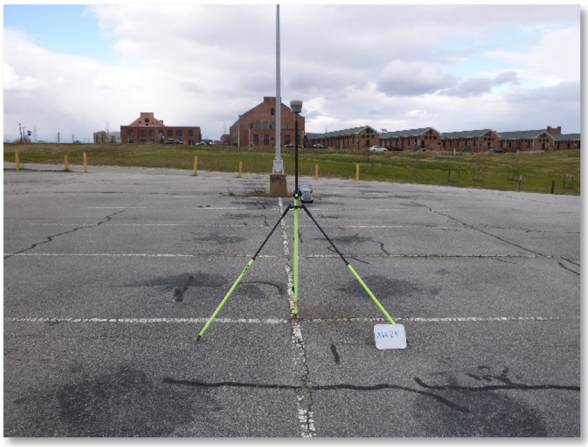
# Check Control Point Survey Report

## "VA FAIRFAX COUNTY QL1 LiDAR Project"
## USGS Contract: G16PC00020
## Task Order Number: 140G0218F0214

## Prepared for:
***United States Geological Survey (USGS)***

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# 1. INTRODUCTION

## 1.1 *Project Summary*

Dewberry Engineers Inc. is under contract to the United States Geological Survey (USGS) to provide 74 Check Points in the State of Virginia. 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 January 7, 2019 thru January 9, 2019.

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 Albers Equal Area NAD83 (2011) in meters. Final Vertical elevations are referenced to NAVD88 in meters using Geoid model 2012B (Geoid12B).

## 1.2 *Points of Contact*

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

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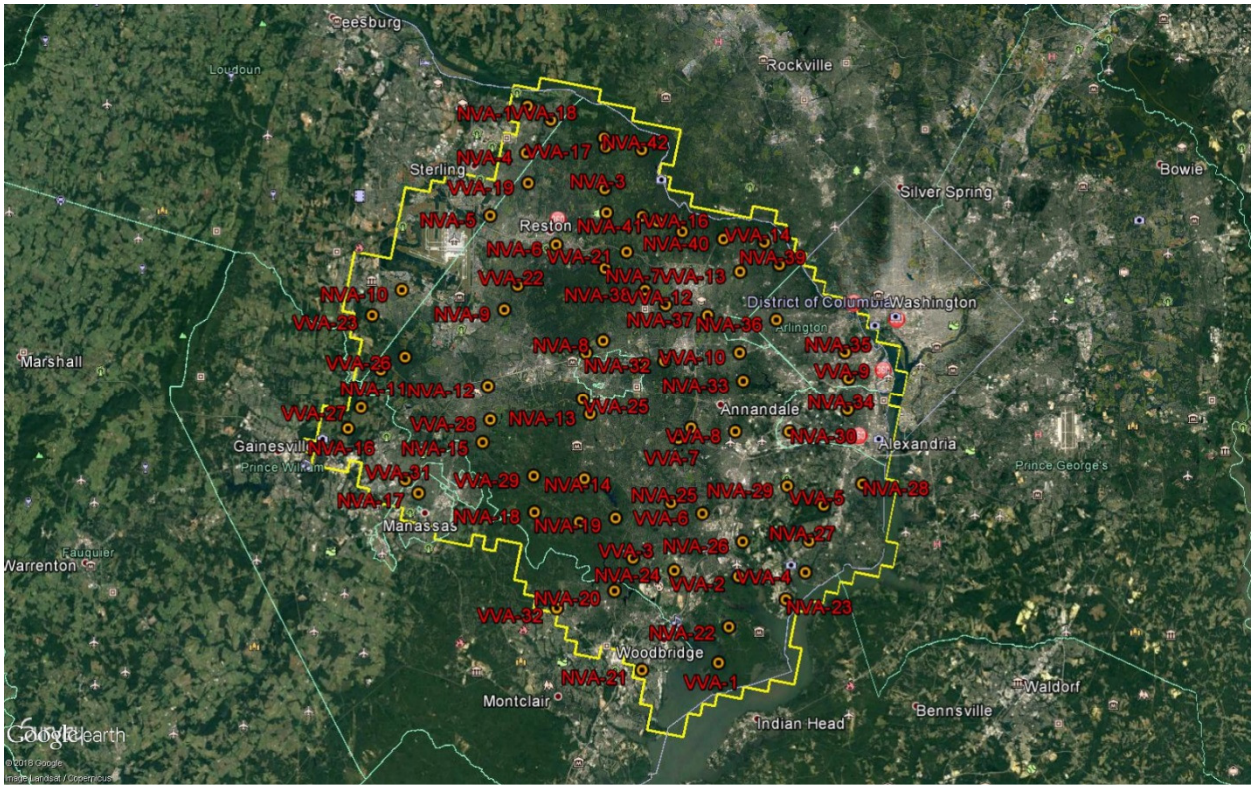
## 1.3 *Project Area*



# PROJECT DETAILS

## 2.1 *Survey Equipment*

In performing the GPS observations Trimble R-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 Check 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 Check Point locations are detailed on the "Check 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 operated by KEYNET. 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 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.

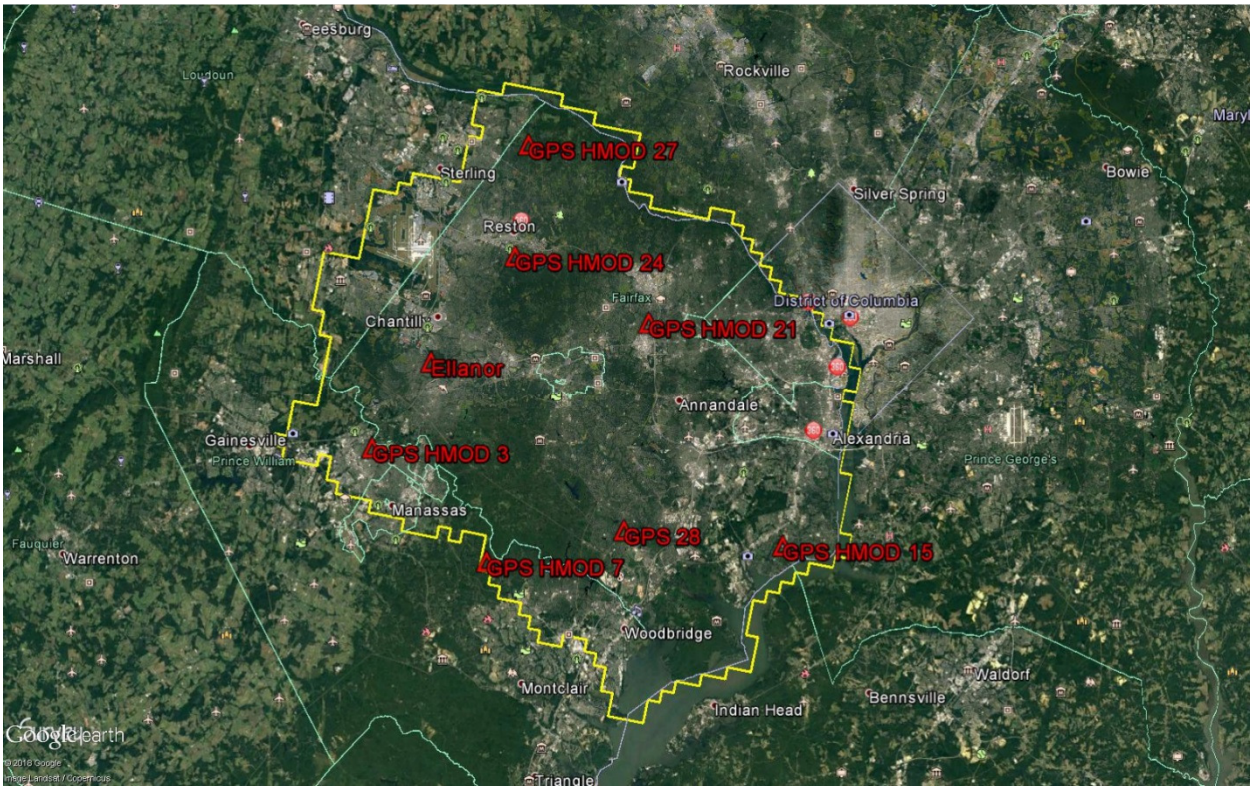
Six (6) existing NGS monument listed in the NSRS database were located for the Virginia and West Virginia areas as an additional QA/QC method to check the horizontal and vertical accuracy of the VRS network as well as being the primary project control monuments designated as DK4418, DK4406, HV9194, DK4409, DK4412, and DK4400 . The results are as follows:

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

| | Observed Values | | | Data Sheet Values | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| PT. # | NORTHING | EASTING | ELEVS. | NORTHING | EASTING | ELEVS. | Δ X | Δ Y | Δ Z |
| ELLANOR | 4304071.602 | 288510.172 | 95.466 | 4304071.593 | 288510.184 | 95.480 | 0.009 | -0.012 | -0.014 |
| GPS HMOD21 | 4306886.963 | 306959.636 | 122.020 | 4306886.955 | 306959.665 | 121.980 | 0.008 | -0.029 | 0.040 |
| GPS 28 | 4289486.970 | 304426.945 | 83.716 | 4289486.981 | 304426.942 | 83.721 | -0.011 | 0.003 | -0.005 |
| GPS HMOD24 | 4312763.992 | 295829.976 | 135.261 | 4312764.007 | 295829.982 | 135.310 | -0.015 | -0.006 | -0.049 |
| GPS HMOD27 | 4322118.771 | 297196.453 | 128.341 | 4322118.770 | 297196.445 | 128.380 | 0.001 | 0.008 | -0.039 |
| GPS HMOD 15 | 4287837.681 | 317812.341 | 30.356 | 4287837.691 | 317812.348 | 30.380 | -0.010 | -0.007 | -0.024 |

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 KEYNET 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 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 2018) 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*

| NVA - Albers Equal Area NAD83 (2011) (METERS) | | | |
|---|---|---|---|
| **Point #** | **Northing** | **Easting** | **Elevation** |
| NVA-1 | 1936593.620 | 1586485.520 | 66.316 |
| NVA-2 | 1935222.070 | 1593086.800 | 104.650 |
| NVA-3 | 1931101.480 | 1593967.730 | 106.897 |
| NVA-4 | 1932780.180 | 1587137.980 | 86.182 |
| NVA-5 | 1927138.500 | 1585286.380 | 110.889 |
| NVA-6 | 1925805.280 | 1590999.790 | 126.001 |
| NVA-7 | 1924688.420 | 1595281.700 | 70.661 |
| NVA-8 | 1918822.490 | 1596287.700 | 125.661 |
| NVA-9 | 1919764.100 | 1587925.210 | 108.451 |
| NVA-10 | 1919738.000 | 1579449.540 | 106.308 |
| NVA-11 | 1912929.090 | 1579057.920 | 70.560 |
| NVA-12 | 1913312.370 | 1587850.720 | 103.285 |
| NVA-13 | 1912652.550 | 1596442.390 | 122.619 |
| NVA-14 | 1907335.820 | 1597033.770 | 122.285 |
| NVA-15 | 1908647.280 | 1588342.360 | 109.124 |
| NVA-16 | 1907625.320 | 1577399.420 | 77.017 |
| NVA-17 | 1903505.610 | 1583965.880 | 77.253 |
| NVA-18 | 1903859.640 | 1593589.090 | 92.819 |
| NVA-19 | 1904667.130 | 1600139.760 | 99.244 |
| NVA-20 | 1898785.350 | 1601221.400 | 75.956 |
| NVA-21 | 1892842.530 | 1604684.970 | 36.080 |
| NVA-22 | 1897686.320 | 1610917.030 | 43.649 |
| NVA-23 | 1903066.580 | 1613791.740 | 41.044 |
| NVA-24 | 1901366.190 | 1605668.970 | 65.481 |
| NVA-25 | 1906777.570 | 1604305.680 | 88.827 |
| NVA-26 | 1904780.450 | 1610640.700 | 45.079 |
| NVA-27 | 1905858.430 | 1615930.040 | 8.079 |
| NVA-28 | 1911320.720 | 1619253.500 | 6.615 |
| NVA-29 | 1909959.680 | 1613308.790 | 44.666 |
| NVA-30 | 1914372.600 | 1612599.050 | 67.760 |
| NVA-31 | 1913101.120 | 1604699.790 | 72.005 |
| NVA-32 | 1918161.560 | 1601488.930 | 100.591 |
| NVA-33 | 1917774.490 | 1608089.040 | 74.586 |
| NVA-34 | 1917093.130 | 1616881.930 | 56.257 |
| NVA-35 | 1921654.680 | 1616219.850 | 48.337 |
| NVA-36 | 1923147.680 | 1609729.830 | 104.848 |

| | | | |
|---|---|---|---|
| NVA-37 | 1922520.420 | 1604191.550 | 133.536 |
| NVA-38 | 1923560.600 | 1598816.340 | 128.260 |
| NVA-39 | 1927764.600 | 1609109.020 | 58.287 |
| NVA-40 | 1928949.930 | 1604228.920 | 91.761 |
| NVA-41 | 1929318.570 | 1598708.950 | 87.064 |
| NVA-42 | 1934858.200 | 1596292.950 | 109.576 |
| VVA - Albers Equal Area NAD83 (2011) (METERS) | | | |
| VVA-1 | 1894664.190 | 1610587.990 | 10.017 |
| VVA-2 | 1902255.230 | 1609667.200 | 39.311 |
| VVA-3 | 1901687.790 | 1602159.540 | 94.106 |
| VVA-4 | 1903287.850 | 1616134.890 | 10.020 |
| VVA-5 | 1909107.110 | 1616491.960 | 14.059 |
| VVA-6 | 1906409.690 | 1606978.900 | 78.865 |
| VVA-7 | 1912056.060 | 1603875.220 | 71.251 |
| VVA-8 | 1913533.800 | 1608276.480 | 87.896 |
| VVA-9 | 1919679.060 | 1616462.370 | 13.146 |
| VVA-10 | 1920060.180 | 1607325.390 | 77.661 |
| VVA-11 | 1917534.550 | 1599628.650 | 87.035 |
| VVA-12 | 1922920.460 | 1600940.530 | 125.417 |
| VVA-13 | 1926554.710 | 1606088.920 | 80.311 |
| VVA-14 | 1929568.510 | 1607611.240 | 73.551 |
| VVA-15 | 1928901.170 | 1600821.340 | 95.469 |
| VVA-16 | 1929499.550 | 1597395.150 | 56.086 |
| VVA-17 | 1934505.000 | 1593426.020 | 107.109 |
| VVA-18 | 1935908.660 | 1588745.130 | 82.496 |
| VVA-19 | 1930235.530 | 1587123.990 | 111.071 |
| VVA-20 | 1929213.710 | 1594507.440 | 91.838 |
| VVA-21 | 1927309.270 | 1596260.990 | 62.275 |
| VVA-22 | 1922168.880 | 1588865.710 | 119.155 |
| VVA-23 | 1917211.260 | 1577495.130 | 97.718 |
| VVA-24 | 1917558.730 | 1595127.240 | 133.260 |
| VVA-25 | 1913593.730 | 1595550.130 | 118.523 |
| VVA-26 | 1914365.440 | 1580780.420 | 83.379 |
| VVA-27 | 1909273.290 | 1578253.290 | 77.516 |
| VVA-28 | 1910588.360 | 1588607.360 | 113.192 |
| VVA-29 | 1906775.730 | 1592931.400 | 61.828 |
| VVA-30 | 1903761.330 | 1597339.760 | 95.418 |
| VVA-31 | 1904401.960 | 1582789.080 | 58.122 |
| VVA-32 | 1896756.000 | 1596865.470 | 91.722 |

## 4. *GPS OBSERVATIONS*

| NVA | | | | | |
|---|---|---|---|---|---|
| POINT ID | OBSERV. DATE | JULIAN DATE | TIME OF DAY (AST) | RE-OBSERV. DATE | RE-OBSERV. TIME |
| NVA-1 | 1/8/2019 | 8 | 8:58 | 1/9/2019 | 13:24 |
| NVA-2 | 1/8/2019 | 8 | 10:28 | N/A | N/A |
| NVA-3 | 1/8/2019 | 8 | 11:38 | 1/9/2019 | 11:09 |
| NVA-4 | 1/8/2019 | 8 | 8:30 | 1/9/2019 | 13:49 |
| NVA-5 | 1/8/2019 | 8 | 7:15 | N/A | N/A |
| NVA-6 | 1/9/2019 | 9 | 7:15 | 1/9/2019 | 7:18 |
| NVA-7 | 1/7/2019 | 7 | 16:09 | 1/9/2019 | 16:15 |
| NVA-8 | 1/8/2019 | 8 | 10:15 | N/A | N/A |
| NVA-9 | 1/8/2019 | 8 | 11:20 | N/A | N/A |
| NVA-10 | 1/9/2019 | 9 | 7:45 | N/A | N/A |
| NVA-11 | 1/9/2019 | 9 | 9:15 | N/A | N/A |
| NVA-12 | 1/8/2019 | 8 | 13:00 | 1/9/2019 | 16:30 |
| NVA-13 | 1/8/2019 | 8 | 8:45 | N/A | N/A |
| NVA-14 | 1/8/2019 | 8 | 7:50 | N/A | N/A |
| NVA-15 | 1/8/2019 | 8 | 14:35 | 1/9/2019 | 16:15 |
| NVA-16 | 1/9/2019 | 9 | 11:00 | N/A | N/A |
| NVA-17 | 1/8/2019 | 8 | 17:15 | N/A | N/A |
| NVA-18 | 1/8/2019 | 8 | 16:00 | 1/9/2019 | 15:40 |
| NVA-19 | 1/8/2019 | 8 | 16:26 | N/A | N/A |
| NVA-20 | 1/7/2019 | 7 | 17:10 | 1/9/2019 | 14:30 |
| NVA-21 | 1/9/2019 | 9 | 17:31 | 1/9/2019 | 17:34 |
| NVA-22 | 1/9/2019 | 9 | 14:56 | N/A | N/A |
| NVA-23 | 1/9/2019 | 9 | 12:20 | N/A | N/A |
| NVA-24 | 1/9/2019 | 9 | 14:09 | N/A | N/A |
| NVA-25 | 1/8/2019 | 8 | 17:08 | 1/10/2019 | 9:48 |
| NVA-26 | 1/9/2018 | 9 | 13:37 | 1/9/2019 | 13:40 |
| NVA-27 | 1/9/2019 | 9 | 11:20 | N/A | N/A |
| NVA-28 | 1/7/2019 | 7 | 17:33 | 1/7/2019 | 17:35 |
| NVA-29 | 1/8/2019 | 8 | 18:02 | 1/9/2019 | 9:16 |
| NVA-30 | 1/8/2019 | 8 | 10:44 | 1/8/2019 | 10:47 |
| NVA-31 | 1/8/2019 | 8 | 15:10 | N/A | N/A |
| NVA-32 | 1/8/2019 | 8 | 14:11 | 1/10/2019 | 10:45 |
| NVA-33 | 1/8/2019 | 8 | 13:48 | 1/8/2019 | 13:51 |
| NVA-34 | 1/8/2019 | 8 | 11:07 | 1/8/2019 | 11:10 |
| NVA-35 | 1/8/2019 | 8 | 12:21 | N/A | N/A |

| | | | | | |
|---|---|---|---|---|---|
| NVA-36 | 1/8/2018 | 8 | 12:59 | 1/8/2019 | 13:02 |
| NVA-37 | 1/8/2019 | 8 | 15:15 | 1/8/2019 | 15:18 |
| NVA-38 | 1/7/2018 | 7 | 16:45 | 1/7/2019 | 16:48 |
| NVA-39 | 1/8/2019 | 8 | 14:18 | N/A | N/A |
| NVA-40 | 1/8/2019 | 8 | 13:10 | N/A | N/A |
| NVA-41 | 1/8/2019 | 8 | 12:28 | N/A | N/A |
| NVA-42 | 1/8/2019 | 8 | 11:04 | N/A | N/A |
| VVA | | | | | |
| VVA-1 | 1/9/2019 | 9 | 15:37 | 1/9/2019 | 15:40 |
| VVA-2 | 1/9/2019 | 9 | 13:18 | 1/9/2019 | 13:21 |
| VVA-3 | 1/7/2019 | 7 | 16:00 | 1/9/2019 | 14:58 |
| VVA-4 | 1/9/2019 | 9 | 11:58 | 1/9/2019 | 12:01 |
| VVA-5 | 1/9/2019 | 9 | 9:43 | N/A | N/A |
| VVA-6 | 1/8/2019 | 8 | 17:27 | 1/10/2019 | 9:35 |
| VVA-7 | 1/8/2019 | 8 | 15:37 | N/A | N/A |
| VVA-8 | 1/9/2019 | 9 | 10:14 | 1/9/2019 | 10:17 |
| VVA-9 | 1/8/2019 | 9 | 11:30 | N/A | N/A |
| VVA-10 | 1/8/2019 | 8 | 16:27 | N/A | N/A |
| VVA-11 | 1/8/2019 | 8 | 14:38 | 1/8/2019 | 14:41 |
| VVA-12 | 1/8/2019 | 8 | 17:06 | N/A | N/A |
| VVA-13 | 1/8/2019 | 8 | 14:41 | N/A | N/A |
| VVA-14 | 1/8/2019 | 8 | 13:28 | 1/9/2019 | 9:24 |
| VVA-15 | 1/8/2019 | 8 | 12:47 | N/A | N/A |
| VVA-16 | 1/8/2019 | 8 | 12:17 | 1/9/2019 | 10:28 |
| VVA-17 | 1/8/2019 | 8 | 10:47 | 1/9/2019 | 12:04 |
| VVA-18 | 1/8/2019 | 8 | 9:15 | 1/9/2019 | 12:39 |
| VVA-19 | 1/8/2019 | 8 | 8:10 | 1/9/2019 | 14:13 |
| VVA-20 | 1/8/2019 | 8 | 11:54 | 1/9/2019 | 10:52 |
| VVA-21 | 1/7/2019 | 7 | 17:10 | 1/7/2019 | 17:15 |
| VVA-22 | 1/7/2019 | 7 | 15:36 | 1/7/2019 | 15:39 |
| VVA-23 | 1/9/2019 | 9 | 8:15 | N/A | N/A |
| VVA-24 | 1/8/2019 | 8 | 14:09 | N/A | N/A |
| VVA-25 | 1/8/2019 | 8 | 9:20 | N/A | N/A |
| VVA-26 | 1/9/2019 | 9 | 8:45 | N/A | N/A |
| VVA-27 | 1/9/2019 | 9 | 10:15 | N/A | N/A |
| VVA-28 | 1/8/2019 | 8 | 14:15 | N/A | N/A |
| VVA-29 | 1/8/2019 | 8 | 15:30 | N/A | N/A |
| VVA-30 | 1/8/2019 | 8 | 7:10 | 1/9/2019 | 15:20 |
| VVA-31 | 1/9/2019 | 9 | 12:05 | N/A | N/A |

| | | | | | |
|---|---|---|---|---|---|
| VVA-32 | 1/9/2019 | 9 | 13:25 | N/A | N/A |

## 5. *POINT COMPARISON*

| NVA | | | | |
|---|---|---|---|---|
| Point ID | Point CK | Delta North (M) | Delta East (M) | Vertical Difference (M) |
| NVA-1 | NVA-1 CK | -0.012 | 0.008 | -0.016 |
| NVA-3 | NVA-3 CK | -0.011 | 0.012 | 0.008 |
| NVA-4 | NVA-4 CK | -0.023 | 0.001 | -0.032 |
| NVA-6 | NVA-6 CK | 0.002 | 0.001 | 0.001 |
| NVA-7 | NVA-7 CK | 0.012 | 0.002 | 0.016 |
| NVA-12 | NVA-12 CK | 0.002 | -0.001 | 0.002 |
| NVA-15 | NVA-15 CK | -0.003 | 0.004 | -0.002 |
| NVA-18 | NVA-18 CK | 0.001 | 0.005 | 0.000 |
| NVA-20 | NVA-20 CK | -0.001 | 0.000 | -0.003 |
| NVA-21 | NVA-21 CK | 0.000 | 0.000 | 0.005 |
| NVA-25 | NVA-25 CK | 0.002 | 0.003 | 0.012 |
| NVA-26 | NVA-26 CK | 0.006 | -0.004 | -0.003 |
| NVA-28 | NVA-28 CK | -0.003 | 0.006 | 0.015 |
| NVA-29 | NVA-29 CK | -0.003 | -0.002 | -0.012 |
| NVA-30 | NVA-30 CK | -0.003 | 0.007 | 0.014 |
| NVA-32 | NVA-32 CK | -0.015 | -0.003 | -0.001 |
| NVA-33 | NVA-33 CK | 0.000 | -0.001 | -0.020 |
| NVA-34 | NVA-34 CK | 0.008 | 0.008 | 0.032 |
| NVA-36 | NVA-36 CK | -0.004 | -0.011 | -0.002 |
| NVA-37 | NVA-37 CK | 0.004 | 0.002 | 0.005 |
| NVA-38 | NVA-38 CK | -0.003 | 0.003 | -0.006 |
| VVA | | | | |
| VVA-1 | VVA-1 C K | 0.005 | -0.008 | 0.006 |
| VVA-2 | VVA-2 CK | -0.014 | 0.008 | 0.001 |
| VVA-3 | VVA-3 CK | 0.000 | -0.005 | 0.016 |
| VVA-4 | VVA-4 CK | -0.003 | 0.008 | -0.006 |
| VVA-6 | VVA-6 CK | 0.002 | -0.009 | 0.021 |
| VVA-8 | VVA-8 CK | 0.001 | 0.022 | 0.018 |
| VVA-10 | VVA-10 CK | 0.004 | -0.001 | 0.007 |
| VVA-12 | VVA-12 CK | 0.026 | -0.006 | 0.039 |
| VVA-14 | VVA-14 CK | -0.004 | 0.008 | 0.000 |
| VVA-16 | VVA-16 CK | 0.000 | 0.009 | 0.010 |
| VVA-17 | VVA-17 CK | 0.004 | 0.014 | 0.042 |

| | | | | |
|---|---|---|---|---|
| **VVA-18** | **VVA-18 CK** | **0.009** | **-0.020** | **0.007** |
| **VVA-20** | **VVA-20 CK** | **0.002** | **0.013** | **0.032** |
| **VVA-21** | **VVA-21 CK** | **0.002** | **0.013** | **0.032** |
| **VVA-22** | **VVA-22 CK** | **-0.001** | **-0.007** | **-0.006** |
| **VVA-30** | **VVA-30 CK** | **-0.011** | **0.009** | **-0.004** |