

# ***GROUND CONTROL SURVEY REPORT***

## **GPS SURVEY FOR LIDAR CONTROL**

**""UCWM'COUNTY, WI  
WROC LIDAR SURVEY**

**""UCWM'COUNTY, WISCONSIN**

*Services provided by:*

**AYRES**  

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## **ABSTRACT**

This report documents the GPS ground surveys conducted in support of FEMA accuracy testing of the lidar data collection for Sauk County, Wisconsin, in 2012. Surveys were conducted at four sites utilizing the base stations established in the static network. These surveys established “ground truth” data at each site on different surface types, including bare earth, low grass, brush lands, low trees, forest, high grass, weeds, crops, and urban areas. Statistical comparisons were made between ground truth points collected from the ground survey and the elevation at the associated horizontal coordinates represented on the LiDAR-derived digital terrain model.

## **SAMPLE POINTS/TEST POINTS**

The ground survey test points were distributed and categorized into sites as shown in the Test Survey Locations map on the next page.

## **DATA ANALYSIS**

To qualify as an acceptable accuracy test, the lidar data must be compared with a dataset of higher accuracy – in this instance ground survey. To develop a comparable dataset of points from the lidar dataset, a utility from proprietary software was used.

The ground control survey results were imported into an ESRI PointZ shapefile with each point’s information as attributes. The utility then accessed the lidar and generated a triangulated irregular network (TIN), which is a continuous digital terrain surface, using the bare-earth lidar points and the compiled breaklines. The utility probed the TIN surface to determine its elevations at each of the survey point’s horizontal locations.

The elevation was then appended as a field to the PointZ shapefile; the attributes for each point were exported to a database; and then statistical analysis was performed. The results can be seen on the following pages.

## **OVERALL ACCURACY**

A comparison of ground survey versus lidar model values indicates a vertical root mean square error (RMSEz) of 0.296 feet. This is within the FEMA specified vertical accuracy tolerance of 0.6 feet. This RMSEz equates to a tested 0.574 feet vertical accuracy at 95% confidence level.

**GROUND TRUTH ANALYSIS**  
Comparison of Lidar Points to Ground-Truth Points  
Sauk County Coordinate System  
NAD 83 HARN / NAVD 88, survey feet

Field definitions

Name – The designation given to the ground survey point to identify it with its coordinates and land cover type

X, Y, and Z – The coordinates that describe the point's horizontal and vertical location within the Sauk County WISCRS Coordinate System. The X and Y values are shared between the ground control points and lidar comparison points. The Z field shows the elevation of the survey number. The lidar comparison point's elevation is implicit in the analysis' delta Z

Delta Z – The error, the difference between the elevation at a horizontal location as determined by ground survey and as determined by the lidar dataset

Laser Z– The elevation at a horizontal location as determined by the lidar dataset

Land Cover – The predominant land cover category at the location of the survey point

Statistic definitions

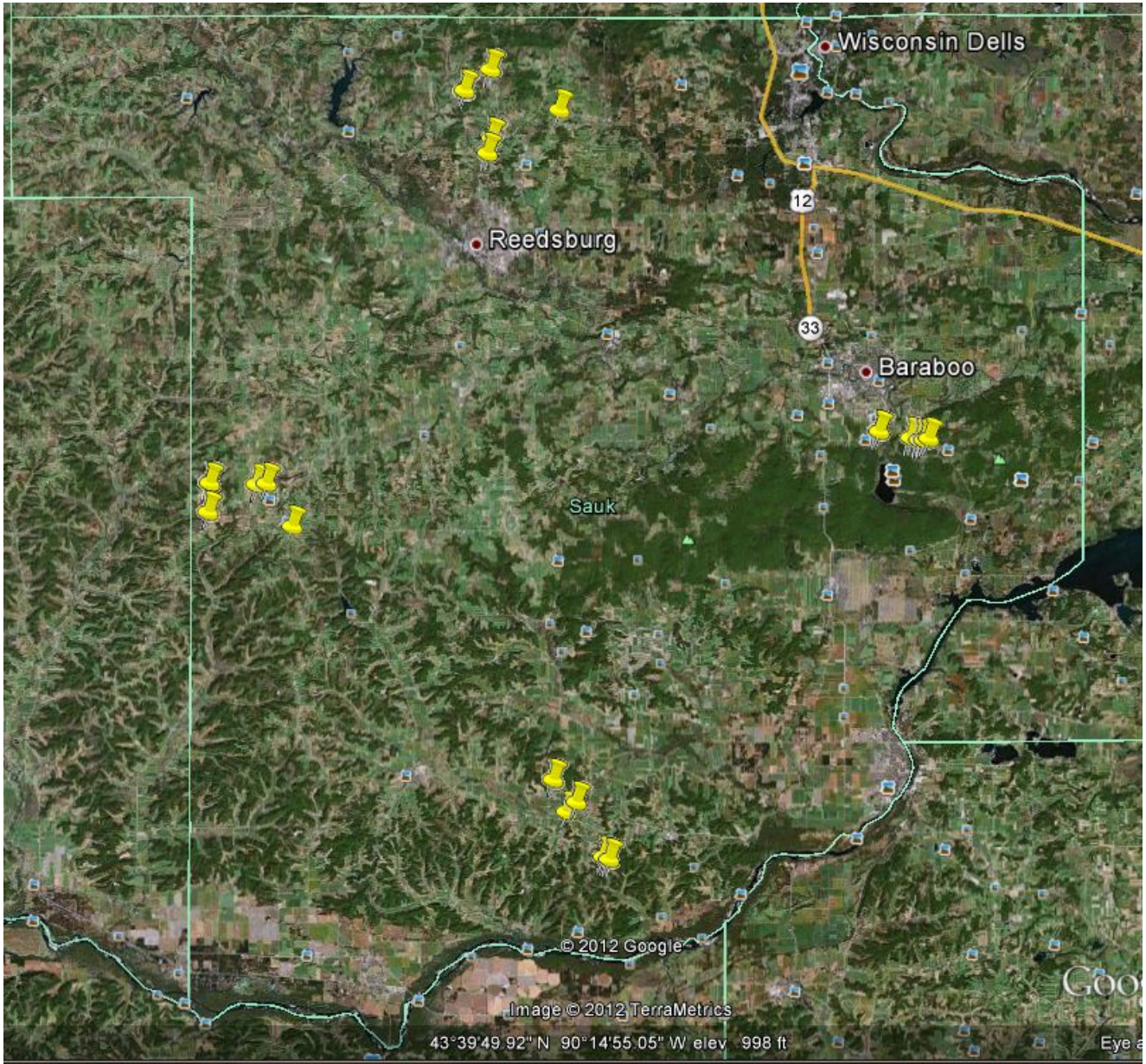
Sum – The sum of the analysis' Delta Z Squared values

Average – The average of the analysis' Delta Z Squared values

RMSE – The root mean squared error, the square root of the average of the squared errors

Accuracyz – The product of multiplying the RMSE with 1.96, a conversion between the RMSE value and a value with a 95% confidence level

# Sauk County LiDAR Check Site Locations



ID	X	Y	Z	Laser Z	Delta Z	Land Cover
DH5199	595478.8	280531.6	993.997	994.31	0.313	NGS
1001	583393.7	287594.9	1115.102	1115.31	0.208	TALL GRASS
1002	583393.5	287599.8	1115.031	1115.16	0.129	TALL GRASS
1003	583393.9	287604.1	1115.006	1115.2	0.194	TALL GRASS
1004	583393.7	287608.3	1115.031	1115.13	0.099	TALL GRASS
1005	583393.8	287612.8	1114.855	1114.99	0.135	TALL GRASS
1006	583399.4	287613.2	1115.241	1115.28	0.039	TALL GRASS
1007	583404.3	287612.9	1115.268	1115.52	0.252	TALL GRASS
1008	583409.4	287613.2	1115.553	1115.89	0.337	TALL GRASS
1009	583414.1	287612.9	1115.967	1116.24	0.273	TALL GRASS
1010	583414.2	287607.8	1116.05	1116.28	0.23	TALL GRASS
1011	583414.4	287603.4	1116.067	1116.18	0.113	TALL GRASS
1012	583414.8	287599.6	1116.128	1116.3	0.172	TALL GRASS
1013	583414.5	287595.1	1116.182	1116.43	0.248	TALL GRASS
1014	583409.1	287595.3	1116.099	1116.17	0.071	TALL GRASS
1015	583404.9	287595.4	1115.819	1115.95	0.131	TALL GRASS
1016	583399.1	287595.5	1115.274	1115.47	0.196	TALL GRASS
1017	583399.5	287600.5	1115.24	1115.33	0.09	TALL GRASS
1018	583399.8	287604.6	1115.173	1115.37	0.197	TALL GRASS
1019	583399.7	287608.9	1115.17	1115.34	0.17	TALL GRASS
1020	583404.7	287608.8	1115.274	1115.53	0.256	TALL GRASS
1021	583409.5	287608.4	1115.785	1115.91	0.125	TALL GRASS
1022	583409.4	287603.6	1115.875	1116.07	0.195	TALL GRASS
1023	583408.8	287599.4	1115.99	1116.13	0.14	TALL GRASS
1024	583404.1	287600.2	1115.571	1115.78	0.209	TALL GRASS
1025	583404.7	287604.5	1115.454	1115.81	0.356	TALL GRASS
1026	578777.9	283965	1150.83	1150.83	0	ASPHALT
1027	578780.4	283962.1	1150.89	1150.78	-0.11	ASPHALT
1028	578783	283959.6	1150.92	1150.76	-0.16	ASPHALT
1029	578785.4	283957.4	1150.957	1150.84	-0.117	ASPHALT
1030	578788.1	283955.2	1150.971	1150.86	-0.111	ASPHALT
1031	578790.6	283958.1	1150.855	1150.61	-0.245	ASPHALT
1032	578787.6	283959.9	1150.823	1150.58	-0.243	ASPHALT
1033	578785.3	283961.9	1150.774	1150.57	-0.204	ASPHALT
1034	578782.6	283964	1150.774	1150.66	-0.114	ASPHALT
1035	578780.2	283967.2	1150.756	1150.62	-0.136	ASPHALT
1036	578783	283970	1150.654	1150.36	-0.294	ASPHALT
1037	578785.6	283966.8	1150.671	1150.47	-0.201	ASPHALT
1038	578787.8	283964.5	1150.667	1150.41	-0.257	ASPHALT
1039	578790.5	283962.1	1150.686	1150.35	-0.336	ASPHALT
1040	578794.1	283960.5	1150.673	1150.65	-0.023	ASPHALT
1041	578796.3	283963.8	1150.524	1150.44	-0.084	ASPHALT
1042	578792.7	283965.4	1150.53	1150.32	-0.21	ASPHALT

1043	578789.9	283967.6	1150.518	1150.35	-0.168	ASPHALT
1044	578787.4	283969.9	1150.515	1150.39	-0.125	ASPHALT
1045	578785.2	283972.7	1150.411	1150.24	-0.171	ASPHALT
1046	578787.4	283976	1150.205	1150.01	-0.195	ASPHALT
1047	578790.1	283973.1	1150.292	1150.21	-0.082	ASPHALT
1048	578792.7	283970.9	1150.349	1150.24	-0.109	ASPHALT
1049	578795.2	283968.3	1150.408	1150.24	-0.168	ASPHALT
1050	578797.7	283966.3	1150.46	1150.27	-0.19	ASPHALT
1051	578750	283764.4	1155.84	1156.15	0.31	MOWED GRASS
1052	578751.4	283760.9	1155.705	1155.94	0.235	MOWED GRASS
1053	578753.4	283757.2	1155.612	1155.75	0.138	MOWED GRASS
1054	578755.3	283753.8	1155.553	1155.62	0.067	MOWED GRASS
1055	578757.2	283750.2	1155.217	1155.48	0.263	MOWED GRASS
1056	578753.6	283747.9	1154.978	1155.03	0.052	MOWED GRASS
1057	578751.7	283752.4	1155.211	1155.31	0.099	MOWED GRASS
1058	578749.8	283755.7	1155.282	1155.44	0.158	MOWED GRASS
1059	578747.9	283759.3	1155.552	1155.52	-0.032	MOWED GRASS
1060	578746.7	283762.7	1155.656	1155.74	0.084	MOWED GRASS
1061	578742.7	283760.4	1155.266	1155.5	0.234	MOWED GRASS
1062	578745	283757	1155.195	1155.32	0.125	MOWED GRASS
1063	578747	283753.9	1155.061	1155.24	0.179	MOWED GRASS
1064	578748.5	283750.6	1154.927	1155.12	0.193	MOWED GRASS
1065	578749.8	283746.5	1154.637	1154.78	0.143	MOWED GRASS
1066	578746.1	283745.1	1154.401	1154.55	0.149	MOWED GRASS
1067	578744.4	283748.5	1154.646	1154.74	0.094	MOWED GRASS
1068	578742.6	283751.8	1154.808	1154.94	0.132	MOWED GRASS
1069	578741.3	283755.1	1154.894	1155.04	0.146	MOWED GRASS
1070	578739.5	283758.3	1155.122	1155.22	0.098	MOWED GRASS
1071	578736.1	283756.5	1154.989	1154.98	-0.009	MOWED GRASS
1072	578737.5	283752.8	1154.689	1154.73	0.041	MOWED GRASS
1073	578739.7	283749.8	1154.664	1154.64	-0.024	MOWED GRASS
1074	578741.8	283746.3	1154.372	1154.51	0.138	MOWED GRASS
1075	578743.6	283742.9	1154.163	1154.32	0.157	MOWED GRASS
1076	582848.1	272940.3	897.306	897.11	-0.196	BRUSH
1077	582845.9	272937	897.306	896.99	-0.316	BRUSH
1078	582843.6	272934.2	897.302	896.71	-0.592	BRUSH
1079	582841.3	272932	897.355	896.6	-0.755	BRUSH
1080	582839.1	272929	897.43	896.53	-0.9	BRUSH
1081	582836.5	272931.9	897.266	896.69	-0.576	BRUSH
1082	582838.7	272934.6	897.165	896.71	-0.455	BRUSH
1083	582841.2	272936.7	897.259	897.07	-0.189	BRUSH
1084	582843.1	272939.1	897.145	897.31	0.165	BRUSH
1085	582845.6	272942.7	897.349	896.86	-0.489	BRUSH
1086	582843	272945.6	897.198	897.09	-0.108	BRUSH
1087	582840.3	272947.7	897.158	897.37	0.212	BRUSH



1088	582837.3	272949.7	897.143	896.93	-0.213	BRUSH
1089	582834.7	272947.7	897.2	896.83	-0.37	BRUSH
1090	582836.7	272945.2	897.182	897.02	-0.162	BRUSH
1091	582839.8	272941.3	897.555	897.52	-0.035	BRUSH
1092	582836.9	272938.9	897.187	896.98	-0.207	BRUSH
1093	582836.1	272936.5	897.284	896.87	-0.414	BRUSH
1094	582832.8	272934.5	897.402	897.11	-0.292	BRUSH
1095	582829.2	272937.6	897.239	896.98	-0.259	BRUSH
1096	582826.8	272941	897.346	897.1	-0.246	BRUSH
1097	582829.5	272943.6	897.216	897.14	-0.076	BRUSH
1098	582831.6	272945.8	897.085	897.05	-0.035	BRUSH
1099	582834.1	272942.8	897.217	897.16	-0.057	BRUSH
1100	582832.1	272940.6	897.269	896.86	-0.409	BRUSH
1101	583564.1	275557.9	909.473	910.49	1.017	WOODED
1102	583564.6	275553.8	909.211	910.3	1.089	WOODED
1103	583564.8	275550	910.337	910.19	-0.147	WOODED
1104	583565	275546.6	910.049	910.21	0.161	WOODED
1105	583565.2	275542.9	909.896	910.21	0.314	WOODED
1106	583569.4	275542.5	910.456	910.17	-0.286	WOODED
1107	583568.9	275546.7	910.182	910.18	-0.002	WOODED
1108	583568.9	275550.7	910.003	910.18	0.177	WOODED
1109	583568.8	275554.7	910.265	910.52	0.255	WOODED
1110	583568.9	275558.1	910.201	910.77	0.569	WOODED
1111	583572.9	275557.9	910.302	910.87	0.568	WOODED
1112	583573.3	275554.4	910.121	910.68	0.559	WOODED
1113	583573.4	275550.7	910.274	910.26	-0.014	WOODED
1114	583573.4	275547.1	910.326	910.17	-0.156	WOODED
1115	583573.2	275543	910.098	910.18	0.082	WOODED
1116	583577.3	275542.5	910.152	910.45	0.298	WOODED
1117	583577.4	275547.2	910.213	910.41	0.197	WOODED
1118	583577.6	275550.9	910.104	910.42	0.316	WOODED
1119	583577.5	275554.5	910.266	910.73	0.464	WOODED
1120	583577.4	275558.3	910.101	910.7	0.599	WOODED
1121	583581.6	275558.2	910.433	910.6	0.167	WOODED
1122	583581.5	275554.1	910.495	910.63	0.135	WOODED
1123	583581.5	275550.2	910.397	910.38	-0.017	WOODED
1124	583581.5	275546.4	909.707	910.39	0.683	WOODED
1125	583581.5	275542.7	910.305	910.36	0.055	WOODED
DH5074	548451.6	207629.7	1155.559	1155.4	-0.159	NGS
2025	542163.3	214963.1	1176.442	1176.73	0.288	BRUSH
2001	542166.8	214963	1176.272	1176.34	0.068	BRUSH
2002	542170.4	214963.1	1176.171	1176.11	-0.061	BRUSH
2003	542174	214963	1176.09	1176.24	0.15	BRUSH
2004	542178	214962.8	1175.919	1176.07	0.151	BRUSH
2005	542177.8	214958.8	1176.068	1175.98	-0.088	BRUSH

2006	542173.9	214958.8	1176.137	1176.14	0.003	BRUSH
2007	542170.5	214958.8	1176.197	1176.25	0.053	BRUSH
2008	542167.1	214959.2	1176.337	1176.34	0.003	BRUSH
2009	542163.2	214959.1	1176.369	1176.36	-0.009	BRUSH
2010	542163.1	214955	1176.483	1176.33	-0.153	BRUSH
2011	542167	214954.8	1176.278	1176.26	-0.018	BRUSH
2012	542170.4	214954.7	1176.168	1176.21	0.042	BRUSH
2013	542174.1	214954.5	1176.103	1176.15	0.047	BRUSH
2014	542178.1	214954.5	1175.974	1175.9	-0.074	BRUSH
2015	542178.1	214950.1	1176.087	1176.21	0.123	BRUSH
2016	542174	214950.4	1176.151	1176.23	0.079	BRUSH
2017	542170.3	214950.7	1176.15	1176.23	0.08	BRUSH
2018	542167	214950.8	1176.465	1176.26	-0.205	BRUSH
2019	542162.7	214950.6	1176.633	1176.4	-0.233	BRUSH
2020	542163	214947.5	1176.746	1176.46	-0.286	BRUSH
2021	542167.3	214947.3	1176.621	1176.31	-0.311	BRUSH
2022	542170.6	214947.4	1176.297	1176.21	-0.087	BRUSH
2023	542174.1	214947.2	1176.215	1176.2	-0.015	BRUSH
2024	542177.9	214946.8	1176.004	1176.1	0.096	BRUSH
2026	533981.5	215202.1	1124.299	1124.93	0.631	WOODED
2027	533980.1	215205.4	1125.209	1125.37	0.161	WOODED
2028	533979	215208.5	1125.648	1126.02	0.372	WOODED
2029	533977.3	215212.2	1126.65	1126.77	0.12	WOODED
2030	533975.4	215215.2	1126.601	1127.29	0.689	WOODED
2031	533979.5	215213.5	1126.404	1126.64	0.236	WOODED
2032	533981.4	215211.1	1125.986	1126.2	0.214	WOODED
2033	533984.8	215203.7	1124.642	1125.09	0.448	WOODED
2034	533987.7	215205.4	1124.885	1125.05	0.165	WOODED
2035	533990.7	215207.2	1125.239	1125.5	0.261	WOODED
2036	533993.6	215208.6	1125.264	1125.62	0.356	WOODED
2037	533992.1	215212.5	1126.06	1126.54	0.48	WOODED
2038	533990.5	215215.2	1127.469	1127.04	-0.429	WOODED
2039	533989.5	215218.5	1126.988	1127.48	0.492	WOODED
2040	533987.9	215221.8	1127.365	1127.83	0.465	WOODED
2041	533985.4	215221.1	1127.445	1127.93	0.485	WOODED
2042	533985.8	215217.4	1126.812	1127.28	0.468	WOODED
2043	533987.1	215214.2	1126.128	1126.66	0.532	WOODED
2044	533988	215211.2	1125.796	1126.24	0.444	WOODED
2045	533985.5	215210	1125.56	1126.02	0.46	WOODED
2046	533984	215207.4	1125.197	1125.62	0.423	WOODED
2047	533982.6	215215.7	1126.848	1127	0.152	WOODED
2048	533982	215219.3	1127.097	1127.59	0.493	WOODED
2049	533978.5	215217.9	1127.369	1127.39	0.021	WOODED
2050	533984.5	215213.1	1126.514	1126.52	0.006	WOODED
2051	533862.4	215352.7	1154.491	1154.65	0.159	TALL GRASS



2052	533862.1	215355.9	1154.919	1155.04	0.121	TALL GRASS
2053	533861.9	215359.3	1155.221	1155.48	0.259	TALL GRASS
2054	533861.6	215362.9	1155.656	1155.99	0.334	TALL GRASS
2055	533861.4	215366.8	1156.254	1156.43	0.176	TALL GRASS
2056	533865.1	215367.3	1156.386	1156.54	0.154	TALL GRASS
2057	533865.8	215363.2	1155.807	1156.07	0.263	TALL GRASS
2058	533866	215359.4	1155.201	1155.61	0.409	TALL GRASS
2059	533866.4	215355.9	1154.913	1155	0.087	TALL GRASS
2060	533866.5	215352.5	1154.541	1154.68	0.139	TALL GRASS
2061	533870.3	215352.3	1154.37	1154.65	0.28	TALL GRASS
2062	533870.4	215355.9	1154.813	1155.05	0.237	TALL GRASS
2063	533870.1	215360	1155.299	1155.55	0.251	TALL GRASS
2064	533869.6	215363.6	1155.788	1156	0.212	TALL GRASS
2065	533868.9	215367.3	1156.391	1156.5	0.109	TALL GRASS
2066	533872.9	215368.1	1156.259	1156.44	0.181	TALL GRASS
2067	533873.4	215364.1	1155.744	1155.95	0.206	TALL GRASS
2068	533873.8	215360	1155.283	1155.47	0.187	TALL GRASS
2069	533874.3	215356.4	1154.823	1155.09	0.267	TALL GRASS
2070	533874.3	215352.5	1154.351	1154.63	0.279	TALL GRASS
2071	533878.3	215352.9	1154.511	1154.63	0.119	TALL GRASS
2072	533878.3	215357	1154.896	1155.03	0.134	TALL GRASS
2073	533877.9	215360.4	1155.222	1155.45	0.228	TALL GRASS
2074	533877.2	215364.7	1155.741	1156.01	0.269	TALL GRASS
2075	533876.6	215368.4	1156.276	1156.45	0.174	TALL GRASS
2076	533685.9	210138.6	1135.405	1135.07	-0.335	GRAVEL
2077	533683.9	210141.6	1135.36	1135.12	-0.24	GRAVEL
2078	533681.9	210144.5	1135.344	1135.1	-0.244	GRAVEL
2079	533679.7	210147	1135.327	1135.07	-0.257	GRAVEL
2080	533677.6	210149.3	1135.253	1134.98	-0.273	GRAVEL
2081	533674.7	210147.9	1135.267	1134.9	-0.367	GRAVEL
2082	533672.1	210146.5	1135.289	1134.83	-0.459	GRAVEL
2083	533669.4	210144.8	1135.311	1134.95	-0.361	GRAVEL
2084	533666.9	210143.1	1135.354	1135.03	-0.324	GRAVEL
2085	533668.2	210140.2	1135.391	1135.04	-0.351	GRAVEL
2086	533670.9	210141.7	1135.364	1134.92	-0.444	GRAVEL
2087	533673.9	210143.1	1135.321	1134.92	-0.401	GRAVEL
2088	533676.8	210144.7	1135.313	1135	-0.313	GRAVEL
2089	533679.1	210141.9	1135.318	1135	-0.318	GRAVEL
2090	533676.1	210140.4	1135.381	1135.02	-0.361	GRAVEL
2091	533673.1	210138.9	1135.464	1135.07	-0.394	GRAVEL
2092	533670.4	210137.3	1135.488	1135.19	-0.298	GRAVEL
2093	533672	210134.7	1135.498	1135.15	-0.348	GRAVEL
2094	533675.1	210136.2	1135.447	1135.11	-0.337	GRAVEL
2095	533678.5	210137.6	1135.425	1135.04	-0.385	GRAVEL
2096	533681.4	210139.3	1135.369	1135.01	-0.359	GRAVEL

2097	533683.4	210137	1135.431	1135.06	-0.371	GRAVEL
2098	533680.2	210135.6	1135.44	1134.99	-0.45	GRAVEL
2099	533677.3	210134.3	1135.481	1135.07	-0.411	GRAVEL
2100	533673.7	210132.4	1135.538	1135.14	-0.398	GRAVEL
2101	543973.6	215149.2	1197.611	1197.5	-0.111	MOWED GRASS
2102	543970.2	215149.7	1197.753	1197.72	-0.033	MOWED GRASS
2103	543966.7	215150	1197.852	1197.73	-0.122	MOWED GRASS
2104	543963.1	215150.5	1197.952	1197.9	-0.052	MOWED GRASS
2105	543959.4	215150.9	1198.084	1197.85	-0.234	MOWED GRASS
2106	543958.7	215147.1	1198.014	1197.83	-0.184	MOWED GRASS
2107	543962.1	215147	1197.836	1197.71	-0.126	MOWED GRASS
2108	543966	215146.5	1197.777	1197.53	-0.247	MOWED GRASS
2109	543969.4	215145.8	1197.655	1197.45	-0.205	MOWED GRASS
2110	543973	215145.2	1197.575	1197.28	-0.295	MOWED GRASS
2111	543972.8	215140.9	1197.548	1197.43	-0.118	MOWED GRASS
2112	543968.4	215141.8	1197.695	1197.55	-0.145	MOWED GRASS
2113	543964.5	215142.4	1197.752	1197.52	-0.232	MOWED GRASS
2114	543960.8	215143.1	1197.862	1197.61	-0.252	MOWED GRASS
2115	543957.7	215143.7	1197.906	1197.74	-0.166	MOWED GRASS
2116	543957.1	215140.2	1197.854	1197.66	-0.194	MOWED GRASS
2117	543960.4	215139.3	1197.777	1197.63	-0.147	MOWED GRASS
2118	543964.1	215138.4	1197.686	1197.54	-0.146	MOWED GRASS
2119	543967.6	215138.1	1197.592	1197.45	-0.142	MOWED GRASS
2120	543971.7	215137.2	1197.477	1197.31	-0.167	MOWED GRASS
2121	543971.8	215134.1	1197.411	1197.19	-0.221	MOWED GRASS
2122	543967.2	215135	1197.524	1197.34	-0.184	MOWED GRASS
2123	543963.4	215135.5	1197.633	1197.48	-0.153	MOWED GRASS
2124	543959.7	215135.9	1197.639	1197.54	-0.099	MOWED GRASS
2125	543955.9	215136.7	1197.843	1197.54	-0.303	MOWED GRASS
GREENFIEL	660435.7	222968.8	1213.375	1213.81	0.435	DH5468
DH5468	660435.7	222968.9	1213.324	1213.81	0.486	GREENFIEL
3001	659510.1	222820.3	1202.591	1202.14	-0.451	GRAVEL
3002	659513.5	222820.1	1202.684	1202.26	-0.424	GRAVEL
3003	659517.1	222819.7	1202.821	1202.47	-0.351	GRAVEL
3004	659520.5	222819.4	1202.922	1202.62	-0.302	GRAVEL
3005	659523.8	222819	1202.996	1202.73	-0.266	GRAVEL
3006	659523.9	222815.2	1202.984	1202.64	-0.344	GRAVEL
3007	659520	222816.1	1202.844	1202.52	-0.324	GRAVEL
3008	659516.9	222816.3	1202.768	1202.44	-0.328	GRAVEL
3009	659513.6	222816.6	1202.641	1202.25	-0.391	GRAVEL
3010	659510	222816.8	1202.557	1202.11	-0.447	GRAVEL
3011	659509.8	222813.6	1202.599	1202.17	-0.429	GRAVEL
3012	659512.9	222813.3	1202.631	1202.24	-0.391	GRAVEL
3013	659516	222812.8	1202.703	1202.38	-0.323	GRAVEL
3014	659519.7	222812.4	1202.835	1202.48	-0.355	GRAVEL

3015	659523.3	222812.1	1202.937	1202.63	-0.307	GRAVEL
3016	659522.9	222808.6	1202.934	1202.56	-0.374	GRAVEL
3017	659519.3	222809.1	1202.803	1202.41	-0.393	GRAVEL
3018	659516	222809.5	1202.714	1202.35	-0.364	GRAVEL
3019	659512.8	222809.9	1202.666	1202.32	-0.346	GRAVEL
3020	659509.3	222810.2	1202.55	1202.33	-0.22	GRAVEL
3021	659508.7	222807	1202.589	1202.21	-0.379	GRAVEL
3022	659512.2	222806.5	1202.653	1202.33	-0.323	GRAVEL
3023	659515.2	222806.1	1202.715	1202.38	-0.335	GRAVEL
3024	659518.7	222805.7	1202.824	1202.4	-0.424	GRAVEL
3025	659521.9	222805.4	1202.894	1202.46	-0.434	GRAVEL
3026	659607.1	222674.1	1201.372	1201.79	0.418	TALL GRASS
3027	659607.2	222670.7	1201.425	1201.71	0.285	TALL GRASS
3028	659607.2	222667.2	1201.46	1201.49	0.03	TALL GRASS
3029	659607.4	222663.9	1201.14	1201.37	0.23	TALL GRASS
3030	659607.4	222660.5	1201.232	1201.28	0.048	TALL GRASS
3031	659611.4	222660.2	1201.183	1201.38	0.197	TALL GRASS
3032	659611.1	222664	1201.431	1201.51	0.079	TALL GRASS
3033	659610.9	222667.5	1201.268	1201.55	0.282	TALL GRASS
3034	659610.6	222671	1201.445	1201.65	0.205	TALL GRASS
3035	659610.8	222674.4	1201.512	1201.73	0.218	TALL GRASS
3036	659614	222674.5	1201.593	1201.79	0.197	TALL GRASS
3037	659614	222671	1201.444	1201.62	0.176	TALL GRASS
3038	659614	222667.6	1201.309	1201.61	0.301	TALL GRASS
3039	659614.4	222664.2	1201.45	1201.48	0.03	TALL GRASS
3040	659614.4	222660.3	1201.184	1201.34	0.156	TALL GRASS
3041	659618.2	222660.5	1201.215	1201.47	0.255	TALL GRASS
3042	659617.9	222664.4	1201.477	1201.57	0.093	TALL GRASS
3043	659617.6	222667.8	1201.51	1201.68	0.17	TALL GRASS
3044	659617.3	222671	1201.6	1201.77	0.17	TALL GRASS
3045	659617.3	222674.6	1201.673	1201.94	0.267	TALL GRASS
3046	659621	222674.8	1201.745	1201.99	0.245	TALL GRASS
3047	659621	222671.2	1201.781	1201.95	0.169	TALL GRASS
3048	659621.1	222667.7	1201.613	1201.86	0.247	TALL GRASS
3049	659621.1	222664.5	1201.489	1201.78	0.291	TALL GRASS
3050	659621.5	222660.8	1201.384	1201.72	0.336	TALL GRASS
3051	658773.7	222720.2	1208.028	1208.29	0.262	BRUSH
3052	658773	222716.8	1208.262	1208.32	0.058	BRUSH
3053	658772.4	222713.6	1208.179	1208.5	0.321	BRUSH
3054	658771.4	222710.6	1208.491	1208.71	0.219	BRUSH
3055	658771	222707.9	1208.549	1208.81	0.261	BRUSH
3056	658767.4	222708	1208.873	1208.98	0.107	BRUSH
3057	658768.3	222711.7	1208.322	1208.83	0.508	BRUSH
3058	658769.1	222714.9	1208.325	1208.58	0.255	BRUSH
3059	658769.6	222718.2	1208.379	1208.48	0.101	BRUSH

3060	658770.1	222721.3	1208.417	1208.5	0.083	BRUSH
3061	658767	222722	1208.551	1208.66	0.109	BRUSH
3062	658766	222718.4	1208.508	1208.67	0.162	BRUSH
3063	658764.8	222715.2	1208.553	1208.78	0.227	BRUSH
3064	658764.4	222712.3	1208.704	1208.96	0.256	BRUSH
3065	658763.4	222708.5	1209.17	1209.16	-0.01	BRUSH
3066	658759.8	222709.3	1209.232	1209.31	0.078	BRUSH
3067	658757.3	222710.6	1209.369	1209.4	0.031	BRUSH
3068	658761.3	222712.9	1209.003	1209.1	0.097	BRUSH
3069	658761.3	222716.1	1208.995	1209.02	0.025	BRUSH
3070	658758	222717.3	1208.844	1209.17	0.326	BRUSH
3071	658757.1	222714.1	1208.904	1209.42	0.516	BRUSH
3072	658759.4	222720.2	1208.68	1208.96	0.28	BRUSH
3073	658760.5	222723.7	1208.635	1208.99	0.355	BRUSH
3074	658763.8	222723.4	1208.616	1208.8	0.184	BRUSH
3075	658762.4	222719.1	1208.654	1208.88	0.226	BRUSH
3076	657261.6	223068.6	1216.689	1216.41	-0.279	WOODED
3077	657264	223068	1215.722	1216.68	0.958	WOODED
3078	657267.7	223067.5	1216.134	1217.36	1.226	WOODED
3079	657271.4	223066.8	1217.69	1217.68	-0.01	WOODED
3080	657275	223066.3	1217.404	1217.84	0.436	WOODED
3081	657275.7	223069.9	1217.754	1218.52	0.766	WOODED
3082	657271.6	223070.7	1217.577	1218.11	0.533	WOODED
3083	657269	223071.7	1217.262	1217.7	0.438	WOODED
3084	657266	223071.7	1216.82	1217.16	0.34	WOODED
3085	657261.8	223073.6	1216.514	1216.86	0.346	WOODED
3086	657262.7	223075.8	1217.188	1217.27	0.082	WOODED
3087	657266.7	223075.9	1217.063	1217.57	0.507	WOODED
3088	657270.4	223074.9	1217.646	1218.02	0.374	WOODED
3089	657274.9	223073.9	1218.06	1218.63	0.57	WOODED
3090	657277.6	223073.9	1218.557	1219.07	0.513	WOODED
3091	657278.9	223076.7	1219.379	1219.45	0.071	WOODED
3092	657274.9	223077.7	1218.777	1218.74	-0.037	WOODED
3093	657271.6	223078.4	1217.979	1218.34	0.361	WOODED
3094	657268.4	223079.3	1217.612	1218.06	0.448	WOODED
3095	657264.9	223079.6	1217.626	1217.72	0.094	WOODED
3097	657280.9	223080.4	1220.042	1219.83	-0.212	WOODED
3098	657273.4	223082.4	1218.579	1218.91	0.331	WOODED
3099	657270.2	223083.1	1218.117	1218.63	0.513	WOODED
3100	657267.1	223083.9	1217.998	1218.24	0.242	WOODED
3101	651575.6	224235.3	1035.277	1034.91	-0.367	ASPHALT
3102	651572.4	224237.5	1035.11	1034.66	-0.45	ASPHALT
3103	651569.3	224239.4	1034.987	1034.71	-0.277	ASPHALT
3104	651566	224241.6	1034.898	1034.5	-0.398	ASPHALT
3105	651562.7	224243.7	1034.77	1034.45	-0.32	ASPHALT

3106	651565.2	224247	1034.749	1034.39	-0.359	ASPHALT
3107	651568.4	224244.8	1034.857	1034.48	-0.377	ASPHALT
3108	651571.5	224242.6	1035.026	1034.71	-0.316	ASPHALT
3109	651574.8	224240.5	1035.182	1034.76	-0.422	ASPHALT
3110	651578	224238.7	1035.283	1034.8	-0.483	ASPHALT
3111	651580.1	224241.5	1035.301	1034.9	-0.401	ASPHALT
3112	651577.1	224243.4	1035.125	1034.78	-0.345	ASPHALT
3113	651574.2	224245.5	1034.972	1034.7	-0.272	ASPHALT
3114	651571	224247.6	1034.741	1034.37	-0.371	ASPHALT
3115	651568	224249.7	1034.601	1034.38	-0.221	ASPHALT
3116	651569.8	224252.8	1034.532	1034.28	-0.252	ASPHALT
3117	651573.2	224250.6	1034.742	1034.35	-0.392	ASPHALT
3118	651576.8	224248.3	1034.866	1034.61	-0.256	ASPHALT
3119	651579.9	224246.4	1035.021	1034.75	-0.271	ASPHALT
3120	651582.4	224244.7	1035.122	1034.85	-0.272	ASPHALT
3121	651584.6	224247.7	1035.112	1034.76	-0.352	ASPHALT
3122	651581.6	224249.9	1034.897	1034.7	-0.197	ASPHALT
3123	651579.4	224251.3	1034.856	1034.71	-0.146	ASPHALT
3124	651576.1	224253.5	1034.742	1034.35	-0.392	ASPHALT
3125	651572.5	224255.5	1034.514	1034.27	-0.244	ASPHALT
3126	651705.6	224205.1	1039.453	1039.02	-0.433	MOWED GRASS
3127	651705.9	224208.3	1039.154	1038.68	-0.474	MOWED GRASS
3128	651706.2	224211.7	1038.908	1038.55	-0.358	MOWED GRASS
3129	651706.4	224214.5	1038.79	1038.46	-0.33	MOWED GRASS
3130	651706.7	224217.7	1038.601	1038.27	-0.331	MOWED GRASS
3131	651710.1	224217.6	1038.752	1038.36	-0.392	MOWED GRASS
3132	651709.9	224214	1038.849	1038.51	-0.339	MOWED GRASS
3133	651709.8	224211.1	1038.947	1038.56	-0.387	MOWED GRASS
3134	651709.3	224208	1039.104	1038.76	-0.344	MOWED GRASS
3135	651708.9	224204.6	1039.449	1038.97	-0.479	MOWED GRASS
3136	651712.3	224204.2	1039.425	1039	-0.425	MOWED GRASS
3137	651712.3	224207.7	1039.107	1038.76	-0.347	MOWED GRASS
3138	651712.6	224210.9	1038.958	1038.63	-0.328	MOWED GRASS
3139	651713.2	224214	1038.937	1038.55	-0.387	MOWED GRASS
3140	651713.3	224217.4	1038.793	1038.34	-0.453	MOWED GRASS
3141	651717	224217.1	1038.834	1038.44	-0.394	MOWED GRASS
3142	651716.6	224213.5	1038.973	1038.58	-0.393	MOWED GRASS
3143	651716.1	224210.3	1039.04	1038.69	-0.35	MOWED GRASS
3144	651715.9	224207.2	1039.251	1038.83	-0.421	MOWED GRASS
3145	651715.8	224203.8	1039.431	1039.04	-0.391	MOWED GRASS
3146	651719.1	224203.3	1039.456	1039.12	-0.336	MOWED GRASS
3147	651719.2	224207.2	1039.186	1038.91	-0.276	MOWED GRASS
3148	651719.5	224210.4	1039.1	1038.81	-0.29	MOWED GRASS
3149	651719.8	224213.6	1039.022	1038.74	-0.282	MOWED GRASS
3150	651720	224217.1	1038.908	1038.47	-0.438	MOWED GRASS

DH5100	596665.3	157560.1	794.047	794	-0.047	DH5100
4001	604215.6	149234.2	855.432	855.32	-0.112	TROY W GP
4002	604217.1	149231	855.196	855.18	-0.016	TALL GRASS
4003	604218.7	149228	855.147	855	-0.147	TALL GRASS
4004	604220.5	149225.1	854.947	854.83	-0.117	TALL GRASS
4005	604222.4	149222.2	854.844	854.65	-0.194	TALL GRASS
4006	604218.8	149220.1	854.68	854.67	-0.01	TALL GRASS
4007	604217.2	149223.9	854.794	854.77	-0.024	TALL GRASS
4008	604215.5	149226.7	854.945	854.84	-0.105	TALL GRASS
4009	604213.9	149229.7	855.067	855.03	-0.037	TALL GRASS
4010	604212.5	149233.1	855.275	855.28	0.005	TALL GRASS
4011	604209.6	149232	855.234	855.12	-0.114	TALL GRASS
4012	604211.3	149228.2	855.005	855.03	0.025	TALL GRASS
4013	604212.8	149225.1	854.826	854.91	0.084	TALL GRASS
4014	604214.8	149221.7	854.71	854.67	-0.04	TALL GRASS
4015	604216.5	149218.6	854.518	854.48	-0.038	TALL GRASS
4016	604212.4	149217.2	854.609	854.37	-0.239	TALL GRASS
4017	604211.3	149220.1	854.709	854.53	-0.179	TALL GRASS
4018	604209.5	149223.3	854.796	854.77	-0.026	TALL GRASS
4019	604208.1	149226.7	855.013	854.93	-0.083	TALL GRASS
4020	604206.8	149230.2	855.167	855.12	-0.047	TALL GRASS
4021	604203.4	149229	855.181	855.17	-0.011	TALL GRASS
4022	604205	149225.1	854.99	854.89	-0.1	TALL GRASS
4023	604206.7	149221.6	854.805	854.73	-0.075	TALL GRASS
4024	604208.3	149218.5	854.672	854.49	-0.182	TALL GRASS
4025	604209.8	149215.7	854.661	854.49	-0.171	TALL GRASS
4051	598425.3	159260.8	792.561	792.31	-0.251	TALL GRASS
4052	598425.4	159264.2	792.51	792.38	-0.13	MOWED GRASS
4053	598425.6	159267.4	792.581	792.43	-0.151	MOWED GRASS
4054	598426.1	159270.5	792.549	792.37	-0.179	MOWED GRASS
4055	598426.4	159274.1	792.548	792.36	-0.188	MOWED GRASS
4056	598423.1	159274.8	792.488	792.24	-0.248	MOWED GRASS
4057	598419.7	159275	792.433	792.15	-0.283	MOWED GRASS
4058	598416.5	159275.2	792.29	792.16	-0.13	MOWED GRASS
4059	598413.1	159275.3	792.217	792.12	-0.097	MOWED GRASS
4060	598412.8	159271.9	792.263	792.06	-0.203	MOWED GRASS
4061	598416.7	159271.8	792.358	792.19	-0.168	MOWED GRASS
4062	598419.5	159271.5	792.431	792.27	-0.161	MOWED GRASS
4063	598422.9	159271	792.589	792.32	-0.269	MOWED GRASS
4064	598422.3	159267.6	792.516	792.32	-0.196	MOWED GRASS
4065	598422.1	159264.3	792.507	792.39	-0.117	MOWED GRASS
4066	598421.8	159261	792.465	792.22	-0.245	MOWED GRASS
4067	598418.1	159261.6	792.321	792.03	-0.291	MOWED GRASS
4068	598414.8	159262	792.236	792.02	-0.216	MOWED GRASS
4069	598411.4	159262.6	792.137	791.92	-0.217	MOWED GRASS

4070	598411.9	159266.4	792.161	792.04	-0.121	MOWED GRASS
4071	598412.4	159269.4	792.227	792.08	-0.147	MOWED GRASS
4072	598416.6	159268.7	792.402	792.2	-0.202	MOWED GRASS
4073	598419.4	159268.4	792.452	792.24	-0.212	MOWED GRASS
4074	598418.9	159265.2	792.457	792.27	-0.187	MOWED GRASS
4075	598415.1	159265.6	792.275	792.1	-0.175	MOWED GRASS
4076	594344.7	163193.8	800.379	800.11	-0.269	MOWED GRASS
4077	594340.5	163193.9	800.341	800.2	-0.141	ASPHALT
4078	594336.9	163193.9	800.316	800.1	-0.216	ASPHALT
4079	594333.3	163193.9	800.312	800	-0.312	ASPHALT
4080	594329.8	163193.9	800.273	799.93	-0.343	ASPHALT
4081	594329.8	163190.2	800.333	800.1	-0.233	ASPHALT
4082	594333.2	163190.2	800.383	800.05	-0.333	ASPHALT
4083	594336.8	163190.1	800.419	800.19	-0.229	ASPHALT
4084	594340.3	163190.1	800.424	800.05	-0.374	ASPHALT
4085	594344.7	163190.1	800.46	800.1	-0.36	ASPHALT
4086	594344.8	163186.5	800.522	800.09	-0.432	ASPHALT
4087	594340.8	163186.7	800.501	800.02	-0.481	ASPHALT
4088	594337.2	163186.7	800.486	800.22	-0.266	ASPHALT
4089	594333.4	163186.8	800.453	800.11	-0.343	ASPHALT
4090	594330	163186.8	800.412	800.13	-0.282	ASPHALT
4091	594329.9	163183.1	800.402	800.21	-0.192	ASPHALT
4092	594333.6	163183	800.445	800.19	-0.255	ASPHALT
4093	594337.3	163183	800.495	800.25	-0.245	ASPHALT
4094	594340.8	163182.9	800.529	800.14	-0.389	ASPHALT
4095	594344.6	163182.8	800.526	800.26	-0.266	ASPHALT
4096	594344.8	163178.9	800.536	800.33	-0.206	ASPHALT
4097	594341.2	163178.9	800.488	800.2	-0.288	ASPHALT
4098	594337.4	163178.9	800.444	800.06	-0.384	ASPHALT
4099	594333.6	163178.8	800.422	800.14	-0.282	ASPHALT
4100	594330.2	163178.8	800.36	800.15	-0.21	ASPHALT
4101	603158.4	149638.6	1015.605	1015.78	0.175	ASPHALT
4102	603160.7	149640.9	1015.753	1015.86	0.107	WOODED
4103	603162.8	149642.7	1015.751	1015.55	-0.201	WOODED
4104	603165.2	149644.7	1016.169	1015.7	-0.469	WOODED
4105	603167.5	149647	1015.993	1015.94	-0.053	WOODED
4106	603167.7	149642.3	1016.303	1016.03	-0.273	WOODED
4107	603165	149640.6	1016.096	1016.03	-0.066	WOODED
4108	603158.6	149643.4	1015.398	1015.48	0.082	WOODED
4109	603160.8	149645.5	1015.527	1015.48	-0.047	WOODED
4110	603161.2	149654.6	1015.368	1015.16	-0.208	WOODED
4111	603158.4	149652.9	1015.157	1015.01	-0.147	WOODED
4112	603156.3	149650.8	1015.406	1015.01	-0.396	WOODED
4113	603150.2	149647.2	1014.686	1014.88	0.194	WOODED
4114	603153.3	149649.2	1014.953	1014.9	-0.053	WOODED



4115	603152.5	149644.7	1015.04	1015	-0.04	WOODED
4116	603154.8	149641.7	1015.285	1015.11	-0.175	WOODED
4117	603162.7	149638.1	1016.236	1016.05	-0.186	WOODED
4118	603159.4	149636.3	1016.044	1015.94	-0.104	WOODED
4119	603169.6	149644.9	1016.275	1016.07	-0.205	WOODED
4120	603165.6	149650.2	1015.869	1015.7	-0.169	WOODED
4121	603163.5	149647.6	1015.651	1015.73	0.079	WOODED
4122	603163.5	149652.5	1015.712	1015.51	-0.202	WOODED
4123	603160.5	149650.2	1015.697	1015.37	-0.327	WOODED
4124	603155	149646	1015.163	1015.24	0.077	WOODED
4125	603157.6	149647.5	1015.08	1015.35	0.27	WOODED

Average dz	-0.039
Minimum dz	-0.9
Maximum dz	1.226
Average magnitude	0.247
Root mean square	0.296
Std deviation	0.293
AccuracyZ	0.5743

FIELD NOTES

Project FEMA ground survey notes

Contains point number and descriptions

Includes Control and Check Points left out of statistical analysis

FEMA POINT #1

Checked NGS Mon. DELONA  
w GPS (PID DHS199)

✓ GOOD

1001-1025	Tall Grass
1026-1050	Asphalt
1051-1075	Mowed Grass
1075-1100	Brush
1101-1125	Wooded Area

FEMA POINT #2

Checked into NGS Monument  
WARDS CORNERS GPS (PID DHS074)

✓ GOOD

2001-2025 BRUSH

2026-2050 WOODED AREA

2051-2075 TALL GRASS

2076-2100 GRAVEL

2101-2125 MOWED GRASS

FEMA POINT #3

Checked NGS Monument

GREENFIELD W GPS (DA 5468)

✓ GOOD

3001 - 3025 GRAVEL

3026 - 3050 TALL GRASS

3051 - 3075 BRUSH

3076 - 3100 WOODED

3101 - 3125 ASPHALT

3126 - 3150 MOWED GRASS

FEMA POINT #4

Checked NGS point TROY w GPS  
(PID DHS100)

✓ Good

4001-4025 TALL GRASS

4051-4075 MOWED GRASS

4076-4100 ASPHALT

4101-4125 WOODED AREA

Unable to find suitable brushy  
area for survey within required  
survey area