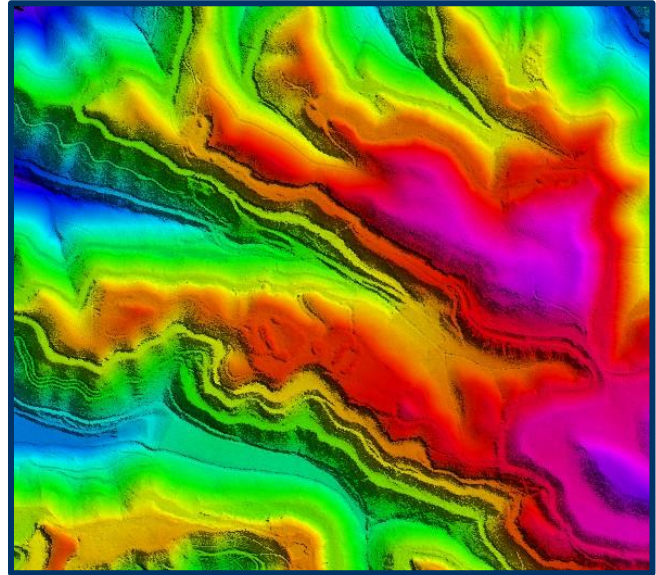


AERIAL LIDAR ACQUISITION REPORT



PRESTON COUNTY AND
NORTH BRANCH (POTOMAC)
LIDAR *.LAS1.2 DATA
COMPREHENSIVE AND BARE EARTH

**WEST VIRGINIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION**

JUNE 2013

PREPARED BY:

WVU NATURAL RESOURCE ANALYSIS CENTER
2014 AGRICULTURAL SCIENCES
PO BOX 6108
MORGANTOWN, WV 26506-6108

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SECTION 1: OVERVIEW

Project Name: Preston County/North Branch of Potomac Airborne LiDAR

NRAC was contracted to perform an aerial acquisition survey of the pertinent mine areas in and around Preston County and the North Branch of the Potomac for the purpose of high-resolution (1-meter) airborne LiDAR to ultimately produce products (digital elevation models, contours, flood and surface modeling, change detection, permit boundaries, etc) for the public. The Preston/North Branch project was collected between 28 Mar 2011 and 21 April 2011 and is composed of 1,374 working segments, covering 748,624 acres.

LiDAR data was collected by the Optech ALTM-3100 100k Hz Multi-pulse LiDAR system mounted in a Piper Navajo PA-31. The ALTM-3100 collects up to four returns per pulse, as well as backscatter reflectance (intensity) data. The aerial LiDAR was collected at the following sensor specifications:

| | |
|-------------------------------------|------------------------------------|
| Post Spacing (Average): | 3.3 ft / 1.0 meter |
| Flying Height (Above Ground Level): | 5,000-ft / 1,524 meters |
| Flying Height (Mean Sea Level): | Varies with terrain |
| Average Ground Speed: | 135 knots (155 MPG) |
| Scanner Pulse Rate Frequency: | 70,000 Hz |
| Scanner Frequency / Field of View: | 35 Hz / 36 degrees (18 half angle) |
| Overlap (Average): | 30% |

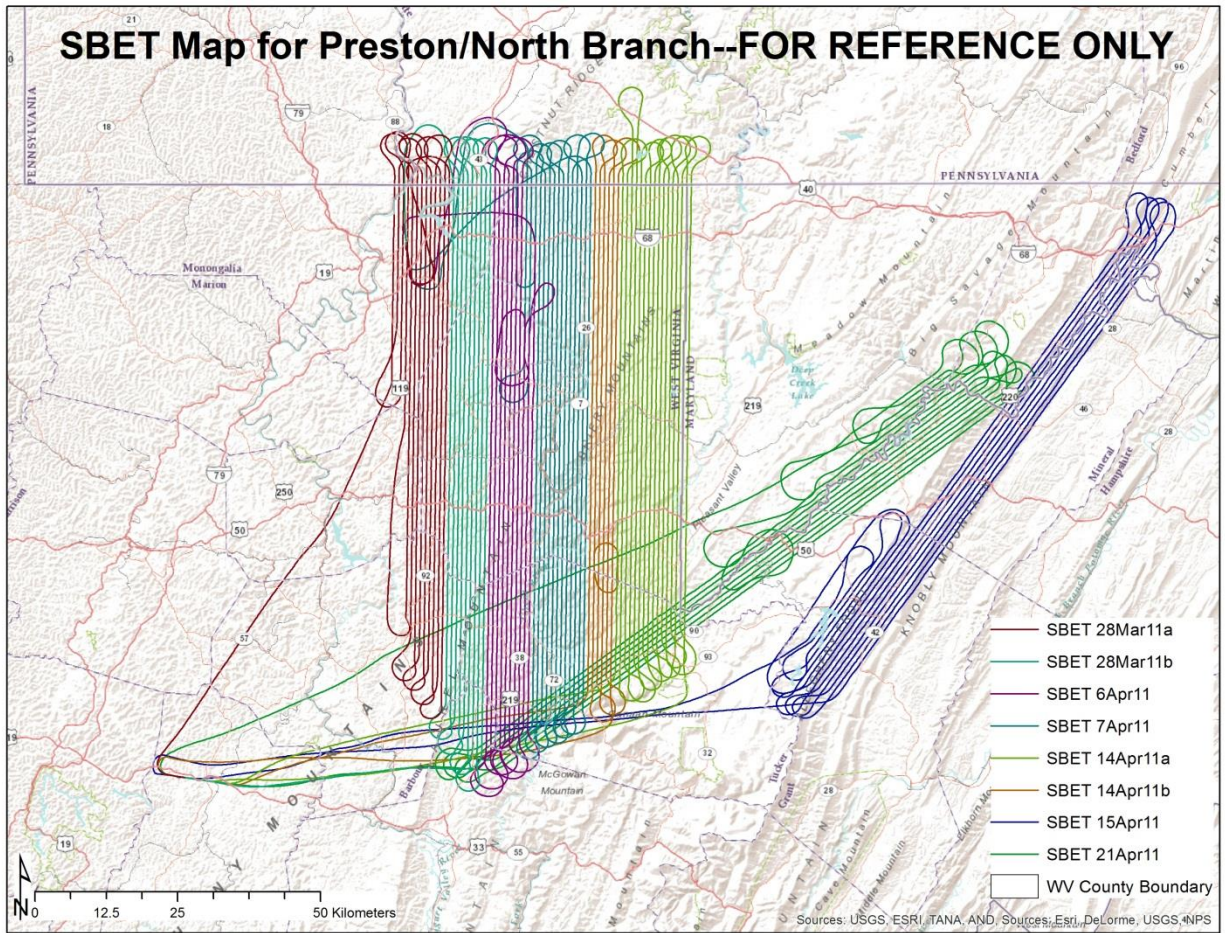
Flight line acquisition was performed around weather, winds, GPS PDOP, vegetation emergence conditions, and fuel, collecting data in as few missions as possible, as close together as possible, to ensure consistency across the project area.

The data collected was flown back to the WVU NRAC office in Morgantown, WV, extracted, viewed, and quality controlled such that immediate re-flights could be performed if necessary.

NRAC's aerial acquisition team coordinated with the necessary Air Traffic Control and Restricted Airspace personnel prior to flying to ensure permissions.

Flight Summary Log

| Date of Flight | Lines/Trajectories | Start week/time (GPS, UTC) | Stop week/time (GPS, UTC) |
|----------------|--------------------|----------------------------|---------------------------|
| 28 Mar 2011 | 14 | 605/ 135346.0608 | 605/ 148855.2756 |
| 28 Mar 2011 | 9 | 605/ 154877.6713 | 605/ 166337.6731 |
| 06 Apr 2011 | 13 | 606/ 308155.2157 | 606/ 321205.2623 |
| 31 07 Apr 2011 | 16 | 606/ 410856.3133 | 606/ 427721.6240 |
| 14 Apr 2011 | 18 | 607/ 397251.8796 | 607/ 415380.0635 |
| 14 Apr 2011 | 7 | 607/ 420308.0411 | 607/ 427449.2323 |
| 15 Apr 2011 | 15 | 607/ 481356.6947 | 607/ 494666.8310 |
| 21 Apr 2011 | 17 | 608/ 405128.0607 | 608/ 420627.3368 |



SECTION 2: GPS BASE STATION DATA

Ground GPS data is collected via two TOPCON HiPER GD dual-frequency, 12-channel geodetic quality receivers. Locations occupied for collection are either registered National Geodetic Survey (NGS) control monuments, or created Online Positioning User's Service (NGS OPUS) control points.

NRAC determines appropriate locations for GPS base station collections and only operates equipment/occupies site with appropriate permissions. Locations are determined based off baseline length from rover (aircraft) to base stations, site assessments (view of sky, obstructions [masks], and multipath sources), along with permissions/access.

Base stations locations for the Preston and North Branch project area are detailed with the following NGS OPUS Datasheets (dates are referenced in file name):

NOTE: NGS monuments are described by their PID (AA9258, DL1902, etc)

FILE: Unit_A_03281_aa9268.tps 000190006

2005 NOTE: The IGS precise and IGS rapid orbits were not available
2005 at processing time. The IGS ultra-rapid orbit was/will be used to
2005 process the data.
2005

NGS OPUS SOLUTION REPORT
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All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu
RINEX FILE: unit0871.11o

DATE: March 29, 2011
TIME: 01:55:03 UTC

SOFTWARE: page5 1009.28 master28.pl 121510 START: 2011/03/28 11:09:00
EPHEMERIS: igu16291.eph [ultra-rapid] STOP: 2011/03/28 23:51:30
NAV FILE: brdc0870.11n OBS USED: 28446 / 31355 : 91%
ANT NAME: TPSHIPER_GD NONE # FIXED AMB: 188 / 195 : 96%
ARP HEIGHT: 2.0 OVERALL RMS: 0.017 (m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2011.2376)

| | | | | |
|----|-----------------|----------|-----------------|----------|
| X: | 861207.428(m) | 0.010(m) | 861206.669(m) | 0.010(m) |
| Y: | -4842520.278(m) | 0.053(m) | -4842518.853(m) | 0.053(m) |
| Z: | 4047586.173(m) | 0.038(m) | 4047586.060(m) | 0.038(m) |

| | | | | |
|------------|----------------|----------|-----------------------------------|----------|
| LAT: | 39 38 27.38118 | 0.005(m) | 39 38 27.41013 | 0.005(m) |
| E LON: | 280 5 3.15610 | 0.001(m) | 280 5 3.13523 | 0.001(m) |
| W LON: | 79 54 56.84390 | 0.001(m) | 79 54 56.86477 | 0.001(m) |
| EL HGT: | 345.700(m) | 0.065(m) | 344.445(m) | 0.065(m) |
| ORTHO HGT: | 378.177(m) | 0.112(m) | [NAVD88 (Computed using GEOID09)] | |

| | UTM COORDINATES | STATE PLANE COORDINATES |
|-----------------------|-----------------|-------------------------|
| | UTM (Zone 17) | SPC (4701 WV N) |
| Northing (Y) [meters] | 4388467.817 | 126746.523 |
| Easting (X) [meters] | 593031.802 | 564311.062 |
| Convergence [degrees] | 0.69174777 | -0.26517961 |
| Point Scale | 0.99970655 | 0.99994078 |
| Combined Factor | 0.99965234 | 0.99988655 |

US NATIONAL GRID DESIGNATOR: 17SND9303188467(NAD 83)

| | | BASE STATIONS USED | | |
|--------|--------------------------|--------------------|--------------|-------------|
| PID | DESIGNATION | LATITUDE | LONGITUDE | DISTANCE(m) |
| DM5974 | WVBR BRIDGEPORT CORS ARP | N391828.884 | W0801638.619 | 48316.5 |
| DK6720 | PAGW WYNSBURG CORS ARP | N395356.119 | W0800936.378 | 35479.3 |
| DL6505 | WVMO MORGANTOWN CORS ARP | N393845.173 | W0795811.693 | 4678.5 |

| | | NEAREST NGS PUBLISHED CONTROL POINT | | |
|--------|-------------|-------------------------------------|--------------|-------------|
| PID | DESIGNATION | LATITUDE | LONGITUDE | DISTANCE(m) |
| AA9268 | MGW A | N393827.380 | W0795456.843 | 0.0 |

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

| FILE: Unit_A_0406ma_BrieryMtn.tps 000196428

2005 NOTE: The IGS precise and IGS rapid orbits were not available
2005 at processing time. The IGS ultra-rapid orbit was/will be used to
2005 process the data.
2005

NGS OPUS SOLUTION REPORT
=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu
RINEX FILE: unit096m.11o

DATE: April 06, 2011
TIME: 22:03:58 UTC

SOFTWARE: page5 1009.28 master2.pl 1215103 START: 2011/04/06 12:08:00
EPHEMERIS: igu16303.eph [ultra-rapid] STOP: 2011/04/06 19:11:00
NAV FILE: brdc0960.11n OBS USED: 13108 / 14858 : 88%
ANT NAME: TPSHIPER_GD # FIXED AMB: 116 / 129 : 90%
ARP HEIGHT: 2.0 OVERALL RMS: 0.016(m)

REF FRAME: NAD_83(CORS96) (EPOCH:2002.0000) ITRF00 (EPOCH:2011.2621)

| | | | | |
|------------|-----------------|----------|-----------------------------------|----------|
| X: | 885630.196(m) | 0.006(m) | 885629.437(m) | 0.006(m) |
| Y: | -4855271.041(m) | 0.015(m) | -4855269.612(m) | 0.015(m) |
| Z: | 4027521.354(m) | 0.009(m) | 4027521.239(m) | 0.009(m) |
| LAT: | 39 24 17.30798 | 0.016(m) | 39 24 17.33683 | 0.016(m) |
| E LON: | 280 20 14.78610 | 0.007(m) | 280 20 14.76561 | 0.007(m) |
| W LON: | 79 39 45.21390 | 0.007(m) | 79 39 45.23439 | 0.007(m) |
| EL HGT: | 596.150(m) | 0.006(m) | 594.885(m) | 0.006(m) |
| ORTHO HGT: | 627.557(m) | 0.016(m) | [NAVD88 (Computed using GEOID09)] | |

| | UTM COORDINATES | STATE PLANE COORDINATES |
|-----------------------|-----------------|-------------------------|
| | UTM (Zone 17) | SPC (4701 WV N) |
| Northing (Y) [meters] | 4362553.329 | 100461.487 |
| Easting (X) [meters] | 615150.576 | 585999.389 |
| Convergence [degrees] | 0.84909425 | -0.10367600 |
| Point Scale | 0.99976326 | 0.99994815 |
| Combined Factor | 0.99966976 | 0.99985464 |

US NATIONAL GRID DESIGNATOR: 17SPD1515062553(NAD 83)

| BASE STATIONS USED | | | | | |
|--------------------|--------------------|----------|-------------|--------------|-------------|
| PID | DESIGNATION | | LATITUDE | LONGITUDE | DISTANCE(m) |
| DM5974 | WVBR BRIDGEPORT | CORS ARP | N391828.884 | W0801638.619 | 54075.5 |
| DL6505 | WVMO MORGANTOWN | CORS ARP | N393845.173 | W0795811.693 | 37617.1 |
| DM4706 | WVCV CANAAN VALLEY | CORS ARP | N390055.076 | W0792725.010 | 46754.6 |

| NEAREST NGS PUBLISHED CONTROL POINT | | | | | |
|-------------------------------------|-------|--|----------|-----------|--------|
| | | | | | |
| JW0836 | RV 15 | | N392408. | W0794047. | 1504.1 |

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

| FILE: Unit_B_0406n_FreemanFarm.tps 000196404

2005 NOTE: The IGS precise and IGS rapid orbits were not available
2005 at processing time. The IGS ultra-rapid orbit was/will be used to
2005 process the data.
2005

NGS OPUS SOLUTION REPORT
=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu
RINEX FILE: unit096n.11o

DATE: April 06, 2011
TIME: 21:28:48 UTC

SOFTWARE: page5 1009.28 master28.pl 121510 START: 2011/04/06 13:04:00
EPHEMERIS: igu16303.eph [ultra-rapid] STOP: 2011/04/06 18:01:00
NAV FILE: brdc0960.11n OBS USED: 9295 / 10591 : 88%
ANT NAME: TPSHIPER_GD # FIXED AMB: 60 / 70 : 86%
ARP HEIGHT: 2.0 OVERALL RMS: 0.014(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2011.2620)

| | | | | |
|------------|-----------------|----------|-----------------------------------|----------|
| X: | 878036.163(m) | 0.008(m) | 878035.405(m) | 0.008(m) |
| Y: | -4872386.491(m) | 0.006(m) | -4872385.060(m) | 0.006(m) |
| Z: | 4008892.365(m) | 0.009(m) | 4008892.248(m) | 0.009(m) |
| LAT: | 39 11 11.88354 | 0.008(m) | 39 11 11.91220 | 0.008(m) |
| E LON: | 280 12 55.57919 | 0.007(m) | 280 12 55.55868 | 0.007(m) |
| W LON: | 79 47 4.42081 | 0.007(m) | 79 47 4.44132 | 0.007(m) |
| EL HGT: | 782.514(m) | 0.010(m) | 781.245(m) | 0.010(m) |
| ORTHO HGT: | 813.828(m) | 0.021(m) | [NAVD88 (Computed using GEOID09)] | |

| | UTM COORDINATES | STATE PLANE COORDINATES |
|-----------------------|-----------------|-------------------------|
| | UTM (Zone 17) | SPC (4701 WV N) |
| Northing (Y) [meters] | 4338191.486 | 76266.914 |
| Easting (X) [meters] | 604971.518 | 575415.145 |
| Convergence [degrees] | 0.76804316 | -0.18148553 |
| Point Scale | 0.99973568 | 0.99996996 |
| Combined Factor | 0.99961295 | 0.99984720 |

US NATIONAL GRID DESIGNATOR: 17SPD0497138191(NAD 83)

BASE STATIONS USED

| PID | DESIGNATION | LATITUDE | LONGITUDE | DISTANCE(m) |
|--------|---------------------------|-------------|--------------|-------------|
| DL3933 | LS08 LOYOLA LS08 CORS ARP | N385849.217 | W0801311.035 | 44076.6 |
| DL6505 | WVMO MORGANTOWN CORS ARP | N393845.173 | W0795811.693 | 53433.8 |
| DM4710 | WVNR ELKINS CORS ARP | N385344.505 | W0795130.270 | 32929.7 |

NEAREST NGS PUBLISHED CONTROL POINT

| | | | | |
|--------|-------|-------------|--------------|--------|
| JW1323 | RIGHT | N390818.058 | W0794527.660 | 5854.3 |
|--------|-------|-------------|--------------|--------|

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

FILE: Unit_B_0407p_BrieryMtn.tps 000197918

2005 NOTE: The IGS precise and IGS rapid orbits were not available
2005 at processing time. The IGS ultra-rapid orbit was/will be used to
2005 process the data.
2005

NGS OPUS SOLUTION REPORT
=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu
RINEX FILE: unit097p.11o

DATE: April 08, 2011
TIME: 15:54:47 UTC

SOFTWARE: page5 1009.28 master10.pl 121510 START: 2011/04/07 15:54:00
EPHEMERIS: igu16304.eph [ultra-rapid] STOP: 2011/04/07 23:28:00
NAV FILE: brdc0970.11n OBS USED: 15304 / 17422 : 88%
ANT NAME: TPSHIPER_GD NONE # FIXED AMB: 111 / 126 : 88%
ARP HEIGHT: 2.0 OVERALL RMS: 0.016(m)

REF FRAME: NAD_83(CORS96) (EPOCH:2002.0000) ITRF00 (EPOCH:2011.2653)

| | | | | |
|------------|-----------------|----------|-----------------------------------|----------|
| X: | 885630.164(m) | 0.028(m) | 885629.405(m) | 0.028(m) |
| Y: | -4855271.018(m) | 0.033(m) | -4855269.589(m) | 0.033(m) |
| Z: | 4027521.347(m) | 0.010(m) | 4027521.232(m) | 0.010(m) |
| LAT: | 39 24 17.30839 | 0.019(m) | 39 24 17.33724 | 0.019(m) |
| E LON: | 280 20 14.78496 | 0.024(m) | 280 20 14.76447 | 0.024(m) |
| W LON: | 79 39 45.21504 | 0.024(m) | 79 39 45.23553 | 0.024(m) |
| EL HGT: | 596.124(m) | 0.027(m) | 594.859(m) | 0.027(m) |
| ORTHO HGT: | 627.531(m) | 0.048(m) | [NAVD88 (Computed using GEOID09)] | |

| | UTM COORDINATES | STATE PLANE COORDINATES |
|-----------------------|-----------------|-------------------------|
| | UTM (Zone 17) | SPC (4701 WV N) |
| Northing (Y) [meters] | 4362553.342 | 100461.500 |
| Easting (X) [meters] | 615150.549 | 585999.361 |
| Convergence [degrees] | 0.84909405 | -0.10367621 |
| Point Scale | 0.99976326 | 0.99994815 |
| Combined Factor | 0.99966976 | 0.99985464 |

US NATIONAL GRID DESIGNATOR: 17SPD1515062553(NAD 83)

| BASE STATIONS USED | | | | | | |
|-------------------------------------|-----------------------------|--|-------------|--------------|-------------|--|
| PID | DESIGNATION | | LATITUDE | LONGITUDE | DISTANCE(m) | |
| DM5974 | WVBR BRIDGEPORT CORS ARP | | N391828.884 | W0801638.619 | 54075.4 | |
| DL6505 | WVMO MORGANTOWN CORS ARP | | N393845.173 | W0795811.693 | 37617.0 | |
| DM4706 | WVCV CANAAN VALLEY CORS ARP | | N390055.076 | W0792725.010 | 46754.7 | |
| NEAREST NGS PUBLISHED CONTROL POINT | | | | | | |
| JW0836 | RV 15 | | N392408. | W0794047. | 1504.0 | |

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

| FILE: Unit_A_0414n_BrieryMtn.tps 000206081

NGS OPUS SOLUTION REPORT

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu
RINEX FILE: unit104n.110

DATE: April 19, 2011
TIME: 12:45:55 UTC

SOFTWARE: page5 1009.28 master40.pl 121510 START: 2011/04/14 13:10:00
EPHEMERIS: igr16314.eph [rapid] STOP: 2011/04/14 23:14:00
NAV FILE: brdc1040.11n OBS USED: 22591 / 25213 : 90%
ANT NAME: TPSHIPER_GD # FIXED AMB: 142 / 152 : 93%
ARP HEIGHT: 2.0 OVERALL RMS: 0.015(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2011.2843)

| | | | | |
|----|-----------------|----------|-----------------|----------|
| X: | 885630.178(m) | 0.006(m) | 885629.419(m) | 0.006(m) |
| Y: | -4855271.042(m) | 0.022(m) | -4855269.613(m) | 0.022(m) |
| Z: | 4027521.369(m) | 0.016(m) | 4027521.254(m) | 0.016(m) |

| | | | | |
|------------|-----------------|----------|-----------------------------------|----------|
| LAT: | 39 24 17.30840 | 0.007(m) | 39 24 17.33726 | 0.007(m) |
| E LON: | 280 20 14.78535 | 0.007(m) | 280 20 14.76487 | 0.007(m) |
| W LON: | 79 39 45.21465 | 0.007(m) | 79 39 45.23513 | 0.007(m) |
| EL HGT: | 596.158(m) | 0.027(m) | 594.893(m) | 0.027(m) |
| ORTHO HGT: | 627.565(m) | 0.048(m) | [NAVD88 (Computed using GEOID09)] | |

| | UTM COORDINATES | STATE PLANE COORDINATES |
|-----------------------|-----------------|-------------------------|
| | UTM (Zone 17) | SPC (4701 WV N) |
| Northing (Y) [meters] | 4362553.342 | 100461.501 |
| Easting (X) [meters] | 615150.558 | 585999.371 |
| Convergence [degrees] | 0.84909412 | -0.10367614 |
| Point Scale | 0.99976326 | 0.99994815 |
| Combined Factor | 0.99966976 | 0.99985464 |

US NATIONAL GRID DESIGNATOR: 17SPD1515062553(NAD 83)

| BASE STATIONS USED | | | | | |
|--------------------|-----------------------------|-------------|--------------|-------------|--|
| PID | DESIGNATION | LATITUDE | LONGITUDE | DISTANCE(m) | |
| DM5974 | WVBR BRIDGEPORT CORS ARP | N391828.884 | W0801638.619 | 54075.5 | |
| DL6505 | WVMO MORGANTOWN CORS ARP | N393845.173 | W0795811.693 | 37617.0 | |
| DM4706 | WVCV CANAAN VALLEY CORS ARP | N390055.076 | W0792725.010 | 46754.7 | |

| NEAREST NGS PUBLISHED CONTROL POINT | | | | |
|-------------------------------------|-------------|----------|-----------|-------------|
| PID | DESIGNATION | LATITUDE | LONGITUDE | DISTANCE(m) |
| JW0836 | RV 15 | N392408. | W0794047. | 1504.1 |

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

NGS OPUS SOLUTION REPORT

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu
RINEX FILE: unit104m.11o

DATE: April 19, 2011
TIME: 12:46:04 UTC

SOFTWARE: page5 1009.28 master2.pl 1215103 START: 2011/04/14 12:10:00
EPHEMERIS: igr16314.eph [rapid] STOP: 2011/04/15 00:09:00
NAV FILE: brdc1040.11n OBS USED: 24931 / 29514 : 84%
ANT NAME: TPSHIPER_GD # FIXED AMB: 144 / 150 : 96%
ARP HEIGHT: 2.0 OVERALL RMS: 0.015(m)

REF FRAME: NAD_83(CORS96) (EPOCH:2002.0000) ITRF00 (EPOCH:2011.2843)

X: 878036.155(m) 0.005(m) 878035.397(m) 0.005(m)
Y: -4872386.490(m) 0.023(m) -4872385.059(m) 0.023(m)
Z: 4008892.366(m) 0.013(m) 4008892.249(m) 0.013(m)

LAT: 39 11 11.88361 0.004(m) 39 11 11.91228 0.004(m)
E LON: 280 12 55.57887 0.007(m) 280 12 55.55836 0.007(m)
W LON: 79 47 4.42113 0.007(m) 79 47 4.44164 0.007(m)
EL HGT: 782.513(m) 0.026(m) 781.243(m) 0.026(m)
ORTHO HGT: 813.827(m) 0.046(m) [NAVD88 (Computed using GEOID09)]

| | UTM COORDINATES | STATE PLANE COORDINATES |
|-----------------------|-----------------|-------------------------|
| | UTM (Zone 17) | SPC (4701 wv N) |
| Northing (Y) [meters] | 4338191.488 | 76266.916 |
| Easting (X) [meters] | 604971.510 | 575415.137 |
| Convergence [degrees] | 0.76804311 | -0.18148559 |
| Point Scale | 0.99973568 | 0.99996996 |
| Combined Factor | 0.99961295 | 0.99984720 |

US NATIONAL GRID DESIGNATOR: 17SPD0497138191(NAD 83)

BASE STATIONS USED

| PID | DESIGNATION | LATITUDE | LONGITUDE | DISTANCE(m) |
|--------|---------------------------|-------------|--------------|-------------|
| DL3933 | LS08 LOYOLA LS08 CORS ARP | N385849.217 | W0801311.035 | 44076.6 |
| DL6505 | WVMO MORGANTOWN CORS ARP | N393845.173 | W0795811.693 | 53433.7 |
| DM4710 | WVNR ELKINS CORS ARP | N385344.505 | W0795130.270 | 32929.7 |

NEAREST NGS PUBLISHED CONTROL POINT

| | | | | |
|--------|-------|-------------|--------------|--------|
| JW1323 | RIGHT | N390818.058 | W0794527.660 | 5854.3 |
|--------|-------|-------------|--------------|--------|

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

NGS OPUS SOLUTION REPORT
=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu
RINEX FILE: unit1051.11o

DATE: April 19, 2011
TIME: 12:51:28 UTC

SOFTWARE: page5 1009.28 master29.pl 121510 START: 2011/04/15 11:57:00
EPHEMERIS: igr16315.eph [rapid] STOP: 2011/04/15 20:22:00
NAV FILE: brdc1050.11n OBS USED: 19772 / 20793 : 95%
ANT NAME: TPSHIPER_GD # FIXED AMB: 107 / 113 : 95%
ARP HEIGHT: 2.0 OVERALL RMS: 0.014(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2011.2868)

| | | | | |
|----|-----------------|----------|-----------------|----------|
| X: | 958768.953(m) | 0.007(m) | 958768.192(m) | 0.007(m) |
| Y: | -4825997.106(m) | 0.014(m) | -4825995.675(m) | 0.014(m) |
| Z: | 4045153.802(m) | 0.014(m) | 4045153.691(m) | 0.014(m) |

| | | | | |
|------------|-----------------|----------|-----------------------------------|----------|
| LAT: | 39 36 49.21614 | 0.005(m) | 39 36 49.24545 | 0.005(m) |
| E LON: | 281 14 11.41964 | 0.004(m) | 281 14 11.40004 | 0.004(m) |
| W LON: | 78 45 48.58036 | 0.004(m) | 78 45 48.59996 | 0.004(m) |
| EL HGT: | 188.186(m) | 0.018(m) | 186.920(m) | 0.018(m) |
| ORTHO HGT: | 220.911(m) | 0.033(m) | [NAVD88 (Computed using GEOID09)] | |

| | UTM COORDINATES | STATE PLANE COORDINATES |
|-----------------------|-----------------|-------------------------|
| | UTM (Zone 17) | SPC (4701 WV N) |
| Northing (Y) [meters] | 4387269.757 | 123895.844 |
| Easting (X) [meters] | 691988.148 | 663241.583 |
| Convergence [degrees] | 1.42644846 | 0.46972328 |
| Point Scale | 1.00005382 | 0.99994076 |
| Combined Factor | 1.00002430 | 0.99991124 |

US NATIONAL GRID DESIGNATOR: 17SPD9198887269(NAD 83)

| | | BASE STATIONS USED | | |
|--------|-----------------------------|--------------------|--------------|-------------|
| PID | DESIGNATION | LATITUDE | LONGITUDE | DISTANCE(m) |
| DM4708 | WVMF MOORFIELD CORS ARP | N390432.344 | W0785556.998 | 61485.4 |
| DL7341 | WVBU BURLINGTON WV CORS ARP | N392016.821 | W0785448.587 | 33216.7 |
| DH8807 | LOYC LOYOLA C COOP CORS ARP | N390712.546 | W0781202.609 | 73173.8 |

| | | NEAREST NGS PUBLISHED CONTROL POINT | | |
|--------|-------------|-------------------------------------|--------------|-------------|
| PID | DESIGNATION | LATITUDE | LONGITUDE | DISTANCE(m) |
| JW1600 | CBE B | N393649.216 | W0784548.579 | 0.0 |

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

| FILE: Unit_B_0415m_50.42.tps 000206095

NGS OPUS SOLUTION REPORT
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All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu
RINEX FILE: unit105m.11o

DATE: April 19, 2011
TIME: 12:50:54 UTC

SOFTWARE: page5 1009.28 master50.p1 121510 START: 2011/04/15 12:55:00
EPHEMERIS: igr16315.eph [rapid] STOP: 2011/04/15 19:15:00
NAV FILE: brdc1050.11n OBS USED: 14249 / 15449 : 92%
ANT NAME: TPSHIPER_GD # FIXED AMB: 87 / 88 : 99%
ARP HEIGHT: 2.0 OVERALL RMS: 0.013(m)

REF FRAME: NAD_83(CORS96) (EPOCH:2002.0000) ITRF00 (EPOCH:2011.2867)

| | | | | |
|----|-----------------|----------|-----------------|----------|
| X: | 931881.509(m) | 0.006(m) | 931880.750(m) | 0.006(m) |
| Y: | -4852555.329(m) | 0.018(m) | -4852553.897(m) | 0.018(m) |
| Z: | 4020724.505(m) | 0.011(m) | 4020724.391(m) | 0.011(m) |

| | | | | |
|------------|-----------------|----------|-----------------------------------|----------|
| LAT: | 39 19 26.80106 | 0.016(m) | 39 19 26.83004 | 0.016(m) |
| E LON: | 280 52 14.51657 | 0.008(m) | 280 52 14.49673 | 0.008(m) |
| W LON: | 79 7 45.48343 | 0.008(m) | 79 7 45.50327 | 0.008(m) |
| EL HGT: | 801.811(m) | 0.011(m) | 800.541(m) | 0.011(m) |
| ORTHO HGT: | 833.438(m) | 0.022(m) | [NAVD88 (Computed using GEOID09)] | |

| | UTM COORDINATES | STATE PLANE COORDINATES |
|-----------------------|-----------------|-------------------------|
| | UTM (Zone 17) | SPC (4701 WV N) |
| Northing (y) [meters] | 4354413.083 | 91556.097 |
| Easting (X) [meters] | 661251.195 | 631963.763 |
| Convergence [degrees] | 1.18572926 | 0.23642184 |
| Point Scale | 0.99992016 | 0.99995454 |
| Combined Factor | 0.99979439 | 0.99982877 |

US NATIONAL GRID DESIGNATOR: 17SPD6125154413(NAD 83)

| BASE STATIONS USED | | | | | | |
|--------------------|-----------------------------|--|-------------|--------------|-------------|--|
| PID | DESIGNATION | | LATITUDE | LONGITUDE | DISTANCE(m) | |
| DM4706 | WCV CANAAN VALLEY CORS ARP | | N390055.076 | W0792725.010 | 44471.2 | |
| DM4708 | WVMF MOORFIELD CORS ARP | | N390432.344 | W0785556.998 | 32408.2 | |
| DL7341 | WVBU BURLINGTON WV CORS ARP | | N392016.821 | W0785448.587 | 18681.9 | |

| NEAREST NGS PUBLISHED CONTROL POINT | | | | | | |
|-------------------------------------|-----------------------|--|-------------|--------------|-------------|--|
| PID | DESIGNATION | | LATITUDE | LONGITUDE | DISTANCE(m) | |
| JW1266 | MT STORM WU MICROWAVE | | N391621.244 | W0791035.642 | 7035.8 | |

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

| FILE: Unit_A_0421m_DavisInd_new.tps 000210310

2005 NOTE: The IGS precise and IGS rapid orbits were not available
2005 at processing time. The IGS ultra-rapid orbit was/will be used to
2005 process the data.
2005

NGS OPUS SOLUTION REPORT
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All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu
RINEX FILE: unit111m.11o

DATE: April 22, 2011
TIME: 16:11:26 UTC

SOFTWARE: page5 1009.28 master2.pl 1215103 START: 2011/04/21 12:24:00
EPHEMERIS: igu16324.eph [ultra-rapid] STOP: 2011/04/21 22:11:00
NAV FILE: brdc1110.11n OBS USED: 22106 / 23266 : 95%
ANT NAME: TPSHIPER_GD # FIXED AMB: 109 / 114 : 96%
ARP HEIGHT: 2.0 OVERALL RMS: 0.014(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2011.3033)

| | | | | |
|----|-----------------|----------|-----------------|----------|
| X: | 907306.498(m) | 0.002(m) | 907305.740(m) | 0.002(m) |
| Y: | -4870155.988(m) | 0.010(m) | -4870154.555(m) | 0.010(m) |
| Z: | 4005313.632(m) | 0.009(m) | 4005313.515(m) | 0.009(m) |

| | | | | |
|------------|-----------------|----------|-----------------------------------|----------|
| LAT: | 39 8 38.81072 | 0.002(m) | 39 8 38.83945 | 0.002(m) |
| E LON: | 280 33 11.44979 | 0.001(m) | 280 33 11.42969 | 0.001(m) |
| W LON: | 79 26 48.55021 | 0.001(m) | 79 26 48.57031 | 0.001(m) |
| EL HGT: | 911.894(m) | 0.013(m) | 910.620(m) | 0.013(m) |
| ORTHO HGT: | 942.687(m) | 0.026(m) | [NAVD88 (Computed using GEOID09)] | |

| | UTM COORDINATES | STATE PLANE COORDINATES |
|-----------------------|-----------------|-------------------------|
| | UTM (Zone 17) | SPC (4701 WV N) |
| Northing (Y) [meters] | 4333917.884 | 71508.929 |
| Easting (X) [meters] | 634222.744 | 604597.364 |
| Convergence [degrees] | 0.98062735 | 0.03391708 |
| Point Scale | 0.99982183 | 0.99997588 |
| Combined Factor | 0.99967881 | 0.99983283 |

US NATIONAL GRID DESIGNATOR: 17SPD3422233917(NAD 83)

| BASE STATIONS USED | | | | |
|--------------------|-----------------------------|-------------|--------------|-------------|
| PID | DESIGNATION | LATITUDE | LONGITUDE | DISTANCE(m) |
| DM4706 | WVCV CANAAN VALLEY CORS ARP | N390055.076 | W0792725.010 | 14329.7 |
| DM4708 | WVMF MOORFIELD CORS ARP | N390432.344 | W0785556.998 | 45137.5 |
| DL7341 | WVBU BURLINGTON WV CORS ARP | N392016.821 | W0785448.587 | 50835.3 |

| NEAREST NGS PUBLISHED CONTROL POINT | | | | |
|-------------------------------------|----------------------------|-------------|--------------|-------------|
| PID | DESIGNATION | LATITUDE | LONGITUDE | DISTANCE(m) |
| JW1291 | THOMAS MUNICIPAL STANDPIPE | N390850.672 | W0792934.709 | 4001.6 |

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

FILE: unit_B_0421n_50.42.tps 000210185

2005 NOTE: The IGS precise and IGS rapid orbits were not available
2005 at processing time. The IGS ultra-rapid orbit was/will be used to
2005 process the data.
2005

NGS OPUS SOLUTION REPORT
=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu
RINEX FILE: unit111n.11o

DATE: April 22, 2011
TIME: 15:27:53 UTC

SOFTWARE: page5 1009.28 master.pl 1215103 START: 2011/04/21 13:02:00
EPHEMERIS: igu16324.eph [ultra-rapid] STOP: 2011/04/21 21:27:30
NAV FILE: brdc1110.11n OBS USED: 18841 / 19935 : 95%
ANT NAME: TPSHIPER_GD NONE # FIXED AMB: 84 / 85 : 99%
ARP HEIGHT: 2.0 OVERALL RMS: 0.014(m)

REF FRAME: NAD_83(CORS96) (EPOCH:2002.0000) ITRF00 (EPOCH:2011.3033)

| | | | | |
|----|-----------------|----------|-----------------|----------|
| X: | 931881.505(m) | 0.008(m) | 931880.746(m) | 0.008(m) |
| Y: | -4852555.326(m) | 0.007(m) | -4852553.894(m) | 0.007(m) |
| Z: | 4020724.491(m) | 0.019(m) | 4020724.377(m) | 0.019(m) |

| | | | | |
|------------|-----------------|----------|-----------------------------------|----------|
| LAT: | 39 19 26.80079 | 0.015(m) | 39 19 26.82976 | 0.015(m) |
| E LON: | 280 52 14.51643 | 0.006(m) | 280 52 14.49659 | 0.006(m) |
| W LON: | 79 7 45.48357 | 0.006(m) | 79 7 45.50341 | 0.006(m) |
| EL HGT: | 801.800(m) | 0.018(m) | 800.529(m) | 0.018(m) |
| ORTHO HGT: | 833.427(m) | 0.034(m) | [NAVD88 (Computed using GEOID09)] | |

| | UTM COORDINATES | STATE PLANE COORDINATES |
|-----------------------|-----------------|-------------------------|
| | UTM (Zone 17) | SPC (4701 WV N) |
| Northing (Y) [meters] | 4354413.074 | 91556.088 |
| Easting (X) [meters] | 661251.192 | 631963.760 |
| Convergence [degrees] | 1.18572924 | 0.23642181 |
| Point Scale | 0.99992016 | 0.99995454 |
| Combined Factor | 0.99979439 | 0.99982877 |

US NATIONAL GRID DESIGNATOR: 17SPD6125154413(NAD 83)

| PID | DESIGNATION | BASE STATIONS USED | LATITUDE | LONGITUDE | DISTANCE(m) |
|--------|-----------------------------|--------------------|-------------|--------------|-------------|
| DM4706 | WVCV CANAAN VALLEY CORS ARP | | N390055.076 | w0792725.010 | 44471.2 |
| DM4708 | WWMF MOORFIELD CORS ARP | | N390432.344 | w0785556.998 | 32408.2 |
| DL7341 | WVBU BURLINGTON WV CORS ARP | | N392016.821 | w0785448.587 | 18681.9 |

| | NEAREST NGS PUBLISHED CONTROL POINT | | |
|--------|-------------------------------------|-------------|---------------------|
| JW1266 | MT STORM WU MICROWAVE | N391621.244 | w0791035.642 7035.7 |

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

SECTION 4: LIDAR SYSTEMS SPECIFICATIONS



The OPTECH ALTM-3100

1. NRAC operates an OPTECH ALTM-3100C airborne laser mapping system. The system integrates a laser Altimeter, a high-end Applanix POS/AV Inertial Measurement Unit (IMU), also called an Inertial Navigation System (INS), and a dual frequency Trimble GPS receiver. The system offers several user-configurable parameters that allow the data capture campaign to be tailored to each specific project. This integrated system is capable of 100kHz operation at an operating height of 1,100 meters (3,609 feet). LiDAR technology offers fast, real-time collection of three-dimensional points that are employed in the creation of Digital Elevation Models (DEMs) and other desired deliverables.
2. In-flight data are logged to hard drives, which provides for immediate extraction and viewing of post-mission data. Data quality, coverage, and other mission critical information are reviewed immediately to determine if re-flights are necessary. Basic parameters of NRAC's LiDAR system include:

| OPTECH ALTM-3100 LiDAR | |
|-------------------------------|---|
| Operating Altitude | 80-3500 meters nominal |
| Horizontal Accuracy | 1/2000 x altitude; 1 σ |
| Elevation Accuracy | <15 cm @ 1200m; 1 σ |
| Range Resolution | 1 cm |
| Range Capture | Up to 4 range measurements for each pulse |
| Intensity Capture | 12-bit dynamic range for each measurement |
| Scan Frequency | Variable; maximum 70 Hz |
| Scan Angle | Variable from 0 to 25°; in increments of 1° |
| Swath width | Variable; 0 to 0.93 x altitude (m) |