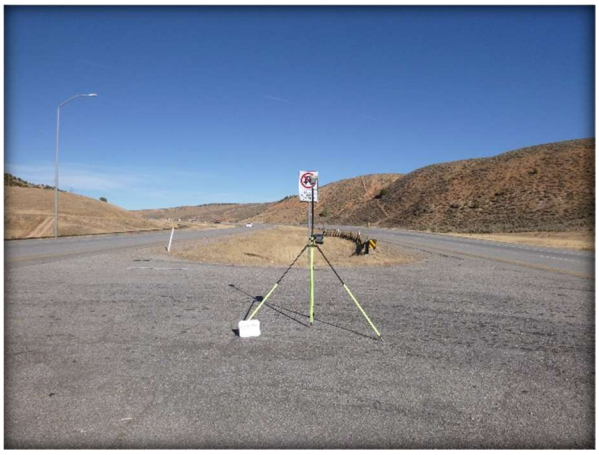
Ground Control Point Survey Report

Utah Flaming Gorge LDAR Project
USGS Contract: G16PC00020
Task Order Number: 140G0220F0147

Prepared for:
United States Geological Survey (USGS)



Prepared By:

Dewberry Engineers Inc.

4601 Forbes Boulevard, Suite 300
Lanham, Maryland, 20706
Phone (301)364-1855 Fax (301)731-0188

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1. INTRODUCTION

1.1 *Project Summary*

Dewberry Engineers Inc. is under contract to the United States Geological Survey to provide 74 Ground Control Points in the State of Utah. Under the above referenced USGS Task Order, Dewberry is tasked to complete the quality assurance of LiDAR products. As part of this work Dewberry staff will complete Ground Control Point surveys that will be used to evaluate vertical and horizontal accuracy. The ground survey was conducted September 2020 thru November 2020.

Existing NGS Control Points were located and surveyed to check the accuracy of the RTK/GPS survey equipment with the results shown in Section 2.4 of this Report.

As an internal QA/QC procedure and to verify that the Ground Control Points meet the 95% confidence level approximately 50% of the points were re-observed and are shown in Section 5 of this report.

Final horizontal coordinates are referenced to UTM 12N, NAD83 (2011) in meters. Final Vertical elevations are referenced to NAVD88 in meters using Geoid model 2018 (Geoid18).

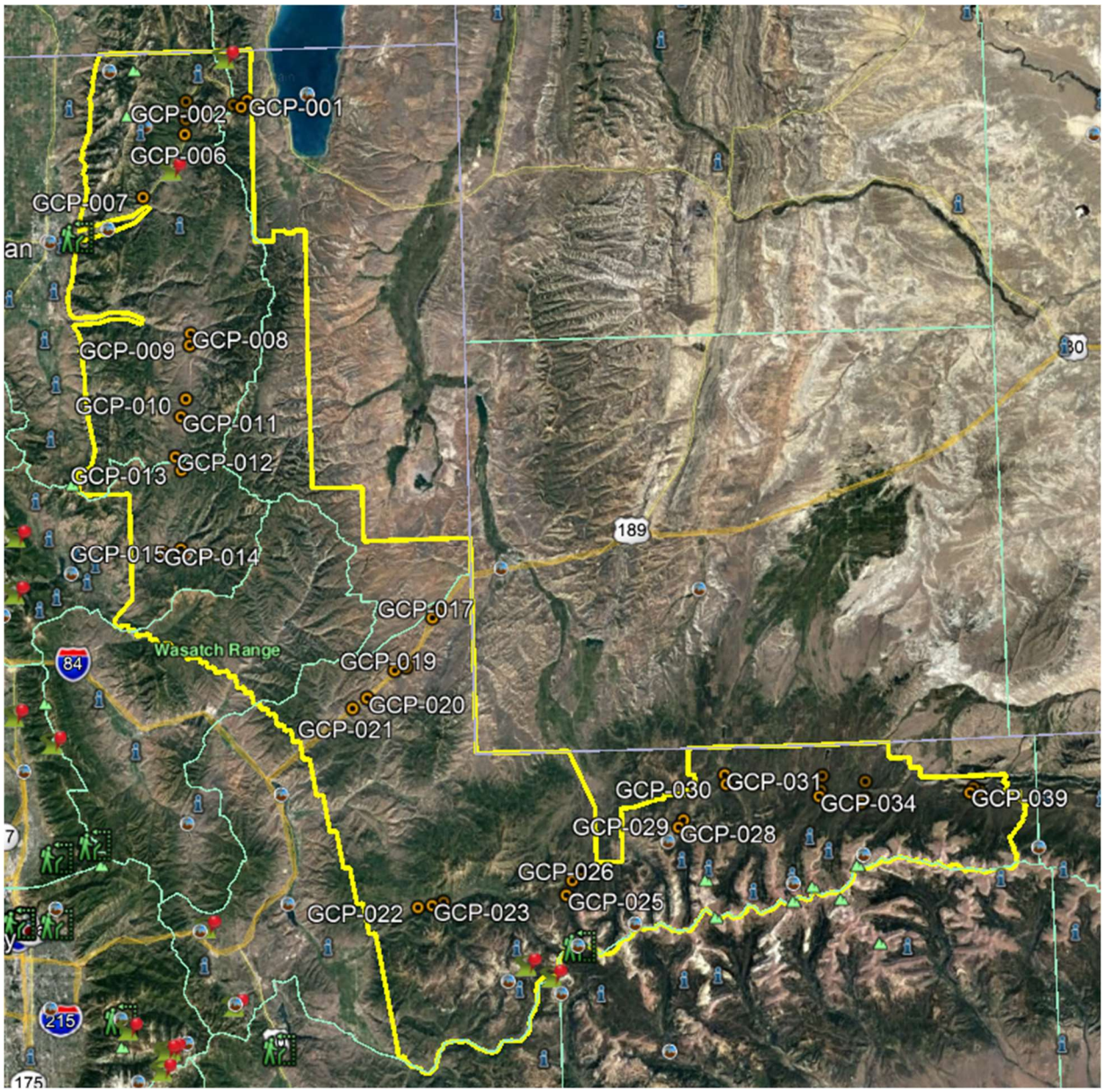
1.2 *Points of Contact*

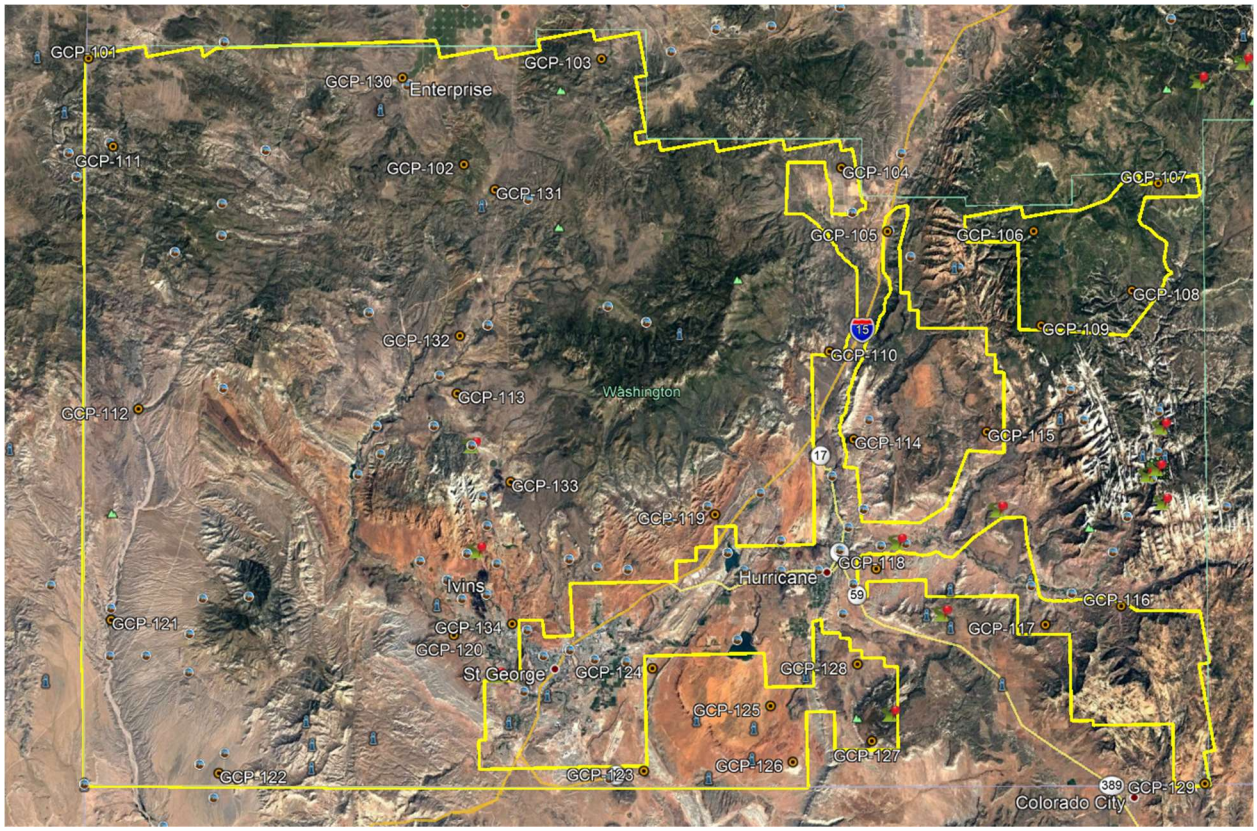
Questions regarding the technical aspects of this report should be addressed to:

Dewberry Engineers Inc.

Gary D. Simpson, L.S.
Senior Associate
4601 Forbes Boulevard
Suite 300
Lanham, Maryland 20706
(301) 364-1855 direct
(301) 731-0188 fax

1.3 *Project Area*




GCP-101
GCP-103
GCP-130
Enterprise
GCP-111
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Colorado City

PROJECT DETAILS

2.1 *Survey Equipment*

In performing the GPS observations Trimble R-10 GNSS receiver/antenna attached to a two meter fixed height pole with a Trimble TSC3 Data Collector to collect GPS raw data were used to perform the field surveys.

2.2 *Survey Point Detail*

The 74 Ground Control Points were well distributed throughout the project area.

A sketch was made for each location and a nail was set at the point where possible or at an identifiable point. The Ground Control Point locations are detailed on the "Control Point Documentation Report" sheets attached to this report.

2.3 *Network Design*

The GPS survey performed by Dewberry Engineers Inc. office located in Lanham, MD was tied to a Real Time Network. The network is a series of "real-time" continuously operating, high precision GPS reference stations. All of the reference stations have been linked together using Trimble GPSNet software, creating a Virtual Reference Station System (VRS).

The Reference Station is a multi-channel, multi-frequency GNSS (Global Navigation Satellite System) receiver designed for use as a stand-alone reference station or as part of a GNSS infrastructure solution. The receiver supports the modernized GPS L2C and L5 signals as well as GLONASS L1/L2 signals.

2.4 *Field Survey Procedures and Analysis*

Dewberry field surveyors used Trimble R-10 GNSS receivers, which is a geodetic quality dual frequency GPS receiver, to collect data at each surveyed location.

All locations were occupied once with approximately 50% of the locations being re-observed. All re-observations matched the initially derived station positions within the allowable tolerance of ± 5cm or within the 95% confidence level. Each occupation which utilized the VRS network was occupied for approximately three (3) minutes in duration and measured to 180 epochs.

Each occupation which utilized OPUS (if used) was occupied between 20 and 30 minutes.

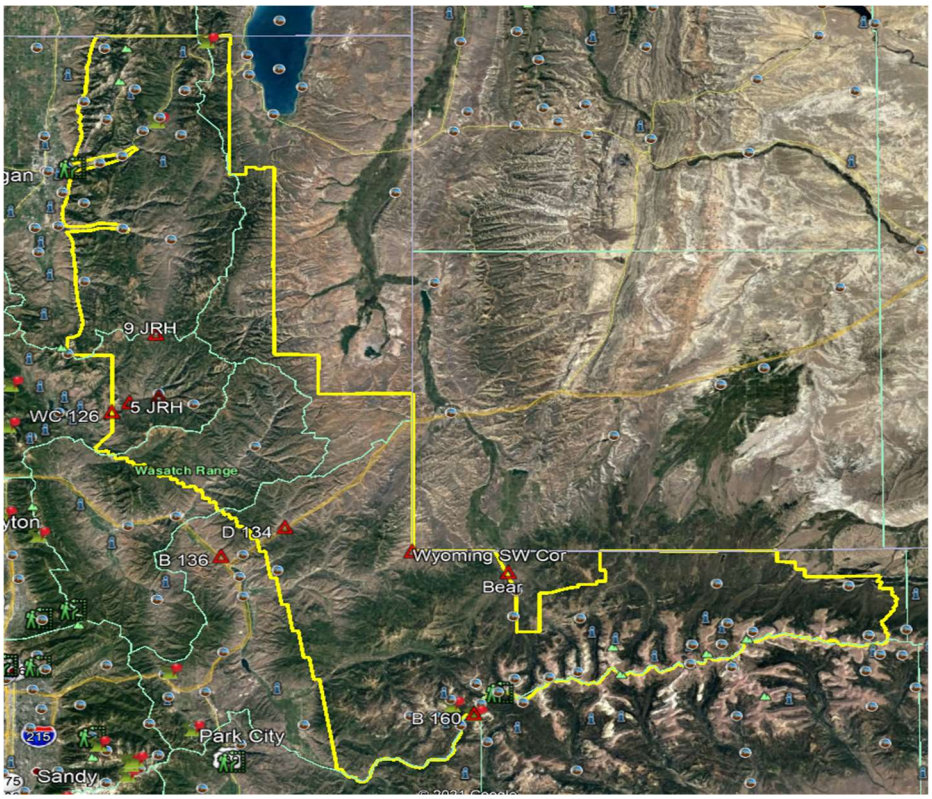
Field GPS observations are detailed on the "Control Point Documentation Reports" submitted as part of this report.

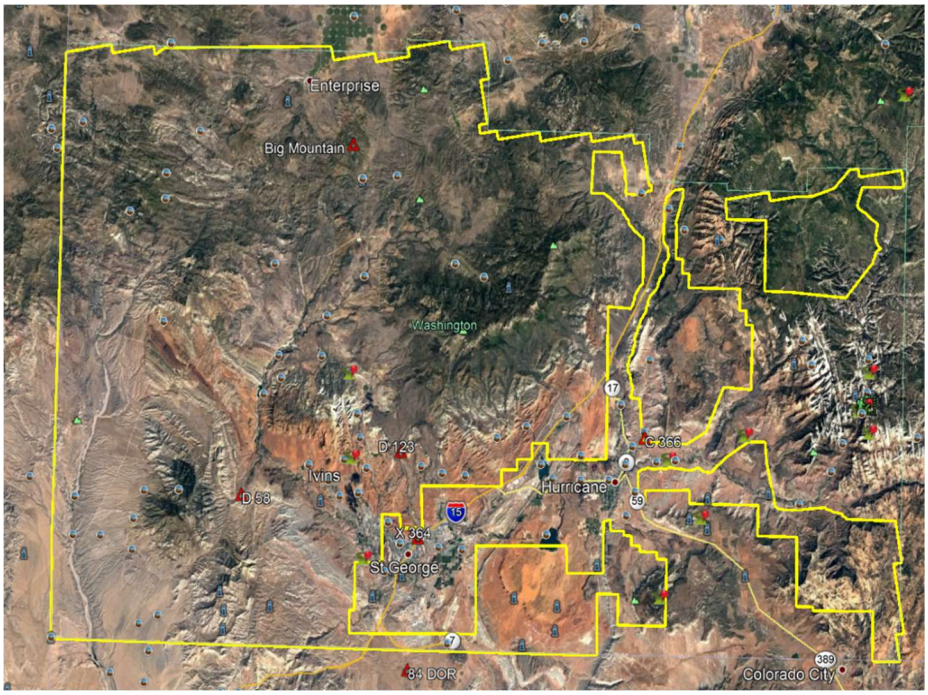
Eight (8) existing NGS monument listed in the NSRS database were located for the Louisiana area as an additional QA/QC method to check the horizontal and vertical accuracy of the VRS network as well as being the primary project control monuments designated as DR5480, AI5797, AI5801, LO0220, MR0316, LO0707, LO0170, DR5561. The results are as follows:

	Observed Values			Data Sheet Values					
PT. #	NORTHING	EASTING	ELEVS.(m)	NORTHING	EASTING	ELEVS.(m)	Δ X	Δ Y	Δ Z
5 JRH	4570706.260	445787.659	1616.925	4570706.268	445787.643	1616.880	-0.008	0.016	0.045
9 JRH	4585525.737	450517.473	2179.650	4585525.745	450517.477	2179.630	-0.008	-0.004	0.020
CAUSEY	4571925.450	451033.789	1761.452	4571925.456	451033.793	1761.450	-0.006	-0.004	0.002
B136	4537500.725	462048.064	1660.420	4537500.728	462048.051	1660.417	-0.003	0.013	0.003
D134	4543738.557	473437.024	1799.253	N/A	N/A	1799.265	N/A	N/A	-0.012
WYSWCOR	4538522.692	496062.450	2181.149	4538522.649	496062.494	2181.140	0.043	-0.044	0.009
B160	4503394.898	507007.417	3154.781	N/A	N/A	3154.736	N/A	N/A	0.045
WC126	4568707.917	442622.596	1567.610	4568707.921	442622.612	1567.570	-0.004	-0.016	0.040

The above results indicate that the VRS network is providing positional values within the 5cm parameters for this survey.

NGS Monuments





2.5 *Adjustment*

The survey data was collected using Virtual Reference Stations (VRS) methodology within a Virtual Reference System (VRS).

The system is designed to provide a true Network RTK performance, the RTKNet software enables high-accuracy positioning in real time across a geographic region. The RTKNet software package uses real-time data streams from the network user and generates correction models for high-accuracy RTK GPS corrections throughout the network. Therefore, corrections were applied to the points as they were being collected, thus negating the need for a post process adjustment.

2.6 *Data Processing Procedures*

After field data is collected the information is downloaded from the data collectors into the office software. The Software program used is called Trimble Business Center.

Downloaded data is run through the TBC program to obtain the following reports; points report, point comparison report and a point detail report. The reports are reviewed for point accuracy and precision.

After review of the point data an “ASCII” or “txt” file which is the industry standard is created. Point files are loaded into our CADD program (Carlson Survey 2019) to make a visual check of the point data (Pt. #, Coordinates, Elev. and Description). The data can now be imported into the final product.

3. *FINAL COORDINATES/ELEVATIONS*

POINT ID	NORTHING (m)	EASTING (m)	ELEV. (m)
UTM 12N, NAD83 (2011), NAVD 88, Meters, Geoid 18			
GCP-1	4642170.104	463088.528	2186.425
GCP-2	4641166.134	462099.015	2317.967
GCP-3	4641562.060	460864.290	2371.409
GCP-4	4642318.999	453421.723	2027.092
GCP-5	4639496.766	453318.685	1967.208
GCP-6	4637166.426	453110.321	1911.404
GCP-7	4627472.718	446229.851	1643.175
GCP-8	4605916.544	453299.129	1715.223
GCP-9	4604058.259	453003.031	1710.843
GCP-10	4595637.311	452166.951	1982.465
GCP-11	4592888.395	451314.791	2086.067
GCP-12	4586615.626	450272.986	2124.145
GCP-13	4584503.168	451175.975	2204.704
GCP-14	4571708.555	447823.784	1655.933
GCP-15	4572138.812	450739.807	1739.836
GCP-16	4561093.574	490875.673	2078.318
GCP-17	4560162.691	490036.626	2055.318
GCP-18	4552532.925	485727.122	1920.161
GCP-19	4552120.395	483864.009	1923.635
GCP-20	4548286.749	480226.930	1864.121
GCP-21	4546326.706	477067.956	1845.844
GCP-22	4514858.834	486441.281	2181.224
GCP-23	4515092.229	488695.742	2221.147
GCP-24	4515592.178	490476.460	2257.896
GCP-25	4516147.011	509859.056	2767.151
GCP-26	4518408.953	510867.556	2758.904
GCP-27	4519890.964	512376.534	2701.572
GCP-28	4526300.802	527801.684	2843.749
GCP-29	4527414.964	528579.599	2843.068
GCP-30	4532822.312	535457.351	2710.248
GCP-31	4534343.346	535279.528	2696.702
GCP-32	4531447.079	550245.044	2867.632
GCP-33	4533703.268	550616.034	2855.464
GCP-34	4530509.972	550009.916	2888.301
GCP-35	4529275.106	556604.807	2859.032
GCP-36	4530020.209	557182.087	2831.422

GCP-37	4532630.863	557321.913	2759.180
GCP-38	4531133.265	574355.561	2804.972
GCP-39	4530424.837	573805.656	2806.907
GCP-40	4530622.719	575278.144	2822.654
GCP-101	4165231.121	230707.028	1877.545
GCP-102	4154641.120	264723.991	2177.924
GCP-103	4163884.574	277523.959	1736.614
GCP-104	4153426.551	299046.061	1728.910
GCP-105	4147534.425	303089.375	1544.750
GCP-106	4146141.911	318074.662	2476.515
GCP-107	4146648.527	319050.326	2480.656
GCP-108	4141935.380	325367.320	2054.825
GCP-109	4138646.056	316808.799	2370.261
GCP-110	4140556.529	300049.918	1518.655
GCP-111	4157159.559	232773.952	1677.880
GCP-112	4133287.546	234490.802	1092.212
GCP-113	4133902.371	263562.703	1431.072
GCP-114	4127520.393	306430.593	1723.535
GCP-115	4129169.106	311633.116	1645.387
GCP-116	4111445.070	314007.382	1430.412
GCP-117	4111563.386	316518.577	1349.890
GCP-118	4116999.192	301256.363	1149.503
GCP-119	4122324.564	286738.363	973.382
GCP-120	4112704.921	263113.765	852.278
GCP-121	4114220.100	231471.558	884.546
GCP-122	4100071.715	240932.882	843.026
GCP-123	4099285.116	279645.883	860.497
GCP-124	4108474.207	280636.563	892.528
GCP-125	4104866.247	291309.206	1065.542
GCP-126	4099735.005	293217.404	1002.870
GCP-127	4101453.218	300450.147	1778.959
GCP-128	4108430.765	299320.667	1326.486
GCP-129	4096747.202	330703.413	1631.841
GCP-130	4162648.979	259340.129	1629.538
GCP-131	4152256.866	267465.980	1775.282
GCP-132	4139117.504	263975.398	1499.711
GCP-133	4125766.716	268191.544	1382.138
GCP-134	4112921.386	268024.264	884.719

4. *GPS OBSERVATIONS*

POINT ID	OBSERV. DATE	JULIAN DATE	TIME OF DAY (AST)	RE-OBSERV. DATE	RE-OBSERV. TIME
GCP-1	9/18/2020	262	9:39	9/19/2020	14:59
GCP-2	9/18/2020	262	9:21	9/19/2020	14:46
GCP-3	9/18/2020	262	9:08	9/19/2020	14:37
GCP-4	9/18/2020	262	11:57	N/A	N/A
GCP-5	9/18/2020	262	12:34	N/A	N/A
GCP-6	9/18/2020	262	13:12	N/A	N/A
GCP-7	9/18/2020	262	14:58	N/A	N/A
GCP-8	9/20/2020	264	13:47	9/21/2020	12:22
GCP-9	9/20/2020	264	14:26	9/21/2020	11:51
GCP-10	9/20/2020	264	16:26	9/21/2020	10:14
GCP-11	9/20/2020	264	17:06	9/21/2020	10:00
GCP-12	9/22/2020	264	17:05	9/23/2020	10:28
GCP-13	9/22/2020	264	16:08	9/23/2020	11:13
GCP-14	9/22/2020	264	13:13	9/23/2020	8:48
GCP-15	9/22/2020	264	13:52	N/A	N/A
GCP-16	10/16/2020	290	11:45	11/20/2020	13:41
GCP-17	10/16/2020	290	12:05	10/20/2020	14:47
GCP-18	10/16/2020	290	16:06	10/20/2020	15:15
GCP-19	10/16/2020	290	12:45	10/20/2020	15:07
GCP-20	10/16/2020	290	15:48	10/20/2020	15:28
GCP-21	10/16/2020	290	13:11	10/20/2020	15:35
GCP-22	10/25/2020	299	12:23	10/25/2020	16:42
GCP-23	10/25/2020	299	12:49	10/25/2020	16:58
GCP-24	10/25/2020	299	13:10	10/25/2020	17:19
GCP-25	10/23/2020	297	14:07	10/24/2020	9:39
GCP-26	10/23/2020	297	13:19	N/A	N/A
GCP-27	10/15/2020	289	15:59	N/A	N/A
GCP-28	10/22/2020	296	14:40	N/A	N/A
GCP-29	10/22/2020	296	13:44	N/A	N/A
GCP-30	10/21/2020	295	15:43	N/A	N/A
GCP-31	10/21/2020	295	14:52	10/22/2020	12:30
GCP-32	10/19/2020	293	17:13	N/A	N/A
GCP-33	10/19/2020	293	18:03	N/A	N/A
GCP-34	10/19/2020	293	16:25	N/A	N/A
GCP-35	10/18/2020	292	13:43	N/A	N/A
GCP-36	10/18/2020	292	14:32	N/A	N/A

GCP-37	10/18/2020	292	15:28	10/19/2020	13:47
GCP-38	10/17/2020	291	12:52	10/17/2020	17:10
GCP-39	10/17/2020	291	11:59	N/A	N/A
GCP-40	10/17/2020	291	13:40	N/A	N/A
GCP-101	9/26/2020	270	14:38	N/A	N/A
GCP-102	9/26/2020	270	11:02	9/27/2020	11:50
GCP-103	10/6/2020	280	12:18	10/7/2020	13:41
GCP-104	10/8/2020	282	8:56	10/9/2020	9:55
GCP-105	10/3/2020	277	16:29	10/4/2020	9:48
GCP-106	10/11/2020	286	10:58	N/A	N/A
GCP-107	10/31/2020	305	12:45	N/A	N/A
GCP-108	10/11/2020	286	16:11	N/A	N/A
GCP-109	10/11/2020	286	13:05	N/A	N/A
GCP-110	10/9/2020	283	10:37	N/A	N/A
GCP-111	10/5/2020	279	17:32	N/A	N/A
GCP-112	10/5/2020	279	10:35	N/A	N/A
GCP-113	9/26/2020	270	9:06	9/27/2020	10:07
GCP-114	10/10/2020	285	13:19	10/17/2020	9:46
GCP-115	10/10/2020	285	10:37	10/12/2020	8:52
GCP-116	10/31/2020	305	16:10	11/1/2020	14:00
GCP-117	10/3/2020	277	11:32	N/A	N/A
GCP-118	10/3/2020	277	14:31	10/4/2020	10:49
GCP-119	10/8/2020	282	10:59	10/9/2020	12:21
GCP-120	9/28/2020	272	14:09	9/29/2020	18:17
GCP-121	9/30/2020	274	14:57	N/A	N/A
GCP-122	9/30/2020	274	13:25	N/A	N/A
GCP-123	9/28/2020	272	11:50	9/29/2020	10:36
GCP-124	9/28/2020	272	10:33	9/29/2020	9:55
GCP-125	10/4/2020	278	17:28	N/A	N/A
GCP-126	10/4/2020	278	16:47	N/A	N/A
GCP-127	10/4/2020	278	15:34	N/A	N/A
GCP-128	10/4/2020	278	13:05	10/12/2020	11:25
GCP-129	10/1/2020	275	11:50	N/A	N/A
GCP-130	11/3/2020	308	12:43	N/A	N/A
GCP-131	11/3/2020	308	12:17	N/A	N/A
GCP-132	11/3/2020	308	11:56	N/A	N/A
GCP-133	11/3/2020	308	11:34	N/A	N/A
GCP-134	11/3/2020	308	11:13	N/A	N/A

5. *POINT COMPARISON*

Point ID	Point CK	Delta North (M)	Delta East (M)	Vertical Difference (M)
GCP-01	GCP-01 CK	0.031	-0.017	0.025
GCP-02	GCP-02 CK	0.003	-0.006	0.017
GCP-03	GCP-03 CK	-0.014	-0.006	0.024
GCP-04	GCP-04 CK	N/A	N/A	N/A
GCP-05	GCP-05 CK	N/A	N/A	N/A
GCP-06	GCP-06 CK	N/A	N/A	N/A
GCP-07	GCP-07 CK	N/A	N/A	N/A
GCP-08	GCP-08 CK	0.024	-0.029	-0.035
GCP-09	GCP-09 CK	-0.030	-0.016	-0.010
GCP-10	GCP-10 CK	0.002	-0.009	-0.002
GCP-11	GCP-11 CK	-0.030	-0.016	-0.010
GCP-12	GCP-12 CK	-0.023	-0.042	-0.031
GCP-13	GCP-13 CK	-0.016	0.007	0.039
GCP-14	GCP-14 CK	-0.023	-0.012	-0.042
GCP-15	GCP-15 CK	N/A	N/A	N/A
GCP-16	GCP-16 CK	-0.002	-0.001	0.011
GCP-17	GCP-17 CK	-0.003	-0.005	0.014
GCP-18	GCP-18 CK	0.008	-0.018	0.000
GCP-19	GCP-19 CK	-0.003	0.006	0.013
GCP-20	GCP-20 CK	-0.001	0.009	0.004
GCP-21	GCP-21 CK	0.020	-0.002	0.011
GCP-22	GCP-22 CK	0.000	0.005	0.015
GCP-23	GCP-23 CK	-0.002	-0.001	0.022
GCP-24	GCP-24 CK	0.013	0.000	0.018
GCP-25	GCP-25 CK	-0.008	0.000	-0.010
GCP-26	GCP-26 CK	N/A	N/A	N/A
GCP-27	GCP-27 CK	N/A	N/A	N/A
GCP-28	GCP-28 CK	N/A	N/A	N/A
GCP-29	GCP-29 CK	N/A	N/A	N/A
GCP-30	GCP-30 CK	N/A	N/A	N/A
GCP-31	GCP-31 CK	0.006	-0.023	-0.003
GCP-32	GCP-32 CK	N/A	N/A	N/A
GCP-33	GCP-33 CK	N/A	N/A	N/A
GCP-34	GCP-34 CK	N/A	N/A	N/A
GCP-35	GCP-35 CK	N/A	N/A	N/A
GCP-36	GCP-36 CK	N/A	N/A	N/A
GCP-37	GCP-37 CK	-0.010	-0.006	-0.024
GCP-38	GCP-38 CK	0.013	0.015	-0.028
GCP-39	GCP-39 CK	N/A	N/A	N/A

GCP-40	GCP-40 CK	N/A	N/A	N/A
GCP-101	GCP-101 CK	N/A	N/A	N/A
GCP-102	GCP-102 CK	-0.009	0.012	0.005
GCP-103	GCP-103 CK	0.012	-0.040	-0.047
GCP-104	GCP-104 CK	-0.008	-0.007	0.008
GCP-105	GCP-105 CK	0.015	0.001	0.002
GCP-106	GCP-106 CK	N/A	N/A	N/A
GCP-107	GCP-107 CK	N/A	N/A	N/A
GCP-108	GCP-108 CK	N/A	N/A	N/A
GCP-109	GCP-109 CK	N/A	N/A	N/A
GCP-110	GCP-110 CK	N/A	N/A	N/A
GCP-111	GCP-111 CK	N/A	N/A	N/A
GCP-112	GCP-112 CK	N/A	N/A	N/A
GCP-113	GCP-113 CK	0.007	-0.006	0.020
GCP-114	GCP-114 CK	-0.004	-0.002	-0.006
GCP-115	GCP-115 CK	0.005	0.004	-0.006
GCP-116	GCP-116 CK	-0.002	0.016	-0.007
GCP-117	GCP-117 CK	N/A	N/A	N/A
GCP-118	GCP-118 CK	-0.009	0.000	0.016
GCP-119	GCP-119 CK	0.004	-0.008	-0.040
GCP-120	GCP-120 CK	-0.024	0.016	0.028
GCP-121	GCP-121 CK	N/A	N/A	N/A
GCP-122	GCP-122 CK	N/A	N/A	N/A
GCP-123	GCP-123 CK	-0.022	0.001	0.037
GCP-124	GCP-124 CK	-0.009	0.001	0.002
GCP-125	GCP-125 CK	N/A	N/A	N/A
GCP-126	GCP-126 CK	N/A	N/A	N/A
GCP-127	GCP-127 CK	N/A	N/A	N/A
GCP-128	GCP-128 CK	0.002	0.003	-0.004
GCP-129	GCP-129 CK	N/A	N/A	N/A
GCP-130	GCP-130 CK	N/A	N/A	N/A
GCP-131	GCP-131 CK	N/A	N/A	N/A
GCP-132	GCP-132 CK	N/A	N/A	N/A
GCP-133	GCP-133 CK	N/A	N/A	N/A
GCP-134	GCP-134 CK	N/A	N/A	N/A