

# CompassData

## FEMA Region V– Waushara, WI Ground Control Project Report for STARR II Flyer: Continental Mapping

May 2018

### Project Information

<b>CDI Project Number:</b>	<b>CDI5319</b>
<b>FEMA Task Order Number:</b>	<b>HSFE05-17-0005</b>
<b>STARR II Project Number:</b>	<b>400000370</b>
<b>STARR II Partner Tracking No:</b>	<b>CD S2 R05 17 T05</b>
<b>WO Period of Performance:</b>	<b>10/2/17 – 7/13/2019</b>
<b>Task Code:</b>	<b>R0502.20.D1</b>
<b>Geographic Location:</b>	<b>Waushara, WI</b>
<b>Number of GCPs Requested:</b>	<b>90</b>
<b>Number of GCPs Collected:</b>	<b>90</b>

### Project Specifications

<b>Precision (Horizontal/Vertical):</b>	<b>CDI Quality 1 <math>\leq</math> 6.5 cm H/V</b>
<b>Coordinate System:</b>	<b>Wisconsin South</b>
<b>Datum:</b>	<b>NAD83 (2011)</b>
<b>Altitude Reference:</b>	<b>NAVD88 (Geoid12B)</b>
<b>Units:</b>	<b>US Survey Feet</b>

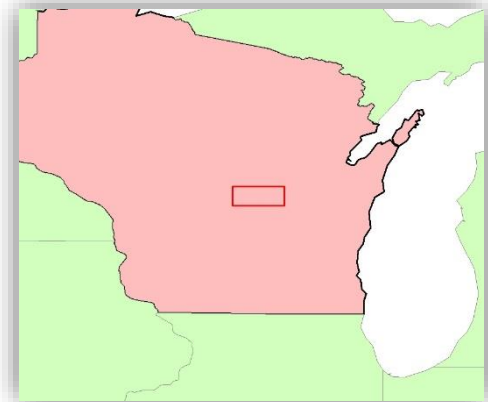
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## Summary

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 Waushara County AOI encompasses ~1,652 sq.km. The flyer has requested 20 ground control points for their processing. In adherence to the USGS v.1.2 quality level 2 requirements, an addition 70 checkpoints will be collected. These numbers are derived from a requirement for under 2500 sq.km. The division of these points will be 40 NVA points, and 30 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 re-observed 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 re-observed 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:

- ❑ Statistics
- ❑ Image Chips
- ❑ Digital Photos
- ❑ Geofiles (Shapefile, KML)
- ❑ Monument Data
- ❑ Coordinates (Spreadsheet)

## Project Notes

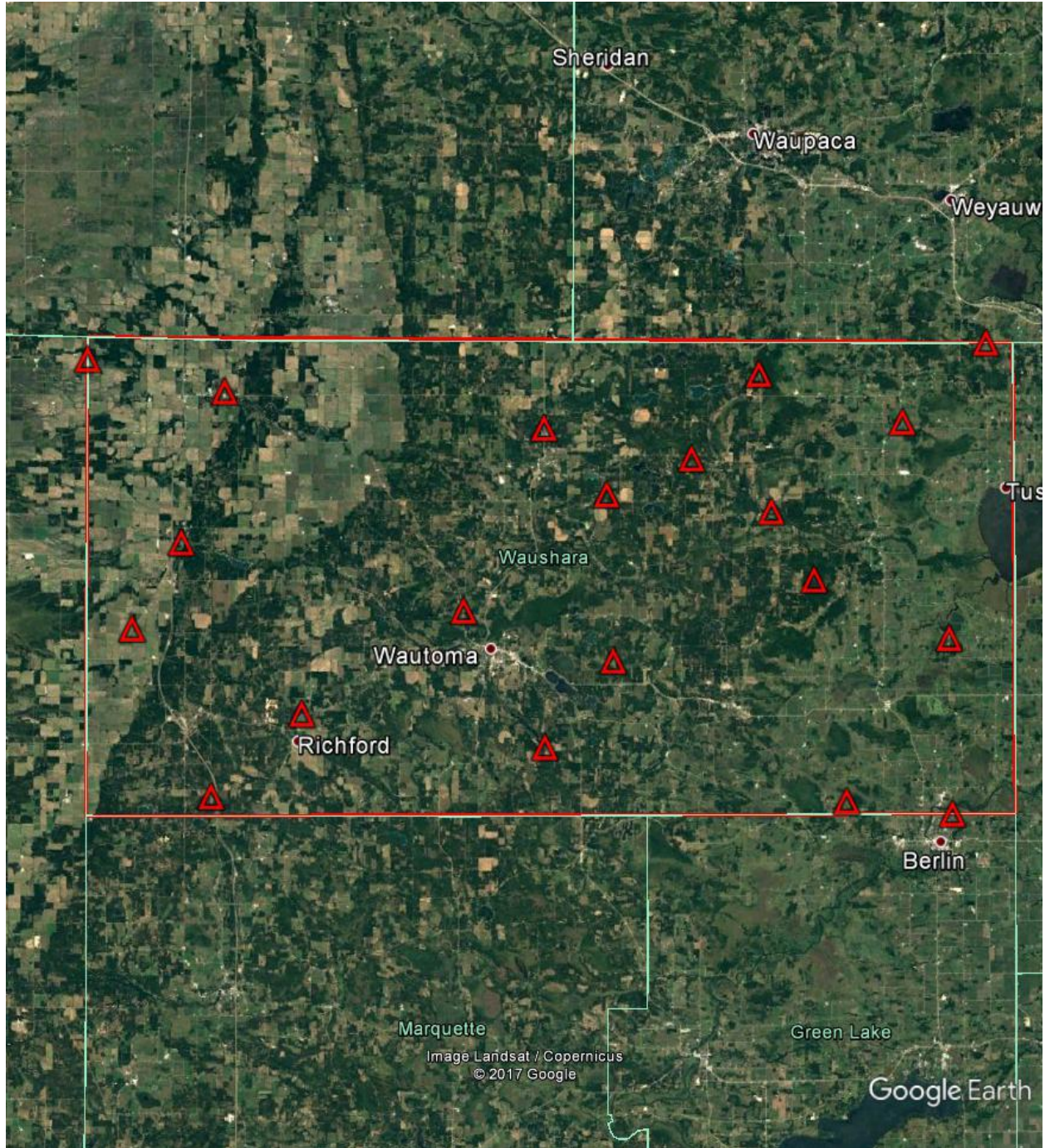
All collected points were retrieved from the Trimble Survey Controller and processed with the Trimble Business Center software. The GPS survey is producing in this step heights above ellipsoid (HAEs).

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 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

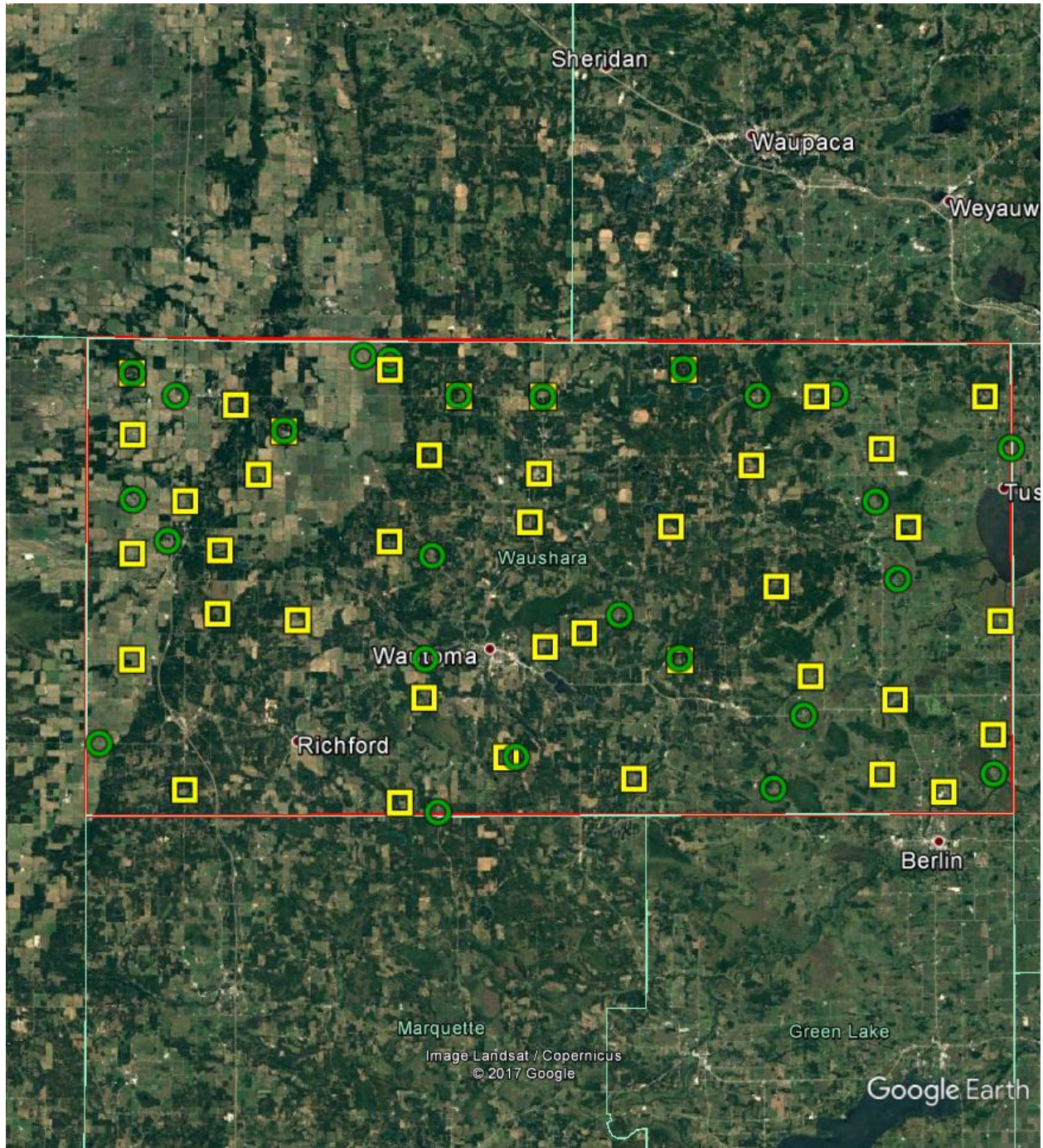


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## Area with NVA and VVA Test Points

Yellow Squares – NVA Test Points

Green Trees – VVA Test Points



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## Results of NVA

Point ID	Easting US Survey Feet	Northing US Survey Feet	NAVD88 MSL US Survey Feet	LiDAR Elevation US Survey Feet	$\Delta Z$ US Survey Feet	$\Delta Z^2$
NVA001	2094333.068	728055.192	1010.745	1010.583	0.163	0.026
NVA002	2137752.908	725882.667	840.349	840.3825	-0.034	0.001
NVA003	2184958.836	731142.976	838.574	838.468	0.106	0.011
NVA004	2235062.582	732423.186	782.179	782.1135	0.065	0.004
NVA005	2237515.613	747482.882	764.352	764.254	0.098	0.010
NVA006	2220391.408	752045.429	779.739	779.4045	0.335	0.112
NVA007	2174642.773	760281.579	903.663	903.7315	-0.068	0.005
NVA008	2194045.155	755028.929	821.143	821.17	-0.027	0.001
NVA009	2116803.912	762376.884	1045.789	1045.64	0.149	0.022
NVA010	2100628.548	763527.848	1144.940	1144.769	0.171	0.029
NVA011	2083415.215	754150.686	1104.499	1104.403	0.097	0.009
NVA012	2083296.123	775431.156	1073.012	1073.026	-0.014	0.000
NVA013	2100971.393	776253.073	1092.268	1092.287	-0.019	0.000
NVA014	2135198.779	778358.537	1109.143	1109.028	0.115	0.013
NVA015	2163490.851	782486.755	967.544	967.4705	0.073	0.005
NVA016	2191957.421	781856.387	903.855	903.655	0.200	0.040
NVA017	2213292.657	770008.156	863.851	863.71	0.141	0.020
NVA018	2239895.583	782198.773	768.431	768.3395	0.091	0.008
NVA019	2234322.167	797886.779	803.995	803.9305	0.064	0.004
NVA020	2221099.970	808283.995	867.999	867.931	0.068	0.005
NVA021	2208060.870	794327.976	878.143	878.001	0.142	0.020
NVA022	2194268.041	813402.442	919.015	918.985	0.030	0.001
NVA023	2165217.384	792255.689	949.768	949.785	-0.017	0.000
NVA024	2165929.719	807738.159	1052.890	1052.779	0.111	0.012
NVA025	2148976.958	807660.587	1077.193	1077.155	0.038	0.001
NVA026	2134982.677	812847.292	1212.161	1211.877	0.284	0.081
NVA027	2143082.115	795751.190	1103.817	1103.641	0.176	0.031
NVA028	2113750.954	800325.901	1130.688	1130.47	0.218	0.048
NVA029	2103949.961	805510.812	1110.333	1110.446	-0.113	0.013
NVA030	2082882.223	811721.805	1084.725	1084.667	0.058	0.003

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NVA031	2083142.995	799343.609	1080.030	1080.04	-0.010	0.000
NVA032	2108626.401	791561.094	1122.716	1122.38	0.336	0.113
NVA033	2093910.018	786116.931	1099.699	1099.226	0.474	0.224
NVA034	2159092.204	735213.933	856.825	856.6	0.225	0.051
NVA035	2142459.464	747031.813	870.490	870.4345	0.056	0.003
NVA036	2166770.900	757479.890	895.711	895.7435	-0.033	0.001
NVA037	2247548.122	729039.494	777.566	777.4125	0.154	0.024
NVA038	2257432.575	740631.337	821.218	821.197	0.021	0.000
NVA039	2258632.053	763527.454	756.029	756.0155	0.014	0.000
NVA040	2255127.304	808606.169	822.571	822.656	-0.085	0.007

Datum: NAD83(2011)  
 Epoch: 2010  
 Geoid: 12B  
 State Plane: Wisconsin State  
 Plane Zone South  
 Units: US Survey Feet

Summary is in US Survey Feet		US Survey Feet		Meters
<b>Z Mean</b>	<b>0.10</b>	<b>RMSE:</b>	<b>0.157</b>	<b>0.048</b>
<b>Z Min:</b>	<b>-0.11</b>	<b>* 1.9600</b>	<b>0.308</b>	<b>0.094</b>
<b>Z Max:</b>	<b>0.47</b>			

## Results of VVA

Point ID	Easting US Survey Feet	Northing US Survey Feet	NAVD88 MSL US Survey Feet	LIDAR Elevation US Survey Feet	$\Delta Z$ US Survey Feet	$\Delta Z^2$
VVA001	2094053.000	728183.387	1013.062	1012.74	0.322	0.104
VVA002	2100516.510	763444.308	1145.291	1145.41	-0.119	0.014
VVA003	2113821.728	800384.222	1128.941	1128.99	-0.049	0.002
VVA004	2082986.079	811688.295	1084.368	1084.44	-0.072	0.005
VVA005	2194232.220	813523.783	920.611	921.04	-0.429	0.184
VVA006	2193942.750	755379.231	818.301	818.53	-0.229	0.052
VVA007	2255175.338	808740.484	830.227	830.18	0.047	0.002
VVA008	2161201.180	735262.531	866.314	866.31	0.004	0.000
VVA009	2163382.127	782614.167	962.859	963.26	-0.401	0.161
VVA010	2148887.214	807754.987	1090.844	1091.28	-0.436	0.190
VVA011	2145512.345	723936.841	838.257	838.81	-0.553	0.306



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VVA012	2257650.331	732650.372	781.830	781.64	0.190	0.036
VVA013	2233306.842	787240.138	769.447	770.12	-0.673	0.453
VVA014	2209246.084	808216.449	871.349	871.61	-0.261	0.068
VVA015	2165869.924	807615.962	1047.465	1048.21	-0.745	0.555
VVA016	2134980.955	814718.383	1201.879	1201.99	-0.111	0.012
VVA017	2143861.181	775494.109	1026.914	1027.43	-0.516	0.266
VVA018	2091799.000	807159.351	1092.215	1092.61	-0.395	0.156
VVA019	2083361.473	786241.614	1075.089	1075.42	-0.331	0.110
VVA020	2094094.441	727819.625	1004.704	1004.65	0.054	0.003
VVA021	2076993.008	737124.631	1072.166	1072.35	-0.184	0.034
VVA022	2090490.609	778001.378	1089.016	1089.15	-0.134	0.018
VVA023	2129578.091	815505.116	1186.924	1186.87	0.054	0.003
VVA024	2181741.646	763917.039	892.080	892.29	-0.210	0.044
VVA025	2142695.292	754728.394	889.379	889.73	-0.351	0.123
VVA026	2219147.057	744098.087	780.852	781.11	-0.258	0.067
VVA027	2213136.934	729373.073	780.001	780.06	-0.059	0.003
VVA028	2237868.274	771678.418	771.897	772.79	-0.893	0.797
VVA029	2224967.606	808742.223	843.208	843.95	-0.742	0.551
VVA030	2260560.298	798253.678	764.457	764.64	-0.183	0.033

		US Survey Feet		Meters
Summary is in US Survey Feet		Feet		
Datum: NAD83(2011)	<b>Z Average</b>	<b>-0.26</b>	<b>RMSE:</b>	<b>0.387</b>
Epoch: 2010	<b>Z Min:</b>	<b>-0.89</b>	<b>* 1.9600</b>	<b>0.759</b>
Geoid: 12B	<b>Z Max:</b>	<b>032</b>	<b>95th Percentile</b>	<b>0.129</b>
State Plane: Wisconsin State Plane Zone South			<b>0.039</b>	
Units: US Survey Feet				

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<b>Contact Information</b>
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Philipp Hummel, PLS, CFedS, CP  
Phone: (303) 627-4058  
E-mail: [phummel@compassdatainc.com](mailto:phummel@compassdatainc.com)