, High Grass, and Brush categories with RMSEz\* 1.9600.



Location of points used in calculation of NVA, SVA, and VVA. Project Boundary is shown as a red polygon.

At each location, a point was collected for each land cover type in 4 well distributed areas throughout the county. For example, Brush points 1 through 5 were surveyed near Fountain City and Brush points 6 through 10 south of Richmond. In all a total of 20 brush points were surveyed and the same was true for the four other vegetation categories such as: urban, open, tall grass and forested. A total of 100 validation points were surveyed to assess the LiDAR accuracy.

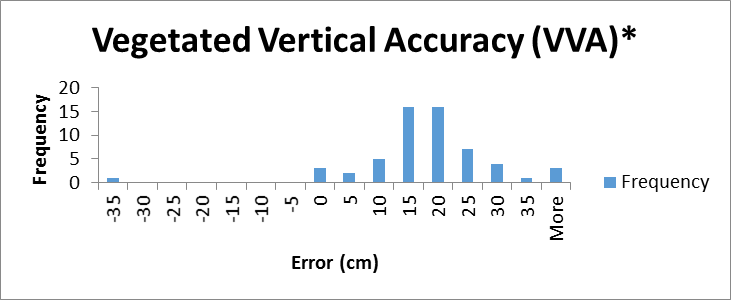
**Density Calculation**

Five (5) randomly chosen 5,000’ x 5,000’ .las tiles of classified LiDAR data were chosen for this calculation. The tiles were composed of complete calibrated flight lines having 50% overlap and in some cases including a cross-flight. The density was calculated in tiles formatted in meters as the unit of measure with LAS Info statistics queried from LAS Tools. The resulting chart indicated a density of 3.468 points using all points and a density of 2.62 points per square meter comparing only the last return.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TILE | ALL DENSITY | LAST DENSITY | ALL SPACING | LAST SPACING |  |
| 15 | 2.36 | 2.25 | 0.65 | 0.67 | Meters |
| 100 | 2.21 | 2.07 | 0.67 | 0.7 | Meters |
| 150 | 4.75 | 3.2 | 0.46 | 0.56 | Meters |
| 300 | 4.39 | 2.92 | 0.48 | 0.58 | Meters |
| 500 | 3.63 | 2.66 | 0.52 | 0.61 | Meters |
| AVG | 3.468 | 2.62 | 0.556 | 0.624 | Meters |
|  |  |  |  |  |  |
| Measured by Las Info from Las Tools. | | |  |  |  |
| Ran on tiles that had been converted to meters. | | | |  |  |

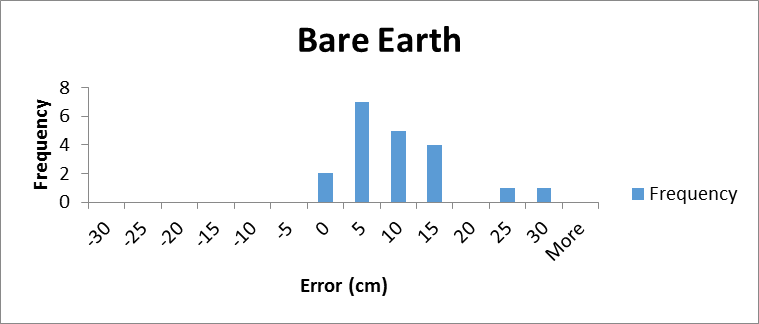
**\* Calculated with Urban Area and Ground Control Validation Points**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Easting | Northing | Elevation | DTM Z | Errors (ft) | Errors (cm) |
| UR 13 | 466909.61 | 1662270.13 | 933.26 | removed | \* |  |
| LID 7 | 562409.41 | 1716146.82 | 1139.34 | 1139.8 | 0.46 | 14.0208 |
| UR 2 | 538017.79 | 1713458.73 | 1086.98 | 1087.43 | 0.45 | 13.716 |
| ADD 108 | 494017.44 | 1663793.38 | 964.681 | 965.13 | 0.449 | 13.68552 |
| UR 11 | 467149.79 | 1662277.41 | 932.15 | 932.49 | 0.34 | 10.3632 |
| LID 12 | 557157.07 | 1638782.21 | 1126.98 | 1127.27 | 0.29 | 8.8392 |
| UR 15 | 466957.36 | 1662604.06 | 933.84 | 934.08 | 0.24 | 7.3152 |
| ADD 109 | 542905.45 | 1674260.73 | 979.023 | 979.26 | 0.237 | 7.22376 |
| LID 10 | 547182.8 | 1661329.71 | 1023.05 | 1023.28 | 0.23 | 7.0104 |
| OP 17 | 537037.25 | 1717588.82 | 1120.46 | 1120.65 | 0.19 | 5.7912 |
| UR 5 | 537087.48 | 1714919.59 | 1105.36 | 1105.52 | 0.16 | 4.8768 |
| UR 3 | 538440.33 | 1713779.63 | 1087.77 | 1087.92 | 0.15 | 4.572 |
| UR 14 | 466741.33 | 1662262.55 | 935.05 | 935.19 | 0.14 | 4.2672 |
| UR 1 | 537413.76 | 1717451.59 | 1117.97 | 1118.1 | 0.13 | 3.9624 |
| ADD 106 | 525854.46 | 1688449.04 | 1028.215 | 1028.34 | 0.125 | 3.81 |
| UR 4 | 538166.04 | 1715255.48 | 1103.36 | 1103.48 | 0.12 | 3.6576 |
| UR 18 | 470025.51 | 1698452.08 | 1005.2 | 1005.31 | 0.11 | 3.3528 |
| LID 5 | 474306 | 1729082.46 | 1083.64 | 1083.74 | 0.1 | 3.048 |
| OP 11 | 559355.22 | 1670178.88 | 1096.77 | 1096.86 | 0.09 | 2.7432 |
| LID 2 | 471807.44 | 1662734.36 | 968.75 | 968.83 | 0.08 | 2.4384 |
| OP 10 | 472024.37 | 1661263.77 | 961.22 | 961.3 | 0.08 | 2.4384 |
| LID 11 | 556989.29 | 1648652.48 | 1113.3 | 1113.37 | 0.07 | 2.1336 |
| OP 13 | 558267.48 | 1669214.79 | 1081.36 | 1081.41 | 0.05 | 1.524 |
| UR 12 | 467012.44 | 1662267.21 | 934.15 | 934.19 | 0.04 | 1.2192 |
| F 277 | 557135.36 | 1642897.61 | 1121.91 | 1121.95 | 0.04 | 1.2192 |
| ADD 101 | 499926.55 | 1727750.85 | 1182.266 | 1182.28 | 0.014 | 0.42672 |
| ADD 102 | 533509.71 | 1728930.57 | 1209.991 | 1209.99 | -0.001 | -0.03048 |
| UR 9 | 516130.35 | 1664988.84 | 1007.76 | 1007.71 | -0.05 | -1.524 |
| ADD 105 | 503230.3 | 1679073.25 | 1093.713 | 1093.66 | -0.053 | -1.61544 |
| ADD 110 | 517590.42 | 1635307.35 | 1055.304 | 1055.25 | -0.054 | -1.64592 |
| UR 20 | 469992.95 | 1698572.2 | 1007.47 | 1007.41 | -0.06 | -1.8288 |
| LID 9 | 563023.71 | 1677282.64 | 1004.87 | 1004.77 | -0.1 | -3.048 |
| ADD 103 | 505405.55 | 1711135 | 1136.431 | 1136.32 | -0.111 | -3.38328 |
| UR 16 | 470016.84 | 1698310.31 | 1002.89 | 1002.74 | -0.15 | -4.572 |
| UR 17 | 470022.18 | 1698391.58 | 1004.32 | 1004.16 | -0.16 | -4.8768 |
| LID 3 | 474840.87 | 1687314.98 | 1045.44 | 1045.2 | -0.24 | -7.3152 |
| UR 8 | 516764.13 | 1665042.24 | 1009.51 | 1009.27 | -0.24 | -7.3152 |
| UR 19 | 469981.71 | 1698515.03 | 1007.47 | 1007.22 | -0.25 | -7.62 |
| UR 7 | 516386.79 | 1665093.32 | 1011.51 | 1011.25 | -0.26 | -7.9248 |
| LID 6 | 562518.85 | 1730035.04 | 1204.77 | 1204.5 | -0.27 | -8.2296 |
| LID 4 | 474700.4 | 1709121.86 | 1040.49 | 1040.2 | -0.29 | -8.8392 |
| LID 1 | 476875.09 | 1633880.32 | 882.84 | 882.49 | -0.35 | -10.668 |
| UR 6 | 516433.46 | 1665339.79 | 1007.39 | 1007.02 | -0.37 | -11.2776 |
| ADD 104 | 458559.62 | 1676088.22 | 1008.764 | 1008.39 | -0.374 | -11.39952 |
| UR 10 | 515937.95 | 1665281.22 | 996.62 | 996.15 | -0.47 | -14.3256 |
| LID 8 | 562278.65 | 1701490.1 | 1096.01 | removed | \* |  |
| *\*Blunder, not included in accuracy calculations* | | |  | **Average** | 0.012 | 0.36576 |
|  |  |  |  | **Minimum** | -0.47 | -14.3256 |
|  |  |  |  | **Maximum** | 0.46 | 14.0208 |
|  |  |  |  | **Std Dev** | 0.231 | 7.04088 |
|  |  |  |  | **RMSE** | 0.228 | 6.94944 |
|  |  |  |  | **95th** | 0.45276 | 13.8001248 |

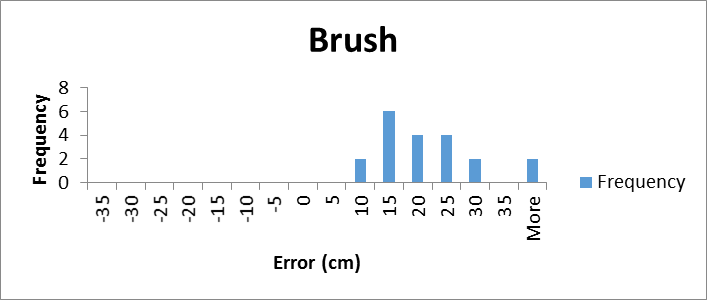


**\* Calculated with all vegetation validation points**

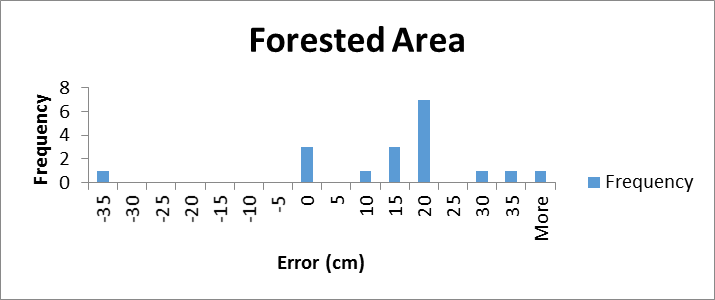
|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Class | Num | Easting | Northing | Elevation | DTM Z | Error (ft) | Error (cm) |
| FA | 11 | 562181.13 | 1675185.89 | 1004.24 | removed | \* |  |
| FA | 20 | 537164.93 | 1714933.99 | 1104.93 | 1106.2 | 1.27 | 38.7096 |
| BR | 6 | 546157.33 | 1659536.62 | 974.91 | 976.06 | 1.15 | 35.052 |
| BR | 13 | 472087.82 | 1663421.78 | 968.84 | 969.99 | 1.15 | 35.052 |
| FA | 18 | 538011.23 | 1713304.98 | 1084.45 | 1085.52 | 1.07 | 32.6136 |
| BR | 11 | 471836.42 | 1663983.2 | 965.36 | 966.34 | 0.98 | 29.8704 |
| BR | 3 | 537082.37 | 1717329.96 | 1114.64 | 1115.62 | 0.98 | 29.8704 |
| FA | 4 | 475569.43 | 1695857.54 | 1068.2 | 1069.07 | 0.87 | 26.5176 |
| TG | 11 | 563878.91 | 1671742.24 | 1054.86 | 1055.7 | 0.84 | 25.6032 |
| TG | 8 | 471904.99 | 1661331.73 | 960.27 | 961.07 | 0.8 | 24.384 |
| BR | 19 | 475463.7 | 1695195.17 | 1051.68 | 1052.43 | 0.75 | 22.86 |
| BR | 2 | 537148.17 | 1717278.91 | 1114.57 | 1115.32 | 0.75 | 22.86 |
| BR | 14 | 472339.95 | 1663085.91 | 965.3 | 966.02 | 0.72 | 21.9456 |
| BR | 4 | 537019.63 | 1717427.05 | 1116.32 | 1117.01 | 0.69 | 21.0312 |
| TG | 12 | 565682.6 | 1671099.66 | 1068.83 | 1069.52 | 0.69 | 21.0312 |
| TG | 6 | 471778.54 | 1663944.28 | 967.21 | 967.9 | 0.69 | 21.0312 |
| BR | 7 | 546214.01 | 1658921.31 | 970.36 | 971.01 | 0.65 | 19.812 |
| FA | 14 | 562231.69 | 1675734.2 | 978.79 | 979.43 | 0.64 | 19.5072 |
| FA | 19 | 538537.65 | 1713827.83 | 1086.94 | 1087.58 | 0.64 | 19.5072 |
| BR | 5 | 537218.03 | 1717826.79 | 1121.25 | 1121.88 | 0.63 | 19.2024 |
| FA | 6 | 471714.88 | 1663823.04 | 962.21 | 962.84 | 0.63 | 19.2024 |
| BR | 1 | 537460.9 | 1717539.04 | 1116.16 | 1116.79 | 0.63 | 19.2024 |
| TG | 16 | 537394.52 | 1717391.98 | 1116.38 | 1117 | 0.62 | 18.8976 |
| TG | 4 | 475306.32 | 1695010.02 | 1046.67 | 1047.29 | 0.62 | 18.8976 |
| FA | 17 | 537035.51 | 1717415.17 | 1116.13 | 1116.71 | 0.58 | 17.6784 |
| FA | 15 | 562067.64 | 1675487.5 | 985.54 | 986.11 | 0.57 | 17.3736 |
| FA | 13 | 562379.07 | 1675390.29 | 991.73 | 992.29 | 0.56 | 17.0688 |
| TG | 2 | 475998.26 | 1695825.99 | 1069.61 | 1070.16 | 0.55 | 16.764 |
| FA | 12 | 562318.17 | 1675146.24 | 1010.82 | 1011.36 | 0.54 | 16.4592 |
| TG | 5 | 475441.6 | 1695161.75 | 1050.14 | 1050.67 | 0.53 | 16.1544 |
| BR | 20 | 475609.74 | 1695269.03 | 1056.2 | 1056.7 | 0.5 | 15.24 |
| TG | 20 | 538013.2 | 1713409.96 | 1085.28 | 1085.78 | 0.5 | 15.24 |
| BR | 15 | 472108.5 | 1661418.85 | 960.48 | 960.97 | 0.49 | 14.9352 |
| TG | 3 | 476195.33 | 1695837.65 | 1078.38 | 1078.85 | 0.47 | 14.3256 |
| BR | 18 | 475332.9 | 1695032.83 | 1047.18 | 1047.64 | 0.46 | 14.0208 |
| FA | 7 | 471969.22 | 1663099.04 | 971.09 | 971.55 | 0.46 | 14.0208 |
| FA | 10 | 467743.99 | 1663587.09 | 924.79 | 925.23 | 0.44 | 13.4112 |
| TG | 10 | 466437.99 | 1661953.99 | 938.04 | 938.47 | 0.43 | 13.1064 |
| FA | 9 | 467541.76 | 1663663.39 | 925.02 | 925.43 | 0.41 | 12.4968 |
| BR | 8 | 546172.16 | 1658717.76 | 969.13 | 969.53 | 0.4 | 12.192 |
| BR | 9 | 546170.84 | 1658675.29 | 968.95 | 969.35 | 0.4 | 12.192 |
| TG | 13 | 559888.06 | 1671343.9 | 1063.13 | 1063.53 | 0.4 | 12.192 |
| TG | 1 | 475617.25 | 1695703.04 | 1061.59 | 1061.98 | 0.39 | 11.8872 |
| TG | 7 | 470353.5 | 1662375.28 | 939.03 | 939.42 | 0.39 | 11.8872 |
| BR | 16 | 476094.99 | 1695895.45 | 1072.09 | 1072.46 | 0.37 | 11.2776 |
| TG | 17 | 537265.83 | 1717370.94 | 1115.59 | 1115.96 | 0.37 | 11.2776 |
| BR | 17 | 475307.18 | 1695830.78 | 1078.18 | 1078.55 | 0.37 | 11.2776 |
| TG | 18 | 537031.23 | 1717492.5 | 1117.68 | 1118.03 | 0.35 | 10.668 |
| BR | 12 | 471960.65 | 1663903.11 | 972.46 | 972.78 | 0.32 | 9.7536 |
| BR | 10 | 546270.58 | 1658668 | 967.63 | 967.93 | 0.3 | 9.144 |
| TG | 9 | 471926.5 | 1661979.75 | 973.74 | 974.04 | 0.3 | 9.144 |
| TG | 14 | 561578.88 | 1671440.69 | 1048.44 | 1048.73 | 0.29 | 8.8392 |
| FA | 16 | 537484.88 | 1717601.46 | 1115.41 | 1115.58 | 0.17 | 5.1816 |
| TG | 15 | 563390.85 | 1669843.5 | 1036.69 | 1036.82 | 0.13 | 3.9624 |
| TG | 19 | 537268.57 | 1717701.23 | 1121.72 | 1121.8 | 0.08 | 2.4384 |
| FA | 2 | 475663.07 | 1695603.58 | 1059.84 | 1059.83 | -0.01 | -0.3048 |
| FA | 1 | 475612.13 | 1695761.14 | 1063.99 | 1063.91 | -0.08 | -2.4384 |
| FA | 3 | 475804.33 | 1695839.26 | 1068.21 | 1068.1 | -0.11 | -3.3528 |
| FA | 8 | 466539.73 | 1661941.02 | 941.12 | 939.54 | -1.58 | -48.1584 |
| FA | 5 | 475391.98 | 1695929.08 | 1079.2 | outside | \* |  |
| *Blunder, point excluded from accuracy calculations* | | | | |  |  |  |
|  |  |  |  |  | **Average** | 0.503 | 15.33144 |
|  |  |  |  |  | **Minimum** | -1.58 | -48.1584 |
|  |  |  |  |  | **Maximum** | 1.27 | 38.7096 |
|  |  |  |  |  | **Std Dev** | 0.398 | 12.13104 |
|  |  |  |  |  | **RMSE** | 0.64 | 19.5072 |
|  |  |  |  |  | **95th** | 1.2544 | 38.23 |



|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Easting | Northing | Elevation | DTM Z | Error (ft) | Error (cm) |
| OP 8 | 472128.3 | 1663785 | 974.11 | 974.95 | 0.84 | 25.6032 |
| OP 9 | 472009.2 | 1663285 | 957.12 | 957.85 | 0.73 | 22.2504 |
| OP 6 | 471611.9 | 1663810 | 957.1 | 957.53 | 0.43 | 13.1064 |
| OP 2 | 472008 | 1699930 | 979.06 | 979.44 | 0.38 | 11.5824 |
| OP 7 | 472028.8 | 1663987 | 969.31 | 969.68 | 0.37 | 11.2776 |
| OP 16 | 537433.8 | 1717573 | 1117.44 | 1117.79 | 0.35 | 10.668 |
| OP 12 | 559205.1 | 1669911 | 1092.22 | 1092.5 | 0.28 | 8.5344 |
| OP 20 | 537239.7 | 1714909 | 1103.58 | 1103.85 | 0.27 | 8.2296 |
| OP 19 | 538481.3 | 1713819 | 1087.44 | 1087.71 | 0.27 | 8.2296 |
| OP 18 | 538024.6 | 1713550 | 1085.55 | 1085.8 | 0.25 | 7.62 |
| OP 17 | 537037.3 | 1717589 | 1120.46 | 1120.65 | 0.19 | 5.7912 |
| OP 1 | 472201.3 | 1700411 | 982.75 | 982.89 | 0.14 | 4.2672 |
| OP 11 | 559355.2 | 1670179 | 1096.77 | 1096.86 | 0.09 | 2.7432 |
| OP 10 | 472024.4 | 1661264 | 961.22 | 961.3 | 0.08 | 2.4384 |
| OP 5 | 471784.6 | 1698773 | 978.63 | 978.71 | 0.08 | 2.4384 |
| OP 13 | 558267.5 | 1669215 | 1081.36 | 1081.41 | 0.05 | 1.524 |
| OP 3 | 471694.3 | 1699721 | 980.93 | 980.96 | 0.03 | 0.9144 |
| OP 4 | 471605.4 | 1699075 | 980.16 | 980.18 | 0.02 | 0.6096 |
| OP 15 | 559834.2 | 1669413 | 1124.32 | 1124.25 | -0.07 | -2.1336 |
| OP 14 | 558911.5 | 1669120 | 1089.92 | 1089.85 | -0.07 | -2.1336 |
|  |  |  |  |  |  |  |
|  |  |  |  | **Average** | 0.236 | 7.19328 |
|  |  |  |  | **Minimum** | -0.07 | -2.1336 |
|  |  |  |  | **Maximum** | 0.84 | 25.6032 |
|  |  |  |  | **Std dev** | 0.25 | 7.62 |
|  |  |  |  | **RMSE** | 0.332 | 10.11936 |
|  |  |  |  | **95th** | 0.65072 | 19.83395 |

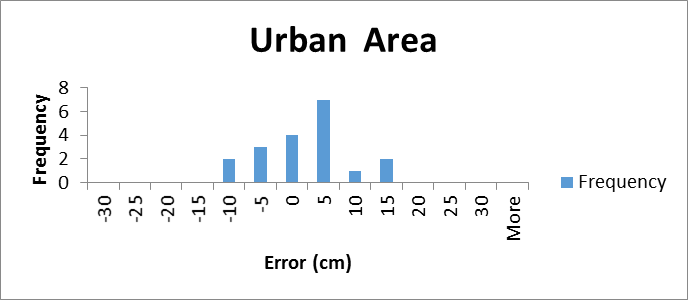


|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Easting | Northing | Elevation | DTM Z | Error (ft) | Error (cm) |
| BR 6 | 546157.33 | 1659536.6 | 974.91 | 976.06 | 1.15 | 35.052 |
| BR 13 | 472087.82 | 1663421.8 | 968.84 | 969.99 | 1.15 | 35.052 |
| BR 11 | 471836.42 | 1663983.2 | 965.36 | 966.34 | 0.98 | 29.8704 |
| BR 3 | 537082.37 | 1717330 | 1114.64 | 1115.62 | 0.98 | 29.8704 |
| BR 19 | 475463.7 | 1695195.2 | 1051.68 | 1052.43 | 0.75 | 22.86 |
| BR 2 | 537148.17 | 1717278.9 | 1114.57 | 1115.32 | 0.75 | 22.86 |
| BR 14 | 472339.95 | 1663085.9 | 965.3 | 966.02 | 0.72 | 21.9456 |
| BR 4 | 537019.63 | 1717427.1 | 1116.32 | 1117.01 | 0.69 | 21.0312 |
| BR 7 | 546214.01 | 1658921.3 | 970.36 | 971.01 | 0.65 | 19.812 |
| BR 5 | 537218.03 | 1717826.8 | 1121.25 | 1121.88 | 0.63 | 19.2024 |
| BR 1 | 537460.9 | 1717539 | 1116.16 | 1116.79 | 0.63 | 19.2024 |
| BR 20 | 475609.74 | 1695269 | 1056.2 | 1056.7 | 0.5 | 15.24 |
| BR 15 | 472108.5 | 1661418.9 | 960.48 | 960.97 | 0.49 | 14.9352 |
| BR 18 | 475332.9 | 1695032.8 | 1047.18 | 1047.64 | 0.46 | 14.0208 |
| BR 8 | 546172.16 | 1658717.8 | 969.13 | 969.53 | 0.4 | 12.192 |
| BR 9 | 546170.84 | 1658675.3 | 968.95 | 969.35 | 0.4 | 12.192 |
| BR 16 | 476094.99 | 1695895.5 | 1072.09 | 1072.46 | 0.37 | 11.2776 |
| BR 17 | 475307.18 | 1695830.8 | 1078.18 | 1078.55 | 0.37 | 11.2776 |
| BR 12 | 471960.65 | 1663903.1 | 972.46 | 972.78 | 0.32 | 9.7536 |
| BR 10 | 546270.58 | 1658668 | 967.63 | 967.93 | 0.3 | 9.144 |
|  |  |  |  |  |  |  |
|  |  |  |  | **Average** | 0.635 | 19.3548 |
|  |  |  |  | **Minimum** | 0.3 | 9.144 |
|  |  |  |  | **Maximum** | 1.15 | 35.052 |
|  |  |  |  | **Std dev** | 0.265 | 8.0772 |
|  |  |  |  | **RMSE** | 0.685 | 20.8788 |
|  |  |  |  | **95th** | 1.3426 | 40.92245 |



|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Easting | Northing | Known Z | Laser Z | Error (ft) | Error (cm) |
| FA 11 | 562181.13 | 1675185.9 | 1004.24 | removed | \* |  |
| FA 20 | 537164.93 | 1714934 | 1104.93 | 1106.2 | 1.27 | 38.7096 |
| FA 18 | 538011.23 | 1713305 | 1084.45 | 1085.52 | 1.07 | 32.6136 |
| FA 4 | 475569.43 | 1695857.5 | 1068.2 | 1069.07 | 0.87 | 26.5176 |
| FA 14 | 562231.69 | 1675734.2 | 978.79 | 979.43 | 0.64 | 19.5072 |
| FA 19 | 538537.65 | 1713827.8 | 1086.94 | 1087.58 | 0.64 | 19.5072 |
| FA 6 | 471714.88 | 1663823 | 962.21 | 962.84 | 0.63 | 19.2024 |
| FA 17 | 537035.51 | 1717415.2 | 1116.13 | 1116.71 | 0.58 | 17.6784 |
| FA 15 | 562067.64 | 1675487.5 | 985.54 | 986.11 | 0.57 | 17.3736 |
| FA 13 | 562379.07 | 1675390.3 | 991.73 | 992.29 | 0.56 | 17.0688 |
| FA 12 | 562318.17 | 1675146.2 | 1010.82 | 1011.36 | 0.54 | 16.4592 |
| FA 7 | 471969.22 | 1663099 | 971.09 | 971.55 | 0.46 | 14.0208 |
| FA 10 | 467743.99 | 1663587.1 | 924.79 | 925.23 | 0.44 | 13.4112 |
| FA 9 | 467541.76 | 1663663.4 | 925.02 | 925.43 | 0.41 | 12.4968 |
| FA 16 | 537484.88 | 1717601.5 | 1115.41 | 1115.58 | 0.17 | 5.1816 |
| FA 2 | 475663.07 | 1695603.6 | 1059.84 | 1059.83 | -0.01 | -0.3048 |
| FA 1 | 475612.13 | 1695761.1 | 1063.99 | 1063.91 | -0.08 | -2.4384 |
| FA 3 | 475804.33 | 1695839.3 | 1068.21 | 1068.1 | -0.11 | -3.3528 |
| FA 8 | 466539.73 | 1661941 | 941.12 | 939.54 | -1.58 | -48.1584 |
| FA 5 | 475391.98 | 1695929.1 | 1079.2 | outside | \* |  |
| *Blunder, not included in accuracy calculations* | | | |  |  |  |
|  |  |  |  | **Average** | 0.393 | 11.97864 |
|  |  |  |  | **Minimum** | -1.58 | -48.1584 |
|  |  |  |  | **Maximum** | 1.27 | 38.7096 |
|  |  |  |  | **Std dev** | 0.611 | 18.62328 |
|  |  |  |  | **RMSE** | 0.712 | 21.70176 |
|  |  |  |  | **95th** | 1.39552 | 42.5354496 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Easting | Northing | Elevation | DTM Z | Error (ft) | Error (cm) |
| TG 11 | 563878.91 | 1671742.2 | 1054.86 | 1055.7 | 0.84 | 25.6032 |
| TG 8 | 471904.99 | 1661331.7 | 960.27 | 961.07 | 0.8 | 24.384 |
| TG 12 | 565682.6 | 1671099.7 | 1068.83 | 1069.52 | 0.69 | 21.0312 |
| TG 6 | 471778.54 | 1663944.3 | 967.21 | 967.9 | 0.69 | 21.0312 |
| TG 16 | 537394.52 | 1717392 | 1116.38 | 1117 | 0.62 | 18.8976 |
| TG 4 | 475306.32 | 1695010 | 1046.67 | 1047.29 | 0.62 | 18.8976 |
| TG 2 | 475998.26 | 1695826 | 1069.61 | 1070.16 | 0.55 | 16.764 |
| TG 5 | 475441.6 | 1695161.8 | 1050.14 | 1050.67 | 0.53 | 16.1544 |
| TG 20 | 538013.2 | 1713410 | 1085.28 | 1085.78 | 0.5 | 15.24 |
| TG 3 | 476195.33 | 1695837.7 | 1078.38 | 1078.85 | 0.47 | 14.3256 |
| TG 10 | 466437.99 | 1661954 | 938.04 | 938.47 | 0.43 | 13.1064 |
| TG 13 | 559888.06 | 1671343.9 | 1063.13 | 1063.53 | 0.4 | 12.192 |
| TG 1 | 475617.25 | 1695703 | 1061.59 | 1061.98 | 0.39 | 11.8872 |
| TG 7 | 470353.5 | 1662375.3 | 939.03 | 939.42 | 0.39 | 11.8872 |
| TG 17 | 537265.83 | 1717370.9 | 1115.59 | 1115.96 | 0.37 | 11.2776 |
| TG 18 | 537031.23 | 1717492.5 | 1117.68 | 1118.03 | 0.35 | 10.668 |
| TG 9 | 471926.5 | 1661979.8 | 973.74 | 974.04 | 0.3 | 9.144 |
| TG 14 | 561578.88 | 1671440.7 | 1048.44 | 1048.73 | 0.29 | 8.8392 |
| TG 15 | 563390.85 | 1669843.5 | 1036.69 | 1036.82 | 0.13 | 3.9624 |
| TG 19 | 537268.57 | 1717701.2 | 1121.72 | 1121.8 | 0.08 | 2.4384 |
|  |  |  |  |  |  |  |
|  |  |  |  | **Average** | 0.472 | 14.38656 |
|  |  |  |  | **Minimum** | 0.08 | 2.4384 |
|  |  |  |  | **Maximum** | 0.84 | 25.6032 |
|  |  |  |  | **Std dev** | 0.201 | 6.12648 |
|  |  |  |  | **RMSE** | 0.511 | 15.57528 |
|  |  |  |  | **95th** | 1.00156 | 30.527549 |



|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number | Easting | Northing | Known Z | DTM Z | Error (ft) | Error (cm) |
| UR 13 | 466909.61 | 1662270.13 | 933.26 | removed | \* |  |
| UR 2 | 538017.79 | 1713458.73 | 1086.98 | 1087.43 | 0.45 | 13.716 |
| UR 11 | 467149.79 | 1662277.41 | 932.15 | 932.49 | 0.34 | 10.3632 |
| UR 15 | 466957.36 | 1662604.06 | 933.84 | 934.08 | 0.24 | 7.3152 |
| UR 5 | 537087.48 | 1714919.59 | 1105.36 | 1105.52 | 0.16 | 4.8768 |
| UR 3 | 538440.33 | 1713779.63 | 1087.77 | 1087.92 | 0.15 | 4.572 |
| UR 14 | 466741.33 | 1662262.55 | 935.05 | 935.19 | 0.14 | 4.2672 |
| UR 1 | 537413.76 | 1717451.59 | 1117.97 | 1118.1 | 0.13 | 3.9624 |
| UR 4 | 538166.04 | 1715255.48 | 1103.36 | 1103.48 | 0.12 | 3.6576 |
| UR 18 | 470025.51 | 1698452.08 | 1005.2 | 1005.31 | 0.11 | 3.3528 |
| UR 12 | 467012.44 | 1662267.21 | 934.15 | 934.19 | 0.04 | 1.2192 |
| UR 9 | 516130.35 | 1664988.84 | 1007.76 | 1007.71 | -0.05 | -1.524 |
| UR 20 | 469992.95 | 1698572.2 | 1007.47 | 1007.41 | -0.06 | -1.8288 |
| UR 16 | 470016.84 | 1698310.31 | 1002.89 | 1002.74 | -0.15 | -4.572 |
| UR 17 | 470022.18 | 1698391.58 | 1004.32 | 1004.16 | -0.16 | -4.8768 |
| UR 8 | 516764.13 | 1665042.24 | 1009.51 | 1009.27 | -0.24 | -7.3152 |
| UR 19 | 469981.71 | 1698515.03 | 1007.47 | 1007.22 | -0.25 | -7.62 |
| UR 7 | 516386.79 | 1665093.32 | 1011.51 | 1011.25 | -0.26 | -7.9248 |
| UR 6 | 516433.46 | 1665339.79 | 1007.39 | 1007.02 | -0.37 | -11.2776 |
| UR 10 | 515937.95 | 1665281.22 | 996.62 | 996.15 | -0.47 | -14.3256 |
| *Blunder, point not included in accuracy calculations* | | | |  |  |  |
|  |  |  |  | **Average** | -0.007 | -0.21336 |
|  |  |  |  | **Minimum** | -0.47 | -14.3256 |
|  |  |  |  | **Maximum** | 0.45 | 13.716 |
|  |  |  |  | **Std dev** | 0.246 | 7.49808 |
|  |  |  |  | **RMSE** | 0.239 | 7.28472 |
|  |  |  |  | **95th** | 0.46844 | 14.278051 |

LiDAR Flight Mission – Summary

LiDAR data was acquired during the late winter and early spring during the period when vegetation was primarily dormant. Using a Cessna 206 single engine aircraft, LiDAR was acquired with an Optech ALTM Gemini LiDAR sensor on board. The objective was USGS QL2 Lidar data suitable for a 2-foot contour at an altitude of 1400 meters above average ground level. Overlap between adjacent flight lines was 50% with line spacing designed to be 1315 feet per swath. The speed of the aircraft was at 120 knots and the resultant density was designed for 2 points per square meter including the overlapping data from adjacent flight lines.

**LiDAR Flight Map**