



# FEMA

Federal Emergency Management Agency

**Worcester County, Massachusetts**

**Blackstone River HUC 8 LiDAR FY2010**

**Technical Support Data Notebook**

**Terrain Project Narrative**

**Elevation Data Acquisition**

**CID 25027C**

CASE NO. 11-01-0716S  
CONTRACT NO. HSFEHQ-09-D-0370  
TASK ORDER NO. HSFEHQ-10-J-0005

Date June 17, 2011

Prepared By:



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## 1. Introduction

Beginning in Fiscal Year 2010, FEMA initiated a five-year program for Risk Mapping, Assessment, and Planning (Risk MAP). The vision for Risk MAP is to deliver quality data that increases public awareness and leads to action that reduces risk to life and property. In order to realize the Risk MAP vision FEMA is acquiring high resolution terrain elevation and land cover elevation data to increase production efficiencies for NFIP regulatory products and support risk assessment data development. FEMA has made a commitment through Risk MAP to work closely with NDEP (National Digital Elevation Program) partners to obtain and support the collection of terrain data throughout the United States.

Terrain data, collected under the Risk MAP program, will be required to meet minimum specifications outlined in the *Draft Procedure Memorandum No. 61—Standards for LiDAR and Other High Quality Digital Topography dated August 1<sup>st</sup>, 2010*<sub>1</sub>. FEMA also requires all deliverables for topographic data collection be submitted in accordance with *Appendix M: Data Capture Standards March 2009*<sub>2</sub>. All relevant project materials have been reviewed to insure that these requirements are met.

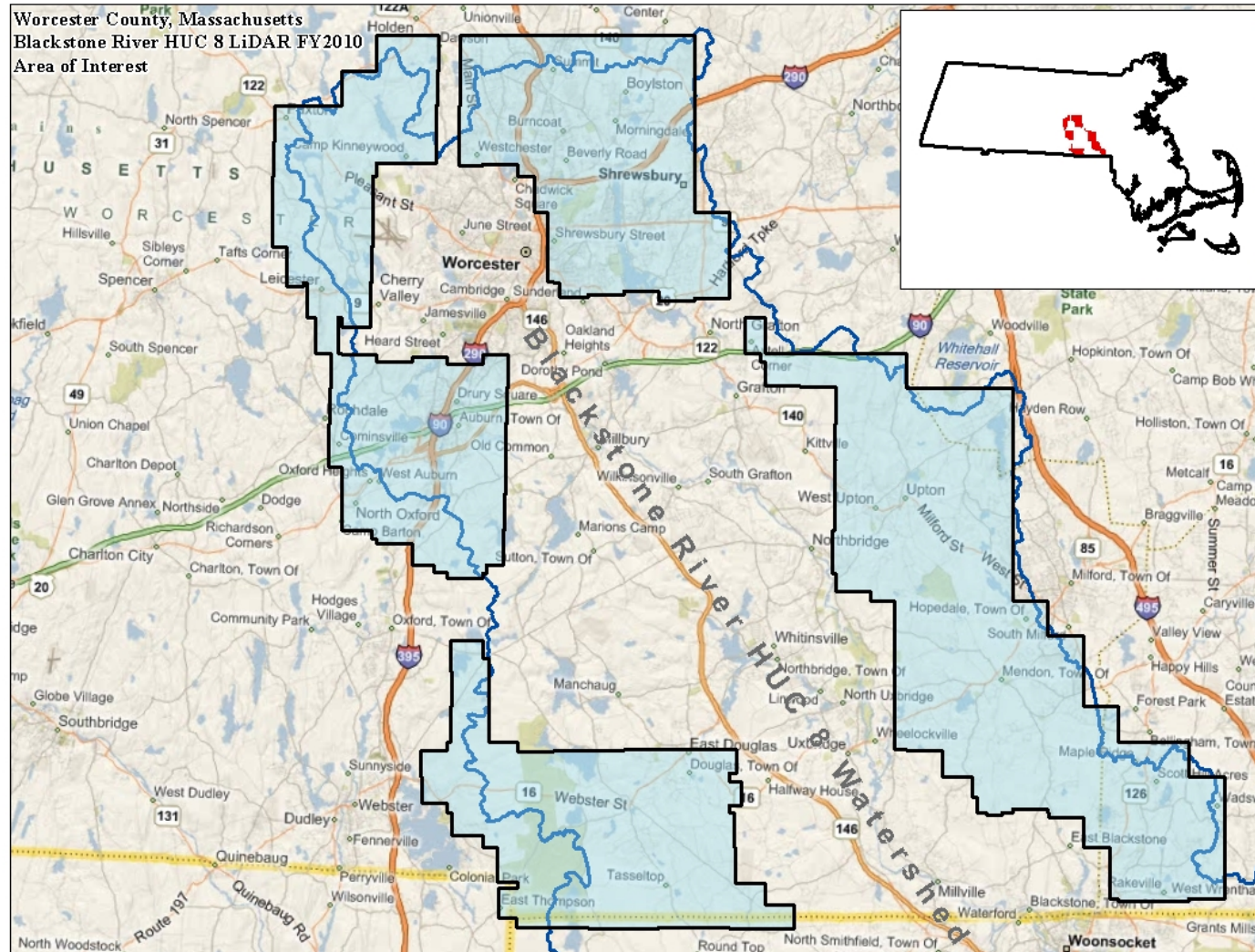
The objectives for elevation data acquisition for the Blackstone River Watershed are as follows:

1. LAS point cloud files collected for 112 square miles
2. LAS point cloud files captured using the “Highest” vertical accuracy requirements
3. LAS point cloud files collected at equivalent of a 2-foot contour accuracy
4. LAS point cloud files collected using a nominal pulse spacing of 1-meter
5. LAS classified as Bare Earth processed for 112 square miles

**Table 1. Vertical Accuracy Requirements**

Contour Accuracy	Specification Level	RMSE <sub>z</sub>	FVA	CVA
2ft	Highest	18.5 cm	24.5 cm	36.3 cm

Figure 1. Project Location



The LiDAR acquired for this project cover portions of Worcester, Middlesex and Norfolk Counties in Massachusetts. The following communities are either partially or completely included within this Area of Interest:

Worcester County

- City of Worcester
- Town of Auburn
- Town of Blackstone
- Town of Boylston
- Town of Douglas
- Town of Grafton
- Town of Holden
- Town of Hopedale
- Town of Leicester
- Town of Mendon
- Town of Milford
- Town of Millbury
- Town of Millville
- Town of Northbridge
- Town of Oxford
- Town of Paxton
- Town of Shrewsbury
- Town of Sutton
- Town of Upton
- Town of Uxbridge
- Town of Webster
- Town of West Boylston
- Town of Westborough

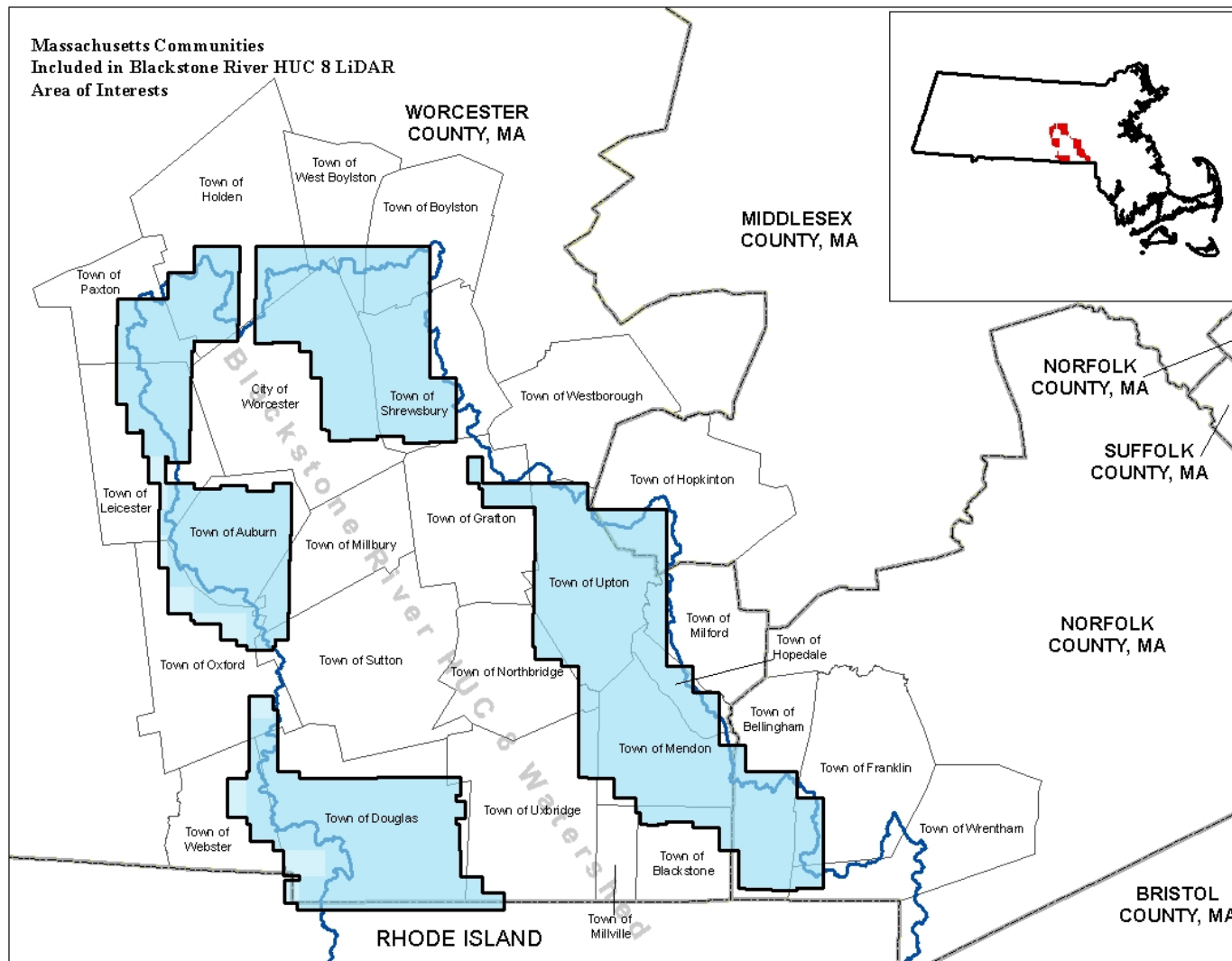
Norfolk County

- Town of Bellingham
- Town of Franklin
- Town of Wrentham

Middlesex County

- Town of Hopkinton

Figure 2. Massachusetts Communities Located Within Blackstone Area of Interest



## **2. Scope of Work**

Statement of Priorities

PTS Elevation Data Acquisition

STARR – Contract # HSFEHQ-09-D-0370

The contractor shall acquire elevation data to support flood hazard data updates based on the minimum requirements shown on the attached ordering sheet. Elevation data shall comply with the draft FEMA Procedure Memorandum: Standards for LiDAR and Other High Quality Elevation Data.

The contractor shall respond with pricing for the minimum elevation collections and bare earth processing specified on the attached ordering sheet. The contractor's proposal shall identify any breakline creation or other post-processing that is required to use the elevation data for the flood hazard data updates based on the risk, terrain type, anticipated engineering methods and other relevant factors. The proposal must explain the reasons this additional processing is needed.

The contractor will also be responsible for performing QA of the elevation data as specified in the Standards for LiDAR and Other High Quality Elevation Data procedure memo.

The contractor shall also propose collection and processing alternatives that group the collections into larger, more cost effective collection blocks or other collection and processing alternatives that may be more advantageous for the government as an alternative option.

Scope Details:

LiDAR acquisition of Blackstone River Watershed, consisting of 112 square miles, divided between 4 areas. All data captured to the "Highest" vertical accuracy requirement. This collection specification is the equivalent of a 2-foot contour accuracy and will be collected with a nominal pulse spacing of 1-meter. Post processing is required for all 112 square miles covering both collection areas.

## **3. Issues**

A. Special Problem Reports

None

B. Project Modifications

None

#### 4. Information for the Next Mapping Partner

The Blackstone River LiDAR collection AOI consists of 4 functional areas. This project included both LiDAR point cloud development and Bare Earth post processing. Point Cloud LiDAR data for this project is partially classified LAS 1.2 binary file format. The Bare Earth LiDAR for this project has been classified using ASPRS LiDAR classifications. Bare Earth classified as class 2 is considered to be Bare Earth and points classified as class 8 are Model Key. All data for this project has been collected using the following spatial reference information:

Projection: Universal Transverse Mercator  
UTM Zone: 19  
Linear units: Meter  
Horizontal Datum: North American Datum 1983  
Vertical Datum: North American Vertical Datum of 1988  
Vertical units: Meters

LAS point files are named according to the UTM Coordinates at the southwest corner of the tile, following the zz\_0xxxxyyy convention, where z is the UTM zone number, x and y are the UTM coordinates.

**Table 2. LAS file information**

Product	# Tiles	Total File Size	Point Count	Avg. Point Spacing
Point Cloud Blackstone	274	31.8GB	1199842529	0.6
Bare Earth Blackstone	274	31.8GB	1223280386	0.6

Details about the storage of this dataset can be found within Appendix G of this document.

Ground control and quality control checkpoints were collected by CompassData, Inc. Photo Science, Inc. performed LiDAR acquisition flights, automated processing and Bare Earth manual edits. Independent QC of the point cloud and bare earth surface was performed by CompassData, Inc. Quality Assurance testing was conducted by Greenhorne & O'Mara, Inc. All firms were under contract to STARR, A Joint Venture which held the FEMA Professional Technical Services contract and task order for this work. All contact information for the project team can be found in Appendix A of this document.

#### **A. Ground Control Survey**

Ground Control is collected throughout the AOI for use in the processing of LiDAR data to ensure data accurately represents the ground surface. QA/QC checkpoints, also collected throughout the AOI, are used for independent quality checks of the processed LiDAR data.

GPS based surveys were utilized to support both processing and testing of LiDAR data within FEMA designated Areas of Interest (AOIs). Geographically distinct ground points were surveyed using GPS technology throughout the AOIs to provide support for three distinct tasks:

Task1 was to provide Vertical Ground Control to support the aerial acquisition and subsequent bare earth model processing. To accomplish this, survey-grade Trimble R-8 GPS receivers were used to collect a series of control points located on open areas, free of excessive or significant slope, and at least 5 meters away from any significant terrain break. Most if not all control points were collected at street/road intersections on bare level pavement.

Task 2 was to collect Fundamental Vertical Accuracy (FVA) checkpoints to evaluate the initial quality of the collected point cloud and to ensure that the collected data was satisfactory for further processing to meet FEMA specifications. The FVA points were collected in identical fashion to the Vertical Ground Control Points, but segregated from the point pool to ensure independent quality testing without prior knowledge of FVA locations by the aerial vendors.

Task 3 was to collect Consolidated Vertical Accuracy (CVA) checkpoints to allow vertical testing of the bare-earth processed LiDAR data in different classes of land cover, including: open (pavement, open dirt, short grass), High Grass and Crops, Brush and Low Trees, Forest, and Urban. CVA points were collected in similar fashion as Control and FVA points with emphasis on establishing point locations within the predominant land cover classes within each AOI or Functional AOI Group.

In order to successfully collect the Forest land cover class, it was necessary to establish a Backsight and Initial Point with the R8 receiver, and then employ a Nikon Total Station to observe a retroreflective prism stationed under tree canopy. This was necessary due to the reduced GPS performance and degradation of signal under tree canopy. The R-8 receivers were equipped with cellular modems to receive real-time correction signals from the Keystone Precision Virtual Reference Station (VRS) network encompassing the Region 1 AOIs.

Use of the VRS network allowed rapid collection times (~3 minutes/point) at 2.54 cm (1 inch) initial accuracy. All points collected were below the 8cm specification for testing 24cm, highest category LiDAR data. To ensure valid in-field collections, an NGS monument with suitable vertical reporting was measured using the same equipment and procedures used for Control, FVA and CVA points on a daily basis. The measurement was compared to the NGS published values to ensure that the GPS collection schema was producing valid data and as a physical proof point of quality of collection. Those monument measurements are summarized in the Accuracy report included in the data delivered to FEMA.

In order to meet FEMA budgetary requirements, AOIs were consolidated into Functional Groups: if AOIs were contiguous, they were treated as one large AOI to allow collection of 20 FVA points and 15 additional CVA points across the group of AOIs. 20 FVA points are necessary to allow testing to CE95 – 1 point out of 20 may fail vertical testing and still allow the entire dataset to meet 95% accuracy requirements. In similar fashion, 20 CVA points are necessary to test to CE95 as discussed above.

15 CVA points were collected per AOI or per Functional Group with the intention at the outset that 5 of the collected FVAs would perform double – duty as Open-class CVA points, to total 20 CVAs per AOI or Functional Group. The Functional Groups are as follows:

- Narragansett/Charles/Blackstone (northeast)
- Nashua, Blackstone (north and west)
- Quinipiac
- Quincy/Suffolk (while included as part of the FEMA Charles AOI, was physically separated from the Charles AOI polygon and treated as an independent functional area)



The following software packages and utilities were used to control the GPS receiver in the field during data collection, and then ingest and export the collected GPS data for all points:

- Trimble Survey Controller
- Trimble Pathfinder Office

The following software utilities were used to translate the collected Latitude/Longitude Decimal Degree HAE GPS data for all points into Latitude/Longitude Degrees/Minutes/Seconds for checking the collected monument data against the published NGS Datasheet Lat/Long DMS values and into UTM NAD83 Northings/Eastings:

- U.S. Army Corps of Engineers CorpsCon
- National Geodetic Survey Geoid09NAVD88

MSL values were determined using the most recent NGS-approved geoid model to generate geoid separation values for each Lat/Long coordinate pair. In this fashion, Orthometric heights were determined for each Control, FVA and CVA point by subtracting the generated Geoid Separation value from the Ellipsoidal Height (HAE) for publication and use as MSL NAVD88(09).

**Figure 3. Blackstone River Watershed AOI Ground Control Survey Coverage**

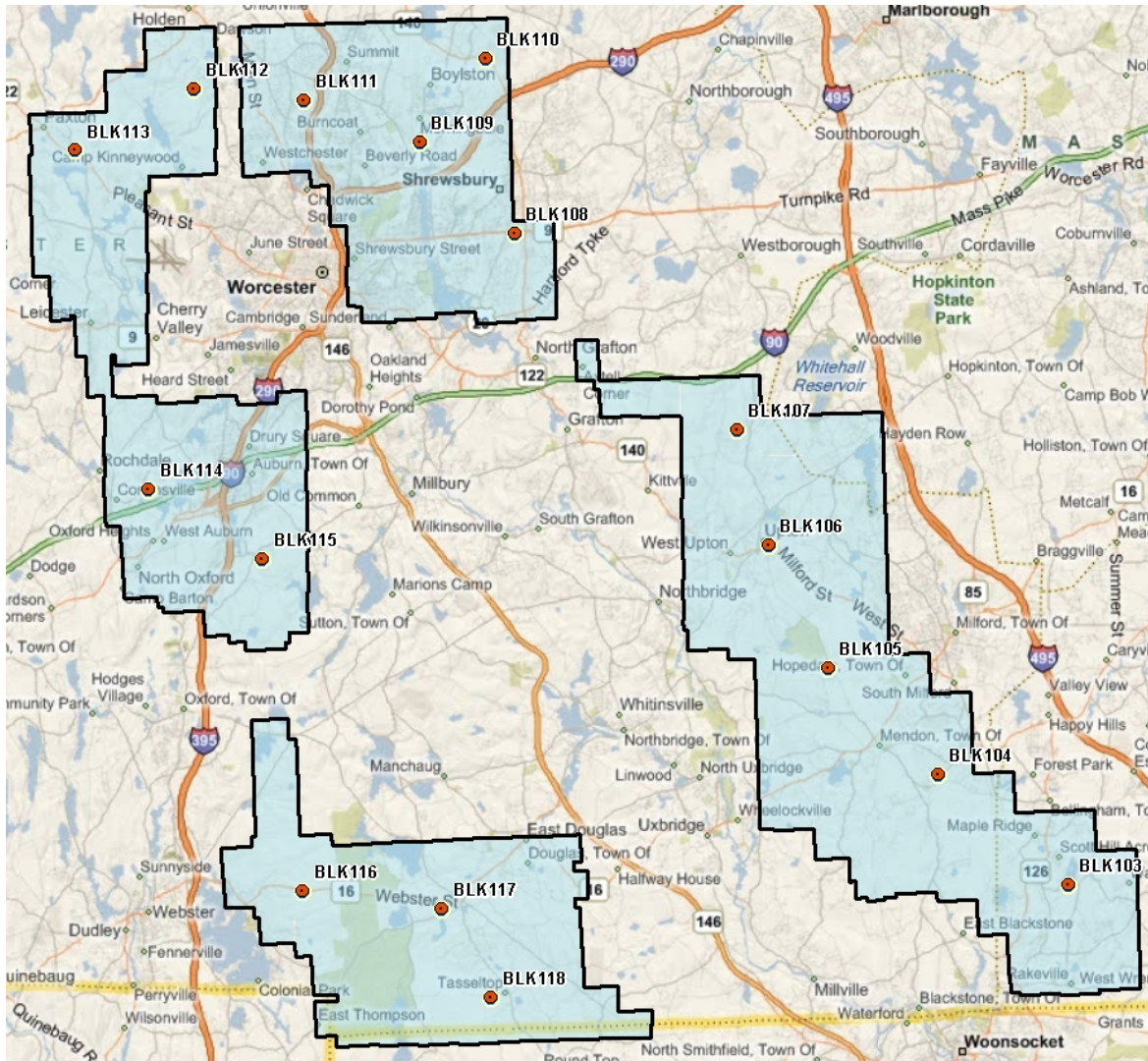


Figure 4. Blackstone River Watershed Area (1) FVA CVA Results

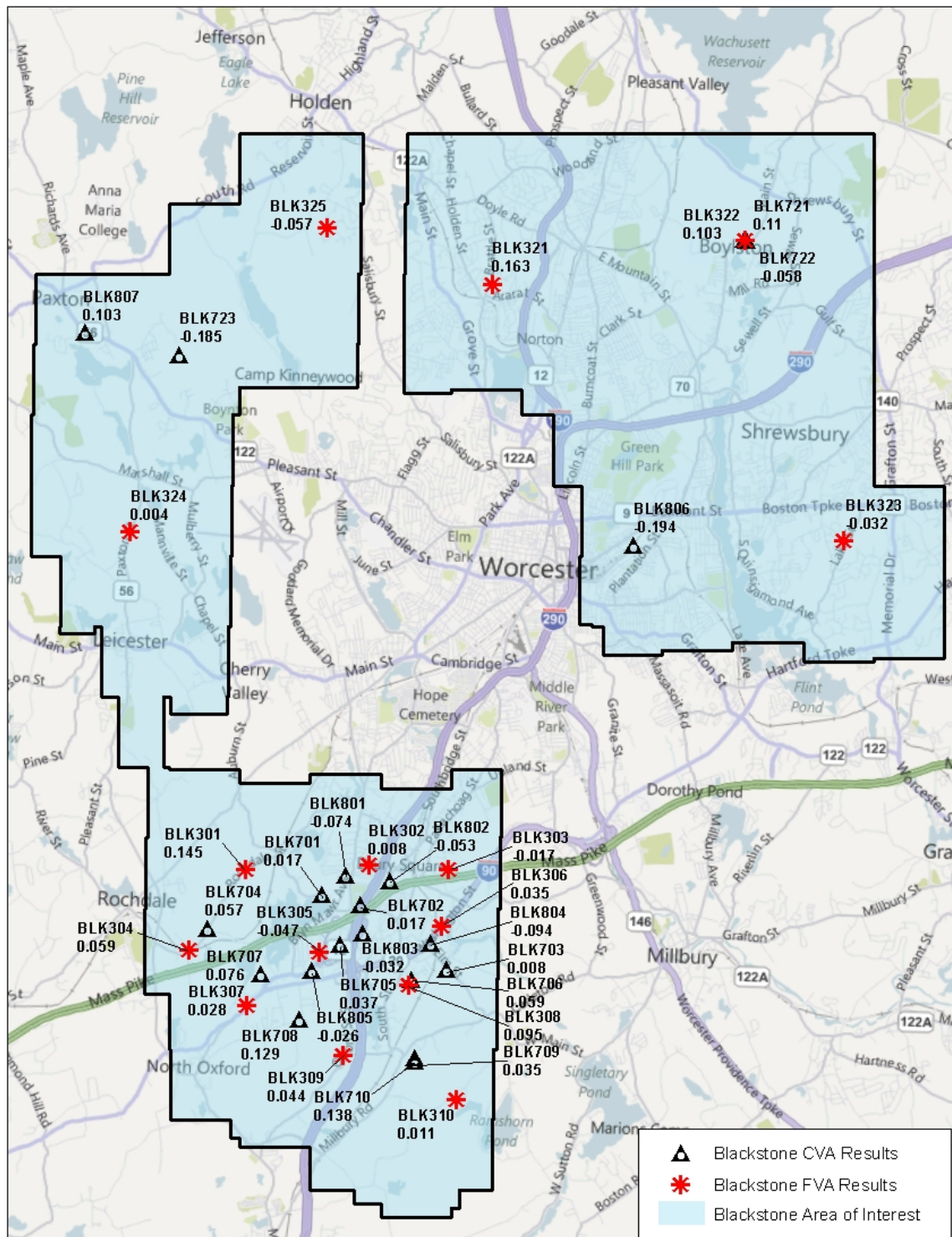
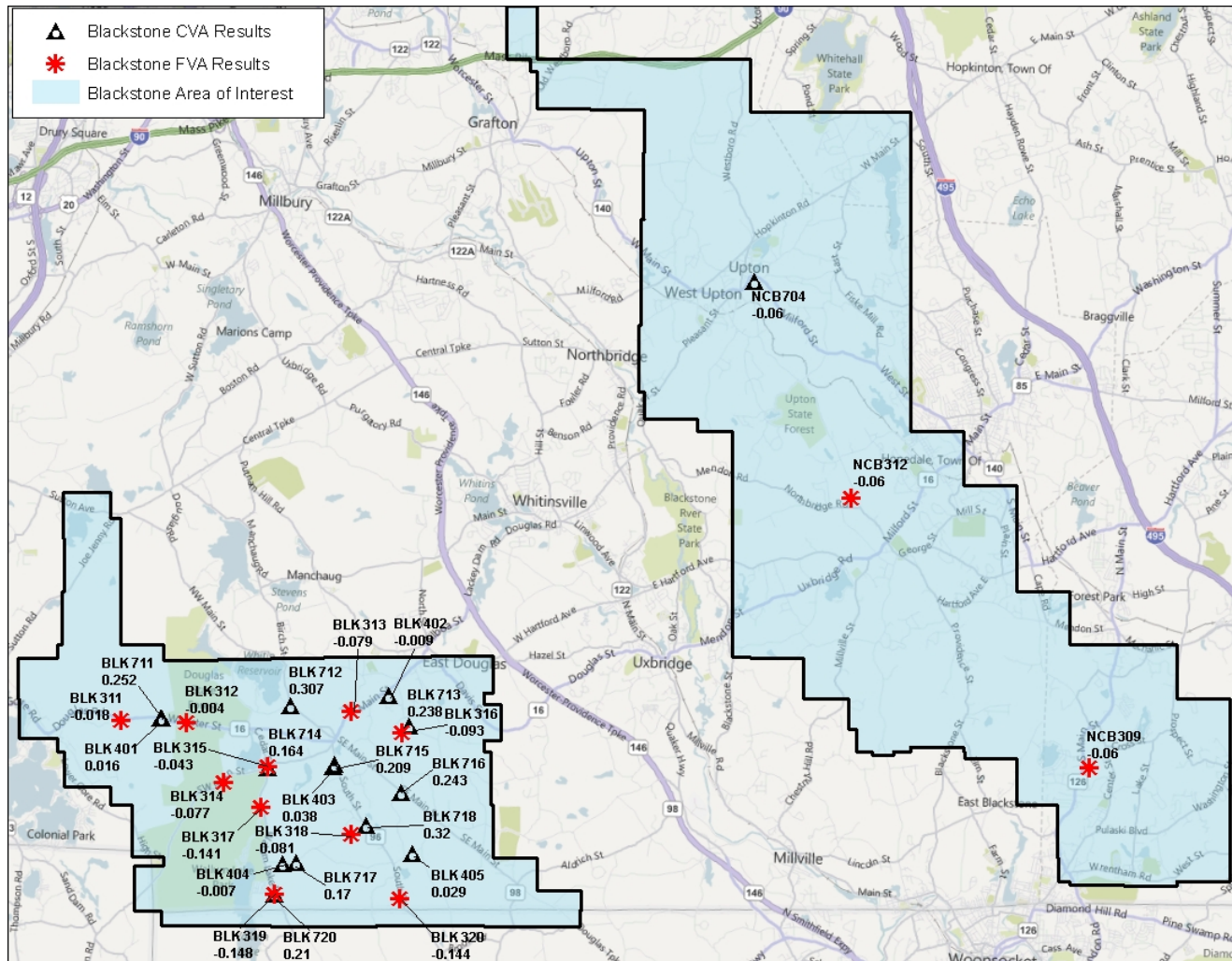




Figure 5. Blackstone River Watershed Area (2) FVA CVA Results



## **B. Data Acquisition**

LiDAR acquisition products include Pre- and Post- flight reports which contain information on the flight lines, equipment parameters, and other pertinent acquisition details. The LiDAR product is considered to be point cloud data and consists of 1500mx1500m tiles of LAS points which are partially classified such that the bare earth points can be calibrated to the ground surface and tested via the independent QC to ensure the ground surface is accurately represented.

Applanix software was used in the post processing of the airborne GPS and inertial data that is critical to the positioning and orientation of the sensor during all flights. POSPac MMS provides the smoothed best estimate of trajectory (SBET) that is necessary for Optech's post processor to develop the point cloud from the LiDAR missions. The point cloud is the mathematical three dimensional collections of all returns from all laser pulses as determined from the aerial mission.

Optech's DASHMap software and Leica's ALS Post Processor software were used to create the Raw LIDAR Flight Line strips. At this point this data is ready for analysis, classification, and filtering to generate a bare earth surface model in which the above ground features are removed from the data set. The GeoCue and TerraScan software packages are then used for the automated data classification. Project specific macros are created to classify the ground and to remove the side overlap between parallel flight lines.

LAS Class 2 (Ground) is used to check the surveyed control points against the Triangulated LIDAR surface. Any bias is then removed using macro functionality within TerraScan. Unclassified Point Cloud tiles are then created using TerraScan macro functionality. These tiles are populated within GeoCue to ensure correct LAS versioning and LAS Header information. LAS Class 2 is used to check the independent QC points against the Triangulated LiDAR surface. If RMSE is not within guidelines TerraScan software is utilized to remove any bias, and the check is performed again.

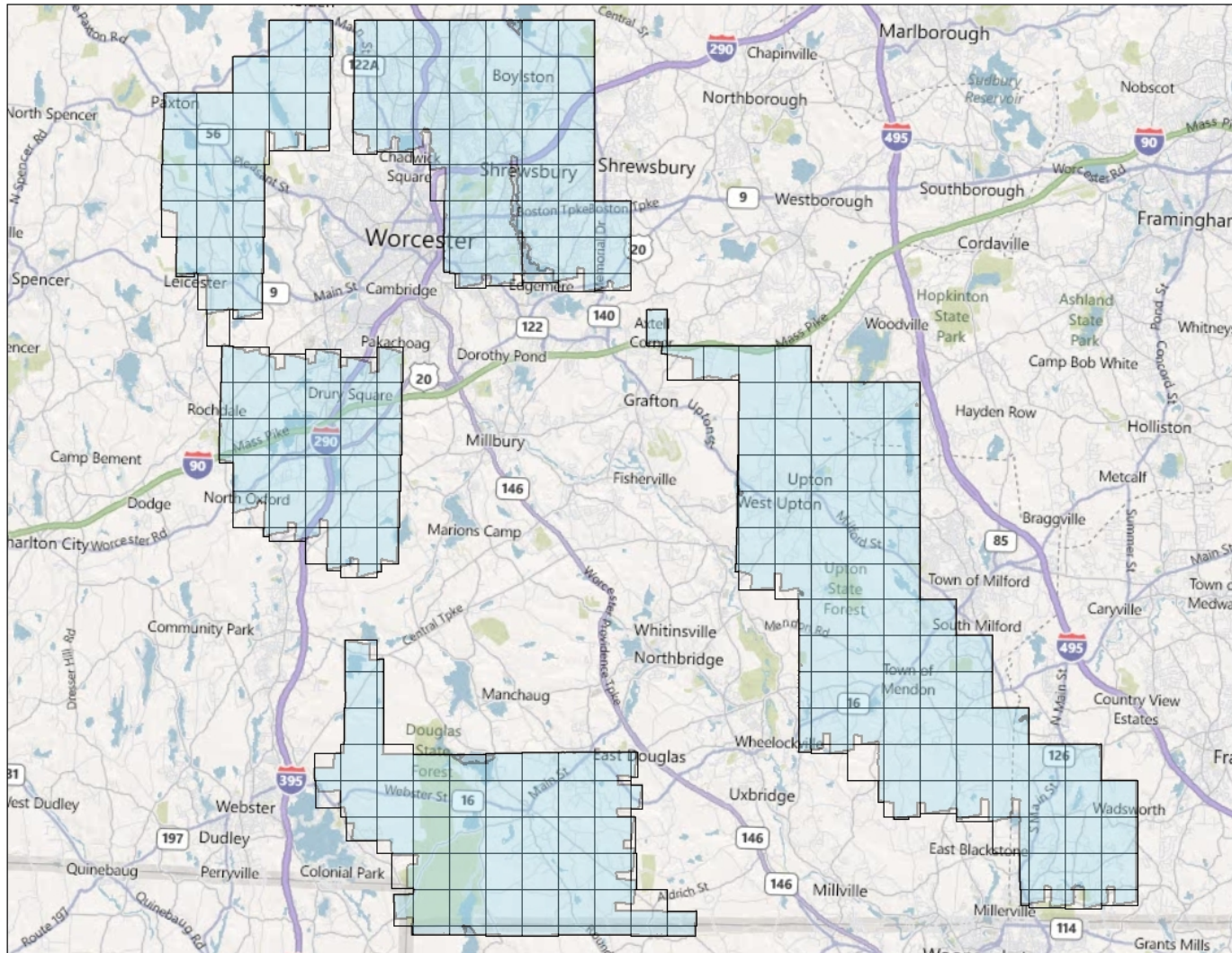
### **C. Post Processing**

Point Cloud data is manually reviewed and any remaining artifacts are removed using functionality provided within the TerraScan and TerraModeler software packages. Additional project specific macros are created and run within GeoCue/TerraScan to ensure correct LAS classification prior to project delivery.

All points were placed in one of the following categories: 1 Unclassified, 2 Ground, 7 Noise, and 12 Overlap Points. Model Key points were then generated from the Ground points and placed in Category 8.

Final Classified LAS tiles are created within GeoCue to confirm correct LAS versioning and header information. In-house software is then used to check LAS header information and final LAS classification prior to delivery. LAS Class 2 is used to check the independent QC points against the Triangulated LiDAR surface.

Figure 6. Blackstone AOI Point Cloud and Post Processing Area



#### **D. Quality Control**

Fundamental Vertical Accuracy (FVA) checkpoints are located only in open terrain, where there is a high probability that the sensor will have detected the ground surface without influence from surrounding vegetation and/or buildings. Checkpoints are located on flat or uniformly sloping terrain and at least five (5) meters away from a break line where there is a change in slope. Checkpoints are located randomly across the acquisition area. At least 20 FVA points were collected for each test.

Consolidated Vertical Accuracy (CVA) checkpoints are collected randomly across different land use types using the ASPRS NSSDA land cover types. The points are located in flat areas with no substantial elevation breaks within a five meter radius. The CVA assessment incorporates a representative sample of the FVA assessment points into the dataset to save on the total number of points collected. CVA points were not collected for any land class comprising less than 10% of the total project area; this may have resulted in less than 4 land classes being collected in a particular area. At least 15 CVA points were collected and 5 FVA points used, for a total of at least 20 points for the CVA testing.

All checkpoints were collected by CompassData to ensure the 'independence' of the quality control check. All points were collected at three times the accuracy of the surface being checked. Thus to check a 24.5cm surface the points were collected accurate to 8cm.

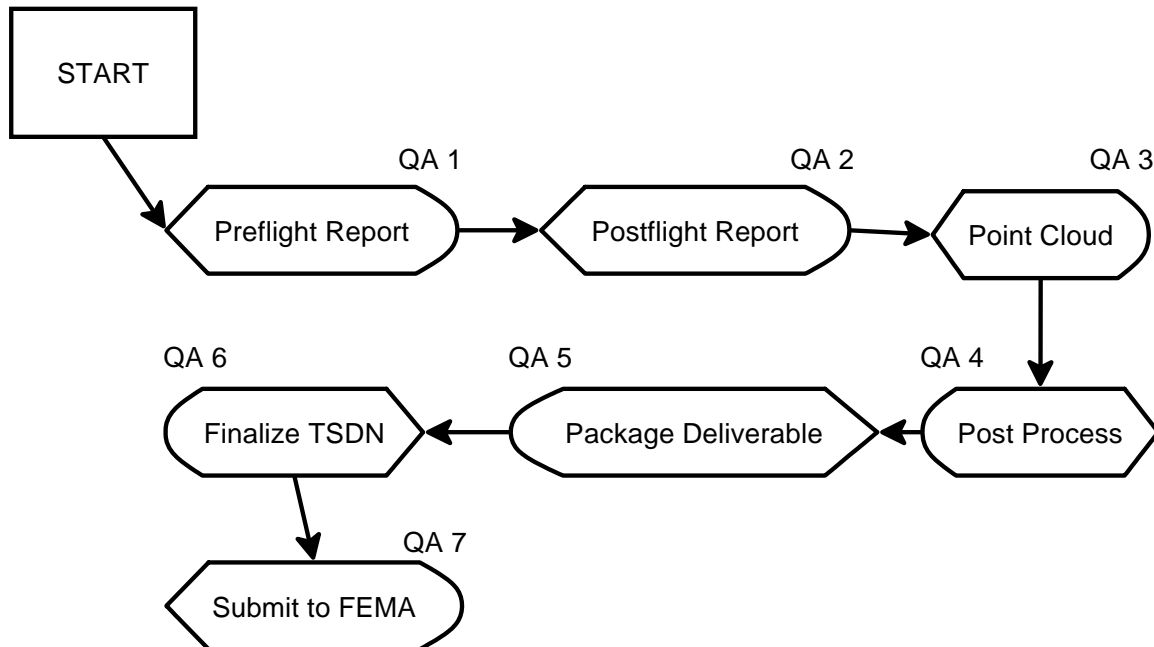
Tests were conducted when processing by the LiDAR vendor was complete and points were called for. CompassData provided the point coordinates in an excel spreadsheet to the LiDAR vendor. The LiDAR vendor found the corresponding elevation from a surface created from the LiDAR points, filled in the spreadsheet and returned it to CompassData. CompassData compared the elevation of the LiDAR data with that of the accuracy check point, calculated the difference and reported their findings both in terms of  $RMSE_z$  and at the 95% confidence level (computed as  $RMSE_z \times 1.9600$ ). LiDAR datasets passing the quality control checks were delivered to STARR for quality assurance approval.



## E. Quality Assurance

Quality assurance for all elevation data collected for this project has been completed using *FEMA Draft PM61*<sub>1</sub>, *FEMA Appendix M*<sub>2</sub>, *USGS LiDAR Guidelines and Base Specifications v13*<sub>3</sub>, and *FEMA Appendix A*<sub>4</sub> as guidance. Products generated during this project are checked for conformance to the aforementioned guidance and specifications before submittal to FEMA.

Figure 7. Quality Assurance Workflow



### QA1: Preflight Planning and Reporting

Project preflight operations planning were delivered as a report. This report was reviewed for completeness based on: *Table 4.1 and checklists provided in section 4.2.1 in PM61*<sub>1</sub>. The report was reviewed and is compliant with FEMA guidance and specifications. This report is included within Appendix C of this document. Appendix G contains information about the location of report data on the MIP.

### QA2: Post flight Report

Post flight reporting for this project has been reviewed for both content and completeness based upon: *Table 4.2 and checklists provided in section 4.2.1 in PM61*<sub>1</sub>. The report is included with Appendix E of this document. The report is complete and all content meets the guidance and specifications.

**QA3: Raw Point Cloud Review**

Fully calibrated raw point cloud data has been reviewed at both a macro and micro level using *Table 4.3 and checklists provided in section 4.2.1 in PM61<sub>1</sub>*, and *USGS LiDAR Guidelines and Base Specifications v13<sub>3</sub>*. 5% of the total number of project tiles was reviewed for compliance with USGS and FEMA specifications. All tiles reviewed for this project passed both the macro and micro reviews. Quality assurance results for the point cloud are contained within Appendix F of this document.

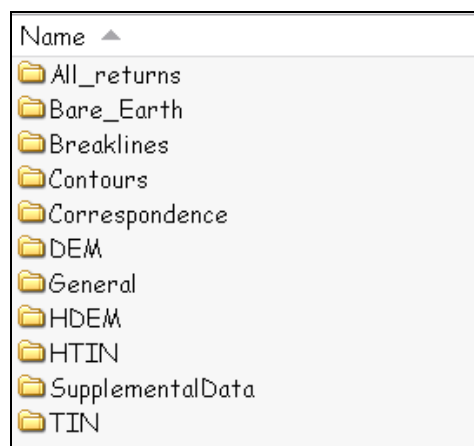
**QA4: Bare Earth Review**

Post-processed data has been reviewed at both a macro and micro level using *Table 4.4 and checklists provided in section 4.2.1 in PM61<sub>1</sub>*, and *USGS LiDAR Guidelines and Base Specifications v13<sub>3</sub>*. 10% of the total number of project tiles was reviewed for compliance with USGS and FEMA specifications. All tiles reviewed for this project passed both the macro and micro reviews. Quality assurance results for the bare earth are contained within Appendix F of this document.

**QA5: Create Delivery Package**

All deliverables have been organized in accordance with *Appendix M: Data Capture Standards March 2009 Section M.4.2.8<sub>2</sub>*.

**Figure 8. Terrain Deliverable Directory Structure**



**QA6: Finalization of Deliverables and TSDN**

All data to be submitted for delivery has been reviewed for completeness based on the map activity statement, scope of work,

and FEMA deliverable requirements. Quality assurance checklists are included in Appendix F of this document.

QA7: FEMA submission

All data for the elevation data acquisition task was delivered to FEMA on July 15, 2011. A transmittal of this submission is included in Appendix G of this document.

## 5. References

1. Draft Procedure Memorandum 61 included in Appendix H
2. FEMA Appendix M section M.4 included in Appendix H
3. USGS LiDAR Guidelines and Base Specifications v13 included in Appendix H
4. Appendix A: Guidance for Aerial Mapping and Surveying [includes guidance on Light Detection and Ranging Systems (LIDAR)]  
<http://www.fema.gov/library/viewRecord.do?id=2206>

## Appendix A: Contact Information

### STARR Contacts:

#### Project Management and Quality Assurance

Company	Greenhorne & O'Mara, Inc.
Name	Diane Rogers
Email	drogers@g-and-o.com
Phone	301-982-2800
Mailing Address	5565 Centerview Drive, Suite 107 Raleigh, NC 27606


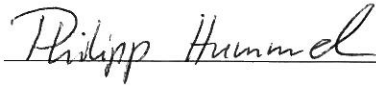
#### LiDAR Ground Control and QC survey


Company	Compass Data, Inc.
Name	Hayden Howard
Email	haydenh@compassdatainc.com
Phone	303-627-4058
Mailing Address	12353 East Easter Avenue, Suite 200 Centennial, CO 80112

#### LiDAR data acquisition and Post Processing

Company	Photo Science, Inc
Name	Paul Bishop
Email	bishop@photoscience.com
Phone	859-277-8700
Mailing Address	2670 Wilhite Drive Lexington, KY 40503

## **Appendix B: FEMA Compliance Forms and Metadata**

Project Name:	<b>Region 1: Blackstone, Massachusetts – Elevation Data Acquisition</b>	
Statement of Work No.:	FEMA TASK ORDER NUMBER: HSFEHQ-10-J-0005 WORK ORDER NUMBER: CP HQ 10 001	
Interagency Agreement No.:	STARR PROJECT NUMBER: 400000058 STARR PARTNER TRACKING NUMBER: CP HQ 10 001	
CTP Agreement No.:	N/A	
Statement/Agreement Date:	10/ 10/10	
Certification Date:	5/16/11	
<b>Tasks/Activities Covered by This Certification (Check All That Apply)</b>		
<input type="checkbox"/>	Base Map	
<input type="checkbox"/>	Topographic Data Development	
<input checked="" type="checkbox"/>	Survey: Including Ground Control Points (GCPs), Fundamental Vertical Accuracy Testing (FVA), and Consolidated Vertical Accuracy Testing (CVA).	
<input type="checkbox"/>	Hydrologic Analysis	
<input type="checkbox"/>	Hydraulic Analysis	
<input type="checkbox"/>	Alluvial Fan Analysis	
<input type="checkbox"/>	Coastal Analysis	
<input type="checkbox"/>	Floodplain Mapping	
<p>This is to certify that the work summarized above was completed in accordance with the statement/agreement cited above and all amendments thereto, together with all such modifications, either written or oral, as the Regional Project Officer and/or Assistance Officer or their representative have directed, as such modifications affect the statement/agreement, and that all such work has been accomplished in accordance with the provisions contained in <i>Guidelines and Specifications for Flood Hazard Mapping Partners</i> cited in the contract document, and in accordance with sound and accepted engineering practices within the contract provisions for respective phases of the work. This is also to certify that data files submitted for the work summarized above are complete and final. Any revisions made to the already submitted data are included in the final submittal.</p>		
Name:	Philipp H. Hummel, PLS	 <p>For and on behalf of Compass Data, Inc. Job. No.: 1508</p>
Title:	Professional Land Surveyor, Geodesist	
Firm Represented:	Compass Data, Inc.	
Registration No.:	38155	
Signature:		
<p>This form must be signed by a representative of the firm or agency contracted to perform the work, who must be a registered or certified professional in the area of work performed, in compliance with Federal and State regulations.</p>		

Project Name:	Blackstone, LiDAR Acquisition
Statement of Work No.:	<u>HSFEHQ-10-J-0005</u>
Interagency Agreement No.:	<u>N/A</u>
CTP Agreement No.:	<u>N/A</u>
Statement/Agreement Date:	<u>N/A</u>
Certification Date:	May 13, 2011
<b>Tasks/Activities Covered by This Certification (Check All That Apply)</b>	
<input type="checkbox"/>	Base Map
<input checked="" type="checkbox"/>	Topographic Data Development
<input type="checkbox"/>	Survey
<input type="checkbox"/>	Hydrologic Analysis
<input type="checkbox"/>	Hydraulic Analysis
<input type="checkbox"/>	Alluvial Fan Analysis
<input type="checkbox"/>	Coastal Analysis
<input type="checkbox"/>	Floodplain Mapping
<p>This is to certify that the work summarized above was completed in accordance with the statement/agreement cited above and all amendments thereto, together with all such modifications, either written or oral, as the Regional Project Officer and/or Assistance Officer or their representative have directed, as such modifications affect the statement/agreement, and that all such work has been accomplished in accordance with the provisions contained in <i>Guidelines and Specifications for Flood Hazard Mapping Partners</i> cited in the contract document, and in accordance with sound and accepted engineering practices within the contract provisions for respective phases of the work. This is also to certify that data files submitted for the work summarized above are complete and final. Any revisions made to the already submitted data are included in the final submittal.</p>	
Name:	Mark E. Meade, PE, PLS, CP
Title:	Senior Vice President
Firm/Agency Represented:	Photo Science
Registration No.:	R1050
Signature:	
<p>This form must be signed by a representative of the firm or agency contracted to perform the work, who must be a registered or certified professional in the area of work performed, in compliance with Federal and State regulations.</p>	





Identification\_Information:

Citation:

Citation\_Information:

Originator: Federal Emergency Management Agency

Publication\_Date: 20110128

Title: TERRAIN, Blackstone, Massachusetts

Geospatial\_Data\_Presentation\_Form: FEMA-DCS-Terrain

Publication\_Information:

Publication\_Place: Washington, DC

Publisher: Federal Emergency Management Agency

Online\_Linkage: <http://hazards.fema.gov>

Larger\_Work\_Citation:

Citation\_Information:

Originator: Federal Emergency Management Agency

Publication\_Date: 20110128

Title: FEMA CASE 11-01-0720S

Description:

Abstract: The Nashua AOI consists of one area. See the Ground Control process step for further information on functional areas. Ground Control is collected throughout the AOI for use in the processing of LiDAR data to ensure data accurately represents the ground surface. QA/QC checkpoints, (FVA and CVA - see Ground Control process step for further information) also collected throughout the AOI, are used for independent quality checks of the processed LiDAR data.

Purpose: Provide high resolution terrain elevation and land cover elevation data. Terrain data is used to represent the topography of a watershed and/or floodplain environment and to extract useful information for hydraulic and hydrologic models.

Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110128

Currentness\_Reference: ground condition

Status:

Progress: Complete

Maintenance\_and\_Update\_Frequency: Unknown

Spatial\_Domain:

Bounding\_Coordinates:

West\_Bounding\_Coordinate: -72.107343

East\_Bounding\_Coordinate: -71.378307

North\_Bounding\_Coordinate: 42.966191

South\_Bounding\_Coordinate: 42.21744

Keywords:

Theme:

Theme\_Keyword\_Thesaurus: ISO 19115 Topic Category

Theme\_Keyword: elevation

Theme:

Theme\_Keyword\_Thesaurus: FEMA NFIP Topic Category

Theme\_Keyword: Land Surface

Theme\_Keyword: Topography

Theme\_Keyword: Digital Terrain Model

Theme\_Keyword: Elevation Data

Theme\_Keyword: LIDAR

Theme:

Theme\_Keyword\_Thesaurus: None

Theme\_Keyword: Ground Control

Place:

Place\_Keyword\_Thesaurus: None

Place\_Keyword: REGION I

Place\_Keyword: STATE MA

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Place\_Keyword: COUNTY-FIPS 027

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4-20110629 Nashua Ground Control Metadata.txt

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Place\_Keyword: FEMA-CID 250191

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Place\_Keyword: FEMA-CID 330097

Access\_Constraints: None

Use\_Constraints: Acknowledgement of FEMA would be appreciated in products derived from these data. This digital data is produced for the purposes of updating/creating a DFIRM database.

Data\_Set\_Credit: Ground control and quality control checkpoints were collected by CompassData, Inc. Quality Assurance testing was conducted by Greenhorne & O'Mara, Inc. All firms were under contract to STARR, A Joint Venture which held the FEMA contract and task order for this work.

Data\_Quality\_Information:

Logical\_Consistency\_Report: Survey data have been confirmed to be in proper units, coordinate systems and format.

Completeness\_Report: Survey data have been checked for completeness, points have been collected in correct vegetation units, and distributed throughout the AOI.

Positional\_Accuracy:

Vertical\_Positional\_Accuracy:

Vertical\_Positional\_Accuracy\_Report: Deliverables were tested by for both vertical and horizontal accuracy. The vertical unit of the data file is in meters with 2-decimal point precision.

Quantitative\_Vertical\_Positional\_Accuracy\_Assessment:

Vertical\_Positional\_Accuracy\_Value:

Vertical\_Positional\_Accuracy\_Explanation: RMSE in meters.

Lineage:

Source\_Information:

Source\_Citation:

Citation\_Information:

#### 4-20110629 Nashua Ground Control Metadata.txt

Originator: STARR

Publication\_Date: 2011

Title: Ground\_Control Nashua

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110128

Source\_Currentness\_Reference: ground condition

Source\_Citation\_Abbreviation: Other1

Source\_Contribution: Control points for tying LiDAR data to the ground surface.

Source\_Information:

Source\_Citation:

Citation\_Information:

Originator: STARR

Publication\_Date: 2011

Title: FVA\_CVA Nashua

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110128

Source\_Currentness\_Reference: ground condition

Source\_Citation\_Abbreviation: Other2

Source\_Contribution: Quality Assurance points to confirm LiDAR data meets vertical accuracy requirements.

#### Process\_Step:

Process\_Description: GPS based surveys were utilized to support both processing and testing of LiDAR data within FEMA designated Areas of Interest (AOIs). Geographically distinct ground points were surveyed using GPS technology throughout the AOIs to provide support for three distinct tasks.

Task 1 was to provide Vertical Ground Control to support the aerial acquisition and subsequent bare earth model processing. To accomplish this, survey-grade Trimble R-8 GPS receivers were used to collect a series of control points located on open areas, free of excessive or significant slope, and at least 5 meters away from any significant terrain break. Most if not all control points were collected at street/road intersections on bare level pavement.

Task 2 was to collect Fundamental Vertical Accuracy (FVA) checkpoints to evaluate the initial quality of the collected point cloud and to ensure that the collected data was satisfactory for further processing to meet FEMA specifications. The FVA points were collected in identical fashion to the Vertical Ground Control Points, but segregated from the point pool to ensure independent quality testing without prior knowledge of FVA locations by the aerial vendor.

Task 3 was to collect Consolidated Vertical Accuracy (CVA) checkpoints to allow vertical testing of the bare-earth processed LiDAR data in different classes of land cover, including: Open (pavement, open dirt, short grass), High Grass and Crops, Brush and Low Trees, Forest, Urban. CVA points were collected in similar fashion as Control and FVA points with emphasis on establishing point locations within the predominant land cover classes within each AOI or Functional AOI Group. In order to successfully collect the Forest land cover class, it was necessary to establish a Backsight and Initial Point with the R8 receiver, and then employ a Nikon Total Station to observe a retroreflective prism stationed under tree canopy. This was necessary due to the reduced GPS performance and degradation of signal under tree canopy.

The R-8 receivers were equipped with cellular modems to receive real-time correction signals from the Keystone Precision Virtual Reference Station (VRS) network encompassing the Region 1 AOIs. Use of the VRS network allowed rapid collection times (~3 minutes/point) at 2.54 cm (1 inch) initial accuracy.

All points collected were below the 8cm specification for testing 24cm, Highest category LiDAR data. To ensure valid in-field collections, an NGS monument with suitable vertical reporting was measured using the same equipment and procedures

#### 4-20110629 Nashua Ground Control Metadata.txt

used for Control, FVA and CVA points on a daily basis. The measurement was compared to the NGS published values to ensure that the GPS collection schema was producing valid data and as a physical proof point of quality of collection. Those monument measurements are summarized in the Accuracy report included in the data delivered to FEMA.

In order to meet FEMA budgetary requirements, AOIs were consolidated into Functional Groups: if AOIs were contiguous, they were treated as one large AOI to allow collection of 20 FVA points and 15 additional CVA points across the group of AOIs. 20 FVA points are necessary to allow testing to CE95 - 1 point out of 20 may fail vertical testing and still allow the entire dataset to meet 95% accuracy requirements.

In similar fashion, 20 CVA points are necessary to test to CE95 as discussed above. 15 CVA points were collected per AOI or per Functional Group with the intention at the outset that 5 of the collected FVAs would perform double-duty as Open-class CVA points, to total 20 CVAs per AOI or Functional Group.

The Functional Groups are as follows: Narragansett/Charles/Blackstone(northeast), Nashua, Blackstone(north and west), Quinipiac, Quincy/Suffolk (while included as part of the FEMA Charles AOI, was physically separated from the Charles AOI polygon and treated as an independent functional area).

The following software packages and utilities were used to control the GPS receiver in the field during data collection, and then ingest and export the collected GPS data for all points: Trimble Survey Controller, Trimble Pathfinder Office.

The following software utilities were used to translate the collected Latitude/Longitude Decimal Degree HAE GPS data for all points into Latitude/Longitude Degrees/Minutes/Seconds for checking the collected monument data against the published NGS Datasheet Lat/Long DMS values and into UTM NAD83 Northings/Eastings: U.S. Army Corps of Engineers CorpsCon, National Geodetic Survey Geoid09NAVD88.

MSL values were determined using the most recent NGS-approved geoid model to generate geoid separation values for each Lat/Long coordinate pair. In this fashion, Orthometric heights were determined for each Control, FVA and CVA point by subtracting the generated Geoid Separation value from the Ellipsoidal Height (HAE) for publication and use as MSL NAVD88(09).

Process\_Date: 2011

#### Spatial\_Reference\_Information:

##### Horizontal\_Coordinate\_System\_Definition:

###### Planar:

###### Grid\_Coordinate\_System:

Grid\_Coordinate\_System\_Name: Universal Transverse Mercator

###### Universal\_Transverse\_Mercator:

UTM\_Zone\_Number: 19

###### Transverse\_Mercator:

Scale\_Factor\_at\_Central\_Meridian: 0.999600

Longitude\_of\_Central\_Meridian: -69.000000

Latitude\_of\_Projection\_Origin: 0.000000

False\_Easting: 500000.000000

False\_Northing: 0.000000

###### Planar\_Coordinate\_Information:

Planar\_Coordinate\_Encoding\_Method: coordinate pair

###### Coordinate\_Representation:

Abscissa\_Resolution: 0.000010

Ordinate\_Resolution: 0.000010

Planar\_Distance\_Units: meters

#### Geodetic\_Model:

Horizontal\_Datum\_Name: North American Datum 1983

Ellipsoid\_Name: Geodetic Reference System 80

Semi-major\_Axis: 6378137.00

Denominator\_of\_Flattening\_Ratio: 298.257222

###### Vertical\_Coordinate\_System\_Definition:

###### Altitude\_System\_Definition:

Altitude\_Datum\_Name: North American Vertical Datum of 1988

Altitude\_Resolution: 0.01

4-20110629 Nashua Ground Control Metadata.txt

Altitude\_Distance\_Units: meters

Altitude\_Encoding\_Method: Attribute Values

Entity\_and\_Attribute\_Information:

Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label: Terrain\2142865\SupplementalData\GroundControl Nashua

Entity\_Type\_Definition: Ground Control Survey for LiDAR collection

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label: Terrain\2142865\SupplementalData\FVA\_CVA Nashua

Entity\_Type\_Definition: Survey for Horizontal and Vertical LiDAR QC

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

Overview\_Description:

Entity\_and\_Attribute\_Overview: The Terrain data package is made up of several data themes containing primarily spatial information. These data supplement the Elevation datasets by providing additional information to aid flood risk evaluation and flood hazard area delineations.

Entity\_and\_Attribute\_Detail\_Citation: Appendix M of FEMA Guidelines and Specifications for FEMA Flood Hazard Mapping Partners contains a detailed description of the data themes and references to other relevant information.

Distribution\_Information:

Distributor:

Contact\_Information:

Contact\_Organization\_Primary:

Contact\_Organization: Federal Emergency Management Agency Engineering

Library

Contact\_Address:

Address\_Type: mailing address

Address: Marie Sparrow, Zimmerman Associates, Inc.

Address: 847 South Pickett Street

City: Alexandria

State\_or\_Province: Virginia

Postal\_Code: 22304

Country: USA

Contact\_Voice\_Telephone: 1-877-336-2627

Contact\_Electronic\_Mail\_Address: miphelp@mapmodteam.com

Distribution\_Liability: No warranty expressed or implied is made by FEMA regarding the utility of the data on any other system nor shall the act of distribution constitute any such warranty.

Standard\_Order\_Process:

Digital\_Form:

Digital\_Transfer\_Information:

Format\_Name: FEMA-DCS-Terrain

Digital\_Transfer\_Option:

Online\_Option:

Computer\_Contact\_Information:

Network\_Address:

Network\_Resource\_Name: <http://hazards.fema.gov>

Fees: Contact Distributor

Metadata\_Reference\_Information:

Metadata\_Date: 20110128

Metadata\_Contact:

Contact\_Information:

Contact\_Person\_Primary:

4-20110629 Nashua Ground Control Metadata.txt  
Contact\_Person: FEMA Representative  
Contact\_Organization: Federal Emergency Management Agency  
Contact\_Address:  
Address\_Type: mailing address  
Address: 500 C Street, S.W.  
City: Washington  
State\_or\_Province: District of Columbia  
Postal\_Code: 20472  
Country: USA  
Contact\_Voice\_Telephone: 1-877-336-2627  
Contact\_Electronic\_Mail\_Address: miphelp@mapmodteam.com  
Metadata\_Standard\_Name: FGDC Content Standards for Digital Geospatial Metadata  
Metadata\_Standard\_Version: FGDC-STD-001-1998  
Metadata\_Extensions:  
Online\_Linkage: <http://hazards.fema.gov>  
Online\_Linkage: <http://www.epsg.org>  
Profile\_Name: FEMA NFIP Metadata Content and Format Standard

5-060611 Blackstone Acquisition Metadata.txt

Identification\_Information:

Citation:

Citation\_Information:

Originator: Federal Emergency Management Agency

Publication\_Date: 20110502

Title: TERRAIN, Blackstone, Massachusetts

Geospatial\_Data\_Presentation\_Form: FEMA-DCS-Terrain

Publication\_Information:

Publication\_Place: Washington, DC

Publisher: Federal Emergency Management Agency

Online\_Linkage: <http://hazards.fema.gov>

Larger\_Work\_Citation:

Citation\_Information:

Originator: Federal Emergency Management Agency

Publication\_Date: 20110502

Title: FEMA CASE 11-01-0716S

Description:

Abstract: The Blackstone AOI consists of five areas which are part of two functional areas. See the Ground Control process step for further information on functional areas. Ground Control is collected throughout the AOI for use in the processing of LiDAR data to ensure data accurately represents the ground surface. QA/QC checkpoints, (FVA and CVA - see Ground Control process step for further information) also collected throughout the AOI, are used for independent quality checks of the processed LiDAR data.

LiDAR acquisition products include Pre- and Post- flight reports which contain information on the flightlines, equipment parameters, and other pertinent acquisition details. The LiDAR product itself consists of tiles of LAS points which are partially classified such that the bare earth points can be calibrated to the ground surface and tested via the independent QC to ensure the ground surface is accurately represented.

Purpose: Provide high resolution terrain elevation and land cover elevation data. Terrain data is used to represent the topography of a watershed and/or floodplain environment and to extract useful information for hydraulic and hydrologic models.

Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110502

Currentness\_Reference: ground condition

Status:

Progress: Complete

Maintenance\_and\_Update\_Frequency: Unknown

Spatial\_Domain:

Bounding\_Coordinates:

West\_Bounding\_Coordinate: -72.016421

East\_Bounding\_Coordinate: -71.284433

North\_Bounding\_Coordinate: 42.438294

South\_Bounding\_Coordinate: 41.769773

Keywords:

Theme:

Theme\_Keyword\_Thesaurus: ISO 19115 Topic Category

Theme\_Keyword: elevation

Theme:

Theme\_Keyword\_Thesaurus: FEMA NFIP Topic Category

Theme\_Keyword: Land Surface

Theme\_Keyword: Topography

Theme\_Keyword: Digital Terrain Model

Theme\_Keyword: Elevation Data

Theme\_Keyword: LIDAR

Theme:

Theme\_Keyword\_Thesaurus: None

Theme\_Keyword: Ground Control



5-060611 Blackstone Acquisition Metadata.txt

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Theme\_Keyword: Point Cloud

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5-060611 Blackstone Acquisition Metadata.txt

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5-060611 Blackstone Acquisition Metadata.txt

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5-060611 Blackstone Acquisition Metadata.txt

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5-060611 Blackstone Acquisition Metadata.txt

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Access\_Constraints: None

Use\_Constraints: Acknowledgement of FEMA would be appreciated in products derived from these data. This digital data is produced for the purposes of updating/creating a DFIRM database.

Data\_Set\_Credit: Ground control and quality control checkpoints were collected by CompassData, Inc. LiDAR data was acquired and processed by Photo Science, Inc. Quality Assurance testing was conducted by Greenhorne & O'Mara, Inc. All firms were under contract to STARR, A Joint Venture which held the FEMA contract and task order for this work.

Data\_Quality\_Information:

Logical\_Consistency\_Report: Survey data have been confirmed to be in proper units, coordinate systems and format. The terrain data have been confirmed as complete LAS format data files. Header files are in proper LAS format with content as specified by FEMA Procedural Memo No. 61.

Completeness\_Report: Survey data have been checked for completeness, points have been collected in correct vegetation units, and distributed throughout the AOI. The terrain data have been checked for completeness against AOI polygons. No gaps as defined by FEMA Procedural Memo No. 61 are known to exist within the dataset. Positional accuracy was calculated for both functional areas. The Blackstone area is reported in the Positional Accuracy section of this metadata. The Charles



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Narragansett partial Blackstone area accuracy value is 0.166 meters.

Positional\_Accuracy:  
Vertical\_Positional\_Accuracy:  
Vertical\_Positional\_Accuracy\_Report: Deliverables were tested by for both vertical and horizontal accuracy. The vertical unit of the data file is in meters with 2-decimal point precision.  
Quantitative\_Vertical\_Positional\_Accuracy\_Assessment:  
Vertical\_Positional\_Accuracy\_Value: 0.167  
Vertical\_Positional\_Accuracy\_Explanation: Fundamental Vertical Accuracy (FVA) equal to 95th Percentile Confidence Level (RMSE[z] x 1.9600) calculated in open terrain. Reported in meters.

Lineage:

Source\_Information:  
Source\_Citation:  
Citation\_Information:  
Originator: STARR  
Publication\_Date: 2011  
Title: GroundControl Blackstone  
Type\_of\_Source\_Media: DIGITAL  
Source\_Time\_Period\_of\_Content:  
Time\_Period\_Information:  
Single\_Date/Time:  
Calendar\_Date: 20110128  
Source\_Currentness\_Reference: ground condition  
Source\_Citation\_Abbreviation: Other1  
Source\_Contribution: Control points for tying LiDAR data to the ground surface.  
Source\_Information:  
Source\_Citation:  
Citation\_Information:  
Originator: STARR  
Publication\_Date: 2011  
Title: FVA\_CVA Blackstone  
Type\_of\_Source\_Media: DIGITAL  
Source\_Time\_Period\_of\_Content:  
Time\_Period\_Information:  
Single\_Date/Time:  
Calendar\_Date: 20110128  
Source\_Currentness\_Reference: ground condition  
Source\_Citation\_Abbreviation: Other2  
Source\_Contribution: Quality Assurance points to confirm LiDAR data meets vertical accuracy requirements.  
Source\_Information:  
Source\_Citation:  
Citation\_Information:  
Originator: STARR  
Publication\_Date: 2011  
Title: Blackstone\_Collection\_Area  
Type\_of\_Source\_Media: DIGITAL  
Source\_Time\_Period\_of\_Content:  
Time\_Period\_Information:  
Single\_Date/Time:  
Calendar\_Date: 20110502  
Source\_Currentness\_Reference: publication date  
Source\_Citation\_Abbreviation: Other3  
Source\_Contribution: Shapefile of Blackstone acquisition area.  
Source\_Information:  
Source\_Citation:  
Citation\_Information:  
Originator: STARR  
Publication\_Date: 2011

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Title: All\_Returns  
Type\_of\_Source\_Media: DIGITAL  
Source\_Time\_Period\_of\_Content:  
Time\_Period\_Information:  
Single\_Date/Time:  
Calendar\_Date: 20110502  
Source\_Currentness\_Reference: ground condition  
Source\_Citation\_Abbreviation: Other4  
Source\_Contribution: Point Cloud (All Returns) LAS point files named according  
to Blck\_Tile\_Index.  
Source\_Information:  
Source\_Citation:  
Citation\_Information:  
Originator: STARR  
Publication\_Date: 2011  
Title: Blackstone\_PreFlightReport  
Type\_of\_Source\_Media: DIGITAL  
Source\_Time\_Period\_of\_Content:  
Time\_Period\_Information:  
Single\_Date/Time:  
Calendar\_Date: 20110502  
Source\_Currentness\_Reference: publication date  
Source\_Citation\_Abbreviation: Other5  
Source\_Contribution: document contains the operation plans for the LiDAR  
acquisition  
Source\_Information:  
Source\_Citation:  
Citation\_Information:  
Originator: STARR  
Publication\_Date: 2011  
Title: Blackstone\_PostFlightReport  
Type\_of\_Source\_Media: DIGITAL  
Source\_Time\_Period\_of\_Content:  
Time\_Period\_Information:  
Single\_Date/Time:  
Calendar\_Date: 20110502  
Source\_Currentness\_Reference: publication date  
Source\_Citation\_Abbreviation: Other6  
Source\_Contribution: document contains the acquisition and calibration reports  
for the LiDAR acquisition.  
Source\_Information:  
Source\_Citation:  
Citation\_Information:  
Originator: STARR  
Publication\_Date: 2011  
Title: Blck\_Tile\_Index  
Type\_of\_Source\_Media: DIGITAL  
Source\_Time\_Period\_of\_Content:  
Time\_Period\_Information:  
Single\_Date/Time:  
Calendar\_Date: 20110502  
Source\_Currentness\_Reference: publication date  
Source\_Citation\_Abbreviation: Other7  
Source\_Contribution: Shapefile of tile index used to populate and reference  
LAS tiled data.  
Source\_Information:  
Source\_Citation:  
Citation\_Information:  
Originator: STARR  
Publication\_Date: 2011  
Title: Region 1 Blackstone Testing Results FVA CVA  
Type\_of\_Source\_Media: DIGITAL  
Source\_Time\_Period\_of\_Content:

5-060611 Blackstone Acquisition Metadata.txt

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110502

Source\_Currentness\_Reference: publication date

Source\_Citation\_Abbreviation: Other8

Source\_Contribution: document contains QC test results for FVA blind test against the automated process resultant bare earth surface generated from the point cloud LAS points.

Source\_Information:

Source\_Citation:

Citation\_Information:

Originator: STARR

Publication\_Date: 2011

Title: Region 1 Charles Narragansett Partial Blackstone Testing Results

FVA CVA

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110502

Source\_Currentness\_Reference: publication date

Source\_Citation\_Abbreviation: Other9

Source\_Contribution: document contains QC test results for FVA blind test against the automated process resultant bare earth surface generated from the point cloud LAS points.

Process\_Step:

Process\_Description: GPS based surveys were utilized to support both processing and testing of LiDAR data within FEMA designated Areas of Interest (AOIs). Geographically distinct ground points were surveyed using GPS technology throughout the AOIs to provide support for three distinct tasks.

Task 1 was to provide Vertical Ground Control to support the aerial acquisition and subsequent bare earth model processing. To accomplish this, survey-grade Trimble R-8 GPS receivers were used to collect a series of control points located on open areas, free of excessive or significant slope, and at least 5 meters away from any significant terrain break. Most if not all control points were collected at street/road intersections on bare level pavement.

Task 2 was to collect Fundamental Vertical Accuracy (FVA) checkpoints to evaluate the initial quality of the collected point cloud and to ensure that the collected data was satisfactory for further processing to meet FEMA specifications. The FVA points were collected in identical fashion to the Vertical Ground Control Points, but segregated from the point pool to ensure independent quality testing without prior knowledge of FVA locations by the aerial vendor.

Task 3 was to collect Consolidated Vertical Accuracy (CVA) checkpoints to allow vertical testing of the bare-earth processed LiDAR data in different classes of land cover, including: Open (pavement, open dirt, short grass), High Grass and Crops, Brush and Low Trees, Forest, Urban. CVA points were collected in similar fashion as Control and FVA points with emphasis on establishing point locations within the predominant land cover classes within each AOI or Functional AOI Group. In order to successfully collect the Forest land cover class, it was necessary to establish a Backsight and Initial Point with the R8 receiver, and then employ a Nikon Total Station to observe a retroreflective prism stationed under tree canopy. This was necessary due to the reduced GPS performance and degradation of signal under tree canopy.

The R-8 receivers were equipped with cellular modems to receive real-time correction signals from the Keystone Precision Virtual Reference Station (VRS) network encompassing the Region 1 AOIs. Use of the VRS network allowed rapid collection times (~3 minutes/point) at 2.54 cm (1 inch) initial accuracy.

All points collected were below the 8cm specification for testing 24cm, Highest category LiDAR data. To ensure valid in-field collections, an NGS monument with suitable vertical reporting was measured using the same equipment and procedures used for Control, FVA and CVA points on a daily basis. The measurement was compared to the NGS published values to ensure that the GPS collection schema was producing valid data and as a physical proof point of quality of collection. Those monument

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measurements are summarized in the Accuracy report included in the data delivered to FEMA.

In order to meet FEMA budgetary requirements, AOIs were consolidated into Functional Groups: if AOIs were contiguous, they were treated as one large AOI to allow collection of 20 FVA points and 15 additional CVA points across the group of AOIs. 20 FVA points are necessary to allow testing to CE95 - 1 point out of 20 may fail vertical testing and still allow the entire dataset to meet 95% accuracy requirements.

In similar fashion, 20 CVA points are necessary to test to CE95 as discussed above. 15 CVA points were collected per AOI or per Functional Group with the intention at the outset that 5 of the collected FVAs would perform double-duty as Open-class CVA points, to total 20 CVAs per AOI or Functional Group.

The Functional Groups are as follows: Narragansett/Charles/Blackstone(northeast), Nashua, Blackstone(north and west), Quinnipiac, Quincy/Suffolk (while included as part of the FEMA Charles AOI, was physically separated from the Charles AOI polygon and treated as an independent functional area).

The following software packages and utilities were used to control the GPS receiver in the field during data collection, and then ingest and export the collected GPS data for all points: Trimble Survey Controller, Trimble Pathfinder Office.

The following software utilities were used to translate the collected

Latitude/Longitude Decimal Degree HAE GPS data for all points into

Latitude/Longitude Degrees/Minutes/Seconds for checking the collected monument data against the published NGS Datasheet Lat/Long DMS values and into UTM NAD83

Northings/Eastings: U.S. Army Corps of Engineers CorpsCon, National Geodetic Survey Geoid09NAVD88.

MSL values were determined using the most recent NGS-approved geoid model to generate geoid separation values for each Lat/Long coordinate pair. In this fashion, Orthometric heights were determined for each Control, FVA and CVA point by subtracting the generated Geoid Separation value from the Ellipsoidal Height (HAE) for publication and use as MSL NAVD88(09).

Process\_Date: 2011

Process\_Step:

Process\_Description: Applanix software was used in the post processing of the airborne GPS and inertial data that is critical to the positioning and orientation of the sensor during all flights. POSPac MMS provides the smoothed best estimate of trajectory (SBET) that is necessary for Optech's post processor to develop the point cloud from the LiDAR missions. The point cloud is the mathematical three dimensional collection of all returns from all laser pulses as determined from the aerial mission.

Optech's DASHMap software and Leica's ALS Post Processor software were used to create the Raw LIDAR Flight Line strips. At this point this data is ready for analysis, classification, and filtering to generate a bare earth surface model in which the above ground features are removed from the data set. The GeoCue and TerraScan software packages are then used for the automated data classification. Project specific macros are created to classify the ground and to remove the side overlap between parallel flight lines.

LAS Class 2 (Ground) is used to check the surveyed control points against the Triangulated LIDAR surface. Any bias is then removed using macro functionality within TerraScan.

Unclassified Point Cloud tiles are then created using TerraScan macro functionality.

These tiles are populated within GeoCue to ensure correct LAS versioning and LAS Header information.

LAS Class 2 is used to check the independent QC points against the Triangulated LiDAR surface. If RMSE is not within guidelines TerraScan software is utilized to remove any bias, and the check is performed again.

Process\_Date: 2011

Spatial\_Reference\_Information:

Horizontal\_Coordinate\_System\_Definition:

Planar:

Grid\_Coordinate\_System:

Grid\_Coordinate\_System\_Name: Universal Transverse Mercator

Universal\_Transverse\_Mercator:

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UTM\_Zone\_Number: 19

Transverse\_Mercator:

Scale\_Factor\_at\_Central\_Meridian: 0.999600

Longitude\_of\_Central\_Meridian: -69.000000

Latitude\_of\_Projection-Origin: 0.000000

False\_Easting: 500000.000000

False\_Northing: 0.000000

Planar\_Coordinate\_Information:

Planar\_Coordinate\_Encoding\_Method: coordinate pair

Coordinate\_Representation:

Abscissa\_Resolution: 0.000010

Ordinate\_Resolution: 0.000010

Planar\_Distance\_Units: meters

Geodetic\_Model:

Horizontal\_Datum\_Name: North American Datum 1983

Ellipsoid\_Name: Geodetic Reference System 80

Semi-major\_Axis: 6378137.00

Denominator\_of\_Flattening\_Ratio: 298.257222

Vertical\_Coordinate\_System\_Definition:

Altitude\_System\_Definition:

Altitude\_Datum\_Name: North American Vertical Datum of 1988

Altitude\_Resolution: 0.01

Altitude\_Distance\_Units: meters

Altitude\_Encoding\_Method: Attribute Values

Entity\_and\_Attribute\_Information:

Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label: Terrain\2142855\SupplementalData\GroundControl Blackstone

Entity\_Type\_Definition: Ground Control Survey for LiDAR collection

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood

Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label: Terrain\2142855\SupplementalData\FVA\_CVA Blackstone

Entity\_Type\_Definition: Survey for Horizontal and Vertical LiDAR QC

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood

Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label: Terrain\2142856\SupplementalData\Blackstone\_Collection

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Entity\_Type\_Definition: Area Spatial File

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood

Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label: Terrain\2142856\All\_Returns

Entity\_Type\_Definition: LAS 1.2 files

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood

Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label: Terrain\2142856\SupplementalData\Blackstone\_PreFlight

Report

Entity\_Type\_Definition: Digital Document

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood

Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

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Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label: Terrain\2142856\SupplementalData\Blackstone\_PostFlight

Report

Entity\_Type\_Definition: Digital Document

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

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Entity\_Type\_Label: Terrain\2142856\SupplementalData\Blck\_Tile\_Index

Entity\_Type\_Definition: Area Spatial File

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label: Terrain\2142857\SupplementalData\Region 1 Blackstone

Testing Results FVA CVA

Entity\_Type\_Definition: Digital Document

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label: Terrain\2142857\SupplementalData\Region 1 Charles

Narragansett partial Blackstone Testing Results FVA CVA

Entity\_Type\_Definition: Digital Document

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

Overview\_Description:

Entity\_and\_Attribute\_Overview: The Terrain data package is made up of several data themes containing primarily spatial information. These data supplement the Elevation datasets by providing additional information to aid flood risk evaluation and flood hazard area delineations.

Entity\_and\_Attribute\_Detail\_Citation: Appendix M of FEMA Guidelines and Specifications for FEMA Flood Hazard Mapping Partners contains a detailed description of the data themes and references to other relevant information.

Distribution\_Information:

Distributor:

Contact\_Information:

Contact\_Organization\_Primary:

Contact\_Organization: Federal Emergency Management Agency Engineering

Library

Contact\_Address:

Address\_Type: mailing address

Address: Marie Sparrow, Zimmerman Associates, Inc.

Address: 847 South Pickett Street

City: Alexandria

State\_or\_Province: Virginia

Postal\_Code: 22304

Country: USA

Contact\_Voice\_Telephone: 1-877-336-2627

Contact\_Electronic\_Mail\_Address: miphelp@mapmodteam.com

Distribution\_Liability: No warranty expressed or implied is made by FEMA regarding the utility of the data on any other system nor shall the act of distribution constitute any such warranty.

Standard\_Order\_Process:

Digital\_Form:

Digital\_Transfer\_Information:

5-060611 Blackstone Acquisition Metadata.txt  
Format\_Name: FEMA-DCS-Terrain  
Digital\_Transfer\_Option:  
Online\_Option:  
Computer\_Contact\_Information:  
Network\_Address:  
Network\_Resource\_Name: <http://hazards.fema.gov>  
Fees: Contact Distributor  
Metadata\_Reference\_Information:  
Metadata\_Date: 20110502  
Metadata\_Contact:  
Contact\_Information:  
Contact\_Person\_Primary:  
Contact\_Person: FEMA Representative  
Contact\_Organization: Federal Emergency Management Agency  
Contact\_Address:  
Address\_Type: mailing address  
Address: 500 C Street, S.W.  
City: Washington  
State\_or\_Province: District of Columbia  
Postal\_Code: 20472  
Country: USA  
Contact\_Voice\_Telephone: 1-877-336-2627  
Contact\_Electronic\_Mail\_Address: [miphelp@mapmodteam.com](mailto:miphelp@mapmodteam.com)  
Metadata\_Standard\_Name: FGDC Content Standards for Digital Geospatial Metadata  
Metadata\_Standard\_Version: FGDC-STD-001-1998  
Metadata\_Extensions:  
Online\_Linkage: <http://hazards.fema.gov>  
Online\_Linkage: <http://www.epsg.org>  
Profile\_Name: FEMA NFIP Metadata Content and Format Standard

6-060611 Blackstone Processing Metadata.txt

Identification\_Information:

Citation:

Citation\_Information:

Originator: Federal Emergency Management Agency

Publication\_Date: 20110502

Title: TERRAIN, Blackstone, Massachusetts

Geospatial\_Data\_Presentation\_Form: FEMA-DCS-Terrain

Publication\_Information:

Publication\_Place: Washington, DC

Publisher: Federal Emergency Management Agency

Online\_Linkage: <http://hazards.fema.gov>

Larger\_Work\_Citation:

Citation\_Information:

Originator: Federal Emergency Management Agency

Publication\_Date: 20110502

Title: FEMA CASE 11-01-0716S

Description:

Abstract: The Blackstone AOI consists of five areas which are part of two functional areas. See the Ground Control process step for further information on functional areas. Ground Control is collected throughout the AOI for use in the processing of LiDAR data to ensure data accurately represents the ground surface. QA/QC checkpoints, (FVA and CVA - see Ground Control process step for further information) also collected throughout the AOI, are used for independent quality checks of the processed LiDAR data.

LiDAR acquisition products include Pre- and Post- flight reports which contain information on the flightlines, equipment parameters, and other pertinent acquisition details. The LiDAR product itself consists of tiles of LAS points which are partially classified such that the bare earth points can be calibrated to the ground surface and tested via the independent QC to ensure the ground surface is accurately represented.

LiDAR bare earth deliverable consists of tiles of fully classified LAS points. A full narrative accompanies this deliverable, as well as the independent QC report.

Purpose: Provide high resolution terrain elevation and land cover elevation data. Terrain data is used to represent the topography of a watershed and/or floodplain environment and to extract useful information for hydraulic and hydrologic models.

Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110502

Currentness\_Reference: ground condition

Status:

Progress: Complete

Maintenance\_and\_Update\_Frequency: Unknown

Spatial\_Domain:

Bounding\_Coordinates:

West\_Bounding\_Coordinate: -72.016421

East\_Bounding\_Coordinate: -71.284433

North\_Bounding\_Coordinate: 42.438294

South\_Bounding\_Coordinate: 41.769773

Keywords:

Theme:

Theme\_Keyword\_Thesaurus: ISO 19115 Topic Category

Theme\_Keyword: elevation

Theme:

Theme\_Keyword\_Thesaurus: FEMA NFIP Topic Category

Theme\_Keyword: Land Surface

Theme\_Keyword: Topography

Theme\_Keyword: Digital Terrain Model

Theme\_Keyword: Elevation Data

Theme\_Keyword: LIDAR

Theme:



6-060611 Blackstone Processing Metadata.txt

Theme\_Keyword\_Thesaurus: None  
Theme\_Keyword: Ground Control  
Theme\_Keyword: LAS point files  
Theme\_Keyword: Point Cloud  
Theme\_Keyword: Bare Earth

Place:

Place\_Keyword\_Thesaurus: None  
Place\_Keyword: REGION I  
Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY ASHBURNHAM, TOWN OF  
Place\_Keyword: FEMA-CID 250290

Place:

Place\_Keyword\_Thesaurus: None  
Place\_Keyword: REGION I  
Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY ATHOL, TOWN OF  
Place\_Keyword: FEMA-CID 250291

Place:

Place\_Keyword\_Thesaurus: None  
Place\_Keyword: REGION I  
Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY AUBURN, TOWN OF  
Place\_Keyword: FEMA-CID 250292

Place:

Place\_Keyword\_Thesaurus: None  
Place\_Keyword: REGION I  
Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY BARRE, TOWN OF  
Place\_Keyword: FEMA-CID 250293

Place:

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Place\_Keyword: REGION I  
Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY BERLIN, TOWN OF  
Place\_Keyword: FEMA-CID 250294

Place:

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Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
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Place\_Keyword: FEMA-CID 250295

Place:

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Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY BOLTON, TOWN OF  
Place\_Keyword: FEMA-CID 250296

Place:

Place\_Keyword\_Thesaurus: None

6-060611 Blackstone Processing Metadata.txt

Place\_Keyword: REGION I  
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Place:  
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Place\_Keyword: REGION I  
Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY BROOKFIELD, TOWN OF  
Place\_Keyword: FEMA-CID 250298  
Place:  
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Place\_Keyword: REGION I  
Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY CHARLTON, TOWN OF  
Place\_Keyword: FEMA-CID 250299  
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Place\_Keyword: REGION I  
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Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
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Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY FITCHBURG, CITY OF  
Place\_Keyword: FEMA-CID 250304  
Place:

6-060611 Blackstone Processing Metadata.txt

Place\_Keyword\_Thesaurus: None  
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Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY GARDNER, CITY OF  
Place\_Keyword: FEMA-CID 250305

Place:

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Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
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Place\_Keyword: FEMA-CID 250306

Place:

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Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY HARDWICK, TOWN OF  
Place\_Keyword: FEMA-CID 250307

Place:

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Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY HARVARD, CITY OF  
Place\_Keyword: FEMA-CID 250308

Place:

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Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY HOLDEN, TOWN OF  
Place\_Keyword: FEMA-CID 250309

Place:

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Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
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Place\_Keyword: FEMA-CID 250310

Place:

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Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY HUBBARDSTON, TOWN OF  
Place\_Keyword: FEMA-CID 250311

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Place\_Keyword: FEMA-CID 250312

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Place:

Place\_Keyword\_Thesaurus: None  
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Place\_Keyword: FEMA-CID 250313

Place:

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Place\_Keyword: FEMA-CID 250314

Place:

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Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
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Place\_Keyword: FEMA-CID 250315

Place:

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Place\_Keyword: STATE MA  
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Place\_Keyword: COUNTY-FIPS 027  
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Place\_Keyword: FEMA-CID 250316

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Place\_Keyword: STATE MA  
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Place\_Keyword: COMMUNITY MILFORD, TOWN OF  
Place\_Keyword: FEMA-CID 250317

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Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
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Place\_Keyword: FEMA-CID 250318

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Place\_Keyword: FEMA-CID 250319

Place:

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Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY NEW BRAintree, TOWN OF

6-060611 Blackstone Processing Metadata.txt

Place\_Keyword: FEMA-CID 250320  
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Place\_Keyword: COMMUNITY NORTHBOROUGH, TOWN OF  
Place\_Keyword: FEMA-CID 250321  
Place:  
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Place\_Keyword: REGION I  
Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY NORTHBRIDGE, TOWN OF  
Place\_Keyword: FEMA-CID 250322  
Place:  
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Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY NORTH BROOKFIELD, TOWN OF  
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Place:  
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Place\_Keyword: REGION I  
Place\_Keyword: STATE MA  
Place\_Keyword: COUNTY WORCESTER  
Place\_Keyword: COUNTY-FIPS 027  
Place\_Keyword: COMMUNITY OAKHAM, TOWN OF  
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Place\_Keyword: STATE MA  
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Place\_Keyword: COUNTY WORCESTER  
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6-060611 Blackstone Processing Metadata.txt

Place\_Keyword: COMMUNITY PHILLIPSTON, TOWN OF

Place\_Keyword: FEMA-CID 250328

Place:

Place\_Keyword\_Thesaurus: None

Place\_Keyword: REGION I

Place\_Keyword: STATE MA

Place\_Keyword: COUNTY WORCESTER

Place\_Keyword: COUNTY-FIPS 027

Place\_Keyword: COMMUNITY PRINCETON, TOWN OF

Place\_Keyword: FEMA-CID 250329

Place:

Place\_Keyword\_Thesaurus: None

Place\_Keyword: REGION I

Place\_Keyword: STATE MA

Place\_Keyword: COUNTY WORCESTER

Place\_Keyword: COUNTY-FIPS 027

Place\_Keyword: COMMUNITY ROYALSTON, TOWN OF

Place\_Keyword: FEMA-CID 250330

Place:

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Place\_Keyword: REGION I

Place\_Keyword: STATE MA

Place\_Keyword: COUNTY WORCESTER

Place\_Keyword: COUNTY-FIPS 027

Place\_Keyword: COMMUNITY RUTLAND, TOWN OF

Place\_Keyword: FEMA-CID 250331

Place:

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Place\_Keyword: STATE MA

Place\_Keyword: COUNTY WORCESTER

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Place\_Keyword: COMMUNITY SHREWSBURY, TOWN OF

Place\_Keyword: FEMA-CID 250332

Place:

Place\_Keyword\_Thesaurus: None

Place\_Keyword: REGION I

Place\_Keyword: STATE MA

Place\_Keyword: COUNTY WORCESTER

Place\_Keyword: COUNTY-FIPS 027

Place\_Keyword: COMMUNITY SOUTHBOROUGH, TOWN OF

Place\_Keyword: FEMA-CID 250333

Place:

Place\_Keyword\_Thesaurus: None

Place\_Keyword: REGION I

Place\_Keyword: STATE MA

Place\_Keyword: COUNTY WORCESTER

Place\_Keyword: COUNTY-FIPS 027

Place\_Keyword: COMMUNITY SOUTHBRIDGE, TOWN OF

Place\_Keyword: FEMA-CID 250334

Place:

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6-060611 Blackstone Processing Metadata.txt

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Place\_Keyword: STATE MA

6-060611 Blackstone Processing Metadata.txt

Place\_Keyword: COUNTY WORCESTER

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Place\_Keyword: COMMUNITY WESTBOROUGH, TOWN OF

Place\_Keyword: FEMA-CID 250344

Place:

Place\_Keyword\_Thesaurus: None

Place\_Keyword: REGION I

Place\_Keyword: STATE MA

Place\_Keyword: COUNTY WORCESTER

Place\_Keyword: COUNTY-FIPS 027

Place\_Keyword: COMMUNITY WEST BOYLSTON, TOWN OF

Place\_Keyword: FEMA-CID 250345

Place:

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Place\_Keyword: REGION I

Place\_Keyword: STATE MA

Place\_Keyword: COUNTY WORCESTER

Place\_Keyword: COUNTY-FIPS 027

Place\_Keyword: COMMUNITY WEST BROOKFIELD, TOWN OF

Place\_Keyword: FEMA-CID 250346

Place:

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Place\_Keyword: STATE MA

Place\_Keyword: COUNTY WORCESTER

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Place\_Keyword: COMMUNITY WESTMINSTER, TOWN OF

Place\_Keyword: FEMA-CID 250347

Place:

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Place\_Keyword: COUNTY-FIPS 027

Place\_Keyword: COMMUNITY WINCHENDON, TOWN OF

Place\_Keyword: FEMA-CID 250348

Place:

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Place\_Keyword: STATE MA

Place\_Keyword: COUNTY WORCESTER

Place\_Keyword: COUNTY-FIPS 027

Place\_Keyword: COMMUNITY WORCESTER, TOWN OF

Place\_Keyword: FEMA-CID 250349

Access\_Constraints: None

Use\_Constraints: Acknowledgement of FEMA would be appreciated in products derived from these data. This digital data is produced for the purposes of updating/creating a DFIRM database.

Data\_Set\_Credit: Ground control and quality control checkpoints were collected by CompassData, Inc. LiDAR data was acquired and processed by Photo Science, Inc. Quality Assurance testing was conducted by Greenhorne & O'Mara, Inc. All firms were under contract to STARR, A Joint Venture which held the FEMA contract and task order for this work.

Data\_Quality\_Information:

Logical\_Consistency\_Report: Survey data have been confirmed to be in proper units, coordinate systems and format. The terrain data have been confirmed as complete LAS format data files. Header files are in proper LAS format with content as specified by FEMA Procedural Memo No. 61.

Completeness\_Report: Survey data have been checked for completeness, points have been collected in correct vegetation units, and distributed throughout the AOI. The terrain data have been checked for completeness against AOI polygons. No gaps as



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defined by FEMA Procedural Memo No. 61 are known to exist within the dataset. Positional accuracy was calculated for both functional areas. The Blackstone area is reported in the Positional Accuracy section of this metadata. The Charles Narragansett partial Blackstone area accuracy value is 0.186 meters.

Positional\_Accuracy:

Vertical\_Positional\_Accuracy:

Vertical\_Positional\_Accuracy\_Report: Deliverables were tested by for both vertical and horizontal accuracy. The vertical unit of the data file is in meters with 2-decimal point precision.

Quantitative\_Vertical\_Positional\_Accuracy\_Assessment:

Vertical\_Positional\_Accuracy\_Value: 0.304

Vertical\_Positional\_Accuracy\_Explanation: Consolidated Vertical Accuracy (CVA) equal to 95th Percentile Confidence Level (RMSE[z] x 1.9600) calculated against the bare earth surface in all ground cover classes. Reported in meters.

Lineage:

Source\_Information:

Source\_Citation:

Citation\_Information:

Originator: STARR

Publication\_Date: 2011

Title: GroundControl Blackstone

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110128

Source\_Currentness\_Reference: ground condition

Source\_Citation\_Abbreviation: Other1

Source\_Contribution: Control points for tying LiDAR data to the ground surface.

Source\_Information:

Source\_Citation:

Citation\_Information:

Originator: STARR

Publication\_Date: 2011

Title: FVA\_CVA Blackstone

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110128

Source\_Currentness\_Reference: ground condition

Source\_Citation\_Abbreviation: Other2

Source\_Contribution: Quality Assurance points to confirm LiDAR data meets vertical accuracy requirements.

Source\_Information:

Source\_Citation:

Citation\_Information:

Originator: STARR

Publication\_Date: 2011

Title: Blackstone\_Collection\_Area

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110502

Source\_Currentness\_Reference: publication date

Source\_Citation\_Abbreviation: Other3

Source\_Contribution: Shapefile of Blackstone acquisition area.

Source\_Information:

Source\_Citation:

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Citation\_Information:

Originator: STARR

Publication\_Date: 2011

Title: All\_Returns

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110502

Source\_Currentness\_Reference: ground condition

Source\_Citation\_Abbreviation: Other4

Source\_Contribution: Point Cloud (All Returns) LAS point files named according to Blackstone LiDAR Tile Index.

Source\_Information:

Source\_Citation:

Citation\_Information:

Originator: STARR

Publication\_Date: 2011

Title: Blackstone\_PreFlightReport

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110502

Source\_Currentness\_Reference: publication date

Source\_Citation\_Abbreviation: Other5

Source\_Contribution: document contains the operation plans for the LiDAR acquisition

Source\_Information:

Source\_Citation:

Citation\_Information:

Originator: STARR

Publication\_Date: 2011

Title: Blackstone\_PostFlightReport

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110502

Source\_Currentness\_Reference: publication date

Source\_Citation\_Abbreviation: Other6

Source\_Contribution: document contains the acquisition and calibration reports for the LiDAR acquisition.

Source\_Information:

Source\_Citation:

Citation\_Information:

Originator: STARR

Publication\_Date: 2011

Title: Blackstone\_Tile\_Index

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110502

Source\_Currentness\_Reference: publication date

Source\_Citation\_Abbreviation: Other7

Source\_Contribution: Shapefile of tile index used to populate and reference LAS tiled data.

Source\_Information:

Source\_Citation:

Citation\_Information:

Originator: STARR

Publication\_Date: 2011

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Title: Region 1 Blackstone Testing Results FVA CVA

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110502

Source\_Currentness\_Reference: publication date

Source\_Citation\_Abbreviation: Other8

Source\_Contribution: document contains QC test results for FVA blind test against the automated process resultant bare earth surface generated from the point cloud LAS points.

Source\_Information:

Source\_Citation:

Citation\_Information:

Originator: STARR

Publication\_Date: 2011

Title: Region 1 Charles Narragansett Partial Blackstone Testing Results

FVA CVA

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110502

Source\_Currentness\_Reference: publication date

Source\_Citation\_Abbreviation: Other9

Source\_Contribution: document contains QC test results for FVA blind test against the automated process resultant bare earth surface generated from the point cloud LAS points.

Source\_Information:

Source\_Citation:

Citation\_Information:

Originator: STARR

Publication\_Date: 2011

Title: R1\_Blackstone\_MA\_Terrain\_TSDN

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110502

Source\_Currentness\_Reference: ground condition

Source\_Citation\_Abbreviation: Other10

Source\_Contribution: SContains complete narrative on the acquisition and processing of the LiDAR dataset, includes area diagrams, reports and metadata.

Source\_Information:

Source\_Citation:

Citation\_Information:

Originator: STARR

Publication\_Date: 2011

Title: Bare\_Earth

Type\_of\_Source\_Media: DIGITAL

Source\_Time\_Period\_of\_Content:

Time\_Period\_Information:

Single\_Date/Time:

Calendar\_Date: 20110502

Source\_Currentness\_Reference: ground condition

Source\_Citation\_Abbreviation: Other11

Source\_Contribution: Bare Earth LAS point files named according to the Blck\_Tile\_Index.

Process\_Step:

Process\_Description: GPS based surveys were utilized to support both processing and testing of LiDAR data within FEMA designated Areas of Interest (AOIs). Geographically distinct ground points were surveyed using GPS technology throughout

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the AOIs to provide support for three distinct tasks.

Task 1 was to provide Vertical Ground Control to support the aerial acquisition and subsequent bare earth model processing. To accomplish this, survey-grade Trimble R-8 GPS receivers were used to collect a series of control points located on open areas, free of excessive or significant slope, and at least 5 meters away from any significant terrain break. Most if not all control points were collected at street/road intersections on bare level pavement.

Task 2 was to collect Fundamental Vertical Accuracy (FVA) checkpoints to evaluate the initial quality of the collected point cloud and to ensure that the collected data was satisfactory for further processing to meet FEMA specifications. The FVA points were collected in identical fashion to the Vertical Ground Control Points, but segregated from the point pool to ensure independent quality testing without prior knowledge of FVA locations by the aerial vendor.

Task 3 was to collect Consolidated Vertical Accuracy (CVA) checkpoints to allow vertical testing of the bare-earth processed LiDAR data in different classes of land cover, including: Open (pavement, open dirt, short grass), High Grass and Crops, Brush and Low Trees, Forest, Urban. CVA points were collected in similar fashion as Control and FVA points with emphasis on establishing point locations within the predominant land cover classes within each AOI or Functional AOI Group. In order to successfully collect the Forest land cover class, it was necessary to establish a Backsight and Initial Point with the R8 receiver, and then employ a Nikon Total Station to observe a retroreflective prism stationed under tree canopy. This was necessary due to the reduced GPS performance and degradation of signal under tree canopy.

The R-8 receivers were equipped with cellular modems to receive real-time correction signals from the Keystone Precision Virtual Reference Station (VRS) network encompassing the Region 1 AOIs. Use of the VRS network allowed rapid collection times (~3 minutes/point) at 2.54 cm (1 inch) initial accuracy.

All points collected were below the 8cm specification for testing 24cm, Highest category LiDAR data. To ensure valid in-field collections, an NGS monument with suitable vertical reporting was measured using the same equipment and procedures used for Control, FVA and CVA points on a daily basis. The measurement was compared to the NGS published values to ensure that the GPS collection schema was producing valid data and as a physical proof point of quality of collection. Those monument measurements are summarized in the Accuracy report included in the data delivered to FEMA.

In order to meet FEMA budgetary requirements, AOIs were consolidated into Functional Groups: if AOIs were contiguous, they were treated as one large AOI to allow collection of 20 FVA points and 15 additional CVA points across the group of AOIs. 20 FVA points are necessary to allow testing to CE95 - 1 point out of 20 may fail vertical testing and still allow the entire dataset to meet 95% accuracy requirements.

In similar fashion, 20 CVA points are necessary to test to CE95 as discussed above. 15 CVA points were collected per AOI or per Functional Group with the intention at the outset that 5 of the collected FVAs would perform double-duty as Open-class CVA points, to total 20 CVAs per AOI or Functional Group.

The Functional Groups are as follows: Narragansett/Charles/Blackstone(northeast), Nashua, Blackstone(north and west), Quinipiac, Quincy/Suffolk (while included as part of the FEMA Charles AOI, was physically separated from the Charles AOI polygon and treated as an independent functional area).

The following software packages and utilities were used to control the GPS receiver in the field during data collection, and then ingest and export the collected GPS data for all points: Trimble Survey Controller, Trimble Pathfinder Office.

The following software utilities were used to translate the collected Latitude/Longitude Decimal Degree HAE GPS data for all points into Latitude/Longitude Degrees/Minutes/Seconds for checking the collected monument data against the published NGS Datasheet Lat/Long DMS values and into UTM NAD83 Northings/Eastings: U.S. Army Corps of Engineers CorpsCon, National Geodetic Survey Geoid09NAVD88.

MSL values were determined using the most recent NGS-approved geoid model to generate geoid separation values for each Lat/Long coordinate pair. In this fashion, Orthometric heights were determined for each Control, FVA and CVA point by subtracting the generated Geoid Separation value from the Ellipsoidal Height (HAE)

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for publication and use as MSL NAVD88(09).

Process\_Date: 2011

Process\_Step:

Process\_Description: Applanix software was used in the post processing of the airborne GPS and inertial data that is critical to the positioning and orientation of the sensor during all flights. POSpac MMS provides the smoothed best estimate of trajectory (SBET) that is necessary for Optech's post processor to develop the point cloud from the LiDAR missions. The point cloud is the mathematical three dimensional collection of all returns from all laser pulses as determined from the aerial mission.

Optech's DASHMap software and Leica's ALS Post Processor software were used to create the Raw LiDAR Flight Line strips. At this point this data is ready for analysis, classification, and filtering to generate a bare earth surface model in which the above ground features are removed from the data set. The GeoCue and TerraScan software packages are then used for the automated data classification. Project specific macros are created to classify the ground and to remove the side overlap between parallel flight lines.

LAS Class 2 (Ground) is used to check the surveyed control points against the Triangulated LiDAR surface. Any bias is then removed using macro functionality within TerraScan.

Unclassified Point Cloud tiles are then created using TerraScan macro functionality.

These tiles are populated within GeoCue to ensure correct LAS versioning and LAS Header information.

LAS Class 2 is used to check the independent QC points against the Triangulated LiDAR surface. If RMSE is not within guidelines TerraScan software is utilized to remove any bias, and the check is performed again.

Process\_Date: 2011

Process\_Step:

Process\_Description:

Point Cloud data is manually reviewed and any remaining artifacts are removed using functionality provided within the TerraScan and TerraModeler software packages.

Additional project specific macros are created and run within GeoCue/TerraScan to ensure correct LAS classification prior to project delivery.

Final Classified LAS tiles are created within GeoCue to confirm correct LAS versioning and header information.

In-house software is then used to check LAS header information and final LAS classification prior to delivery.

LAS Class 2 is used to check the independent QC points against the Triangulated LiDAR surface.

Process\_Date: 2011

Spatial\_Reference\_Information:

Horizontal\_Coordinate\_System\_Definition:

Planar:

Grid\_Coordinate\_System:

Grid\_Coordinate\_System\_Name: Universal Transverse Mercator

Universal\_Transverse\_Mercator:

UTM\_Zone\_Number: 19

Transverse\_Mercator:

Scale\_Factor\_at\_Central\_Meridian: 0.999600

Longitude\_of\_Central\_Meridian: -69.000000

Latitude\_of\_Projection\_Origin: 0.000000

False\_Easting: 500000.000000

False\_Northing: 0.000000

Planar\_Coordinate\_Information:

Planar\_Coordinate\_Encoding\_Method: coordinate pair

Coordinate\_Representation:

Abcissa\_Resolution: 0.000010

Ordinate\_Resolution: 0.000010

Planar\_Distance\_Units: meters

Geodetic\_Model:

Horizontal\_Datum\_Name: North American Datum 1983

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Ellipsoid\_Name: Geodetic Reference System 80  
Semi-major\_Axis: 6378137.00  
Denominator\_of\_Flattening\_Ratio: 298.257222  
Vertical\_Coordinate\_System\_Definition:  
  Altitude\_System\_Definition:  
    Altitude\_Datum\_Name: North American Vertical Datum of 1988  
    Altitude\_Resolution: 0.01  
    Altitude\_Distance\_Units: meters  
    Altitude\_Encoding\_Method: Attribute Values

Entity\_and\_Attribute\_Information:  
  Detailed\_Description:  
    Entity\_Type:  
      Entity\_Type\_Label: Terrain\2142855\SupplementalData\GroundControl Blackstone  
      Entity\_Type\_Definition: Ground Control Survey for LiDAR collection  
      Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood  
Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture  
Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))  
      Detailed\_Description:  
        Entity\_Type:  
          Entity\_Type\_Label: Terrain\2142855\SupplementalData\FVA\_CVA Blackstone  
          Entity\_Type\_Definition: Survey for Horizontal and Vertical LiDAR QC  
          Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood  
Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture  
Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))  
          Detailed\_Description:  
            Entity\_Type:  
              Entity\_Type\_Label: Terrain\2142856\SupplementalData\Blackstone\_Collection  
              Entity\_Type\_Definition: Area Spatial File  
              Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood  
Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture  
Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))  
              Detailed\_Description:  
                Entity\_Type:  
                  Entity\_Type\_Label: Terrain\2142856\All\_Returns  
                  Entity\_Type\_Definition: LAS 1.2 files  
                  Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood  
Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture  
Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))  
                  Detailed\_Description:  
                    Entity\_Type:  
                      Entity\_Type\_Label:  
Terrain\2142856\SupplementalData\Blackstone\_PreFlightReport  
                      Entity\_Type\_Definition: Digital Document  
                      Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood  
Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture  
Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))  
                      Detailed\_Description:  
                        Entity\_Type:  
                          Entity\_Type\_Label:  
Terrain\2142856\SupplementalData\Blackstone\_PostFlightReport  
                          Entity\_Type\_Definition: Digital Document  
                          Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood  
Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture  
Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))  
                          Detailed\_Description:  
                            Entity\_Type:  
                              Entity\_Type\_Label: Terrain\2142856\SupplementalData\Blck\_Tile\_Index  
                              Entity\_Type\_Definition: Area Spatial File  
                              Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood  
Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture  
Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

6-060611 Blackstone Processing Metadata.txt

Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label: Terrain\2142857\SupplementalData\Region 1 Blackstone

Testing Results FVA CVA

Entity\_Type\_Definition: Digital Document

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label: Terrain\2142857\SupplementalData\Region 1 Charles

Narragansett partial Blackstone Testing Results FVA CVA

Entity\_Type\_Definition: Digital Document

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label:

Terrain\2142857\SupplementalData\R1\_Blackstone\_MA\_Terrain\_TSDN

Entity\_Type\_Definition: Digital Document

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

Detailed\_Description:

Entity\_Type:

Entity\_Type\_Label: Terrain\2142857\Bare\_Earth

Entity\_Type\_Definition: LAS 1.2 files

Entity\_Type\_Definition\_Source: FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix M: Data Capture Standards and Data Capture Guidelines (available at [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm))

Overview\_Description:

Entity\_and\_Attribute\_Overview: The Terrain data package is made up of several data themes containing primarily spatial information. These data supplement the Elevation datasets by providing additional information to aid flood risk evaluation and flood hazard area delineations.

Entity\_and\_Attribute\_Detail\_Citation: Appendix M of FEMA Guidelines and Specifications for FEMA Flood Hazard Mapping Partners contains a detailed description of the data themes and references to other relevant information.

Distribution\_Information:

Distributor:

Contact\_Information:

Contact\_Organization\_Primary:

Contact\_Organization: Federal Emergency Management Agency Engineering

Library

Contact\_Address:

Address\_Type: mailing address

Address: Marie Sparrow, Zimmerman Associates, Inc.

Address: 847 South Pickett Street

City: Alexandria

State\_or\_Province: Virginia

Postal\_Code: 22304

Country: USA

Contact\_Voice\_Telephone: 1-877-336-2627

Contact\_Electronic\_Mail\_Address: miphelp@mapmodteam.com

Distribution\_Liability: No warranty expressed or implied is made by FEMA regarding the utility of the data on any other system nor shall the act of distribution constitute any such warranty.

Standard\_Order\_Process:

Digital\_Form:

Digital\_Transfer\_Information:

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Format\_Name: FEMA-DCS-Terrain

Digital\_Transfer\_Option:

Online\_Option:

Computer\_Contact\_Information:

Network\_Address:

Network\_Resource\_Name: <http://hazards.fema.gov>

Fees: Contact Distributor

Metadata\_Reference\_Information:

Metadata\_Date: 201100502

Metadata\_Contact:

Contact\_Information:

Contact\_Person\_Primary:

Contact\_Person: FEMA Representative

Contact\_Organization: Federal Emergency Management Agency

Contact\_Address:

Address\_Type: mailing address

Address: 500 C Street, S.W.

City: Washington

State\_or\_Province: District of Columbia

Postal\_Code: 20472

Country: USA

Contact\_Voice\_Telephone: 1-877-336-2627

Contact\_Electronic\_Mail\_Address: [miphelp@mapmodteam.com](mailto:miphelp@mapmodteam.com)

Metadata\_Standard\_Name: FGDC Content Standards for Digital Geospatial Metadata

Metadata\_Standard\_Version: FGDC-STD-001-1998

Metadata\_Extensions:

Online\_Linkage: <http://hazards.fema.gov>

Online\_Linkage: <http://www.epsg.org>

Profile\_Name: FEMA NFIP Metadata Content and Format Standard



## **Appendix C: Pre Flight Planning Report**



Blackstone

Pre-Flight Operations Plan

November 2010

# BLACKSTONE PRE-FLIGHT OPERATIONS PLAN

## Planned Flight Lines

Photo Science has completed preliminary flight planning for the Blackstone project area. Blackstone is scheduled to be acquired this fall when the leaves are off and delivered to FEMA in late spring of 2011. The Blackstone area is 112 square miles and initial planning details are depicted in Figure 1 on the following page. This Figure details that STARR expects to collect **68 flight lines covering 423 flight line miles**. This area warranted a “Highest” vertical accuracy requirement and will be collected with a nominal pulse spacing of 1-meter. Key components of this flight planning include:

- ✓ Generating a plan that takes all specifications into account, and the required Laser settings to meet those specs, review of terrain and water issues, along with potential base station locations at airports with sufficient services available to support the crews.
- ✓ Orientation of flight lines parallel to major terrain features and variation in flight line spacing due to terrain variation (steeper slopes generally require tighter line spacing between adjacent parallel lines to ensure point density and side overlap are maintained)
- ✓ Check Airspace issues, and access issues for Base Stations.
- ✓ Safety considerations, both for flights, and Laser collection.

Acquisition (112 sq. miles @ 1-meter nominal post spacing to meet 24.5 cm FVA, LAS point cloud delivery with metadata, pre-operations flight plan, and post flight aerial acquisition report).

## Planned GPS Stations

Normally existing high accuracy monuments at airports are utilized if possible. Typically a Primary Airport Control Monument (or Secondary) is available; otherwise any other high accuracy monument can be used. We typically prefer these on the airport grounds as they can be monitored for security by airport staff. If no monument is available or an existing monument is damaged, we will set a monument with re-bar and use OPUS to control the monument. These are then used for initial field processing of the data.

## Planned Control

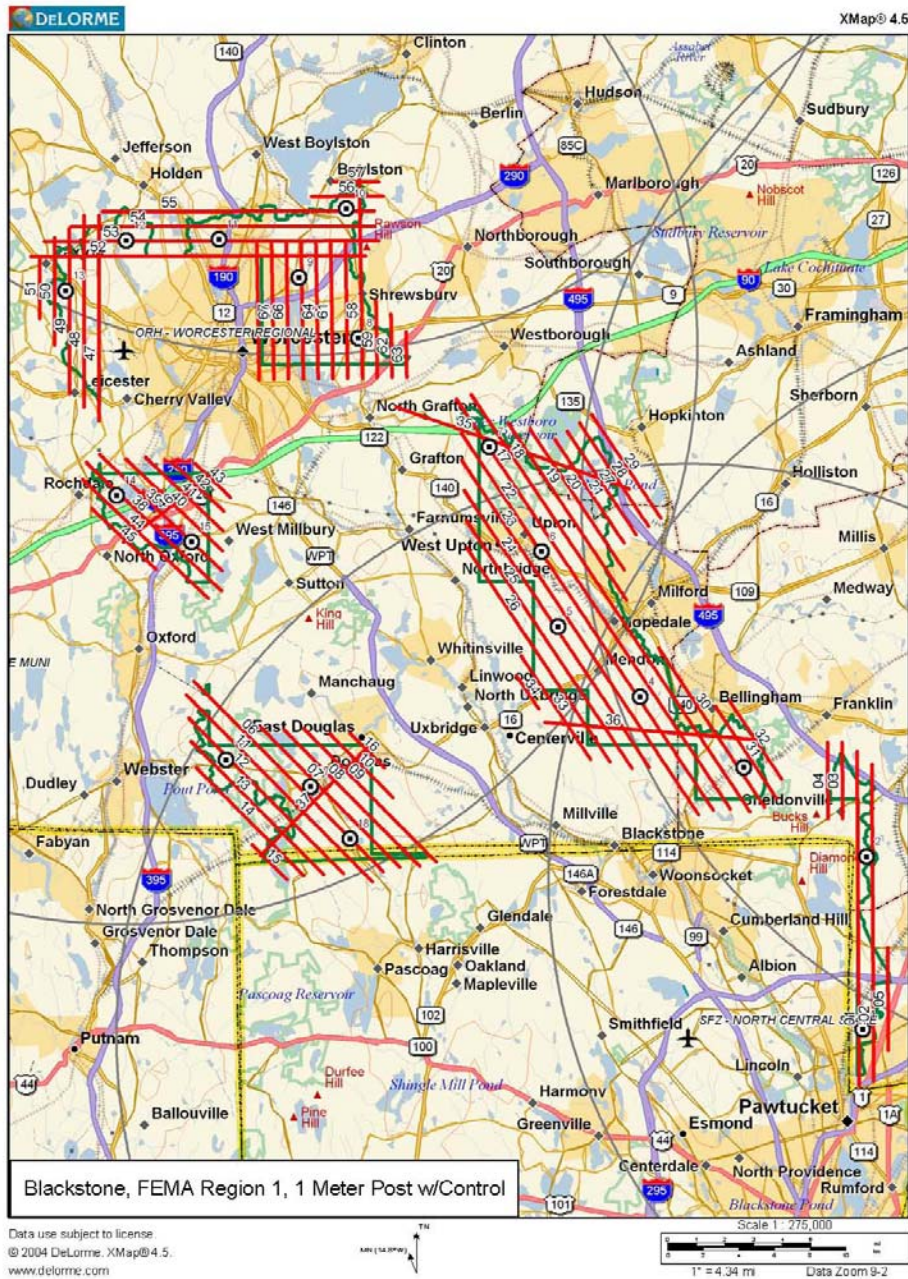
Eighteen (18) ground control points will be surveyed to control the LiDAR data and to support a vertical test. Each of these two functions shall remain independent of each other and also be collected by an independent subcontractor (CompassData). Independent check or calibration points will be three times as accurate as the surface being checked. Therefore, in order to validate a 24.5 cm LiDAR surface (consistent with 2 foot contours), STARR will collect elevation control data accurate to 8 cm. This “three times” model for collecting ground control and QA points will be used throughout the task order.

Vertical accuracy checkpoints will be located by another independent STARR contractor (CompassData) to check Photo Science’s work in open terrain, where there is a high probability that the sensor will have detected the ground surface without influence from surrounding vegetation. Checkpoints will be located on flat or uniformly sloping terrain and will be at least five (5) meters away from any break line where there is a

# BLACKSTONE PRE-FLIGHT OPERATIONS PLAN

change in slope. This criterion applies for all QA points for the Fundamental Vertical Accuracy (FVA) Assessment as well.

Blind vertical QA points for the Consolidated Accuracy Check (CVA) will also be collected by CompassData to check Photo Science's work randomly across different land use types using the ASPRS NSSDA land cover types. The points will be located in flat areas with no substantial elevation breaks within a 3-5 meter radius. We expect to normally pick one area and get 3-5 different land use classes from a single setup. We expect to normally use GPS to position an occupation and backsight point and then use a total station to get the other classes from that setup. The CVA assessment will incorporate a representative sample of the FVA assessment into the dataset to save on the total number of points collected. Figure 1 below has a location map of the flight lines and ground control points.



**Figure 1-Blackstone Flight Lines, Ground Control, and Airport Locations**

# BLACKSTONE PRE-FLIGHT OPERATIONS PLAN

## Planned Airport Locations

Photo Science will be utilizing two airports for Blackstone for mobilization and demobilization. As indicated in Figure 1 the two airports will be ORH-Worcester Regional and SFZ-North Central State. All base stations used during flights are based at these Airports

## Calibration Plans

Periodic detailed boresighting of the LiDAR sensor is performed at a boresight facility established in Lexington, Kentucky for both our LiDAR and imagery platforms. Over 95 high-accuracy control points are located within this facility. The area also has numerous pitched roofs that are necessary in boresighting LiDAR instruments. Local boresights are also carried out at individual project sites. Typically these are established at local airports and consist of opposing and cross flights conducted at multiple flight elevations. The boresight data is processed by our Lead LiDAR Specialist with the results for all boresight parameters applied to the project acquisition. Figure 2 below outlines some of the basic principles that Photo Sciences conducts for LiDAR boresighting.

Figure2

Sensor Calibration Boresighting	
✦	Photo Science routinely performs a Comprehensive Calibration process from our permanent boresighting location at the Capital City Airport in Frankfort, KY, as well as daily, local project specific boresighting locations.
✦	Photo Science established GPS survey points for LiDAR ground truthing and reflective survey analysis.
✦	Our calibration methodology adheres to the basic survey principle of <i>"working for the whole of the parts"</i> ensuring that residual values of the calibration are reduced, <i>not</i> multiplied.
✦	Photo Science calibration process validates roll, pitch, heading, pitch at swath edge, and torsion.

**Calibration** – all of our sensors are calibrated by flying lines at multiple altitudes and at varying directions over features on land, typically at the airport where the acquisition is staged. These lines are used to remove angular errors between the IMU and scanning mirror and to determine the precise positioning of the sensor in relationship with the phase center of the GPS antenna mounted on the fuselage of the aircraft.

**Calibration of the Elevation Surface** – the raw LiDAR surface is compared against ground points that are established for the calibration of the elevation surface. System biases are identified and removed during this calibration. An early statistical analysis takes place that provides an indication of the precision of the acquired data.

Additionally, each lift requires a cross flight over the lines collected during that flight. This also acts as a daily calibration and is used if any anomalies are discovered with processed data.

## Quality Control Procedures for Flight Crew

### Acquisition Crews

An experienced and knowledgeable acquisition crew is also critical to a successful LiDAR project. We will bring two capable crews to the project site with three more in reserve should any unexpected health issues or similar complications arise.

# BLACKSTONE PRE-FLIGHT OPERATIONS PLAN

## General Flight Mission Procedures

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On a lift by lift basis the flight crew will check cloud conditions, atmospheric conditions (fog or probability of fog) and winds and turbulence. If any of those factors would make acquisition difficult they will wait a few hours and review again.

LiDAR crews can fly at night or during the day. Night flights can be smoother in some cases, but extra care must be used as it is easy to lose orientation with the ground if in very rural areas or over large expanses of water. Additionally, if there are fog probabilities then flights will not take place as fog will block the laser. It must be clear below the aircraft at all times.

The initial item is to set the base station properly over the monument, verify it is secure and running. Prior to setting the crew will have ascertained that it has storage space on the hard drives and full battery life. They will also verify that it is running with proper collection parameters. PDOP is also reviewed as collection will not take place during times of high PDOP.

The LiDAR system (controller hard drives and Laser) is connected to the flight management system and once the project plan is loaded the parameters for collection will load as well. The sensor operator will verify that everything loaded correctly before flight.

Once the LiDAR has been started the crew will taxi to the run up area and wait for the IMU, GPS and the rest of the system level out. They will collect data in a stationary position for about 5-10 minutes until the POS (position and orientation system) provides good level characteristics (Green Lights!).

After this they crew will take off and start collection data, avoiding hard steep turns (banks typically <20 degrees). Collection requires that speeds be maintained, sometimes quite slow depending on the accuracy requirements. Additionally altitudes must be watched closely.

During flights the sensor operator must monitor the laser to sure that temperatures are consistent and within guidelines, that pulsing is taking place correctly and returns are consistent and within guidelines while watching atmospheric conditions, speeds and monitoring the pilot.



# BLACKSTONE PRE-FLIGHT OPERATIONS PLAN

## Planned ScanSet (Laser Collection Parameters)

Parameters	15cm RMSE, 1m
Flying Height	5000
Aircraft Ground Speed (knots)	94
Pulse Rate (KHz)	143.7
Scan Rate (Hz)	48.3
Full Field of View (degrees)	34
Multi-Pulse	Yes
Full Swath Width (meters)	844/961
Swath Overlap (percentage)	30%
Max. Point Spacing Across Track (meters)	1.0
Max. Point Spacing Along Track (meters)	1.0
Across Track/Along Track Ratio	1.0
Average Point Density (M2)	3.10
Average Point Area (M2)	.32
Average Point Spacing (Meters)	.57
Nadir Point Density (pts/m2)	2.00
Illuminated Foot Print Diameter (meters)	.35

Acquisition (112 sq. miles @ 1-meter nominal post spacing to meet 24.5 cm FVA, LAS point cloud delivery with metadata, pre-operations flight plan, and post flight aerial acquisition report)

## Type of Aircraft

All of our LiDAR sensors are currently flown in specially modified single-engine Cessna 206 platforms. This platform provides a very stable platform for LiDAR data acquisition, with the ability to easily achieve altitudes and speeds that are most common for LiDAR collection. Achieving an accurate, dense posting of LiDAR returns on the ground is most often associated with altitudes of 2,000 to 7,000 feet above the average terrain height at speeds ranging from 90 to 140 knots. These ranges are ideal for this single-engine platform.

Our platforms also have significant fuel capacity, which allows us considerable time over target for performing data collection. It is also a safe platform, which is important when flying over rugged terrain. The added bonus is this is a very economical platform to fly in terms of operational and maintenance costs. Moreover, that translates to competitive rates for LiDAR data acquisition.

Aircraft Name	Engine Configuration	ABGPS	Flight Management System	Ceiling Feet
Cessna U-206G	Single	Yes	Yes	16,700
Cessna U-206G	Single	Yes	Yes	16,700
Cessna U-206H	Single	Yes	Yes	15,700
Cessna U-206H	Single	Yes	Yes	15,700



# BLACKSTONE PRE-FLIGHT OPERATIONS PLAN

## Procedure for Tracking, Executing, and Checking Re-flights

All daily flights are tracked with specific logs for each area. These include general logs indicating the lines, date flown etc. as well as very specific mission logs concerning the lift, weather conditions, times, speeds and other criteria critical to the performance of the laser. The daily flight logs are faxed to the office on a daily basis and entered into an access database for tracking purposes. This helps determine where next to move crews and overall project status.

After flight each day, the GPS ground base station data is processed and verified and is then run against the LiDAR POS data in both a forward and reverse sense. The two solutions are then compared against one another for all GPS epochs and the individual differences for the northing, easting, and elevation components are plotted for easy comparison. This data is then run against the LiDAR returns and a point cloud generated. Any anomalies in the data are quickly analyzed, and if required, re-flights take place for the portions of the flight missions that require remediation.

Once the data is checked it is archived, backed up and a set sent to the office via overnight delivery, while the backup copy remains with the crew.

The flight crews do not leave the area of collection until all data has been verified and shipped.

## Considerations for Terrain, Cover, and Weather

Terrain is not an issue for flight planning on this project. The area is very flat. Cover has been considered and collection is scheduled for the Fall of 2010 during leaf-off conditions. Traditional LiDAR weather conditions will be observed for this area.

## **Appendix D: Ground Control Survey and Vertical Testing Quality Control**



**FEMA Region 1 – MA, NH, CT**  
**Ground Control Project Report for Photo Science Inc.**

**November 22, 2010**

<b>Project Information</b>
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<b>CDI Project Number:</b>	<b>FSG1508</b>
<b>Geographic Location:</b>	<b>New England; MA, NH, CT</b>
<b>Number of GCPs Requested:</b>	<b>86</b>
<b>Number of GCPs Collected:</b>	<b>86</b>

<b>Project Specifications</b>
-------------------------------

<b>Precision (Horizontal/Vertical):</b>	<b>CDI Precision-1 <math>\leq 8\text{cm H/V}</math></b>
<b>Coordinate System:</b>	<b>UTM</b>
<b>Datum:</b>	<b>NAD83</b>
<b>Zone:</b>	<b>18 &amp; 19</b>
<b>Altitude Reference:</b>	<b>HAE (WGS84) and NAVD88 (09)</b>
<b>Units:</b>	<b>Meters</b>

<b>RTK GPS</b>
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All Ground Control Points for this project were collected within the boundaries of the Keystone Precision Instruments New England Virtual Reference Station System, which provides continuous real-time broadcast correction signals within a network of 170 base stations encompassing New England and the northern Mid-Atlantic region.

All Control Points were observed for 180 epochs to determine a coordinate location  $\leq 8\text{cm}$  in both Horizontal and Vertical to support subsequent LiDAR post-processing and bare earth deliverables generation.

All data collected were well within the confines of the Keystone VRS system with multiple base locations providing position and correction data for each point collected.

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# CompassData

## Summary

The purpose of this project was to locate and survey photo-identifiable ground control points (GCPs) in multiple areas of interest as defined by FEMA-supplied shape and kml files. The GCP coordinates are to be used to control the vertical aspect of all newly-flown LiDAR data during post-processing and subsequent deliverables creation. CompassData visited the project area, found suitable GCPs, and determined accurate coordinates for each GCP according to the customer's specifications.

## Equipment

CompassData used a Trimble R8 to perform the Control survey. This device is accurate to within 1 cm on a position-by-position basis per Trimble specifications. Operating within the VRS network provided accurate coordinate values at or around 5 cm H/V within 3-5 minutes observation times. CompassData has consistently demonstrated this level of accuracy on many GCP collection jobs across North and South America and Africa. Specifications for the Trimble R8 are available upon request.

## Survey Methodology

CompassData has met the required precision for this project by using a high-quality GPS receiver with differential corrections provided by a VRS network surrounding the project area. The GPS antenna sat atop a bubble-leveled, fixed-height range pole that was placed over the center of the desired GCP. At least 180 positions (captured at a rate of one per second) were geometrically averaged to calculate a single coordinate for each GCP. All required field documentation was filled out and the points were identified on web-based imagery and diagrammed on the CompassData-supplied sketch sheets. Digital pictures of each GCP location were collected in the field.

## Quality Control Procedures

CompassData collects GCPs with an unobstructed view of the sky to ensure proper GPS operation. CompassData works to avoid potential sources of multipath error such as trees, buildings, and fences that may adversely affect the GPS accuracy.

# CompassData

Additional quality control comes from the fact that at least 180 GPS positions are collected for each GCP. While operating within a VRS, valid solutions are reached within seconds; however, we continue to collect additional data to ensure meeting collection specifications. To ensure project integrity, a GCP will be reobserved or moved to a more suitable location if it does not meet project specifications.

In addition to the aforementioned procedures, CompassData “surveys” existing geodetic control monuments to see if our coordinates match the published coordinates to the required accuracy. These monuments are usually established by the National Geodetic Survey (NGS) in the United States. If it is found that our coordinates are outside the acceptable accuracy, the reason for the difference will be found or the GCPs will be reobserved under different GPS constellation constraints. There are certain geodetic considerations that must be taken into account that affect whether a GPS-derived coordinate will line up with a survey monument, especially when these monuments reference local coordinate systems or the systems of another country. Sometimes the published coordinates for a monument are not accurate, although this is very infrequent.

CompassData visited multiple survey monuments during the course of this project. The results of those monument measurements are summarized in the Accuracy Report.

## Deliverables

Deliverables for this project include:

- ❑ Coordinates (in spreadsheet format)
- ❑ Image Chips
- ❑ Sketch Sheets
- ❑ Digital Pictures
- ❑ QA/QC Data

## Project Notes

# CompassData

All collected points were retrieved from the Trimble Survey Controller in Decimal Degrees, NAD83, HAE Meters.

CorpsCon was used to generate files in the following format:

Degrees Minutes Decimal Seconds, NAD83 HAE (QC purposes)  
UTM Meters, NAD83 HAE

Geoid09 was then used to generate the geoid separation at every Lat/Long location. NAVD88(09) orthometric heights were then generated in spreadsheet form using the formula  $HAE - \text{Geoid} = \text{Orthometric Height}$ . Those values were then included into the final delivery coordinate CSV files and have been tested against NGS monuments collected during the course of this survey and are showing millimeter-level agreement.

The Horizontal and Vertical accuracies reported in the Final Coordinates file were obtained from the Survey Report generated by Trimble Survey Controller. The report contains all points collected during each daily survey deployment, including CVAs, FVAs and Ground Control. Copies of these reports can be provided upon request once the CVA and FVA data has been redacted.

<b>Contact Information</b>
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Hayden Howard Phone: (303) 627-4058 E-mail: [haydenh@compassdatainc.com](mailto:haydenh@compassdatainc.com)

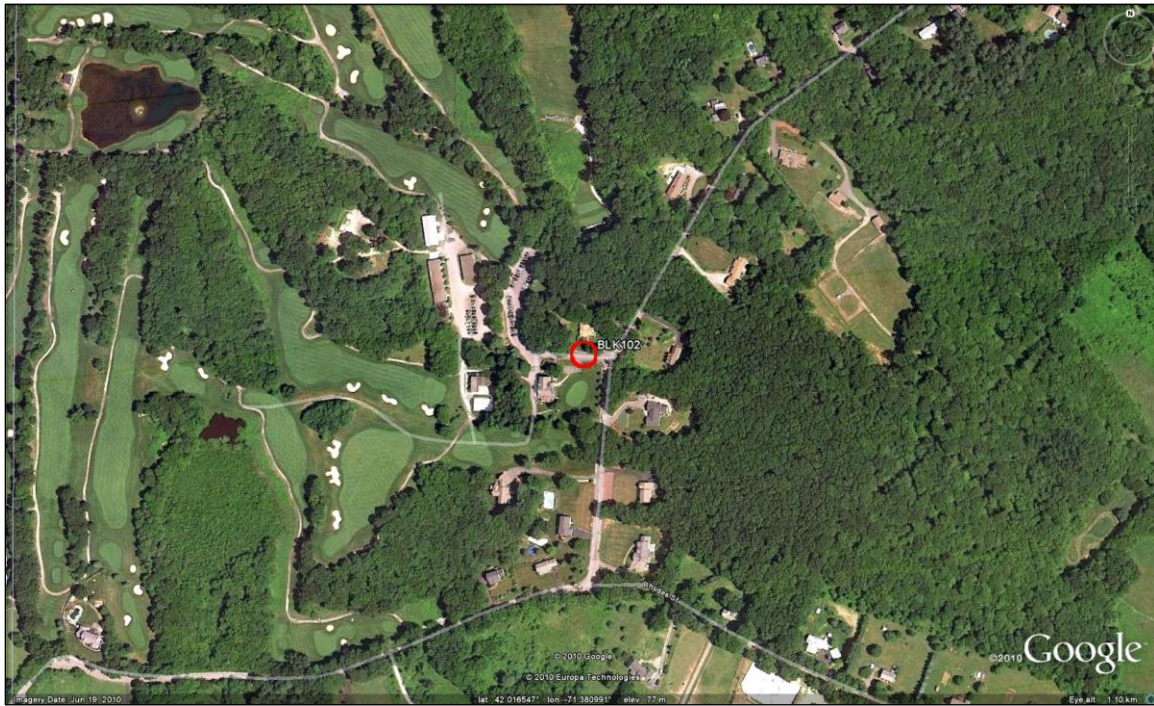
BLACKSTONE, MASSACHUSETTS										
GCP	Date	Vert_Prec	Horz_Prec	Latitude	Longitude	Northing	Easting	HAE	GEOID09_Separation	NAVD88
BLK101	10/17/2010	0.0067	0.0046	41.92523377	-71.37344624	4644199.418	303200.755	-3.1257303	-29.17	26.0443
BLK102	10/17/2010	0.0134	0.0098	42.01363186	-71.37439699	4654017.192	303394.093	67.175007	-28.989	96.164
BLK103	10/15/2010	0.0055	0.0043	42.05918959	-71.4656659	4659289.723	295982.179	36.3931932	-29.066	65.4592
BLK104	10/15/2010	0.0064	0.0046	42.09577451	-71.52455776	4663494.424	291228.967	47.9494036	-29.064	77.0134
BLK105	10/15/2010	0.007	0.0043	42.13141176	-71.57435533	4667574.602	287229.936	107.790603	-29.007	136.798
BLK106	10/15/2010	0.0073	0.0049	42.17235298	-71.60104541	4672187.736	285162.451	58.2409963	-28.917	87.158
BLK107	10/15/2010	0.0085	0.0055	42.21070313	-71.61517507	4676481.986	284125.943	152.680418	-28.807	181.487
BLK108	10/18/2010	0.011	0.0055	42.27614241	-71.71543681	4684007.612	276080.770	139.114962	-28.603	167.718
BLK109	10/18/2010	0.0113	0.0058	42.30664505	-71.75823193	4687508.325	272661.364	101.811025	-28.525	130.336
BLK110	10/18/2010	0.008	0.0055	42.33430324	-71.7288714	4690501.622	275180.053	124.180646	-28.442	152.623
BLK111	10/18/2010	0.0076	0.0058	42.32061048	-71.81057653	4689200.400	268397.949	193.719382	-28.483	222.202
BLK112	10/19/2010	0.0122	0.0085	42.32408713	-71.86037384	4689723.325	264307.129	248.750523	-28.438	277.189
BLK113	10/18/2010	0.0067	0.0052	42.30382329	-71.91364374	4687622.113	259840.267	320.980648	-28.425	349.406
BLK114	10/19/2010	0.0085	0.0058	42.19076294	-71.88074003	4674974.673	262127.838	186.771452	-28.802	215.573
BLK115	10/19/2010	0.0128	0.0085	42.16779891	-71.82963863	4672283.265	266263.162	160.279097	-28.914	189.193
BLK116	10/19/2010	0.0158	0.0082	42.05700397	-71.81126471	4659929.876	267375.890	218.048872	-29.223	247.272
BLK117	10/19/2010	0.0116	0.0064	42.05110857	-71.74846064	4659106.184	272552.118	153.518315	-29.273	182.791
BLK118	10/19/2010	0.0143	0.0082	42.02129759	-71.72624976	4655737.024	274284.768	125.18344	-29.346	154.529
Survey Control										
NGS_MY5929	10/19/2010	0.02	0.004	42.038041	-71.85943	4657956.388	263319.547	127.857761	-29.233	157.091
NGS_AJ4047	10/17/2010	0.031	0.008	42.039175	-71.305465	4656697.394	309178.594	32.5307598	-28.838	61.3688
NGS_AI9590	10/18/2010	0.032	0.021	42.608507	-71.493971	4720356.823	295429.204	58.0892056	-27.819	85.9082
NGS_AJ4046	10/15/2010	0.025	0.023	42.121683	-71.471289	4666242.523	295717.625	47.2203205	-28.923	76.1433
Metadata										
UTM 19 North, NAD83, NAVD88										
All units in meters where applicable.										
HAE - GEOID09 = NAVD88										

BLK101\_C

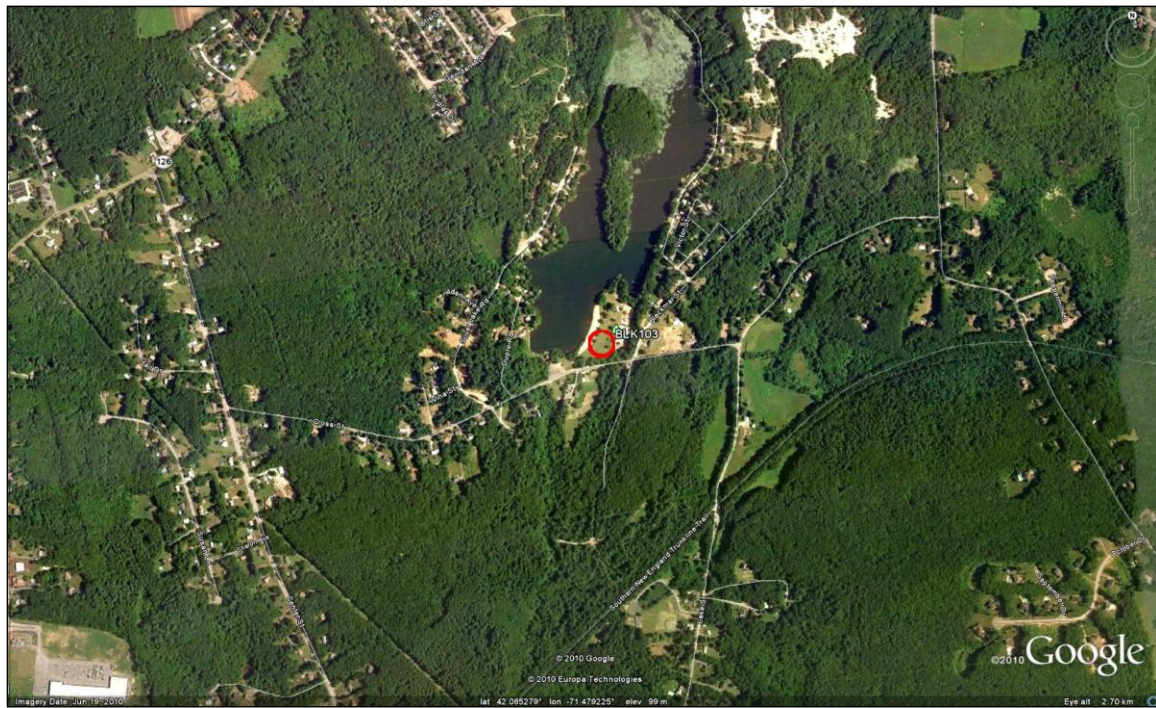




BLK102\_C



BLK103\_C

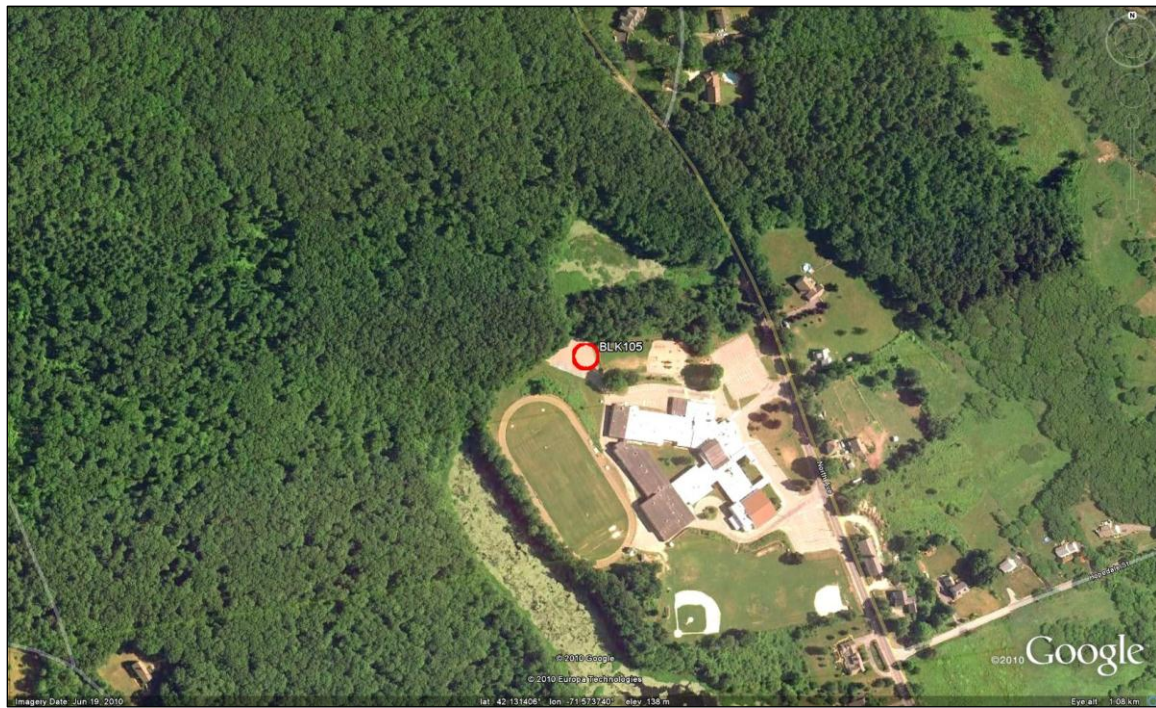




BLK104\_C

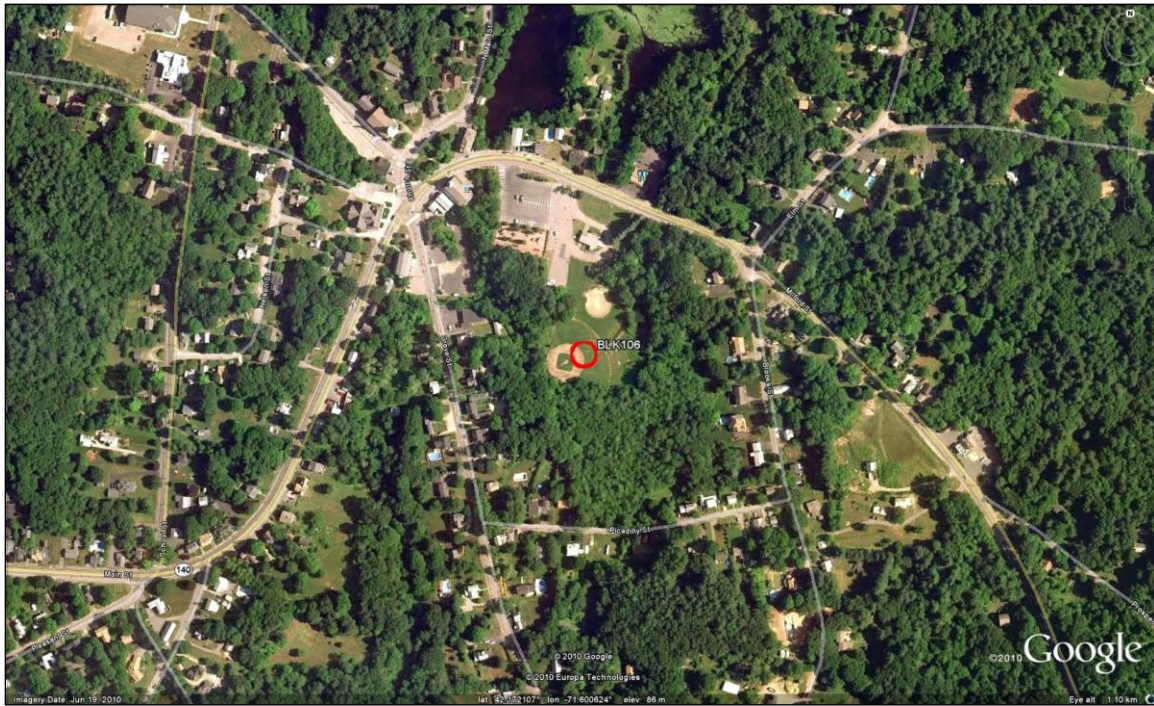


BLK105\_C

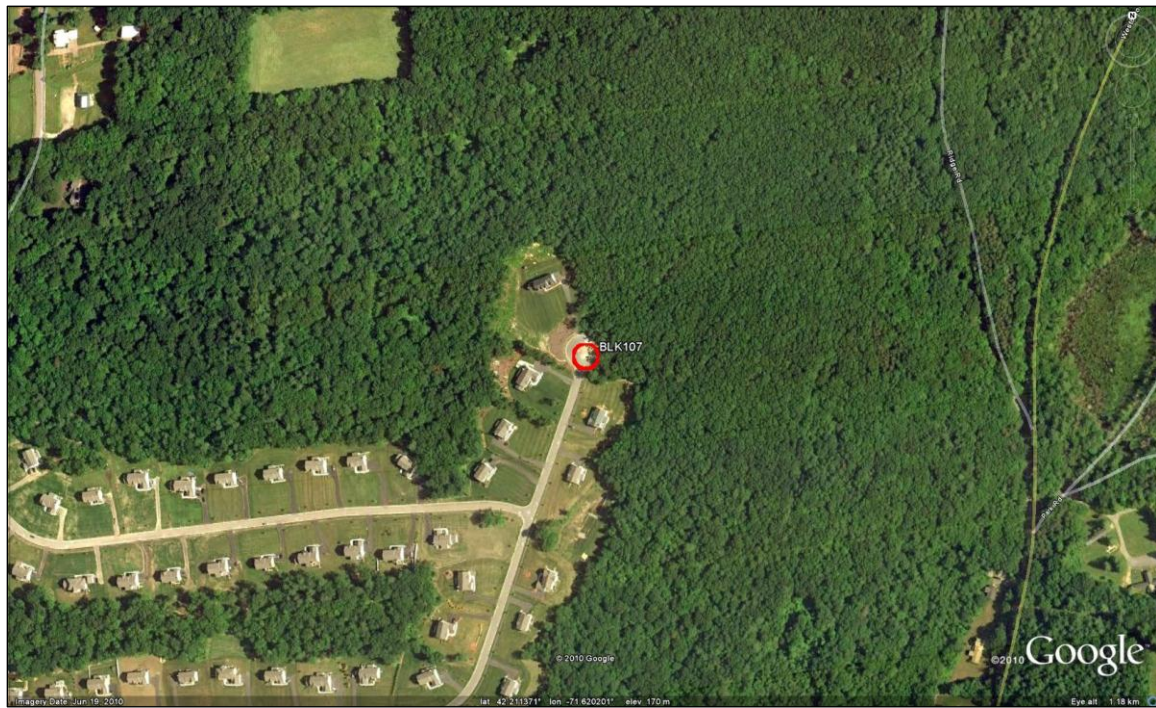




BLK106\_C



BLK107\_C

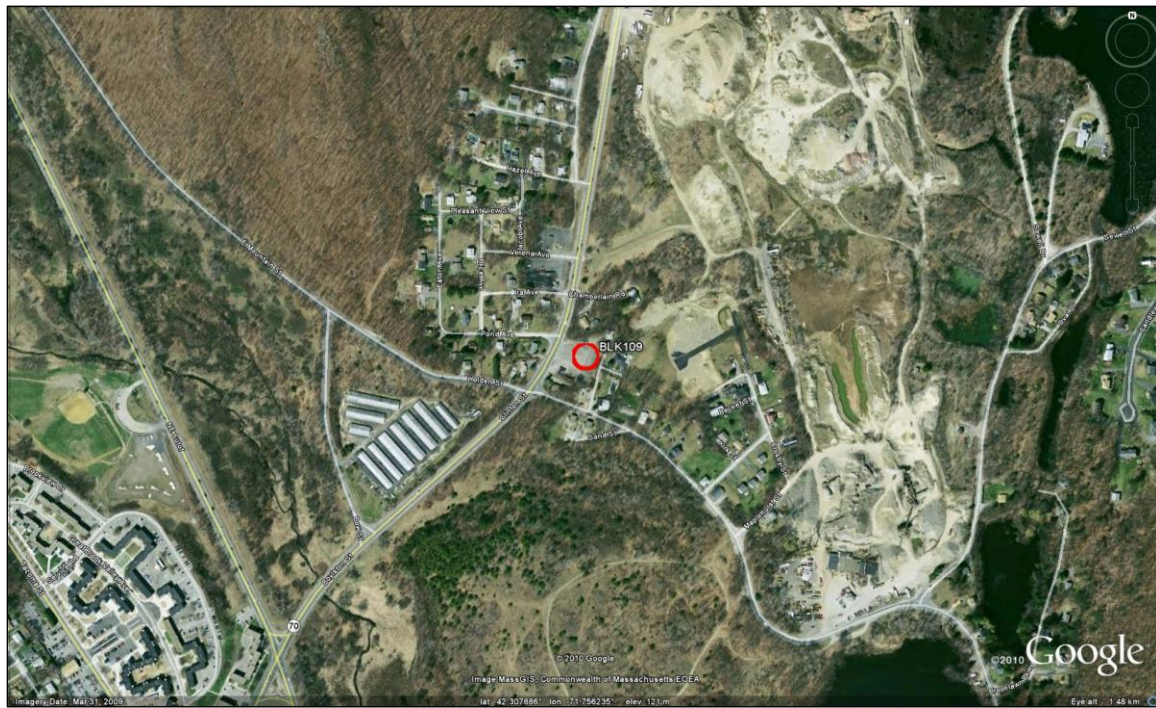




BLK108\_C

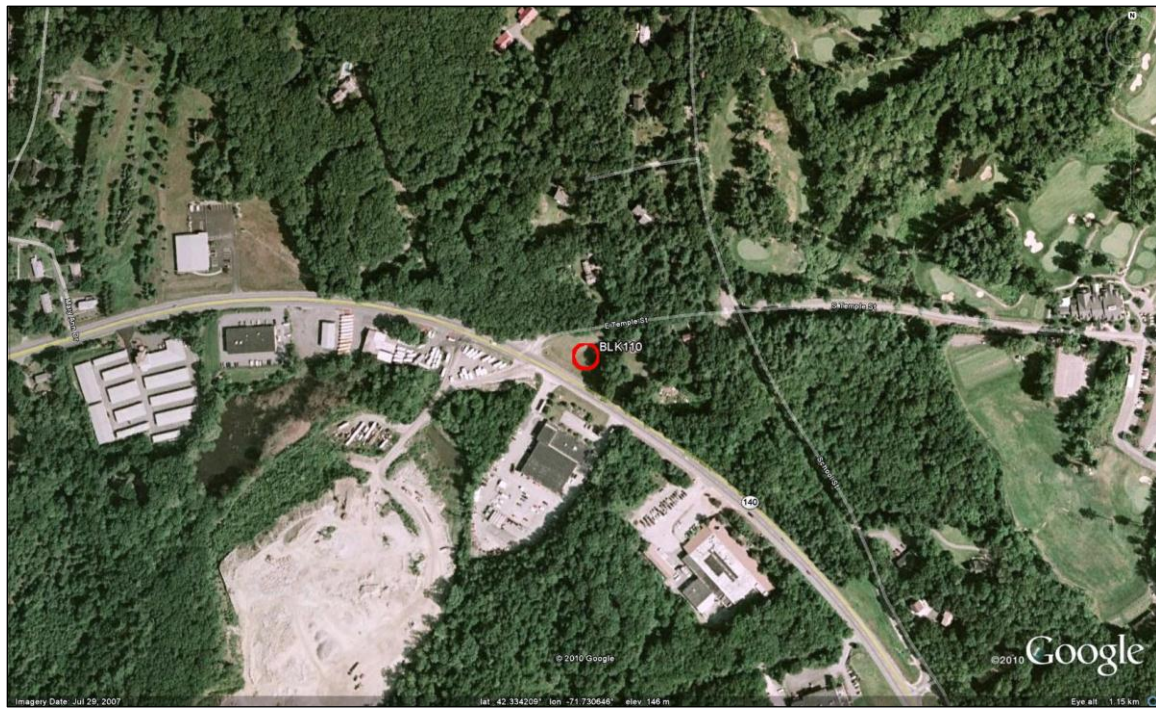


BLK109\_C





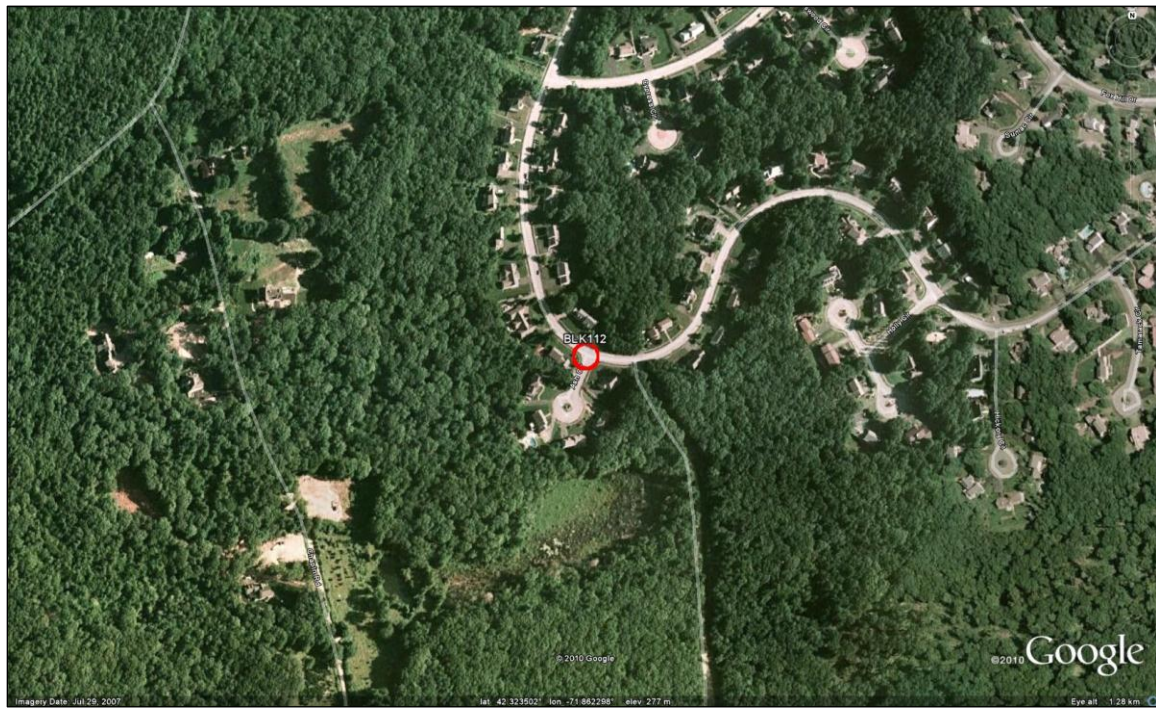
BLK110\_C



An aerial photograph from Google Earth showing a residential neighborhood nestled at the base of a steep, wooded hill. A red circle highlights a specific location labeled 'BLK111'. The neighborhood features several winding streets, including 'Meadow Ln', 'Cedar St', 'Maple St', and 'Oak St'. The houses are mostly small, single-story structures with dark roofs. The surrounding hillside is covered in dense, brownish vegetation, suggesting a wooded area. The image is a Google Earth screenshot, with a copyright notice for 2010 and a scale bar indicating 1.22 km. The text 'Image Map© 2010, Commonwealth of Massachusetts ECEA' is visible at the bottom. The Google logo is in the bottom right corner. The text '©2010 Google' is also present. The text 'lat: 42.3206101 lon: -71.8105771 elev: 222 m' is at the bottom. The text 'Imagery Date: Jul 29, 2007, Mar 31, 2009' is at the bottom left.



BLK112\_C

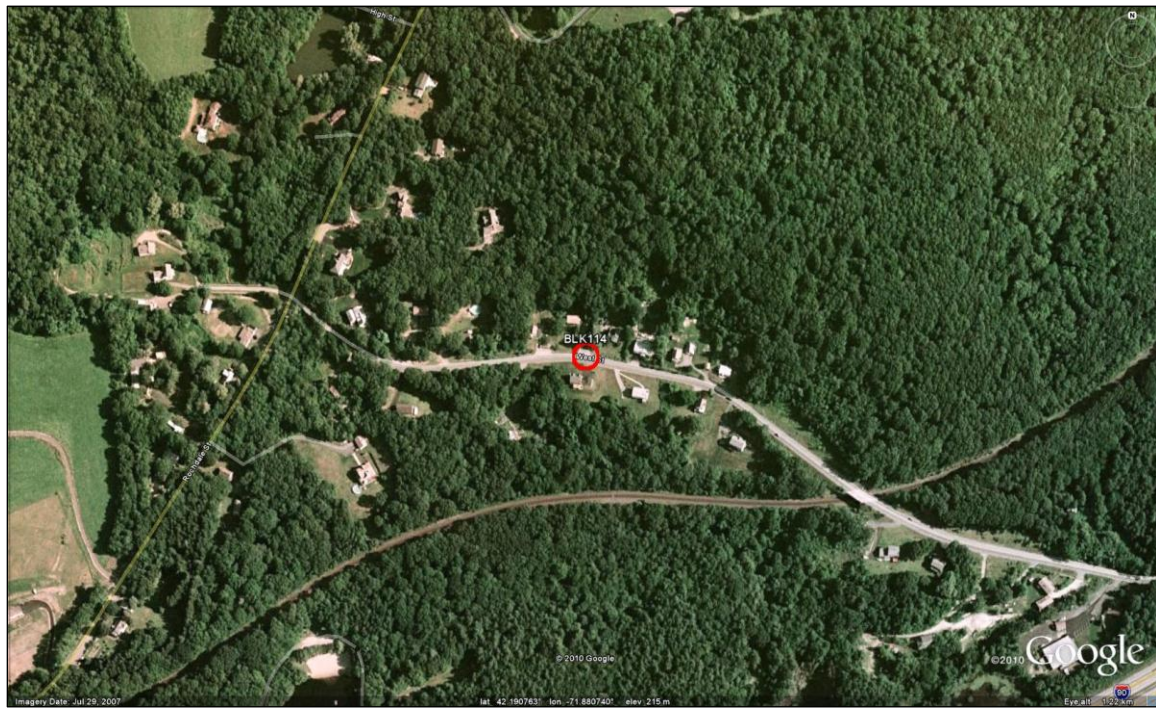


BLK113\_C

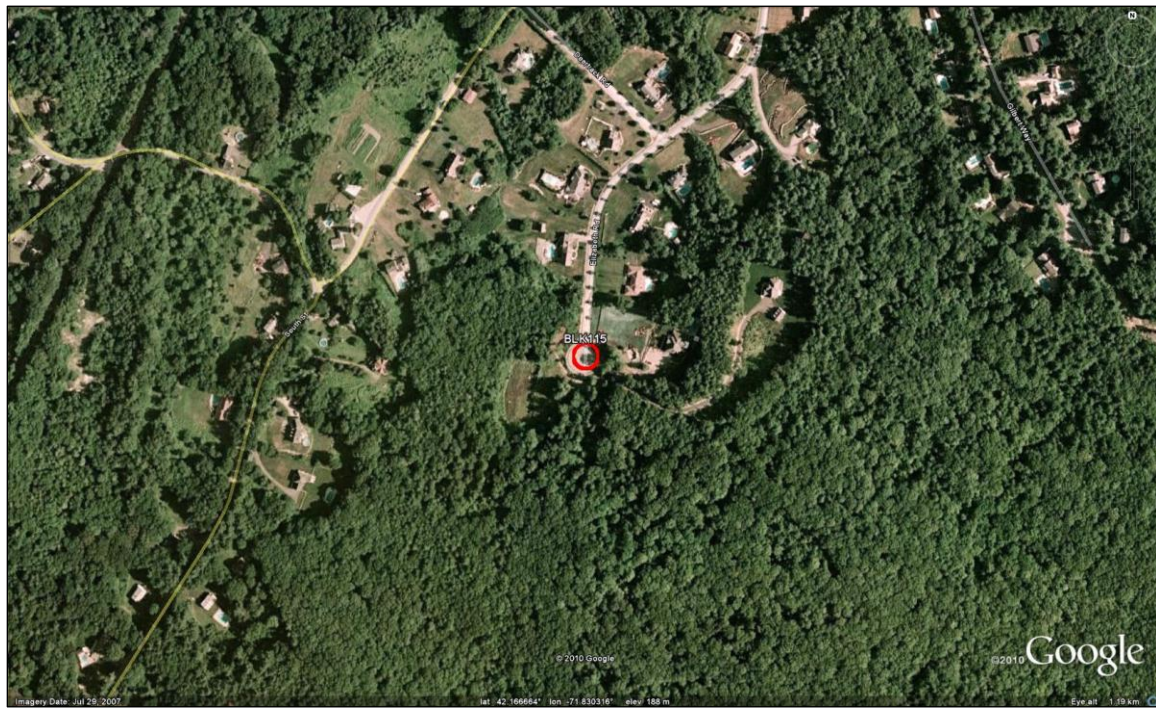




BLK114\_C

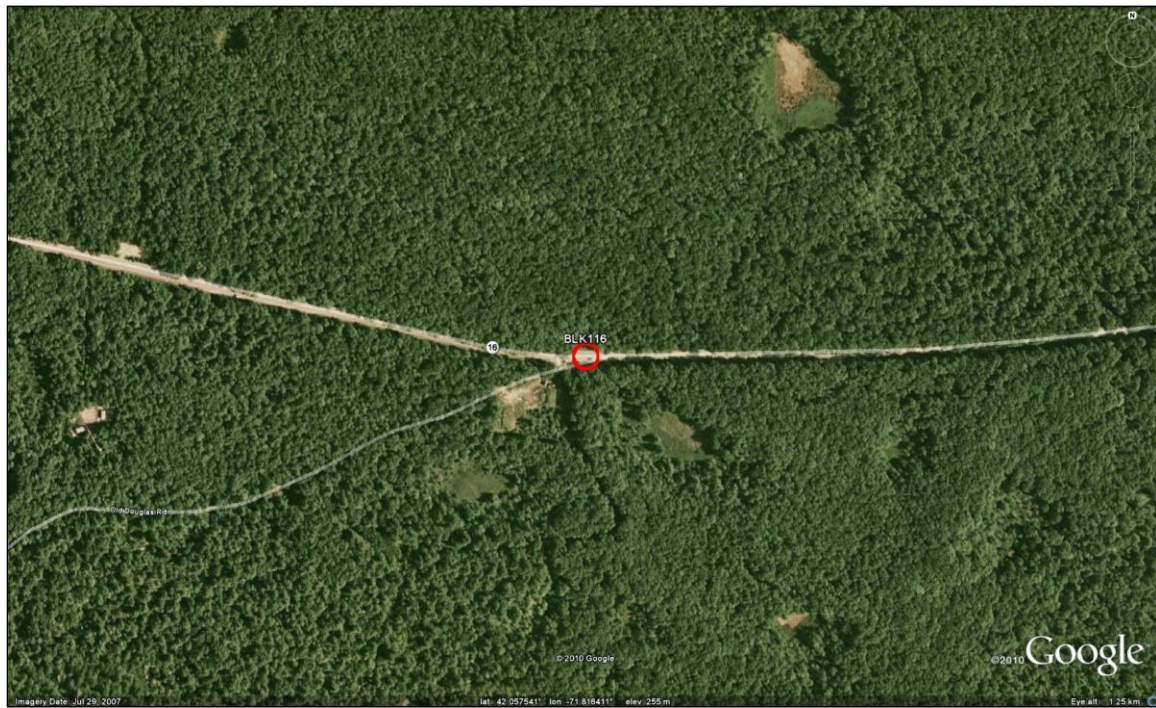


BLK115\_C

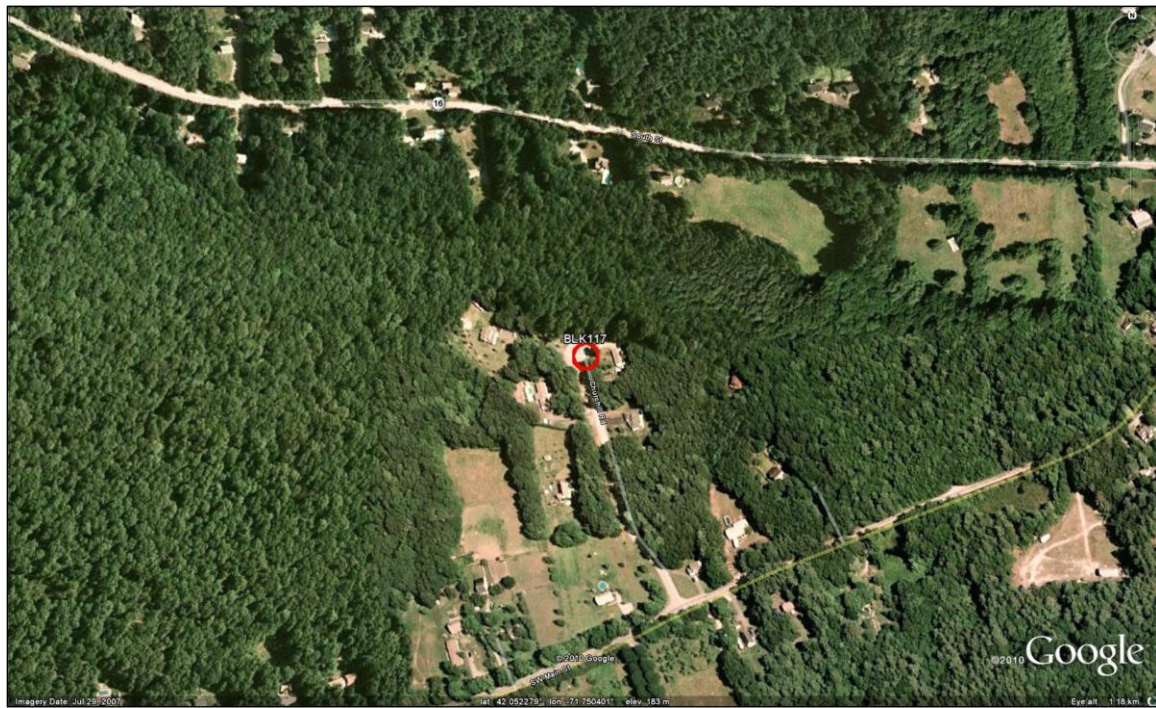




BLK116\_C

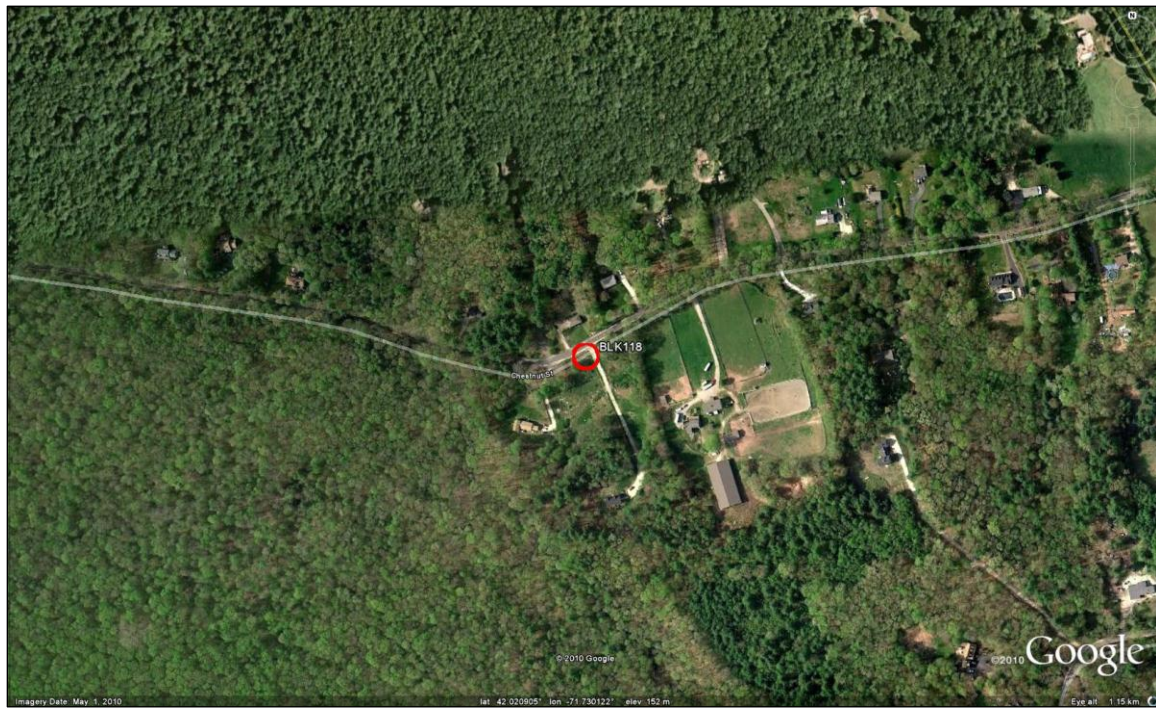


BLK117\_C





BLK118\_C



BLK101

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK101
CDI Project Number: 1508	Date: 10/17/2010



GPS Antenna Height: 2m

**Comments:**



Point taken near center of culdesac on Siesta Drive, Bristol County, Massachusetts

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK102

# CompassData

## GCP Station Diagram for LiDAR



Project Name: Blackstone	GCP Number: BLK102
CDI Project Number: 1508	Date: 10/17/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken near center of road near intersection of Bow St. Norfolk County, Massachusetts	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:



BLK103

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK103
CDI Project Number: 1508	Date: 10/15/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken in a field near SE corner of Silver Lake just North of Cross St. Norfolk County, Massachusetts	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK104

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK104
CDI Project Number: 1508	Date: 10/15/2010



GPS Antenna Height: 2m

**Comments:**

Point taken in center of road Just SE of intersection.  
Worcester County, Massachusetts

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK105

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK105
CDI Project Number: 1508	Date: 10/15/2010



GPS Antenna Height: 2m

### Comments:

Point taken in east central part of an asphalt area NW of Misco Hill Elementary School in Worcester County, Massachusetts

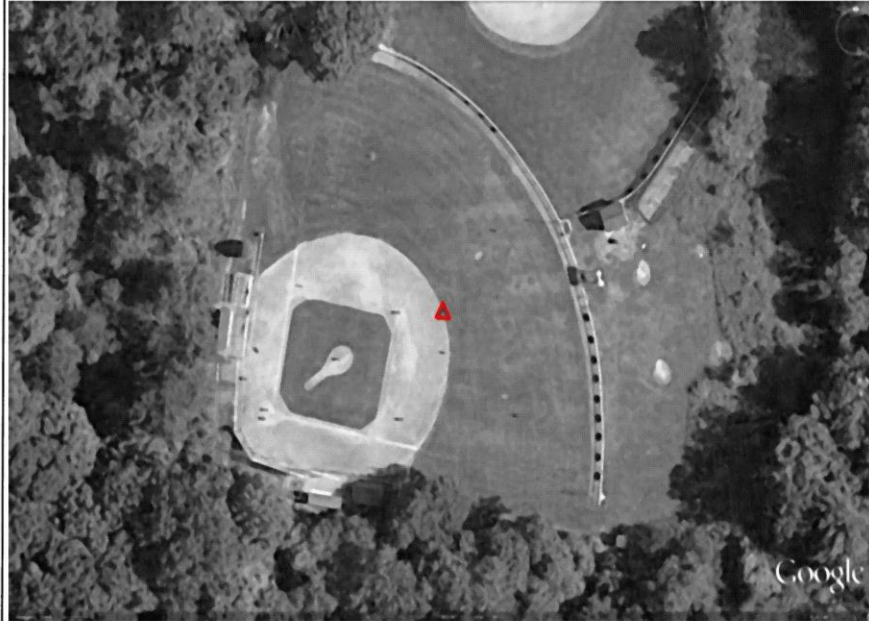
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK106

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK106
CDI Project Number: 1508	Date: 10/15/2010



GPS Antenna Height: 2m

**Comments:**

Point taken in baseball field just NE of home plate where the grass (outfield) meets the infield dirt line.  
Worcester County, Massachusetts

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:



BLK107

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK107
CDI Project Number: 1508	Date: 10/15/2010



GPS Antenna Height: 2m

### Comments:

Point taken in culdesac just SE of center.  
Worcester County, Massachusetts

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:



BLK108

# CompassData


## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK108
CDI Project Number: 1508	Date: 10/18/2010
	
GPS Antenna Height: 2m	
Comments:  Point taken in the Home Depot parking Lot just North of the store. Worcester County, Massachusetts	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK109

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK109
CDI Project Number: 1508	Date: 10/18/2010
	
GPS Antenna Height: 2m	
Comments:  Point taken in asphalt lot off of Clinton St. just south of storage shed. Worcester County, Massachusetts	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK110

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK110
CDI Project Number: 1508	Date: 10/18/2010



GPS Antenna Height: 2m

**Comments:**

Point taken in grass lot on the corner of Shrewbury St and E. Temple St.  
Worcester County, Massachusetts

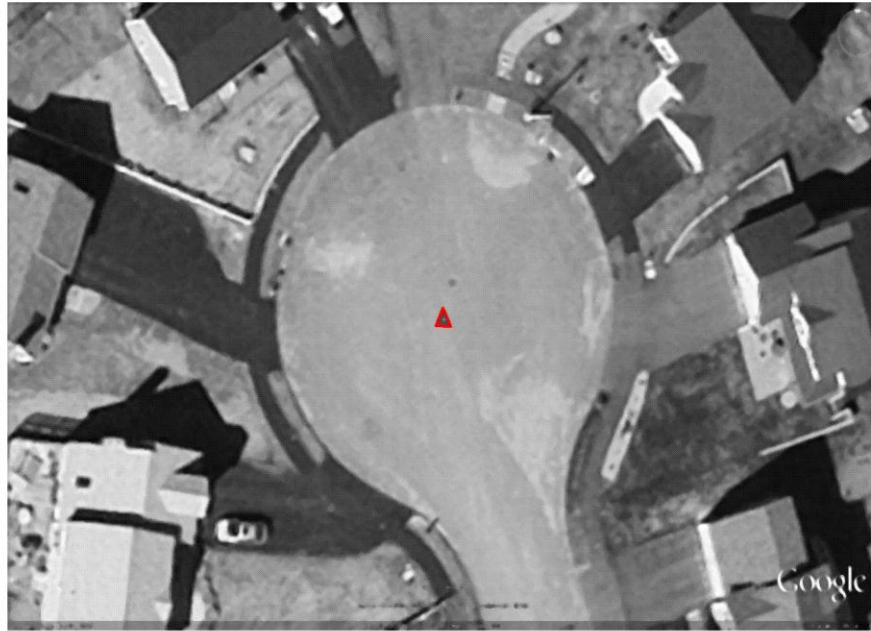
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK111

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK111
CDI Project Number: 1508	Date: 10/18/2010



GPS Antenna Height: 2m

**Comments:**

Point taken in center of culdesac of Ridgewood Rd.  
Worcester County, Massachusetts


Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:



BLK112

# CompassData


## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK112
CDI Project Number: 1508	Date: 10/19/2010
	
GPS Antenna Height: 2m	
Comments: Point taken at road intersection of Ash Cir and Sycamore Dr. Worcester County, Massachusetts	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK113

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK113
CDI Project Number: 1508	Date: 10/18/2010
	
GPS Antenna Height: 2m	
Comments: Point taken on culdesac of Eugenia Ln. Worcester County, Massachusetts	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK114

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK114
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken on West St. where a private driveway meets the road. Worcester County, Massachusetts	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK115

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK115
CDI Project Number: 1508	Date: 10/19/2010



GPS Antenna Height: 2m

**Comments:**

Point taken on culdesac on Elizabeth St.  
Worcester County, Massachusetts

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:



BLK116

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK116
CDI Project Number: 1508	Date: 10/19/2010



GPS Antenna Height: 2m

**Comments:**

Point taken on center of Webster St.  
Worcester County, Massachusetts

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Nate Yannacone	Checked By:

BLK117

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK117
CDI Project Number: 1508	Date: 10/19/2010



GPS Antenna Height: 2m

**Comments:**

Point taken on culdesac of Churchill Rd.  
Worcester County, Massachusetts

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Nate Yannacone	Checked By:

BLK118

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: BLK118
CDI Project Number: 1508	Date: 10/19/2010



GPS Antenna Height: 2m

**Comments:**

Point taken on NE corner of a lot between a private drive and Chestnut St.  
Worcester County, Massachusetts

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Nate Yannacone	Checked By:

BLK101\_E





BLK101\_N



BLK101\_S



BLK101\_W





BLK102\_E



BLK102\_N



BLK102\_S



BLK102\_W





BLK103\_E



BLK103\_N





BLK103\_S



BLK103\_W



BLK104\_E



BLK104\_N



BLK104\_S





BLK104\_W





BLK105\_E



BLK105\_N



BLK105\_S



BLK105\_W



BLK106\_E



BLK106\_N





BLK106\_S



BLK106\_W



BLK107\_E



BLK107\_N



BLK107\_S





BLK107\_W





BLK108\_E



BLK108\_N



BLK108\_S



BLK108\_W



BLK109\_E



BLK109\_N





BLK109\_S



BLK109\_W



BLK110\_E



BLK110\_N



BLK110\_S





BLK110\_W





BLK111\_E



BLK111\_N



BLK111\_S



BLK111\_W



BLK112\_E



BLK112\_N





BLK112\_S



BLK112\_W



BLK113\_E



BLK113\_N



BLK113\_S





BLK113\_W





BLK114\_E



BLK114\_N



BLK114\_S



BLK114\_W



BLK115\_E





BLK115\_N





BLK115\_S



BLK115\_W



BLK116\_E



BLK116\_N





BLK116\_S



BLK116\_W





BLK117\_E



BLK117\_N



BLK117\_S



BLK117\_W





BLK118\_E



BLK118\_N





BLK118\_S



BLK118\_W



## Accuracy Report

$$\Delta H = 0.008\text{m}$$

$$\Delta V = 0.031\text{m}$$



42°02'21.04"N

42°02'21.03"N

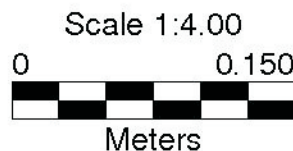
42°02'21.02"N

71°18'19.68"W

71°18'19.67"W

NGS\_AJ4047 10\_17\_2010

Lat/Long  
WGS 1984



10/28/2010

GPS Pathfinder<sup>®</sup> Office  
 Trimble<sup>™</sup>

## Accuracy Report

$\Delta H = 0.021\text{m}$

$\Delta V = 0.032\text{m}$

42°36'30.63"N

42°36'30.62"N

71°29'38.29"E

71°29'38.30"E



NGS\_AI9590 10\_18\_2010

Lat/Long  
WGS 1984



Scale 1:4.00



Meters

10/28/2010

GPS Pathfinder<sup>®</sup> Office



## Accuracy Report

$$\Delta H = 0.004\text{m}$$

$$\Delta V = 0.020\text{m}$$

42°02'16.95"N

42°02'16.94"N

71°51'33.96"W

71°51'33.95"W

71°51'33.94"W



NGS\_MY5929 10\_19\_2010

Lat/Long  
WGS 1984



Scale 1:4.00



Meters

10/28/2010

GPS Pathfinder<sup>®</sup> Office



42°07'18.07"N

## Accuracy Report

$$\Delta H = 0.023\text{m}$$

$$\Delta V = 0.025\text{m}$$

42°07'18.06"N



42°07'18.05"N

71°28'16.63"E

71°28'16.64"E

71°28'16.65"E

NGS\_AJ4046 10\_15\_2010

Lat/Long  
WGS 1984



Scale 1:4.00



Meters

10/28/2010

GPS Pathfinder<sup>®</sup> Office







**FEMA Region 1 – MA, NH, CT**  
**FVA and CVA Project Report for FEMA**  
**Inc. Narragansett, Charles, Concord, lac stone, Nashua**  
**& Quinnipiac**

<b>Project Information</b>
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<b>CDI Project Number:</b>	<b>FSG1508</b>
<b>Geographic Location:</b>	<b>New England; MA, NH, CT</b>
<b>Number of FVA/CVAs Requested:</b>	<b>210</b>
<b>Number of GCPs Collected:</b>	<b>210</b>

<b>Project Specifications</b>
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<b>Precision (Horizontal/Vertical):</b>	<b>CDI Precision-1 <math>\leq 8\text{cm}</math> H/V</b>
<b>Coordinate System:</b>	<b>UTM</b>
<b>Datum:</b>	<b>NAD83</b>
<b>Zone:</b>	<b>18 &amp; 19</b>
<b>Altitude Reference:</b>	<b>HAE (WGS84) and NAVD88 (09)</b>
<b>Units:</b>	<b>Meters</b>

<b>RTK GPS</b>
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All FVA and CVA Quality Assurance Points for this project were collected within the boundaries of the Keystone Precision Instruments New England Virtual Reference Station System, which provides continuous real-time broadcast correction signals within a network of 170 base stations encompassing New England and the northern Mid-Atlantic region.

All QA Points were observed for 180 epochs to determine a coordinate location  $\leq 8\text{cm}$  in both Horizontal and Vertical to support subsequent LiDAR post-processing and bare earth deliverables generation.

All data collected were well within the confines of the Keystone VRS system with multiple base locations providing position and correction data for each point collected.

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# CompassData

## Summary

The purpose of this project was to locate and survey photo-identifiable QA test points (FVA/CVAs) in multiple areas of interest as defined by FEMA-supplied shape and kml files. The QA coordinates are to be used to test the vertical aspect of all newly-flown LiDAR data during post-processing and subsequent deliverables creation. CompassData visited the project area, found suitable FVA and CVA locations, and determined accurate coordinates for each point according to the customer's specifications.

## Equipment

CompassData used a Trimble R8 to perform the Control survey. This device is accurate to within 1 cm on a position-by-position basis per Trimble specifications. Operating within the VRS network provided accurate coordinate values at or around 5 cm H/V within 3-5 minutes observation times. CompassData has consistently demonstrated this level of accuracy on many GCP collection jobs across North and South America and Africa. Specifications for the Trimble R8 are available upon request.

## Survey Methodology

CompassData has met the required precision for this project by using a high-quality GPS receiver with differential corrections provided by a VRS network surrounding the project area. The GPS antenna sat atop a bubble-leveled, fixed-height range pole that was placed over the center of the desired QA point. At least 180 positions (captured at a rate of one per second) were geometrically averaged to calculate a single coordinate for each FVA/CVA point. All required field documentation was filled out and the points were identified on web-based imagery and diagrammed on the CompassData-supplied sketch sheets (FVA points only). Digital pictures of each GCP location were collected in the field.

## Quality Control Procedures

CompassData collects QA points with an unobstructed view of the sky to ensure proper GPS operation. CompassData works to avoid potential sources of multipath error such as trees, buildings, and fences that may adversely affect the GPS accuracy.

# CompassData

Additional quality control comes from the fact that at least 180 GPS positions are collected for each point. While operating within a VRS, valid solutions are reached within seconds; however, we continue to collect additional data to ensure meeting collection specifications. To ensure project integrity, an FVA or CVA will be reobserved or moved to a more suitable location if it does not meet project specifications.

In addition to the aforementioned procedures, CompassData “surveys” existing geodetic control monuments to see if our coordinates match the published coordinates to the required accuracy. These monuments are usually established by the National Geodetic Survey (NGS) in the United States. If it is found that our coordinates are outside the acceptable accuracy, the reason for the difference will be found or the GCPs will be reobserved under different GPS constellation constraints. There are certain geodetic considerations that must be taken into account that affect whether a GPS-derived coordinate will line up with a survey monument, especially when these monuments reference local coordinate systems or the systems of another country. Sometimes the published coordinates for a monument are not accurate, although this is very infrequent.

CompassData visited multiple survey monuments during the course of this project. The results of those monument measurements are summarized in the Accuracy Report.

## Deliverables

Deliverables for this project include:

- ❑ Coordinates (in spreadsheet format)
- ❑ Image Chips
- ❑ Sketch Sheets (FVA points only)
- ❑ Digital Pictures
- ❑ QA/QC Data

## Project Notes

# CompassData

All collected points were retrieved from the Trimble Survey Controller in Decimal Degrees, NAD83, HAE Meters.

CorpsCon was used to generate files in the following format:

Degrees Minutes Decimal Seconds, NAD83 HAE (QC purposes)

UTM Meters, NAD83 HAE

Geoid09 was then used to generate the geoid separation at every Lat/Long location. NAVD88(09) orthometric heights were then generated in spreadsheet form using the formula  $HAE - \text{Geoid} = \text{Orthometric Height}$ . Those values were then included into the final delivery coordinate CSV files and have been tested against NGS monuments collected during the course of this survey and are showing millimeter-level agreement.

The Horizontal and Vertical accuracies reported in the Final Coordinates file were obtained from the Survey Report generated by Trimble Survey Controller. The report contains all points collected during each daily survey deployment, including CVAs, FVAs and NGS Monuments.

<b>Contact Information</b>
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Hayden Howard Phone: (303) 627-4058 E-mail: [haydenh@compassdatainc.com](mailto:haydenh@compassdatainc.com)

December 29, 2010

<b>BLACKSTONE, MASSACHUSETTS</b>										
<b>CVAs/FVAs</b>	<b>Date</b>	<b>Vert_Prec</b>	<b>Horz_Prec</b>	<b>Latitude</b>	<b>Longitude</b>	<b>Easting</b>	<b>Northing</b>	<b>HAE</b>	<b>GEOID09</b>	<b>NAVD88</b>
BLK301	10/19/2010	0.0128	0.0064	42.20306625	-71.87517710	4676325.404	262633.315	187.294	-28.771	216.0645757
BLK302	10/19/2010	0.011	0.007	42.20479888	-71.84337572	4676429.711	265265.384	148.124	-28.794	176.917649
BLK303	10/19/2010	0.0119	0.007	42.20441251	-71.82296328	4676330.778	266949.246	146.695	-28.808	175.5030485
BLK304	10/19/2010	0.0082	0.0055	42.18727869	-71.88890745	4674610.586	261440.257	192.537	-28.802	221.3390606
BLK305	10/19/2010	0.0073	0.0058	42.1878624	-71.85529802	4674581.889	264218.053	162.597	-28.836	191.433106
BLK306	10/19/2010	0.0076	0.0055	42.19352499	-71.82425333	4675125.291	266802.673	135.703	-28.842	164.5453288
BLK307	10/19/2010	0.0085	0.0055	42.17699676	-71.87375426	4673426.518	262653.193	164.798	-28.85	193.6483761
BLK308	10/19/2010	0.0076	0.0052	42.18199189	-71.83214289	4673866.202	266108.635	140.354	-28.871	169.2249765
BLK309	10/19/2010	0.0119	0.0058	42.16823889	-71.84829065	4672383.417	264723.953	155.076	-28.898	183.9741509
BLK310	10/19/2010	0.0101	0.0073	42.16040238	-71.81892683	4671432.607	267120.915	178.200	-28.941	207.1411542
BLK311	10/19/2010	0.0165	0.0101	42.05665329	-71.81212001	4659893.263	267303.829	222.468	-29.224	251.6915664
BLK312	10/19/2010	0.0104	0.007	42.05646465	-71.78993832	4659812.155	269138.779	184.408	-29.238	213.6457235
BLK313	10/19/2010	0.011	0.0076	42.06060088	-71.73385627	4660121.479	273794.509	123.324	-29.257	152.5808519
BLK314	10/19/2010	0.011	0.007	42.04181241	-71.77653397	4658148.997	270195.201	177.033	-29.28	206.3133775
BLK315	10/19/2010	0.0116	0.0067	42.04610375	-71.76185887	4658586.174	271425.306	181.580	-29.277	210.8567834
BLK316	10/19/2010	0.0125	0.0061	42.05560954	-71.71630399	4659520.912	275229.324	140.046	-29.271	169.3165183
BLK317	10/19/2010	0.0125	0.0079	42.03559215	-71.76360768	4657423.611	271242.829	164.648	-29.301	193.9494142
BLK318	10/19/2010	0.0107	0.007	42.02956163	-71.73245470	4656671.08	273800.32	130.992	-29.327	160.3193305
BLK319	10/19/2010	0.0189	0.0101	42.01380027	-71.75792980	4654988.602	271634.816	193.996	-29.356	223.3518364
BLK320	10/19/2010	0.011	0.0061	42.01356771	-71.71537884	4654850.045	275157.63	107.480	-29.366	136.8457065
BLK401	11/18/2010	0.004	0.0024	42.05738368	-71.79824227	4659936.674	268454.961	208.421	-28.002	236.423
BLK402	11/18/2010	0.0021	0.0015	42.06507707	-71.72150046	4660585.896	274832.793	126.855	-28.024	154.879
BLK403	11/18/2010	0.003	0.0018	42.04706675	-71.73925244	4658632.905	273299.845	147.465	-28.056	175.521
BLK404	11/18/2010	0.0027	0.0018	42.0217138	-71.75582317	4655861.719	271837.606	199.486	-28.108	227.594
BLK405	11/18/2010	0.0024	0.0018	42.02530329	-71.71175397	4656143.669	275499.147	113.771	-28.108	141.879
BLK701	12/5/2010			42.1987558	-71.85540694	4675791.862	264249.616	182.961	-28.803	211.764
BLK701_BK	12/5/2010	0.0027	0.003	42.19853842	-71.85525590	4675767.305	264261.278	155.321	-27.58	182.901
BLK701_TP	12/5/2010	0.004	0.0018	42.19860196	-71.85554629	4675775.164	264237.537	154.623	-27.58	182.203
BLK702	12/5/2010			42.19708837	-71.84529201	4675578.769	265078.619	170.042	-28.816	198.858
BLK702_BK	12/5/2010	0.0027	0.0021	42.19765942	-71.84633094	4675645.046	264994.951	146.488	-27.59	174.078
BLK702_TP	12/5/2010	0.0024	0.0021	42.19719018	-71.84557813	4675590.863	265055.371	141.762	-27.592	169.354
BLK703	12/5/2010			42.18534196	-71.82265240	4674212.22	266904.815	158.431	-28.868	187.299
BLK703_BK	12/5/2010	0.0034	0.0021	42.18578702	-71.82307059	4674262.786	266871.915	128.995	-27.642	156.637
BLK703_TP	12/5/2010	0.0034	0.0021	42.18546258	-71.82254004	4674225.307	266914.538	129.728	-27.644	157.372

BLK704	12/5/2010			42.19158801	-71.88444011	4675076.628	261825.42	225.52	-28.795	254.315
BLK704_BK	12/5/2010	0.003	0.0021	42.19116013	-71.88439552	4675028.989	261827.494	196.681	-27.572	224.253
BLK704_TP	12/5/2010	0.0034	0.0021	42.19138045	-71.88425230	4675053.055	261840.149	197.695	-27.572	225.267
BLK705	12/5/2010			42.1894881	-71.85016339	4674748.227	264648.16	179.001	-28.836	207.837
BLK705_BK	12/5/2010	0.0034	0.0024	42.18915529	-71.85030744	4674711.667	264635.029	149.187	-27.612	176.799
BLK705_TP	12/5/2010	0.0037	0.0024	42.18932826	-71.85015822	4674730.463	264647.994	149.534	-27.612	177.146
BLK706	12/5/2010			42.18310646	-71.83170145	4673988.761	266149.237	172.499	-28.868	201.367
BLK706_BK	12/5/2010	0.004	0.0027	42.18346946	-71.83151757	4674028.566	266165.762	144.937	-27.643	172.58
BLK706_TP	12/5/2010	0.0046	0.0024	42.18327503	-71.83174264	4674007.592	266146.457	144.704	-27.643	172.347
BLK707	12/5/2010			42.18335537	-71.870425	4674123.354	262951.991	193.972	-28.836	222.808
BLK707_BK	12/5/2010	0.0034	0.0018	42.18290098	-71.86979193	4674071.136	263002.578	164.896	-27.614	192.51
BLK707_TP	12/5/2010	0.0034	0.0018	42.18314003	-71.87015866	4674098.701	262973.183	164.780	-27.612	192.392
BLK708	12/5/2010			42.17475077	-71.85996978	4673138.827	263783.434	236.078	-28.87	264.948
BLK708_BK	12/5/2010	0.0034	0.0018	42.17439928	-71.85984377	4673099.446	263792.533	208.491	-27.647	236.138
BLK708_TP	12/5/2010	0.0034	0.0018	42.17462269	-71.85994136	4673124.525	263785.304	207.560	-27.647	235.207
BLK709	12/5/2010			42.16814481	-71.83011139	4672322.972	266225.415	183.703	-28.913	212.616
BLK709_10_BK	12/5/2010	0.0027	0.0024	42.16780878	-71.82953459	4672284.076	266271.826	160.381	-27.689	188.07
BLK709_10_TP	12/5/2010	0.0037	0.0018	42.16780322	-71.82982521	4672284.255	266247.797	160.363	-27.689	188.052
BLK710	12/5/2010			42.16754536	-71.82985479	4672255.701	266244.404	187.821	-28.915	216.736
BLK711	12/5/2010			42.05742577	-71.7985706	4659942.238	268427.943	237.035	-29.23	266.265
BLK711_BK	12/5/2010	0.003	0.0021	42.05736002	-71.79810300	4659933.669	268466.4	207.998	-28.003	236.001
BLK712_BK	12/5/2010	0.0034	0.0024	42.06138865	-71.75436940	4660263.459	272099.918	171.160	-28.018	199.178
BLK712_TP	12/5/2010	0.003	0.0018	42.06137796	-71.75458286	4660262.841	272082.216	172.187	-28.018	200.205
BLK713	12/5/2010			42.05775217	-71.71420261	4659753.312	275410.805	163.429	-29.267	192.696
BLK713_BK	12/5/2010	0.0021	0.0018	42.05782629	-71.71464111	4659762.695	275374.78	139.295	-28.038	167.333
BLK713_TP	12/5/2010	0.0021	0.0018	42.05762983	-71.71465000	4659740.903	275373.351	139.475	-28.038	167.513
BLK714	12/5/2010			42.04590043	-71.76156086	4658562.8	271449.271	210.474	-29.278	239.752
BLK714_BK	12/5/2010	0.003	0.0018	42.04622034	-71.76188199	4658599.183	271423.839	181.482	-28.048	209.53
BLK714_TP	12/5/2010	0.003	0.0021	42.04596943	-71.76179963	4658571.1	271429.756	181.572	-28.049	209.621
BLK715	12/5/2010			42.04652161	-71.73945424	4658572.905	273281.203	186.559	-29.287	215.846
BLK715_TP	12/5/2010	0.0043	0.0027	42.04663737	-71.73941293	4658585.651	273285.034	156.787	-28.057	184.844
BLK716	12/5/2010			42.04062541	-71.71632532	4657857.088	275174.713	178.936	-29.303	208.239
BLK716_BK	12/5/2010	0.0021	0.0015	42.04091227	-71.71645599	4657889.286	275164.909	149.281	-28.074	177.355
BLK716_TP	12/5/2010	0.0021	0.0015	42.04076482	-71.71637366	4657872.696	275171.203	149.408	-28.074	177.482
BLK717	12/5/2010			42.02185361	-71.75117674	4655864.858	272222.828	212.637	-29.339	241.976
BLK717_BK	12/5/2010	0.003	0.0021	42.02185136	-71.75159483	4655865.722	272188.202	185.421	-28.109	213.53
BLK717_TP	12/5/2010	0.0061	0.0046	42.02199171	-71.75135096	4655880.657	272208.896	183.596	-28.109	211.705



BLK718	12/5/2010			42.03193265	-71.72761101	4656921.563	274209.75	156.278	-29.323	185.601
BLK718_BK	12/5/2010	0.0024	0.0018	42.03165552	-71.72774434	4656891.141	274197.73	128.698	-28.094	156.792
BLK718_TP	12/5/2010	0.003	0.0021	42.03182652	-71.72775963	4656910.17	274197.07	128.368	-28.094	156.462
BLK719	12/5/2010			42.01390779	-71.7581024	4655001.002	271620.936	222.914	-29.355	252.269
BLK719_BK	12/5/2010	0.0034	0.0021	42.0137241	-71.75782897	4654979.874	271642.921	193.970	-28.126	222.096
BLK719_TP	12/5/2010	0.0034	0.0021	42.01383049	-71.75797577	4654992.08	271631.145	194.002	-28.126	222.128
BLK720	12/5/2010			42.01378313	-71.71494312	4654872.821	275194.497	136.579	-29.365	165.944
BLK720_BK	12/5/2010	0.0024	0.0018	42.01353964	-71.71540988	4654847.01	275154.987	107.447	-28.136	135.583
BLK720_TP	12/5/2010	0.003	0.0021	42.01365379	-71.71517265	4654859.062	275175.034	107.390	-28.135	135.525
BLK801	12/5/2010	0.0027	0.0021	42.20277716	-71.84931221	4676221.578	264767.784	144.867	-27.571	172.438
BLK802	12/5/2010	0.0037	0.0024	42.20182387	-71.83799278	4676084.534	265698.839	128.265	-27.583	155.848
BLK803	12/5/2010	0.0037	0.0024	42.19178234	-71.84440297	4674987.104	265132.366	135.427	-27.609	163.036
BLK804	12/5/2010	0.003	0.0018	42.1902063	-71.82696887	4674764.197	266566.244	130.603	-27.626	158.229
BLK805	12/5/2010	0.0034	0.0018	42.18428881	-71.85739416	4674190.856	264031.679	162.730	-27.621	190.351
NBL316	10/19/2010	0.0104	0.0067	42.26712825	-71.90778792	4683530.678	260183.714	297.729	-28.534	326.2632385
NBL317	10/19/2010	0.0165	0.0073	42.32661719	-71.85963769	4690002.242	264377.243	238.680	-28.433	267.112911
NBL318	10/18/2010	0.0076	0.0058	42.31682153	-71.81646249	4688795.695	267898.95	185.694	-28.489	214.1832869
NBL319	10/18/2010	0.0094	0.0064	42.31943259	-71.74675065	4688897.718	273653.605	104.149	-28.489	132.638455
NBL320	10/18/2010	0.0104	0.007	42.26985269	-71.72359553	4683330.661	275385.59	139.123	-28.625	167.7475821
NBL710	12/6/2010			42.32676752	-71.75130286	4689724.37	273304.835	141.6	-28.473	170.073
NBL710_BK	12/6/2010	0.0034	0.0021	42.32684006	-71.75224272	4689734.932	273227.65	115.125	-27.253	142.378
NBL710_TP	12/6/2010	0.0024	0.0015	42.32680532	-71.75167989	4689729.573	273273.903	113.970	-27.253	141.223
NBL804	12/6/2010	0.0027	0.0018	42.32236246	-71.79882669	4689363.014	269372.688	154.278	-27.264	181.542
NBL805	12/6/2010	0.0021	0.0018	42.28011532	-71.72531390	4684474.825	275280.385	134.142	-27.37	161.512
NCB304	10/17/2010	0.0073	0.0051	41.94280306	-71.37045848	4646143.418	303502.475	7.468	-29.124	36.59191981
NCB306	10/17/2010	0.0067	0.0046	42.02329697	-71.37028870	4655080.966	303764.026	75.228	-28.965	104.1928392
NCB309	10/15/2010	0.0058	0.0043	42.05207431	-71.48272370	4658540.495	294547.718	62.965	-29.109	92.07410097
NCB312	10/15/2010	0.0058	0.004	42.11868159	-71.56626220	4666140.866	287856.38	123.241	-29.034	152.2746413
NCB704	12/3/2010			42.17285949	-71.601668	4672245.549	285112.761	87.663	-28.916	116.579
NCB704_BK	12/3/2010	0.0027	0.0012	42.17329831	-71.60119830	4672293.094	285153.045	63.020	-28.914	91.934
NCB704_TP	12/3/2010	0.0037	0.0018	42.17300638	-71.60140047	4672261.187	285135.357	62.304	-28.915	91.219
<b>Survey Control</b>										
NGS_MY5929	10/19/2010	0.02	0.004	42.038041	-71.85943000	263319.547	4657956.388	127.858	-29.233	157.090761
NGS_AJ4047	10/17/2010	0.031	0.008	42.039175	-71.30546500	309178.594	4656697.394	32.531	-28.838	61.36875979
NGS_AI9590	10/18/2010	0.032	0.021	42.608507	-71.49397100	295429.204	4720356.823	58.089	-27.819	85.90820557

[illegible]

BLK301\_C



BLK302\_C

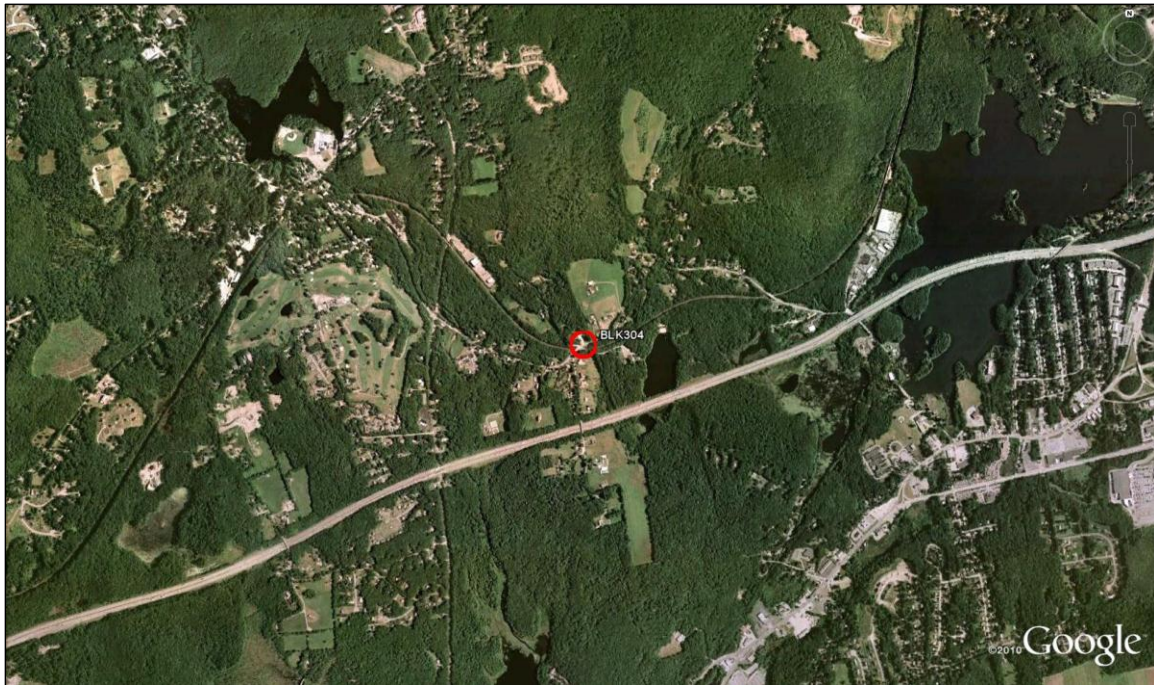




BLK303\_C

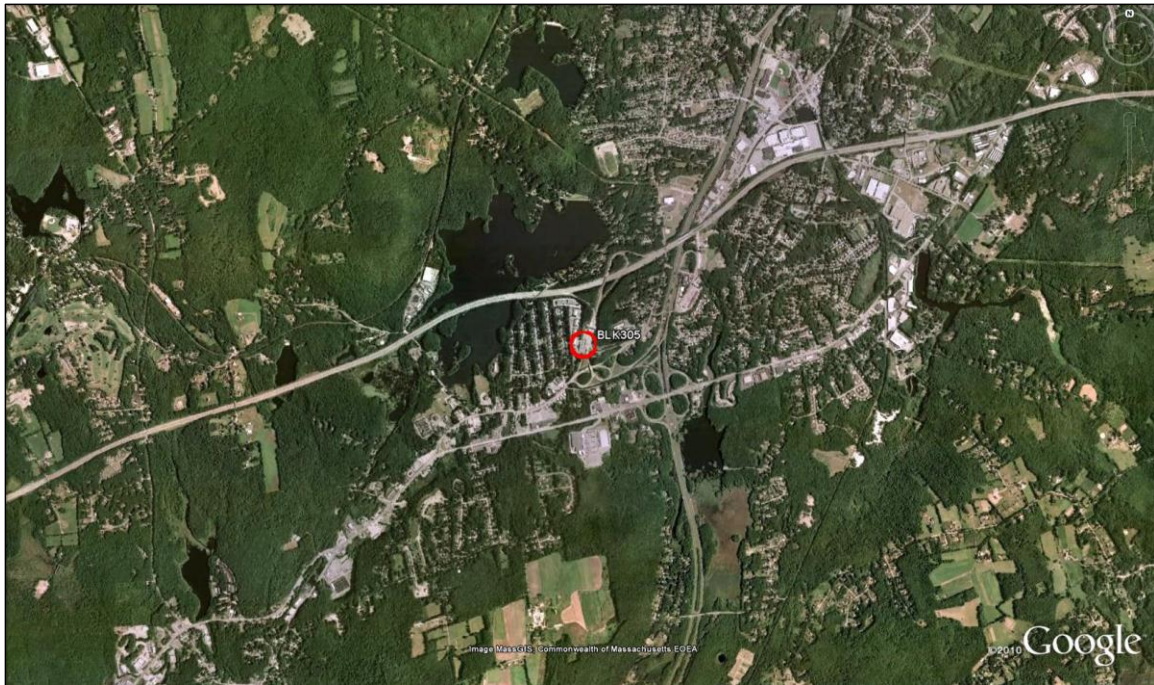


BLK304\_C

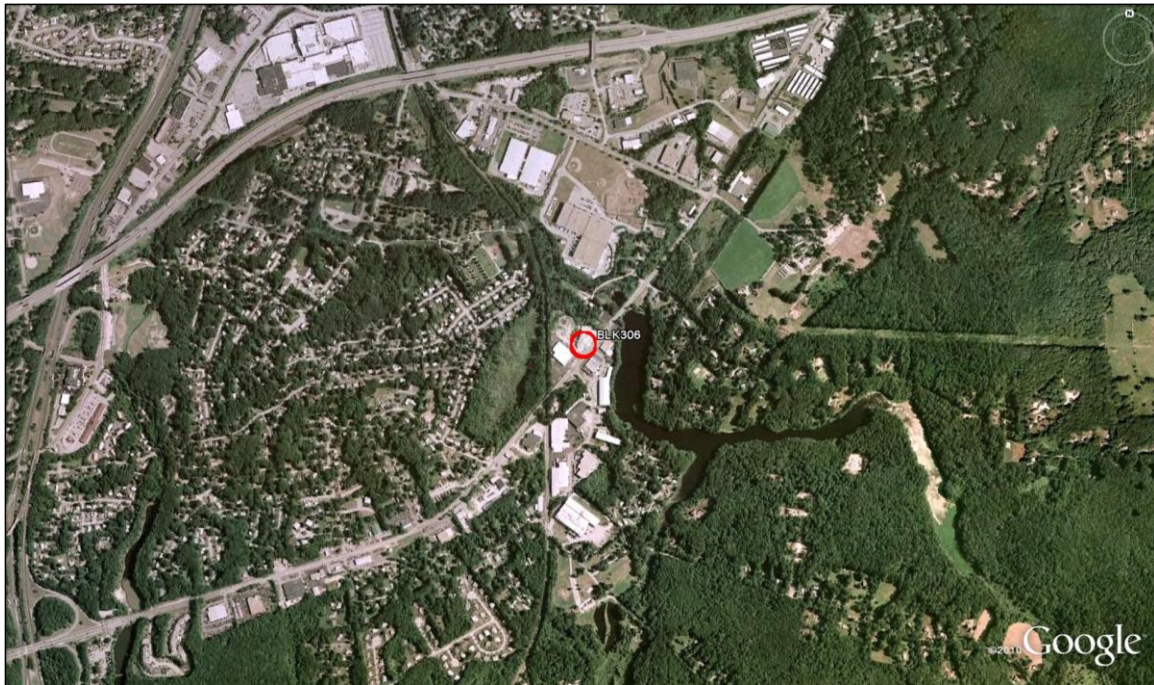




BLK305\_C

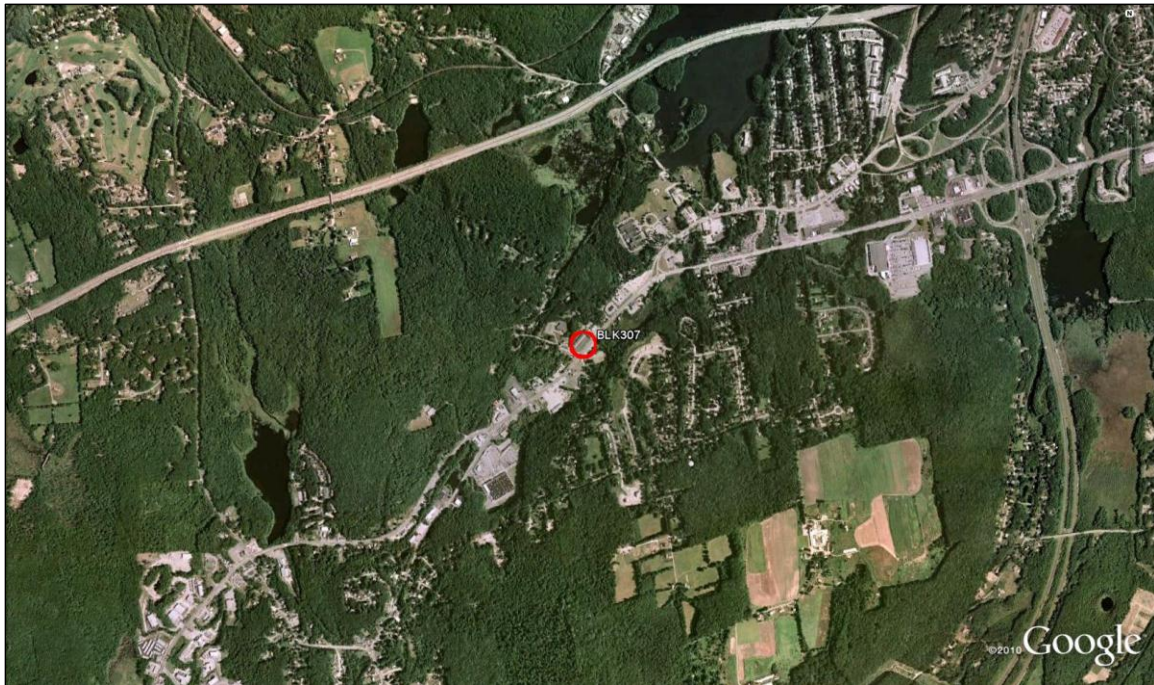


BLK306\_C

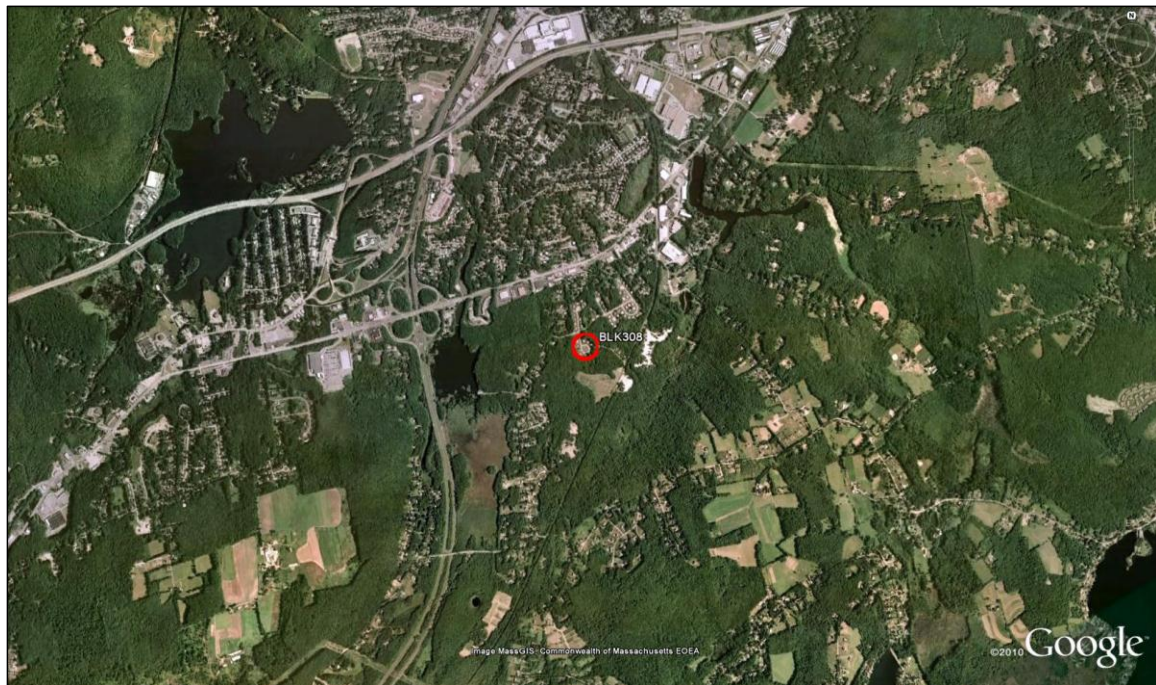




BLK307\_C



BLK308\_C

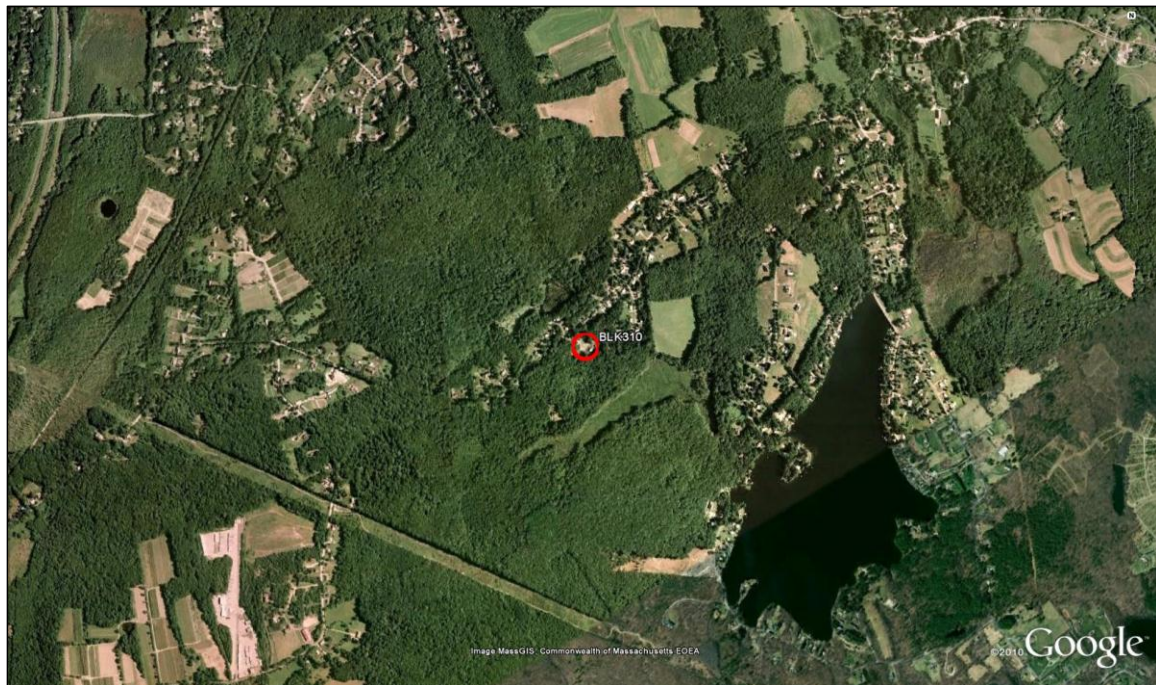




BLK309\_C

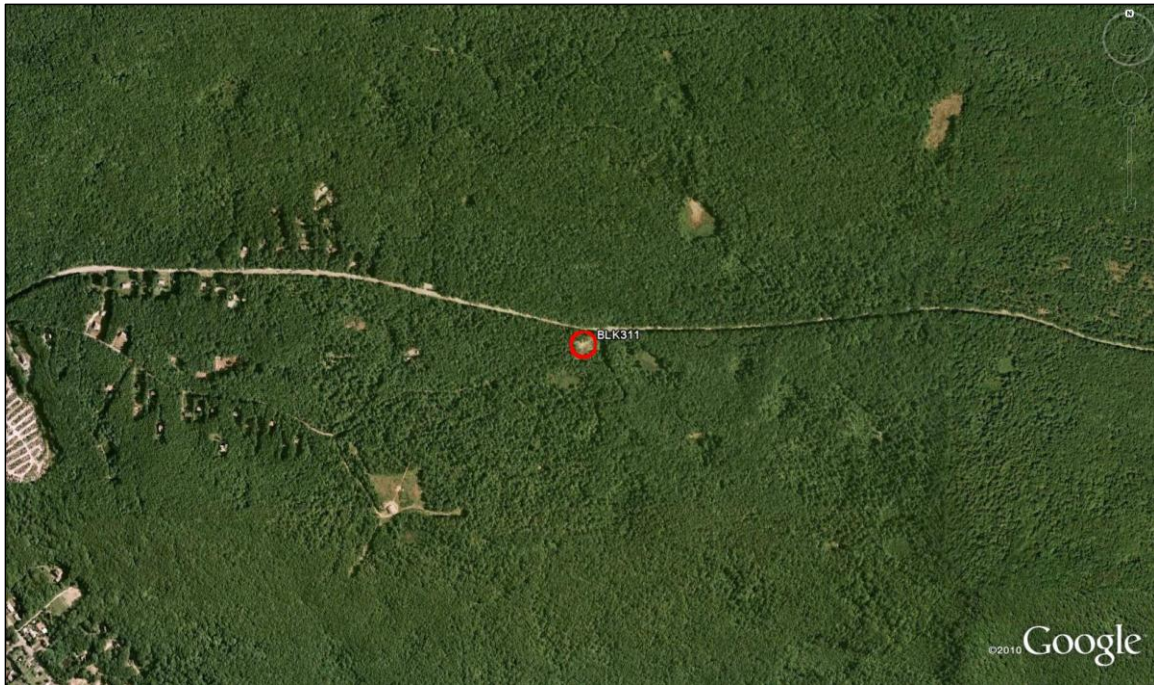


BLK310\_C

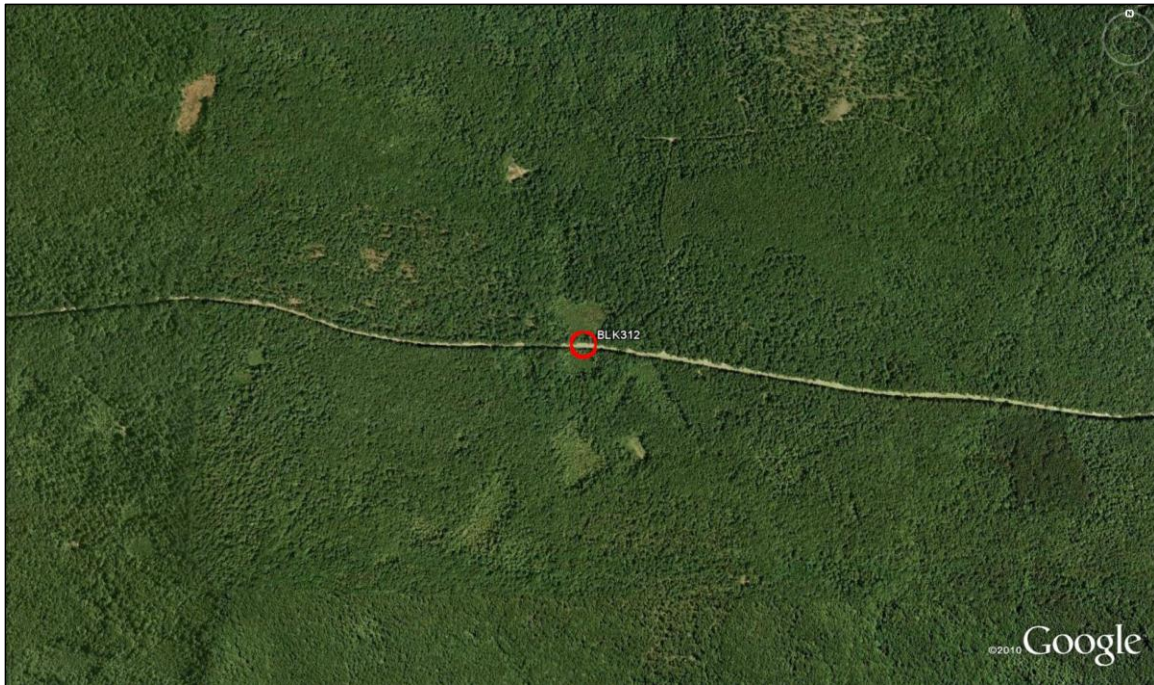




BLK311\_C

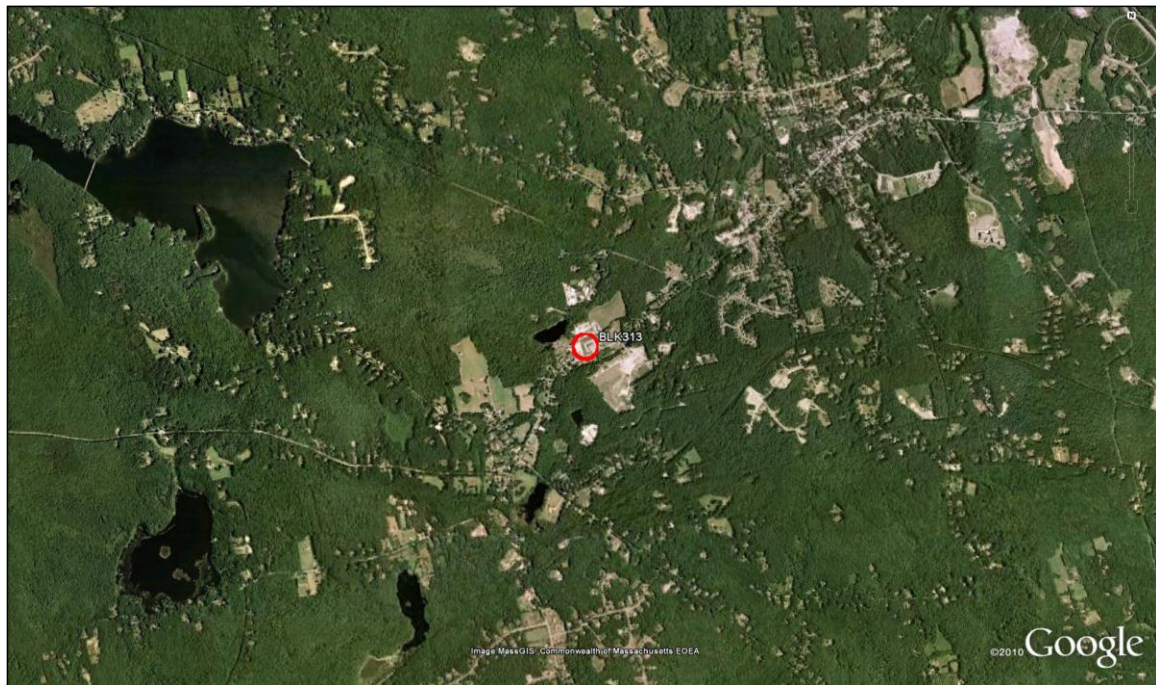


BLK312\_C





BLK313\_C

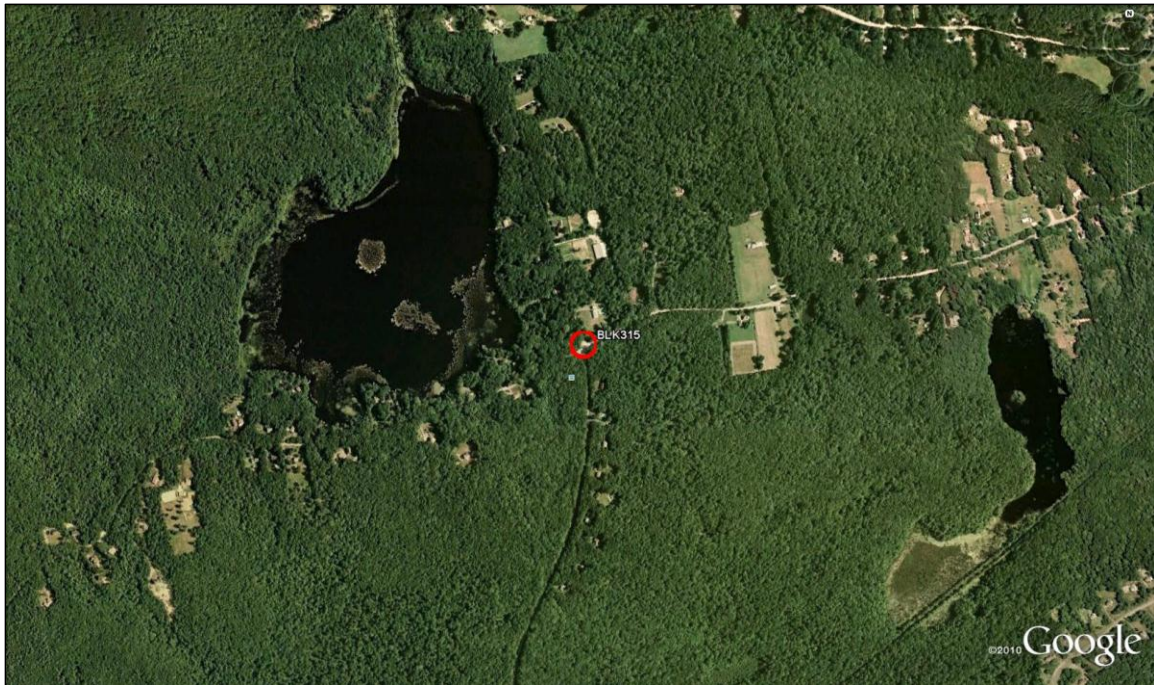


BLK314\_C



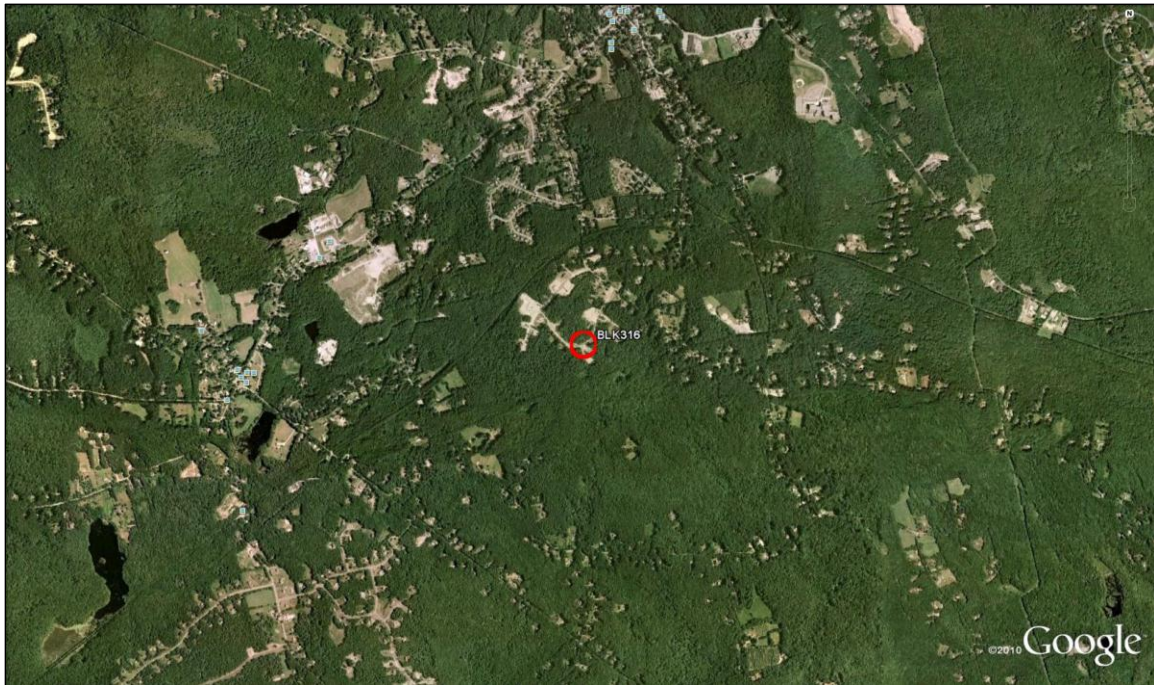


BLK315\_C





BLK316\_C

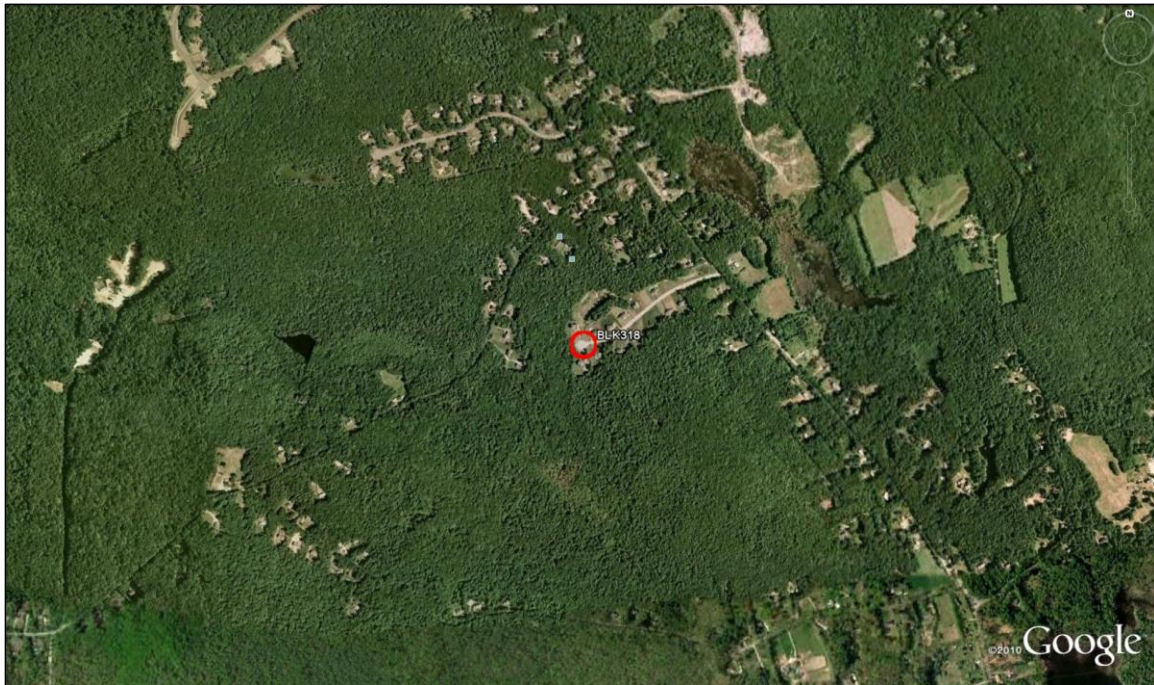


BLK317\_C

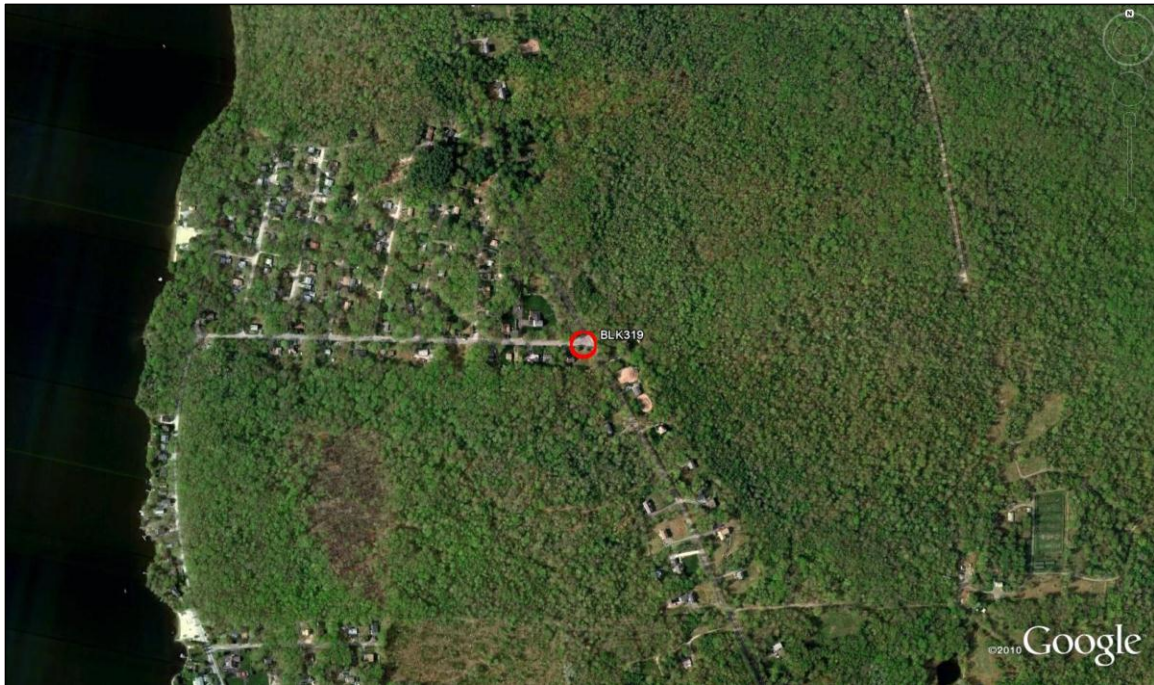




BLK318\_C

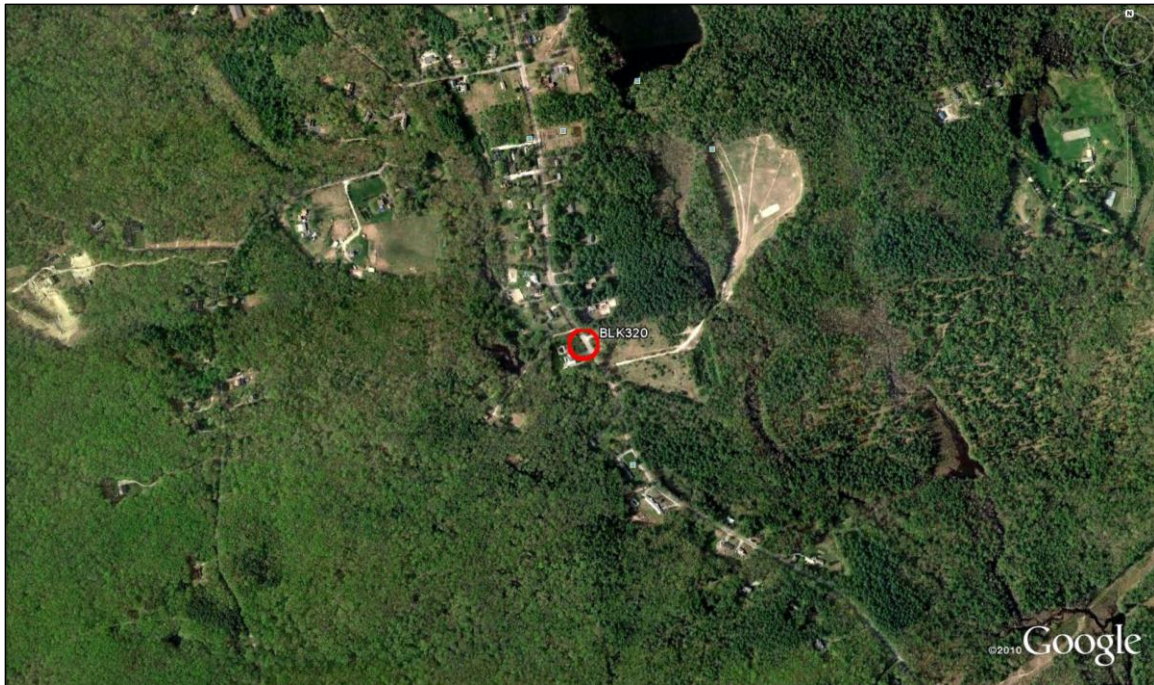


BLK319\_C



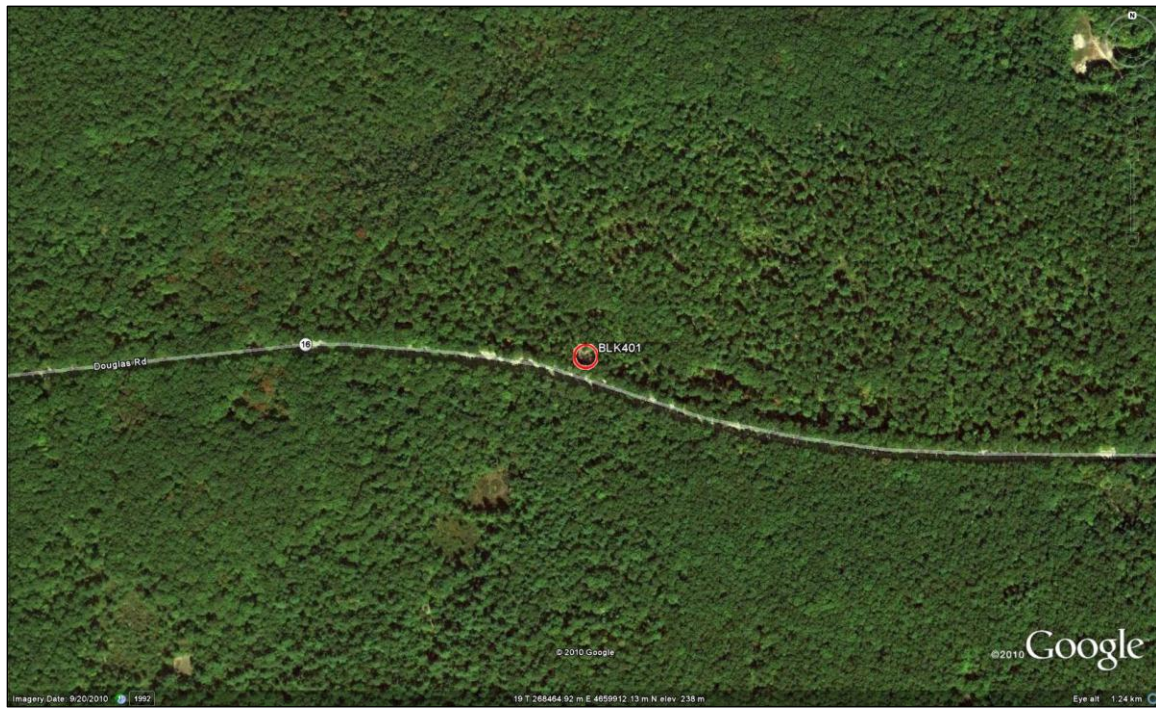


BLK320\_C





BLK401\_C

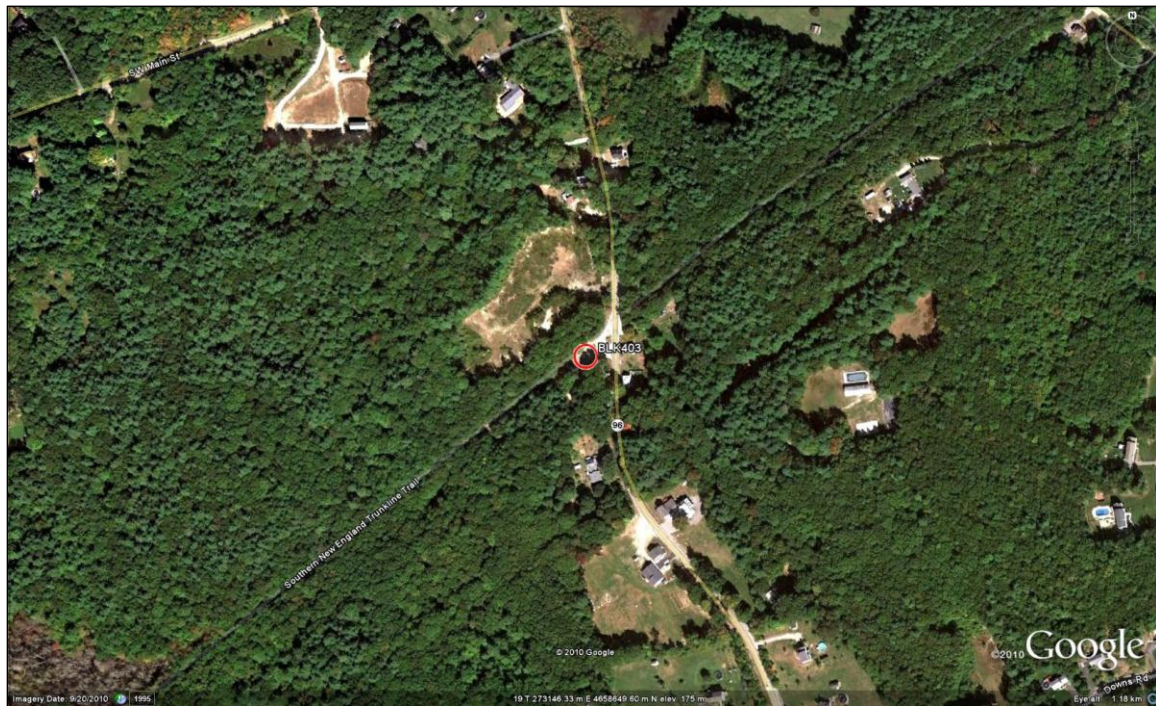


BLK402\_C

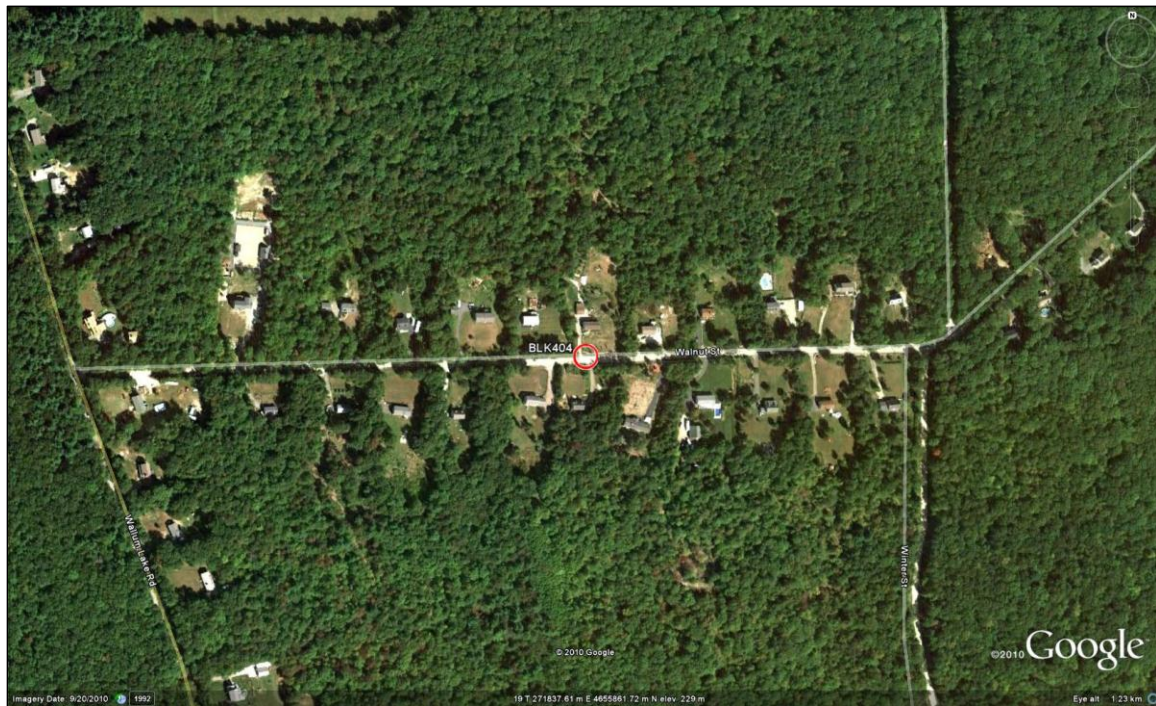




BLK403\_C



BLK404\_C



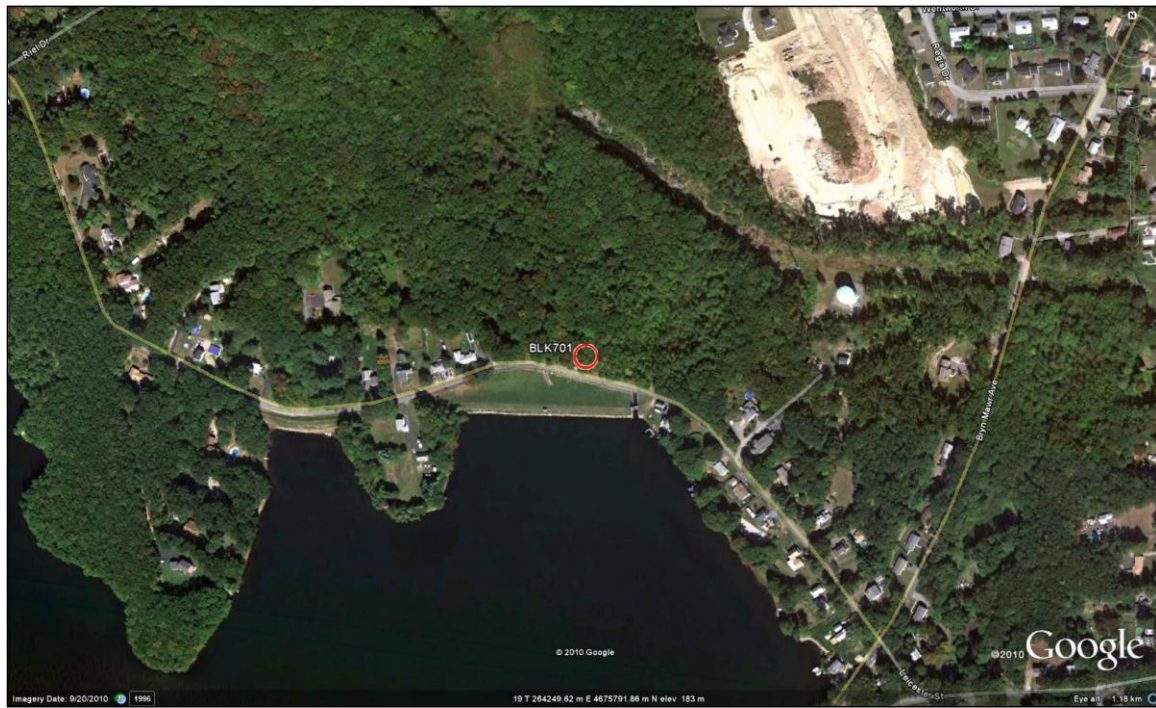


BLK405\_C

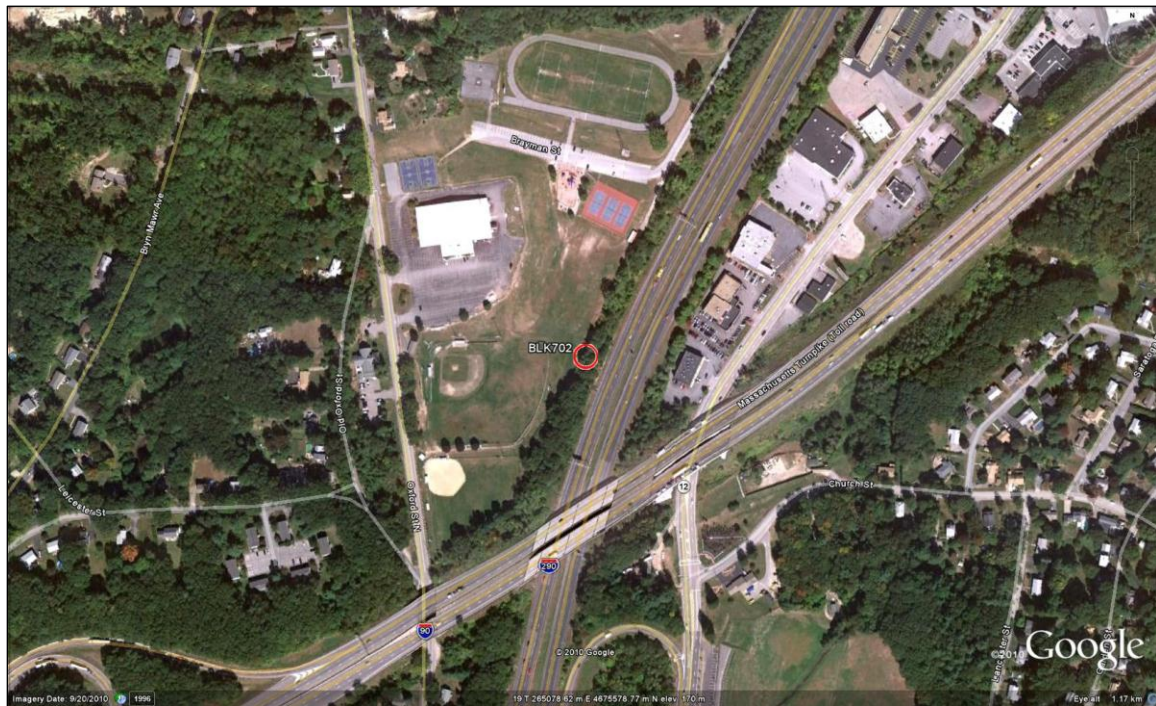




BLK701\_C

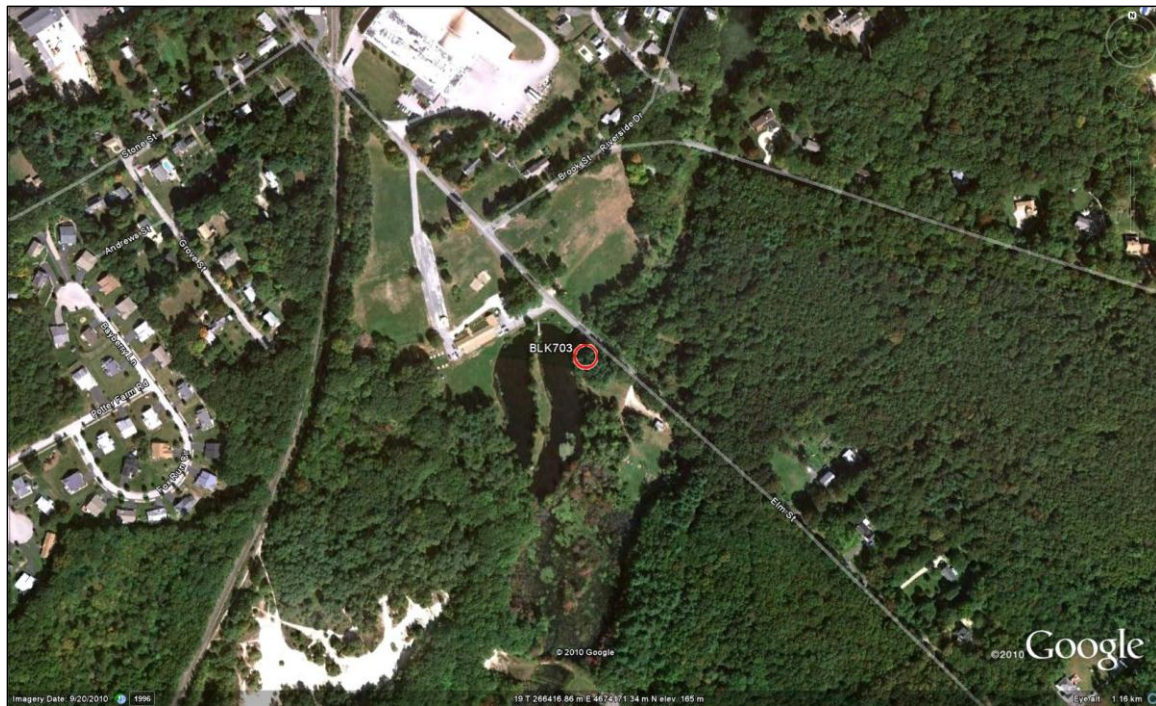


BLK702\_C

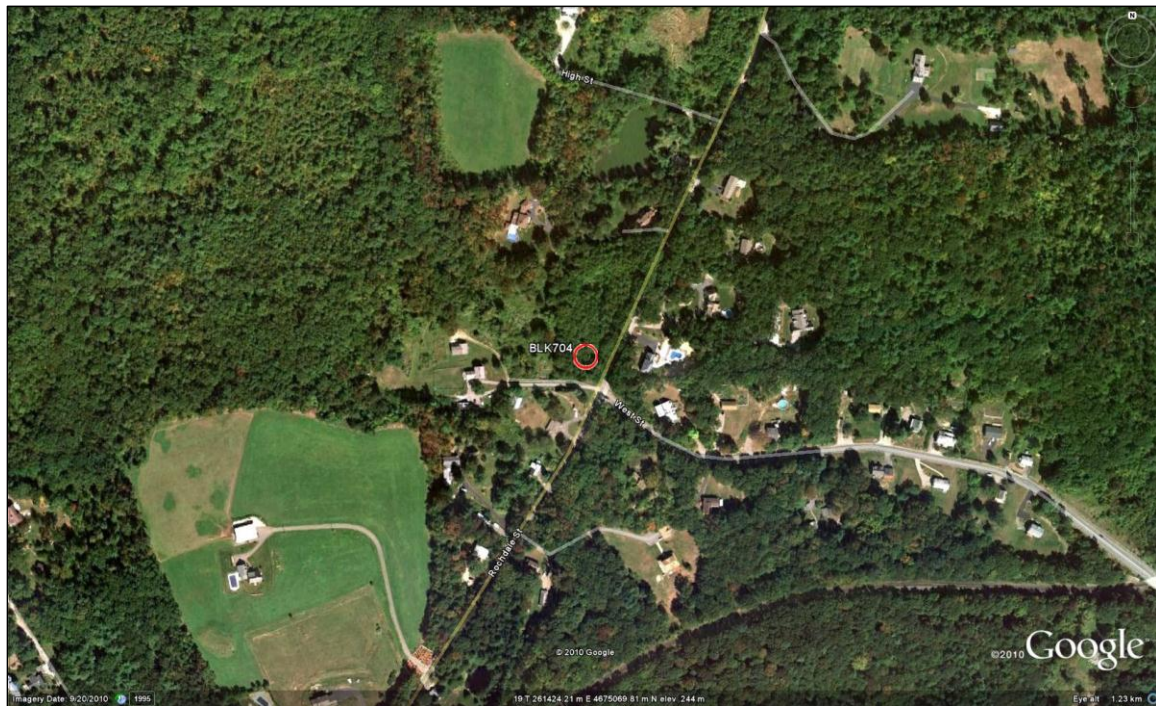




BLK703\_C

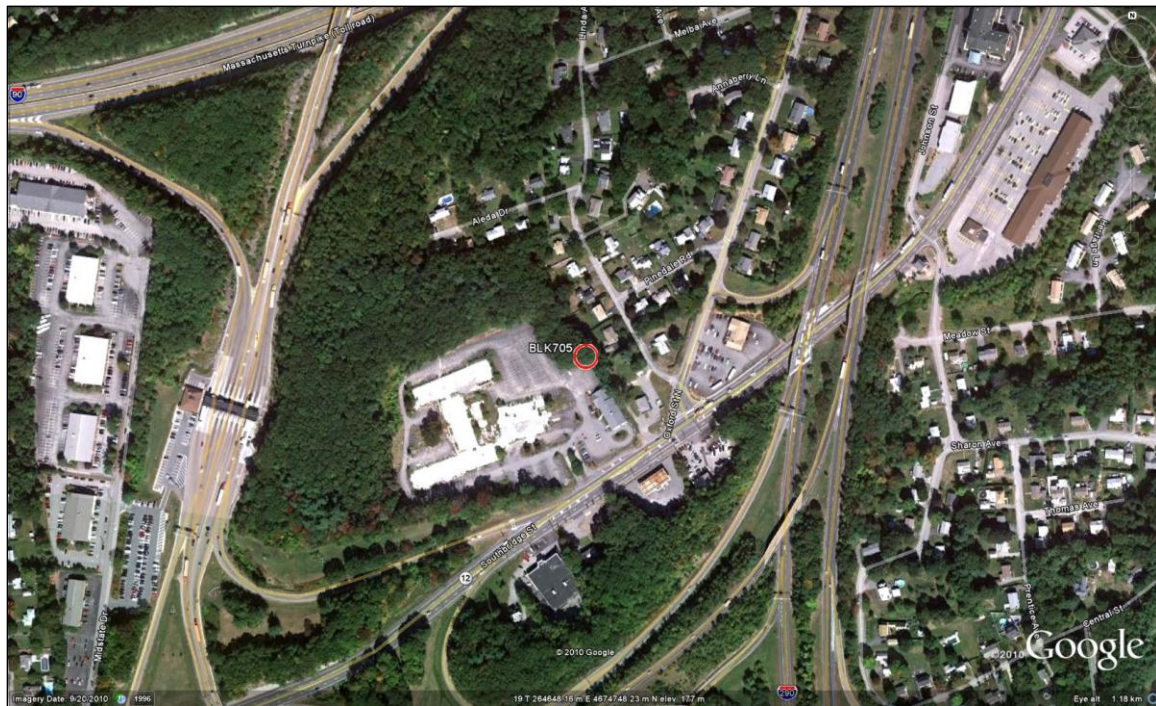


BLK704\_C





BLK705\_C





BLK706\_C

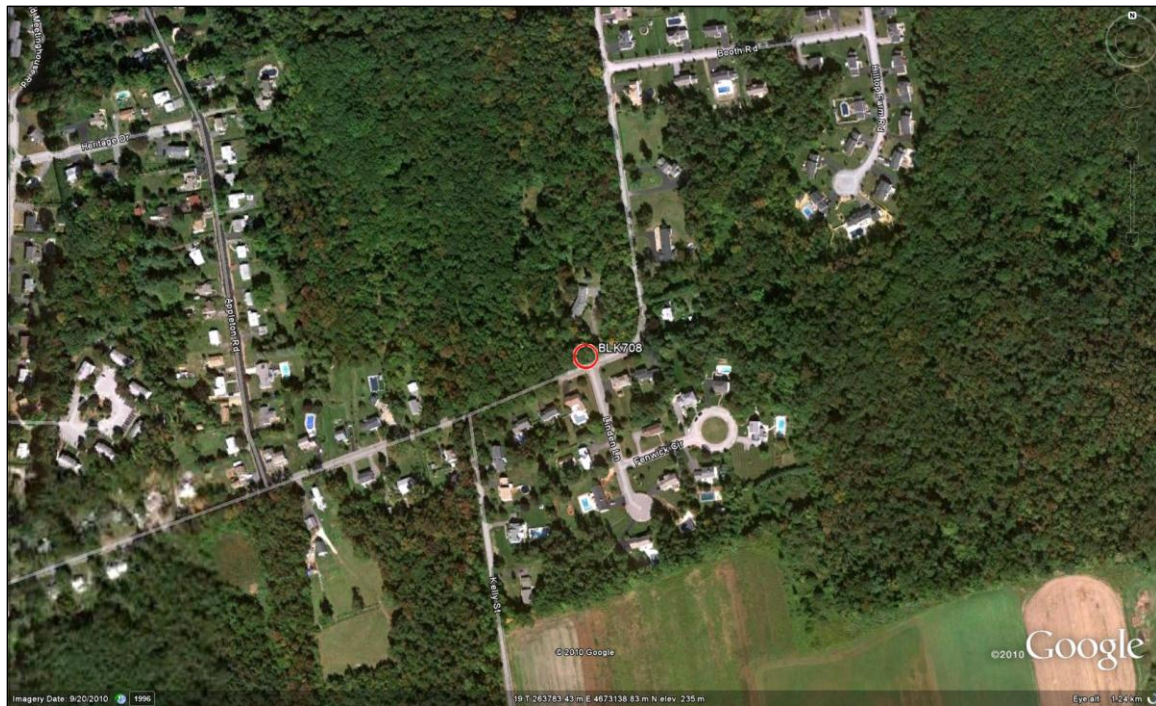


BLK707\_C





BLK708\_C

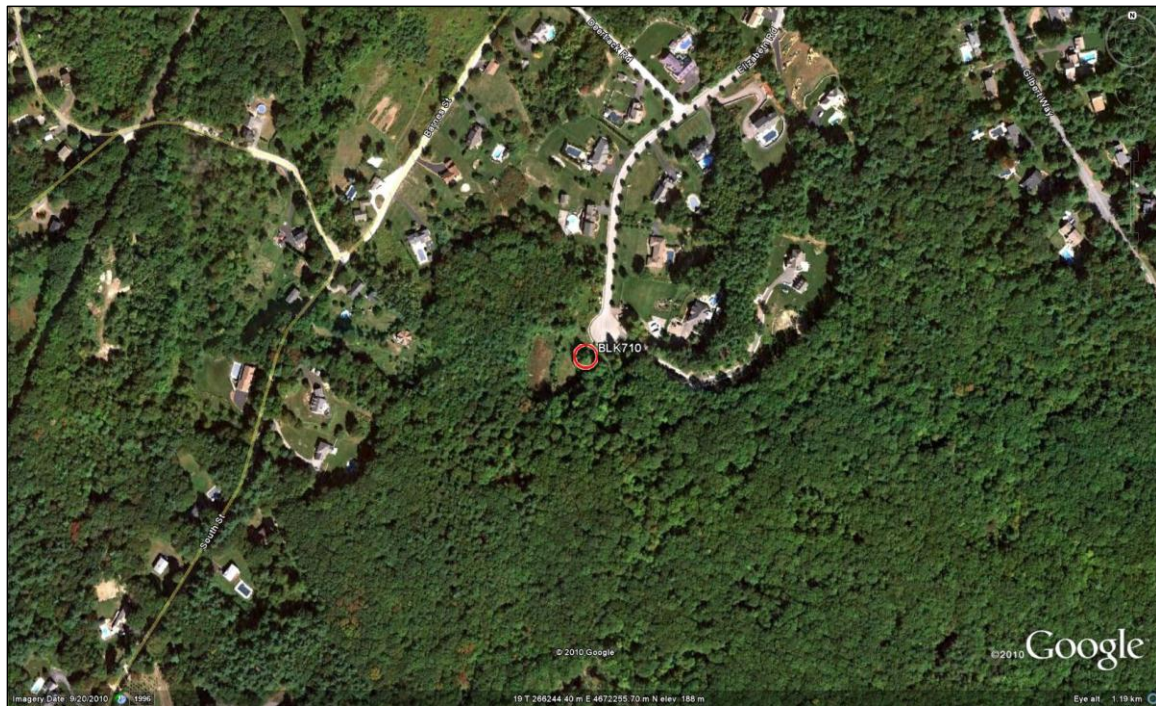


BLK709\_C





BLK710\_C





BLK711\_C

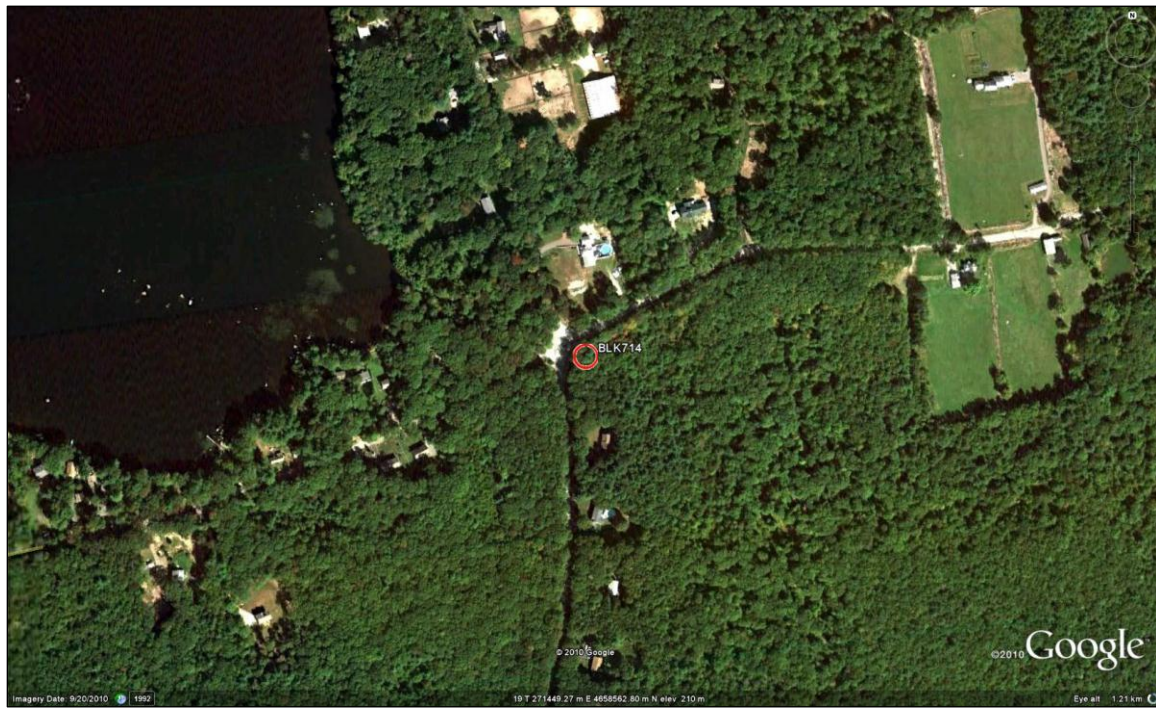


BLK713\_C





BLK714\_C



BLK715\_C



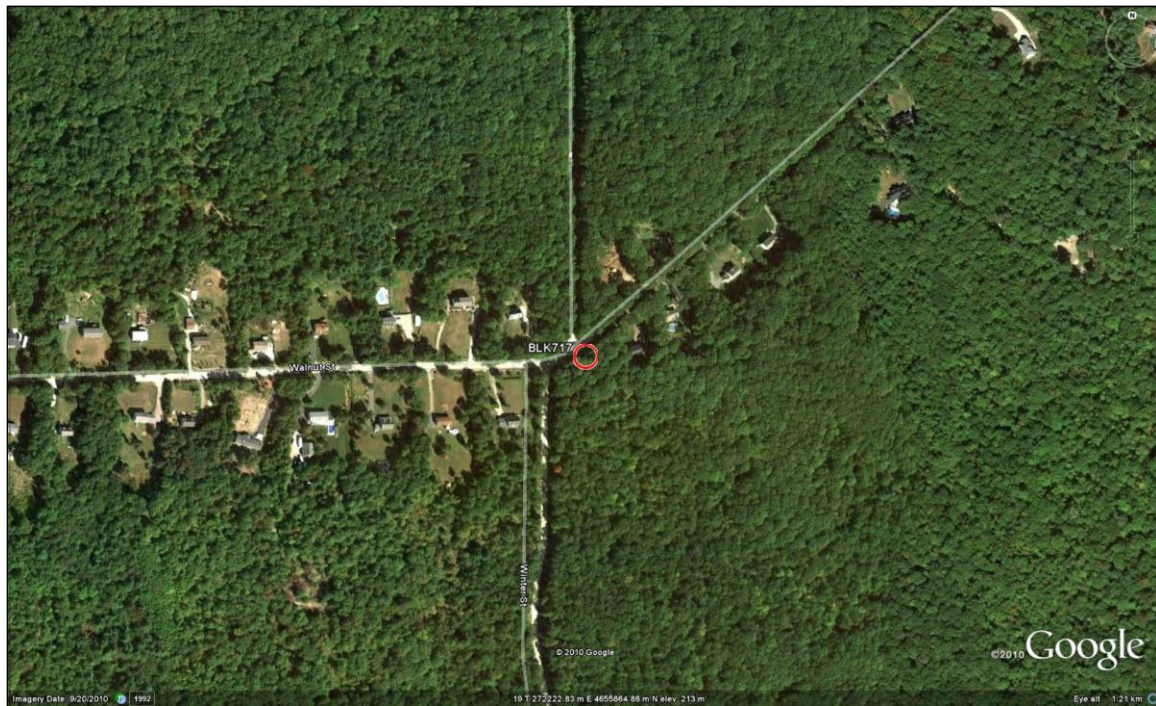


BLK716\_C





BLK717\_C

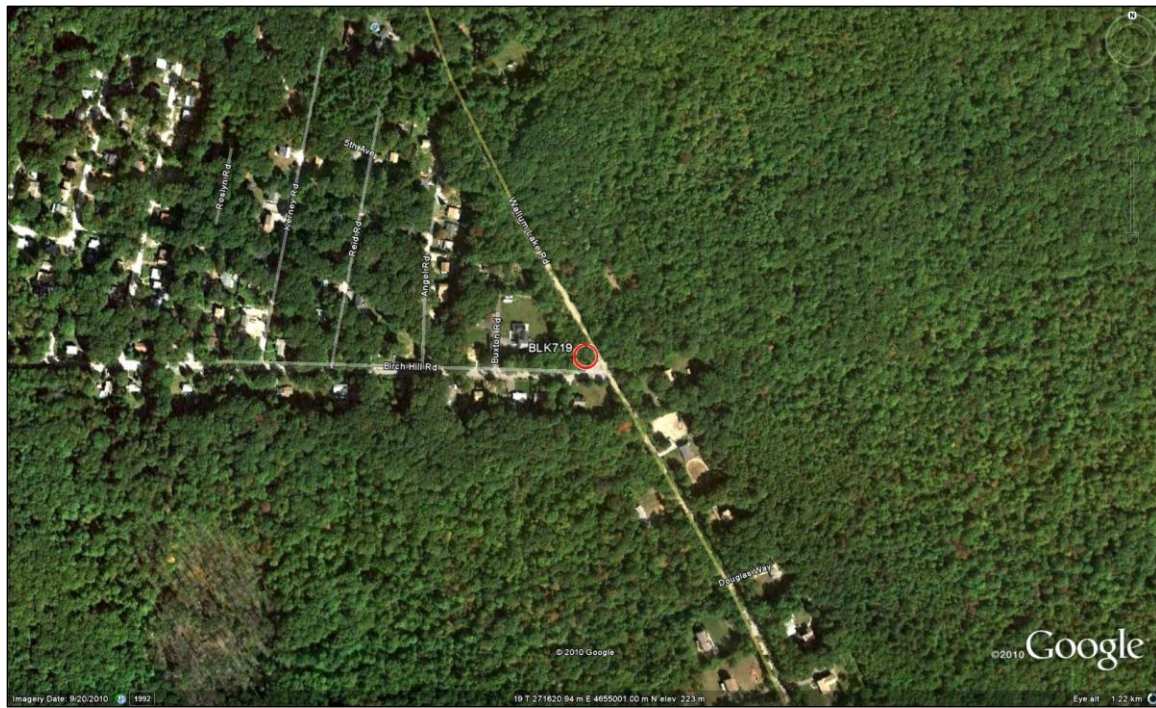


BLK718\_C





BLK719\_C



BLK720\_C





BLK801\_C





[illegible]

BLK803\_C





BLK804\_C



BLK805\_C



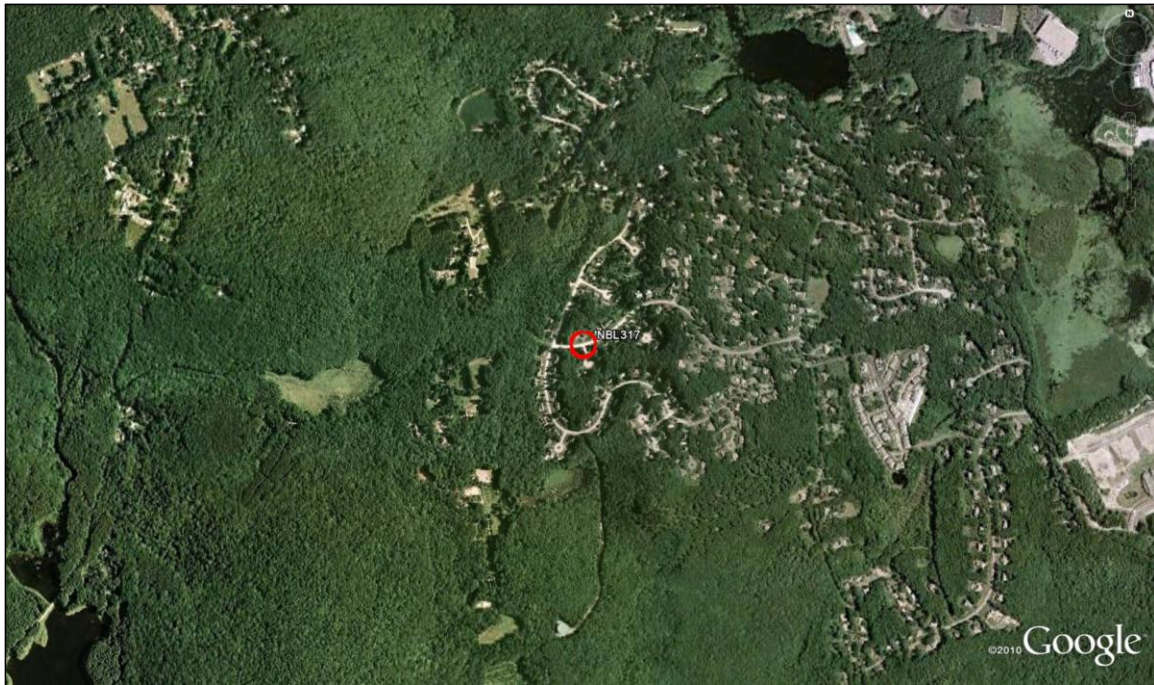


NBL316\_C

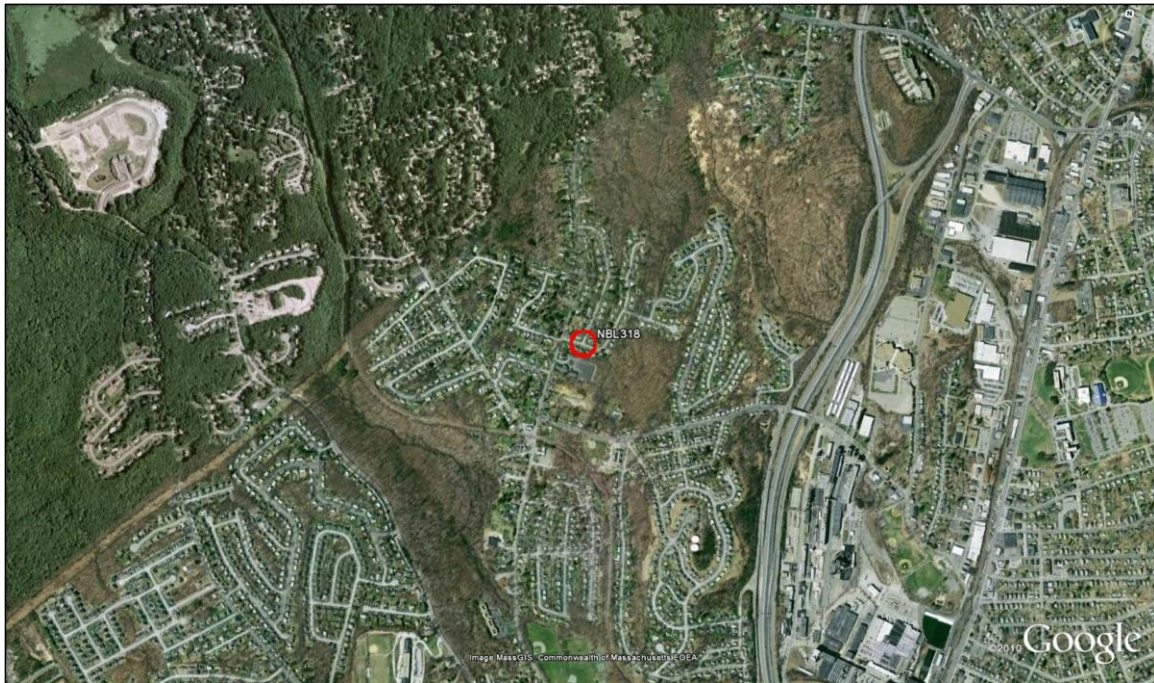




NBL317\_C

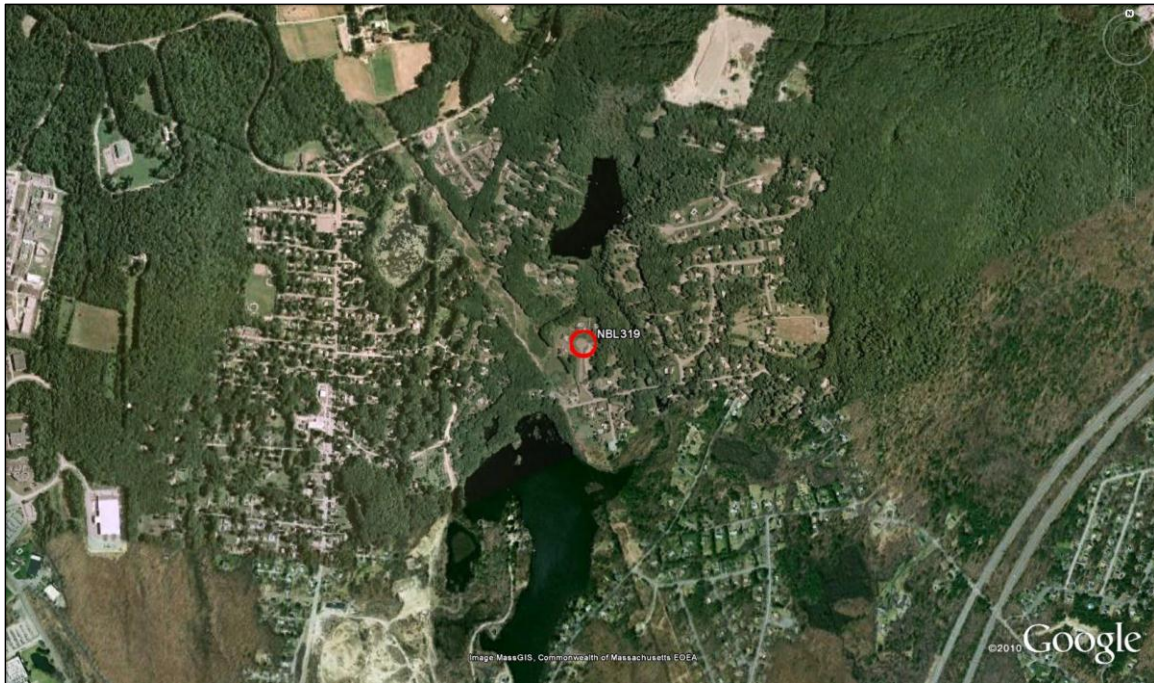


NBL318\_C

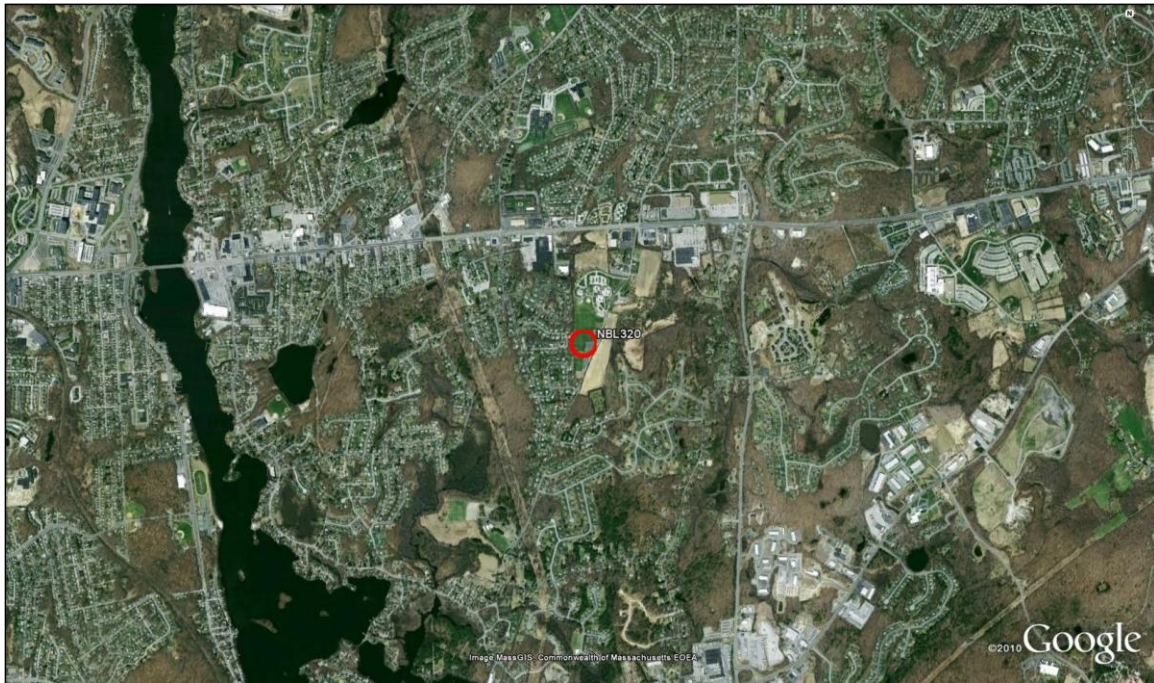




NBL319\_C



NBL320\_C





NBL710\_C



NBL804\_C





NBL805\_C

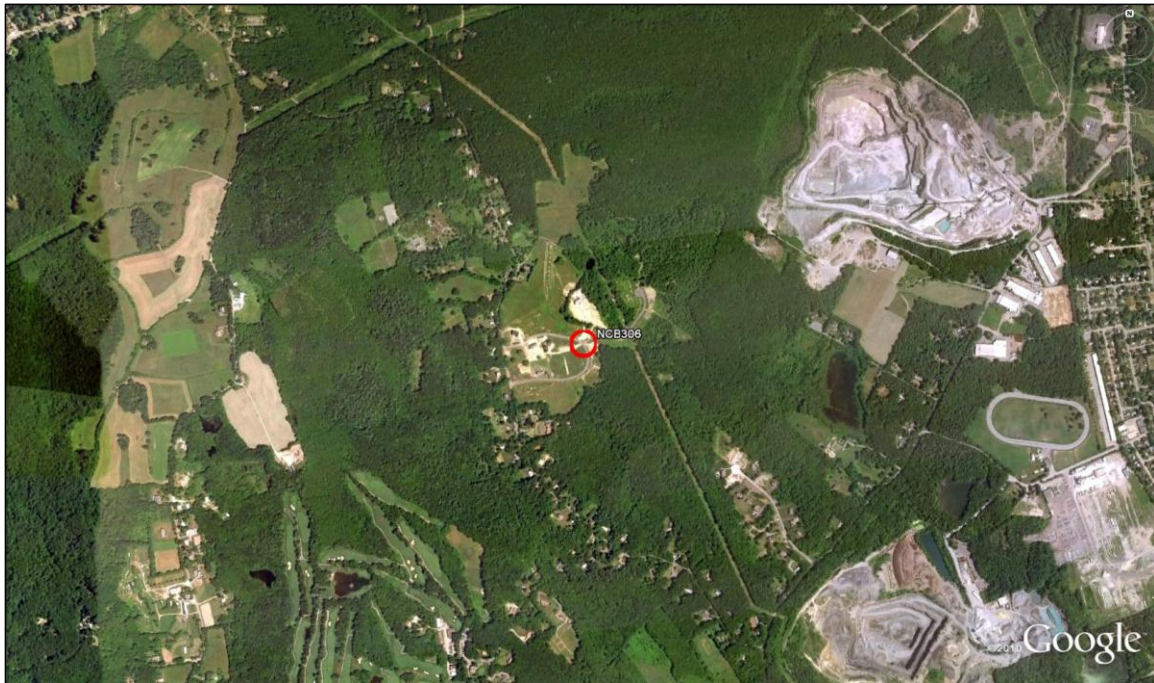


NCB304\_C





NCB306\_C



NCB309\_C





NCB312\_C



NCB704\_C

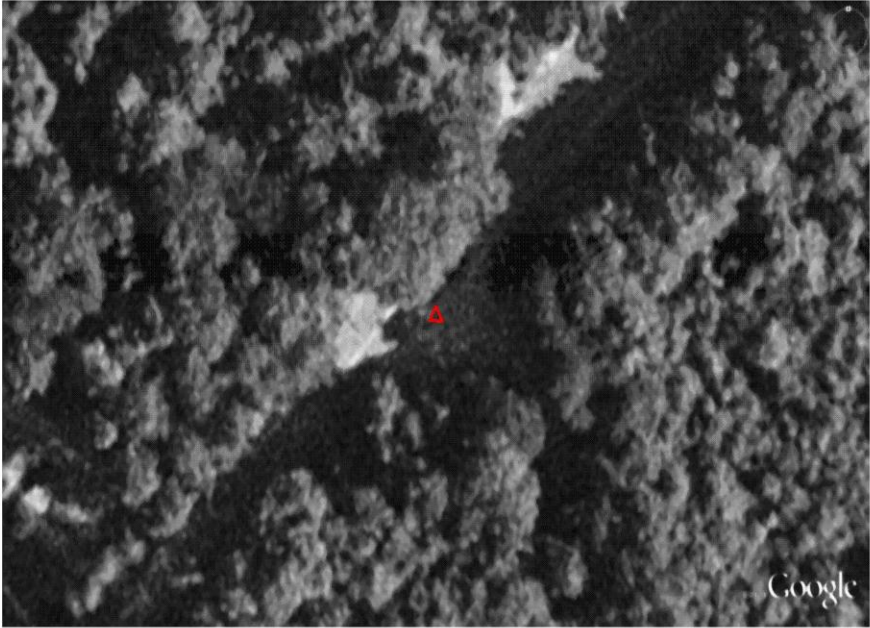





BLK301

# CompassData

## GCP Station Diagram for LiDAR

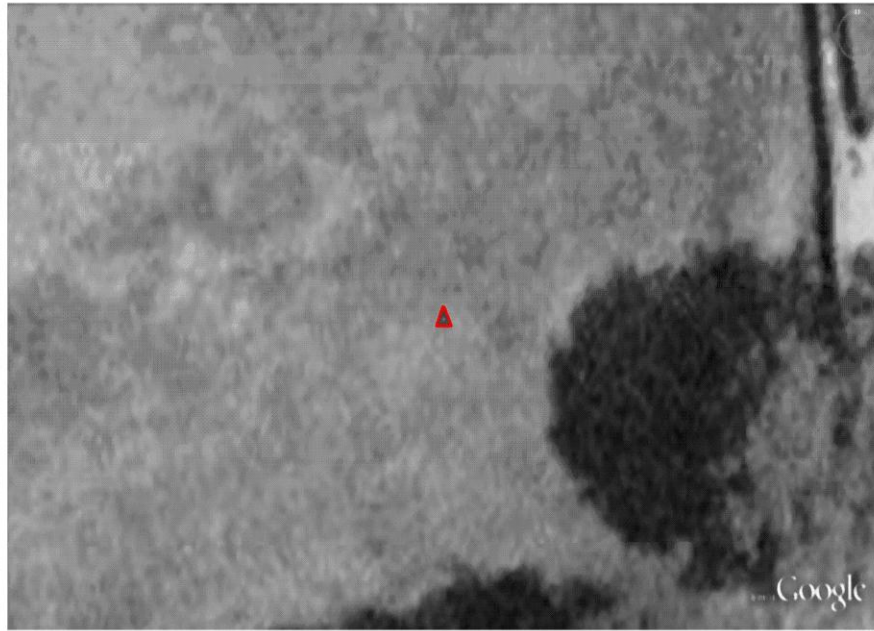
Project Name: Quincy	GCP Number: BLK301
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken on Rochdale St. Worcester, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK302

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK302
CDI Project Number: 1508	Date: 10/19/2010



GPS Antenna Height: 2m

**Comments:**

Point taken in field S of baseball diamond and  
E of Bryn Mawr School.  
Worcester, MA

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK303

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK303
CDI Project Number: 1508	Date: 10/19/2010



GPS Antenna Height: 2m

**Comments:**

Point taken in field W of Tuck Farm Rd and E. of Bancroft St  
and South of a residential house.  
Worcester, MA

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK304

# CompassData

## GCP Station Diagram for LiDAR



Project Name: Quincy	GCP Number: BLK304
CDI Project Number: 1508	Date: 10/19/2010
	
GPS Antenna Height: 2m	
Comments: Point taken at intersection of Rochdale St, and a private driveway. Intersection of Bridge street is just SW of point location. Worcester, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:



BLK305

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK305
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken in East part of the parking lot, West of the highway and East of the buildings. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK306

# CompassData

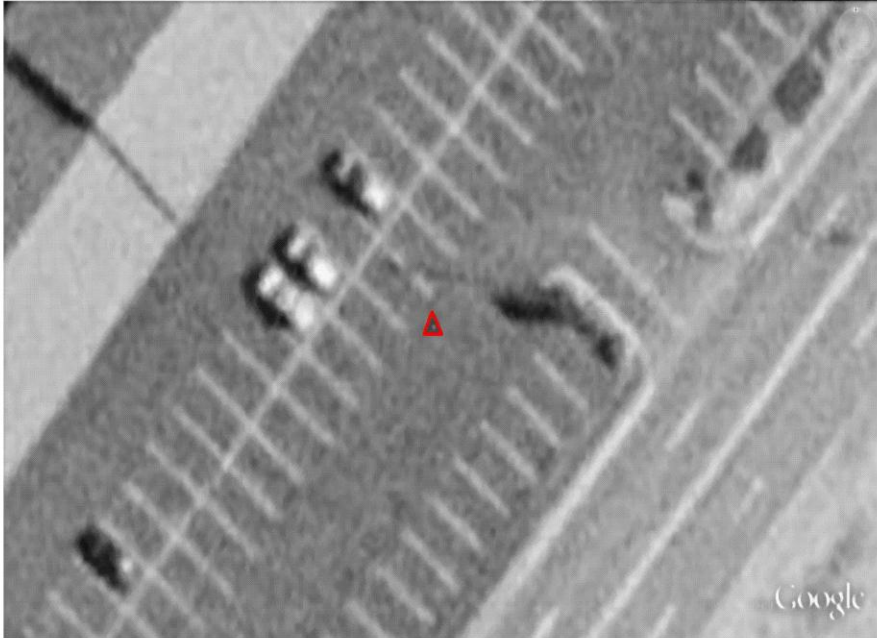

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK306
CDI Project Number: 1508	Date: 10/19/2010
	
GPS Antenna Height: 2m	
Comments: Point taken in rubble of an old foundation NE of Motor Sports International building and NW of U.S. Highway 20 (Washington St). Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK307

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK307
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken in parking lot SE of building, NW of Southbridge St. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK308

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK308
CDI Project Number: 1508	Date: 10/19/2010
	
GPS Antenna Height: 2m	
Comments: Point taken in grassy area of Pine Valley Dr. road circle. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:



BLK309

# CompassData



## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK309
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken in culdesac of Coachman Ln. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK310

# CompassData



## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK310
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken in culdesac of Wedgewood Dr.. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK311

# CompassData

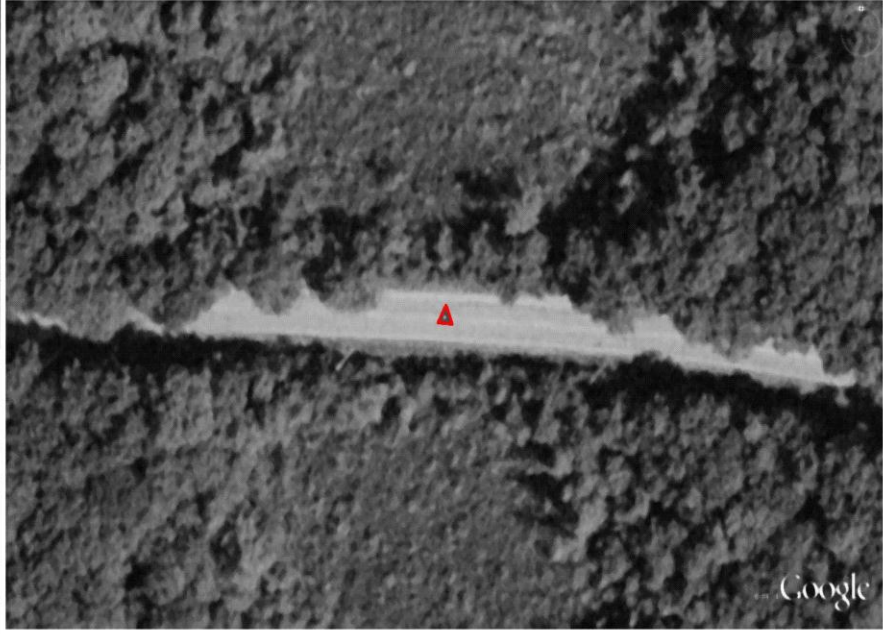

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK311
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken in dirt area south of Webster St. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK312

# CompassData

## GCP Station Diagram for LiDAR

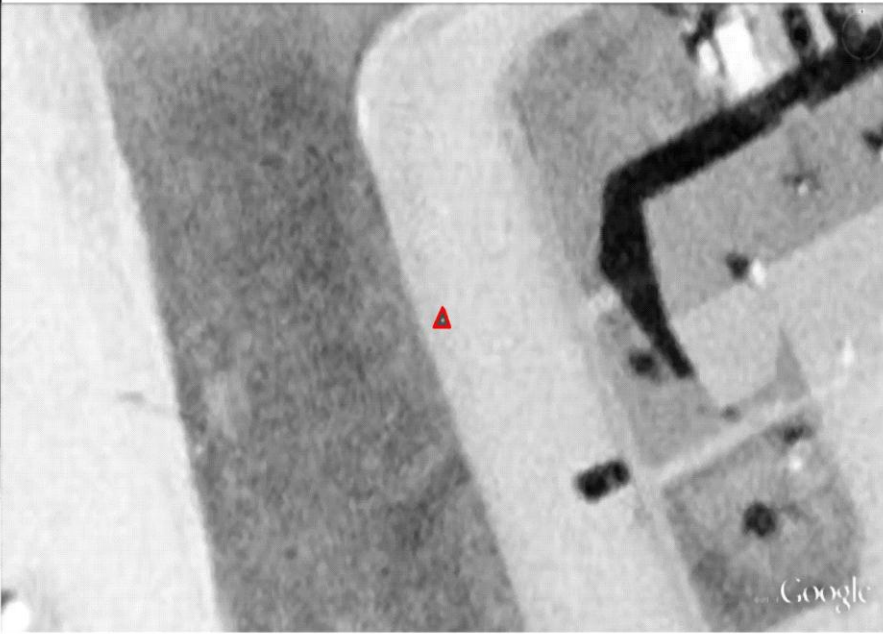

Project Name: Quincy	GCP Number: BLK312
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken in center of Webster St in Douglas State Forest. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:



BLK313

# CompassData

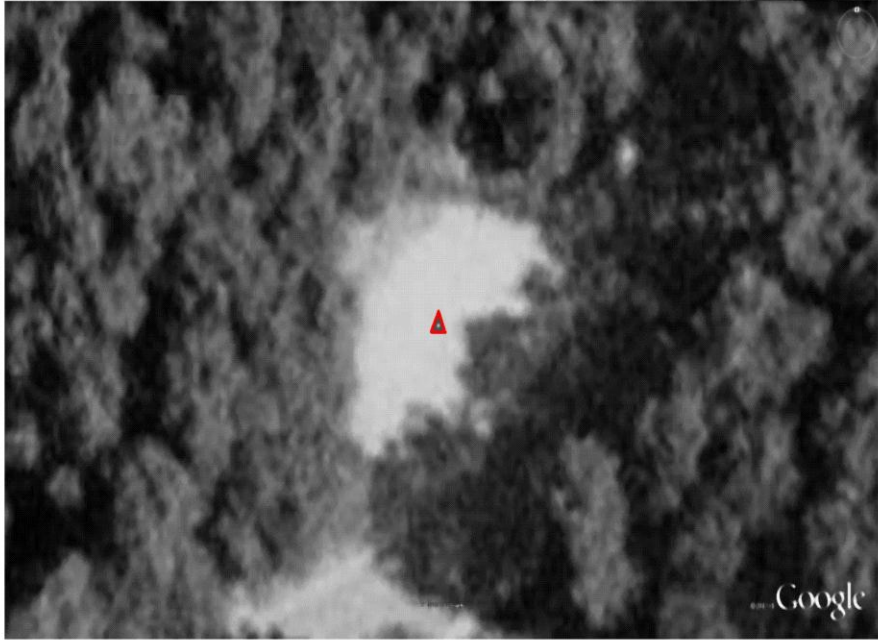
## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK313
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken Douglas Fire Station parking lot just East of building. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK314

# CompassData

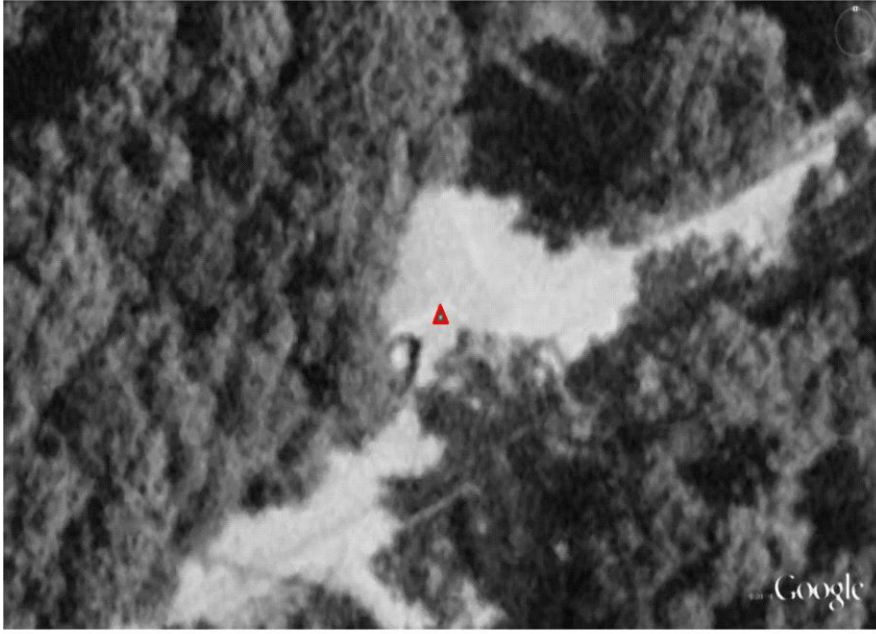

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK314
CDI Project Number: 1508	Date: 10/19/2010
	
GPS Antenna Height: 2m	
Comments: Point taken in dirt area just off SW Main St. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK315

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK315
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken at northern portion of intersection of SW. Main St. and Wallum Lake Rd and Cedar St. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK316

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK316
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken at NE corner of Meetinghous Ln. where road intersects Olde Carriage Ln. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:



BLK317

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK317
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken in field in Wallum State Park just East of Wallum Lake Rd. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK318

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK318
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken in Culdesac of Jepherson Dr. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK319

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK319
CDI Project Number: 1508	Date: 10/19/2010



GPS Antenna Height: 2m

**Comments:**

Point taken on Birch Hill road, just south of  
Wallum Lake Rd intersection.  
Worcester County, MA

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK320

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: BLK320
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken on grass of private yard just NE of House and SW of South St. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:



NBL316

# CompassData



## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: NBL316
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken in center of Paxton St in front of a private drive. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

NBL317

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: NBL317
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken at intersection of Foxhill Dr and Cypress Cir. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

NBL318

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: NBL318
CDI Project Number: 1508	Date: 10/19/2010



GPS Antenna Height: 2m

**Comments:**

Point taken at intersection of Stoneleigh Rd. and  
Chevy Chase Rd.  
Worcester County, MA

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

NBL319

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: NBL319
CDI Project Number: 1508	Date: 10/19/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken in culdesac of Brooke Rd. Worcester County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

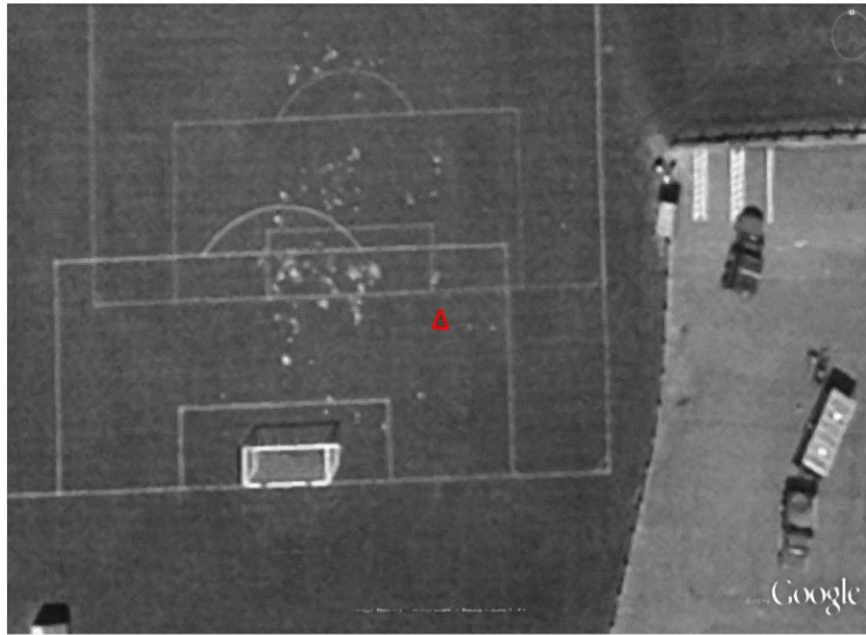


NBL320

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Quincy	GCP Number: NBL320
CDI Project Number: 1508	Date: 10/19/2010



GPS Antenna Height: 2m

**Comments:**

Point taken in soccer field West of Lake St.  
Worcester County, MA

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

NCB304

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: NCB304
CDI Project Number: 1508	Date: 10/17/2010
	
	
GPS Antenna Height: 2m	
Comments: Point taken in field south of baseball diamond. North of Chemawa Country Golf Course. Bristol County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

NCB306

# CompassData


## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: NCB306
CDI Project Number: 1508	Date: 10/17/2010
	
GPS Antenna Height: 2m	
Comments: Point taken in intersection of two roads. Norfolk County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

NCB309

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: NCB309
CDI Project Number: 1508	Date: 10/15/2010
	
GPS Antenna Height: 2m	
Comments: Point taken in field N of Parking lot and E of building with small parking lot. Norfolk County, MA	
Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:



NCB312

# CompassData

## GCP Station Diagram for LiDAR

Project Name: Blackstone	GCP Number: NCB312
CDI Project Number: 1508	Date: 10/15/2010



GPS Antenna Height: 2m

**Comments:**

Point taken in culdesac of Etsy Rd.  
Worcester County, MA

Disk (Roll) / Frame Number:	Sketch <u>1</u> of <u>1</u>
Collected By: Bryan Frazier	Checked By:

BLK301\_E



BLK301\_N





BLK301\_S





BLK301\_W



BLK302\_E



BLK302\_N



BLK302\_S





BLK302\_W



BLK303\_E



BLK303\_N



BLK303\_S





BLK303\_W



BLK304\_E



BLK304\_N



BLK304\_S





BLK304\_W



BLK305\_E



BLK305\_N



BLK305\_S





BLK305\_W



BLK306\_E



BLK306\_N



BLK306\_S





BLK306\_W



BLK307\_E



BLK307\_N



BLK307\_S





BLK307\_W



BLK308\_E



BLK308\_N



BLK308\_S





BLK308\_W



BLK309\_E



BLK309\_N



BLK309\_S





BLK309\_W



BLK310\_E



BLK310\_N



BLK310\_S





BLK310\_W



BLK311\_E



BLK311\_N



BLK311\_S





BLK311\_W



BLK312\_E



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BLK312\_W



BLK313\_E



BLK313\_N



BLK313\_S





BLK313\_W



BLK314\_E



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BLK314\_W



BLK315\_E



BLK315\_N



BLK315\_S





BLK315\_W



BLK316\_E



BLK316\_N



BLK316\_S





BLK316\_W



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BLK320\_W



BLK401\_E



BLK401\_N





BLK401\_S





BLK402\_E



BLK402\_N



BLK402\_S



BLK402\_W





BLK403\_E



BLK403\_N



BLK403\_S



BLK403\_W





BLK404\_E



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BLK405\_E



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BLK405\_W





BLK701



BLK702



BLK703





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BLK713



BLK714



BLK715





BLK716





BLK717



BLK718



BLK719





BLK720





BLK801\_E



BLK801\_N



BLK801\_S



BLK801\_W





BLK802\_E



BLK802\_N



BLK802\_S



BLK802\_W





BLK803\_E



BLK803\_N



BLK803\_S



BLK803\_W





BLK804\_E



BLK804\_N



BLK804\_S



BLK804\_W





BLK805\_E



BLK805\_N



BLK805\_S



BLK805\_W





NBL316\_E



NBL316\_N



NBL316\_S



NBL316\_W





NBL317\_E



NBL317\_N



NBL317\_S



NBL317\_W





NBL318\_E



NBL318\_N



NBL318\_S



NBL318\_W





NBL319\_E



NBL319\_N



NBL319\_S



NBL319\_W





NBL320\_E



NBL320\_N



NBL320\_S



NBL320\_W





NBL710



NBL804\_E



NBL804\_N



NBL804\_S





NBL804\_W



NBL805\_E



NBL805\_N



NBL805\_S





NBL805\_W



NCB304\_E



NCB304\_N



NCB304\_S





NCB304\_W



NCB306\_E



NCB306\_N



NCB306\_S





NCB306\_W



NCB309\_E



NCB309\_N



NCB309\_S





NCB309\_W



NCB312\_E



NCB312\_N



NCB312\_S





NCB312\_W



NCB704





# Region 1: Test results for Blackstone, MA

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## Summary

In FEMA-Region 1 the Blackstone area is split up in multiple parts. This test encompasses 5 parts in total about 85 square miles. (Other Blackstone parts are processed and tested with the adjoining Narragansett and Charles areas.) A LiDAR data acquisition was ordered for a 2' equivalent contour accuracy, which equals the highest specification level. The area was flown and post-processed by Photo Science. CompassData performed the quality control of the collected and processed LiDAR data with a fundamental vertical accuracy (FVA) and a consolidated vertical accuracy (CVA) assessment, respectively. The planning, data collection, data processing, and data testing were successfully accomplished by the STARR members.

## Index

- Final Test Results
- FVA Test
- CVA Test
- Distribution of Testing Points
- FVA Test Details
- CVA Test Details

## Final Test Results

**The vertical accuracy requirements based on flood risk and terrain slope are met with 16.7 cm and 30.4 cm for both FVA and CVA testing. The mandatory requirements for the highest specification for vertical accuracy, 95% confidence level are for FVA < 24.5 cm and CVA < 36.3 cm.**

### FVA Test

Tested 16.7 cm fundamental vertical accuracy at 95% confidence level in open terrain using  $RMSE_{(Z)} \times 1.9600$ . The Root Mean Square Error for the elevation differences between GPS control points and LiDAR points is 8.5 cm calculated with 25 FVA points.

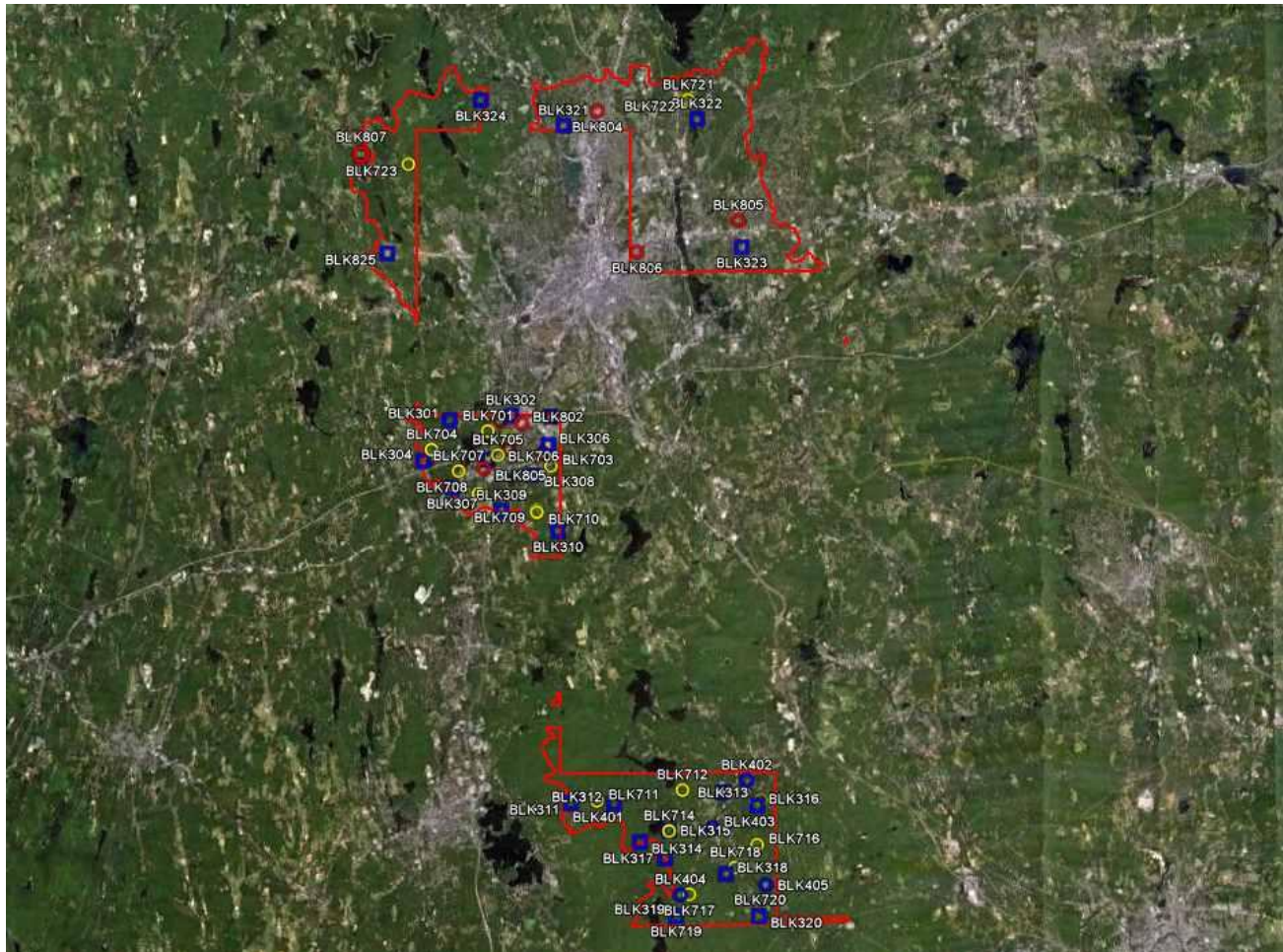
### CVA Test

Tested 30.4 cm consolidated vertical accuracy at 95th percentile in: open terrain, forest terrain, and urban terrain. The Root Mean Square Error for the elevation differences between GPS control points and LiDAR points is 15.1 cm calculated with 35 supplemental vertical accuracy points (SVA).










## Distribution of Testing Points



### Region 1, Blackstone, MA

#### Legend:

-  FVA points in open terrain on hard surface
-  FVA points in open terrain used as well in CVA test
-  SVA points in open terrain
-  SVA points in urban terrain
-  SVA points in forest terrain

According to the area to be tested the 25 FVA points are evenly distributed. Additional 35 SVA points are distributed in respect to the available major land classes.





## FVA Test Details

FVA-Points	Date	Northing (GPS)	Easting (GPS)	MSL (GPS)	MSL (LiDAR)	$\Delta Z$
BLK301	10/19/2010	4676325.404	262633.315	216.065	215.92	0.14
BLK302	10/19/2010	4676429.711	265265.384	176.918	176.91	0.01
BLK303	10/19/2010	4676330.778	266949.246	175.503	175.52	-0.02
BLK304	10/19/2010	4674610.586	261440.257	221.339	221.28	0.06
BLK305	10/19/2010	4674581.889	264218.053	191.433	191.48	-0.05
BLK306	10/19/2010	4675125.291	266802.673	164.545	164.51	0.04
BLK307	10/19/2010	4673426.518	262653.193	193.648	193.62	0.03
BLK308	10/19/2010	4673866.202	266108.635	169.225	169.13	0.09
BLK309	10/19/2010	4672383.417	264723.953	183.974	183.93	0.04
BLK310	10/19/2010	4671432.607	267120.915	207.141	207.13	0.01
BLK311	10/19/2010	4659893.263	267303.829	251.692	251.71	-0.02
BLK312	10/19/2010	4659812.155	269138.779	213.646	213.65	0.00
BLK313	10/19/2010	4660121.479	273794.509	152.581	152.66	-0.08
BLK314	10/19/2010	4658148.997	270195.201	206.313	206.39	-0.08
BLK315	10/19/2010	4658586.174	271425.306	210.857	210.90	-0.04
BLK316	10/19/2010	4659520.912	275229.324	169.317	169.41	-0.09
BLK317	10/19/2010	4657423.611	271242.829	193.949	194.09	-0.14
BLK318	10/19/2010	4656671.08	273800.320	160.319	160.40	-0.08
BLK319	10/19/2010	4654988.602	271634.816	223.352	223.50	-0.15
BLK320	10/19/2010	4654850.045	275157.630	136.846	136.99	-0.14
BLK321	11/21/2010	4688795.695	267898.982	214.183	214.02	0.16
BLK322	11/21/2010	4689729.573	273273.903	142.443	142.34	0.10
BLK323	11/21/2010	4683330.662	275385.617	167.748	167.78	-0.03
BLK324	11/21/2010	4683530.678	260183.752	326.264	326.26	0.00
BLK325	11/21/2010	4690002.242	264377.276	267.113	267.17	-0.06

<b><math>\Delta Z</math> Mean</b>	<b>0.07</b>		
<b><math>\Delta Z</math> Min</b>	<b>-0.15</b>	<b>RMSE:</b>	<b>0.085</b>
<b><math>\Delta Z</math> Max</b>	<b>0.16</b>	<b>* 1.96</b>	<b>0.167</b>

UTM Zone 19 North, NAD83, NAVD88

MSL = NAVD88/Geoid09

All units in meters

### Note:

All 25 of the FVA points (open terrain) passed. 100% of the points are within the 24.5 cm confidence level. The FVA test is passed.



## CVA Test Details

SVA-Points	Typ	Date	Northing (GPS)	Easting (GPS)	MSL (GPS)	MSL (LiDAR)	Δ Z
BLK401	O	11/18/2010	4659936.674	268454.961	237.654	237.67	0.02
BLK402	O	11/18/2010	4660585.896	274832.793	156.109	156.10	-0.01
BLK403	O	11/18/2010	4658632.905	273299.845	176.752	176.79	0.04
BLK404	O	11/18/2010	4655861.719	271837.606	228.827	228.82	-0.01
BLK405	O	11/18/2010	4656143.669	275499.147	143.111	143.14	0.03
BLK701	F	12/5/2010	4675791.862	264249.616	182.963	182.98	0.02
BLK702	F	12/5/2010	4675578.769	265078.619	170.043	170.06	0.02
BLK703	F	12/5/2010	4674212.220	266904.815	158.432	158.44	0.01
BLK704	F	12/5/2010	4675076.628	261825.420	225.523	225.58	0.06
BLK705	F	12/5/2010	4674748.227	264648.160	179.003	179.04	0.04
BLK706	F	12/5/2010	4673988.761	266149.237	172.501	172.56	0.06
BLK707	F	12/5/2010	4674123.354	262951.991	193.974	194.05	0.08
BLK708	F	12/5/2010	4673138.827	263783.434	236.081	236.21	0.13
BLK709	F	12/5/2010	4672322.972	266225.415	183.705	183.74	0.03
BLK710	F	12/5/2010	4672255.701	266244.404	187.822	187.96	0.14
BLK711	F	12/5/2010	4659942.238	268427.943	237.038	237.29	0.25
BLK712	F	4/1/2011	4660283.362	272073.356	201.033	201.34	0.31
BLK713	F	4/1/2011	4659719.347	275395.389	162.902	163.14	0.24
BLK714	F	12/5/2010	4658562.800	271449.271	210.476	210.64	0.16
BLK715	F	12/5/2010	4658572.905	273281.203	186.561	186.77	0.21
BLK716	F	12/5/2010	4657857.088	275174.713	178.937	179.18	0.24
BLK717	F	12/5/2010	4655864.858	272222.828	212.640	212.81	0.17
BLK718	F	12/5/2010	4656921.563	274209.750	156.280	156.60	0.32
BLK719	F	4/1/2011	4655006.133	271615.572	222.887	223.19	0.30
BLK720	F	12/5/2010	4654872.821	275194.497	136.580	136.79	0.21
BLK721	F	11/21/2010	4689724.370	273304.835	141.600	141.71	0.11
BLK722	F	11/21/2010	4689752.231	273264.212	143.208	143.15	-0.06
BLK723	F	11/21/2010	4687298.947	261213.830	424.195	424.01	-0.19
BLK801	U	12/5/2010	4676221.578	264767.784	173.664	173.59	-0.07
BLK802	U	12/5/2010	4676084.534	265698.839	157.073	157.02	-0.05
BLK803	U	12/5/2010	4674987.104	265132.366	164.262	164.23	-0.03
BLK804	U	12/5/2010	4674764.197	266566.244	159.454	159.36	-0.09
BLK805	U	12/5/2010	4674190.856	264031.679	191.576	191.55	-0.03
BLK806	U	11/21/2010	4683245.411	270886.452	149.684	149.49	-0.19
BLK807	U	11/21/2010	4687774.686	259206.339	349.767	349.87	0.10

<b>Z Mean</b>	<b>0.12</b>	<b>RMSE:</b>	<b>0.152</b>
<b>Z Min:</b>	<b>-0.19</b>	<b>* 1.9600</b>	<b>0.297</b>
<b>Z Max:</b>	<b>0.32</b>	<b>95 Percentile</b>	<b>0.304</b>

Land Class Types: O = Open, F = Forest, U = Urban



*UTM Zone 19 North, NAD83, NAVD88*

*MSL = NAVD88/Geoid09*

*All units in meters*

Note:

All 35 of the SVA points (open, forest, and urban terrain) passed. 100% of the points are within the 36.3 cm confidence level. The CVA test is passed.

BLACKSTONE, MA										
SVA-Points	Typ	Date	Latitude	Longitude	Northing (GPS)	Easting (GPS)	MSL (GPS)	MSL (LiDAR)	$\Delta Z$	$\Delta Z^2$
BLK401	O	11/18/2010	42.0573837	-71.7982423	4659936.674	268454.961	237.654	237.67	0.02	0.000
BLK402	O	11/18/2010	42.0650771	-71.7215005	4660585.896	274832.793	156.109	156.10	-0.01	0.000
BLK403	O	11/18/2010	42.0470668	-71.7392524	4658632.905	273299.845	176.752	176.79	0.04	0.001
BLK404	O	11/18/2010	42.0217138	-71.7558232	4655861.719	271837.606	228.827	228.82	-0.01	0.000
BLK405	O	11/18/2010	42.0253033	-71.7117540	4656143.669	275499.147	143.111	143.14	0.03	0.001
BLK701	F	12/5/2010	42.1987558	-71.8554069	4675791.862	264249.616	182.963	182.98	0.02	0.000
BLK702	F	12/5/2010	42.1970884	-71.8452920	4675578.769	265078.619	170.043	170.06	0.02	0.000
BLK703	F	12/5/2010	42.1853420	-71.8226524	4674212.220	266904.815	158.432	158.44	0.01	0.000
BLK704	F	12/5/2010	42.1915880	-71.8844401	4675076.628	261825.420	225.523	225.58	0.06	0.003
BLK705	F	12/5/2010	42.1894881	-71.8501634	4674748.227	264648.160	179.003	179.04	0.04	0.001
BLK706	F	12/5/2010	42.1831065	-71.8317015	4673988.761	266149.237	172.501	172.56	0.06	0.003
BLK707	F	12/5/2010	42.1833554	-71.8704250	4674123.354	262951.991	193.974	194.05	0.08	0.006
BLK708	F	12/5/2010	42.1747508	-71.8599698	4673138.827	263783.434	236.081	236.21	0.13	0.017
BLK709	F	12/5/2010	42.1681448	-71.8301114	4672322.972	266225.415	183.705	183.74	0.03	0.001
BLK710	F	12/5/2010	42.1675454	-71.8298548	4672255.701	266244.404	187.822	187.96	0.14	0.019
BLK711	F	12/5/2010	42.0574258	-71.7985706	4659942.238	268427.943	237.038	237.29	0.25	0.064
BLK712	F	4/1/2011	42.0615600	-71.7546978	4660283.362	272073.356	201.033	201.34	0.31	0.094
BLK713	F	4/1/2011	42.0574422	-71.7143757	4659719.347	275395.389	162.902	163.14	0.24	0.057
BLK714	F	12/5/2010	42.0459004	-71.7615609	4658562.800	271449.271	210.476	210.64	0.16	0.027
BLK715	F	12/5/2010	42.0465216	-71.7394542	4658572.905	273281.203	186.561	186.77	0.21	0.044
BLK716	F	12/5/2010	42.0406254	-71.7163253	4657857.088	275174.713	178.937	179.18	0.24	0.059
BLK717	F	12/5/2010	42.0218536	-71.7511767	4655864.858	272222.828	212.640	212.81	0.17	0.029
BLK718	F	12/5/2010	42.0319327	-71.7276110	4656921.563	274209.750	156.280	156.60	0.32	0.102
BLK719	F	4/1/2011	42.0139524	-71.7581691	4656411.082	768437.200	222.887	223.19	0.30	0.092
BLK720	F	12/5/2010	42.0137831	-71.7149431	4655006.133	271615.572	136.580	136.79	0.21	0.044
BLK721	F	11/21/2010	42.3267675	-71.7513029	4689724.370	273304.835	141.600	141.71	0.11	0.012
BLK722	F	11/21/2010	42.3270063	-71.7518063	4689752.231	273264.212	143.208	143.15	-0.06	0.003
BLK723	F	11/21/2010	42.3013391	-71.8968670	4687298.947	261213.830	424.195	424.01	-0.19	0.034
BLK801	U	12/5/2010	42.2027772	-71.8493122	4676221.578	264767.784	173.664	173.59	-0.07	0.005
BLK802	U	12/5/2010	42.2018239	-71.8379928	4676084.534	265698.839	157.073	157.02	-0.05	0.003
BLK803	U	12/5/2010	42.1917823	-71.8444030	4674987.104	265132.366	164.262	164.23	-0.03	0.001
BLK804	U	12/5/2010	42.1902063	-71.8269689	4674764.197	266566.244	159.454	159.36	-0.09	0.009
BLK805	U	12/5/2010	42.1842888	-71.8573942	4674190.856	264031.679	191.576	191.55	-0.03	0.001
BLK806	U	11/21/2010	42.2677780	-71.7780561	4683245.411	270886.452	149.684	149.49	-0.19	0.038



[illegible]

BLACKSTONE, MASSACHUSETTS							
FVA-Points	Date	Northing (GPS)	Easting (GPS)	MSL (GPS)	MSL (LiDAR)	$\Delta Z$	$\Delta Z^2$
BLK301	10/19/2010	4676325.404	262633.315	216.065	215.92	0.14	0.021
BLK302	10/19/2010	4676429.711	265265.384	176.918	176.91	0.01	0.000
BLK303	10/19/2010	4676330.778	266949.246	175.503	175.52	-0.02	0.000
BLK304	10/19/2010	4674610.586	261440.257	221.339	221.28	0.06	0.003
BLK305	10/19/2010	4674581.889	264218.053	191.433	191.48	-0.05	0.002
BLK306	10/19/2010	4675125.291	266802.673	164.545	164.51	0.04	0.001
BLK307	10/19/2010	4673426.518	262653.193	193.648	193.62	0.03	0.001
BLK308	10/19/2010	4673866.202	266108.635	169.225	169.13	0.09	0.009
BLK309	10/19/2010	4672383.417	264723.953	183.974	183.93	0.04	0.002
BLK310	10/19/2010	4671432.607	267120.915	207.141	207.13	0.01	0.000
BLK311	10/19/2010	4659893.263	267303.829	251.692	251.71	-0.02	0.000
BLK312	10/19/2010	4659812.155	269138.779	213.646	213.65	0.00	0.000
BLK313	10/19/2010	4660121.479	273794.509	152.581	152.66	-0.08	0.006
BLK314	10/19/2010	4658148.997	270195.201	206.313	206.39	-0.08	0.006
BLK315	10/19/2010	4658586.174	271425.306	210.857	210.90	-0.04	0.002
BLK316	10/19/2010	4659520.912	275229.324	169.317	169.41	-0.09	0.009
BLK317	10/19/2010	4657423.611	271242.829	193.949	194.09	-0.14	0.020
BLK318	10/19/2010	4656671.08	273800.320	160.319	160.40	-0.08	0.007
BLK319	10/19/2010	4654988.602	271634.816	223.352	223.50	-0.15	0.022
BLK320	10/19/2010	4654850.045	275157.630	136.846	136.99	-0.14	0.021
BLK321	11/21/2010	4688795.695	267898.982	214.183	214.02	0.16	0.027
BLK322	11/21/2010	4689729.573	273273.903	142.443	142.34	0.10	0.011
BLK323	11/21/2010	4683330.662	275385.617	167.748	167.78	-0.03	0.001
BLK324	11/21/2010	4683530.678	260183.752	326.264	326.26	0.00	0.000
BLK325	11/21/2010	4690002.242	264377.276	267.113	267.17	-0.06	0.003
			$\Delta Z$ Mean	0.07			
			$\Delta Z$ Min	-0.15	RMSE:	0.085	
			$\Delta Z$ Max	0.16	* 1.96	0.167	
Metadata							
UTM 19 North, NAD83, NAVD88							
All units in meters where applicable.							
HAE - GEOID09 = NAVD88							



# Region 1: Test results for Charles, Narragansett and adjoining Blackstone areas, MA

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## Summary

In FEMA-Region 1 the areas of Charles, Narragansett and partially Blackstone encompasses in total about 560 square miles. A LiDAR data acquisition was ordered for a 2' equivalent contour accuracy, which equals the highest specification level. The area was flown and post-processed by Photo Science. CompassData performed the quality control of the collected and processed LiDAR data with a fundamental vertical accuracy (FVA) and a consolidated vertical accuracy (CVA) assessment, respectively. The planning, data collection, data processing, and data testing were successfully accomplished by the STARR members.

## Index

- Final Test Results
- FVA Test
- CVA Test
- Distribution of Testing Points
- FVA Test Details
- CVA Test Details

## Final Test Results

**The vertical accuracy requirements based on flood risk and terrain slope are met with 16.6 cm and 18.6 cm for both FVA and CVA testing. The mandatory requirements for the highest specification for vertical accuracy, 95% confidence level are for FVA < 24.5 cm and CVA < 36.3 cm.**

## FVA Test

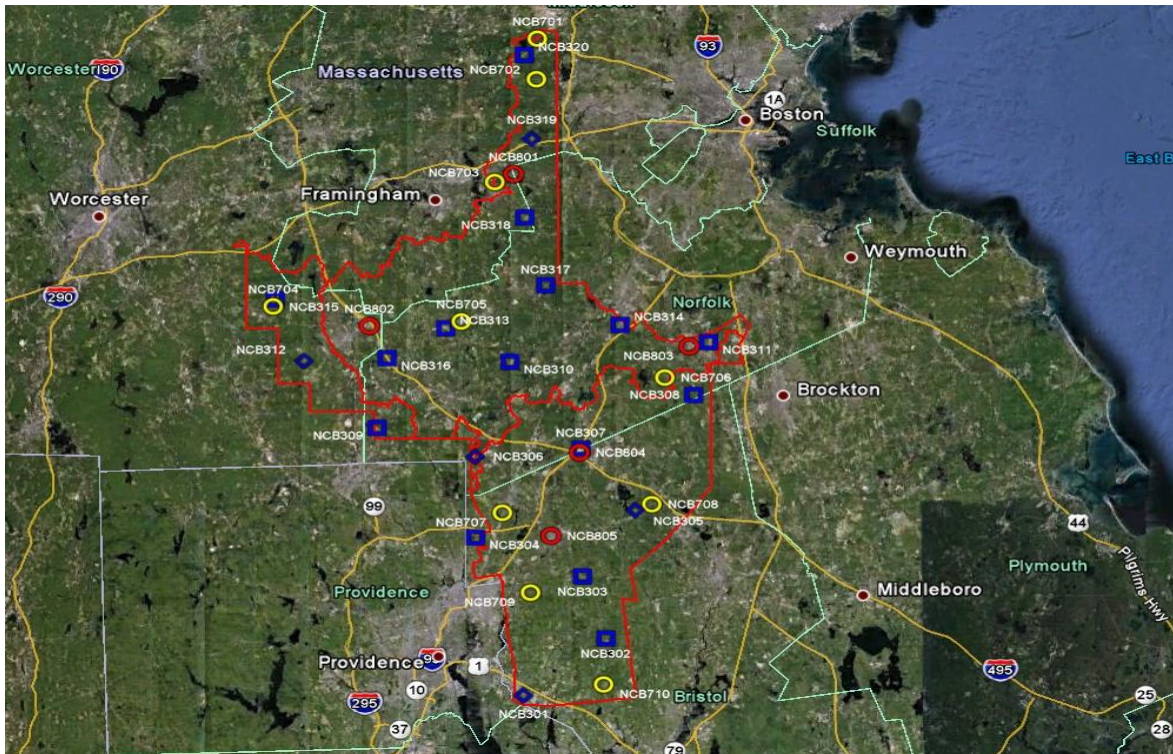
Tested 16.6 cm fundamental vertical accuracy at 95% confidence level in open terrain using  $RMSE_{(Z)} \times 1.9600$ . The Root Mean Square Error for the elevation differences between GPS control points and LiDAR points is 8.5 cm calculated with 20 FVA points.



## CVA Test






Tested 18.6 cm consolidated vertical accuracy at 95th percentile in: open terrain, forest terrain, and urban terrain. The Root Mean Square Error for the elevation differences between GPS control points and LiDAR points is 9.4 cm calculated with 20 supplemental vertical accuracy points (SVA).

## Distribution of Testing Points



## Region 1, Blackstone, MA

### Legend:

-  FVA points in open terrain on hard surface
-  FVA points in open terrain used as well in CVA test
-  SVA points in open terrain
-  SVA points in urban terrain
-  SVA points in forest terrain





According to the area to be tested the 20 FVA points are evenly distributed. Additional 20 SVA points are distributed in respect to the available major land classes.

## FVA Test Details

FVA-Points	Date	Northing (GPS)	Easting (GPS)	MSL (GPS)	MSL (LiDAR)	$\Delta Z$
NCB301	10/17/2010	4628494.838	307533.374	10.029	10.00	0.03
NCB302	10/17/2010	4634605.935	315513.463	34.915	34.84	0.07
NCB303	10/17/2010	4641539.998	313490.146	44.364	44.31	0.05
NCB304	10/17/2010	303502.475	4646143.418	36.592	36.58	0.01
NCB305	10/17/2010	4648736.941	318721.900	31.321	31.36	-0.04
NCB306	10/17/2010	303764.026	4655080.966	104.193	104.13	0.06
NCB307	10/17/2010	4655700.389	313765.162	65.519	65.44	0.08
NCB308	10/17/2010	4661311.798	324586.148	70.294	70.28	0.01
NCB309	10/15/2010	294547.718	4658540.495	92.074	92.13	-0.06
NCB310	10/17/2010	4665489.855	307320.864	75.617	75.54	0.08
NCB311	10/15/2010	4667120.100	326162.869	71.197	71.12	0.08
NCB312	10/15/2010	287856.380	4666140.866	152.275	152.33	-0.06
NCB313	10/17/2010	4669381.293	301359.001	62.492	62.54	-0.05
NCB314	10/16/2010	4669278.445	317849.221	40.964	40.91	0.05
NCB315	10/15/2010	4675576.809	298445.293	97.177	97.31	-0.13
NCB316	10/15/2010	4666242.506	295717.649	69.524	69.35	0.17
NCB317	10/17/2010	4673867.749	310950.283	69.647	69.53	0.12
NCB318	10/17/2010	4681441.377	309177.060	56.169	56.31	-0.14
NCB319	10/17/2010	4690139.969	310102.157	62.979	63.09	-0.11
NCB320	10/16/2010	4699469.255	309660.020	66.862	66.93	-0.07

<b>Z Mean</b>	<b>0.07</b>	<b>RMSE:</b>	<b>0.085</b>
<b>Z Min:</b>	<b>-0.14</b>	<b>* 1.9600</b>	<b>0.166</b>
<b>Z Max:</b>	<b>0.17</b>		

UTM Zone 19 North, NAD83, NAVD88

MSL = NAVD88/Geoid09

All units in meters

### Note:

All 20 of the FVA points (open terrain) passed. 100% of the points are within the 24.5 cm confidence level. The FVA test is passed.



## CVA Test Details

CVAs	Typ	Date	Northing (GPS)	Easting (GPS)	MSL (GPS)	MSL (LiDAR)	Δ Z
NCB301	O	10/17/2010	4628494.838	307533.374	10.029	10.00	0.03
NCB305	O	10/17/2010	4648736.941	318721.900	31.321	31.35	-0.03
NCB306	O	10/17/2010	4655080.966	303764.026	104.193	104.13	0.06
NCB312	O	10/15/2010	4666140.866	287856.380	152.275	152.35	-0.08
NCB319	O	10/17/2010	4690139.969	310102.157	62.979	63.10	-0.12
NCB701	F	11/21/2010	4701210.743	310945.898	83.864	84.05	-0.19
NCB702	F	11/21/2010	4696716.338	310730.807	41.222	41.41	-0.19
NCB703	F	11/21/2010	4685420.328	306465.675	66.446	66.49	-0.04
NCB704	F	11/21/2010	4672245.549	285112.761	87.663	87.72	-0.06
NCB705	F	11/21/2010	4670062.450	302862.852	42.068	42.05	0.02
NCB706	F	11/21/2010	4663291.743	321927.411	93.695	93.75	-0.06
NCB707	F	11/21/2010	4648766.875	306139.995	60.485	60.45	0.03
NCB708	F	11/21/2010	4649309.082	320298.206	24.906	25.03	-0.12
NCB709	F	11/21/2010	4639847.906	308544.841	34.154	34.29	-0.14
NCB710	F	11/21/2010	4629478.233	315161.002	30.520	30.62	-0.10
NCB801	U	11/21/2010	4686251.323	308267.450	38.909	38.90	0.01
NCB802	U	11/21/2010	4669813.904	294164.121	83.204	83.32	-0.12
NCB803	U	11/21/2010	4666682.629	324338.796	56.482	56.53	-0.05
NCB804	U	11/21/2010	4655225.613	313637.080	59.767	59.70	0.07
NCB805	U	11/21/2010	4646074.360	310663.867	38.840	38.76	0.08

<b>Z Mean</b>	<b>-0.11</b>	<b>RMSE:</b>	<b>0.094</b>
<b>Z Min:</b>	<b>-0.19</b>	<b>* 1.9600</b>	<b>0.184</b>
<b>Z Max:</b>	<b>0.08</b>	<b>95-Percentile</b>	<b>0.186</b>

Land Class Types: O = Open, F = Forest, U = Urban

UTM Zone 19 North, NAD83, NAVD88

MSL = NAVD88/Geoid09

All units in meters

### Note:

All 20 of the SVA points (open, forest, and urban terrain) passed. 100% of the points are within the 36.3 cm confidence level. The CVA test is passed.



CHARLES/NARRAGANSETT/BLACKSTONE, MASSACHUSETTS										
CVA Testing @ 36.3cm Req'd Accuracy										
CVAs	Typ	Date	Latitude	Longitude	Northing (GPS)	Easting (GPS)	MSL (GPS)	MSL (LiDAR)	$\Delta Z$	$\Delta Z^2$
NCB301	O	10/17/2010	41.7849682	-71.3161281	4628494.838	307533.374	10.029	10.00	<b>0.03</b>	0.00086
NCB305	O	10/17/2010	41.9697882	-71.1877914	4648736.941	318721.900	31.321	31.35	<b>-0.03</b>	0.00085
NCB306	O	10/17/2010	42.0232970	-71.3702887	4655080.966	303764.026	104.193	104.13	<b>0.06</b>	0.00395
NCB312	O	10/15/2010	42.1186816	-71.5662622	4666140.866	287856.380	152.275	152.35	<b>-0.08</b>	0.00568
NCB319	O	10/17/2010	42.3403519	-71.3052306	4690139.969	310102.157	62.979	63.10	<b>-0.12</b>	0.01466
NCB701	F	11/21/2010	42.4401810	71.2986303	4701210.743	310945.898	83.864	84.05	<b>-0.19</b>	0.03460
NCB702	F	11/21/2010	42.3996846	71.2997642	4696716.338	310730.807	41.222	41.41	<b>-0.19</b>	0.03534
NCB703	F	11/21/2010	42.2969861	71.3477593	4685420.328	306465.675	66.446	66.49	<b>-0.04</b>	0.00194
NCB704	F	11/21/2010	42.1728595	71.6016680	4672245.549	285112.761	87.663	87.72	<b>-0.06</b>	0.00325
NCB705	F	11/21/2010	42.1578859	71.3862152	4670062.450	302862.852	42.068	42.05	<b>0.02</b>	0.00032
NCB706	F	11/21/2010	42.1015156	71.1535517	4663291.743	321927.411	93.695	93.75	<b>-0.06</b>	0.00303
NCB707	F	11/21/2010	41.9670644	71.3395303	4648766.875	306139.995	60.485	60.45	<b>0.03</b>	0.00122
NCB708	F	11/21/2010	41.9752985	71.1689555	4649309.082	320298.206	24.906	25.03	<b>-0.12</b>	0.01538
NCB709	F	11/21/2010	41.8873862	71.3076352	4639847.906	308544.841	34.154	34.29	<b>-0.14</b>	0.01850
NCB710	F	11/21/2010	41.7956325	71.2247122	4629478.233	315161.002	30.520	30.62	<b>-0.10</b>	0.01000
NCB801	U	11/21/2010	42.3049093	71.3261950	4686251.323	308267.450	38.909	38.90	<b>0.01</b>	0.00008
NCB802	U	11/21/2010	42.1534120	71.4913255	4669813.904	294164.121	83.204	83.32	<b>-0.12</b>	0.01346
NCB803	U	11/21/2010	42.1325780	71.1254288	4666682.629	324338.796	56.482	56.53	<b>-0.05</b>	0.00230
NCB804	U	11/21/2010	42.0269989	71.2511718	4655225.613	313637.080	59.767	59.70	<b>0.07</b>	0.00449
NCB805	U	11/21/2010	41.9439323	71.2841122	4646074.360	310663.867	38.840	38.76	<b>0.08</b>	0.00640
						<b>Z Mean</b>	<b>-0.11</b>	<b>RMSE:</b>		<b>0.094</b>
						<b>Z Min:</b>	<b>-0.19</b>	<b>* 1.9600</b>		<b>0.184</b>
						<b>Z Max:</b>	<b>0.08</b>	<b>95-Percentile</b>		<b>0.186</b>
<b>Metadata</b>										
UTM 19 North, NAD83, NAVD88										
All units in meters where applicable.										
HAE - GEOID09 = NAVD88										



[illegible]

## **Appendix E: Post Flight Reports**

March 30, 2011

Post Flight Report  
PSI Project 7556-005  
Blackstone, MA LiDAR

FEMA Task Order Number: HSFEHQ-10-J0005

Client: STARR (Project Number: 40000058)

Project Name: Blackstone

Attached Reference files: 7556-005 Blackstone\_MA\_Background  
7556-005\_Bed-Charles\_MA\_Background.ZIP  
7556-005\_Orh-Charles\_MA\_Background.ZIP  
7556-005\_1B9-Narragansett\_MA\_Background.ZIP  
7556-005\_SFZ-Blackstone\_MA\_Background.ZIP

General Specifications: 1-meter nominal spacing LiDAR Acquisition and processing with a 24.5 cm vertical accuracy at 95% confidence level.

Acquisition Dates: LiDAR data for the Blackstone area was acquired over several different dates and encompassed four (4) sub-block areas. Data for these areas are included in the background files listed above and a part of this report.

Equipment Used: The data was collected with Optech Gemini LiDAR systems, Serial Numbers 246 and 247, Base GPS Receiver used was a Trimble 5700 collecting data at half second intervals. The aircraft used were Cessna 206 models, tail numbers N2448G and N7266Z. The pilots were Cameron Caldwell, Mark Young and Nick Greenwell and the Operators were Jeremy Berry and Nathan Galieti. This information is also included in the background files attached and included as a part of this report.

Project: The project was flown at an altitude of 5,000 feet above ground and at a planned average speed of 116 knots with a field of view of 36 degrees. The scan rates used was 30.1 Hz with a Laser Pulse Rate of 71,429 Hz with Multi-Pulse enabled. The full swath width was 989.18 meters with a planned sidelap of 30%. The point spacing was <1 meter with a NADIR point density of 1.2 points per square meter and an average point density of 3.03 points per square meter. The area covered consisted of 285.53 square miles.

GPS Base Station / Monument: The Base Stations used are included in the area reports attached.

Control: 18 control points were collected as part of the project and used to calibrate the project data, remove any bias and verify accuracy. This data is compared to the collected model and results indicated below. This control data is included in the attached .ZIP file under “Control”.

Flight Files: The planned flight files are included as reference in the attached .ZIP file under “Flight Files” for each of the sub-blocks.

Flight Logs: Flight Logs used by the crew are included in the attached .ZIP file under “Flight Logs” for each sub-block and include the following type information:

- job #/name
- block or AOI
- date (s) flown
- aircraft tail #
- lines - #
- lines - direction
- lines – altitude
- lines – speed
- conditions
- comments
- pilot name
- operator name
- AGC switch
- GPS base station used

Processing Summary: Data is included in the attached .ZIP file under “Processing Summary” for each sub-block and includes the GPS / IMU processing summary data including at a minimum:

- Processing Logs
- Message Logs
- Extract Logs
- Laser configuration files for each lift
- Max Horizontal GPS Variance (cm)
- Max Vertical GPS Variance (cm)
- Notes on GPS quality (High, Good, etc.)
- GPS separation plot
- GPS altitude plot
- PDOP plot
- Plot of GPS distance from base station/s

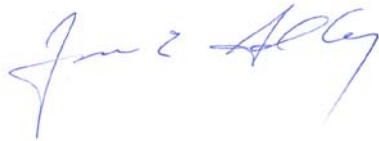


Project Coverage: within the attached .ZIP file in the “Project Coverage” directory is the overall boundary Shape File and the as flown trajectory Shape Files which include the project calibration flight lines (cross flights) for each sub-block.

Accuracy: The LiDAR data was tested against the Control check points indicated above and the results are included in the “Accuracy Results” directory in the attached .ZIP file. All control points in the Blackstone area and the surrounding project areas were used to generate the accuracy results.

The LiDAR data as collected tested at 0.095 (meters) fundamental vertical accuracy at 95% confidence level. Within the accuracies indicated in the specifications, as provided.

Sincerely,

A handwritten signature in blue ink, appearing to read "Forrest Godby". The signature is fluid and cursive, with the first name "Forrest" being more prominent than the last name "Godby".

Forrest Godby  
Senior Project Manager / Flight Operations Manager

March 29, 2011

Post Flight Report  
PSI Project 7556-005  
SFZ\_Blackstone LiDAR

CONTRACT: \_\_\_\_\_

Client: \_\_\_\_\_

Project Name: SFZ Blackstone sub-block

Attached Reference file: 7556-005\_SFZ-Blackstone\_MA\_Background.ZIP

General Specifications: 1-meter nominal spacing LiDAR Acquisition and processing with a 24.5 cm vertical accuracy at 95% confidence level.

Acquisition Dates: LiDAR data for the SFZ\_Blackstone data was acquired on the dates of 12/15, 12/16 and 12/17 2010 over 5 lifts by two different Aircraft.

Equipment Used: The data was collected with Optech Gemini LiDAR systems, Serial Numbers 246 and 247; Base GPS Receiver used was a Trimble 5700 collecting data at half second intervals. The aircraft used were Cessna 206 models, tail numbers N2448G and N7266Z. The pilots were Mark Young and Nick Greenwell and the Operators were Jeremy Berry and Nathan Galieti. The Base Station was set on the monument "Central, LW0418" at the North Central State Airport (SFZ) and was set by the flight crew.

Project: The project consisted of 40 flight lines of 355.00 miles. The project was flown at an altitude of 5,000 feet above ground and at a planned average speed of 116 knots with a field of view of 36 degrees. The scan rates used was 30.1 Hz with a Laser Pulse Rate of 71,429 Hz with Multi-Pulse enabled. The full swath width was 989.18 meters with a planned sidelap of 30%. The point spacing was <1 meter with a NADIR point density of 1.2 points per square meter and an average point density of 3.03 points per square meter. The planned vertical accuracy was 0.13 meters. The area consisted of 155 square miles.

GPS Base Station / Monument: The Base Station was set on the monument "Central, LW0418" at the North Central State Airport (SFZ) and was set by the flight crew. Information on this monument is included in the attached .ZIP file under "Base Station Data".

Control: 17 control points were collected as part of the project and used to calibrate the project data, remove any bias and verify accuracy. This data is compared to the collected model and results indicated below. This control data is included in the attached .ZIP file under "Control".

Flight Files: The planned flight files are included as reference in the attached .ZIP file under “Flight Files”.

Flight Logs: Flight Logs used by the crew are included in the attached .ZIP file under “Flight Logs” and include the following type information:

- job #/name
- block or AOI
- date (s) flown
- aircraft tail #
- lines - #
- lines - direction
- lines – altitude
- lines – speed
- conditions
- comments
- pilot name
- operator name
- AGC switch
- GPS base station used

Processing Summary: Data is included in the attached .ZIP file under “Processing Summary” which includes GPS / IMU processing summary data including at a minimum:

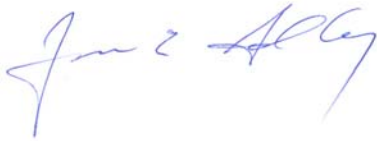
- Processing Logs
- Message Logs
- Extract Logs
- Laser configuration files for each lift
- Max Horizontal GPS Variance (cm)
- Max Vertical GPS Variance (cm)
- Notes on GPS quality (High, Good, etc.)
- GPS separation plot
- GPS altitude plot
- PDOP plot
- Plot of GPS distance from base station/s

Project Coverage: within the attached .ZIP file in the “Project Coverage” directory is the overall boundary Shape File and the as flown trajectory Shape Files which include the project calibration flight lines (cross flights).

Accuracy: The LiDAR data was tested against the Control check points indicated above and the results are included in the “Accuracy Results” directory in the attached .ZIP file.

The LiDAR data as collected tested at 0.095 (meters) fundamental vertical accuracy at 95% confidence level. Within the accuracies indicated in the specifications, as provided.

Sincerely,

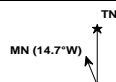
A handwritten signature in blue ink, appearing to read "Forrest Godby". The signature is fluid and cursive, with a large initial "F" and a stylized "G".

Forrest Godby  
Senior Project Manager / Flight Operations Manager

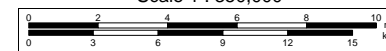




Data use subject to license.  
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www.delorme.com



Scale 1 : 350,000



---


$$1'' = 5.52 \text{ mi}$$

---

Data Zoom 9-2



# SFZ\_Blackstone Base Monument

See file [dsdata.txt](#) for more information about the datasheet.

DATABASE = ,PROGRAM = datasheet, VERSION = 7.85  
1 National Geodetic Survey, Retrieval Date = NOVEMBER 29, 2010  
LW0418 \*\*\*\*\*  
LW0418 FBN - This is a Federal Base Network Control Station.  
LW0418 DESIGNATION - CENTRAL  
LW0418 PID - LW0418  
LW0418 STATE/COUNTY- RI/PROVIDENCE  
LW0418 USGS QUAD - PAWTUCKET (1975)  
LW0418  
LW0418 \*CURRENT SURVEY CONTROL  
LW0418  
LW0418\* NAD 83(2007)- 41 55 08.78493(N) 071 29 16.22822(W) ADJUSTED  
LW0418\* NAVD 88 - 141.913 (meters) 465.59 (feet) ADJUSTED  
LW0418  
LW0418 EPOCH DATE - 2002.00  
LW0418 X - 1,509,134.136 (meters) COMP  
LW0418 Y - -4,507,147.660 (meters) COMP  
LW0418 Z - 4,238,997.637 (meters) COMP  
LW0418 LAPLACE CORR- 4.05 (seconds) DEFLEC09  
LW0418 ELLIP HEIGHT- 112.555 (meters) (02/10/07) ADJUSTED  
LW0418 GEOID HEIGHT- -29.37 (meters) GEOID09  
LW0418 DYNAMIC HT - 141.869 (meters) 465.45 (feet) COMP  
LW0418  
LW0418 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----  
LW0418 Type PID Designation North East Ellip  
LW0418 -----  
LW0418 NETWORK LW0418 CENTRAL 0.51 0.39 1.20  
LW0418 -----  
LW0418 MODELED GRAV- 980,308.1 (mgal) NAVD 88  
LW0418  
LW0418 VERT ORDER - SECOND CLASS 0  
LW0418  
LW0418.This mark is at North Central State Airport (SFZ)  
LW0418  
LW0418.The horizontal coordinates were established by GPS observations  
LW0418.and adjusted by the National Geodetic Survey in February 2007.  
LW0418  
LW0418.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).  
LW0418.See [National Readjustment](#) for more information.  
LW0418.The horizontal coordinates are valid at the epoch date displayed above.  
LW0418.The epoch date for horizontal control is a decimal equivalence  
LW0418.of Year/Month/Day.  
LW0418  
LW0418.The orthometric height was determined by differential leveling and  
LW0418.adjusted in June 1991.  
LW0418  
LW0418.[Photographs](#) are available for this station.  
LW0418  
LW0418.The X, Y, and Z were computed from the position and the ellipsoidal ht.  
LW0418  
LW0418.The Laplace correction was computed from DEFLEC09 derived deflections.

```
LW0418
LW0418.The ellipsoidal height was determined by GPS observations
LW0418.and is referenced to NAD 83.
LW0418
LW0418.The geoid height was determined by GEOID09.
LW0418
LW0418.The dynamic height is computed by dividing the NAVD 88
LW0418.geopotential number by the normal gravity value computed on the
LW0418.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
LW0418.degrees latitude (g = 980.6199 gals.).
LW0418
LW0418.The modeled gravity was interpolated from observed gravity values.
LW0418
LW0418;                North            East           Units Scale Factor Converg.
LW0418;SPC RI      -    92,823.524     101,008.637   MT    0.99999376   +0 00 29.2
LW0418;SPC RI      -    304,538.51       331,392.50   sFT    0.99999376   +0 00 29.2
LW0418;UTM 19      -    4,643,788.144     293,695.093   MT    1.00012376   -1 39 45.6
LW0418
LW0418!              - Elev Factor x Scale Factor = Combined Factor
LW0418!SPC RI        -    0.99998235 x 0.99999376 = 0.99997611
LW0418!UTM 19         -    0.99998235 x 1.00012376 = 1.00010610
LW0418
LW0418:               Primary Azimuth Mark                     Grid Az
LW0418:SPC RI          - CENTRAL AZ MK 2                         284 02 20.3
LW0418:UTM 19          - CENTRAL AZ MK 2                         285 42 35.1
LW0418
-----|-----
LW0418 | PID             Reference Object                   Distance           Geod. Az
LW0418 |                               dddmmss.s
LW0418 | LW0417 CENTRAL RM 1                                16.942 METERS 03324
LW0418 | CS6847 GREENVILLE WATER DIST TANK                    2434958.3
LW0418 | LW2763 AIRPORT BCN N CENTRAL ST APT                  181.893 METERS 27719
LW0418 | LW1771 CENTRAL AZ MK 2                             APPROX. 0.7 KM 2840249.5
LW0418 | LW0421 CENTRAL AZ MK                                    2962952.9
LW0418 | LW0419 CENTRAL RM 2                                 16.661 METERS 30524
LW0418 | LW1769 NORTH CENTRAL CBL 900                       480.129 METERS 3083751.7
LW0418 | -----|-----
LW0418
LW0418                                     SUPERSEDED SURVEY CONTROL
LW0418
LW0418 ELLIP H (06/22/01) 112.528 (m) GP( ) 4 1
LW0418 NAD 83(1996)- 41 55 08.78524(N) 071 29 16.22880(W) AD( ) B
LW0418 ELLIP H (07/24/97) 112.510 (m) GP( ) 1 1
LW0418 NAD 83(1992)- 41 55 08.78369(N) 071 29 16.22790(W) AD( ) B
LW0418 ELLIP H (04/16/93) 112.480 (m) GP( ) 4 1
LW0418 NAD 83(1986)- 41 55 08.78250(N) 071 29 16.22742(W) AD( ) 1
LW0418 NAD 27 - 41 55 08.42594(N) 071 29 18.01019(W) AD( ) 1
LW0418 NAVD 88 (04/16/93) 141.91 (m) 465.6 (f) LEVELING 3
LW0418 NGVD 29 (??/?/92) 142.153 (m) 466.38 (f) ADJ UNCH 2 0
LW0418
LW0418.Superseded values are not recommended for survey control.
LW0418.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
LW0418.See file dsdata.txt to determine how the superseded data were derived.
LW0418
LW0418_U.S. NATIONAL GRID SPATIAL ADDRESS: 19TBG9369543788(NAD 83)
LW0418_MARKER: DH = HORIZONTAL CONTROL DISK
LW0418_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
```

LW0418\_SP\_SET: CONCRETE POST  
 LW0418\_STAMPING: CENTRAL 1968  
 LW0418\_MARK LOGO: CGS  
 LW0418\_MAGNETIC: N = NO MAGNETIC MATERIAL  
 LW0418\_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO  
 LW0418+STABILITY: SURFACE MOTION  
 LW0418\_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR  
 LW0418+SATELLITE: SATELLITE OBSERVATIONS - August 10, 2010

LW0418	HISTORY	- Date	Condition	Report By
LW0418	HISTORY	- 1968	MONUMENTED	CGS
LW0418	HISTORY	- 1969	GOOD	NGS
LW0418	HISTORY	- 1975	GOOD	LOCENG
LW0418	HISTORY	- 1978	GOOD	NGS
LW0418	HISTORY	- 1985	GOOD	RIGS
LW0418	HISTORY	- 1985	GOOD	RIGS
LW0418	HISTORY	- 1987	GOOD	RIGS
LW0418	HISTORY	- 19880601	GOOD	NGS
LW0418	HISTORY	- 19890402	GOOD	RIGS
LW0418	HISTORY	- 19920506	GOOD	NGS
LW0418	HISTORY	- 19920630	GOOD	NGS
LW0418	HISTORY	- 19991206	GOOD	WOOLPT
LW0418	HISTORY	- 20000610	GOOD	NGS
LW0418	HISTORY	- 20030519	GOOD	INDIV
LW0418	HISTORY	- 20100810	GOOD	PB

LW0418  
 LW0418 STATION DESCRIPTION  
 LW0418

LW0418'DESCRIBED BY COAST AND GEODETIC SURVEY 1968 (LMC)  
 LW0418'STATION IS LOCATED ABOUT 7-1/2 MILES NORTHWEST OF PROVIDENCE, 6 MILES  
 LW0418'SOUTH OF WOONSOCKET, 1-1/2 MILES WEST OF STATE HIGHWAY 146 AND 0.1  
 LW0418'MILE EAST OF THE NORTH CENTRAL STATE AIRPORT TERMINAL BUILDING.

LW0418'  
 LW0418'TO REACH FROM THE JUNCTION OF STATE HIGHWAYS 116 AND 146 ABOUT 8  
 LW0418'MILES NORTH OF CENTER OF PROVIDENCE, GO WEST ON HIGHWAY 116 FOR 0.8  
 LW0418'MILES TO THE JUNCTION OF STATE HIGHWAY 123. TURN LEFT AND GO SOUTH  
 LW0418'ON HIGHWAY 123 (ALBINO ROAD) FOR 0.95 MILE TO A SIDE ROAD LEFT.  
 LW0418'(TO REACH THE AZIMUTH MARK FROM HERE CONTINUE AHEAD SOUTH PASSING  
 LW0418'THROUGH HANGAR AREA FOR 0.2 MILE TO THE TERMINAL BUILDING AND A GATE  
 LW0418'ON THE RIGHT. TURN RIGHT AND GO WEST PASSING THROUGH GATE AND  
 LW0418'CROSSING RUNWAYS FOR 0.3 MILE TO THE EDGE OF WOODS AND MARK ON  
 LW0418'RIGHT AS DESCRIBED.) BEAR LEFT KEEPING WITH HIGHWAY 123 AND  
 LW0418'GO EAST FOR 0.15 MILE TO A SIDE ROAD RIGHT LEADING TO THE NORTH  
 LW0418'CENTRAL STATE AIRPORT. TURN RIGHT AND GO SOUTH FOR 0.15  
 LW0418'MILE TO STATION ON LEFT AS DESCRIBED.

LW0418'  
 LW0418'STATION MARK, STAMPED CENTRAL 1968 IS SET IN A ROUND CONCRETE POST  
 LW0418'WHICH IS FLUSH WITH THE GROUND SURFACE. IT IS 98 FEET NORTH OF A  
 LW0418'PAVED ROAD, 74 FEET SOUTHEAST OF A PAVED ROAD AND 66.6 FEET EAST OF  
 LW0418'A METAL WITNESS POST.

LW0418'  
 LW0418'RM 1, STAMPED CENTRAL NO 1 1968 IS SET IN A DRILL HOLE IN A BOULDER  
 LW0418'WHICH PROJECTS ABOUT 4 INCHES ABOVE THE GROUND SURFACE AND IS 2 BY 4  
 LW0418'FOOT IN SIZE. IT IS 104 FEET EAST OF A LONE TREE AND 53 FEET  
 LW0418'SOUTHEAST OF A PAVED ROAD.

LW0418'  
 LW0418'RM 2, STAMPED CENTRAL NO 2 1968 IS SET IN A DRILL HOLE IN A BOULDER



LW0418'WHICH PROJECTS ABOUT 4 FEET ABOVE THE GROUND SURFACE AND IS 5 BY 7  
LW0418'FOOT IN SIZE. IT IS 65 FEET SOUTHEAST OF A PAVED ROAD, 45 FEET  
LW0418'EAST OF THE LONE TREE AND 13.9 FEET NORTHEAST OF A METAL WITNESS  
LW0418'POST.

LW0418'

LW0418'AZ MK, STAMPED CENTRAL 1968 IS SET IN A DRILL HOLE IN A BOULDER  
LW0418'WHICH PROJECTS 1 FOOT ABOVE THE GROUND SURFACE AND IS 5 BY 6 FOOT IN  
LW0418'SIZE. IT IS ABOUT 0.1 MILE WEST OF A NORTH-SOUTH RUNWAY, 0.05  
LW0418'MILE NORTH OF AN EAST-WEST RUNWAY, 43 FEET SOUTHEAST OF A 12-INCH  
LW0418'OAK TREE AND 3 FEET NORTHEAST OF A METAL WITNESS POST.

LW0418'

LW0418'HEIGHT OF LIGHT ABOVE STATION MARK 22 METERS.

LW0418

LW0418

STATION RECOVERY (1969)

LW0418

LW0418'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1969

LW0418'9.4 MI NW FROM PROVIDENCE.

LW0418'ABOUT 7.4 MILES NORTH ALONG CHARLES STREET AND STATE HIGHWAY 146  
LW0418'FROM THE INTERSTATE HIGHWAY 95 OVERPASS OVER CHARLES STREET,  
LW0418'THENCE 0.8 MILE WEST ALONG STATE HIGHWAY 116, THENCE 1.1 MILES  
LW0418'SOUTH ALONG STATE HIGHWAY 123, THENCE 0.15 MILE SOUTHWEST ALONG  
LW0418'THE DRIVEWAY TO THE NORTH CENTRAL STATE AIRPORT, ABOUT 0.1  
LW0418'MILE EAST OF THE ADMINISTRATION BUILDING, ON A HIGH BANK BETWEEN  
LW0418'THE TWO DRIVES TO THE AIRPORT, 98.8 FEET NORTHEAST OF THE  
LW0418'NORTHEAST CORNER OF A CATCH BASIN, 74 FEET NORTH OF THE CENTER  
LW0418'LINE OF THE EASTBOUND LANE OF THE DRIVE, 8 FEET ABOVE THE  
LW0418'LEVEL OF THE DRIVE AND SET IN THE TOP OF A CONCRETE POST  
LW0418'FLUSH WITH THE GROUND.

LW0418

LW0418

STATION RECOVERY (1975)

LW0418

LW0418'RECOVERY NOTE BY LOCAL ENGINEER (INDIVIDUAL OR FIRM) 1975

LW0418'STATION MARK WAS RECOVERED IN GOOD CONDITION. THERE IS NO

LW0418'WITNESS POST, NONE NEEDED.

LW0418'

LW0418'RM 1 WAS RECOVERED IN GOOD CONDITION. THERE IS NO LONE TREE.

LW0418'

LW0418'RM 2 WAS RECOVERED IN POOR CONDITION, NOT ABLE TO READ.

LW0418'

LW0418'AZIMUTH MARK WAS BLOCKED BY NEW CONSTRUCTION, STATE SETTING NEW  
LW0418'ONE.

LW0418

LW0418

STATION RECOVERY (1978)

LW0418

LW0418'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1978 (CLN)

LW0418'THE STATION MARK, REFERENCE MARKS 1 AND 2 AND THE AZIMUTH MARK WERE

LW0418'RECOVERED IN GOOD CONDITION. A HANGAR WAS BUILT ON LINE TO THE

LW0418'AZIMUTH MARK SO AZIMUTH MARK 2 WAS ESTABLISHED AT THIS TIME WITH A

LW0418'POLARIS OBSERVATION. THE DISTANCES AND DIRECTIONS TO THE REFERENCE

LW0418'MARKS CHECKED. A NEW DESCRIPTION FOLLOWS.

LW0418'

LW0418'THE STATION IS LOCATED ABOUT 7.5 MILES NORTHWEST OF PROVIDENCE, 6

LW0418'MILES SOUTH OF WOONSOCKET AND 0.1 MILE EAST OF THE NORTH CENTRAL STATE

LW0418'AIRPORT TERMINAL BUILDING.

LW0418'

LW0418'TO REACH THE STATION FROM THE JUNCTION OF STATE HIGHWAYS 146 AND 116

LW0418'ABOUT 8 MILES NORTH OF PROVIDENCE, GO WEST ON HIGHWAY 116 FOR 0.8 MILE

LW0418' TO A CROSSROAD. TURN LEFT AND GO SOUTH ON HIGHWAY 123 FOR 0.95 MILE  
LW0418' TO A FORK. TO REACH AZIMUTH MARKS FROM THIS POINT GO SOUTH ON THE  
LW0418' PAVED ROAD FOR 0.2 MILE TO THE TERMINAL BUILDING. TURN RIGHT THROUGH  
LW0418' GATE AND GO WESTERLY CROSSING THE NORTHEAST-SOUTHWEST RUNWAY FOR ABOUT  
LW0418' 0.3 MILE TO THE AZIMUTH MARK ON THE RIGHT AND AZIMUTH MARK 2 ON THE  
LW0418' LEFT. TAKE THE LEFT FORK AND GO SOUTHEAST ON HIGHWAY 123 FOR 0.15  
LW0418' MILE TO A SIDE ROAD RIGHT. TURN RIGHT AND GO WESTERLY ON THE PAVED  
LW0418' ROAD FOR 0.15 MILE TO THE MARK ON LEFT, IN MEDIAN OF ROADS.

LW0418'

LW0418' THE STATION MARK STAMPED---CENTRAL 1968---IS A STANDARD DISK SET IN  
LW0418' THE TOP OF A 12-INCH CYLINDRICAL CONCRETE MONUMENT THAT IS FLUSH WITH  
LW0418' THE GROUND SURFACE. IT IS 98 FEET SOUTH OF THE CENTER OF A PAVED  
LW0418' ROAD, 74 FEET NORTH OF THE CENTER OF A PAVED ROAD AND 52 FEET  
LW0418' SOUTHEAST OF A METAL WITNESS POST.

LW0418'

LW0418' REFERENCE MARK 1 STAMPED---CENTRAL NO 1 1968---IS A STANDARD DISK  
LW0418' CEMENTED IN A DRILL HOLE IN A BOULDER THAT PROJECTS 4 INCHES. IT IS  
LW0418' 69 FEET EAST OF THE METAL WITNESS POST AND 54 FEET SOUTH OF THE  
LW0418' CENTER OF THE NORTH PAVED ROAD.

LW0418'

LW0418' REFERENCE MARK 2 STAMPED---CENTRAL NO 2 1968---IS A STANDARD DISK  
LW0418' CEMENTED IN A DRILL HOLE IN A BOULDER THAT PROJECTS 4 FEET. IT IS 65  
LW0418' FEET SOUTH OF THE CENTER OF THE NORTH PAVED ROAD AND 7.5 FEET  
LW0418' WEST-SOUTHWEST OF THE METAL WITNESS POST.

LW0418'

LW0418' THE AZIMUTH MARK STAMPED---CENTRAL 1968---IS A STANDARD DISK CEMENTED  
LW0418' IN A DRILL HOLE IN A BOULDER THAT PROJECTS 1-FOOT. IT IS 0.05 MILE  
LW0418' EAST-NORTHEAST OF THE NORTHWEST-SOUTHEAST RUNWAY, 43 FEET SOUTHWEST OF  
LW0418' A 12-INCH OAK TREE AND 3 FEET SOUTHEAST OF A METAL WITNESS POST.

LW0418'

LW0418' AZIMUTH MARK 2 STAMPED---CENTRAL 1968 NO 2 1978---IS A STANDARD DISK  
LW0418' CEMENTED IN A DRILL HOLE IN A BOULDER THAT PROJECTS 6 INCHES. IT IS  
LW0418' 0.1 MILE NORTHWEST OF THE NORTHEAST-SOUTHWEST RUNWAY, 189 FEET  
LW0418' WEST-SOUTHWEST OF THE NORTHWEST-SOUTHEAST RUNWAY EVEN WITH THE LIGHTS  
LW0418' AND 4 FEET SOUTH-SOUTHEAST OF A METAL WITNESS POST.

LW0418

LW0418 STATION RECOVERY (1985)

LW0418

LW0418' RECOVERY NOTE BY RHODE ISLAND GEODETIC SURVEY 1985 (RJP)

LW0418' THE STATION WAS RECOVERED AT THIS DATE.

LW0418' THE STATION MARK, REFERENCE MARKS 1 AND 2, AND AZIMUTH MARKS 1 AND 2,  
LW0418' WERE RECOVERED AS DESCRIBED IN GOOD CONDITION. AZIMUTH MARK 1, SET IN  
LW0418' 1968, IS NO LONGER VISIBLE FROM GROUND.

LW0418'

LW0418' THE STATION IS A STANDARD NGS DISK

LW0418

LW0418 STATION RECOVERY (1985)

LW0418

LW0418' RECOVERY NOTE BY RHODE ISLAND GEODETIC SURVEY 1985

LW0418' RECOVERED IN GOOD CONDITION.

LW0418

LW0418 STATION RECOVERY (1987)

LW0418

LW0418' RECOVERY NOTE BY RHODE ISLAND GEODETIC SURVEY 1987 (GEC)

LW0418' THE DESIGNATED MARK WAS RECOVERED AS PREVIOUSLY DESCRIBED.

LW0418'

LW0418' RECOVERED BY THE RHODE ISLAND GEODETIC SURVEY.

LW0418

LW0418

STATION RECOVERY (1988)

LW0418

LW0418'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1988

LW0418'THE STATION WAS RECOVERED IN GOOD CONDITION. THE ORIGINAL DESCRIPTION

LW0418'WAS ADEQUATE WITH CHANGES IN A ROAD NAME, ALBION INSTEAD OF ALBINO AND

LW0418'CHANGES IN DIRECTIONS IN THE MEASUREMENTS. A NEW DESCRIPTION FOLLOWS.

LW0418'THE STATION IS LOCATED ABOUT 12.1 KM (7.50 MI) NORTHWEST OF

LW0418'PROVIDENCE, 9.7 KM (6.05 MI) SOUTH OF WOONSOCKET, 2.4 KM (1.50 MI)

LW0418'WEST OF STATE HIGHWAY 146, AND 0.2 KM (0.10 MI) EAST OF THE NORTH

LW0418'CENTRAL STATE AIRPORT TERMINAL BUILDING.

LW0418'OWNERSHIP--STATE OF RHODE ISLAND, C/O AIRPORT MANAGER TED POLAK.

LW0418'PHONE 401-351-6800.

LW0418'TO REACH THE STATION FROM THE JUNCTION OF STATE HIGHWAYS 146 AND 116,

LW0418'ABOUT 12.9 KM (8.00 MI) NORTHWEST FROM THE CENTER OF PROVIDENCE, GO

LW0418'WEST FOR 1.3 KM (0.80 MI) ON HIGHWAY 116 TO THE JUNCTION OF STATE

LW0418'ROUTE 123, ALBION ROAD, ON THE LEFT. TURN LEFT AND GO SOUTH FOR 1.5

LW0418'KM (0.95 MI) ON ROUTE 123 TO THE NORTH ENTRANCE ROAD TO THE AIRPORT ON

LW0418'THE RIGHT, AT A CURVE IN THE ROAD. BEAR LEFT AND GO SOUTH FOR 0.2 KM

LW0418'(0.10 MI) ON ROUTE 123 TO THE MAIN ENTRANCE ROAD TO THE AIRPORT ON THE

LW0418'RIGHT. TURN RIGHT AND GO WEST FOR 0.2 KM (0.10 MI) ON THE PAVED

LW0418'AIRPORT ROAD TO THE STATION ON THE LEFT, ON TOP OF A LOW, FLAT, GRASSY

LW0418'HILL IN THE CENTER OF THE CIRCULAR DRIVE.

LW0418'THE STATION IS A STANDARD CGS DISK STAMPED---CENTRAL 1968---, SET INTO

LW0418'THE TOP OF A ROUND CONCRETE MONUMENT 30 CM IN DIAMETER FLUSH WITH THE

LW0418'GROUND. LOCATED 46.2 M (151.6 FT) WEST FROM THE SOUTHWEST CORNER OF A

LW0418'CHAIN LINK FENCE AROUND AN ANTENNA, 29.7 M (97.4 FT) SOUTH FROM THE

LW0418'CENTER OF THE ENTRANCE ROAD, AND 22.3 M (73.2 FT) NORTH FROM THE

LW0418'CENTER OF THE ROAD LEAVING THE AIRPORT.

LW0418'DESCRIBED BY C.L. SMITH, TYPED BY R.L. ZURFLUH.

LW0418

LW0418

STATION RECOVERY (1989)

LW0418

LW0418'RECOVERY NOTE BY RHODE ISLAND GEODETIC SURVEY 1989

LW0418'RECOVERED IN GOOD CONDITION.

LW0418

LW0418

STATION RECOVERY (1992)

LW0418

LW0418'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1992

LW0418'THE STATION AND RM1 AND RM2 WERE RECOVERED IN GOOD CONDITION. NO

LW0418'OTHER MARKS SEARCHED FOR THIS SURVEY. AN UPDATED DESCRIPTION

LW0418'FOLLOWS.

LW0418'STATION IS LOCATED ABOUT 12 KM (7.45 MI) NORTHWEST OF PROVIDENCE, 9.6

LW0418'KM (5.95 MI) SOUTH OF WOONSOCKET, AND 0.16 KM (0.10 MI) EAST OF THE

LW0418'NORTH CENTRAL STATE AIRPORT AND THE CHESTER M. SPOONER MEMORIAL

LW0418'TERMINAL BUILDING. OWNERSHIP--STATE OF RHODE ISLAND, C/O AIRPORT

LW0418'MANAGER TED POLAK IN 1986, PH-401-351-6800. NO CONTACT WAS NEEDED

LW0418'THIS SURVEY.

LW0418'TO REACH THE STATION FROM THE JUNCTION OF STATE ROUTE 146 AND 116

LW0418'LOCATED ABOUT 12.9 KM (8.00 MI) NORTH OF PROVIDENCE AND 1 KM

LW0418'(0.60 MI) SOUTH OF INTERSTATE 95 EXIT 9A, GO WEST ALONG HIGHWAY 116

LW0418'FOR 0.6 KM (0.35 MI) TO WAKE ROBIN ROAD ON THE LEFT. CONTINUE WEST

LW0418'ALONG HIGHWAY 116 FOR 0.6 KM (0.35 MI) TO HIGHWAY 123 ON THE LEFT.

LW0418'TURN LEFT AND GO SOUTH ALONG HIGHWAY 123 FOR 1.5 KM (0.95 MI) TO A

LW0418'FORK IN THE ROAD. BEAR LEFT SOUTHEAST ALONG HIGHWAY 123 FOR 0.24 KM

LW0418'(0.15 MI) TO A SIDE ROAD RIGHT. TURN RIGHT ON PAVED ROAD WESTERLY

LW0418'FOR 0.16 KM (0.10 MI) TO THE STATION ON THE LEFT JUST PAST A RADIO

LW0418'TOWER AND ON TOP OF A MOUND IN MEDIAN OF TWO ROADS.  
LW0418'STATION IS 29.8 M (97.8 FT) SOUTH OF THE CENTER OF THE PAVED ROAD,  
LW0418'22.5 M (73.8 FT) NORTH OF THE CENTER OF A PAVED ROAD, 45.9 M  
LW0418'(150.6 FT) WEST OF THE SOUTHWEST CORNER FENCE POST OF FENCE AROUND  
LW0418'RADIO TOWER, 16.7 M (54.8 FT) SOUTHEAST OF RM2, 16.7 M (54.8 FT)  
LW0418'SOUTHWEST OF RM1, 0.31 M (1.02 FT) NORTH OF A FIBERGLASS WITNESS POST,  
LW0418'AND ABOUT FLUSH WITH THE GROUND SURFACE.

LW0418

LW0418 STATION RECOVERY (1992)

LW0418

LW0418'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1992

LW0418'STATION IS LOCATED ON ELEVATED GROUND EAST OF THE OPERATIONS BUILDING  
LW0418'BETWEEN THE NDB AND A TALL SKELETAL STEEL TOWER, BOTH OF WHICH ARE  
LW0418'WITHIN FENCED COMPOUNDS. IT IS SOUTHEAST OF THE LARGEST BOULDER ON  
LW0418'THE ELEVATED GROUND, ON WHICH RM 2 IS LOCATED. THE STATION IS 55.6  
LW0418'FEET (16.9 M) SW OF CENTRAL RM 1 1968 AND 54.7 FEET (16.7 M) SOUTHEAST  
LW0418'OF CENTRAL RM 2 1968. THE STATION IS AN NGS DISK STAMPED CENTRAL 1968  
LW0418'SET IN THE TOP OF A CONCRETE MONUMENT FLUSH WITH THE GROUND.

LW0418

LW0418 STATION RECOVERY (1999)

LW0418

LW0418'RECOVERY NOTE BY WOOLPERT CONSULTANTS 1999 (ARL)

LW0418'RECOVERED AS DESCRIBED.

LW0418

LW0418 STATION RECOVERY (2000)

LW0418

LW0418'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 2000 (CSM)

LW0418'THE STATION RM 1 AND RM 2 WERE RECOVERED IN GOOD CONDITION, NEW  
LW0418'DESCRIPTION FOLLOWS. THE STATION IS LOCATED ABOUT 12.1 KM (7.50 MI)  
LW0418'NORTHWEST OF PROVIDENCE, ABOUT 9.67 KM (6.00 MI) SOUTH OF  
LW0418'WOONSOCKET AT THE NORTH CENTRAL STATE AIRPORT, ABOUT 0.16 KM  
LW0418'(0.10 MI) EAST OF THE ENTRANCE TO THE TERMINAL BUILDING ON TOP OF  
LW0418'THE SOUTH SIDE OF A MOUND IN THE MEDIAN BETWEEN THE ENTRANCE  
LW0418'AND EXIT DRIVES. OWNERSHIP--STATE OF RHODE ISLAND. TO REACH THE  
LW0418'STATION FROM THE JUNCTION OF STATE HIGHWAY 146 AND 116 LOCATED  
LW0418'ABOUT 11.27 KM (7.00 MI) NORTHWEST OF PROVIDENCE, ABOUT 0.97 KM (0.60  
LW0418'MI) SOUTHEAST OF INTERSTATE HIGHWAY 295 (EXIT 9A), FROM THE CENTER  
LW0418'OF THE UNDERPASS GO WESTERLY ON HIGHWAY 116 FOR 1.21 KM (0.75 MI)  
LW0418'TO THE JUNCTION OF ALBION ROAD (STATE HIGHWAY 123) ON THE LEFT,  
LW0418'TURN LEFT, SOUTH ON ALBION ROAD FOR 1.53 KM (0.95 MI) TO A ROAD ON  
LW0418'THE RIGHT LEADING SOUTH TO THE HANGAR-AIRPLANE ACCESS AREA,  
LW0418'CONTINUE AHEAD, SOUTHEASTERLY ON ALBION ROAD FOR 0.16 KM (0.10 MI)  
LW0418'TO THE MAIN ENTRANCE DRIVE TO THE AIRPORT ON THE RIGHT, TURN  
LW0418'RIGHT, WEST ON THE DRIVE FOR 0.32 KM (0.20 MI) TO THE ENTRANCE TO THE  
LW0418'CHESTER SPOONER MEMORIAL BUILDING (TERMINAL BUILDING) ON THE  
LW0418'RIGHT, CONTINUE AHEAD, EASTERLY ON THE THE EXIT DRIVE FOR 0.16 KM  
LW0418'TO THE STATION ON THE RIGHT ON TOP OF THE SOUTH SIDE OF A MOUND IN  
LW0418'THE MEDIAN, ABOUT 45.72 M (150.00 FT) WEST OF THE SOUTHWEST CORNER  
LW0418'OF A CHAIN LINK FENCE ENCLOSING A RADIO TOWER ANTENNA AND ON THE  
LW0418'NORTH SIDE OF A WITNESS POST. THE STATION IS A CGS TRIANGULATION  
LW0418'STATION DISK SET IN TOP OF A 30 CM ROUND CONCRETE POST ABOUT  
LW0418'FLUSH WITH THE GROUND, LOCATED 45.88 M (150.52 FT) WEST OF THE  
LW0418'SOUTHWEST CORNER OF A CHAIN LINK FENCE AROUND A RADIO TOWER  
LW0418'ANTENNA, 16.77 M (55.02 FT) SOUTHEAST OF RM 2 (WHICH IS SET IN THE TOP  
LW0418'OF A LARGE BOULDER ALONG THE NORTH SIDE OF THE MOUND), 22.41 M  
LW0418'(73.52 FT) NORTH OF THE CENTER OF THE AIRPORT EXIT DRIVE (SLOPE),  
LW0418'16.77



LW0418'M (55.02 FT) SOUTHWEST OF RM 1 AND 0.3 M (1.0 FT) NORTH OF A  
LW0418'FIBERGLASS WITNESS POST.

LW0418'

LW0418

LW0418 STATION RECOVERY (2003)

LW0418

LW0418'RECOVERY NOTE BY INDIVIDUAL CONTRIBUTORS 2003 (PMC)

LW0418'RECOVERED IN GOOD CONDITION.

LW0418

LW0418 STATION RECOVERY (2010)

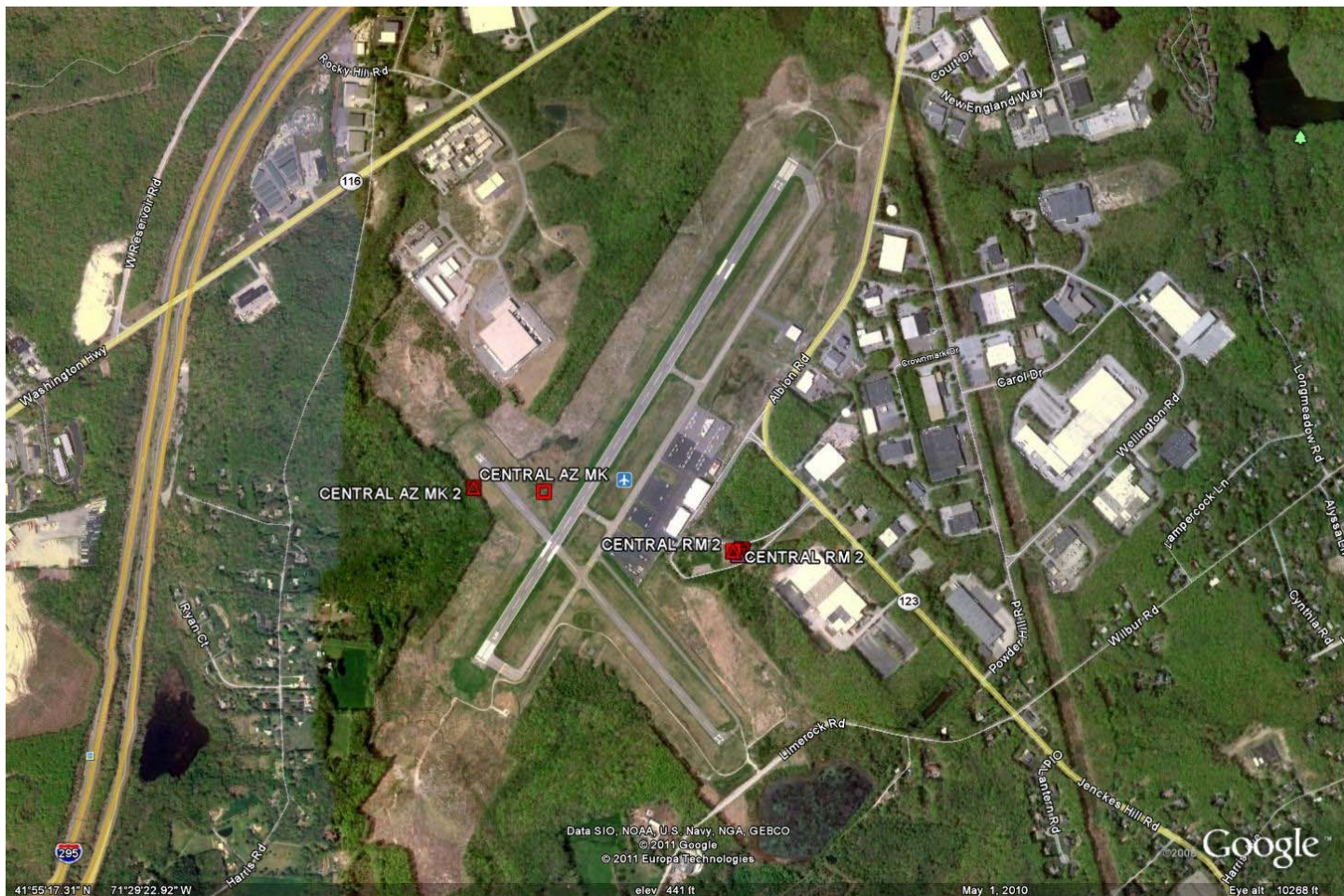
LW0418

LW0418'RECOVERY NOTE BY PBS&J 2010 (MAZ)

LW0418'PHOTOS, RINEX (20MIN.) ARE AVAILABLE

\*\*\* retrieval complete.

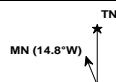
Elapsed Time = 00:00:01



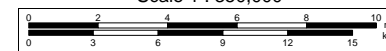




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Scale 1 : 350,000



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$$1'' = 5.52 \text{ mi}$$

Data Zoom 9-0



# Mass Area: OWD-Quincy

Project No 7556-005

Contact: Photo Science: F Godby at  
859 277-8700 or Cell: 859 421-5258

## Flight Logs

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
1	7.9	5010	<del>OWD-A</del>	OWD_QUINC OWD_QUINC	12-17-2006	246	93	
2	8.6	5010	<del>OWD-A</del>	OWD_QUINC OWD_QUINC				
3	9.6	5010	<del>OWD-A</del>	OWD_QUINC OWD_QUINC				
4	9.6	5000	<del>OWD-A</del>	OWD_QUINC OWD_QUINC				
5	10.1	5000	<del>OWD-A</del>	OWD_QUINC OWD_QUINC				
6	11.7	5010	<del>OWD-A</del>	OWD_QUINC OWD_QUINC				
7	7.9	5010	<del>OWD-A</del>	OWD_QUINC OWD_QUINC				
8	5.1	5010	<del>OWD-A</del>	OWD_QUINC OWD_QUINC				
9	11.3	5010	<del>OWD-A</del>	OWD_QUINC OWD_QUINC				
10	8.6	5010	<del>OWD-A</del>	OWD_QUINC OWD_QUINC				
11	8.9	5010	<del>OWD-A</del>	OWD_QUINC OWD_QUINC				
12	8.4	5010	<del>OWD-A</del>	OWD_QUINC OWD_QUINC				
13	8.2	5010	<del>OWD-A</del>	OWD_QUINC OWD_QUINC				

112

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: Berry Young

AIRCRAFT Tail Number: N7260Z

Pilot: 246

Sensor Serial Number: 12-17-2006



FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
8	14	7.0	5010	<del>OWD-A</del> OWD_QUINC OWD_QUINC	12-17-2010	246	QB	
8	15	8.1	5020	<del>OWD-A</del> OWD_QUINC OWD_QUINC				
8	16	8.4	5020	<del>OWD-A</del> OWD_QUINC OWD_QUINC				
9	17	9.6	5010	<del>OWD-A</del> OWD_QUINC OWD_QUINC				
7	18	6.2	5010	<del>OWD-A</del> OWD_QUINC OWD_QUINC				
7	19	5.8	5020	<del>OWD-A</del> OWD_QUINC OWD_QUINC				
7	20	5.3	5020	<del>OWD-A</del> OWD_QUINC OWD_QUINC				
6	21	3.6	5030	<del>OWD-A</del> OWD_QUINC OWD_QUINC				
5	22	2.0	5000	<del>OWD-A</del> OWD_QUINC OWD_QUINC				
5	23	2.9	5000	<del>OWD-A</del> OWD_QUINC OWD_QUINC				
6	24	2.9	5010	<del>OWD-A</del> OWD_QUINC OWD_QUINC				
5	25	2.7	5010	<del>OWD-A</del> OWD_QUINC OWD_QUINC				
6	26	2.2	5030	<del>OWD-A</del> OWD_QUINC OWD_QUINC				
5	27	2.2	5030	<del>OWD-A</del> OWD_QUINC OWD_QUINC	✓	✓	✓	

Flight Logs should be FAXED to 859-277-8903 immediately after each days flights with lines and other details noted

204 miles 3.5 hours.

Operator: Barry  
Pilot: Young  
AIRCRAFT Tail Number: N72602  
Sensor Serial Number: 246

Date: 12-17-2010  
Page 2 of 2

# Mass Area: SFZ Blackstone Project No 7556-005

Contact: Photo Science, F Godby at  
859 277-8700 or Cell: 859 421-5258

## Flight Logs

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
1	12.9	5250	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	
2	12.9	5250	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	
3	12.9	5250	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	
4	12.9	5250	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	
5	12.9	5240	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	
6	12.9	5250	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	
7	12.9	5260	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	
8	12.9	5280	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	
9	12.9	5270	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	
10	12.9	5250	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	
11	12.9	5260	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	Clouds possible @ S end
12	12.9	5280	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	
13	12.9	5290	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	35mi S of N end possible clouds

Flight Logs should be FAXED to 859-277-8901 immediately  
after each days flights with lines and other details noted

Operator: Greenwell

AIRCRAFT Tail Number: N14486

Sensor Serial Number: 247

Date: 12/16/2010

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
14	10.7	5320	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	Clouds possible on line
15	10.7	5320	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/16	247	✓	Clouds possible on line
16 ✓	10.7	5310	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	—			
17	10.7	5330	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	—			
18	8.1	5310	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	—			
19	8.1	5340	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	—			
20	8.1	5360	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	—			
21	8.1	5360	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	—			
22	8.1	5390	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	—			
23	6.2	5430	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	—			
24	6.2	5450	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	—			
25	6.2	5430	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	—			
26	6.2	5370	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	—			
27 ✓	6.2	5290	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	—			

Flight Logs should be FAXED to 859-277-8907 immediately after each days flights with lines and other details noted

Operator: Galich  
Pilot: Greenwell

AIRCRAFT Tail Number: N2448G  
Sensor Serial Number: 247

Date: 12/16/2010

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
28	6.5	5560	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/17	247	✓	
29	5.0	5580	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/17	"	✓	
30	5.0	5580	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/17	"	✓	
31	4.7	5570	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/17	"	✓	
32	4.8	5590	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/17	"	✓	
33	5.1	5650	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/17	"	✓	
34	6.5	5680	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/17	"	✓	
35	6.5	5670	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/17	"	✓	
36	6.8	5650	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/17	"	✓	
37	7.0	5640	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/17	"	✓	
38	7.0	5620	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/17	"	✓	
39	4.3	5810	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/17	"	✓	
40	4.3	5750	SFZ_Blac	SFZ_Blacksto SFZ_BLACKS	12/17	"	✓	

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: Callie  
Pilot: Creaswell

AIRCRAFT Tail Number: N1448G  
Sensor Serial Number: 247

Date: \_\_\_\_\_



## Station Occupation Report For Airborne GPS

Project: Fenna MASS

Location: K SFZ (N. Central State RI) Project Number: 7556-005

Completed by: Berry / Galieti Date: \_\_\_\_\_

Receiver: Trimble "2"

Receiver Type: 5700

Antenna Type: Zephyr

Station ID: CENTRAL

Start -- H.I. (m): 1.482 / 1.481 / 1.482 m

End -- H.I. (m): 1.482

H.I. (ft): 4.86 ft

Start Time: 920 AM

End Time: 1048 AM

Time Zone: EST

Operator: Berry

Comments: 101215a-246 (void)

101215a-247

\_\_\_\_\_

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Date Flown:	December 15, 2010		
Takeoff Time (Z):	447Z	Local:	Airport 3-2
Landing Time (Z)	526Z	Local:	Airport SF2

	Ground	Altport
Begin Temp	-8.0°	55Z
Begin Dewpoint	-15.0°	
Begin Pressure	29.53	
End Temp		
End Dewpoint		
End Pressure		

[illegible]

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Date Flown:	12/15/2010		
Takeoff Time (Z):	1445	Local:	airport KSFZ
Landing Time (Z)		Local:	airport

Ground	Airport
-9 °C	K5FZ
-16 °C	
19.55	
Begin Pressure	
End Temp	
-9 °C	
End Dewpoint	
-16 °C	K5FZ
End Pressure	
19.55	

[illegible]

## Station Occupation Report For Airborne GPS

**Project:** FEMA MASS

**Location:** KSFZ

**Project Number:** 7556-005

**Completed by:** Berry / Galati

**Date:** December 16, 2010

**Receiver:** Trimble "4"

**Receiver Type:** 5700

**Antenna Type:** Zephyr Geodetic

**Station ID:** CENTRAL

**Start -- H.I. (m):** 1.569 / 1.565 / 1.565 m

**End -- H.I. (m):** 1.565m

**H.I. (ft):** 5.135ft

**Start Time:** 9:20 AM

**End Time:** 2:04 PM

**Time Zone:** EST

**Operator:** Berry

**Comments** 101216a-246

101216a-247





# LIDAR MISSION RECORD SHEET - Optech



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Project Name	Emme - MPSS
Project Number	7556-005
Altitude/NAV - pin file	SF2 Blackstone open

Pilot	Yanaka
Operator	Beckley
Aircraft	N7266Z

Date Flown:	December 16, 2010
Takeoff Time (Z):	1440Z
Landing Time (Z):	1655Z
Local:	0400 AM EST
Local:	05 AM EST
Altitude	SF2
Altitude	SF2

Project Scanning Requirements	
FOV (half-degrees):	± 18°
Altitude AGL (ft):	5000'
Scan Rate:	30 Hz
Pulse Rate:	71 kHz
Ground Speed:	116 kts
A.R.F.:	Range

Data Information	
LIDAR Unit	Optech Gemini sn246
HD #	246 HD 1
POS File Name	101816a
from, to	000 - 019

Begin Temp	-3°C	Ground	Altitude
Begin Dewpoint	-10°C		SF2
Begin Pressure	29.75		
End Temp	-1		
End Dewpoint	-10		
End Pressure	29.74		SF2

GPS Base Location(s)	Central
PDOP Avoidance	Good all day
Static or Flyover?	Static

Flight Line Name/#	Start Time	End Time	Alt. (AMSL)	Heading	Speed	Returns	Crab	NOTES (weather, visibility, winds, tide, etc.)
09	1453	1454	5500'	W	116	100%	-	Wind refight Atmospheric returns/Clouds
19	1502	1507	5350'	N	116	100%	-9	Smooth Clouds around
20	1510	1514	5350'	S	116	100%	10	"
21	1517	1521	5300'	N	116	100%	9	"
22	1525	1529	5350'	S	116	100%	10	"
23	1533	1536	5450'	N	116	100%	-9	"
24	1541	1543	5400'	S	116	100%	9	"
27	1545	1549	5310'	N	116	100%	-9	"
26	1552	1555	5400'	S	116	100%	9	"
25	1559	1602	5450'	N	116	100%	-10	"
18	1605	1609	5210'	S	116	100%	10	"
17	1613	1619	5220'	N	116	100%	-9	"
16	1622	1627	5350'	S	116	100%	10	"
Empire	1634	1637	5800'	W	116	100%	3	"

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Date Flown:	10/16/10		
Takeoff Time (Z):	1430	Local:	9:00 AM
Landing Time (Z):		Local:	Airport
			KSFE

	Ground	Airport
Begin Temp	-7.0°C	K8ED
Begin Dewpoint	-11°C	
Begin Pressure	29.75	
End Temp	6°C	
End Dewpoint	-11°C	
End Pressure	29.73	

light set clouds in area @ 41k 15004

[illegible]



## Station Occupation Report For Airborne GPS

Project: SFZ-Blackstone

Location: SFZ-Blackstone (PAc)

Project Number: 7556-005

Completed by: Northan Galieh

Date: 12/17/10

Receiver: Trimble 2

Receiver Type: Trimble 5700

Antenna Type: Zephyr Geodetic

Station ID: SFZ-Blackstone

Start -- H.I. (m): ~~1.574~~ 1.574 / 1.573 m

End -- H.I. (m): 1.574 m

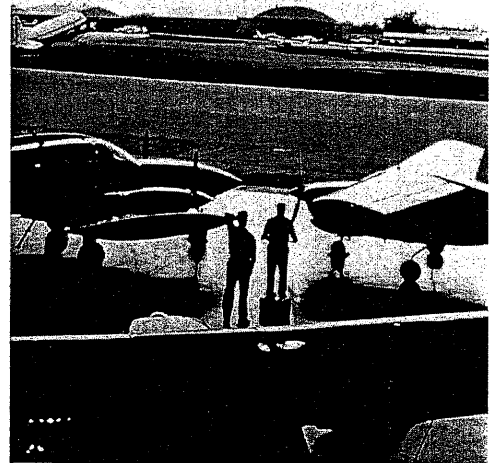
H.I. (ft): 5.16 ft.

Start Time: 9:33 AM

End Time: 12:14 PM

Time Zone: EST

Operator: Galieh



Comments 10/217a-247

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Date Flown: 12/17/10	
Takeoff Time (Z): 1445	Local: 9:45 EST
Landing Time (Z):	Local: Airport

	Ground	Airport
Begin Temp	-11 °C	KSFZ
Begin Dewpoint	-13 °C	
Begin Pressure	29.80	
End Temp	0 °C	
End Dewpoint	-9 °C	KSFZ
End Pressure	29.81	

12/60  
note wrong  
data entered

	Ground	Airport
Begin Temp	-11 °C	15°F
Begin Dewpoint	-13 °C	
Begin Pressure	29.88	
End Temp	0 °C	
End Dewpoint	-9 °C	15°F
End Pressure	29.81	

[illegible]





## Station Occupation Report For Airborne GPS

Project: FEMA - MASSACHUSETTS

Location: KBED @ Bedford Municipal Project Number: 7556-005

Completed by: Berry / Galich Date: 12-17-2010

Receiver: Trimble "4"

Receiver Type: 5700

Antenna Type: Zephyr Geodetic

Station ID: KBED (BED A)

Start -- H.I. (m): 1.499 1.496

End -- H.I. (m): 1.497

H.I. (ft): 4.92

Start Time: 7:08 AM EST

End Time: 12:11 PM EST

Time Zone: EST

Operator: Berry

Comments: 101217a-246



# LIDAR MISSION RECORD SHEET - Optech

SN 1215

## PHOTO SCIENCE

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Project Name	Fema - Massachusetts
Project Number	756.005
Alt/NAV/Pln File	020-Quincy.ph

Pilot	Younis
Operator	BERAY
Aircraft	N7266Z

Date From:	December 17, 2010
Takeoff Time (Z)	14:52
Landing Time (Z)	15:15

FOV (half-degrees):	± 18.0°	Altitude AGL (ft):	5000
Scan Rate:	30.1 Hz	(MPL) or SPIA	
Pulse Rate:	71 kHz	Fixed or Auto	
Ground Speed:	116 kts	Samples	1000
		A.R.F. Range	300m

LIDAR Unit	Optech Gemini sn246
HD #	246 HD1
Pos File Name	10217a
from, to	000 →

Begin Temp	-12°C	Ground	Altport
Begin Dewpoint	-14°C		
Begin Pressure	29.79		
End Temp			
End Dewpoint			
End Pressure			

GPS Base Location(s)	BEA
PDOP Avoidance	1045-1215 (SN246 backonline @ 921 am)
Static or Flyover?	Static

Flight Line Name/#	Start Time	End Time	Alt. (AMSL)	Heading	Speed	Returns	Crab	NOTES (weather, visibility, winds, tide, etc.)
Improv	1258	1301	5000'	NE	116 kts	100%	-8	Clear and smooth
24	1301	1303	5000'	NE	116 kts	100%	-8	"
23	1308	1309	5000'	SW	116 kts	100%	7	"
22	1313	1314	5000'	SW	116 kts	100%	-6	"
21	1318	1320	5000'	SE	116 kts	100%	0	"
20	1325	1328	5000'	SW	116 kts	100%	-4	"
19	1332	1335	5000'	SE	116 kts	100%	0	"
18	1339	1342	5000'	SW	116 kts	100%	-4	"
17	1345	1350	5000'	SE	116 kts	100%	2	"
16	1353	1358	5000'	SW	116 kts	100%	-4	"
15	1401	1405	5000'	SE	116 kts	100%	3	"
14	1409	1413	5000'	SW	116 kts	100%	-7	"
13	1417	1421	5000'	SE	116 kts	100%	4	"
12	1424	1429	5000'	SW	116 kts	100%	-5	"
11	1432	1436	5000'	SE	116 kts	100%	4	"
10	1439	1443	5000'	SW	116 kts	100%	-5	"
9	1446	1448	5000'	SE	116 kts	100%	3	Need to redo (ARF not set to ON)
8	1455	1501	5000'	SW	116 kts	100%	-5	
7	1504	1510	5000'	SE	116 kts	100%	3	
6	1514	1518	5000'	SW	116 kts	100%	-5	

# LIDAR MISSION RECORD SHEET - Optech

## PHOTO SCIENCE

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Project Name	Tennamper
Project Number	1500-000
ASTM/NAV/DOJ File	000-000000

### Project's Scanning Requirements

FOV (half-degrees):	± 18.5 °	Altitude AGL (ft):	5000
Scan Rate:	301 Hz	MPIA or SPIA	
Pulse Rate:	71 kHz	Fixed or Auto	
Ground Speed:	116 kts	Samples	1600
		Range	465

Pilot	Y. Jones
Operator	B. Baker
Aircraft	N7266Z

Date Flown:	December 17, 2010				
Takeoff Time (Z)	1045	Local:	7:55 AM EST	Airport	BE0
Landing Time (Z)	1045	Local:	11:45 AM EST	Airport	BE0

Begin Temp	-02 °	Ground		Airport	
Begin Dewpoint	44 °				
Begin Pressure	29.79				
End Temp	-1 °				
End Dewpoint	-9 °				
End Pressure	29.83				

GPS Base Location(s)	Central
PDOP Avoidance	See sheet 1
Static or Flyover?	Static

Flight Line Name/ID	Start	End	Alt. (AMSL)	Heading	Speed	Returns	Crab	NOTES (weather, visibility, winds, tide, etc.)
---------------------	-------	-----	-------------	---------	-------	---------	------	--

Flight Line Name/ID	Start	End	Alt. (AMSL)	Heading	Speed	Returns	Crab	NOTES (weather, visibility, winds, tide, etc.)
3	1501	1506	5000'	88	116 kts	100%	5	
2	1506	1514	5000'	88	116 kts	100%	5	
1	1514	1541	5000'	88	116 kts	100%	5	
7	1541	1547	5000'	88	116 kts	100%	5	
8	1547	1554	5000'	88	116 kts	100%	5	
35	1554	1558	5000'	88	116 kts	100%	5	
26	1558	1604	5000'	88	116 kts	100%	5	
27	1604	1608	5000'	88	116 kts	100%	5	
9	1608	1614	5000'	88	116 kts	100%	5	Ref. 1, 4, 11, 12, 13, 14, 15, 16, 17, 18, 19

# Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

## Weather

-----  
Date : December 15, 2010  
Julian Day : 349  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

## Statistics

-----  
Laser Time : 00:08:48

=====  
10:05:07.237 GMT : 00:00:02 (212) GPS 1PPS Lost  
10:05:07.237 GMT : 00:00:03 (166) Divergence Error  
10:05:07.237 GMT : 00:00:03 (107) Rx Shutter Closed  
10:05:07.237 GMT : 00:00:03 (109) Tx Shutter Closed  
10:05:07.237 GMT : 00:00:04 (164) Beam Wide  
10:05:07.237 GMT : 00:00:08 (213) GPS 1PPS Ok  
10:05:07.237 GMT : 00:00:09 (120) Laser PS Comm Ok  
10:05:07.237 GMT : 00:00:09 (112) Laser Emission Off  
10:05:07.237 GMT : 00:00:12 (204) POSAV Connected  
10:05:07.237 GMT : 00:00:13 (207) POSAV Rate Not 50 Hz  
10:05:07.237 GMT : 00:00:13 (211) POSAV new status  
10:05:07.237 GMT : 00:00:21 (211) POSAV new status  
10:05:07.237 GMT : 00:00:22 (208) POSAV Rate Is 50 Hz  
10:05:07.237 GMT : 00:00:22 (215) Nav Data Ok  
10:05:07.237 GMT : 00:00:23 (211) POSAV new status  
10:05:07.237 GMT : 00:02:04 (211) POSAV new status  
14:39:42.274 GMT : 00:04:27 (153) Eyesafety Disabled  
14:39:42.474 GMT : 00:04:27 (162) Roll Comp On  
14:39:42.674 GMT : 00:04:28 (164) Beam Wide  
14:39:42.774 GMT : 00:04:28 (144) MultiPulse Mode Varies  
14:39:47.674 GMT : 00:04:33 (165) Beam Narrow  
14:40:04.074 GMT : 00:04:49 (211) POSAV new status  
14:45:45.679 GMT : 14:45:44 (211) POSAV new status



14:53:16.586 GMT : 14:53:15 (106) Rx Shutter Open  
14:53:16.586 GMT : 14:53:15 (108) Tx Shutter Open  
14:55:52.588 GMT : 14:55:51 (113) Laser Emission On  
14:59:13.891 GMT : 14:59:12 (112) Laser Emission Off  
15:02:33.894 GMT : 15:02:32 (113) Laser Emission On  
15:05:31.097 GMT : 15:05:29 (112) Laser Emission Off  
15:09:21.901 GMT : 15:09:20 (113) Laser Emission On  
15:12:01.103 GMT : 15:11:59 (112) Laser Emission Off  
15:15:38.907 GMT : 15:15:37 (107) Rx Shutter Closed  
15:15:39.107 GMT : 15:15:37 (109) Tx Shutter Closed

#### Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 15, 2010  
Julian Day : 349  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

#### Statistics

-----  
Laser Time : 00:08:48

=====

#### Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :

HOBBS End :

Weather

-----  
Date : December 15, 2010  
Julian Day : 349  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 00:08:48

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
=====									
14:55:53.088	14:59:15.391	29	1693	70	30.10	18.00	ON	NAR	
ON 0.00	88.3								
15:02:33.894	15:05:30.897	30	1700	70	30.10	18.00	ON	NAR	
ON 0.00	268.29								
15:09:22.501	15:12:01.703	31	1697	70	30.10	18.00	ON	NAR	
ON 0.00	88.29								

Flight Log

-----  
Project Number: SFZ\_Blackstone 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KSFZ  
Mission : 1  
Wheels Up :  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 16, 2010  
Julian Day : 350  
Temperature : -3 C  
Visibility : CLR  
Clouds : Very SCT 040  
Precipitation : none  
Wind Dir : 250  
Wind Speed : 4  
Pressure : 29.43 HG

# Statistics

-----  
Laser Time : 01:34:17

=====  
14:39:48.569 GMT : 00:00:02 (212) GPS 1PPS Lost  
14:39:48.569 GMT : 00:00:03 (166) Divergence Error  
14:39:48.569 GMT : 00:00:03 (107) Rx Shutter Closed  
14:39:48.569 GMT : 00:00:03 (109) Tx Shutter Closed  
14:39:48.569 GMT : 00:00:04 (164) Beam Wide  
14:39:48.569 GMT : 00:00:05 (213) GPS 1PPS Ok  
14:39:48.569 GMT : 00:00:12 (204) POSAV Connected  
14:39:48.569 GMT : 00:00:12 (207) POSAV Rate Not 50 Hz  
14:39:48.569 GMT : 00:00:13 (211) POSAV new status  
14:39:48.569 GMT : 00:00:19 (208) POSAV Rate Is 50 Hz  
14:39:48.569 GMT : 00:00:20 (211) POSAV new status  
14:39:48.569 GMT : 00:00:21 (211) POSAV new status  
14:39:48.569 GMT : 00:00:22 (215) Nav Data Ok  
14:39:48.569 GMT : 00:00:25 (120) Laser PS Comm Ok  
14:39:48.569 GMT : 00:00:25 (112) Laser Emission Off  
14:39:48.569 GMT : 00:02:00 (211) POSAV new status  
14:35:51.313 GMT : 00:04:01 (307) Format Disk  
14:36:30.713 GMT : 00:04:40 (153) Eyesafety Disabled  
14:36:34.713 GMT : 00:04:44 (211) POSAV new status  
14:36:53.513 GMT : 14:36:52 (160) Safe Aided Wide  
14:36:53.713 GMT : 14:36:52 (160) Safe Aided Wide  
14:37:19.713 GMT : 14:37:18 (157) Safe Unaided Profile  
14:37:19.913 GMT : 14:37:18 (162) Roll Comp On  
14:37:19.913 GMT : 14:37:18 (157) Safe Unaided Profile  
14:37:20.513 GMT : 14:37:19 (164) Beam Wide  
14:37:20.713 GMT : 14:37:19 (144) MultiPulse Mode Varies  
14:37:24.513 GMT : 14:37:23 (165) Beam Narrow  
14:41:54.515 GMT : 14:41:53 (211) POSAV new status  
14:44:56.117 GMT : 14:44:55 (157) Safe Unaided Profile  
14:45:26.917 GMT : 14:45:25 (157) Safe Unaided Profile  
14:45:27.817 GMT : 14:45:26 (157) Safe Unaided Profile  
14:45:32.017 GMT : 14:45:30 (106) Rx Shutter Open  
14:45:32.217 GMT : 14:45:30 (108) Tx Shutter Open  
14:53:08.622 GMT : 14:53:07 (113) Laser Emission On  
14:59:44.825 GMT : 14:59:43 (112) Laser Emission Off  
15:03:58.828 GMT : 15:03:58 (113) Laser Emission On  
15:10:19.832 GMT : 15:10:18 (112) Laser Emission Off  
15:14:53.835 GMT : 15:14:52 (113) Laser Emission On  
15:21:11.339 GMT : 15:21:09 (112) Laser Emission Off  
15:25:18.541 GMT : 15:25:17 (113) Laser Emission On  
15:31:29.745 GMT : 15:31:27 (112) Laser Emission Off  
15:35:34.648 GMT : 15:35:33 (113) Laser Emission On  
15:41:49.852 GMT : 15:41:48 (112) Laser Emission Off  
15:46:17.355 GMT : 15:46:16 (113) Laser Emission On  
15:52:29.86 GMT : 15:52:28 (112) Laser Emission Off  
15:56:49.062 GMT : 15:56:47 (113) Laser Emission On  
16:03:02.467 GMT : 16:03:01 (112) Laser Emission Off  
16:07:37.67 GMT : 16:07:36 (113) Laser Emission On  
16:13:45.974 GMT : 16:13:44 (112) Laser Emission Off

16:17:58.177 GMT : 16:17:57 (113) Laser Emission On  
16:24:27.682 GMT : 16:24:26 (112) Laser Emission Off  
16:29:20.085 GMT : 16:29:19 (113) Laser Emission On  
16:35:33.39 GMT : 16:35:32 (112) Laser Emission Off  
16:40:05.093 GMT : 16:40:04 (113) Laser Emission On  
16:46:25.698 GMT : 16:46:23 (112) Laser Emission Off  
16:50:32.201 GMT : 16:50:31 (113) Laser Emission On  
16:56:40.605 GMT : 16:56:39 (112) Laser Emission Off  
17:01:32.809 GMT : 17:01:31 (113) Laser Emission On  
17:07:56.713 GMT : 17:07:55 (112) Laser Emission Off  
17:12:22.217 GMT : 17:12:20 (113) Laser Emission On  
17:17:39.821 GMT : 17:17:38 (112) Laser Emission Off  
17:20:45.723 GMT : 17:20:44 (113) Laser Emission On  
17:26:07.927 GMT : 17:26:06 (112) Laser Emission Off  
17:27:07.228 GMT : 17:27:05 (153) Eyesafety Disabled  
17:29:47.33 GMT : 17:29:46 (113) Laser Emission On  
17:32:32.132 GMT : 17:32:30 (112) Laser Emission Off  
17:35:55.934 GMT : 17:35:54 (107) Rx Shutter Closed  
17:35:55.934 GMT : 17:35:54 (109) Tx Shutter Closed

#### Flight Log

-----  
Project Number: SFZ\_Blackstone 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KSFZ  
Mission : 1  
Wheels Up :  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 16, 2010  
Julian Day : 350  
Temperature : -3 C  
Visibility : CLR  
Clouds : Very SCT 040  
Precipitation : none  
Wind Dir : 250  
Wind Speed : 4  
Pressure : 29.43 HG

#### Statistics

-----  
Laser Time : 01:34:17  
=====

#### Flight Log

-----  
Project Number: SFZ\_Blackstone 7556-005

S/N : 247  
 Operator : Galieti  
 Pilot(s) : Greenwell  
 Aircraft : N2448G  
 Airport : KSFZ  
 Mission : 1  
 Wheels Up :  
 Flight Length :  
 HOBBS Start :  
 HOBBS End :

#### Weather

-----  
 Date : December 16, 2010  
 Julian Day : 350  
 Temperature : -3 C  
 Visibility : CLR  
 Clouds : Very SCT 040  
 Precipitation : none  
 Wind Dir : 250  
 Wind Speed : 4  
 Pressure : 29.43 HG

#### Statistics

-----  
 Laser Time : 01:34:17

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
=====									
14:53:08.622	14:59:46.025	1	1601	70	30.10	18.00	ON	NAR	
ON 0.00	358.4								
15:03:59.828	15:10:21.032	2	1617	70	30.10	18.00	ON	NAR	
ON 0.00	178.39								
15:14:54.035	15:21:10.939	4	1606	70	30.10	18.00	ON	NAR	
ON 0.00	358.38								
15:25:19.141	15:31:29.945	4	1616	70	30.10	18.00	ON	NAR	
ON 0.00	178.38								
15:25:19.141	15:31:29.945	5	1616	70	30.10	18.00	ON	NAR	
ON 0.00	178.38								
15:35:35.348	15:41:50.952	6	1603	70	30.10	18.00	ON	NAR	
ON 0.00	358.37								
15:46:17.855	15:52:31.16	6	1623	70	30.10	18.00	ON	NAR	
ON 0.00	178.37								
15:46:17.855	15:52:31.16	7	1623	70	30.10	18.00	ON	NAR	
ON 0.00	178.37								
15:56:49.362	16:03:04.667	7	1593	70	30.10	18.00	ON	NAR	
ON 0.00	358.37								
16:07:38.27	16:13:47.374	8	1619	70	30.10	18.00	ON	NAR	
ON 0.00	178.36								
16:07:38.27	16:13:47.374	9	1619	70	30.10	18.00	ON	NAR	
ON 0.00	178.36								



16:17:58.877	16:24:28.582	9	1606	70	30.10	18.00	ON	NAR
ON 0.00	358.36							
16:29:20.785	16:35:33.89	10	1614	70	30.10	18.00	ON	NAR
ON 0.00	178.35							
16:40:06.093	16:46:25.398	11	1593	70	30.10	18.00	ON	NAR
ON 0.00	358.35							
16:50:33.101	16:56:42.605	12	1623	70	30.10	18.00	ON	NAR
ON 0.00	178.34							
17:01:33.209	17:07:58.113	13	1600	70	30.10	18.00	ON	NAR
ON 0.00	358.33							
17:12:22.817	17:17:40.521	15	1612	70	30.10	18.00	ON	NAR
ON 0.00	178.32							
17:20:46.323	17:26:08.327	15	1602	70	30.10	18.00	ON	NAR
ON 0.00	358.32							
17:29:48.13	17:32:32.632	15	1618	70	30.10	18.00	ON	NAR
ON 0.00	358.32							
17:29:48.13	17:32:32.632	15	1617	70	30.10	18.00	ON	NAR
ON 0.00	358.32							

#### Flight Log

```

-----
Project Number: 7505-056
S/N           : 246
Operator      : BERRY
Pilot(s)     : YOUNG
Aircraft     : N7266Z
Airport      : KSFZ
Mission      : 101216A
Wheels Up    : 1440Z
Flight Length :
HOBBS Start  :
HOBBS End    :

```

#### Weather

```

-----
Date          : December 16, 2010
Julian Day    : 350
Temperature   : -1
Visibility    : >10
Clouds        : 4500'
Precipitation : NO
Wind Dir      : -
Wind Speed    : -
Pressure      : 29.75

```

#### Statistics

```

-----
Laser Time    : 00:50:02

```

```

=====
09:55:52.781 GMT : 00:00:02 (212) GPS 1PPS Lost
09:55:52.781 GMT : 00:00:03 (166) Divergence Error
09:55:52.781 GMT : 00:00:03 (107) Rx Shutter Closed
09:55:52.781 GMT : 00:00:03 (109) Tx Shutter Closed
09:55:52.781 GMT : 00:00:04 (164) Beam Wide

```

09:55:52.781 GMT : 00:00:05 (213) GPS 1PPS Ok  
09:55:52.781 GMT : 00:00:08 (212) GPS 1PPS Lost  
09:55:52.781 GMT : 00:00:09 (120) Laser PS Comm Ok  
09:55:52.781 GMT : 00:00:09 (112) Laser Emission Off  
09:55:52.781 GMT : 00:00:12 (204) POSAV Connected  
09:55:52.781 GMT : 00:00:13 (207) POSAV Rate Not 50 Hz  
09:55:52.781 GMT : 00:00:13 (211) POSAV new status  
09:55:52.781 GMT : 00:00:14 (213) GPS 1PPS Ok  
09:55:52.781 GMT : 00:00:25 (211) POSAV new status  
09:55:52.781 GMT : 00:00:26 (208) POSAV Rate Is 50 Hz  
09:55:52.781 GMT : 00:00:26 (215) Nav Data Ok  
09:55:52.781 GMT : 00:00:27 (211) POSAV new status  
09:55:52.781 GMT : 00:01:57 (211) POSAV new status  
14:34:43.96 GMT : 00:04:40 (211) POSAV new status  
14:35:20.761 GMT : 14:35:19 (153) Eyesafety Disabled  
14:35:20.961 GMT : 14:35:19 (162) Roll Comp On  
14:35:21.461 GMT : 14:35:20 (164) Beam Wide  
14:35:21.661 GMT : 14:35:20 (144) MultiPulse Mode Varies  
14:35:25.261 GMT : 14:35:24 (165) Beam Narrow  
14:40:25.764 GMT : 14:40:24 (106) Rx Shutter Open  
14:40:25.964 GMT : 14:40:24 (108) Tx Shutter Open  
14:41:09.465 GMT : 14:41:08 (211) POSAV new status  
14:53:36.175 GMT : 14:53:34 (113) Laser Emission On  
14:54:17.076 GMT : 14:54:15 (112) Laser Emission Off  
15:03:00.784 GMT : 15:02:59 (113) Laser Emission On  
15:07:03.088 GMT : 15:07:01 (112) Laser Emission Off  
15:10:38.491 GMT : 15:10:37 (113) Laser Emission On  
15:14:36.295 GMT : 15:14:35 (112) Laser Emission Off  
15:17:46.698 GMT : 15:17:45 (113) Laser Emission On  
15:21:55.302 GMT : 15:21:54 (112) Laser Emission Off  
15:25:33.506 GMT : 15:25:32 (113) Laser Emission On  
15:29:41.309 GMT : 15:29:39 (112) Laser Emission Off  
15:33:36.813 GMT : 15:33:35 (113) Laser Emission On  
15:36:44.916 GMT : 15:36:43 (112) Laser Emission Off  
15:39:54.419 GMT : 15:39:53 (113) Laser Emission On  
15:43:17.823 GMT : 15:43:16 (112) Laser Emission Off  
15:45:59.325 GMT : 15:45:58 (113) Laser Emission On  
15:49:15.629 GMT : 15:49:14 (112) Laser Emission Off  
15:52:31.832 GMT : 15:52:30 (113) Laser Emission On  
15:55:48.735 GMT : 15:55:47 (112) Laser Emission Off  
15:59:36.539 GMT : 15:59:35 (113) Laser Emission On  
16:02:58.443 GMT : 16:02:56 (112) Laser Emission Off  
16:05:37.445 GMT : 16:05:36 (113) Laser Emission On  
16:09:43.15 GMT : 16:09:42 (112) Laser Emission Off  
16:13:49.454 GMT : 16:13:47 (113) Laser Emission On  
16:19:04.06 GMT : 16:19:03 (112) Laser Emission Off  
16:22:45.364 GMT : 16:22:43 (113) Laser Emission On  
16:27:58.07 GMT : 16:27:56 (112) Laser Emission Off  
16:34:34.877 GMT : 16:34:33 (113) Laser Emission On  
16:37:23.981 GMT : 16:37:22 (112) Laser Emission Off  
16:43:51.788 GMT : 16:43:50 (107) Rx Shutter Closed  
16:43:51.888 GMT : 16:43:50 (109) Tx Shutter Closed

Flight Log

-----  
Project Number: 7505-056  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : KSFZ  
Mission : 101216A  
Wheels Up : 1440Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 16, 2010  
Julian Day : 350  
Temperature : -1  
Visibility : >10  
Clouds : 4500'  
Precipitation : NO  
Wind Dir : -  
Wind Speed : -  
Pressure : 29.75

Statistics

-----  
Laser Time : 00:50:02

=====

Flight Log

-----  
Project Number: 7505-056  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : KSFZ  
Mission : 101216A  
Wheels Up : 1440Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 16, 2010  
Julian Day : 350  
Temperature : -1  
Visibility : >10  
Clouds : 4500'  
Precipitation : NO  
Wind Dir : -  
Wind Speed : -

Pressure : 29.75

Statistics

-----  
Laser Time : 00:50:02

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
	14:53:35.975	14:54:18.276	29	1692	70	30.10	18.00	ON	NAR
ON	0.00	268.3							
	15:03:01.284	15:07:03.288	20	1632	70	30.10	18.00	ON	NAR
ON	0.00	178.3							
	15:10:39.091	15:14:37.995	21	1634	70	30.10	18.00	ON	NAR
ON	0.00	178.29							
	15:17:47.398	15:21:52.702	22	1635	70	30.10	18.00	ON	NAR
ON	0.00	178.29							
	15:25:34.306	15:29:42.01	23	1640	70	30.10	18.00	ON	NAR
ON	0.00	358.28							
	15:33:37.513	15:36:45.716	24	1654	70	30.10	18.00	ON	NAR
ON	0.00	358.28							
	15:39:55.019	15:43:18.223	27	1666	70	30.10	18.00	ON	NAR
ON	0.00	178.26							
	15:45:59.825	15:49:16.829	26	1612	70	30.10	18.00	ON	NAR
ON	0.00	178.27							
	15:52:31.832	15:55:50.235	25	1640	70	30.10	18.00	ON	NAR
ON	0.00	358.27							
	15:59:37.439	16:02:59.143	25	1659	70	30.10	18.00	ON	NAR
ON	0.00	358.27							
	16:05:38.445	16:09:44.15	17	1618	70	30.10	18.00	ON	NAR
ON	0.00	178.31							
	16:13:50.254	16:19:05.26	16	1618	70	30.10	18.00	ON	NAR
ON	0.00	358.32							
	16:22:46.064	16:27:59.17	16	1623	70	30.10	18.00	ON	NAR
ON	0.00	178.32							
	16:34:35.877	16:37:25.481	39	1603	70	30.10	18.00	ON	NAR
ON	0.00	358.59							

Flight Log

-----  
Project Number: SFZ\_Blackstone  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED KSFZ  
Mission : 1  
Wheels Up : 9:45 AM EST 1445Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 17, 2010  
Julian Day : 351  
Temperature : -11 C  
Visibility : -13 C  
Clouds : None  
Precipitation : None  
Wind Dir : 290  
Wind Speed : 6  
Pressure : 29.81 HG

Statistics

-----  
Laser Time : 00:38:46

=====  
14:57:15.275 GMT : 00:00:02 (212) GPS 1PPS Lost  
14:57:15.275 GMT : 00:00:03 (166) Divergence Error  
14:57:15.275 GMT : 00:00:03 (107) Rx Shutter Closed  
14:57:15.275 GMT : 00:00:03 (109) Tx Shutter Closed  
14:57:15.275 GMT : 00:00:04 (164) Beam Wide  
14:57:15.275 GMT : 00:00:05 (213) GPS 1PPS Ok  
14:57:15.275 GMT : 00:00:12 (204) POSAV Connected  
14:57:15.275 GMT : 00:00:12 (207) POSAV Rate Not 50 Hz  
14:57:15.275 GMT : 00:00:12 (211) POSAV new status  
14:57:15.275 GMT : 00:00:18 (208) POSAV Rate Is 50 Hz  
14:57:15.275 GMT : 00:00:18 (211) POSAV new status  
14:57:15.275 GMT : 00:00:18 (215) Nav Data Ok  
14:57:15.275 GMT : 00:00:20 (211) POSAV new status  
14:57:15.275 GMT : 00:00:21 (120) Laser PS Comm Ok  
14:57:15.275 GMT : 00:00:21 (112) Laser Emission Off  
14:57:15.275 GMT : 00:01:54 (211) POSAV new status  
14:47:58.544 GMT : 00:04:36 (211) POSAV new status  
14:48:27.744 GMT : 14:48:27 (153) Eyesafety Disabled  
14:48:27.944 GMT : 14:48:27 (162) Roll Comp On  
14:48:28.544 GMT : 14:48:28 (164) Beam Wide  
14:48:28.744 GMT : 14:48:28 (144) MultiPulse Mode Varies  
14:48:31.944 GMT : 14:48:31 (165) Beam Narrow  
14:48:48.144 GMT : 14:48:47 (157) Safe Unaided Profile  
14:48:48.344 GMT : 14:48:47 (157) Safe Unaided Profile  
14:53:35.646 GMT : 14:53:34 (211) POSAV new status  
14:57:01.448 GMT : 14:57:01 (157) Safe Unaided Profile  
14:57:02.448 GMT : 14:57:01 (157) Safe Unaided Profile  
14:57:07.548 GMT : 14:57:06 (106) Rx Shutter Open  
14:57:07.748 GMT : 14:57:06 (108) Tx Shutter Open  
15:07:32.954 GMT : 15:07:32 (113) Laser Emission On  
15:11:01.155 GMT : 15:11:00 (112) Laser Emission Off  
15:15:28.458 GMT : 15:15:28 (113) Laser Emission On  
15:18:09.26 GMT : 15:18:08 (112) Laser Emission Off  
15:23:32.563 GMT : 15:23:32 (113) Laser Emission On  
15:26:17.365 GMT : 15:26:16 (112) Laser Emission Off  
15:30:08.067 GMT : 15:30:07 (113) Laser Emission On  
15:32:48.469 GMT : 15:32:47 (112) Laser Emission Off  
15:37:59.172 GMT : 15:37:58 (113) Laser Emission On  
15:40:38.974 GMT : 15:40:37 (112) Laser Emission Off



15:45:11.777 GMT : 15:45:11 (113) Laser Emission On  
 15:48:03.079 GMT : 15:48:02 (112) Laser Emission Off  
 15:53:13.283 GMT : 15:53:12 (113) Laser Emission On  
 15:56:38.285 GMT : 15:56:37 (112) Laser Emission Off  
 16:01:02.288 GMT : 16:01:01 (113) Laser Emission On  
 16:04:20.99 GMT : 16:04:20 (112) Laser Emission Off  
 16:09:31.194 GMT : 16:09:30 (113) Laser Emission On  
 16:13:12.497 GMT : 16:13:12 (112) Laser Emission Off  
 16:17:41.6 GMT : 16:17:41 (113) Laser Emission On  
 16:21:20.003 GMT : 16:21:18 (112) Laser Emission Off  
 16:26:30.307 GMT : 16:26:29 (113) Laser Emission On  
 16:30:11.01 GMT : 16:30:10 (112) Laser Emission Off  
 16:35:43.114 GMT : 16:35:42 (113) Laser Emission On  
 16:38:04.916 GMT : 16:38:04 (112) Laser Emission Off  
 16:42:38.92 GMT : 16:42:38 (113) Laser Emission On  
 16:45:00.221 GMT : 16:44:59 (112) Laser Emission Off  
 16:46:23.223 GMT : 16:46:22 (157) Safe Unaided Profile  
 16:46:47.123 GMT : 16:46:46 (157) Safe Unaided Profile  
 16:46:51.223 GMT : 16:46:50 (107) Rx Shutter Closed  
 16:46:51.423 GMT : 16:46:50 (109) Tx Shutter Closed

#### Flight Log

-----  
 Project Number: SFZ\_Blackstone  
 S/N : 247  
 Operator : Galieti  
 Pilot(s) : Greenwell  
 Aircraft : N2448G  
 Airport : KBED KSFZ  
 Mission : 1  
 Wheels Up : 9:45 AM EST 1445Z  
 Flight Length :  
 HOBBS Start :  
 HOBBS End :

#### Weather

-----  
 Date : December 17, 2010  
 Julian Day : 351  
 Temperature : -11 C  
 Visibility : -13 C  
 Clouds : None  
 Precipitation : None  
 Wind Dir : 290  
 Wind Speed : 6  
 Pressure : 29.81 HG

#### Statistics

-----  
 Laser Time : 00:38:46

=====

#### Flight Log

-----

Project Number: SFZ\_Blackstone  
 S/N : 247  
 Operator : Galieti  
 Pilot(s) : Greenwell  
 Aircraft : N2448G  
 Airport : KBED KSFZ  
 Mission : 1  
 Wheels Up : 9:45 AM EST 1445Z  
 Flight Length :  
 HOBBS Start :  
 HOBBS End :

#### Weather

-----  
 Date : December 17, 2010  
 Julian Day : 351  
 Temperature : -11 C  
 Visibility : -13 C  
 Clouds : None  
 Precipitation : None  
 Wind Dir : 290  
 Wind Speed : 6  
 Pressure : 29.81 HG

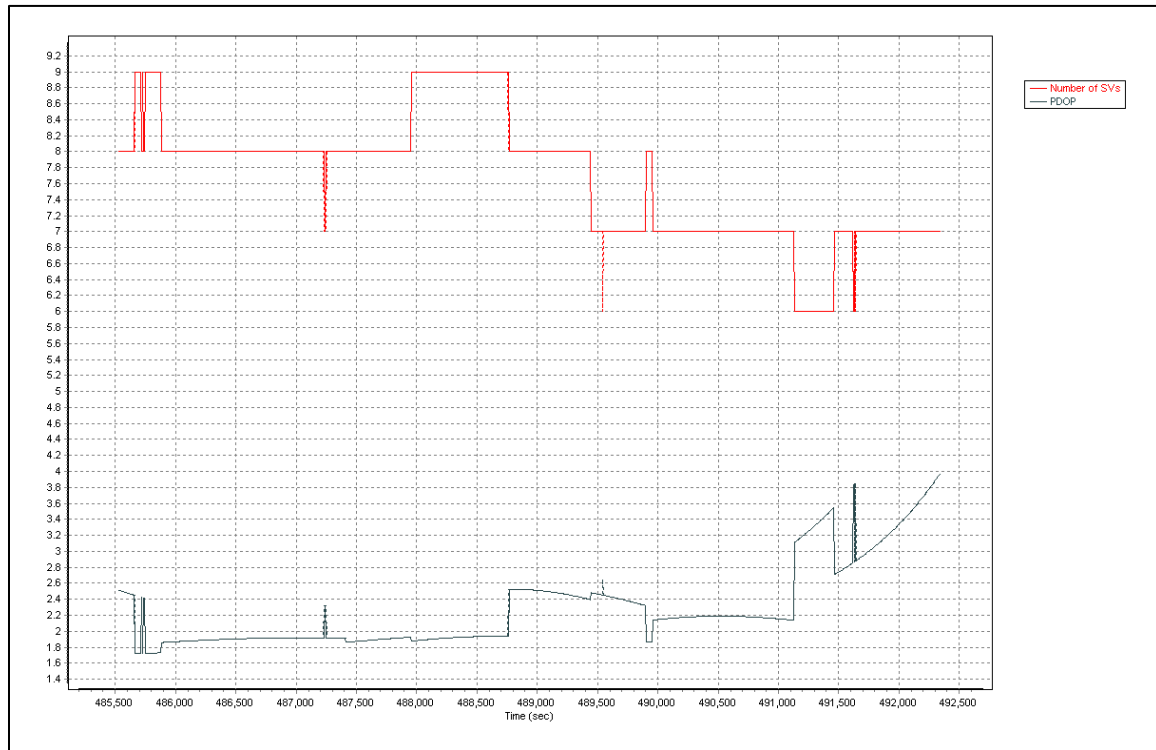
#### Statistics

-----  
 Laser Time : 00:38:46

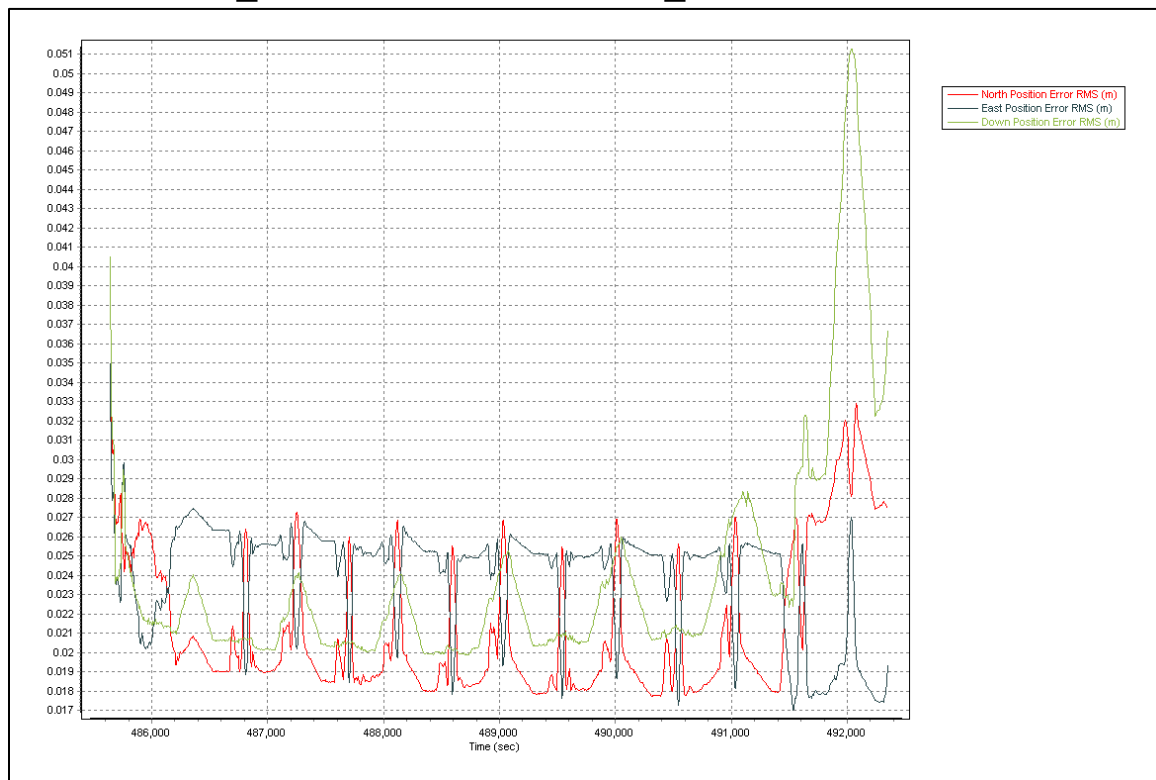
RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
=====									
15:07:33.954	15:10:57.855	28	1689	70	30.10	18.00	ON	NAR	
ON 0.00	268.32								
15:15:29.358	15:18:10.76	29	1699	70	30.10	18.00	ON	NAR	
ON 0.00	88.3								
15:15:29.358	15:18:10.76	29	1699	70	30.10	18.00	ON	NAR	
ON 0.00	88.3								
15:23:33.563	15:26:19.365	30	1691	70	30.10	18.00	ON	NAR	
ON 0.00	268.29								
15:23:33.563	15:26:19.365	30	1691	70	30.10	18.00	ON	NAR	
ON 0.00	268.29								
15:30:08.067	15:32:48.169	32	1702	70	30.10	18.00	ON	NAR	
ON 0.00	88.3								
15:37:59.372	15:40:39.674	32	1691	70	30.10	18.00	ON	NAR	
ON 0.00	268.3								
15:37:59.372	15:40:39.674	32	1691	70	30.10	18.00	ON	NAR	
ON 0.00	268.3								
15:45:12.477	15:48:00.379	33	1702	70	30.10	18.00	ON	NAR	
ON 0.00	88.3								
15:53:13.083	15:56:40.085	34	1692	70	30.10	18.00	ON	NAR	
ON 0.00	268.29								
15:53:13.083	15:56:40.085	35	1692	70	30.10	18.00	ON	NAR	
ON 0.00	268.28								

16:01:03.088	16:04:22.091	35	1701	70	30.10	18.00	ON	NAR
ON 0.00	88.28							
16:09:32.094	16:13:14.497	36	1688	70	30.10	18.00	ON	NAR
ON 0.00	268.29							
16:09:32.094	16:13:14.497	36	1688	70	30.10	18.00	ON	NAR
ON 0.00	268.29							
16:17:42.4	16:21:16.003	37	1697	70	30.10	18.00	ON	NAR
ON 0.00	88.3							
16:26:30.607	16:30:08.51	38	1688	70	30.10	18.00	ON	NAR
ON 0.00	268.3							
16:26:30.607	16:30:08.51	38	1688	70	30.10	18.00	ON	NAR
ON 0.00	268.3							
16:35:43.714	16:38:06.616	39	1761	70	30.10	18.00	ON	NAR
ON 0.00	358.59							
16:35:43.714	16:38:06.616	39	1761	70	30.10	18.00	ON	NAR
ON 0.00	358.59							
16:42:39.52	16:45:02.221	40	1766	70	30.10	18.00	ON	NAR
ON 0.00	178.6							
□								

# 101217A-247\_SVS&PDOP

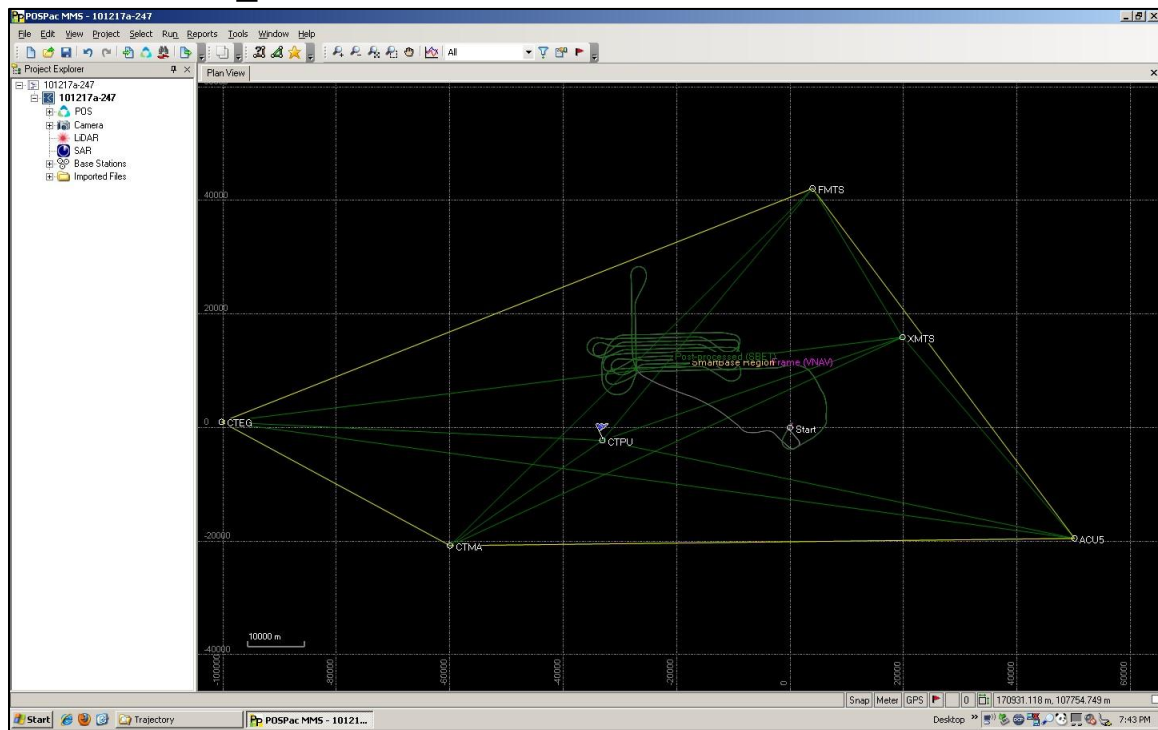


# 101217A-247\_SMOOTHPERFMETRIC\_NED

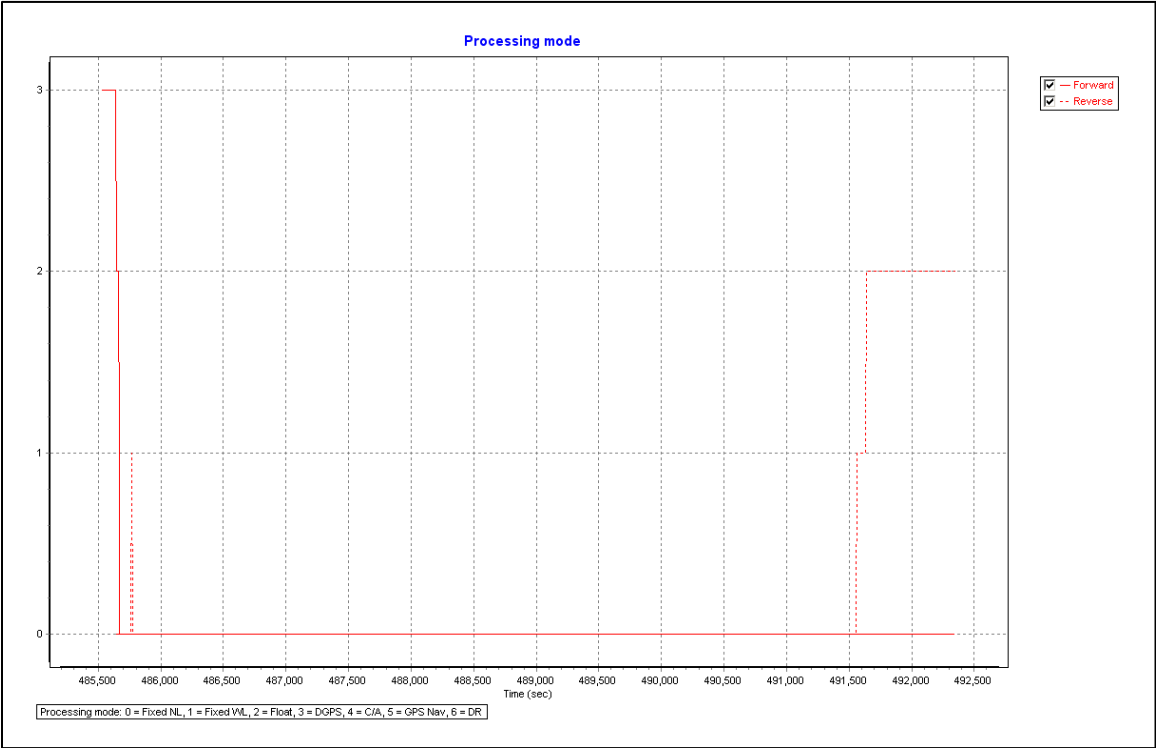




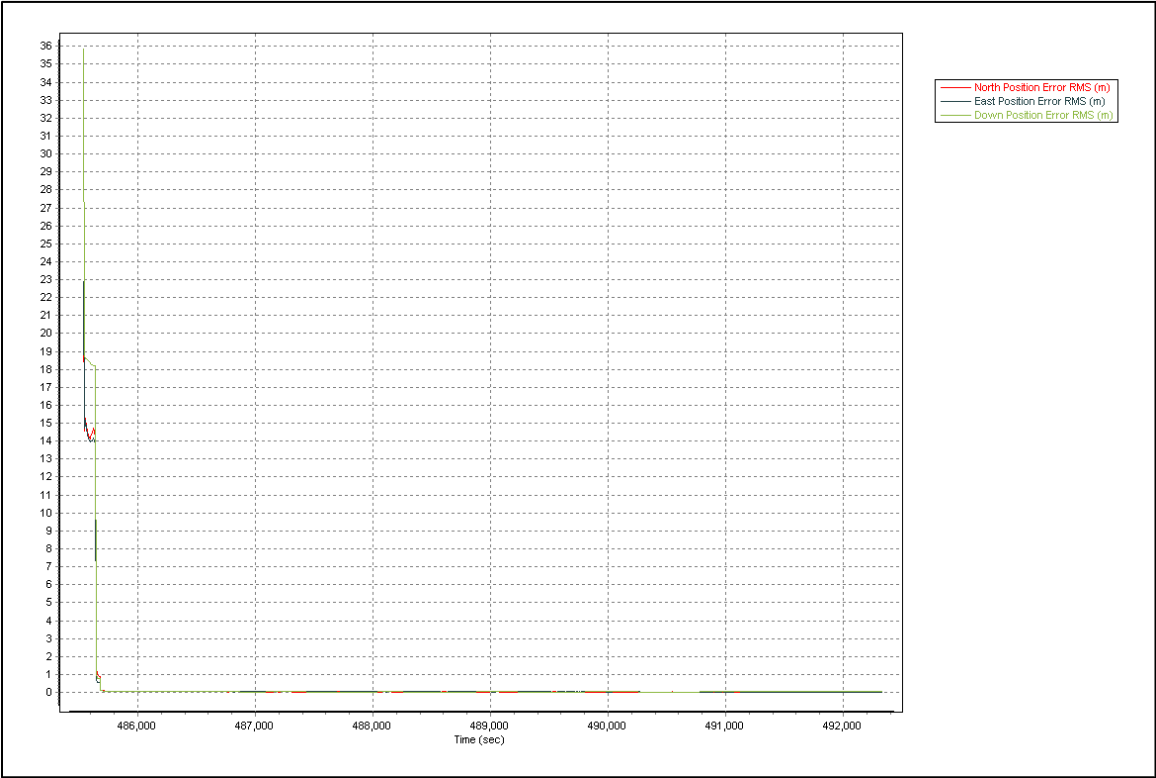
# 101217A-247\_SCREENSHOT



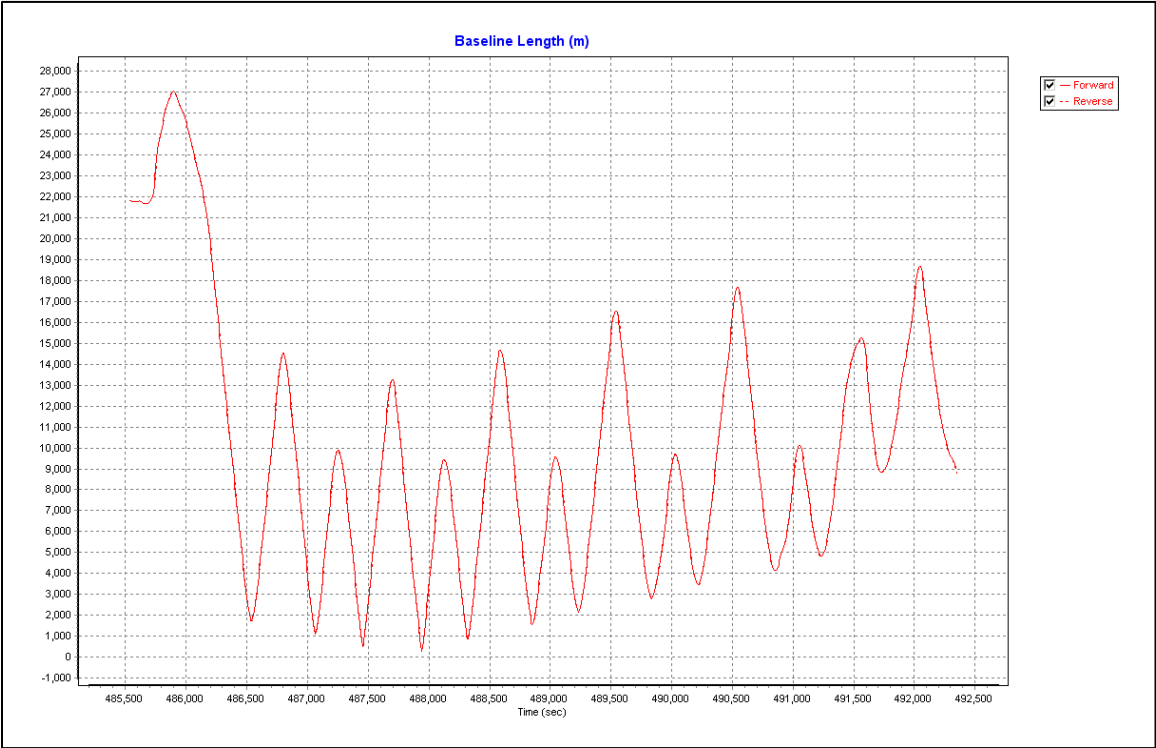
101217A-247\_PROCESSMODE



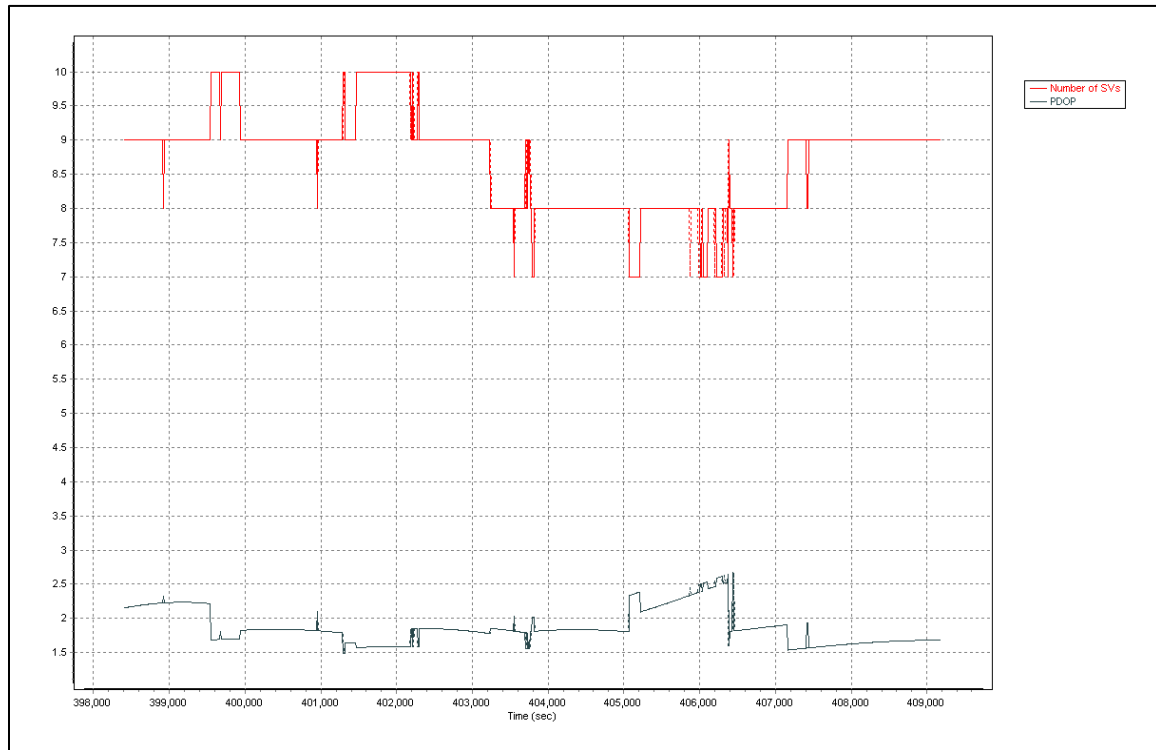
101217A-247\_FOWARDPROCPERFMETRIC\_NED



101217A-247\_BASELINE

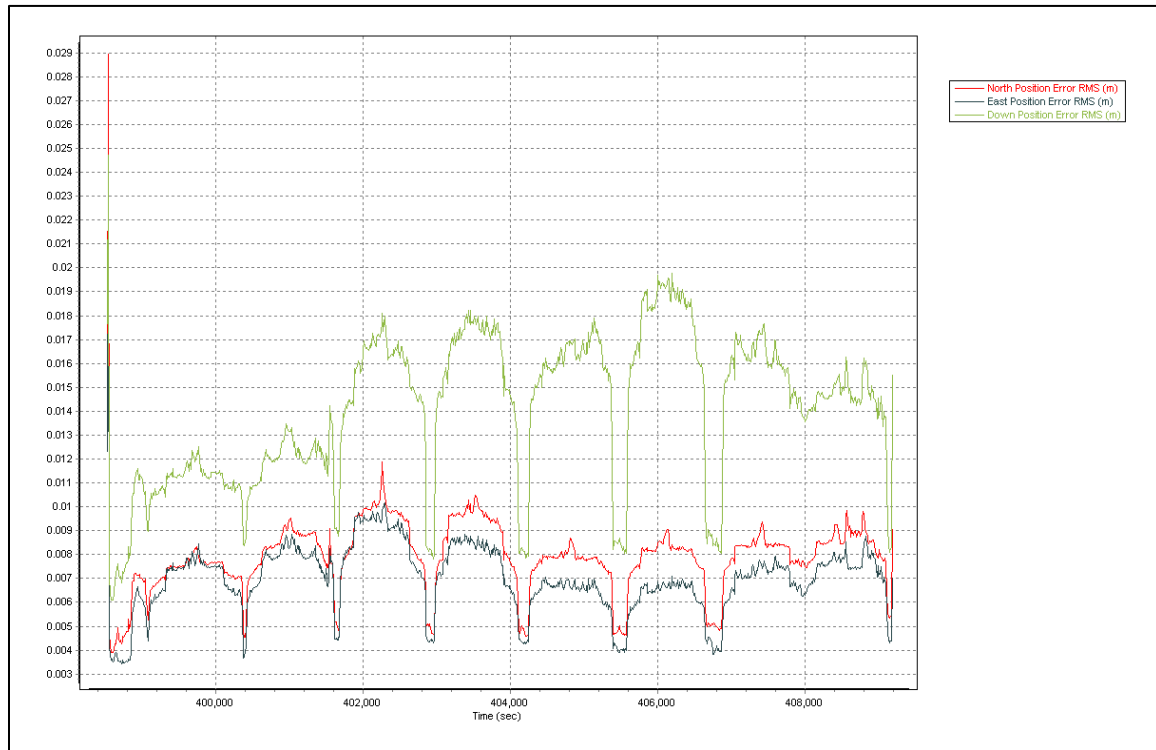


# 101216A-247\_SVS&PDOP

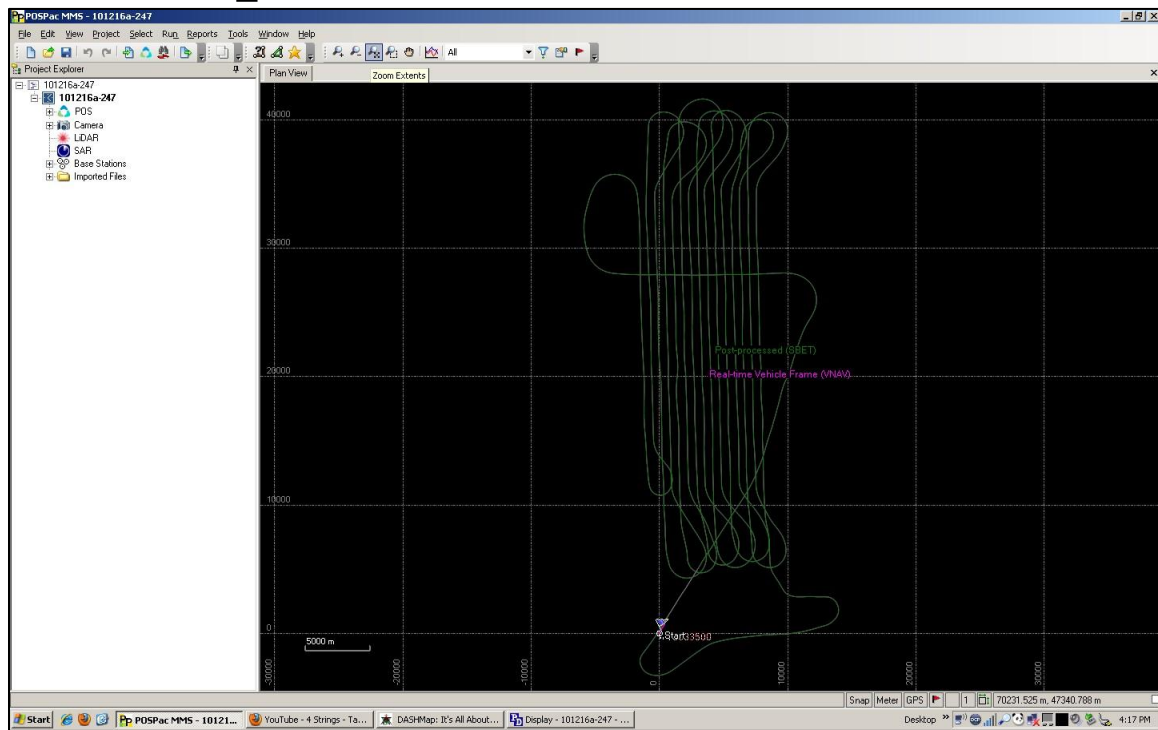




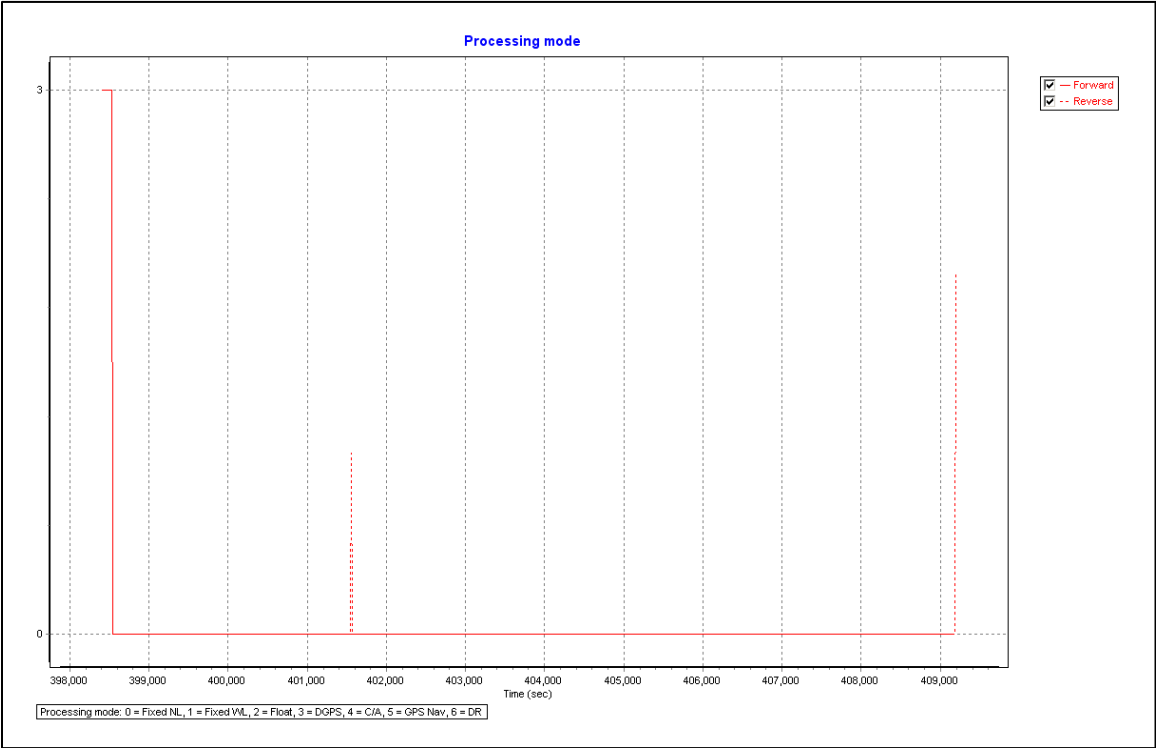
# 101216A-247\_SMOOTHPERFMETRIC\_NED



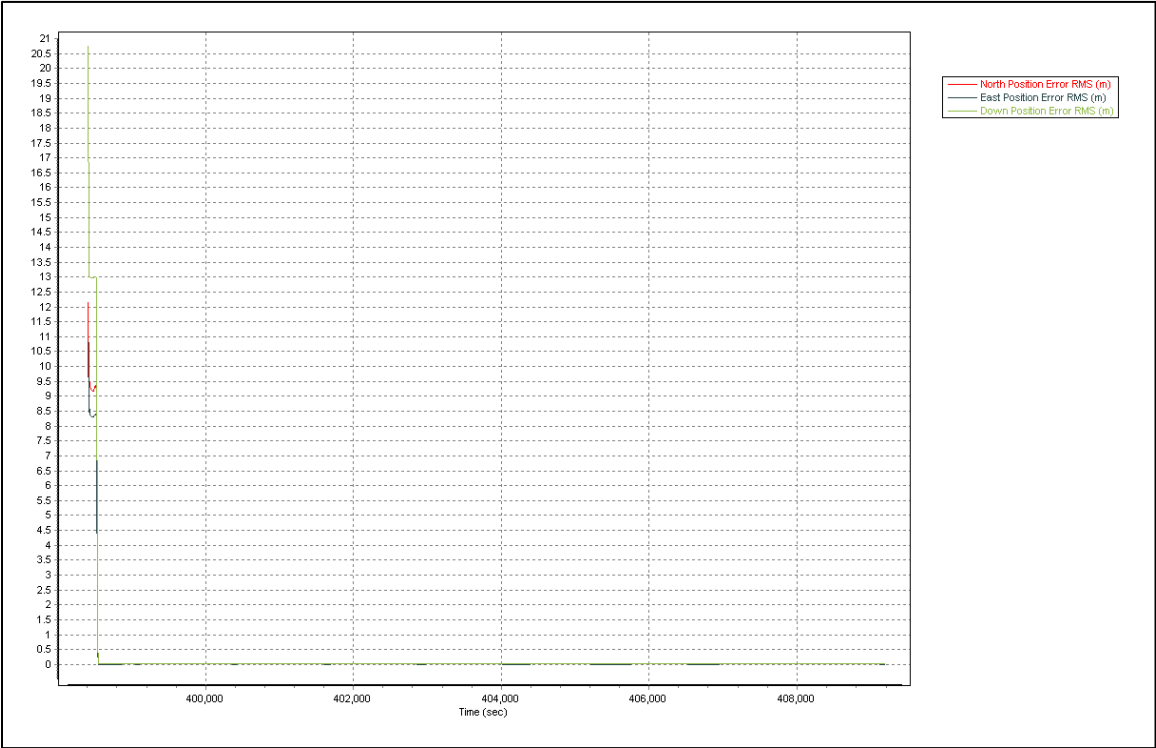
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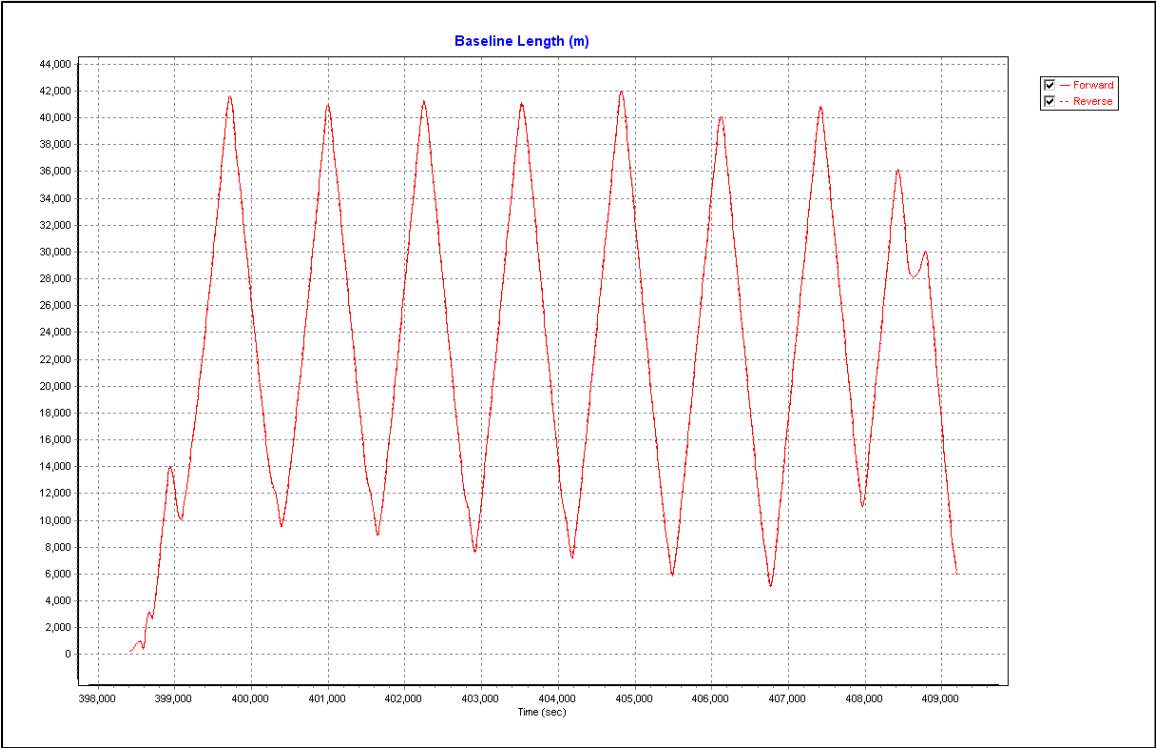
101216A-247\_PROCESSMODE



101216A-247\_FORWARDPROCPERFMETRIC\_NED

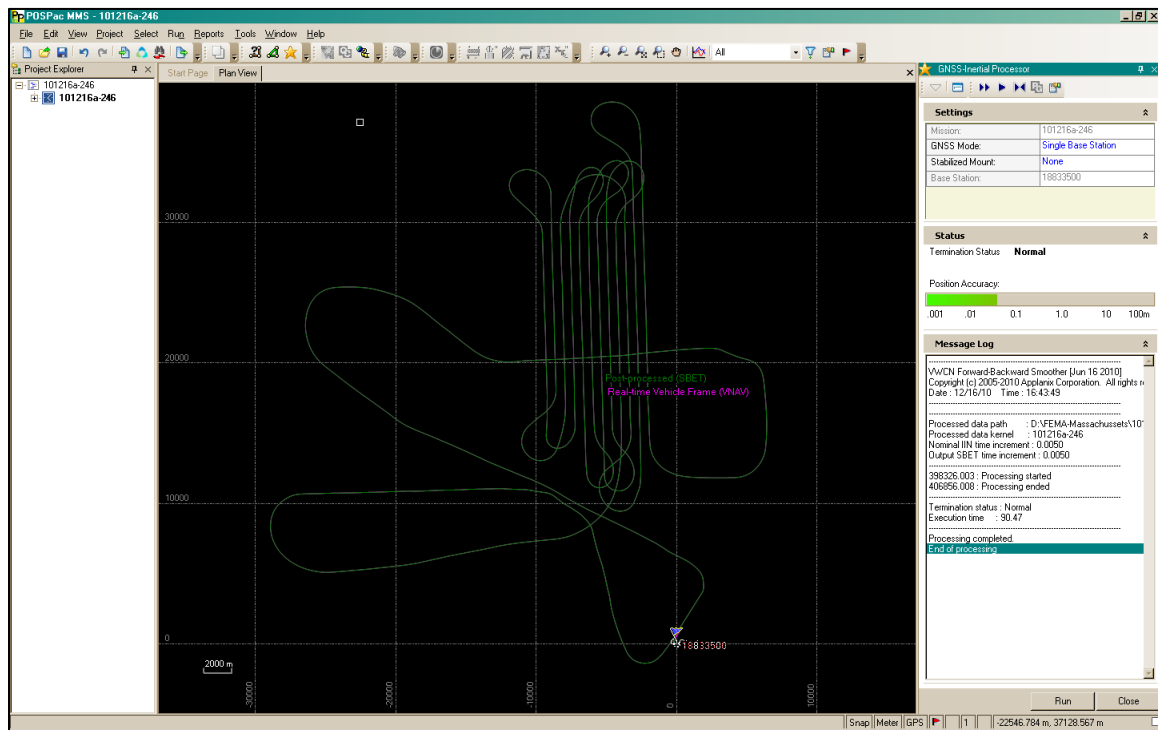


101216A-247\_BASELINE

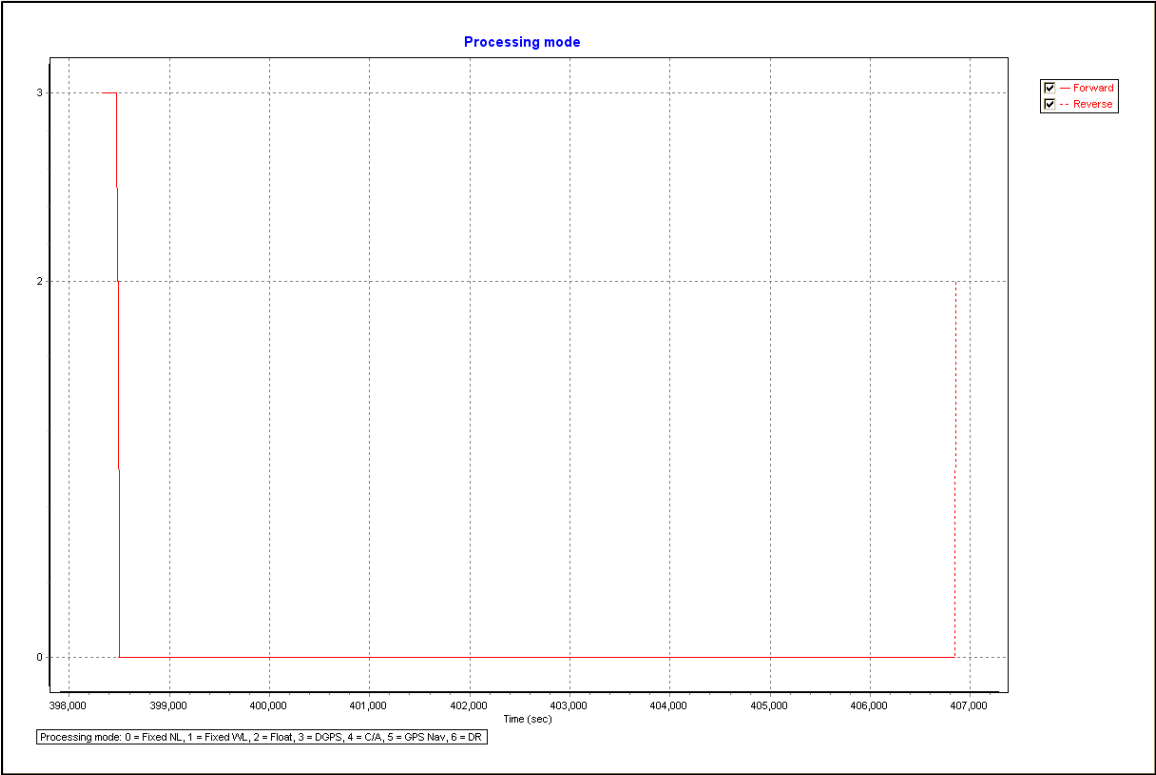




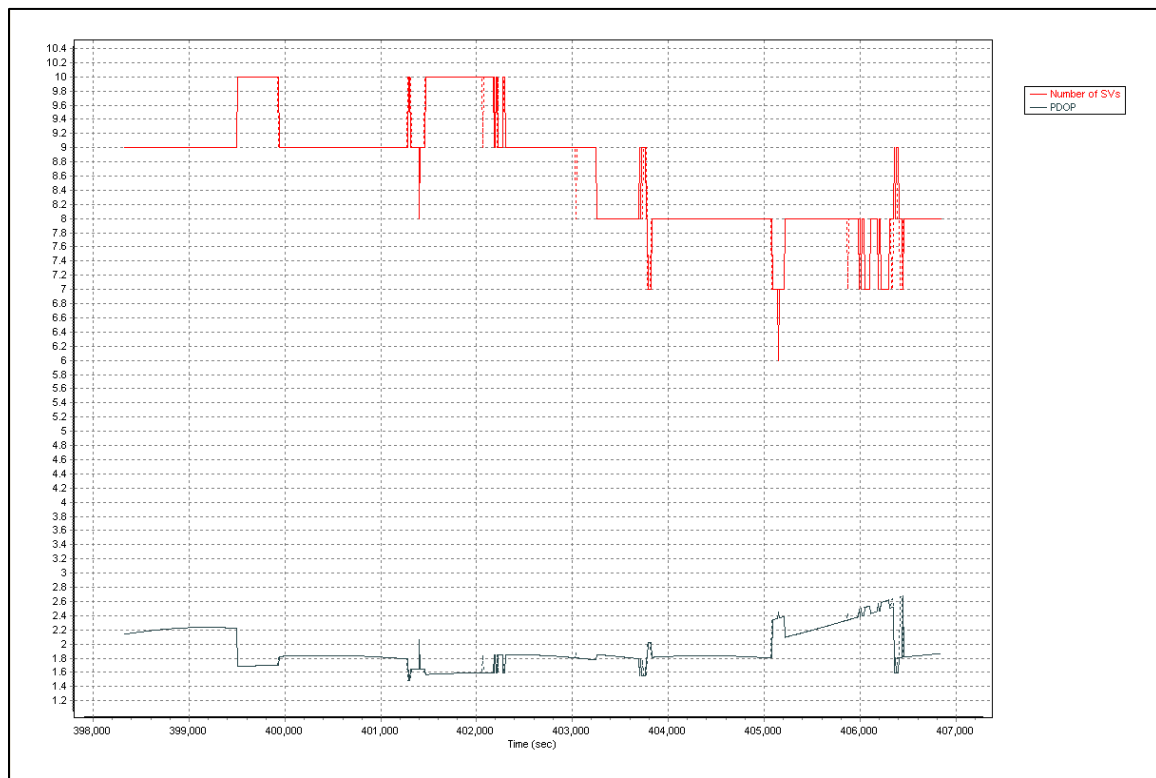
# 101216A-246-TRAJECTORY



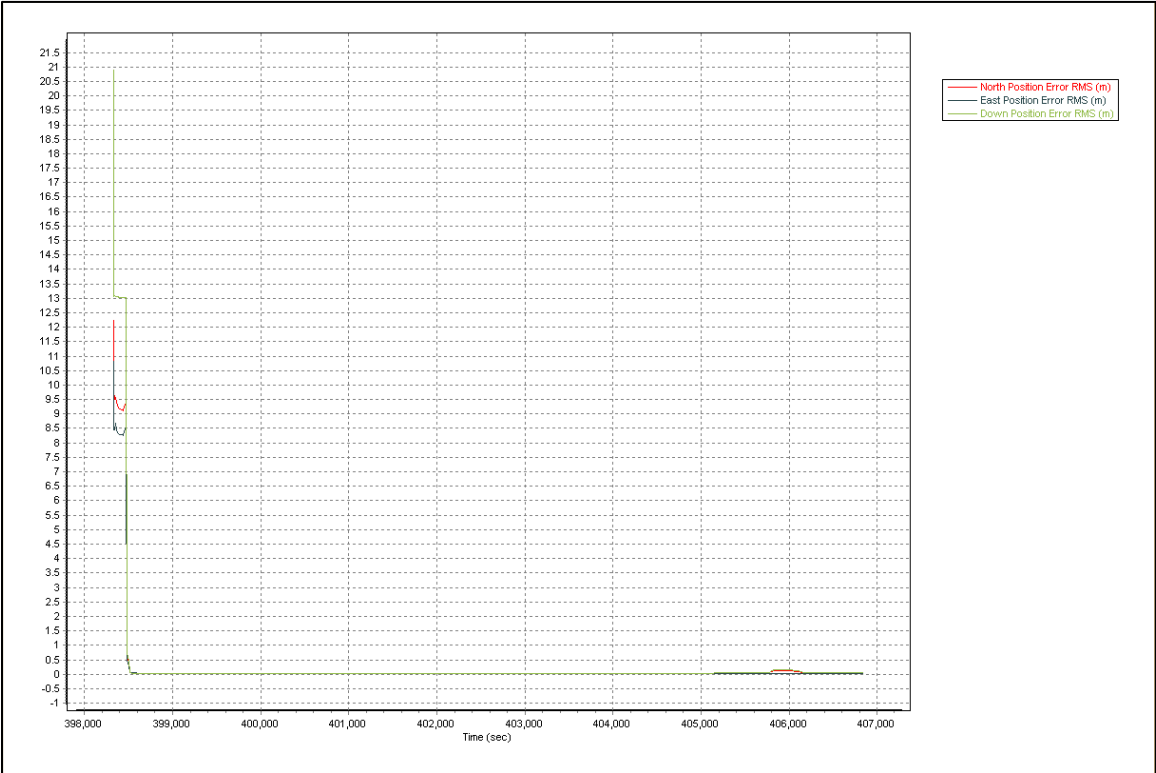
101216A-246-PROCMODE



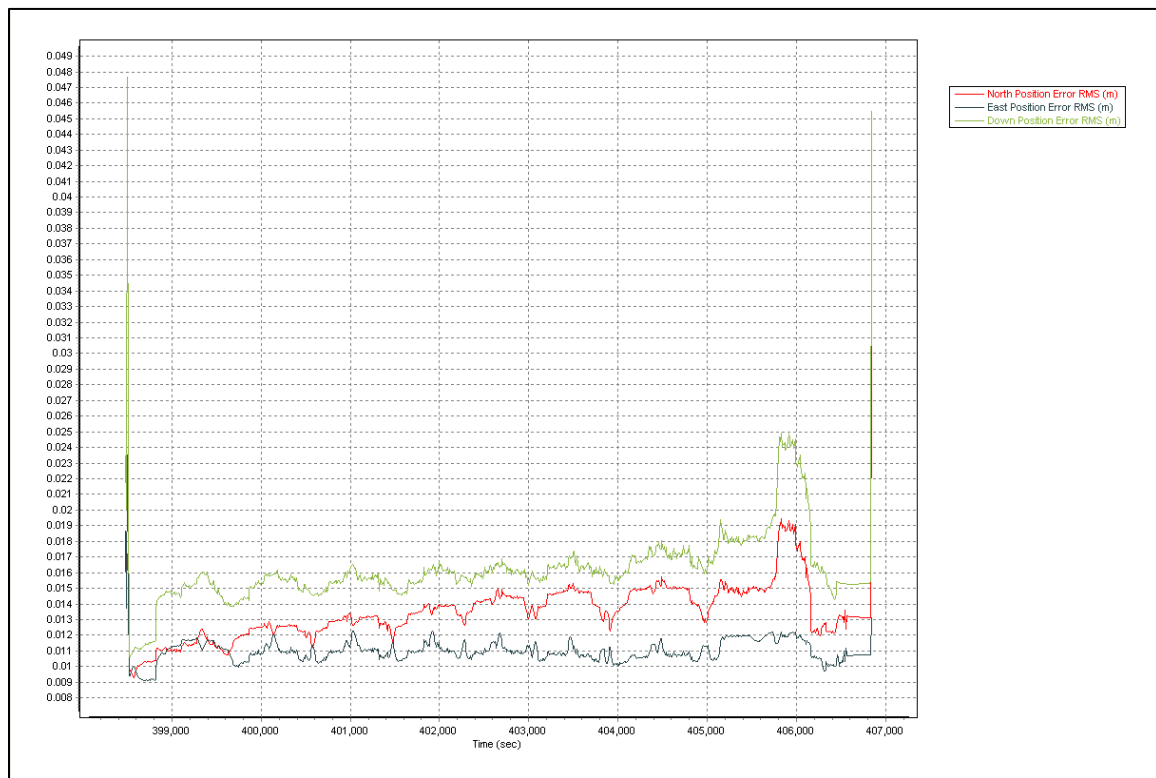
# 101216A-246-PDOP&SVS



101216A-246-NEDPOSITIONERROR-SMOOTHED

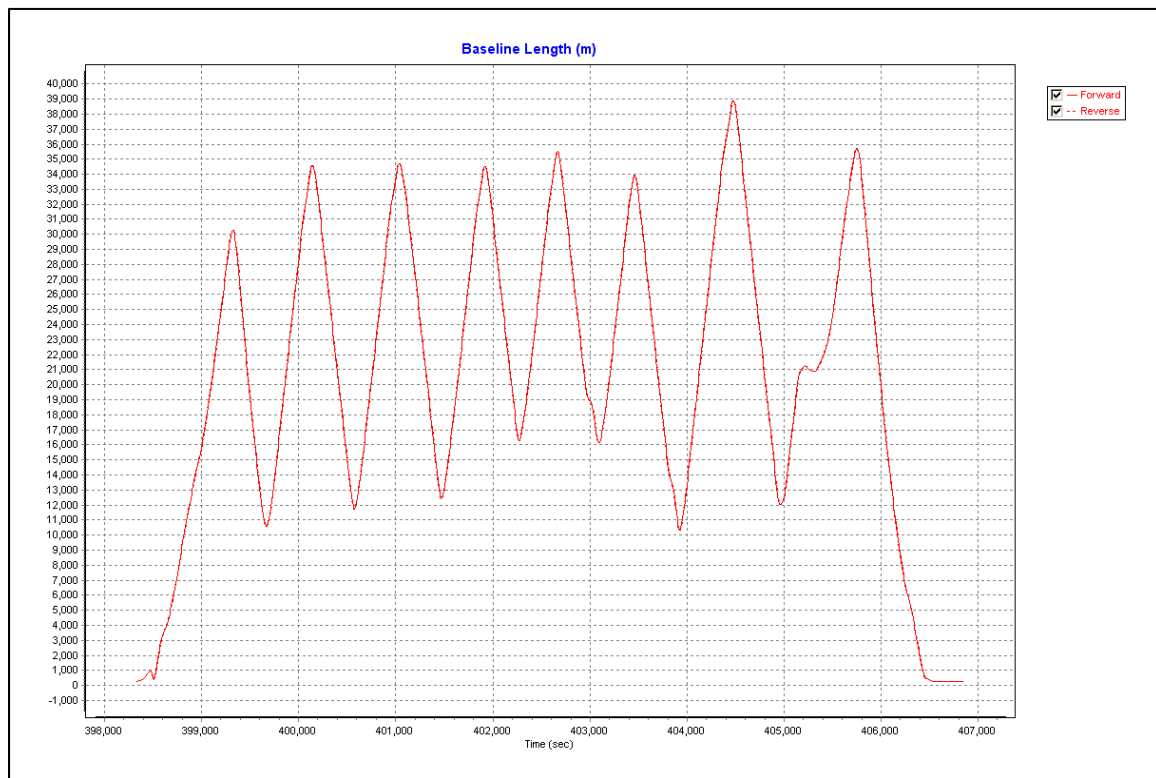


# 101216A-246-NEDPOSITIONERROR-FORWARD

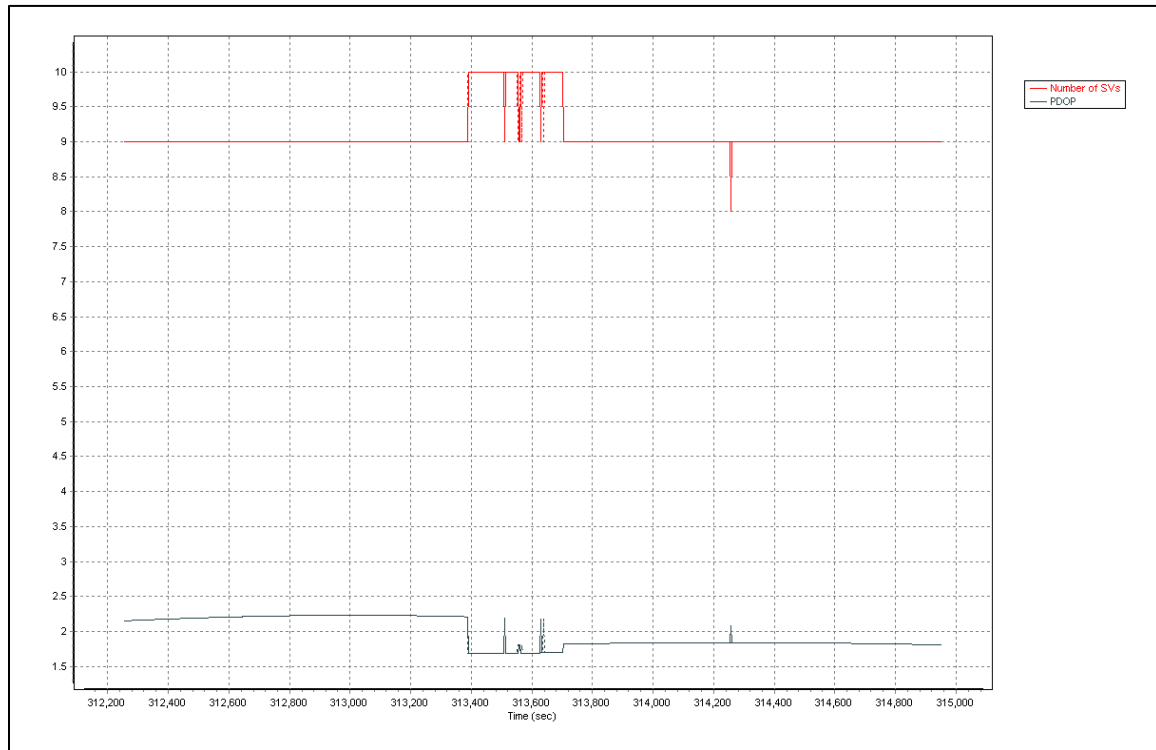




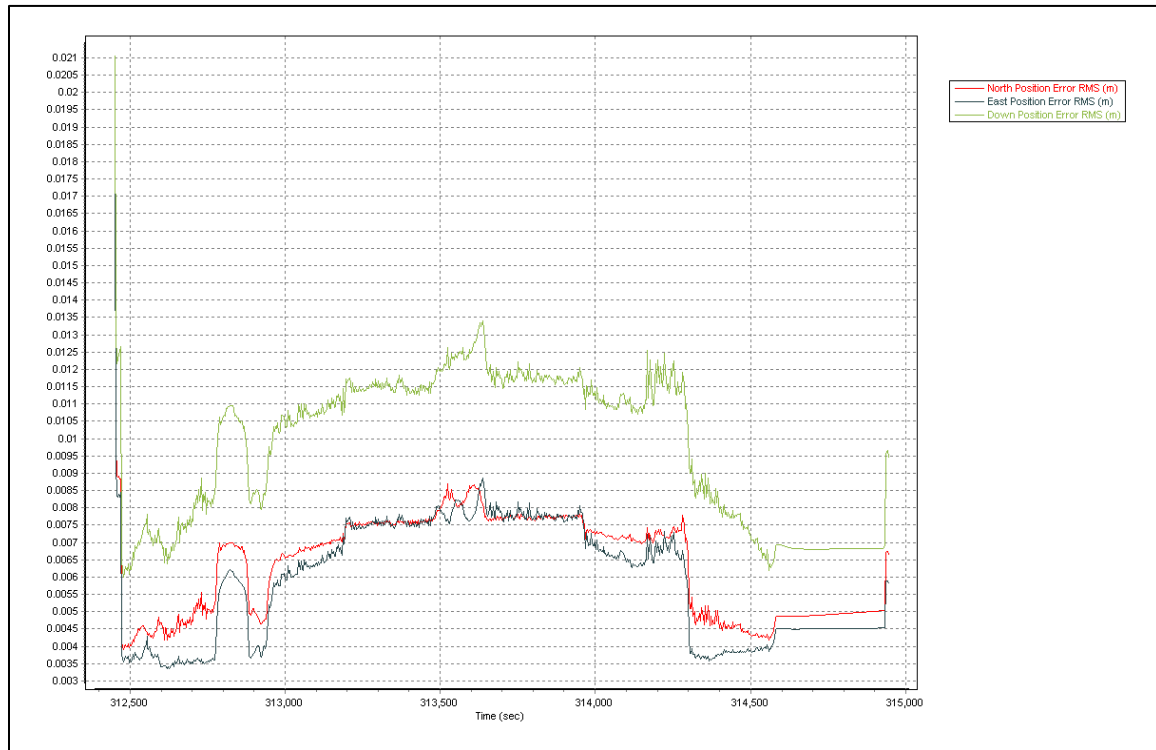
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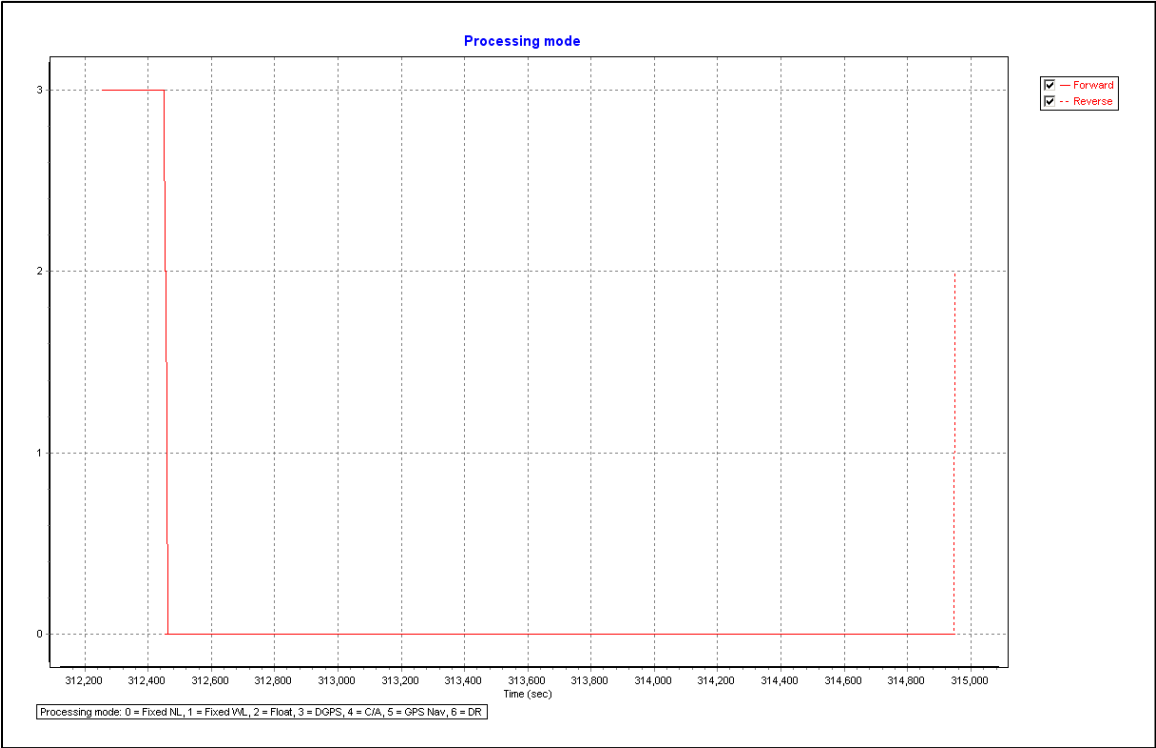
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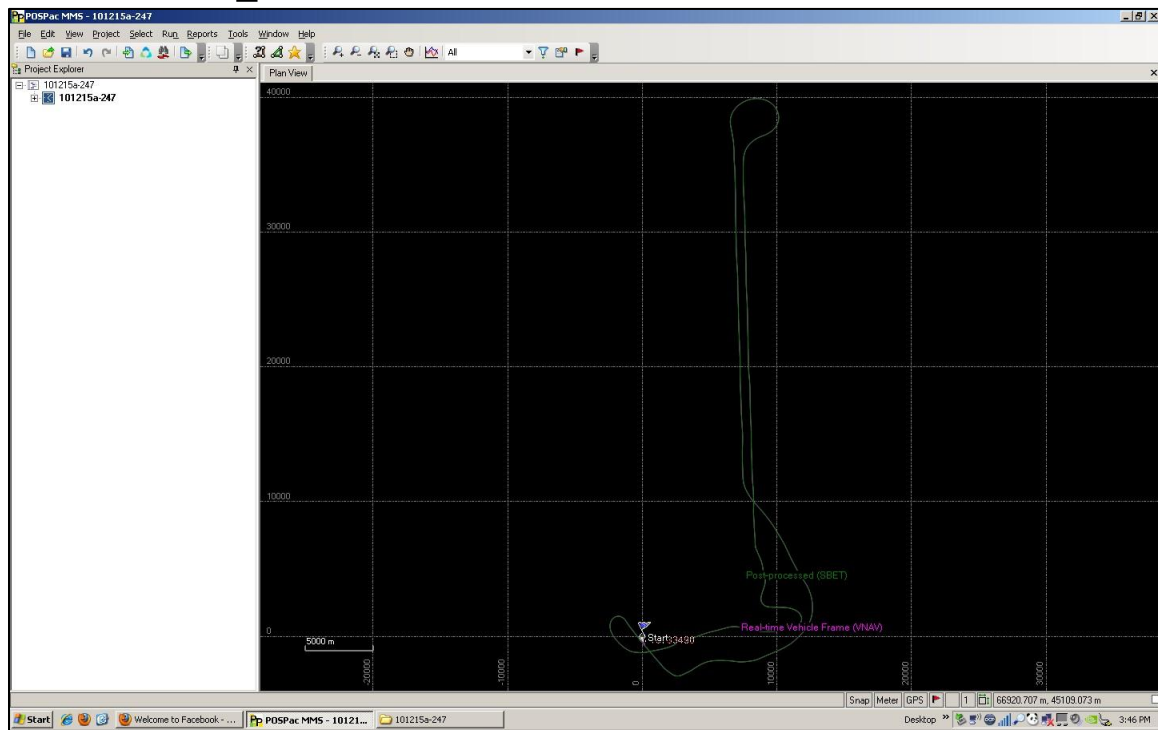
# 101215A-247\_SMOOTHPERFMETRIC\_NED



101215A-247\_PROCESSMODE

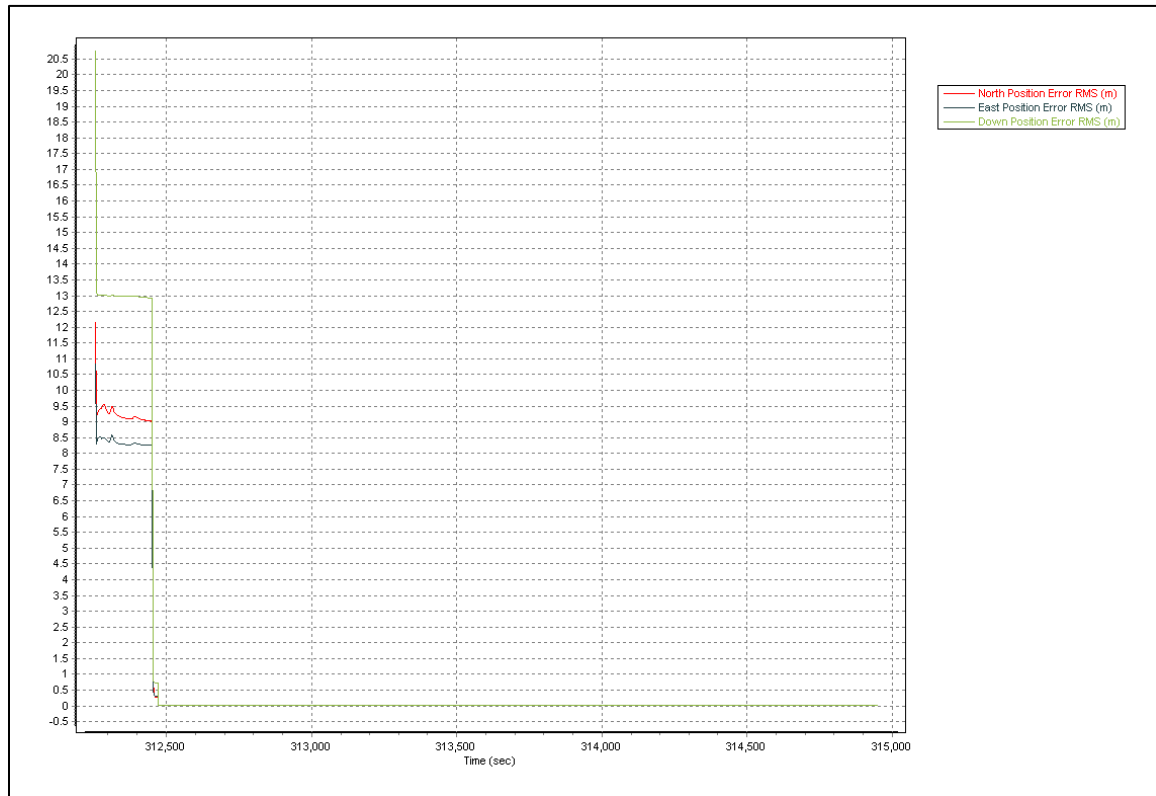


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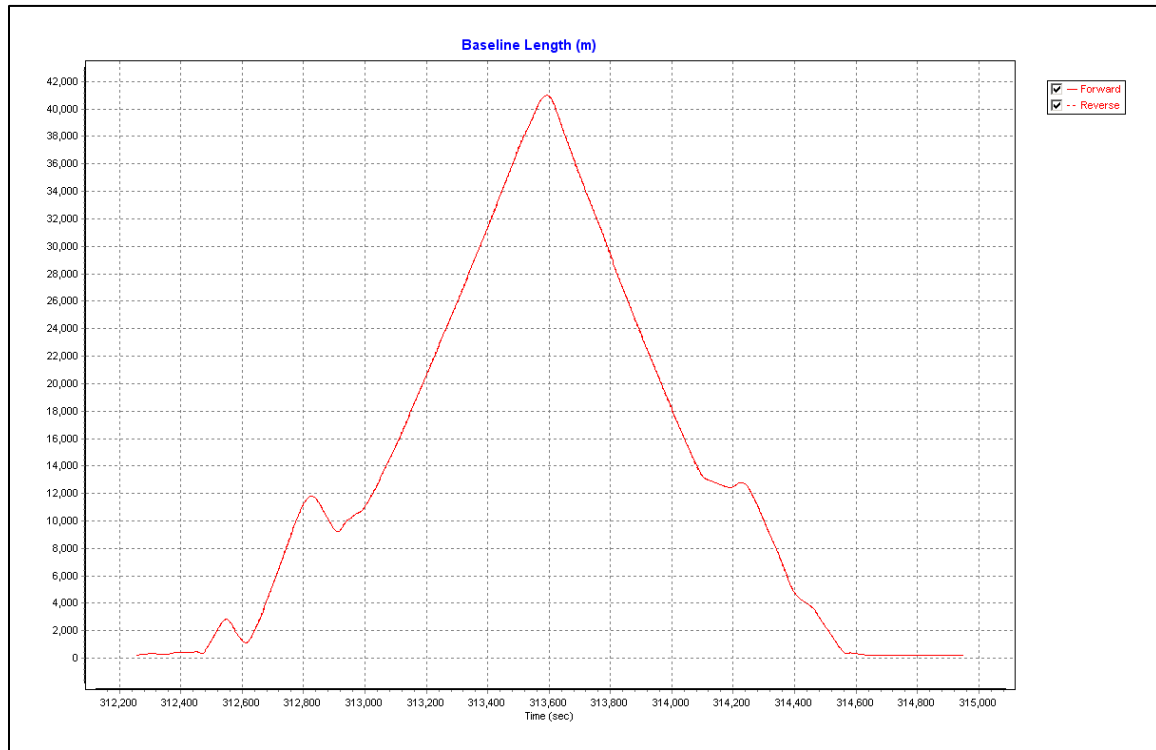




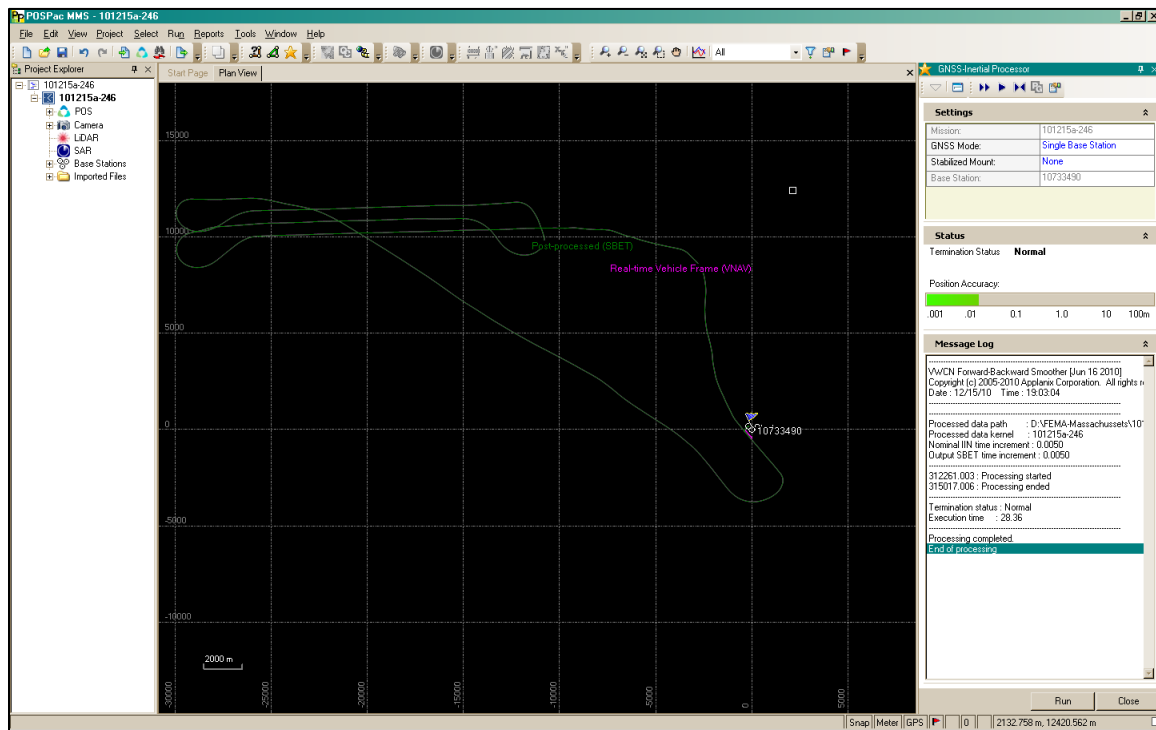
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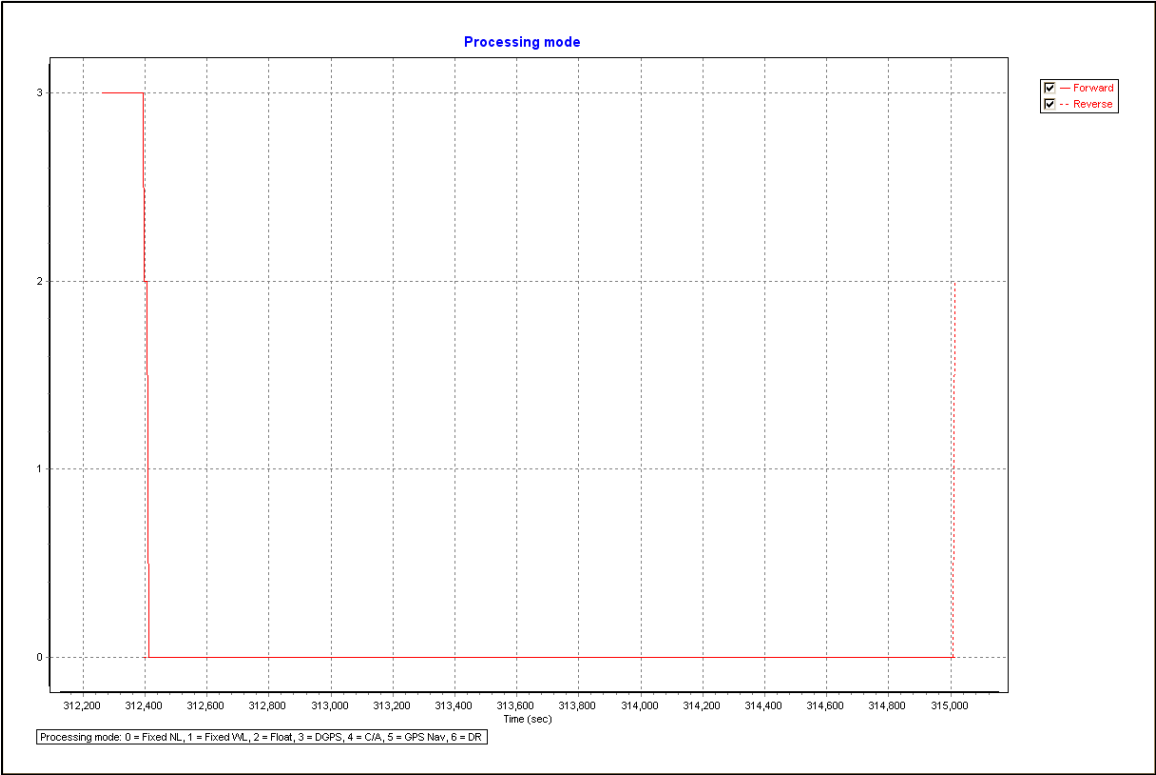
# 101215A-247\_BASELINE



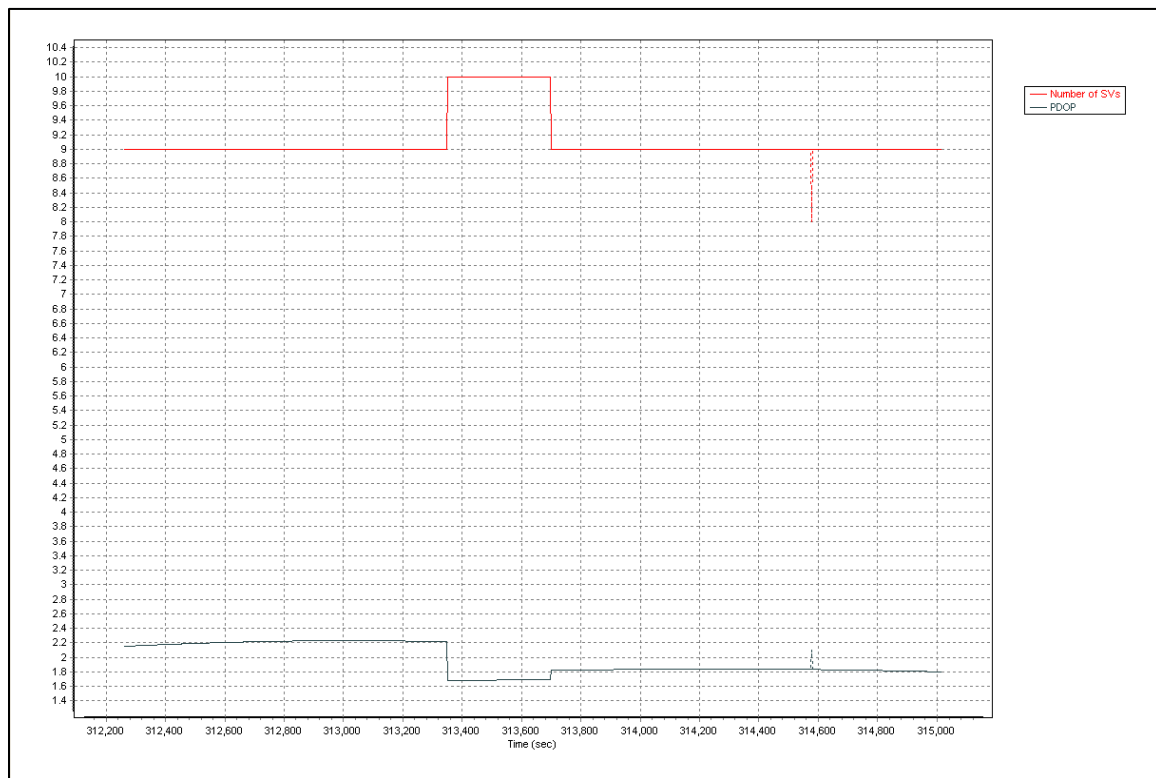
# 101215A-246-TRAJECTORY



101215A-246-PROCMODE

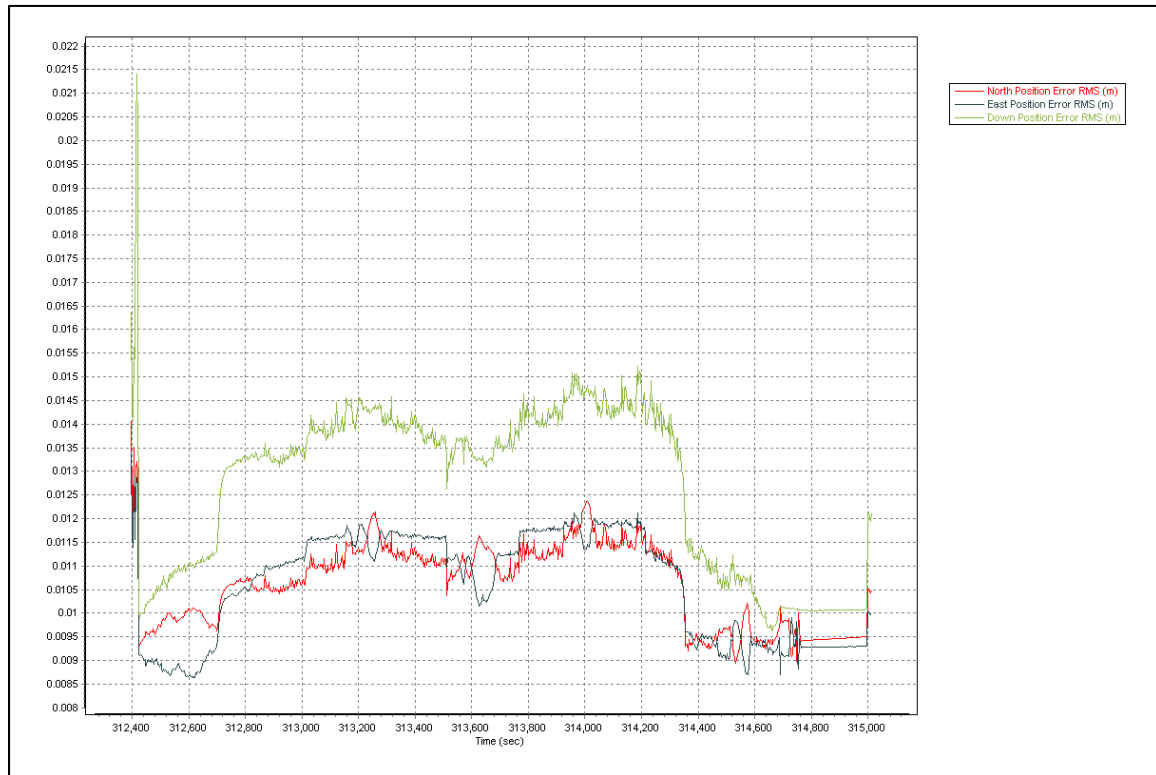


# 101215A-246-PDOP&SVS

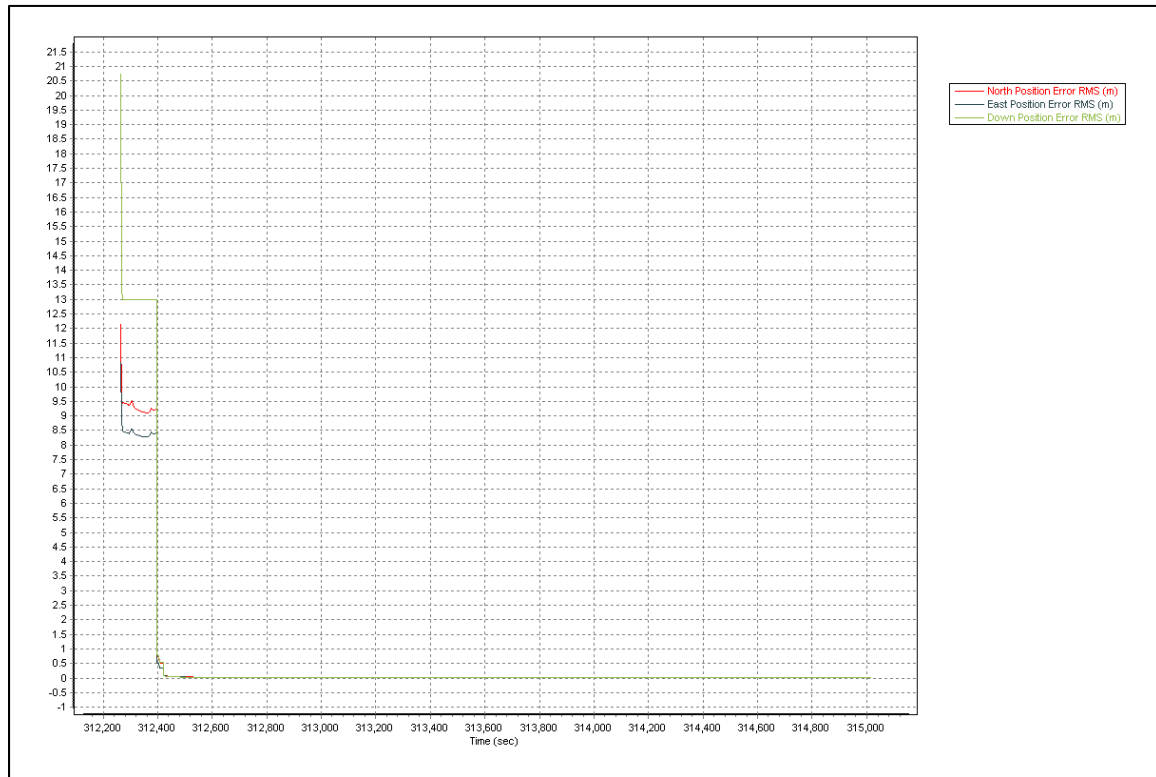




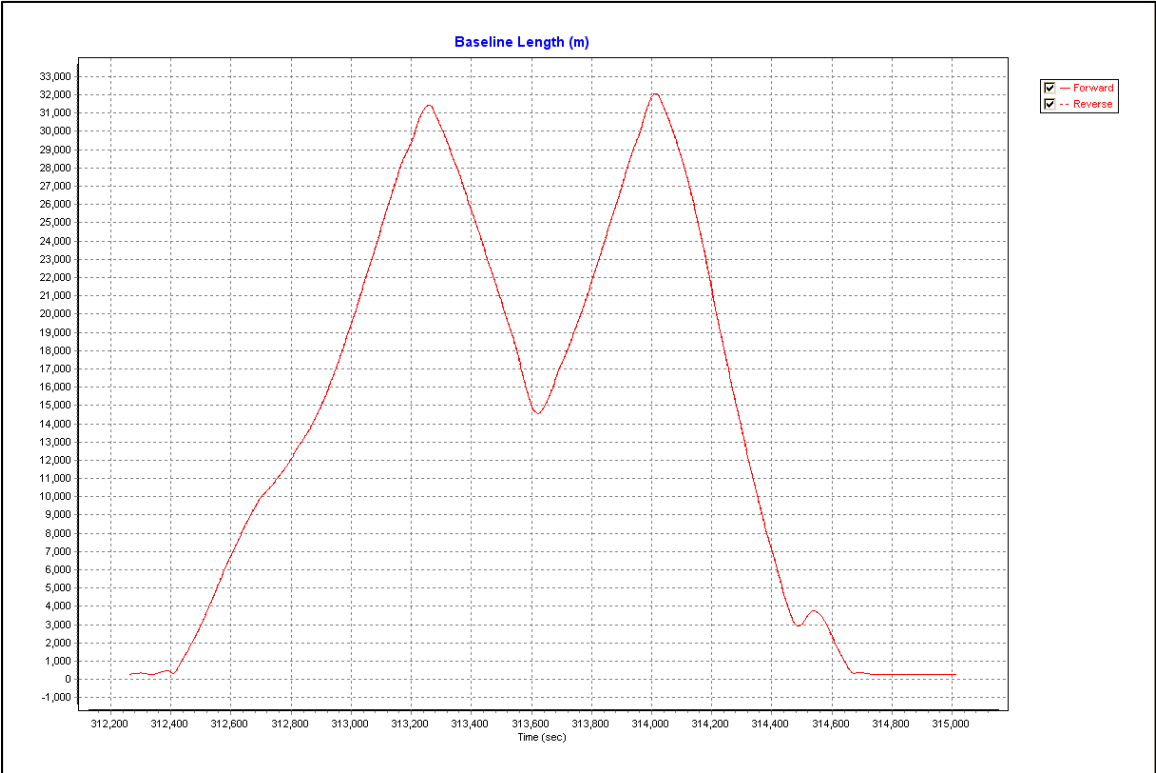
# 101215A-246-NEDPOSITIONERROR-SMOOTHED



# 101215A-246-NEDPOSITIONERROR-FORWARD



101215A-246-BASELINELENGTH





2670 WILHITE DRIVE  
LEXINGTON, KENTUCKY 40503  
PHONE 859-277-8700 + FAX 859-277-8901  
WWW.PHOTOSCIENCE.COM

March 29, 2011

Post Flight Report  
PSI Project 7556-005  
BED Charles, MA LiDAR

CONTRACT: \_\_\_\_\_

Client: \_\_\_\_\_

Project Name: Bedford Charles Sub Block

Attached Reference file: 7556-005\_Bed-Charles\_MA\_Background.ZIP

General Specifications: 1-meter nominal spacing LiDAR Acquisition and processing with a 24.5 cm vertical accuracy at 95% confidence level.

Acquisition Dates: LiDAR data for the BED-Charles data was acquired on the dates of 12/02, 12/3, 12/7, 12/12, 12/10, and 12/11 2010 over 9 lifts. Crews had been on site previously without success due to weather and ground condition issues (low clouds, snow and rain).

Equipment Used: The data was collected with Optech Gemini LiDAR systems, Serial Numbers 246 and 247, Base GPS Receiver used was a Trimble 5700 collecting data at half second intervals. The aircraft used were Cessna 206 models, tail numbers N2448G and N7266Z. The pilots were Cameron Caldwell, Mark Young and Nick Greenwell and the Operators were Jeremy Berry and Nathan Galieti. The Base Station was set on the monument "BED A, AI5558" at the Laurence G Hanscom Field Airport (BED) set by the crews.

Project: The project consisted of 50 flight lines of 1008.55 miles. The project was flown at an altitude of 5,000 feet above ground and at a planned average speed of 116 knots with a field of view of 36 degrees. The scan rates used was 30.1 Hz with a Laser Pulse Rate of 71,429 Hz with Multi-Pulse enabled. The full swath width was 989.18 meters with a planned sidelap of 30%. The point spacing was <1 meter with a NADIR point density of 1.2 points per square meter and an average point density of 3.03 points per square meter. The planned vertical accuracy was 0.13 meters.

GPS Base Station / Monument: The Base Station was set on the monument "BED A, AI5558" at the Laurence G Hanscom Field Airport (BED) and the Base Station was set by the flight crews. Information on this monument is included in the attached .ZIP file under "Base Station Data".

Control: Control points were collected as part of the project and used to calibrate the project data, remove any bias and verify accuracy. This data is compared to the collected model and results indicated below. This control data is included in the attached .ZIP file under “Control”.

Flight Files: The planned flight files are included as reference in the attached .ZIP file under “Flight Files”.

Flight Logs: Flight Logs used by the crew are included in the attached .ZIP file under “Flight Logs” and include the following type information:

- job #/name
- block or AOI
- date (s) flown
- aircraft tail #
- lines - #
- lines - direction
- lines – altitude
- lines – speed
- conditions
- comments
- pilot name
- operator name
- AGC switch
- GPS base station used

Processing Summary: Data is included in the attached .ZIP file under “Processing Summary” which includes GPS / IMU processing summary data including at a minimum:

- Processing Logs
- Message Logs
- Extract Logs
- Laser configuration files for each lift
- Max Horizontal GPS Variance (cm)
- Max Vertical GPS Variance (cm)
- Notes on GPS quality (High, Good, etc.)
- GPS separation plot
- GPS altitude plot
- PDOP plot
- Plot of GPS distance from base station/s

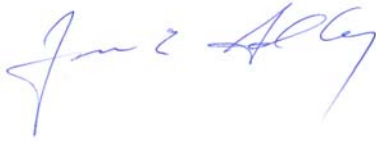


Project Coverage: within the attached .ZIP file in the “Project Coverage” directory is the overall boundary Shape File and the as flown trajectory Shape Files which include the project calibration flight lines (cross flights).

Accuracy: The LiDAR data was tested against the Control check points indicated above and the results are included in the “Accuracy Results” directory in the attached .ZIP file.

The LiDAR data as collected tested at 0.095 (meters) fundamental vertical accuracy at 95% confidence level. Within the accuracies indicated in the specifications, as provided.

Sincerely,

A handwritten signature in blue ink, appearing to read "Forrest Godby". The signature is stylized with a large initial 'F' and a long, sweeping underline.

Forrest Godby  
Senior Project Manager / Flight Operations Manager

# BED\_MA\_Concord\_FEMA\_Base Station Monument

See file [dsdata.txt](#) for more information about the datasheet.

DATABASE = ,PROGRAM = datasheet, VERSION = 7.85  
1 National Geodetic Survey, Retrieval Date = OCTOBER 29, 2010  
AI5558 \*\*\*\*\*  
AI5558 PACS - This is a Primary Airport Control Station.  
AI5558 DESIGNATION - BED A  
AI5558 PID - AI5558  
AI5558 STATE/COUNTY- MA/MIDDLESEX  
AI5558 USGS QUAD -  
AI5558  
AI5558 \*CURRENT SURVEY CONTROL  
AI5558  
AI5558\* NAD 83(2007)- 42 28 07.77843(N) 071 16 59.30167(W) ADJUSTED  
AI5558\* NAVD 88 - 42.05 (meters) 138.0 (feet) GPS OBS  
AI5558  
AI5558 EPOCH DATE - 2002.00  
AI5558 X - 1,512,043.591 (meters) COMP  
AI5558 Y - -4,462,815.458 (meters) COMP  
AI5558 Z - 4,284,170.733 (meters) COMP  
AI5558 LAPLACE CORR- 4.06 (seconds) DEFLEC09  
AI5558 ELLIP HEIGHT- 14.280 (meters) (02/10/07) ADJUSTED  
AI5558 GEOID HEIGHT- -27.77 (meters) GEOID09  
AI5558  
AI5558 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----  
AI5558 Type PID Designation North East Ellip  
AI5558 -----  
AI5558 NETWORK AI5558 BED A 1.00 0.86 2.27  
AI5558 -----  
AI5558  
AI5558.This mark is at Laurence G Hanscom Fld Airport (BED)  
AI5558  
AI5558.The horizontal coordinates were established by GPS observations  
AI5558.and adjusted by the National Geodetic Survey in February 2007.  
AI5558  
AI5558.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).  
AI5558.See [National Readjustment](#) for more information.  
AI5558.The horizontal coordinates are valid at the epoch date displayed above.  
AI5558.The epoch date for horizontal control is a decimal equivalence  
AI5558.of Year/Month/Day.  
AI5558  
AI5558.The orthometric height was determined by GPS observations and a  
AI5558.high-resolution geoid model.  
AI5558  
AI5558.GPS derived orthometric heights for airport stations designated as  
AI5558.PACS or SACS are published to 2 decimal places. This maintains  
AI5558.centimeter relative accuracy between the PACS and SACS. It does  
AI5558.not indicate centimeter accuracy relative to other marks which are  
AI5558.part of the NAVD 88 network.  
AI5558  
AI5558.[Photographs](#) are available for this station.

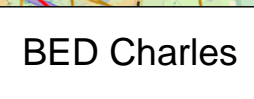
```
AI5558
AI5558.The X, Y, and Z were computed from the position and the ellipsoidal ht.
AI5558
AI5558.The Laplace correction was computed from DEFLEC09 derived deflections.
AI5558
AI5558.The ellipsoidal height was determined by GPS observations
AI5558.and is referenced to NAD 83.
AI5558
AI5558.The geoid height was determined by GEOID09.
AI5558
AI5558;
North East Units Scale Factor Converg.
AI5558;SPC MA M - 913,166.589 217,834.126 MT 0.99997548 +0 08 44.4
AI5558;SPC MA M - 2,995,947.38 714,677.46 sFT 0.99997548 +0 08 44.4
AI5558;UTM 19 - 4,704,357.395 312,305.643 MT 1.00003346 -1 32 31.2
AI5558
AI5558! - Elev Factor x Scale Factor = Combined Factor
AI5558!SPC MA M - 0.99999776 x 0.99997548 = 0.99997324
AI5558!UTM 19 - 0.99999776 x 1.00003346 = 1.00003122
AI5558
AI5558: Primary Azimuth Mark Grid Az
AI5558:SPC MA M - BED B 098 36 23.5
AI5558:UTM 19 - BED B 100 17 39.1
AI5558
AI5558|-----|
AI5558| PID Reference Object Distance Geod. Az |
AI5558| | | | dddmmss.s |
AI5558| AI5559 BED B 458.707 METERS 0984507.9 |
AI5558| MY0669 BED ARP APPROX. 0.5 KM 2854318.4 |
AI5558|-----|
AI5558
AI5558 SUPERSEDED SURVEY CONTROL
AI5558
AI5558 ELLIP H (06/04/02) 14.273 (m) GP( ) 4 1
AI5558 NAD 83(1996)- 42 28 07.77845(N) 071 16 59.30211(W) AD( ) B
AI5558 ELLIP H (05/22/00) 14.281 (m) GP( ) 4 1
AI5558
AI5558.Superseded values are not recommended for survey control.
AI5558.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AI5558.See file dsdata.txt to determine how the superseded data were derived.
AI5558
AI5558_U.S. NATIONAL GRID SPATIAL ADDRESS: 19TCH1230504357(NAD 83)
AI5558_MARKER: DD = SURVEY DISK
AI5558_SETTING: 66 = SET IN ROCK OUTCROP
AI5558_STAMPING: BED A 1999
AI5558_MARK LOGO: NOS
AI5558_MAGNETIC: N = NO MAGNETIC MATERIAL
AI5558_STABILITY: A = MOST RELIABLE AND EXPECTED TO HOLD
AI5558+STABILITY: POSITION/ELEVATION WELL
AI5558_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
AI5558+SATELLITE: SATELLITE OBSERVATIONS - May 20, 2002
AI5558
AI5558 HISTORY - Date Condition Report By
AI5558 HISTORY - 1999 MONUMENTED WOOLPT
AI5558 HISTORY - 20020520 GOOD INDIV
AI5558
AI5558 STATION DESCRIPTION
AI5558
```

AI5558'DESCRIBED BY WOOLPERT CONSULTANTS 1999 (ARL)  
AI5558'THE STATION IS LOCATED ABOUT 4.95 MI (7.97 KM) EAST OF CONCORD, 3.00  
AI5558'MI (4.83 KM) WEST-NORTHWEST OF LEXINGTON, AT THE L.G. HANSCOM FIELD  
AI5558'AIRPORT, IN THE HIGHEST POINT OF HILL IN THE WEST ANGLE FORMED BY THE  
AI5558'INTERSECTION OF RUNWAYS. OWNERSHIP--MASSACHUSETTS PORT AUTHORITY, C/O  
AI5558'AIRPORT MANAGER BARBARA PATZNER, CIVIL AIR TERMINAL, HANSCOM FIELD,  
AI5558'BEDFORD MA 01730. PHONE (617) 274-7200. CONTACT THE AIRPORT MANAGER  
AI5558'AT LEAST 24 HOURS PRIOR TO ACCESS TO ARRANGE FOR AN ESCORT.  
AI5558'TO REACH THE STATION FROM THE JUNCTION OF INTERSTATE HIGHWAY 95 AND  
AI5558'STATE HIGHWAY 2A, EXIT 45, GO WEST FOR 1.60 MI (2.57 KM) ON HIGHWAY 2A  
AI5558'TO A PAVED ROAD ON THE RIGHT. TURN RIGHT AND GO NORTH FOR 0.50 MI  
AI5558'(0.80 KM) ON THE PAVED ROAD TO A FORK. BEAR LEFT AND GO NORTH FOR  
AI5558'0.55 MI (0.89 KM) ON THE PAVED ROAD, FOLLOWING SIGNS TO THE CIVIL AIR  
AI5558'TERMINAL, AND A GATE AT THE NORTHWEST CORNER OF THE AIRPORT TERMINAL  
AI5558'BUILDING. PASS THROUGH THE GATE AND PROCEED NORTH 0.10 MI (0.16 KM)  
AI5558'ACROSS THE WEST RAMP TO TWY SIERRA. GO NORTHEAST 0.5 MI (0.8 KM)  
AI5558'ALONG TWY SIERRA TO TWY ECHO. HEAD EAST 0.3 MI (0.5 KM) ALONG TWY  
AI5558'ECHO, PAST TWY GULF TO STATION ON THE LEFT, SET ON THE EAST SIDE OF  
AI5558'THE HILL NEAR THE CROWN.  
AI5558'THE STATION IS LOCATED ONLINE WITH THE THIRD SET OF TWY LIGHTS WEST OF  
AI5558'A TWY LEADING TO THE EAST RAMP, 121.20 M (397.64 FT) SOUTH SOUTHWEST  
AI5558'OF THE EDGE OF PAVEMENT OF RWY 11-29, ROCK OUTCROP, 73.34 M (240.62  
AI5558'FT) NORTH NORTHEAST OF THE EDGE OF PAVEMENT OF TWY ECHO, 48.23 M  
AI5558'(158.23 FT) SOUTHWEST OF A SAFETY BOUNDARY MARKER FOR RWY 11-29, AND  
AI5558'7.50 M (24.61 FT) EAST OF THE TOP OF SLOPE THE STATION IS A STANDARD  
AI5558'NOS DISK STAMPED-- BED A 1999-- SET IN A EXPOSED PORTION OF THE ROCK  
AI5558'LEDGE, AND IS SUBSET 3 CM INTO THE ROCK. THIS STATION IS DESIGNATED  
AI5558'AS THE PRIMARY AIRPORT CONTROL STATION.  
AI5558  
AI5558 STATION RECOVERY (2002)  
AI5558  
AI5558'RECOVERY NOTE BY INDIVIDUAL CONTRIBUTORS 2002 (KL)  
AI5558'FOUND IN GOOD CONDITION BY MASSPORT - HANSCOM FIELD AIRPORT OPERATIONS  
AI5558'  
AI5558'(KL) CONTACT NUMBER FOR ACCESS TO SURVEY MARK HAS CHANGED. NEW  
AI5558'NUMBER IS 781-869-8000 BARBARA PATZNER, AIRPORT MANAGER  
AI5558'

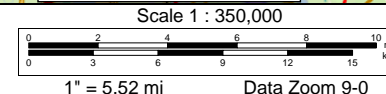
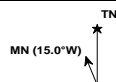
\*\*\* retrieval complete.  
Elapsed Time = 00:00:00







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www.delorme.com





STATE(s): MASSACHUSETTS

Project 7556-005  
Numbers A004

AREA ID: BED-CHARLES / CONCORD

AREA NAME: BED-CHARLES (BEDFORD, MA)

FILE TYPES/NAMES: ☒ OPTECH: BED-CHARLES ☒ LEICA: BED-CHARLES

Lines: 50 FL Miles: 1008 Square Miles: \_\_\_\_\_ Flight Altitudes: 5000' Tide Coord: ☐ Yes ☒ See Notes ☒ NO

AIRPORT ID: BED Name: HANSCOMB FIELD

Services: FULL ☒ Self ☒ None ☐ See Notes RUNWAY Length: 7001 Ft

Contact Name(s): Barbara Pitzner / Mauzyer

Phone(s): (781) 869-8000 (\_\_\_\_) \_\_\_\_ - \_\_\_\_ e-mail: \_\_\_\_\_

Hotels: ALL MAJOR

Rentals: ALL MAJOR

EXIST BASE Station: A15558 Name: BED A

TYPE: PACS ☒ SACS ☐ Other ☐ Data Sheet Attached ☒

SET BASE STATION Name: \_\_\_\_\_ Date Set: \_\_\_\_\_

What was Set: Re-Bar ☐ or: \_\_\_\_\_ CAP: \_\_\_\_\_

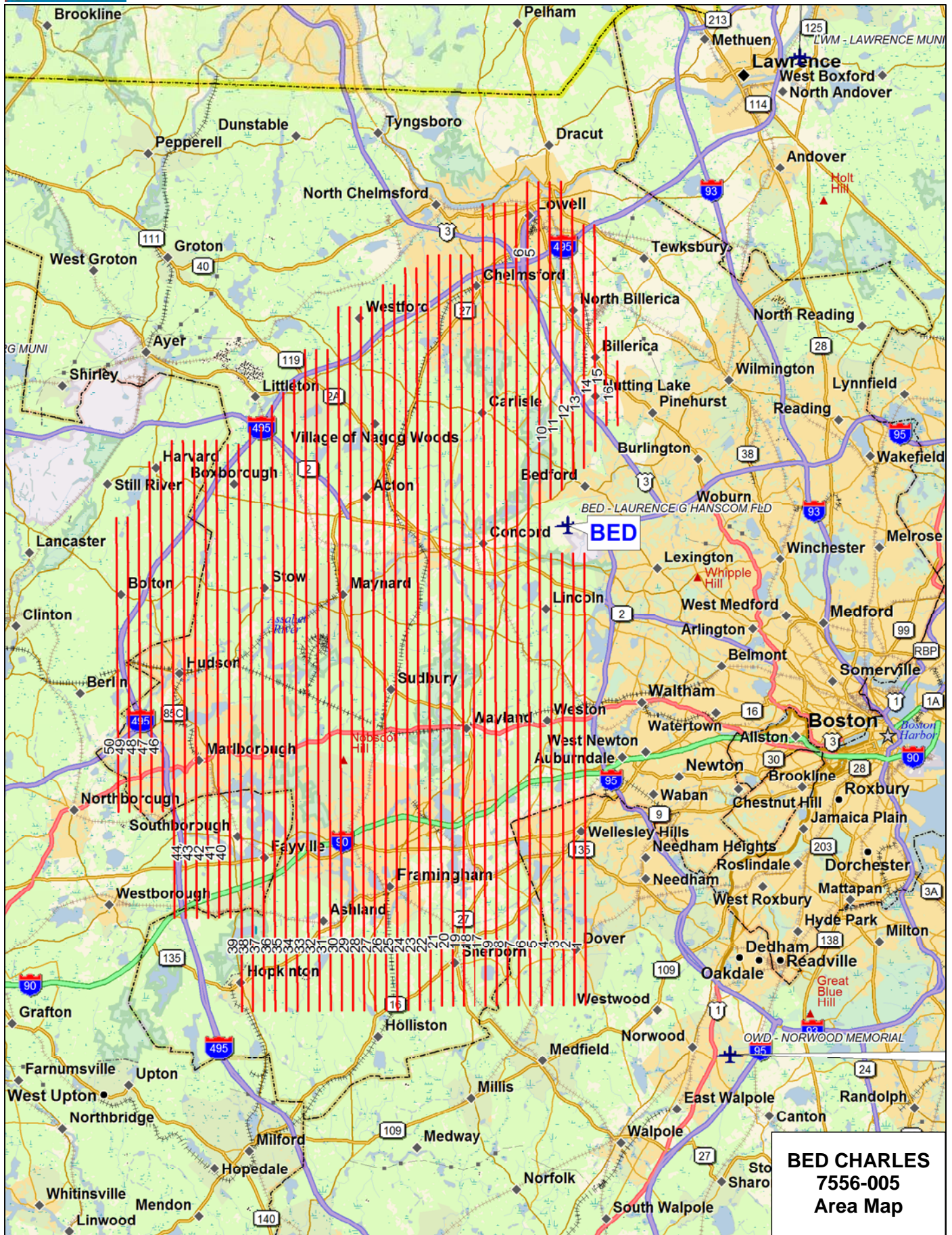
Who Set: \_\_\_\_\_ Where Set: \_\_\_\_\_ Attach Data Sheet

Logs ☒ Sectional ☒ Lo En-route ☒ Database ☒ OPTECH ☒ LEICA ☒  
by: LR by: LR by: LR by: LR by: LR by: LR

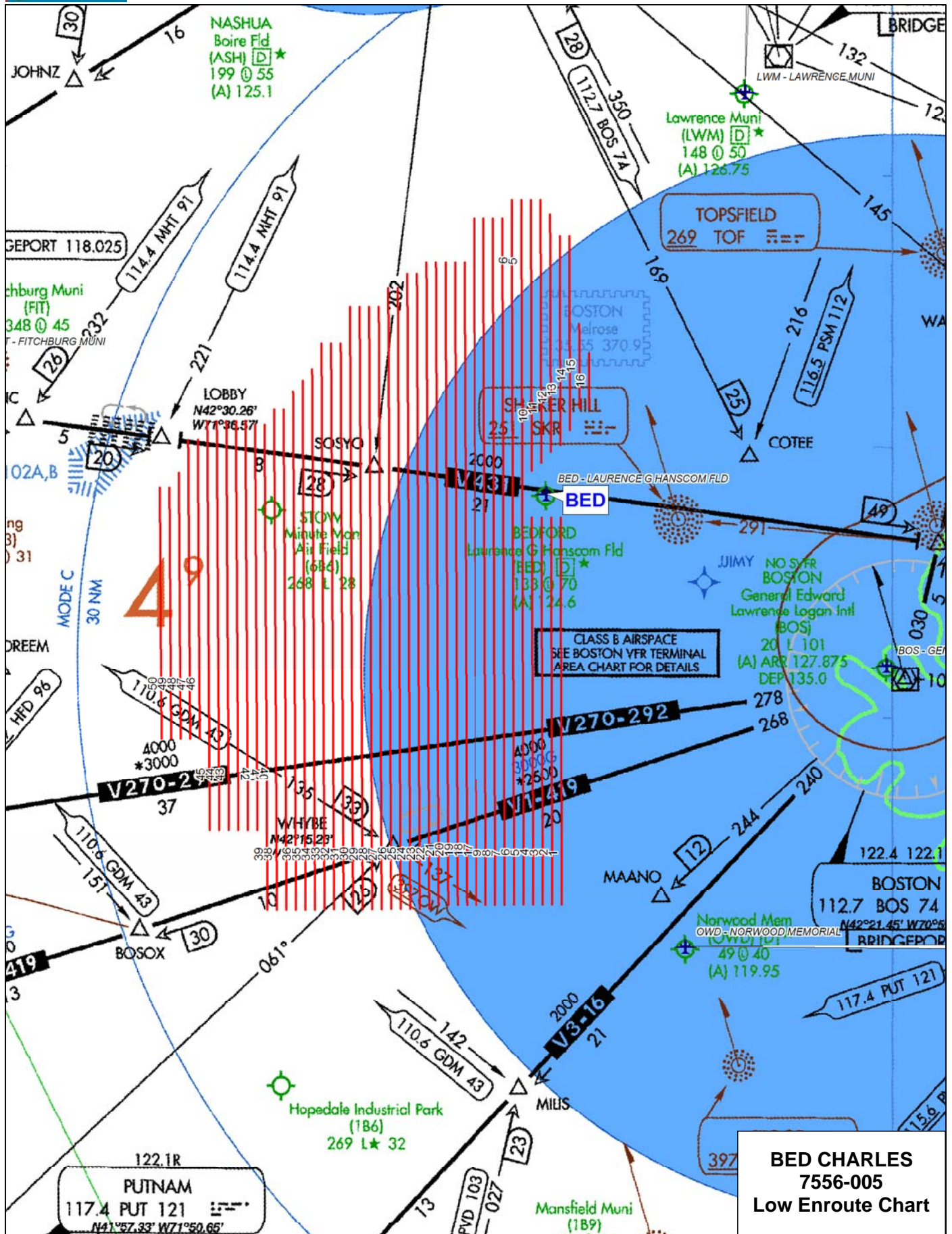
Accuracy: Vert; 24.5 Horiz; \_\_\_\_\_ cm Post Spacing: 1.0 Points Sq Meter: \_\_\_\_\_

NOTES: TOWNSHIP AIRPORT  
CALL AHEAD FOR SECURITY ACCESS

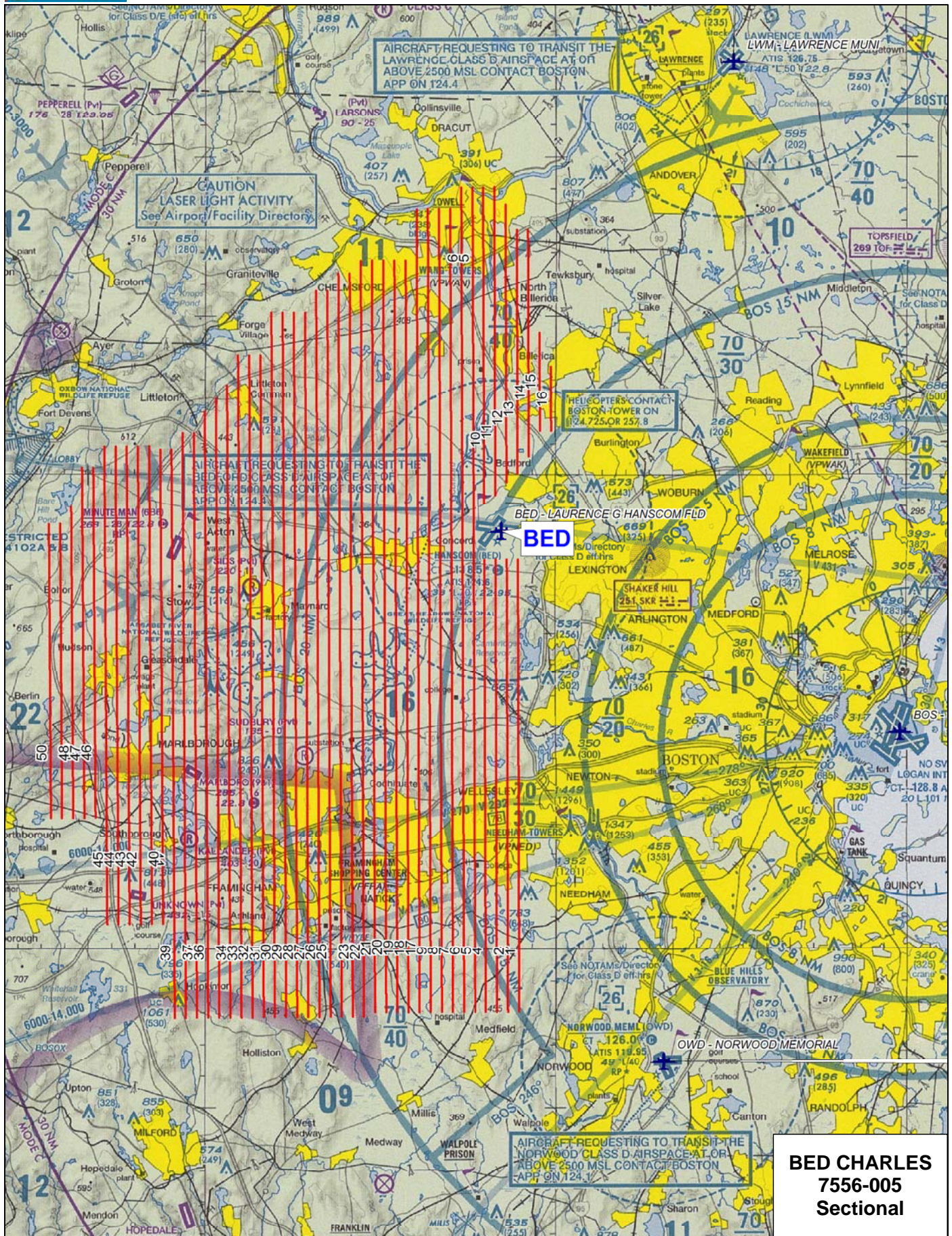














# Mass Area: BED-Charles

Project No 7556-005

Contact: Photo Science; F Godby at  
859 277-8700 or Cell: 859 421-5258

## Flight Logs

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
1	16.4	5180	BED A	BED_Charles. BED_CHARLE				
2	16.4	5190	BED A	BED_Charles. BED_CHARLE				
3	16.4	5190	BED A	BED_Charles. BED_CHARLE				
4	16.4	5200	BED A	BED_Charles. BED_CHARLE				
5	29.9	5170	BED A	BED_Charles. BED_CHARLE				
6	29.9	5170	BED A	BED_Charles. BED_CHARLE				
7	29.1	5180	BED A	BED_Charles. BED_CHARLE				
8	29.1	5170	BED A	BED_Charles. BED_CHARLE				
9	29.1	5170	BED A	BED_Charles. BED_CHARLE				
10	11.5	5140	BED A	BED_Charles. BED_CHARLE				
11	11.2	5140	BED A	BED_Charles. BED_CHARLE				
12	10.0	5150	BED A	BED_Charles. BED_CHARLE				
13	8.8	5160	BED A	BED_Charles. BED_CHARLE				

Flight Logs should be FAXED to 859-277-8901 immediately  
after each days flights with lines and other details noted

Operator: \_\_\_\_\_

AIRCRAFT Tail Number: \_\_\_\_\_

Page 1 of 4

Pilot: \_\_\_\_\_

Sensor Serial Number: \_\_\_\_\_

Date: \_\_\_\_\_

<i>FLIGHT LINE</i>	<i>FL MILES</i>	<i>ALTITUDE</i>	<i>BASE STATION</i>	<i>FLIGHT FILES</i>	<i>DATE FLOWN</i>	<i>S/N</i>	<i>FIELD QC</i>	<i>Comments</i>
14	8.2	5170	BED A	BED_Charles. BED_CHARLE				
15	3.5	5200	BED A	BED_Charles. BED_CHARLE				
16	2.3	5190	BED A	BED_Charles. BED_CHARLE				
17	29.1	5170	BED A	BED_Charles. BED_CHARLE				
18	27.3	5180	BED A	BED_Charles. BED_CHARLE				
19	27.3	5180	BED A	BED_Charles. BED_CHARLE				
20	27.3	5170	BED A	BED_Charles. BED_CHARLE				
21	27.3	5170	BED A	BED_Charles. BED_CHARLE				
22	27.4	5180	BED A	BED_Charles. BED_CHARLE				
23	27.0	5190	BED A	BED_Charles. BED_CHARLE				
24	27.0	5190	BED A	BED_Charles. BED_CHARLE				
25	26.4	5190	BED A	BED_Charles. BED_CHARLE				
26	26.4	5190	BED A	BED_Charles. BED_CHARLE				
27	25.5	5200	BED A	BED_Charles. BED_CHARLE				

Flight Logs should be FAXED to 859-277-8901 immediately  
after each days flights with lines and other details noted

Operator:

AIRCRAFT Tail Number:

Page 2 of 4

Pilot:

Sensor Serial Number:

**Date:** \_\_\_\_\_

<i>FLIGHT LINE</i>	<i>FL MILES</i>	<i>ALTITUDE</i>	<i>BASE STATION</i>	<i>FLIGHT FILES</i>	<i>DATE FLOWN</i>	<i>S/N</i>	<i>FIELD QC</i>	<i>Comments</i>
28	25.5	5210	BED A	BED_Charles. BED_CHARLE				
29	25.5	5230	BED A	BED_Charles. BED_CHARLE				
30	25.5	5240	BED A	BED_Charles. BED_CHARLE				
31	24.0	5240	BED A	BED_Charles. BED_CHARLE				
32	24.0	5240	BED A	BED_Charles. BED_CHARLE				
33	24.0	5250	BED A	BED_Charles. BED_CHARLE				
34	22.9	5260	BED A	BED_Charles. BED_CHARLE				
35	22.4	5260	BED A	BED_Charles. BED_CHARLE				
36	22.0	5280	BED A	BED_Charles. BED_CHARLE				
37	21.2	5300	BED A	BED_Charles. BED_CHARLE				
38	21.2	5300	BED A	BED_Charles. BED_CHARLE				
39	20.6	5310	BED A	BED_Charles. BED_CHARLE				
40	17.2	5300	BED A	BED_Charles. BED_CHARLE				
41	17.4	5300	BED A	BED_Charles. BED_CHARLE				

Flight Logs should be FAXED to 859-277-8901 immediately  
after each days flights with lines and other details noted

Operator:

AIRCRAFT Tail Number:

Page 3 of 4

Pilot:

Sensor Serial Number:

**Date:** \_\_\_\_\_

<i>FLIGHT LINE</i>	<i>FL MILES</i>	<i>ALTITUDE</i>	<i>BASE STATION</i>	<i>FLIGHT FILES</i>	<i>DATE FLOWN</i>	<i>S/N</i>	<i>FIELD QC</i>	<i>Comments</i>
42	17.4	5310	BED A	BED_Charles. BED_CHARLE				
43	17.4	5340	BED A	BED_Charles. BED_CHARLE				
44	17.4	5360	BED A	BED_Charles. BED_CHARLE				
45	17.4	5360	BED A	BED_Charles. BED_CHARLE				
46	12.7	5370	BED A	BED_Charles. BED_CHARLE				
47	12.7	5370	BED A	BED_Charles. BED_CHARLE				
48	11.3	5370	BED A	BED_Charles. BED_CHARLE				
49	10.7	5360	BED A	BED_Charles. BED_CHARLE				
50	10.7	5360	BED A	BED_Charles. BED_CHARLE				

*Flight Logs should be FAXED to 859-277-8901 immediately  
after each days flights with lines and other details noted*

*Operator:* \_\_\_\_\_

*AIRCRAFT Tail Number:* \_\_\_\_\_

Page 4 of 4

*Pilot:* \_\_\_\_\_

*Sensor Serial Number:* \_\_\_\_\_

**Date:** \_\_\_\_\_

BED





## Station Occupation Report For Airborne GPS

Project: Fema Mass

Location: KBED (Hanscom Field)

Project Number: 7556-005

Completed by: Berry / Galieti

Date: December 2, 2010

Receiver: Trimble

Receiver Type: 5700

Antenna Type: Zephyr Geodetic

Station ID: BEBA

Start -- H.I. (m): 1.384 m / 1.382 m / 1.383 m

End -- H.I. (m): 1.383 m

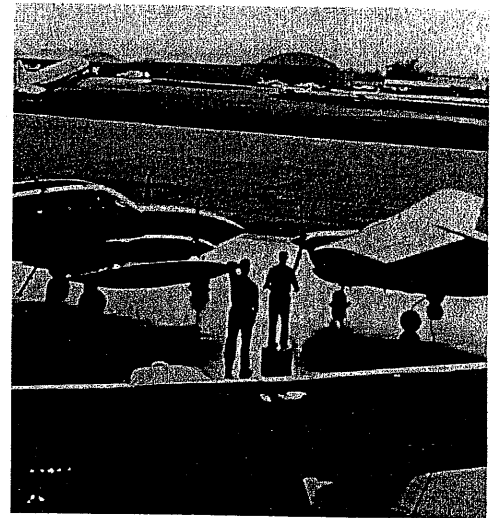
H.I. (ft): 4.54 ft

Start Time: 1809 Z / 109 PM

End Time: 440 PM

Time Zone: EST

Operator: Berry / Galieti



Comments: 101202a-246

101202a-247

# LIDAR MISSION RECORD SHEET – Optech


Project Name:	FEMA MEDS
Project Number:	756-005
ATTN:AV pinella	Deq-Charles.ph

Project Scanning Requirements	
FOV (half-degrees):	$\pm 18^\circ$
Scan Rate:	30.0 Hz
Pulse Rate:	71 kHz
Ground Speed:	116 kts
	Altitude AGL (ft):
	MPLA or SPIA
	Fixed or Auto
A.R.F.:	Samples
Range	-

Pilot	Caldwell
Operator	Berry
Aircraft	N7266Z

Data Information	
LIDAR Unit	OpTech Gemini sn246
HD #	246 HD
POS File Name	101200a
from, to	000 → 012

Date Flown: December 19, 2010		
Takeoff Time (Z): 1400Z	Local: 0600 AMST	Airport: BED
Landing Time (Z): 0000Z	Local: 0800 AMST	Airport: BED

	Ground	Altport
Begin Temp	6	BED
Begin Dewpoint	-4	
Begin Pressure	29.94	
End Temp		BED
End Dewpoint		
End Pressure		

GPS Base Location(s)	Red A	
PDOP Avoidance	on ground @ 330 pm EST	
Static or Flyover?	Static	-> If flyovers, times: -

[illegible]

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ODD North  
EVEN South

Date Flown:	12/2/2016		
Takeoff Time (Z):	Local:	Airport <u>BEB</u>	
Landing Time (Z):	Local:	Airport	

	Ground	Airport
Begin Temp	6°C	KBED
Begin Dewpoint	-4°C	
Begin Pressure	29.95 Hg	
End Temp	6°C	
End Dewpoint	-4°C	KBED
End Pressure	29.96 Hg	

10200-27

A

**Station Occupation Report  
For Airborne GPS**

**Project:** FEMA MASS

**Location:** KBED HANSCOM FIELD

**Project Number:** 7556-005

**Completed by:** Berry / Balisti

**Date:** December 3, 2010

**Receiver:** Trimble

**Receiver Type:** 5700

**Antenna Type:** Zephyr Geodetic

**Station ID:** BED A

**Start -- H.I. (m):** 1.444m / 1.445m / 1.445m

**End -- H.I. (m):** 1.445m

**H.I. (ft):** 4.74 ft.

**Start Time:** 7:36 AM

**End Time:** 1042 AM

**Time Zone:** EST

**Operator:** Berry

**Comments** 1012039-246

1012030-247







2670 Wilhite Drive - Lexington KY - 40503 850 977 8700  
www-abe@acajournal.com

Date Flown:	12/3/2010		
Takeoff Time (Z):	1340	Local:	840 EST
Landing Time (Z):	1547	Local:	1607 EST
		Airport:	KRFD

	Ground	Airport
Begin Temp	-1 °C	KBE0
Begin Dewpoint	-4 °C	
Begin Pressure	19.96	
End Temp	2 °C	
End Dewpoint	-3 °C	
End Pressure	19.95 Hg	KBE0.

7-2-01

[illegible]

Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	



## Station Occupation Report For Airborne GPS

Project:

FEMA - MASS

Location:

KBED HANSCOM FIELD

Completed by:

Berry/Galieti

Project Number: 7556-005

Date: December 7, 2010

Receiver:

Trimble "4"

Receiver Type:

5700

Antenna Type:

Zephyr

Station ID:

BE0A

Start -- H.I. (m):

1.433

End -- H.I. (m):

1.433

H.I. (ft):

4.695

Start Time:

750AM

End Time:

11:51AM

Time Zone:

EST

Operator:

Berry



Comments

101207a-246

101207a-247

# LIDAR MISSION RECORD SHEET - Optech

## PHOTO SCIENCE

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Project Name	FEMA MASS
Project Number	756-005
Altitude	150 - Charles, Va

Pilot	Young
Operator	BEAR
Aircraft	N7266Z

Date Flown:	December 7, 2010
Takeoff Time (Z)	1315Z
Landing Time (Z)	1515Z
Local:	8:45 AM EST
Local:	1045 AM EST
Airport	BE0
Airport	BE0

FOV (half-degrees):	± 9.0°	Altitude AGL (ft):	5000'
Scan Rate:	30.0 Hz	MPIA or SPIA	
Pulse Rate:	71 KHz	Fixed or Auto	
Ground Speed:	116 kts	Samples	
A.R.F.:	Range		

LIDAR Unit	Optech Gemini sr246
HD #	246102
POS File Name	101207a
from, to	100 - 003

Begin Temp	-3°C	Ground	Airport
Begin Dewpoint	-10°C		
Begin Pressure	29.33"		
End Temp	0°C		
End Dewpoint	-10°C		
End Pressure	29.35"		

101207a-246

GPS Base Location(s)	BE0 A
PDOP Avoidance	Good all day
Static or Flyover?	Static

-> if flyovers, times: -

Flight Line Name/#	Start Time	End Time	Alt. (AMSL)	Heading	Speed	Returns	Crab	NOTES (weather, visibility, winds, tide, etc.)
86	1327	1333	5300'	S	116	100%	8	Smooth Calm. Clouds above and SE/SW
31	1338	1341	5350'	N	116	100%	9	Just the bend for patching
32	1345	1357	5350'	S	116	100%	8	Some turbulence on South end
33	1401	1412	5350'	N	116	100%	9	Some turbulence on South end
34	1417	1428	5350'	S	116	100%	7	"
35	1432	1442	5350'	N	116	100%	9	"
36	1446	1456	5300'	S	116	100%	7	"
37	1501	1511	5300'	N	116	100%	8	"
38	1515	1522	5300'	S	116	100%	11	"
39	1526	1534	5300'	N	116	100%	7	"
Improv	1537	1539	5300'	E	116	100%	12	"

Refly

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Date Flown: 12/7/2010			
Takeoff Time (Z): 1345	Local: 840	Airport: Red	
Landing Time (Z): 1636	Local: 1136	Airport: Red	

	Ground	Airport
Begin Temp	-3 C	KBED
Begin Dewpoint	-10 C	
Begin Pressure	29.334 in.	
End Temp		
End Dewpoint		
End Pressure		KBED.

[illegible]

10  
5  
0



## Station Occupation Report For Airborne GPS

Project:

FEMA-Mass

Location:

KBED

Completed by:

Berry

Project Number: 7556-005

Date: 12-10-2010

Receiver:

Trimble '4'

Receiver Type:

5700

Antenna Type:

Zephyr

Station ID:

BED A

Start -- H.I. (m):

1410

End -- H.I. (m):

1410

H.I. (ft):

4625

Start Time:

11:35 AM EST

End Time:

5:53 PM EST

Time Zone:

EST

Operator:

Berry

Comments

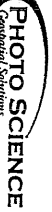
101210b-246

101210b-247





# LIDAR MISSION RECORD SHEET - Optech



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Project Name	Fama - Mass
Project Number	1356-005
ASTM NAV file	Ben-Charles.ph

Pilot	Younis
Operator	Berry
Aircraft	N7266Z

Date From:	December 12 2010
Takeoff Time (Z):	1355Z
Landing Time (Z):	1845Z

FOV (half-degrees):	± 18°	Altitude AGL (ft):	5000'
Scan Rate:	8000 Hz	(MPIA) or SPIA	
Pulse Rate:	71 KHz	Fixed or Auto	
Ground Speed:	116 kts	Samples	-
A.R.F.:	Range		

LIDAR Unit	Optech Gemini sn246
HD #	210441
POS File Name	1012106
from, to	005 - 087

Begin Temp	-7°C	Ground	116	Altport	BED
Begin Dewpoint	-14°C				
Begin Pressure	30.39				
End Temp	-4°C				
End Dewpoint	-15°C				
End Pressure	30.28				

GPS Base Location(s)	BED A
PDOP Avoidance	Good all day
Static or Flyover?	Static
→ If flyovers, times: -	

1012106-246

Flight Line Name#	Start Time	End Time	Alt. (AMSL)	Heading	Speed	Returns	Crab	NOTES (weather, visibility, winds, ride, etc.)
36	1744	1754	5300'	S	116	100%	5	Clear below and smooth, Harry
37	1758	1808	5300'	N	116	100%	-7	
38	1811	1831	5300'	S	116	100%	6	
39	1835	1844	5300'	N	116	100%	-6	
40	1837	1846	5300'	S	116	100%	5	
41	1849	1857	5300'	N	116	100%	-6	
42	1900	1909	5300'	S	116	100%	4	
43	1911	1919	5300'	N	116	100%	-7	
44	1923	1931	5300'	S	116	100%	5	
45	1934	1942	5300'	N	116	100%	-6	
46	1947	1953	5300'	S	116	100%	5	
47	1956	2003	5370'	N	116	100%	-9	
48	2006	2012	5350'	S	116	100%	6	
49	2015	2020	5350'	N	116	100%	-7	
50	2024	2029	5400'	S	116	100%	5	
Turnover	2032	2035	5410'	E	116	100%	7	

# LIDAR MISSION RECORD SHEET - Optech

## PHOTO SCIENCE

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Project Name	BED Charles.1
Project Number	7556-005
Altitude NAV pin file	Bed-Charles.pln

Pilot	Greeneville
Operator	Gallagher
Aircraft	N248G

Date Flown:	12/10/2010	#2
Takeoff Time (Z)	1730	Local: 1730
Landing Time (Z)	2200	Local: 2000
Airport	KBED	KBED

Projects Scanning Requirements	
FOV (half-degrees):	± 18°
Altitude AGC (ft):	5000
Scan Rate:	30 Hz
Pulse Rate:	70 KHz
Ground Speed:	116 kts
A.R.F.:	Range

Data Information	
LIDAR Unit	Optech Gemini sn247
HD #	2
POS File Name	101210b
from, to	0 → 35

Begin Temp	-7 C	Ground	Airport
Begin Dewpoint	-14 C		
Begin Pressure	30.394		
End Temp	-4 C		
End Dewpoint	-14 C		
End Pressure	30.354		

GPS Base Location(s)	BED A
PDOP Avoidance	none during day
Static or Flyover?	static

101210b-247

Flight Line Name/#	Start Time	End Time	Alt. (AMSL)	Heading	Speed	Returns	Crab	NOTES (weather, visibility, winds, tide, etc.)
5	1754	1808	5130	359	116	100	6	
6	1813	1828	5140	179	116	100	7	
7	1832	1846	5170	359	116	100	6	
8	1851	1905	5150	179	114	100	5	
19	1909	1922	5140	359	119	~100	6	high drops might be lakes? @ S-end
20	1927	1940	5180	179	119	100	5	
21	1945	1958	5190	359	119	100	5	
22	2003	2016	5180	179	115	100	6	
23	2021	2033	5200	359	115	100	6	
24	2039	2052	5190	179	112	100	8	3 mi S & N end HZ/4 min cloud
25	2057	—	5230	359	122	—	7	software clipped out mid line.
25	2109	2121	5183	359	125	100	8	
17	2132	2137	5190	359	118	~	7	Reshoot North low of line (high returns prob bad data)
Crossline	2149	2146	5000	270	114	100	6	

whole line →  
Reshoot  
redo midline  
1/3



## Station Occupation Report For Airborne GPS

**Project:** BED-Charles FEMA-MASS 7656-005

**Location:** KBED

**Project Number:** 7656-005

**Completed by:** Nathan Galieti

**Date:** 12/11/2010

**Receiver:** \_\_\_\_\_

**Receiver Type:** Trimble 5700

**Antenna Type:** \_\_\_\_\_

**Station ID:** KBED A (PAC)

**Start -- H.I. (m):** 1.471 m.

**End -- H.I. (m):** 1.469 / 1.470 m

**H.I. (ft):** 4.83 ft.

**Start Time:** 845 AM

**End Time:** 10:35 AM

**Time Zone:** EST

**Operator:** Nathan Galieti



**Comments** 101211a-247

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Date Flown: 12/11/10		
Takeoff Time (Z): 1400	Local: 9:00 AM	Airport KRE D
Landing Time (Z): 1525	Local: 10:25 AM	Airport KGE D

	Ground	Airport
Begin Temp	-2 C	KBED
Begin Dewpoint	-6 C	
Begin Pressure	30.25 Hg	
End Temp	-2	
End Dewpoint	-4	
End Pressure	30.25 Hg	KBED -

10611a-247 winds clim clear

[illegible]

# Mass Area: BED-Charles

Project No 7556-005

Contact: Photo Science; F. Godby at  
859 277-8700 or Cell: 859 421-5258

Flight Logs

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
1	16.4	5180	BED A	BED_Charles. BED_CHARLE	12/2/2010	247		
2	16.4	5190	BED A	BED_Charles. BED_CHARLE	12/7/2010	247		
3	16.4	5190	BED A	BED_Charles. BED_CHARLE	12/7/2010	247		
4	16.4	5200	BED A	BED_Charles. BED_CHARLE	12/7/2010	247		
5	29.9	5170	BED A	BED_Charles. BED_CHARLE	12/7 12/10	247	X	flew on 12/7 but Atmospheric returns line will be refown
6	29.9	5170	BED A	BED_Charles. BED_CHARLE	12/7 12/10	247	X	same as line 5
7	29.1	5180	BED A	BED_Charles. BED_CHARLE	12/7 12/10	247	X	same as line 5
8	29.1	5170	BED A	BED_Charles. BED_CHARLE	12/7 12/10	247	X	same as line 5
9	29.1	5170	BED A	BED_Charles. BED_CHARLE	12/9/2010	247		
10	11.5	5140	BED A	BED_Charles. BED_CHARLE	12/7/2010	247		
11	11.2	5140	BED A	BED_Charles. BED_CHARLE	12/2/2010	247		
12	10.0	5150	BED A	BED_Charles. BED_CHARLE	12/2/2010	247		
13	8.8	5160	BED A	BED_Charles. BED_CHARLE	12/2/2010	247		

N S N S

Good  
Good  
Good  
Good

Flight Logs should be FAXED to 859-277-8901 immediately  
after each days flights with lines and other details noted

Operator: Calieff AIRCRAFT Tail Number: N2448G  
Pilot: Greenwell Sensor Serial Number: 247 Date: \_\_\_\_\_



FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
14	8.2	5170	BED A	BED_Charles. BED_CHARLE	12/2/2010	247		possible fast ground speed at south end of line
15	3.5	5200	BED A	BED_Charles. BED_CHARLE	12/2/2010	247		
16	2.3	5190	BED A	BED_Charles. BED_CHARLE	12/2/2010	247		
17	29.1	5170	BED A	BED_Charles. BED_CHARLE	12/3/2010	247		Reflew on 12/7/10 But data bad
18	27.3	5180	BED A	BED_Charles. BED_CHARLE	12/3/2010	247		12/1/10 GOOD ✓ Refly Again
19	27.3	5180	BED A	BED_Charles. BED_CHARLE	12/10/2010	247		
20	27.3	5170	BED A	BED_Charles. BED_CHARLE	12/10/2010	247		
21	27.3	5170	BED A	BED_Charles. BED_CHARLE	12/10/2010	247		
22	27.4	5180	BED A	BED_Charles. BED_CHARLE	12/10/2010	247		
23	27.0	5190	BED A	BED_Charles. BED_CHARLE	12/10/2010	247		
24	27.0	5190	BED A	BED_Charles. BED_CHARLE	12/12/11	247		Refly high returns GOOD ✓
25	26.4	5190	BED A	BED_Charles. BED_CHARLE	12/12/11	247		Refly middle 1/3 of lines high returns. GOOD ✓
26	26.4	5190	BED A	BED_Charles. BED_CHARLE	---			
27	25.5	5200	BED A	BED_Charles. BED_CHARLE				

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: Galich

AIRCRAFT Tail Number: N1448G

Page 2 of 4

Pilot: Greenwell

Sensor Serial Number: 247

Date: \_\_\_\_\_

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
14	8.2	5170	BED A	BED_Charles. BED_CHARLE				
15	3.5	5200	BED A	BED_Charles. BED_CHARLE				
16	2.3	5190	BED A	BED_Charles. BED_CHARLE				
17	29.1	5170	BED A	BED_Charles. BED_CHARLE				
18	27.3	5180	BED A	BED_Charles. BED_CHARLE				
19	27.3	5180	BED A	BED_Charles. BED_CHARLE				
20	27.3	5170	BED A	BED_Charles. BED_CHARLE				
21	27.3	5170	BED A	BED_Charles. BED_CHARLE				
22	27.4	5180	BED A	BED_Charles. BED_CHARLE				
23	27.0	5190	BED A	BED_Charles. BED_CHARLE				
24	27.0	5190	BED A	BED_Charles. BED_CHARLE				
25	26.4	5190	BED A	BED_Charles. BED_CHARLE				
26	26.4	5190	BED A	BED_Charles. BED_CHARLE	12-2-10	246	JB	Complete 12-7-10 HALF LINE * *
27	25.5	5200	BED A	BED_Charles. BED_CHARLE	↓	↓	↓	

Operator: Berry AIRCRAFT Tail Number: N76662

Pilot: Caldwell Sensor Serial Number: 246

Date: 12-2-2010

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

1/10/2010

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
28	25.5	5210	BED A	BED_Charles. BED_CHARLE	12-2-2010	246	JB	
29	25.5	5230	BED A	BED_Charles. BED_CHARLE	12-3-2010	246	JB	
30	25.5	5240	BED A	BED_Charles. BED_CHARLE				
31	24.0	5240	BED A	BED_Charles. BED_CHARLE				Patched for Clouds
32	24.0	5240	BED A	BED_Charles. BED_CHARLE	12-7-2010	246	JB	
33	24.0	5250	BED A	BED_Charles. BED_CHARLE				
34	22.9	5260	BED A	BED_Charles. BED_CHARLE				
35	22.4	5260	BED A	BED_Charles. BED_CHARLE				
36	22.0	5280	BED A	BED_Charles. BED_CHARLE	12-10-2010	246	JB	Flown but too many atmospheric returns
37	21.2	5300	BED A	BED_Charles. BED_CHARLE				
38	21.2	5300	BED A	BED_Charles. BED_CHARLE				
39	20.6	5310	BED A	BED_Charles. BED_CHARLE				
40	17.2	5300	BED A	BED_Charles. BED_CHARLE				
41	17.4	5300	BED A	BED_Charles. BED_CHARLE				

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: Berry

AIRCRAFT Tail Number: N72603

Page 3 of 4

Pilot: Caldwell

Sensor Serial Number: 246

Date: 12-2-2010

Youngs

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
42	17.4	5310	BED A	BED_Charles. BED_CHARLE	10-12-2010	246	93	
43	17.4	5340	BED A	BED_Charles. BED_CHARLE				
44	17.4	5360	BED A	BED_Charles. BED_CHARLE				
45	17.4	5360	BED A	BED_Charles. BED_CHARLE				
46	12.7	5370	BED A	BED_Charles. BED_CHARLE				
47	12.7	5370	BED A	BED_Charles. BED_CHARLE				
48	11.3	5370	BED A	BED_Charles. BED_CHARLE				
49	10.7	5360	BED A	BED_Charles. BED_CHARLE				
50	10.7	5360	BED A	BED_Charles. BED_CHARLE				

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: Berry AIRCRAFT Tail Number: N22662

Pilot: YANE Sensor Serial Number: 246

Date: 10-12-2010

# Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : KBED  
Mission : 101210B  
Wheels Up : 1735  
Flight Length :  
HOBBS Start :  
HOBBS End :

## Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : -7C  
Visibility : GOOD  
Clouds : 11000FT  
Precipitation : NEGATIVE  
Wind Dir : CALM  
Wind Speed : CALM  
Pressure : 3039

## Statistics

-----  
Laser Time : 01:59:12

=====  
12:49:39.923 GMT : 00:00:02 (212) GPS 1PPS Lost  
12:49:39.923 GMT : 00:00:03 (166) Divergence Error  
12:49:39.923 GMT : 00:00:03 (107) Rx Shutter Closed  
12:49:39.923 GMT : 00:00:03 (109) Tx Shutter Closed  
12:49:39.923 GMT : 00:00:04 (164) Beam Wide  
12:49:39.923 GMT : 00:00:09 (120) Laser PS Comm Ok  
12:49:39.923 GMT : 00:00:09 (112) Laser Emission Off  
12:49:39.923 GMT : 00:00:12 (204) POSAV Connected  
12:49:39.923 GMT : 00:00:12 (207) POSAV Rate Not 50 Hz  
12:49:39.923 GMT : 00:00:13 (211) POSAV new status  
12:49:39.923 GMT : 00:00:14 (213) GPS 1PPS Ok  
12:49:39.923 GMT : 00:00:17 (212) GPS 1PPS Lost  
12:49:39.923 GMT : 00:00:23 (213) GPS 1PPS Ok  
12:49:39.923 GMT : 00:00:36 (208) POSAV Rate Is 50 Hz  
12:49:39.923 GMT : 00:00:36 (211) POSAV new status  
12:49:39.923 GMT : 00:00:37 (211) POSAV new status  
12:49:39.923 GMT : 00:00:38 (215) Nav Data Ok  
12:49:39.923 GMT : 00:02:12 (211) POSAV new status  
17:23:43.364 GMT : 00:04:48 (307) Format Disk  
17:23:50.364 GMT : 00:04:55 (211) POSAV new status  
17:24:00.865 GMT : 17:23:59 (153) Eyesafety Disabled  
17:24:00.965 GMT : 17:23:59 (162) Roll Comp On  
17:24:00.965 GMT : 17:24:00 (164) Beam Wide



17:24:01.165 GMT : 17:24:00 (144) MultiPulse Mode Varies  
17:24:05.465 GMT : 17:24:04 (165) Beam Narrow  
17:29:09.869 GMT : 17:29:08 (211) POSAV new status  
17:42:54.782 GMT : 17:42:54 (106) Rx Shutter Open  
17:42:54.982 GMT : 17:42:54 (108) Tx Shutter Open  
17:44:24.183 GMT : 17:44:23 (113) Laser Emission On  
17:54:54.093 GMT : 17:54:53 (112) Laser Emission Off  
17:58:31.496 GMT : 17:58:30 (113) Laser Emission On  
18:08:21.606 GMT : 18:08:20 (112) Laser Emission Off  
18:11:32.61 GMT : 18:11:31 (113) Laser Emission On  
18:21:37.521 GMT : 18:21:36 (112) Laser Emission Off  
18:25:11.325 GMT : 18:25:10 (113) Laser Emission On  
18:34:40.836 GMT : 18:34:39 (112) Laser Emission Off  
18:38:00.24 GMT : 18:37:59 (113) Laser Emission On  
18:46:07.45 GMT : 18:46:06 (112) Laser Emission Off  
18:49:04.454 GMT : 18:49:03 (113) Laser Emission On  
18:57:21.364 GMT : 18:57:20 (112) Laser Emission Off  
19:00:35.168 GMT : 19:00:34 (113) Laser Emission On  
19:08:48.679 GMT : 19:08:47 (112) Laser Emission Off  
19:11:39.282 GMT : 19:11:38 (113) Laser Emission On  
19:19:57.493 GMT : 19:19:56 (112) Laser Emission Off  
19:23:19.098 GMT : 19:23:18 (113) Laser Emission On  
19:31:43.408 GMT : 19:31:41 (112) Laser Emission Off  
19:34:31.112 GMT : 19:34:30 (113) Laser Emission On  
19:42:34.623 GMT : 19:42:33 (112) Laser Emission Off  
19:47:19.929 GMT : 19:47:18 (113) Laser Emission On  
19:53:20.037 GMT : 19:53:18 (112) Laser Emission Off  
19:56:40.141 GMT : 19:56:38 (113) Laser Emission On  
20:02:47.949 GMT : 20:02:46 (112) Laser Emission Off  
20:06:51.454 GMT : 20:06:50 (113) Laser Emission On  
20:12:27.061 GMT : 20:12:25 (112) Laser Emission Off  
20:15:48.766 GMT : 20:15:47 (113) Laser Emission On  
20:20:53.772 GMT : 20:20:51 (112) Laser Emission Off  
20:24:09.277 GMT : 20:24:08 (113) Laser Emission On  
20:29:21.683 GMT : 20:29:19 (112) Laser Emission Off  
20:32:50.788 GMT : 20:32:49 (113) Laser Emission On  
20:35:37.592 GMT : 20:35:36 (112) Laser Emission Off  
20:36:37.793 GMT : 20:36:36 (107) Rx Shutter Closed  
20:36:37.793 GMT : 20:36:36 (109) Tx Shutter Closed

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : KBED  
Mission : 101210B  
Wheels Up : 1735  
Flight Length :  
HOBBS Start :  
HOBBS End :

# Weather

```

-----
Date           : December 10, 2010
Julian Day     : 344
Temperature    : -7C
Visibility     : GOOD
Clouds         : 11000FT
Precipitation  : NEGATIVE
Wind Dir       : CALM
Wind Speed     : CALM
Pressure       : 3039
  
```

## Statistics

```

-----
Laser Time     : 01:59:12
  
```

=====

# Flight Log

```

-----
Project Number: 7556-005
S/N           : 246
Operator       : BERRY
Pilot(s)      : YOUNG
Aircraft      : N7266Z
Airport       : KBED
Mission       : 101210B
Wheels Up     : 1735
Flight Length :
HOBBS Start   :
HOBBS End     :
  
```

# Weather

```

-----
Date           : December 10, 2010
Julian Day     : 344
Temperature    : -7C
Visibility     : GOOD
Clouds         : 11000FT
Precipitation  : NEGATIVE
Wind Dir       : CALM
Wind Speed     : CALM
Pressure       : 3039
  
```

## Statistics

```

-----
Laser Time     : 01:59:12
  
```

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
=====									
17:44:24.883	17:54:55.493	37	1609	70	30.10	18.00	ON	NAR	
ON	0.00	359.68							

17:58:32.396	18:08:22.806	37	1611	70	30.10	18.00	ON	NAR
ON 0.00	359.68							
18:11:33.31	18:21:38.821	39	1616	70	30.10	18.00	ON	NAR
ON 0.00	359.67							
18:25:12.125	18:34:41.836	40	1613	70	30.10	18.00	ON	NAR
ON 0.00	359.67							
18:38:01.14	18:46:08.15	41	1613	70	30.10	18.00	ON	NAR
ON 0.00	179.66							
18:49:05.354	18:57:18.564	42	1612	70	30.10	18.00	ON	NAR
ON 0.00	359.65							
19:00:35.868	19:08:48.879	43	1616	70	30.10	18.00	ON	NAR
ON 0.00	359.65							
19:11:40.082	19:19:58.493	43	1622	70	30.10	18.00	ON	NAR
ON 0.00	359.65							
19:23:19.698	19:31:43.208	45	1631	70	30.10	18.00	ON	NAR
ON 0.00	359.64							
19:34:32.012	19:42:35.723	46	1632	70	30.10	18.00	ON	NAR
ON 0.00	359.63							
19:47:20.429	19:53:21.237	47	1632	70	30.10	18.00	ON	NAR
ON 0.00	359.62							
19:56:40.741	20:02:49.249	48	1640	70	30.10	18.00	ON	NAR
ON 0.00	179.61							
20:06:51.954	20:12:25.161	0	1635	70	30.10	18.00	ON	NAR
ON 0.00	179.83							
20:15:48.966	20:20:54.872	50	1632	70	30.10	18.00	ON	NAR
ON 0.00	359.61							
20:24:10.177	20:29:22.483	50	1636	70	30.10	18.00	ON	NAR
ON 0.00	179.61							
20:32:50.588	20:35:39.092	50	1636	70	30.10	18.00	ON	NAR
ON 0.00	179.61							

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED & 1B9  
Mission : 1  
Wheels Up : 1300 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : -14 C  
Visibility : clear  
Clouds : High OVC  
Precipitation : none  
Wind Dir :

Wind Speed :  
Pressure : 30.43 HG  
Statistics

-----  
Laser Time : 01:14:32

=====  
13:01:35.751 GMT : 00:00:02 (212) GPS 1PPS Lost  
13:01:35.751 GMT : 00:00:03 (166) Divergence Error  
13:01:35.751 GMT : 00:00:03 (107) Rx Shutter Closed  
13:01:35.751 GMT : 00:00:03 (109) Tx Shutter Closed  
13:01:35.751 GMT : 00:00:04 (164) Beam Wide  
13:01:35.751 GMT : 00:00:12 (204) POSAV Connected  
13:01:35.751 GMT : 00:00:13 (207) POSAV Rate Not 50 Hz  
13:01:35.751 GMT : 00:00:13 (211) POSAV new status  
13:01:35.751 GMT : 00:00:14 (213) GPS 1PPS Ok  
13:01:35.751 GMT : 00:00:23 (120) Laser PS Comm Ok  
13:01:35.751 GMT : 00:00:23 (112) Laser Emission Off  
13:01:35.751 GMT : 00:00:45 (208) POSAV Rate Is 50 Hz  
13:01:35.751 GMT : 00:00:45 (211) POSAV new status  
13:01:35.751 GMT : 00:00:46 (215) Nav Data Ok  
13:01:35.751 GMT : 00:00:47 (211) POSAV new status  
13:01:35.751 GMT : 00:01:33 (211) POSAV new status  
13:01:35.751 GMT : 00:01:45 (211) POSAV new status  
13:01:35.751 GMT : 12:23:55 (211) POSAV new status  
12:58:37.175 GMT : 12:58:35 (153) Eyesafety Disabled  
12:58:37.275 GMT : 12:58:35 (162) Roll Comp On  
12:58:37.875 GMT : 12:58:36 (164) Beam Wide  
12:58:37.875 GMT : 12:58:36 (144) MultiPulse Mode Varies  
12:58:41.475 GMT : 12:58:40 (165) Beam Narrow  
12:59:34.076 GMT : 12:59:32 (157) Safe Unaided Profile  
12:59:34.076 GMT : 12:59:32 (157) Safe Unaided Profile  
13:05:13.78 GMT : 13:05:12 (157) Safe Unaided Profile  
13:05:13.98 GMT : 13:05:12 (157) Safe Unaided Profile  
13:05:19.48 GMT : 13:05:17 (106) Rx Shutter Open  
13:05:19.48 GMT : 13:05:17 (108) Tx Shutter Open  
13:19:45.49 GMT : 13:19:44 (113) Laser Emission On  
13:27:52.396 GMT : 13:27:50 (112) Laser Emission Off  
13:31:56.099 GMT : 13:31:55 (113) Laser Emission On  
13:40:11.905 GMT : 13:40:09 (112) Laser Emission Off  
13:45:23.408 GMT : 13:45:22 (113) Laser Emission On  
13:53:50.615 GMT : 13:53:49 (112) Laser Emission Off  
13:59:24.419 GMT : 13:59:23 (113) Laser Emission On  
14:07:56.425 GMT : 14:07:55 (112) Laser Emission Off  
14:13:34.23 GMT : 14:13:33 (113) Laser Emission On  
14:26:46.44 GMT : 14:26:45 (112) Laser Emission Off  
14:32:07.544 GMT : 14:32:06 (113) Laser Emission On  
14:45:16.755 GMT : 14:45:15 (112) Laser Emission Off  
14:50:39.959 GMT : 14:50:39 (113) Laser Emission On  
15:04:08.37 GMT : 15:04:07 (112) Laser Emission Off  
15:11:56.777 GMT : 15:11:55 (113) Laser Emission On  
15:13:46.778 GMT : 15:13:45 (112) Laser Emission Off  
15:15:22.28 GMT : 15:15:21 (157) Safe Unaided Profile  
15:15:27.18 GMT : 15:15:25 (107) Rx Shutter Closed

15:15:27.28 GMT : 15:15:25 (109) Tx Shutter Closed

Flight Log

-----  
Project Number: 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED & 1B9  
Mission : 1  
Wheels Up : 1300 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : -14 C  
Visibility : clear  
Clouds : High OVC  
Precipitation : none  
Wind Dir :  
Wind Speed :  
Pressure : 30.43 HG

Statistics

-----  
Laser Time : 01:14:32

=====

Flight Log

-----  
Project Number: 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED & 1B9  
Mission : 1  
Wheels Up : 1300 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : -14 C  
Visibility : clear  
Clouds : High OVC



Precipitation : none  
Wind Dir :  
Wind Speed :  
Pressure : 30.43 HG

Statistics

-----  
Laser Time : 01:14:32

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
	13:19:46.19	13:27:52.696	11	1521	70	30.10	18.00	ON	NAR
ON	0.00	178.54							
	13:31:57.199	13:40:11.705	10	1585	70	30.10	18.00	ON	NAR
ON	0.00	358.54							
	13:45:24.008	13:53:51.515	9	1577	70	30.10	18.00	ON	NAR
ON	0.00	178.53							
	13:59:25.419	14:07:57.725	8	1570	70	30.10	18.00	ON	NAR
ON	0.00	358.53							
	14:13:35.23	14:26:48.44	7	1583	70	30.10	18.00	ON	NAR
ON	0.00	178.52							
	14:32:08.144	14:45:17.555	6	1572	70	30.10	18.00	ON	NAR
ON	0.00	358.51							
	14:50:40.759	15:04:10.07	5	1580	70	30.10	18.00	ON	NAR
ON	0.00	178.51							
	15:11:57.677	15:13:48.178	5	1585	70	30.10	18.00	ON	NAR
ON	0.00	178.51							

Flight Log

-----  
Project Number: 7556-005 (BED\_Charles)  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED  
Mission : 2  
Wheels Up : 1730 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : -7 C  
Visibility : -14 C  
Clouds : High OVC 090  
Precipitation : none  
Wind Dir : CLM  
Wind Speed : CLM

Pressure : 30.39

Statistics

-----  
Laser Time : 02:10:20

=====  
17:41:01.989 GMT : 00:00:02 (212) GPS 1PPS Lost  
17:41:01.989 GMT : 00:00:03 (166) Divergence Error  
17:41:01.989 GMT : 00:00:03 (107) Rx Shutter Closed  
17:41:01.989 GMT : 00:00:03 (109) Tx Shutter Closed  
17:41:01.989 GMT : 00:00:04 (164) Beam Wide  
17:41:01.989 GMT : 00:00:11 (213) GPS 1PPS Ok  
17:41:01.989 GMT : 00:00:12 (204) POSAV Connected  
17:41:01.989 GMT : 00:00:14 (207) POSAV Rate Not 50 Hz  
17:41:01.989 GMT : 00:00:14 (211) POSAV new status  
17:41:01.989 GMT : 00:00:23 (120) Laser PS Comm Ok  
17:41:01.989 GMT : 00:00:23 (112) Laser Emission Off  
17:41:01.989 GMT : 00:00:28 (208) POSAV Rate Is 50 Hz  
17:41:01.989 GMT : 00:00:28 (211) POSAV new status  
17:41:01.989 GMT : 00:00:30 (211) POSAV new status  
17:41:01.989 GMT : 00:00:30 (215) Nav Data Ok  
17:41:01.989 GMT : 00:02:10 (211) POSAV new status  
17:41:01.989 GMT : 00:04:30 (211) POSAV new status  
17:30:46.68 GMT : 17:30:45 (153) Eyesafety Disabled  
17:30:46.78 GMT : 17:30:45 (162) Roll Comp On  
17:30:47.58 GMT : 17:30:46 (164) Beam Wide  
17:30:47.68 GMT : 17:30:46 (144) MultiPulse Mode Varies  
17:30:49.08 GMT : 17:30:48 (165) Beam Narrow  
17:36:13.683 GMT : 17:36:12 (211) POSAV new status  
17:44:42.388 GMT : 17:44:41 (106) Rx Shutter Open  
17:44:42.388 GMT : 17:44:41 (108) Tx Shutter Open  
17:54:47.194 GMT : 17:54:45 (113) Laser Emission On  
18:08:29.703 GMT : 18:08:28 (112) Laser Emission Off  
18:13:54.107 GMT : 18:13:53 (113) Laser Emission On  
18:28:08.417 GMT : 18:28:06 (112) Laser Emission Off  
18:32:39.72 GMT : 18:32:38 (157) Safe Unaided Profile  
18:32:53.32 GMT : 18:32:52 (113) Laser Emission On  
18:46:20.23 GMT : 18:46:18 (112) Laser Emission Off  
18:51:24.534 GMT : 18:51:23 (113) Laser Emission On  
19:05:09.645 GMT : 19:05:08 (112) Laser Emission Off  
19:09:39.048 GMT : 19:09:37 (113) Laser Emission On  
19:22:09.858 GMT : 19:22:08 (112) Laser Emission Off  
19:27:50.863 GMT : 19:27:49 (113) Laser Emission On  
19:40:35.273 GMT : 19:40:34 (112) Laser Emission Off  
19:45:58.478 GMT : 19:45:57 (113) Laser Emission On  
19:58:17.688 GMT : 19:58:16 (112) Laser Emission Off  
20:03:57.793 GMT : 20:03:56 (113) Laser Emission On  
20:16:44.404 GMT : 20:16:43 (112) Laser Emission Off  
20:21:25.608 GMT : 20:21:24 (113) Laser Emission On  
20:33:53.118 GMT : 20:33:51 (112) Laser Emission Off  
20:39:59.223 GMT : 20:39:58 (113) Laser Emission On  
20:52:58.235 GMT : 20:52:56 (112) Laser Emission Off  
20:57:22.738 GMT : 20:57:21 (113) Laser Emission On

Flight Log

-----  
Project Number: 7556-005 (BED\_Charles)  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED  
Mission : 2  
Wheels Up : 1730 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : -7 C  
Visibility : -14 C  
Clouds : High OVC 090  
Precipitation : none  
Wind Dir : CLM  
Wind Speed : CLM  
Pressure : 30.39

Statistics

-----  
Laser Time : 02:10:20

=====

Flight Log

-----  
Project Number: 7556-005 (BED\_Charles)  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED  
Mission : 2  
Wheels Up : 1730 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : -7 C  
Visibility : -14 C  
Clouds : High OVC 090  
Precipitation : none  
Wind Dir : CLM

Wind Speed : CLM  
Pressure : 30.39  
Statistics

-----  
Laser Time : 02:10:20

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
	17:54:47.194	18:08:30.403	5	1573	70	30.10	18.00	ON	NAR
ON	0.00	359.81							
	18:13:54.907	18:28:09.817	7	1573	70	30.10	18.00	ON	NAR
ON	0.00	179.8							
	18:32:54.12	18:46:20.43	7	1575	70	30.10	18.00	ON	NAR
ON	0.00	359.8							
	18:51:25.534	19:05:11.045	8	1571	70	30.10	18.00	ON	NAR
ON	0.00	179.79							
	19:09:40.048	19:22:09.658	20	1581	70	30.10	18.00	ON	NAR
ON	0.00	359.77							
	19:27:51.363	19:40:37.073	20	1581	70	30.10	18.00	ON	NAR
ON	0.00	179.77							
	19:45:59.178	19:58:19.488	21	1583	70	30.10	18.00	ON	NAR
ON	0.00	359.77							
	20:03:58.393	20:16:45.404	22	1578	70	30.10	18.00	ON	NAR
ON	0.00	179.76							
	20:21:25.908	20:33:54.418	23	1585	70	30.10	18.00	ON	NAR
ON	0.00	359.75							
	20:40:00.023	20:52:58.835	24	1580	70	30.10	18.00	ON	NAR
ON	0.00	179.74							

Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???

Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 00:19:24

=====  
21:07:01.401 GMT : 20:59:21 (300) ALTM Not Ready  
21:12:47.196 GMT : 21:00:15 (300) ALTM Not Ready  
21:00:42.241 GMT : 21:00:41 (112) Laser Emission Off  
21:09:47.649 GMT : 21:09:46 (113) Laser Emission On  
21:21:51.46 GMT : 21:21:50 (112) Laser Emission Off  
21:32:03.669 GMT : 21:32:02 (113) Laser Emission On  
21:32:29.469 GMT : 21:32:28 (183) Eye Safety Shutoff  
21:32:30.869 GMT : 21:32:29 (112) Laser Emission Off  
21:32:40.569 GMT : 21:32:39 (113) Laser Emission On  
21:32:58.97 GMT : 21:32:58 (183) Eye Safety Shutoff  
21:33:00.67 GMT : 21:32:59 (112) Laser Emission Off  
21:33:13.27 GMT : 21:33:11 (153) Eyesafety Disabled  
21:33:21.87 GMT : 21:33:20 (113) Laser Emission On  
21:37:50.874 GMT : 21:37:49 (112) Laser Emission Off  
21:43:04.579 GMT : 21:43:03 (113) Laser Emission On  
21:46:05.781 GMT : 21:46:04 (112) Laser Emission Off

Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 00:19:24



=====

### Flight Log

-----

Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

### Weather

-----

Date : December 10, 2010  
Julian Day : 344  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

### Statistics

-----

Laser Time : 00:19:24

	START	STOP	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
RC	HDG	Plan File							

=====

	START	STOP	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
RC	HDG	Plan File							
	21:12:47.196	21:00:42.741	25	1594	70	30.10	18.00	ON	NAR
ON	0.00	359.74							
	21:09:48.349	21:21:52.36	25	1595	70	30.10	18.00	ON	NAR
ON	0.00	359.74							
	21:33:22.87	21:37:51.874	17	1579	70	30.10	18.00	ON	NAR
ON	0.00	359.78							
	21:43:05.579	21:46:06.981	5	1519	70	30.10	18.00	ON	NAR
ON	0.00	359.81							

### Flight Log

-----

Project Number: BED\_Charles 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell

Aircraft : N2448G  
Airport : KBED  
Mission : 1  
Wheels Up : 1415 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 11, 2010  
Julian Day : 345  
Temperature : -2 C  
Visibility : Clear  
Clouds : Clear  
Precipitation : none  
Wind Dir : CLM  
Wind Speed : CLM  
Pressure : 30.25 HG

Statistics

-----  
Laser Time : 00:32:10

=====  
14:14:08.279 GMT : 00:00:02 (212) GPS 1PPS Lost  
14:14:08.279 GMT : 00:00:03 (166) Divergence Error  
14:14:08.279 GMT : 00:00:03 (107) Rx Shutter Closed  
14:14:08.279 GMT : 00:00:03 (109) Tx Shutter Closed  
14:14:08.279 GMT : 00:00:04 (164) Beam Wide  
14:14:08.279 GMT : 00:00:12 (204) POSAV Connected  
14:14:08.279 GMT : 00:00:12 (207) POSAV Rate Not 50 Hz  
14:14:08.279 GMT : 00:00:12 (211) POSAV new status  
14:14:08.279 GMT : 00:00:13 (120) Laser PS Comm Ok  
14:14:08.279 GMT : 00:00:13 (112) Laser Emission Off  
14:14:08.279 GMT : 00:00:14 (213) GPS 1PPS Ok  
14:14:08.279 GMT : 00:00:28 (211) POSAV new status  
14:14:08.279 GMT : 00:00:29 (208) POSAV Rate Is 50 Hz  
14:14:08.279 GMT : 00:00:30 (211) POSAV new status  
14:14:08.279 GMT : 00:00:30 (215) Nav Data Ok  
14:14:08.279 GMT : 00:02:25 (211) POSAV new status  
14:14:08.279 GMT : 00:05:26 (211) POSAV new status  
14:08:12.713 GMT : 14:08:12 (307) Format Disk  
14:08:27.413 GMT : 14:08:26 (153) Eyesafety Disabled  
14:08:27.613 GMT : 14:08:26 (162) Roll Comp On  
14:08:27.613 GMT : 14:08:27 (164) Beam Wide  
14:08:27.813 GMT : 14:08:27 (144) MultiPulse Mode Varies  
14:08:30.613 GMT : 14:08:30 (165) Beam Narrow  
14:08:40.713 GMT : 14:08:39 (157) Safe Unaided Profile  
14:08:40.813 GMT : 14:08:39 (157) Safe Unaided Profile  
14:12:13.616 GMT : 14:12:12 (211) POSAV new status  
14:22:12.923 GMT : 14:22:12 (157) Safe Unaided Profile  
14:22:16.323 GMT : 14:22:15 (106) Rx Shutter Open  
14:22:16.423 GMT : 14:22:15 (108) Tx Shutter Open  
14:25:49.326 GMT : 14:25:48 (113) Laser Emission On

14:31:50.93 GMT : 14:31:49 (112) Laser Emission Off  
14:35:35.433 GMT : 14:35:35 (113) Laser Emission On  
14:48:03.143 GMT : 14:48:02 (112) Laser Emission Off  
14:53:03.248 GMT : 14:53:02 (113) Laser Emission On  
15:05:08.658 GMT : 15:05:08 (112) Laser Emission Off  
15:09:10.361 GMT : 15:09:09 (113) Laser Emission On  
15:10:59.363 GMT : 15:10:57 (112) Laser Emission Off  
15:12:39.965 GMT : 15:12:39 (157) Safe Unaided Profile  
15:12:45.765 GMT : 15:12:45 (107) Rx Shutter Closed  
15:12:45.865 GMT : 15:12:45 (109) Tx Shutter Closed

#### Flight Log

-----  
Project Number: BED\_Charles 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED  
Mission : 1  
Wheels Up : 1415 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 11, 2010  
Julian Day : 345  
Temperature : -2 C  
Visibility : Clear  
Clouds : Clear  
Precipitation : none  
Wind Dir : CLM  
Wind Speed : CLM  
Pressure : 30.25 HG

#### Statistics

-----  
Laser Time : 00:32:10  
-----

=====

#### Flight Log

-----  
Project Number: BED\_Charles 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED  
Mission : 1  
Wheels Up : 1415 Z  
Flight Length :  
HOBBS Start :

HOBBS End :

Weather

-----  
Date : December 11, 2010  
Julian Day : 345  
Temperature : -2 C  
Visibility : Clear  
Clouds : Clear  
Precipitation : none  
Wind Dir : CLM  
Wind Speed : CLM  
Pressure : 30.25 HG

Statistics

-----  
Laser Time : 00:32:10

RC	START HDG	STOP Plan	LINE# File	ALT	PRF	FREQ	ANGLE	MP	DIV
=====									
14:25:49.426		14:31:51.23	17	1576	70	30.10	18.00	ON	NAR
ON	0.00	359.78							
14:35:36.533		14:48:04.043	24	1586	70	30.10	18.00	ON	NAR
ON	0.00	179.74							
14:53:03.048		15:05:10.658	25	1582	70	30.10	18.00	ON	NAR
ON	0.00	359.74							
15:09:10.461		15:10:58.963	25	1570	70	30.10	18.00	ON	NAR
ON	0.00	359.74							
15:09:10.461		15:10:58.963	25	1571	70	30.10	18.00	ON	NAR
ON	0.00	359.74							

Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 02, 2010  
Julian Day : 336  
Temperature : ???  
Visibility : ???  
Clouds : ???

Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 00:33:26

=====  
14:22:07.31 GMT : 00:00:02 (212) GPS 1PPS Lost  
14:22:07.31 GMT : 00:00:03 (166) Divergence Error  
14:22:07.31 GMT : 00:00:03 (107) Rx Shutter Closed  
14:22:07.31 GMT : 00:00:03 (109) Tx Shutter Closed  
14:22:07.31 GMT : 00:00:04 (164) Beam Wide  
14:22:07.31 GMT : 00:00:05 (213) GPS 1PPS Ok  
14:22:07.31 GMT : 00:00:09 (120) Laser PS Comm Ok  
14:22:07.31 GMT : 00:00:09 (112) Laser Emission Off  
14:22:07.31 GMT : 00:00:12 (204) POSAV Connected  
14:22:07.31 GMT : 00:00:12 (207) POSAV Rate Not 50 Hz  
14:22:07.31 GMT : 00:00:13 (211) POSAV new status  
14:22:07.31 GMT : 00:00:24 (208) POSAV Rate Is 50 Hz  
14:22:07.31 GMT : 00:00:25 (211) POSAV new status  
14:22:07.31 GMT : 00:00:26 (211) POSAV new status  
14:22:07.31 GMT : 00:00:26 (215) Nav Data Ok  
18:52:16.491 GMT : 00:02:03 (211) POSAV new status  
18:53:55.293 GMT : 00:03:25 (211) POSAV new status  
18:53:55.493 GMT : 18:53:54 (153) Eyesafety Disabled  
18:53:56.093 GMT : 18:53:54 (162) Roll Comp On  
18:53:56.393 GMT : 18:53:55 (164) Beam Wide  
18:54:00.593 GMT : 18:54:00 (166) Divergence Error  
18:54:02.193 GMT : 18:54:01 (165) Beam Narrow  
18:55:03.194 GMT : 18:55:02 (144) MultiPulse Mode Varies  
18:59:13.698 GMT : 18:59:12 (211) POSAV new status  
19:19:38.718 GMT : 19:19:37 (106) Rx Shutter Open  
19:19:38.818 GMT : 19:19:37 (108) Tx Shutter Open  
19:20:19.919 GMT : 19:20:18 (113) Laser Emission On  
19:20:45.119 GMT : 19:20:44 (112) Laser Emission Off  
19:25:19.924 GMT : 19:25:19 (113) Laser Emission On  
19:32:43.533 GMT : 19:32:42 (112) Laser Emission Off  
19:37:07.038 GMT : 19:37:06 (113) Laser Emission On  
19:50:05.754 GMT : 19:50:05 (112) Laser Emission Off  
19:54:52.96 GMT : 19:54:52 (113) Laser Emission On  
20:07:10.076 GMT : 20:07:08 (112) Laser Emission Off  
20:09:14.078 GMT : 20:09:13 (113) Laser Emission On  
20:10:04.379 GMT : 20:10:03 (112) Laser Emission Off  
20:13:43.284 GMT : 20:13:42 (107) Rx Shutter Closed  
20:13:43.484 GMT : 20:13:42 (109) Tx Shutter Closed

Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???



Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 02, 2010  
Julian Day : 336  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 00:33:26

=====

Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 02, 2010  
Julian Day : 336  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 00:33:26

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
	19:20:19.719	19:20:26.919	26	1567	70	30.10	18.00	ON	NAR
ON	0.00	179.73							
	19:20:19.719	19:20:46.019	26	1574	70	30.10	18.00	ON	NAR
ON	0.00	179.73							
	19:25:20.724	19:32:44.633	27	1562	70	30.10	18.00	ON	NAR
ON	0.00	179.73							
	19:37:07.838	19:50:07.154	28	1583	70	30.10	18.00	ON	NAR
ON	0.00	359.72							
	19:54:53.46	20:07:10.576	28	1547	70	30.10	18.00	ON	NAR
ON	0.00	179.72							
	20:09:14.878	20:10:05.279	28	1555	70	30.10	18.00	ON	NAR
ON	0.00	179.72							

#### Flight Log

Project Number: BED\_Charles  
 S/N : 247  
 Operator : Galieti  
 Pilot(s) : Greenwell  
 Aircraft : N2448G  
 Airport : KBED  
 Mission : 111202a-247  
 Wheels Up : ???  
 Flight Length :  
 HOBBS Start :  
 HOBBS End :

#### Weather

Date : December 02, 2010  
 Julian Day : 336  
 Temperature : 6 C  
 Visibility : -4 C  
 Clouds : nill  
 Precipitation : nill  
 Wind Dir : 310  
 Wind Speed : 9 kts  
 Pressure : 29.95 HG

#### Statistics

Laser Time : 00:33:48

19:08:29.756 GMT : 18:40:04 (300) ALTM Not Ready  
 18:40:50.556 GMT : 18:40:49 (153) Eyesafety Disabled  
 18:40:50.757 GMT : 18:40:49 (162) Roll Comp On  
 18:40:51.657 GMT : 18:40:50 (164) Beam Wide  
 18:40:51.657 GMT : 18:40:50 (144) MultiPulse Mode Varies  
 18:40:53.657 GMT : 18:40:53 (165) Beam Narrow

18:41:08.457 GMT : 18:41:07 (160) Safe Aided Wide  
 18:41:08.657 GMT : 18:41:07 (163) Roll Comp Off  
 18:41:08.757 GMT : 18:41:07 (160) Safe Aided Wide  
 18:41:09.257 GMT : 18:41:08 (165) Beam Narrow  
 18:41:09.357 GMT : 18:41:08 (141) MultiPulse Mode Off  
 18:41:13.657 GMT : 18:41:12 (160) Safe Aided Wide  
 18:41:13.757 GMT : 18:41:12 (160) Safe Aided Wide  
 18:41:13.957 GMT : 18:41:13 (165) Beam Narrow  
 18:41:15.257 GMT : 18:41:14 (164) Beam Wide  
 18:41:24.057 GMT : 18:41:22 (160) Safe Aided Wide  
 18:41:24.157 GMT : 18:41:22 (160) Safe Aided Wide  
 18:41:24.157 GMT : 18:41:23 (144) MultiPulse Mode Varies  
 18:41:29.457 GMT : 18:41:28 (157) Safe Unaided Profile  
 18:41:29.657 GMT : 18:41:28 (157) Safe Unaided Profile  
 18:41:30.457 GMT : 18:41:29 (164) Beam Wide  
 18:41:33.457 GMT : 18:41:32 (157) Safe Unaided Profile  
 18:41:33.657 GMT : 18:41:32 (162) Roll Comp On  
 18:41:33.857 GMT : 18:41:32 (157) Safe Unaided Profile  
 18:41:34.157 GMT : 18:41:33 (164) Beam Wide  
 18:41:34.857 GMT : 18:41:34 (165) Beam Narrow  
 18:53:06.564 GMT : 18:53:05 (211) POSAV new status  
 18:59:21.468 GMT : 18:59:20 (157) Safe Unaided Profile  
 18:59:23.768 GMT : 18:59:23 (106) Rx Shutter Open  
 18:59:23.968 GMT : 18:59:23 (108) Tx Shutter Open  
 19:10:32.676 GMT : 19:10:31 (113) Laser Emission On  
 19:18:30.781 GMT : 19:18:29 (112) Laser Emission Off  
 19:19:06.382 GMT : 19:19:04 (113) Laser Emission On  
 19:23:45.285 GMT : 19:23:43 (112) Laser Emission Off  
 19:28:10.588 GMT : 19:28:09 (113) Laser Emission On  
 19:32:51.892 GMT : 19:32:51 (112) Laser Emission Off  
 19:37:46.796 GMT : 19:37:46 (113) Laser Emission On  
 19:40:16.398 GMT : 19:40:15 (112) Laser Emission Off  
 19:45:15.302 GMT : 19:45:14 (113) Laser Emission On  
 19:47:03.303 GMT : 19:47:02 (112) Laser Emission Off  
 19:56:02.21 GMT : 19:56:01 (113) Laser Emission On  
 20:01:17.515 GMT : 20:01:16 (112) Laser Emission Off  
 20:04:06.817 GMT : 20:04:05 (113) Laser Emission On  
 20:09:56.922 GMT : 20:09:56 (112) Laser Emission Off  
 20:15:43.627 GMT : 20:15:42 (113) Laser Emission On  
 20:17:14.528 GMT : 20:17:13 (112) Laser Emission Off

#### Flight Log

-----  
 Project Number: BED\_Charles  
 S/N : 247  
 Operator : Galieti  
 Pilot(s) : Greenwell  
 Aircraft : N2448G  
 Airport : KBED  
 Mission : 111202a-247  
 Wheels Up : ???  
 Flight Length :  
 HOBBS Start :  
 HOBBS End :

# Weather

```

-----
Date       : December 02, 2010
Julian Day  : 336
Temperature : 6 C
Visibility  : -4 C
Clouds      : nill
Precipitation : nill
Wind Dir    : 310
Wind Speed  : 9 kts
Pressure    : 29.95 HG
  
```

# Statistics

```

-----
Laser Time   : 00:33:48
  
```

=====

# Flight Log

```

-----
Project Number: BED_Charles
S/N           : 247
Operator      : Galieti
Pilot(s)      : Greenwell
Aircraft      : N2448G
Airport       : KBED
Mission       : 111202a-247
Wheels Up     : ???
Flight Length :
HOBBS Start   :
HOBBS End     :
  
```

# Weather

```

-----
Date       : December 02, 2010
Julian Day  : 336
Temperature : 6 C
Visibility  : -4 C
Clouds      : nill
Precipitation : nill
Wind Dir    : 310
Wind Speed  : 9 kts
Pressure    : 29.95 HG
  
```

# Statistics

```

-----
Laser Time   : 00:33:48
  
```

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
19:10:32.876	19:18:31.681	1	1569	70	30.10	18.00	ON	NAR	
ON	0.00	359.83							

19:19:07.482	19:23:45.785	13	1567	70	30.10	18.00	ON	NAR
ON	0.00		359.84					
19:28:11.389	19:32:53.092	14	1571	70	30.10	18.00	ON	NAR
ON	0.00		179.81					
19:37:47.596	19:40:17.898	16	1588	70	30.10	18.00	ON	NAR
ON	0.00		359.82					
19:45:16.102	19:47:03.803	16	1586	70	30.10	18.00	ON	NAR
ON	0.00		179.82					
19:56:03.01	20:01:18.915	12	1576	70	30.10	18.00	ON	NAR
ON	0.00		179.82					
20:04:06.617	20:09:58.622	11	1567	70	30.10	18.00	ON	NAR
ON	0.00		359.81					
20:15:43.327	20:17:15.628	11	1569	70	30.10	18.00	ON	NAR
ON	0.00		359.81					
20:15:43.327	20:17:15.628	11	1568	70	30.10	18.00	ON	NAR
ON	0.00		359.81					

#### Flight Log

##### ----- Project Number:

S/N : 0  
 Operator : Galieti  
 Pilot(s) : Greenwell  
 Aircraft : N2448G  
 Airport : KBED  
 Mission : A  
 Wheels Up : 1340Z  
 Flight Length :  
 HOBBS Start :  
 HOBBS End :

#### Weather

-----  
 Date : December 03, 2010  
 Julian Day : 337  
 Temperature : 1  
 Visibility : clear  
 Clouds : overcast  
 Precipitation : nill  
 Wind Dir : ???  
 Wind Speed : ???  
 Pressure : 29.95 HG

#### Statistics

-----  
Laser Time : 00:27:49

=====

14:03:25.852	GMT	:	00:02:52	(121)	Laser PS Comm Wait
14:03:25.852	GMT	:	00:04:43	(211)	POSAV new status
14:03:25.852	GMT	:	13:19:32	(120)	Laser PS Comm Ok
14:03:25.852	GMT	:	13:19:59	(121)	Laser PS Comm Wait
14:03:25.852	GMT	:	13:20:11	(120)	Laser PS Comm Ok
14:03:25.852	GMT	:	13:23:54	(121)	Laser PS Comm Wait
14:03:25.852	GMT	:	13:24:06	(120)	Laser PS Comm Ok



14:03:25.852 GMT : 13:27:44 (121) Laser PS Comm Wait  
14:03:25.852 GMT : 13:27:57 (120) Laser PS Comm Ok  
13:32:03.255 GMT : 13:32:01 (153) Eyesafety Disabled  
13:32:03.255 GMT : 13:32:01 (162) Roll Comp On  
13:32:03.455 GMT : 13:32:02 (164) Beam Wide  
13:32:03.655 GMT : 13:32:02 (144) MultiPulse Mode Varies  
13:32:06.955 GMT : 13:32:06 (165) Beam Narrow  
13:35:41.957 GMT : 13:35:40 (211) POSAV new status  
13:36:57.058 GMT : 13:36:55 (157) Safe Unaided Profile  
13:36:57.258 GMT : 13:36:55 (157) Safe Unaided Profile  
13:49:25.364 GMT : 13:49:23 (157) Safe Unaided Profile  
13:49:28.664 GMT : 13:49:27 (106) Rx Shutter Open  
13:49:28.764 GMT : 13:49:27 (108) Tx Shutter Open  
14:01:02.671 GMT : 14:01:01 (113) Laser Emission On  
14:15:00.48 GMT : 14:14:58 (112) Laser Emission Off  
14:19:12.883 GMT : 14:19:11 (113) Laser Emission On  
14:32:49.392 GMT : 14:32:48 (183) Eye Safety Shutoff  
14:32:50.792 GMT : 14:32:49 (112) Laser Emission Off  
14:36:59.595 GMT : 14:36:58 (113) Laser Emission On  
14:50:10.405 GMT : 14:50:09 (112) Laser Emission Off  
14:54:59.109 GMT : 14:54:58 (113) Laser Emission On  
14:55:50.609 GMT : 14:55:49 (112) Laser Emission Off

#### Flight Log

-----  
Project Number:  
S/N : 0  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED  
Mission : A  
Wheels Up : 1340Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 03, 2010  
Julian Day : 337  
Temperature : 1  
Visibility : clear  
Clouds : overcast  
Precipitation : nill  
Wind Dir : ???  
Wind Speed : ???  
Pressure : 29.95 HG

#### Statistics

-----  
Laser Time : 00:27:49  
=====

# Flight Log

-----  
Project Number:

S/N : 0  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED  
Mission : A  
Wheels Up : 1340Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

## Weather

-----  
Date : December 03, 2010  
Julian Day : 337  
Temperature : 1  
Visibility : clear  
Clouds : overcast  
Precipitation : nill  
Wind Dir : ???  
Wind Speed : ???  
Pressure : 29.95 HG

## Statistics

-----  
Laser Time : 00:27:49

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
=====									
14:01:03.771	14:15:02.08	9	1580	70	30.10	18.00	ON	NAR	
ON 0.00	179.79								
14:37:00.295	14:50:11.905	18	1585	70	30.10	18.00	ON	NAR	
ON 0.00	179.78								
14:37:00.295	14:50:11.905	18	1586	70	30.10	18.00	ON	NAR	
ON 0.00	179.78								
14:55:00.309	14:55:52.209	18	1533	70	30.10	18.00	ON	NAR	
ON 0.00	179.78								

# Flight Log

-----  
Project Number: 0

S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :

HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 03, 2010  
Julian Day : 337  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 00:36:41

=====  
08:57:52.669 GMT : 00:00:02 (212) GPS 1PPS Lost  
08:57:52.669 GMT : 00:00:03 (166) Divergence Error  
08:57:52.669 GMT : 00:00:03 (107) Rx Shutter Closed  
08:57:52.669 GMT : 00:00:03 (109) Tx Shutter Closed  
08:57:52.669 GMT : 00:00:04 (164) Beam Wide  
08:57:52.669 GMT : 00:00:11 (213) GPS 1PPS Ok  
08:57:52.669 GMT : 00:00:12 (204) POSAV Connected  
08:57:52.669 GMT : 00:00:12 (207) POSAV Rate Not 50 Hz  
08:57:52.669 GMT : 00:00:15 (211) POSAV new status  
08:57:52.669 GMT : 00:00:27 (121) Laser PS Comm Wait  
08:57:52.669 GMT : 00:00:27 (112) Laser Emission Off  
08:57:52.669 GMT : 00:00:28 (208) POSAV Rate Is 50 Hz  
08:57:52.669 GMT : 00:00:28 (211) POSAV new status  
08:57:52.669 GMT : 00:00:29 (211) POSAV new status  
08:57:52.669 GMT : 00:00:30 (215) Nav Data Ok  
08:57:52.669 GMT : 00:00:59 (120) Laser PS Comm Ok  
08:57:52.669 GMT : 00:02:19 (211) POSAV new status  
08:57:52.669 GMT : 00:03:36 (211) POSAV new status  
13:27:15.239 GMT : 13:27:14 (153) Eyesafety Disabled  
13:27:15.339 GMT : 13:27:14 (162) Roll Comp On  
13:27:15.939 GMT : 13:27:15 (164) Beam Wide  
13:27:20.639 GMT : 13:27:20 (165) Beam Narrow  
13:33:21.643 GMT : 13:33:20 (211) POSAV new status  
13:52:24.957 GMT : 13:52:24 (106) Rx Shutter Open  
13:52:24.957 GMT : 13:52:24 (108) Tx Shutter Open  
13:53:30.758 GMT : 13:53:30 (113) Laser Emission On  
14:05:41.769 GMT : 14:05:40 (112) Laser Emission Off  
14:09:17.872 GMT : 14:09:17 (113) Laser Emission On  
14:21:37.784 GMT : 14:21:37 (112) Laser Emission Off  
14:25:42.088 GMT : 14:25:41 (113) Laser Emission On  
14:37:05.9 GMT : 14:37:05 (112) Laser Emission Off  
14:39:56.504 GMT : 14:39:55 (113) Laser Emission On  
14:40:54.905 GMT : 14:40:53 (112) Laser Emission Off  
14:41:05.105 GMT : 14:41:04 (107) Rx Shutter Closed  
14:41:05.305 GMT : 14:41:04 (109) Tx Shutter Closed

### Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

### Weather

-----  
Date : December 03, 2010  
Julian Day : 337  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

### Statistics

-----  
Laser Time : 00:36:41

=====

### Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

### Weather

-----  
Date : December 03, 2010  
Julian Day : 337  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???

Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

Laser Time : 00:36:41

RC	START HDG	STOP Plan	LINE# File	ALT	PRF	FREQ	ANGLE	MP	DIV
	13:53:31.458	14:05:42.769	30	1574	70	30.10	18.00	OFF	NAR
ON	0.00	179.71							
	14:09:18.572	14:21:38.884	31	1568	70	30.10	18.00	OFF	NAR
ON	0.00	179.71							
	14:25:42.888	14:37:06.8	31	1555	70	30.10	18.00	OFF	NAR
ON	0.00	359.71							
	14:39:56.504	14:40:55.305	31	1515	70	30.10	18.00	OFF	NAR
ON	0.00	359.71							
	14:39:56.504	14:40:55.305	31	1512	70	30.10	18.00	OFF	NAR
ON	0.00	359.71							

Flight Log

Project Number: 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED  
Mission : 1  
Wheels Up : 1340Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

Date : December 07, 2010  
Julian Day : 341  
Temperature : -3 C  
Visibility : CLR  
Clouds : High SCT moving to OVC @ PRJ ALT  
Precipitation : nill  
Wind Dir : 240  
Wind Speed : 7 KTS  
Pressure : 29.33

Statistics

Laser Time : 01:32:21

13:55:26.276 GMT : 13:28:09 (120) Laser PS Comm Ok



13:55:26.276 GMT : 13:31:01 (121) Laser PS Comm Wait  
13:55:26.276 GMT : 13:31:16 (120) Laser PS Comm Ok  
13:55:26.276 GMT : 13:34:13 (121) Laser PS Comm Wait  
13:55:26.276 GMT : 13:34:28 (120) Laser PS Comm Ok  
13:55:26.276 GMT : 13:36:44 (211) POSAV new status  
13:38:30.101 GMT : 13:38:29 (153) Eyesafety Disabled  
13:38:30.301 GMT : 13:38:29 (162) Roll Comp On  
13:38:30.901 GMT : 13:38:30 (164) Beam Wide  
13:38:30.901 GMT : 13:38:30 (144) MultiPulse Mode Varies  
13:38:35.401 GMT : 13:38:35 (165) Beam Narrow  
13:43:24.603 GMT : 13:43:23 (106) Rx Shutter Open  
13:43:24.703 GMT : 13:43:23 (108) Tx Shutter Open  
13:52:39.408 GMT : 13:52:38 (113) Laser Emission On  
13:58:24.611 GMT : 13:58:23 (112) Laser Emission Off  
13:58:40.911 GMT : 13:58:39 (113) Laser Emission On  
14:06:55.515 GMT : 14:06:55 (112) Laser Emission Off  
14:11:45.218 GMT : 14:11:44 (113) Laser Emission On  
14:19:42.423 GMT : 14:19:41 (112) Laser Emission Off  
14:24:45.426 GMT : 14:24:44 (113) Laser Emission On  
14:32:59.632 GMT : 14:32:58 (112) Laser Emission Off  
14:34:07.133 GMT : 14:34:06 (152) Invalid Beam  
14:34:07.233 GMT : 14:34:06 (152) Invalid Beam  
14:34:28.633 GMT : 14:34:27 (152) Invalid Beam  
14:34:28.833 GMT : 14:34:27 (152) Invalid Beam  
14:36:42.134 GMT : 14:36:41 (113) Laser Emission On  
14:50:48.444 GMT : 14:50:47 (112) Laser Emission Off  
14:55:23.348 GMT : 14:55:22 (113) Laser Emission On  
15:09:49.358 GMT : 15:09:48 (112) Laser Emission Off  
15:13:48.462 GMT : 15:13:47 (113) Laser Emission On  
15:27:05.672 GMT : 15:27:04 (112) Laser Emission Off  
15:31:24.176 GMT : 15:31:22 (113) Laser Emission On  
15:43:45.686 GMT : 15:43:45 (112) Laser Emission Off  
15:47:45.289 GMT : 15:47:44 (113) Laser Emission On  
15:49:13.89 GMT : 15:49:12 (112) Laser Emission Off  
15:54:42.295 GMT : 15:54:41 (113) Laser Emission On  
16:01:46.501 GMT : 16:01:45 (112) Laser Emission Off

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED  
Mission : 1  
Wheels Up : 1340Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 07, 2010

## Statistics

=====

Project Number: 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED  
Mission : 1  
Wheels Up : 1340Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

## Weather

## Statistics

Laser Time : 01:32:21

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
	13:52:40.608	13:58:25.211	10	1560	70	30.10	18.00	ON	NAR
ON	0.00	179.82							
	13:52:40.608	13:58:25.211	4	1559	70	30.10	18.00	ON	NAR
ON	0.00	179.82							
	13:58:41.111	14:06:57.515	4	1566	70	30.10	18.00	ON	NAR
ON	0.00	179.82							

13:58:41.111	14:06:57.515	4	1569	70	30.10	18.00	ON	NAR
ON 0.00	179.82							
14:11:45.818	14:19:40.223	3	1576	70	30.10	18.00	ON	NAR
ON 0.00	359.82							
14:11:45.818	14:19:44.623	2	1575	70	30.10	18.00	ON	NAR
ON 0.00	359.83							
14:24:46.226	14:33:01.232	2	1597	70	30.10	18.00	ON	NAR
ON 0.00	179.83							
14:36:42.734	14:50:50.144	5	1576	70	30.10	18.00	ON	NAR
ON 0.00	359.81							
14:55:24.548	15:09:50.758	6	1597	70	30.10	18.00	ON	NAR
ON 0.00	179.8							
14:55:24.548	15:09:50.758	6	1597	70	30.10	18.00	ON	NAR
ON 0.00	179.8							
15:13:48.462	15:27:05.472	7	1573	70	30.10	18.00	ON	NAR
ON 0.00	359.8							
15:13:48.462	15:27:05.472	7	1569	70	30.10	18.00	ON	NAR
ON 0.00	359.8							
15:31:23.775	15:43:47.586	8	1591	70	30.10	18.00	ON	NAR
ON 0.00	179.79							
15:31:23.775	15:43:47.586	8	1591	70	30.10	18.00	ON	NAR
ON 0.00	179.79							
15:47:45.289	15:49:14.39	8	1574	70	30.10	18.00	ON	NAR
ON 0.00	179.79							
15:47:45.289	15:49:14.39	8	1573	70	30.10	18.00	ON	NAR
ON 0.00	179.79							
15:54:42.695	16:01:43.701	17	1563	70	30.10	18.00	ON	NAR
ON 0.00	359.78							
15:54:42.695	16:01:48.701	17	1563	70	30.10	18.00	ON	NAR
ON 0.00	359.78							

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : KBED  
Mission : 101207A  
Wheels Up : 1315Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 07, 2010  
Julian Day : 341  
Temperature : -3C  
Visibility : >10  
Clouds : SOME CLDS AROUND  
Precipitation : NO  
Wind Dir : 240

Wind Speed : 5  
Pressure : 2933  
Statistics

-----  
Laser Time : 01:29:50

=====  
08:21:43.774 GMT : 00:00:02 (212) GPS 1PPS Lost  
08:21:43.774 GMT : 00:00:03 (166) Divergence Error  
08:21:43.774 GMT : 00:00:03 (107) Rx Shutter Closed  
08:21:43.774 GMT : 00:00:03 (109) Tx Shutter Closed  
08:21:43.774 GMT : 00:00:04 (164) Beam Wide  
08:21:43.774 GMT : 00:00:09 (120) Laser PS Comm Ok  
08:21:43.774 GMT : 00:00:09 (112) Laser Emission Off  
08:21:43.774 GMT : 00:00:12 (204) POSAV Connected  
08:21:43.774 GMT : 00:00:13 (207) POSAV Rate Not 50 Hz  
08:21:43.774 GMT : 00:00:13 (211) POSAV new status  
08:21:43.774 GMT : 00:00:14 (213) GPS 1PPS Ok  
08:21:43.774 GMT : 00:00:29 (208) POSAV Rate Is 50 Hz  
08:21:43.774 GMT : 00:00:30 (211) POSAV new status  
08:21:43.774 GMT : 00:00:30 (215) Nav Data Ok  
08:21:43.774 GMT : 00:00:31 (211) POSAV new status  
08:21:43.774 GMT : 00:02:01 (211) POSAV new status  
13:00:53.172 GMT : 00:04:19 (153) Eyesafety Disabled  
13:00:53.872 GMT : 00:04:19 (162) Roll Comp On  
13:00:54.472 GMT : 00:04:20 (164) Beam Wide  
13:00:59.172 GMT : 00:04:25 (165) Beam Narrow  
13:01:03.272 GMT : 00:04:28 (106) Rx Shutter Open  
13:01:03.372 GMT : 00:04:28 (108) Tx Shutter Open  
13:01:19.173 GMT : 00:04:45 (107) Rx Shutter Closed  
13:01:19.173 GMT : 00:04:45 (109) Tx Shutter Closed  
13:01:19.873 GMT : 00:04:45 (211) POSAV new status  
13:08:06.676 GMT : 13:08:05 (211) POSAV new status  
13:27:32.99 GMT : 13:27:31 (106) Rx Shutter Open  
13:27:33.19 GMT : 13:27:31 (108) Tx Shutter Open  
13:27:40.89 GMT : 13:27:39 (113) Laser Emission On  
13:33:43.094 GMT : 13:33:41 (112) Laser Emission Off  
13:38:48.299 GMT : 13:38:47 (113) Laser Emission On  
13:41:15.501 GMT : 13:41:14 (112) Laser Emission Off  
13:45:48.905 GMT : 13:45:47 (113) Laser Emission On  
13:57:05.615 GMT : 13:57:04 (112) Laser Emission Off  
14:01:30.12 GMT : 14:01:29 (113) Laser Emission On  
14:13:00.831 GMT : 14:12:59 (112) Laser Emission Off  
14:17:31.535 GMT : 14:17:30 (113) Laser Emission On  
14:28:14.346 GMT : 14:28:13 (112) Laser Emission Off  
14:32:18.851 GMT : 14:32:17 (113) Laser Emission On  
14:43:00.763 GMT : 14:42:59 (112) Laser Emission Off  
14:46:39.567 GMT : 14:46:38 (113) Laser Emission On  
14:56:57.679 GMT : 14:56:56 (112) Laser Emission Off  
15:01:24.685 GMT : 15:01:23 (113) Laser Emission On  
15:11:34.597 GMT : 15:11:33 (112) Laser Emission Off  
15:15:02.702 GMT : 15:15:01 (113) Laser Emission On  
15:22:56.912 GMT : 15:22:55 (112) Laser Emission Off  
15:26:37.816 GMT : 15:26:36 (113) Laser Emission On

15:34:03.726 GMT : 15:34:02 (112) Laser Emission Off  
15:37:11.03 GMT : 15:37:10 (113) Laser Emission On  
15:39:05.432 GMT : 15:39:04 (112) Laser Emission Off

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : KBED  
Mission : 101207A  
Wheels Up : 1315Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 07, 2010  
Julian Day : 341  
Temperature : -3C  
Visibility : >10  
Clouds : SOME CLDS AROUND  
Precipitation : NO  
Wind Dir : 240  
Wind Speed : 5  
Pressure : 2933

#### Statistics

-----  
Laser Time : 01:29:50

=====

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : KBED  
Mission : 101207A  
Wheels Up : 1315Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 07, 2010  
Julian Day : 341  
Temperature : -3C



Visibility : >10  
 Clouds : SOME CLDS AROUND  
 Precipitation : NO  
 Wind Dir : 240  
 Wind Speed : 5  
 Pressure : 2933

Statistics

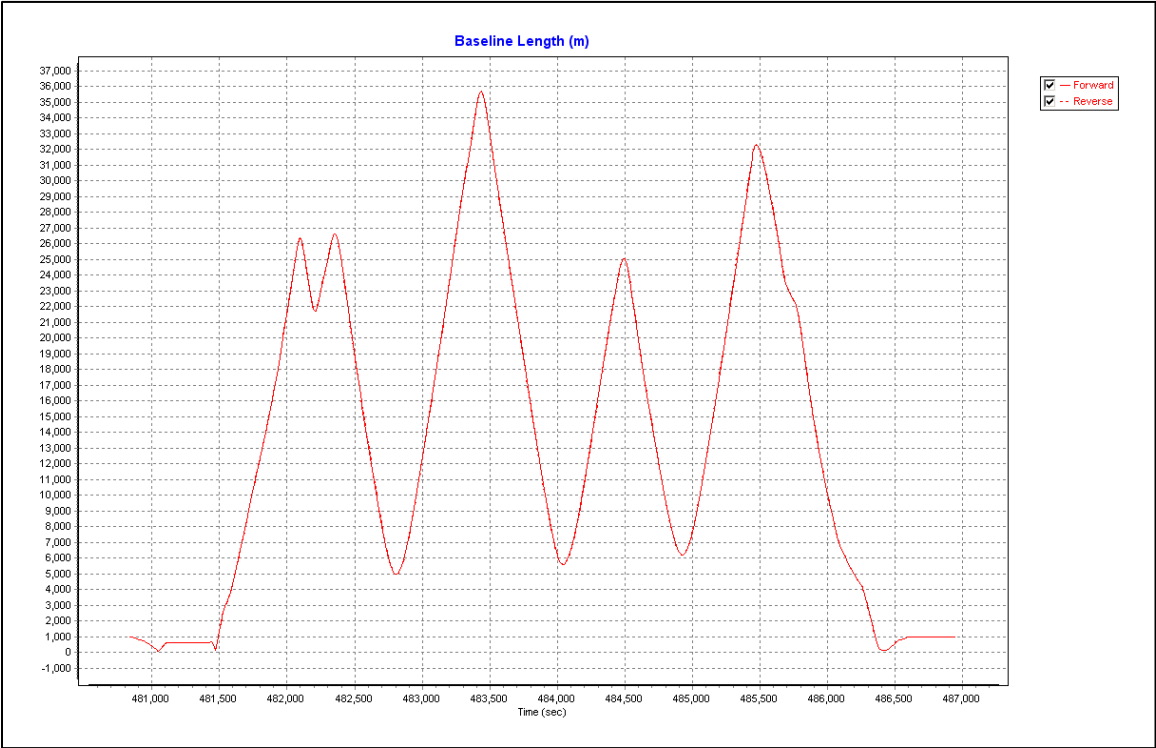
-----  
 Laser Time : 01:29:50

RC	START HDG	STOP Plan	LINE# File	ALT	PRF	FREQ	ANGLE	MP	DIV
	13:27:41.39	13:33:41.094	31	1587	70	30.10	18.00	OFF	NAR
ON	0.00	179.71							
	13:38:48.899	13:41:16.301	32	1600	70	30.10	18.00	OFF	NAR
ON	0.00	359.7							
	13:45:49.605	13:57:07.115	33	1595	70	30.10	18.00	OFF	NAR
ON	0.00	179.7							
	14:01:30.92	14:13:01.731	34	1602	70	30.10	18.00	OFF	NAR
ON	0.00	359.7							
	14:17:32.035	14:28:15.246	34	1608	70	30.10	18.00	OFF	NAR
ON	0.00	179.7							
	14:32:18.951	14:43:01.063	35	1601	70	30.10	18.00	OFF	NAR
ON	0.00	359.69							
	14:46:40.267	14:56:59.679	36	1608	70	30.10	18.00	OFF	NAR
ON	0.00	179.69							
	15:01:25.485	15:11:36.097	37	1604	70	30.10	18.00	OFF	NAR
ON	0.00	359.68							
	15:15:03.202	15:22:58.112	38	1616	70	30.10	18.00	OFF	NAR
ON	0.00	179.68							
	15:26:37.616	15:34:04.026	39	1615	70	30.10	18.00	OFF	NAR
ON	0.00	359.67							
	15:37:11.93	15:39:06.132	39	1614	70	30.10	18.00	OFF	NAR
ON	0.00	359.67							

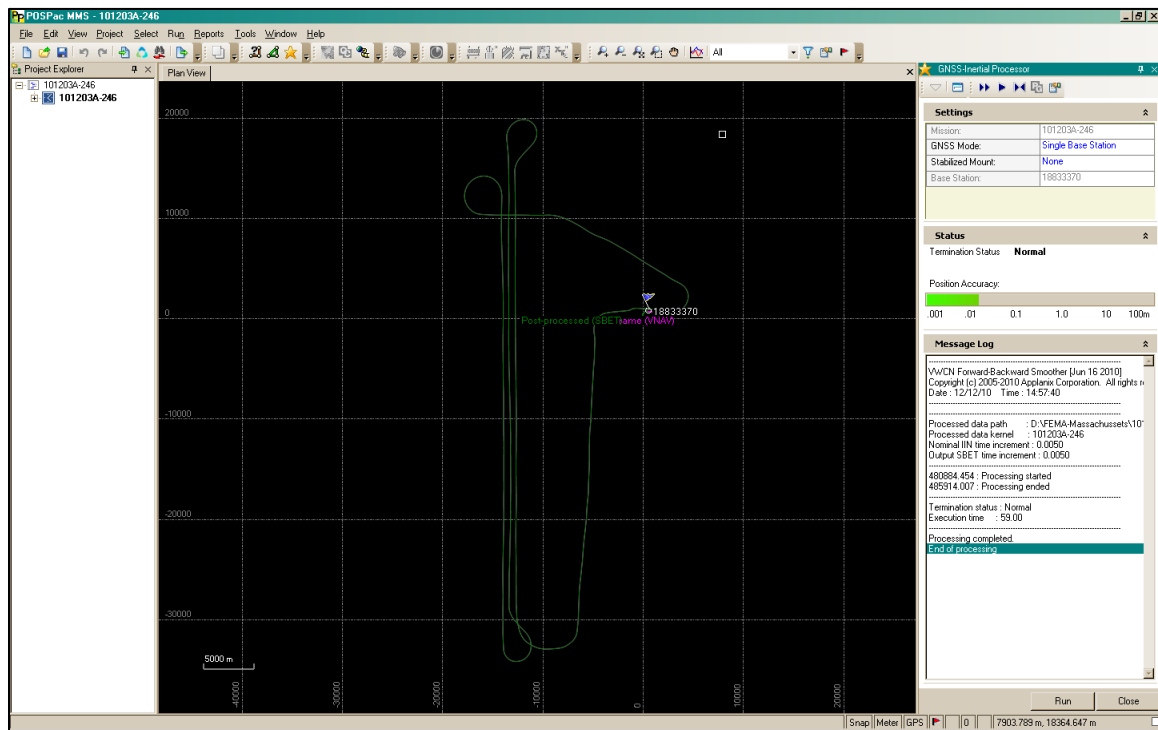
□



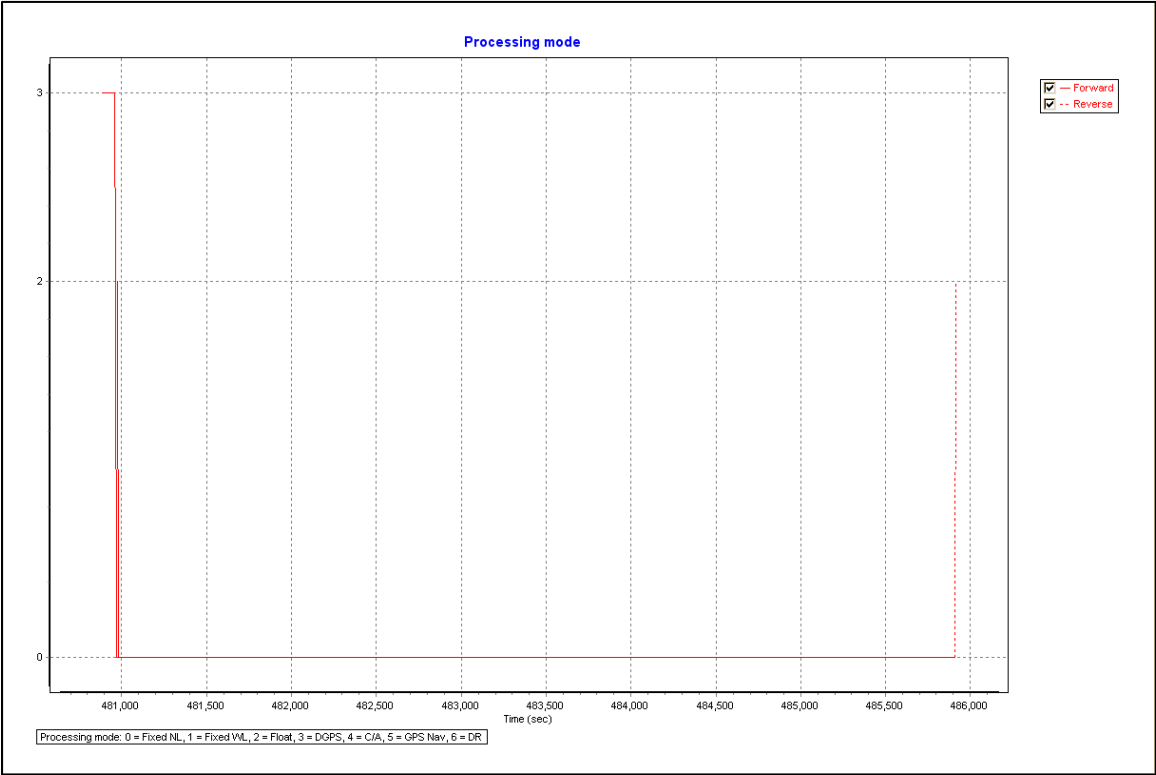
101203A-247\_BASELINE



# 101203A-246-TRAJECTORY

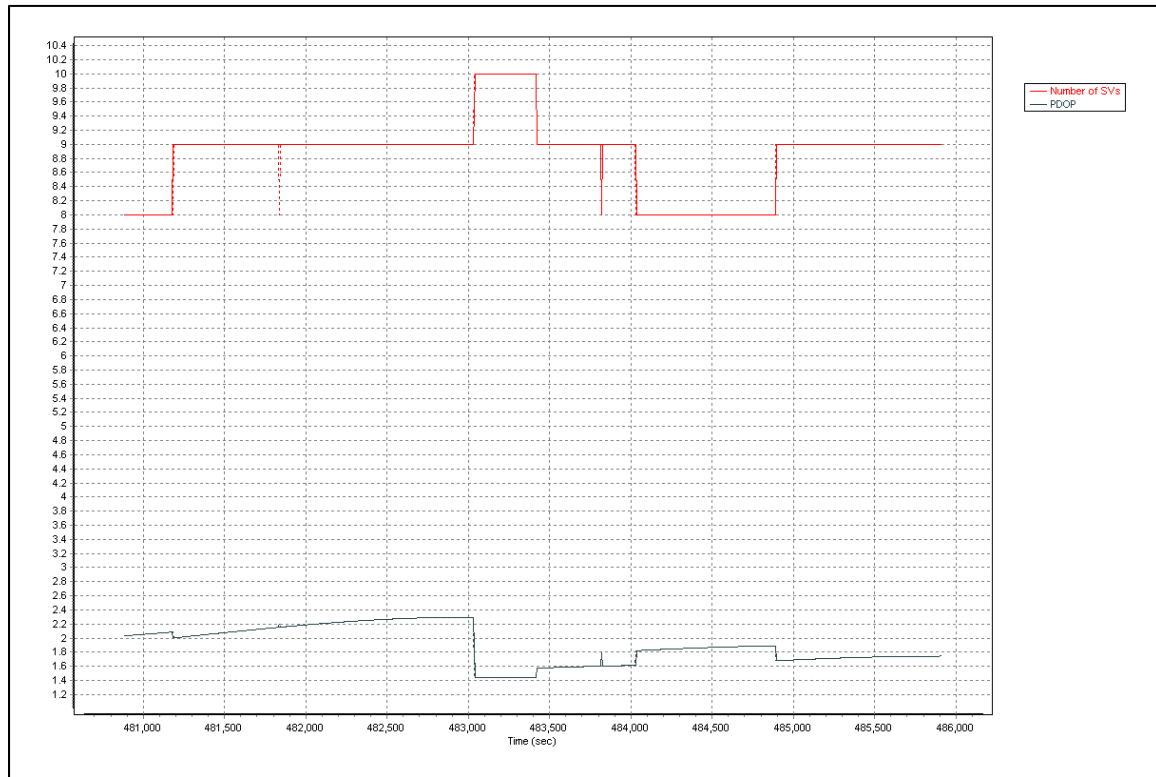


101203A-246-PROCMODE

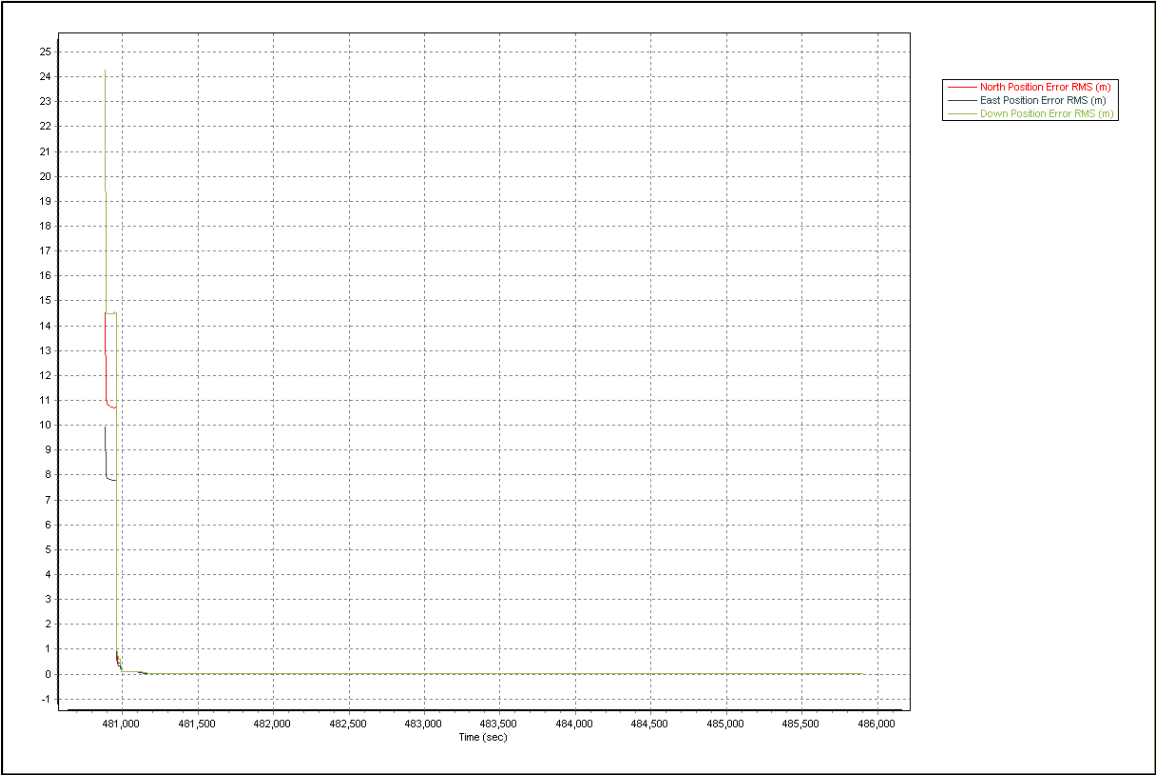




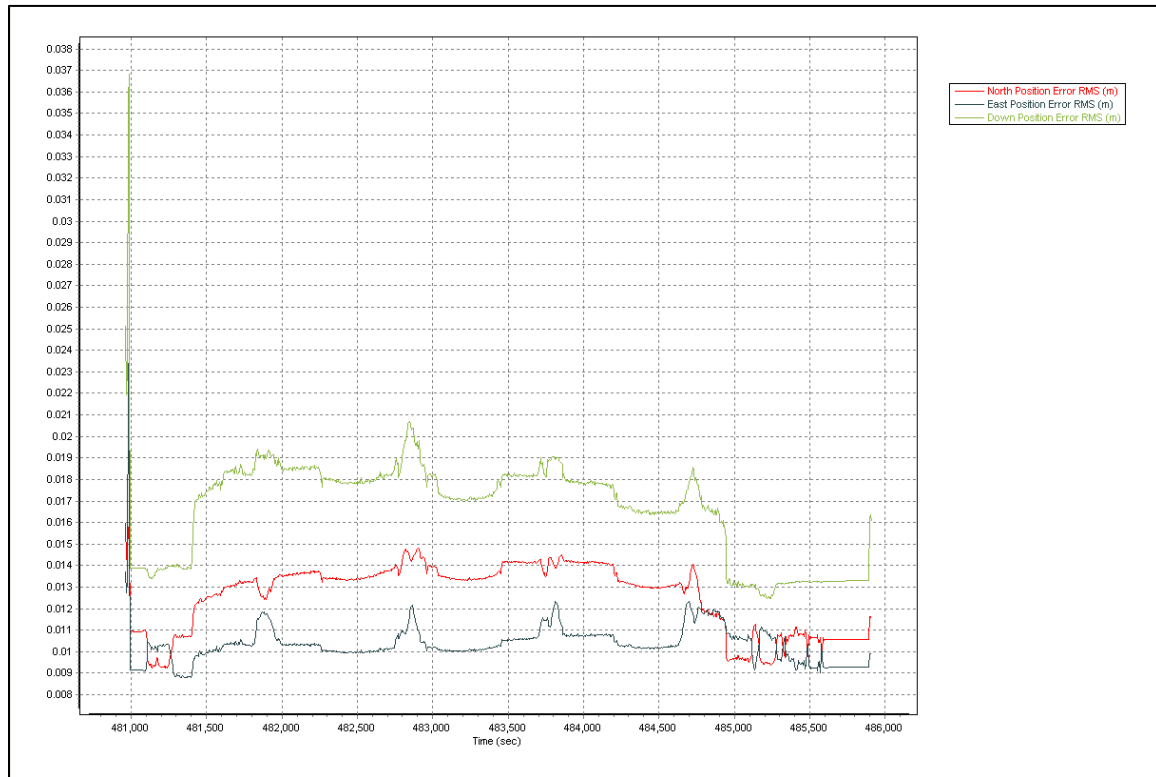
# 101203A-246-PDOP&SVS



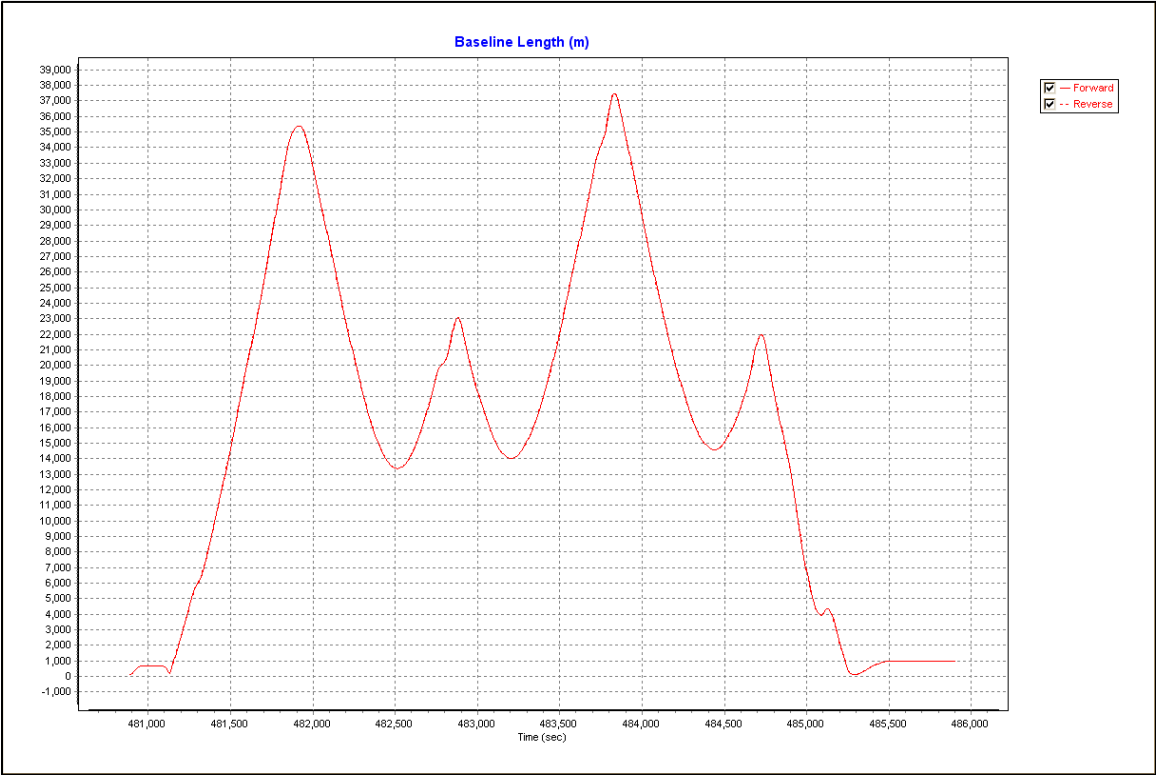
101203A-246-NEDPOSITIONERROR-FORWARD



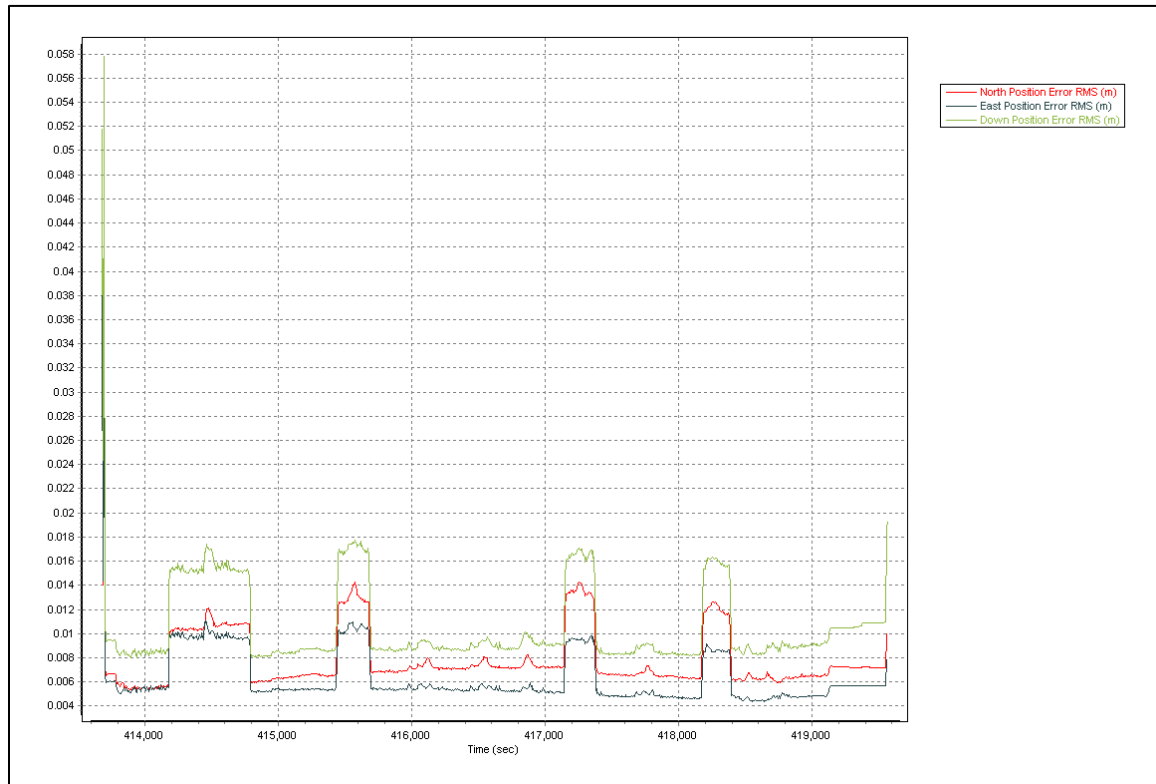
# 101203A-246-NEDPOSITIONERROR-SMOOTHED



101203A-246-BASELINELENGTH

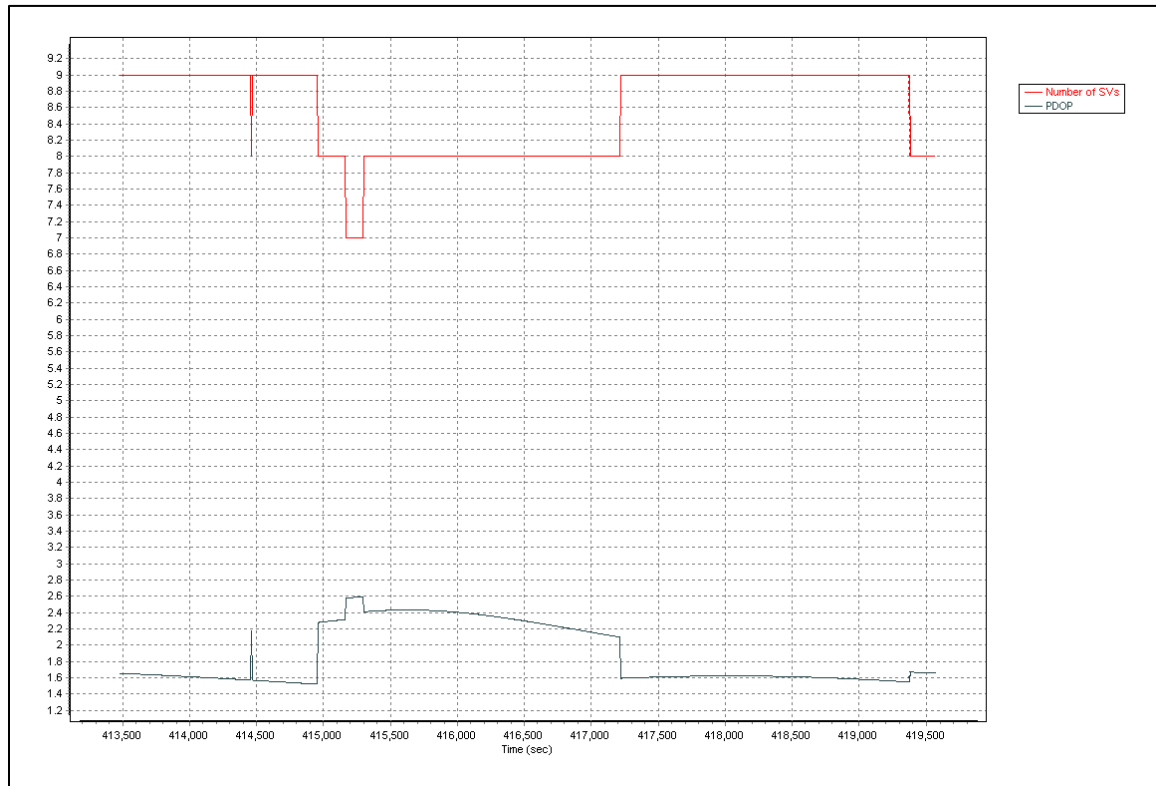


# 101202A-247\_SMOOTHPERFMETRIC\_NED

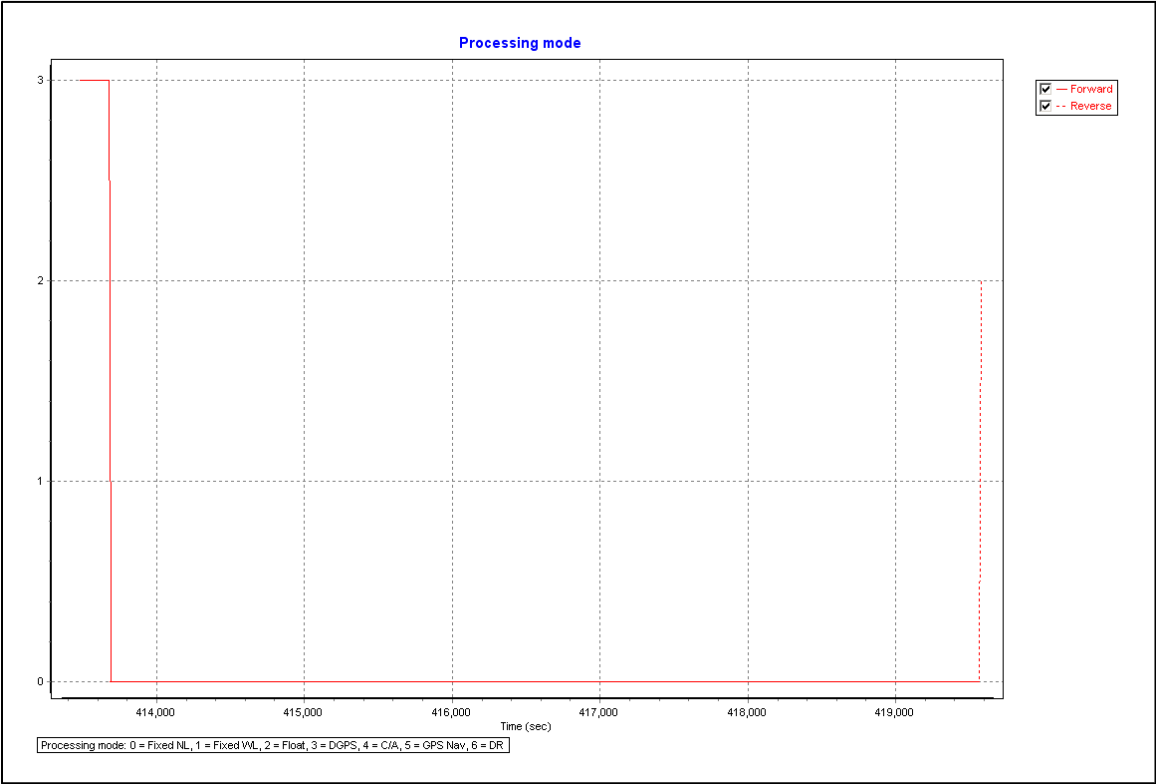




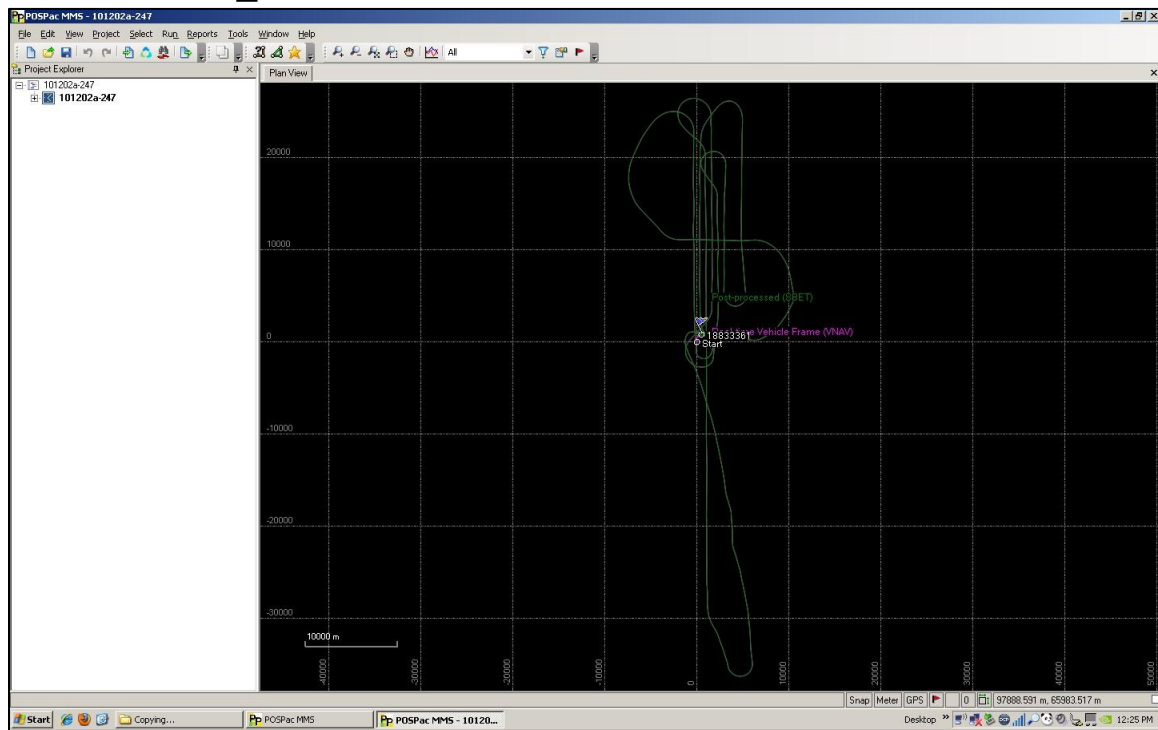
# 101202A-247\_SVS&PDOP



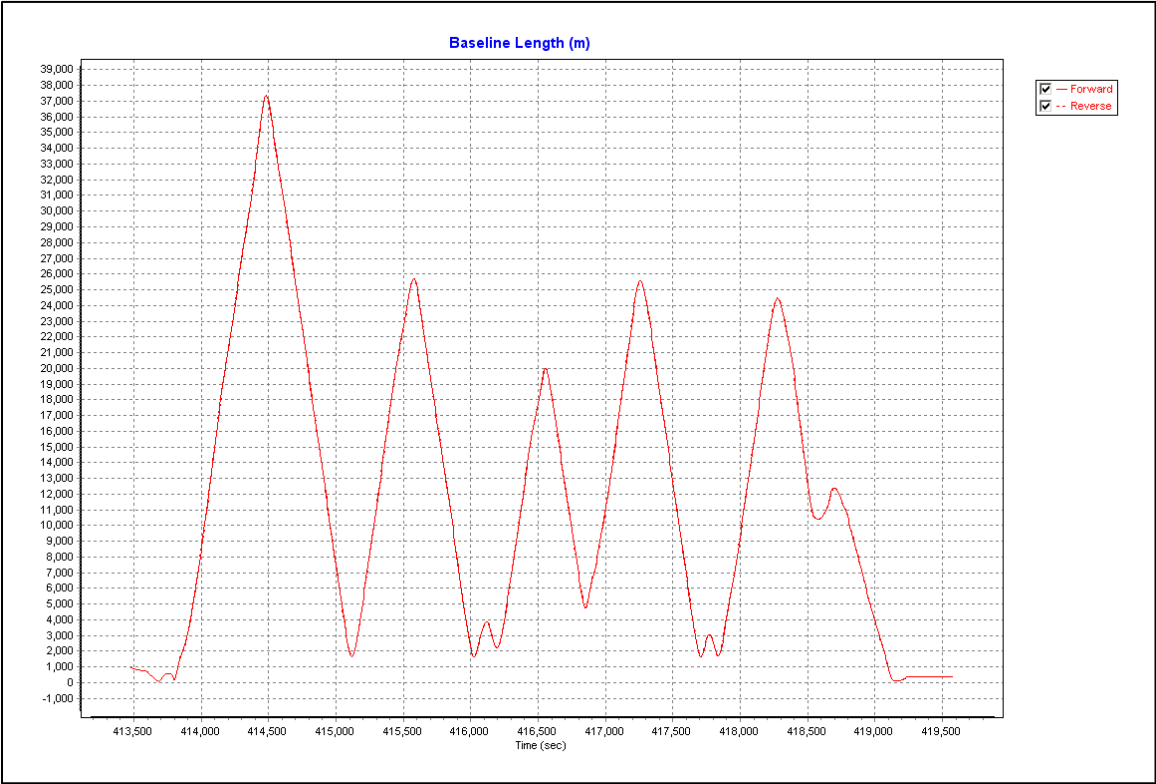
101202A-247\_PROCESSMODE



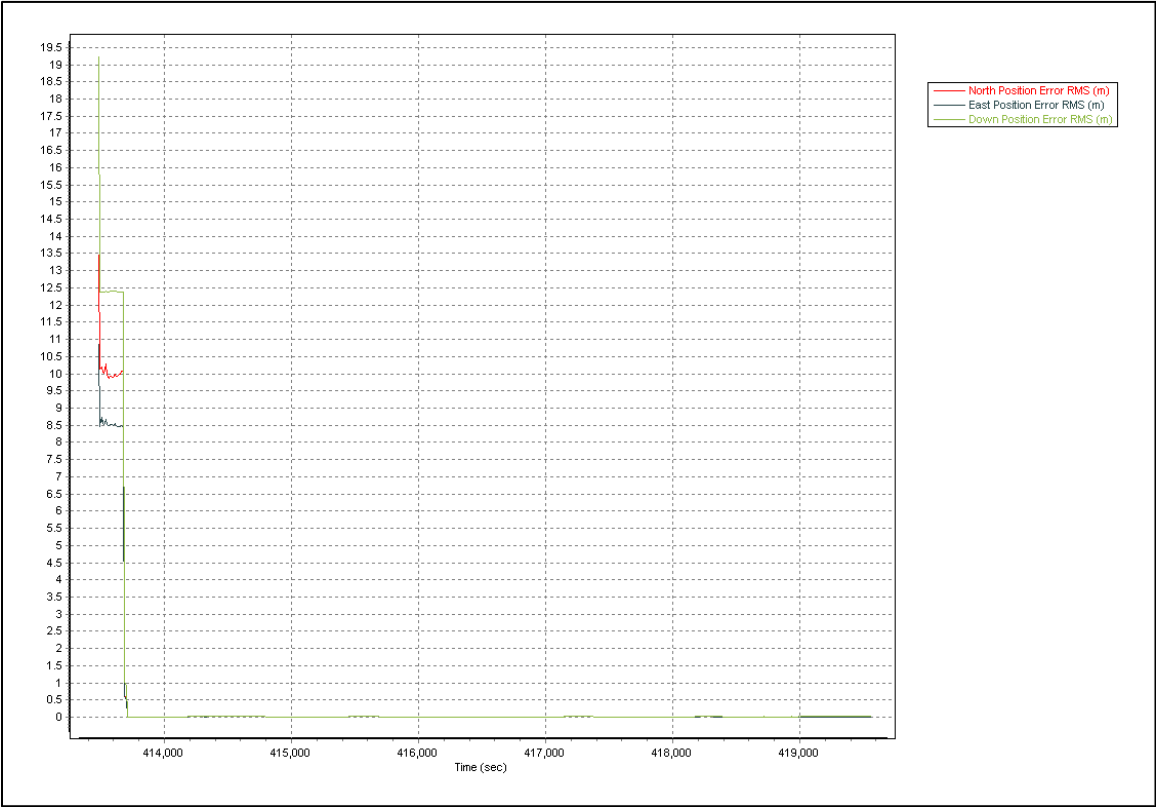
# 101202A-247\_SCREENSHOT



101202A-247\_BASELINE

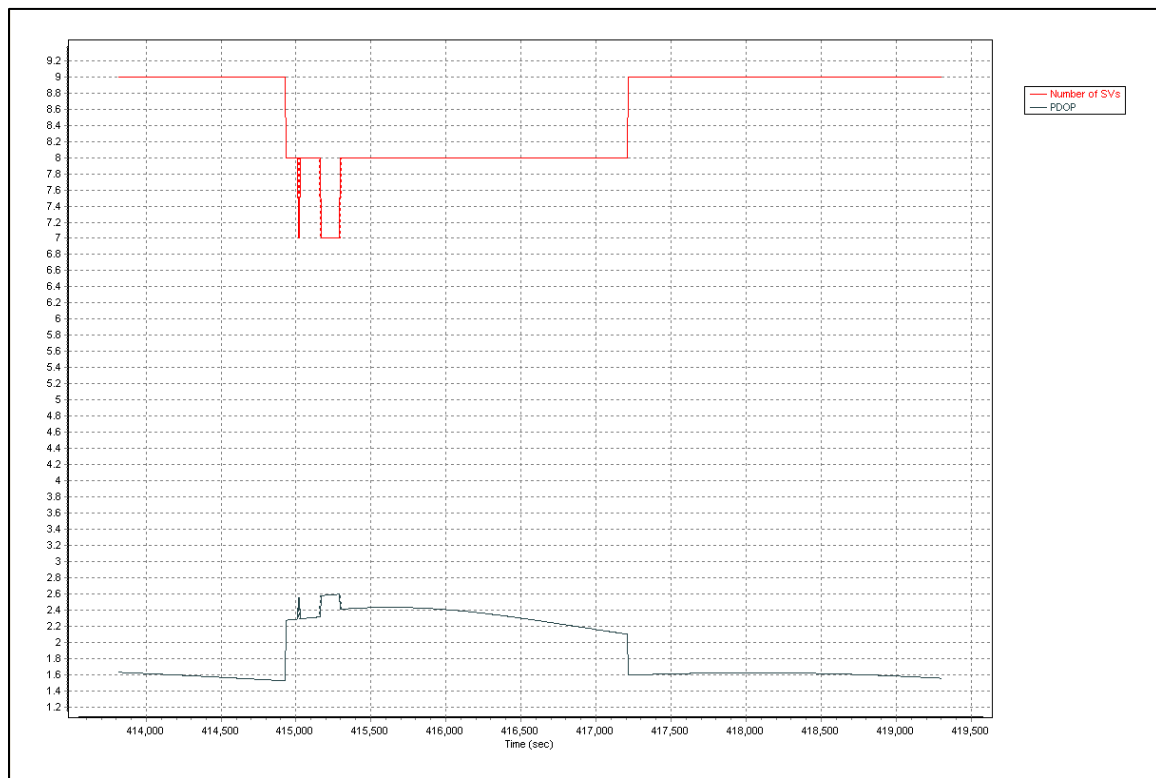


101202A-247\_FORWARDPROCPERFMETRIC\_NED

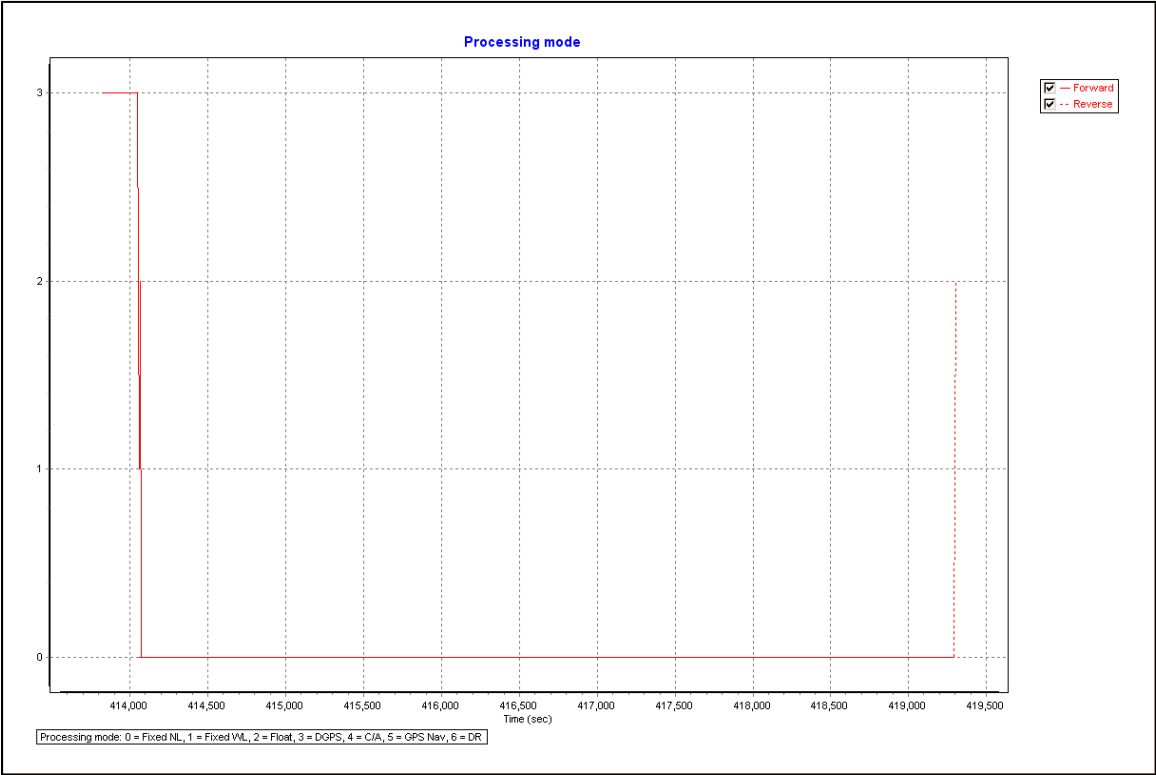




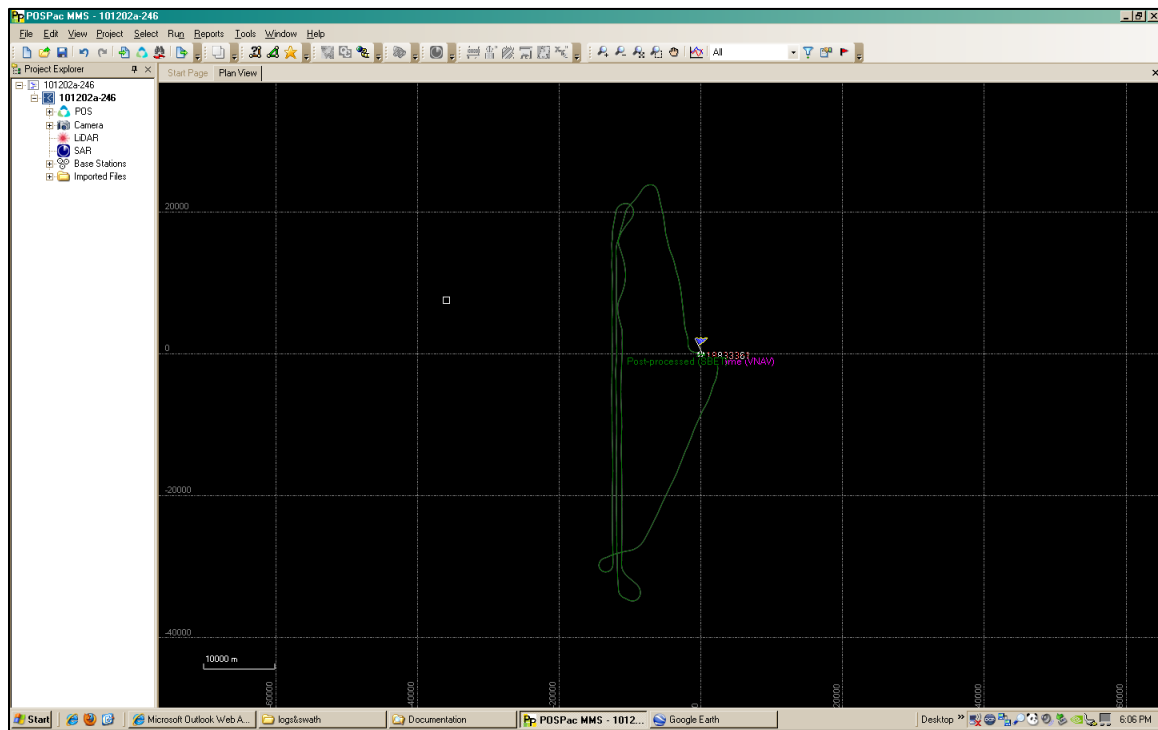
# 101202A-246-PDOP&SVS



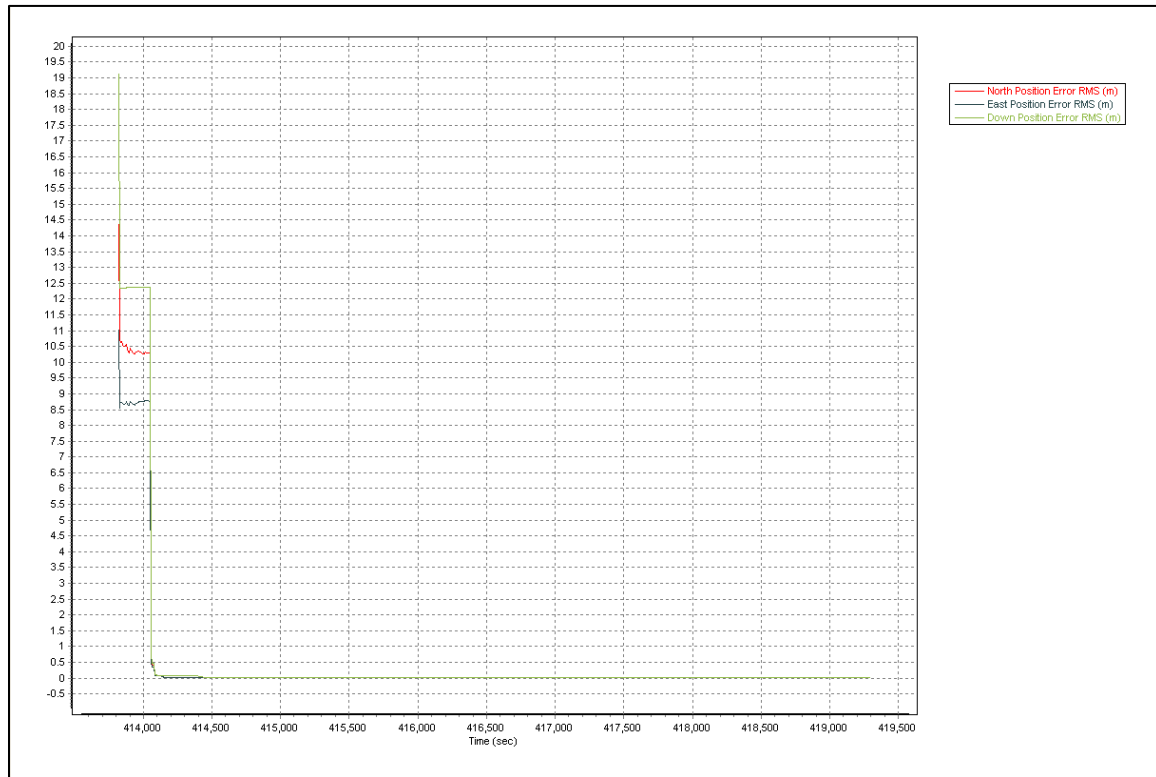
101202A-246-PROCMODE



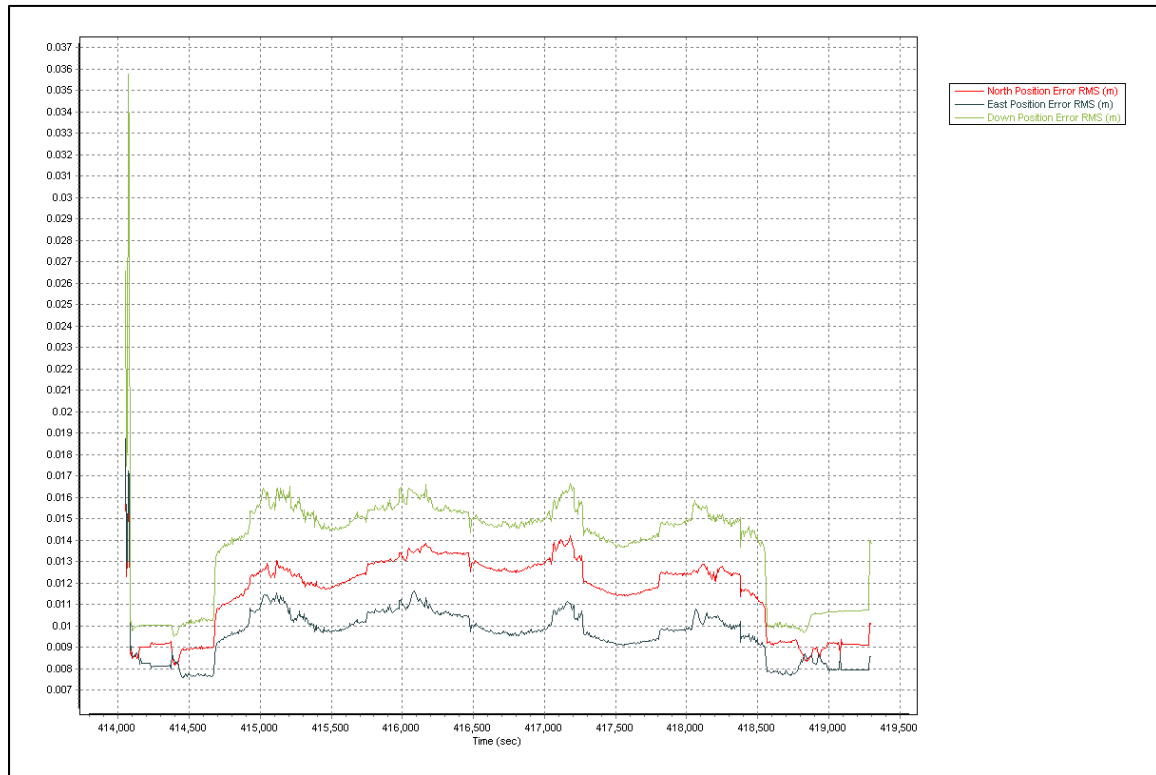
# 101202A-246-TRAJECTORY



# 101202A-246-NEDPOSITIONERROR-FORWARD

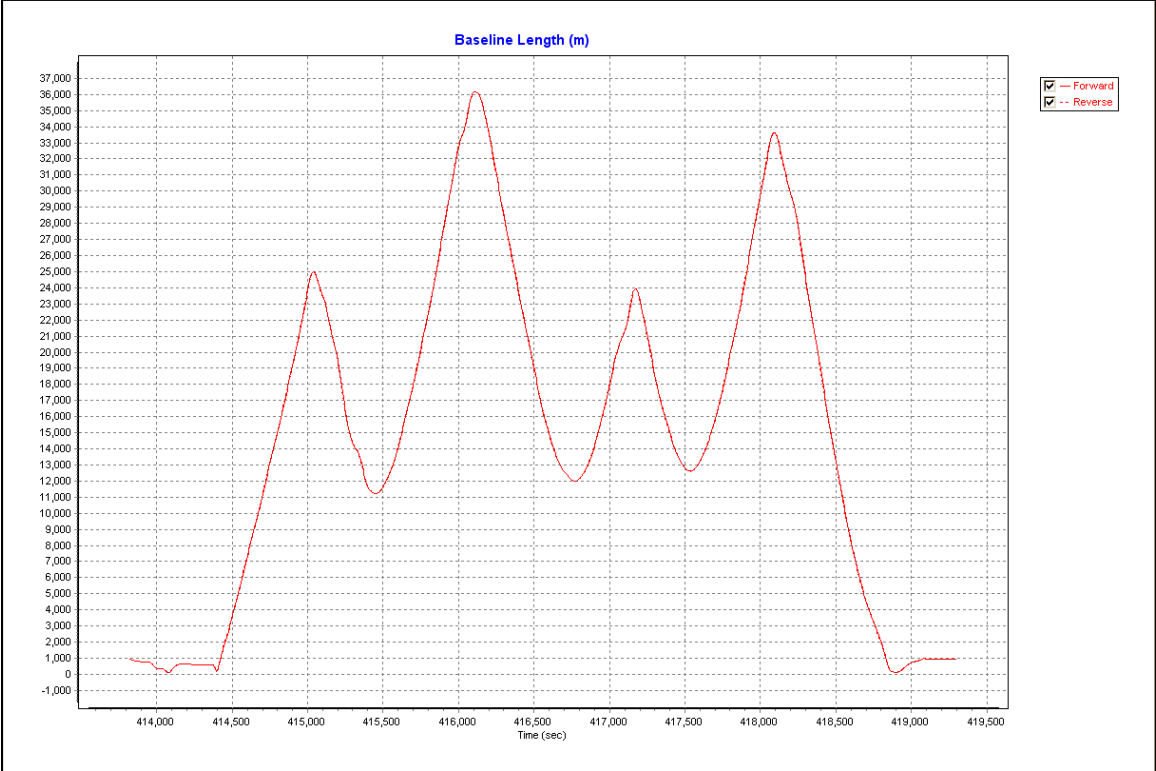


# 101202A-246-NEDPOSITIONERROR-SMOOTHED

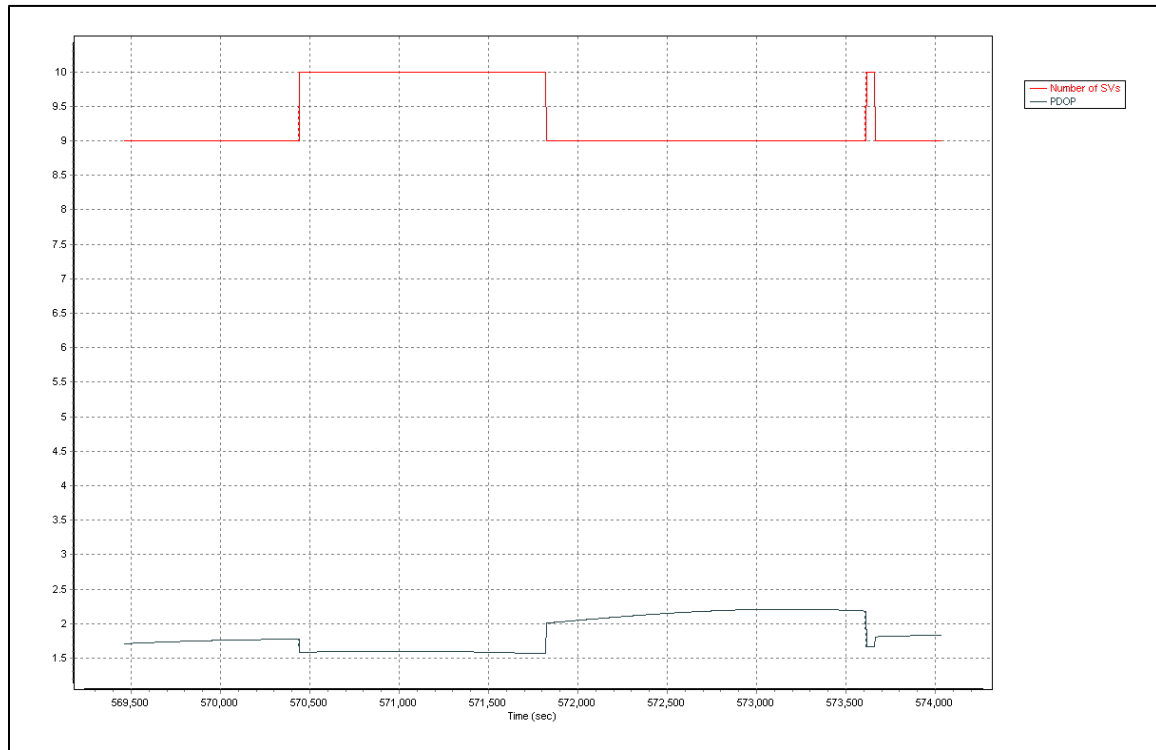




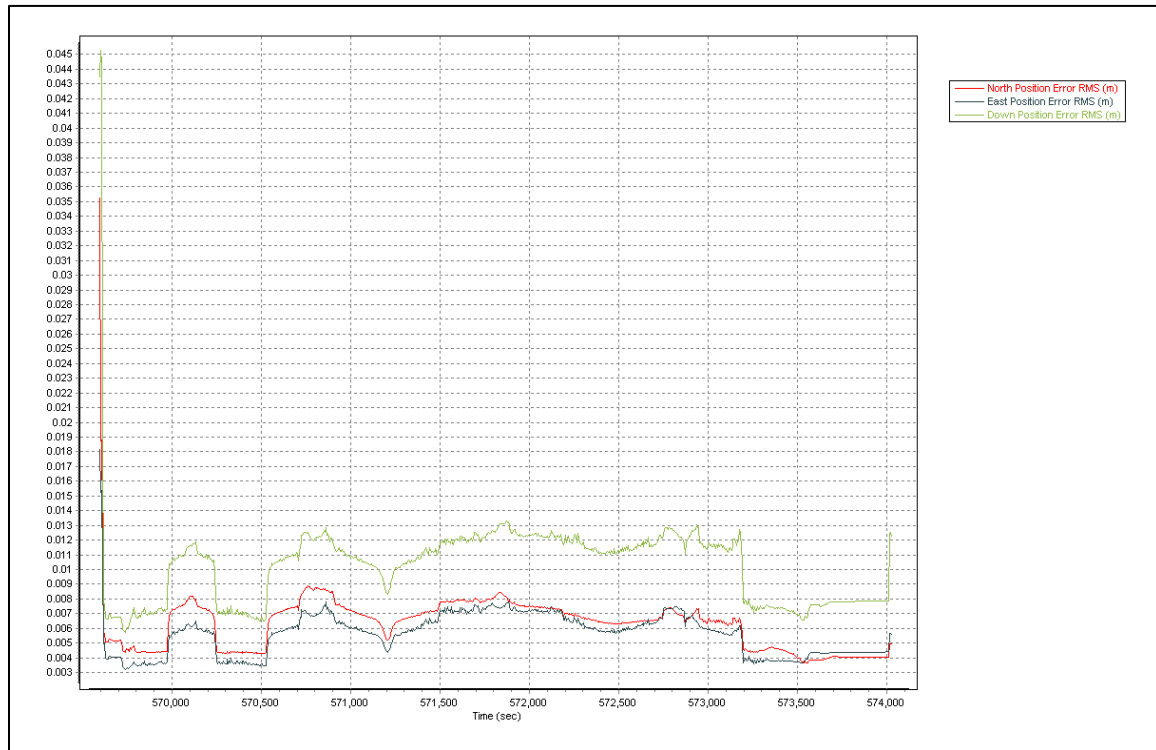
101202A-246-BASELINELENGTH



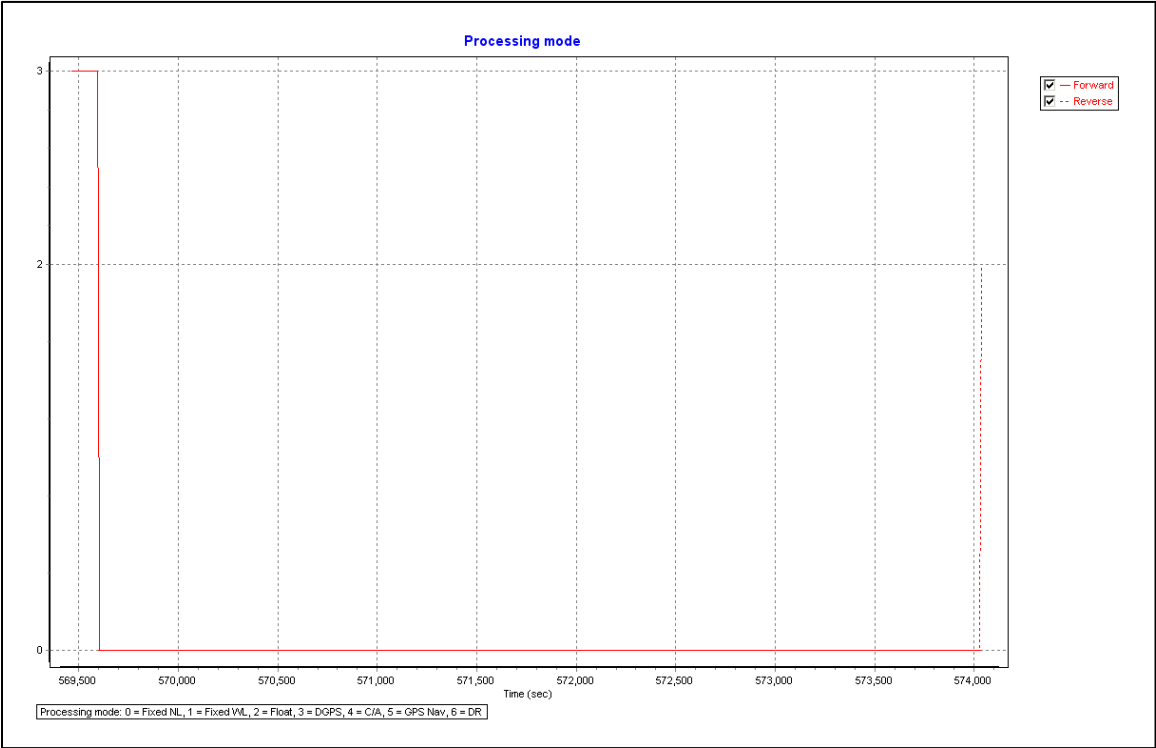
# 101211A-247\_SVS&PDOP



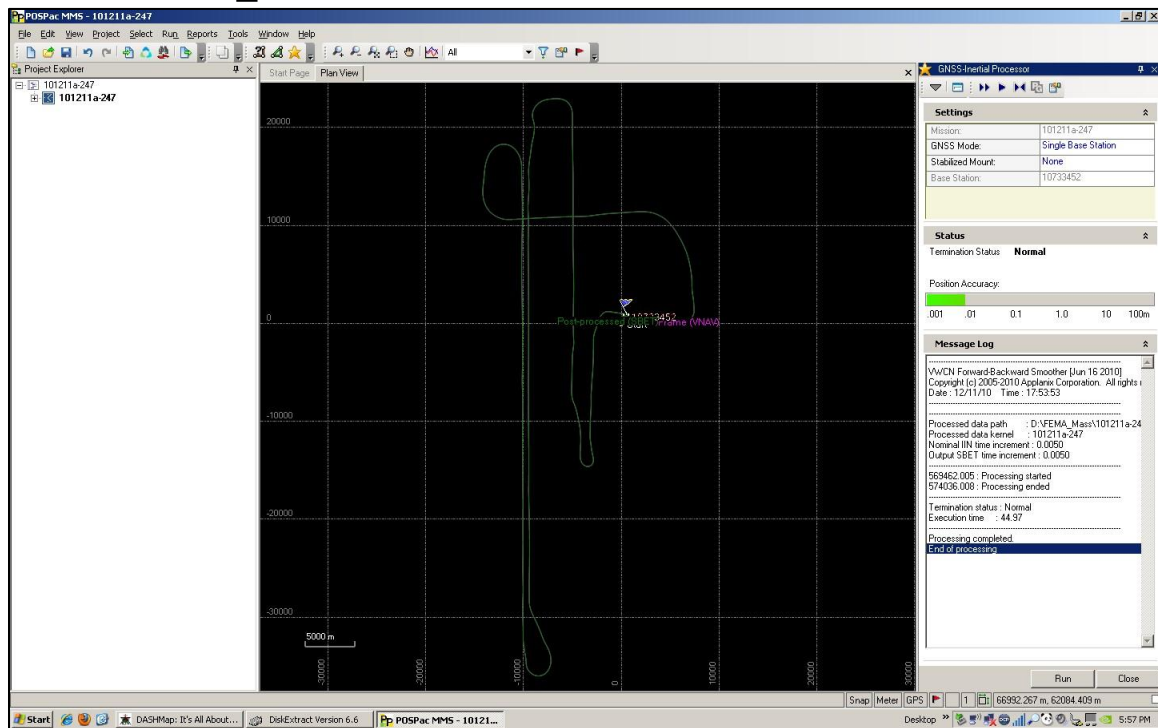
# 101211A-247\_SMOOTHPERFMETRIC\_NED



101211A-247\_PROCESSMODE

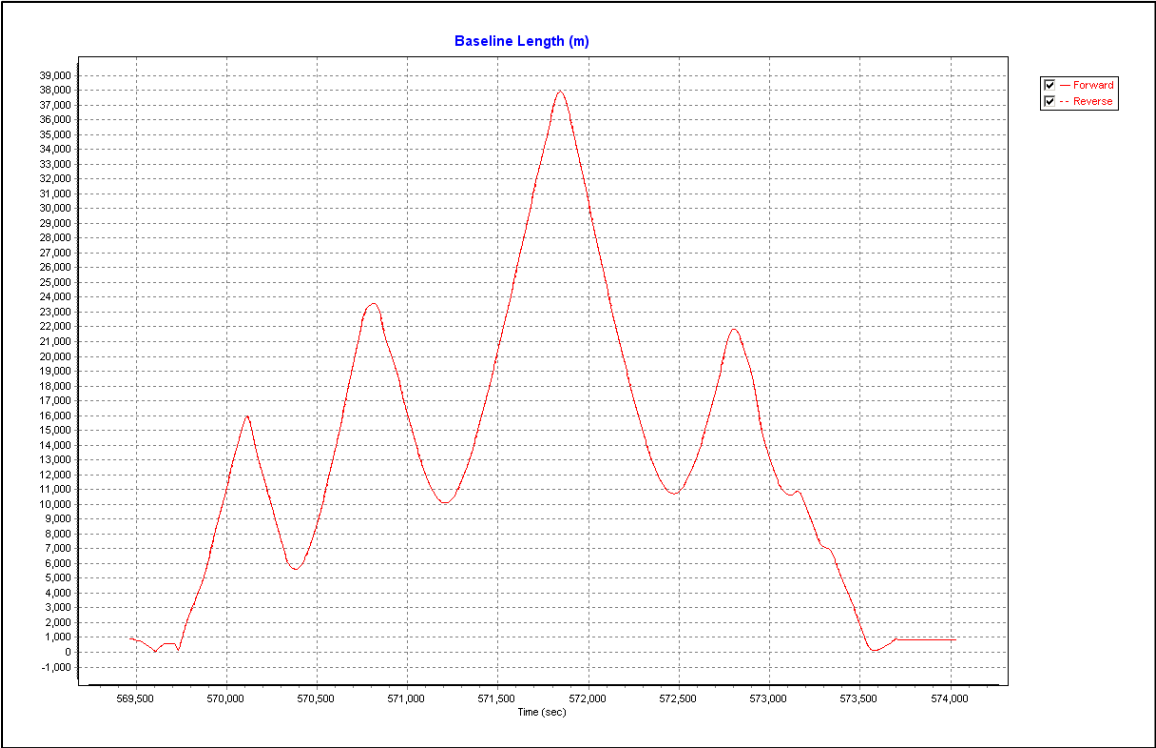


# 101211A-247\_SCREENSHOT

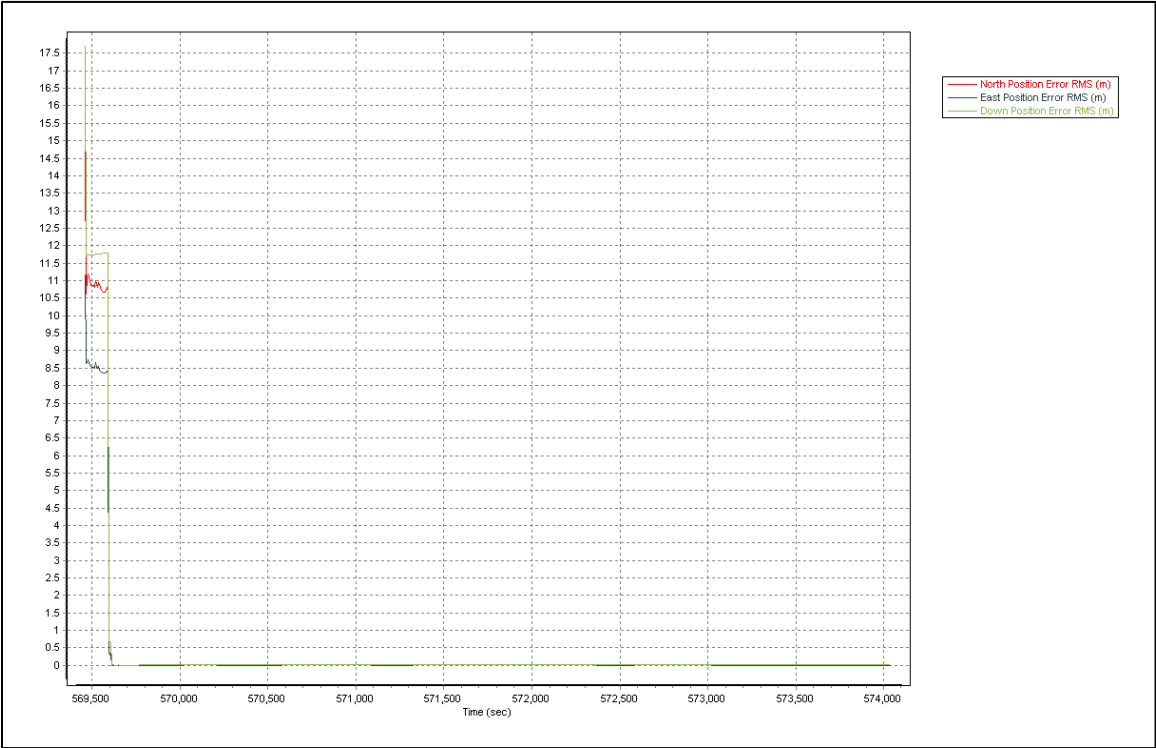




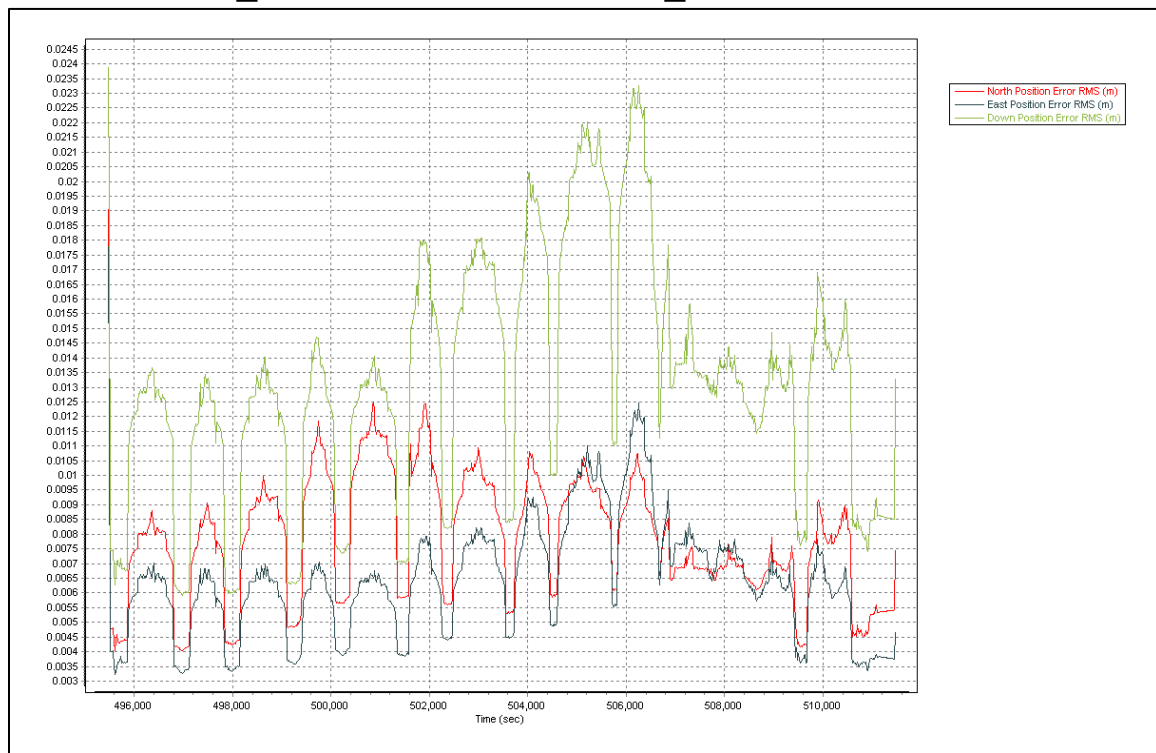
101211A-247\_BASELINE



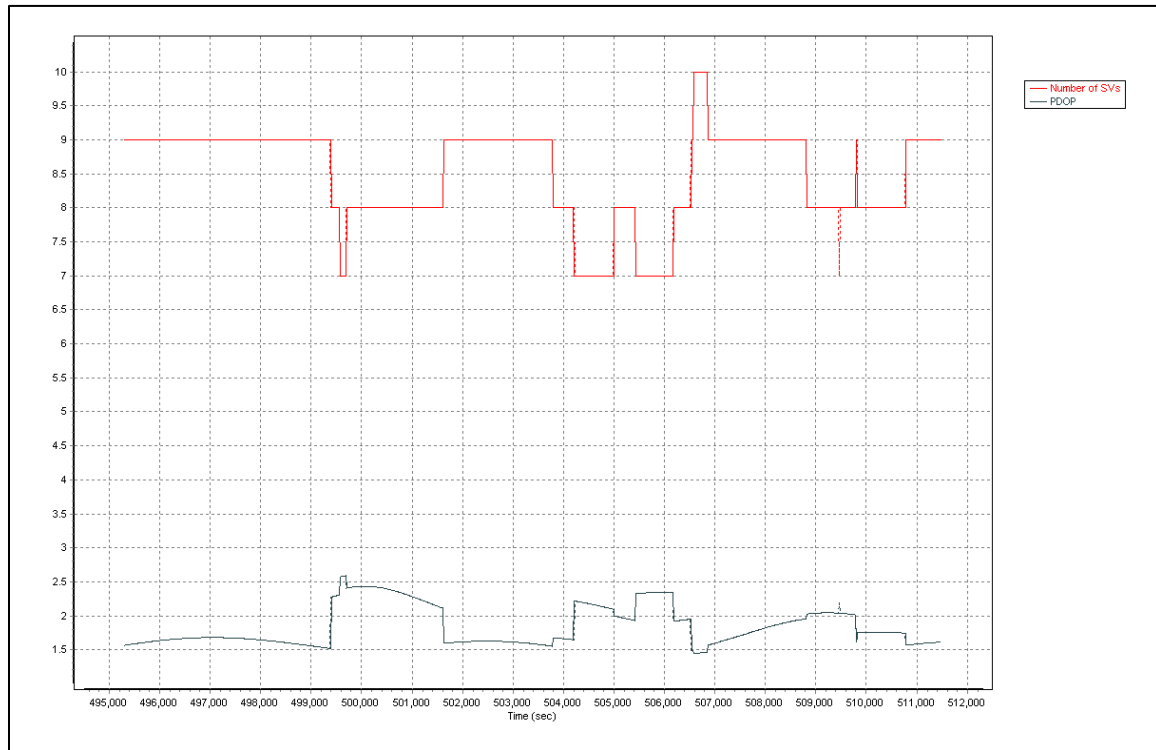
101211A-247\_FORWARDPROCPERFMETRIC\_NED



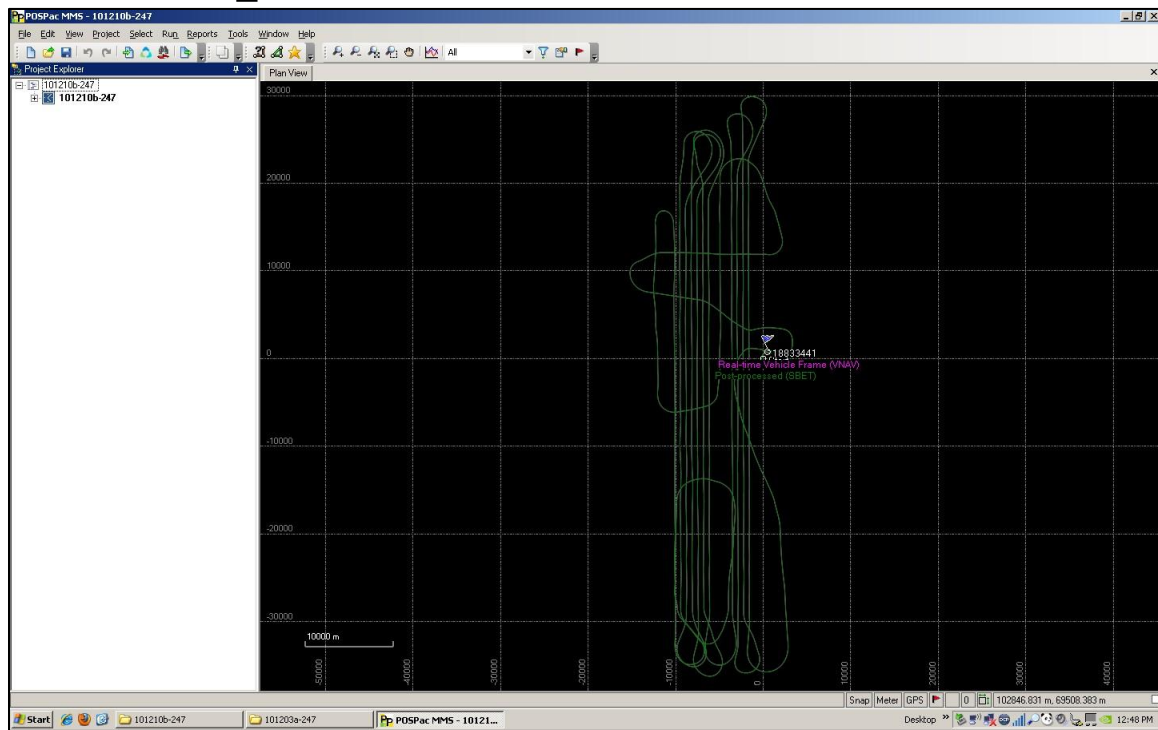
# 101210B-247\_SMOOTHPERFMETRIC\_NED



# 101210B-247\_SVS&PDOP

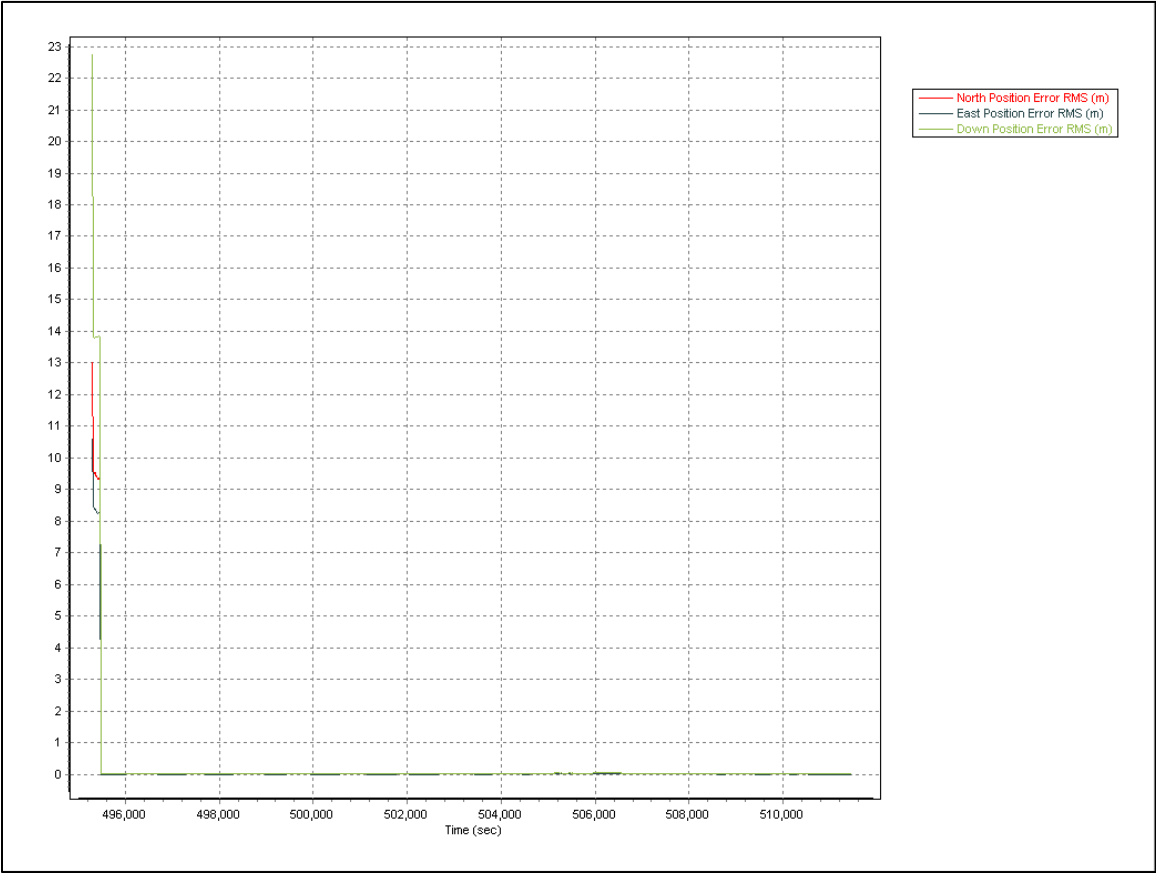


# 101210B-247\_SCREENSHOT

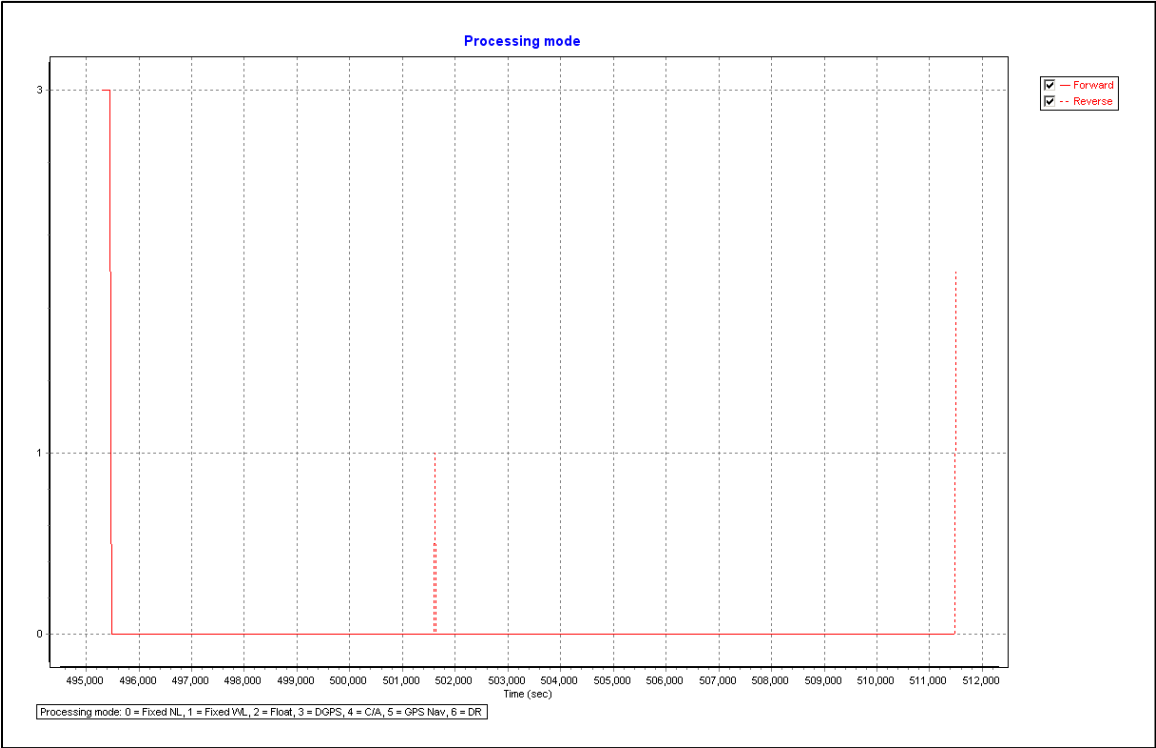




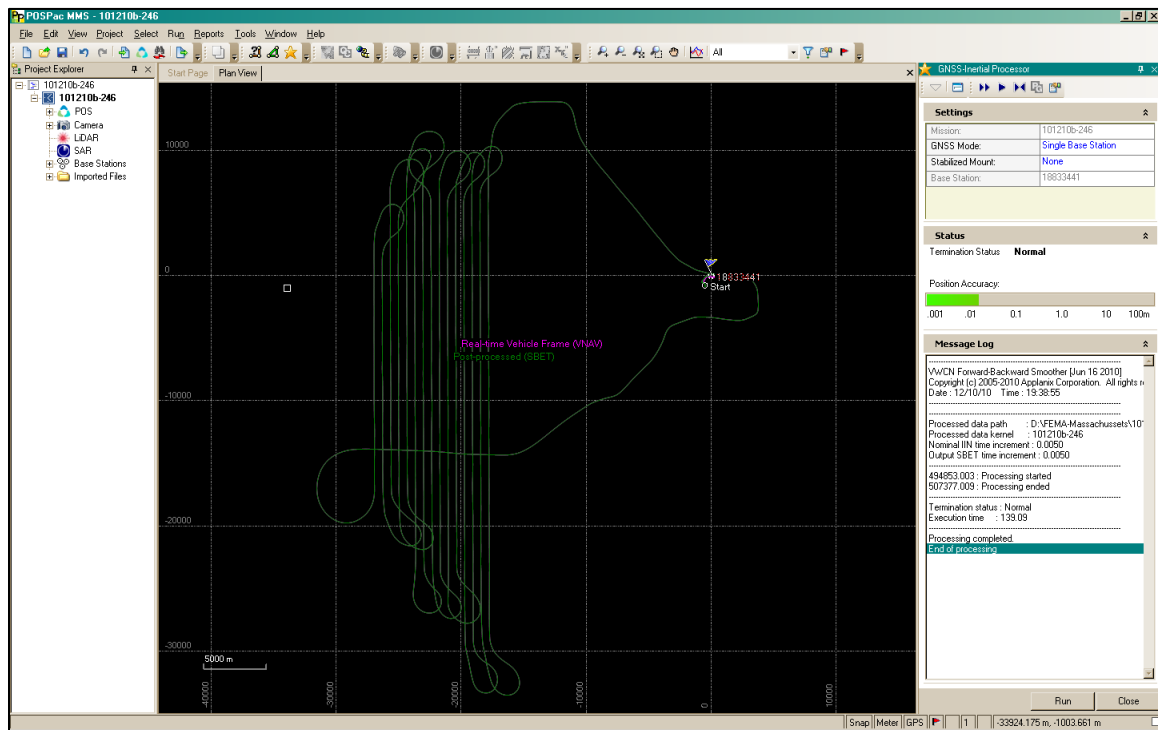
101210B-247\_FORWARDPROCPERFMETRIC\_NED



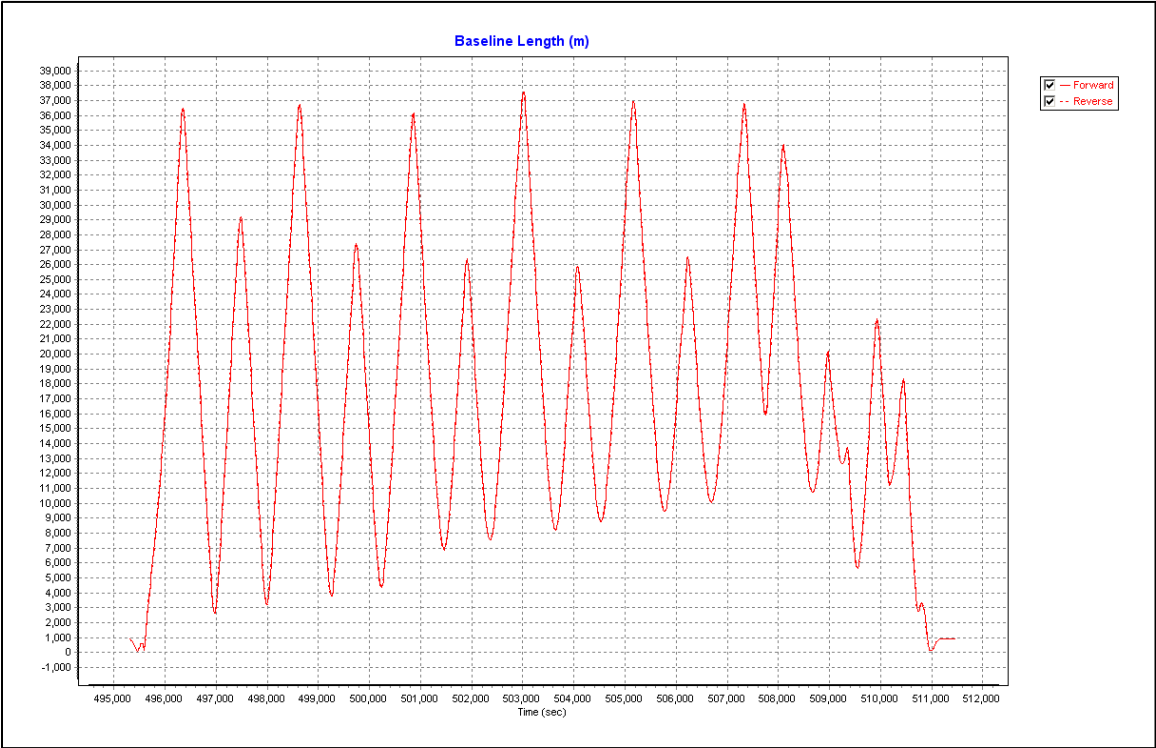
101210B-247\_PROCESSINGMODE



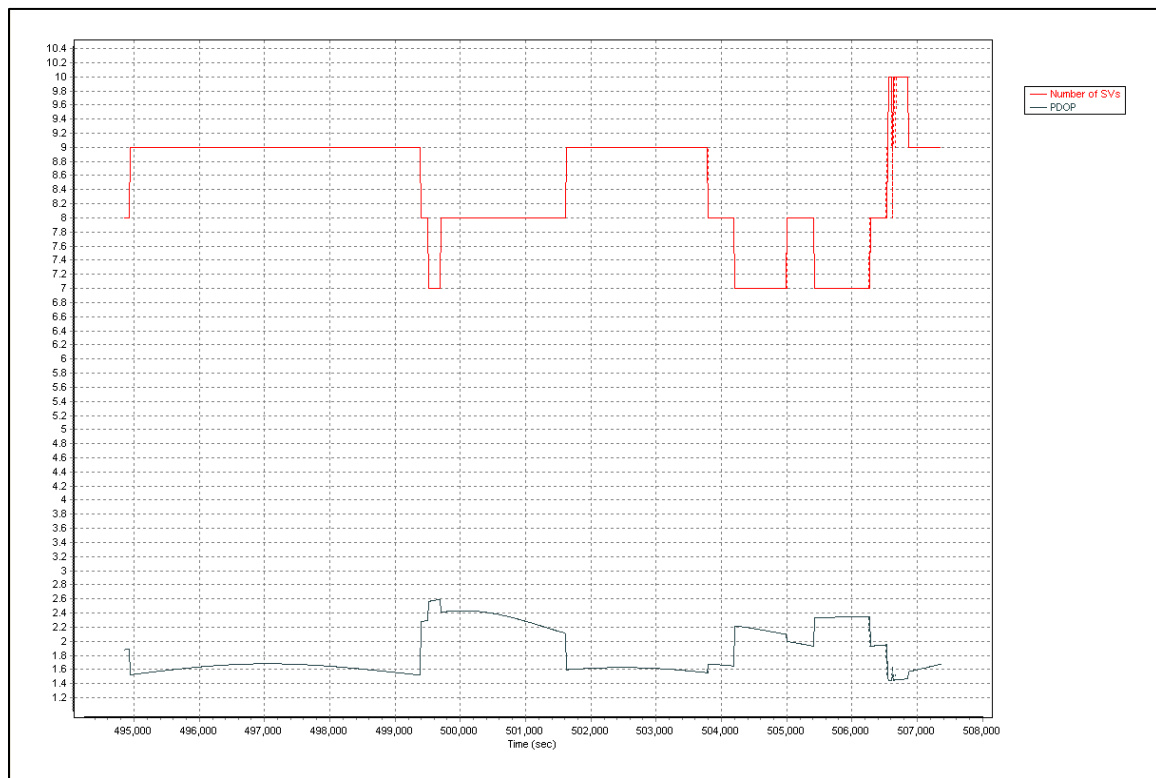
# 101210B-246-TRAJECTORY



101210B-247\_BASELINE

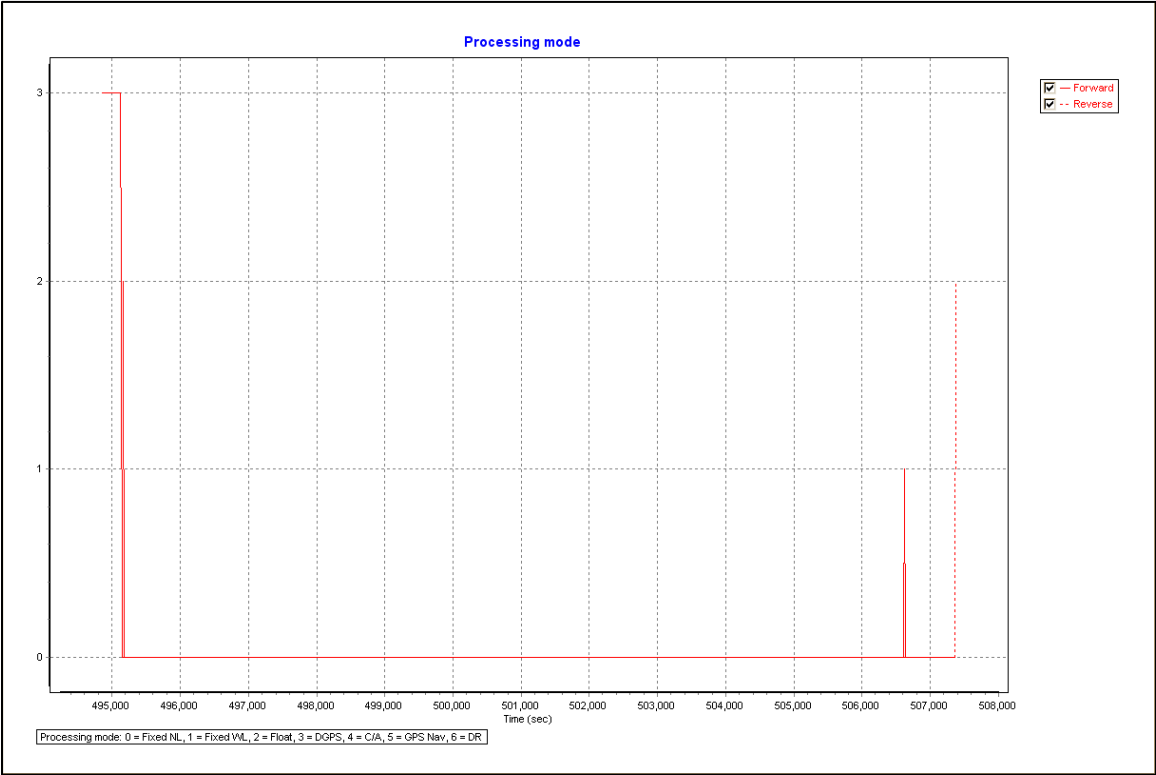


# 101210B-246-PDOP&SVS

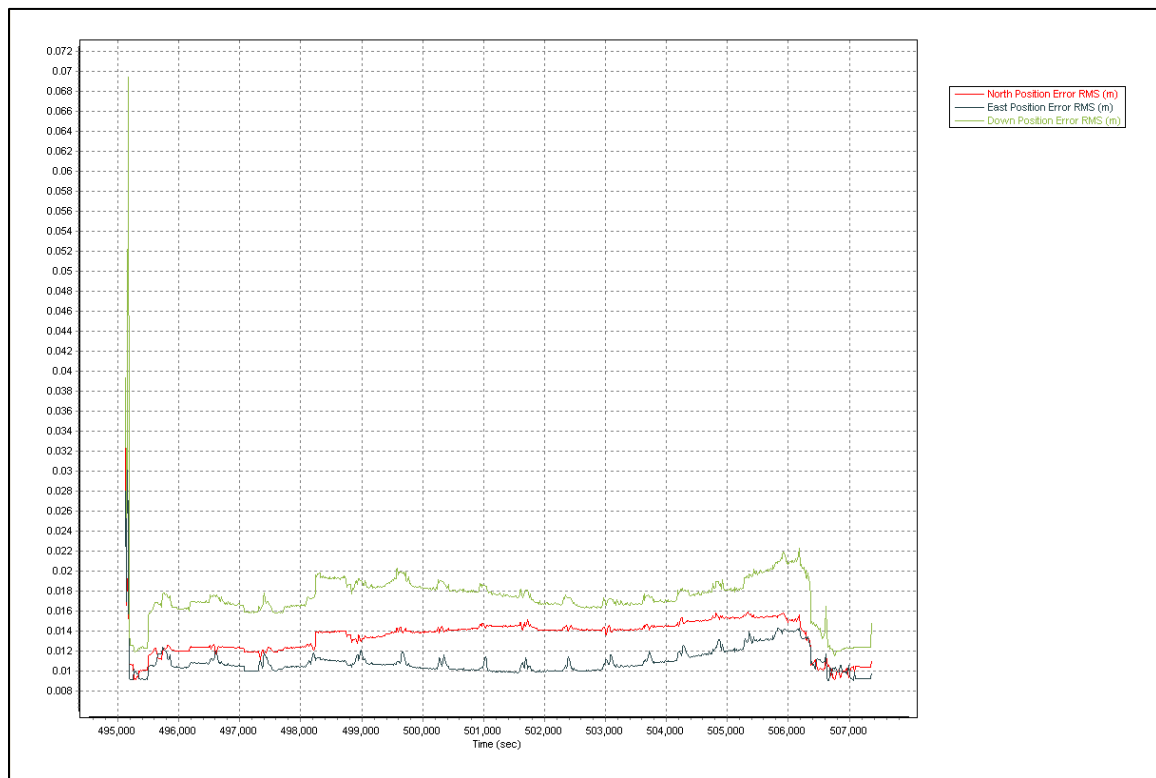




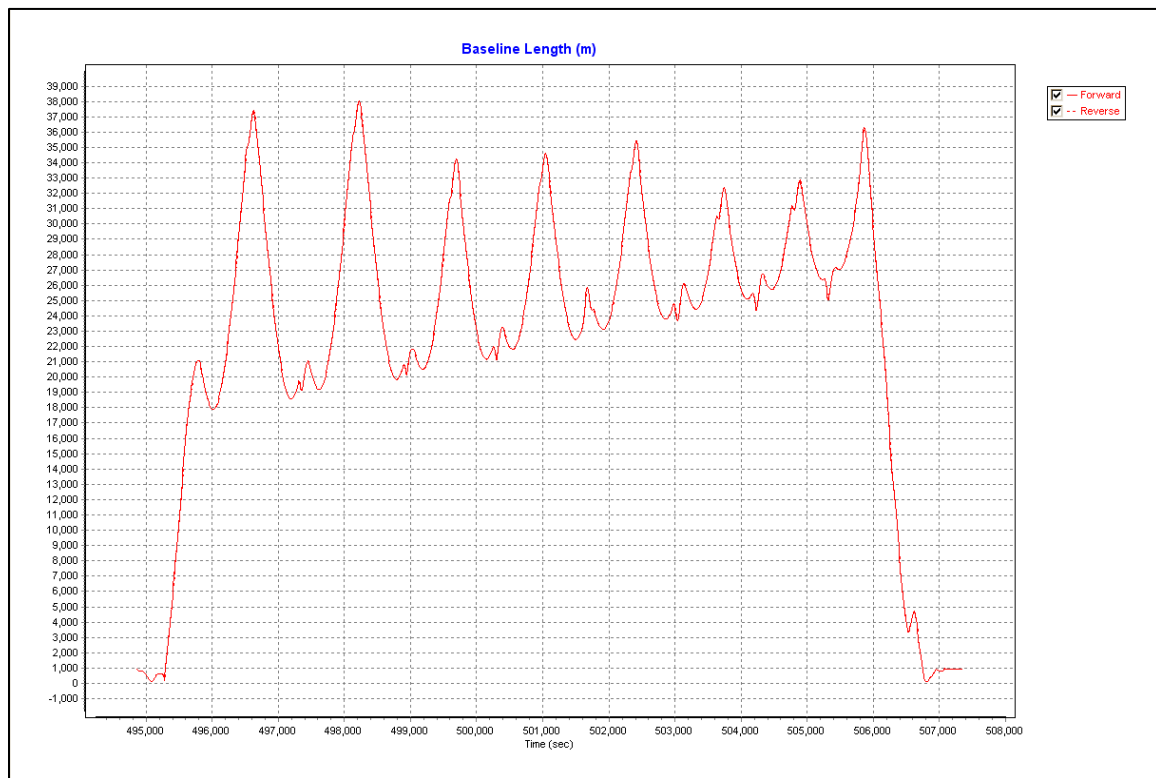
101210B-246-PROCMODE



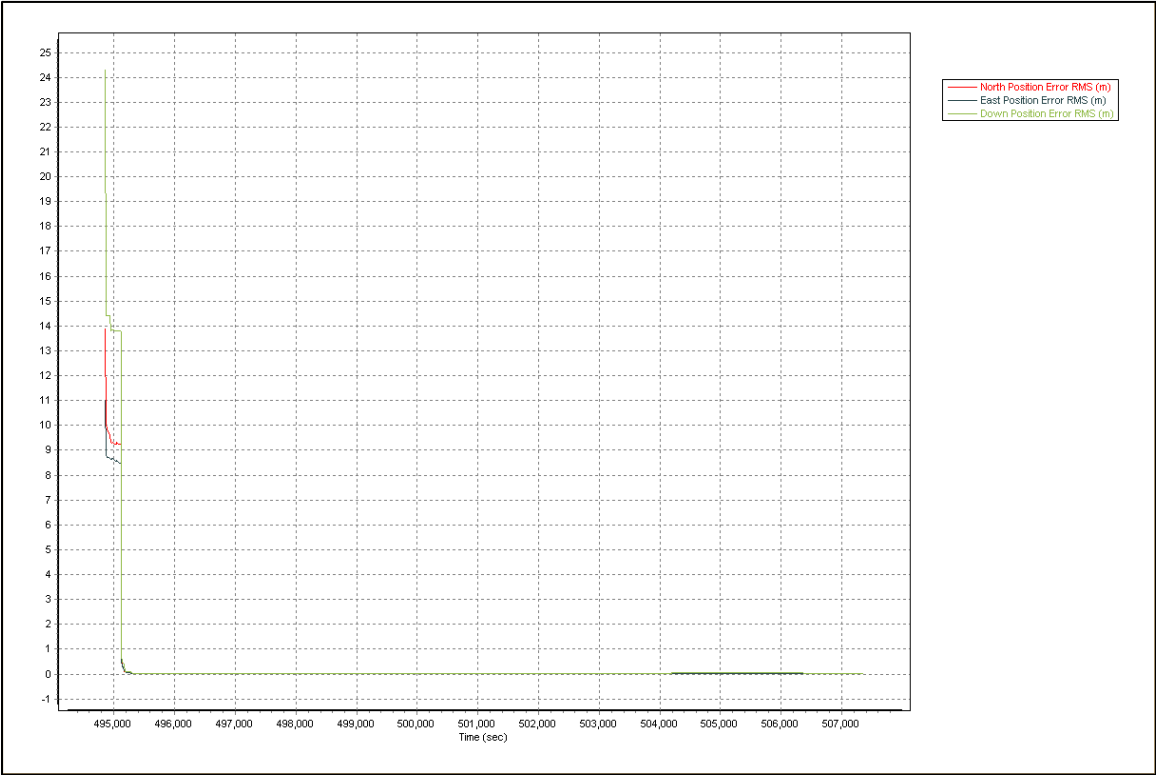
# 101210B-246-NEDPOSITIONERROR-SMOTHED



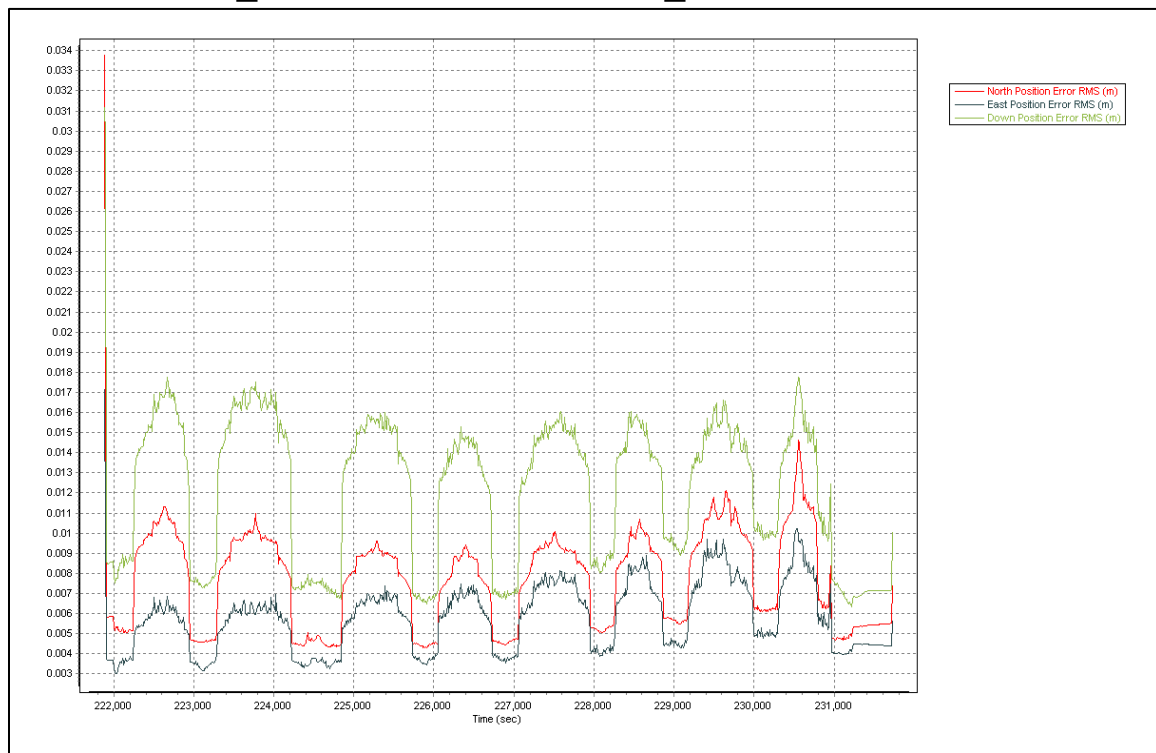
# 101210B-246-BASELINELENGTH



101210B-246-NEDPOSITIONERROR--FORWARD

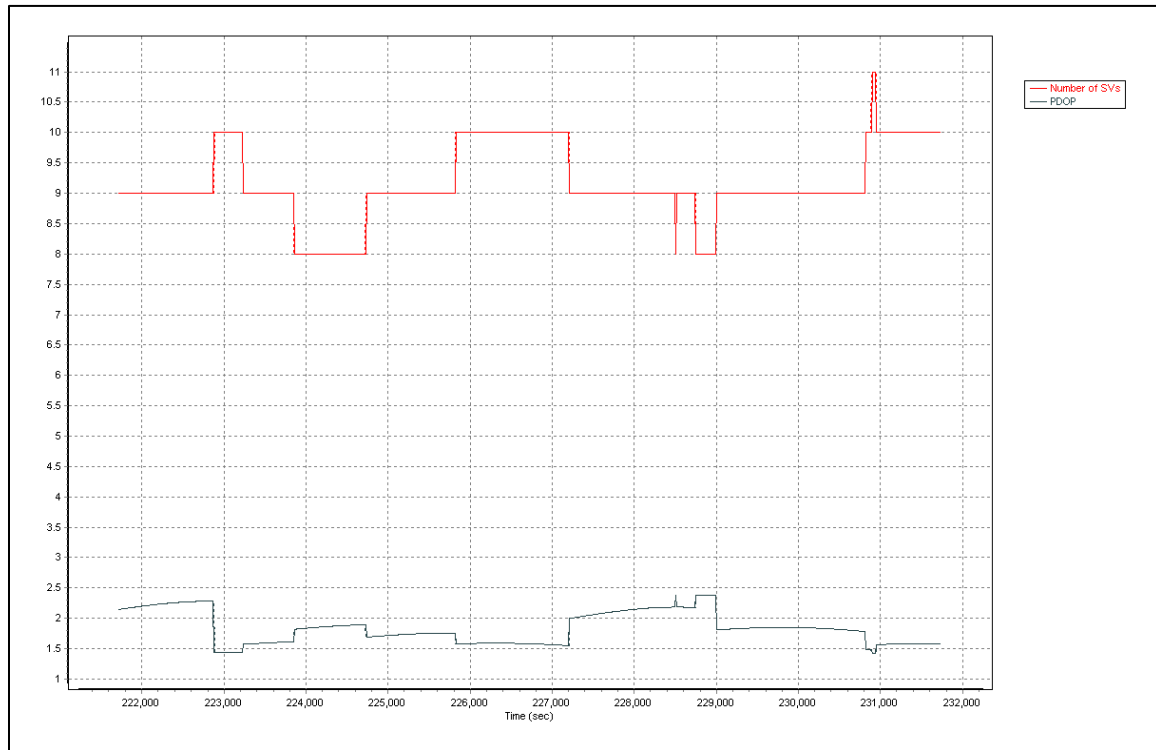


# 101207A-247\_SMOOTHPERFMETRIC\_NED

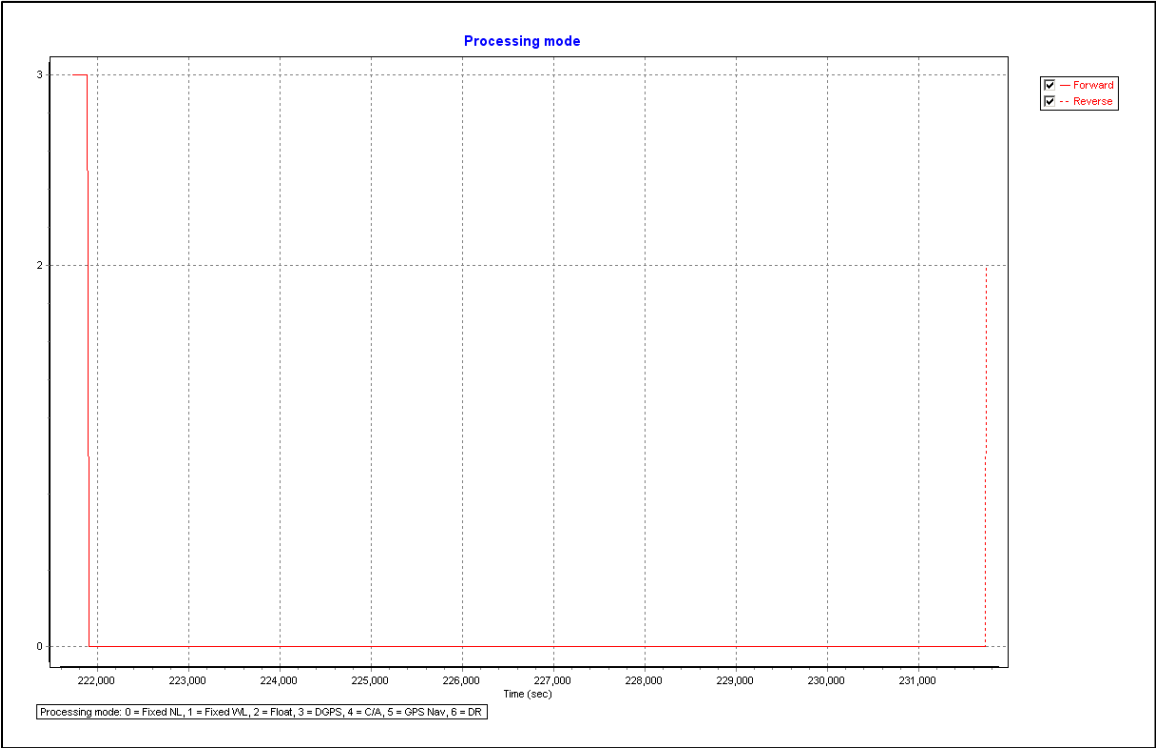




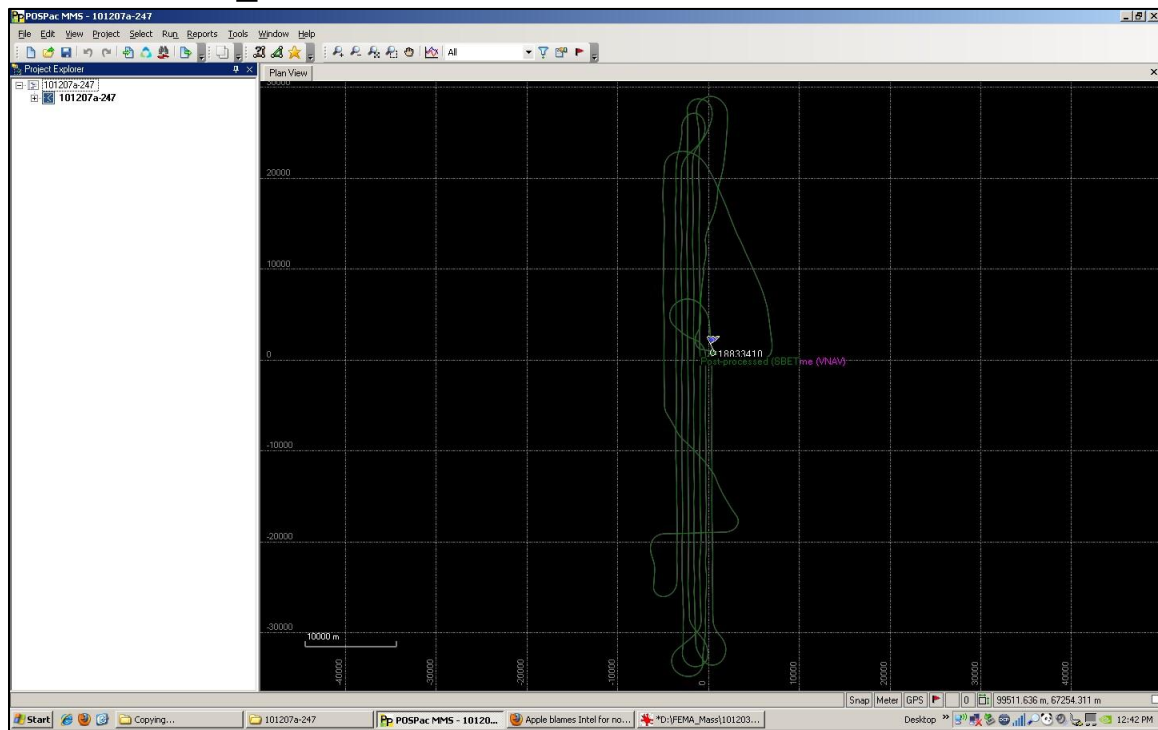
# 101207A-247\_SVS&PDOP



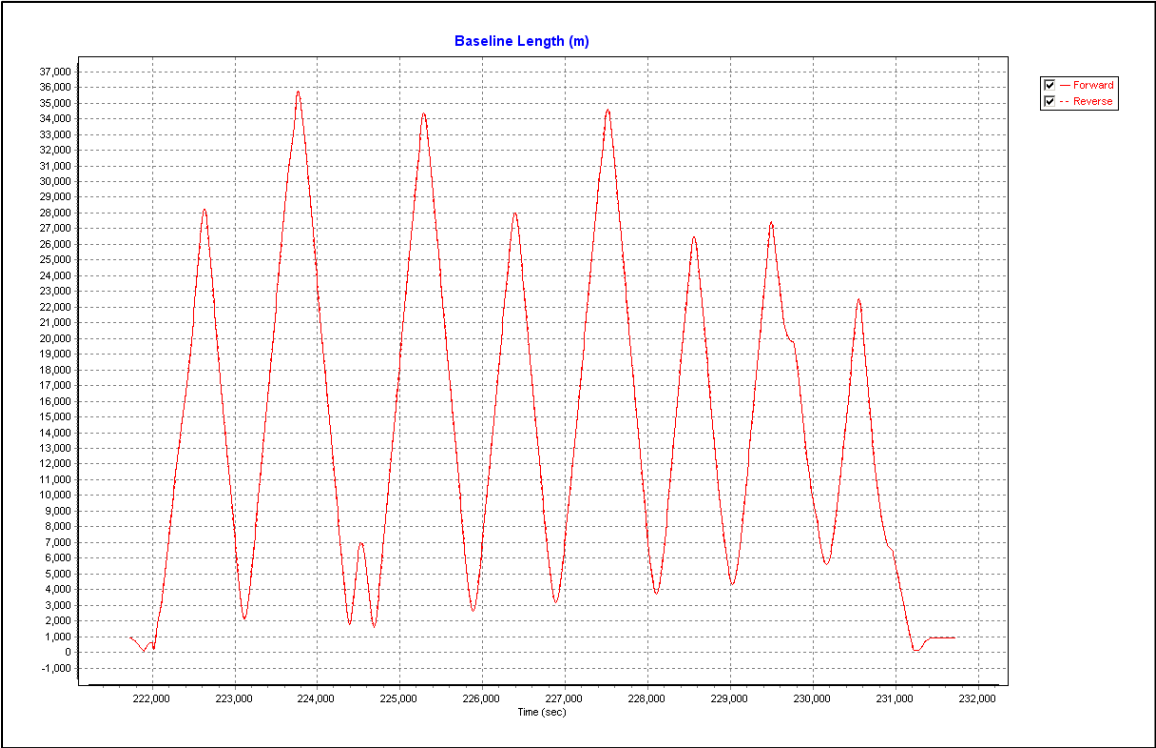
101207A-247\_PROCESSMODE



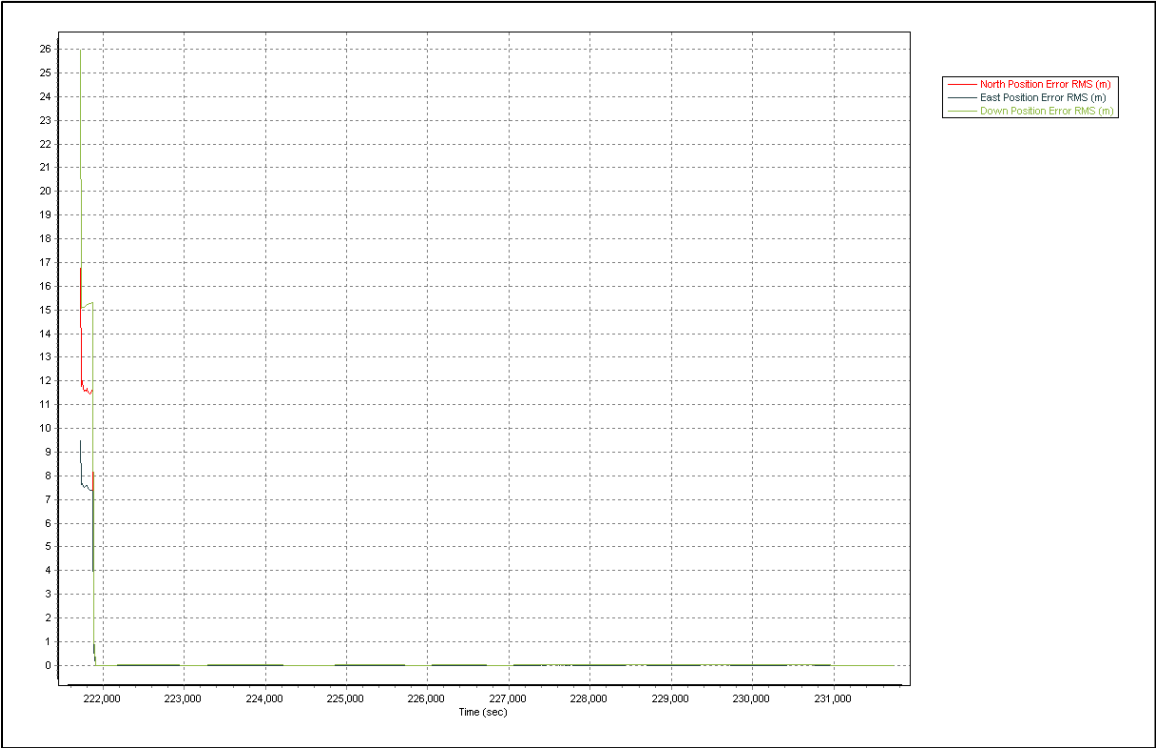
# 101207A-247\_SCREENSHOT



101207A-247\_BASELINE

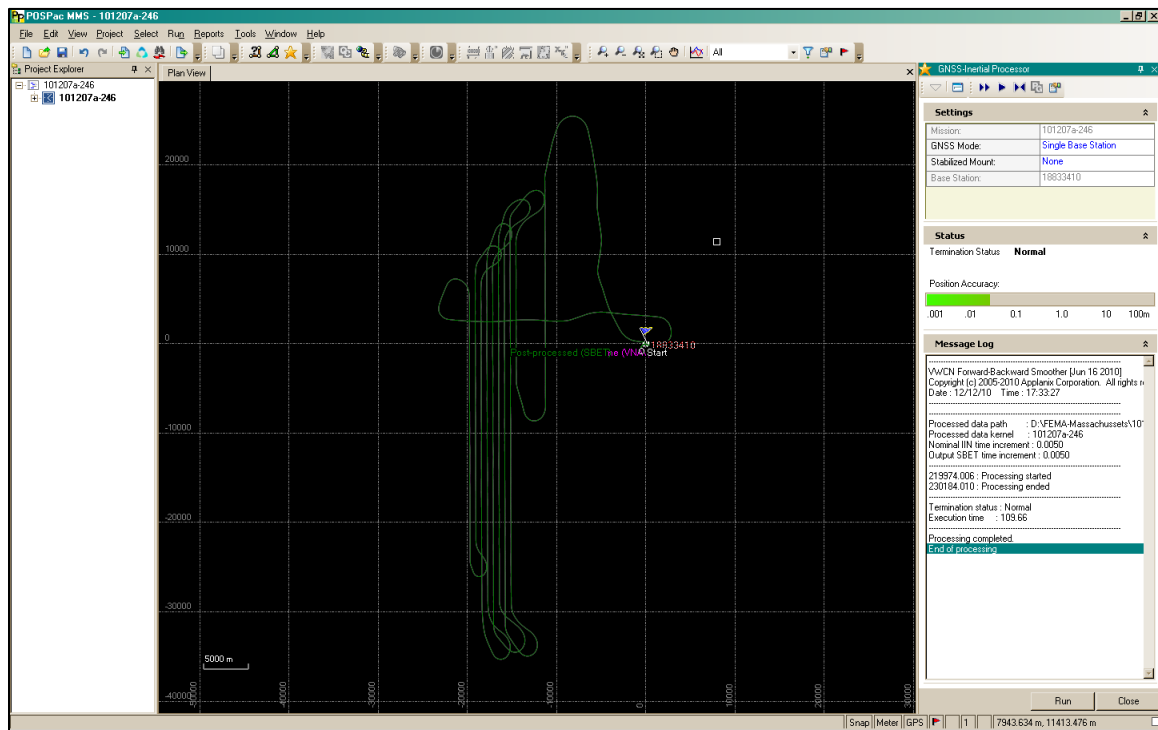


101207A-247\_FORWARDPROCPERFMETRIC\_NED

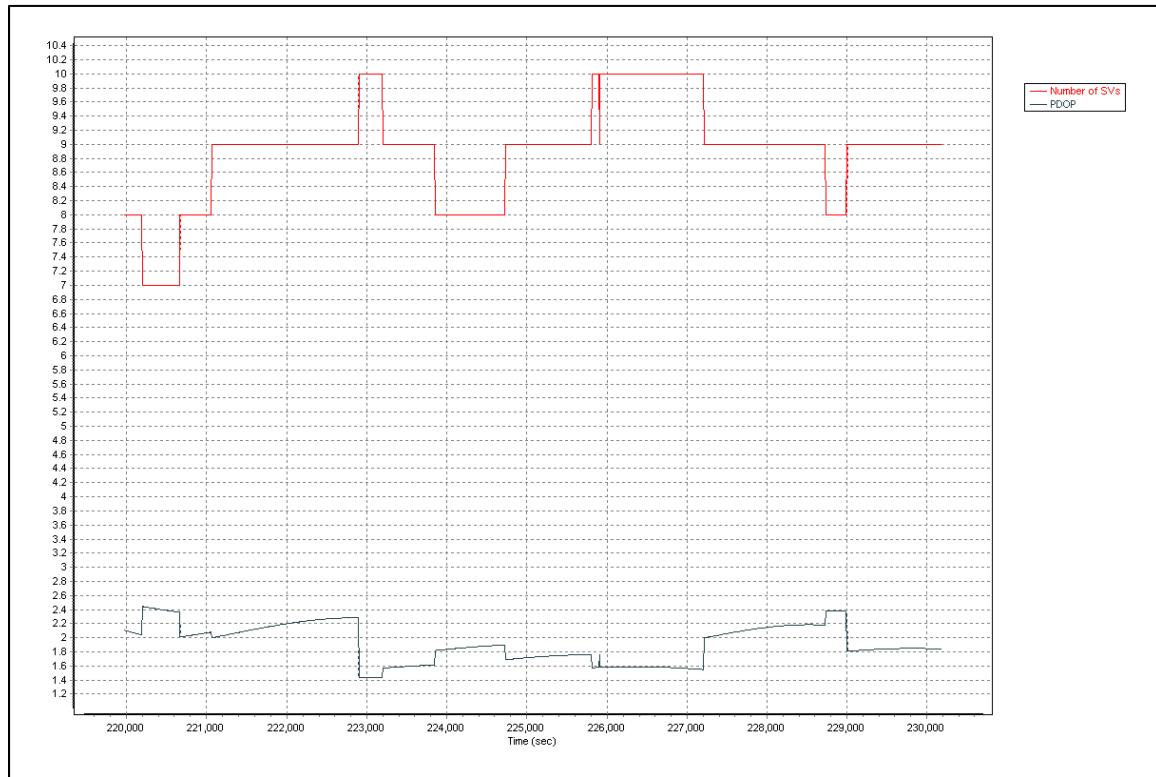




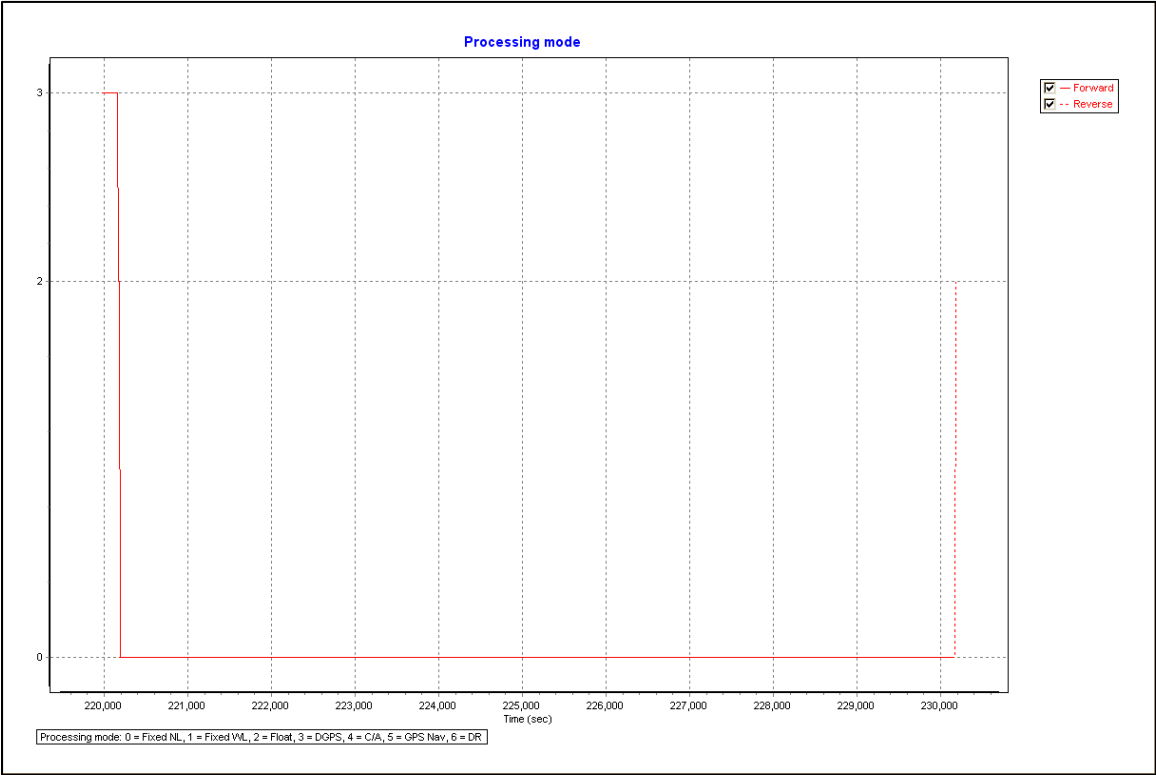
# 101207A-246-TRAJECTORY



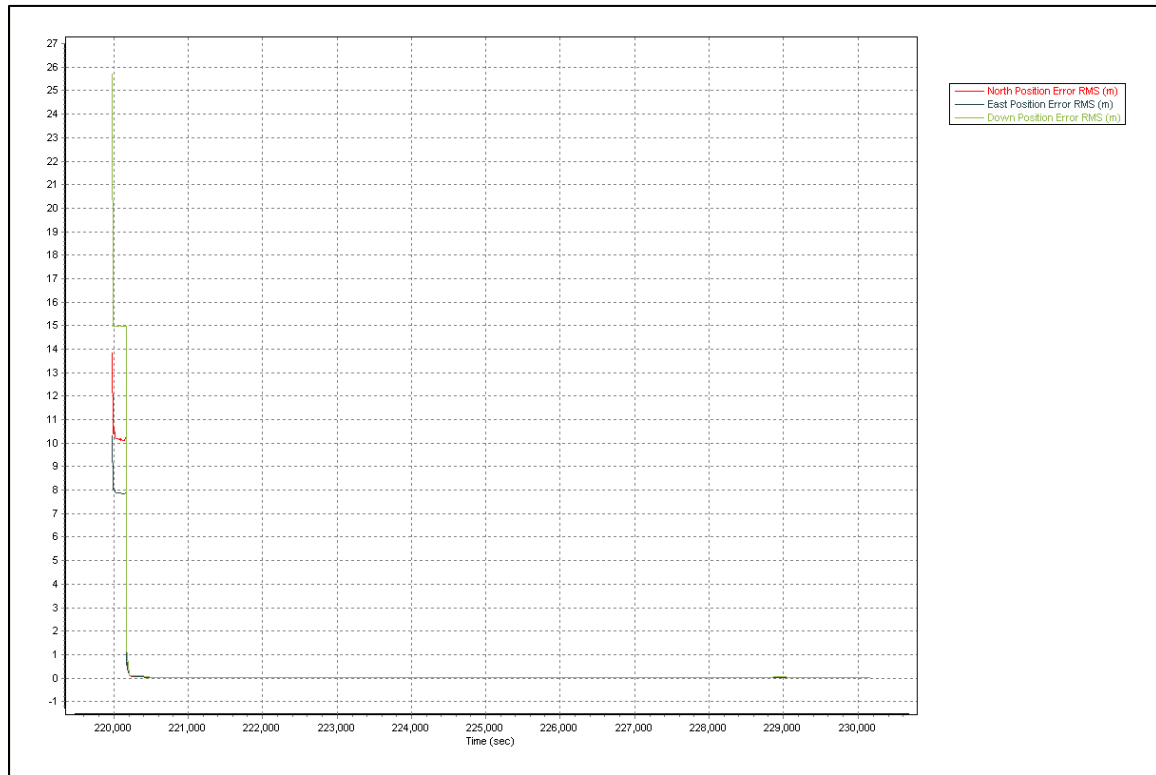
# 101207A-246-PDOP&SVS



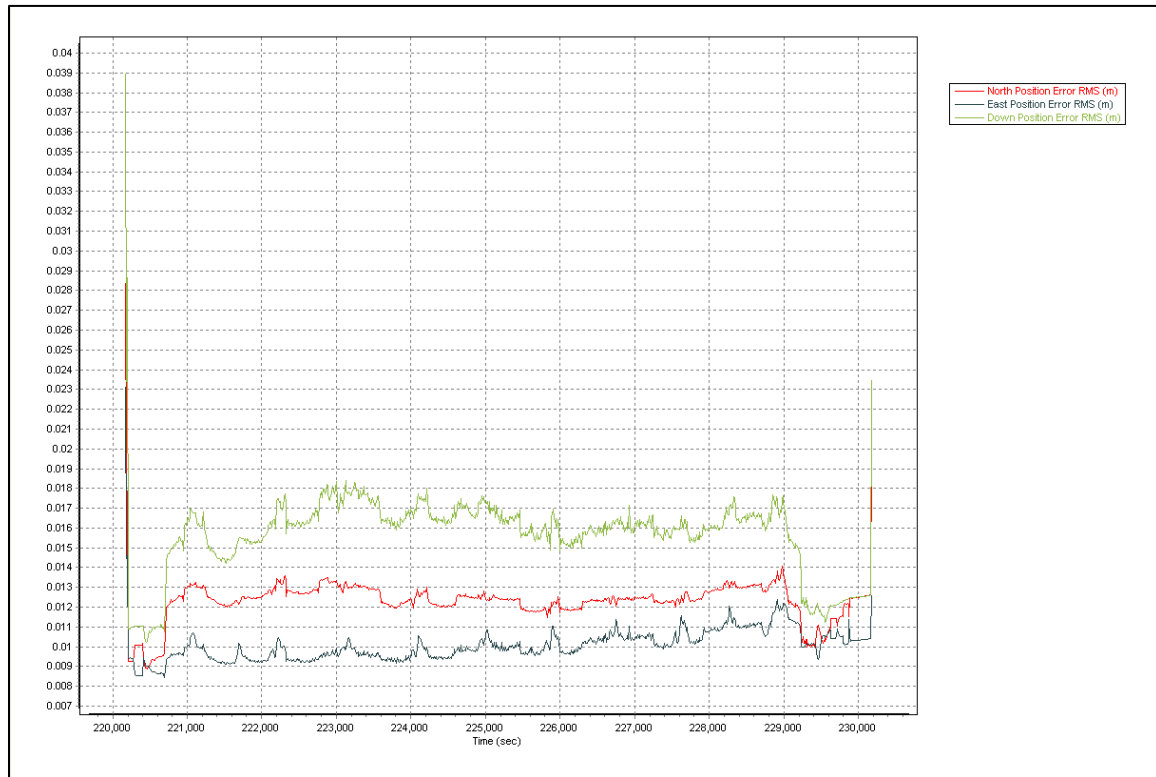
101207A-246-PROCMODE



# 101207A-246-NEDPOSITIONERROR-FORWARD

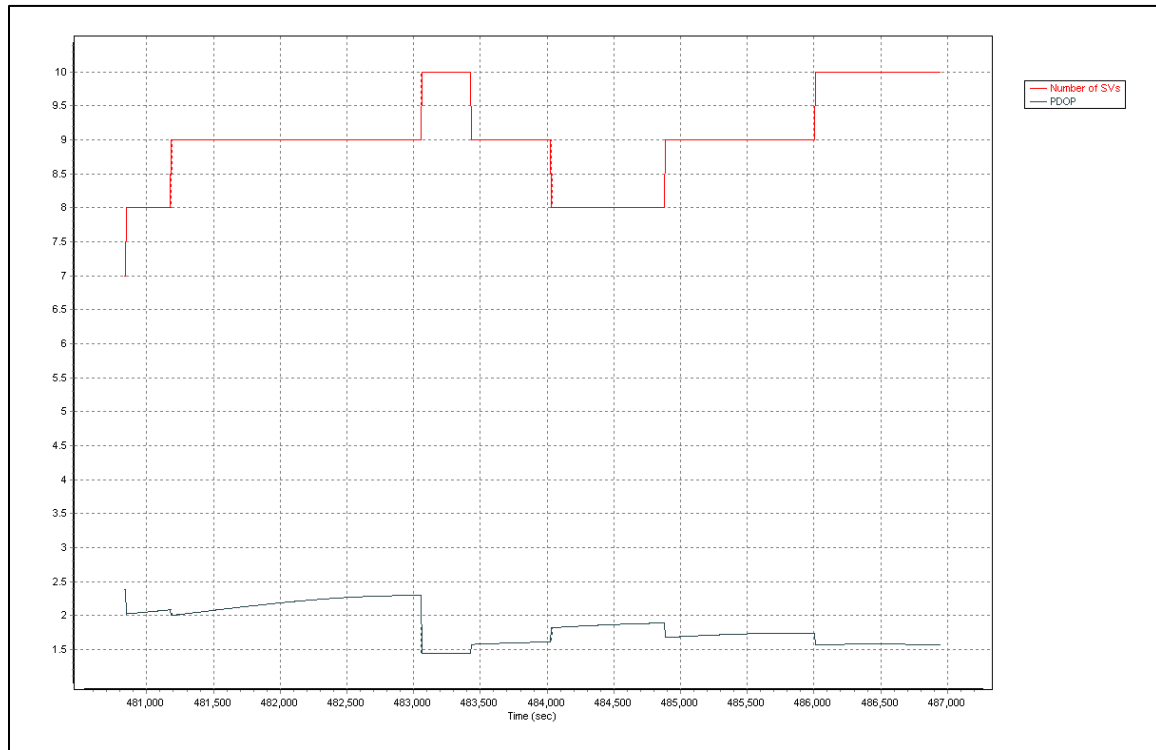


# 101207A-246-NEDPOSITIONERROR-SMOOTHED

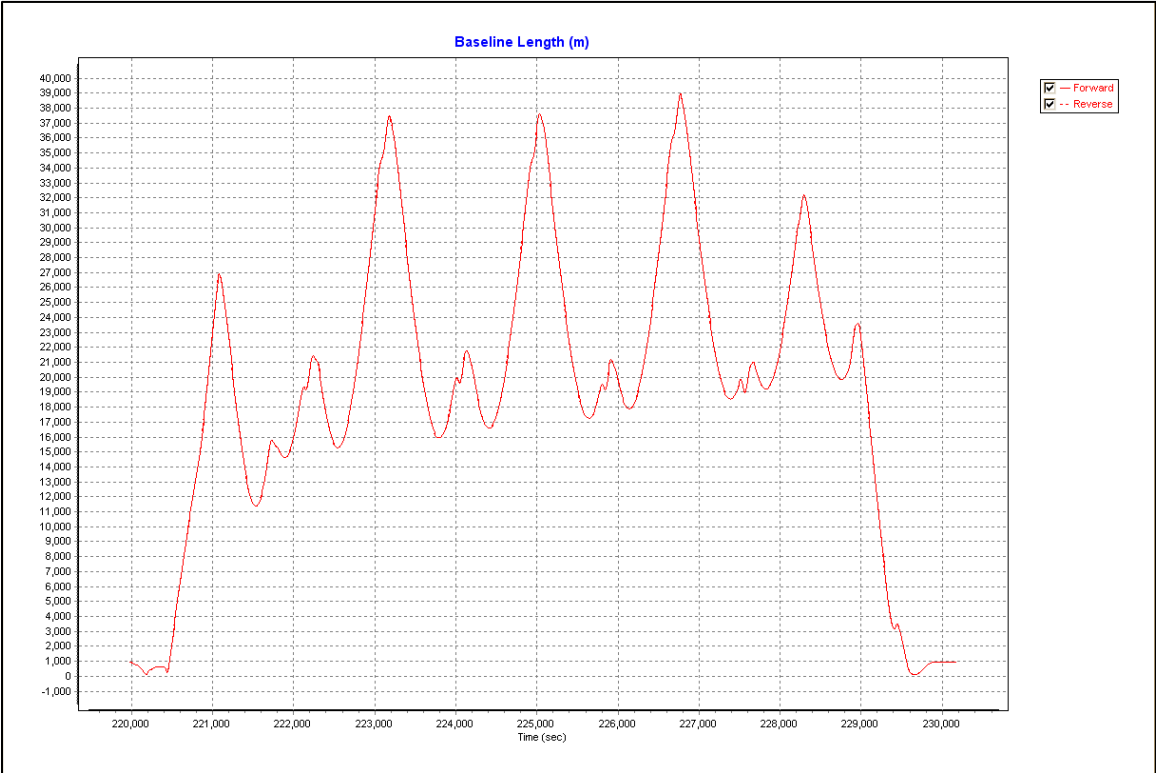




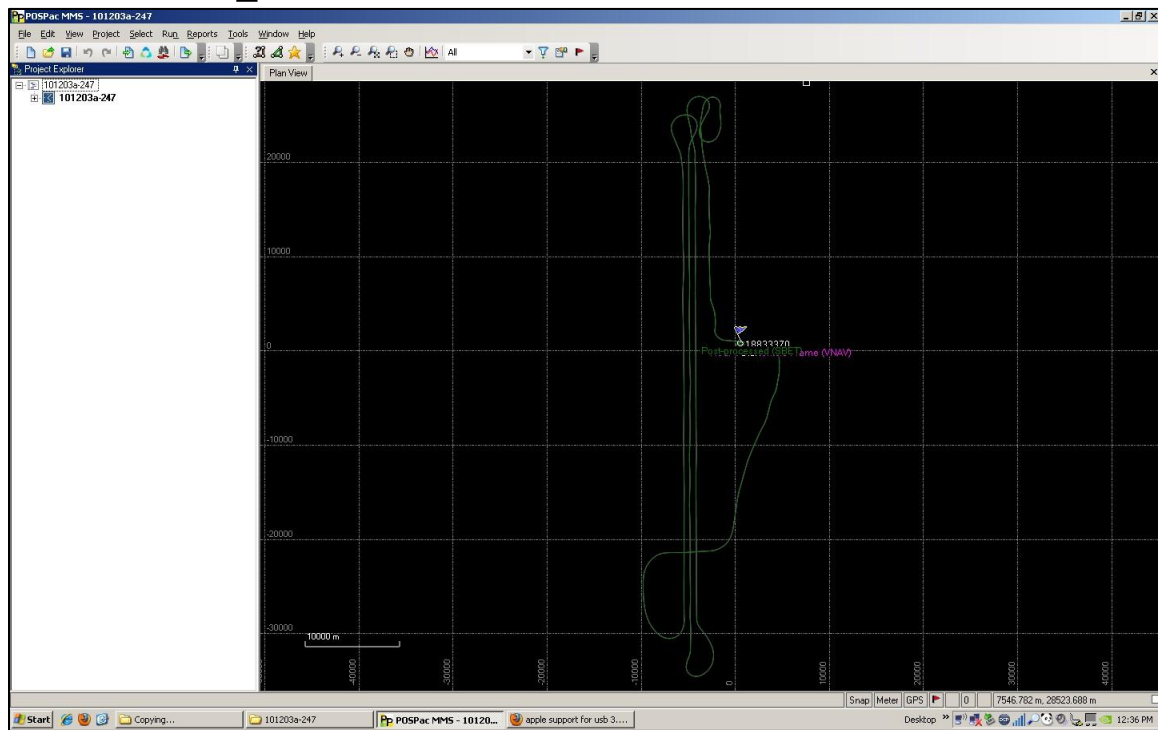
# 101203A-247\_SVS&PDOP



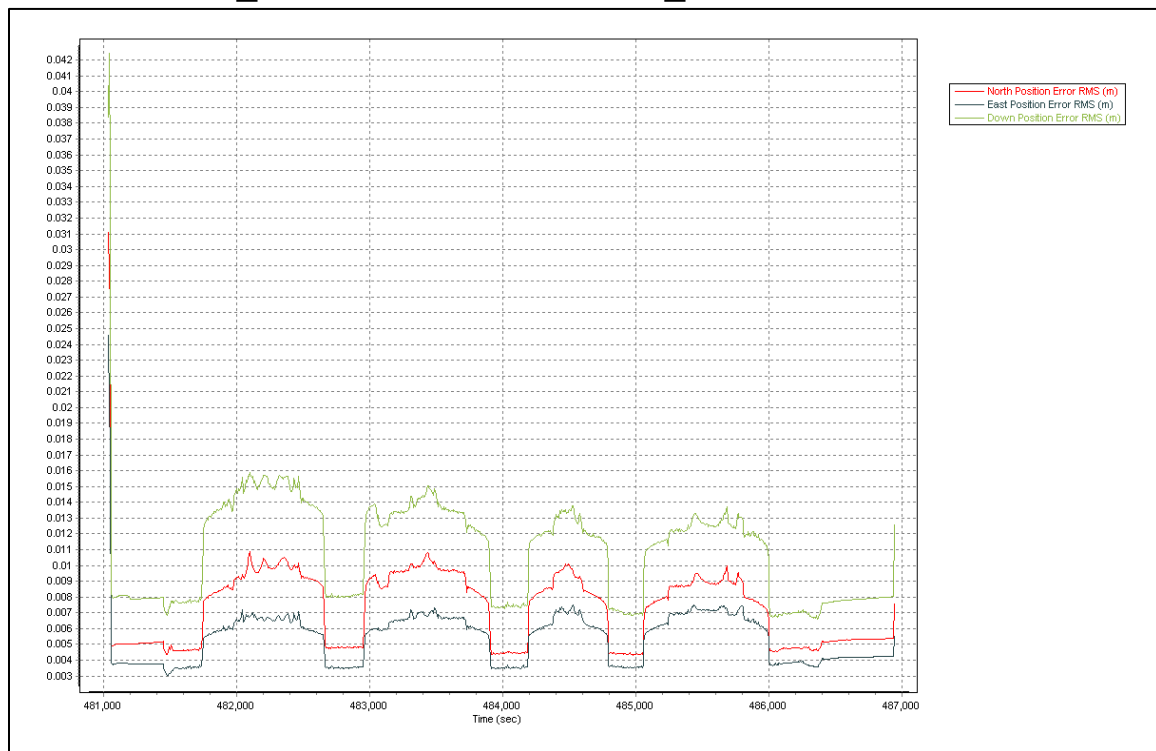
101207A-246-BASELINELENGTH



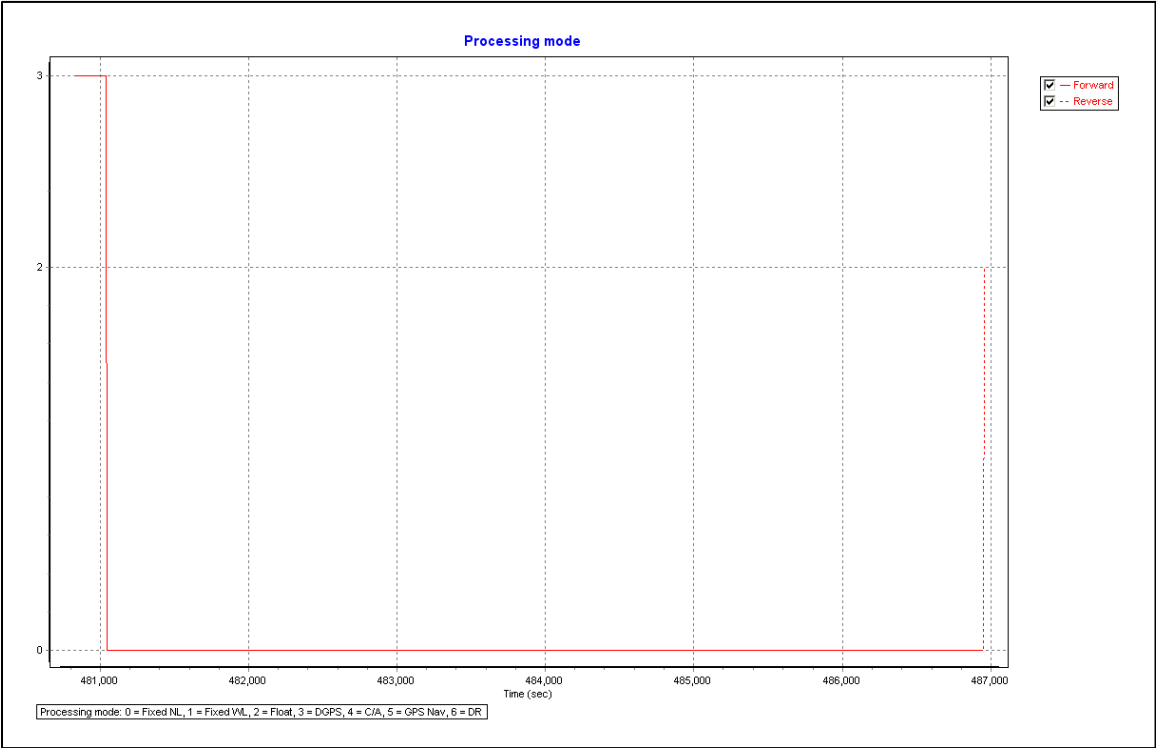
# 101203A-247\_SCREENSHOT



# 101203A-247\_SMOOTHPERFMETRIC\_NED



101203A-247\_PROCESSMODE





March 29, 2011

Post Flight Report  
PSI Project 7556-005  
ORH Charles, MA LiDAR

CONTRACT: \_\_\_\_\_

Client: \_\_\_\_\_

Project Name: ORH Charles Sub Area

Attached Reference file: 7556-005\_ORH-Charles\_MA\_Background.ZIP

General Specifications: 1-meter nominal spacing LiDAR Acquisition and processing with a 24.5 cm vertical accuracy at 95% confidence level.

Acquisition Dates: LiDAR data for the ORH-Charles data was acquired on the dates of 12/11/2010 over 3 lifts by two different Aircraft.

Equipment Used: The data was collected with Optech Gemini LiDAR systems, Serial Numbers 246 and 247, Base GPS Receiver used was a Trimble 5700 collecting data at half second intervals. The aircraft used were Cessna 206 models, tail numbers N2448G and N7266Z. The pilots were Mark Young and Nick Greenwell and the Operators were Jeremy Berry and Nathan Galieti. The Base Station was set on the monument "ORH A, AI5600" at the Worcester Municipal Airport (ORH) set by the crews.

Project: The project consisted of 61 flight lines of 456.00 miles. The project was flown at an altitude of 5,000 feet above ground and at a planned average speed of 116 knots with a field of view of 36 degrees. The scan rates used was 30.1 Hz with a Laser Pulse Rate of 71,429 Hz with Multi-Pulse enabled. The full swath width was 989.18 meters with a planned sidelap of 30%. The point spacing was <1 meter with a NADIR point density of 1.2 points per square meter and an average point density of 3.03 points per square meter. The planned vertical accuracy was 0.13 meters.

GPS Base Station / Monument: The Base Station was set on the monument "ORH A, AI5600" at the Worcester Municipal Airport (ORH) set by the crews. Information on this monument is included in the attached .ZIP file under "Base Station Data".

Control: Control points were collected as part of the project and used to calibrate the project data, remove any bias and verify accuracy. This data is compared to the collected model and results indicated below. This control data is included in the attached .ZIP file under "Control".

Flight Files: The planned flight files are included as reference in the attached .ZIP file under “Flight Files”.

Flight Logs: Flight Logs used by the crew are included in the attached .ZIP file under “Flight Logs” and include the following type information:

- job #/name
- block or AOI
- date (s) flown
- aircraft tail #
- lines - #
- lines - direction
- lines – altitude
- lines – speed
- conditions
- comments
- pilot name
- operator name
- AGC switch
- GPS base station used

Processing Summary: Data is included in the attached .ZIP file under “Processing Summary” which includes GPS / IMU processing summary data including at a minimum:

- Processing Logs
- Message Logs
- Extract Logs
- Laser configuration files for each lift
- Max Horizontal GPS Variance (cm)
- Max Vertical GPS Variance (cm)
- Notes on GPS quality (High, Good, etc.)
- GPS separation plot
- GPS altitude plot
- PDOP plot
- Plot of GPS distance from base station/s

Project Coverage: within the attached .ZIP file in the “Project Coverage” directory is the overall boundary Shape File and the as flown trajectory Shape Files which include the project calibration flight lines (cross flights).

Accuracy: The LiDAR data was tested against the Control check points indicated above and the results are included in the “Accuracy Results” directory in the attached .ZIP file.

The LiDAR data as collected tested at 0.095 (meters) fundamental vertical accuracy at 95% confidence level. Within the accuracies indicated in the specifications, as provided.

Sincerely,

A handwritten signature in blue ink, appearing to read "Forrest Godby". The signature is fluid and cursive, with a large initial 'F' and a stylized 'G'.

Forrest Godby  
Senior Project Manager / Flight Operations Manager

## ORH Concord FEMA Base Station Monument

See file [dsdata.txt](#) for more information about the datasheet.

DATABASE = ,PROGRAM = datasheet, VERSION = 7.85  
1 National Geodetic Survey, Retrieval Date = OCTOBER 29, 2010  
AI5600 \*\*\*\*\*  
AI5600 PACS - This is a Primary Airport Control Station.  
AI5600 DESIGNATION - ORH A  
AI5600 PID - AI5600  
AI5600 STATE/COUNTY- MA/WORCESTER  
AI5600 USGS QUAD - WEBSTER (1979)  
AI5600  
AI5600 \*CURRENT SURVEY CONTROL  
AI5600  
AI5600\* NAD 83(2007)- 42 16 08.44724(N) 071 52 36.42870(W) ADJUSTED  
AI5600\* NAVD 88 - 309.46 (meters) 1015.3 (feet) GPS OBS  
AI5600  
AI5600 EPOCH DATE - 2002.00  
AI5600 X - 1,470,437.757 (meters) COMP  
AI5600 Y - -4,492,645.101 (meters) COMP  
AI5600 Z - 4,267,951.584 (meters) COMP  
AI5600 LAPLACE CORR- -2.78 (seconds) DEFLEC09  
AI5600 ELLIP HEIGHT- 280.922 (meters) (02/10/07) ADJUSTED  
AI5600 GEOID HEIGHT- -28.57 (meters) GEOID09  
AI5600  
AI5600 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----  
AI5600 Type PID Designation North East Ellip  
AI5600 -----  
AI5600 NETWORK AI5600 ORH A 0.92 0.80 2.04  
AI5600 -----  
AI5600  
AI5600.This mark is at Worcester Municipal Airport (ORH)  
AI5600  
AI5600.The horizontal coordinates were established by GPS observations  
AI5600.and adjusted by the National Geodetic Survey in February 2007.  
AI5600  
AI5600.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).  
AI5600.See [National Readjustment](#) for more information.  
AI5600.The horizontal coordinates are valid at the epoch date displayed above.  
AI5600.The epoch date for horizontal control is a decimal equivalence  
AI5600.of Year/Month/Day.  
AI5600  
AI5600.The orthometric height was determined by GPS observations and a  
AI5600.high-resolution geoid model.  
AI5600  
AI5600.GPS derived orthometric heights for airport stations designated as  
AI5600.PACS or SACS are published to 2 decimal places. This maintains  
AI5600.centimeter relative accuracy between the PACS and SACS. It does  
AI5600.not indicate centimeter accuracy relative to other marks which are  
AI5600.part of the NAVD 88 network.  
AI5600  
AI5600.[Photographs](#) are available for this station.  
AI5600  
AI5600.The X, Y, and Z were computed from the position and the ellipsoidal ht.  
AI5600

```

AI5600.The Laplace correction was computed from DEFLEC09 derived deflections.
AI5600
AI5600.The ellipsoidal height was determined by GPS observations
AI5600.and is referenced to NAD 83.
AI5600
AI5600.The geoid height was determined by GEOID09.
AI5600
AI5600;
AI5600;North East Units Scale Factor Converg.
AI5600;SPC MA M - 891,017.799 168,916.022 MT 0.99996526 -0 15 11.2
AI5600;SPC MA M - 2,923,280.90 554,185.32 sFT 0.99996526 -0 15 11.2
AI5600;UTM 19 - 4,683,653.096 262,747.901 MT 1.00029264 -1 56 09.1
AI5600
AI5600! - Elev Factor x Scale Factor = Combined Factor
AI5600!SPC MA M - 0.99995594 x 0.99996526 = 0.99992120
AI5600!UTM 19 - 0.99995594 x 1.00029264 = 1.00024857
AI5600
AI5600 SUPERSEDED SURVEY CONTROL
AI5600
AI5600 ELLIP H (06/04/02) 280.920 (m) GP( ) 4 1
AI5600 NAD 83(1996)- 42 16 08.44728(N) 071 52 36.42911(W) AD( ) B
AI5600 ELLIP H (05/22/00) 280.927 (m) GP( ) 4 1
AI5600
AI5600.Superseded values are not recommended for survey control.
AI5600.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AI5600.See file dsdata.txt to determine how the superseded data were derived.
AI5600
AI5600_U.S. NATIONAL GRID SPATIAL ADDRESS: 19TBG6274783653(NAD 83)
AI5600_MARKER: DH = HORIZONTAL CONTROL DISK
AI5600_SETTING: 66 = SET IN ROCK OUTCROP
AI5600_STAMPING: ORH A 1999
AI5600_MARK LOGO: NOS
AI5600_MAGNETIC: N = NO MAGNETIC MATERIAL
AI5600_STABILITY: A = MOST RELIABLE AND EXPECTED TO HOLD
AI5600+STABILITY: POSITION/ELEVATION WELL
AI5600_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
AI5600+SATELLITE: SATELLITE OBSERVATIONS - 1999
AI5600
AI5600 HISTORY - Date Condition Report By
AI5600 HISTORY - 1999 MONUMENTED WOOLPT
AI5600
AI5600 STATION DESCRIPTION
AI5600
AI5600'DESCRIBED BY WOOLPERT CONSULTANTS 1999 (ARL)
AI5600'THE STATION IS LOCATED APPROXIMATELY 9.0 KM (5.60 MI) SOUTH OF HOLDEN,
AI5600'4.7 KM (2.90 MI) WEST-SOUTHWEST OF WORCESTER, 3.6 KM (2.25 MI)
AI5600'NORTHWEST OF LEICESTER, AT THE WORCESTER MUNICIPAL AIRPORT.
AI5600'OWNERSHIP-- WORCESTER MUNICIPAL AIRPORT, C/O ERIC WALDRON AIRPORT
AI5600'MANAGER, WORCESTER MUNICIPAL AIRPORT, 375 AIRPORT DRIVE, WORCESTER MA
AI5600'01602, PHONE NUMBER 508-799.1350, FAX NUMBER 508-799-1866. THIS
AI5600'STATION REQUIRES 24 HOUR NOTICE TO AIRPORT CONTACT FOR ACCESS.
AI5600'TO REACH THE STATION FROM THE JUNCTION OF STATE ROUTES 122 AND 9 GO
AI5600'WESTERLY APPROXIMATELY 2.0 MI (3.2 KM) TO AIRPORT DRIVE ON THE LEFT,
AI5600'TURN LEFT ON AIRPORT DRIVE AND GO APPROXIMATELY 0.9 MI (1.4 KM) TO THE
AI5600'CONTINUATION OF AIRPORT DRIVE ON THE RIGHT, TURN RIGHT TO STAY ON
AI5600'AIRPORT DRIVE AND GO APPROXIMATELY 0.5 MI (0.8 KM) TO THE AIRPORT ON
AI5600'THE LEFT. THE STATION IS LOCATED AT THE TOP OF THE ROCK OUTCROP AND
AI5600'VIRTUALLY AT THE TOP OF THE HILL.

```



AI5600'THE STATION IS A STANDARD NOS DISK STAMPED--ORH A 1999-- DRIVEN INTO  
AI5600'AN EXPOSED PORTION OF A ROCK OUTCROP. THE STATION IS LOCATED 119 M  
AI5600'(390.4 FT) FROM THE EDGE OF PAVEMENT OF TAXIWAY D ON AN AZIMUTH OF 350  
AI5600'DEGREES, 2.04 M (6.69 FT) FROM A BRONZE DISK STAMPED-- V 8-- ON AN  
AI5600'AZIMUTH OF 115 DEGREES. THIS STATION IS DESIGNATED AS THE PRIMARY  
AI5600'AIRPORT CONTROL STATION.

\*\*\* retrieval complete.

Elapsed Time = 00:00:00



Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
© 2011 Google  
© 2011 Europa Technologies

© 2008 Google

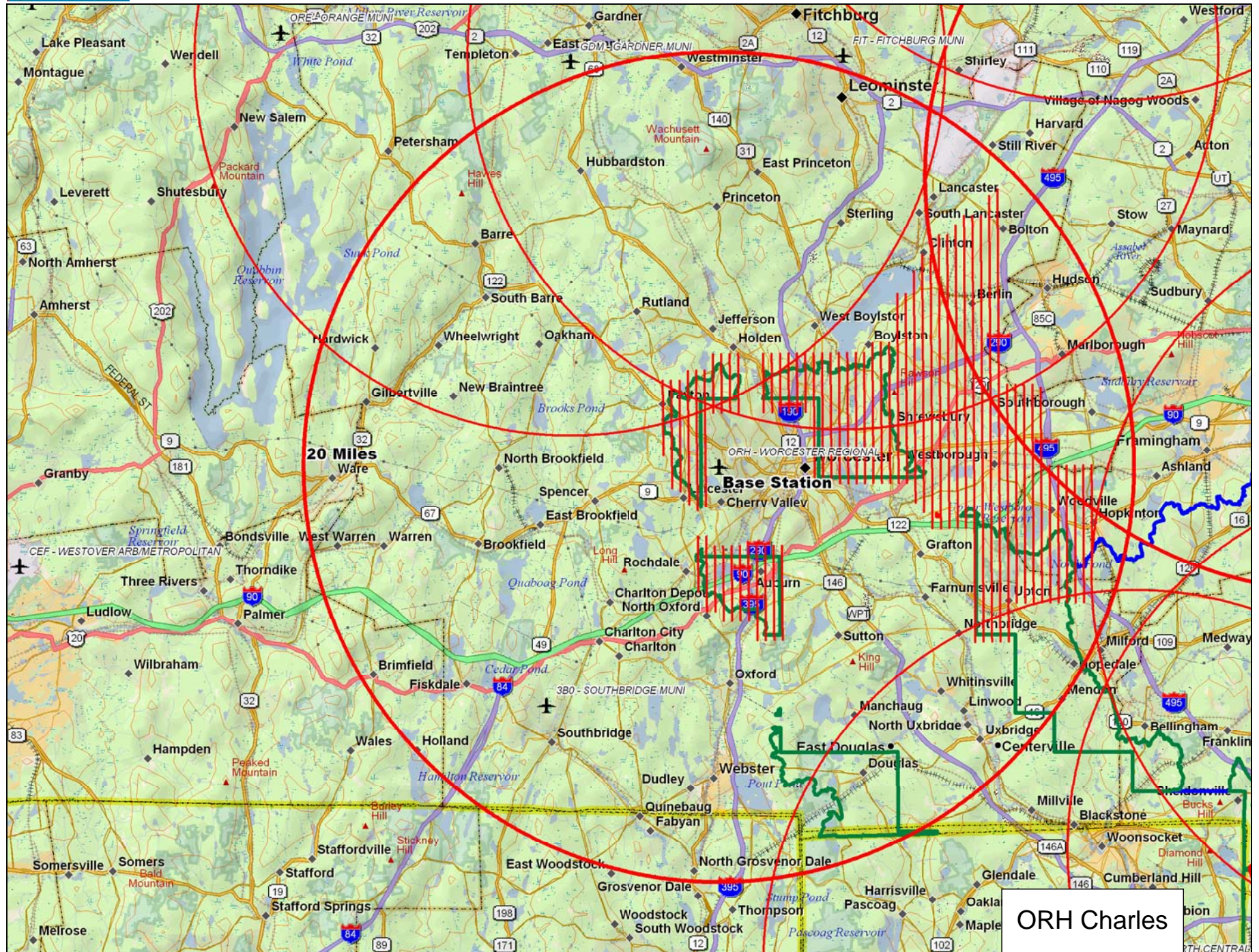
42°16'08.53" N 71°52'38.54" W

elev 1013 ft

Sep 21, 2010

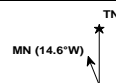
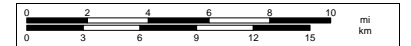
Eye alt 11262 ft



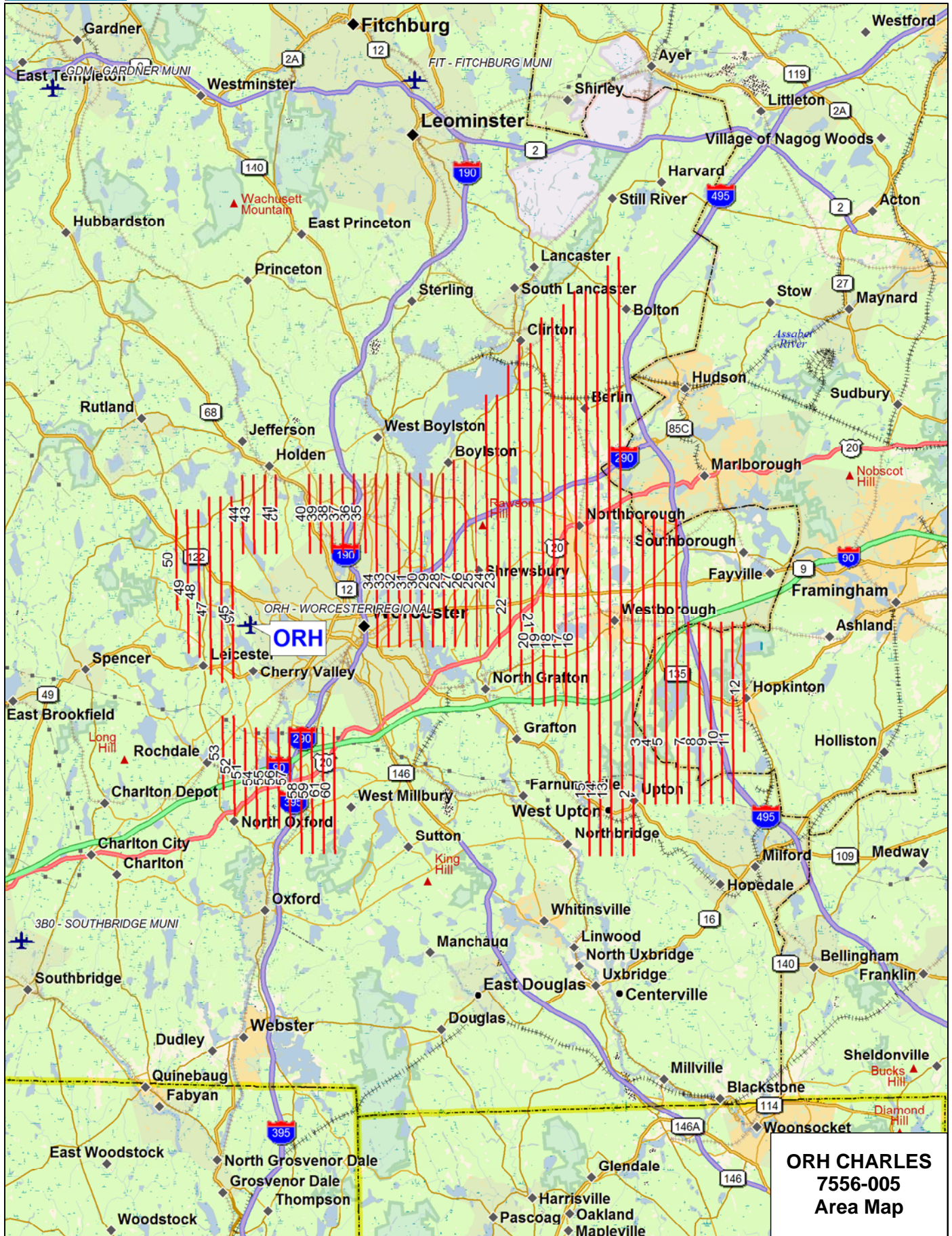


ORH Charles

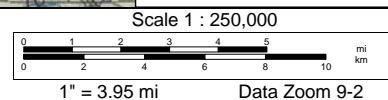
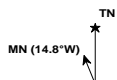
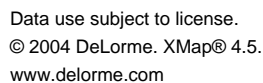
Scale 1 : 400,000



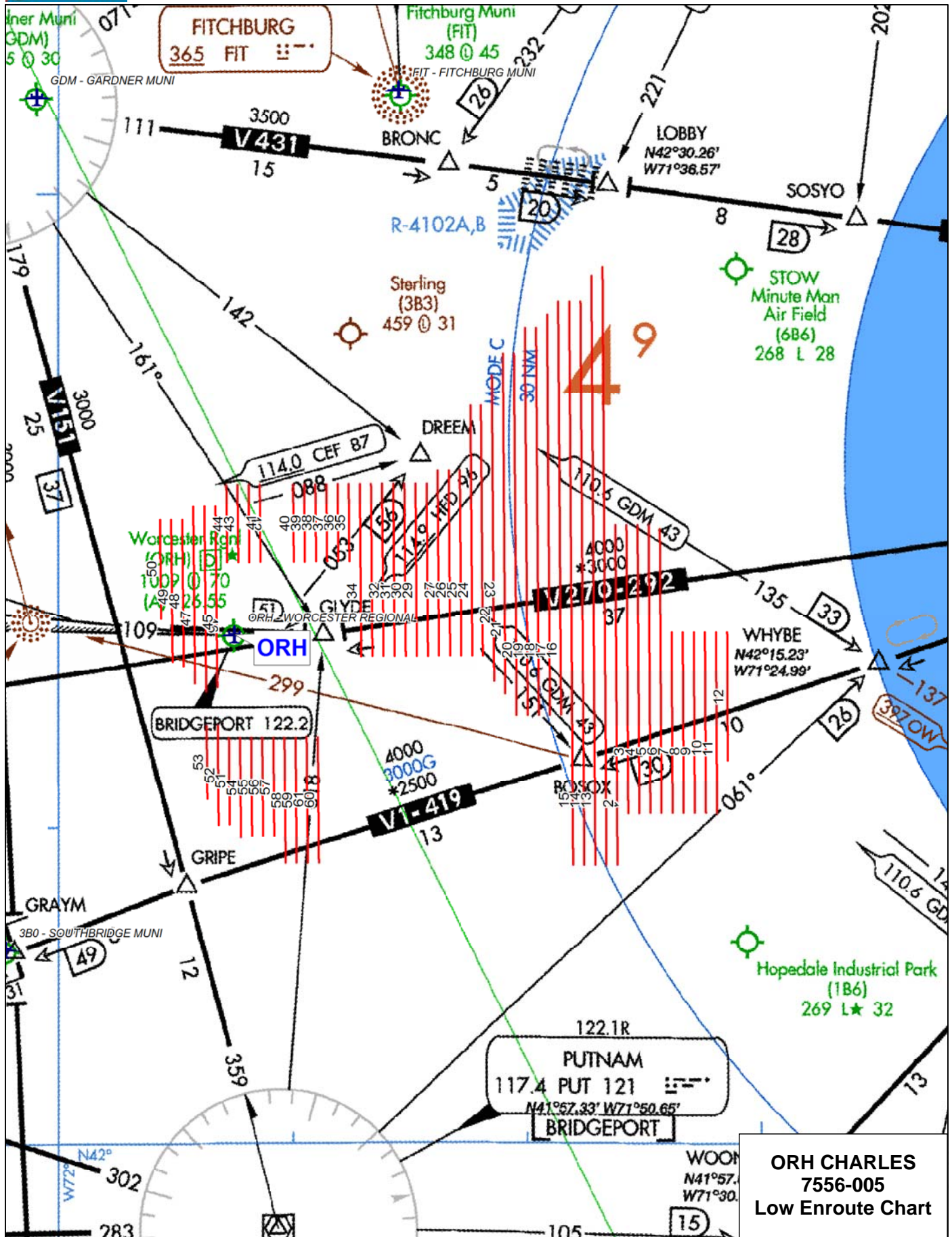












STATE(s): MASSACHUSETTS

Project 7556-005  
Numbers 1004

AREA ID: ORH-CHARLES

AREA NAME: CHARLES / BLACKSTONE / CONCORD

FILE TYPES/NAMES: ☒ OPTECH: ORH-CHARLES ☒ LEICA: ORH-CHARLES

Lines: 61 FL Miles: 455 Square Miles: \_\_\_\_\_ Flight Altitudes: 5000' Tide Coord: ☐ Yes ☒ See Notes ☒ NO

AIRPORT ID: ORH Name: WORCESTER REGIONAL

Services: FULL ☒ Self ☒ None ☐ See Notes RUNWAY Length: 7000 Ft

Contact Name(s): Andrew Davis / Murphy

Phone(s): (508) 799-1350 (\_\_\_\_) \_\_\_\_ - \_\_\_\_ e-mail: \_\_\_\_\_

Hotels: All major

Rentals: All major

EXIST BASE Station: A15600 Name: ORH A

TYPE: PACS ☒ SACS ☐ Other ☐ Data Sheet Attached ☒

SET BASE STATION Name: \_\_\_\_\_ Date Set: \_\_\_\_\_

What was Set: Re-Bar ☐ or: \_\_\_\_\_ CAP: \_\_\_\_\_

Who Set: \_\_\_\_\_ Where Set: \_\_\_\_\_ Attach Data Sheet

Logs ☒ Sectional ☐ Lo En-route ☒ Database ☒ OPTECH ☒ LEICA ☒  
by: LR by: LR by: LR by: LR by: LR by: LR

Accuracy: Vert; 24.5 Horiz; \_\_\_\_\_ cm Post Spacing: 1 Points Sq Meter: \_\_\_\_\_

NOTES: TOWNSHIP AIRPORT  
LOU AHEAD FOR PERMISSION TO SET  
BASE STATION

ORH

## Station Occupation Report For Airborne GPS

Project:

FEMA - MASS

Location:

KIORH (Worcester, MA)

Completed by:

Berry/Young

Project Number: 7556-005

Date: December 11, 2010

Receiver:

Trimble "4"

Receiver Type:

5700

Antenna Type:

Zephyr Geodetic

Station ID:

~~ORHA~~ Marked "V8"

Start -- H.I. (m):

1.491 1.491

End -- H.I. (m):

1.491

H.I. (ft):

4.89 4.89

Start Time:

1000 AM

End Time:

4:12 PM

Time Zone:

EST

Operator:

Berry/Young

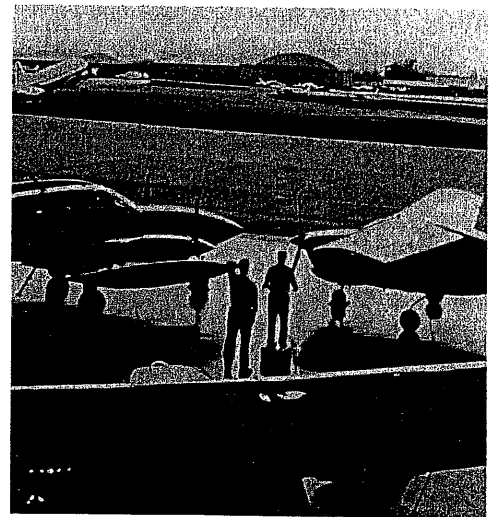
Comments

1012116-246

1012116-247

Reference Mark near ORHA called V8  
was setup on!

Opus height: 1.437 for OPUS Submission





# LIDAR MISSION RECORD SHEET - Optech

## PHOTO SCIENCE

2670 Wilshire Drive • Lexington KY • 40503 • 859.277.8700 • www.photoscience.com

Project Name: **Fernat Mass**  
 Project Number: **7556-005**  
 Assignment: **ORH, Charles, pla**

Pilot: **Young**  
 Operator: **Berry**  
 Aircraft: **N7266Z**

Date Flown: **December 11, 2016**  
 Takeoff Time (Z): **1508Z** Local: **1028 AM EST** Airport: **ORH**  
 Landing Time (Z): **1946Z** Local: **140 PM EST** Airport: **ORH**

Project Scanning Requirements  
 FOV (half-degrees): **± 18°** Altitude AGL (ft): **5000**  
 Scan Rate: **3012Hz** (MPIA) or SPIA  
 Pulse Rate: **71 KHz** Fixed or (Auto)  
 Ground Speed: **116 kts** Samples / 1000 Range: **320**  
 A.R.F.: **Range**

Data Information  
 LIDAR Unit: **Optech Gemini sn246**  
 HD #: **246401**  
 POS File Name: **101211a**  
 from, to: **000 - 026**

Begin Temp	0°C	Ground	Altport
Begin Dewpoint	-4°C		
Begin Pressure	30.21		
End Temp	04°C		
End Dewpoint	-03°C		
End Pressure	30.18		ORH

GPS Base Location(s): **V8 OKH A**  
 PDOP Avoidance: **Good all day**  
 Static or Flyover? **Static** → if flyovers, times: **-**

101211a-246  
 1/2

Flight Line Name#	Start Time	End Time	Alt. (AMSL)	Heading	Speed	Returns	Crab	NOTES (weather, visibility, winds, tide, etc.)
38	1540	1542	5750'	S	116	100%	13	Smooth, some snow on ground; just a dusting
100	1544	1546	5630'	S	116	100%	13	
101	1550	1552	5630'	N	116	100%	-13	
39	1555	1556	5750'	N	116	100%	-14	
40	1600	1602	5750'	S	116	100%	12	
39	1605	1607	5600'	S	116	100%	12	
58	1611	1614	5600'	N	116	100%	-14	
57	1617	1619	5630'	S	116	100%	11	
36	1622	1624	5670'	N	116	100%	-13	
41	1626	1628	5870'	N	116	100%	-14	
42	1631	1632	5910'	S	116	100%	12	
55	1635	1637	5880'	S	116	100%	12	
54	1640	1642	5700'	N	116	100%	-13	
43	1645	1646	5910'	N	116	100%	-14	
44	1650	1651	5850'	S	116	100%	12	
51	1654	1655	5700'	S	116	100%	14	
52	1659	1700	5730'	N	116	100%	-13	
45	1701	1704	6000'	N	116	100%	-16	
46	1707	1710	6050'	S	116	100%	13	
53	1710	1712	5770'	S	116	100%	13	



# LIDAR MISSION RECORD SHEET – Optech

Project Name	Fennel Mass
Project Number	7586-005
Alt-MNAV-001-File	0824-Charles ph

Project Scanning Requirements	
FOV (half-degrees):	$\pm 18^\circ$
Scan Rate:	5000 Hz
Pulse Rate:	7 kHz
Ground Speed:	116 kts
Altitude AGL (ft): 5000	
MIPPA or SPIA	
Fixed or Auto	
A.R.F.:	Samples 1000
Range	300

**PHOTO SCIENCE**  
Geospatial Solutions

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Pilot	<i>Yunker</i>
Operator	<i>BERRY</i>
Aircraft	N7266Z
Data Information	
LIDAR Unit	Optech Gemini s1246
HD #	346 HD 1
POS File Name	101119
from, to	000 → 036

Date From:	December 11, 2010		
Takeoff Time (Z):	0832	Local:	0838 AM EST
Landing Time (Z):	0840Z	Local:	140 PM EST
		Airport	ORH

	Ground	Altport
Begin Temp	0°C	OK H
Begin Dewpoint	-4°C	
Begin Pressure	30.01	
End Temp	4	OK H
End Dewpoint	-3	
End Pressure	30.16	

GPS Base Location(s)	V3 ORHA	
PDOP Avoidance	Good all day	
Static or Flyover?	Static	-> If flyovers, times: ...

Station Name	Start Time	End Time	Alt. (AMSL)	Heading	Speed	Returns	Crab	NOTES (weather, visibility, winds, tide, etc.)
47	1715	1719	10050	N	116	100%	-12	
48	1722	1724	40005	S	116	100%	13	
49	1727	1730	60710	N	116	100%	-13	
50	1733	1735	6130	S	116	100%	12	
Imperial	1735	1741	5900	E	116	100%	-14	
53	1744	1748	5550	N	116	100%	-13	
54	1751	1756	5550	S	116	100%	12	
55	1757	1802	5600	N	116	100%	-13	
56	1804	1808	5575	S	116	100%	11	
57	1810	1813	5530	N	116	100%	-13	
58	1816	1819	5555	S	116	100%	13	
59	1822	1825	5420	N	116	100%	-13	
60	1827	1831	5400	S	116	100%	11	

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Date/Flight:	December 11, 2010		
Takeoff Time (TZ)	10:07Z	Local:	8:05am EST
Landing Time (TZ)	00:59Z	Local:	3:50pm EST
		Altport	OKH

GPS Base Location(s)	QCH A	
PDOP Avoidance	Good all day	
Static or Flyover?	Static	-> If flyovers, times: -

97E-9112101

Sheet 1 of 1

# LIDAR MISSION RECORD SHEET - Optech

PHOTO SCIENCE  
Geospatial Solutions

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Project Name:	DRH - Charles
Project Number:	7556 - 005
ALTIM-NAV .pln file	DRH - Charles .pln

Pilot:	Greenwell
Operator:	Galieti
Aircraft:	N2448G

Date Flown:	12/11/10	#	2
Takeoff Time (Z):	16:37	Local:	11:37
Landing Time (Z):	21:02	Local:	4:06
		Airport	KORH

Project's Scanning Requirements	
FOV (half-degrees):	± 16°
Altitude AGL (ft):	5000
Scan Rate:	30 Hz
Pulse Rate:	70 kHz
Ground Speed:	116 kts
A.R.F.:	Range

Data Information	
LIDAR Unit	Optech Gemini sn247
HD #	1
POS File Name	101211b
from, to	0 → 33

Begin Temp	2 C	Ground	Airport
Begin Dewpoint	-3 C		
Begin Pressure	30.20		
End Temp			
End Dewpoint			
End Pressure			

GPS Base Location(s)	DRH
PDOP Avoidance	Good all day
Static or Flyover?	Static

101211b-247

Flight Line Name/#	Start Time	End Time	Alt. (AMSL)	Heading	Speed	Returns	Crab	NOTES (weather, visibility, winds, ride, etc.)
12	1707	1709	5386	179	120	106	12	
11	1713	1717	5420	359	120	100	10	
10	1722	1725	5400	179	120	100	12	
9	1731	1734	5376	359	121	106	11	
8	1739	1743	5400	179	113	100	13	
7	1749	1752	5400	359	118	100	12	
6	1758	1803	5400	179	118	100	13	
5	1808	1813	5370	359	114	100	12	
4	1818	1823	5360	179	118	100	11	
3	1828	1834	5350	359	115	100	12	
2	1839	1845	5390	179	117	100	11	
1	1850	1900	5380	359	117	100	10	
13	1904	1914	5360	179	121	100	13	
14	1919	1929	5380	359	117	100	9	
15	1933	1943	5380	179	117	100	12	
16	1949	1955	5370	359	115	100	10	
17	2011	2018	5410	179	115	100	12	
18	2023	2030	5450	359	110	100	10	
19	2034	2041	5430	179	112	100	12	
Cross line	2043	2046	5430	090	130	160	1	

# Mass Area: ORH-Charles

Project No 7556-005

Contact: Photo Science: F Godby at  
859 277-8700 or Cell: 859 421-5258

## Flight Logs

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
1	21.7	5370	ORH A	ORH_Charles. ORH_CHARL	12/11/10	247		
2	12.3	5360	ORH A	ORH_Charles. ORH_CHARL	12/11/10	247		
3	10.5	5350	ORH A	ORH_Charles. ORH_CHARL	12/11/10	247		
4	10.5	5360	ORH A	ORH_Charles. ORH_CHARL	12/11/10	247		
5	10.5	5370	ORH A	ORH_Charles. ORH_CHARL	12/11/10	247		
6	10.3	5380	ORH A	ORH_Charles. ORH_CHARL	12/11/10	247		
7	6.6	5380	ORH A	ORH_Charles. ORH_CHARL	12/11/10	247		
8	6.6	5370	ORH A	ORH_Charles. ORH_CHARL	12/11/10	247		
9	6.6	5380	ORH A	ORH_Charles. ORH_CHARL	12/11/10	247		
10	6.6	5390	ORH A	ORH_Charles. ORH_CHARL	12/11/10	247		
11	6.6	5400	ORH A	ORH_Charles. ORH_CHARL	12/11/10	247		
12	4.7	5400	ORH A	ORH_Charles. ORH_CHARL	12/11/10	247	✓	
13	21.4	5380	ORH A	ORH_Charles. ORH_CHARL	12/11/10	247	✓	

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: Salich  
Pilot: Greenwell

AIRCRAFT Tail Number: K12448G  
Sensor Serial Number: 247

Date: 12/11/10  
Page 1 of 5

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
14	20.5	5380	ORH A	ORH_Charles. ORH_CHARL	12/11/10			
15	20.5	5390	ORH A	ORH_Charles. ORH_CHARL	12/11/10			
16	15.0	5370	ORH A	ORH_Charles. ORH_CHARL	12/11/10			
17	14.5	5360	ORH A	ORH_Charles. ORH_CHARL	12/11/10			
18	14.1	5380	ORH A	ORH_Charles. ORH_CHARL	12/11/10			
19	14.1	5420	ORH A	ORH_Charles. ORH_CHARL	12/11/10			
20	13.1	5440	ORH A	ORH_Charles. ORH_CHARL				
21	12.3	5460	ORH A	ORH_Charles. ORH_CHARL				
22	11.1	5490	ORH A	ORH_Charles. ORH_CHARL				
23	9.1	5550	ORH A	ORH_Charles. ORH_CHARL				
24	9.1	5560	ORH A	ORH_Charles. ORH_CHARL				
25	6.7	5590	ORH A	ORH_Charles. ORH_CHARL				
26	6.7	5570	ORH A	ORH_Charles. ORH_CHARL				
27	6.7	5510	ORH A	ORH_Charles. ORH_CHARL				

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: Salvetti  
Pilot: Greenwell

AIRCRAFT Tail Number: N24486  
Sensor Serial Number: 247

Date: 12/11/10 Page 2 of 5



FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
14	20.5	5380	ORH A	ORH_Charles. ORH_CHARL	12-11-2010	247	N9	
15	20.5	5390	ORH A	ORH_Charles. ORH_CHARL				
16	15.0	5370	ORH A	ORH_Charles. ORH_CHARL				
17	14.5	5360	ORH A	ORH_Charles. ORH_CHARL				
18	14.1	5380	ORH A	ORH_Charles. ORH_CHARL				
19	14.1	5420	ORH A	ORH_Charles. ORH_CHARL				
20	13.1	5440	ORH A	ORH_Charles. ORH_CHARL	12-11-2010	246	JB	
21	12.3	5460	ORH A	ORH_Charles. ORH_CHARL				
22	11.1	5490	ORH A	ORH_Charles. ORH_CHARL				
23	9.1	5550	ORH A	ORH_Charles. ORH_CHARL				
24	9.1	5560	ORH A	ORH_Charles. ORH_CHARL				
25	6.7	5590	ORH A	ORH_Charles. ORH_CHARL				
26	6.7	5570	ORH A	ORH_Charles. ORH_CHARL				
27	6.7	5510	ORH A	ORH_Charles. ORH_CHARL				

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: Berny Young AIRCRAFT Tail Number: N72602 Date: 12-11-2010  
Pilot: Young Sensor Serial Number: 246

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
28	6.3	5450	ORH A	ORH_Charles. ORH_CHARL	12-11-2010	246	JB	
29	6.3	5430	ORH A	ORH_Charles. ORH_CHARL				
30	6.3	5420	ORH A	ORH_Charles. ORH_CHARL				
31	6.3	5500	ORH A	ORH_Charles. ORH_CHARL				
32	6.3	5550	ORH A	ORH_Charles. ORH_CHARL				
33	6.3	5600	ORH A	ORH_Charles. ORH_CHARL				
34	6.3	5630	ORH A	ORH_Charles. ORH_CHARL				
35	2.8	5650	ORH A	ORH_Charles. ORH_CHARL				
36	2.8	5660	ORH A	ORH_Charles. ORH_CHARL				
37	2.8	5730	ORH A	ORH_Charles. ORH_CHARL				
38 ✓	2.8	5750	ORH A	ORH_Charles. ORH_CHARL				
39 ✓	2.8	5750	ORH A	ORH_Charles. ORH_CHARL				
40 ✓	2.8	5750	ORH A	ORH_Charles. ORH_CHARL				
41 ✓	2.8	5860	ORH A	ORH_Charles. ORH_CHARL				

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: Berry  
Pilot: Young

AIRCRAFT Tail Number: N7266Z  
Sensor Serial Number: 246

Date: 12-11-2010

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
42 ✓	2.8	5910	ORH A	ORH_Charles. ORH_CHARL	12-11-2016	846	JB	
43 ✓	2.8	5900	ORH A	ORH_Charles. ORH_CHARL				
44 ✓	2.8	5860	ORH A	ORH_Charles. ORH_CHARL				
45 ✓	6.6	5950	ORH A	ORH_Charles. ORH_CHARL				
46 ✓	6.7	6020	ORH A	ORH_Charles. ORH_CHARL				
47 ✓	6.4	6080	ORH A	ORH_Charles. ORH_CHARL				
48 ✓	5.3	6090	ORH A	ORH_Charles. ORH_CHARL				
49 ✓	5.1	6090	ORH A	ORH_Charles. ORH_CHARL				
50 ✓	3.6	6100	ORH A	ORH_Charles. ORH_CHARL				
51 ✓	3.1	5710	ORH A	ORH_Charles. ORH_CHARL				
52 ✓	3.6	5750	ORH A	ORH_Charles. ORH_CHARL				
53 ✓	2.7	5780	ORH A	ORH_Charles. ORH_CHARL				
54 ✓	3.6	5700	ORH A	ORH_Charles. ORH_CHARL				
55 ✓	3.6	5680	ORH A	ORH_Charles. ORH_CHARL				

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: Berry  
Pilot: JB

AIRCRAFT Tail Number: N72662  
Sensor Serial Number: 846

Date: 12-12-2016  
Page 4 of 5

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
56 ✓	3.6	5660	ORH A	ORH_Charles. ORH_CHARL	12-11-2010	246	DB	
57 ✓	3.6	5600	ORH A	ORH_Charles. ORH_CHARL				
58 ✓	4.5	5600	ORH A	ORH_Charles. ORH_CHARL				
59 ✓	4.5	5610	ORH A	ORH_Charles. ORH_CHARL				
60 ✓	4.5	5640	ORH A	ORH_Charles. ORH_CHARL				
61 ✓	4.5	5630	ORH A	ORH_Charles. ORH_CHARL				

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: Benny  
Pilot: Lyons

AIRCRAFT Tail Number: N72602  
Sensor Serial Number: 246

Date: 12-11-2010

# Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : KORH  
Mission : 101211A  
Wheels Up : 1528Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

## Weather

-----  
Date : December 11, 2010  
Julian Day : 345  
Temperature : 0C  
Visibility : HAZY  
Clouds : NONE  
Precipitation : NONE  
Wind Dir : CALM  
Wind Speed : CALM  
Pressure : 30.21

## Statistics

-----  
Laser Time : 01:21:25

=====  
10:45:03.486 GMT : 00:00:02 (212) GPS 1PPS Lost  
10:45:03.486 GMT : 00:00:03 (166) Divergence Error  
10:45:03.486 GMT : 00:00:03 (107) Rx Shutter Closed  
10:45:03.486 GMT : 00:00:03 (109) Tx Shutter Closed  
10:45:03.486 GMT : 00:00:04 (164) Beam Wide  
10:45:03.486 GMT : 00:00:09 (120) Laser PS Comm Ok  
10:45:03.486 GMT : 00:00:09 (112) Laser Emission Off  
10:45:03.486 GMT : 00:00:11 (213) GPS 1PPS Ok  
10:45:03.486 GMT : 00:00:12 (204) POSAV Connected  
10:45:03.486 GMT : 00:00:12 (207) POSAV Rate Not 50 Hz  
10:45:03.486 GMT : 00:00:12 (211) POSAV new status  
10:45:03.486 GMT : 00:00:24 (208) POSAV Rate Is 50 Hz  
10:45:03.486 GMT : 00:00:24 (211) POSAV new status  
10:45:03.486 GMT : 00:00:26 (211) POSAV new status  
10:45:03.486 GMT : 00:00:26 (215) Nav Data Ok  
10:45:03.486 GMT : 00:02:05 (211) POSAV new status  
15:19:01.948 GMT : 00:03:51 (307) Format Disk  
15:20:00.349 GMT : 00:04:49 (211) POSAV new status  
15:23:07.952 GMT : 15:23:07 (153) Eyesafety Disabled  
15:23:08.652 GMT : 15:23:07 (162) Roll Comp On  
15:23:08.852 GMT : 15:23:08 (164) Beam Wide  
15:23:11.952 GMT : 15:23:11 (165) Beam Narrow  
15:23:16.552 GMT : 15:23:15 (211) POSAV new status



15:23:27.152 GMT : 15:23:26 (144) MultiPulse Mode Varies  
15:35:23.264 GMT : 15:35:22 (106) Rx Shutter Open  
15:35:23.264 GMT : 15:35:22 (108) Tx Shutter Open  
15:40:14.369 GMT : 15:40:13 (113) Laser Emission On  
15:42:01.57 GMT : 15:42:00 (112) Laser Emission Off  
15:44:19.473 GMT : 15:44:19 (113) Laser Emission On  
15:46:53.876 GMT : 15:46:52 (112) Laser Emission Off  
15:50:23.08 GMT : 15:50:22 (113) Laser Emission On  
15:52:51.682 GMT : 15:52:50 (112) Laser Emission Off  
15:55:14.185 GMT : 15:55:13 (113) Laser Emission On  
15:56:58.287 GMT : 15:56:57 (112) Laser Emission Off  
16:00:50.892 GMT : 16:00:49 (113) Laser Emission On  
16:02:30.194 GMT : 16:02:29 (112) Laser Emission Off  
16:05:14.897 GMT : 16:05:14 (113) Laser Emission On  
16:07:39.2 GMT : 16:07:38 (112) Laser Emission Off  
16:11:42.005 GMT : 16:11:41 (113) Laser Emission On  
16:14:07.509 GMT : 16:14:06 (112) Laser Emission Off  
16:17:21.713 GMT : 16:17:21 (113) Laser Emission On  
16:19:25.015 GMT : 16:19:24 (112) Laser Emission Off  
16:22:03.219 GMT : 16:22:02 (113) Laser Emission On  
16:24:10.821 GMT : 16:24:09 (112) Laser Emission Off  
16:26:32.925 GMT : 16:26:32 (113) Laser Emission On  
16:28:13.927 GMT : 16:28:13 (112) Laser Emission Off  
16:31:17.931 GMT : 16:31:17 (113) Laser Emission On  
16:32:56.633 GMT : 16:32:55 (112) Laser Emission Off  
16:35:28.236 GMT : 16:35:27 (113) Laser Emission On  
16:37:30.939 GMT : 16:37:30 (112) Laser Emission Off  
16:40:46.043 GMT : 16:40:45 (113) Laser Emission On  
16:42:46.446 GMT : 16:42:45 (112) Laser Emission Off  
16:45:11.249 GMT : 16:45:10 (113) Laser Emission On  
16:46:53.952 GMT : 16:46:52 (112) Laser Emission Off  
16:50:03.056 GMT : 16:50:02 (113) Laser Emission On  
16:51:40.158 GMT : 16:51:39 (112) Laser Emission Off  
16:54:10.061 GMT : 16:54:09 (113) Laser Emission On  
16:56:00.564 GMT : 16:55:59 (112) Laser Emission Off  
16:58:48.068 GMT : 16:58:47 (113) Laser Emission On  
17:00:45.271 GMT : 17:00:44 (112) Laser Emission Off  
17:01:03.771 GMT : 17:01:03 (113) Laser Emission On  
17:04:25.376 GMT : 17:04:24 (112) Laser Emission Off  
17:07:04.28 GMT : 17:07:03 (113) Laser Emission On  
17:10:27.284 GMT : 17:10:26 (112) Laser Emission Off  
17:10:46.985 GMT : 17:10:46 (113) Laser Emission On  
17:12:14.187 GMT : 17:12:13 (112) Laser Emission Off  
17:15:44.392 GMT : 17:15:43 (113) Laser Emission On  
17:19:01.897 GMT : 17:19:01 (112) Laser Emission Off  
17:22:17.802 GMT : 17:22:17 (113) Laser Emission On  
17:24:59.606 GMT : 17:24:59 (112) Laser Emission Off  
17:27:57.31 GMT : 17:27:56 (113) Laser Emission On  
17:30:34.614 GMT : 17:30:34 (112) Laser Emission Off  
17:33:27.418 GMT : 17:33:27 (113) Laser Emission On  
17:35:30.821 GMT : 17:35:30 (112) Laser Emission Off  
17:39:07.827 GMT : 17:39:07 (113) Laser Emission On  
17:41:05.029 GMT : 17:41:04 (112) Laser Emission Off  
17:44:19.634 GMT : 17:44:19 (113) Laser Emission On

17:48:53.741 GMT : 17:48:52 (112) Laser Emission Off  
17:51:42.345 GMT : 17:51:41 (113) Laser Emission On  
17:56:12.352 GMT : 17:56:11 (112) Laser Emission Off  
17:59:08.857 GMT : 17:59:08 (113) Laser Emission On  
18:02:34.962 GMT : 18:02:33 (112) Laser Emission Off  
18:04:59.465 GMT : 18:04:58 (113) Laser Emission On  
18:08:14.17 GMT : 18:08:13 (112) Laser Emission Off  
18:10:15.474 GMT : 18:10:15 (113) Laser Emission On  
18:13:37.279 GMT : 18:13:36 (112) Laser Emission Off  
18:16:30.783 GMT : 18:16:30 (113) Laser Emission On  
18:19:44.388 GMT : 18:19:43 (112) Laser Emission Off  
18:22:22.692 GMT : 18:22:22 (113) Laser Emission On  
18:25:33.997 GMT : 18:25:33 (112) Laser Emission Off  
18:27:57.301 GMT : 18:27:56 (113) Laser Emission On  
18:31:08.706 GMT : 18:31:08 (112) Laser Emission Off  
18:34:22.811 GMT : 18:34:22 (107) Rx Shutter Closed  
18:34:23.111 GMT : 18:34:22 (109) Tx Shutter Closed

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : KORH  
Mission : 101211A  
Wheels Up : 1528Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 11, 2010  
Julian Day : 345  
Temperature : 0C  
Visibility : HAZY  
Clouds : NONE  
Precipitation : NONE  
Wind Dir : CALM  
Wind Speed : CALM  
Pressure : 30.21

#### Statistics

-----  
Laser Time : 01:21:25

=====

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY

Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : KORH  
Mission : 101211A  
Wheels Up : 1528Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 11, 2010  
Julian Day : 345  
Temperature : 0C  
Visibility : HAZY  
Clouds : NONE  
Precipitation : NONE  
Wind Dir : CALM  
Wind Speed : CALM  
Pressure : 30.21  
-----

#### Statistics

-----  
Laser Time : 01:21:25  
-----

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
=====									
15:40:14.769	15:42:02.77	60	1758	70	30.10	18.00	ON	NAR	
ON 0.00	179.48								
15:44:20.273	15:46:48.476	61	1714	70	30.10	18.00	ON	NAR	
ON 0.00	179.47								
15:50:23.88	15:52:52.982	39	1715	70	30.10	18.00	ON	NAR	
ON 0.00	359.44								
15:55:14.985	15:56:58.987	40	1749	70	30.10	18.00	ON	NAR	
ON 0.00	359.44								
16:00:51.192	16:02:30.394	59	1755	70	30.10	18.00	ON	NAR	
ON 0.00	179.48								
16:05:15.697	16:07:41	59	1707	70	30.10	18.00	ON	NAR	
ON 0.00	179.48								
16:11:42.406	16:14:08.009	57	1710	70	30.10	18.00	ON	NAR	
ON 0.00	179.47								
16:17:22.613	16:19:26.715	56	1704	70	30.10	18.00	ON	NAR	
ON 0.00	179.46								
16:22:03.719	16:24:11.722	56	1725	70	30.10	18.00	ON	NAR	
ON 0.00	359.46								
16:26:33.325	16:28:14.727	41	1789	70	30.10	18.00	ON	NAR	
ON 0.00	359.42								
16:31:18.631	16:32:58.233	42	1801	70	30.10	18.00	ON	NAR	
ON 0.00	179.42								
16:35:28.636	16:37:28.139	55	1734	70	30.10	18.00	ON	NAR	
ON 0.00	179.45								

16:40:46.543	16:42:48.046	43	1736	70	30.10	18.00	ON	NAR
ON 0.00	359.41							
16:45:11.649	16:46:54.952	44	1799	70	30.10	18.00	ON	NAR
ON 0.00	359.42							
16:50:04.156	16:51:42.258	51	1783	70	30.10	18.00	ON	NAR
ON 0.00	179.47							
16:54:10.661	16:56:00.964	52	1744	70	30.10	18.00	ON	NAR
ON 0.00	179.43							
16:58:48.868	17:00:46.571	45	1766	70	30.10	18.00	ON	NAR
ON 0.00	359.4							
17:01:04.271	17:04:26.576	46	1811	70	30.10	18.00	ON	NAR
ON 0.00	359.4							
17:07:04.08	17:10:28.084	53	1838	70	30.10	18.00	ON	NAR
ON 0.00	179.43							
17:10:47.685	17:12:15.287	47	1764	70	30.10	18.00	ON	NAR
ON 0.00	359.39							
17:15:44.192	17:19:02.697	47	1848	70	30.10	18.00	ON	NAR
ON 0.00	359.39							
17:22:18.402	17:25:00.306	48	1861	70	30.10	18.00	ON	NAR
ON 0.00	179.38							
17:27:57.51	17:30:35.614	50	1857	70	30.10	18.00	ON	NAR
ON 0.00	359.38							
17:33:28.118	17:35:31.321	53	1862	70	30.10	18.00	ON	NAR
ON 0.00	179.43							
17:39:08.327	17:41:06.13	53	1807	70	30.10	18.00	ON	NAR
ON 0.00	179.43							
17:44:20.534	17:48:55.041	24	1706	70	30.10	18.00	ON	NAR
ON 0.00	359.56							
17:51:42.345	17:56:13.052	25	1694	70	30.10	18.00	ON	NAR
ON 0.00	179.56							
17:59:09.657	18:02:35.862	26	1714	70	30.10	18.00	ON	NAR
ON 0.00	179.55							
18:05:00.166	18:08:15.57	27	1699	70	30.10	18.00	ON	NAR
ON 0.00	359.55							
18:10:16.374	18:13:38.679	28	1680	70	30.10	18.00	ON	NAR
ON 0.00	359.55							
18:16:31.483	18:19:45.888	28	1693	70	30.10	18.00	ON	NAR
ON 0.00	179.55							
18:22:23.592	18:25:35.297	30	1657	70	30.10	18.00	ON	NAR
ON 0.00	359.54							
18:27:58.101	18:31:09.306	30	1650	70	30.10	18.00	ON	NAR
ON 0.00	179.54							

# Flight Log

-----

Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : KORH  
Mission : 101211B  
Wheels Up : 1925Z  
Flight Length :

HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 11, 2010  
Julian Day : 345  
Temperature : 4  
Visibility : GOOD  
Clouds : NONE  
Precipitation : NONE  
Wind Dir : 240  
Wind Speed : 4  
Pressure : 30.17

Statistics

-----  
Laser Time : 00:36:23

=====

14:43:08.678	GMT	: 00:00:02	(212)	GPS 1PPS Lost
14:43:08.678	GMT	: 00:00:03	(166)	Divergence Error
14:43:08.678	GMT	: 00:00:03	(107)	Rx Shutter Closed
14:43:08.678	GMT	: 00:00:03	(109)	Tx Shutter Closed
14:43:08.678	GMT	: 00:00:04	(164)	Beam Wide
14:43:08.678	GMT	: 00:00:05	(213)	GPS 1PPS Ok
14:43:08.678	GMT	: 00:00:09	(120)	Laser PS Comm Ok
14:43:08.678	GMT	: 00:00:09	(112)	Laser Emission Off
14:43:08.678	GMT	: 00:00:12	(204)	POSAV Connected
14:43:08.678	GMT	: 00:00:12	(207)	POSAV Rate Not 50 Hz
14:43:08.678	GMT	: 00:00:13	(211)	POSAV new status
14:43:08.678	GMT	: 00:00:22	(208)	POSAV Rate Is 50 Hz
14:43:08.678	GMT	: 00:00:22	(215)	Nav Data Ok
14:43:08.678	GMT	: 00:00:23	(211)	POSAV new status
14:43:08.678	GMT	: 00:00:24	(211)	POSAV new status
14:43:08.678	GMT	: 00:01:51	(211)	POSAV new status
14:43:08.678	GMT	: 00:04:33	(211)	POSAV new status
19:18:43.088	GMT	: 19:18:42	(153)	Eyesafety Disabled
19:18:43.788	GMT	: 19:18:42	(162)	Roll Comp On
19:18:43.988	GMT	: 19:18:43	(164)	Beam Wide
19:18:49.688	GMT	: 19:18:48	(165)	Beam Narrow
19:19:01.089	GMT	: 19:19:00	(144)	MultiPulse Mode Varies
19:23:07.994	GMT	: 19:23:06	(211)	POSAV new status
19:24:14.095	GMT	: 19:24:13	(106)	Rx Shutter Open
19:24:14.295	GMT	: 19:24:13	(108)	Tx Shutter Open
19:36:23.212	GMT	: 19:36:22	(113)	Laser Emission On
19:39:37.117	GMT	: 19:39:36	(112)	Laser Emission Off
19:43:04.121	GMT	: 19:43:03	(113)	Laser Emission On
19:46:26.726	GMT	: 19:46:26	(112)	Laser Emission Off
19:49:52.931	GMT	: 19:49:52	(113)	Laser Emission On
19:53:05.036	GMT	: 19:53:04	(112)	Laser Emission Off
19:56:06.14	GMT	: 19:56:05	(113)	Laser Emission On
19:59:19.444	GMT	: 19:59:18	(112)	Laser Emission Off
20:02:04.748	GMT	: 20:02:04	(113)	Laser Emission On
20:04:05.551	GMT	: 20:04:04	(112)	Laser Emission Off



20:06:44.455 GMT : 20:06:43 (113) Laser Emission On  
20:08:27.457 GMT : 20:08:26 (112) Laser Emission Off  
20:10:56.061 GMT : 20:10:55 (113) Laser Emission On  
20:12:39.064 GMT : 20:12:38 (112) Laser Emission Off  
20:20:45.175 GMT : 20:20:44 (113) Laser Emission On  
20:27:00.184 GMT : 20:26:59 (112) Laser Emission Off  
20:30:00.989 GMT : 20:30:00 (113) Laser Emission On  
20:35:54.597 GMT : 20:35:53 (112) Laser Emission Off  
20:40:50.505 GMT : 20:40:50 (113) Laser Emission On  
20:46:17.013 GMT : 20:46:16 (112) Laser Emission Off  
20:48:12.815 GMT : 20:48:12 (113) Laser Emission On  
20:49:10.317 GMT : 20:49:09 (112) Laser Emission Off  
20:49:21.617 GMT : 20:49:20 (107) Rx Shutter Closed  
20:49:21.817 GMT : 20:49:20 (109) Tx Shutter Closed

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : KORH  
Mission : 101211B  
Wheels Up : 1925Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 11, 2010  
Julian Day : 345  
Temperature : 4  
Visibility : GOOD  
Clouds : NONE  
Precipitation : NONE  
Wind Dir : 240  
Wind Speed : 4  
Pressure : 30.17

#### Statistics

-----  
Laser Time : 00:36:23  
-----

=====

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : KORH

Mission : 101211B  
Wheels Up : 1925Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 11, 2010  
Julian Day : 345  
Temperature : 4  
Visibility : GOOD  
Clouds : NONE  
Precipitation : NONE  
Wind Dir : 240  
Wind Speed : 4  
Pressure : 30.17

#### Statistics

-----  
Laser Time : 00:36:23

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
=====									
19:36:23.812	19:39:38.217	32	1671	70	30.10	18.00	ON	NAR	
ON 0.00	179.51								
19:43:04.821	19:46:28.426	33	1688	70	30.10	18.00	ON	NAR	
ON 0.00	359.51								
19:49:53.431	19:53:05.736	34	1701	70	30.10	18.00	ON	NAR	
ON 0.00	359.5								
19:56:06.54	19:59:20.544	35	1719	70	30.10	18.00	ON	NAR	
ON 0.00	179.51								
20:02:05.948	20:04:06.151	36	1724	70	30.10	18.00	ON	NAR	
ON 0.00	179.5								
20:06:44.955	20:08:27.257	36	1722	70	30.10	18.00	ON	NAR	
ON 0.00	179.5								
20:10:57.061	20:12:40.064	37	1745	70	30.10	18.00	ON	NAR	
ON 0.00	359.49								
20:20:44.975	20:27:01.084	21	1654	70	30.10	18.00	ON	NAR	
ON 0.00	179.59								
20:30:01.889	20:35:54.797	22	1659	70	30.10	18.00	ON	NAR	
ON 0.00	359.57								
20:40:51.205	20:46:18.613	22	1674	70	30.10	18.00	ON	NAR	
ON 0.00	179.57								
20:48:13.615	20:49:11.217	21	1701	70	30.10	18.00	ON	NAR	
ON 0.00	179.59								

#### Flight Log

-----  
Project Number: ORH\_Charles  
S/N : 247  
Operator : Galieti

Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KORH  
Mission : 2  
Wheels Up :  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 11, 2010  
Julian Day : 345  
Temperature : 2  
Visibility : Clear  
Clouds : None  
Precipitation : None HZ  
Wind Dir : 270  
Wind Speed : 6  
Pressure : 30.20 HG

Statistics

-----  
Laser Time : 01:55:18

=====  
16:51:51.407 GMT : 00:00:02 (212) GPS 1PPS Lost  
16:51:51.407 GMT : 00:00:03 (166) Divergence Error  
16:51:51.407 GMT : 00:00:03 (107) Rx Shutter Closed  
16:51:51.407 GMT : 00:00:03 (109) Tx Shutter Closed  
16:51:51.407 GMT : 00:00:04 (164) Beam Wide  
16:51:51.407 GMT : 00:00:05 (213) GPS 1PPS Ok  
16:51:51.407 GMT : 00:00:12 (204) POSAV Connected  
16:51:51.407 GMT : 00:00:12 (207) POSAV Rate Not 50 Hz  
16:51:51.407 GMT : 00:00:12 (211) POSAV new status  
16:51:51.407 GMT : 00:00:18 (120) Laser PS Comm Ok  
16:51:51.407 GMT : 00:00:18 (112) Laser Emission Off  
16:51:51.407 GMT : 00:00:26 (208) POSAV Rate Is 50 Hz  
16:51:51.407 GMT : 00:00:26 (211) POSAV new status  
16:51:51.407 GMT : 00:00:26 (215) Nav Data Ok  
16:51:51.407 GMT : 00:00:28 (211) POSAV new status  
16:51:51.407 GMT : 00:02:01 (211) POSAV new status  
16:51:51.407 GMT : 00:02:54 (211) POSAV new status  
16:43:56.257 GMT : 16:43:55 (153) Eyesafety Disabled  
16:43:56.357 GMT : 16:43:55 (162) Roll Comp On  
16:43:56.857 GMT : 16:43:56 (164) Beam Wide  
16:43:57.057 GMT : 16:43:56 (144) MultiPulse Mode Varies  
16:44:02.057 GMT : 16:44:01 (166) Divergence Error  
16:44:02.757 GMT : 16:44:02 (165) Beam Narrow  
16:44:11.957 GMT : 16:44:11 (157) Safe Unaided Profile  
16:44:12.057 GMT : 16:44:11 (157) Safe Unaided Profile  
16:50:20.761 GMT : 16:50:19 (211) POSAV new status  
16:59:10.268 GMT : 16:59:09 (157) Safe Unaided Profile  
16:59:23.368 GMT : 16:59:22 (157) Safe Unaided Profile  
16:59:29.368 GMT : 16:59:28 (106) Rx Shutter Open

16:59:29.468 GMT : 16:59:28 (108) Tx Shutter Open  
17:07:14.174 GMT : 17:07:13 (113) Laser Emission On  
17:09:44.976 GMT : 17:09:43 (112) Laser Emission Off  
17:13:53.18 GMT : 17:13:52 (113) Laser Emission On  
17:17:15.582 GMT : 17:17:14 (112) Laser Emission Off  
17:22:38.787 GMT : 17:22:38 (113) Laser Emission On  
17:26:00.79 GMT : 17:25:59 (112) Laser Emission Off  
17:31:23.994 GMT : 17:31:23 (113) Laser Emission On  
17:34:43.097 GMT : 17:34:42 (112) Laser Emission Off  
17:39:50.101 GMT : 17:39:49 (113) Laser Emission On  
17:43:14.104 GMT : 17:43:13 (112) Laser Emission Off  
17:49:13.709 GMT : 17:49:12 (113) Laser Emission On  
17:52:32.212 GMT : 17:52:31 (112) Laser Emission Off  
17:58:08.117 GMT : 17:58:07 (113) Laser Emission On  
18:03:11.222 GMT : 18:03:10 (112) Laser Emission Off  
18:08:10.926 GMT : 18:08:10 (113) Laser Emission On  
18:13:25.031 GMT : 18:13:24 (112) Laser Emission Off  
18:18:17.536 GMT : 18:18:16 (113) Laser Emission On  
18:23:21.44 GMT : 18:23:20 (112) Laser Emission Off  
18:28:50.445 GMT : 18:28:49 (113) Laser Emission On  
18:34:11.45 GMT : 18:34:10 (112) Laser Emission Off  
18:39:19.655 GMT : 18:39:18 (113) Laser Emission On  
18:45:21.261 GMT : 18:45:19 (112) Laser Emission Off  
18:50:18.766 GMT : 18:50:18 (113) Laser Emission On  
19:00:22.476 GMT : 19:00:21 (112) Laser Emission Off  
19:04:47.08 GMT : 19:04:45 (113) Laser Emission On  
19:14:24.389 GMT : 19:14:23 (112) Laser Emission Off  
19:19:31.694 GMT : 19:19:30 (113) Laser Emission On  
19:29:05.104 GMT : 19:29:04 (112) Laser Emission Off  
19:33:46.308 GMT : 19:33:45 (113) Laser Emission On  
19:43:13.518 GMT : 19:43:12 (112) Laser Emission Off  
19:47:58.522 GMT : 19:47:57 (113) Laser Emission On  
19:55:07.53 GMT : 19:55:06 (112) Laser Emission Off  
20:04:42.439 GMT : 20:04:41 (113) Laser Emission On  
20:05:11.14 GMT : 20:05:09 (112) Laser Emission Off  
20:11:19.446 GMT : 20:11:18 (113) Laser Emission On  
20:18:28.653 GMT : 20:18:28 (112) Laser Emission Off  
20:23:11.058 GMT : 20:23:10 (113) Laser Emission On  
20:30:04.564 GMT : 20:30:02 (112) Laser Emission Off  
20:34:48.369 GMT : 20:34:47 (113) Laser Emission On  
20:41:36.276 GMT : 20:41:35 (112) Laser Emission Off  
20:43:44.578 GMT : 20:43:43 (113) Laser Emission On  
20:46:59.681 GMT : 20:46:59 (112) Laser Emission Off  
20:50:07.784 GMT : 20:50:07 (157) Safe Unaided Profile  
20:50:12.084 GMT : 20:50:11 (107) Rx Shutter Closed  
20:50:12.284 GMT : 20:50:11 (109) Tx Shutter Closed

#### Flight Log

-----  
Project Number: ORH\_Charles  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G

Airport : KORH  
Mission : 2  
Wheels Up :  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 11, 2010  
Julian Day : 345  
Temperature : 2  
Visibility : Clear  
Clouds : None  
Precipitation : None HZ  
Wind Dir : 270  
Wind Speed : 6  
Pressure : 30.20 HG

#### Statistics

-----  
Laser Time : 01:55:18

=====

#### Flight Log

-----  
Project Number: ORH\_Charles  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KORH  
Mission : 2  
Wheels Up :  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 11, 2010  
Julian Day : 345  
Temperature : 2  
Visibility : Clear  
Clouds : None  
Precipitation : None HZ  
Wind Dir : 270  
Wind Speed : 6  
Pressure : 30.20 HG

#### Statistics

-----  
Laser Time : 01:55:18

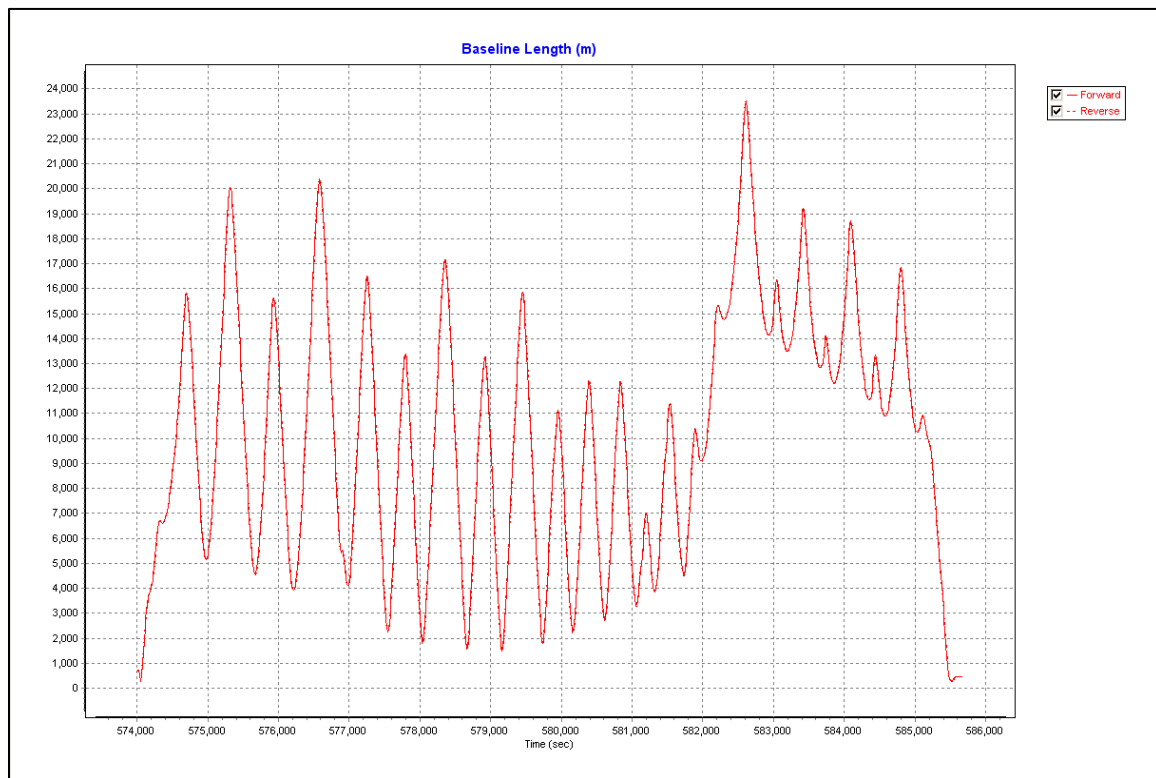


RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
	17:07:15.374	17:09:45.676	12	1644	70	30.10	18.00	ON	NAR
ON	0.00	179.73							
	17:13:54.18	17:17:16.282	11	1644	70	30.10	18.00	ON	NAR
ON	0.00	359.7							
	17:22:39.387	17:26:01.69	10	1645	70	30.10	18.00	ON	NAR
ON	0.00	179.69							
	17:31:24.694	17:34:43.597	9	1639	70	30.10	18.00	ON	NAR
ON	0.00	359.69							
	17:39:50.901	17:43:15.504	8	1645	70	30.10	18.00	ON	NAR
ON	0.00	179.68							
	17:39:50.901	17:43:15.504	8	1645	70	30.10	18.00	ON	NAR
ON	0.00	179.68							
	17:49:14.209	17:52:33.612	7	1641	70	30.10	18.00	ON	NAR
ON	0.00	359.67							
	17:49:14.209	17:52:33.612	7	1641	70	30.10	18.00	ON	NAR
ON	0.00	359.67							
	17:58:08.817	18:03:12.122	6	1645	70	30.10	18.00	ON	NAR
ON	0.00	179.65							
	17:58:08.817	18:03:12.122	6	1645	70	30.10	18.00	ON	NAR
ON	0.00	179.65							
	18:08:11.826	18:13:25.631	5	1638	70	30.10	18.00	ON	NAR
ON	0.00	359.65							
	18:18:17.836	18:23:22.74	4	1635	70	30.10	18.00	ON	NAR
ON	0.00	179.64							
	18:28:50.945	18:34:13.551	3	1630	70	30.10	18.00	ON	NAR
ON	0.00	359.63							
	18:39:19.855	18:45:22.461	1	1644	70	30.10	18.00	ON	NAR
ON	0.00	179.62							
	18:50:19.866	19:00:19.576	1	1638	70	30.10	18.00	ON	NAR
ON	0.00	359.62							
	19:04:47.68	19:14:26.689	13	1637	70	30.10	18.00	ON	NAR
ON	0.00	179.62							
	19:19:31.494	19:29:05.804	14	1637	70	30.10	18.00	ON	NAR
ON	0.00	359.61							
	19:33:46.108	19:43:15.118	15	1636	70	30.10	18.00	ON	NAR
ON	0.00	179.6							
	19:33:46.108	19:43:15.118	15	1636	70	30.10	18.00	ON	NAR
ON	0.00	179.6							
	19:47:59.322	19:55:07.73	17	1637	70	30.10	18.00	ON	NAR
ON	0.00	359.59							
	19:47:59.322	19:55:07.73	17	1637	70	30.10	18.00	ON	NAR
ON	0.00	359.59							
	20:04:42.239	20:05:12.54	17	1643	70	30.10	18.00	ON	NAR
ON	0.00	179.59							
	20:11:20.246	20:18:29.653	18	1653	70	30.10	18.00	ON	NAR
ON	0.00	179.58							
	20:23:11.958	20:30:04.964	19	1649	70	30.10	18.00	ON	NAR
ON	0.00	359.58							
	20:34:49.269	20:41:37.876	19	1648	70	30.10	18.00	ON	NAR
ON	0.00	179.58							

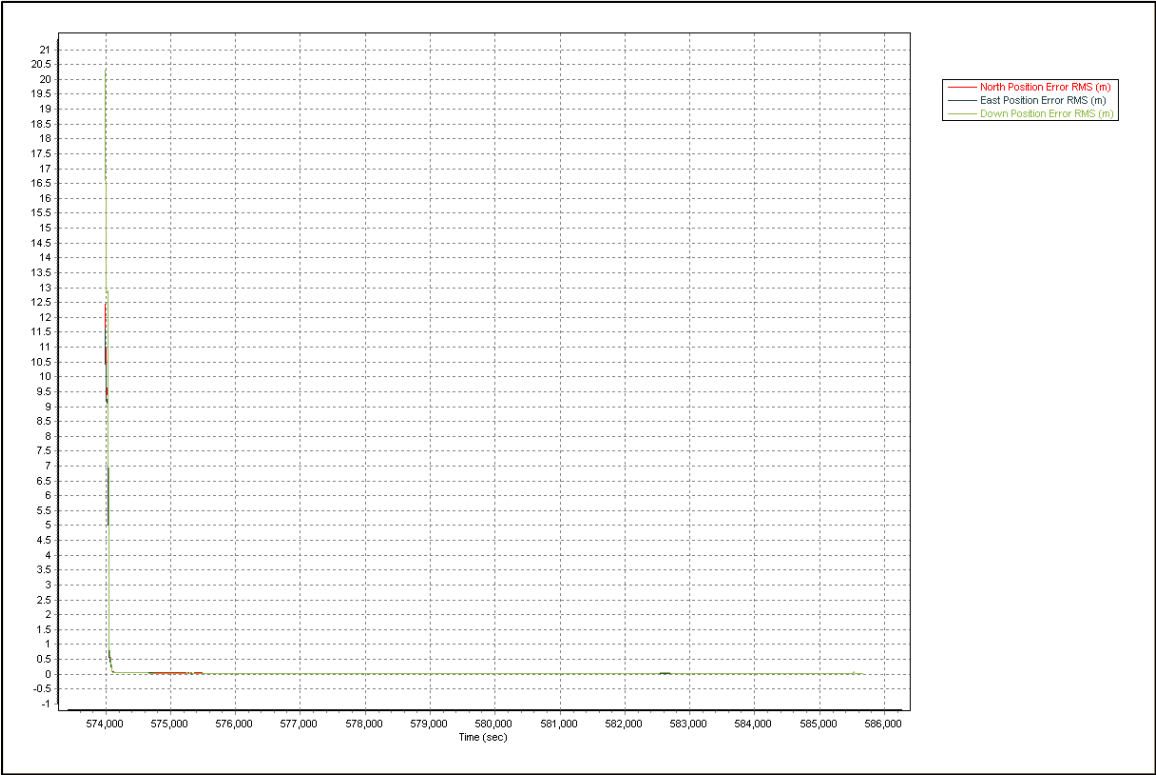
20:34:49.269	20:41:37.876	19	1648	70	30.10	18.00	ON	NAR
ON	0.00							
20:43:44.578	20:47:00.281	19	1638	70	30.10	18.00	ON	NAR
ON	0.00							

□

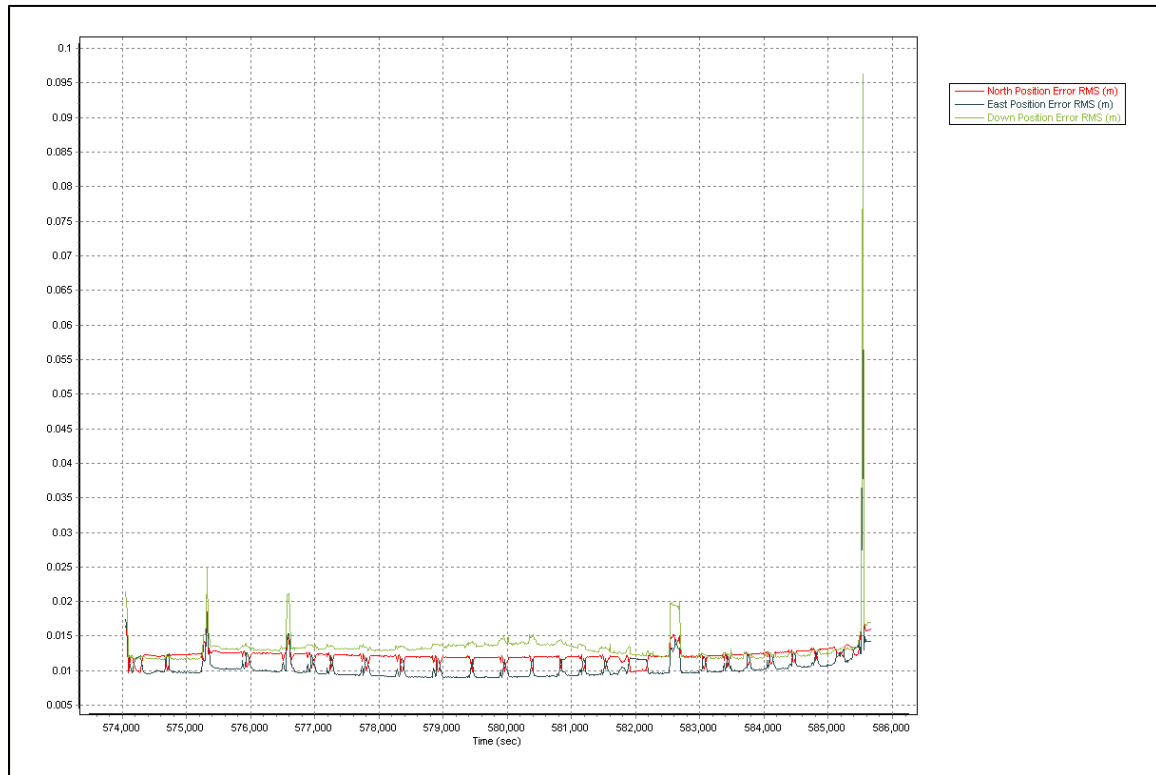
# 101211A-246-BASELINELENGTH



101211A-246-NEDPOSITIONERROR-FORWARD

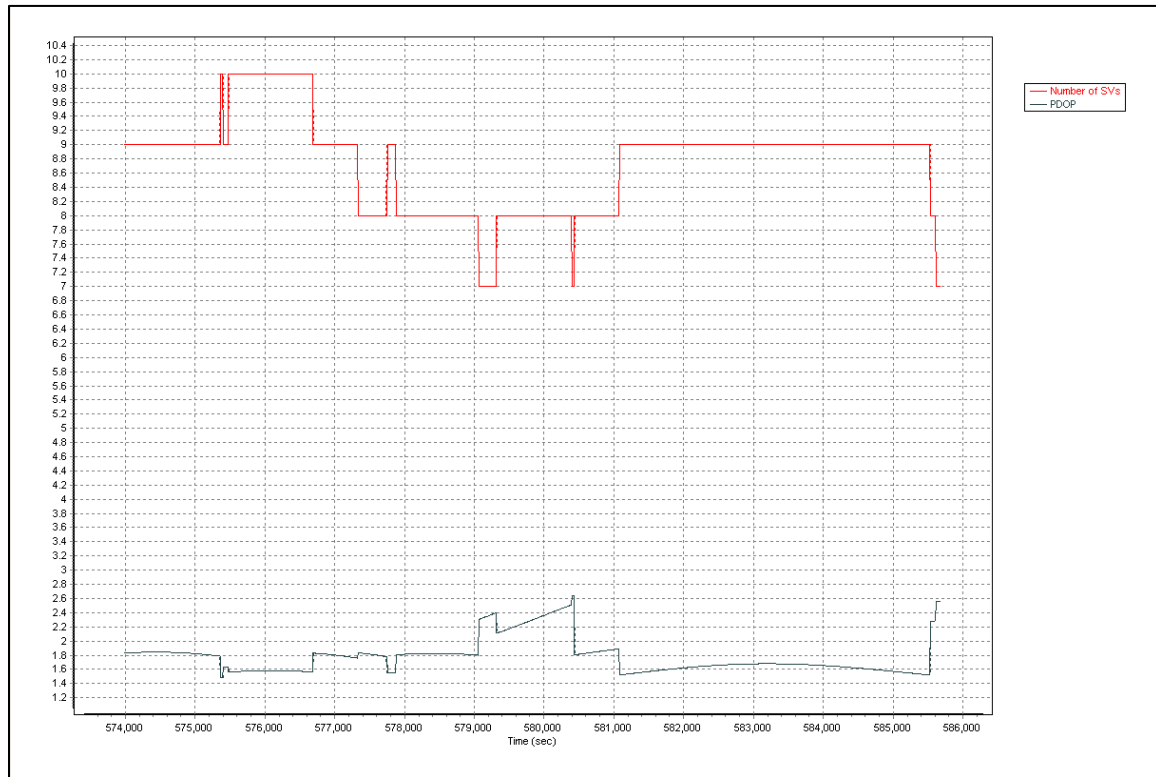


# 101211A-246-NEDPOSITIONERROR-SMOOTHED

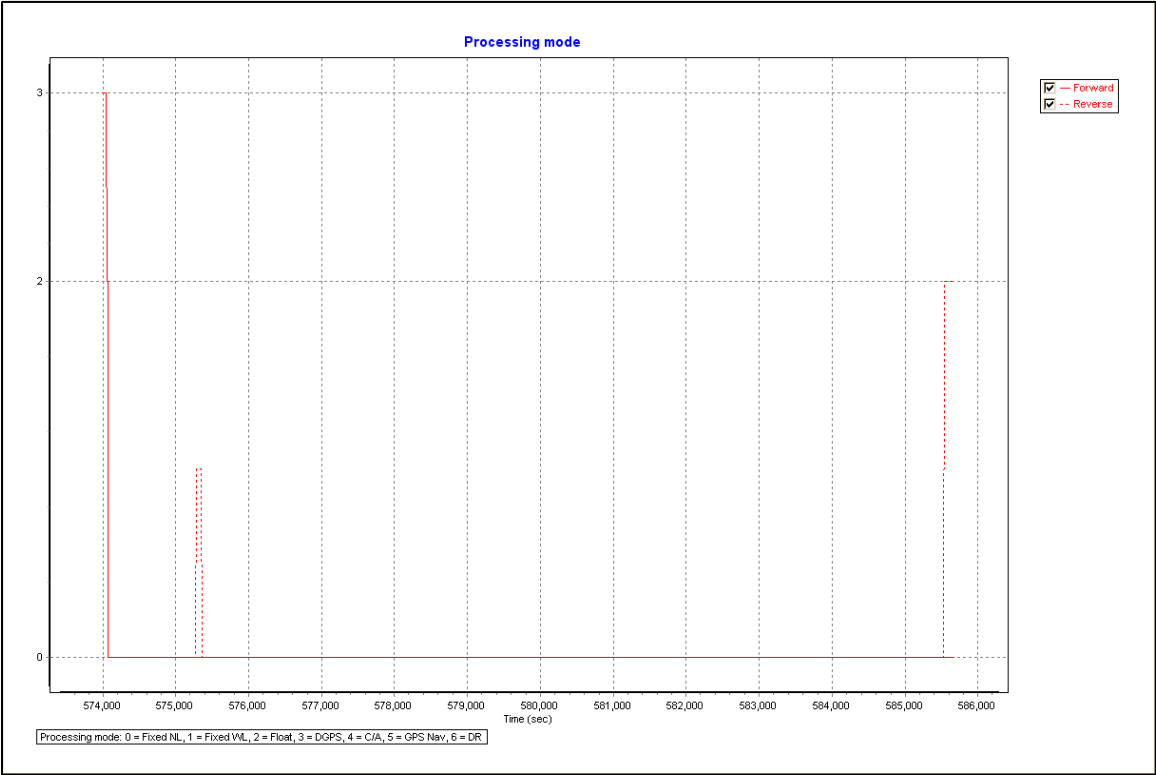




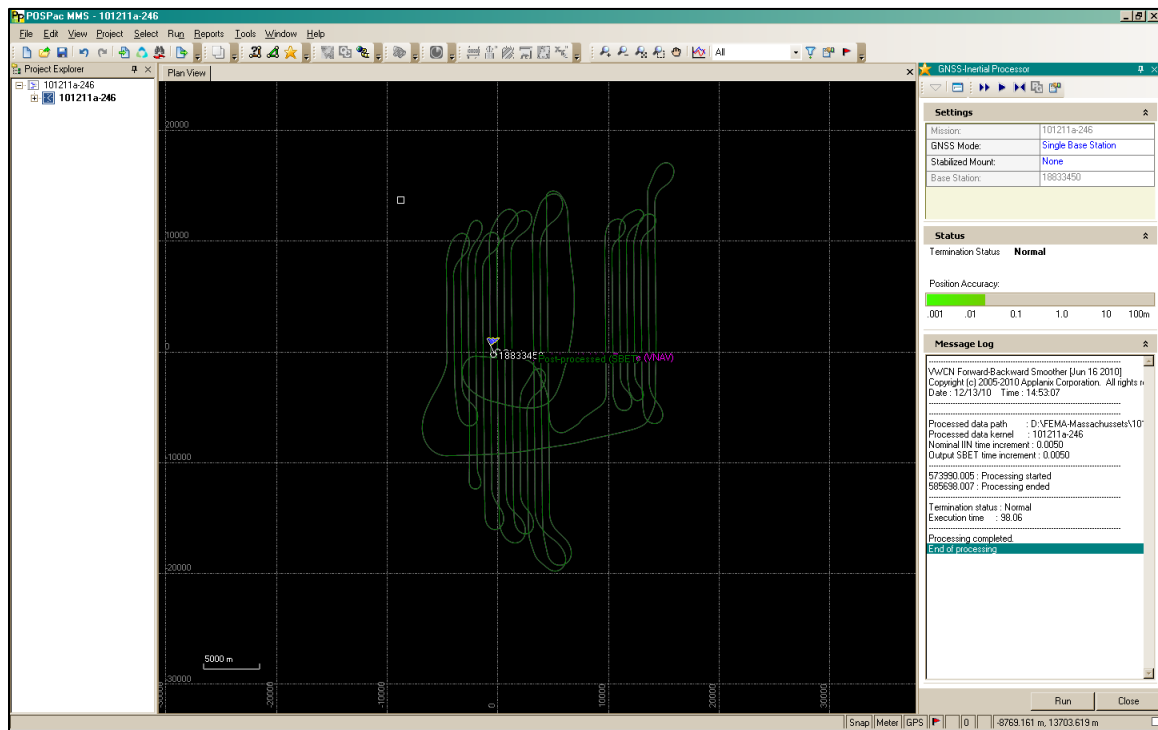
# 101211A-246-PDOP&SVS



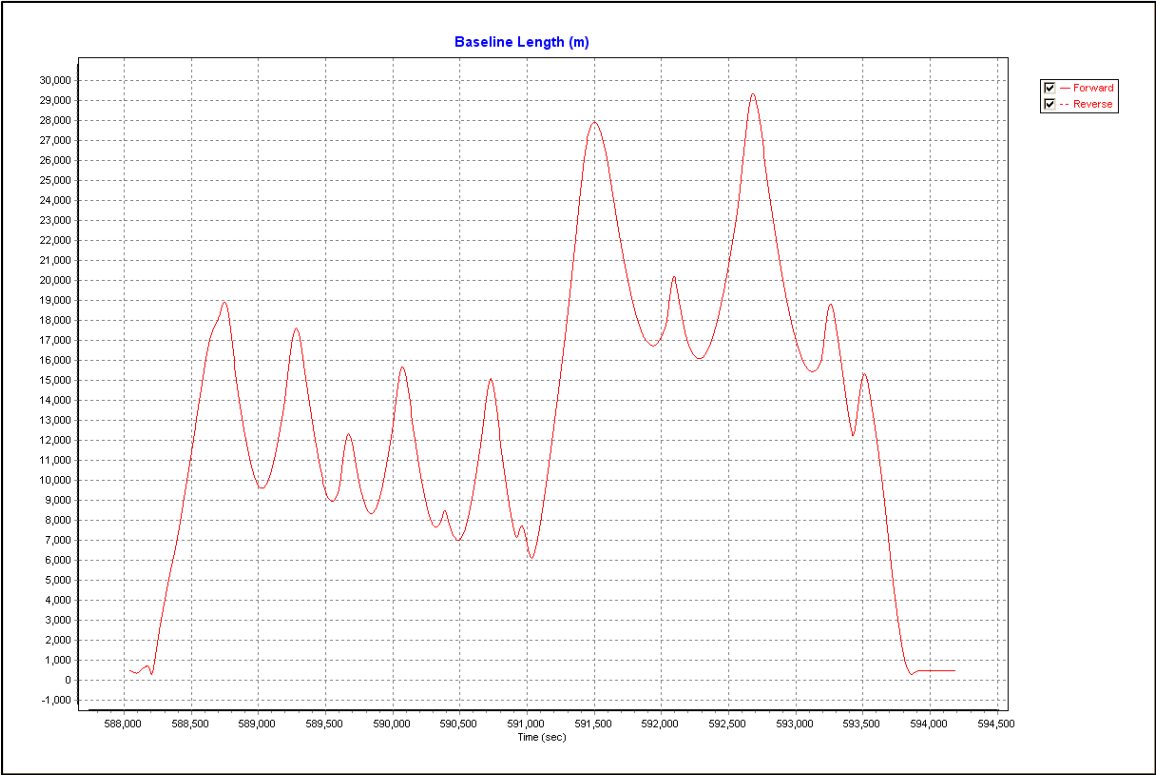
101211A-246-PROCMODE



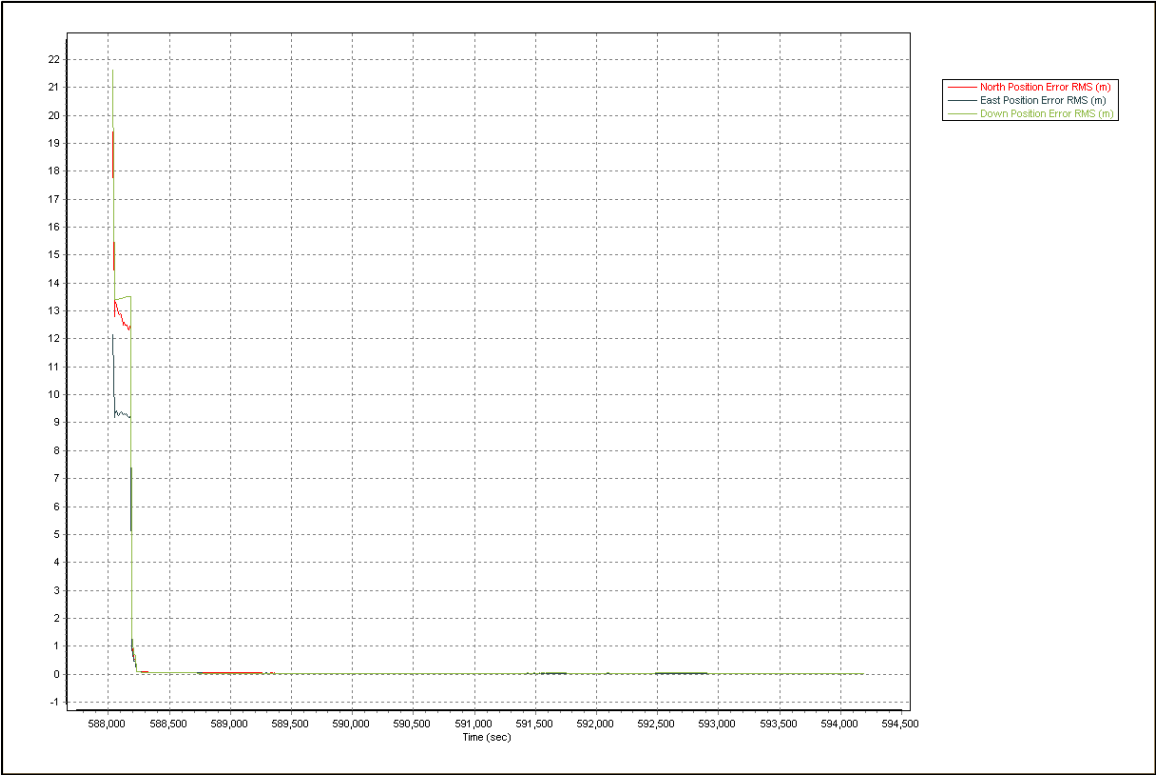
# 101211A-246-TRAJECTORY



101211B-246-BASELINELENGTH

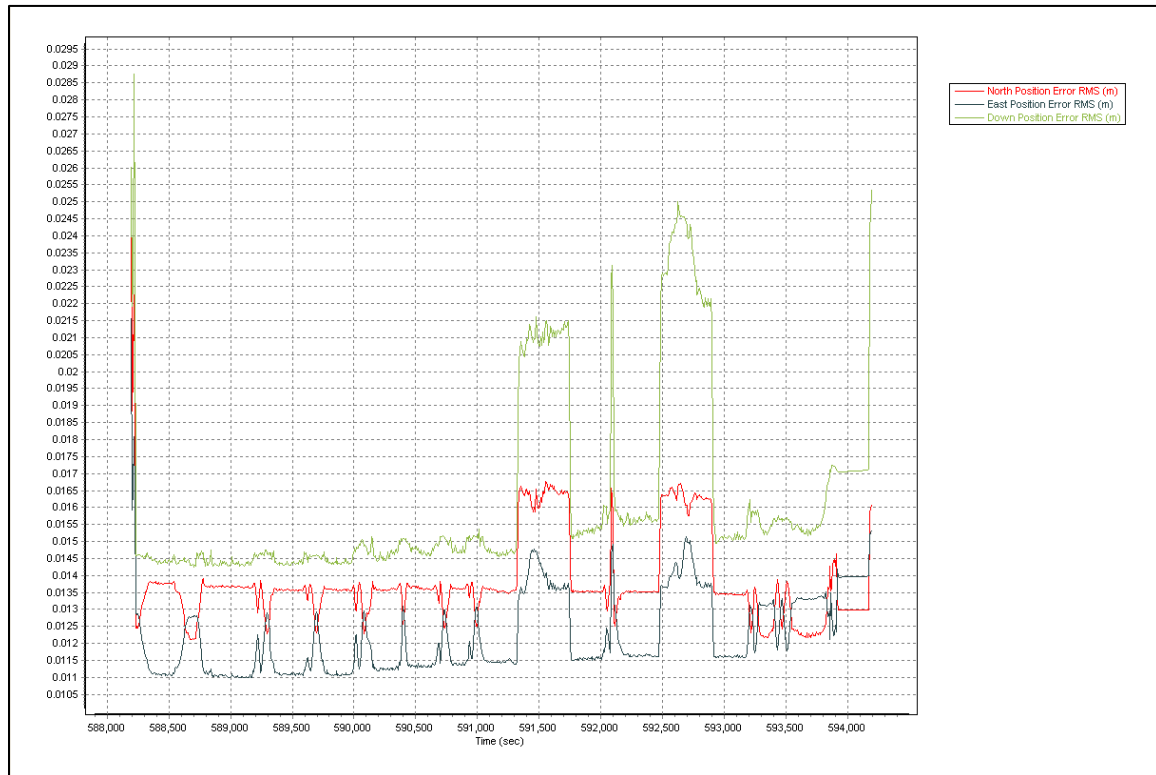


101211B-246-NEDPOSITIONERROR-FORWARD

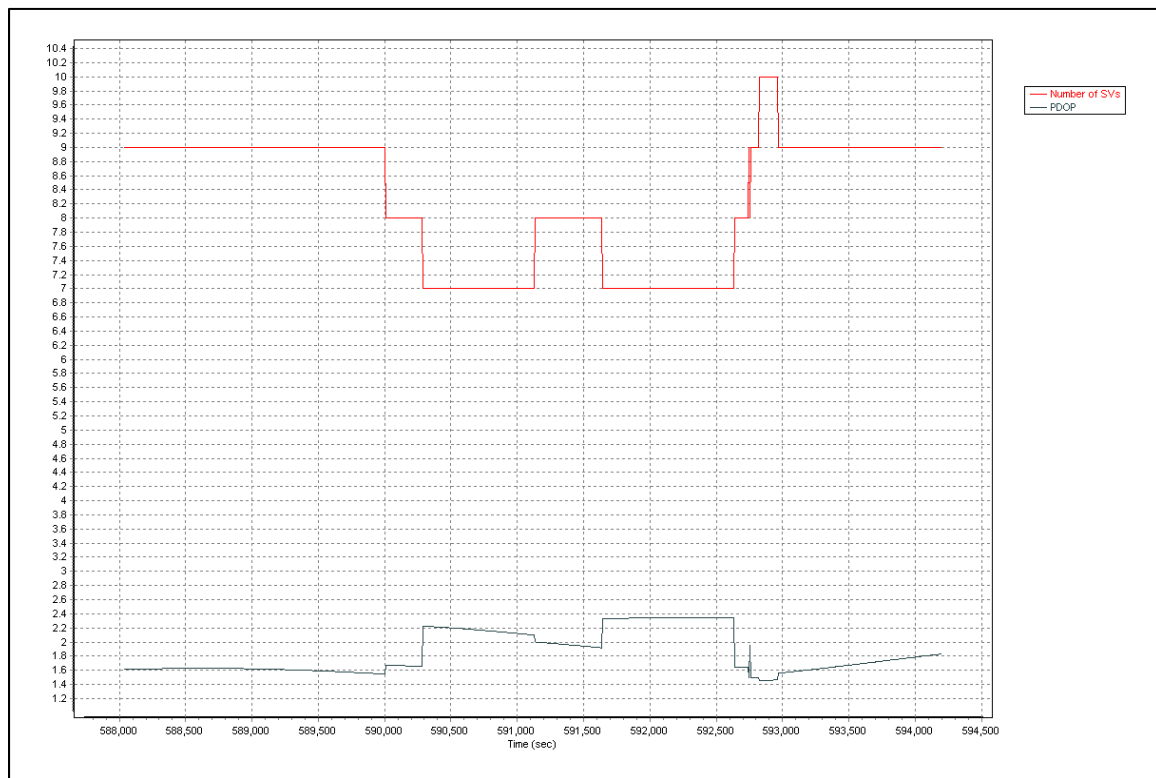




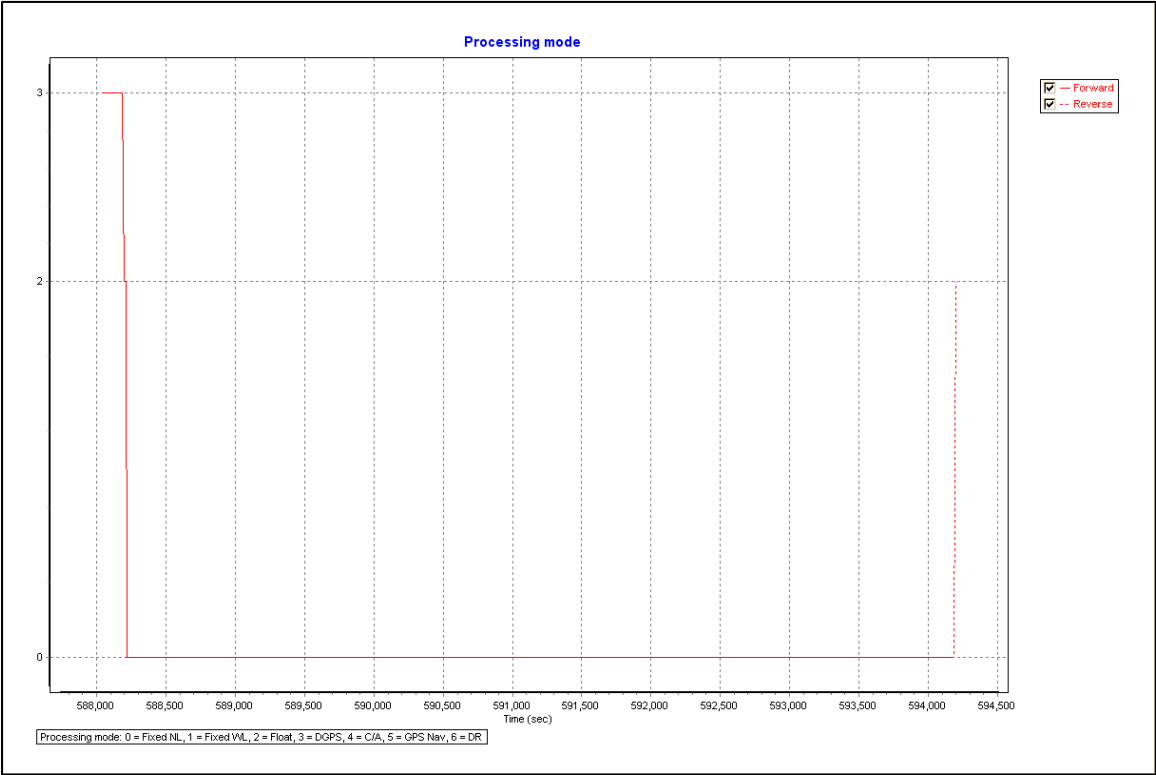
# 101211B-246-NEDPOSITIONERROR-SMOOTHED



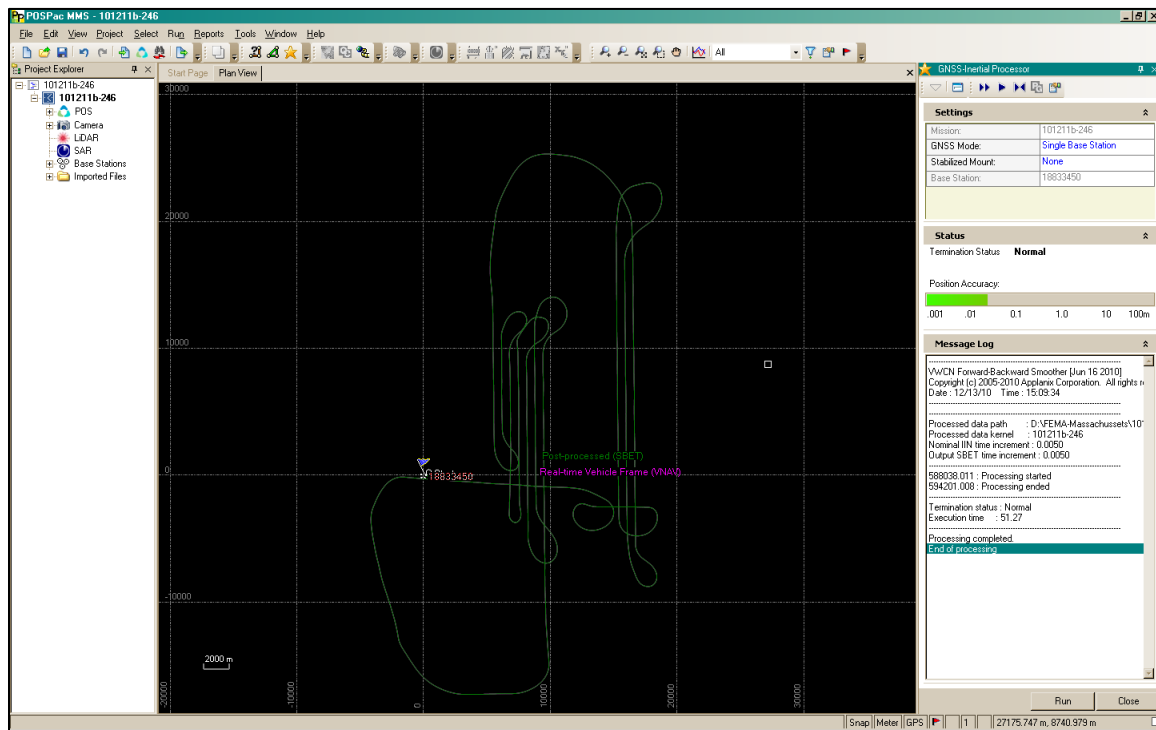
# 101211B-246-PDOP&SVS



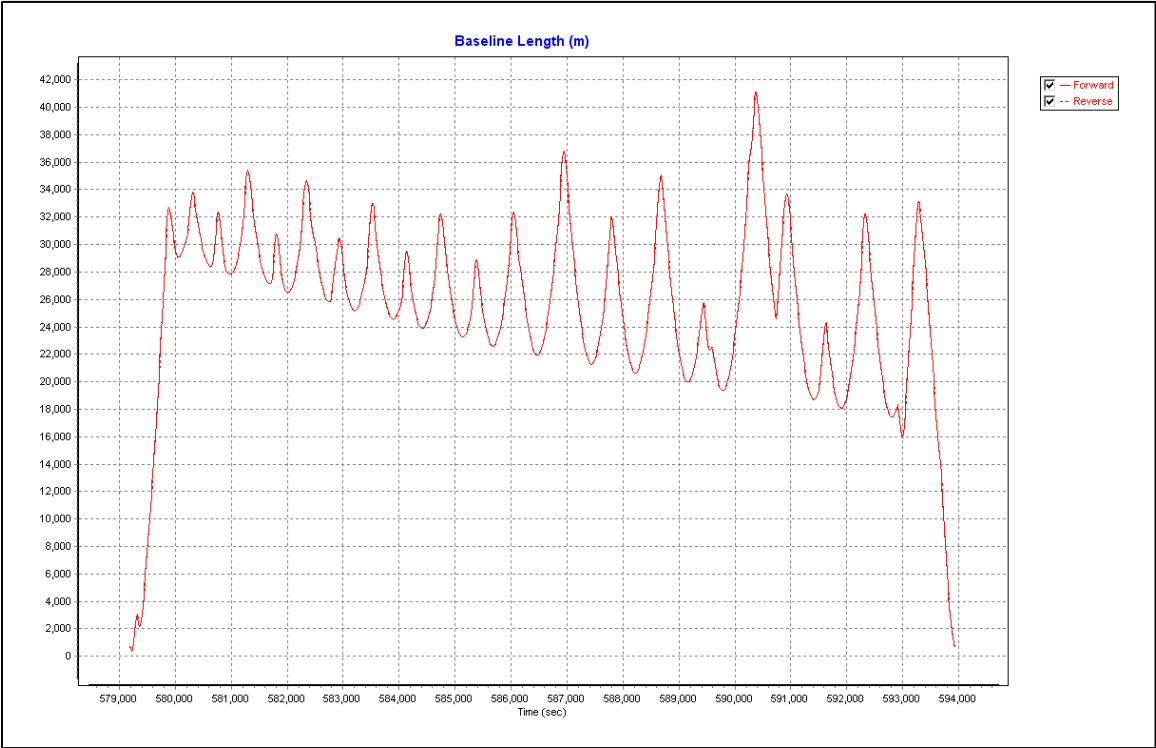
101211B-246-PROCMODE



# 101211B-246-TRAJECTORY

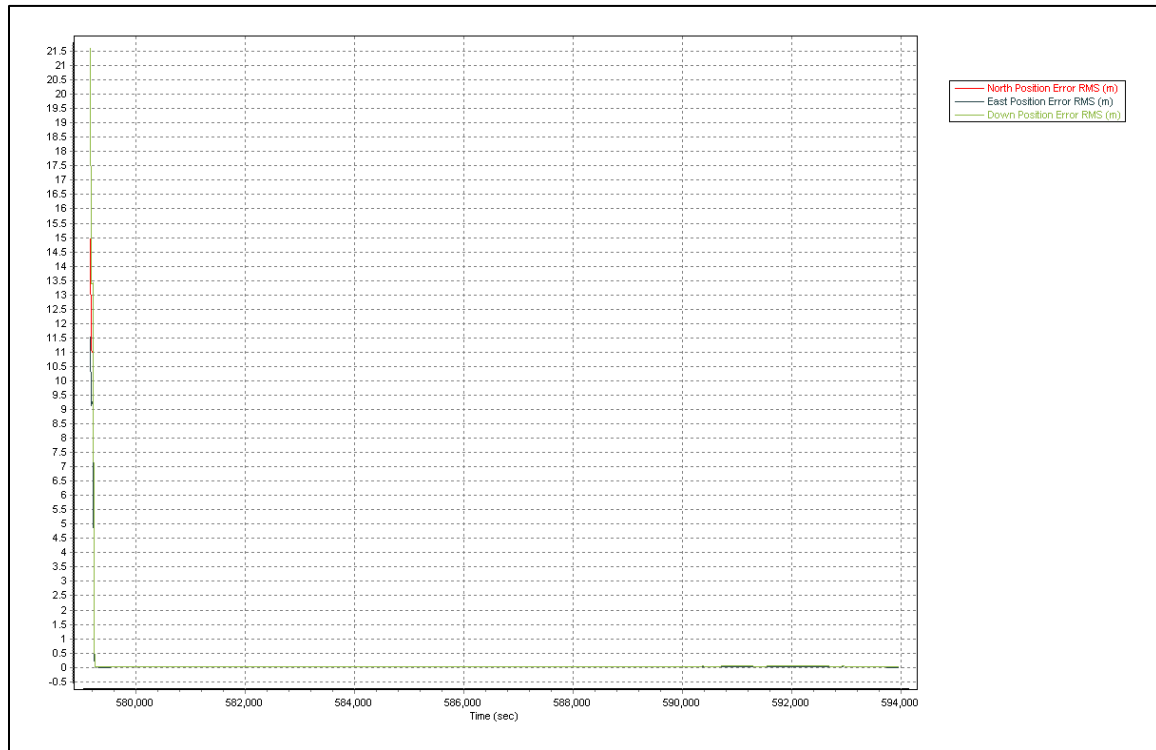


101211B-247\_BASELINE

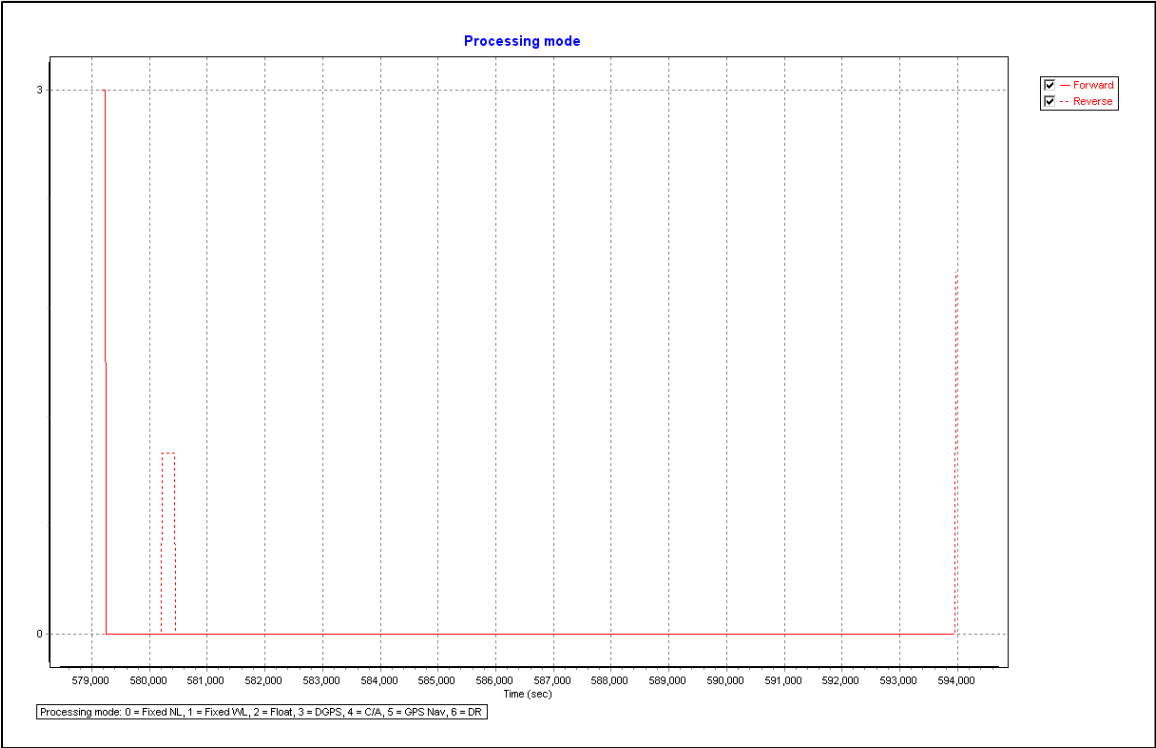




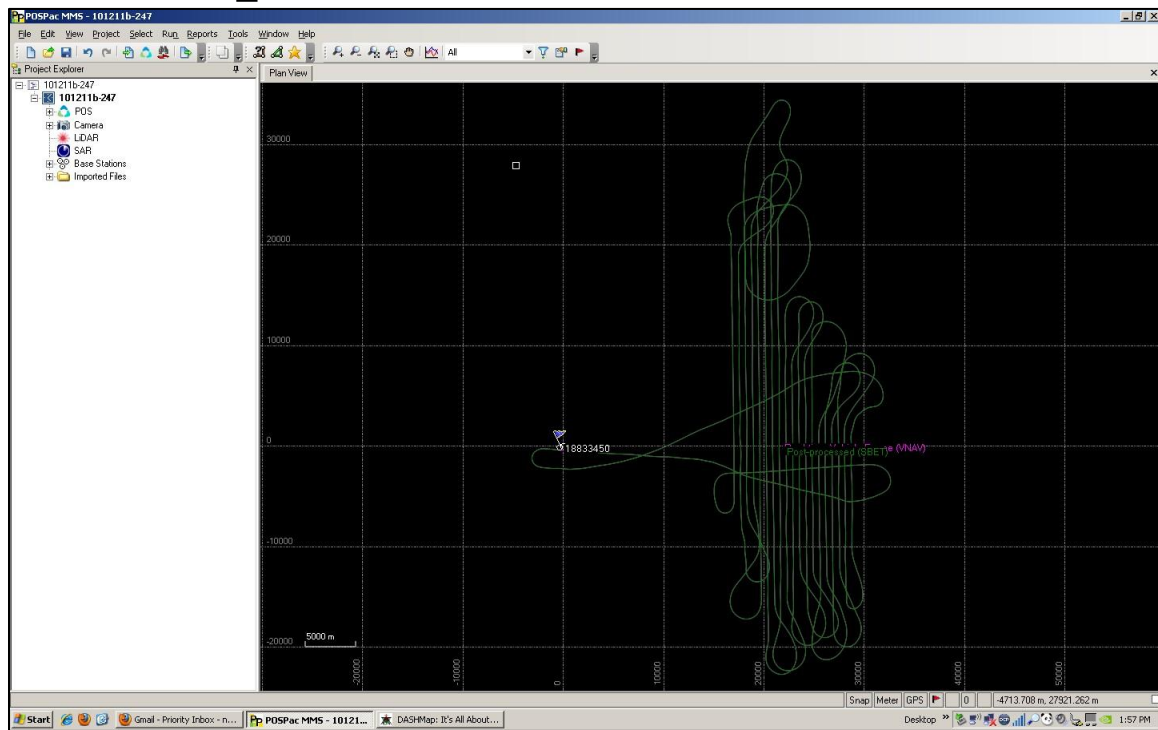
# 101211B-247\_FORWARDPROCESSPERFMETRIC\_NED



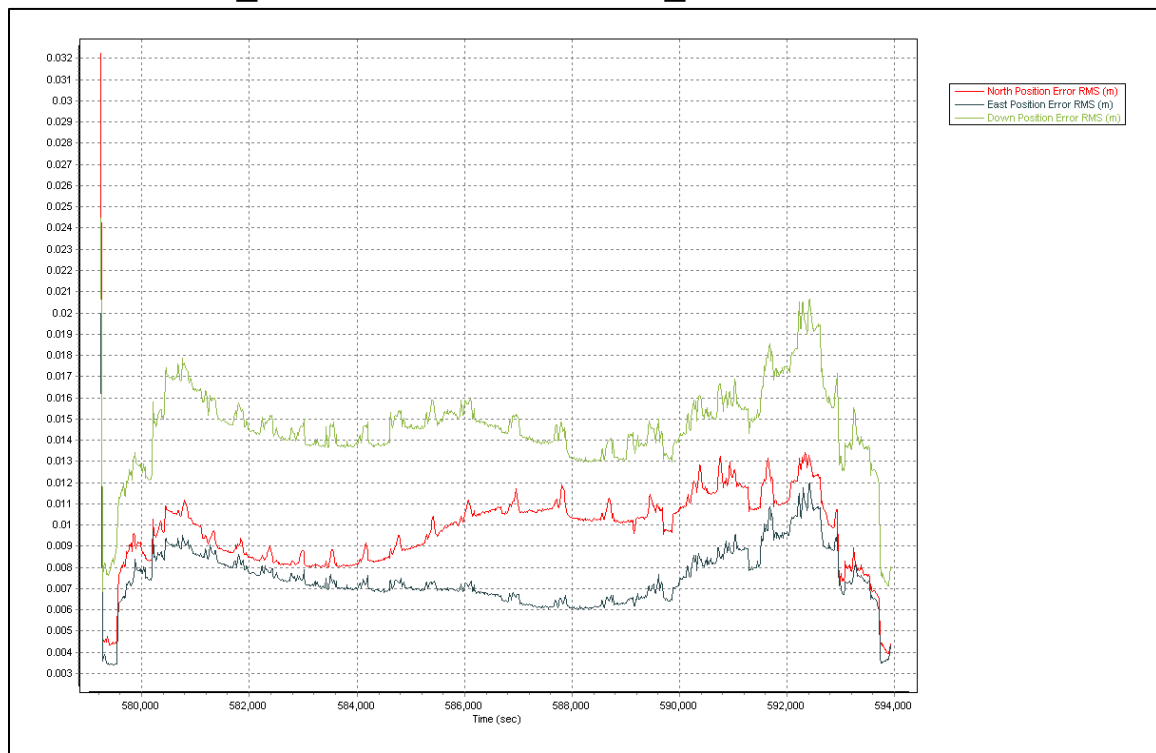
101211B-247\_PROCESSMODE



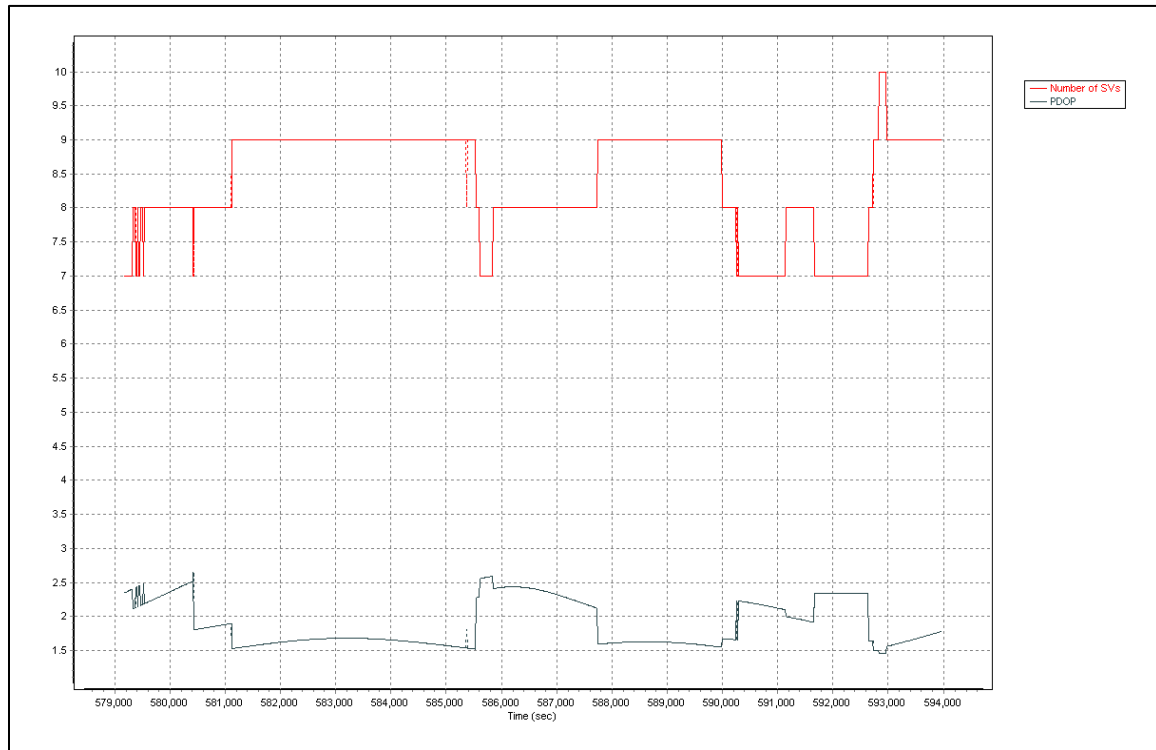
# 101211B-247\_SCREENSHOT



# 101211B-247\_SMOOTHPERFMETRIC\_NED



101211B-247\_SVS&PDOP



March 28, 2011

Post Flight Report  
PSI Project 7556-005  
Narragansett, MA LiDAR

CONTRACT: \_\_\_\_\_  
Client: STARR  
Project Name: Narragansett  
Attached Reference file: 7556-005\_Narragansett\_MA\_Background.ZIP

General Specifications: 1-meter nominal spacing LiDAR Acquisition and processing with a 24.5 cm vertical accuracy at 95% confidence.

Acquisition Dates: LiDAR data for the Narragansett data was acquired on the dates of 12/08/2010, 12/10/2010, over 6 lifts by two different Aircraft.

Equipment Used: The data was collected with a Optech Gemini, Serial Numbers 246 and 247, Base GPS Receiver used was a Trimble 5700 collecting data at half second intervals. The aircraft used were Cessna 206 models, tail numbers N2448G and N7266Z. The pilots were Mark Young and Nick Greenwell and the Operators were Jeremy Berry and Nathan Galieti. The Base Station was set on the monument "Mansfield, LW5147" at the Mansfield Airport 1B9 set by the crews.

Project: The project consisted of 44 flight lines of 390.66 miles. The project was flown at an altitude of 5,000 feet above ground and at a planned average speed of 116 knots with a field of view of 36 degrees. The scan rates used was 30.1 Hz with a Laser Pulse Rate of 71.429 Hz with Multi-Pulse enabled. The full swath width was 989.18 meters with a planned sidelap of 30%. The point spacing was .912 meter with a NADIR point density of 1.2 points per square meter and an average point density of 2.93 points per square meter. The planned vertical accuracy was 0.13 meters. The area consisted of 217 square miles.

GPS Base Station / Monument: The Base Station was set on the monument "Mansfield, LW5147" at the Mansfield Airport 1B9 set by the crews. Information on this monument is included in the attached .ZIP file under "Base Station Data".

Control: 13 control points were collected as part of the project and used to calibrate the project data, remove any bias and verify accuracy. This data is compared to the collected model and results indicated below. This control data is included in the attached .ZIP file under "Control".



Flight Files: The planned flight files are included as reference in the attached .ZIP file under “Flight Files”.

Flight Logs: Flight Logs used by the crew are included in the attached .ZIP file under “Flight Logs” and include the following type information:

- job #/name
- block or AOI
- date (s) flown
- aircraft tail #
- lines - #
- lines - direction
- lines – altitude
- lines – speed
- conditions
- comments
- pilot name
- operator name
- AGC switch
- GPS base station used

Processing Summary: Data is included in the attached .ZIP file under “Processing Summary” which includes GPS / IMU processing summary data including at a minimum:

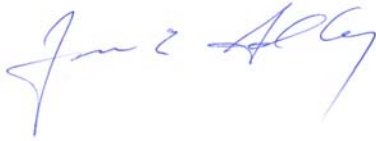
- Processing Logs
- Message Logs
- Extract Logs
- Laser configuration files for each lift
- Max Horizontal GPS Variance (cm)
- Max Vertical GPS Variance (cm)
- Notes on GPS quality (High, Good, etc.)
- GPS separation plot
- GPS altitude plot
- PDOP plot
- Plot of GPS distance from base station/s

Project Coverage: within the attached .ZIP file in the “Project Coverage” directory is the overall boundary Shape File and the as flown trajectory Shape Files which include the project calibration flight lines (cross flights).

Accuracy: The LiDAR data was tested against the Control check points indicated above and the results are included in the “Accuracy Results” directory in the attached .ZIP file.

The LiDAR data as collected tested at 0.095 (meters) fundamental vertical accuracy at 95% confidence level. Within the accuracies indicated in the specifications, as provided.

Sincerely,

A handwritten signature in blue ink, appearing to read "Forrest Godby". The signature is fluid and cursive, with the first name "Forrest" and last name "Godby" clearly distinguishable.

Forrest Godby  
Senior Project Manager / Flight Operations Manager







309124.28,4627858.76,NAR101  
315137.56,4629447.78,NAR102  
316540.02,4637360.83,NAR103  
307444.56,4640935.41,NAR104  
312364.10,4645307.56,NAR105  
305881.82,4649935.23,NAR106  
315387.71,4653817.28,NAR107  
321582.88,4651547.08,NAR108  
325222.77,4660253.86,NAR109  
316403.93,4662726.09,NAR110  
308587.34,4656165.11,NAR111  
329772.47,4663745.59,NGS\_AJ4042  
309178.59,4656697.39,NGS\_AJ4047

Statistical Analysis	
Average Dz	0.08
Minimum Dz	-0.029
Maximum Dz	0.15
RMSE	0.095
Standard Deviation	0.054

Coordinate System
Horizontal Projection
NAD83 - UTM Zone 19N, Meters
Vertical Datum
NAVD88 - Geoid09, Meters

Point	Easting	Northing	Known Z	LIDAR Z	Dz
NAR101	309124.28	4627858.76	4.18	4.29	0.11
NAR102	315137.56	4629447.78	30.45	30.51	0.06
NAR103	316540.02	4637360.83	37.43	37.56	0.13
NAR104	307444.56	4640935.41	28.97	29.04	0.07
NAR105	312364.10	4645307.56	41.21	41.31	0.10
NAR106	305881.82	4649935.23	81.73	81.81	0.08
NAR107	315387.71	4653817.28	46.45	46.60	0.15
NAR108	321582.88	4651547.08	29.84	29.91	0.07
NAR109	325222.77	4660253.86	53.10	53.21	0.11
NAR110	316403.93	4662726.09	78.04	78.16	0.12
NAR111	308587.34	4656165.11	71.09	71.17	0.08
NGS_AJ4042	329772.47	4663745.59	74.83	74.81	-0.02
NGS_AJ4047	309178.59	4656697.39	61.37	61.34	-0.03

## Base Monument for NARR\_1B9

DATABASE = ,PROGRAM = datasheet, VERSION = 7.85  
1 National Geodetic Survey, Retrieval Date = NOVEMBER 28, 2010  
LW5147 \*\*\*\*\*  
LW5147 PACS - This is a Primary Airport Control Station.  
LW5147 DESIGNATION - MANSFIELD  
LW5147 PID - LW5147  
LW5147 STATE/COUNTY- MA/BRISTOL  
LW5147 USGS QUAD -  
LW5147  
LW5147 \*CURRENT SURVEY CONTROL  
LW5147  
LW5147\* NAD 83(2007)- 41 59 51.83741(N) 071 11 32.63915(W) ADJUSTED  
LW5147\* NAVD 88 - 35.61 (meters) 116.8 (feet) GPS OBS  
LW5147  
LW5147 EPOCH DATE - 2002.00  
LW5147 X - 1,530,446.961 (meters) COMP  
LW5147 Y - -4,493,704.408 (meters) COMP  
LW5147 Z - 4,245,421.236 (meters) COMP  
LW5147 LAPLACE CORR- 2.37 (seconds) DEFLEC09  
LW5147 ELLIP HEIGHT- 6.817 (meters) (02/10/07) ADJUSTED  
LW5147 GEOID HEIGHT- -28.78 (meters) GEOID09  
LW5147  
LW5147 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----  
LW5147 Type PID Designation North East Ellip  
LW5147 -----  
LW5147 NETWORK LW5147 MANSFIELD 0.29 0.24 0.69  
LW5147 -----  
LW5147  
LW5147.This mark is at Mansfield Airport (1B9)  
LW5147  
LW5147.The horizontal coordinates were established by GPS observations  
LW5147.and adjusted by the National Geodetic Survey in February 2007.  
LW5147  
LW5147.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).  
LW5147.See [National Readjustment](#) for more information.  
LW5147.The horizontal coordinates are valid at the epoch date displayed above.  
LW5147.The epoch date for horizontal control is a decimal equivalence  
LW5147.of Year/Month/Day.  
LW5147  
LW5147.The orthometric height was determined by GPS observations and a  
LW5147.high-resolution geoid model.  
LW5147  
LW5147.GPS derived orthometric heights for airport stations designated as  
LW5147.PACS or SACS are published to 2 decimal places. This maintains  
LW5147.centimeter relative accuracy between the PACS and SACS. It does  
LW5147.not indicate centimeter accuracy relative to other marks which are  
LW5147.part of the NAVD 88 network.  
LW5147  
LW5147.[Photographs](#) are available for this station.  
LW5147  
LW5147.The X, Y, and Z were computed from the position and the ellipsoidal ht.  
LW5147  
LW5147.The Laplace correction was computed from DEFLEC09 derived deflections.  
LW5147



LW5147.The ellipsoidal height was determined by GPS observations  
LW5147.and is referenced to NAD 83.

LW5147

LW5147.The geoid height was determined by GEOID09.

LW5147

LW5147;		North	East	Units	Scale Factor	Converg.
LW5147;SPC MA M	-	860,863.397	225,485.019	MT	0.99997079	+0 12 23.8
LW5147;SPC MA M	-	2,824,349.33	739,778.77	sFT	0.99997079	+0 12 23.8
LW5147;UTM 19	-	4,651,849.573	318,419.504	MT	1.00000573	-1 28 02.4

LW5147

LW5147!	-	Elev Factor	x	Scale Factor	=	Combined Factor
LW5147!SPC MA M	-	0.99999893	x	0.99997079	=	0.99996972
LW5147!UTM 19	-	0.99999893	x	1.00000573	=	1.00000466

LW5147

LW5147:		Primary Azimuth Mark	Grid Az
LW5147:SPC MA M	-	MANSFIELD AZ MK	311 03 51.3
LW5147:UTM 19	-	MANSFIELD AZ MK	312 44 17.5

LW5147

LW5147	PID	Reference Object	Distance	Geod. Az
LW5147				ddmmss.s
LW5147	LW5356 419 A		235.366 METERS	14336
LW5147	MY5414 MANSFIELD AZ MK		APPROX. 0.7 KM	3111615.1

LW5147

LW5147 SUPERSEDED SURVEY CONTROL

LW5147

LW5147	NAD 83(1996)-	41 59 51.83745(N)	071 11 32.63956(W)	AD(	) A
LW5147	ELLIP H (06/22/01)	6.810 (m)		GP(	) 4 1
LW5147	NAD 83(1996)-	41 59 51.83738(N)	071 11 32.63964(W)	AD(	) 1
LW5147	ELLIP H (05/22/00)	6.809 (m)		GP(	) 4 1
LW5147	NAD 83(1996)-	41 59 51.83703(N)	071 11 32.63959(W)	AD(	) 1
LW5147	ELLIP H (06/29/98)	6.797 (m)		GP(	) 4 1
LW5147	NAD 83(1992)-	41 59 51.83556(N)	071 11 32.63872(W)	AD(	) 1
LW5147	ELLIP H (10/08/95)	6.770 (m)		GP(	) 4 2
LW5147	NAD 83(1986)-	41 59 51.83432(N)	071 11 32.63531(W)	AD(	) 1
LW5147	NGVD 29 (07/20/87)	35.9 (m)	118. (f)	GPS OBS	

LW5147

LW5147.Superseded values are not recommended for survey control.

LW5147.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.

LW5147.[See file dsdata.txt](#) to determine how the superseded data were derived.

LW5147

LW5147\_U.S. NATIONAL GRID SPATIAL ADDRESS: 19TCG1841951849(NAD 83)

LW5147\_MARKER: DH = HORIZONTAL CONTROL DISK

LW5147\_SETTING: 66 = SET IN ROCK OUTCROP

LW5147\_SP\_SET: ROCK OUTCROP

LW5147\_STAMPING: MANSFIELD 1985

LW5147\_MARK LOGO: NGS

LW5147\_MAGNETIC: N = NO MAGNETIC MATERIAL

LW5147\_STABILITY: A = MOST RELIABLE AND EXPECTED TO HOLD

LW5147+STABILITY: POSITION/ELEVATION WELL

LW5147\_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR

LW5147+SATELLITE: SATELLITE OBSERVATIONS - March 17, 2010

LW5147

LW5147	HISTORY	- Date	Condition	Report By
LW5147	HISTORY	- 1985	MONUMENTED	NGS
LW5147	HISTORY	- 1985	GOOD	NGS

LW5147	HISTORY	- 19861121	GOOD	MAGS
LW5147	HISTORY	- 19880520	GOOD	NGS
LW5147	HISTORY	- 19990930	GOOD	WOOLPT
LW5147	HISTORY	- 20000608	GOOD	NGS
LW5147	HISTORY	- 20100317	GOOD	INDIV

LW5147

LW5147 STATION DESCRIPTION

LW5147

LW5147'DESCRIBED BY NATIONAL GEODETIC SURVEY 1985 (REP)

LW5147'THE STATION IS LOCATED ABOUT 4.0 KM (2.5 MI)

LW5147'SOUTH-SOUTHEAST OF MANSFIELD, 0.4 KM (0.25 MI) EAST OF INTERSTATE

LW5147'HIGHWAY 495, AT THE MANSFIELD MUNICIPAL AIRPORT AND NEAR THE END OF

LW5147'THE NORTHWEST-SOUTHEAST RUNWAY.

LW5147'OWNERSHIP--MANSFIELD MUNICIPAL AIRPORT, DAVID AND ROY POWELL,

LW5147'AIRPORT MANAGERS, MANSFIELD MA 02048, PHONE 617-339-3624

LW5147'

LW5147'TO REACH THE STATION FROM THE POST OFFICE IN MANSFIELD, GO SOUTH ON

LW5147'MAIN STREET, FOR 2.0 KM (1.25 MI) TO A CROSSROAD, WILLOW STREET ON

LW5147'THE RIGHT, FRUIT STREET ON THE LEFT, TURN LEFT AND GO EAST AND

LW5147'SOUTHEAST ON FRUIT STREET FOR 1.3 KM (0.8 MI) TO A DRIVEWAY LEADING

LW5147'TO THE AIRPORT ON THE RIGHT. TURN RIGHT AND GO SOUTH ON THE DRIVEWAY

LW5147'FOR 1.0 KM (0.05 MI) TO A GATE AT THE TERMINAL BUILDING. PASS

LW5147'THROUGH THE GATE AND GO SOUTHEAST FOR 0.3 KM (0.2 MI) TO THE WIND

LW5147'SOCK AND THE AZIMUTH MARK. CONTINUE SOUTHEAST FOR 0.7 KM (0.45 MI)

LW5147'TO THE STATION AS DESCRIBED.

LW5147'

LW5147'THE STATION IS A STANDARD NGS DISK

LW5147'STAMPED---MANSFIELD 1985 --,

LW5147'SET INTO A DRILL HOLE IN ROCK OUTCROP. LOCATED

LW5147'86.3 METERS (283.0 FT) WEST-NORTHWEST FROM THE EXTREME SOUTHEAST

LW5147'CORNER OF THE RUNWAY

LW5147'34.7 METERS (114.0 FT) WEST-NORTHWEST FROM THE SOUTH BLUE LIGHT OF

LW5147'FOUR BLUE LIGHTS.

LW5147'18.3 METERS (60.0 FT) SOUTHEAST FROM THE SOUTHERLY EDGE OF THE

LW5147'RUNWAY AND

LW5147'10.1 METERS (33.0 FT) NORTHEAST FROM A CARSONITE WITNESS POST SET ON

LW5147'EDGE OF A DRAINAGE DITCH.

LW5147'

LW5147'AZIMUTH MARK NO. 1 IS A STANDARD NGS DISK

LW5147'STAMPED---MANSFIELD 1985---,

LW5147'SET INTO THE TOP OF A ROUND CONCRETE MONUMENT

LW5147'30 CM IN DIAMETER FLUSH WITH GROUND. LOCATED

LW5147'25.9 METERS (85.0 FT) SOUTHEAST FROM THE WIND SOCK AND

LW5147'16.6 METERS (54.0 FT) EAST-NORTHEAST FROM THE EAST EDGE OF THE

LW5147'TAXIWAY.

LW5147'TO REACH THE AZIMUTH FROM THE STATION,

LW5147'GO NORTHWEST FOR 0.7 KM (0.45 MI) TO THE WIND SOCK AND THE

LW5147'AZIMUTH MARK AS DESCRIBED.

LW5147'THE UNDERGROUND MARK IS A STANDARD NGS DISK

LW5147'STAMPED---MANSFIELD 1985---,

LW5147'SET INTO AN IRREGULAR MASS OF CONCRETE 1.1 METERS BELOW THE SURFACE.

LW5147'

LW5147'AN EDM TIE WAS MADE TO MANSFIELD AZ MK

LW5147'

LW5147'DESCRIBED BY R. T. WOODRUFF

LW5147

LW5147 STATION RECOVERY (1985)

LW5147  
LW5147'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1985  
LW5147'RECOVERED IN GOOD CONDITION.  
LW5147  
LW5147 STATION RECOVERY (1986)  
LW5147  
LW5147'RECOVERY NOTE BY MASSACHUSETTS GEODETIC SURVEY 1986  
LW5147'RECOVERED IN GOOD CONDITION.  
LW5147  
LW5147 STATION RECOVERY (1988)  
LW5147  
LW5147'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1988  
LW5147'THE STATION WAS RECOVERED IN GOOD CONDITION AS DESCRIBED IN THE 1985  
LW5147'AIRPORT SURVEY PROJECT. A NEW DESCRIPTION FOLLOWS.  
LW5147'THE STATION IS LOCATED ABPIT 2.9 KM (1.80 MI) SOUTHEAST FROM THE  
LW5147'CENTER OF MANSFIELD, 0.5 KM (0.30 MI) NORTH OF INTERSTATE HIGHWAY 495,  
LW5147'AT THE MANSFIELD MUNICIPAL AIRPORT, NEAR THE SOUTH CORNER OF THE  
LW5147'SINGLE RUNWAY.  
LW5147'OWNERSHIP--CITY OF MANSFIELD, C/O PRESIDENT RAYMOND G. POWELL, FRUIT  
LW5147'STREET, MANSFIELD MA 02048. PHONE 617 339-3624.  
LW5147'TO REACH THE STATION FROM THE POST OFFICE IN MANSFIELD, GO SOUTH FOR  
LW5147'1.9 KM (1.20 MI) ON SOUTH MAIN STREET TO A PAVED CROSS ROAD, FRUIT  
LW5147'STREET ON THE LEFT AND WILLOW STREET ON THE RIGHT. THIS POINT MAY  
LW5147'ALSO BE REACHED BY GOING NORTH FOR 1.2 KM (0.75 MI) ON SOUTH MAIN  
LW5147'STREET FROM THE OVERPASS BRIDGE OVER INTERSTATE HIGHWAY 495 AT EXIT  
LW5147'11. TURN LEFT AND GO SOUTHEAST FOR 1.1 KM (0.70 MI) ON FRUIT STREET  
LW5147'TO A PAVED DRIVE ON THE RIGHT, LEADING TO THE WEST END OF THE HANGARS.  
LW5147'TURN RIGHT AND GO SOUTHWEST THEN SOUTHEAST FOR 0.4 KM (0.25 MI) ON  
LW5147'THE PAVED DRIVE BETWEEN THE HANGARS, ACROSS THE PARKING RAMP THEN  
LW5147'SOUTHWEST ON THE TAXIWAY TO THE SOUTHEAST END OF THE RUNWAY. CROSS  
LW5147'THE RUNWAY THEN GO NORTHWEST FOR 86 M (282.2 FT) TO THE STATION ON THE  
LW5147'SOUTHWEST SIDE OF THE RUNWAY.  
LW5147'THE STATION IS A STANDARD NGS DISK SET INTO A DRILL HOLE IN THE TOP OF  
LW5147'A 0.6 BY 0.8 METER EXPOSURE OF OUTCROP FLUSH WITH THE GROUND. LOCATED  
LW5147'86.3 M (283.1 FT) WEST-NORTHWEST FROM THE SOUTH CORNER OF THE ASPHALT  
LW5147'RUNWAY, 34.8 M (114.2 FT) WEST-NORTHWEST FROM THE SOUTHWEST ONE OF  
LW5147'FOUR LANDING LIGHTS AT THE DISPLACED THRESHOLD, 29.7 M (97.4 FT)  
LW5147'SOUTHWEST FROM THE CENTER OF THE RUNWAY, 18.1 M (59.4 FT) SOUTHWEST  
LW5147'FROM THE SOUTHWEST EDGE OF THE ASPHALT RUNWAY, AND 10.0 M (32.8 FT)  
LW5147'NORTHEAST FROM A FIBERGLASS WITNESS POST ON THE NORTHEAST EDGE OF A  
LW5147'DRAINAGE DITCH.  
LW5147'DESCRIBED BY C.L. SMITH, TYPED BY R.L. ZURFLUH.  
LW5147  
LW5147 STATION RECOVERY (1999)  
LW5147  
LW5147'RECOVERY NOTE BY WOOLPERT CONSULTANTS 1999 (ARL)  
LW5147'RECOVERED AS DESCRIBED. THIS STATION IS DESIGNATED AS THE PRIMARY  
LW5147'AIRPORT CONTROL STATION.  
LW5147  
LW5147 STATION RECOVERY (2000)  
LW5147  
LW5147'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 2000 (CSM)  
LW5147'THE STATION IS LOCATED ON THE SOUTHEAST SIDE OF MANSFIELD, AT THE  
LW5147'MANSFIELD MUNICIPAL AIRPORT ON THE SOUTHWEST SIDE OF RUNWAY 36,  
LW5147'IN THE GRASS FIELD ABOUT 35.05 M (114.99 FT) NORTHWEST OF THE  
LW5147'DISPLACED THRESHOLD BAR FOR RUNWAY 36. OWNERSHIP--CITY OF  
LW5147'MANSFIELD. NOTE--CONTACT MR. DAVID DINNEN, (AIRPORT MANAGER) ONE

LW5147'DAY IN ADVANCE BEFORE OCCUPYING THE STATION, PHONE 508-339-3624.  
LW5147'TO REACH THE STATION FROM THE INTERSECTION OF NORTH-SOUTH MAIN  
LW5147'STREET AND EAST-WEST STREETS AT THE CITY PARK IN THE CENTER OF  
LW5147'MANSFIELD, GO SOUTH ON SOUTH MAIN STREET FOR 1.61 KM (1.00 MI) TO  
LW5147'THE JUNCTION OF FRUIT STREET ON THE LEFT, TURN LEFT, EASTERLY ON  
LW5147'FRUIT STREET FOR 0.72 KM (0.45 MI) TO THE JUNCTION OF HALL STREET ON  
LW5147'THE LEFT (AT A STOP SIGN), TURN LEFT, SOUTHEASTERLY AND CONTINUE  
LW5147'AHED ON FRUIT STREET FOR 0.56 KM (0.35 MI) TO THE AIRPORT ENTRANCE  
LW5147'DRIVE ON THE RIGHT, TURN RIGHT, SOUTHWEST ON THE DRIVE AND BEAR  
LW5147'RIGHT ACROSS THE PARKING LOT TO THE SECURITY GATE, PASS THROUGH  
LW5147'THE GATE AND BEAR LEFT BETWEEN THE HANGARS AND ONTO THE APRON,  
LW5147'GO SOUTHEAST ACROSS THE APRON PASSING THE AIRPORT OFFICE  
LW5147'BUILDING TO THE SOUTHEAST SIDE OF THE APRON TO A TAXIWAY, TURN  
LW5147'LEFT, SOUTHEAST ON THE TAXIWAY AND BEAR RIGHT, NORTHWEST FOR  
LW5147'ABOUT 0.05 KM (0.05 MI) TO THE JUNCTION OF THE PARALLEL TAXIWAY AND  
LW5147'WIND SOCK ON THE LEFT, TURN LEFT, SOUTHEAST ON THE TAXIWAY FOR  
LW5147'0.72 KM (0.45 MI) TO THE END OF RUNWAY 36, TURN RIGHT, SOUTHWEST  
LW5147'CROSSING THE END OF RUNWAY 36 AND ONTO THE GRASS, TURN RIGHT,  
LW5147'NORTHWEST FOR ABOUT 76.2 M (250.0 FT) TO THE DISPLACED THRESHOLD  
LW5147'AND THRESHOLD LIGHTS ON THE RIGHT, CONTINUE AHEAD, NORTHWEST  
LW5147'FOR ABOUT 30.48 M (100.00 FT) TO THE STATION IN A SMALL AREA OF  
LW5147'EXPOSED ROCK OUTCROP FLUSH WITH THE GROUND. THE STATION IS AN  
LW5147'NGS HORIZONTAL DISK SET IN A DRILL HOLE IN ROCK OUTCROP. LOCATED  
LW5147'18.14 M (59.51 FT) SOUTHWEST OF THE SOUTHWEST EDGE OF RUNWAY 36,  
LW5147'34.81 M (114.21 FT) WEST-NORTHWEST OF THE SOUTHWEST ONE OF FOUR  
LW5147'THRESHOLD LIGHTS, AND 10.06 M (33.01 FT) NORTHEAST OF AN NGS  
LW5147'FIBERGLASS WITNESS POST SET ALONG THE TREE LINE.

LW5147'

LW5147

STATION RECOVERY (2010)

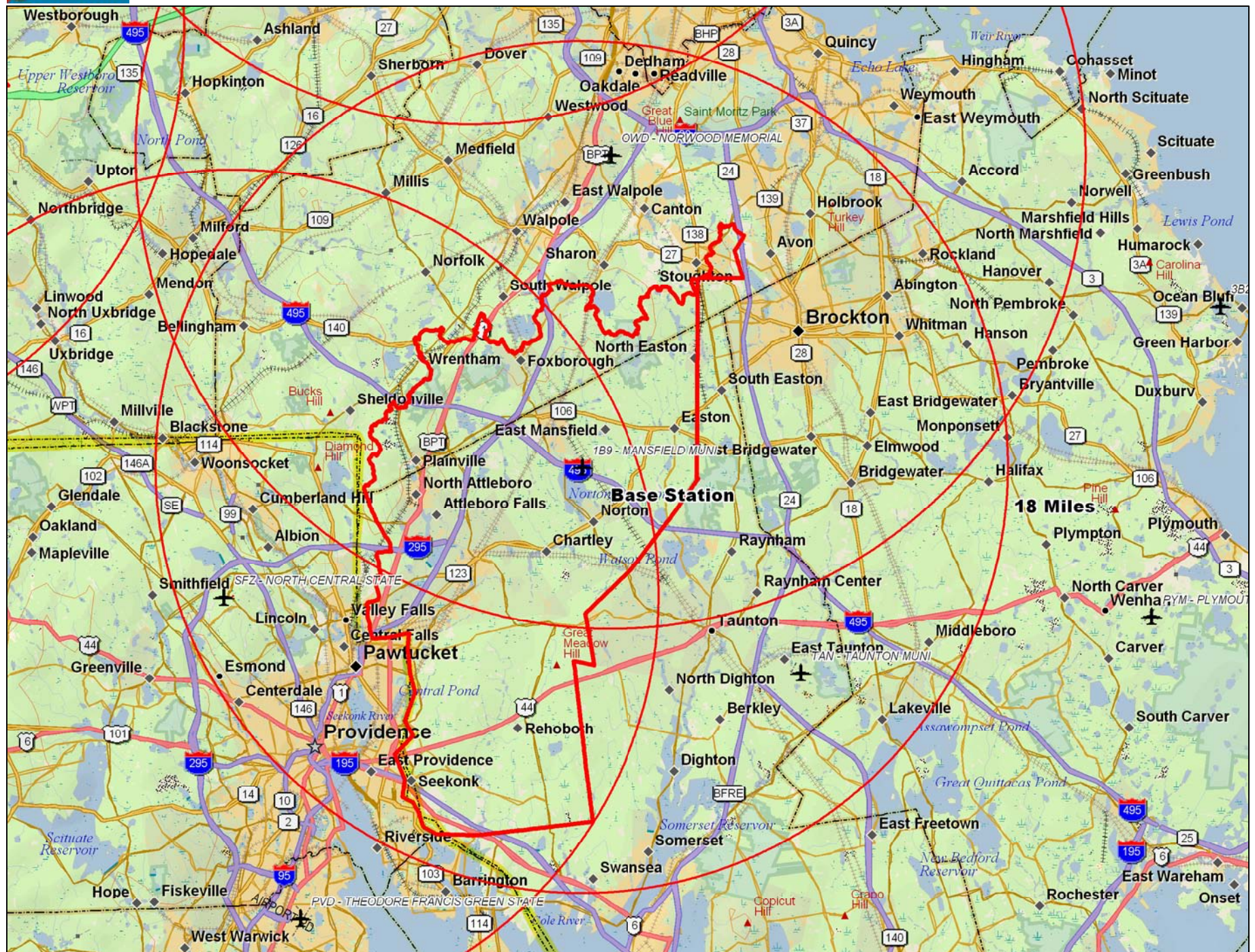
LW5147

LW5147'RECOVERY NOTE BY INDIVIDUAL CONTRIBUTORS 2010 (KK)

LW5147'RECOVERED IN GOOD CONDITION.









STATE(s): MASSACHUSETTS

Project 7556-005  
Numbers A003

AREA ID: ~~FE~~ NARR-1B9

STARRE-FBMH

AREA NAME: NARRAGANSETT - FEMA

FILE TYPES/NAMES: ☒ OPTECH: NARR-1B9.OP ☒ LEICA: 1B9\_NARRA\_MA

Lines: 44 FL Miles: 945 Square Miles: \_\_\_\_\_ Flight Altitudes: 5,000 Tide Coord: ☐ Yes ☒ See Notes ☒ NO

AIRPORT ID: 1B9 Name: MANSFIELD MUNICIPAL

Services: FULL ☒ Self ☒ None ☐ See Notes RUNWAY Length: 3500 Ft

Contact Name(s): David Dinneen / Muzger

Phone(s): (\_\_\_\_) \_\_\_\_ - \_\_\_\_ (\_\_\_\_) \_\_\_\_ - \_\_\_\_ e-mail: \_\_\_\_\_

Hotels: ALL MAJOR

Rentals: ENTERPRISE

EXIST BASE Station: LW5147 Name: MANSFIELD

TYPE: PACS ☒ SACS ☐ Other ☐ Data Sheet Attached ☒

SET BASE STATION Name: \_\_\_\_\_ Date Set: \_\_\_\_\_

What was Set: Re-Bar ☐ or: \_\_\_\_\_ CAP: \_\_\_\_\_

Who Set: \_\_\_\_\_ Where Set: \_\_\_\_\_ Attach Data Sheet

Logs ☐ Sectional ☐ Lo En-route ☐ Database ☐ OPTECH ☒ LEICA ☒  
by: \_\_\_\_\_ by: \_\_\_\_\_ by: \_\_\_\_\_ by: \_\_\_\_\_ by: FBG by: FBG

Accuracy: Vert; 24.5 Horiz; \_\_\_\_\_ cm Post Spacing: 1.0m Points Sq Meter: \_\_\_\_\_

NOTES: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

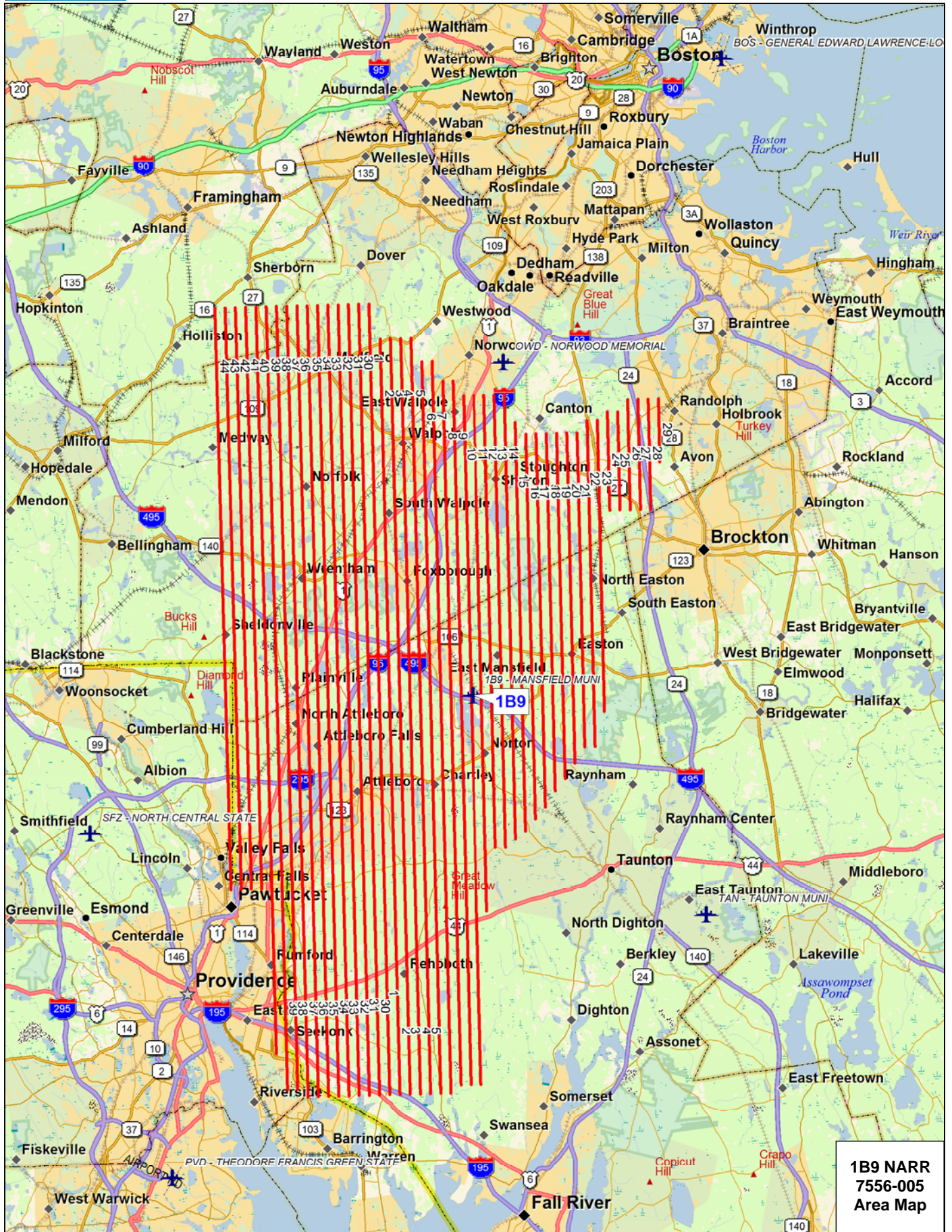
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HIGH PRIORITY

42 0 0 71 11 98

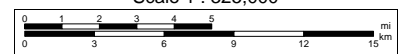
14.350



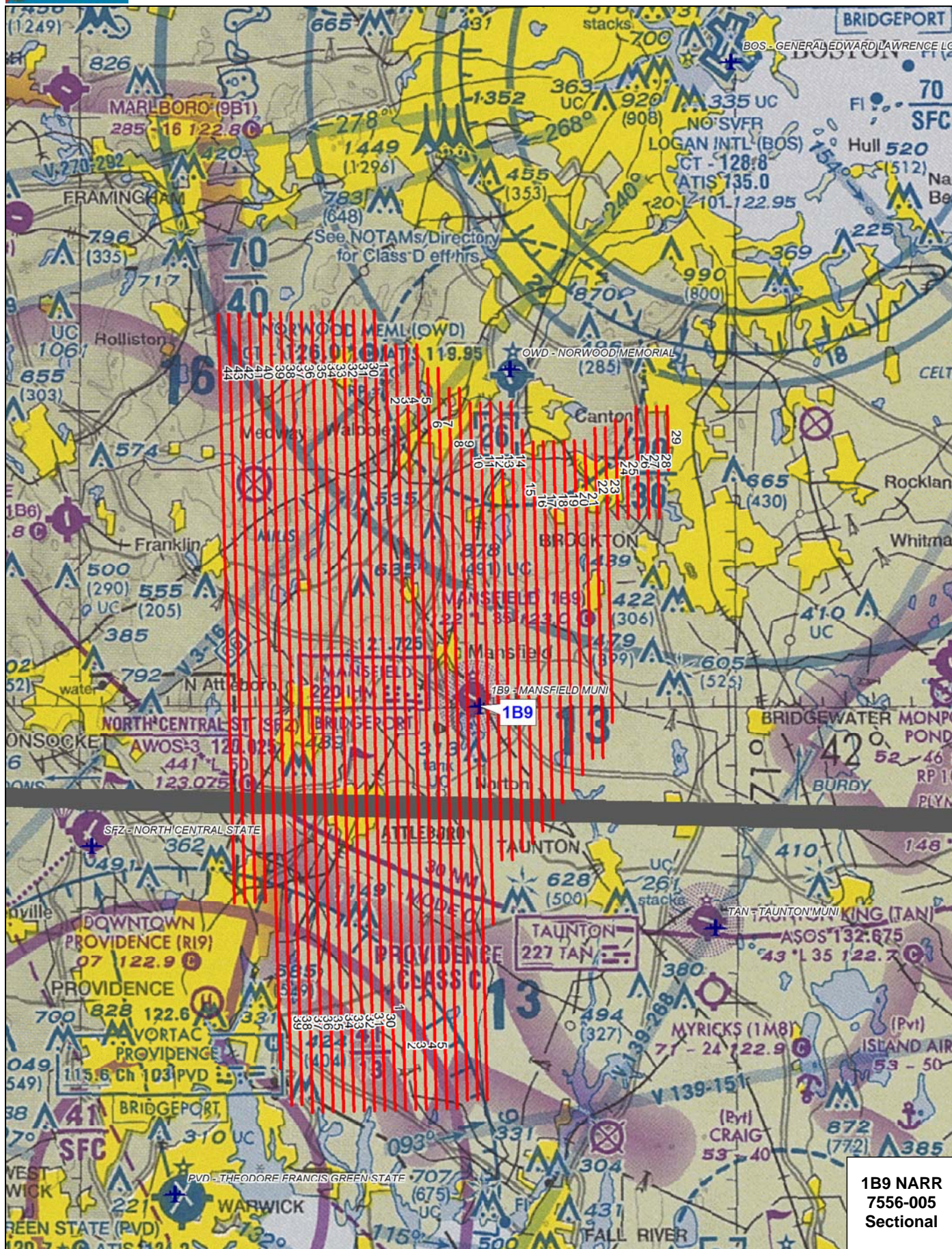


**1B9 NARR  
7556-005  
Area Map**

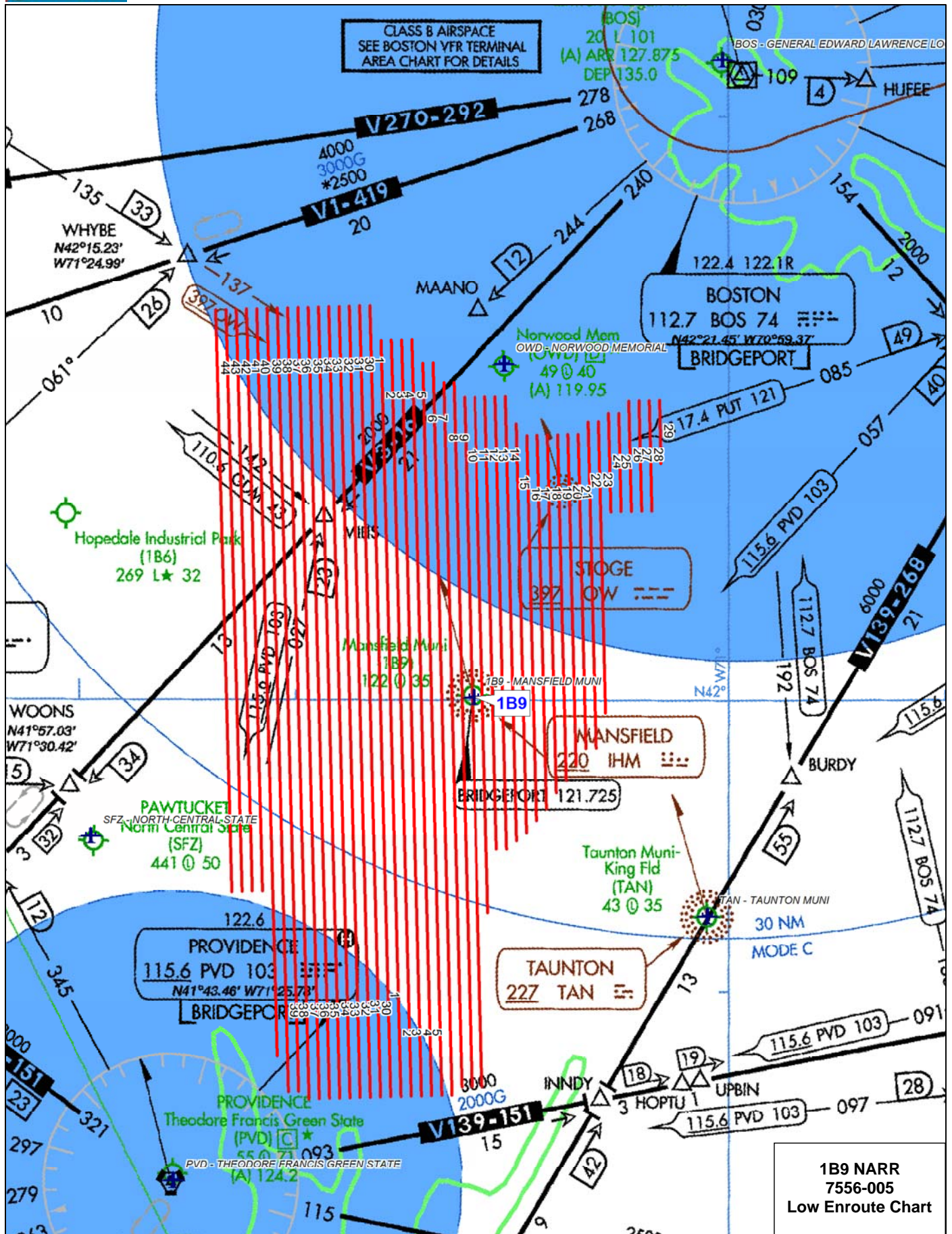
Scale 1 : 325,000











# Mass Area: 1B9 NARR

Project No 7556-005

Contact: Photo Science; F Godby at  
859 277-8700 or Cell: 859 421-5258

## Flight Logs

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
1	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
2	29.8	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
3	29.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
4	29.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
5	29.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
6	28.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
7	28.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
8	27.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
9	27.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
10	27.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
11	20.3	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
12	17.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
13	17.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				

Flight Logs should be FAXED to 859-277-8901 immediately  
after each days flights with lines and other details noted

Operator: \_\_\_\_\_

AIRCRAFT Tail Number: \_\_\_\_\_

Page 1 of 4

Pilot: \_\_\_\_\_

Sensor Serial Number: \_\_\_\_\_

Date: \_\_\_\_\_



<i>FLIGHT LINE</i>	<i>FL MILES</i>	<i>ALTITUDE</i>	<i>BASE STATION</i>	<i>FLIGHT FILES</i>	<i>DATE FLOWN</i>	<i>S/N</i>	<i>FIELD QC</i>	<i>Comments</i>
14	17.5	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
15	16.1	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
16	15.2	5170	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
17	14.8	5170	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
18	14.1	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
19	13.6	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
20	13.0	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
21	12.4	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
22	12.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
23	11.5	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
24	3.9	5240	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
25	3.9	5240	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
26	4.3	5230	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
27	4.3	5230	1B9_NAR	NARR_1B9_O 1B9_NARRA_				

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after each days flights with lines and other details noted*

*Operator:* \_\_\_\_\_

*AIRCRAFT Tail Number:* \_\_\_\_\_

Page 2 of 4

*Pilot:* \_\_\_\_\_

*Sensor Serial Number:* \_\_\_\_\_

**Date:** \_\_\_\_\_

<i>FLIGHT LINE</i>	<i>FL MILES</i>	<i>ALTITUDE</i>	<i>BASE STATION</i>	<i>FLIGHT FILES</i>	<i>DATE FLOWN</i>	<i>S/N</i>	<i>FIELD QC</i>	<i>Comments</i>
28	4.3	5220	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
29	2.5	5210	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
30	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
31	31.2	5170	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
32	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
33	31.2	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
34	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
35	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
36	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
37	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
38	30.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
39	30.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
40	29.5	5170	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
41	22.9	5210	1B9_NAR	NARR_1B9_O 1B9_NARRA_				

*Flight Logs should be FAXED to 859-277-8901 immediately  
after each days flights with lines and other details noted*

*Operator:* \_\_\_\_\_

*AIRCRAFT Tail Number:* \_\_\_\_\_

Page 3 of 4

*Pilot:* \_\_\_\_\_

*Sensor Serial Number:* \_\_\_\_\_

**Date:** \_\_\_\_\_

<i>FLIGHT LINE</i>	<i>FL MILES</i>	<i>ALTITUDE</i>	<i>BASE STATION</i>	<i>FLIGHT FILES</i>	<i>DATE FLOWN</i>	<i>S/N</i>	<i>FIELD QC</i>	<i>Comments</i>
42	22.9	5220	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
43	22.9	5210	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
44	22.9	5210	1B9_NAR	NARR_1B9_O 1B9_NARRA_				

*Flight Logs should be FAXED to 859-277-8901 immediately  
after each days flights with lines and other details noted*

*Operator:* \_\_\_\_\_

*AIRCRAFT Tail Number:* \_\_\_\_\_

Page 4 of 4

*Pilot:* \_\_\_\_\_

*Sensor Serial Number:* \_\_\_\_\_

**Date:** \_\_\_\_\_

IBq



## Station Occupation Report For Airborne GPS

Project: Narr - 1B9

Location: 1B9

Project Number: 7556-005

Completed by: Nathan Calieti

Date: 12/8/10

Receiver: 2 9n 1073

Receiver Type: Trimble 5700

Antenna Type: Zephyr Geodetic

Station ID: Narr-1B9

Start -- H.I. (m): 1,511 (m)

End -- H.I. (m): 1,511 (m)

H.I. (ft): 4,96 (ft)

Start Time: 9:28 AM EST

End Time: 3:29 PM EST

Time Zone: EST

Operator: Nathan Calieti



Comments: Station used for N2448G & 667

101208a+b-246

101208a+b-247



# LIDAR MISSION RECORD SHEET – Optech

Project Name	ITEMA MASS
Project Number	7856-005
ATTN/NAV. BUDGET	NAAR 189 OP 4

Project Scanning Requirements	
FOV (half-degrees):	$\pm 10^\circ$
Scan Rate:	30 / Hz
Pulse Rate:	7 / kHz
Ground Speed:	16 kts
Altitude AGL (ft):	
(MPIA) or SPIA	
Fixed or Auto	
A.R.F.:	Samples 1000
Range	300

Pilot	Young
Operator	Berny
Aircraft	N7266Z

Data Information	
LIDAR Unit	Oppech Gemini sn246
HD #	046 HD1
POS File Name	01808a
from, to	000 → 025

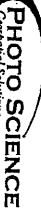
Date Flown:	December 8, 2010		
Takeoff Time (Z):	1445z	Local:	945 EST
Landing Time (Z)	1740z	Local:	1240 EST
		Local:	Airport

	Ground	Airport
Begin Temp	-2°C	SFZ
Begin Dampoint	-13°C	
Begin Pressure	8973	
End Temp	-1°C	
End Dampoint	-13°C	SFZ
End Pressure	8978	

GPS Base Location(s)	Margfield
PDOP Avoidance	Good all day
Static or Flyover?	Static
	-> if flyovers, times: -

[illegible]

# LIDAR MISSION RECORD SHEET - Optech



2670 Wildlife Drive - Lexington KY - 40503 - 859.277.8700 - www.photoscience.com

Project Name	Tenn-Mass
Project Number	7556-005
Altitude/Altitude	114K 185-20, ph

Pilot	Young
Operator	BERRY
Aircraft	N7266Z

Date Flown:	December 8, 2010
Takeoff Time (Z)	1830Z
Landing Time (Z)	2000Z
Local:	1800MST
Local:	500PMEST
Altitude	185

FOV (half-degrees):	± 18°	Altitude AGL (ft):	5000'
Scan Rate:	20.1 Hz	MPA or SPIA	MPA
Pulse Rate:	71 kHz	Fixed or Auto	Auto
Ground Speed:	116 kts	Samples	-
A.R.F.:	-	Range	-

LIDAR Unit	Optech Gemini sn246
HD #	346HD1
POS File Name	1012086
from, to	000 - 080

Begin Temp	-1°	Ground	Altitude
Begin Dewpoint	-15°	SFZ	SFZ
Begin Pressure	29.13	-32	-
End Temp	-32	-162	SFZ
End Dewpoint	-162	29.81	-
End Pressure	29.81	-	-

GPS Base Location(s)	Mass Field
PDOP Avoidance	Good all day
Static or Flyover?	Static
-> If flyovers, times:	-

1012086-246

Flight Line Name#	Start Time	End Time	Alt. (AMSL)	Heading	Speed	Returns	Crab	NOTES (weather, visibility, winds, tide, etc.)
34	1833	1848	4800'	S	116	100%	9	Clouds above, turbulence. Refly S end 5 miles
33	1852	1854	4750'	N	116	100%	-11	Refly S end 5 miles
32	1959	1908	4800'	S	116	100%	7	Refly S end 5 miles
35	1905	1920	4750'	N	116	100%	-10	Refly N 1/2 mi
36	1932	1937	4800'	S	116	100%	6	Refly N 1/2 mi
37	1940	1955	4750'	N	116	100%	-9	Refly N 1/2 mi
38	1959	2003	4750'	S	116	100%	8	Refly N 1/2 mi
39	2016	2031	4800'	N	116	100%	-7	Refly N 1/2 mi
40	2034	2047	4800'	S	116	100%	8	Refly N 1/2 mi
41	2051	2103	4800'	N	116	100%	-9	Refly N 1/2 mi
42	2107	2117	4800'	S	116	100%	6	Refly N 1/2 mi
43	2120	2123	4800'	N	116	100%	-12	Refly N 1/2 mi
44	2134	2145	4800'	S	116	100%	8	Refly N 1/2 mi
Improvov	2148	2151	4850'	E	116	100%	-8	All good

# LIDAR MISSION RECORD SHEET - Optech

Project Name	NARR-1B5
Project Number	758-005
ALIM NAV pin file	NARR-1B5-0F.pin

Project's Scanning Requirements	
FOV (half-degrees):	± 18°
Altitude AGL (ft):	5000
Scan Rate:	30 Hz
Pulse Rate:	70 KHz
Ground Speed:	116 Kts
	A.R.F. : Range

GPS Base Location(s)	NARR-1B7 e(1B9)
PDOP Avoidance	none till 1420Z
Static or Flyover?	static

## PHOTO SCIENCE

Pilot	Greenwell
Operator	Colette
Aircraft	N248G

Data Information	
LIDAR Unit	Optech Gemini sn247
HD #	2
POS File Name	61208a
from, to	D -

Date Flown:	12/8/10
Takeoff Time (Z):	1438
Landing Time (Z):	1825

Begin Temp	-4	Ground	Airport
Begin Dewpoint	-12		
Begin Pressure	29.64		
End Temp			
End Dewpoint			
End Pressure			

Ocean! CIDS @ ALT very light  
in area not on line  
\* CIDS @ pri altitude

101208a-247

Flight # 1

Flight Line Name#	Start Time	End Time	Alt. (AMSL)	Heading	Speed	Returns	Crab	NOTES (weather, visibility, winds, tide, etc.)
29	1507	1509	5218	178	116	100	13	
28	1513	1516	5252	358	114	100	9	
27	1520	1523	5215	178	123	100	13	
26	1528	1531	5182	358	119	100	8	
25	1535	1537	5132	178	116	100	13	
24	1542	1544	5153	358	111	99	7	
23	1549	1554	5254	178	122	100	11	possible high drop @ N end
22	1551	1605	5128	358	110	100	9	2-3 mi. from S end light TB
21	1610	1614	5183	178	118	100	12	
20	1620	1627	5167	358	109	100	10	CIDS @ Alt around line close line
19	1632	1638	4842	178	113	100	14	CL LGT TB @ S End
18	1643	1650	4741	358	117	100	9	CL LGT TB @ S End ~ 5.6 mi
17	1654	1702	4815	178	113	100	11	CL LGT TB @ S End
16	1706	1714	4857	358	114	100	9	CL LGT TB through line
15	1719	1727	4822	178	106	100	12	LGT wing reeking through line
14	1731	1740	4825	358	107	100	9	LGT wing reeking through line
13	1744	1752	4814	178	108	100	14	LGT wing reeking through line
12	1757	1806	4814	358	116	100	9	
11	1811	1814	4760	090	131	100	5	

5 mi from  
with check  
over top

descent due  
to CDS →

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#2 flight

Date Flown: 12/8/16	
Takeoff Time (Z): 1914	Local: 2114
Landing Time (Z): 2200	Local: 5:00
	Airport: 139
	Airport: 139

	Ground	Airport
Begin Temp		—
Begin Dewpoint		—
Begin Pressure	29.74	
End Temp		
End Dewpoint		—
End Pressure	29.74	

7-08010

[illegible]

**Station Occupation Report  
For Airborne GPS**

**Project:**

FEMA-MASS

**Location:**

K1B9 (Mansfield Municipal)

**Project Number:** 7556-005

**Completed by:**

Berry

**Date:** 12-10-2010

**Receiver:**

Trimble "4"

**Receiver Type:**

5700

**Antenna Type:**

Zephyr

**Station ID:**

Mansfield

**Start -- H.I. (m):**

1578

**End -- H.I. (m):**

1578

**H.I. (ft):**

518

**Start Time:**

7:52 AM EST

**End Time:**

10:49 AM EST

**Time Zone:**

EST

**Operator:**

Berry

**Comments**

101210a-246

101210a-247





# LIDAR MISSION RECORD SHEET - Optech

## PHOTO SCIENCE

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Project Name	EMA-Mass
Project Number	756-008
Altitude/AV Distance	NAR-189-00.ph

Pilot	Yanaka
Operator	28841
Aircraft	N7266Z

Date Flown:	December 10, 2010
Takeoff Time (Z)	13:05Z
Landing Time (Z)	15:51Z
Local:	8:05 PM EST
Local:	10:51 PM EST
Airport	189
Airport	189

FOV (half-degrees):	± 18.0°	Altitude AGL (ft):	5000'
Scan Rate:	30.10 Hz	MPIA or SPIA	
Pulse Rate:	71 kHz	Fixed or Auto	
Ground Speed:	416 kts	Samples / 1000	
A.R.F.:	Range		300

LIDAR Unit	Optech Gemini sr246
HD #	846 HD2
POS File Name	101210a-246
from, to	000 - 017

Begin Temp	-11°C	Ground	Airport
Begin Dewpoint	-15°C		
Begin Pressure	30.39		
End Temp	-9°C		
End Dewpoint	-11°C		
End Pressure	30.35		
			SF2

GPS Base Location(s)	Mass Field
PDOP Avoidance	Good all day
Static or Flyover?	Static
→ If flyovers, times: -	

101210a-246

Flight Line Name/ID	Start Time	End Time	Alt. (AMSL)	Heading	Speed	Returns	Crab	NOTES (weather, visibility, winds, tide, etc.)
34	1313	1319	5000'	S	116	100%	5	
35	1328	1335	5000'	N	116	100%	-4	Clear Smooth Path
36	1338	1344	5000'	S	116	100%	3	All Inshore patches for Lincarea
37	1347	1354	5000'	N	116	100%	-6	
38	1358	1404	5000'	S	116	100%	3	
39	1408	1415	5000'	N	116	100%	-5	
40	1419	1425	5000'	S	116	100%	5	
41	1431	1435	5000'	N	116	100%	-1	
42	1438	1444	5000'	S	116	100%	4	
43	1447	1453	5000'	N	116	100%	5	
Tempor	1455	1459	5200'	E	116	100%	-2	

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Date Flown: 12/10/10 #1	
Takeoff Time (Z): 1210	Local: 7:10
Landing Time (Z): 1530	Local: 10:30
	Airport: BED
	Airport: B9

	Ground	Airport
Begin Temp	-14 C	KBED
Begin Dewpoint	-16 C	
Begin Pressure	30.43 in	
End Temp	<del>29</del> 27	
End Dewpoint	-14	KBED
End Pressure	30.45 in	

End Dewpoint	-14	777	C
End Pressure	88.85	416	
	30.48	8	

KBED-

[illegible]

# Mass Area: 1B9 NARR

Project No 7556-005

Contact: Photo Science, F. Godby at  
859 277-8700 or Cell: 859 421-5258

## Flight Logs

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
1	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12-8-10	246	JP	Some Clusters
2	29.8	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				of Atmosphere
3	29.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				returns
4	29.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
5	29.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_		247	NS	
6	28.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
7	28.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
8	27.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
9	27.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
10	27.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
11	20.3	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
12	17.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
13	17.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: Berry

Pilot: John

AIRCRAFT Tail Number: 72462

Sensor Serial Number: 246

Date: 12-8-10

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
14	17.5	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12-8-10	247	N6	
15	16.1	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
16	15.2	5170	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
17	14.8	5170	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
18	14.1	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
19	13.6	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
20	13.0	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
21	12.4	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
22	12.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
23	11.5	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
24	3.9	5240	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
25	3.9	5240	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
26	4.3	5230	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
27	4.3	5230	1B9_NAR	NARR_1B9_O 1B9_NARRA_				

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with times and other details noted

Operator: Bern

Pilot: yan

AIRCRAFT Tail Number: N22262

Sensor Serial Number: 240

Date: 12-8-10

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
28	4.3	5220	1B9_NAR	NARR_1B9_O 1B9_NARRA_	B-8-10	247	106	
29	2.5	5210	1B9_NAR	NARR_1B9_O 1B9_NARRA_	↑	↑	↑	
30	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12-8-10	246	103	
31	31.2	5170	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
32	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
33	31.2	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
34	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
35	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
36	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
37	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
38	30.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
39	30.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
40	29.5	5170	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
41	22.9	5210	1B9_NAR	NARR_1B9_O 1B9_NARRA_				

Refight Needed Reflight 10-12

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: PKM  
Pilot: Young

AIRCRAFT Tail Number: N281067  
Sensor Serial Number: 246

Date: 18-8-2010



FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
42	22.9	5220	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
43	22.9	5210	1B9_NAR	NARR_1B9_O 1B9_NARRA_				Refight Needed Reflight 10-12
44	22.9	5210	1B9_NAR	NARR_1B9_O 1B9_NARRA_				

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with lines and other details noted

Operator: Berry  
Pilot: Young

AIRCRAFT Tail Number: 170612  
Sensor Serial Number: 246

Date: 12-8-10

# Mass Area: 1B9 NARR

Project No 7556-005

Contact: Photo Science: F. Godby at  
859 277-8700 or Cell: 859 421-5258

## Flight Logs

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
1	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
2	29.8	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
3	29.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
4	29.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
5	29.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10	247b		
6	28.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10	247b		
7	28.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10	247b		
8	27.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10	247b		
9	27.8	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10	247b		
10	27.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10	247b		
11	20.3	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10	247a		
12	17.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10	247a		
13	17.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10	247a		

Flight Logs should be FAXED to 859-277-8901 immediately  
after each days flights with times and other details noted

Operator: Salvetti  
Pilot: Greenwell

AIRCRAFT Tail Number: N24486  
Sensor Serial Number: 247

Date: 12/8/10  
Page 1 of 4

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
14	17.5	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10	2479		
15	16.1	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10			
16	15.2	5170	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10			
17	14.8	5170	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10			
18	14.1	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10			
19	13.6	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10			
20	13.0	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10			
21	12.4	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10			
22	12.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10			
23	11.5	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10			
24	3.9	5240	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10			
25	3.9	5240	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10			
26	4.3	5230	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10			
27	4.3	5230	1B9_NAR	NARR_1B9_O 1B9_NARRA_	12/8/10			

Flight Logs should be FAXED to 856-277-8901 immediately after each day's flights with times and other details noted

Operator: Galetti  
Pilot: Greenwell

AIRCRAFT Tail Number: N2448G  
Sensor Serial Number: 247

Date: 12/8/10 Page 2 of 4

FLIGHT LINE	FL MILES	ALTITUDE	BASE STATION	FLIGHT FILES	DATE FLOWN	S/N	FIELD QC	Comments
28	4.3	5220	1B9_NAR	NARR_1B9_O 1B9_NARRA_	10/8/10	247a		
29	2.5	5210	1B9_NAR	NARR_1B9_O 1B9_NARRA_	10/8/10	247a		
30	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
31	31.2	5170	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
32	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
33	31.2	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
34	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
35	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
36	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
37	31.2	5160	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
38	30.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
39	30.9	5150	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
40	29.5	5170	1B9_NAR	NARR_1B9_O 1B9_NARRA_				
41	22.9	5210	1B9_NAR	NARR_1B9_O 1B9_NARRA_				

Flight Logs should be FAXED to 859-277-8901 immediately after each days flights with times and other details noted

Operator: Greenwell

AIRCRAFT Tail Number: N7 4486

Sensor Serial Number: 247

Date: 10/8/10

Plan Type : Fixed Survey

\*\*\*\*\*Survey Totals\*\*\*\*\*

Total Passes : 44  
Total Length : 1522.498 km  
Total Flight Time : 11:35:33  
Total Laser Time : 07:02:55  
Total Swath Area : 1054.223 km^2  
Total AOI Area : 1428.98 km^2

Number of Sub-Areas : 1

\*\*\*\*\*Area 1\*\*\*\*\*

Area Flight Profile

-----  
Total Length : 1522.498 km  
Flight Time : 11:35:33  
Laser Time : 07:02:55  
Swath Area : 346.962 km^2  
AOI Area : 1428.98 km^2  
Altitude : 5000 ft AGL  
Speed : 116.6 kts  
Flight Lines : 44  
Pass Heading : 178.49  
Pass Spacing : 227.89 m  
Overlap : 30% = 761.29 m  
Turn Time : 5 min

Area LIDAR Settings

-----  
Desired Res : 0.912 m  
Density : 1.2 ppm^2  
Cross Track Res : 0.835 m  
Down Track Res : 0.997 m  
Scan Frequency : 30.1 Hz  
Scan Angle : 18 deg  
Scan Cutoff : 0.02 deg  
Scan Offset : 0 deg  
System PRF : 71.429 kHz  
Swath Width : 989.18 m  
DEM Estimates

-----  
DEM Min Z : -1  
DEM Max Z : 483

Cost Estimates

-----  
Area Cost : \$0  
Time Cost : \$0



# Flight Log

-----  
Project Number: 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED & 1B9  
Mission : 1  
Wheels Up : 1300 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

## Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : -14 C  
Visibility : clear  
Clouds : High OVC  
Precipitation : none  
Wind Dir :  
Wind Speed :  
Pressure : 30.43 HG

## Statistics

-----  
Laser Time : 01:14:32

=====  
13:01:35.751 GMT : 00:00:02 (212) GPS 1PPS Lost  
13:01:35.751 GMT : 00:00:03 (166) Divergence Error  
13:01:35.751 GMT : 00:00:03 (107) Rx Shutter Closed  
13:01:35.751 GMT : 00:00:03 (109) Tx Shutter Closed  
13:01:35.751 GMT : 00:00:04 (164) Beam Wide  
13:01:35.751 GMT : 00:00:12 (204) POSAV Connected  
13:01:35.751 GMT : 00:00:13 (207) POSAV Rate Not 50 Hz  
13:01:35.751 GMT : 00:00:13 (211) POSAV new status  
13:01:35.751 GMT : 00:00:14 (213) GPS 1PPS Ok  
13:01:35.751 GMT : 00:00:23 (120) Laser PS Comm Ok  
13:01:35.751 GMT : 00:00:23 (112) Laser Emission Off  
13:01:35.751 GMT : 00:00:45 (208) POSAV Rate Is 50 Hz  
13:01:35.751 GMT : 00:00:45 (211) POSAV new status  
13:01:35.751 GMT : 00:00:46 (215) Nav Data Ok  
13:01:35.751 GMT : 00:00:47 (211) POSAV new status  
13:01:35.751 GMT : 00:01:33 (211) POSAV new status  
13:01:35.751 GMT : 00:01:45 (211) POSAV new status  
13:01:35.751 GMT : 12:23:55 (211) POSAV new status  
12:58:37.175 GMT : 12:58:35 (153) Eyesafety Disabled  
12:58:37.275 GMT : 12:58:35 (162) Roll Comp On  
12:58:37.875 GMT : 12:58:36 (164) Beam Wide  
12:58:37.875 GMT : 12:58:36 (144) MultiPulse Mode Varies  
12:58:41.475 GMT : 12:58:40 (165) Beam Narrow

12:59:34.076 GMT : 12:59:32 (157) Safe Unaided Profile  
12:59:34.076 GMT : 12:59:32 (157) Safe Unaided Profile  
13:05:13.78 GMT : 13:05:12 (157) Safe Unaided Profile  
13:05:13.98 GMT : 13:05:12 (157) Safe Unaided Profile  
13:05:19.48 GMT : 13:05:17 (106) Rx Shutter Open  
13:05:19.48 GMT : 13:05:17 (108) Tx Shutter Open  
13:19:45.49 GMT : 13:19:44 (113) Laser Emission On  
13:27:52.396 GMT : 13:27:50 (112) Laser Emission Off  
13:31:56.099 GMT : 13:31:55 (113) Laser Emission On  
13:40:11.905 GMT : 13:40:09 (112) Laser Emission Off  
13:45:23.408 GMT : 13:45:22 (113) Laser Emission On  
13:53:50.615 GMT : 13:53:49 (112) Laser Emission Off  
13:59:24.419 GMT : 13:59:23 (113) Laser Emission On  
14:07:56.425 GMT : 14:07:55 (112) Laser Emission Off  
14:13:34.23 GMT : 14:13:33 (113) Laser Emission On  
14:26:46.44 GMT : 14:26:45 (112) Laser Emission Off  
14:32:07.544 GMT : 14:32:06 (113) Laser Emission On  
14:45:16.755 GMT : 14:45:15 (112) Laser Emission Off  
14:50:39.959 GMT : 14:50:39 (113) Laser Emission On  
15:04:08.37 GMT : 15:04:07 (112) Laser Emission Off  
15:11:56.777 GMT : 15:11:55 (113) Laser Emission On  
15:13:46.778 GMT : 15:13:45 (112) Laser Emission Off  
15:15:22.28 GMT : 15:15:21 (157) Safe Unaided Profile  
15:15:27.18 GMT : 15:15:25 (107) Rx Shutter Closed  
15:15:27.28 GMT : 15:15:25 (109) Tx Shutter Closed

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED & 1B9  
Mission : 1  
Wheels Up : 1300 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : -14 C  
Visibility : clear  
Clouds : High OVC  
Precipitation : none  
Wind Dir :  
Wind Speed :  
Pressure : 30.43 HG

#### Statistics

-----  
Laser Time : 01:14:32

=====

# Flight Log

-----  
Project Number: 7556-005  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : KBED & 1B9  
Mission : 1  
Wheels Up : 1300 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

## Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : -14 C  
Visibility : clear  
Clouds : High OVC  
Precipitation : none  
Wind Dir :  
Wind Speed :  
Pressure : 30.43 HG

## Statistics

-----  
Laser Time : 01:14:32

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
=====									
13:19:46.19	13:27:52.696	11	1521	70	30.10	18.00	ON	NAR	
ON 0.00	178.54								
13:31:57.199	13:40:11.705	10	1585	70	30.10	18.00	ON	NAR	
ON 0.00	358.54								
13:45:24.008	13:53:51.515	9	1577	70	30.10	18.00	ON	NAR	
ON 0.00	178.53								
13:59:25.419	14:07:57.725	8	1570	70	30.10	18.00	ON	NAR	
ON 0.00	358.53								
14:13:35.23	14:26:48.44	7	1583	70	30.10	18.00	ON	NAR	
ON 0.00	178.52								
14:32:08.144	14:45:17.555	6	1572	70	30.10	18.00	ON	NAR	
ON 0.00	358.51								
14:50:40.759	15:04:10.07	5	1580	70	30.10	18.00	ON	NAR	
ON 0.00	178.51								
15:11:57.677	15:13:48.178	5	1585	70	30.10	18.00	ON	NAR	
ON 0.00	178.51								

# Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : K1B9  
Mission : 101210A  
Wheels Up : 1305Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

## Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : -11C  
Visibility : >10  
Clouds : 11000FT  
Precipitation : NO  
Wind Dir : CLM  
Wind Speed : CLM  
Pressure : 30.39

## Statistics

-----  
Laser Time : 01:03:09

=====  
08:33:06.953 GMT : 00:00:02 (212) GPS 1PPS Lost  
08:33:06.953 GMT : 00:00:03 (166) Divergence Error  
08:33:06.953 GMT : 00:00:03 (107) Rx Shutter Closed  
08:33:06.953 GMT : 00:00:03 (109) Tx Shutter Closed  
08:33:06.953 GMT : 00:00:04 (164) Beam Wide  
08:33:06.953 GMT : 00:00:09 (120) Laser PS Comm Ok  
08:33:06.953 GMT : 00:00:09 (112) Laser Emission Off  
08:33:06.953 GMT : 00:00:11 (213) GPS 1PPS Ok  
08:33:06.953 GMT : 00:00:12 (204) POSAV Connected  
08:33:06.953 GMT : 00:00:12 (207) POSAV Rate Not 50 Hz  
08:33:06.953 GMT : 00:00:13 (211) POSAV new status  
08:33:06.953 GMT : 00:00:25 (208) POSAV Rate Is 50 Hz  
08:33:06.953 GMT : 00:00:26 (211) POSAV new status  
08:33:06.953 GMT : 00:00:26 (215) Nav Data Ok  
08:33:06.953 GMT : 00:00:27 (211) POSAV new status  
08:33:06.953 GMT : 00:01:56 (211) POSAV new status  
13:00:14.809 GMT : 00:04:39 (211) POSAV new status  
13:04:33.813 GMT : 13:04:32 (211) POSAV new status  
13:05:20.114 GMT : 13:05:19 (153) Eyesafety Disabled  
13:05:20.314 GMT : 13:05:19 (162) Roll Comp On  
13:05:20.714 GMT : 13:05:20 (164) Beam Wide  
13:05:20.914 GMT : 13:05:20 (144) MultiPulse Mode Varies  
13:05:25.514 GMT : 13:05:25 (165) Beam Narrow  
13:05:37.214 GMT : 13:05:36 (106) Rx Shutter Open

13:05:37.314 GMT : 13:05:36 (108) Tx Shutter Open  
13:13:21.622 GMT : 13:13:20 (113) Laser Emission On  
13:19:12.827 GMT : 13:19:11 (112) Laser Emission Off  
13:28:28.036 GMT : 13:28:27 (113) Laser Emission On  
13:35:28.343 GMT : 13:35:27 (112) Laser Emission Off  
13:38:17.346 GMT : 13:38:16 (113) Laser Emission On  
13:44:23.952 GMT : 13:44:23 (112) Laser Emission Off  
13:47:43.055 GMT : 13:47:42 (113) Laser Emission On  
13:54:02.362 GMT : 13:54:00 (112) Laser Emission Off  
13:58:11.267 GMT : 13:58:10 (113) Laser Emission On  
14:04:21.874 GMT : 14:04:21 (112) Laser Emission Off  
14:08:43.979 GMT : 14:08:43 (113) Laser Emission On  
14:15:57.888 GMT : 14:15:56 (112) Laser Emission Off  
14:19:41.093 GMT : 14:19:40 (113) Laser Emission On  
14:25:34.4 GMT : 14:25:33 (112) Laser Emission Off  
14:29:08.604 GMT : 14:29:08 (113) Laser Emission On  
14:35:14.512 GMT : 14:35:13 (112) Laser Emission Off  
14:38:53.217 GMT : 14:38:52 (113) Laser Emission On  
14:44:13.523 GMT : 14:44:11 (112) Laser Emission Off  
14:47:29.428 GMT : 14:47:28 (113) Laser Emission On  
14:53:02.735 GMT : 14:53:02 (112) Laser Emission Off  
14:55:54.238 GMT : 14:55:53 (113) Laser Emission On  
14:58:05.541 GMT : 14:58:04 (112) Laser Emission Off  
14:58:20.342 GMT : 14:58:19 (107) Rx Shutter Closed  
14:58:20.442 GMT : 14:58:19 (109) Tx Shutter Closed

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : K1B9  
Mission : 101210A  
Wheels Up : 1305Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : -11C  
Visibility : >10  
Clouds : 11000FT  
Precipitation : NO  
Wind Dir : CLM  
Wind Speed : CLM  
Pressure : 30.39

#### Statistics

-----  
Laser Time : 01:03:09



=====

Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : K1B9  
Mission : 101210A  
Wheels Up : 1305Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 10, 2010  
Julian Day : 344  
Temperature : -11C  
Visibility : >10  
Clouds : 11000FT  
Precipitation : NO  
Wind Dir : CLM  
Wind Speed : CLM  
Pressure : 30.39

Statistics

-----  
Laser Time : 01:03:09

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
13:13:21.422	13:19:14.227	35	1576	70	30.10	18.00	ON	NAR	
ON 0.00	178.46								
13:28:28.536	13:35:29.543	36	1577	70	30.10	18.00	ON	NAR	
ON 0.00	178.45								
13:38:17.446	13:44:24.752	37	1574	70	30.10	18.00	ON	NAR	
ON 0.00	358.45								
13:47:43.555	13:54:03.762	37	1569	70	30.10	18.00	ON	NAR	
ON 0.00	358.45								
13:58:11.967	14:04:22.774	39	1571	70	30.10	18.00	ON	NAR	
ON 0.00	178.43								
14:08:44.679	14:15:58.388	40	1570	70	30.10	18.00	ON	NAR	
ON 0.00	178.43								
14:19:41.593	14:25:34.6	41	1576	70	30.10	18.00	ON	NAR	
ON 0.00	178.42								
14:29:09.604	14:35:15.712	42	1587	70	30.10	18.00	ON	NAR	
ON 0.00	358.41								

14:38:54.017	14:44:13.223	43	1592	70	30.10	18.00	ON	NAR
ON	0.00	358.41						
14:47:29.528	14:53:03.435	43	1587	70	30.10	18.00	ON	NAR
ON	0.00	358.41						
14:55:54.939	14:58:06.241	43	1583	70	30.10	18.00	ON	NAR
ON	0.00	358.41						

#### Flight Log

-----

Project Number: 0  
 S/N : 0  
 Operator : ???  
 Pilot(s) : ???  
 Aircraft : ???  
 Airport : ???  
 Mission : ???  
 Wheels Up : ???  
 Flight Length :  
 HOBBS Start :  
 HOBBS End :

#### Weather

-----

Date : December 08, 2010  
 Julian Day : 342  
 Temperature : ???  
 Visibility : ???  
 Clouds : ???  
 Precipitation : ???  
 Wind Dir : ???  
 Wind Speed : ???  
 Pressure : ???

#### Statistics

-----

Laser Time : 0

=====

#### Flight Log

-----

Project Number: 0  
 S/N : 0  
 Operator : ???  
 Pilot(s) : ???  
 Aircraft : ???  
 Airport : ???  
 Mission : ???  
 Wheels Up : ???  
 Flight Length :  
 HOBBS Start :  
 HOBBS End :

#### Weather

-----

Date : December 08, 2010  
 Julian Day : 342

Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 0

=====

Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 08, 2010  
Julian Day : 342  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 0

	START	STOP	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
RC	HDG	Plan	File						

=====

Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???

Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 08, 2010  
Julian Day : 342  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

#### Statistics

-----  
Laser Time : 01:56:27

=====  
10:25:56.168 GMT : 14:59:40 (106) Rx Shutter Open  
10:25:56.168 GMT : 14:59:41 (108) Tx Shutter Open  
10:25:56.168 GMT : 15:00:29 (109) Tx Shutter Closed  
10:25:56.168 GMT : 15:00:30 (107) Rx Shutter Closed  
10:25:56.168 GMT : 15:00:49 (108) Tx Shutter Open  
10:25:56.168 GMT : 15:00:52 (106) Rx Shutter Open  
10:25:56.168 GMT : 15:00:53 (107) Rx Shutter Closed  
10:25:56.168 GMT : 15:00:57 (106) Rx Shutter Open  
15:02:52.437 GMT : 15:02:51 (107) Rx Shutter Closed  
15:02:52.637 GMT : 15:02:51 (109) Tx Shutter Closed  
15:03:00.337 GMT : 15:02:59 (106) Rx Shutter Open  
15:03:00.337 GMT : 15:02:59 (108) Tx Shutter Open  
15:07:15.34 GMT : 15:07:14 (113) Laser Emission On  
15:21:11.153 GMT : 15:21:10 (112) Laser Emission Off  
15:24:24.756 GMT : 15:24:24 (113) Laser Emission On  
15:38:51.47 GMT : 15:38:50 (112) Laser Emission Off  
15:42:26.974 GMT : 15:42:26 (113) Laser Emission On  
15:56:21.288 GMT : 15:56:20 (112) Laser Emission Off  
15:59:30.992 GMT : 15:59:30 (113) Laser Emission On  
16:14:25.108 GMT : 16:14:24 (112) Laser Emission Off  
16:18:22.113 GMT : 16:18:21 (113) Laser Emission On  
16:32:42.529 GMT : 16:32:41 (112) Laser Emission Off  
16:35:10.432 GMT : 16:35:09 (113) Laser Emission On  
16:49:53.45 GMT : 16:49:51 (112) Laser Emission Off  
16:52:53.454 GMT : 16:52:52 (113) Laser Emission On  
17:07:18.672 GMT : 17:07:17 (112) Laser Emission Off  
17:10:06.575 GMT : 17:10:06 (113) Laser Emission On  
17:24:50.994 GMT : 17:24:49 (112) Laser Emission Off  
17:28:31.998 GMT : 17:28:31 (113) Laser Emission On  
17:30:07 GMT : 17:30:06 (112) Laser Emission Off  
17:31:34.402 GMT : 17:31:33 (107) Rx Shutter Closed

17:31:34.402 GMT : 17:31:33 (109) Tx Shutter Closed

Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 08, 2010  
Julian Day : 342  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 01:56:27

=====

Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 08, 2010  
Julian Day : 342  
Temperature : ???  
Visibility : ???  
Clouds : ???

Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 01:56:27

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
	15:07:16.24	15:21:12.453	4	1571	70	30.10	18.00	ON	NAR
ON	0.00	178.5							
	15:24:25.656	15:38:51.57	2	1450	70	30.10	18.00	ON	NAR
ON	0.00	178.49							
	15:42:27.574	15:56:17.888	1	1414	70	30.10	18.00	ON	NAR
ON	0.00	358.49							
	15:59:31.492	16:14:25.708	1	1381	70	30.10	18.00	ON	NAR
ON	0.00	358.49							
	16:18:22.613	16:32:42.829	30	1391	70	30.10	18.00	ON	NAR
ON	0.00	178.48							
	16:35:10.532	16:49:54.65	32	1393	70	30.10	18.00	ON	NAR
ON	0.00	358.47							
	16:52:54.254	17:07:18.972	33	1398	70	30.10	18.00	ON	NAR
ON	0.00	178.47							
	17:10:07.175	17:24:51.694	33	1387	70	30.10	18.00	ON	NAR
ON	0.00	358.47							
	17:28:32.798	17:30:07.7	33	1397	70	30.10	18.00	ON	NAR
ON	0.00	358.47							

Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : 1B9  
Mission : 101208B  
Wheels Up : 120 PM EST  
Flight Length : -  
HOBBS Start : -  
HOBBS End : -

Weather

-----  
Date : December 08, 2010  
Julian Day : 342  
Temperature : -1C  
Visibility : CLOUDS AT 5700 '  
Clouds : CLOUDS AT 5700 '  
Precipitation : NEGATIVE GHOST RIDER



Wind Dir : 340  
Wind Speed : BLOWING AT 15 KTS  
Pressure : 2973

Statistics

-----  
Laser Time : 02:33:39

=====  
13:40:23.615 GMT : 00:00:02 (212) GPS 1PPS Lost  
13:40:23.615 GMT : 00:00:03 (166) Divergence Error  
13:40:23.615 GMT : 00:00:03 (107) Rx Shutter Closed  
13:40:23.615 GMT : 00:00:03 (109) Tx Shutter Closed  
13:40:23.615 GMT : 00:00:04 (164) Beam Wide  
13:40:23.615 GMT : 00:00:05 (213) GPS 1PPS Ok  
13:40:23.615 GMT : 00:00:09 (120) Laser PS Comm Ok  
13:40:23.615 GMT : 00:00:09 (112) Laser Emission Off  
13:40:23.615 GMT : 00:00:12 (204) POSAV Connected  
13:40:23.615 GMT : 00:00:13 (207) POSAV Rate Not 50 Hz  
13:40:23.615 GMT : 00:00:14 (211) POSAV new status  
13:40:23.615 GMT : 00:00:22 (215) Nav Data Ok  
13:40:23.615 GMT : 00:00:23 (208) POSAV Rate Is 50 Hz  
13:40:23.615 GMT : 00:00:24 (211) POSAV new status  
13:40:23.615 GMT : 00:00:25 (211) POSAV new status  
13:40:23.615 GMT : 00:01:52 (211) POSAV new status  
13:40:23.615 GMT : 00:03:00 (211) POSAV new status  
18:09:05.496 GMT : 18:09:04 (211) POSAV new status  
18:13:51.001 GMT : 18:13:49 (153) Eyesafety Disabled  
18:13:51.201 GMT : 18:13:49 (162) Roll Comp On  
18:13:51.901 GMT : 18:13:50 (164) Beam Wide  
18:13:52.001 GMT : 18:13:50 (144) MultiPulse Mode Varies  
18:13:53.101 GMT : 18:13:52 (165) Beam Narrow  
18:26:09.516 GMT : 18:26:08 (106) Rx Shutter Open  
18:26:09.516 GMT : 18:26:08 (108) Tx Shutter Open  
18:33:52.326 GMT : 18:33:51 (113) Laser Emission On  
18:48:38.444 GMT : 18:48:36 (112) Laser Emission Off  
18:52:29.049 GMT : 18:52:27 (113) Laser Emission On  
18:55:00.252 GMT : 18:54:58 (112) Laser Emission Off  
18:59:40.958 GMT : 18:59:39 (113) Laser Emission On  
19:02:38.362 GMT : 19:02:37 (112) Laser Emission Off  
19:05:31.865 GMT : 19:05:30 (113) Laser Emission On  
19:20:15.884 GMT : 19:20:14 (112) Laser Emission Off  
19:23:18.788 GMT : 19:23:17 (113) Laser Emission On  
19:37:58.706 GMT : 19:37:57 (112) Laser Emission Off  
19:40:40.609 GMT : 19:40:39 (113) Laser Emission On  
19:55:37.328 GMT : 19:55:35 (112) Laser Emission Off  
19:59:01.332 GMT : 19:59:00 (113) Laser Emission On  
20:13:22.85 GMT : 20:13:21 (112) Laser Emission Off  
20:17:01.055 GMT : 20:16:59 (113) Laser Emission On  
20:31:25.073 GMT : 20:31:23 (112) Laser Emission Off  
20:34:10.876 GMT : 20:34:09 (113) Laser Emission On  
20:47:50.694 GMT : 20:47:49 (112) Laser Emission Off  
20:51:50.499 GMT : 20:51:49 (113) Laser Emission On  
21:04:01.114 GMT : 21:03:59 (112) Laser Emission Off  
21:07:08.618 GMT : 21:07:07 (113) Laser Emission On

21:17:58.632 GMT : 21:17:57 (112) Laser Emission Off  
21:20:44.735 GMT : 21:20:43 (113) Laser Emission On  
21:31:44.749 GMT : 21:31:43 (112) Laser Emission Off  
21:34:24.252 GMT : 21:34:22 (113) Laser Emission On  
21:45:15.866 GMT : 21:45:14 (112) Laser Emission Off  
21:48:57.47 GMT : 21:48:56 (113) Laser Emission On  
21:51:28.673 GMT : 21:51:26 (112) Laser Emission Off  
21:51:44.374 GMT : 21:51:42 (107) Rx Shutter Closed  
21:51:44.374 GMT : 21:51:42 (109) Tx Shutter Closed

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : 1B9  
Mission : 101208B  
Wheels Up : 120 PM EST  
Flight Length : -  
HOBBS Start : -  
HOBBS End : -

#### Weather

-----  
Date : December 08, 2010  
Julian Day : 342  
Temperature : -1C  
Visibility : CLOUDS AT 5700 '  
Clouds : CLOUDS AT 5700 '  
Precipitation : NEGATIVE GHOST RIDER  
Wind Dir : 340  
Wind Speed : BLOWING AT 15 KTS  
Pressure : 2973

#### Statistics

-----  
Laser Time : 02:33:39

=====

#### Flight Log

-----  
Project Number: 7556-005  
S/N : 246  
Operator : BERRY  
Pilot(s) : YOUNG  
Aircraft : N7266Z  
Airport : 1B9  
Mission : 101208B  
Wheels Up : 120 PM EST  
Flight Length : -  
HOBBS Start : -  
HOBBS End : -

# Weather

```

-----
Date       : December 08, 2010
Julian Day  : 342
Temperature : -1C
Visibility  : CLOUDS AT 5700'
Clouds      : CLOUDS AT 5700'
Precipitation : NEGATIVE GHOST RIDER
Wind Dir    : 340
Wind Speed  : BLOWING AT 15 KTS
Pressure    : 2973
  
```

# Statistics

```

-----
Laser Time   : 02:33:39
  
```

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
=====									
18:33:53.226		18:48:38.244	34	1426	70	30.10	18.00	ON	NAR
ON	0.00	178.46							
18:52:29.049		18:55:01.052	33	1435	70	30.10	18.00	ON	NAR
ON	0.00	358.47							
18:59:41.958		19:02:39.262	35	1447	70	30.10	18.00	ON	NAR
ON	0.00	178.46							
19:05:32.466		19:20:16.684	36	1454	70	30.10	18.00	ON	NAR
ON	0.00	178.45							
19:23:19.488		19:37:59.206	36	1446	70	30.10	18.00	ON	NAR
ON	0.00	178.45							
19:40:41.309		19:55:37.028	38	1445	70	30.10	18.00	ON	NAR
ON	0.00	178.44							
19:59:02.332		20:13:24.65	38	1456	70	30.10	18.00	ON	NAR
ON	0.00	178.44							
20:17:01.855		20:31:26.173	40	1445	70	30.10	18.00	ON	NAR
ON	0.00	178.43							
20:34:11.476		20:47:51.494	41	1464	70	30.10	18.00	ON	NAR
ON	0.00	178.42							
20:51:51.099		21:04:02.614	42	1459	70	30.10	18.00	ON	NAR
ON	0.00	178.41							
21:07:09.218		21:17:59.132	43	1460	70	30.10	18.00	ON	NAR
ON	0.00	358.41							
21:20:45.335		21:31:46.749	44	1454	70	30.10	18.00	ON	NAR
ON	0.00	358.4							
21:34:25.052		21:45:16.866	44	1475	70	30.10	18.00	ON	NAR
ON	0.00	178.4							
21:48:58.17		21:51:29.173	44	1479	70	30.10	18.00	ON	NAR
ON	0.00	178.4							

# Flight Log

```

-----
Project Number: 0
S/N           : 0
  
```

Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 08, 2010  
Julian Day : 342  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 0

=====  
15:12:35.543 GMT : 00:00:02 (212) GPS 1PPS Lost  
15:12:35.543 GMT : 00:00:03 (166) Divergence Error  
15:12:35.543 GMT : 00:00:03 (107) Rx Shutter Closed  
15:12:35.543 GMT : 00:00:03 (109) Tx Shutter Closed  
15:12:35.543 GMT : 00:00:04 (164) Beam Wide  
15:12:35.543 GMT : 00:00:08 (213) GPS 1PPS Ok  
15:12:35.543 GMT : 00:00:12 (204) POSAV Connected  
15:12:35.543 GMT : 00:00:13 (207) POSAV Rate Not 50 Hz  
15:12:35.543 GMT : 00:00:13 (211) POSAV new status  
15:12:35.543 GMT : 00:00:18 (120) Laser PS Comm Ok  
15:12:35.543 GMT : 00:00:18 (112) Laser Emission Off  
15:12:35.543 GMT : 00:00:20 (208) POSAV Rate Is 50 Hz  
15:12:35.543 GMT : 00:00:20 (211) POSAV new status  
15:12:35.543 GMT : 00:00:22 (211) POSAV new status  
15:12:35.543 GMT : 00:00:22 (215) Nav Data Ok  
15:12:35.543 GMT : 00:01:57 (211) POSAV new status  
14:44:05.275 GMT : 00:03:20 (307) Format Disk

Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :

HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 08, 2010  
Julian Day : 342  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 0

=====

Flight Log

-----  
Project Number: 0  
S/N : 0  
Operator : ???  
Pilot(s) : ???  
Aircraft : ???  
Airport : ???  
Mission : ???  
Wheels Up : ???  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 08, 2010  
Julian Day : 342  
Temperature : ???  
Visibility : ???  
Clouds : ???  
Precipitation : ???  
Wind Dir : ???  
Wind Speed : ???  
Pressure : ???

Statistics

-----  
Laser Time : 0

START STOP LINE# ALT PRF FREQ ANGLE MP DIV  
RC HDG Plan File

=====

Flight Log

-----  
Project Number: NARR\_1B9  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : 1B9 Mansfield, MA  
Mission : 1  
Wheels Up :  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 08, 2010  
Julian Day : 342  
Temperature : -4 C @KBED  
Visibility : clear  
Clouds : none  
Precipitation : nill  
Wind Dir :  
Wind Speed :  
Pressure : 29.64 HG @KBED

Statistics

-----  
Laser Time : 01:42:05

=====  
15:18:13.952 GMT : 00:04:38 (157) Safe Unaided Profile  
15:18:13.952 GMT : 00:04:38 (162) Roll Comp On  
15:18:13.952 GMT : 00:04:38 (157) Safe Unaided Profile  
15:18:13.952 GMT : 00:04:39 (164) Beam Wide  
14:45:27.775 GMT : 00:04:42 (165) Beam Narrow  
14:45:29.875 GMT : 00:04:44 (211) POSAV new status  
14:46:45.876 GMT : 14:46:44 (157) Safe Unaided Profile  
14:47:01.876 GMT : 14:47:00 (157) Safe Unaided Profile  
14:47:01.876 GMT : 14:47:01 (157) Safe Unaided Profile  
14:47:13.376 GMT : 14:47:11 (152) Invalid Beam  
14:47:13.576 GMT : 14:47:11 (152) Invalid Beam  
14:47:28.076 GMT : 14:47:26 (157) Safe Unaided Profile  
14:47:28.276 GMT : 14:47:26 (157) Safe Unaided Profile  
14:48:44.577 GMT : 14:48:43 (157) Safe Unaided Profile  
14:48:44.677 GMT : 14:48:43 (157) Safe Unaided Profile  
14:48:45.277 GMT : 14:48:44 (144) MultiPulse Mode Varies  
14:51:43.278 GMT : 14:51:42 (211) POSAV new status  
15:00:24.783 GMT : 15:00:23 (157) Safe Unaided Profile  
15:00:29.183 GMT : 15:00:27 (106) Rx Shutter Open  
15:00:29.383 GMT : 15:00:27 (108) Tx Shutter Open  
15:07:31.987 GMT : 15:07:30 (113) Laser Emission On  
15:09:26.188 GMT : 15:09:24 (112) Laser Emission Off  
15:13:52.591 GMT : 15:13:51 (113) Laser Emission On  
15:16:21.093 GMT : 15:16:19 (112) Laser Emission Off  
15:20:54.095 GMT : 15:20:53 (113) Laser Emission On



15:23:10.697 GMT : 15:23:09 (112) Laser Emission Off  
15:28:35.6 GMT : 15:28:34 (113) Laser Emission On  
15:31:02.102 GMT : 15:31:00 (112) Laser Emission Off  
15:35:22.005 GMT : 15:35:20 (113) Laser Emission On  
15:37:30.206 GMT : 15:37:29 (112) Laser Emission Off  
15:42:37.11 GMT : 15:42:35 (113) Laser Emission On  
15:44:53.911 GMT : 15:44:52 (112) Laser Emission Off  
15:49:28.814 GMT : 15:49:27 (113) Laser Emission On  
15:55:00.818 GMT : 15:54:59 (112) Laser Emission Off  
15:59:09.921 GMT : 15:59:08 (113) Laser Emission On  
16:05:35.525 GMT : 16:05:34 (112) Laser Emission Off  
16:10:21.828 GMT : 16:10:20 (113) Laser Emission On  
16:16:26.333 GMT : 16:16:24 (112) Laser Emission Off  
16:20:57.836 GMT : 16:20:56 (113) Laser Emission On  
16:27:35.74 GMT : 16:27:33 (112) Laser Emission Off  
16:32:11.844 GMT : 16:32:10 (113) Laser Emission On  
16:38:54.148 GMT : 16:38:52 (112) Laser Emission Off  
16:43:19.252 GMT : 16:43:18 (113) Laser Emission On  
16:50:22.757 GMT : 16:50:21 (112) Laser Emission Off  
16:54:59.86 GMT : 16:54:58 (113) Laser Emission On  
17:02:09.565 GMT : 17:02:08 (112) Laser Emission Off  
17:06:49.968 GMT : 17:06:48 (113) Laser Emission On  
17:14:38.674 GMT : 17:14:37 (112) Laser Emission Off  
17:19:02.977 GMT : 17:19:02 (113) Laser Emission On  
17:27:06.983 GMT : 17:27:05 (112) Laser Emission Off  
17:31:45.587 GMT : 17:31:44 (113) Laser Emission On  
17:40:01.293 GMT : 17:40:00 (112) Laser Emission Off  
17:44:38.496 GMT : 17:44:37 (113) Laser Emission On  
17:52:48.802 GMT : 17:52:46 (112) Laser Emission Off  
17:57:42.006 GMT : 17:57:40 (113) Laser Emission On  
18:06:25.612 GMT : 18:06:24 (112) Laser Emission Off  
18:11:03.916 GMT : 18:11:02 (113) Laser Emission On  
18:14:04.918 GMT : 18:14:03 (112) Laser Emission Off  
18:19:06.122 GMT : 18:19:05 (157) Safe Unaided Profile  
18:19:28.822 GMT : 18:19:27 (157) Safe Unaided Profile  
18:19:33.122 GMT : 18:19:31 (107) Rx Shutter Closed  
18:19:33.222 GMT : 18:19:31 (109) Tx Shutter Closed

#### Flight Log

-----  
Project Number: NARR\_1B9  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : 1B9 Mansfield, MA  
Mission : 1  
Wheels Up :  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----

## Statistics

=====

-----

## Weather

## Statistics

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
=====									
15:07:31.787	15:09:26.488	29	1599	70	30.10	18.00	ON	NAR	
ON	0.00	178.63							
15:07:31.787	15:09:26.488	29	1599	70	30.10	18.00	ON	NAR	
ON	0.00	178.63							

15:13:53.391	15:16:22.293	28	1582	70	30.10	18.00	ON	NAR
ON 0.00	358.62							
15:13:53.391	15:16:22.293	28	1583	70	30.10	18.00	ON	NAR
ON 0.00	358.62							
15:20:55.095	15:23:12.597	27	1586	70	30.10	18.00	ON	NAR
ON 0.00	178.62							
15:20:55.095	15:23:12.597	26	1586	70	30.10	18.00	ON	NAR
ON 0.00	178.61							
15:28:36.2	15:31:03.002	26	1579	70	30.10	18.00	ON	NAR
ON 0.00	358.61							
15:35:21.805	15:37:32.006	24	1597	70	30.10	18.00	ON	NAR
ON 0.00	178.6							
15:42:38.31	15:44:52.111	24	1568	70	30.10	18.00	ON	NAR
ON 0.00	358.6							
15:42:38.31	15:44:56.211	24	1569	70	30.10	18.00	ON	NAR
ON 0.00	358.6							
15:49:29.014	15:55:01.618	23	1611	70	30.10	18.00	ON	NAR
ON 0.00	178.6							
15:59:09.621	16:05:36.125	22	1570	70	30.10	18.00	ON	NAR
ON 0.00	358.59							
15:59:09.621	16:05:36.125	21	1571	70	30.10	18.00	ON	NAR
ON 0.00	178.59							
16:10:22.728	16:16:25.833	21	1576	70	30.10	18.00	ON	NAR
ON 0.00	178.59							
16:20:57.736	16:27:37.74	20	1536	70	30.10	18.00	ON	NAR
ON 0.00	358.58							
16:32:12.844	16:38:53.848	19	1463	70	30.10	18.00	ON	NAR
ON 0.00	178.58							
16:43:20.452	16:50:24.157	18	1450	70	30.10	18.00	ON	NAR
ON 0.00	358.57							
16:43:20.452	16:50:24.157	17	1450	70	30.10	18.00	ON	NAR
ON 0.00	358.57							
16:55:00.76	17:02:11.065	17	1482	70	30.10	18.00	ON	NAR
ON 0.00	178.57							
16:55:00.76	17:02:11.065	17	1483	70	30.10	18.00	ON	NAR
ON 0.00	178.57							
17:06:49.968	17:14:39.674	16	1468	70	30.10	18.00	ON	NAR
ON 0.00	358.56							
17:19:04.177	17:27:03.583	15	1477	70	30.10	18.00	ON	NAR
ON 0.00	178.56							
17:31:46.287	17:40:01.993	14	1468	70	30.10	18.00	ON	NAR
ON 0.00	358.55							
17:31:46.287	17:40:01.993	14	1466	70	30.10	18.00	ON	NAR
ON 0.00	358.55							
17:44:39.096	17:52:50.302	13	1456	70	30.10	18.00	ON	NAR
ON 0.00	178.55							
17:57:42.206	18:06:27.812	12	1472	70	30.10	18.00	ON	NAR
ON 0.00	358.54							
18:11:04.416	18:14:06.318	12	1440	70	30.10	18.00	ON	NAR
ON 0.00	358.54							
18:11:04.416	18:14:06.318	12	1438	70	30.10	18.00	ON	NAR
ON 0.00	358.54							

Flight Log

-----  
Project Number: NARR\_1B9  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : 1B9  
Mission : 2  
Wheels Up : 1914 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

Weather

-----  
Date : December 08, 2010  
Julian Day : 342  
Temperature :  
Visibility : +10 SM  
Clouds : SCT 060  
Precipitation : nill  
Wind Dir :  
Wind Speed :  
Pressure : 29.74 HG

Statistics

-----  
Laser Time : 01:30:36

=====  
19:46:19.541 GMT : 19:14:34 (157) Safe Unaided Profile  
19:14:58.319 GMT : 19:14:56 (157) Safe Unaided Profile  
19:14:58.519 GMT : 19:14:56 (157) Safe Unaided Profile  
19:16:11.22 GMT : 19:16:10 (157) Safe Unaided Profile  
19:16:16.92 GMT : 19:16:15 (157) Safe Unaided Profile  
19:16:20.02 GMT : 19:16:18 (106) Rx Shutter Open  
19:16:20.22 GMT : 19:16:18 (108) Tx Shutter Open  
19:27:11.628 GMT : 19:27:10 (113) Laser Emission On  
19:36:44.835 GMT : 19:36:43 (112) Laser Emission Off  
19:43:55.741 GMT : 19:43:54 (113) Laser Emission On  
19:56:47.05 GMT : 19:56:45 (112) Laser Emission Off  
20:01:23.853 GMT : 20:01:22 (113) Laser Emission On  
20:07:17.158 GMT : 20:07:15 (214) Nav Data Lost  
20:07:21.158 GMT : 20:07:19 (215) Nav Data Ok  
20:14:47.963 GMT : 20:14:45 (112) Laser Emission Off  
20:19:23.167 GMT : 20:19:21 (113) Laser Emission On  
20:32:15.376 GMT : 20:32:14 (112) Laser Emission Off  
20:37:20.98 GMT : 20:37:19 (113) Laser Emission On  
20:50:36.19 GMT : 20:50:34 (112) Laser Emission Off  
20:55:38.393 GMT : 20:55:36 (113) Laser Emission On  
21:09:12.503 GMT : 21:09:10 (112) Laser Emission Off  
21:13:28.506 GMT : 21:13:27 (113) Laser Emission On  
21:27:34.217 GMT : 21:27:33 (112) Laser Emission Off  
21:34:02.521 GMT : 21:34:01 (113) Laser Emission On  
21:35:29.722 GMT : 21:35:28 (112) Laser Emission Off

21:37:34.224 GMT : 21:37:33 (157) Safe Unaided Profile  
21:37:35.024 GMT : 21:37:33 (157) Safe Unaided Profile  
21:37:38.624 GMT : 21:37:37 (107) Rx Shutter Closed  
21:37:38.824 GMT : 21:37:37 (109) Tx Shutter Closed

#### Flight Log

-----  
Project Number: NARR\_1B9  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : 1B9  
Mission : 2  
Wheels Up : 1914 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 08, 2010  
Julian Day : 342  
Temperature :  
Visibility : +10 SM  
Clouds : SCT 060  
Precipitation : nill  
Wind Dir :  
Wind Speed :  
Pressure : 29.74 HG

#### Statistics

-----  
Laser Time : 01:30:36

=====

#### Flight Log

-----  
Project Number: NARR\_1B9  
S/N : 247  
Operator : Galieti  
Pilot(s) : Greenwell  
Aircraft : N2448G  
Airport : 1B9  
Mission : 2  
Wheels Up : 1914 Z  
Flight Length :  
HOBBS Start :  
HOBBS End :

#### Weather

-----  
Date : December 08, 2010  
Julian Day : 342

Temperature :  
 Visibility : +10 SM  
 Clouds : SCT 060  
 Precipitation : nill  
 Wind Dir :  
 Wind Speed :  
 Pressure : 29.74 HG

Statistics

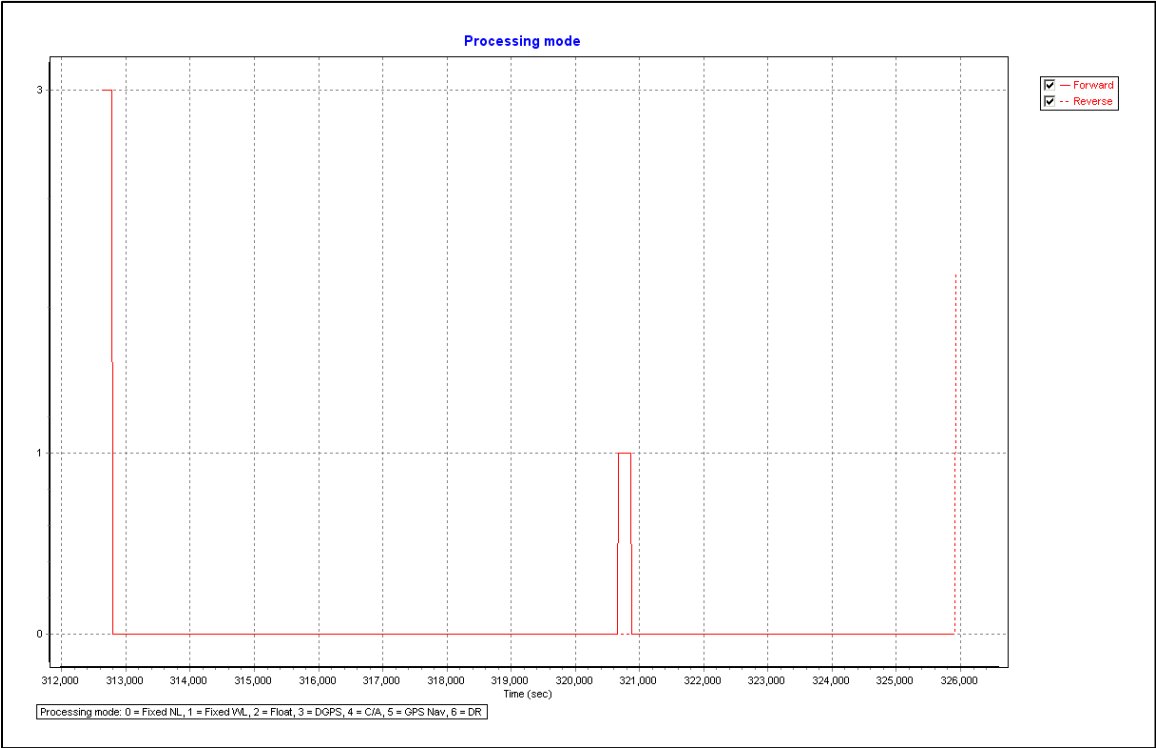
-----  
 Laser Time : 01:30:36

RC	START HDG	STOP Plan File	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV
	19:27:12.228	19:36:46.135	11	1565	70	30.10	18.00	ON	NAR
ON	0.00	178.54							
	19:43:56.641	19:56:48.35	10	1560	70	30.10	18.00	ON	NAR
ON	0.00	358.54							
	19:43:56.641	19:56:48.35	10	1560	70	30.10	18.00	ON	NAR
ON	0.00	358.54							
	20:01:24.553	20:14:48.163	9	1584	70	30.10	18.00	ON	NAR
ON	0.00	178.53							
	20:01:24.553	20:14:48.163	9	1585	70	30.10	18.00	ON	NAR
ON	0.00	178.53							
	20:19:23.067	20:32:16.376	8	1559	70	30.10	18.00	ON	NAR
ON	0.00	358.53							
	20:37:20.98	20:50:35.99	7	1580	70	30.10	18.00	ON	NAR
ON	0.00	178.52							
	20:55:39.293	21:09:11.903	6	1560	70	30.10	18.00	ON	NAR
ON	0.00	358.51							
	21:13:29.406	21:27:36.517	5	1575	70	30.10	18.00	ON	NAR
ON	0.00	178.51							
	21:34:03.621	21:35:30.322	5	1519	70	30.10	18.00	ON	NAR
ON	0.00	178.51							
	21:34:03.621	21:35:30.322	5	1516	70	30.10	18.00	ON	NAR
ON	0.00	178.51							

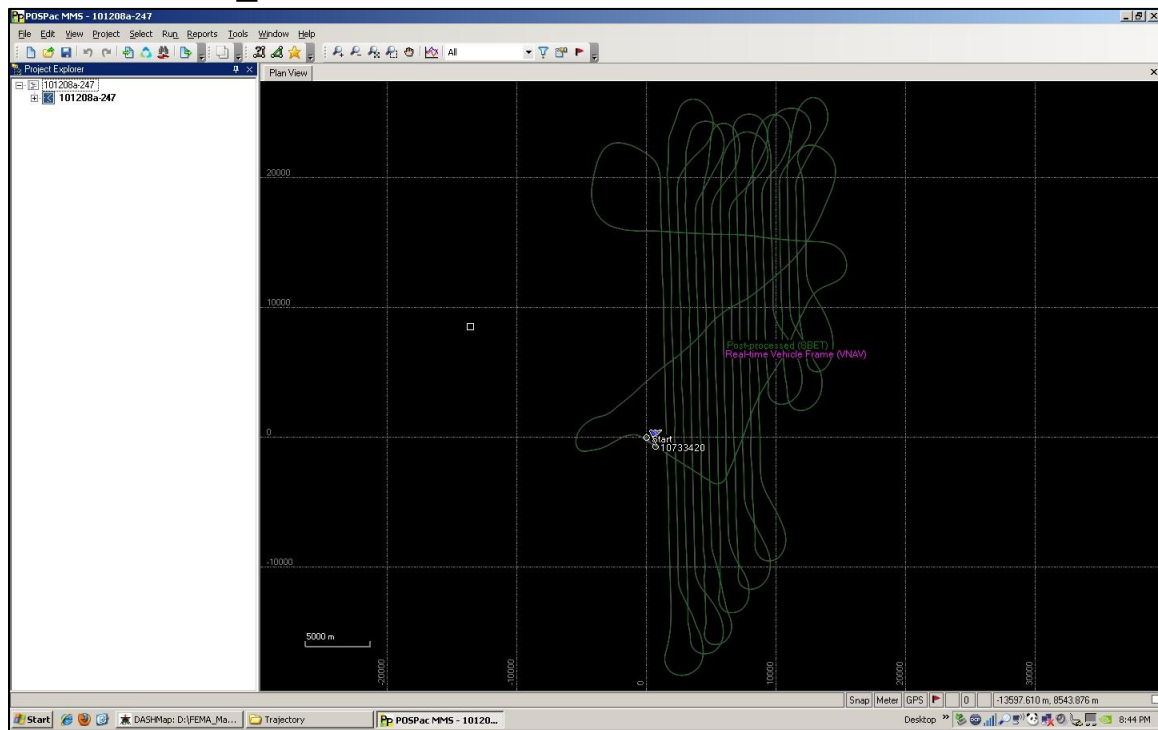
□



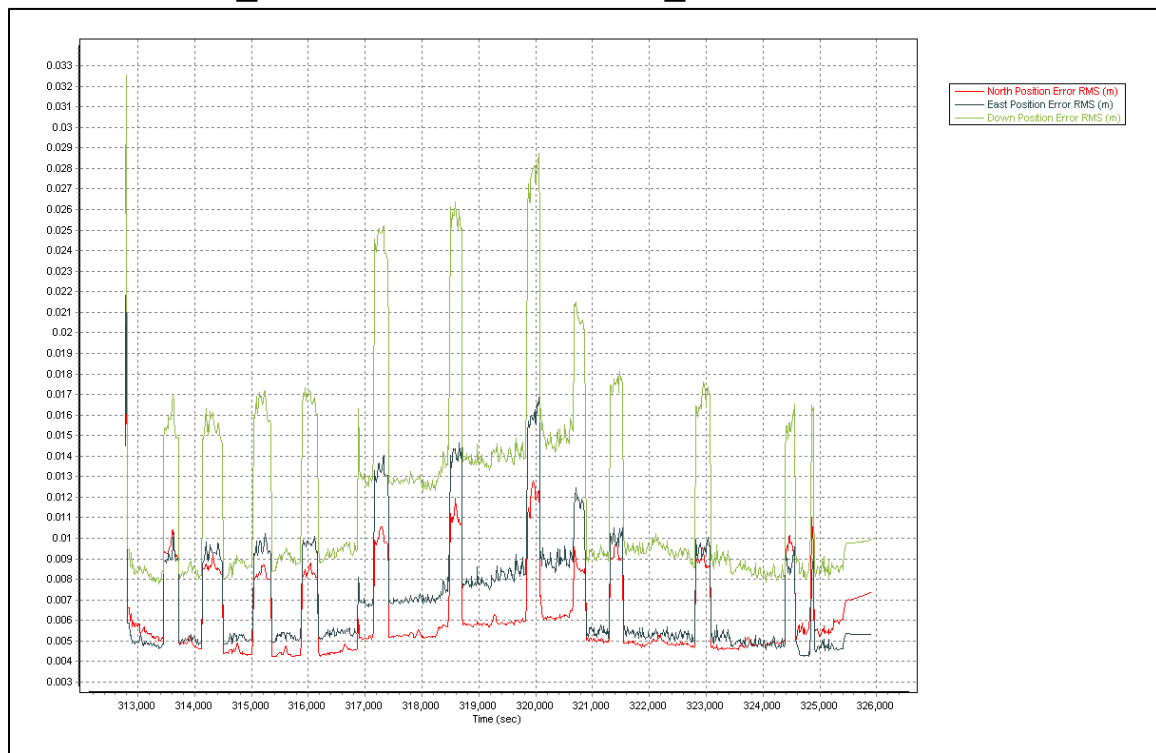
101208A-247\_PROCESSMODE



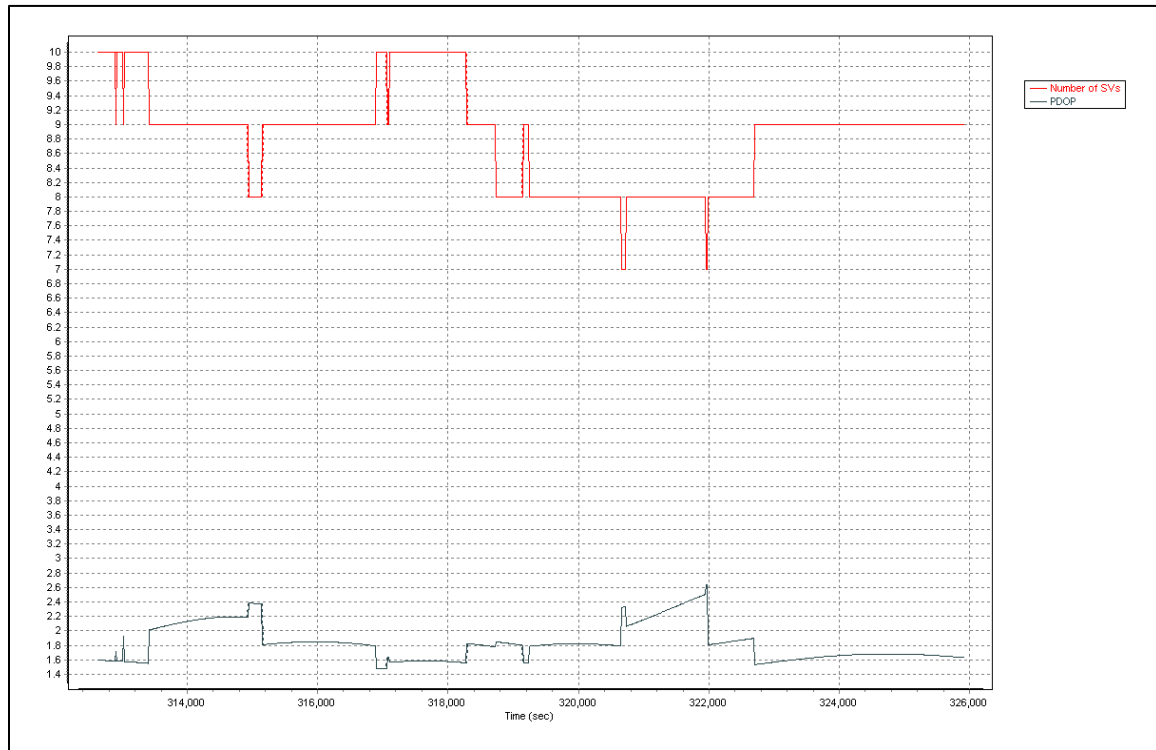
# 101208A-247\_SCREENSHOT



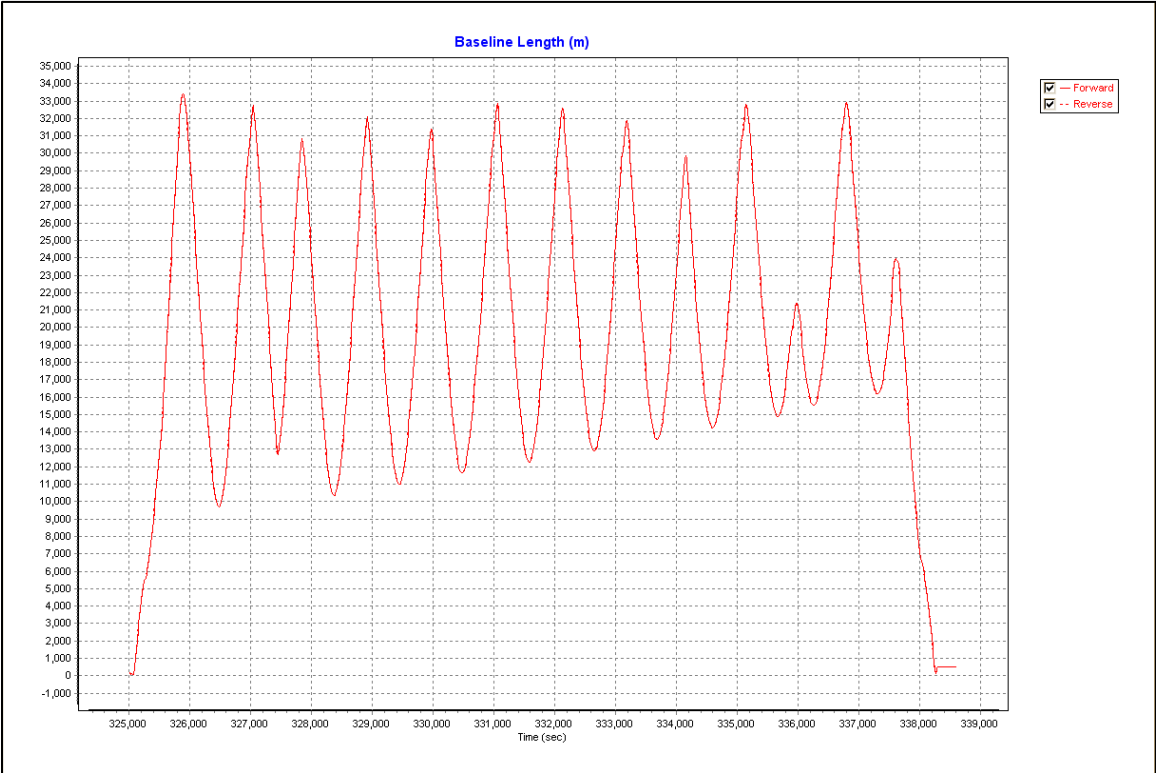
# 101208A-247\_SMOOTHPERFMETRIC\_NED



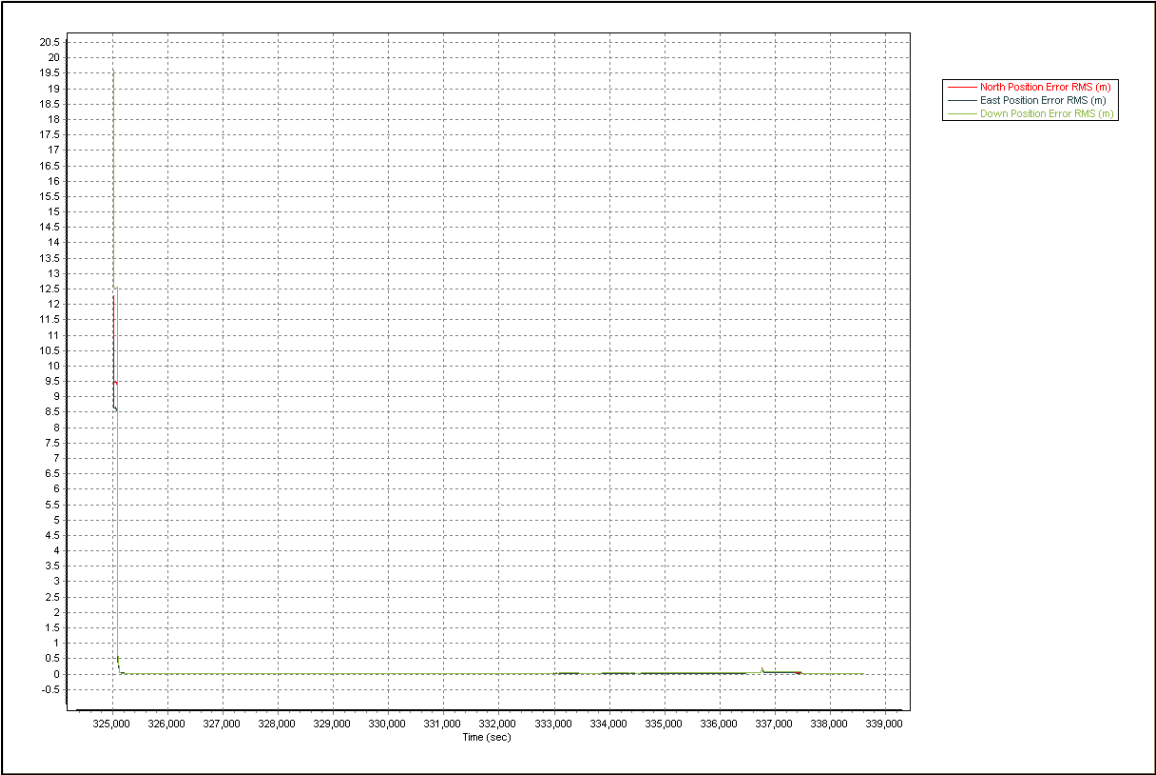
# 101208A-247\_SVS&PDOP



101208B-246-BASELINELENGTH

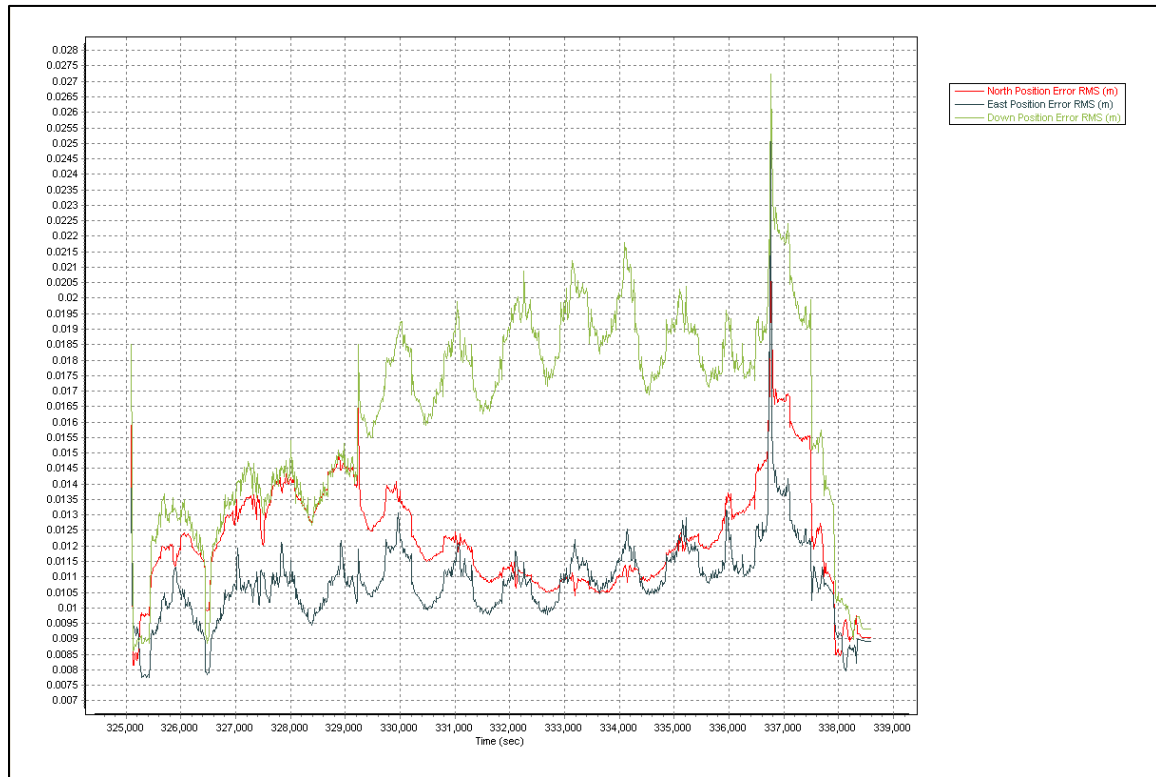


101208B-246-NEDPOSITIONERROR-FORWARD

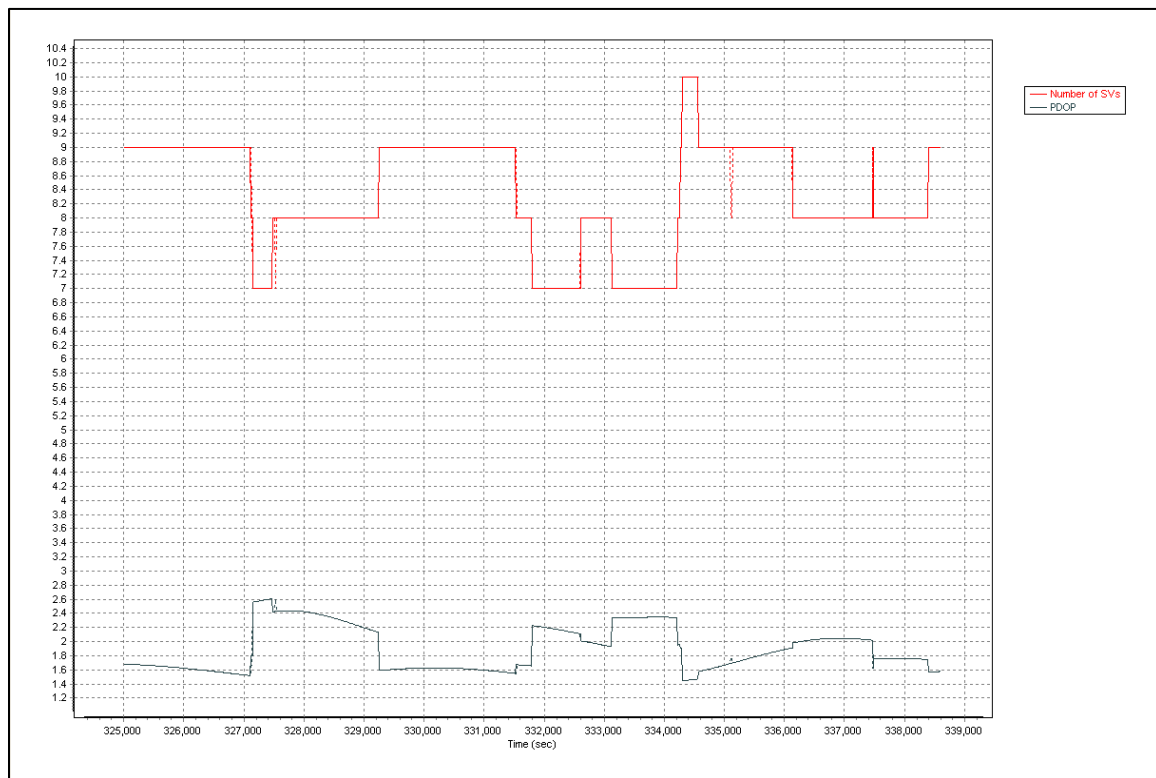




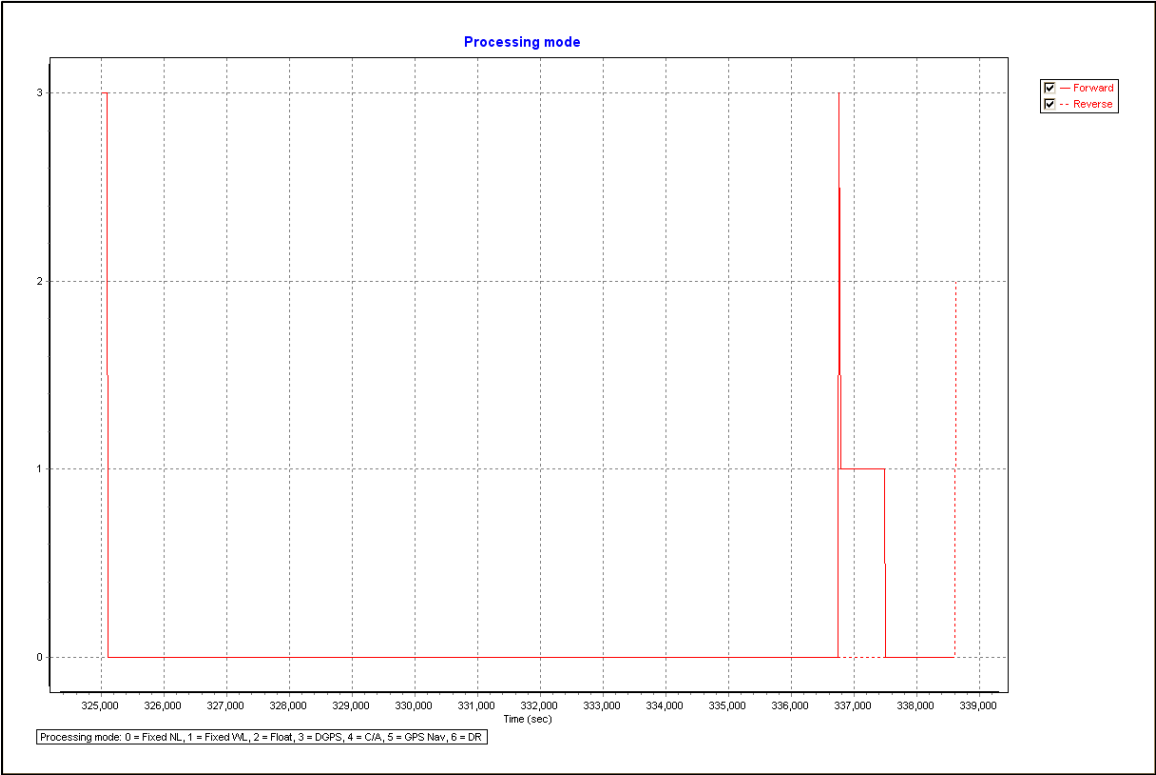
# 101208B-246-NEDPOSITIONERROR-SMOOTHED



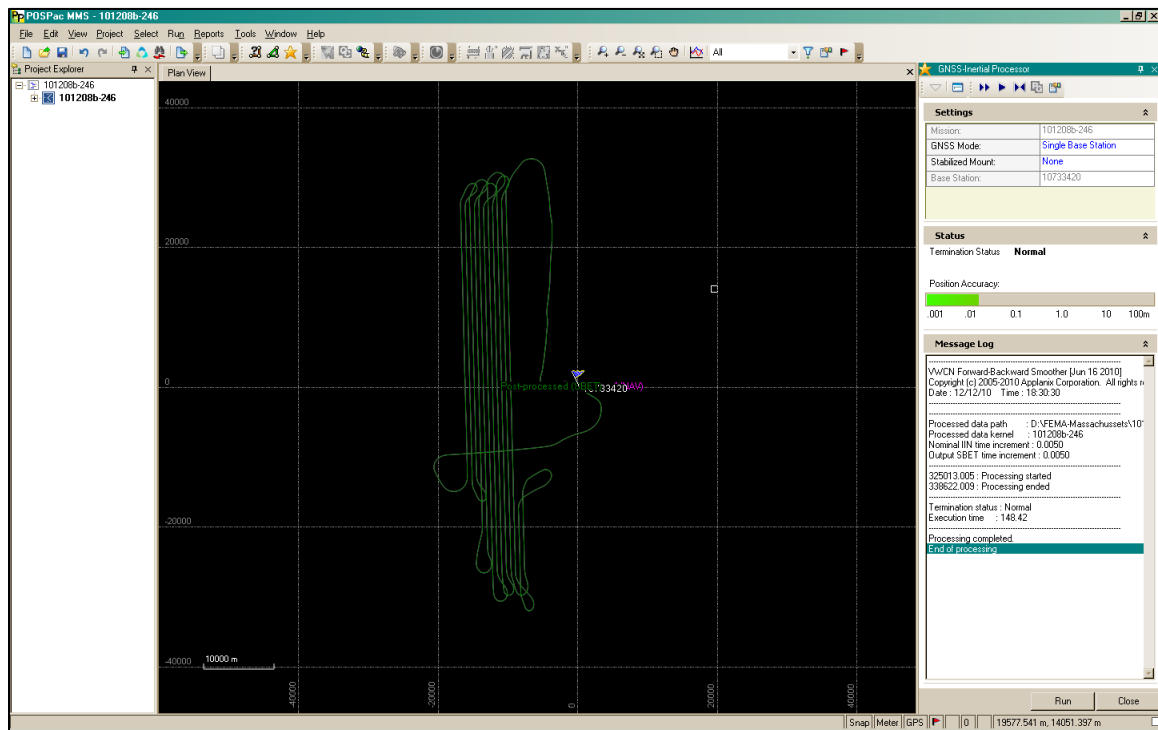
# 101208B-246-PDOP&SVS



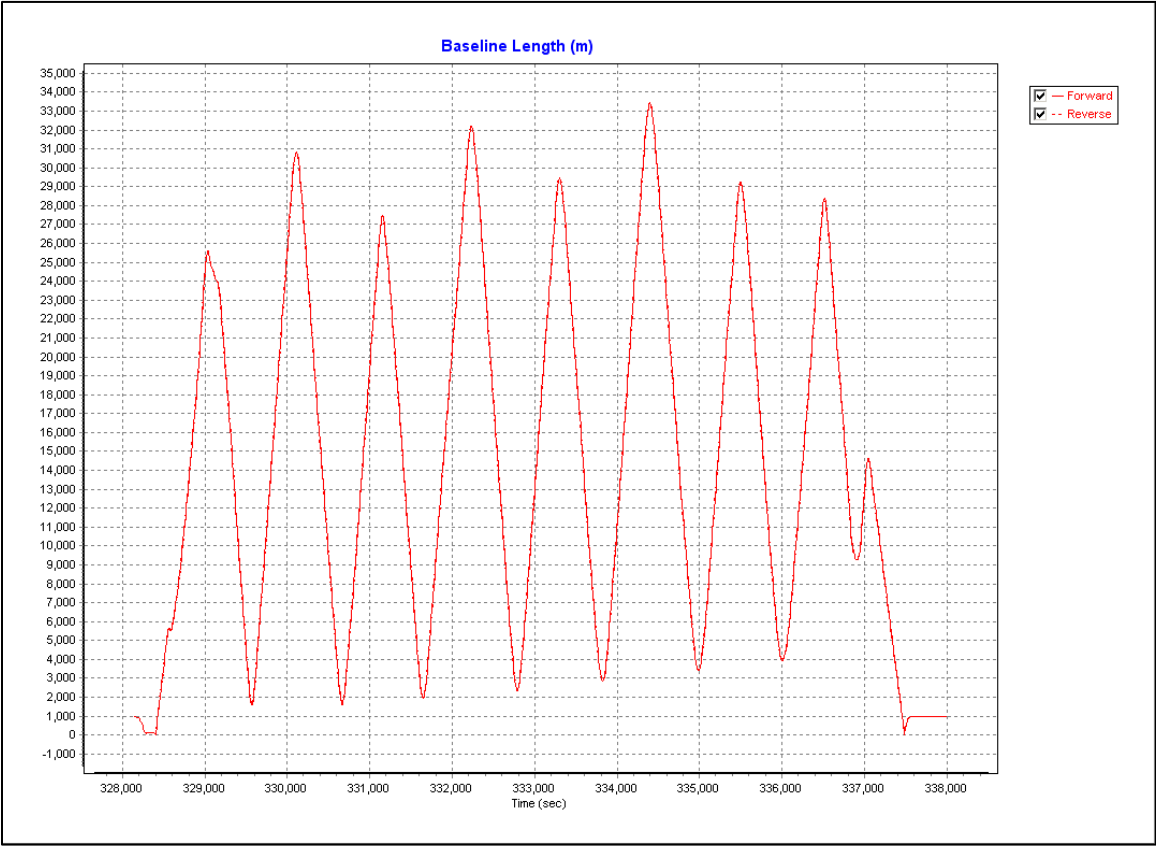
101208B-246-PROCMODE



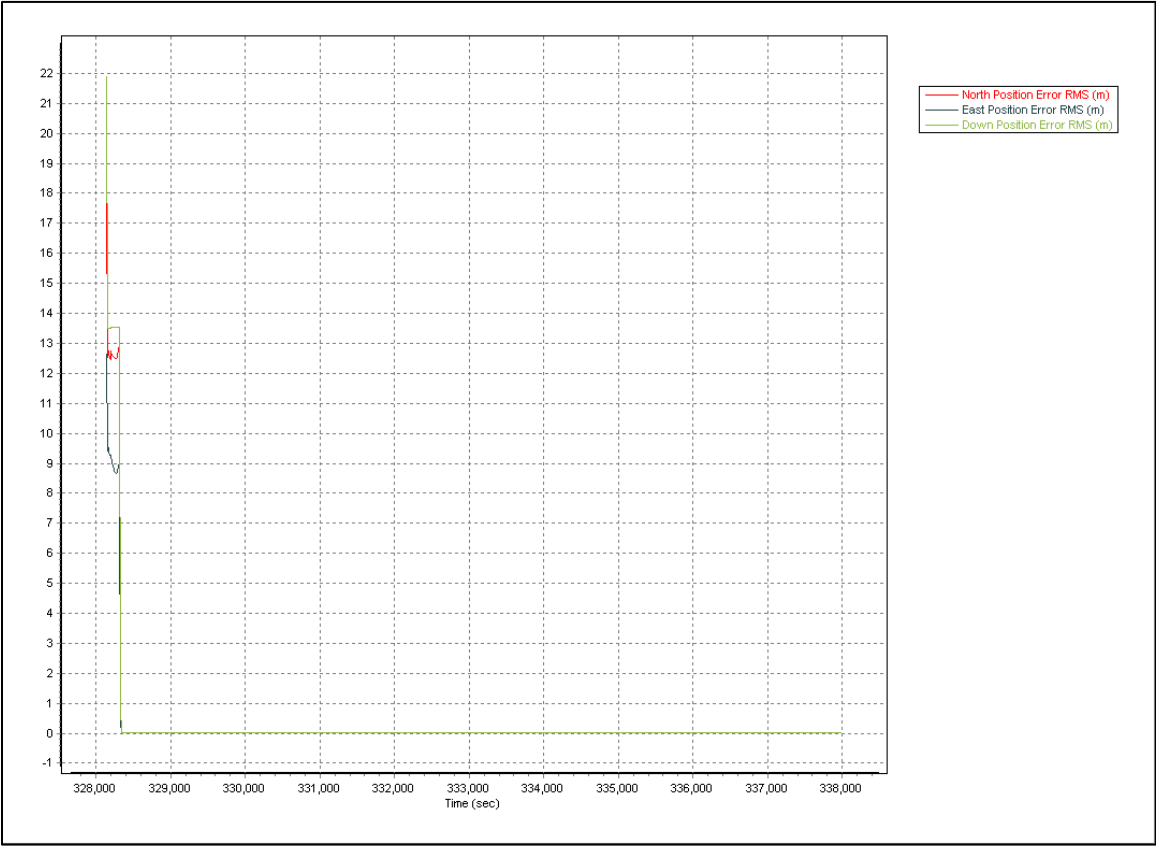
# 101208B-246-TRAJECTORY



101208B-247\_BASELINE

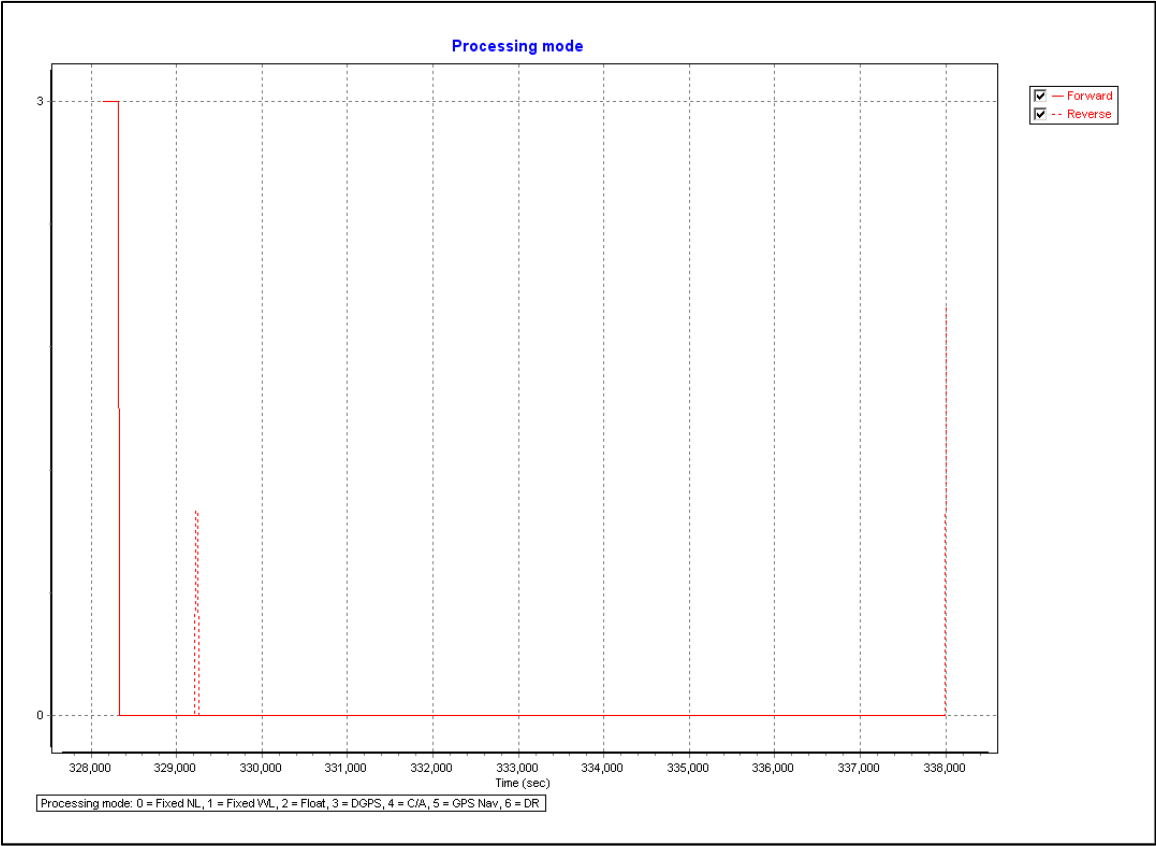


101208B-247\_FORWARDPROCPERFMETRIC\_NED

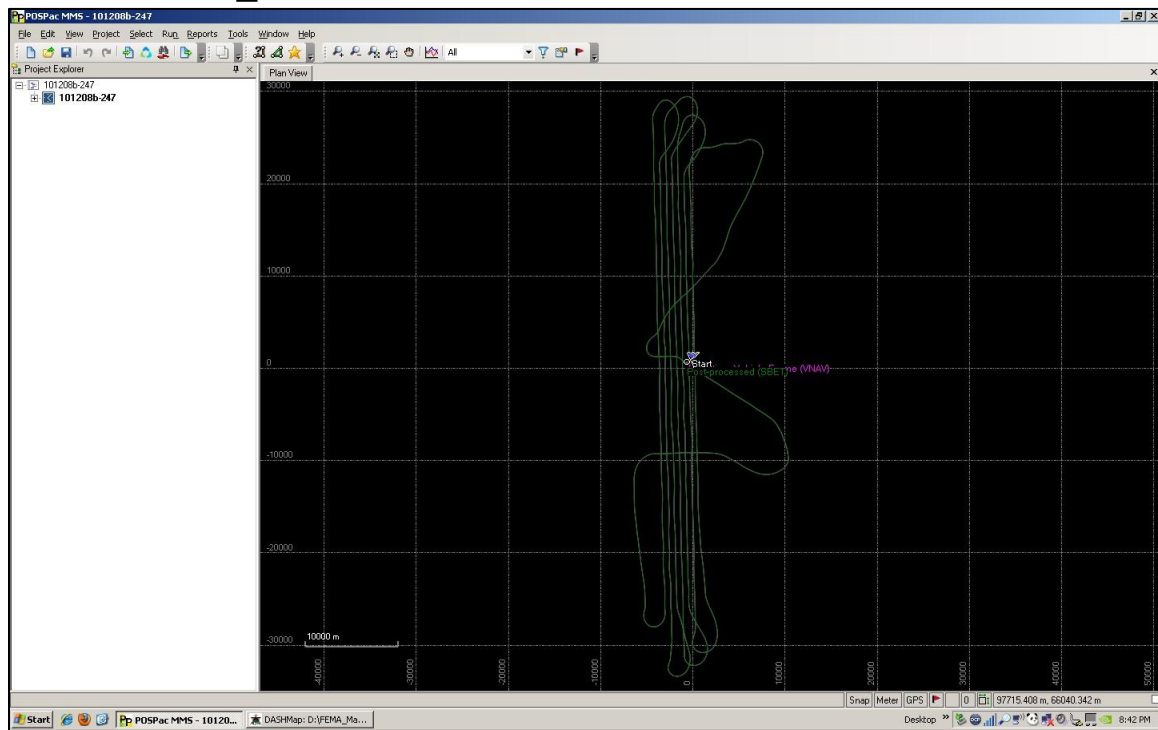




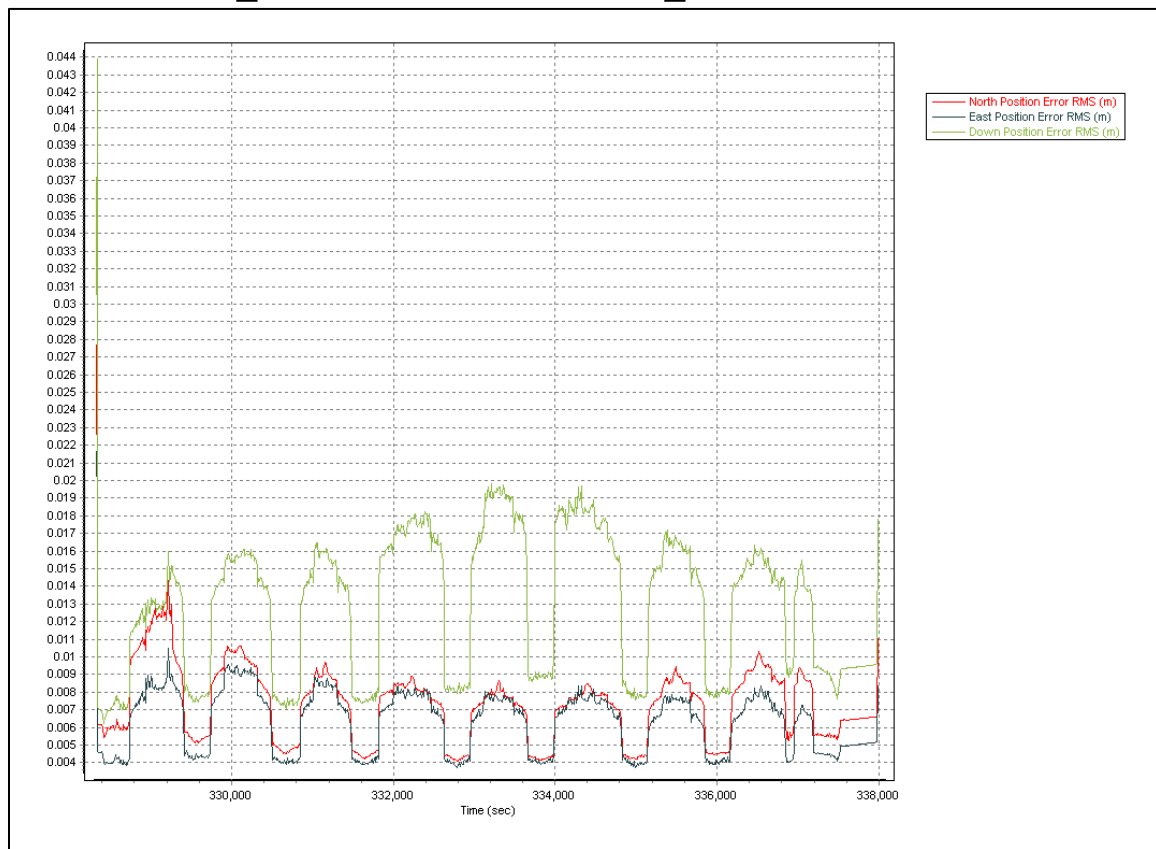
101208B-247\_PROCESSMODE



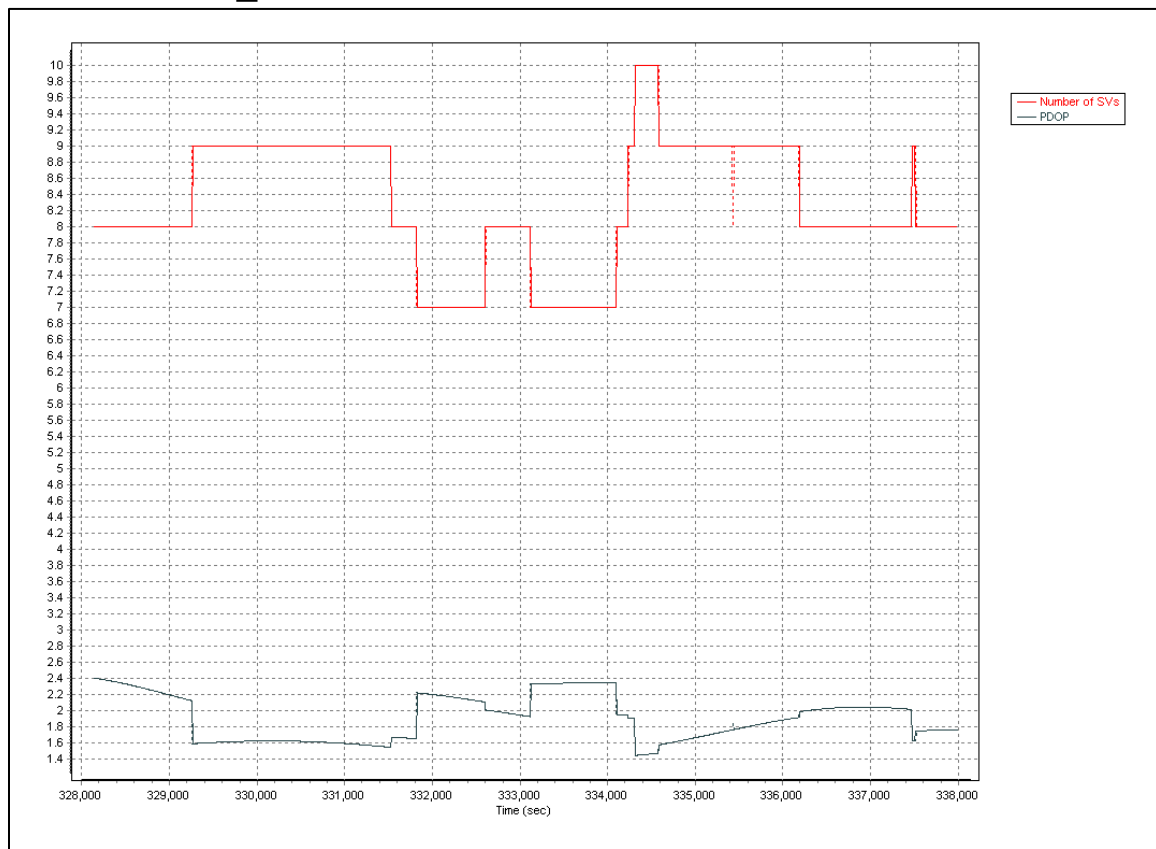
# 101208B-247\_SCREENSHOT



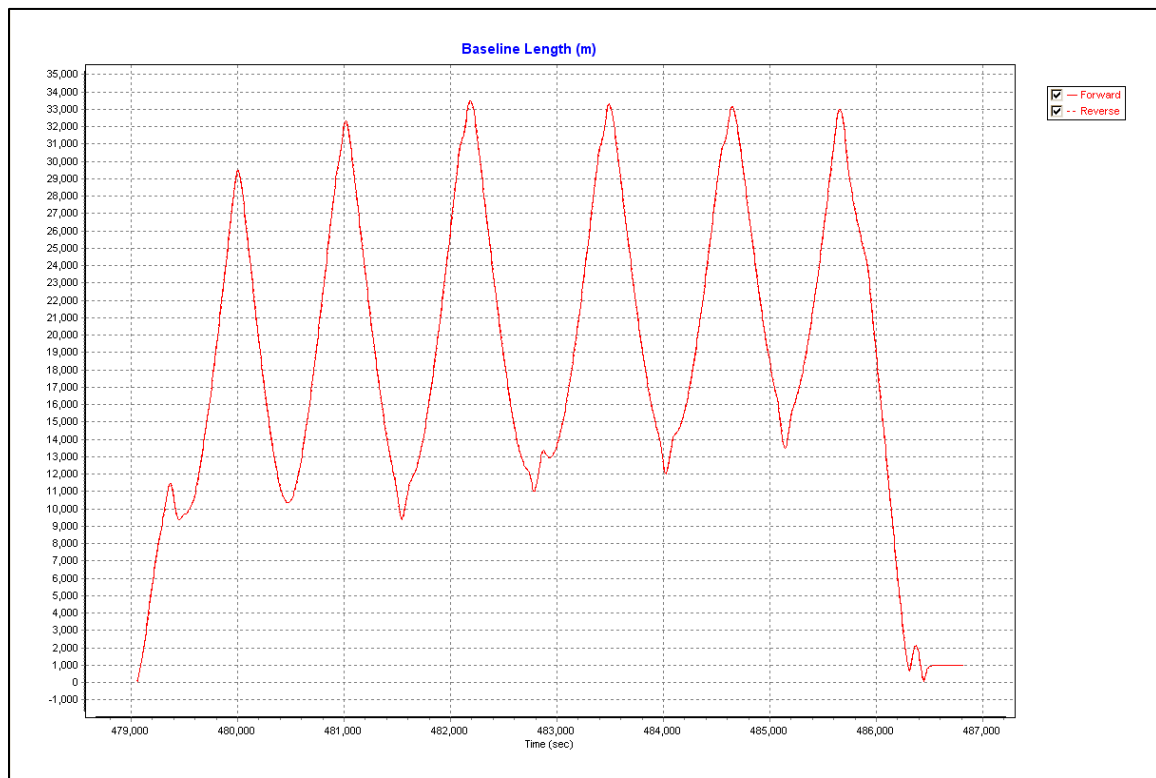
# 101208B-247\_SMOOTHPERFMETRIC\_NED



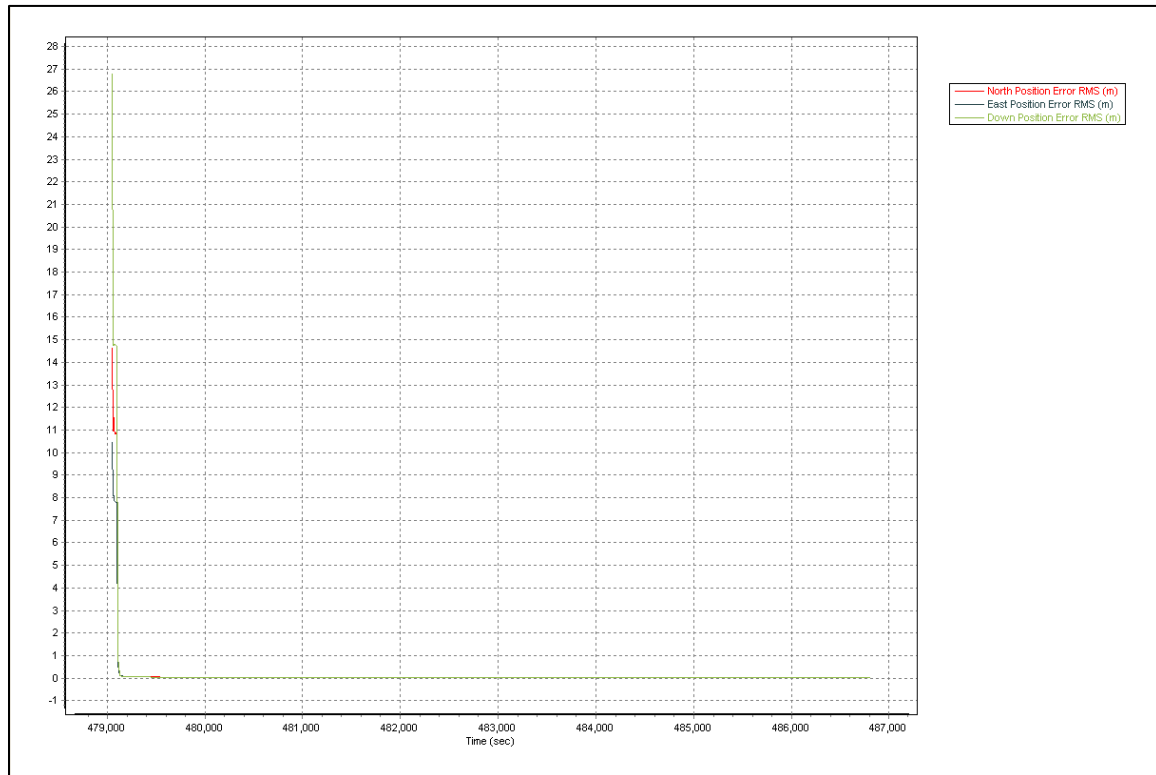
# 101208B-247\_SVS&PDOP



# 101210A-246-BASELINELENGTH

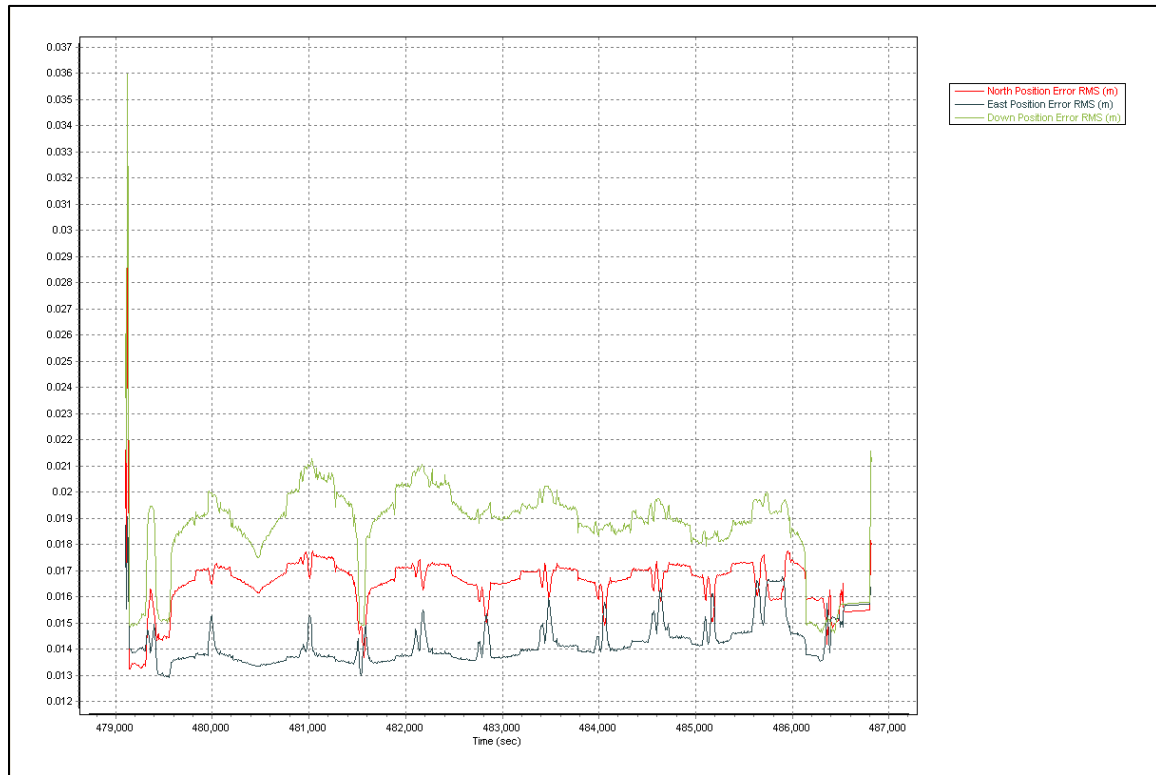


# 101210A-246-NEDPOSITIONERROR-FORWARD

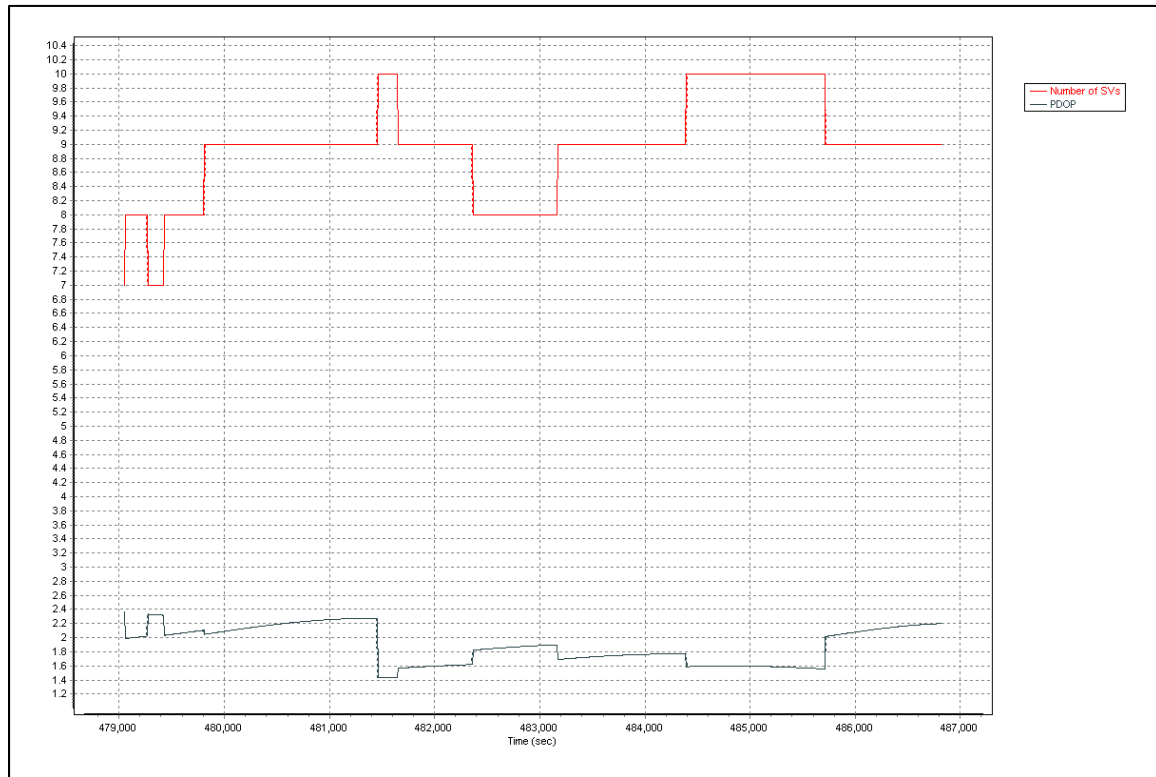




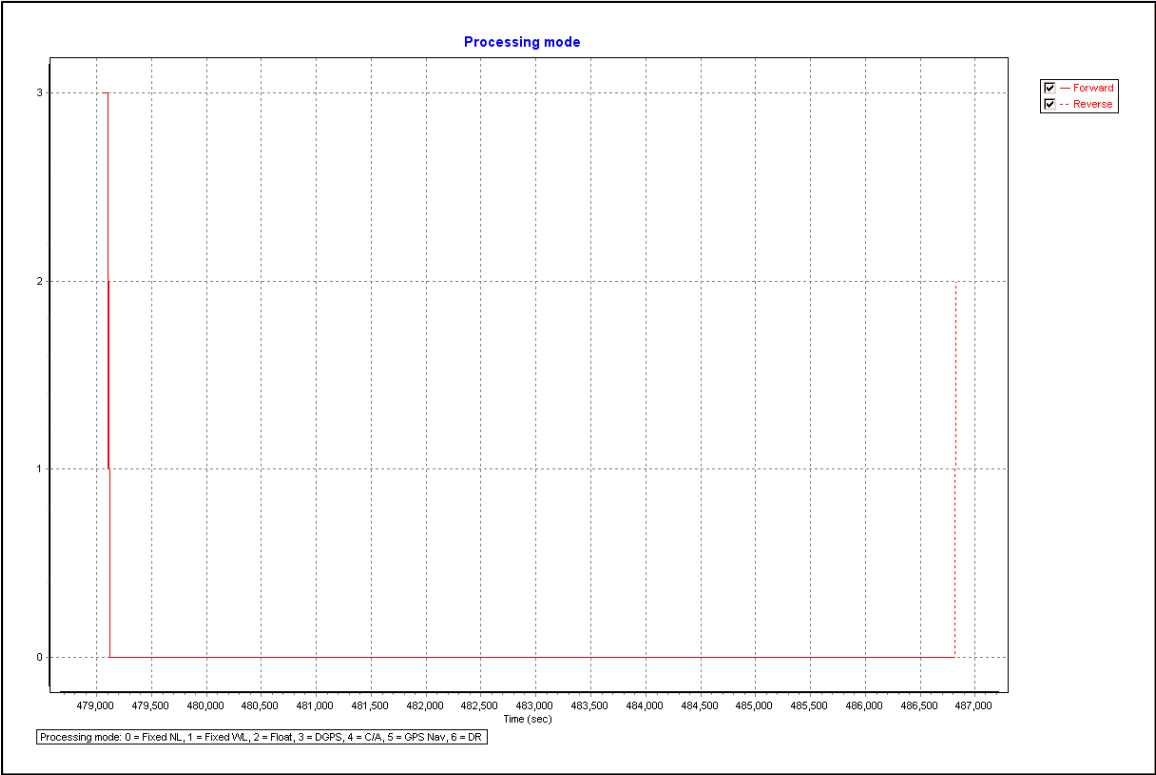
# 101210A-246-NEDPOSITIONERROR-SMOOTHED



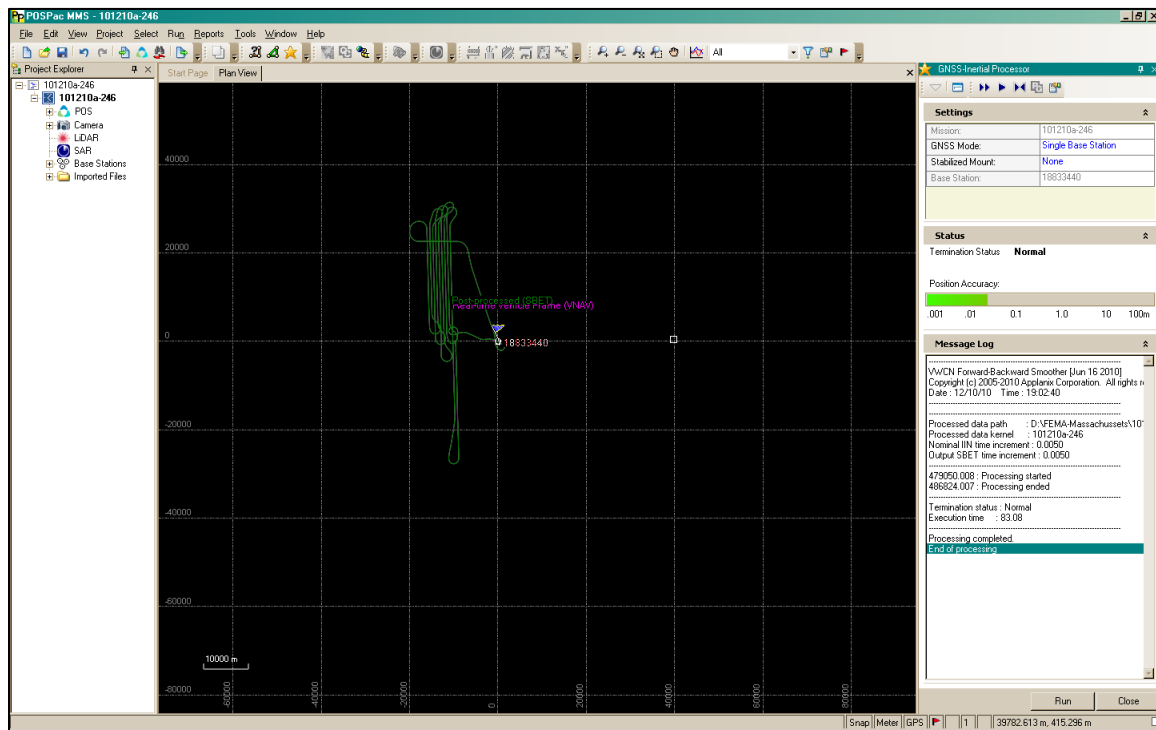
# 101210A-246-PDOP&SVS



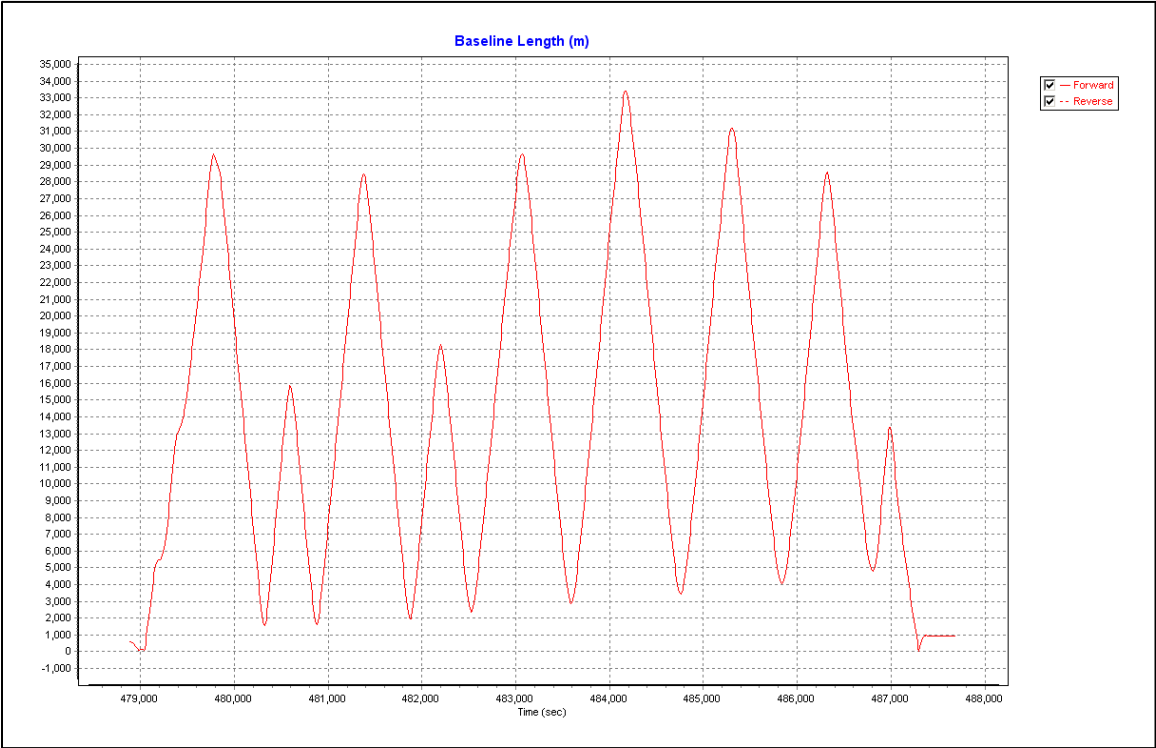
101210A-246-PROCMODE



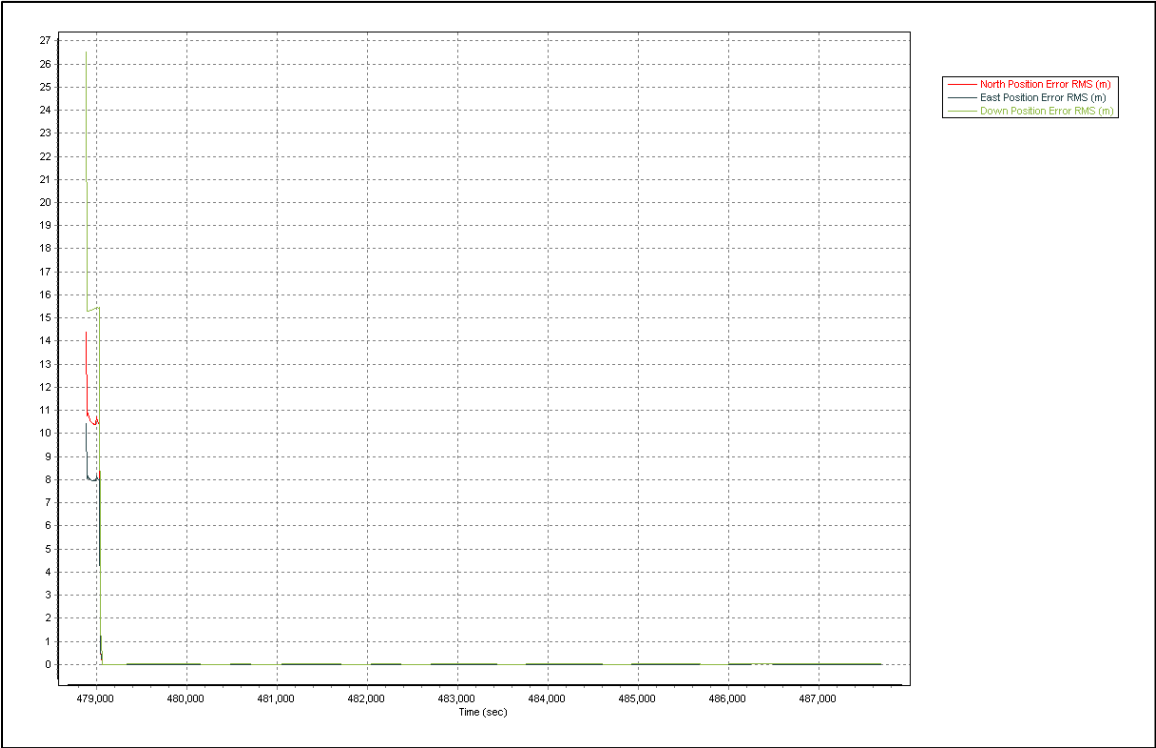
# 101210A-246-TRAJECTORY



101210A-247\_BASELINE

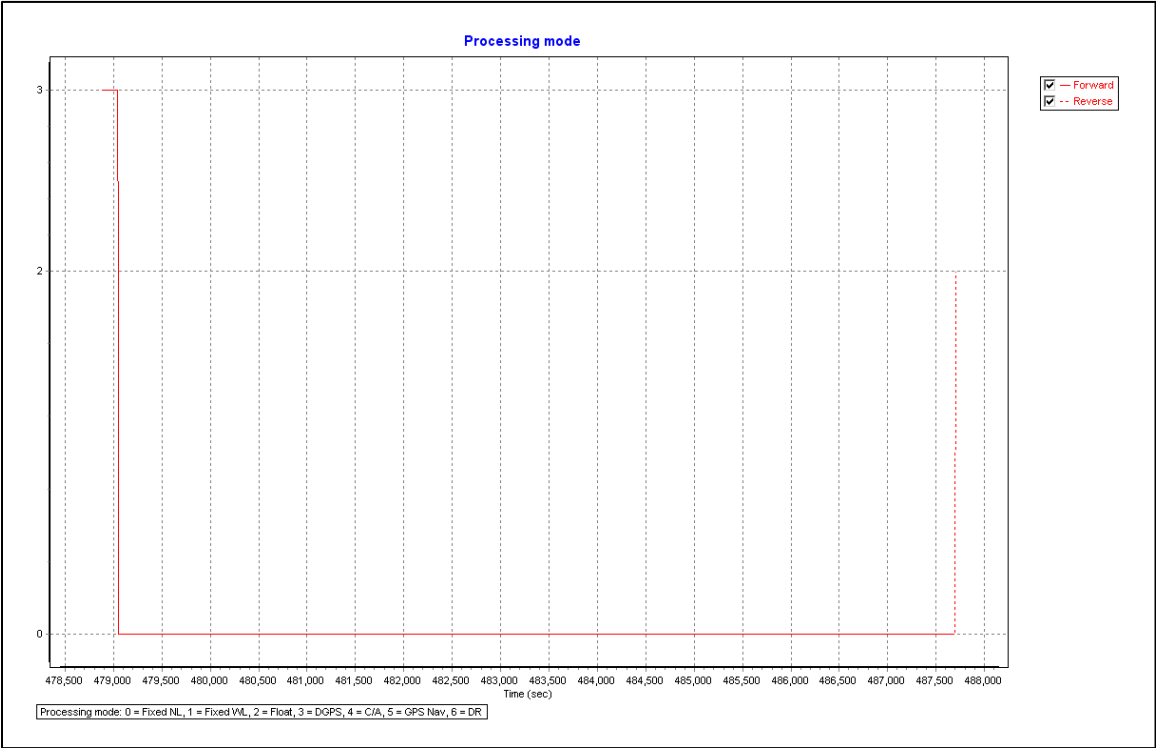


101210A-247\_FORWARDPROCPERFSMETRIC\_NED

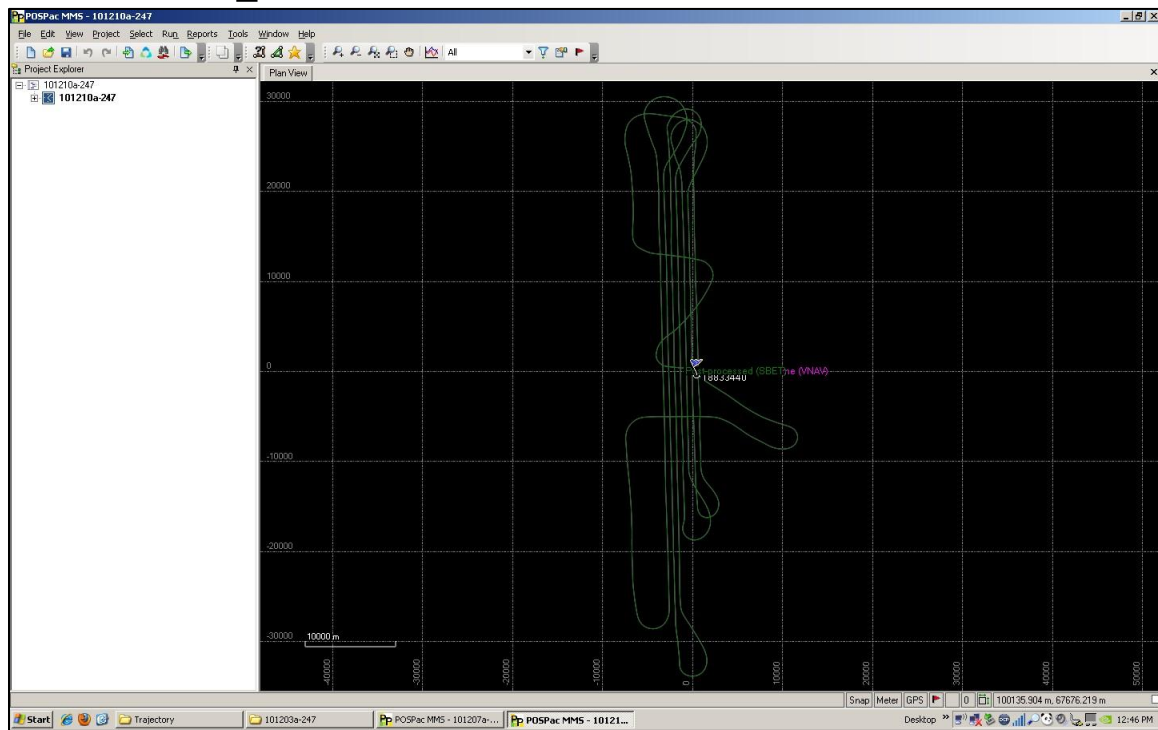




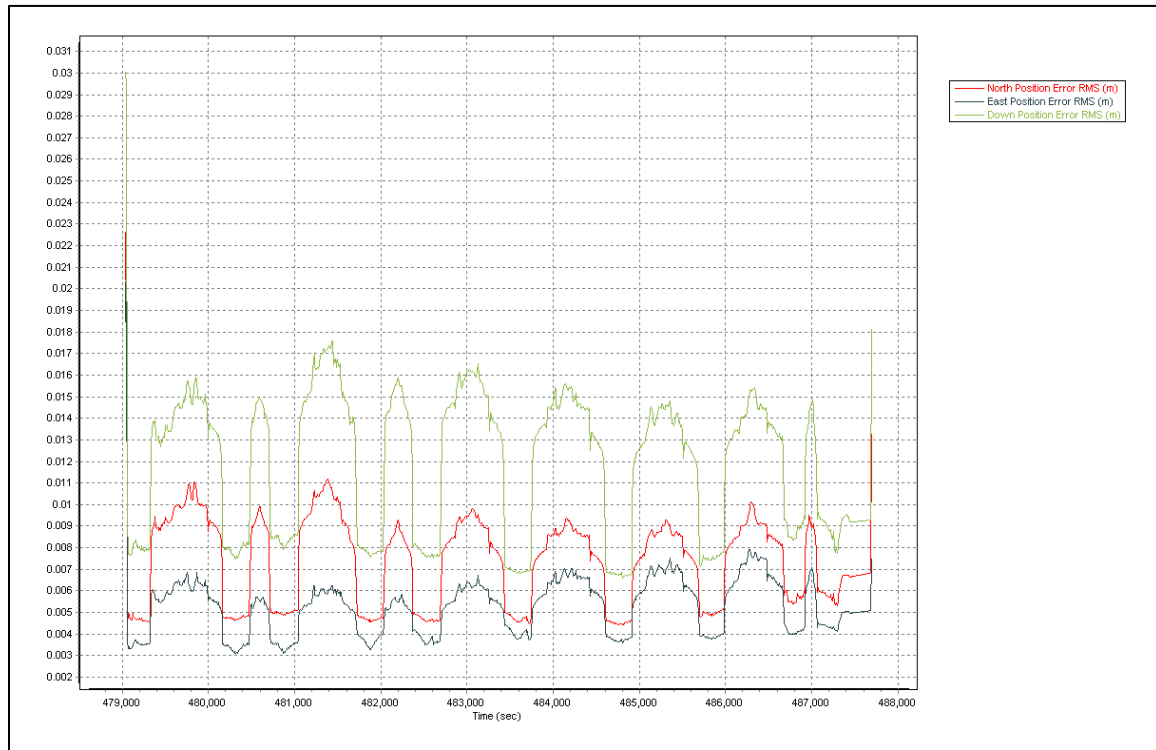
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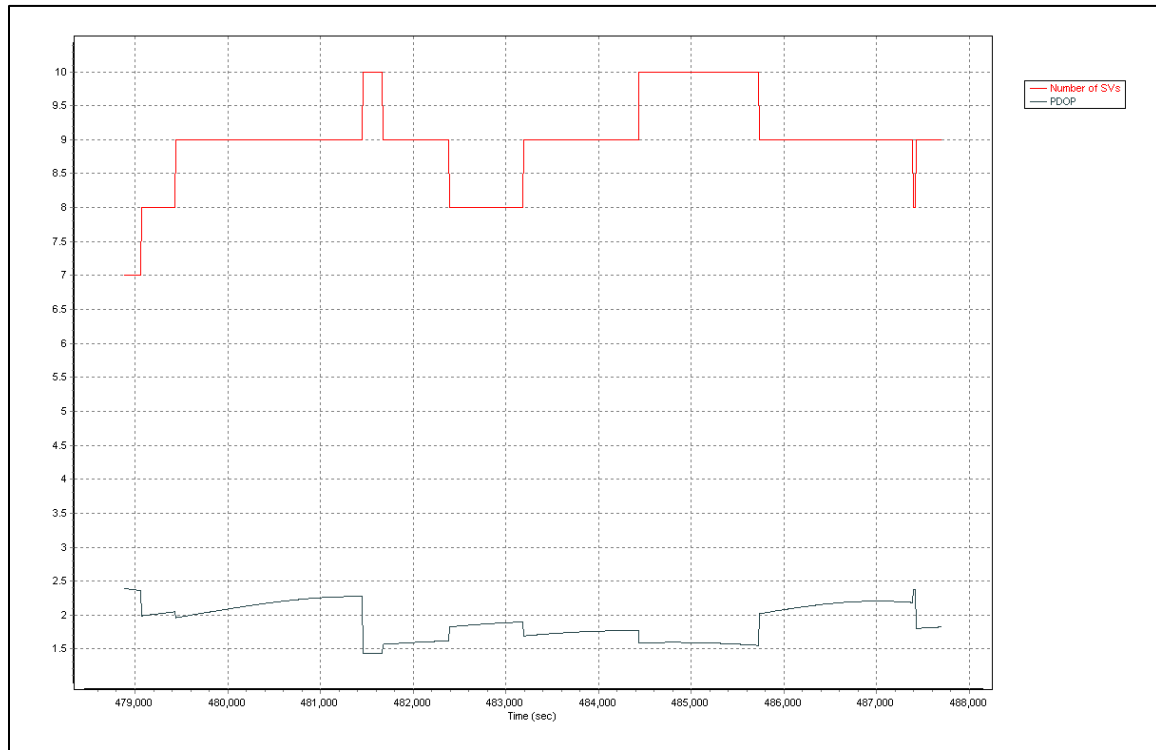
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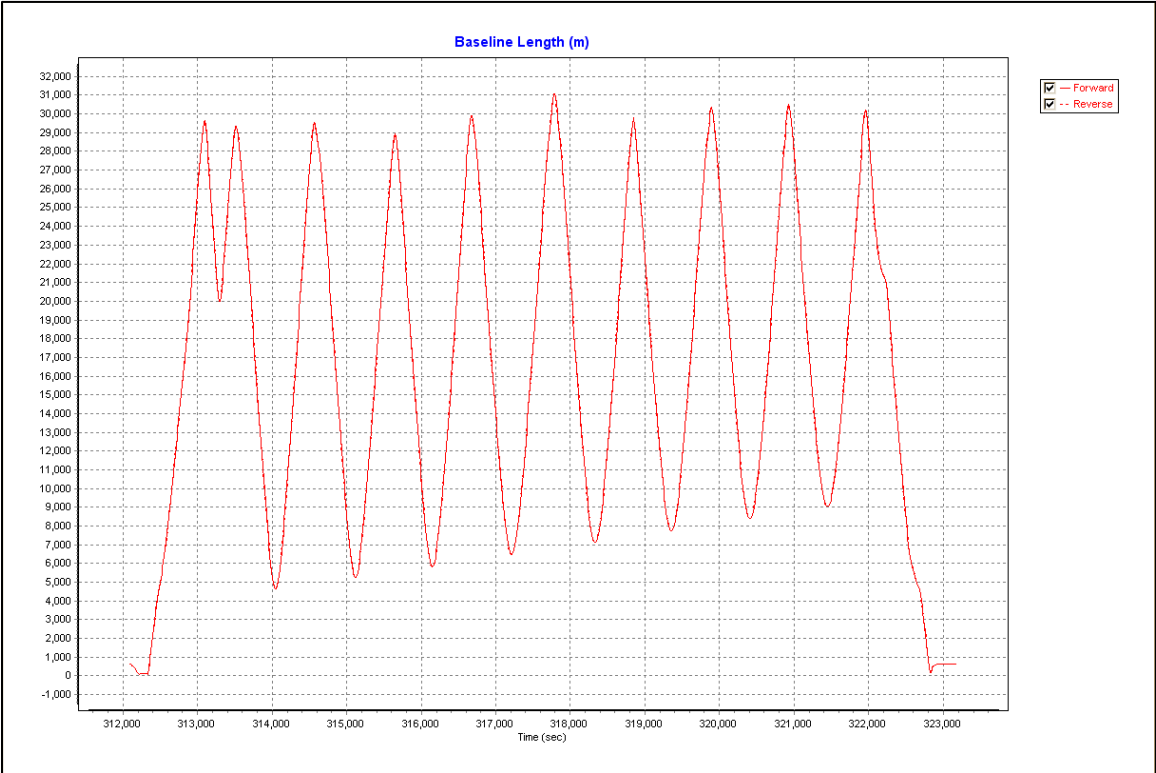
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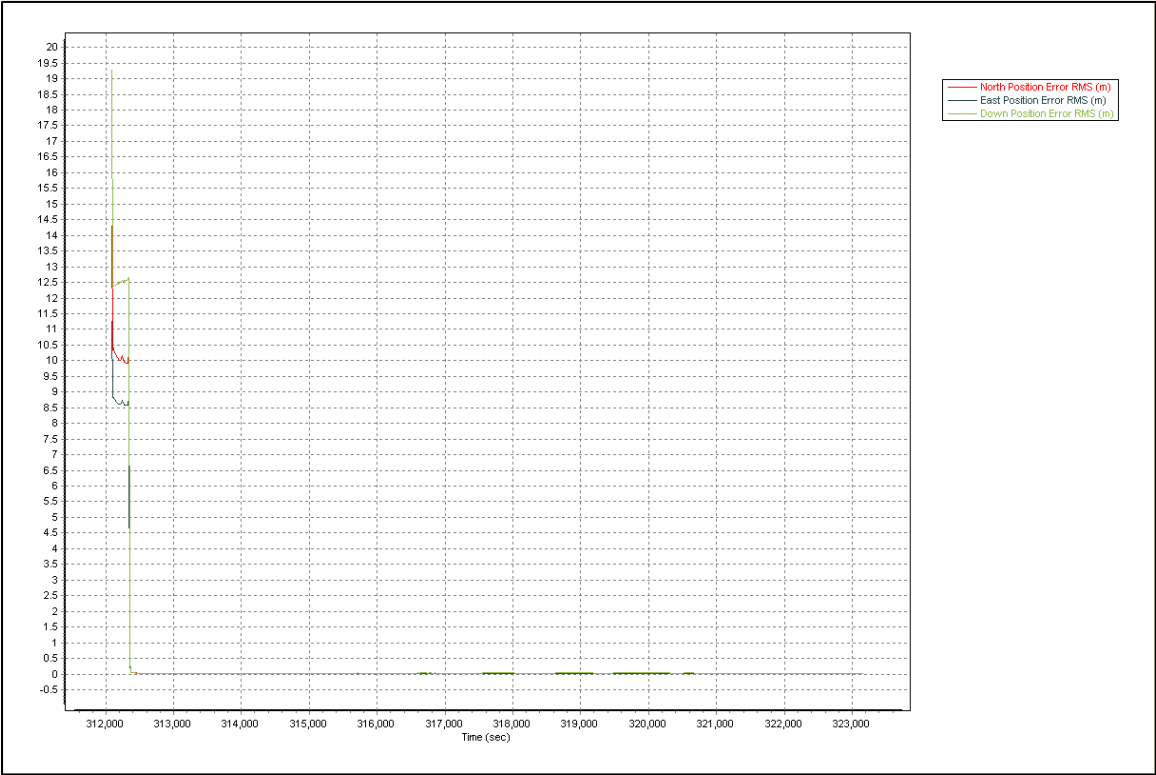
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101208A-246-BASELINELENGTH

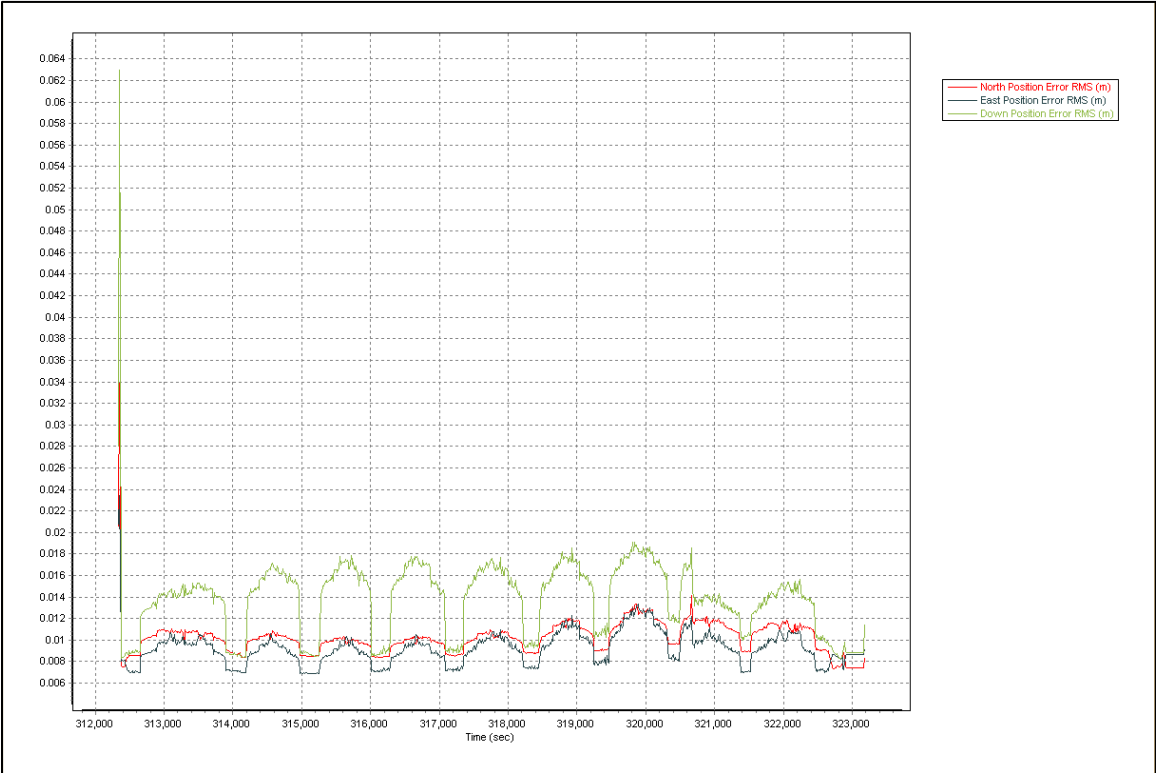


101208A-246-NEDPOSITIONERROR-FORWARD

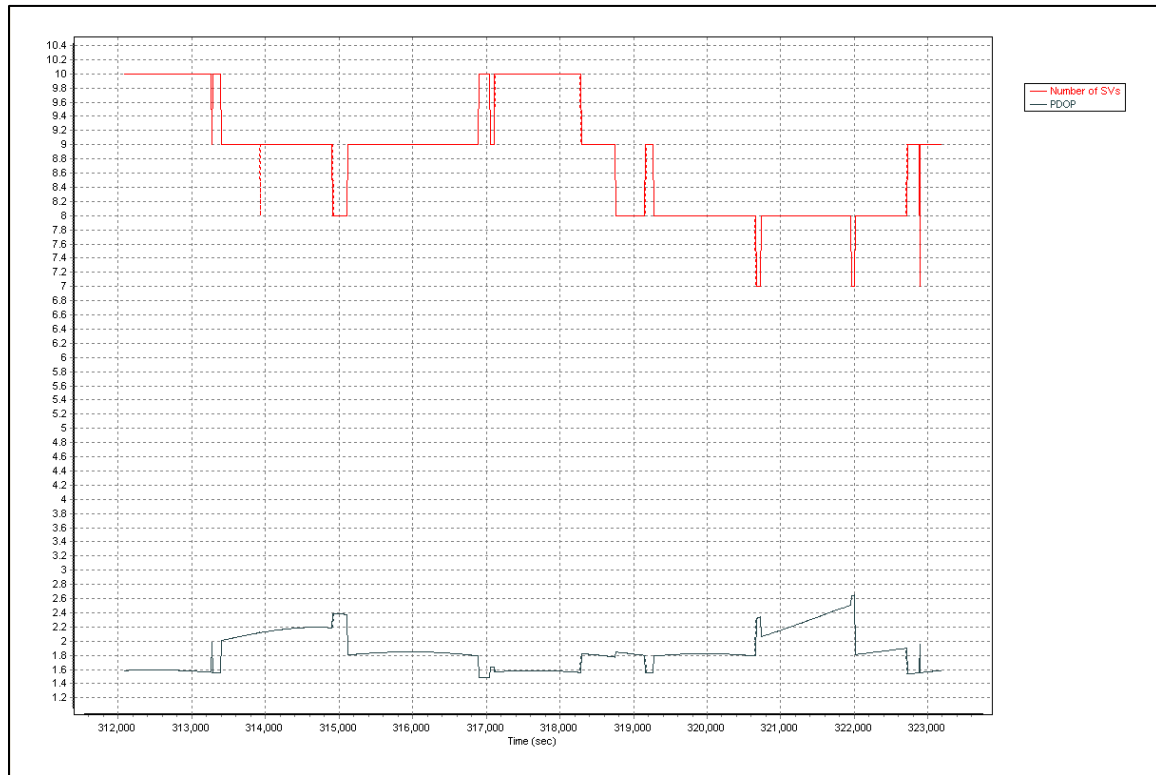




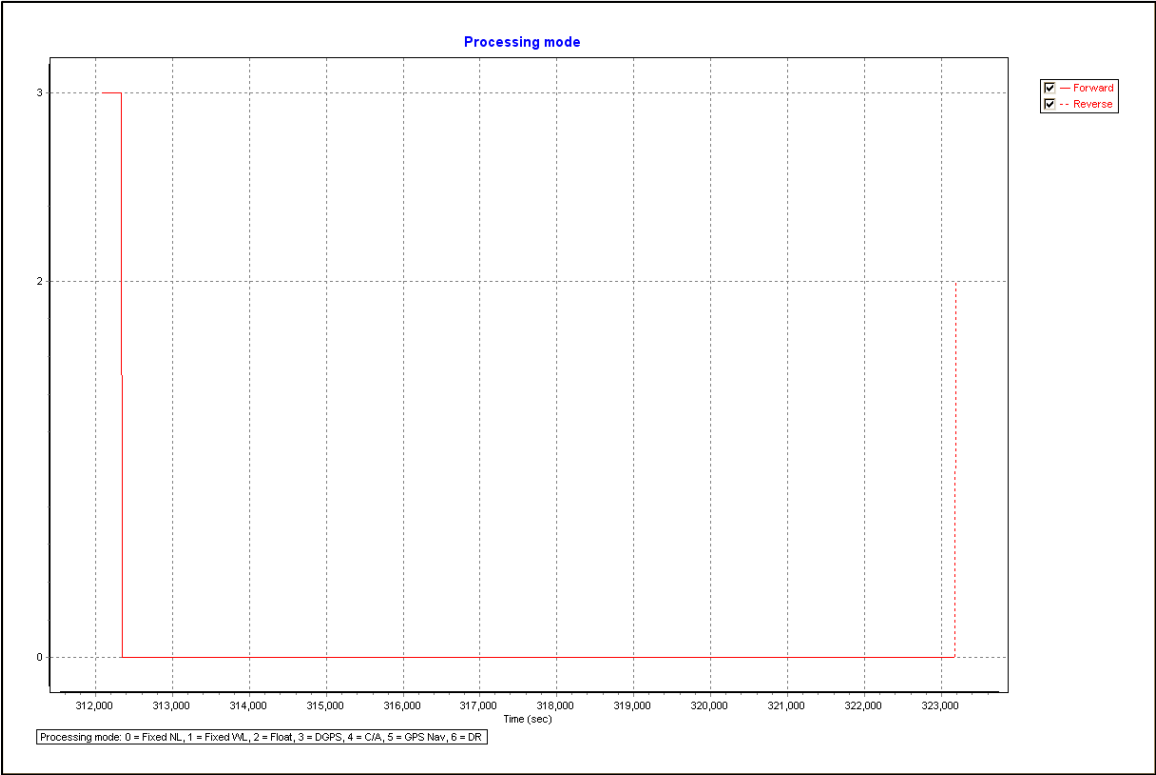
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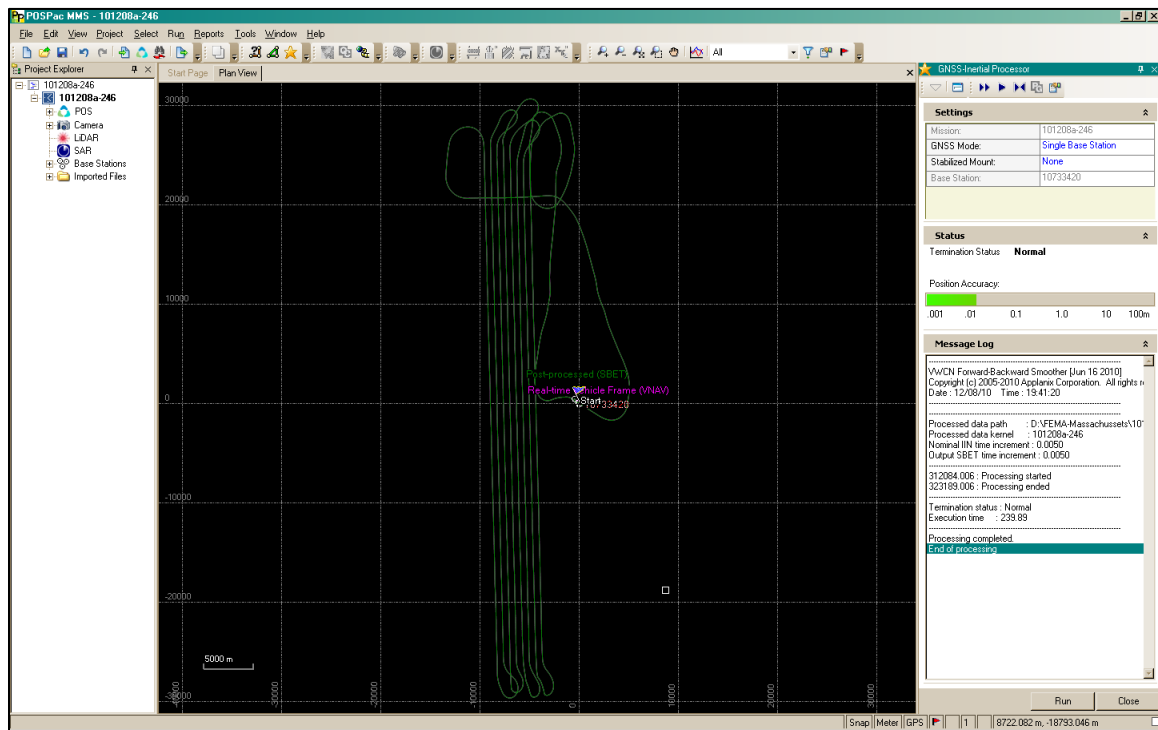
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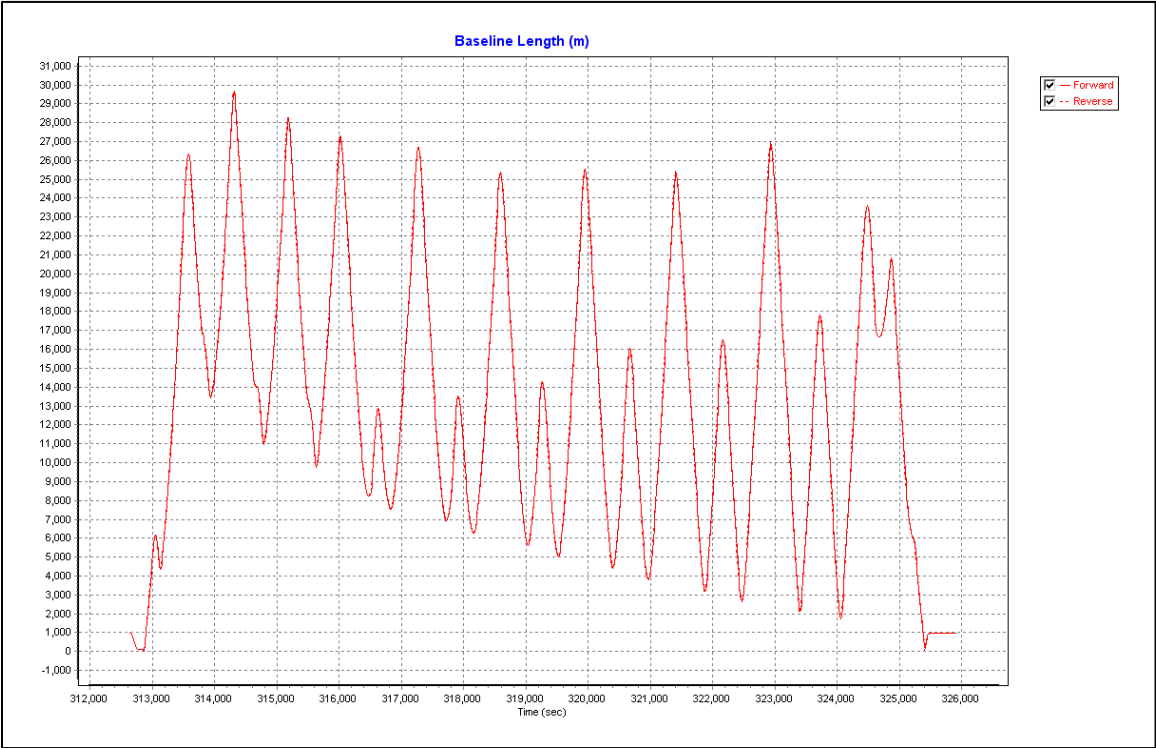
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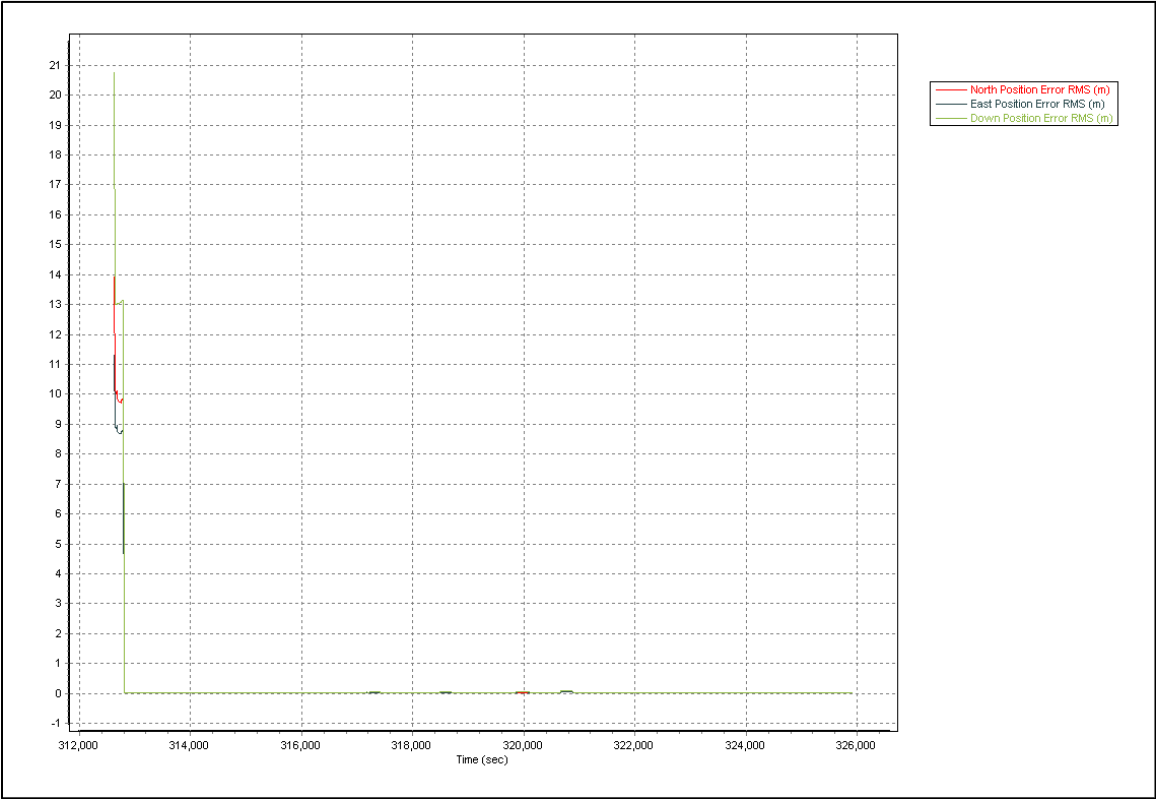
# 101208A-246-TRAJECTORY



101208A-247\_BASELINE



101208A-247\_FORWARDPROCPERFMETRIC\_NED





## **Appendix F: Quality Assurance**

Project Name:	<b>Blackstone</b>
Project Description:	Region1 LiDAR Acquisition
State:	MA, RI
HUC-8:	1090003
Provider Name:	Photo Science, Inc.
Collection Area:	232 SqMi ( Includes all overlapping tiles and all no data voids at edges.)
Specification Level:	HIGH
Contour Accuracy:	2ft
<b>Point Cloud</b>	
NPS	0.67m
Date Delivered:	3/7/2011
Date QC:	3/15/2011
Media:	Hard Drive
Contents of Media:	320 version 1.2 las files
Tiles Reviewed	22
QC tiles with NPS > Spec Level	Pass-only at edges where including no data voids
Voids or Gaps	Pass-Voids only over open water
Reviewed By:	Dan Hoff
<b>Bare Earth</b>	
NPS	0.67m
Date Delivered:	3/7/2011
Date QC:	4/4/2011
Media:	Hard Drive
Contents of Media:	320 version 1.2 las files
Tiles Reviewed	44
QC tiles with NPS > Spec Level	Pass-only at edges where including no data voids
Voids or Gaps	Pass-Voids only over open water
Artifact QA	Pass
Reviewed By:	Dan Hoff

	Included	Comments
<b>GPS Base Station INFO</b>	Pass	
GPS base station - names	Pass	
GPS base station - lat/longs	Pass	
GPS base station - heights	Pass	
GPS base station - Maximum PDOP	Pass	
GPS base station - map	Pass	
GPS base station - spatial data	Pass	
<b>GPS/IMU</b>		
GPS quality - Max horizontal variance (cm).	Pass	
GPS quality - Max vertical variance (cm).	Pass	
GPS quality - Notes on GPS quality	Pass	
GPS quality - GPS separation plot	Pass	
GPS quality - GPS altitude plot	Pass	
GPS quality - PDOP plot	Pass	
GPS quality - Plot of GPS distance from base stations	Pass	
<b>Coverage</b>		
Coverage - Verification of AOI coverage	Pass	
Coverage - Spatial data	Pass	
<b>Flights</b>		
Flights - Calibration lines	Pass	
Flights - As-flown trajectories	Pass	
Flights - Spatial data	Pass	
<b>Control</b>		
Control - Ground control and base station layout	Pass	
Control - Spatial data	Pass	
<b>Data verification/QC</b>		
Data verification process documented	Pass	
<b>Flight logs</b>		
Incorporated as appendix		
Job # / name	Pass	
Lift #	Pass	
Block or AOI designator	Pass	
Date	Pass	
Aircraft tail number, type	Pass	
Pilot name	Pass	
Operator name	Pass	
Airport of operations	Pass	
GPS base station names	Pass	
<b>Flight lines</b>		
Flight line	Pass	
Line #	Pass	
Direction	Pass	
Start/stop	Pass	
Altitude	Pass	
Scan angle/rate	Pass	

Speed	Pass	
Conditions	Pass	
Comments	Pass	
<b>Settings</b>		
AGC switch setting	N/A	
Laser pulse rate	Pass	
Mirror rate	N/A	
Field of view	Pass	
Comments	Pass	

<b>LAS Point Cloud Files</b>	Pass/Fail	Comments
Projection	Pass	
Datum	Pass	
Units	Pass	
Area covered 100m buffer	Pass	
Data Voids	Pass	only over water
Correct Header	Pass	
Correct NPS	Pass	
<b>Returns Contain</b>		
GPS time stamp	Pass	
GPS second in microsec	Pass	
Easting	Pass	
Northing	Pass	
Elevation	Pass	
Intensity	Pass	
Return #	Pass	
Classification	Pass	
Classification is correct	Pass	Point Cloud
Cloud file structure conforms to layout	Pass	
Cloud file naming conforms to project	Pass	
Tiles checked for gaps and voids	Pass	voids only over water
<b>Micro Review</b>		
Total Number of Tiles:	320	
Number of tiles to be reviewed:	22	
	Pass/Fail	
Excessive Noise	Pass	
Elevation Steps	Pass	
LP360 Scan and profile	Pass	

<b>LAS Bare Earth</b>	<b>Pass/Fail</b>	<b>Comments</b>
Projection	Pass	
Datum	Pass	
Units	Pass	
Area covered 100m buffer		
Data Voids	Pass	
Correct Header	Pass	
Correct NPS	Pass	
<b>Returns Contain</b>		
GPS time stamp	Pass	
GPS second in microsec	Pass	
Easting	Pass	
Northing	Pass	
Elevation	Pass	
Intensity	Pass	
Return #	Pass	
Classification	Pass	
Classification is correct	Pass	
Cloud file structure conforms to layout	Pass	
Cloud file naming conforms to project	Pass	
Tiles checked for gaps and voids	Pass	
<b>Micro Review</b>		
Total Number of Tiles:	274	
Number of tiles to be reviewed:	44	
Excessive Noise	Pass	
Elevation Steps	Pass	
2% Artifacts	Pass	
LP360 Scan and profile	Pass	



## **Appendix G: Deliverables**

**Date:**

July 15, 2011

**Contract #**

HSFEHQ-090D-0370

**Task Order #**

HSFEHQ -10-J-0005

**Subject:****STARR Elevation Data (LiDAR)****Transmittal:**

**To: Marie Sparrow**  
**FEMA Engineering Library**  
**%Zimmerman Associates, Inc**  
**847 South Pickett Street**  
**Alexandria, VA 22304**

**From: James Huffines**  
**Greenhorne & O'Mara, Inc**  
**5565 Centerview Drive**  
**Ste 107**  
**Raleigh, NC 27606**

**Transmitted:**

- ☐ For Your Use                      ☐ For Your Review                      ☒ For Storage  
☐ For Your Approval/Signature      ☐ As Requested  
☐ For Your Information

**The following:**

COPIES	DATE	DESCRIPTION
1	7/15/11	Blackstone HUC8, MA terrain data - see readme.txt included on hard drive for directory structure.
		Includes: Ground Control data, QC Checkpoint (FVA/CVA) data, PreFlight Report, PostFlight Report, Tile Index shapefile, Collection Area shapefile, Point Cloud (All Returns) LAS files, Bare Earth (Fully Classified) LAS files, QC Testing Results, QA Review spreadsheet, Compliance Certificates for Survey and LiDAR, Metadata for Survey, Point Cloud Data, and Bare Earth Data, and TSDN

**Remarks:**

If you have any questions or require additional information please feel free to contact me at 919-532-2332.  
Please sign this transmittal upon receipt and mail to address shown above or fax to 919-851-8393.

Printed Name and Date: \_\_\_\_\_

Signature: \_\_\_\_\_

## Work Item Details - Project # 11-01-0716S

Data Submission | Review

Save and Close

Continue >

### Develop Topographic Data : Data Submission (Worcester County-wide)

Click the Submit Data arrow to view data content or to Submit Data Files.  
Click the Submission Status arrow to view the status of submitted data. Once all data has been uploaded and has passed all validation, click "Continue".


▼ Expand All ▶ Collapse All

#### ▼ Project and Task Information

Project Name:	Blackstone HUC8 - LIDAR - FY10
Case Number:	11-01-0716S
Task Description:	ground control
Baseline Task End Date:	11/30/2010
Projected Preliminary Date:	

#### ▼ Submit Data

##### Submission Contents

 /R01/MASSACHUSETTS\_25/WORCESTER\_25027/WORCESTER\_027C/11-01-0716S/SubmissionUpload/Terrain/2142855

Update Contents

Submit Data Files...

[Download Sample Metadata Template](#) to view the data file submission format.

## Work Item Details - Project # 11-01-0716S

Data Submission | Review

Save and Close

Continue >

### Develop Topographic Data : Data Submission (Worcester County-wide)

Click the Submit Data arrow to view data content or to Submit Data Files.  
Click the Submission Status arrow to view the status of submitted data. Once all data has been uploaded and has passed all validation, click "Continue".


▼ Expand All ▶ Collapse All

#### ▼ Project and Task Information

Project Name:	Blackstone HUC8 - LIDAR - FY10
Case Number:	11-01-0716S
Task Description:	acquisition
Baseline Task End Date:	01/17/2011
Projected Preliminary Date:	

#### ▼ Submit Data

##### Submission Contents

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Update Contents

Submit Data Files...

## Work Item Details - Project # 11-01-0716S

Data Submission | Review

Save and Close

Continue >

### Develop Topographic Data : Data Submission (Worcester County-wide)

Click the Submit Data arrow to view data content or to Submit Data Files.

Click the Submission Status arrow to view the status of submitted data. Once all data has been uploaded and has passed all validation, click "Continue".

▼ Expand All   ► Collapse All

#### ▼ Project and Task Information

Project Name:	Blackstone HUC8 - LIDAR - FY10
Case Number:	11-01-0716S
Task Description:	processing
Baseline Task End Date:	05/23/2011
Projected Preliminary Date:	

#### ▼ Submit Data

##### Submission Contents

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Update Contents

Submit Data Files...

[Download Sample Metadata Template](#) to view the data file submission format.

## **Appendix H: Guidance Documents**



**FEMA**

**DATE**

**MEMORANDUM FOR:** Mitigation Division Directors Regions I-X, CTPs,  
Mapping Partners

**FROM:** Doug Bellomo, Director  
Risk Analysis Division

**SUBJECT:** Procedure Memorandum No. XX—Standards for Lidar and  
Other High Quality Digital Topography

**EFFECTIVE DATES:** August 1, 2010

**Background:** Beginning in Fiscal Year (FY) 2010, Federal Emergency Management Agency (FEMA) initiated a five-year program for Risk Mapping, Assessment, and Planning (Risk MAP). FEMA's vision for the Risk MAP program is to deliver quality data that increases public awareness and leads to mitigation actions that reduce risk to life and property. To achieve this vision, FEMA will transform its traditional flood identification and mapping efforts into a more integrated process of accurately identifying, assessing, communicating, planning for, and mitigating flood risks.

Under Risk MAP, FEMA seeks to:

- Deliver new data and products that expand risk awareness and promote mitigation planning that leads to risk reduction actions.
- Increase production efficiencies for Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FISs).

**Issue:** To implement FEMA's Risk MAP vision and provide the high quality topographic data necessary to meet Risk MAP's goals, FEMA Regions and Mapping Partners need upgraded guidance concerning the accuracy, and processing of high quality topographic data including Light Detection and Ranging (lidar) data. To that end, this Procedure Memorandum will supersede Appendix A: Guidance for Aerial Mapping and Surveying of the *Guidelines and Specifications for Flood Hazard Mapping Partners* (Guidelines) in key areas (defined in the Procedure Memorandum Attachments), and must be implemented beginning with all topographic data collected by FEMA beginning in FY 2010.



**Actions Taken:** When procuring topographic data under the Risk MAP Program the Mapping Partner assigned to obtain topographic data or perform independent QA of topographic data must meet the specifications detailed in this Procedure Memorandum's attachments. The attachments align FEMA's high quality topographic specifications, found in Appendix A of the Guidelines, with the United States Geological Survey (USGS) *Lidar Guidelines and Base Specifications* v13 so that data procured and used by the Federal government is consistent across agencies and is updated to industry standards. Further, adherence to these specifications will support the Risk MAP Program by closing gaps in existing flood hazard data; supporting risk assessments; and better communicating risks to community officials and the public.

Existing elevation data, not acquired by FEMA, but planned for use on a new flood hazard analysis must comply with the accuracy, density and the final product metadata requirements detailed in the attachments and, but is not required to comply with the other specifications included and referenced below.

Consistent with FEMA's overall approach to flood hazard identification, this Procedure Memorandum aligns FEMA topographic data specifications to level of risk, and accounts for different slopes in the terrain that can affect the accuracy of base flood elevations and the delineation of mapped floodplains. These specifications represent the minimum requirements. Where funding partners are involved or where the engineering requirements dictate, projects may use higher specification levels or include additional processing. Quality assurance requirements for high quality topographic data are also provided.

**Attachments:**

Attachment 1 – Definitions

Attachment 2 – Alignment of FEMA Appendix A to USGS *Lidar Guidelines and Base Specification* v13

Attachment 3 – Topographic Breakline and Hydro-Enforcement Specifications

Attachment 4 – Topographic Data Quality Review Process

**Distribution List:**

## Attachment 1 – Definitions

**Digital Elevation Data** – Includes all of the following terms: mass points, point clouds, breaklines, contours, TINs, DEMs, DTMs or DSMs.

- **Breakline** – A linear feature demarking a change in the smoothness or continuity of a surface such as abrupt elevation changes or a stream line. The two most common forms of breaklines are as follows:
  - A **soft breakline** ensures that known elevations, or z-values, along a linear feature are maintained (e.g., elevations along a pipeline, road centerline or drainage ditch), and ensures the boundary of natural and man-made features on the Earth's surface are appropriately represented in the digital terrain data by use of linear features and polygon edges. They are generally synonymous with 3-D breaklines because they are depicted with series of x/y/z coordinates.
  - A **hard breakline** defines interruptions in surface smoothness, e.g., to define streams, shorelines, dams, ridges, building footprints, and other locations with abrupt surface changes. Although some hard breaklines are three dimensional (3-D) breaklines, they are often depicted as two dimensional (2-D) breaklines because features such as shorelines and building footprints are normally depicted with a series of horizontal coordinates only which are often digitized from digital orthophotographs that include no elevation data.
- **Contours** – Lines of equal elevation on a surface. An imaginary line on the ground, all points of which are at the same elevation above or below a specified vertical datum.
- **Digital Elevation Model (DEM)** – An elevation model created for use in computer software where bare-earth elevation values have regularly spaced intervals in latitude and longitude (x and y). The  $\Delta x$  and  $\Delta y$  values are normally measured in feet or meters to even units; however, the National Elevation Dataset (NED) defines the spacing interval in terms of arc-seconds of latitude and longitude, e.g.,  $1/3^{\text{rd}}$  arc-second.
- **Digital Surface Model (DSM)** – An elevation model created for use in computer software that is similar to DEMs or DTMs except that DSMs depict the elevations of the top surfaces of buildings, trees, towers, and other features elevated above the bare earth.
- **Digital Terrain Model (DTM)** – An elevation model created for use in computer software of bare-earth mass points and breaklines. DTMs are technically superior to a gridded DEM for many applications because distinctive terrain features are more clearly defined and precisely located, and contours generated from DTMs more closely approximate the real shape of the terrain.
- **Mass Points** – Irregularly spaced points, each with latitude and longitude location coordinates and elevation values typically used to form a TIN.
- **Metadata** – Project descriptive information about the elevation dataset.
- **Point Cloud** – Often referred to as the “raw point cloud”, this is the first data product of a lidar instrument. In its crudest form, a lidar raw point cloud is a collection of range measurements and sensor orientation parameters. After initial processing, the range and orientation of each laser value is converted to a position in a three dimensional frame of reference and this spatially coherent cloud of points is the base for further processing and analysis. The raw point cloud typically includes first, last, and intermediate returns for each laser pulse. In addition to spatial information, lidar intensity returns provide texture or color information. The combination of three dimensional spatial information and spectral information contained

in the lidar dataset allows great flexibility for data manipulation and extraction. As used in this procedure memorandum, two additional lidar data processing terms are defined as follows:

- **Lidar Preliminary Processing** – The initial processing and analysis of laser data (GPS/IMU/laser ranges) to fully “calibrated point clouds” in some specified tile format. All lidar data will be set to ASPRS LAS Class 1 (unclassified) and must include testing for Fundamental Vertical Accuracy (FVA). The tile format can change later, if necessary.
- **Lidar Post-Processing** – The final processing and classification of lidar data to the required ASPRS LAS classes, per project specifications. This must include testing for Consolidated Vertical Accuracy (CVA). At this point, the datasets are referred to as the “classified point cloud.”
- **Triangulated Irregular Network (TIN)** – A set of adjacent, non-overlapping triangles computed from irregularly-spaced points with latitude, longitude, and elevation values. The TIN data structure is based on irregularly-spaced point, line, and polygon data interpreted as mass points and breaklines and stores the topological relationship between triangles and their adjacent neighbors. The TIN model may be preferable to a DEM when it is critical to preserve the precise location of narrow or small features, such as levees, ditch or stream centerlines, isolated peaks or pits in the data model.
- **Z-Values** – The elevations of the 3-D surface above the vertical datum at designated x/y locations.

**Geospatial Accuracy Standard** – A common accuracy testing and reporting methodology that facilitates sharing and interoperability of geospatial data. Published in 1998, the National Standard for Spatial Data Accuracy (NSSDA) is the Federal Geographic Data Committee (FGDC) standard relevant to digital elevation data when assuming that errors follow a normal error distribution. However, after it was learned that lidar datasets do not necessarily follow a normal distribution in vegetated terrain, the National Digital Elevation Program (NDEP) published its “Guidelines for Digital Elevation Data” and the American Society for Photogrammetry and Remote Sensing (ASPRS) published the “ASPRS Guidelines: Vertical Accuracy Reporting for Lidar Data,” both of which were published in 2004 and use newer terms defined below as Fundamental Vertical Accuracy (FVA), Supplemental Vertical Accuracy (SVA) and Consolidated Vertical Accuracy (CVA). All of these standards, designed for digital elevation data, replace the National Map Accuracy Standard (NMAS) that is applicable only to graphic maps defined by map scale and contour interval.

**Accuracy** – The closeness of an estimated value (e.g., measured or computed) to a standard or accepted (true) value of a particular quantity. Note: With the exception of GPS Continuously Operating Reference Stations (CORS), assumed to be known with zero errors relative to established datums, the true locations of 3-D spatial coordinates or other points are not known, but only estimated. Therefore, the accuracy of other coordinate information is unknown and can only be estimated. Other accuracy definitions are as follows.

- **Absolute Accuracy** – A measure that accounts for all systematic and random errors in a data set. Absolute accuracy is stated with respect to a defined datum or reference system.
- **Accuracy<sub>r</sub>** – The NSSDA reporting standard in the horizontal component that equals the radius of a circle of uncertainty, such that the true or theoretical horizontal location of the

point falls within that circle 95-percent of the time.  $Accuracy_r = 1.7308 \times RMSE_r$ . Horizontal accuracy is defined as the positional accuracy of a dataset with respect to a horizontal datum.

- **Accuracy<sub>z</sub>** — The NSSDA reporting standard in the vertical component that equals the linear uncertainty value, such that the true or theoretical vertical location of the point falls within that linear uncertainty value 95-percent of the time.  $Accuracy_z = 1.9600 \times RMSE_z$ . Vertical accuracy is defined as the positional accuracy of a dataset with respect to a vertical datum.
- **Consolidated Vertical Accuracy (CVA)** – The result of a test of the accuracy of vertical checkpoints (z-values) consolidated for two or more of the major land cover categories, representing both open terrain and other land cover categories. Computed by using the 95<sup>th</sup> percentile, CVA is always accompanied by Fundamental Vertical Accuracy (FVA).
- **Fundamental Vertical Accuracy (FVA)** – The value by which vertical accuracy can be equitably assessed and compared among datasets. The FVA is determined with vertical checkpoints located only in open terrain, where there is a very high probability that the sensor will have detected the ground surface. FVA is calculated at the 95% confidence level in open terrain only, using  $RMSE_z \times 1.9600$ .
- **Local Accuracy** – A value that represents the uncertainty in the coordinates of a control point relative to the coordinates of other directly-connected, adjacent control points at the 95-percent confidence level. The reported local accuracy is an approximate average of the individual local accuracy values between this control point and other observed control points used to establish the coordinates of the control point.
- **Network Accuracy** – A value that represents the uncertainty in the coordinates of a control point with respect to the geodetic datum at the 95-percent confidence level. For National Spatial Reference System (NSRS) network accuracy classification in the U.S., the datum is considered to be best expressed by the geodetic values at the CORS supported by the National Geodetic Survey (NGS). By this definition, the local and network accuracy values at CORS sites are considered to be infinitesimal, i.e., to approach zero.
- **Percentile** – Any of the values in a dataset of errors dividing the distribution of the individual errors in the dataset into one hundred groups of equal frequency. Any of those groups can specify a specific percentile, e.g., the 95<sup>th</sup> percentile as defined below.
- **Precision** – A statistical measure of the tendency of a set of random numbers to cluster about a number determined by the dataset. *Precision* relates to the quality of the method by which the measurements were made and is distinguished from *accuracy* which relates to the quality of the result. The term “precision” not only applies to the fidelity with which required operations are performed, but, by custom, has been applied to methods and instruments employed in obtaining results of a high order of precision. Precision is exemplified by the number of decimal places to which a computation is carried and a result stated.
- **Positional Accuracy** – The accuracy of the position of features, including horizontal and/or vertical positions.
- **Relative Accuracy** – A measure that accounts for random errors in a data set. Relative accuracy may also be referred to as point-to-point accuracy. The general measure of relative accuracy is an evaluation of the random errors (systematic errors and blunders removed) in determining the positional orientation (e.g., distance, azimuth) of one point or feature with respect to another.
- **Root Mean Square Error (RMSE)** – The square root of the average of the set of squared differences between dataset coordinate values and coordinate values from an independent

source of higher accuracy for identical points. The vertical RMSE ( $RMSE_z$ ), for example, is calculated as the square root of  $\sum(Z_n - Z'_n)^2/N$ , where:

- $Z_n$  is the set of  $N$   $z$ -values (elevations) being evaluated, normally interpolated (for TINs and DEMs) from dataset elevations of points surrounding the  $x/y$  coordinates of checkpoints
- $Z'_n$  is the corresponding set of checkpoint elevations for the points being evaluated
- $N$  is the number of checkpoints
- $n$  is the identification number of each of the checkpoints from 1 through  $N$ .
- **Supplemental Vertical Accuracy (SVA)** – The result of a test of the accuracy of  $z$ -values over areas with ground cover categories or combination of categories other than open terrain. Computed by using the 95<sup>th</sup> percentile, SVA is always accompanied by Fundamental Vertical Accuracy (FVA). SVA values are computed individually for different land cover categories. Each land cover type representing 10% or more of the total project area is typically tested and reported as an SVA. SVA specifications are normally target values that may be exceeded so long as overall CVA requirements are satisfied.
- **95% Confidence Level** – Accuracy reported at the 95% confidence level means that 95% of the positions in the dataset will have an error with respect to true ground position that is equal to or smaller than the reported accuracy value. The reported accuracy value reflects all uncertainties, including those introduced by geodetic control coordinates, compilation, and final computation of ground coordinate values in the product. Where errors follow a normal error distribution,  $Accuracy_z$  defines vertical accuracy at the 95% confidence level (computed as  $RMSE_z \times 1.9600$ ), and  $Accuracy_r$  defines horizontal (radial) accuracy at the 95% confidence level (computed as  $RMSE_r \times 1.7308$ ).
- **95<sup>th</sup> Percentile** – Accuracy reported at the 95<sup>th</sup> percentile indicates that 95% of the errors will be of equal or lesser value and 5% of the errors will be of larger value. This term is used when errors may not follow a normal error distribution, e.g., in forested areas where the classification of bare-earth elevations may have a positive bias. Vertical accuracy at the 95% confidence level and 95<sup>th</sup> percentile may be compared to evaluate the degree to which actual errors approach a normal error distribution.

**Resolution** – In the context of elevation data, resolution is synonymous with the horizontal density of elevation data points for which two similar terms are used:

- **Nominal Pulse Spacing (NPS)** – The estimated average spacing of irregularly-spaced lidar points in both the along-track and cross-track directions resulting from: the laser pulse repetition frequency (e.g., 100,000 pulses of laser energy emitted in one second from a 100 kHz sensor); scan rate (sometimes viewed as the number of zigzags per second for this common scanning pattern); field-of-view; and flight airspeed. Lidar system developers currently provide “design NPS” as part of the design pulse density, although the American Society for Photogrammetry and Remote Sensing (ASPRS) is currently developing standard procedures to compute the “empirical NPS” which should be approximately the same as the “design NPS” when accepting statistically insignificant loss of returns and disregarding void areas, from water for example. The NPS assessment is made against single swath first return data located within the geometrically usable center portion (typically ~90%) of each swath. Average along-track and cross-track pulse spacing should be comparable. When point density is increased by relying on overlap or double-coverage it should be documented in

metadata and not by changing the project's reported NPS. The NPS should be equal to or less than the Digital Elevation Model (DEM) post spacing when gridded DEMs are required as part of project specifications. This same definition for NPS could similarly apply to irregularly-spaced mass points from photogrammetry or Interferometric Synthetic Aperture Radar (IFSAR) data. NPS pertains to lidar only and is not intended to pertain to photogrammetry or IFSAR.

•**DEM Post Spacing** – Sometimes confused with Nominal Pulse Spacing, the DEM Post Spacing is defined as the constant sampling interval in x- and y-directions of a DEM lattice or grid. This is also called the horizontal resolution of a gridded DEM or the DEM grid spacing. It is standard industry practice to have:

- 1-meter DEM post spacing for elevation data with 1-foot equivalent contour accuracy;
- 2-meter DEM post spacing for elevation data with 2-foot equivalent contour accuracy;
- 5-meter DEM post spacing for elevation data with 5-foot equivalent contour accuracy.

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## Attachment 2 – Alignment of FEMA Appendix A to USGS Lidar Specification v13

FEMA is aligning Appendix A of the *Guidelines and Specifications for Flood Hazard Mapping Partners* (Guidelines) to the USGS *Lidar Guidelines and Base Specification* v13 to modernize the FEMA specifications to current industry practice, leverage the expertise of the USGS Geography discipline, maintain Federal standards across agencies, and support the use of elevation products acquired as part of Risk MAP by other agencies for other purposes thus maximizing the Government's investment.

Overall, new elevation data purchased by FEMA must comply with the USGS *Lidar Guidelines and Base Specification* v13, except where specifically noted in this Procedure Memorandum.

Because FEMA's needs for elevation are specific to floodplain mapping, FEMA has some unique requirements that differ from the USGS specifications. To supplement the existing USGS specifications, FEMA-specific items such as cross section surveys, bridges, and other features in Appendix A of the Guidelines remain valid except where superseded by more current information provided in this attachment. Table 1 summarizes the sections in Appendix A that are fully superseded, partially superseded or not superseded by this Procedure Memorandum.

**Table 2.1 Currency of Major Sections within FEMA's Appendix A: Guidance for Aerial Mapping and Surveying**

Section	Name	Status
A.1	Introduction	Is not superseded and remains valid.
A.2	Industry Geospatial Standards	Remains valid but is appended by additional standards which use newer standards from the National Digital Elevation Program (NDEP) and American Society for Photogrammetry and Remote Sensing (ASPRS) to test elevation data for Fundamental Vertical Accuracy (FVA), Supplemental Vertical Accuracy (SVA), and Consolidated Vertical Accuracy (CVA).
A.3	Accuracy Guidelines	Partly superseded, especially Table 2, below, that specifies variable vertical accuracy standards and nominal pulse spacing (NPS), depending on the risk level and terrain slope within the floodplain being mapped.
A.4	Data Requirements	Major portions are superseded. Subsection A.4.2.3 pertaining to breaklines, subsection A.4.3 pertaining to elevation data vertical accuracy, and subsection A.4.5 pertaining to mapping area, are superseded. Subsection A.4.11 pertaining to other digital topographic data requirements, including Table A-3, Digital Topographic Data Requirements Checklist, is now superseded by other FEMA procurement guidelines. Subsection A.4.9 on data formats is partially superseded by the addition of lidar LAS formatted datasets. Subsections pertaining to cross sections (A.4.6) and hydraulic structures (A.4.7) remain valid.
A.5	Ground Control	Is not superseded and remains valid.
A.6	Ground Surveys	Is not superseded and remains valid.

Section	Name	Status
A.7	Photogrammetric Surveys	Remains valid but is appended by additional standards which require low confidence areas to be delineated for photogrammetry as well as lidar and interferometric synthetic aperture radar (IFSAR). The vast majority of section A.7 remains valid and unchanged.
A.8	Airborne LiDAR	Superseded with references the USGS <i>Lidar Guidelines and Base Specification</i> v13; and by NDEP and ASPRS guidelines for accuracy testing and reporting of lidar data.

## **2.1 Elevation Specifications Based on Risk Levels**

FEMA maintains a national dataset that estimates flood risk. The basic data is calculated at the Census Block Group level, and is also aggregated to the sub-watershed, watershed and county levels. These data assign a risk value and a risk rank to each area. The areas are grouped into 10 classes with an equal number of members based on risk rank. These 10 classes are called risk deciles.

The table below provides the minimum elevation standards for new engineering analyses produced by FEMA. The highest and high specifications are suitable for either basic or enhanced engineering analyses. The medium and low specifications are suitable for basic engineering analyses. Where more than 20% of the project area covered by the new elevation will have enhanced engineering analyses, the next higher elevation specification level may be appropriate. When the scope of the enhanced engineering analyses is not sufficient to justify increasing the overall project specification level, the bulk elevation data collection may be enhanced by field survey in areas of enhanced engineering analyses if necessary.

**Table 2.2. Vertical Accuracy Requirements based on Flood Risk and Terrain Slope within the Floodplain being mapped**

Level of Flood Risk	Typical Slopes	Specification Level	Vertical Accuracy, 95% Confidence Level FVA/CVA	Lidar Nominal Pulse Spacing (NPS)
High (Deciles 1,2,3)	Flattest	Highest	24.5 cm/36.3 cm	≤1 meter
High (Deciles 1,2,3)	Rolling or Hilly	High	49.0 cm/72.6 cm	≤2 meters
High (Deciles 2,3,4,5)	Hilly	Medium	98.0 cm/145 cm	≤3.5 meters
Medium (Deciles 3,4,5,6,7)	Flattest	High	49.0 cm/72.6 cm	≤2 meters
Medium (Deciles 3,4,5,6,7)	Rolling	Medium	98.0 cm/145 cm	≤3.5 meters

Medium (Deciles 4,5,6,7)	Hilly	Low	147 cm/218 cm	≤5 meters
Low (Deciles 7,8,9,10)	All	Low	147 cm/218 cm	≤5 meters

Whereas contour lines are for visual interpretation and are unnecessary for FEMA’s automated H&H analyses, the term “equivalent contour accuracy” is used to show the accuracy of contour lines that could be produced from a DEM if needed for manual analysis; this is also for the benefit of those who do not understand NSSDA terminology that defines vertical accuracy at the 95% confidence level. Table 3 explains “equivalent contour accuracy” for various standard contour intervals, referenced also in terms of vertical root mean square error (RMSE<sub>z</sub>), National Standard for Spatial Data Accuracy (NSSDA) Accuracy<sub>z</sub>, SVA and CVA.

**Table 2.3. Accuracy Terms that Equal “Equivalent Contour Accuracy”**

Equivalent Contour Accuracy	FEMA Specification Level	RMSE <sub>z</sub>	NSSDA Accuracy <sub>z</sub> 95% confidence level	SVA (target)	CVA (mandatory)
1 ft		0.30 ft or 9.25 cm	0.60 ft or 18.2 cm	0.60 ft or 18.2 cm	0.60 ft or 18.2 cm
2 ft	Highest	0.61 ft or 18.5 cm	1.19 ft or 36.3 cm	1.19 ft or 36.3 cm	1.19 ft or 36.3 cm
4 ft	High	1.22 ft or 37.1 cm	2.38 ft or 72.6 cm	2.38 ft or 72.6 cm	2.38 ft or 72.6 cm
5 ft		1.52 ft or 46.3 cm	2.98 ft or 90.8 cm	2.98 ft or 90.8 cm	2.98 ft or 90.8 cm
8 ft	Medium	2.43 ft or 73.9 cm	4.77 ft or 1.45 m	4.77 ft or 1.45 m	4.77 ft or 1.45 m
10 ft		3.04 ft or 92.7 cm	5.96 ft or 1.82 m	5.96 ft or 1.82 m	5.96 ft or 1.82 m
12 ft	Low	3.65 ft or 1.11m	7.15 ft or 2.18 m	7.15 ft or 2.18 m	7.15 ft or 2.18 m

FEMA’s requirements for elevation data are specific to flood risk analysis. As a result, FEMA’s requirements diverge from the USGS specification which is intended to serve a different purpose. Two of the key differences with the FEMA specifications are the requirements for vertical accuracy and nominal pulse spacing. The FEMA requirements in these areas are only similar to the USGS requirements in the highest specification level, but otherwise differ for the lower accuracy levels.

All data collected must go through lidar preliminary processing and the unclassified point cloud must be tested as specified in the USGS specification. Where the Mapping Activity Statement (MAS) requires bare earth post-processing of the floodplain area of interest (AOI), the elevation data must be tested and comply with both the FVA and CVA requirements. Where no bare earth post-processing is specified, only the FVA requirements apply for lidar preliminary processing.

Many other organizations require higher-accuracy lidar data for diverse applications and combine their resources to solve multiple needs with lidar. FEMA prefers to acquire elevation data through partnerships so that the resulting data will meet a broader variety of end user needs and be more consistent with the overall USGS specification. These partnership elevation collection activities will frequently utilize specifications that exceed the minimums described above in Table 2. Before committing funds to a new elevation mapping project, FEMA Regional staff should first determine whether funds could be spent more effectively by cooperating with

other agencies to more cost-effectively acquire elevation data. FEMA is a member of the National Digital Elevation Program (NDEP) which was formed, in part, to avoid duplication of effort among state and federal government agencies acquiring digital elevation data. USGS maintains state geospatial liaisons that are a good source of information regarding the status of existing and/or planned mapping activities in their states.

## **2.2 Light Detection and Ranging (lidar)**

Lidar is capable of delivering 1- foot equivalent contour accuracy with sub-meter NPS used to produce DEMs with 1-meter DEM gridded post spacing. Therefore, lidar could satisfy FEMA's requirements for elevation data in high risk, moderate risk, and low risk areas. Lidar is often the best technology for mapping the elevations of the bare earth terrain in dense vegetation.

If this technology is selected for high risk areas, lidar will be collected in accordance with the USGS *Lidar Guidelines and Base Specification*, v13, for the National Geospatial Program except as noted. FEMA does not require the data to be hydro-flattened, as specified in v13. Also, FEMA does not require all data to be processed to the bare earth terrain, but instead limits the area to be processed to areas in the vicinity of floodplains that will require hydraulic modeling. See FEMA's Procurement Guidelines for specifics on this topic.

The following USGS specifications are most relevant to FEMA and are consistent with FEMA requirements:

- Fundamental Vertical Accuracy (FVA) pertains only to open, non-vegetated terrain. The FVA is specified at a higher level of accuracy than other land cover categories. The FVA is a mandatory specification that must be satisfied in order to be usable by FEMA for flood risk mapping within the specified level of flood risk.
- Supplemental Vertical Accuracy (SVA) pertains to other major land cover categories representative of the floodplain being mapped. SVA values are target values, where one SVA category can test higher and another lower than the target SVA value so long as the overall CVA is satisfied for the consolidated equivalent contour accuracy.
- Consolidated Vertical Accuracy (CVA) pertains to all land cover categories combined. Compliance with the CVA specification is mandatory in order for an elevation dataset to qualify for satisfaction of a specified equivalent contour accuracy.
- For the highest specification level equivalent to 2 foot contour accuracy, the relative accuracy should be  $\leq 7$  cm RMSE<sub>z</sub> within individual swaths;  $\leq 10$  cm RMSE<sub>z</sub> within swath overlap (between adjacent swaths). These relative accuracy specifications double to 14 and 20 cm, respectively, for risk areas that utilize the high elevation specification with 4 foot equivalent contour accuracy. This specification is not applicable to lower risk areas.
- Consistent with USGS *Lidar Guidelines and Base Specification*, v13, a regular grid, with cell size equal to the design NPS\*2 will be laid over the first return data within the geometrically usable center portion of each swath. At least 90% of the cells in the grid shall contain at least one lidar point.
- All data collected will be delivered consistent with the USGS Raw Point Cloud deliverable requirements.

- Where lidar post-processing is performed, the deliverables must also include the classified point cloud deliverable. The data will be delivered in full compliance with LAS classes 1 (processed, but unclassified), 2 (bare-earth ground), 7 (noise), 9 (water), 10 (ignored), and 11 (withheld). All points not identified as “withheld” are to be classified. “Overlap” classification (Class 12) shall not be used.
- The horizontal datum shall be referenced to the latest adjustment of the North American Datum of 1983 (NAD83 [NSRS2007]).
- The vertical datum shall be referenced to the North American Vertical Datum of 1988 (NAVD88) whenever available. Areas outside of the continental U.S. where NAVD88 is not available should be referenced to a reproducible local datum that can be used to support floodplain management.
- The most recent approved Geoid model from the National Geodetic Survey (NGS) shall be used to perform conversions from ellipsoidal heights to orthometric heights.
- The standard coordinate reference system and units shall be Universal Transverse Mercator (UTM), meters. Considerations for other standard coordinate systems such as State Plane can be made for projects which are contributed to by mapping partners.
- The single non-overlapped tiling scheme shall be established and agreed upon by the data producer and FEMA prior to collection, consistent with the USGS *Lidar Guidelines and Base Specifications*, v13.
- Specifications for breaklines and hydro-enforcement are addressed in Attachment B.
- Specifications for lidar accuracy testing by land cover categories within the floodplain being mapped are addressed in Attachment C.

Lidar dataset deliverables shall include the following:

1. Metadata should comply with the requirements in the USGS *Lidar Guidelines and Base Specification*, v13. In addition, the finished elevation product for hydraulic modeling should be documented by a FGDC-compliant metadata file that complies with the FEMA Elevation Metadata Profile. Project documentation must also include a Pre-flight Operations Plan and Post-flight Aerial Survey and Calibration Report as described in Attachment 4.
2. Raw point cloud data shall comply with the requirements in the USGS Lidar Guidelines and Base Specification, v13.
3. Classified point cloud data shall comply with requirements in the USGS Lidar Guidelines and Base Specification, v13.
4. Optional breaklines, when produced, shall be delivered in compliance with guidance in Attachment 3
5. Optional digital bare earth elevation data product(s) (e.g., DEM, DTM, contours) in file formats specified in the Statement of Work.

### **2.3 Photogrammetry**

Photogrammetry is also capable of delivering 1-foot equivalent contour accuracy and a DEM with 1-meter post spacing. Therefore, photogrammetry could also satisfy FEMA’s requirements for elevation data in high risk, moderate risk, and low risk areas. Except for the new requirement to delineate areas of low confidence, existing guidance published in section A.7,

Photogrammetric Surveys, in Appendix A of FEMA's Guidelines, remain current for new aerial image acquisition with either film or digital cameras.

The USGS annually contracts for leaf-off orthoimagery of selected areas under the National Geospatial Program, typically producing digital orthophotographs with pixel resolution of 30 cm (~1 foot) or 15 cm (~6 inches), as do many states and local governments; and the USDA contracts for leaf-on orthoimagery of major areas of the U.S. annually under the National Agricultural Imagery Program (NAIP) with pixel resolution of 1 meter. Although intended for production of digital orthophotos, those same images could be reused for production of digital elevation data because the aerotriangulation (AT) solution for production of orthophotos can be reused for establishing stereo models from which DEMs can be produced by photogrammetric auto-correlation and/or manual compilation. Elevation accuracies typically achievable by reuse of digital imagery and AT metrics are as follows:

- Typically acquired at an elevation of approximately 4,800 feet above mean terrain, imagery and AT solutions used to produce digital orthophotos with 6-inch pixel resolution should be acceptable for elevation data with 2.5-foot equivalent contour accuracy
- Typically acquired at an elevation of approximately 9,600 feet above mean terrain, imagery and AT solutions used to produce digital orthophotos with 1-foot pixel resolution should be acceptable for elevation data with 5-foot equivalent contour accuracy
- Typically acquired at an elevation of approximately 30,000 feet above mean terrain, imagery and AT solutions used to produce digital orthophotos with 1-meter pixel resolution should be acceptable for elevation data with 15-foot equivalent contour accuracy.

Photogrammetric dataset deliverables shall include the following:

1. Metadata shall include:
  - Collection Report detailing mission planning and flight logs, flying heights, camera parameters, forward overlap and sidelap.
  - Survey Report detailing the collection of control and reference points used for calibration and QA/QC.
  - Aerial triangulation (AT) report detailing compliance with relevant accuracy statistics
  - Processing Report detailing photogrammetric processed used to manually compile elevation data or to semi-automatically compile elevation data with automated image correlation or other techniques.
  - QA/QC reports.
  - Geo-referenced extents of each delivered dataset.
2. Digital bare earth elevation data product (DEM, DTM, mass points, breaklines, contours) specified in the Statement of Work.
3. Optional breaklines, when produced, shall be delivered in compliance with guidance in Attachment 3

## **2.4 Ground Surveys**

All ground surveys must be performed in accordance with procedures in Section A.5, Ground Control, and Section A.6, Ground Surveys, in Appendix A of FEMA's Guidelines. Cross-



section surveys and hydraulic structure surveys shall also be performed in accordance with sections A.4.6 and A.4.7, respectively, of Appendix A.

## **2.5 Low Confidence Areas**

Regardless of technology used, FEMA requires that low confidence areas be delineated by the data provider to indicate areas where the vertical data may not meet the data accuracy requirements due to heavy vegetation even though the specified nominal pulse spacing was met or exceeded in those areas. The metadata must explain steps taken to minimize the areas delineated as low confidence areas. Accuracy test points are normally retained within such areas and are not discarded. The data provider must take reasonable steps to minimize areas delineated as low confidence areas, taking into consideration the density of the vegetation in the floodplain being mapped and other factors.

These low confidence areas must be delivered as polygons in accordance with a database schema. The database schema for polygons defining low confidence areas is as follows.

**Feature Dataset:** TOPOGRAPHIC **Feature Class:** CONFIDENCE

**Feature Type:** Polygon

**Contains M Values:** No **Contains Z Values:** No

**Annotation Subclass:** None

**XY Resolution:** Accept Default Setting **Z Resolution:** Accept Default Setting

**XY Tolerance:** 0.003 **Z Tolerance:** N/A

### **2.5.1 Description**

This polygon feature class will depict areas where the ground is obscured by dense vegetation, meaning that the resultant bare-earth digital terrain model (DTM) may not meet the required accuracy specifications in these obscured areas. Low confidence areas can pertain to lidar, photogrammetry or IFSAR.

### **2.5.2 Table Definition**

Field Name	Data Type	Allow Null Values	Default Value	Domain	Precision	Scale	Length	Responsibility
OBJECTID	Object ID							Assigned by Software
SHAPE	Geometry							Assigned by Software
DATESTAMP_DT	Date	Yes			0	0	8	Assigned by Contractor
SHAPE_LENGTH	Double	Yes			0	0		Calculated by Contractor
SHAPE_AREA	Double	Yes			0	0		Calculated by

								Contractor
TYPE	Long Integer	No	1	Obscure	0	0		Assigned by Contractor

### **2.5.3 Feature Definition**

Code	Description	Definition	Capture Rules
1	Low Confidence Area	“Low confidence areas” are defined by the data provider to indicate areas where the vertical data may not meet the data accuracy requirements due to heavy vegetation even though the nominal pulse spacing was met or exceeded in those areas.	Capture as closed polygon. Compiler does not need t z-values of vertices; feature class will be 2-D only.

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### Attachment 3 – Topographic Breakline and Hydro-Enforcement Specifications

FEMA has no minimum breakline requirements; breaklines are optional and depend upon the procedures used to perform hydrologic and hydraulic modeling. The FEMA Project Manager should specify the breaklines requirements if desired based on the planned approach for hydraulic analysis or the mapping partner may propose breakline requirements based on the anticipated hydraulic modeling approach.

When optional breaklines are produced, the following breakline topology rules must be followed for the applicable feature classes. The topology must be validated by each contractor prior to delivery to FEMA.

<b>Name: BREAKLINES_Topology</b>			Cluster Tolerance: 0.003 Maximum Generated Error Count: Undefined State: Analyzed without errors	
Feature Class	Weight	XY Rank	Z Rank	Event Notification
COASTALSHORELINE	5	1	1	No
HYDROGRAPHICFEATURE	5	1	1	No
PONDS_AND_LAKES	5	1	1	No
HYDRAULICSTRUCTURE	5	1	1	No
ISLAND	5	1	1	No

#### Topology Rules

Name	Rule Type	Trigger Event	Origin (FeatureClass::Subtype)	Destination (FeatureClass::Subtype)
Must not intersect	The rule is a line-no intersection rule	No	HYDRAULICSTRUCTURE::All	HYDRAULICSTRUCTURE::All
Must not intersect	The rule is a line-no intersection rule	No	HYDROGRAPHICFEATURE::All	HYDROGRAPHICFEATURE::All
Must not intersect	The rule is a line-no intersection rule	No	COASTALSHORELINE::All	COASTALSHORELINE::All
Must not intersect	The rule is a line-no intersection rule	No	PONDS_AND_LAKES::All	PONDS_AND_LAKES::All
Must not intersect	The rule is a line-no intersection rule	No	ISLAND::All	ISLAND::All
Must not overlap	The rule is a line-no overlap line rule	No	HYDROGRAPHICFEATURE::All	COASTALSHORELINE::All
Must not self-intersect	The rule is a line-no self intersect rule	No	HYDRAULICSTRUCTURE::All	HYDRAULICSTRUCTURE::All
Must not self-intersect	The rule is a line-no self intersect rule	No	HYDROGRAPHICFEATURE::All	HYDROGRAPHICFEATURE::All
Must not self-intersect	The rule is a line-no self intersect rule	No	COASTALSHORELINE::All	COASTALSHORELINE::All

Name	Rule Type	Trigger Event	Origin (FeatureClass::Subtype)	Destination (FeatureClass::Subtype)
Must not self-intersect	The rule is a line-no self intersect rule	No	PONDS_AND_LAKES::All	PONDS_AND_LAKES::All
Must not self-intersect	The rule is a line-no self intersect rule	No	ISLAND::All	ISLAND::All

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## **Attachment 4 – Topographic Data Quality Review and Reporting Process**

To complement the topographic data specifications in this procedure memorandum, this attachment describes data quality review processes and reporting obligations to be performed on new topographic data procured by FEMA as part of a flood hazard study or Risk MAP project. The mapping partner responsible for producing the elevation data is responsible for the quality of the product. In addition, FEMA may assign another mapping partner to perform Independent QA/QC of Topographic Data

Existing topographic data leveraged by FEMA should be certified to meet or tested for the vertical accuracy requirements specified in this procedure memo. In addition, the quality reviews described here are best practices that may be applied to existing topographic data. However, some of the documentation needed to perform some of these reviews may not be readily available for existing data..

### **4.1 Quality Reviews and Reporting Performed by Data Provider**

The mapping partner responsible for producing new elevation data must submit copies of QA reports as specified in USGS Lidar Guidelines and Base Specification version 13. Unless the responsibility for checkpoint surveys and vertical accuracy testing is specifically assigned to a different mapping partner performing Independent QA/QC, the mapping partner responsible for producing the elevation data must test the unclassified point cloud data for Fundamental Vertical Accuracy (FVA) and, when lidar post-processing is performed must also test the bare earth product for Supplemental Vertical Accuracy (SVA) and Consolidated Vertical Accuracy (CVA).

#### **4.1.1 Ground Survey of Quality Review Checkpoints**

Quality review checkpoint surveys shall be performed in accordance with procedures in Section A.6.4, Checkpoint Surveys and A.6.5, Survey Records, in Appendix A of FEMA's Guidelines.

Checkpoints surveyed for accuracy reporting shall not be used by the data provider in the calibration or adjustment of the topographic data.

#### **4.1.2 Assessment of Initial Vertical Accuracy**

Assessment of the fully calibrated, raw point cloud initial vertical accuracy is required to ensure data has successfully completed preliminary processing. The absolute and relative accuracy of the data, relative to known control, shall be verified prior to classification and subsequent product development, by calculating FVA, measured in open, non-vegetated terrain. The spatial distribution of checkpoints for FVA testing should be based on the entire project collection area, distributed to avoid clustering, and support vertical accuracy reporting that is representative of the whole project.

If the project area exceeds 2,000 square miles it must be divided into smaller blocks of 2,000 square miles or less and tested as individual areas. In addition, the division of large project areas should apply the following rules if applicable:

- Divide areas by vendor used
- Divide areas by sensor type (manufacturer)
- Divide areas by flight dates if significant temporal difference is present
- Other logical project divisions based factors that might have a systematic relationships to data quality.

Reporting of positional accuracy shall be in accordance with ASPRS/NDEP standards as well as the USGS *Lidar Guidelines and Base Specification*, v13, Section II.13 and shall use the following statement:

Tested \_\_\_\_ (meters) fundamental vertical accuracy at 95% confidence level

Reporting on the assessment of the point cloud initial vertical accuracy shall include the following at a minimum:

- ***A description of the process used to test the points***
- A graphic depicting the spatial distribution of the ground survey checkpoints
- Descriptive statistics and RMSEz in FVA calculations

#### **4.1.3 Assessment of Bare Earth Vertical Accuracy**

When bare earth post-processing is included in the project, assessment of the vertical accuracy for the delivered bare earth elevation product is required to ensure data has successfully completed post processing. Reporting of positional accuracy shall be in accordance with ASPRS/NDEP standards for FVA and CVA. Testing should be performed on the bare earth deliverable as specified in the mapping activity statement, along with the following guidance:

- If an assessment of initial vertical accuracy (FVA) was conducted prior to the processing of the data (section 4.1.2), the FVA checkpoints can again be used in the CVA computations if located within the area to be processed
- The SVA for up to three significant land cover categories, in terms of percentage of the project area covered, shall be tested in addition to the open/bare ground areas already tested for FVA Land cover categories making up 10% or more of the project area should be included in the SVA testing
- For smaller projects less than 1,000 square miles, fewer check points for SVA testing is acceptable. The number of checkpoints shall be reduced to control the QA cost to about 10% of the acquisition and processing cost. The checkpoints should be distributed evenly across the SVA land cover types.
- Processing areas greater than 2,000 square miles must be divided into smaller blocks of 2,000 square miles or less and tested as individual areas. In addition,



the division of large processing areas should apply the following rules if applicable:

- Divide areas by vendor used
- Divide areas by sensor type (manufacturer)
- Divide areas by flight dates if significant temporal difference is present
- Other logical project divisions based factors that might have a systematic relationships to data quality.

1.

- Each block of 2,000 square miles or less shall be tested for FVA, SVA, and CVA

Checkpoints used for testing SVA of the bare earth elevation product must be located in the areas where bare earth post-processing was performed, distributed to avoid clustering, and support vertical accuracy reporting that is representative of the post processed areas. The SVA results will then be combined with the FVA results to compute CVA for the entire project area.

Reporting on the assessment of the vertical accuracy of the post-processed, delivered elevation data shall include the following at a minimum:

- *A description of the process used to test the points*
- A graphic depicting the spatial distribution of the ground survey checkpoints
- An analysis of checkpoints that have errors exceeding the 95<sup>th</sup> percentile in SVA and CVA calculations
- Descriptive statistics and RMSEz in FVA calculations

#### **4.1.4 Aerial Data Acquisition and Calibration**

The mapping partner responsible for producing new elevation data must also submit a pre-flight Operations Plan and a post-flight Aerial Acquisition and Calibration Report will be provided to FEMA and/or their representatives by the data acquisition provider and uploaded to the MIP by the data provider. This information will aid future quality review efforts. The required reporting includes the following, outlined in Tables 4.1 and 4.2.

**Table 4.1. Pre-flight Operations Plan**

Item	Contents	Format
Flight Operations	<ul style="list-style-type: none"> <li>• Planned flight lines</li> </ul>	MS Word or

Plan	<ul style="list-style-type: none"> <li>Planned GPS stations</li> <li>Planned control</li> <li>Planned airport locations</li> <li>Calibration plans</li> <li>Quality procedures for flight crew (project-related for pilot and operator)</li> <li>Planned scanset (sensor settings and altitude)</li> <li>Type of aircraft</li> <li>Procedure for tracking, executing, and checking reflights</li> <li>Considerations for terrain, cover, and weather in project</li> </ul>	PDF
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**Table 4.2. Post-flight Aerial Acquisition and Calibration Report**

Item	Contents	Format
GPS Base station info	<ul style="list-style-type: none"> <li>Base station name</li> <li>Latitude/Longitude (ddd-mm-ss.sss)</li> <li>Base height (Ellipsoidal meters)</li> <li>Maximum Position Dilution of Precision PDOP</li> <li>Map of locations</li> </ul>	Excel, TXT, MS Word, or PDF for data; ESRI shape file for map of locations (data and info may be in attribute table)
GPS/IMU processing summary	<ul style="list-style-type: none"> <li>Max Horizontal GPS Variance (cm)</li> <li>Max Vertical GPS Variance (cm)</li> <li>Notes on GPS quality (High, Good, etc.)</li> <li>GPS separation plot</li> <li>GPS altitude plot</li> <li>PDOP plot</li> <li>Plot of GPS distance from base station/s</li> </ul>	MS Word or PDF with screenshots
Coverage	<ul style="list-style-type: none"> <li>Verification of project coverage</li> </ul>	ESRI shape files reflecting the actual coverage area and not the applicable tiles.
Flights	<ul style="list-style-type: none"> <li>As-flown trajectories</li> <li>Calibration lines</li> </ul>	ESRI shape files

Item	Contents	Format
Flight logs	<ul style="list-style-type: none"> <li>Incorporated as appendix</li> </ul> Should include: <ul style="list-style-type: none"> <li>Job # / name</li> <li>Lift #</li> <li>Block or AOI designator</li> <li>Date</li> <li>Aircraft tail number, type</li> <li>Flight line, line #, direction, start/stop, altitude, scan angle/rate, speed, conditions, comments</li> <li>Pilot name</li> <li>Operator name</li> <li>AGC switch setting</li> <li>Laser pulse rate</li> <li>Mirror rate</li> <li>Field of view</li> <li>Airport of operations</li> <li>GPS base station names or numbers</li> </ul> Comments	
Control	<ul style="list-style-type: none"> <li>Ground control and base station layouts</li> </ul>	ESRI shape files
Data verification/QC	<ul style="list-style-type: none"> <li>Description of data verification/QC process</li> <li>Results of verification and QC steps</li> </ul>	MS Word, Excel or PDF

#### **4.2 Quality Reviews and Reporting Performed by Independent QA/QC**

When a mapping partner is assigned to perform *Independent QA of Topographic Data* macro and micro reviews of the submitted reports and data shall be performed. Macro reviews are automated processes or are checks required to establish overall data quality and shall be applied to the entire project area. Micro reviews are typically manual in nature and shall be used to check no less than 3 project tiles or 5% of the total number of project tiles, whichever is the greater amount.

Tables 4.3 and 4.4 outline macro and micro reviews to be conducted on the raw point cloud and for data that is post-processed. Some reviews are duplicated between the raw point cloud and post-processing phases due to the potential for errors to be introduced into the data during post-processing.

**Table 4.3. Review of fully calibrated raw point cloud**

Macro Reviews	
Product	Reviewed for
Pre-flight Operations Plan	<ul style="list-style-type: none"> <li>Compliance with section 4.1.4 and checklists in 4.2.1</li> <li>Compliance with the specifications outlined in the Mapping Activity Statement</li> </ul>
Post-flight Aerial Acquisition and Calibration Report	<ul style="list-style-type: none"> <li>Compliance with section 4.1.4 and checklists in 4.2.1</li> <li>Compliance with the specifications outlined in the Mapping Activity Statement</li> </ul>

Macro Reviews	
Product	Reviewed for
LAS Point Cloud Files	<ul style="list-style-type: none"> <li>• Project area coverage – buffered by a minimum of 100 meters</li> <li>• Data voids</li> <li>• Inclusion of GPS time stamp</li> <li>• Correct projection, datum and units</li> <li>• Multiple Discrete Returns (at least 3 returns per pulse)</li> <li>• Correct header information</li> <li>• Other LAS attributes required by Mapping Activity Statement such as intensity values</li> <li>• Correct nominal pulse spacing as required by specific risk and/or level of study and buy-up options.</li> </ul>
Metadata	<ul style="list-style-type: none"> <li>• Compliance with the FEMA Terrain Metadata Profile</li> </ul>
Micro Reviews	
Product	Reviewed for
LAS Point Cloud Files	<ul style="list-style-type: none"> <li>• Excessive noise</li> <li>• Elevation steps</li> <li>• Other anomalies present in the point cloud</li> </ul>

**Table 4.4. Review of post-processed data**

Macro Reviews	
Product	Reviewed for
LAS Point Cloud Files	<ul style="list-style-type: none"> <li>• Compliance with checklists in section 4.2.1</li> <li>• Project area coverage – buffered by a minimum of 100 meters</li> <li>• Data voids</li> <li>• Inclusion of GPS time stamp</li> <li>• Correct projection, datum and units</li> <li>• Multiple Discrete Returns (at least 3 returns per pulse)</li> <li>• Correct header information</li> <li>• Other LAS attributes required by Mapping Activity Statement such as intensity values</li> <li>• Correct nominal pulse spacing as required by specific risk and/or level of study and buy-up options.</li> <li>• Easting, northing and elevation reported to nearest 0.01m or 0.01 ft</li> <li>• Correct file-naming convention</li> </ul>
Metadata	<ul style="list-style-type: none"> <li>• Compliance with the FEMA Terrain Metadata Profile</li> </ul>

Macro Reviews	
Product	Reviewed for
Micro Reviews	
Product	Reviewed for
LAS Point Cloud Files	<ul style="list-style-type: none"> <li>Excessive noise</li> <li>Elevation steps</li> <li>Other anomalies present in the point cloud</li> <li>Correct classification and cleanliness: no more than 2% of the project area classified to bare ground shall contain artifacts such as buildings, trees, overpasses or other above-ground features in the ground point classification (Class 2). In addition, no more than 2% of the project area shall contain incorrect classifications of points. (USGS Lidar Guidelines and Base Specification, v13, Section IV.14.</li> <li></li> </ul>
Optional - Breaklines	<ul style="list-style-type: none"> <li>Correct topology</li> <li>Horizontal placement</li> <li>Completeness</li> <li>Continuity</li> </ul> <p>See Attachment 3 for breakline topology rules to be checked against</p>

If the mapping partner responsible *Independent QA of Topographic Data* is tasked to perform assessment of vertical accuracy of the elevation data as described above in sections 4.1.2 and 4.1.3:

- Assessment of FVA only for pre-processed data to be stored and FVA, SVA, and CVA for post-processed data
- Review of data provider vertical accuracy assessment reports

#### **4.2.1 Recommended Checklists**

The following checklists are recommended for use during Independent QA/QC review to facilitate the process.

##### ***Pre-flight review checklist***

Checklist	Pass / Fail	Comments
Planned lines – sufficient coverage, spacing, and length		
Planned GPS stations		
Planned ground control – sufficient to control and boresight		
Calibration plans		
Vendor quality procedures		
Lidar sensor scan set – planned for proper scan angle, sidelap, design pulse.		
Aircraft utilizes ABGPS		

Sensor supports project design pulse density		
Type of aircraft – supports project design parameters		
Reflight procedure – tracking, documenting, processing		
Project design supports accuracy requirements of project		
Project design accounts for land cover and terrain types		

### *Post-flight review checklists*

Checklist for QA of Flight Logs		
Checklist	Included Yes/No	Comments
Flight logs – job #/name		
Flight logs – block or AOI		
Flight logs – date		
Flight logs – aircraft tail #		
Flight logs – lines - #		
Flight logs – lines - direction		
Flight logs – lines – start/stop		
Flight logs – lines – altitude		
Flight logs – lines – scan angle		
Flight logs – lines – speed		
Flight logs – conditions		
Flight logs – comments		
Flight logs - pilot name		
Flight logs - operator name		
Flight logs - AGC switch		
Flight logs – GPS base stations		

Checklist for Aerial Acquisition Report		
Checklist	Included? Yes/No	Comments
GPS base station – names		
GPS base station – lat/longs		
GPS base station – heights		
GPS base station – map		
GPS quality – separation plot		
GPS quality – PDOP plot		



GPS quality - horizontal Acc.		
GPS quality - vertical Acc.		
Sensor calibration process		
Verification of AOI coverage		
As-flown trajectories		
Ground control layout		
Data verification process documented		

***Final terrain product review checklists***

Checklist for QA of Terrain Products		
Checklist	Pass/Fail	Comments
Vertical datum correct		
Horizontal datum correct		
Projection correct		
Vertical units correct		
Horizontal units correct		
Each return contains – GPS week, GPS second, easting, northing, elevation, intensity, return # and classification		
No duplicate entries		
GPS second reported to nearest microsecond		
Easting, northing, and elevation reported to nearest 0.01 m or 0.01 ft		
Classifications correct – 1. Unclassified; 2. Bare-earth ground; 7. Noise; 9. Water; 10. Ignored ground; 11. Withheld		
Cloud file structure conforms to project tile layout		
Naming conforms project requirements		
Deliverable tiles checked for significant gaps not covered by aerial acquisition checks and/or caused by data post-processing/filtering		

### M.4 Terrain Submittal Standards

#### M.4.1 Overview

This section describes the format and type of terrain data required to be submitted to FEMA for FISs. All data must be submitted in digital format. The Mapping Partner performing “Develop Topographic Data” is required to submit the data in this section.

The Mapping Partner should refer to Appendix A of these Guidelines for guidance on terrain data production. This section is not intended to detail the specifications and procedures for coastal hydrographic surveys. The reader is referred to the following additional sources for details on coastal surveys:

- National Oceanic and Atmospheric Administration (NOAA) NOS Hydrographic Survey Specifications and Deliverables (April 2007);
- NOAA Office of Coast Survey Hydrographic Surveys Division Field Procedures Manual (March 2007); and
- U.S. Army Corps of Engineers (USACE) National Coastal Mapping Program Joint LiDAR Bathymetry Technical Center for Expertise.
- Appendix D of the *Guidelines and Specifications for Flood Hazard Mapping Partners* (February 2007).

The submitting Mapping Partner must retain copies of all Project-related data for a period of 3 years. The submitting Mapping Partner will need these data for responding to the following:

- Questions from FEMA or the receiving Mapping Partner during the review of the final draft materials;
- Comments and appeals submitted to FEMA during the 90-day appeal period following the issuance of preliminary maps; and
- Other concerns and issues that may develop during the processing of the new or revised FIS report and FIRM.

#### M.4.2 Requirements

##### M.4.2.1 Data Files

The minimum data required for the terrain data submission are the source terrain and topographic maps from the terrain data used in the study. These data can be contained in a single file or in tiled files. When tiled files are submitted, they must be accompanied by a tiling index file. If any processing has been performed, the original and final files must be submitted as well. For instance, if terrain data were blended from three different sources to create the final terrain data, the original of the three sources and the final terrain file that results from the blending process must be submitted. This information is required to be a georeferenced, digital submittal. The following information must be submitted when it is used to perform a study:

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- LiDAR data (bare earth and all returns);
- Tiling index for data files;
- Breaklines and Mass Points;
- Contours;
- Bathymetry;
- Digital Elevation Models (DEMs);
- Hydro-corrected DEMs;
- Triangulated Irregular Networks (TINs);
- Hydro-corrected TINs;
- USGS topographic data;
- All other terrain data; and
- LiDAR data generated as part of the project must be submitted as two separate files: one for bare earth only, and one for all returns if bare earth processing was performed as part of this project. For existing LiDAR data not processed as part of the project, the bare earth data must be submitted, and the submittal of the all returns data (if available) is optional.

A project narrative describing the SOW, direction from FEMA, issues, information for next Mapping Partner, etc. (see DCS User Guide for additional details).

### M.4.2.2 General Correspondence

A file that compiles general correspondence must be submitted by the Mapping Partner assigned to “Develop Topographic Data.” General correspondence is the written correspondence generated or received by the Mapping Partner to fulfill the requirements of developing topographic data.

Correspondence includes any documentation generated during this task such as letters; transmittals; memoranda; general status reports and queries; SPRs; technical issues that need to be documented; and direction given by FEMA.. Contractual documents, such as a signed SOW or MAS, are not to be submitted as a part of this appendix.

### M.4.2.3 Certification of Work

FEMA-funded (including CTP-funded projects if they are a part of FEMA’s flood mapping program) terrain data development must be certified using the Certification of Compliance Form provided in Figure M-11 in section M.10. Submittal of this certification at “Develop Topographic Data” workflow step is required if this is the only task performed by the Mapping Partner.

Mapping Partners that are contracted to perform multiple mapping tasks can submit one certification form to certify all the work performed. A PDF file of this form with the original signature, data, and seal affixed to the form must be submitted digitally in the general directory identified in section M.4.2.8. This form must be signed by a registered or certified professional from the firm contracted to perform the work, or by the responsible official of a government agency. A digital version of this form is available at [www.fema.gov](http://www.fema.gov).

### M.4.2.4 Acceptable File Formats

Terrain data used to perform the study must be submitted in a georeferenced, digital format as listed below. These data can be contained in a single file or in a tiled set of files. Any tiled data must have an accompanying index spatial file.

- Contours, Masspoints, and breaklines – Personal geodatabase, DXF, or shapefile
- DEMs – ESRI grid, GeoTIFF, or ASCII grid
- LiDAR – LAS file, ASCII x, y, z file
- Terrain – ESRI ArcGIS
- Word – project narrative
- PDF – correspondence and certification

PDF files must be created using the source file (e.g., Word file), if the source file is created by the Mapping Partner, rather than raster scans of hard copy text documents. PDF files created must allow copying of text and pasting to another document. In addition, ESRI shapefiles must include .PRJ files.

### M.4.2.5 Metadata

A metadata file in XML format that complies with the NFIP Terrain Metadata Profiles (provided in Section M.14) must be included with the submittal. The profiles follow the FGDC Content Standard for metadata and define additional domains and business rules for some elements that are mandatory for FEMA, based on the specific submittal type. For each spatial data source in the metadata file, the Mapping Partner must assign a Source Citation Abbreviation.

If metadata is available from an agency or organization that provided data for use in the study, it should be included in the metadata submittal in addition to the NFIP Terrain Metadata Profiles. Reference the data providers' original metadata record in the Lineage section of the NFIP metadata profile. If there is a Web-accessible metadata record for the original data set, the URL to the metadata may be provided in the optional Source Citation - Online Linkage element. Otherwise, the Source Contribution [free text] element may include information on how to access the metadata record for the data sets obtained.

### M.4.2.6 Transfer Media

Mapping Partners must submit files via the internet by uploading to the MIP (<http://www.hazards.fema.gov>) or by mailing the files to FEMA on one or more of the following electronic media:

- CD-ROM;
- DVD; or
- External Hard Drive (for very large data submissions with a return label for shipment back to the partner).

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In special situations or as technology changes, other media may be acceptable if coordinated with FEMA.

When data is mailed to FEMA, all submitted digital media must be labeled with at least the following information:

- Mapping Partner's name;
- Community name and State for which the FIS was prepared;
- Terrain Data;
- Date of submission (formatted mm/dd/yyyy); and
- Disk [*sequential number*] of [*number of disks*]. The media must be numbered sequentially, starting at Disk 1. [Number of disks] represents the total number of disks in the submission.

### M.4.2.7 Transfer Methodology

Terrain artifacts can be uploaded to the MIP by following the guidelines for Data Submission and Validation located on the MIP (<https://hazards.fema.gov>) under "User Guidance" in the "Guides & Documentation" tab of "MIP User Care".

### M.4.2.8 Directory Structure and Folder Naming Conventions

The files presented in section M.4.2 Requirements must be submitted to the MIP or mailed to FEMA within the following directory structure. Data files must be organized under an applicable 8-digit Hydrologic Unit Code (HUC-8). The following folders can be created either on a local work space (i.e., a personal computer) or within the work space for the community on the MIP. If the following folders are generated locally, these newly created folders and their contents must be uploaded to the MIP. Terrain files are arranged into appropriate directories based on data type.

- \HUC-8\General
  - Project narrative
  - Certification
- \HUC-8\Correspondence
  - Letters; transmittals; memoranda; general status reports and queries; SPRs; technical issues; direction by FEMA; and internal communications, routing slips, and notes.
- \HUC-8\All\_Returns
  - LIDAR data – All Returns
  - LIDAR Tile Index spatial file (if used)
- \HUC-8\Bare\_Earth
  - LIDAR data – Bare Earth Points
  - LIDAR Tile Index spatial file (if used)
- \HUC-8\Breaklines
  - 3D breakline spatial files
  - 3D breakline Tile Index spatial file (if used)

- 2D breakline spatial files
  - 2D breakline Tile Index spatial file (if used)
  - Mass Points
- \HUC-8\Contours
  - Contour spatial files
  - Contour Tile Index spatial file (if used)
  - Bathymetric files
  - Bathymetric Tile Index spatial file (if used)
- \HUC-8\DEM
  - Uncorrected DEM files
  - Tile Index spatial file (if used)
- \HUC-8\HDEM
  - Hydrologically correct DEM files
  - Tile Index spatial file (if used)
- \HUC-8\TIN
  - Uncorrected TIN files
  - Terrain (ESRI ArcGIS format)
  - Tile index spatial file (if used)
- \HUC-8\HTIN
  - Hydrologically corrected TIN files
  - Terrain (ESRI ArcGIS format)
  - Tile Index spatial file (if used)
- \HUC-8\Supplemental Data
  - As-built drawings
  - GIS representation of structures



# U.S. Geological Survey National Geospatial Program Lidar Guidelines and Base Specification

Version 13 – ILMF 2010

The U.S. Geological Survey National Geospatial Program (NGP) has cooperated in the collection of numerous lidar datasets across the nation for a wide array of applications. These collections have used a variety of specifications and required a diverse set of products, resulting in many incompatible datasets and making cross-project analysis extremely difficult. The need for a single base specification, defining minimum collection parameters and a consistent set of deliverables, is apparent.

Beginning in late 2009, an increase in the rate of lidar data collection due to American Reinvestment and Recovery Act (ARRA) funding for The National Map makes it imperative that a single data specification be implemented to ensure consistency and improve data utility. Although the development of this specification was prompted by the ARRA stimulus funding, the specification is intended to remain durable beyond ARRA funded NGP projects.

The primary intent of this specification is to create consistency across all NGP funded lidar collections, in particular those undertaken in support of the National Elevation Dataset (NED). Unlike most other “lidar specs” which focus on the derived bare-earth DEM product, this specification places unprecedented emphasis on the handling of the source lidar point cloud data. This is to assure that the complete source dataset collected remains intact and viable to support the wide variety of non-DEM science and mapping applications that benefit from lidar technology. In the absence of other comprehensive specifications or standards, it is hoped that this specification will, to the highest degree practical, be adopted by other USGS programs and disciplines, and by other Federal agencies.

Adherence to these minimum specifications ensures that bare-earth Digital Elevation Models (DEMs) derived from lidar data is suitable for ingestion into the NED (National Elevation Dataset) at the 1/9 arc-second resolution, and can be resampled for use in the 1/3 and 1 arc-second NED resolutions. It also ensures that the point cloud source data are handled in a consistent manner by all data providers and delivered to the USGS in clearly defined formats. This allows straight-forward ingest into CLICK (Center for Lidar Information, Coordination, and Knowledge) and simplifies subsequent use of the source data by the broader scientific community, particularly with regard to cross-collection analysis.

It must be stressed that this is a **base specification**, defining minimum parameters. It is expected that local conditions in any given project area, specialized applications for the data, or the preferences of cooperators, may mandate more stringent requirements. The

USGS encourages the collection of more detailed, accurate, or value-added data. A list of common upgrades to the minimum requirements defined here is provided in Appendix 1.

In addition, it is recognized that the USGS NGP also employs lidar technology for specialized scientific research and other projects whose requirements are incompatible with the provisions of this Specification. In such cases, and with properly documented justification supporting the need for the variance, waivers of any part or all of this Specification may be granted.

It is conceivable that in some cases, based on specific topography, land cover, intended application, or other factors, the USGS-NGP may require specifications more rigorous than those defined in this document. It is expected that this would be highly uncommon.

Lidar is still a relatively new technology; adolescent but not fully matured.. Advancements and improvements in instrumentation, software, processes, applications, and understanding are constantly being made. It would not be possible to develop a set of guidelines and specifications that address all of these advances. The current document is based on our understanding of and experience with the industry and technology at the present time. Furthermore, we acknowledge that there is a lack of commonly accepted “best practices” for numerous processes and technical assessments (i.e., measurement of NPS, point clustering, classification accuracy, etc.). The USGS encourages the development of such best practices through the appropriate industry and professional governance organizations, and we eagerly await the opportunity to include them in future revisions to this and other similar documents.

It is not the intention of the USGS to stifle the development of the lidar industry, nor to discourage innovation within the technology. Technical alternatives to any part of this document may be submitted with any proposal and will be given due professional consideration.

## I. COLLECTION

1. Multiple Discrete Return, capable of at least 3 returns per pulse

*Note: Full waveform collection is both acceptable and welcomed; however, waveform data is regarded as supplemental information. The requirement for deriving and delivering multiple discrete returns remains in force in all cases.*

2. Intensity values for each return.
3. Nominal **Pulse** Spacing (NPS) of 1-2 meters, dependent on the local terrain and landcover conditions. Assessment to be made against single swath, first return data located within the geometrically usable center portion (typically ~90%) of each swath. Average along-track and cross-track point spacings should be comparable.
4. Collections designed to achieve the NPS through swath overlap or multiple passes are generally discouraged. Such collections may be permitted with prior approval.
5. Data Voids [areas  $\Rightarrow (4 \times \text{NPS})^2$ , measured using 1<sup>st</sup>-returns only] within a single swath are not acceptable, except:
  - where caused by water bodies
  - where caused by areas of low near infra-red (NIR) reflectivity such as asphalt or composition roofing.
  - where appropriately filled-in by another swath
6. The spatial distribution of geometrically usable points is expected to be uniform and free from clustering. In order to ensure uniform densities throughout the data set:
  - A regular grid, with cell size equal to the design  $\text{NPS} \times 2$  will be laid over the data.
  - At least 90% of the cells in the grid shall contain at least 1 lidar point.
  - Assessment to be made against single swath, first return data located within the geometrically usable center portion (typically ~90%) of each swath.
  - Acceptable data voids identified previously in this specification are excluded.

*Note: This requirement may be relaxed in areas of significant relief where it is impractical to maintain a consistent NPS.*

7. Scan Angle: Total FOV should not exceed 40° (+/-20° from nadir) USGS quality assurance on collections performed using scan angles wider than 34° will be particularly rigorous in the edge-of-swath areas. Horizontal and vertical accuracy shall remain within the requirements as specified below.

*Note: This requirement is primarily applicable to oscillating mirror lidar systems. Other instrument technologies may be exempt from this requirement.*

8. Vertical Accuracy of the lidar data will be assessed and reported in accordance with the guidelines developed by the NDEP and subsequently adopted by the ASPRS. The complete guidelines may be found in Section 1.5 of the Guidelines document. See:

[http://www.ndep.gov/NDEP\\_Elevation\\_Guidelines\\_Ver1\\_10May2004.pdf](http://www.ndep.gov/NDEP_Elevation_Guidelines_Ver1_10May2004.pdf)

Vertical accuracy requirements using the NDEP/ASPRS methodology are:

FVA  $\leq$  24.5cm ACCz, 95% (12.5cm RMSEz)

CVA  $\leq$  36.3cm, 95th Percentile

SVA  $\leq$  36.3cm, 95th Percentile

- Accuracy for the lidar point cloud data is to be reported independently from accuracies of derivative products (i.e., DEMs). Point cloud data accuracy is to be tested against a TIN constructed from bare-earth lidar points.
- Each landcover type representing 10% or more of the total project area must be tested and reported as an SVA.
- For SVAs, the value is provided as a target. It is understood that in areas of dense vegetation, swamps, or extremely difficult terrain, this value may be exceeded. Overall CVA requirements must be met in spite of "busts" in individual SVAs.

*Note: These requirements may be relaxed in cases:*

- *where there exists a demonstrable and substantial increase in cost to obtain this accuracy.*
  - *where an alternate specification is needed to conform to previously contracted phases of a single larger overall collection effort, i.e., multi-year statewide collections, etc.*
  - *where the USGS agrees that it is reasonable and in the best interest of all stakeholders to use an alternate specification.*
9. Relative accuracy  $\leq$  7cm RMSE<sub>z</sub> within individual swaths;  $\leq$  10cm RMSE<sub>z</sub> within swath overlap (between adjacent swaths).
10. Flightline overlap 10% or greater, as required to ensure there are no data gaps between the usable portions of the swaths. Collections in high relief terrain are expected to require greater overlap. Any data with gaps between the geometrically usable portions of the swaths will be rejected.
11. Collection Area: Defined Project Area, buffered by a minimum of 100 meters.
12. Collection Conditions:
- Atmospheric: Cloud and fog-free between the aircraft and ground
  - Ground:
    - Snow free. Very light, undrifted snow may be acceptable in special cases, with prior approval.

- No unusual flooding or inundation, except in cases where the goal of the collection is to map the inundation.
- Vegetation: Leaf-off is preferred, however:
  - As numerous factors will affect vegetative condition at the time of any collection, the USGS NGP only requires that penetration to the ground must be adequate to produce an accurate and reliable bare-earth surface suitable for incorporation into the 1/9 (3-meter) NED.
  - Collections for specific scientific research projects may be exempted from this requirement, with prior approval.

## II. DATA PROCESSING and HANDLING

1. All processing should be carried out with the understanding that all point deliverables are required to be in fully compliant LAS format, v1.2 or v1.3. Data producers are encouraged to review the LAS specification in detail.
2. If full waveform data is collected, delivery of the waveform packets is required. LAS v1.3 deliverables with waveform data are to use external “auxiliary” files with the extension “.wdp” for the storage of waveform packet data. See the LAS v1.3 Specification for additional information.
3. GPS times are to be recorded as Adjusted GPS Time, at a precision sufficient to allow unique timestamps for each pulse. Adjusted GPS Time is defined to be Standard (or satellite) GPS time minus  $1 \times 10^9$ . See the LAS Specification for more detail.
4. Horizontal datum shall be referenced to the North American Datum of 1983/HARN adjustment. Vertical datum shall be referenced to the North American Vertical Datum of 1988 (NAVD 88). The most recent NGS-approved Geoid model shall be used to perform conversions from ellipsoidal heights to orthometric heights.
5. The USGS preferred Coordinate Reference System for the Conterminous United States (CONUS) is: UTM, NAD83, Meters. Each discrete project is to be processed using the predominant UTM zone for the overall collection area.

State Plane Coordinate Reference Systems that have been accepted by the European Petroleum Survey Group (EPSG) and that are recognized by ESRI GIS software may be used by prior agreement with the USGS.

Alternative projected coordinate systems for collections in Alaska, Hawaii, and other areas Outside the Conterminous United States (OCONUS) must be approved by the USGS prior to collection.

6. All references to the Unit of Measure “Feet” or “Foot” must specify either “International” or “U.S. Survey”
7. Long swaths (those which result in a LAS file larger than 2GB) should be split into segments no greater than 2GB each. Each segment will thenceforth be

- regarded as a unique swath and shall be assigned a unique File Source ID. Other swath segmentation approaches may be acceptable, with prior approval. Renaming schemes for split swaths are at the discretion of the data producer. The Processing Report shall include detailed information on swath segmentation sufficient to allow reconstruction of the original swaths if needed.
8. Each swath shall be assigned a unique File Source ID. The Point Source ID field for each point within each LAS swath file shall be set equal to the File Source ID prior to any processing of the data. See the LAS Specification.
  9. Point Families (multiple return “children” of a single “parent” pulse) shall be maintained intact through all processing prior to tiling. Multiple returns from a given pulse shall be stored in sequential (collected) order.
  10. All collected swaths are to be delivered as part of the “Raw Data Deliverable”. This includes calibration swaths and cross-ties. All collected points are to be delivered. No points are to be deleted from the swath LAS files. This in no way requires or implies that calibration swath data are to be included in product generation. Excepted from this are extraneous data outside of the buffered project area (aircraft turns, transit between the collection area and airport, transit between fill-in areas, etc.). These points may be permanently removed.
  11. Outliers, blunders, noise points, geometrically unreliable points near the extreme edge of the swath, and other points deemed unusable are to be identified using the “Withheld” flag, as defined in the LAS specification.
    - This applies primarily to points which are identified during pre-processing or through automated post-processing routines.
    - If processing software is not capable of populating the “Withheld” bit, these points may be identified using Class=11.
    - “Noise points” subsequently identified during manual Classification and Quality Assurance/Quality Control (QA/QC) may be assigned the standard LAS classification value for “Noise” (Class=7), regardless of whether the noise is “low” or “high” relative to the ground surface.
  12. The ASPRS/LAS “Overlap” classification (Class=12) shall not be used. ALL points not identified as “Withheld” are to be classified.
    - If overlap points are required to be differentiated by the data producer or cooperating partner, they must be identified using a method that does not interfere with their classification, such as:
      - Overlap points are tagged using Bit:0 of the User Data byte, as defined in the LAS specification. (SET=Overlap).
      - Overlap points are classified using the Standard Class values + 16.
      - Other techniques as agreed upon in advance
    - The technique utilized must be clearly described in the project metadata files.



*Note: A standard bit setting for identification of overlap points has been planned for a future version of LAS.*

13. Positional Accuracy Validation: The absolute and relative accuracy of the data, both horizontal and vertical, and relative to known control, shall be verified prior to classification and subsequent product development. This validation is obviously limited to the Fundamental Vertical Accuracy, measured in clear, open areas. A detailed report of this validation is a required deliverable.

14. Classification Accuracy: It is expected that due diligence in the classification process will produce data that meets the following test:

Within any 1km x 1km area, no more than 2% of non-withheld points will possess a demonstrably erroneous classification value.

This includes points in Classes 0 and 1 that should correctly be included in a different Class as required by the contract.

*Note: This requirement may be relaxed to accommodate collections in areas where the USGS agrees classification to be particularly difficult.*

15. Classification Consistency: Point classification is to be consistent across the entire project. Noticeable variations in the character, texture, or quality of the classification between tiles, swaths, lifts, or other non-natural divisions will be cause for rejection of the entire deliverable.

16. Tiles:

*Note: This section assumes a projected coordinate reference system.*

- A single non-overlapped tiling scheme will be established and agreed upon by the data producer and the USGS prior to collection. This scheme will be used for **all** tiled deliverables.
- Tile size must be an integer multiple of the cell size of raster deliverables.
- Tiles must be sized using the same units as the coordinate system of the data.
- Tiled deliverables shall conform to the tiling scheme, without added overlap.
- Tiled deliverables shall edge-match seamlessly and without gaps in both the horizontal and vertical.

### III. HYDRO-FLATTENING REQUIREMENTS

*Note: Please refer to Appendix 2 for reference information on hydro-flattening.*

Hydro-flattening pertains only to the creation of derived DEMs. No manipulation of or changes to originally computed lidar point elevations are to be made. Breaklines may be used to help classify the point data.

#### 1. Inland Ponds and Lakes:

- ~2-acre or greater surface area (~350' diameter for a round pond) at the time of collection.
- Flat and level water bodies (single elevation for every bank vertex defining a given water body).
- The entire water surface edge must be at or below the immediately surrounding terrain.
- Long impoundments such as reservoirs, inlets, and fjords, whose water surface elevations drop when moving downstream, should be treated as rivers.

#### 2. Inland Streams and Rivers:

- 100' **nominal** width: This should not unnecessarily break a stream or river into multiple segments. At times it may squeeze slightly below 100' for short segments. Data producers should use their best professional judgment.
- Flat and level bank-to-bank (perpendicular to the apparent flow centerline); gradient to follow the immediately surrounding terrain.
- The entire water surface edge must be at or below the immediately surrounding terrain.
- Streams channels should break at road crossings (culvert locations). These road fills should not be removed from DEM. However, streams and rivers should **not** break at elevated bridges. Bridges should be removed from DEM. When the identification of a feature as a bridge or culvert cannot be made reliably, the feature should be regarded as a culvert.

#### 3. Non-Tidal Boundary Waters:

- Represented only as an edge or edges within the project area; collection does not include the opposing shore.
- The entire water surface edge must be at or below the immediately surrounding terrain.
- The elevation along the edge or edges should behave consistently throughout the project. May be a single elevation (i.e., lake) or gradient (i.e., river), as appropriate.

#### 4. Tidal Waters:

- Water bodies such as oceans, seas, gulfs, bays, inlets, salt marshes, very large lakes, etc. Includes any water body that is affected by tidal variations.
- Tidal variations over the course of a collection or between different collections, will result in discontinuities along shorelines. This is considered normal and these “anomalies” should be retained. The final DEM should represent as much ground as the collected data permits.
- Variations in water surface elevation resulting in tidal variations during a collection should NOT be removed or adjusted, as this would require either the removal of valid, measured ground points or the introduction of unmeasured ground into the DEM. The USGS NGP priority is on the ground surface, and accepts there may be occasional, unavoidable irregularities in water surface.
- Scientific research projects in coastal areas often have very specific requirements with regard to how tidal land-water boundaries are to be handled. For such projects, the requirements of the research will take precedence.

Cooperating partners may require collection and integration of single-line streams within their lidar projects. While the USGS does not require these breaklines be collected or integrated, it does require that if used and incorporated into the DEMs, the following guidelines are met:

1. All vertices along single-line stream breaklines are at or below the immediately surrounding terrain.
2. Single-line stream breaklines are not to be used to introduce cuts into the DEM at road crossings (culverts), dams, or other such features. This is hydro-enforcement and as discussed in Section VI, creates a non-traditional DEM that is not suitable for integration into the NED.
3. All breaklines used to modify the surface are to be delivered to the USGS with the DEMs.

The USGS does not require any particular process or methodology be used for breakline collection, extraction, or integration. However, the following general guidelines must be adhered to:

1. Bare-earth lidar points that are in close proximity breaklines should be excluded from the DEM generation process. This is analogous to the removal of masspoints for the same reason in a traditional photogrammetrically compiled DTM.

The proximity threshold for reclassification as “Ignored Ground” is at the discretion of the data producer, but in general should be approximately equal to the NPS.

2. These points are to be retained in the delivered lidar point dataset and shall be reclassified as “Ignored Ground” (class value = 10) so that they may be subsequently identified.
3. Delivered data must be sufficient for the USGS to effectively recreate the delivered DEMs using the lidar points and breaklines without significant further editing.

#### IV. DELIVERABLES

The USGS shall have unrestricted rights to all delivered data and reports, which will be placed in the public domain. This specification places no restrictions on the data provider's rights to resell data or derivative products as they see fit.

##### 1. Metadata

*Note: “Metadata” refers to all descriptive information about the project. This includes textual reports, graphics, supporting shapefiles, and FGDC-compliant metadata files.*

- Collection Report detailing mission planning and flight logs.
- Survey Report detailing the collection of control and reference points used for calibration and QA/QC.
- Processing Report detailing calibration, classification, and product generation procedures including methodology used for breakline collection and hydro-flattening (*see Sections III and Appendix 1 for more information on hydro-flattening*).
- QA/QC Reports (detailing the analysis, accuracy assessment and validation of:
  - The point data (absolute, within swath, and between swath)
  - The bare-earth surface (absolute)
  - Other optional deliverables as appropriate
- Control and Calibration points: All control and reference points used to calibrate, control, process, and validate the lidar point data or any derivative products are to be delivered.
- Geo-referenced, digital spatial representation of the precise extents of each delivered dataset. This should reflect the extents of the actual lidar source or derived product data, exclusive of Triangular Irregular Network (TIN) artifacts or raster NODATA areas. A union of tile boundaries or minimum bounding rectangle is not acceptable. ESRI Polygon shapefile or geodatabase is preferred.
- Product metadata (FGDC compliant, XML format metadata). One file for each:

- Project
  - Lift
  - Tiled deliverable product group (classified point data, bare-earth DEMs, breaklines, etc.). Metadata files for individual tiles are not required.
- FGDC compliant metadata must pass the USGS metadata parser (“mp”) with no errors or warnings.

## 2. Raw Point Cloud

- All returns, all collected points, fully calibrated and adjusted to ground, by swath.
- Fully compliant LAS v1.2 or v1.3, Point Record Format 1, 3, 4, or 5
- LAS v1.3 deliverables with waveform data are to use external “auxiliary” files with the extension “.wdp” for the storage of waveform packet data. See the LAS v1.3 Specification for additional information.
- Georeference information included in all LAS file headers
- GPS times are to be recorded as Adjusted GPS Time, at a precision sufficient to allow unique timestamps for each pulse.
- Intensity values (native radiometric resolution)
- 1 file per swath, 1 swath per file, file size not to exceed 2GB, as described in Section II, Paragraph 7.

## 3. Classified Point Cloud

*Note: Delivery of a classified point cloud is a standard requirement for USGS NGP lidar projects. Specific scientific research projects may be exempted from this requirement.*

- Fully compliant LAS v1.2 or v1.3, Point Record Format 1, 3, 4, or 5
- LAS v1.3 deliverables with waveform data are to use external “auxiliary” files with the extension “.wdp” for the storage of waveform packet data. See the LAS v1.3 Specification for additional information.
- Georeference information included in LAS header
- GPS times are to be recorded as Adjusted GPS Time, at a precision sufficient to allow unique timestamps for each pulse.
- Intensity values (native radiometric resolution)
- Tiled delivery, without overlap (tiling scheme TBD)

- Classification Scheme (minimum):

Code	Description
1	Processed, but unclassified
2	Bare-earth ground
7	Noise (low or high, manually identified, if needed)
9	Water
10	Ignored Ground (Breakline Proximity)
11	Withheld (if the “Withheld” bit is not implemented in processing software)

*Note: Class 7, Noise, is included as an adjunct to the “Withheld” bit. All “noise points” are to be identified using one of these two methods.*

*Note: Class 10, Ignored Ground, is for points previously classified as bare-earth but whose proximity to a subsequently added breakline requires that it be excluded during Digital Elevation Model (DEM) generation.*

#### 4. Bare Earth Surface (Raster DEM)

*Note: Delivery of a bare-earth DEM is a standard requirement for USGS NGP lidar projects. Specific scientific research projects may be exempted from this requirement.*

- Cell Size no greater than 3 meters or 10 feet, and no less than the design Nominal Pulse Spacing (NPS).
- Delivery in an industry-standard, GIS-compatible, 32-bit floating point raster format (ERDAS .IMG preferred)
- Georeference information shall be included in each raster file
- Tiled delivery, without overlap
- DEM tiles will show no edge artifacts or mismatch. A quilted appearance in the overall project DEM surface, whether caused by differences in processing quality or character between tiles, swaths, lifts, or other non-natural divisions, will be cause for rejection of the entire DEM deliverable.
- Void areas (i.e., areas outside the project boundary but within the tiling scheme) shall be coded using a unique “NODATA” value. This value shall be identified in the appropriate location within the file header.
- Vertical Accuracy of the bare earth surface will be assessed and reported in accordance with the guidelines developed by the NDEP and subsequently adopted by the ASPRS. The complete guidelines may be found in Section 1.5 of the Guidelines document. See:

[http://www.ndep.gov/NDEP\\_Elevation\\_Guidelines\\_Ver1\\_10May2004.pdf](http://www.ndep.gov/NDEP_Elevation_Guidelines_Ver1_10May2004.pdf)



Vertical accuracy requirements using the NDEP/ASPRS methodology are:

FVA  $\leq$  24.5cm ACCz, 95% (12.5cm RMSEz)

CVA  $\leq$  36.3cm, 95th Percentile

SVA  $\leq$  36.3cm, 95th Percentile

All QA/QC analysis materials and results are to be delivered to the USGS.

- Depressions (sinks), natural or man-made, are **not** to be filled (as in hydro-conditioning and hydro-enforcement).
- Water Bodies (ponds and lakes), wide streams and rivers (“double-line”), and other non-tidal water bodies as defined in Section III are to be hydro-flattened within the DEM. Hydro-flattening shall be applied to all water impoundments, natural or man-made, that are larger than ~2 acre in area (equivalent to a round pond ~350’ in diameter), to all streams that are nominally wider than 100’, and to all non-tidal boundary waters bordering the project area regardless of size. The methodology used for hydro-flattening is at the discretion of the data producer.

*Note: Please refer to the Sections III and VI for detailed discussions of hydro-flattening.*

## 5. Breaklines

*Note: Delivery of the breaklines used in hydro-flattening is a standard requirement for USGS NGP lidar projects. Specific scientific research projects may be exempted from this requirement. If hydro-flattening is achieved through other means, this section may not apply.*

- All breaklines developed for use in hydro-flattening shall be delivered as an ESRI feature class (PolylineZ or PolygonZ format, as appropriate to the type of feature represented and the methodology used by the data producer). Shapefile or geodatabase is preferred.
- Each feature class or shapefile will include properly formatted and accurate georeference information in the standard location. All shapefiles must include the companion .prj file.
- Breaklines must use the same coordinate reference system (horizontal and vertical) and units as the lidar point delivery.
- Breakline delivery may be as a continuous layer or in tiles, at the discretion of the data producer. Tiled deliveries must edge-match seamlessly in both the horizontal and vertical.

## APPENDIX 1

### COMMON DATA UPGRADES

1. Independent 3<sup>rd</sup>-Party QA/QC by another AE Contractor (encouraged)
2. Higher Nominal Pulse Spacing (point density)
3. Increased Vertical Accuracy
4. Full Waveform collection and delivery
5. Additional Environmental Constraints
  - Tidal coordination, flood stages, crop/plant growth cycles, etc.
  - Shorelines corrected for tidal variations within a collection
6. Top-of Canopy (First-Return) Raster Surface (tiled). Raster representing the highest return within each cell is preferred.
7. Intensity Images (8-bit gray scale, tiled)
8. Detailed Classification (additional classes):

Code	Description
3	Low vegetation
4	Medium vegetation (use for single vegetation class)
5	High vegetation
6	Buildings, bridges, other man-made structures
n	additional Class(es) as agreed upon in advance

9. Hydro-Enforced and/or Hydro-Conditioned DEMs
10. Breaklines (PolylineZ and PolygonZ) for single-line hydrographic features (narrow streams not collected as double-line, culverts, etc.), including appropriate integration into delivered DEMs
11. Breaklines (PolylineZ and PolygonZ) for other features (TBD), including appropriate integration into delivered DEMs
12. Extracted Buildings (PolygonZ): Footprints with maximum elevation and/or height above ground as an attribute.
13. Other products as defined by requirements and agreed upon in advance of funding commitment.

## APPENDIX 2

### HYDRO-FLATTENING REFERENCE

The subject of modifications to lidar-based DEMs is somewhat new, and although authoritative references are available, there remains significant variation in the understanding of the topic across the industry. The following material was developed to provide a definitive reference on the subject only as it relates to the creation of DEMs intended to be integrated into the USGS NED. The information presented here is not meant to supplant other reference materials and it should not be considered authoritative beyond its intended scope.

The term “**hydro-flattening**” is also new, coined for this document and to convey our specific needs. It is not, at this time, a known or accepted term across the industry. It is our hope that its use and acceptance will expand beyond the USGS with the assistance of other industry leaders.

Hydro-flattening of DEMs is predominantly accomplished through the use of breaklines, and this method is considered standard. Although other techniques may exist to achieve similar results, this section assumes the use of breaklines. The USGS does not require the use of any specific technique.

The Digital Elevation Model Technologies and Applications: The DEM Users Manual, 2<sup>nd</sup> Edition (Maune *et al.*, 2007) provides the following definitions related to the adjustment of DEM surfaces for hydrologic analyses:

1. **Hydrologically-Conditioned (Hydro-Conditioned)** – Processing of a DEM or TIN so that the flow of water is continuous across the entire terrain surface, including the removal of all spurious sinks or pits. The only sinks that are retained are the real ones on the landscape. Whereas “hydrologically-enforced” is relevant to drainage features that are generally mapped, “hydrologically-conditioned” is relevant to the entire land surface and is done so that water flow is continuous across the surface, whether that flow is in a stream channel or not. The purpose for continuous flow is so that relationships/links among basins/catchments can be known for large areas. This term is specifically used when describing EDNA (see Chapter 4), the dataset of NED derivatives made specifically for hydrologic modeling purposes.
2. **Hydrologically-Enforced (Hydro-Enforced)** – Processing of mapped water bodies so that lakes and reservoirs are level and so that streams flow downhill. For example, a DEM, TIN or topographic contour dataset with elevations removed from the tops of selected drainage structures (bridges and culverts) so as to depict the terrain under those structures. Hydro-enforcement enables hydrologic and hydraulic models to depict water flowing under these structures, rather than appearing in the computer model to be dammed by them because of road deck elevations higher than the water levels. Hydro-enforced TINs also utilize breaklines along shorelines and stream centerlines, for example, where these breaklines form the edges of TIN triangles along the alignment of drainage features. Shore breaklines for streams would be 3-D breaklines

with elevations that decrease as the stream flows downstream; however, shore breaklines for lakes or reservoirs would have the same elevation for the entire shoreline if the water surface is known or assumed to be level throughout. See figures 1.21 through 1.24. See also the definition for “hydrologically-conditioned” which has a slightly different meaning.

While these are important and useful modifications, they both result in surfaces that differ significantly from a traditional DEM. A “hydro-conditioned” surface has had its sinks filled and may have had its water bodies flattened. This is necessary for correct flow modeling within and across large drainage basins. “Hydro-enforcement” extends this conditioning by requiring water bodies be leveled and streams flattened with the appropriate downhill gradient, and also by cutting through road crossings over streams (culvert locations) to allow a continuous flow path for water within the drainage. Both treatments result in a surface on which water behaves as it physically does in the real world, and both are invaluable for specific types of hydraulic and hydrologic (H&H) modeling activities. Neither of these treatments is typical of a traditional DEM surface.

A traditional DEM such as the NED, on the other hand, attempts to represent the ground surface more the way a bird, or person in an airplane, sees it. On this surface, natural depressions exist, and road fills create apparent sinks because the road fill and surface is depicted without regard to the culvert beneath. Bridges, it should be noted, are removed in most all types of DEMs because they are man-made, above-ground structures that have been added to the landscape.

*Note: DEMs developed solely for orthophoto production may include bridges, as their presence can prevent the “smearing” of structures and reduce the amount of post-production correction of the final orthophoto. These are “special use DEMs” and are not relevant to this discussion.*

For years, raster Digital Elevation Models (DEMs), have been created from a Digital Surface Model (DSM) of masspoints and breaklines, which in turn were created through photogrammetric compilation from stereo imagery. Photogrammetric DSMs inherently contain breaklines defining the edges of water bodies, coastlines, single-line streams, and double-line streams and rivers, as well as numerous other surface features.

Lidar technology, however, does not inherently collect the breaklines necessary to produce traditional DEMs. Breaklines have to be developed separately through a variety of techniques, and either used with the lidar points in the generation of the DEM, or applied as a correction to DEMs generated without breaklines.

In order to maintain the consistent character of the NED as a traditional DEM, the USGS NGP requires that all DEMs delivered have their inland water bodies flattened. This does not imply that a complete network of topologically correct hydrologic breaklines be developed for every dataset; only those breaklines necessary to ensure that the conditions defined in Section III exist in the final DEM.

**APPENDIX 3**  
**SAMPLE METADATA TEMPLATE**

[to be added]

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## APPENDIX 4

### REFERENCES

Maune, D.F., 2007. Definitions, in *Digital Elevation Model Technologies and Applications: The DEM Users Manual, 2<sup>nd</sup> Edition* (D.F. Maune, editor), American Society for Photogrammetry and Remote Sensing, Bethesda, MD pp. 550-551

National Digital Elevation Program, 2004. *Guidelines for Digital Elevation Data—Version 1*, 93 p., available online at:  
[http://www.ndep.gov/NDEP\\_Elevation\\_Guidelines\\_Ver1\\_10May2004.pdf](http://www.ndep.gov/NDEP_Elevation_Guidelines_Ver1_10May2004.pdf)  
(last date accessed: 29 September 2009)

FEMA, 2003. *Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A: Guidance for Aerial Mapping and Surveying*, 59 p., available online at: <http://www.fema.gov/library/viewRecord.do?id=2206>  
(last date accessed 29 September 2009)

USGS NED Website: [www.ned.usgs.gov](http://www.ned.usgs.gov)

USGS CLICK Website: [www.lidar.cr.usgs.gov](http://www.lidar.cr.usgs.gov)

MP-Metadata Parser: <http://geology.usgs.gov/tools/metadata>