1. INTRODUCTION

1.1 Project Summary

Dewberry Engineers Inc., under contract to United States Geodetic Survey to provide 60 Quality Assurance check points for 230 square miles in Fluvanna, Louisa, Orange, and Spotsylvania Counties in Virginia. Under the above USGS Task Order, Dewberry is tasked to complete the quality assurance of high resolution LiDAR-derived elevation products. As a part of this contract Dewberry staff has completed checkpoint surveys that will be used to evaluate vertical accuracy on the bare-earth terrain derived from the LiDAR.

Existing NGC 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 5.0 in this report.

Final horizontal coordinates are referenced to UTM Zone 17 North (Universal Transverse Mercator), NAD83, in meters (North American Datum). Final Vertical elevations are referenced to NAVD88, in meters (North American Vertical Datum).

1.2 Points of Contact

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

Dewberry Engineers Inc.

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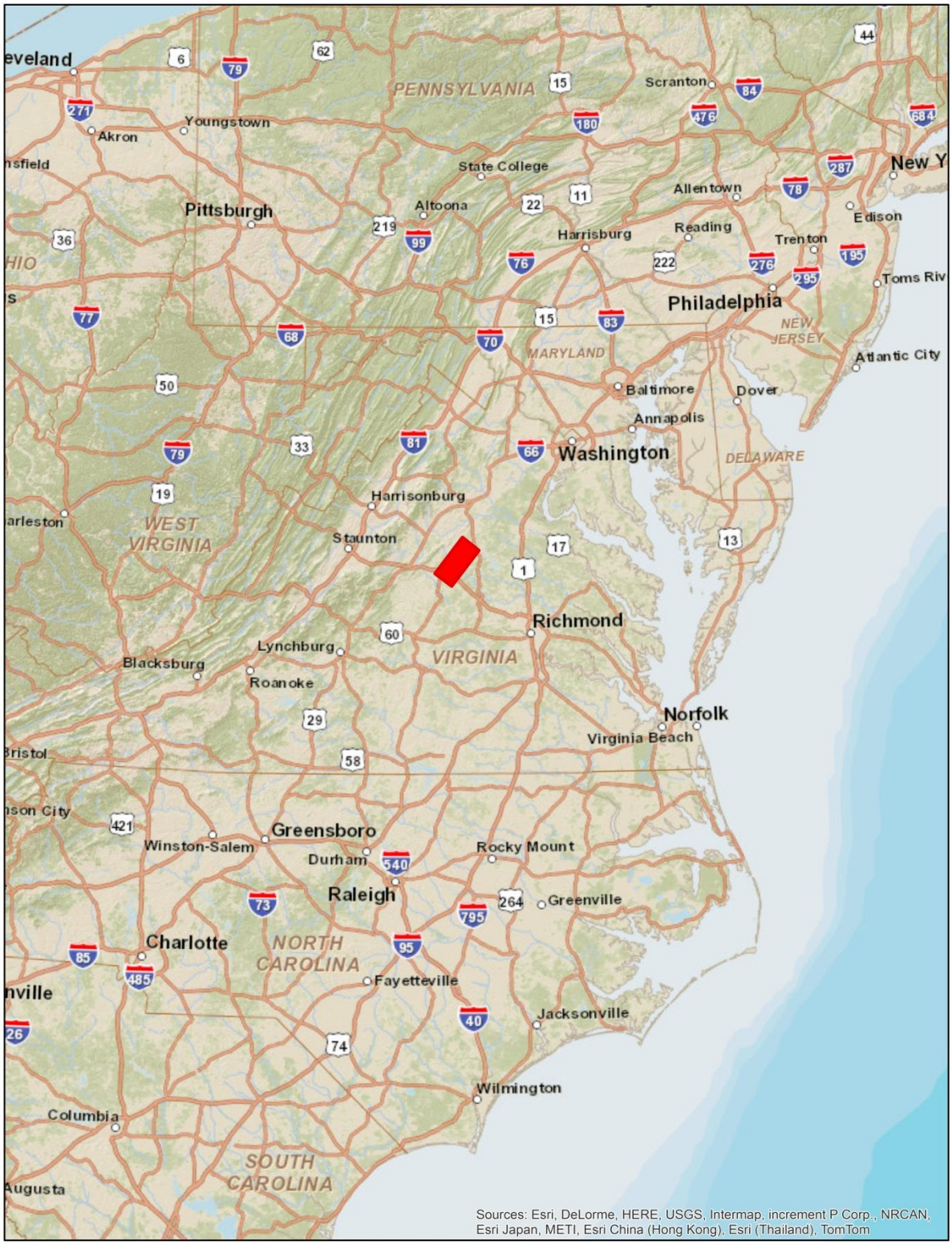
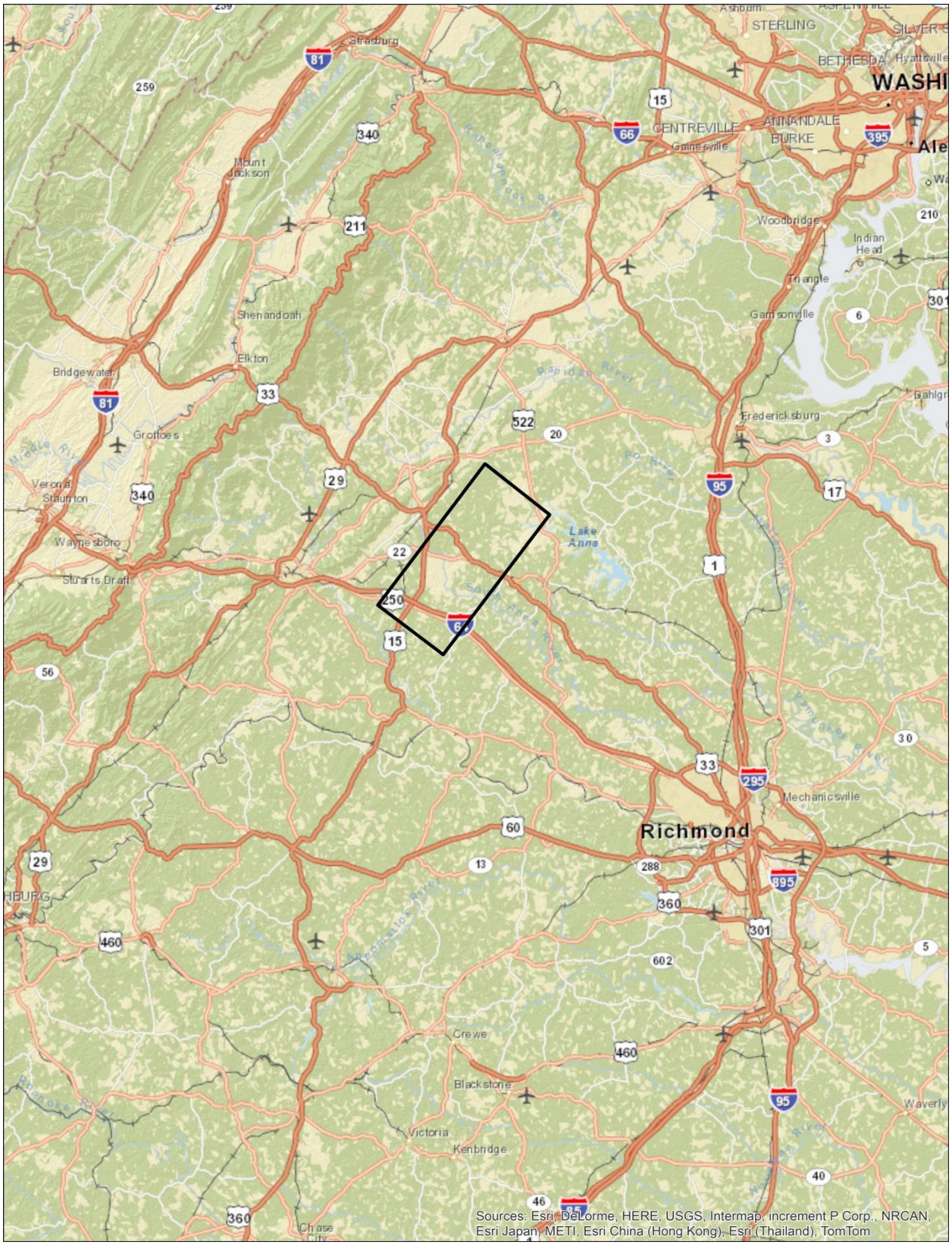
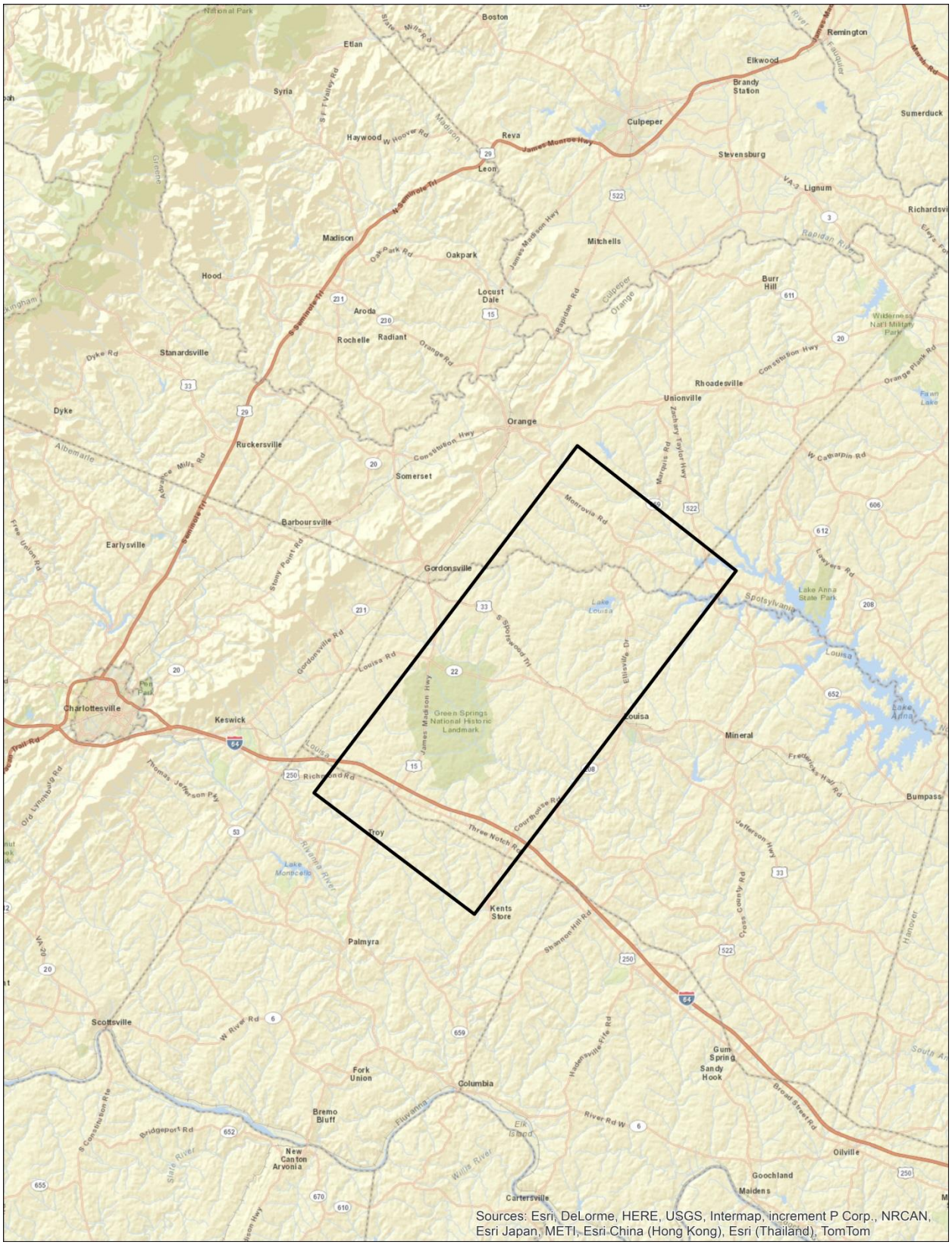
6135 Lakeview Road
Suite 150
Charlotte, NC 20269
(704)264-1257direct
(704)509-9937

1.3 Project Area




Strasburg
STERLING
BETHESDA
Hyattsville
WASHI
CENTREVILLE
ANNANDALE
BURKE
Gainesville
Mount Jackson
Woodbridge
Indian Head
Triangle
Garrisonville
Shenandoah
Elkton
Bridgewater
Grottoes
Rapidan River
Fredericksburg
Verona
Staunton
Waynesboro
Stuarts Draft
Lake Anna
Mechanicsville
Richmond
Crewe
Blackstone
Victoria
Kenbridge
Waverly
Chase City
Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom


Boston
Etlan
Syria
Remington
Elkwood
Brandy Station
Culpeper
Sumerduck
Haywood
Reva
Leon
Stevensburg
Lignum
Madison
Mitchells
Oakpark
Hood
Locust Dale
Burr Hill
Aroda
Rochelle
Radiant
Stanardsville
Rhoadesville
Unionville
Dyke
Orange
Ruckersville
Somerset
Barboursville
Earlysville
Gordonsville
Monrovia Rd
Lake Louisa
Spotsylvania
Lake Anna State Park
Louisa
Charlottesville
Keswick
Green Springs National Historic Landmark
Mineral
Bumpass
Roy
Three Notch Rd
Kents Store
Palmyra
Scottsville
Fork Union
Columbia
Gum Spring
Sandy Hook
Bremo Bluff
New Canton
Arvonia
Oilville
Goochland
Maidens
Cartersville
Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

2. PROJECT DETAILS

2.1 Survey Equipment

For the purpose of GPS observations the following equipment was utilized for data collection.

- Trimble R-8 GNSS (Global Navigation Satellite System) receiver / antenna
- 2 meter fixed height pole
- Trimble TSC2 Data Collector

2.2 Survey Point Detail

The 60 check points were well distributed throughout the project area so as to cover as many flight lines as possible using “dispersed method” of placement.

A “Ground Control Point Documentation Report” sheet was used to show the placement of the nail and a sketch for each of the points surveyed.

2.3 Network Design

The GPS survey performed by Dewberry Engineers Inc. was tied to a Real Time Network (RTN) managed by KeyNetGPS inc. KeyNetGPS is a series of continuously operating, high precision GNSS reference stations. These reference stations have all been linked together using Trimble VRS3Net App software, creating a Virtual Reference Station System (VRS).

2.4 Field Survey Procedures and Analysis

Dewberry Engineers 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 tolerances 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 at least 180 epochs.

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

10 existing NGS (National Geodetic Survey) monuments listed in the NSRS (National Spatial Reference System) database were located as an additional QA/QC method to check the accuracy of the VRS network. Some of these monuments were used as Horizontal and Vertical control checks. Some monuments were used as Horizontal or Vertical checks only as shown in the table below.

	AS SURVEYED(m)			AS PUBLISHED(m)						
NGS PT. ID	NORTHING	EASTING	ELEV	NORTHING	EASTING	ELEV	Δ N	Δ E	Δ ELEV	CHK TYPE
LKU A	4075440.488	380599.04	3.73	4,075,440.59	380,599.12	3.75	-0.103	-0.084	-0.020	VERT.
VA 21	4100627.566	384554.955	2.124	4,100,627.56	384,554.95	2.3	0.010	0.007	X	HORIZ.
K 502	4098672.971	376462.99	3.503	4,098,672.96	376,463.00	4	0.008	-0.006	X	HORIZ.
P 94	4097985.036	375769.747	2.108	4,097,985.03	375,769.74	2	0.004	0.007	X	HORIZ.
F-455	4096857.383	376079.277	3.927	X	X	3.957	X	X	-0.030	VERT.
MON 007	4135651.82	349236.942	23.259	4,135,651.79	349,236.96	23.5	0.031	-0.022	X	HORIZ.
124	4107886.234	372228.771	8.579	4,107,886.28	372,228.77	8.7	-0.048	0.003	X	HORIZ.
PASCALE	4071366.848	371222.946	5.515	4,071,366.85	371,222.94	5.6	-0.003	0.009	X	HORIZ.
PEAKE	4094521.001	376414.781	2.479	4,094,520.99	376,414.77	2.5	0.008	0.013	-0.021	VERT.
D 470	4076051.123	3999352.192	3.401	X	X	3.447	X	X	-0.046	VERT.

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

2.5 Data Processing Procedures

After field data was collected the information was downloaded from the data collectors into the office software. The software programs used included Trimble Business Center and ArcGIS 10.1.

Downloaded field data is processed through the Trimble Business Center program to obtain the following reports; points report, point comparison, 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 is created. Point files are loaded into ArcGIS software for a visual check of the point data to confirm that it also checks with the “Ground Control Point Documentation Report” sketch and description as well as the point ID, Coordinates, and Elevation.

3. FINAL COORDINATES

The final coordinate system for checkpoints is as follows:

- Coordinate System = UTM
- UTM Zone = Zone 17 N
- Horizontal Datum = NAD83
- Vertical Datum = NAVD88
- Units = both in Meters
- Geoid Model = GEOID12A

BARE EARTH			
PT ID	NORTHING	EASTING	ELEVATION
BE-1	4205923.338	738266.635	146.451
BE-2	4203414.456	746479.682	158.513
BE-3	4199325.52	749487.308	129.006
BE-4	4210077.428	743030.99	157.501
BE-5	4209005.05	746395.346	146.01
BE-6	4208516.72	748983.928	135.017
BE-7	4207806.456	752160.721	134.485
BE-8	4210970.96	755424.937	140.858
BE-9	4208558.963	759304.868	122.677
BE-10	4215044.178	746668.328	134.657
BE-11	4218264.261	754393.073	157.888
BE-12	4213962.033	759466.55	158.478
BE-13	4215236.355	762871.92	121.242
BE-14	4221973.621	749914.866	167.102
BE-15	4222735.756	755460.975	143.945
BE-16	4216962.612	762982.793	110.563
BE-17	4226411.574	756571.987	125.615
BE-18	4227206.591	758880.416	127.374
BE-19	4223380.954	762912.569	99.706
BE-20	4226838.83	764628.486	118.702
BE-21	4223813.94	767929.509	85.474

URBAN AREA			
PT ID	NORTHING	EASTING	ELEVATION
UA1	4207667.568	739772.433	136.051
UA2	4203010.436	742111.944	144.485
UA3	4201189.534	745680.342	159.344
UA4	4198972.223	752762.015	131.723
UA5CHKA	4208537.881	742529.854	161.803
UA6	4205664.871	745645.187	157.548
UA7	4203724.201	750599.464	163.472
UA8	4204877.624	755796.043	155.288
UA9	4217428.815	746822.286	150.254
UA10	4215497.947	756756.6	155.058
UA11	4213245.725	762298.902	147.012
UA12CHKA	4221046.288	752617.21	159.425
UA13	4220581.326	759892.776	128.516
UA14	4220551.312	767412.33	111.851
UA15	4229134.716	754035.965	137.12
UA16CHKA	4223359.401	758713.273	126.115
UA17	4228753.827	761739.17	142.225
UA18	4227248.984	762947.77	122.523
UA19	4222693.563	762047.898	88.564
UA20	4223917.942	770343.993	92.066
UA21	4209800.163	750727.808	121.076

FORESTED OBSERVATION			
PT ID	NORTHING	EASTING	ELEVATION
FO1	4205279.158	739869.008	127.666
FO2	4205856.625	742592.427	151.814
FO3	4203783.284	743085.954	135.297
FO4	4202063.09	751134.38	158.205
FO5	4209632.286	741009.128	144.742
FO6	4207516.693	744579.765	143.527
FO7	4205666.017	749050.253	146.319
FO8	4205307.683	753441.359	153.343
FO9	4212441.304	747488.756	127.174
FO10	4213075.587	752191.847	131.462
FO11	4211918.396	756009.393	138.772
FO12	4210549.947	757339.677	118.66
FO13	4219311.284	750930.136	133.971
FO14	4220068.104	758167.518	125.919
FO15	4217373.261	765598.1	113.242
FO16	4231583.672	756885.075	145.71
FO17	4232604.009	761699.282	135.698
FO18	4229966.527	762829.338	134.038
FO19	4225912.924	765893.662	109.987
FO20	4225078.951	768009.365	110.329
FO21	4224687.011	770932.635	108.591

4. GPS OBSERVATIONS

PT ID	OBSERVATION DATE	JULIAN DATE	TIME OF DAY	RE-OBSERVATION DATE	RE-OBSERVATION TIME
BE-1	4/17/2014	107	9:42	X	X
BE-2	4/17/2014	107	13:31	4/18/2014	13:02
BE-3	4/17/2014	107	14:40	X	X
BE-4	4/17/2014	107	18:05	4/18/2014	14:32
BE-5	4/17/2014	107	17:45	4/18/2014	14:52
BE-6	4/17/2014	107	16:43	4/18/2014	14:12
BE-7	4/17/2014	107	16:22	4/18/2014	14:02
BE-8	4/18/2014	108	10:19	X	X
BE-9	4/18/2014	108	9:59	5/1/2014	12:56
BE-10	4/18/2014	108	8:22	X	X
BE-11	4/18/2014	108	8:52	4/18/2014	15:38
BE-12	4/18/2014	108	9:34	4/18/2014	15:59
BE-13	4/17/2014	107	12:57	X	X
BE-14	4/17/2014	107	18:33	4/19/2014	9:22
BE-15	4/17/2014	107	11:40	4/19/2014	11:11
BE-16	4/17/2014	107	12:30	4/19/2014	12:20
BE-17	4/17/2014	107	10:26	4/19/2014	8:59
BE-18	4/17/2014	107	9:52	X	X
BE-19	4/16/2014	106	17:43	4/19/2014	12:01
BE-20	4/16/2014	106	17:04	X	X
BE-21	4/17/2014	107	16:21	4/18/2014	174/28/201406
FO-1	4/17/2014	107	10:09	X	X
FO-2	4/17/2014	107	11:37	X	X
FO-3	4/17/2014	107	12:24	X	X
FO-4	4/17/2014	107	14:59	X	X
FO-5	4/17/2014	107	18:24	X	X
FO-6	4/17/2014	107	17:16	X	X
FO-7	4/17/2014	107	16:43	X	X
FO-8	4/17/2014	107	15:51	X	X
FO-9	4/17/2014	107	18:59	X	X
FO-10	4/17/2014	107	19:30	X	X
FO-11	4/18/2014	108	10:29	X	X
FO-12	4/18/2014	108	11:19	X	X
FO-13	4/19/2014	109	10:02	X	X
FO-14	4/18/2014	108	18:36	X	X
FO-15	4/17/2014	107	14:01	X	X

FO-16	4/16/2014	106	14:43	X	X
FO-17	4/18/2014	108	10:43	X	X
FO-18	4/18/2014	108	11:55	X	X
FO-19	4/18/2014	108	13:40	X	X
FO-20	4/18/2014	108	14:55	X	X
FO-21	4/18/2014	108	16:20	X	X
UA-1	4/17/2014	107	9:55	4/18/2014	12:28
UA-2	4/17/2014	107	12:58	4/18/2014	12:45
UA-3	4/17/2014	107	13:17	4/18/2014	13:12
UA-4	4/17/2014	107	14:10	4/18/2014	13:39
UA-5CHKA	5/1/2014	121	14:21	4/18/2014	14:25
UA-6	4/17/2014	107	13:40	5/1/2014	13:38
UA-7	4/17/2014	107	13:52	4/18/2014	13:23
UA-8	4/17/2014	107	15:38	4/18/2014	13:51
UA-9	4/18/2014	108	8:09	4/18/2014	15:06
UA-10	4/18/2014	108	9:17	X	X
UA-11	4/18/2014	108	9:44	4/18/2014	16:09
UA-12CHKA	5/1/2014	121	15:23	4/18/2014	15:23
UA-13	4/16/2014	106	20:18	4/18/2014	18:02
UA-14	4/17/2014	107	15:33	4/18/2014	17:34
UA-15	4/17/2014	107	19:19	4/19/2014	8:37
UA-16CHKA	5/1/2014	121	11:26	4/19/2014	11:26
UA-17	4/16/2014	106	16:12	4/18/2014	12:48
UA-18	4/16/2014	106	16:40	4/18/2014	13:06
UA-19	4/17/2014	107	17:48	4/19/2014	12:46
UA-20	4/17/2014	107	16:57	4/18/2014	15:57
UA-21	4/18/2014	108	12:04	X	X

5. POINT COMPARISON

POINT ID	N	E	EL	CHECK POINT ID	N	E	EL	Δ NORTHING	Δ EASTING	Δ ELEVATION
BE2	4203414.456	746479.682	158.513	BE2CHK	4203414.44	746479.67	158.537	-0.019	-0.012	0.024
BE4	4210077.428	743030.99	157.501	BE4CHK	4210077.43	743030.975	157.523	0.000	-0.015	0.022
BE5	4209005.05	746395.346	146.01	BE5CHK	4209005.06	746395.351	145.996	0.010	0.005	-0.014
BE6	4208516.72	748983.928	135.017	BE6CHK	4208516.72	748983.923	135.001	0.004	-0.005	-0.016
BE7	4207806.456	752160.721	134.485	BE7CHK	4207806.46	752160.704	134.463	-0.001	-0.017	-0.022
BE9	4208558.963	759304.868	122.677	BE9CHKA	4208558.98	759304.881	122.641	0.014	0.013	-0.036
BE11	4218264.261	754393.073	157.888	BE11CHK	4218264.26	754393.081	157.873	0.000	0.008	-0.015
BE12	4213962.033	759466.55	158.478	BE12CHK	4213962.07	759466.556	158.475	0.041	0.006	-0.003
BE14	4221973.621	749914.866	167.102	BE14CHK	4221973.63	749914.855	167.074	0.007	-0.011	-0.028
BE15	4222735.756	755460.975	143.945	BE15CHK	4222735.75	755460.98	143.946	-0.005	0.005	0.001
BE16	4216962.612	762982.793	110.563	BE16CHK	4216962.6	762982.784	110.575	-0.013	-0.009	0.012
BE17	4226411.574	756571.987	125.615	BE17CHK	4226411.58	756571.963	125.59	0.003	-0.024	-0.025
BE19	4223380.954	762912.569	99.706	BE19CHK	4223380.94	762912.575	99.705	-0.013	0.006	-0.001
BE21	4223813.94	767929.509	85.474	BE21CHK	4223813.93	767929.519	85.438	-0.008	0.01	-0.036
UA1	4207667.568	739772.433	136.051	UA1CHK	4207667.52	739772.441	136.094	-0.048	0.008	0.043
UA2	4203010.436	742111.944	144.485	UA2CHK	4203010.44	742111.95	144.467	0.002	0.006	-0.018
UA3	4201189.534	745680.342	159.344	UA3CHK	4201189.54	745680.335	159.351	0.001	-0.007	0.007
UA4	4198972.223	752762.015	131.723	UA4CHK	4198972.22	752762.024	131.745	-0.003	0.009	0.022
UA5CHKA	4208537.881	742529.854	161.803	UA5CHK	4208537.87	742529.83	161.816	-0.011	-0.024	0.013
UA6	4205664.871	745645.187	157.548	UA6CHKA	4205664.87	745645.205	157.498	-0.006	0.018	-0.05
UA7	4203724.201	750599.464	163.472	UA7CHK	4203724.21	750599.466	163.471	0.004	0.002	-0.001
UA8	4204877.624	755796.043	155.288	UA8CHK	4204877.66	755796.051	155.307	0.034	0.008	0.019
UA9	4217428.815	746822.286	150.254	UA9CHK	4217428.83	746822.298	150.265	0.013	0.012	0.011
UA11	4213245.725	762298.902	147.012	UA11CHK	4213245.74	762298.909	146.978	0.013	0.007	-0.034
UA12CHKA	4221046.288	752617.21	159.425	UA12CHK	4221046.27	752617.23	159.464	-0.023	0.02	0.039
UA13	4220581.326	759892.776	128.516	UA13CHK	4220581.31	759892.792	128.493	-0.014	0.016	-0.023
UA14	4220551.312	767412.33	111.851	UA14CHK	4220551.32	767412.329	111.832	0.012	-0.001	-0.019
UA15	4229134.716	754035.965	137.12	UA15CHK	4229134.71	754035.952	137.106	-0.003	-0.013	-0.014
UA16CHKA	4223359.401	758713.273	126.115	UA16CHK3	4223359.42	758713.248	126.11	0.023	-0.025	-0.005
UA17	4228753.827	761739.17	142.225	UA17CHK	4228753.82	761739.162	142.238	-0.008	-0.008	0.013
UA18	4227248.984	762947.77	122.523	UA18CHK	4227248.98	762947.789	122.531	-0.005	0.019	0.008
UA19	4222693.563	762047.898	88.564	UA19CHK	4222693.56	762047.888	88.598	-0.006	-0.01	0.034
UA20	4223917.942	770343.993	92.066	UA20CHK	4223917.92	770343.993	92.068	-0.018	0	0.002