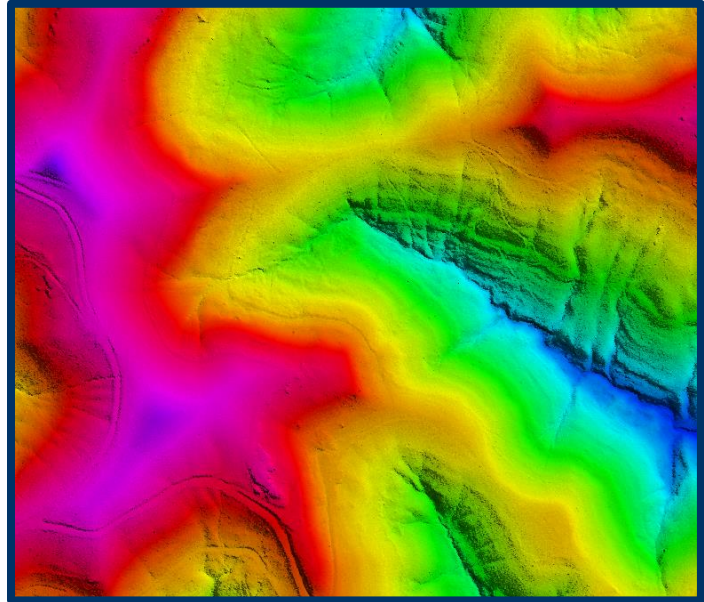


AERIAL LIDAR ACQUISITION REPORT



TUG NOTCH
LIDAR *.LAS1.2 DATA
COMPREHENSIVE AND BARE EARTH

**WEST VIRGINIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION**

JUNE 2013

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SECTION 1: OVERVIEW

Project Name: Tug Notch Airborne LiDAR

NRAC was contracted to perform an aerial acquisition survey of the pertinent mine areas in and around Tug Watershed pertaining to Wayne County, WV 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 Tug Notch project was collected 19 Dec 2011 and is composed of 125 working segments, covering 63,846.64 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%

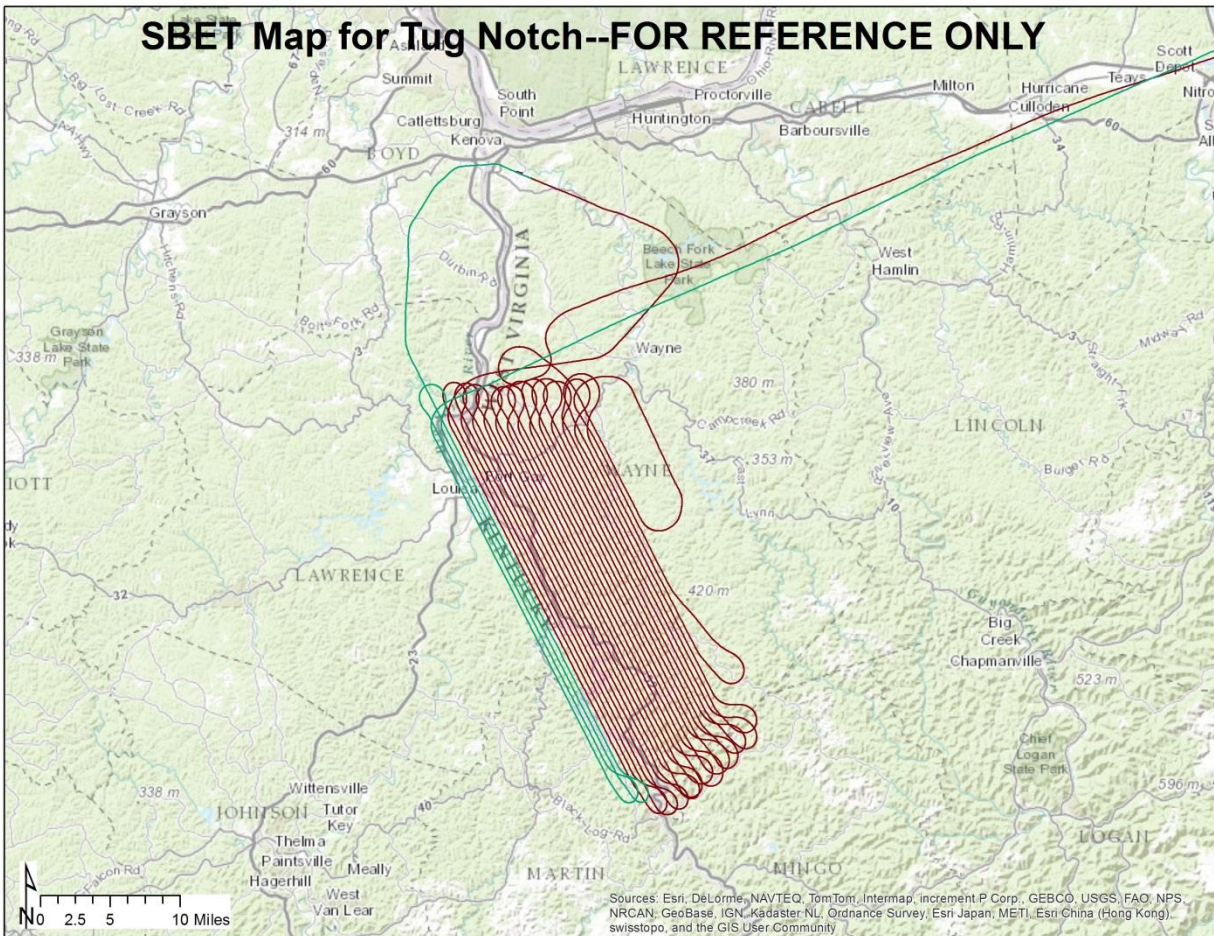
Flight line acquisition was performed around weather, winds, GPS PDOP, vegetation emergence conditions, and fuel, collecting data in as few missions as possible, as close together as possible, to ensure consistency across the project area.

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)
19 Dec 2011	29	643/ 133151.8106	643/ 151988.0027
19 Dec 2011	5	643/ 161858.2068	643/ 164497.3279



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 Tug Notch project area are detailed with the following NGS OPUS Datasheets (dates are referenced in file name):

FILE: Unit_B_12191_EastLynnLake_b.tps OP1324501734828

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: unit3531.11o

DATE: December 21, 2011
TIME: 21:04:28 UTC

SOFTWARE: page5 1108.09 master80.pl 060711 START: 2011/12/19 11:48:00
EPHEMERIS: igr16671.eph [rapid] STOP: 2011/12/19 23:42:30
NAV FILE: brdc3530.11n OBS USED: 26721 / 27411 : 97%
ANT NAME: TPSHIPER_GD # FIXED AMB: 104 / 113 : 92%
ARP HEIGHT: 2.0 OVERALL RMS: 0.014(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2011.9664)

X: 665648.542(m) 0.038(m) 665647.780(m) 0.038(m)
Y: -4978352.704(m) 0.007(m) -4978351.273(m) 0.007(m)
Z: 3918223.430(m) 0.018(m) 3918223.298(m) 0.018(m)

LAT: 38 8 41.72861 0.020(m) 38 8 41.75568 0.020(m)
E LON: 277 36 56.76350 0.037(m) 277 36 56.74027 0.037(m)
W LON: 82 23 3.23650 0.037(m) 82 23 3.25973 0.037(m)
EL HGT: 187.495(m) 0.004(m) 186.219(m) 0.004(m)
ORTHO HGT: 220.374(m) 0.015(m) [NAVD88 (Computed using GEOID09)]

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 17)	SPC (4702 WV S)
Northing (Y) [meters]	4222799.996	127979.250
Easting (X) [meters]	378704.830	478672.620
Convergence [degrees]	-0.85507905	-0.85572609
Point Scale	0.99978120	0.99992592
Combined Factor	0.99975178	0.99989650

US NATIONAL GRID DESIGNATOR: 17SLC7870422799(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DK7557	KYGB GREENBO LAKE SRP CORS ARP	N382850.195	W0825223.978	56730.2
DK3332	KYTL KY HWY DIST 12 CORS ARP	N372900.177	W0823207.696	74626.1
DF4048	GALP GALLIPOLIS CORS ARP	N385039.148	W0821640.092	78179.6

NEAREST NGS PUBLISHED CONTROL POINT

HY0670	E 147	N380839.	W0822310.	184.9
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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)