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FEMA Region V– Calhoun, MI Ground Control Project Report for STARR II Flyer: Continental Mapping

July 2017

Project Information

CDI Project Number:	FSG5017
FEMA Task Order Number:	HSFE05-16-J-0207
STARR II Project Number:	400000347
STARR II Partner Tracking No:	CD S2 R05 16 T0207
WO Period of Performance:	9/30/16 – 3/31/2018
Task Code:	R0501.13.G
Geographic Location:	Calhoun, MI
Number of GCPs Requested:	105
Number of GCPs Collected:	105

Project Specifications

Precision (Horizontal/Vertical):	CDI Quality 1 \leq 6.5 cm H/V
Coordinate System:	Michigan South
Datum:	NAD83 (2011)
Altitude Reference:	NAVD88 (Geoid12B)
Units:	International Feet

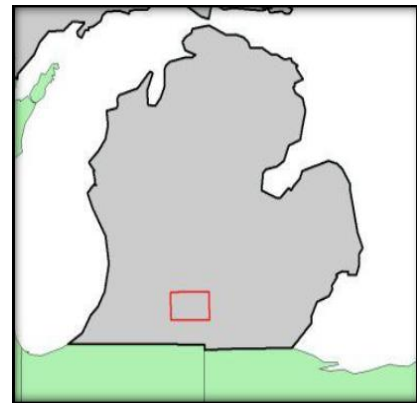
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Summary

The purpose of this project was to locate and survey ground control points (GCPs) in multiple areas of interest as defined by FEMA-supplied shape and kml files. The GCP coordinates are to be used to control the vertical aspect of all newly-flown LiDAR data during post-processing and subsequent deliverables creation. CompassData visited the project area, found suitable GCPs, and determined accurate coordinates for each GCP according to the customer's specifications.

Area Specification and Request

The Calhoun County AOI encompasses ~1863 sq.km. The flyer has requested 25 ground control points for their processing. In adherence to the USGS v.1.2 quality level 2 requirements, an addition 141 checkpoints will be collected. These numbers are derived from a requirement for under 2500 sq.km. The division of these points will be 45 NVA points and 35 VVA points. Distribution will be determined through discussions with the flier and based on locations of different land classifications.



Equipment

CompassData used a Trimble R10 to perform the control survey. This device is accurate to within 1 cm on a position-by-position basis per Trimble specifications. Operating within the VRS network provided accurate coordinate values at or around 6.5 cm H/V. CompassData has consistently demonstrated this level of accuracy on many GCP collection jobs across North and South America, Europe, Asia and Africa. Specifications for the Trimble R10 are available upon request.

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Survey Methodology

CompassData has met the required precision for this project by using a high-quality GPS receiver with differential corrections provided by a RTK and RTN network setup in the area. The GPS antenna used to survey the control and test points sat atop a bubble-leveled, fixed-height range pole that was placed over the center of the desired GCP. At least 180 positions (captured at a rate of one per second) were geometrically averaged to calculate a single coordinate for each GCP. All required field documentation was filled out and the points were identified on web-based imagery. Digital pictures of each GCP location were collected in the field.

Quality Control Procedures

CompassData collects GCPs with an unobstructed view of the sky to ensure proper GPS-operation. CompassData works to avoid potential sources of multipath error such as trees, buildings, and fences that may adversely affect the GPS accuracy. Additional quality control comes from the fact that at least 180 GPS positions are collected for each GCP. While operating within a RTN network, valid solutions are reached within seconds; however, we continue to collect additional data to ensure meeting collection specifications. To ensure project integrity, a GCP will be reobserved or moved to a more suitable location if it does not meet project specifications.

In addition to the afore mentioned procedures, CompassData “surveys” existing geodetic control monuments to see if our coordinates match the published coordinates to the required accuracy. These monuments are usually established by the National Geodetic Survey (NGS) in the United States. If it is found that our coordinates are outside the acceptable accuracy, the reason for the difference will be found or the GCPs will be reobserved under different GPS constellation constraints. There are certain geodetic considerations that must be taken in account that affect whether a GPS-derived coordinate will line up with a survey monument, especially when these monuments reference local coordinate systems or the systems of another country. Sometimes the published coordinates for a monument are not accurate, although this is very infrequent.

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Deliverables

Deliverables for this project include:

- ❑ Coordinates (in spreadsheet format)
- ❑ Digital Pictures
- ❑ QA/QC Data

Project Notes

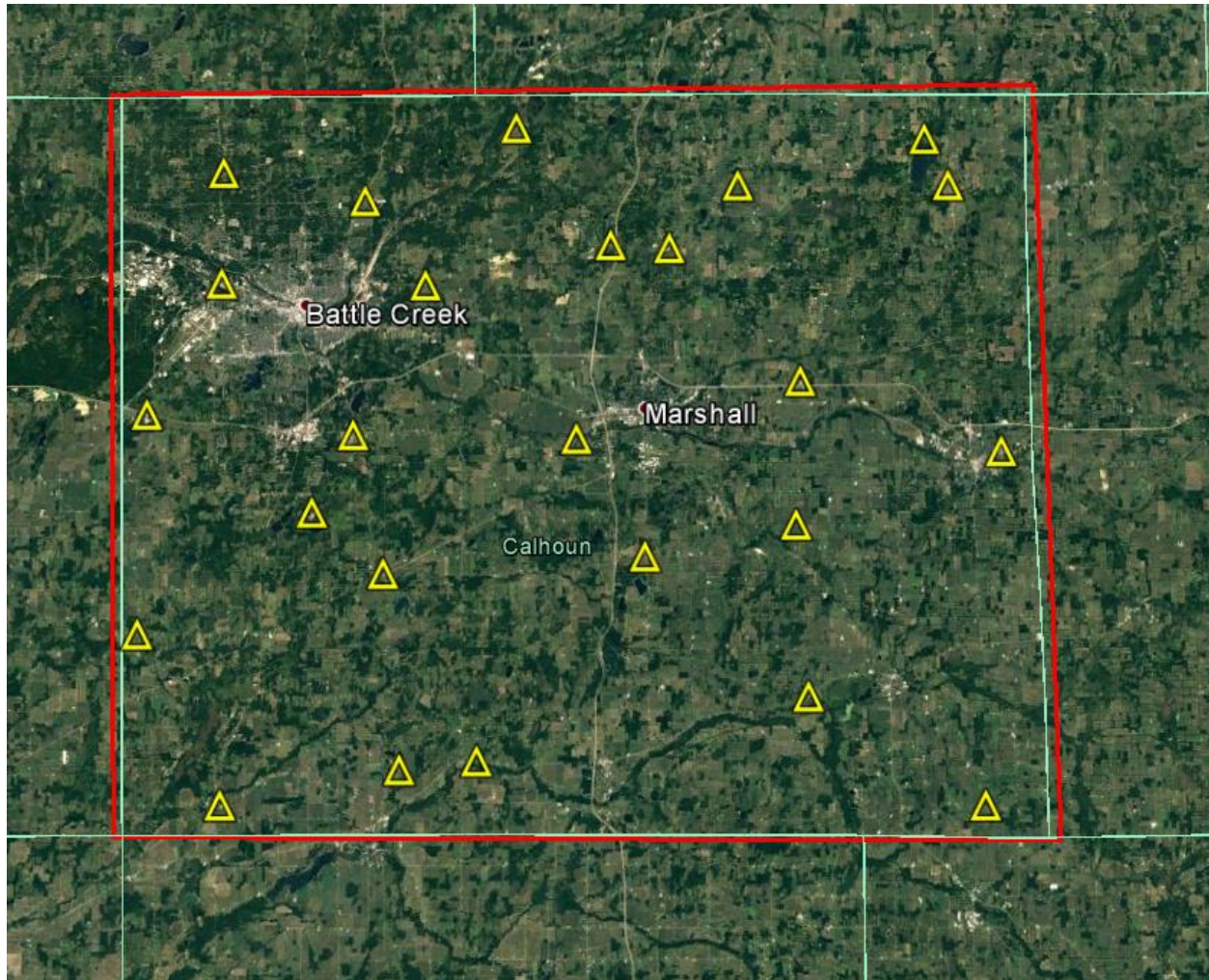
All collected points were retrieved from the Trimble Survey Controller and processed with the Trimble Business Center software. The GPS survey is producing in this step heights above ellipsoid (HAEs).

Geoid12B was then used to generate the geoid separation at every Lat/Long location. NAVD88 orthometric heights were then generated in spreadsheet form using the formula $HAE - Geoid = Orthometric Height$. Those values were then included into the final delivery coordinate CSV files and have been tested against NGS monuments collected during the course of this survey and are showing millimeter-level agreement.

The Horizontal and Vertical accuracies reported in the Final Coordinates file were obtained from field measurements and post-processing. The report contains all points collected during each daily survey deployment, including NVA, VVA and Ground Control.

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Area with Ground Control Points



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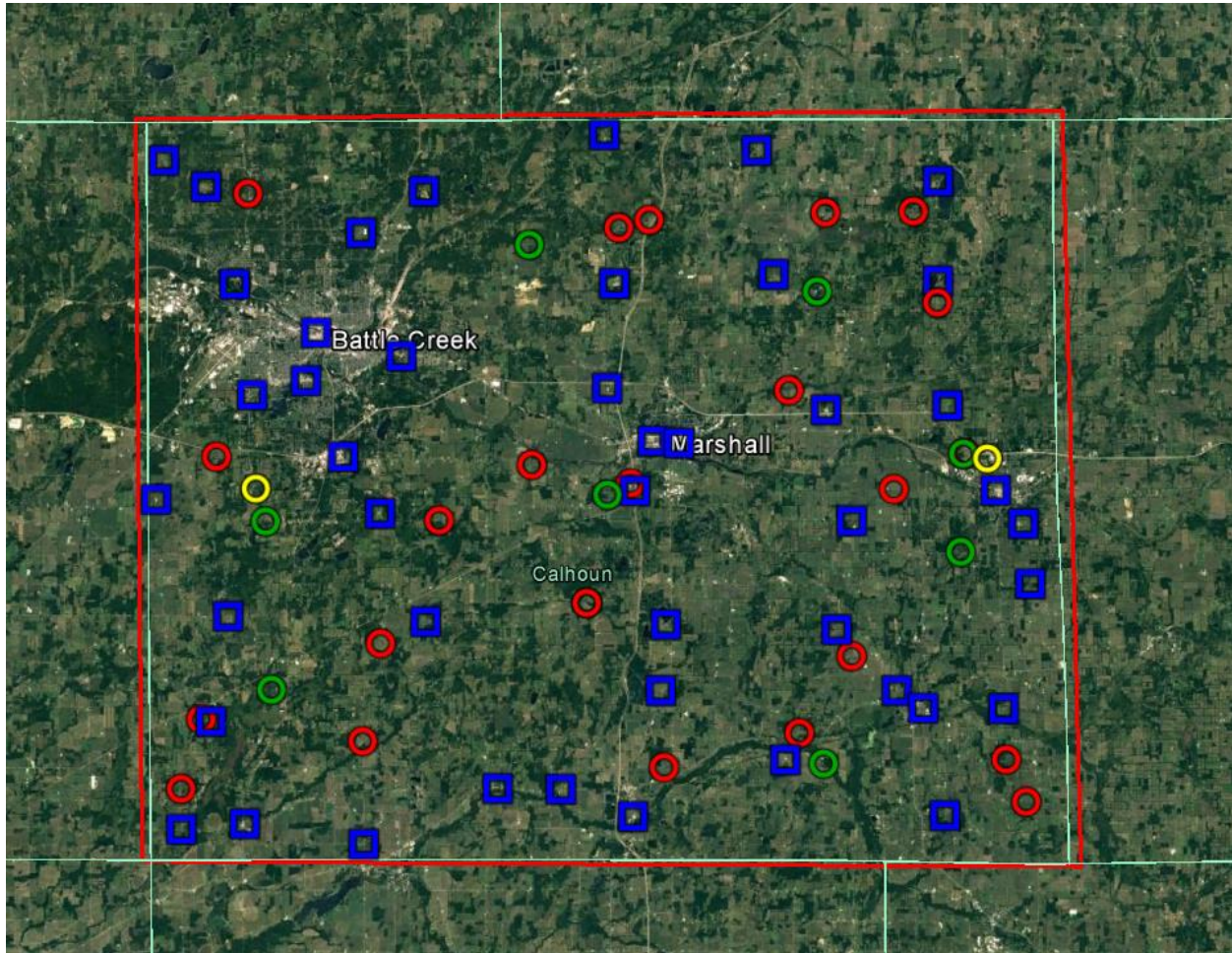
Area with NVA and VVA Test Points

Blue Squares – NVA Test Points

Yellow Circles – VVA Grass

Red Circles – VVA Crop and Brush

Green Trees – VVA Forest



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Results of NVA

Point ID	Easting Int. Survey Feet	Northing Int. Survey Feet	NAVD88 MSL Int. Survey Feet	LiDAR Elevation Int. Survey Feet	ΔZ Int. Survey Feet	ΔZ^2
NVA301	12876885.278	214987.285	881.136	880.901	0.235	0.055
NVA302	12908445.594	212303.117	905.554	905.251	0.303	0.092
NVA303	12942591.502	221547.753	932.285	932.354	-0.069	0.005
NVA304	12981409.506	226333.732	964.984	964.732	0.252	0.064
NVA305	13008888.053	216630.473	991.459	991.561	-0.102	0.010
NVA306	12882140.862	233526.497	916.564	916.361	0.203	0.041
NVA307	12931650.754	221725.971	920.013	920.036	-0.023	0.001
NVA308	12959956.895	238381.608	976.153	976.251	-0.098	0.010
NVA309	13000707.422	238145.352	985.057	985.281	-0.224	0.050
NVA310	13019105.758	234908.431	983.040	983.106	-0.066	0.004
NVA311	12885257.585	251619.916	961.937	961.723	0.214	0.046
NVA312	12919407.409	250473.468	912.632	912.321	0.311	0.097
NVA313	12960891.244	249737.445	948.847	948.681	0.166	0.028
NVA314	12990372.440	248673.450	986.198	986.136	0.062	0.004
NVA315	13023860.251	256346.027	986.392	986.281	0.111	0.012
NVA316	12872937.901	271783.820	972.808	972.723	0.085	0.007
NVA317	12911675.176	269141.710	948.442	948.261	0.181	0.033
NVA318	12955706.826	272749.098	928.736	928.616	0.120	0.014
NVA319	12993084.291	267331.530	981.831	981.881	-0.050	0.002
NVA320	13022732.045	266676.830	974.055	974.201	-0.146	0.021
NVA321	12889656.117	289622.495	920.279	920.236	0.043	0.002
NVA322	12915463.170	296145.152	886.299	886.279	0.020	0.000
NVA323	12951028.186	290407.185	938.073	938.184	-0.111	0.012
NVA324	12988769.388	286472.181	968.122	968.014	0.108	0.012
NVA325	13009769.584	287068.531	947.148	947.021	0.127	0.016
NVA326	12881904.124	325500.051	889.265	889.178	0.087	0.008
NVA327	12908648.885	317366.033	937.893	937.720	0.173	0.030
NVA328	12952366.197	308354.208	944.596	944.714	-0.118	0.014
NVA329	12979849.521	309757.543	924.679	924.891	-0.212	0.045
NVA330	13008259.405	308478.801	920.034	920.158	-0.124	0.015

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NVA331	12874648.210	330058.218	952.470	952.356	0.114	0.013
NVA332	12919569.639	324452.459	844.771	844.621	0.150	0.022
NVA333	12950780.964	333948.700	894.428	894.301	0.127	0.016
NVA334	12977091.632	331082.165	958.232	958.294	-0.062	0.004
NVA335	13008376.276	325611.168	946.570	946.701	-0.131	0.017
NVA701	12958818.277	281295.859	917.627	917.744	-0.117	0.014
NVA702	13017971.518	272424.421	939.929	939.906	0.023	0.001
NVA703	12955018.004	216777.893	940.493	940.316	0.177	0.031
NVA704	12887871.683	215908.210	889.698	889.326	0.372	0.139
NVA705	12905344.535	278903.881	935.063	935.068	-0.005	0.000
NVA706	12898973.824	292017.618	931.594	931.644	-0.050	0.003
NVA707	13005242.166	235103.020	991.026	991.171	-0.145	0.021
NVA708	12963392.686	280894.553	902.273	902.347	-0.074	0.006
NVA709	12886700.722	308689.932	807.079	807.451	-0.372	0.138
NVA710	12900747.367	300256.627	818.509	818.774	-0.265	0.070

Datum: NAD83(2011)	Summary is in International Feet		International Feet	Meters
Epoch: 2010	Z Mean	0.03	RMSE:	0.168
Geoid: 12B	Z Min:	-0.37	* 1.9600	0.330
State Plane: Michigan South	Z Max:	0.37		0.100
Units: International Feet				

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Results of VVA

Point ID	Easting Int. Survey Feet	Northing Int. Survey Feet	NAVD88 MSL Int. Survey Feet	LiDAR Elevation Int. Survey Feet	ΔZ Int. Survey Feet	ΔZ^2
VVA401	12889172.749	324200.552	898.961	898.950	0.011	0.000
VVA402	12953231.955	317876.812	945.485	945.320	0.165	0.027
VVA403	12958480.477	319206.289	934.726	934.690	0.036	0.001
VVA404	12988927.922	320237.319	933.686	933.590	0.096	0.009
VVA405	13004123.524	320369.261	976.835	976.870	-0.035	0.001
VVA406	12883478.309	278973.033	978.562	978.340	0.222	0.049
VVA407	12937953.061	277227.119	947.598	947.470	0.128	0.016
VVA408	12982412.770	289750.457	913.341	913.090	0.251	0.063
VVA409	13008197.661	304664.753	975.628	975.310	0.318	0.101
VVA410	12880535.608	233860.914	912.102	911.850	0.252	0.064
VVA411	12921904.184	267788.984	919.699	919.710	-0.011	0.000
VVA412	12955000.287	273916.859	917.509	917.420	0.089	0.008
VVA413	13000437.079	272656.031	964.724	964.830	-0.106	0.011
VVA414	13012707.275	278730.797	985.526	985.620	-0.094	0.009
VVA415	12947281.122	253449.524	925.446	925.090	0.356	0.127
VVA416	12911635.066	246708.526	935.441	935.100	0.341	0.116
VVA417	12992980.003	244034.056	1015.658	1016.080	-0.422	0.178
VVA418	12983887.501	230868.075	967.050	967.320	-0.270	0.073
VVA419	12876939.299	221894.113	904.273	904.120	0.153	0.023
VVA420	12908407.463	229918.388	919.721	919.330	0.391	0.153
VVA421	12960468.679	225120.057	997.975	997.860	0.115	0.013
VVA422	13019556.356	226091.186	1011.540	1011.680	-0.140	0.020
VVA423	13022968.618	218809.179	1052.956	1052.680	0.276	0.076
VVA501	12890249.583	273456.647	945.107	944.850	0.257	0.066
VVA502	13016611.250	277841.752	990.952	990.770	0.182	0.033
VVA601A	12886882.621	308876.125	805.989	806.780	-0.791	0.626
VVA602A	12937744.293	315065.055	878.070	877.940	0.130	0.017
VVA603A	12987412.943	306730.221	962.853	962.210	0.643	0.413
VVA604A	12891890.356	267811.895	926.362	926.410	-0.048	0.002

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VVA605A	12950985.371	272014.376	927.168	926.820	0.348	0.121
VVA606A	13012477.195	278691.869	978.472	978.640	-0.168	0.028
VVA607A	12892703.707	238861.931	876.811	876.760	0.051	0.003
VVA708A	12947370.627	253514.659	921.684	921.430	0.254	0.065
VVA709A	13011912.767	261822.177	957.074	957.770	-0.696	0.484
VVA710A	12988019.460	225593.928	967.769	968.000	-0.231	0.053

Summary is in International Feet			International Feet	Meters
Datum: NAD83(2011)	Z Average	0.06	RMSE:	0.300
Epoch: 2010	Z Min:	-0.79	* 1.9600	0.587
Geoid: 12B	Z Max:	0.64	95th Percentile	0.366
State Plane: Michigan South				0.112
Units: International Feet				

Contact Information

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