Check Point Survey Report
"Louisa, Virginia LiDAR Quality Assurance"
USGS Contract: G10PC00013
Task Order Number: G12PD00264

Prepared for:
UNITED STATES GEOLOGICAL SURVEY

Prepared By:

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1. INTRODUCTION

1.1 *Project Summary*

Dewberry & Davis, LLC is under contract to the United States Geological Survey to provide 44 QA Check Points IN Louisa County, Virginia. Under the above referenced USGS Task Order, Dewberry is tasked to complete the quality assurance of high resolution LiDAR-derived elevation products. As part of this work Dewberry staff will complete checkpoint surveys that will be used to evaluate vertical accuracy on the bare-earth terrain derived from the LiDAR.

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 Check 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, Zone 18, NAD83 (NSRS 2007), in meters. Final Vertical elevations are referenced to NAVD 88 in meters, orthometric heights, using Geoid 09.

1.2 *Points of Contact*

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

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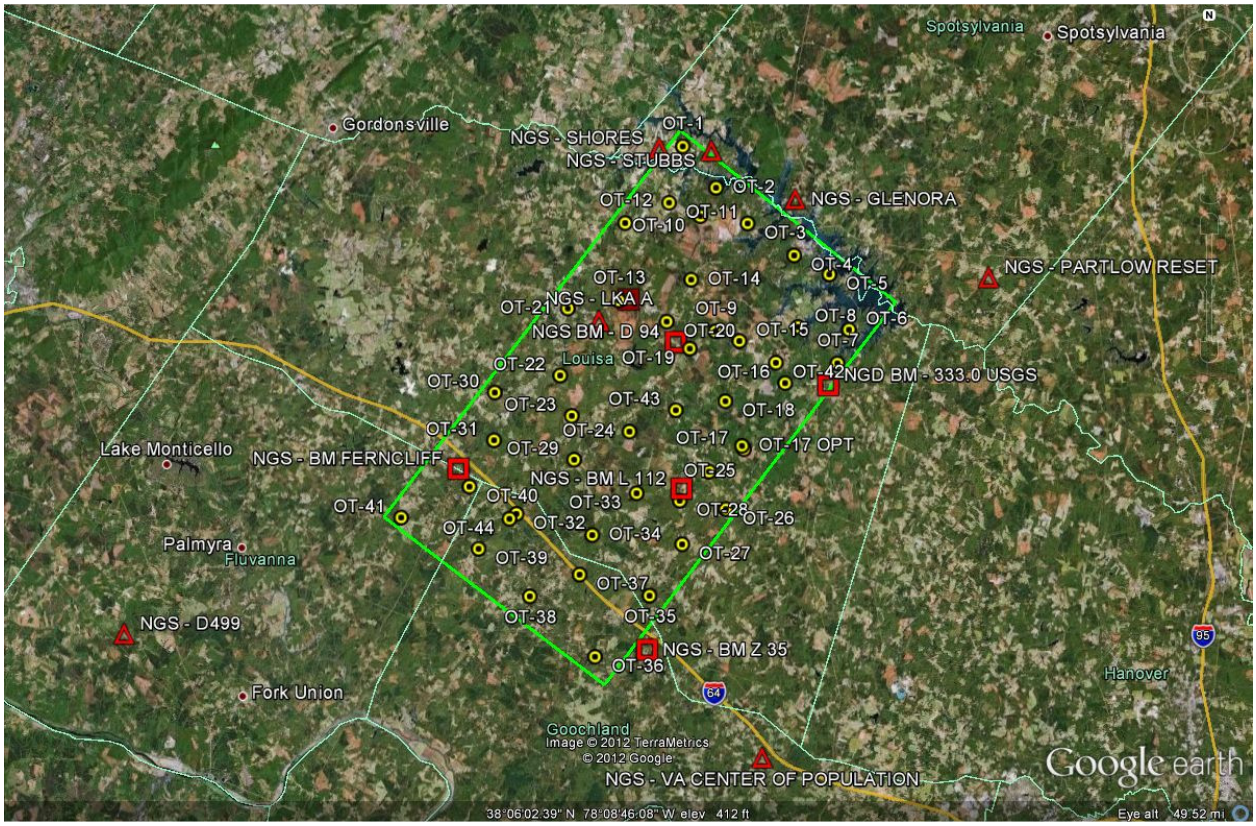
1.3 *Project Area*



PROJECT DETAILS

2.1 *Survey Equipment*

In performing the GPS observations, Trimble R-8 GNSS receiver/antenna attached to a two meter fixed height pole with a Trimble TSC2 Data Collector to collect GPS raw data were used to perform the field surveys.

2.2 *Survey Point Detail*

The 44 Check Points were well distributed throughout the project area so as to cover as many flight lines as possible using the "dispersed method" of placement.

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

2.3 *Network Design*

The GPS survey performed by Dewberry & Davis, Inc office located in Lanham, MD was tied to a Real Time Network (RTN) managed by KeyNet GPS, Inc. 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 Trimble NetR5 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. Trimble R-Track technology in the NetR5 receiver supports the modernized GPS L2C and L5 signals as well as GLONASS L1/L2 signals.

2.4 *Field Survey Procedures and Analysis*

Dewberry & Davis, Inc used Trimble R-8 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 18 and 20 minutes.

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

NINE (9) existing NGS monuments listed in the NSRS database were located as an additional QA/QC method to check the accuracy of the VRS network as well as being the primary project control monuments. The results are as follows:

	UTM ZONE 18 As Surveyed (m)			UTM ZONE 18 Published (m)			Differences (m)		
NGS PT. ID	Northing(m)	Easting(m)	Elev.(m)	Northing(m)	Easting(m)	Elev.(m)	Δ N	Δ E	Δ Elev.
BM TT7K	4213385.962	268411.102	116.509	4213385.971	268411.111	116.570	0.009	0.009	0.061
D 499	4187356.228	732296.026	153.104	4187356.229	732296.015	153.069	0.001	0.011	0.035
F 94	4212630.621	241908.291	147.902	N/A	N/A	147.895	N/A	N/A	0.007
FERNCLIFF	4200210.228	756479.310	152.775	4200210.303	756479.200	152.765	0.075	0.110	0.010
LKA A	4211162.063	239703.205	148.738	4211162.081	239703.191	148.730	0.018	0.014	0.008
PARTLOW	4213402.161	268439.387	116.155	4213402.182	268439.377	116.200	0.021	0.010	0.045
STUBBS	4223309.295	248365.244	107.096	4223309.294	248365.225	107.100	0.001	0.019	0.004
VA CNTR POP	4178850.968	250669.006	92.392	4178850.967	250668.974	92.400	0.001	0.032	0.008
V21	4211074.887	238950.244	144.784	4211074.895	238950.217	144.79	0.008	0.027	0.006

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

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 GPSNet system 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 TGO or Trimble Geomatics Office.

Downloaded data is run through the TGO 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 2010) 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*

LOUISA, VIRGINIA LiDAR QA			
UTM ZONE 18 COORDINATE SYSTEM			
	NAD83 (m)		NAVD88 (m)
POINT ID	NORTHING (m)	EASTING (m)	ORTHO HEIGHT (m)
OPEN TERRAIN POINTS			
OT-1	4223780.061	246334.167	99.726
OT-2	4220660.185	248679.867	103.899
OT-3	4217770.888	250747.009	98.399
OT-4	4215531.335	254256.194	103.109
OT-5	4214065.721	256802.691	84.791
OT-6	4210445.772	257932.492	79.821
OT-7	4207546.480	257188.888	83.926
OT-8	4210303.473	254347.241	84.391
OT-9	4210177.053	248284.651	131.940
OT-10	4218621.780	247456.675	127.745
OT-11	4219653.849	245162.049	90.414
OT-12	4218107.005	242413.234	121.080
OT-13	4212655.926	241274.385	144.029
OT-14	4214015.328	246634.629	132.701
OT-15	4209404.457	250008.772	111.231
OT-16	4206234.512	253216.736	99.772
OT-17	4201831.875	250721.408	108.985
OT-18	4205075.536	248499.542	99.862
OT-19	4208978.633	246381.997	145.011
OT-20	4211008.178	244747.636	142.979
OT-21	4212237.938	237351.251	127.684
OT-22	4207306.609	236782.495	132.358
OT-23	4204335.982	237540.178	116.591
OT-24	4203370.179	241983.361	121.661
OT-25	4199574.800	247816.766	121.627
OT-26	4197143.475	249010.598	96.515
OT-27	4194712.869	245353.418	78.948
OT-28	4197907.516	245272.386	102.598
OT-29	4201140.683	237622.671	133.236
OT-30	4206228.697	231945.961	130.331

OT-31	**4202745.399**	**231777.230**	**135.291**
OT-32	**4192731.704**	**237743.951**	**119.420**
OT-33	**4198474.968**	**242076.753**	**90.501**
OT-34	**4195581.033**	**238768.986**	**122.261**
OT-35	**4191032.375**	**242823.317**	**113.339**
OT-36	**4186669.411**	**238662.740**	**91.882**
OT-37	**4197323.415**	**233251.810**	**155.836**
OT-38	**4191024.595**	**233863.911**	**84.293**
OT-39	**4194841.392**	**230399.740**	**150.240**
OT-40	**4199415.218**	**229870.041**	**150.996**
OT-41	**4197319.757**	**224775.655**	**114.062**
OT-42	**4207631.392**	**252559.615**	**101.619**
OT-43	**4204510.643**	**245197.517**	**130.127**
OT-44	**4196976.214**	**232730.660**	**159.520**

4. *GPS OBSERVATIONS*

LOUISA, VIRGINIA LiDAR QA					
POINT ID	**OBSERV. DATE**	**JULIAN DATE**	**TIME OF DAY**	**RE-OBSERV. DATE**	**RE-OBSERV. TIME**
OPEN TERRAIN POINTS					
OT-1	3/26/2012	85	13:30	N/A	N/A
OT-2	3/26/2012	85	15:15	N/A	N/A
OT-3	3/26/2012	85	15:56	N/A	N/A
OT-4	3/26/2012	85	16:24	N/A	N/A
OT-5	3/26/2012	85	16:20	4/21/2012	8:02
OT-6	3/26/2012	85	17:12	N/A	N/A
OT-7	3/26/2012	85	15:30	4/21/2012	18:30
OT-8	3/26/2012	85	15:49	N/A	N/A
OT-9	3/26/2012	85	12:40	N/A	N/A
OT-10	3/26/2012	85	14:15	4/21/2012	8:43
OT-11	3/26/2012	85	13:50	N/A	N/A
OT-12	3/26/2012	85	14:50	N/A	N/A
OT-13	3/26/2012	85	12:15	4/21/2012	9:57
OT-14	3/26/2012	85	13:32	N/A	N/A
OT-15	3/26/2012	85	12:20	N/A	N/A
OT-16	3/26/2012	85	11:54	N/A	N/A
OT-17	3/26/2012	85	8:52	4/21/2012	15:40
OT-18	3/26/2012	85	10:55	4/21/2012	16:32
OT-19	3/26/2012	85	12:52	5/2/2012	7:15
OT-20	3/26/2012	85	13:12	4/21/2012	9:15
OT-21	3/26/2012	85	12:15	5/2/2012	7:30
OT-22	3/26/2012	85	11:02	N/A	N/A
OT-23	3/26/2012	85	10:30	4/21/2012	15:13
OT-24	3/26/2012	85	9:51	4/21/2012	12:02
OT-25	3/26/2012	85	9:00	4/21/2012	13:01
OT-26	3/26/2012	85	8:20	4/21/2012	14:44
OT-27	3/26/2012	85	12:40	4/21/2012	7:48
OT-28	3/26/2012	85	11:15	4/21/2012	14:16
OT-29	3/26/2012	85	13:20	4/21/2012	11:35
OT-30	3/26/2012	85	14:00	N/A	N/A

OT-31	**3/26/2012**	**85**	**14:50**	**N/A**	**N/A**
OT-32	**3/27/2012**	**86**	**10:30**	**5/2/2012**	**6:15**
OT-33	**3/26/2012**	**85**	**16:20**	**N/A**	**N/A**
OT-34	**3/26/2012**	**85**	**17:20**	**N/A**	**N/A**
OT-35	**3/27/2012**	**86**	**8:40**	**N/A**	**N/A**
OT-36	**3/27/2012**	**86**	**9:40**	**N/A**	**N/A**
OT-37	**3/26/2012**	**85**	**15:30**	**5/2/2012**	**8:39**
OT-38	**3/27/2012**	**86**	**10:50**	**N/A**	**N/A**
OT-39	**3/27/2012**	**86**	**11:43**	**N/A**	**N/A**
OT-40	**3/27/2012**	**86**	**12:15**	**N/A**	**N/A**
OT-41	**3/27/2012**	**86**	**12:36**	**N/A**	**N/A**
OT-42	**3/26/2012**	**85**	**11:40**	**4/21/2012**	**17:00**
OT-43	**3/27/2012**	**86**	**13:20**	**5/2/2012**	**9:43**
OT-44	**3/27/2012**	**86**	**13:58**	**5/2/2012**	**8:21**

5. *POINT COMPARISON*

LOUISA, VIRGINIA LiDAR QA				
POINT ID	**POINT CK**	**DELTA NORTH (M)**	**DELTA EAST (M)**	**VERT. DIFF (M)**
OT-5	OT-5CK	0.008	0.026	0.040
OT-7	OT-7CK	0.019	0.018	0.040
OT-10	OT-10CK	0.026	0.023	0.026
OT-13	OT-13CK	0.010	0.028	0.030
OT-17	OT-17CK	0.013	0.032	0.008
OT-18	OT-18CK	0.009	0.004	0.025
OT-19	OT-19CK	0.009	0.007	0.031
OT-20	OT-20CK	0.041	0.030	0.034
OT-21	OT-21CK	0.008	0.009	0.044
OT-23	OT-23CK	0.018	0.010	0.020
OT-24	OT-24CK	0.007	0.003	0.039
OT-25	OT-25CK	0.022	0.013	0.041
OT-26	OT-26CK	0.002	0.000	0.034
OT-27	OT-27CK	0.009	0.013	0.041
OT-28	OT-28CK	0.020	0.042	0.043
OT-29	OT-29CK	0.002	0.007	0.025
OT-32	OT-32CK	0.025	0.013	0.005
OT-37	OT-37CK	0.016	0.033	0.017
OT-42	OT-42CK	0.005	0.029	0.005
OT-43	OT-43CK	0.001	0.008	0.007
OT-44	OT-44CK	0.004	0.005	0.039