APPENDIX G — PHOTOGRAMMETRY ACCURACY ANALYSES

APPENDIX G is a spreadsheet that computes the vertical accuracy of 40 houses surveyed photogrammetrically in 2000 by the Philadelphia District of the U.S. Army Corps of Engineers (USACE). The Corps contracted with an aerial survey firm to survey photogrammetric spot heights at the adjacent grade of all house corners visible in stereo (normally 2 or 3 spot heights per building), and the Corps contracted with a land survey firm to measure vertical offsets on-site, either up or down from selected spot heights as necessary to compute the elevation of the top of bottom floor, including basements and enclosures. Dewberry's goal for its FEMA study was to estimate the vertical accuracy of this process.

Ground truth surveys were performed in 2003 by Greenhorne & O'Mara, as subcontractor to Dewberry, which randomly selected 40 houses from a much larger dataset and surveyed their top of bottom floor elevations using a combination of GPS and conventional survey techniques. All surveys were performed using the NAVD 88 vertical datum.

The major statistics are highlighted in green at the bottom of the spreadsheet. The average elevation error is 0.34 ft, and the dataset tested 1.19 ft vertical accuracy at the 95% confidence level. This almost exactly equaled the accuracy expected from random elevation points interpolated between 2' contours, i.e., 1.2 ft at the 95% confidence level. At the 95% confidence level, two of 40 points will have errors larger than 1.19 ft; in this case, the two addresses with top of bottom floor errors larger than 1.19 ft are highlighted in yellow on the spreadsheet.

This test verifies that conventional photogrammetric standards can be applied to photogrammetric spot heights supplemented with vertical offset measurements to indirectly determine top of bottom floor elevations to traditional photogrammetric standards.

For other aspects of this FEMA study, the validity of this survey method was also extended by Dewberry to the use of on-site vertical offset measurements to indirectly determine top of bottom floor elevations from other forms of aerial remote sensing, i.e., LIDAR and IFSAR, which also provide adjacent grade elevations at varying levels of accuracy.

APPENDIX G — ACCURACY OF PHOTOGRAMMETRIC SPOT HEIGHTS WITH MEASURED OFFSETS

Susquehanna comparison of Top of Bottom Floor (TBF) surveyed elevations with LAG/HAG spot elevations from conventional photogrammetry; TBF elevations from manual LAG offset measurements

ID # Structure	TBF per Photo/Offset	TBF per GPS Svy	Ft. Δ	Ft. Δ abs	Ft² Δ²	Street Address and City
7201	440.90	440.86	0.04	0.04	0.0016	600 Island Street, Northumberland
7298	439.90	439.79	0.11	0.11	0.0121	418 Park Street, Northumberland
7280	444.20	444.00	0.20	0.20	0.0400	275 Guyer Street, Northumberland
7239	442.90	443.01	-0.11	0.11	0.0121	540 Island Street, Northumberland
7130	433.60	433.72	-0.12	0.12	0.0144	635 Park Street, Northumberland
7172	457.30	457.66	-0.36	0.36	0.1296	630 Park Street, Northumberland
17487	530.10	530.00	0.10	0.10	0.0100	25 West Union Street, Shickshinny
17513	512.80	512.76	0.04	0.04	0.0016	10 South Main Street, Shickshinny
17470	511.70	511.70	0.00	0.00	0.0000	20 West Union Street. Shickshinny
17453	530.70	530.86	-0.16	0.16	0.0256	26 West Union Street, Shickshinny
17519	518.80	518.78	0.02	0.02	0.0004	27 East Union Street, Shickshinny
83491	472.20	472.16	0.04	0.04	0.0016	290 East 9th Street, Danville
83549	471.60	471.60	0.00	0.00	0.0000	262 East 9th Street, Danville
83521	471.90	471.55	0.35	0.35	0.1225	251 East 9th Street, Danville
83543	471.00	471.00	0.00	0.00	0.0000	243 East 9th Street, Danville
83653	470.50	470.66	-0.16	0.16	0.0256	224 East 9th Street, Danville
22054	476.20	476.20	0.00	0.00	0.0000	114 South Street, Catawissa
22032	467.50	466.60	0.90	0.90	0.8100	112 South Street,Catawissa
21926	468.30	468.70	-0.40	0.40	0.1600	117 South Street, Catawissa
21886	461.20	462.80	-1.60	1.60	2.5600	101 South Street, Catawissa
21836	462.10	463.70	-1.60	1.60	2.5600	138 South 1st Street, Catawissa
21759	462.10	463.00	-0.90	0.90	0.8100	134 South 1st Street, Catawissa
21720	472.90	473.70	-0.80	0.80	0.6400	Old Feed Mill, 1st Street, Catawissa
21672	462.50	462.10	0.40	0.40	0.1600	124 1st Street, Catawissa
21481	471.40	470.23	1.17	1.17	1.3689	102 1st Street, Catawissa
19083	453.40	452.94	0.46	0.46	0.2116	319 Mahoning Street, Danville
19091	460.70	460.65	0.05	0.05	0.0025	315 Mahoning Street, Danville
19104	452.30	452.88	-0.58	0.58	0.3364	319 Mahoning Street, Danville
19115	461.50	461.80	-0.30	0.30	0.0900	307 Mahoning Street, Danville
19120	453.40	453.51	-0.11	0.11	0.0121	305 Mahoning Street, Danville
19128	453.60	453.53	0.07	0.07	0.0049	301 Mahoning Street, Danville
17398	511.10	511.12	-0.02	0.02	0.0004	69 Canal Street, Shickshinny
17411	510.50	511.00	-0.50	0.50	0.2500	67 Canal Street, Shickshinny
17474	512.00	512.00	0.00	0.00	0.0000	43 Canal Street, Shickshinny
17458	523.00	522.92	0.08	0.08	0.0064	51 Canal Street, Shickshinny
17287	517.50	516.59	0.91	0.91	0.8281	156 Canal Street, Shickshinny
21684	467.10	467.00	0.10	0.10	0.0100	208 Legion Road, Catawissa
21696	476.60	476.01	0.59	0.59	0.3481	206 Legion Road, Catawissa
21682	469.70	469.73	-0.03	0.03	0.0009	204 Legion Road, Catawissa
21676	465.80	466.11	-0.31	0.31	0.0961	202 Legion Road, Catawissa
	0.34		1.19	11.6635	0.29	0.54
	Avg		95th percentile		MSE	RMSE

Accuracy equals that of random points interpolated between 2' contours, i.e., 1.2' at 95% confidence level.