

APPENDIX L — IFSAR ACCURACY ANALYSES

This appendix includes evaluations of LAG and HAG elevations extracted from IFSAR imagery of Jefferson County, Colorado in the Denver suburbs. Because building footprints were not available, and because the surveyed latitudes and longitudes pertained to the front door of each house, Dewberry devised alternative procedures to draw circles around the geographic coordinates for each house, utilizing circles of two sizes — 20 ft radius and 30 ft radius.

The size of the circles made little difference. LAG and HAG errors were between 15 and 17 feet at the 95% confidence level.

Intermap's *Product Handbook*, at www.intermaptechnologies.com, identifies limitations of IFSAR DTMs, especially DTMs in built-up areas, as follows:

- ◆ Layover and foreshortening which tend to make objects (including buildings) look shorter than they really are.
- ◆ Shadowing which causes no returns on the back sides of buildings.
- ◆ Signal saturation where too much light is returned and image detail is lost — most often a problem over urban areas because of the strong return from buildings.
- ◆ Multipath, where the radar signals bounce off of buildings and other objects before hitting the ground, making the ground appear lower than it really is. (Note: this affects LIDAR also).
- ◆ Edge effects, sometimes called "blooming," near buildings and forests where interpolation between true ground and elevated points creates intermediate elevations in transition zones up to 25 meters away from the elevated edge.
- ◆ Slope effects that degrade accuracy. The impact depends on the magnitude of the slope, where the slope is positive or negative, aspect angle, and where it lies in the radar swath (look angle).

After this analysis was already complete, FEMA indicated that technologies that yielded elevations with errors larger than 4 ft at the 95% confidence level, would have no value for populating an elevation registry used for eRating of flood insurance policies. Nevertheless, IFSAR still remains potentially viable for other FEMA applications to include hydrologic modeling of floodplains and general elevation modeling for wildfire modeling and other natural and manmade disasters.

APPENDIX L — IFSAR ACCURACY ANALYSIS (JEFFERSON COUNTY, CO)

STRUCTURES IN DENVER SUBURBS				QC Surveys (Ft)		IFSAR (Meters)				20 Ft Radius		30 Ft Radius	
ADDRESS		LAT	LONG	LAG	HAG	20 Ft LAG	20 Ft HAG	30 Ft LAG	30 Ft HAG	Δ LAG	Δ HAG	Δ LAG	Δ HAG
801 Kilmer	No trees	39.7293	-105.1716	5806.98	5807.80	1774.28	1775.03	1774.10	1775.21	14.15	15.79	13.56	16.38
770 Loveland St	No trees	39.7287	-105.1723	5817.74	5818.56	1777.26	1777.49	1777.20	1777.55	13.17	13.10	12.97	13.30
615 Kilmer	No trees	39.7259	-105.1717	5845.03	5845.92	1782.52	1783.07	1782.38	1783.21	3.13	4.05	2.67	4.51
791 Juniper St	Some tre	39.7288	-105.1693	5804.19	5805.11	1769.69	1770.24	1769.55	1770.38	1.88	2.76	1.42	3.22
15202 7th Ave	No trees	39.7272	-105.1704	5825.12	5826.56	1776.92	1777.47	1776.78	1777.61	4.67	5.03	4.21	5.49
660 Juniper St	Some tre	39.7265	-105.1689	5835.45	5837.19	1781.40	1781.96	1781.26	1782.09	9.04	9.14	8.58	9.56
612 Juniper St	Some tre	39.7260	-105.1688	5842.61	5843.33	1783.96	1784.51	1783.82	1784.65	10.28	11.36	9.82	11.82
775 Isabell St	Some tre	39.7286	-105.1669	5809.40	5811.21	1771.73	1772.39	1771.57	1772.56	3.36	3.72	2.84	4.28
685 Kendrick St	No trees	39.7268	-105.1704	5829.55	5831.32	1778.91	1779.46	1778.77	1779.60	6.77	6.80	6.31	7.26
Unit C	No trees	39.7267	-105.1704	5829.55	5831.32	1779.41	1779.96	1779.27	1780.10	8.41	8.44	7.95	8.90
775 Loveland St	No trees	39.7282	-105.1728	5823.41	5824.59	1778.57	1778.80	1778.51	1778.86	11.79	11.37	11.60	11.56
14076 2nd Ave	Trees	39.7207	-105.1566	5874.10	5874.99	1788.10	1788.25	1788.06	1788.29	-7.63	-8.03	-7.76	-7.90
13887 3rd Place	Trees	39.7219	-105.1557	5861.01	5869.21	1786.14	1786.30	1786.10	1786.34	-0.97	-8.65	-1.10	-8.51
482 Deframe Court	Trees	39.7236	-105.1544	5821.05	5821.61	1778.86	1779.56	1778.66	1779.69	15.10	16.84	14.45	17.27
421 Ellis Way	Some tre	39.7226	-105.1570	5845.03	5849.46	1786.16	1786.32	1786.13	1786.36	15.07	11.17	14.98	11.30
14197 W. 3rd Pl	Trees	39.7220	-105.1591	5874.99	5877.55	1792.68	1793.40	1792.50	1793.57	6.51	6.31	5.92	6.87
14163 3rd Ave	Trees	39.7213	-105.1584	5875.58	5880.60	1791.85	1792.58	1791.66	1792.77	3.19	0.57	2.57	1.19
338 Howell St	Some tre	39.7204	-105.1636	5974.96	5982.44	1823.14	1824.36	1822.84	1824.55	6.47	2.99	5.49	3.62
14359 W. Cedar Pl	Trees	39.7129	-105.1594	6004.61	6005.76	1829.85	1831.49	1829.44	1831.90	-1.17	3.07	-2.51	4.41
14410 W. Cedar Pl	Trees	39.7131	-105.1608	6022.00	6022.46	1842.85	1843.74	1842.63	1843.97	24.10	26.56	23.37	27.31
13881 Maple Pl	Trees	39.7140	-105.1557	6002.71	6009.96	1830.92	1831.35	1830.82	1831.45	4.25	-1.59	3.92	-1.27

QC Survey LAG/HAG elevations are in U.S. Survey Feet

IFSAR LAG/HAG elevations are in meters, then converted to feet for comparison

20 Ft LAG and 20 Ft HAG means lowest and highest elevations that bound a circle with a 20 ft radius around the latitude/longitude of building centroids

30 Ft LAG and 30 Ft HAG means lowest and highest elevations that bound a circle with a 30 ft radius around the latitude/longitude of building centroids

Δ LAG and Δ HAG values are in U.S. Survey Feet and are elevation errors between surveyed LAG/HAG values and those from 20 and 30 ft circles around centroids

High positive errors normally indicate that vegetation was not penetrated to the ground

Standard Deviation (ft)	6.99	8.10	7.00	8.16
Maximum Error (ft)	24.10	26.56	23.37	27.31
Minimum Error (ft)	-7.63	-8.65	-7.76	-8.51
Average ± Error (ft)	7.22	6.70	6.73	7.17
Average Absolute Er (ft)	8.15	8.44	7.81	8.85
Count of Structures	21	21	21	21
95th Percentile (ft)	15.10	16.84	14.98	17.27
90th Percentile (ft)	15.07	15.79	14.45	16.38
85th Percentile (ft)	14.15	13.10	13.56	13.30