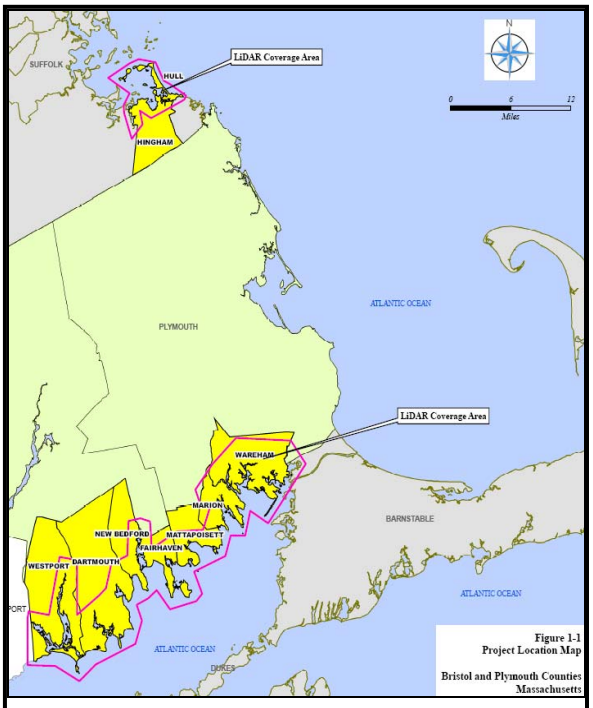
CDM

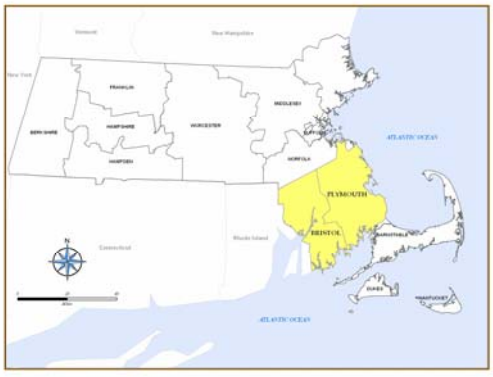


LiDAR Coverage Areas
Plymouth and Bristol Counties

Flood Mapping Activities for Plymouth and Bristol Counties, Massachusetts

Task Order 18
Activity 1--Topographic Data Development / Acquisition
Summary Report

Contract No. EME-2003-CO-0340
Task Order T018



Prepared for:

FEMA Region I

February 2008

Contents

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Section 1
Introduction

This report was prepared as the deliverable for Topographic Data Development / Acquisition for portions of the coastal areas in Bristol and Plymouth Counties Massachusetts under Federal Emergency Management Agency (FEMA) Contract No. EME-2003-CO-0340, Task Order TO018. This section of the report explains the objective of the task and the purpose of the report.

1.1 Background

FEMA is embarking on a map modernization program nationwide to:

- Develop up-to-date data for all flood prone areas in support of floodplain management
- Provide maps and data in digital format to improve the efficiency and precision of the mapping program
- Integrate FEMA's community and state partners into the mapping process

In Region I, FEMA selected CDM as an IDIQ contractor to help the region accomplish its map modernization goals. One of the region's priorities is to develop updated Digital Flood Insurance Rate Maps (DFIRMs) and Flood Insurance Studies (FISs) for Bristol and Plymouth Counties, Massachusetts. FEMA's Task Order 18 for CDM is for development of topographic data to support subsequent flood mapping tasks. The information provided in this report describes the methods used to acquire the topographic data and to verify that the data meets FEMA standards. The topographic data will ultimately be used in the production of new DFIRMs and FISs in Bristol and Plymouth Counties, Massachusetts.

1.2 Scope of Work

The following is the scope of work for Activity 1 – Topographic Data Development/Acquisition.

Activity 1 – Topographic Data Development/Acquisition

CDM will obtain additional topographic data for coastal area flooding sources studied to delineate floodplain boundaries and to supplement the field surveys conducted under Activity 2 – Task 1 - Field Surveys and Reconnaissance. Specifically, CDM will conduct a LiDAR mission to generate new topographic data for the areas subject to coastal flooding in the communities of **Westport, Dartmouth, New Bedford and Fairhaven in Bristol County and Mattapoisett, Marion, Wareham, Hull and Hingham in Plymouth County.** The LiDAR coverage areas are shown on Figure 1-1 Project Location Map.

The LiDAR mission will accomplish the following:

- The contour interval and/or accuracy for the topographic data will be 2 feet based on the current FEMA requirements, as documented in *Guidelines and Specifications for Flood Hazard Mapping Partners*.
- Breaklines will be created using existing aerial photography from MassGIS or from LiDAR intensity images.
- CDM will acquire LiDAR intensity images for the production of 2D breaklines, if needed.
- CDM will produce a bare earth Digital Elevation Model, a TIN and mass points to delineate floodplain boundaries in revised coastal areas and for use in hydrologic and hydraulic modeling using the data collected under this and other activities.
- CDM will acquire ground survey for the number of check points listed in the table below to check the accuracy of the LIDAR data.

Location (See Figure 1)	**Proposed LiDAR Coverage (Square Miles)**	**Number of Survey Points to Check LiDAR**
Hull and Hingham	25	20
Westport, Dartmouth, New Bedford, Fairhaven, Mattapoisett, Marion and Wareham	200	20
Total:	**225**	**40**

Deliverables: Upon completion of topographic data collection and processing, CDM will submit this data to FEMA or their designate for a QA/QC review. In accordance with the TSDN format described in Appendix M of *Guidelines and Specifications for Flood Hazard Mapping Partners*, CDM will make the following products available to FEMA:

- Hardcopy or pfd files of topographic maps
- Report summarizing methodology and results
- A Summary Report that describes and provides the results of all automated or manual QA/QC review steps taken during the preparation of the data. In addition, the Study Contractor shall be prepared to address all concerns or questions regarding this activity that are raised as a result of an independent QA/QC review.

At the appropriate time, FEMA may elect to forgo the Independent Quality Assurance of this activity, which would leave the Study Contractor solely responsible for ensuring the accuracy of its work under this Activity.

- Mass points and 2D breakline data on CD-ROM
- Digital work maps with contours
- Checkpoint analyses to assess the accuracy of data, including Root Mean Square Error calculations to support vertical accuracy
- Identification of remote-sensing data voids and methods used to supplement data voids
- National Geodetic Survey (NGS) data sheets for Network Control Points used to control remote-sensing and ground surveys
- Metadata compliant with FEMA Metadata Profiles
- Data Delivery consistent with the Data Capture Standards—Appendix N of the *Guidelines and Specifications for Flood Hazard Mapping Partners* and associated procedural memoranda

Appendix M may be downloaded from the FEMA Flood Hazard Mapping Web site at http://www.fema.gov/pdf/fhm/frm_gsam.pdf.

This report responds to these deliverable requirements. It provides a summary of data collection efforts conducted for this task, as well as information on quality control.

Figure 1-1, Project Location Map, shows the coastal areas of Bristol and Plymouth Counties included in the LiDAR data acquisition.

Additional detail is included in LiDAR Campaign Final Report for Plymouth & Bristol Counties, Massachusetts, dated November 2006, prepared by Sanborn Mapping Company, and included in Appendix A of this report.

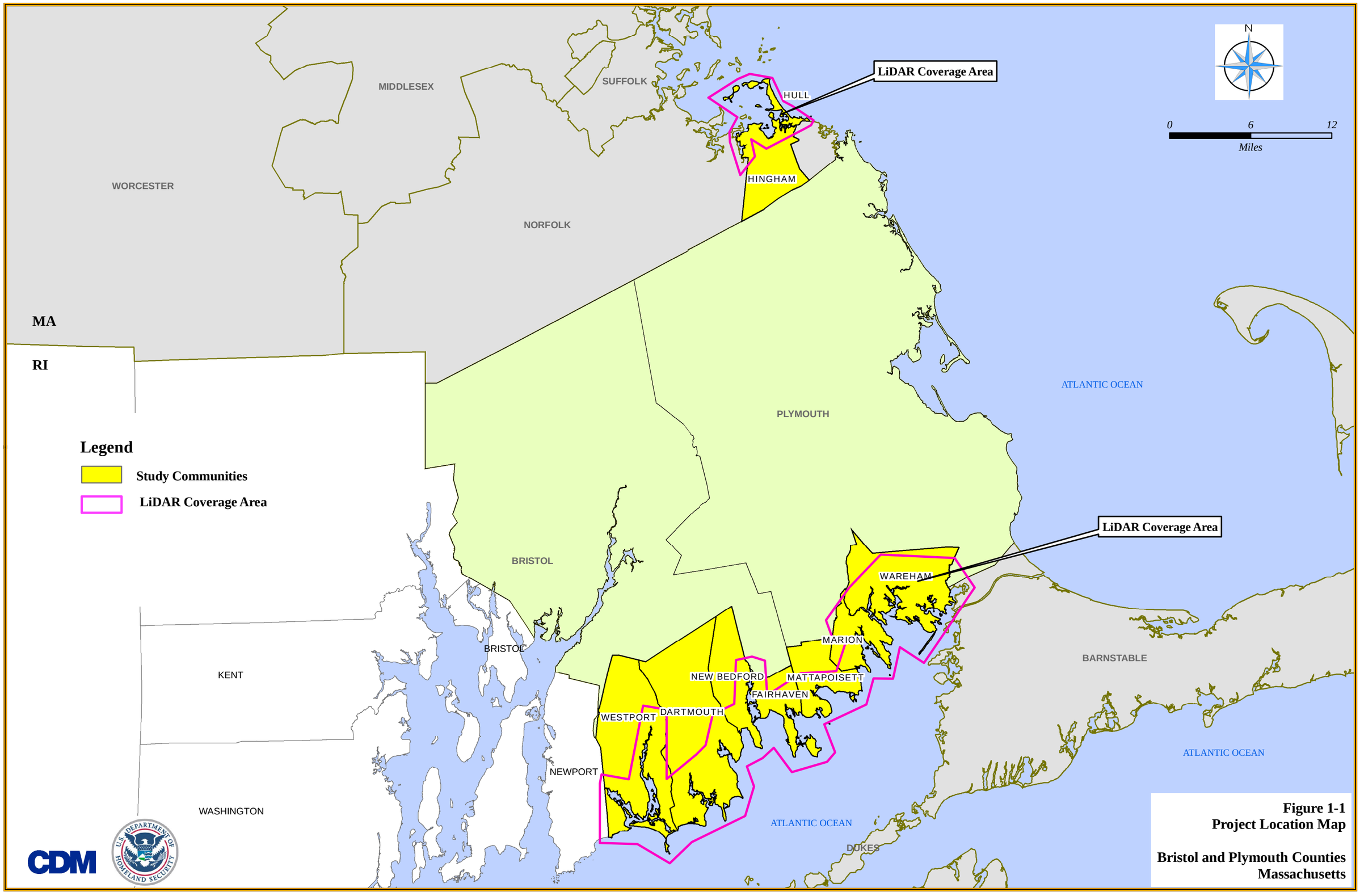

Figure 1-1
Project Location Map

Bristol and Plymouth Counties
Massachusetts

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Section 2
LIDAR Data Acquisition and Processing

The LIDAR Data Acquisition and Processing was completed by Sanborn under subcontract to CDM. This section summarizes the objectives, accuracy, specifications and tasks completed to acquire and process the LIDAR data.

A detailed LiDAR Campaign Final Report for Plymouth and Bristol Counties, dated November 2006 and prepared by Sanborn Mapping Company, is included in Appendix A of this report. The report documents the tools and techniques applied by Sanborn to acquire, process, check and deliver the LIDAR data.

2.1 Objectives

The project objectives are to produce digital topographic data needed for coastal flood mapping; including production and delivery of digital terrain models within the project area (see Figure 1-1, Project Location Map). The data is provided in four formats:

(1) Triangulated irregular networks (TIN) in the ESRI Coverage format

(2) Masspoints and Breaklines as x, y and z-attributed points in ASCII format

(3) Contour lines at 2-foot intervals in the ESRI Coverage format

(4) Digital elevation model (DEM) as x, y and z-attributed points in ASCII format

The data formats were developed using automated procedures with manual intervention as necessary (such as breakline coding and point cloud cleansing) to achieve accuracy requirements.

2.2 Accuracy

Vertical accuracy of all data sets in all four formats is 1.2-feet absolute at the 95 percent confidence interval, as defined by the Federal NSSDA (National Spatial Standard for Accuracy).

2.3 Specifications

All work products, performance specifications and compliance standards are in accordance with Subcontractor's Proposal for LIDAR Mapping Services for Riverine and Coastal Flood Insurance Studies in FEMA Region I dated April 5, 2004 and the Federal Emergency Management Agency's (FEMA) Guidelines and Specifications for Flood Hazard Mapping Partners (http://www.fema.gov/fhm/dl_cgs.shtm). Special attention shall be paid to Sections 1.4, A.2, A.3, A.8, Appendix I and Appendix M of said guidelines.

2.4 Work Plan

The goal of the work plan is to generate new topographic data using Light detection and ranging (LiDAR) technology as defined in Volume 1 of the Guidelines and described in Appendix A.8. Activities included in this work are:

(1) Flight mission planning

(2) Create stereo LiDAR Intensity Models

(3) LiDAR data acquisition (point clouds at required density to support vertical accuracy requirements)

(4) LiDAR data inspection and cleansing

(5) Breakline development and coding using the 3D Intensity Models

(6) Data set production and quality control

(7) Data set delivery

In accordance with the TSDN format described in Appendix M of the Guidelines, the Subcontractor provided CDM the following products in addition to the digital data products listed above:

- Contour maps
- Report summarizing methodology and results

All data sets were submitted to CDM for independent QA/QC review, inspection and acceptance.

2.5 Quality Control Requirements

All relevant documentation as a result of the activities conducted for this scope of work was maintained and an internal QC review of all deliverable products was conducted prior to submittal to CDM.

2.6 Schedule

The LIDAR flights were completed during November 2006. Processing of the LIDAR data was completed in April 2007.

Section 3
LIDAR Data Quality Review

Following LIDAR acquisition and processing, the resulting work products (DEM, TIN, Breaklines, Contour and Masspoints) were reviewed and independently checked for accuracy and for systematic error. This was accomplished by using field survey elevation data obtained at 48 locations within the project area and comparing the measured elevations to the LIDAR topography.

Note that Sanborn also performed a ground-based check point survey as described in Appendix A. The LiDAR data was evaluated by Sanborn using a collection of 21 GPS surveyed check points for bare earth, low grass, and urban vegetation class areas. Sanborn reports that the LiDAR data was compared to each of these classes and yielded a much better result than was required for the project.

3.1 Field Survey

CDM identified the general location for the 48 checkpoint locations. Twenty of the locations were obtained from checkpoint surveys and the remaining 28 points were obtained as part of the transect surveys. The locations of these points are indicated on Figure 3-1, Location of Field Surveyed Checkpoints. Green International Affiliates, Inc. (GIA), a CDM subcontractor, performed the cross-section field surveys. GIA employed an RTK GPS system on this project.

Figure 3-1, Location of Field Surveyed Checkpoints, shows the locations of the checkpoints. The RTK GPS data collected in the field consists of both points and transects at selected coastal locations. Table 3-1, LIDAR Data Check Analysis, presents the field survey analysis data.

3.2 Comparison of Field Survey to LIDAR

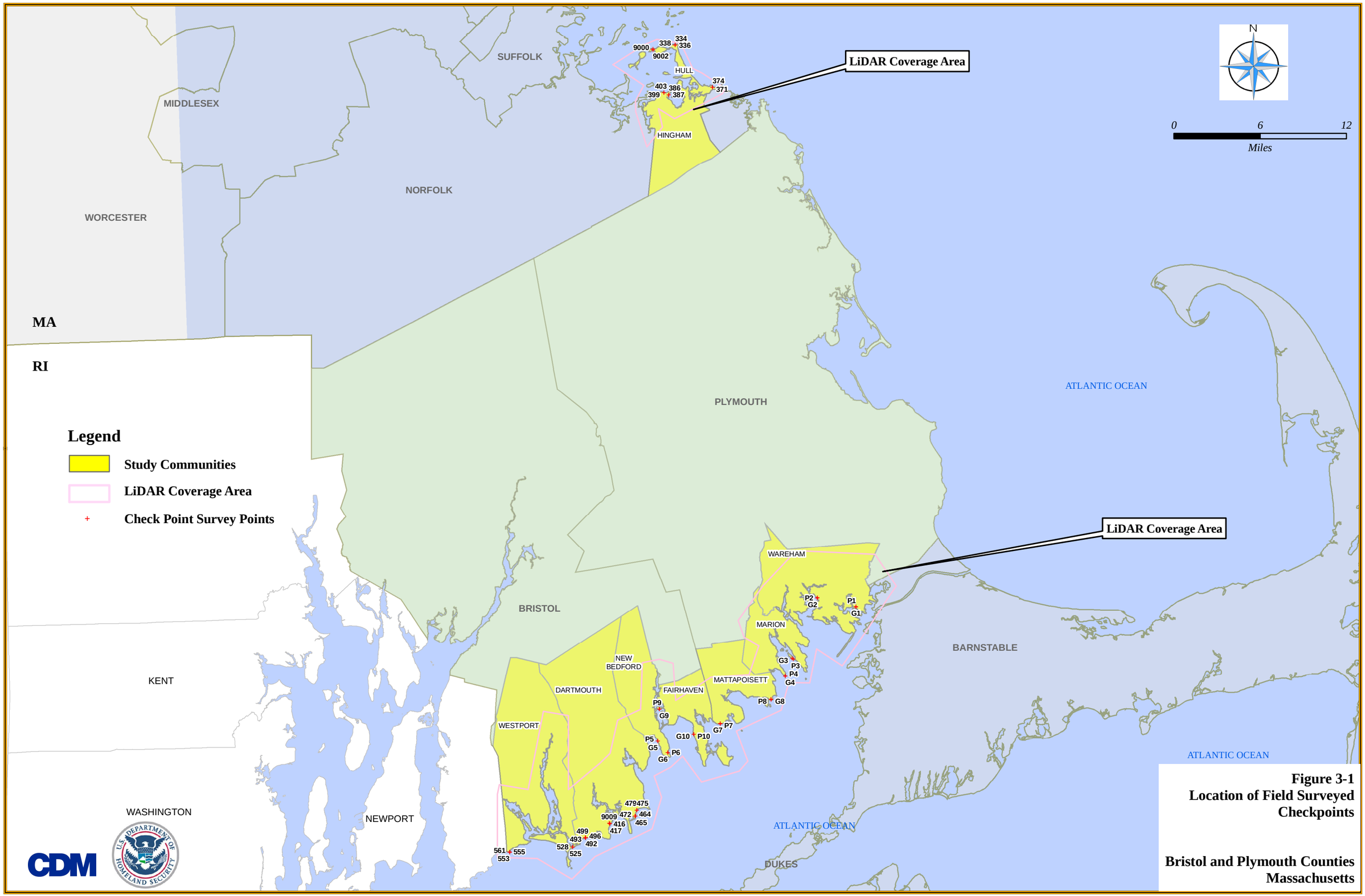
Table 3-1 LiDAR Data Check Analysis compares the 48 surveyed points to the LIDAR elevations. LIDAR elevation values were derived from the TIN data using GIS tools. For each check point location (e.g. G1 and P1) and transect point location (e.g. 334 and 472), the table presents the community name, description, location (MA state-plane coordinates, NAD 83 feet), surveyed elevation (NAVD 88 feet), elevation derived from the LiDAR TIN data and the difference between surveyed and LiDAR elevations.

The LIDAR and Survey data are in good agreement with all 48 points within the 1.2 foot elevation accuracy specification. The data quality review did not indicate any systematic errors in the LIDAR topography. The results are summarized below:

- The RMS average difference in elevation for 48 Surveyed Points as compared to the LiDAR TIN data is 0.52 feet.

Based on this analysis, this LiDAR data is acceptable for use in H&H analyses and flood zone mapping.

This independent LiDAR Check Point analysis supports Sanborn's evaluation (included in Appendix A): "The LiDAR data was compared to each of these classes yielding much better result than was required for the project." Sanborn reported RMS differences were 0.41 feet for Plymouth County checkpoints and 0.48 feet for Bristol County checkpoints.



\\cdmlcy2xqc1\H\projects\FEMA\TO18\MXDs\LiDAR_survey_diff.mxd AD Date Printed: 02/06/08

Figure 3-1
Location of Field Surveyed Checkpoints

Bristol and Plymouth Counties
Massachusetts

Table 3-1 LiDAR Data Check Analysis

2-Dec-07
Task Order 18 Plymouth and Bristol Counties, MA---LiDAR Data Check Analysis
Compare Field Survey Points to LiDAR Elevation Data for Selected Coastal Areas
Analysis by R. Miner
Field Survey Data by Green International Reports dated June 7, July 16 and July 31, 2007
LiDAR Data by Sanborn Mapping Company, Final Delivery Dated August 31, 2007
Referenced ArcGIS Project "Check Point Survey 113007.mxd"
Results: The RMS average difference in elevation for 48 Surveyed Points as compared to the LiDAR TIN data is 0.52 feet. The LiDAR data is acceptable for use in H&H analyses and flood zone mapping.

Checkpoint #	Community	Description	SPC (NAD 83) 2001 MA State Coordinate System		Field Survey ELEV (NAVD 88 -ft)	LiDAR Data from TIN (Elevation ft)	Elevation Difference (Survey - LiDAR ft)
			Northing (ft)	Easting (ft)			
G1	Wareham	Grass	2732106.586	888541.835	22.01	21.50	0.51
G2	Wareham	Grass	2735228.004	874260.545	13.15	12.20	0.95
G3	Marion	Grass	2712950.801	865021.931	11.45	11.50	-0.05
G4	Marion	Grass	2706605.607	862505.604	8.13	8.20	-0.07
G5	New Bedford	Grass	2682699.556	815662.148	8.31	7.70	0.61
G6	New Bedford	Grass	2678412.737	819339.667	11.79	11.20	0.59
G7	Mattapoisett	Grass	2689074.077	838606.968	7.49	6.70	0.79
G8	Mattapoisett	Grass	2697935.746	857316.569	6.51	6.04	0.47
G9	Fairhaven	Grass	2694351.924	816217.150	6.10	5.30	0.80
G10	Fairhaven	Grass	2685123.413	828887.594	6.45	5.90	0.55
P1	Wareham	Pavement	2731873.060	888493.289	10.80	10.00	0.80
P2	Wareham	Pavement	2735260.297	874279.528	11.96	11.10	0.86
P3	Marion	Pavement	2712794.525	865479.667	7.77	7.00	0.77
P4	Marion	Pavement	2706701.204	862496.953	7.63	6.70	0.93
P5	New Bedford	Pavement	2682668.716	815669.038	8.07	7.70	0.37
P6	New Bedford	Pavement	2678404.115	819293.342	12.06	11.40	0.66
P7	Mattapoisett	Pavement	2689052.499	838628.582	7.13	6.08	1.05
P8	Mattapoisett	Pavement	2698039.843	857224.509	6.97	6.00	0.97
P9	Fairhaven	Pavement	2694398.115	816274.004	6.58	5.80	0.78
P10	Fairhaven	Pavement	2685171.743	828848.109	4.75	4.20	0.55
334	Hull	HL-7/@CLRD	2938372.028	822049.814	31.51	31.19	0.32
336	Hull	HL-7/@GRASS	2938394.960	822041.986	29.81	29.86	-0.05
338	Hull	HL-7/@TOPBANK	2938466.285	822035.420	23.77	23.51	0.26
371	Hull	HL-14/@CL.RD	2922943.540	835718.306	6.37	6.13	0.24
374	Hull	HL-14/@GRAV	2923016.151	835745.379	7.57	7.67	-0.10
386	Hingham	HI-7@CL.RD	2920228.985	819709.668	10.35	10.30	0.05
387	Hingham	HI-7@EDGE.RD	2920222.230	819716.603	9.95	9.91	0.05
399	Hingham	HI-9@CL.BIT.DR	2920918.938	817916.107	43.85	44.31	-0.46
403	Hingham	HI-9@GRASS	2920945.923	817932.505	36.71	36.82	-0.11
416	Dartmouth	DM-18/@T.BANK	2652197.349	797999.178	8.02	8.10	-0.08
417	Dartmouth	DM-18/@B.BANK	2652190.514	798009.611	5.48	5.89	-0.41
464	Dartmouth	DM-12/@EDGE.RD	2655143.710	807344.010	12.99	12.77	0.21
465	Dartmouth	DM-12/@GRASS	2655120.027	807370.299	11.03	11.02	0.02
472	Dartmouth	DM-12/@STONE	2655063.337	807432.100	1.56	2.02	-0.46
475	Dartmouth	DM-11/@GRASS.TOP	2657342.723	807925.264	6.89	7.04	-0.15
479	Dartmouth	DM-11/@BEACH	2657308.796	807954.590	3.08	2.74	0.34
492	Dartmouth	DM-21/@GRAV.DR	2647310.515	789095.431	3.53	3.45	0.08
493	Dartmouth	DM-21/@GRAV.DR	2647266.723	789107.171	5.80	5.70	0.10
496	Dartmouth	DM-21/@GRAV.DR	2647136.922	789113.250	8.27	8.10	0.17
499	Dartmouth	DM-21/@GRAV.GS	2647097.965	789115.610	7.63	7.66	-0.03
525	Westport	WP-2/@CL.RD	2643784.840	784403.213	5.10	4.70	0.40
528	Westport	WP-2/@GRAV	2643745.307	784425.552	6.26	5.41	0.85
553	Westport	WP-15/@CL.RD.EDGE.	2641981.488	761208.644	20.69	20.06	0.63
555	Westport	WP-15/@GRASS	2641920.650	761219.188	20.10	19.50	0.60
561	Westport	WP-15/@STONE.BEACH	2641818.457	761219.283	-0.37	-0.42	0.05
9000	Hull	A-2	2936891.603	813932.742	9.83	9.48	0.35
9002	Hull	A-1	2936747.581	813929.320	6.26	6.07	0.19
9009	Dartmouth	MAG/R-1A	2652475.113	797845.791	4.95	4.85	0.10
						RMS Difference:	**0.52**

Section 4
LIDAR Data Deliverables

4.1 Introduction

This section describes the LIDAR deliverables for this task order. Deliverables include this report, Sanborn's LiDAR Campaign Final Report for Plymouth and Bristol Counties, Massachusetts dated November 2006 (Appendix A), LiDAR Metadata (Appendix B), the Field Survey Reports containing field notes and sketches (Appendix C) and digital data files.

The digital data files are large (approximately 40 GB) and it is not practical to deliver the data on optical media with this report as it would require more than 8 discs. The data have been delivered for upload to the FEMA data portal via portable hard drive and will be made available on the CITRIX server submittal drive "J drive ":

- https://tools.hazards.fema.gov/Citrix/MetaFrame/default/default.aspx
- J:\FEMA\R01\MASSACHUSETTS_25\BRISTOL_25005\BRISTOL_005C\xx-xx-xxxxx\SubmissionUpload\...\Terrain
- J:\FEMA\R01\MASSACHUSETTS_25\PLYMOUTH_25023\PLYMOUTH_023C\xx-xx-xxxxx \SubmissionUpload\...\Terrain

The data files are stored in the following directory structure:

General
- Metadata
- Topo report

Supplemental Info
- Breaklines
- Contours
- First_Return
- Intensity
- Last_Return
- Masspoints
- Projection File
- Tile-layout
- TIN

Figures 4-1 and 4-2 present filled out FEMA Table A-3, Digital Topographic Data Requirements Checklist, and FEMA Table A-4, LiDAR System Mission Data Collection Checklist. Both are from Appendix A of FEMA's Guidelines and Specifications for Flood Mapping Partners and provide a summary of the data.

Figures 4-3 and 4-4 show the LiDAR data tile layouts.

4.2 Deliverable Listing

The following items comprise the project deliverables:

- This report
- One disc containing project data (included with the report)
  - This report (PDF file)
  - LIDAR Metadata (HTML format)
  - LIDAR Tile Layout Figures (PDF file)
  - LIDAR Tile Layout (ESRI shapefile format)

Sent to FEMA Data Repository:

- LIDAR Data Files:
  - This report (PDF file)
  - LIDAR Tile Layout (ESRI shapefile format)
  - LIDAR Metadata (HTML format)
  - Breaklines (ASCI format, x, y, z coordinates)
  - Contours (ArcInfo coverage format)
  - First Return (elevation data in ASCI format, x, y, z coordinates)
  - Last Return (elevation data in ASCI format, x, y, z coordinates)
  - LiDAR Intensity (ArcInfo coverage format)
  - Masspoints (BareEarth elevation data in ASCI format, x, y, z coordinates)
  - TIN (elevation data in TIN format)

Figure 4—5 lists the directory structure as submitted to the FEMA data repository.

Figure 4-1
FEMA Table A-3

Table A-3. Digital Topographic Data Requirements Checklist

Surface Description (choose one)
- [x] Bare-earth surface (FEMA default)
- [ ] Top surface (e.g., treetops/rooftops)
- [ ] Bathymetric surface

Reflective surface (if using LIDAR)
- [ ] First
- [x] Last (FEMA default)
- [ ] All
- [ ] LIDAR intensity returns
- [ ] Other simultaneous imagery

Vertical Accuracy (choose one)
- [ ] 1' contour equiv. ($Accuracy_z$ = 0.6 ft.)
- [x] 2' contour equiv. ($Accuracy_z$ = 1.2 ft.)
- [ ] 4' contour equiv. ($Accuracy_z$ = 2.4 ft.)
- [ ] 5' contour equiv. ($Accuracy_z$ = 3.0 ft.)
- [ ] Other: $Accuracy_z$ = ___ ft.

Vertical accuracy at the 95% confidence level ($Accuracy_z$) = $RMSE_z$ x 1.9600 with normal distribution

Horizontal Accuracy (choose one)
- [ ] 1" = 500' equiv. ($Accuracy_r$ = 11' or 3.35 m)
- [ ] 1" = 1000' equiv. ($Accuracy_r$ = 22' or 6.7 m)
- [x] $RMSE_r$ = 1 m
- [ ] $RMSE_r$ = _____

Horizontal accuracy at the 95% confidence level ($Accuracy_r$) = $RMSE_r$ x 1.7308

Data Model (choose one or more)
- [x] Contours
- [ ] Cross sections
- [x] Mass points
- [x] Breaklines
- [x] TIN (average point spacing = ___meters) *
- [x] DEM (post spacing = 8-foot)

* FEMA's standard DEM post spacing is 5-meters when mass points are supplemented with breaklines for hydraulic modeling. The TIN point spacing is typically smaller than the DEM post spacing to allow a denser network of irregularly-spaced points for interpolation of the uniformly-spaced DEM.

Horizontal Datum (choose one)
- [ ] NAD 27
- [x] NAD 83 (default)

Vertical Datum (choose one)
- [ ] NGVD 29
- [x] NAVD 88 (default)

Coordinate System (choose one)
- [ ] UTM
- [x] State Plane
- [ ] Geographic

Units Note: For feet and meters, vertical (V) units may differ from horizontal (H) units
- [x] Feet to ___ decimal places [ ] V [ ] H
- [ ] Meters to ___ decimal places [ ] V [ ] H
- [ ] Decimal degrees to ___ decimal places
- [ ] DDDMMSS to ___ decimal places

Feet are assumed to be U.S. Survey Feet unless specified to the contrary: US Survey foot, MA State Plane

Data Format (choose one or more)

Digital contour lines and breaklines
- [ ] .DGN
- [ ] .DO (DLG Optional)
- [ ] .DWG
- [ ] .DXF
- [ ] .E00
- [ ] .MIF/.MID
- [ ] .SHP
- [ ] SDTS
- [ ] TAB
- [x] Other: ESRI Coverage format

Mass points and TINs
- [x] ASCII x/y/z
- [ ] ASCII with attribute data
- [ ] BIN
- [x] TIN Arc/Info Export File
- [ ] Other _____

DEMs
- [x] ASCII x/y/z
- [ ] .BIL
- [ ] .BIP
- [ ] .BSQ
- [ ] .DEM (USGS standard)
- [ ] ESRI Float Grid
- [ ] ESRI Integer Grid
- [ ] GeoTiff
- [ ] .RLE
- [ ] Other: Provided in ArcGenerate format

File size or Tile size (choose one)
- [ ] File size ____ MB or 1 GB (max)
- [ ] Tile size _____ x _____ (specify feet or meters)
- [x] Other tile size: 5,000-ft by 5,000-ft grid _____
- [ ] Buffer size: _____

Other Quality Factors (optional, explain on separate page)
- [ ] Cleanness from artifacts
- [ ] Limits on size/location of void areas where there are no elevation data shown
- [ ] How elevations are to be shown for void areas
- [ ] Hydro-enforcement
- [ ] Other requirements

Bridges/culverts removed? [ ] Yes [ ] No

Figure 4-2
FEMA Table A-4

Table A-4. LIDAR System Mission Data Collection Checklist

Notes	A. Data collection (each flight)
LIDAR Parameters Optech LiDAR System 35 Hertz scan frequency 20 degree scan angle Flying height 1,000 meters AGL Flying speed 140 knots Vertical Accuracy 18.5 cm Bare Earth _____ _____ _____ _____ Flight Start Date: November 10, 2006 Flight Finish Date: November 26, 2006 _____ _____ _____ _____ _____ _____	1. Record flight date and time.* 2. Record flight altitude(s).* 3. Record LIDAR system scan angle, scan rates, and pulse rates.* 4. Record time LIDAR system receiver is activated/ deactivated.* 5. Record all Position Dilution of Precision values.* 6. Record height of instrument (before and after flight). 7. Record on-board antenna offsets. 8. Note any site obstructions at GPS base station(s). 9. Record airborne and ground-site GPS receiver types and serial numbers. 10. Record ground site GPS station monument names and stability.* 11. Record flight staff.
Notes	**B. Data handling (each flight)**
LiDAR filtering was accomplished using TerraSolid, TerraScan LiDAR processing and modeling software _____ _____ _____ _____ _____ _____	1. Record that all files have been labeled correctly and cross-indexed. 2. Record analyst name(s) responsible for processing and product generation. 3. List any auxiliary information used during processing of LIDAR to generate products delivered. 4. List major data processing components used.

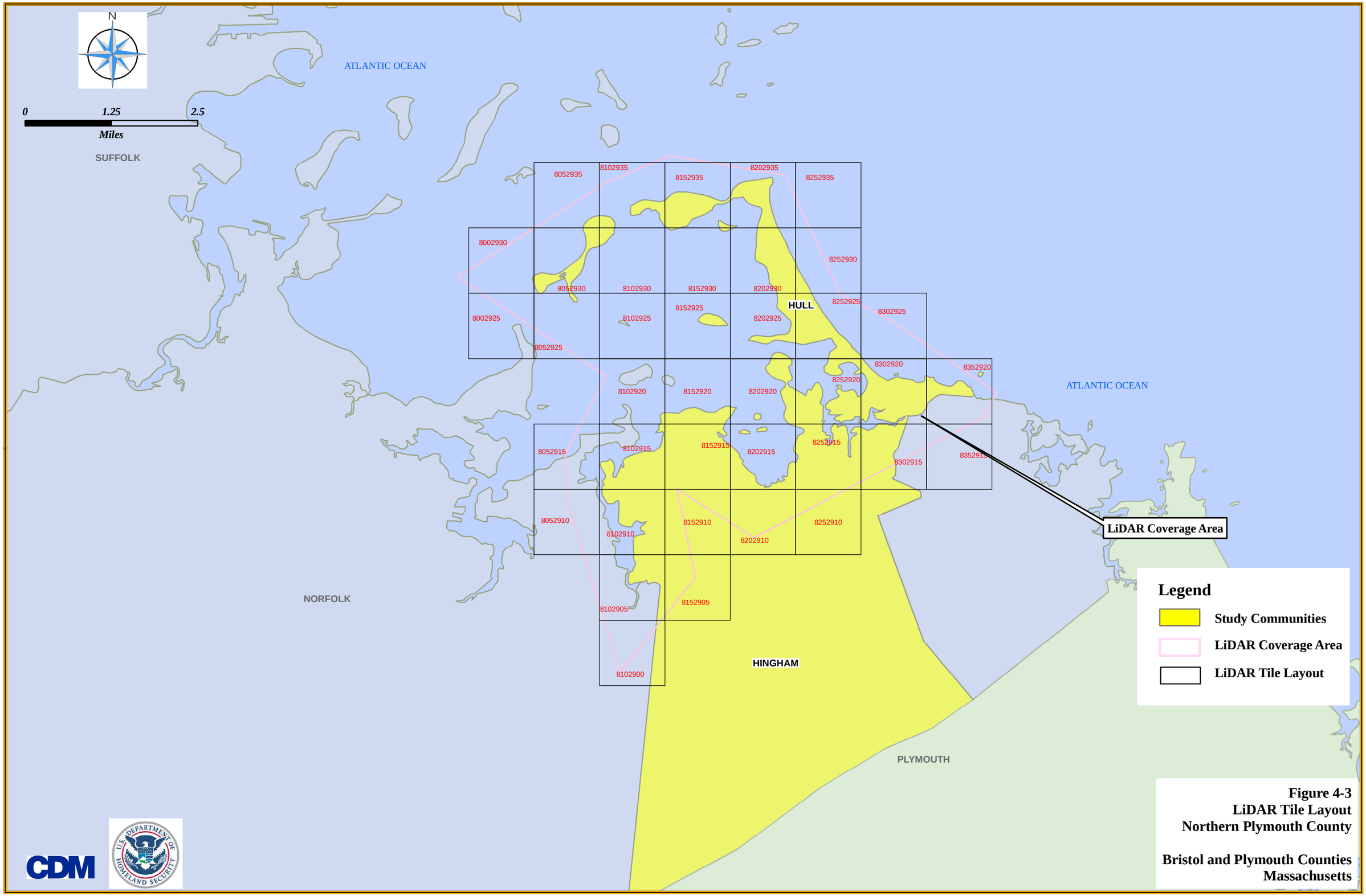


Figure 4-3
LiDAR Tile Layout
Northern Plymouth County

Bristol and Plymouth Counties
Massachusetts

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N

0 2.5 5

Miles

PLYMOUTH

BRISTOL

NEW BEDFORD

MATTAPOISETT

MARION

WAREHAM

FAIRHAVEN

BARNSTABLE

WESTPORT

DARTMOUTH

NEWPORT

ATLANTIC OCEAN

ATLANTIC OCEAN

DUKES

LiDAR Coverage Area

Legend

- Study Communities
- LiDAR Coverage Area
- LiDAR Tile Layout

Figure 4-4
LiDAR Tile Layout
Bristol and South Plymouth Counties

Bristol and Plymouth Counties
Massachusetts

CDM

U.S. DEPARTMENT OF HOMELAND SECURITY

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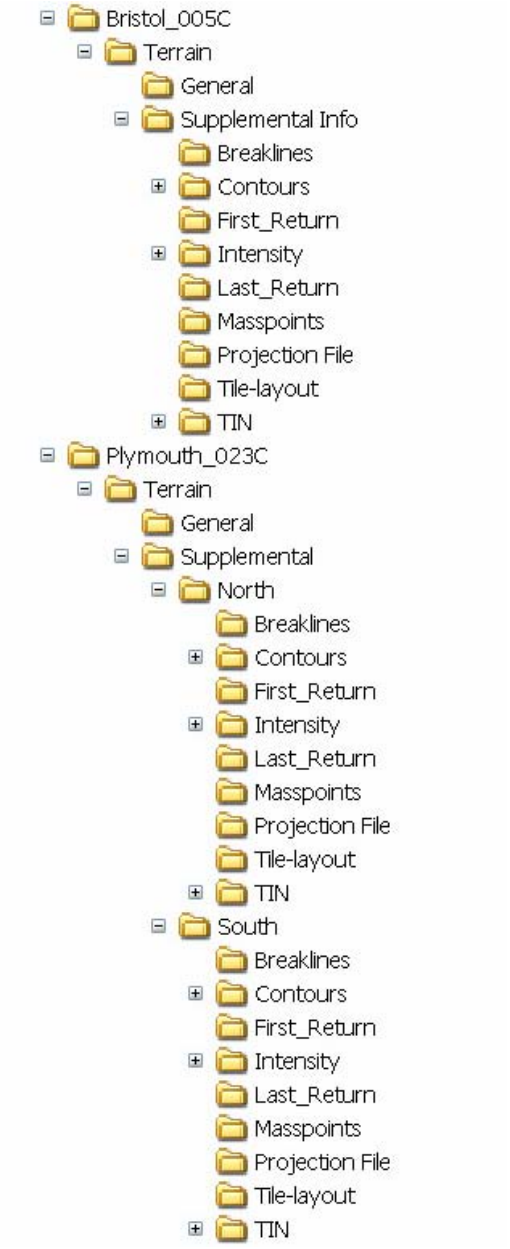
Figure 4-5 Data Delivery Directory Structure



Appendix A

LiDAR Campaign Final Report

Camp Dresser Mckee, Inc

CDM Plymouth & Bristol Counties Massachusettes

NOVEMBER 2006

LiDAR Campaign

Final Report

Prepared by:
Sanborn
1935 Jamboree Dr., Suite 100
Colorado Springs, CO, 80920
Phone: (719) 593-0093
Fax: (719) 528-5093

EXECUTIVE SUMMARY

In November thru mid December 2006, Sanborn was contracted by Camp Dresser McKee Inc to execute a LiDAR (Light Detection and Ranging) survey campaign in the state of Massachusetts. LiDAR data in the form of 3-dimensional positions of a dense set of masspoints was collected for the whole area. This data was used in the development of the bare-earth-classified elevation point data sets

The Optech ALTM (Airborne Laser Terrain Mapping) and Leica ALS-50 systems are used to collect LIDAR data. The systems are calibrated by conducting flight passes over a known ground surface before and after each LIDAR mission. During final data processing, the calibration parameters are inserted into post-processing software.

Two airborne GPS (Global Positioning System) base stations were used in this project. Two existing National Geodetic Survey (NGS) markers were used as the base stations for the GPS airborne ground support. The coordinates of these two stations were checked against each other with the three dimensional GPS baseline created at the airborne support set up and determined to be within project specifications.

The acquired LiDAR data was processed to obtain first and last return point data. The last return data was further filtered to yield a LiDAR surface representing the bare earth.

The contents of this report summarize the methods used to establish the base station coordinate check, preform the LiDAR data collection and post-processing as well as the results of these methods.

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1 INTRODUCTION

This report contains the technical write-up of the Plymouth County and Bristol County LiDAR campaign, including system calibration techniques, the establishment of base stations by a differential GPS network survey, and the collection and post-processing of the LiDAR data.

1.1 Contact Info

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

Sanborn
1935 Jamboree Drive, Suite 100
Colorado Springs, CO 80920

Attention: ---------- Tom Leier (Project Manager)
---------- Jamie Young (Project Coordinator)
Telephone: -------- 1–719-593-0093
FAX: ---------- 1–719-528-5093
email: ---------- tleier@sanborn.com

1.2 Purpose of the LIDAR Acquisition

This LiDAR operation was designed to provide a highly detailed ground surface dataset to be used for the development of topographic and countour mapping as well as hydraulic modeling.

1.3 Project Location

Plymouth County and Bristol County, Massachusetts coastal areas.

1.4 Project Scope and Time Line

In November thru Mid December 2006, acquisition of all new LiDAR data and collection of 2D breaklines was captured for both the Plymouth County and Bristol County, Massachusetts coastal areas. The size of the area for Plymouth is approximately 18 square miles with lots of water and the Bristol area is approximately 143 square miles along a jaggeded coastline, which totals 161 square miles. Size of area as blocked for acqusition is 225 square miles. There are no tidal restrictions for the acquisition.

Table 1: **Project specifications and deliverable coordinate and datum systems**

Area (sq. mi)	**161**	**Product type**	**Fema(F)**	**Projection**	**Mass State Plane**
Vertical Accuracy (CM)	**Bare Earth 18.5 (F)**	**Check Points required**	**Yes**	**Horizontal Datum Vertical Datum**	**NAD 83 NAVD 88**
Horizontal accuracy (M)	**1meter (F)**	**Number Collected**	**42**	**Units**	**US Survey Ft**

Table 2: Project time line and actual Finish Dates

Schedule Assumptions:

	Days	Start	Actual Finish
LiDAR Collection	**6**	**11/10/2006**	**11/26/06**
Weather factor	**2.67x**		
Total days:	**16**	**11/10/2006**	**11/26/06**
Processing due from acquisition	**90**	**9/18/2006**	**12/5/06**
Contract end date from acquisition	**120**	**9/18/2006**	**2/15/07**

Additional Basic Project Information: Two Project areas to acquire; Plymouth is 18 square miles coastal north of the Bristol area. Bristol area 143 square miles coastal south of Plymouth area, see maps The areas should be blocked for acquisition since the boundary is so convoluted along the coastlines.

Figure 1: **PLYMOUTH AND BRISTOL: FEMA 1.4 M LIDAR PRODUCT-(TOTALING 161 SQ. MILES)**

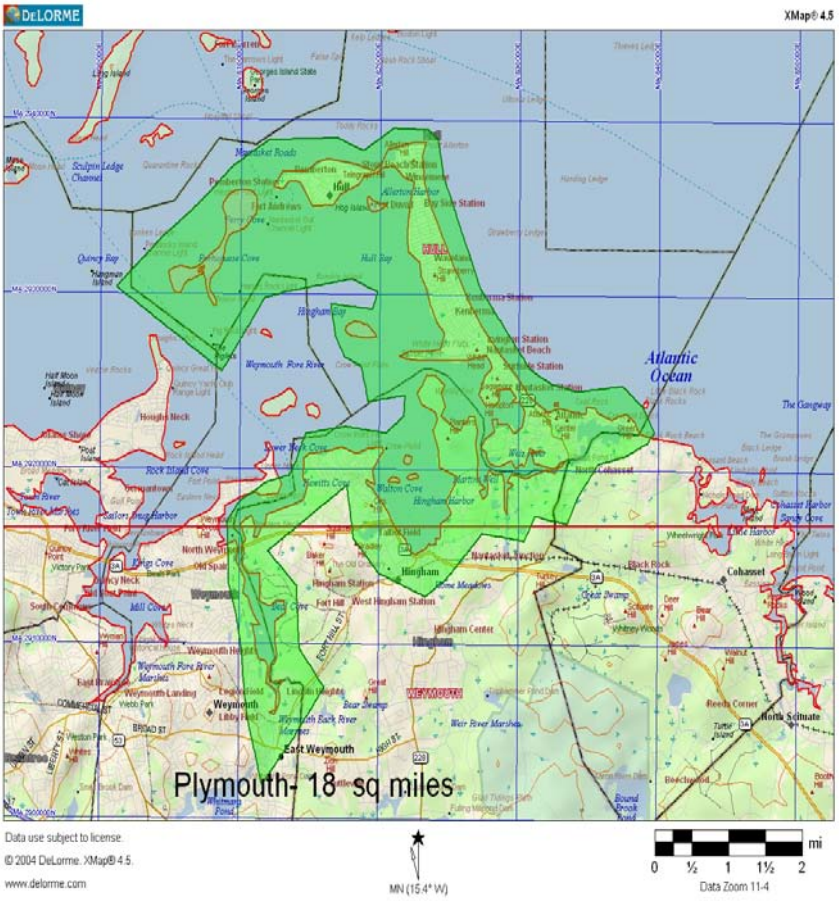

Figure 2: PLYMOUTH: FEMA 1.4 M LIDAR PRODUCT- (TOTALING 18 SQ. MILES)

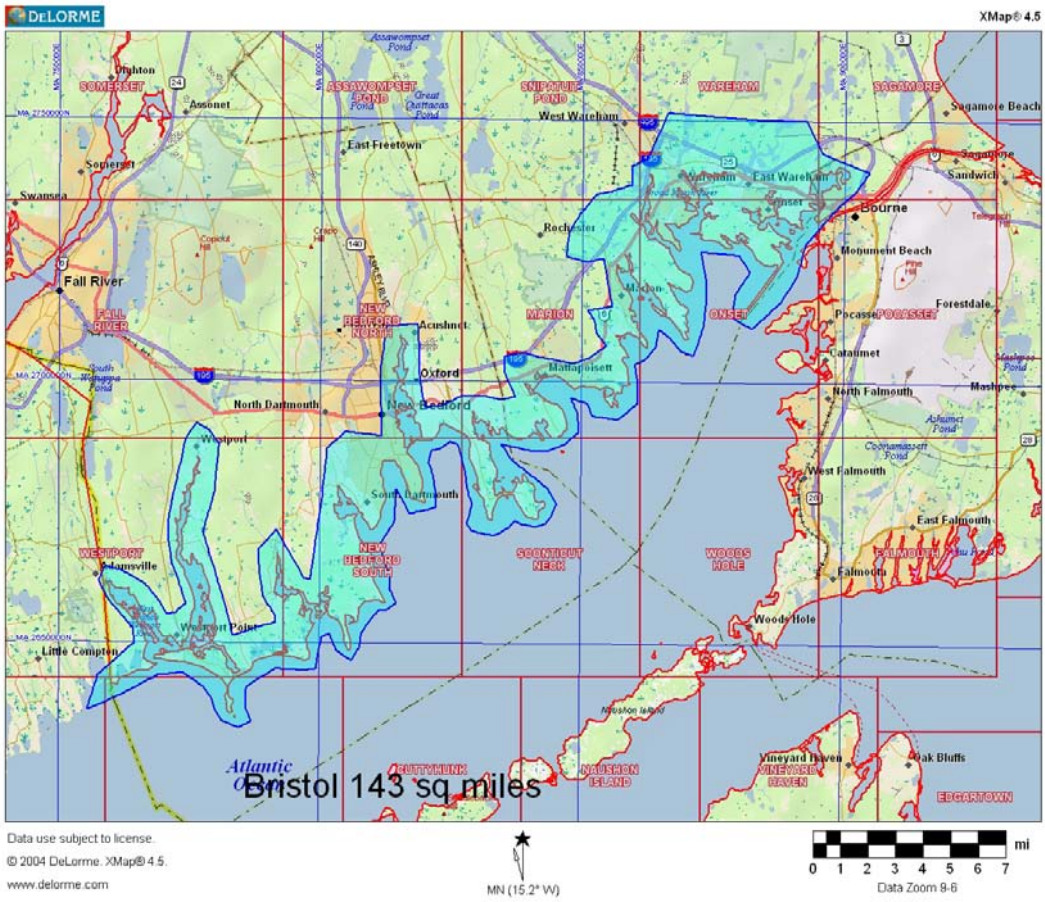

Figure 3: **BRISTOL FEMA 1.4 M LIDAR PRODUCT - (TOTALING 143 SQ MILES)**

Table 3: Control

AGPS (Y/N)	**Y**	**Target Size**	**N/A**
IMU (Y/N)	**Y**	**Length (leg)**	
Ground Control (Y/N)	**Y**	**Width (leg)**	
Photo ID (Y/N)	**N**		
GEOID	**2003**		

Additional Control Information:
Sanborn to Survey Base Stations for the LiDAR Acquisition.

Sanborn to provide 7 sets of 3 classifications of FEMA LiDAR check points for both the Plymouth and Bristol Project areas totaling 42 FEMA Check Points.

Additional LiDAR Information: Acquisition Scheduled in November of 2006 after leaf off and before snow. Finish delivery of all products within 12 weeks of acquisition. No later than March 16,2007.

2 LiDAR CALIBRATION

2.1 Introduction

LiDAR calibrations are performed to determine and therefore eliminate systematic biases that occur within the hardware of the ALS-50 system. Once the biases are determined they can be modeled out. The systematic biases that are corrected for include scale, roll, and pitch.

The following procedures are intended to prevent operational errors in the field and office work, and are designed to detect inconsistencies. The emphasis is not only on the quality control (QC) aspects, but also on the documentation, i.e., on the quality assurance (QA).

2.2 Calibration Procedures

Sanborn performs two types of calibrations on its LiDAR system. The first is a building calibration, and it is done any time the LiDAR system has been moved from one plane to another. New calibration parameters are computed and compared with previous calibration runs. If there is any change, the new values are updated internally or during the LiDAR post-processing. These values are applied to all data collected with this plane/ALS-50 system configuration.

Once final processing calibration parameters are established from the building data, a precisely-surveyed surface is observed with the LiDAR system to check for stability in the system. This is done several times during each mission. An average of the systematic biases are applied on a per mission basis.

2.3 Building Calibration

Whenever the ALS-50 is moved to a new aircraft, a building calibration is performed. The rooftop of a large, flat, rectangular building is surveyed on the ground using conventional survey methods, and used as the LIDAR calibration target. The aircraft flies several specified passes over the building with the ALS-50 system set first in scan mode, then in profile mode, and then in both scan and profile modes (scan angle set to zero degrees.)

Figure 4 shows a pass over the center of the building. The purpose of this pass is to identify a systematic bias in the scale of the system.

Figure 5 demonstrates a pass along a distinct edge of the building to verify the roll compensation performed by the INS.

Additionally, a pass is made in profile mode across the middle of the building to compensate for any bias in pitch.

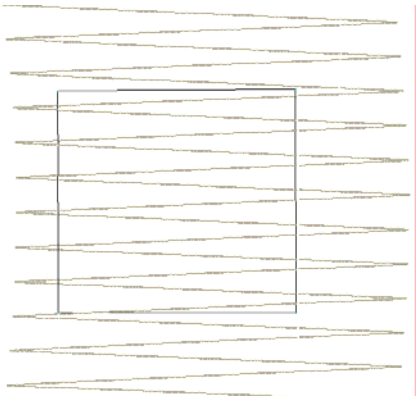

Figure 4: Calibration Pass 1

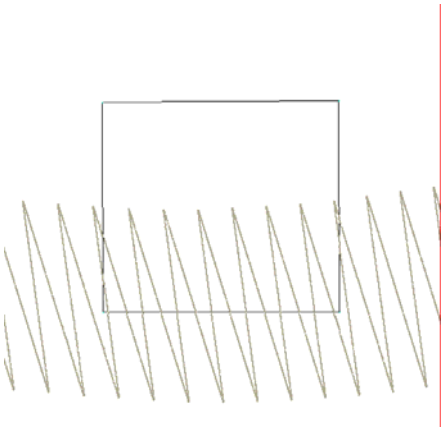

Figure 5: Calibration Pass 2

2.4 Runway Calibration, System Performance Validation

An active asphalt runway was precisely-surveyed at the Norwood and New Bedford airports using kinematic GPS survey techniques (accuracy: ±3cm at 1σ, along each coordinate axis) to establish an accurate digital terrain model of the runway surface. The LiDAR system is flown at right angles over the runway several times and residuals are generated from the processed data. Figure 6 shows a typical pass over the runway surface.

Approximately 25,000 LiDAR points are observed with each pass. These points are "draped" over the runway surface TIN (Triangular Irregular Network) to compute vertical residuals for every data point. The residuals are analyzed with respect to the location *along* the runway to identify the level of noise and system biases.

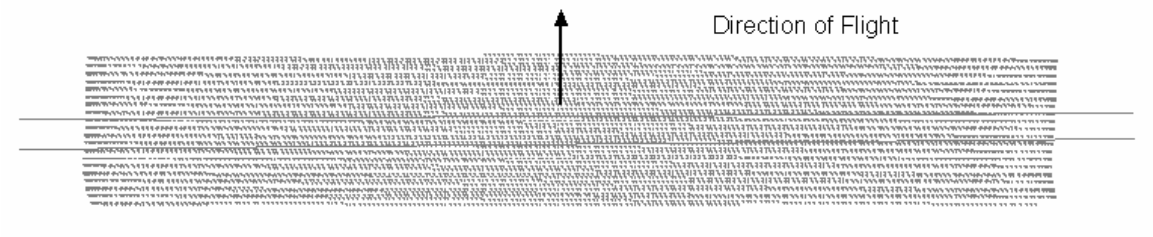

Figure 6: Runway Calibration

2.5 Calibration Results

The LiDAR data captured over the building is used to determine whether there have been any changes to the alignment of the IMU with respect to the laser system. The parameters are designed to eliminate systematic biases within certain system parameters.

The runway over-flights are intended to be a quality check on the calibration and to identify any system irregularities and the overall noise. IMU misalignments and internal system calibration parameters are verified by comparing the collected LiDAR points with the runway surface.

Figure 7: Runway Calibration Results shows the typical results of a runway over-flight analysis. The X-axis represents the position along the runway. The overall statistics from this analysis provides evidence of the overall random noise in the data; typically, 7 cm standard deviation (an unbiased estimator) and 8 cm RMS which includes any biases and indicates that the system is performing within specifications. As described in later sections of this report, this analysis will identify any peculiarities within the data along with mirror-angle scale errors (identified as a “smile” or “frown” in the data band) or roll biases.

3 Runway Calibration, System Performance Validation

3.1 Calibration Results

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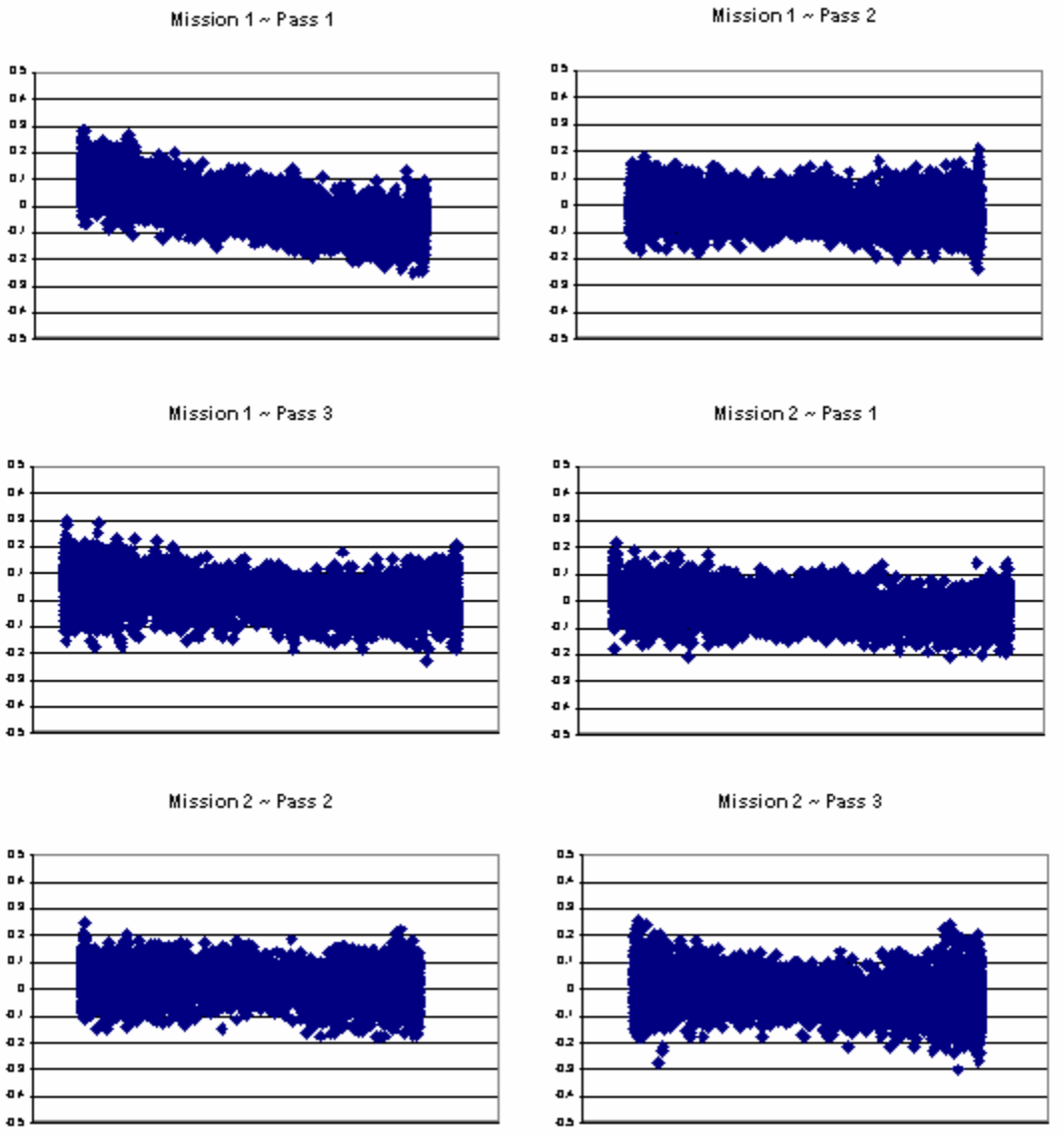

Figure 7: Runway Calibration Results

3.2 Daily Runway Performance/Data Validation Tests

Performance flights over the runway test field were performed before and after each mission. Table 4 shows the standard deviation and RMS values of the residuals between the test flights and the known surface of the test ranges for each pass. The maximum RMS value is 0.056 meters and the maximum standard deviation is 0.091 meters. The average RMS among all test flights is 0.045 meters. Rigorous quality assurance procedures were followed to ensure that the appropriate data accuracy was achieved

Table 4: Runway Validation Results (meters)

Mission	Pass	Standard Deviation	RMS
314a	4	0.056	0.056
314b	4	0.036	0.034
315a	4	0.091	0.045
325a	4	0.053	0.053
329a	3	0.036	0.036
330a	4	0.049	0.050
330b	4	0.044	0.045
331a	4	0.044	0.044

4 LiDAR Flight and System Report

4.1 Introduction

This section addresses LiDAR system, flight reporting and data acquisition methodology used during the collection of the Plymouth and Bristol campaigns. Although Sanborn conducts all LiDAR with the same rigorous and strict procedures and processes, all LiDAR collections are unique.

4.2 Field Work Procedures

A minimum of two GPS base stations were set up, with one receiver located at the airport, and the secondary GPS receiver placed at a survey control point within the project area or within the required baseline specifications of the project.

Pre-flight checks such as cleaning the sensor head glass are performed. A four minute INS initialization is conducted on the ground, with the engines running prior to flight, to establish fine-alignment of the INS. GPS ambiguities are resolved by flying within ten kilometers of the base stations.

The flight missions were typically four or five hours in duration including runway calibration flights flown at the beginning and the end of each mission. During the data collection, the operator recorded information on log sheets which includes weather conditions, LiDAR operation parameters, and flight line statistics. Near the end of the mission GPS ambiguities are again resolved by flying within ten kilometers of the base stations, to aid in post-processing.

Table 5 shows the planned LiDAR acquisition parameters with a flying height of 1,200 meters above ground level (AGL) on a mission to mission basis.

Table 5- LIDAR Acquisition Parameters

Average Altitude	**1,200 Meters AGL**
Airspeed	**~120 Knots**
Scan Frequency	**36 Hertz**
Scan Width Half Angle	**16 Degrees**
Pulse Rate	**50000 Hertz**

Preliminary data processing was performed in the field immediately following the missions for quality control of GPS data and to ensure sufficient overlap between flight lines. Any problematic data could then be re-flown immediately as required. Final data processing was completed in the Colorado Springs office.

Table 6: Collection dates, times, Average per flight collection parameters and PDOP

Mission	Date	Start Time	End Time	Altitude (m)	Airspeed	Scan Angle	Scan Rate	Pulse Rate	PDOP
314a	Nov 10	18:02	20:11	1200	120 Knots	16˚	36	50000	2.41
314b	Nov 10	00:44	03:16	1200	120 Knots	16˚	36	50000	2.14
315a	Nov 11	16:55	19:29	1200	120 Knots	16˚	36	50000	2.20
325a	Nov 21	20:54	23:26	1200	120 Knots	16˚	36	50000	1.06
329a	Nov 25	21:09	23:21	1200	120 knots	16˚	36	50000	1.70
330a	Nov 26	13:28	14:49	1200	120 Knots	16˚	36	50000	2.00
330b	Nov 26	19:18	21:53	1200	120 knots	16˚	36	50000	1.60
331a	Nov 26	03:43	04:48	1200	120 knots	16˚	36	50000	1.40

4.3 Final LiDAR Processing

Final post-processing of LiDAR data involves several steps. The airborne GPS data was post-processed using Waypoint's GravNAV™ software (version 7.5). A fixed-bias carrier phase solution was computed in both the forward and reverse chronological directions. The data was processed for both base stations and combined. In the event that the solution worsened as a result of the combination of both solutions, the best of both solutions was used to yield more accurate data. LiDAR acquisition was limited to periods when the PDOP was less than 3.2.

The GPS trajectory was combined with the raw IMU data and post-processed using Applanix Inc.'s POSPROC Kalman Filtering software. This results in a two-fold improvement in the attitude accuracies over the real-time INS data. The best estimated trajectory (BET) and refined attitude data are then re-introduced into the Optech REALM software for the OPTEC system and Leica post processor for the ALS50 system to compute the laser point-positions. The trajectory is then combined with the attitude data and laser range measurements to produce the 3-dimensional coordinates of the mass points.

All return values are produced within Realm and ALS Post processing software. The multi -return information minus the last return provides a useful depiction of the "canopy" within the project area. The last return is further processed to obtain The "bare earth dataset" as a deliverable to Bristol and Plymouth Counties. All LiDAR data is processed using the binary LAS format 1.1 file format.

LiDAR filtering was accomplished using TerraSolid, TerraScan LiDAR processing and modeling software. The filtering process reclassifies all the data into classes with in the LAS formatted file based scheme set using the LAS format 1.1 specifications or by the client. Once the data is classified, the entire data set is reviewed and manually edited for anomalies that are outside the required

guidelines of the product specification or contract guidelines, whichever apply. In this case, Table 7 indicates the required product specifications.

Once the data is processed and classified, the data is checked against the GPS check points and/or a kinematic drive survey conducted in the field during time of collection as required by the product or project specifications. Table 7 indicates the results of this check as it relates to the Sanborn FEMA compliant product check points.

The coordinate and datum transformations are then applied to the data set to reflect the required deliverable projection, coordinate and datum systems as provided in the contract.

The client required deliverables are then generated. At this time, a final QC process is undertaken to validate all deliverables for the project. Prior to release of data for delivery, Sanborn's Quality control/ quality assurance department reviews the data and releases it for delivery.

Table 7: Project requirements and specifications for Bristol and Plymouth Counties

Accuracy of LiDAR data in bare areas	**18.5 cm RMSE**
Accuracy of LiDAR data in bare areas	**37 cm RMSE**
Percent of artifacts removed (terrain and vegetation dependent)	**90%**
Percent of all outliers removed	**95%**
Percent of all vegetation removed	**95%**
Percent of all buildings removed	**98%**

4.4 LiDAR Accuracy results

The LiDAR data was evaluated using a collection of 21 GPS surveyed check points. The category classes of bare earth, low grass and urban were used. The LiDAR data was compared to each of these classes and Table 8 indicates the results for each point and the overall results as it compares to the LiDAR data set. Points indicating removed are points outside the statistical variance in the data. Points indicating outside are points taken in areas where LiDAR data is not present or the TIN used to generate the analysis could not compute a value as a result of data void as a result of the filtering process. Z and statistical data are represented in meters. For the Plymouth checkpoints, the standard deviation is 0.119 and the root mean squared is 0.125. For the Bristol checkpoints, the standard deviation is 0.154 and the root mean squared is 0.147. Each area yielded much better result than was required for the project.

Table 8: **LiDAR accuracy assessment based on the check point survey.**

Plymouth checkpoints UTM xyz

11	340401.916	4678998.186	-22.005	-21.790	+0.215	19.7
8	343802.064	4680642.572	-25.010	-24.850	+0.160	24.5
4	345713.420	4682490.284	-24.729	-24.580	+0.149	20.5
13	343788.217	4680647.401	-24.895	-24.760	+0.135	24.7
5	346317.287	4682017.537	-24.211	-24.130	+0.081	14.9
6	344396.588	4678831.580	-25.112	-25.060	+0.052	24.7
2	342178.438	4685308.580	-24.915	-24.880	+0.035	11.3
14	346834.213	4681415.331	-25.055	-25.100	-0.045	6.9
3	344016.862	4685599.293	-24.583	-24.660	-0.077	25.5
1	341580.587	4685197.453	-24.969	-25.130	-0.161	9.3
12	347796.904	4680598.408	-21.358	removed	*	*
7	342416.676	4678781.709	-16.440	outside	*	*
9	340192.690	4679575.708	-24.994	outside	*	*
10	341369.399	4680275.897	-24.350	outside	*	*
15	320268.296	4672831.974	-12.595	outside	*	*
16	296955.440	4734450.159	40.244	outside	*	*

Average dz +0.054
Minimum dz -0.161
Maximum dz +0.215
Average magnitude 0.111
Root mean square 0.125
Std deviation 0.119

Bristol checkpoints SP UTM xyz

9	353055.660	4619357.960	-27.050	-26.880	+0.170	8.6
1	340351.470	4607800.070	-27.450	-27.280	+0.170	6.1
12	347822.490	4615657.230	-4.350	-4.230	+0.120	10.4
10	358968.360	4624597.790	-27.140	-27.030	+0.110	10.7
5	331191.130	4596769.570	-26.960	-26.860	+0.100	4.6
11	367571.860	4623457.230	-22.540	-22.480	+0.060	3.5
8	348414.530	4615186.370	-9.250	-9.210	+0.040	10.4
6	332825.040	4603816.070	-28.330	-28.430	-0.100	5.8
4	327379.700	4604090.970	-26.510	-26.700	-0.190	3.2
2	337221.070	4615222.180	-9.550	-9.750	-0.200	8.9
7	337098.520	4605437.370	-27.120	-27.350	-0.230	4.4
3	325167.590	4610551.840	28.480	outside	*	*

Average dz +0.005
Minimum dz -0.230
Maximum dz +0.170
Average magnitude 0.135
Root mean square 0.147
Std deviation 0.154

5 Geodetic Base Network

5.1 Network Scope

During the LiDAR campaign, the Sanborn field crew conducted a GPS field survey to establish final coordinates of the ground base stations for final processing of the base-remote GPS solutions. NGS points numbered 501, 902, 901, and 701 were used as the network for Bristol and NGS points 705, 903,704, and 801 were used for the network for Plymouth

5.2 Horizontal Datum

The horizontal datum associated with the LiDAR data is NAD83 (1993), as realized by the physical NGS control monuments used to constrain the survey control network.

5.3 Vertical Datum

The vertical datum associated with the LIDAR data is the NAVD88, as realized by the physical NGS benchmarks used to constrain the survey control network

5.4 Data Processing and Network Adjustment

The one static baseline created between the NGS points were processed using Trimble Navigation's GPSurvey™ (Ver. 2.35a) software. Fixed bias solution was obtained for the baselines. The broadcast ephemeris was used, since the accuracy and extent of the network does not warrant the use of the precise ephemeris The results were satisfactory; therefore, fulfilling project specifications for first order control network.

Table 9: NGS Constraints

Horizontal

Code	NGS Station Name	PID	Order	ϕ	λ
701	ACU1 B	DF7272	B	0.014	0.014
902	ACU1A	DF7271	B	0.014	0.014
903	Y30	MY0497	B	0.014	0.014
701	438R	AJ4049	A	0.014	0.014
704	438G	AJ4040	A	0.014	0.014
705	438H	AJ4041	A	0.014	0.014

Vertical

Code	NGS Station Name	Order	Ht
801	1	1ST	class 2
901	ACU1 B	1ST	class 2
902	ACU1 A	1ST	class 2
903	Y 30	1ST	class 2

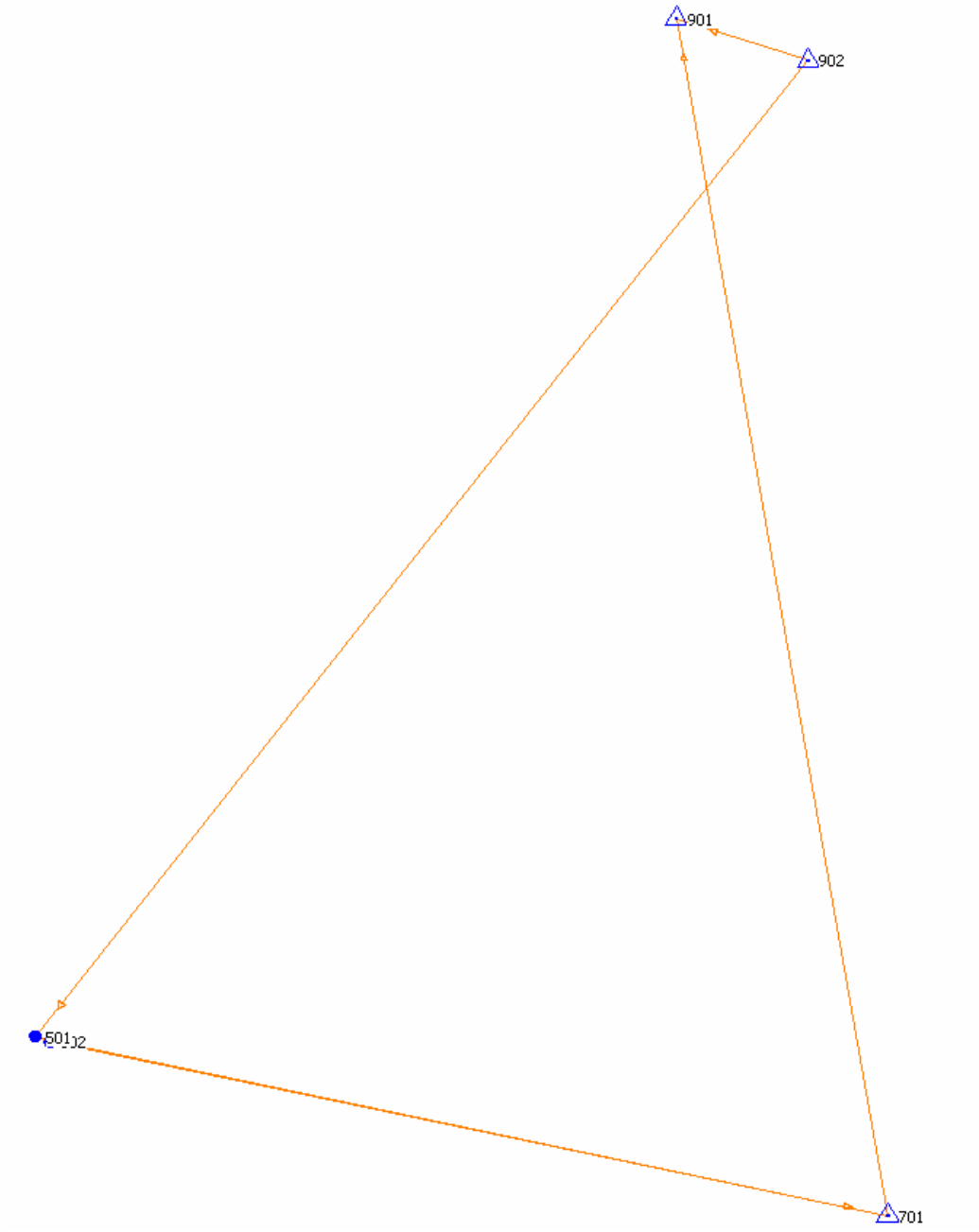

Figure 8: Bristol Network

Network point location and associated distances related to Lat-long distances related in degrees in grid format

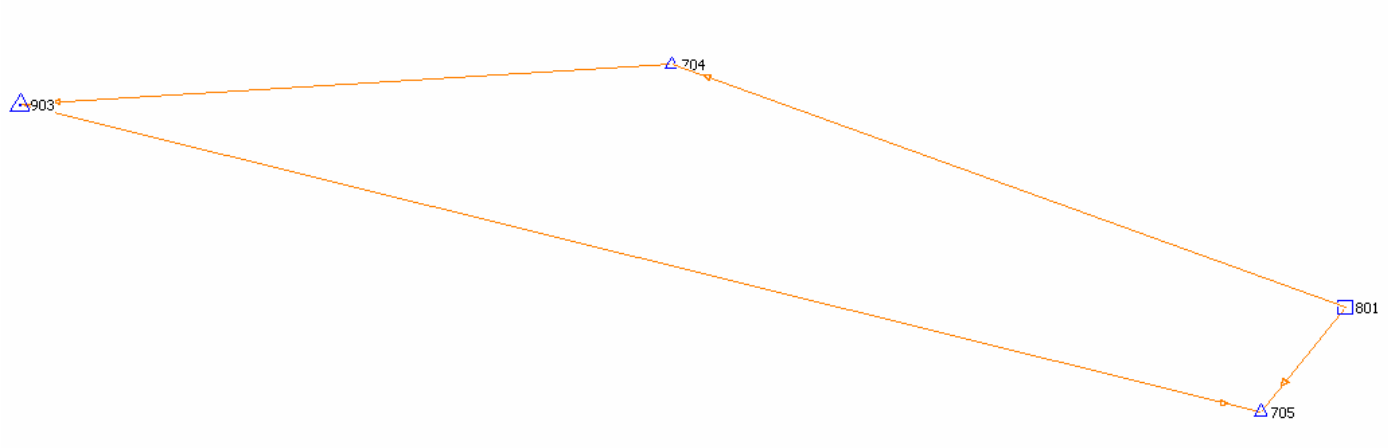

Figure 9: Plymouth Network

Network point location and associated distances related to Lat-long distances related in degrees in grid format

Table 10: Bristol County Survey Loop Closure Summary

Loop	Horizontal (sft)	Vertical (sft)	Length (sft)	ppm
902: 901: 701: 501: 902	0.041sft	-0.095sft	86213.871sft	1.198
902: 901: 701: 502: 501: 902	0.030sft	-0.070sft	86218.006sft	0.880
701: 501: 502: 701	0.032sft	-0.025sft	43315.489sft	0.942

Table 11: Plymouth County Survey Loop Closure Summary

Loop	Horizontal (sft)	Vertical (sft)	Length (sft)	ppm
704: 903: 705: 801: 704	0.086sft	-0.149sft	248917.554sft	0.691

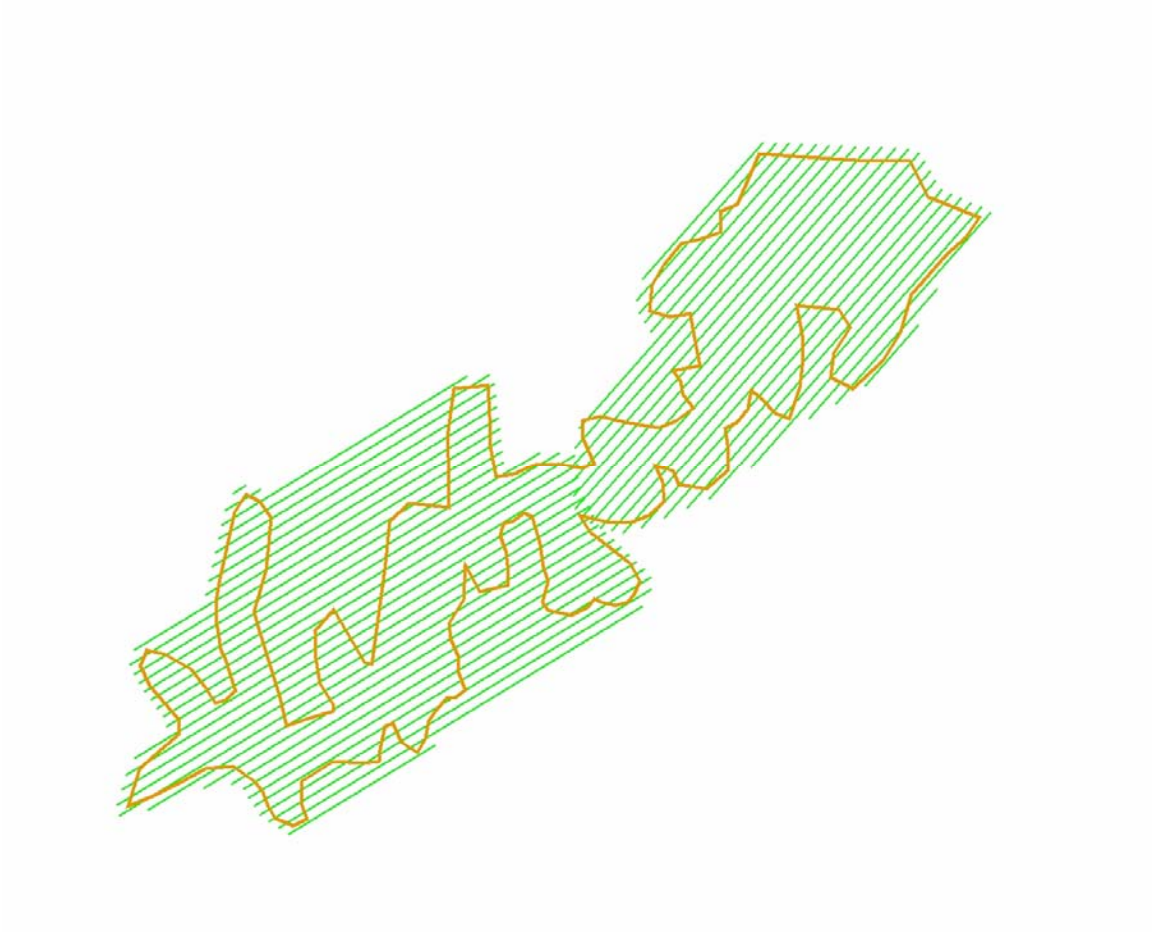

Figure 10: Bristol Flightlines

Figure 11: Plymouth Flightlines

APPENDIX A

Project : Bristol Network 032007005

User name	kszczubelek	**Date & Time**	4:40:39 PM 2/6/2007
Coordinate System	US State Plane 1983	**Zone**	Massachusetts Mainland 2001
Project Datum	NAD 1983 (Conus)		
Vertical Datum		**Geoid Model**	GEOID03US
Coordinate Units	US survey feet		
Distance Units	US survey feet		
Height Units	US survey feet		

Adjustment Style Settings - 95% Confidence Limits

Residual Tolerances

To End Iterations : 0.000033sft

Final Convergance Cutoff : 0.016404sft

Covariance Display

Horizontal

Propagated Linear Error [E] U.S.

Constant Term [C] 0.00000000sft

Scale on Linear Error [S] 1.96

Three-Dimensional

Propagated Linear Error [E] : U.S.

Constant Term [C] : 0.00000000sft

Scale on Linear Error [S] : 1.96

Elevation Errors were used in the calculations.

Adjustment Controls

Compute Correlations for Geoid : True

Horizontal and Vertical adjustment performed

Set-up Errors

GPS

Error in Height of Antenna 0.010sft

Centering Error 0.007sft

Statistical Summary

Successful Adjustment in 1 iteration(s)

Network Reference Factor : 1.36

Chi Square Test (α=95%) : PASS

Degrees of Freedom : 8.00

GPS Observation Statistics

Reference Factor : 1.36

Redundancy Number (r) : 8.00

Individual GPS Observation Statistics

Observation ID	Reference Factor	Redundancy Number
B7	2.43	1.99
B8	0.49	1.70
B9	0.48	1.46
B10	0.74	0.89
B11	0.83	0.93
B12	1.09	1.03

Geoid Model Statistics

Reference Factor : 1.12
Redundancy Number (r) : 0.00

Weighting Strategies

GPS Observations
User-defined Scalar Applied to All Observations

Scalar : 4.50

Geoid Observations
Default Scalar Applied to All Observations

Scalar : 1.00

Adjusted Coordinates

Adjustment performed in WGS-84

Number of Points : 5
Number of Constrained Points : 3
Horizontal and Elevation Only : 3

Adjusted Grid Coordinates

Errors are reported using 1.96σ.

Point Name	Northing	N error	Easting	E error	Elevation	e error	Fix
902	2730265.730sft	0.000sft	824150.829sft	0.000sft	90.439sft	0.000sft	N E e
901	2731311.769sft	0.000sft	820874.783sft	0.000sft	78.268sft	0.000sft	N E e
701	2701582.258sft	0.000sft	826135.461sft	0.000sft	42.108sft	0.000sft	N E e
501	2706027.079sft	0.038sft	804940.617sft	0.039sft	63.473sft	2.472sft	
502	2705891.827sft	0.039sft	805310.865sft	0.041sft	60.191sft	2.433sft	

Adjusted Geodetic Coordinates

Errors are reported using 1.96σ.

Point Name	Latitude	N error	Longitude	E error	Height	h error	Fix
902	41°44'17.85839"N	0.000sft	70°53'04.23372"W	0.000sft	-4.569sft	0.836sft	Lat Long e
901	41°44'28.42362"N	0.000sft	70°53'47.34676"W	0.000sft	-16.780sft	0.836sft	Lat Long e

701	41°39'34.34824"N	0.000sft	70°52'40.81561"W	0.000sft	-53.254sft	0.836sft	Lat Long e
501	41°40'19.69124"N	0.038sft	70°57'19.65646"W	0.039sft	-32.246sft	2.504sft	
502	41°40'18.33168"N	0.039sft	70°57'14.78937"W	0.041sft	-35.522sft	2.466sft	

Coordinate Deltas

Point Name	ΔNorthing	ΔEasting	ΔElevation	ΔHeight	ΔGeoid Separation
902	0.000sft	0.000sft	0.000sft	0.002sft	-0.002sft
901	0.000sft	0.000sft	0.000sft	0.000sft	0.000sft
701	0.000sft	0.000sft	0.000sft	-0.001sft	0.001sft
501	0.000sft	0.000sft	-0.013sft	-0.014sft	0.001sft
502	0.000sft	0.001sft	-0.014sft	-0.015sft	0.001sft

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Control Coordinate Comparisons

Values shown are control coord minus adjusted coord.

Point Name	ΔNorthing	ΔEasting	ΔElevation	ΔHeight
902	N/A	N/A	N/A	N/A
901	N/A	N/A	N/A	N/A
701	N/A	N/A	N/A	N/A

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Adjusted Observations

Adjustment performed in WGS-84

GPS Observations

GPS Transformation Group: <GPS Default>

Deflection in Longitude	: 0°00'01.4358"	**(1.96σ)**	: 0°00'24.0927"
Deflection in Latitude	: -0°00'00.1289"	**(1.96σ)**	: 0°00'08.0759"
Azimuth Rotation	: -0°00'00.4178"	**(1.96σ)**	: 0°00'00.2778"
Network Scale	: 0.99999866	**(1.96σ)**	: 0.00000152
Number of Observations	: 6		
Number of Outliers	: 0		

Observation Adjustment (Critical Tau = 2.46). Any outliers are in red.

Obs. ID	From Pt.	To Pt.		Observation	A-posteriori Error (1.96σ)	Residual	Stand. Residual
B7	902	901	**Az.**	288°07'17.5261"	0°00'00.2779"	0°00'02.7223"	2.44
			ΔHt.	-12.190sft	0.066sft	0.009sft	1.29
			Dist.	3439.000sft	0.005sft	0.024sft	1.30

B12	502	501	**Az.**	290°26'01.8305"	0°00'16.9055"	-0°00'09.5997"	-1.16
			ΔHt.	3.279sft	0.089sft	0.011sft	0.61
			Dist.	394.175sft	0.031sft	0.003sft	0.17
B11	502	701	**Az.**	102°03'32.1498"	0°00'00.2703"	-0°00'00.0892"	-1.14
			ΔHt.	-17.874sft	0.153sft	0.005sft	0.08
			Dist.	21265.650sft	0.027sft	0.002sft	0.29
B10	902	501	**Az.**	218°48'41.3877"	0°00'00.2353"	-0°00'00.0191"	-0.36
			ΔHt.	-27.527sft	0.189sft	-0.026sft	-0.24
			Dist.	30927.957sft	0.034sft	-0.009sft	-1.10
B9	701	501	**Az.**	282°15'41.1139"	0°00'00.2788"	0°00'00.0589"	0.52
			ΔHt.	21.153sft	0.153sft	0.029sft	0.26
			Dist.	21655.697sft	0.028sft	0.004sft	0.34
B8	701	901	**Az.**	350°22'58.5928"	0°00'00.2788"	0°00'00.0604"	0.27
			ΔHt.	36.490sft	0.155sft	-0.019sft	-0.36
			Dist.	30191.250sft	0.046sft	0.018sft	0.38

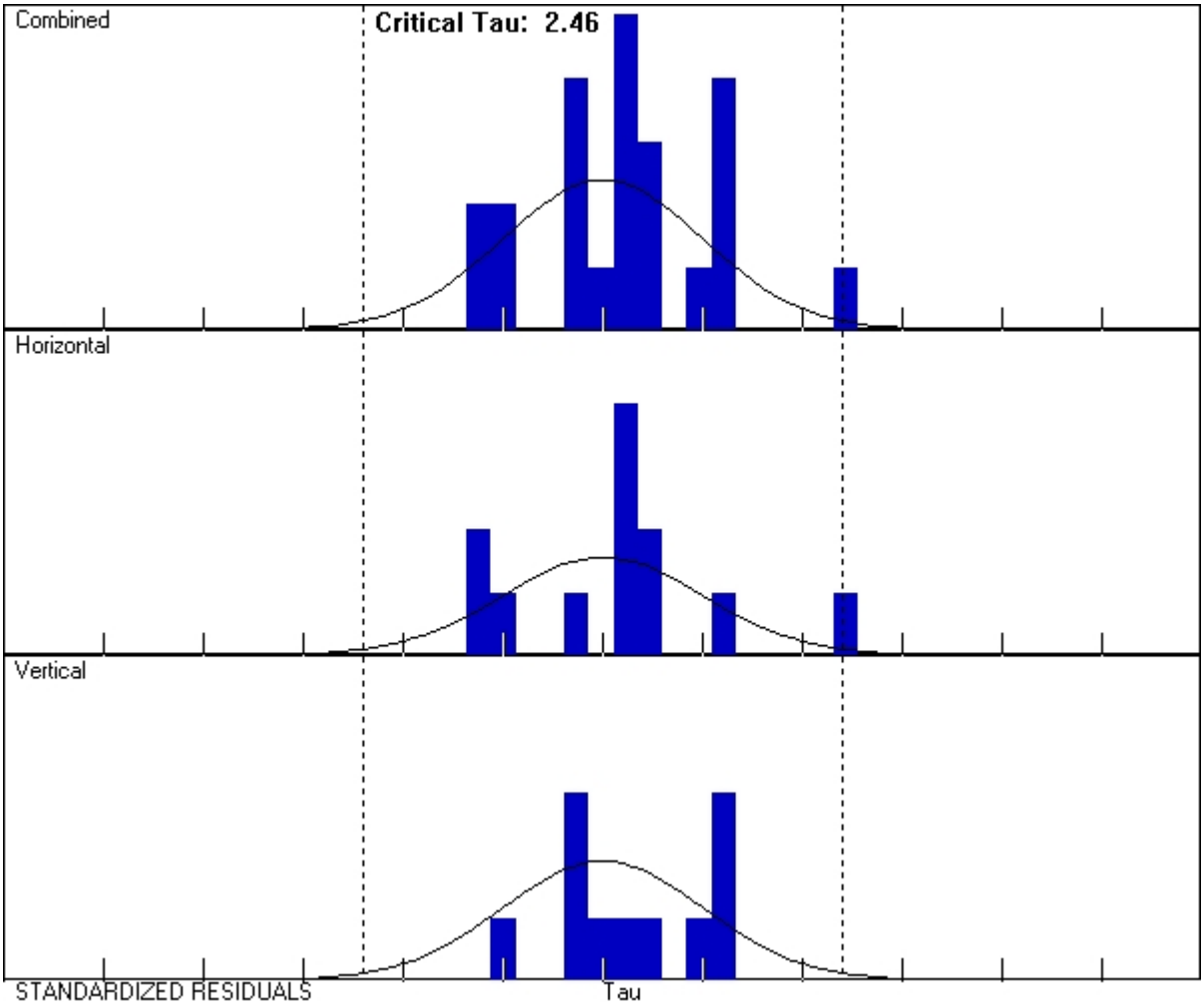
Geoid Observations

Number of Observations : 5
Number of Outliers : 0

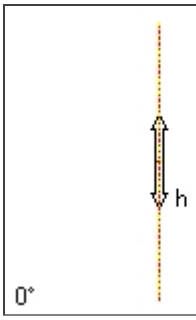
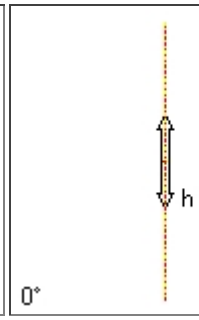
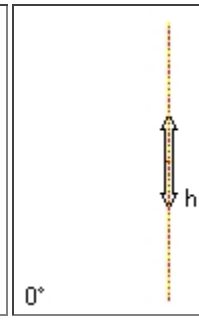
Observation Adjustment (Critical Tau = 2.46). Any outliers are in red.

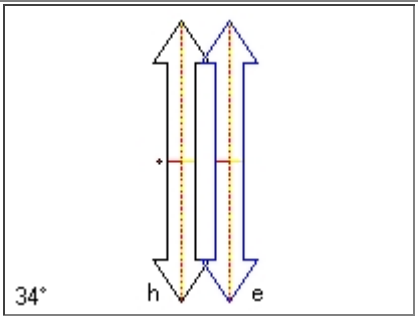
Observation ID	Point Name	Separation	A-posteriori Error (1.96σ)	Residual	Standardized Residual
G5	502	-95.713sft	0.836sft	0.004sft	1.14
G4	501	-95.719sft	0.836sft	0.004sft	1.13
G1	902	-95.008sft	0.836sft	-0.011sft	-1.12
G3	701	-95.363sft	0.836sft	0.005sft	0.99
G2	901	-95.048sft	0.836sft	-0.002sft	-0.31

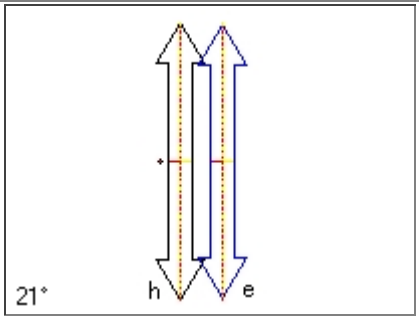
Histograms of Standardized Residuals



Point Error Ellipses

902	901	701
		
Tick Size: 0.0100sft Horizontal Bivariate Scalar: 2.45σ Vertical Univariate Scalar: 1.96σ		
501	**502**	





Tick Size: 0.0100sft Horizontal Bivariate Scalar: 2.45σ Vertical Univariate Scalar: 1.96σ

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Covariant Terms

Adjustment performed in WGS-84

From Point	To Point		Components	A-posteriori Error (1.96σ)	Horiz. Precision (Ratio)	3D Precision (Ratio)
902	901	**Az.**	288°07'17.9438"	0°00'00.0000"	1:0	1:0
		ΔHt.	-12.212sft	0.362sft		
		ΔElev.	-12.172sft	0.000sft		
		Dist.	3439.004sft	0.000sft		
902	501	**Az.**	218°48'41.8063"	0°00'00.2516"	1:774178	1:774178
		ΔHt.	-27.677sft	2.760sft		
		ΔElev.	-26.967sft	2.472sft		
		Dist.	30927.999sft	0.040sft		
901	701	**Az.**	170°22'14.7506"	0°00'00.0000"	1:0	1:0
		ΔHt.	-36.474sft	1.075sft		
		ΔElev.	-36.159sft	0.000sft		
		Dist.	30191.290sft	0.000sft		
701	501	**Az.**	282°15'41.5314"	0°00'00.3708"	1:558513	1:558513
		ΔHt.	21.008sft	2.417sft		
		ΔElev.	21.364sft	2.472sft		
		Dist.	21655.727sft	0.039sft		
701	502	**Az.**	282°06'34.7008"	0°00'00.3807"	1:528622	1:528622
		ΔHt.	17.732sft	2.375sft		
		ΔElev.	18.083sft	2.433sft		
		Dist.	21265.678sft	0.040sft		
501	502	**Az.**	110°25'59.0123"	0°00'16.8763"	1:12813	1:12813
		ΔHt.	-3.276sft	0.098sft		
		ΔElev.	-3.281sft	0.157sft		
		Dist.	394.176sft	0.031sft		

APPENDIX B

Project : Plymouth Network 032007005

User name	kszczubelek	**Date & Time**	4:37:09 PM 2/6/2007
Coordinate System	US State Plane 1983	**Zone**	Massachusetts Mainland 2001
Project Datum	NAD 1983 (Conus)		
Vertical Datum		**Geoid Model**	GEOID03US
Coordinate Units	US survey feet		
Distance Units	US survey feet		
Height Units	US survey feet		

Adjustment Style Settings - 95% Confidence Limits

Residual Tolerances

To End Iterations : 0.000033sft
Final Convergence Cutoff : 0.016404sft

Covariance Display

Horizontal
Propagated Linear Error [E] : U.S.
Constant Term [C] : 0.00000000sft
Scale on Linear Error [S] : 1.96

Three-Dimensional
Propagated Linear Error [E] : U.S.
Constant Term [C] : 0.00000000sft
Scale on Linear Error [S] : 1.96

Elevation Errors were used in the calculations.

Adjustment Controls

Compute Correlations for Geoid : True

Horizontal and Vertical adjustment performed

Set-up Errors

GPS
Error in Height of Antenna : 0.010sft
Centering Error : 0.007sft

Statistical Summary

Successful Adjustment in 1 iteration(s)

Network Reference : 0.88

Factor

Chi Square Test (α=95%) : PASS
Degrees of Freedom : 3.00

GPS Observation Statistics

Reference Factor : 1.05
Redundancy Number (r) : 2.07

Individual GPS Observation Statistics

Observation ID	Reference Factor	Redundancy Number
B1	0.96	1.17
B2	1.20	0.85
B4	0.13	0.06

Geoid Model Statistics

Reference Factor : 0.13
Redundancy Number (r) : 0.93

Weighting Strategies

GPS Observations
User-defined Scalar Applied to All Observations

Scalar : 10.93

Geoid Observations
Default Scalar Applied to All Observations

Scalar : 1.00

Adjusted Coordinates

Adjustment performed in WGS-84

Number of Points : 4
Number of Constrained Points : 4
Horizontal Only : 2
Elevation Only : 1
Horizontal and Elevation Only : 1

Adjusted Grid Coordinates

Errors are reported using 1.96σ.

Point Name	Northing	N error	Easting	E error	Elevation	e error	Fix
704	2896969.916sft	0.000sft	802178.814sft	0.000sft	124.717sft	0.690sft	N E
903	2893334.688sft	0.000sft	743827.429sft	0.000sft	51.722sft	0.000sft	N E e
705	2865810.551sft	0.000sft	854816.996sft	0.000sft	108.296sft	0.432sft	N E
801	2875181.117sft	0.176sft	862397.893sft	0.115sft	122.546sft	0.000sft	e

Adjusted Geodetic Coordinates

Errors are reported using 1.96σ.

Point Name	Latitude	N error	Longitude	E error	Height	h error	Fix

704	42°11'46.19399"N	0.000sft	70°57'40.15261"W	0.000sft	32.780sft	0.692sft	Lat Long
903	42°11'13.19610"N	0.000sft	71°10'35.55437"W	0.000sft	-41.131sft	0.600sft	Lat Long e
705	42°06'34.50526"N	0.000sft	70°46'04.40986"W	0.000sft	16.279sft	0.601sft	Lat Long
801	42°08'06.41864"N	0.176sft	70°44'22.72742"W	0.115sft	30.871sft	0.600sft	e

Coordinate Deltas

Point Name	ΔNorthing	ΔEasting	ΔElevation	ΔHeight	ΔGeoid Separation
704	0.000sft	0.000sft	0.000sft	0.000sft	0.000sft
903	0.000sft	0.000sft	0.000sft	0.000sft	0.000sft
705	0.000sft	0.000sft	0.000sft	0.000sft	0.000sft
801	0.000sft	0.000sft	0.000sft	0.000sft	0.000sft

Control Coordinate Comparisons

Values shown are control coord minus adjusted coord.

Point Name	ΔNorthing	ΔEasting	ΔElevation	ΔHeight
704	N/A	N/A	N/A	N/A
903	N/A	N/A	N/A	N/A
705	N/A	N/A	N/A	N/A
801	N/A	N/A	N/A	N/A

Adjusted Observations

Adjustment performed in WGS-84

GPS Observations

GPS Transformation Group: <GPS Default>

Azimuth Rotation	-0°00'00.0798"	**(1.96σ)**	0°00'00.1050"
Network Scale	0.99999967	**(1.96σ)**	0.00000043

Number of Observations 3

Number of Outliers 0

Observation Adjustment (Critical Tau = 1.72). Any outliers are in red.

Obs. ID	From Pt.	To Pt.		Observation	A-posteriori Error (1.96σ)	Residual	Stand. Residual
B2	903	705	**Az.**	104°08'42.2832"	0°00'00.1050"	-0°00'00.0322"	-0.83
			ΔHt.	57.410sft	0.155sft	0.003sft	0.20
			Dist.	114355.444sft	0.049sft	-0.046sft	-1.72
B1	704	903	**Az.**	266°47'49.4485"	0°00'00.1050"	0°00'00.0242"	0.31
			ΔHt.	-73.911sft	0.347sft	0.002sft	0.05
			Dist.	58466.562sft	0.025sft	0.021sft	1.68

B4	801	705	**Az.**	219°29'02.3304"	0°00'03.1196"	0°00'00.0190"	0.15
			ΔHt.	-14.592sft	0.273sft	-0.005sft	-0.15
			Dist.	12053.523sft	0.104sft	-0.001sft	-0.15

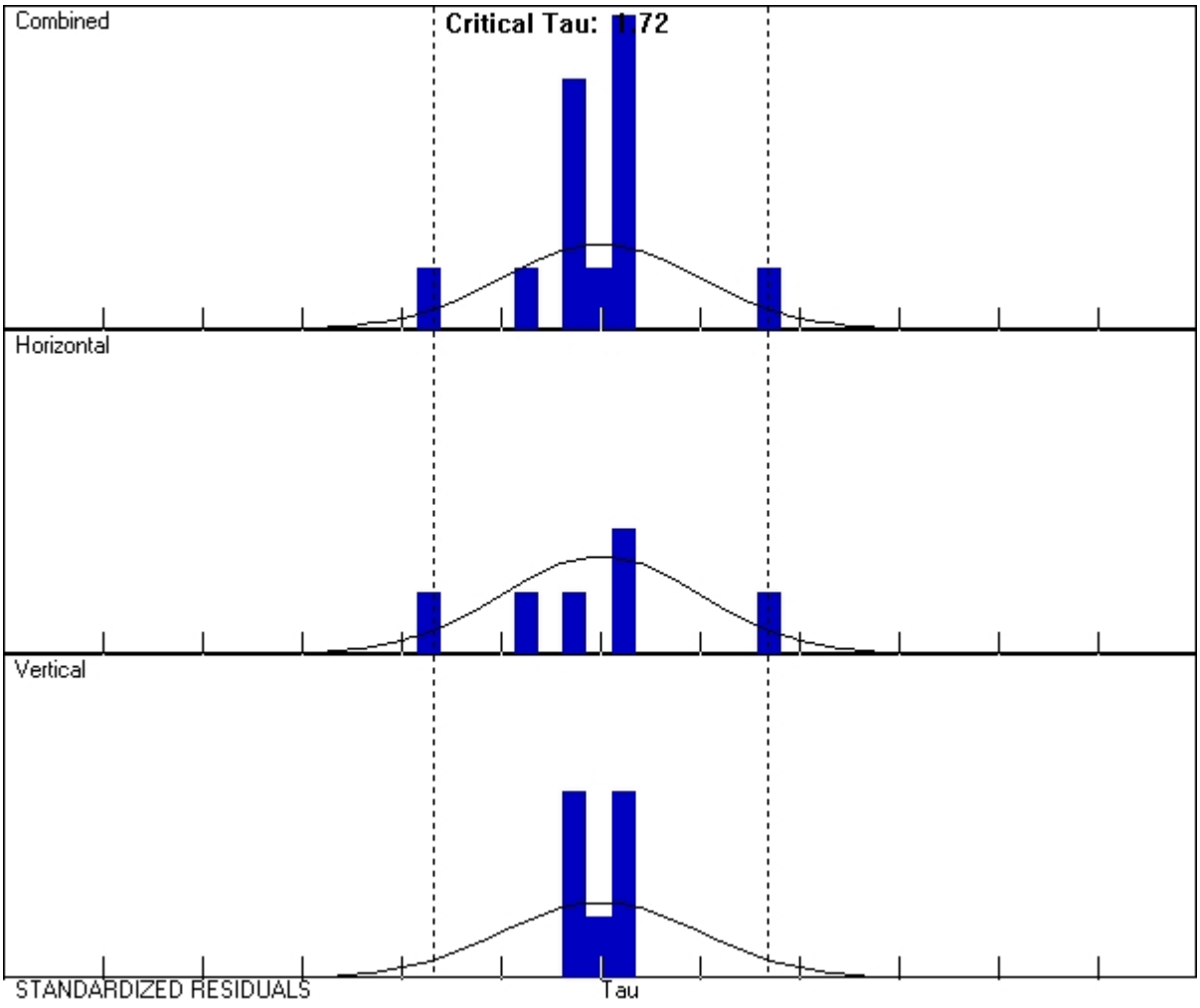
Geoid Observations

Number of Observations 4
Number of Outliers 0

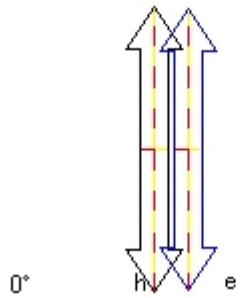
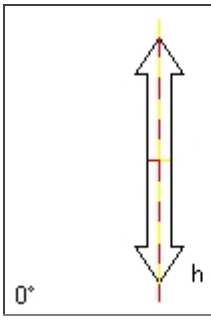
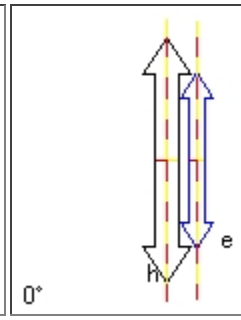
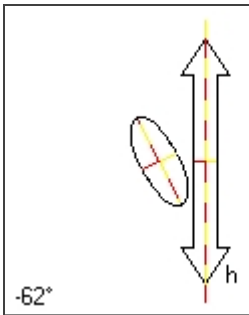
Observation Adjustment (Critical Tau = 1.72). Any outliers are in red.

Observation ID	Point Name	Separation	A-posteriori Error (1.96σ)	Residual	Standardized Residual
G4	801	-91.675sft	0.600sft	-0.041sft	-0.15
G3	705	-92.017sft	0.664sft	-0.035sft	-0.15
G2	903	-92.854sft	0.600sft	0.041sft	0.15
G1	704	-91.937sft	0.810sft	0.002sft	0.15

Histograms of Standardized Residuals



Point Error Ellipses

704	903	705
		
Tick Size: 0.1000sft Horizontal Bivariate Scalar: 2.45σ Vertical Univariate Scalar: 1.96σ		
801		
		
Tick Size: 0.1000sft Horizontal Bivariate Scalar: 2.45σ Vertical Univariate Scalar: 1.96σ		

Covariant Terms

Adjustment performed in WGS-84

From Point	To Point		Components	A-posteriori Error (1.96σ)	Horiz. Precision (Ratio)	3D Precision (Ratio)
704	903	**Az.**	266°47'49.5283"	0°00'00.0000"	1:0	1:0
		ΔHt.	-73.911sft	0.347sft		
		ΔElev.	-72.994sft	0.690sft		
		Dist.	58466.582sft	0.000sft		
903	705	**Az.**	104°08'42.3630"	0°00'00.0000"	1:0	1:0
		ΔHt.	57.411sft	0.155sft		
		ΔElev.	56.573sft	0.432sft		
		Dist.	114355.482sft	0.000sft		
705	801	**Az.**	39°27'54.2102"	0°00'03.1206"	1:115527	1:115527
		ΔHt.	14.592sft	0.273sft		
		ΔElev.	14.250sft	0.432sft		
		Dist.	12053.527sft	0.104sft		

APPENDIX C
Loop Closure Report

Project : Bristol Network 032007005

User name	kszczubelek	**Date & Time**	4:22:02 PM 2/6/2007
Coordinate System	US State Plane 1983	**Zone**	Massachusetts Mainland 2001
Project Datum	NAD 1983 (Conus)		
Vertical Datum		**Geoid Model**	GEOID03US
Coordinate Units	US survey feet		
Distance Units	US survey feet		
Height Units	US survey feet		

Summary

Report includes both active and inactive solutions (if any).
Report applies to whole database.

Legs in loop: 7
Number of Loops: 3
Number Passed: 3
Number Failed: 0

	Length	ΔHoriz	ΔVert	PPM
Pass/Fail Criteria		0.098sft	0.164sft	
Best		0.030sft	-0.025sft	0.880
Worst		0.041sft	-0.095sft	1.198
Average Loop	71915.789sft	0.034sft	-0.063sft	1.007
Standard Deviation	20223.466sft	0.005sft	0.029sft	0.138

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Passed Loops

GPS Loop 1:
902: 901: 701: 501: 902

Observations:

Baseline ID	Solution ID	From	To	Solution Type	Start Time
B7	S1	902	901	L1 fixed	13:48:18 9 Nov 2006
B8	S2	701	901	Iono free fixed	12:08:08 9 Nov 2006
B9	S10	701	501	Iono free fixed	09:15:56 11 Nov 2006
B10	S9	902	501	Iono free fixed	10:23:41 10 Nov 2006

Passed combinations for loop 1:

	Length	ΔHoriz	ΔVert	PPM
S1 - S2 - S10 - S9	86213.871sft	0.041sft	-0.095sft	1.198

GPS Loop 2:
902: 901: 701: 502: 501: 902

Observations:

Baseline ID	Solution ID	From	To	Solution Type	Start Time

B7	S1	902	901	L1 fixed	13:48:18 9 Nov 2006
B8	S2	701	901	Iono free fixed	12:08:08 9 Nov 2006
B11	S11	502	701	Iono free fixed	05:37:02 26 Nov 2006
B12	S12	502	501	L1 fixed	08:30:45 26 Nov 2006
B10	S9	902	501	Iono free fixed	10:23:41 10 Nov 2006

Passed combinations for loop 2:

	Length	ΔHoriz	ΔVert	PPM
S1 - S2 - S11 - S12 - S9	86218.006sft	0.030sft	-0.070sft	0.880

GPS Loop 3:
701: 501: 502: 701

Observations:

Baseline ID	Solution ID	From	To	Solution Type	Start Time
B9	S10	701	501	Iono free fixed	09:15:56 11 Nov 2006
B12	S12	502	501	L1 fixed	08:30:45 26 Nov 2006
B11	S11	502	701	Iono free fixed	05:37:02 26 Nov 2006

Passed combinations for loop 3:

	Length	ΔHoriz	ΔVert	PPM
S10 - S12 - S11	43315.489sft	0.032sft	-0.025sft	0.942

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Passed Loop Details

Loop S1 - S2 - S10 - S9:

From: 902

To:	901		L1 fixed	13:48:18 9 Nov 2006
		Slope:	3438.998sft	2731323.181sft
		Total:	3438.998sft	820870.243sft
				82.570sft
To:	701		Iono free fixed	12:08:08 9 Nov 2006
		Slope:	30191.227sft	2701593.720sft
		Total:	33630.225sft	826130.980sft
				46.365sft
To:	501		Iono free fixed	09:15:56 11 Nov 2006
		Slope:	21655.677sft	2706038.490sft
		Total:	55285.902sft	804936.145sft
				67.858sft
To:	902		Iono free fixed	10:23:41 10 Nov 2006

	Slope:	30927.969sft	2730277.164sft
	Total:	86213.871sft	824146.298sft
			94.621sft
Precision:	1.198ppm		
Errors	Horiz:	0.041sft	Vert: -0.095sft

Loop S1 - S2 - S11 - S12 - S9:

From: 902

To: 901		L1 fixed	13:48:18 9 Nov 2006
	Slope:	3438.998sft	2731323.181sft
	Total:	3438.998sft	820870.243sft
			82.570sft
To: 701		Iono free fixed	12:08:08 9 Nov 2006
	Slope:	30191.227sft	2701593.720sft
	Total:	33630.225sft	826130.980sft
			46.365sft
To: 502		Iono free fixed	05:37:02 26 Nov 2006
	Slope:	21265.626sft	2705903.253sft
	Total:	54895.851sft	805306.395sft
			64.609sft
To: 501		L1 fixed	08:30:45 26 Nov 2006
	Slope:	394.186sft	2706038.520sft
	Total:	55290.037sft	804936.156sft
			67.883sft
To: 902		Iono free fixed	10:23:41 10 Nov 2006
	Slope:	30927.969sft	2730277.194sft
	Total:	86218.006sft	824146.309sft
			94.646sft
Precision:	0.880ppm		
Errors	Horiz:	0.030sft	Vert: -0.070sft

Loop S10 - S12 - S11:

From: 701

To: 501		Iono free fixed	09:15:56 11 Nov 2006
	Slope:	21655.677sft	2706027.067sft
	Total:	21655.677sft	804937.439sft

				65.663sft
To:	502		L1 fixed	08:30:45 26 Nov 2006
		Slope:	394.186sft	2705891.800sft
		Total:	22049.863sft	805307.679sft
				62.390sft
To:	701		Iono free fixed	05:37:02 26 Nov 2006
		Slope:	21265.626sft	2701582.266sft
		Total:	43315.489sft	826132.266sft
				44.149sft

Precision: 0.942ppm

Errors Horiz: 0.032sft Vert: -0.025sft

APPENDIX D
Loop Closure Report

Project : Plymouth Network 032007005

User name	kszczubelek	**Date & Time**	4:27:18 PM 2/6/2007
Coordinate System	US State Plane 1983	**Zone**	Massachusetts Mainland 2001
Project Datum	NAD 1983 (Conus)		
Vertical Datum		**Geoid Model**	GEOID03US
Coordinate Units	US survey feet		
Distance Units	US survey feet		
Height Units	US survey feet		

Contents

Summary

Report includes both active and inactive solutions (if any).
Report applies to whole database.

Legs in loop: *

Number of Loops: 1

Number Passed: 1

Number Failed: 0

	Length	ΔHoriz	ΔVert	PPM
Pass/Fail Criteria		0.098sft	0.164sft	
Best		0.086sft	-0.149sft	0.691
Worst		0.086sft	-0.149sft	0.691
Average Loop	248917.554sft	0.086sft	-0.149sft	0.691
Standard Deviation	0.000sft	0.000sft	0.000sft	0.000

Passed Loops

GPS Loop 1:
704: 903: 705: 801: 704

Observations:

Baseline ID	Solution ID	From	To	Solution Type	Start Time
B1	S1	704	903	Iono free fixed	13:05:58 21 Nov 2006
B2	S2	903	705	Iono free fixed	11:07:55 17 Nov 2006
B4	S9	801	705	L1 fixed	14:13:32 17 Nov 2006
B3	S3	801	704	Iono free fixed	13:00:01 17 Nov 2006

Passed combinations for loop 1:

	Length	ΔHoriz	ΔVert	PPM
S1 - S2 - S9 - S3	248917.554sft	0.086sft	-0.149sft	0.691

Passed Loop Details

Loop S1 - S2 - S9 - S3:

From:	704			
To:	903		Iono free fixed	13:05:58 21 Nov 2006
		Slope:	58466.558sft	2893339.523sft
		Total:	58466.558sft	743827.955sft
				50.671sft
To:	705		Iono free fixed	11:07:55 17 Nov 2006
		Slope:	114355.294sft	2865815.408sft
		Total:	172821.852sft	854817.542sft
				107.056sft
To:	801		L1 fixed	14:13:32 17 Nov 2006
		Slope:	12053.546sft	2875185.975sft
		Total:	184875.398sft	862398.433sft
				121.298sft
To:	704		Iono free fixed	13:00:01 17 Nov 2006
		Slope:	64042.155sft	2896974.863sft
		Total:	248917.554sft	802179.297sft
				123.425sft

Precision:	0.691ppm				
Errors	Horiz:	0.086sft	Vert:	-0.149sft	

APPENDIX E
Check Point Images

Check Point 1

Check Point 2

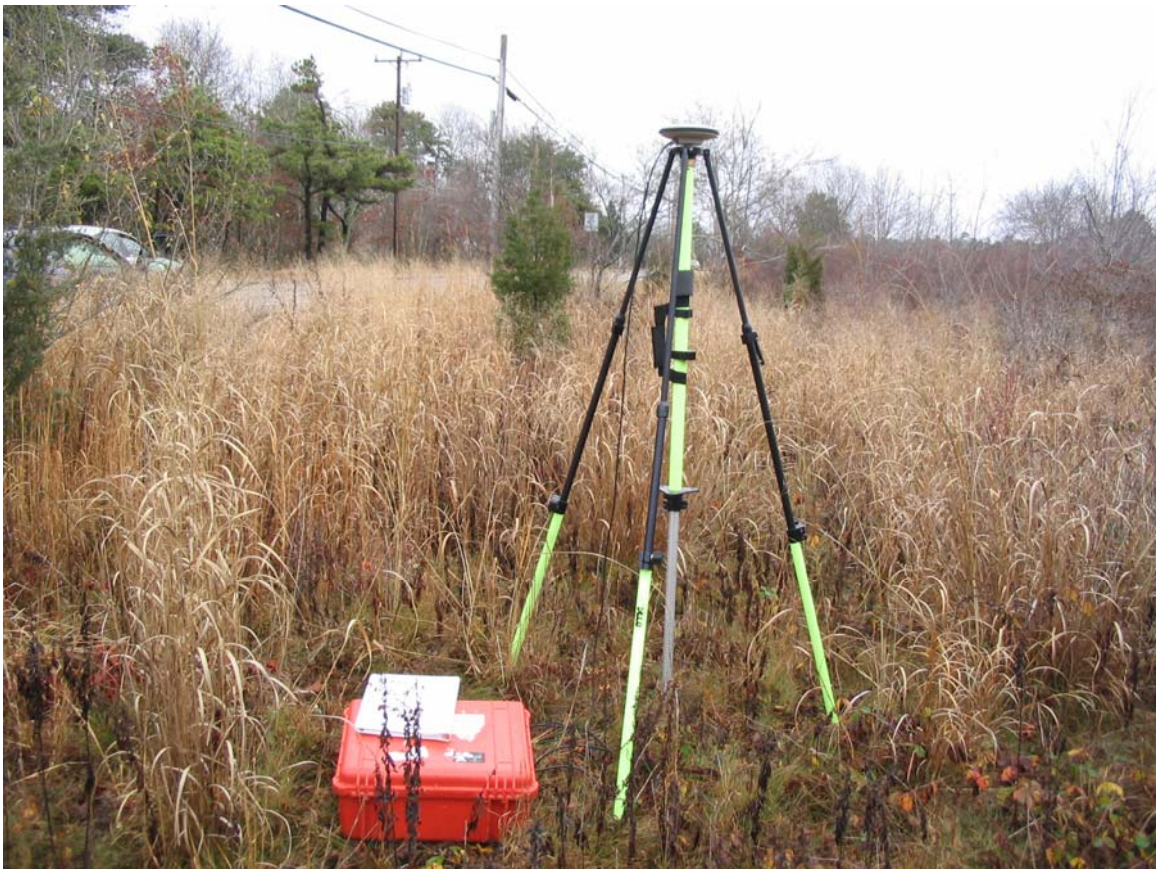
Check Point 3

Check Point 4

Check Point 5

Check Point 6

Check Point 7



Check Point 8

Check Point 9

Check Point 10

Check Point 11

Check Point 12

Check Point 13

Check Point 14

Appendix B

LiDAR Metadata

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          Fairhaven, Mattapoisett, Marion, and Wareham. The project area was
          defined using a buffered shapefile with limits along the coastline. The
          project area included a portion of both counties. All lidar data was
          acquired during November 2006 by Sanborn. Source
          orthophotography used to create 2D breaklines was produced in 2005
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          Flood Insurance Rate Maps and flood insurance studies for coastal
          areas in Massachusetts. Contours are based on bare earth LIDAR and
          breaklines digitized from 2D orthophotography (subsequently draped
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          Appendix N. Coastal shoreline areas were set a 0.00 elevation to
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        <enttypds>FEMA Guidelines and Specifications for Flood Hazard
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          Data and DFIRM Databases (available at
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Appendix C

Field Survey Reports

DIGITAL FLOOD INSURANCE RATE MAP TASK FOR COASTAL ANALYSIS PLYMOUTH AND BRISTOL COUNTIES (MA)

FEMA CONTRACT NO. EME-2003-CO-0340 (TASK ORDER #18)
CDM SUBCONTRACT NO. 2809-999-002-CS (TASK ORDER #10)

LIDAR CHECKPOINTS SURVEY DATA REPORT

for

PLYMOUTH AND BRISTOL COUNTIES, MA

Prepared for:

Camp Dresser & McKee, Inc.

June 7, 2007

Prepared By:

Green International Affiliates, Inc.

GREEN INTERNATIONAL AFFILIATES, INC.
407R MYSTIC AVENUE, UNIT 25, MEDFORD, MA 02155
(781) 391-5757 FAX (781) 391-8889

June 7, 2007

Ronald Miner, P.E.
Camp Dresser & McKee, Inc.
50 Hampshire Street
Cambridge, MA 02139

Subject:

Plymouth and Bristol Counties (MA)
LiDAR Checkpoints Survey
FEMA Contract No.
EME-2003-CO-340 (Task Order18)

Dear Ron:

Enclosed please find the LiDAR checkpoint survey report for the above referenced project. The checkpoint survey was performed for twenty locations (22), ten points on paved surfaces and the remaining on grass surfaces, in Plymouth and Bristol, Counties (MA). In addition, supplemental checkpoints survey was performed in the vicinity of each check pointes site. Green International Affiliates, Inc. (Green) established x, y and z coordinates for these points using Global Position System (GPS) equipment (TPS Hiper GD integrated antenna/receiver) in conformance with FEMA Standards.

The GPS data was processed using the online positioning user services from the National Geodetic Survey (NGS) and the National Oceanic and Atmospheric Administration (NOAA) website. The horizontal coordinates (northing and easting) are referenced to the Universal Transverse Mercator (UTM) Zone 19 and to the North American Datum NAD 83 Coordinate System, Massachusetts, Mainland State Plane Coordinate (SPC 2001 MA-M) (both in Metric and U.S. English units in the NGS date reports).

Elevations are referenced to the North American Vertical Datum (NAVD 88) (U.S. English units).

Below is a summary table for the checkpoints to be used for LiDAR mapping.

Checkpoint #	Town	Ground Surface	SPC (NAD 83) 2001 MA-M State Coordinate System		Elevation (NAVD 88 - ft)
			Northing (ft)	Easting (ft)	
G1	Wareham	Grass	2732106.586	888541.835	22.01
G2	Wareham	Grass	2735228.004	874260.545	13.15
G3	Marion	Grass	2712950.801	865021.931	11.45
G4	Marion	Grass	2706605.607	862505.604	8.13
G5	New Bedford	Grass	2682699.556	815662.148	8.31
G6	New Bedford	Grass	2678412.737	819339.667	11.79
G7	Mattapoisett	Grass	2689074.077	838606.968	7.49
G8	Mattapoisett	Grass	2697935.746	857316.569	6.51
G9	Fairhaven	Grass	2694351.924	816217.150	6.10
G10	Fairhaven	Grass	2685123.413	828887.594	6.45
P1	Wareham	Pavement	2731873.060	888493.289	10.80
P2	Wareham	Pavement	2735260.297	874279.528	11.96
P3	Marion	Pavement	2712794.525	865479.667	7.77
P4	Marion	Pavement	2706701.204	862496.953	7.63
P5	New Bedford	Pavement	2682668.716	815669.038	8.07
P6	New Bedford	Pavement	2678404.115	819293.342	12.06
P7	Mattapoisett	Pavement	2689052.499	838628.582	7.13
P8	Mattapoisett	Pavement	2698039.843	857224.509	6.97
P9	Fairhaven	Pavement	2694398.115	816274.004	6.58
P10	Fairhaven	Pavement	2685171.743	828848.109	4.75

Please refer to the Appendixes for the checkpoints photos, field notes and sketches, supplemental check pointes survey, and NGS data base stations.

Please feel free to contact me should you have any questions regarding this matter.

Sincerely,

Green International Affiliates, Inc.

Peter A. Richardson

Peter A. Richardson, P.E., CFM
Vice President

SMS/sase

Checkpoints Photos

Wham--G1-Grass

Wham--P1-Pavement

Wham--G2-Grass

Wham--P2-Pavement

Marion-P3-Pavement

Marion--G3-Grass

Marion-G4-Grass

Marion-P4-Pavement

New Bedf-G5-Grass

New Bedf-P5-Pavement

New Bedf-P6-Pavement

New Bedf-G6-Grass

Mattap.-G7-Grass

Mattap.-P7-Pavement

Mattap.-P8-Pavement

Mattap.-G8-Grass

Fhaven-G9-Grass

Fhaven-P9-Pavement

Fhaven-P10-Pavement

Fhaven-G10-Grass

Field Notes & Sketches

G-1

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 2 OF 2
OBSERVER KS, KR DATE 1/8/07
TEMPERATURE _____ WEATHER RAINY
STATION NAME _____
LOCATION WAREHAM, MASS

Station/Monument Designation: G-1

Receiver Number: R1 Session: A

Receiver Model: Topcon HIPER GD

Receiver S/N: _____

Slant Height: 1.475 (m) 4.84 (ft)

ARP vertical offset: 0.0305 (m) 0.10 (ft)

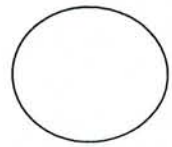
ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.445 (m) 4.74 (ft)

$$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$$ METRIC

$$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$$ ENGLISH

GPS RECEIVER LOCATION SKETCH



Indicate North

Session Information

Planned Observation
Start Time: 10:00 AM
End Time: 12:30 PM

Actual Observation
Start Time: 10:10AM
End Time: 12:44 PM

Site Description:

Comments:

G-2

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 1 OF 2
OBSERVER K.R, K.K DATE 1/8/07
TEMPERATURE _____ WEATHER _____
STATION NAME Crab Cove
LOCATION PUBLIC BOAT RAMP

Station/Monument Designation: G-2

Receiver Number: R-1 Session: B

Receiver Model: Topcon HIPER GD

Receiver S/N: _____

Slant Height: 1.353 (m) 4.44 (ft)

ARP vertical offset: 0.0305 (m) 0.10 (ft)

ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.323 (m) 4.34 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

Session Information

Planned Observation
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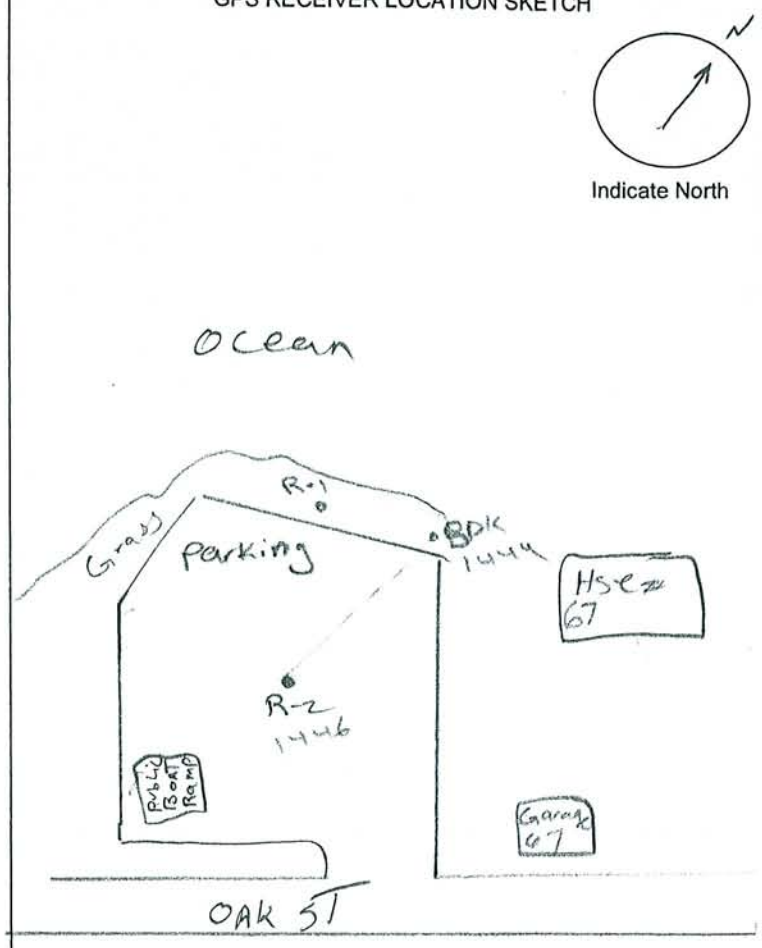
End Time: 3:30 PM

Actual Observation
Start Time: 1:16 PM
End Time: 3:40 PM

GPS RECEIVER LOCATION SKETCH



Site Description:

Comments:

G-3

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 1 OF 2
OBSERVER KS, KR DATE 1/3/07
TEMPERATURE WEATHER Cloudy
STATION NAME PLANTING Island
LOCATION MARION, MASS

Station/Monument Designation: G-3

Receiver Number: R-2 Session: A

Receiver Model: Topcon HIPER GD

Receiver S/N:

Slant Height: 1.53 (m) 5.01 (ft)

ARP vertical offset: 0.0305 (m) 0.10 (ft)

ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.50 (m) 4.91 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

Session Information

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End Time: 12:30 PM

Actual Observation
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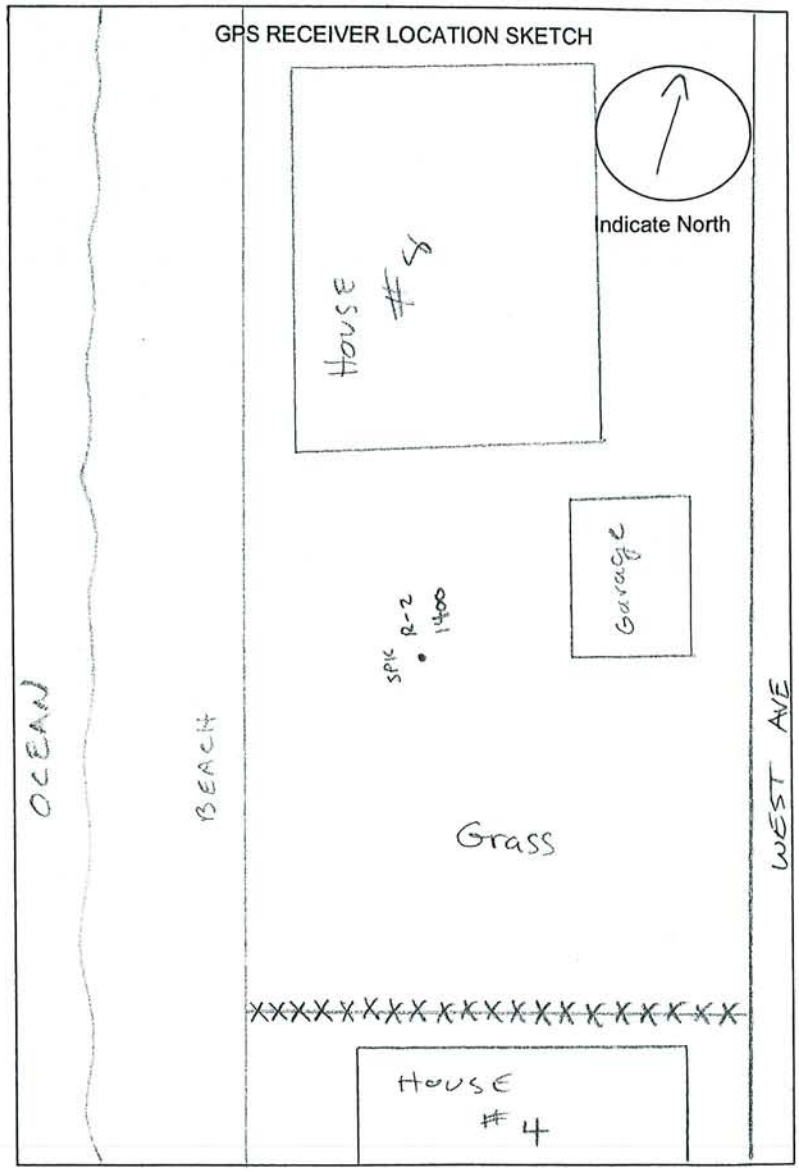
End Time: 12:34 PM

GPS RECEIVER LOCATION SKETCH



Site Description:

Comments:

G-4

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 2 OF 2
OBSERVER KS, KR DATE 1/3/07
TEMPERATURE _____ WEATHER Cloudy
STATION NAME _____
LOCATION MARION, MASS

Station/Monument Designation: G-4
Receiver Number: R-1 Session: B
Receiver Model: Topcon HIPER GD
Receiver S/N: _____

Slant Height: 1.545 (m) 5.06 (ft)
ARP vertical offset: 0.0305 (m) 0.10 (ft)
ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.51 (m) 4.96 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

Session Information

Planned Observation
Start Time: 1:00 PM
End Time: 3:30 PM

Actual Observation
Start Time: 1:12 PM
End Time: 3:43 PM

GPS RECEIVER LOCATION SKETCH

Indicate North

Site Description:

Comments:

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 1 OF 2
OBSERVER KS, KR DATE 12/28/06
TEMPERATURE 42°F WEATHER Sunny
STATION NAME Clark's Cove Public Beach
LOCATION New Bidford, MA.

Station/Monument Designation: G-5

Receiver Number: R-1 Session: A

Receiver Model: Topcon HIPER GD

Receiver S/N:

Slant Height: 1.41 (m) 4.63 (ft)

ARP vertical offset: 0.0305 (m) 0.10 (ft)

ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.38 (m) 4.53 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

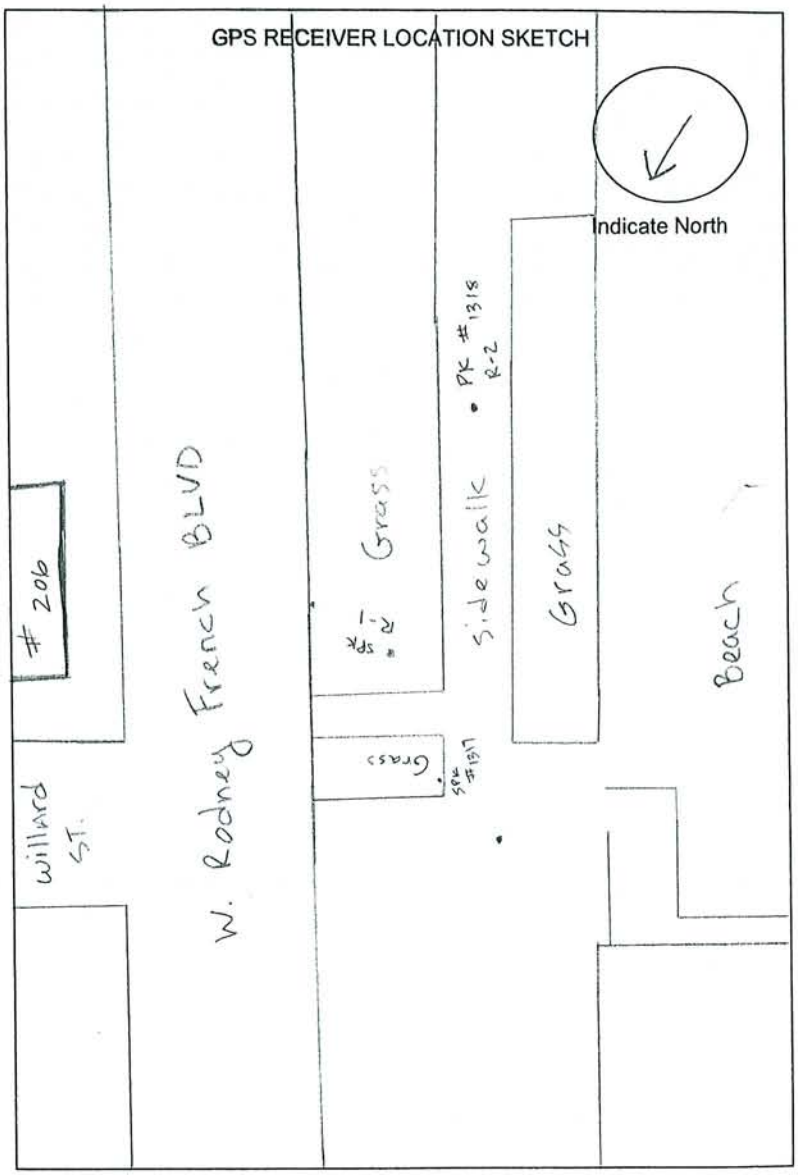
$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

Session Information

Planned Observation
Start Time: 9:30AM
End Time: 12:00 PM

Actual Observation
Start Time: 9:37AM
End Time: 12:10 PM

GPS RECEIVER LOCATION SKETCH



Site Description:

Comments:

G-6

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 1 OF 2
OBSERVER KS, KR DATE 12/28/06
TEMPERATURE 40°F WEATHER Sunny
STATION NAME FORT TABER Park
LOCATION New Bedford, MA

Station/Monument Designation: G-6
Receiver Number: R-1 Session: B
Receiver Model: Topcon HIPER GD
Receiver S/N:

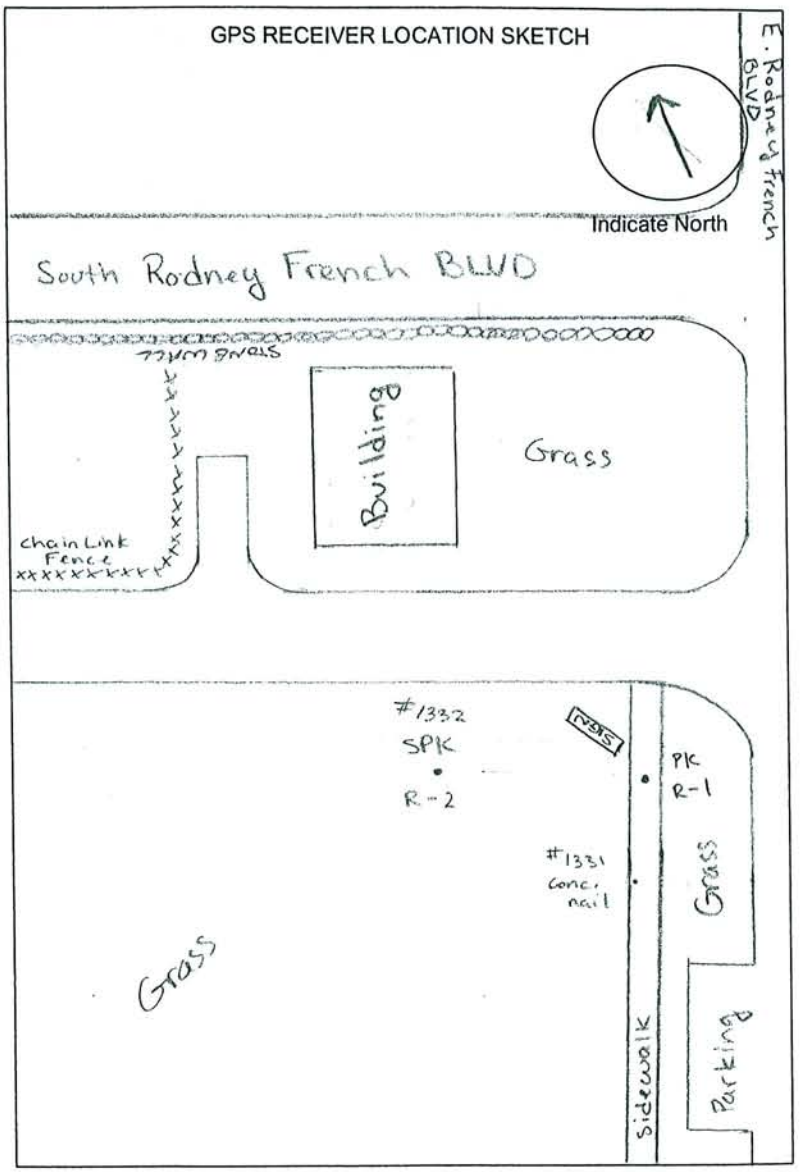
Slant Height: 1.335 (m) 4.39 (ft)
ARP vertical offset: 0.0305 (m) 0.10 (ft)
ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.305 (m) 4.29 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

GPS RECEIVER LOCATION SKETCH



Session Information

Planned Observation
Start Time: 12:30 PM
End Time: 3:00 PM

Actual Observation
Start Time: 12:36 PM
End Time: 3:06 PM

Site Description:

Comments:

G-7

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 1 OF 2
OBSERVER KS, KR DATE 1/2/07
TEMPERATURE _____ WEATHER Sunny
STATION NAME BRANT BEACH
LOCATION MATTAPOISETT, MASS

Station/Monument Designation: G-7

Receiver Number: R-1 Session: A

Receiver Model: Topcon HIPER GD

Receiver S/N: _____

Slant Height: 1.43 (m) 4.68 (ft)

ARP vertical offset: 0.0305 (m) 0.10 (ft)

ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.40 (m) 4.58 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

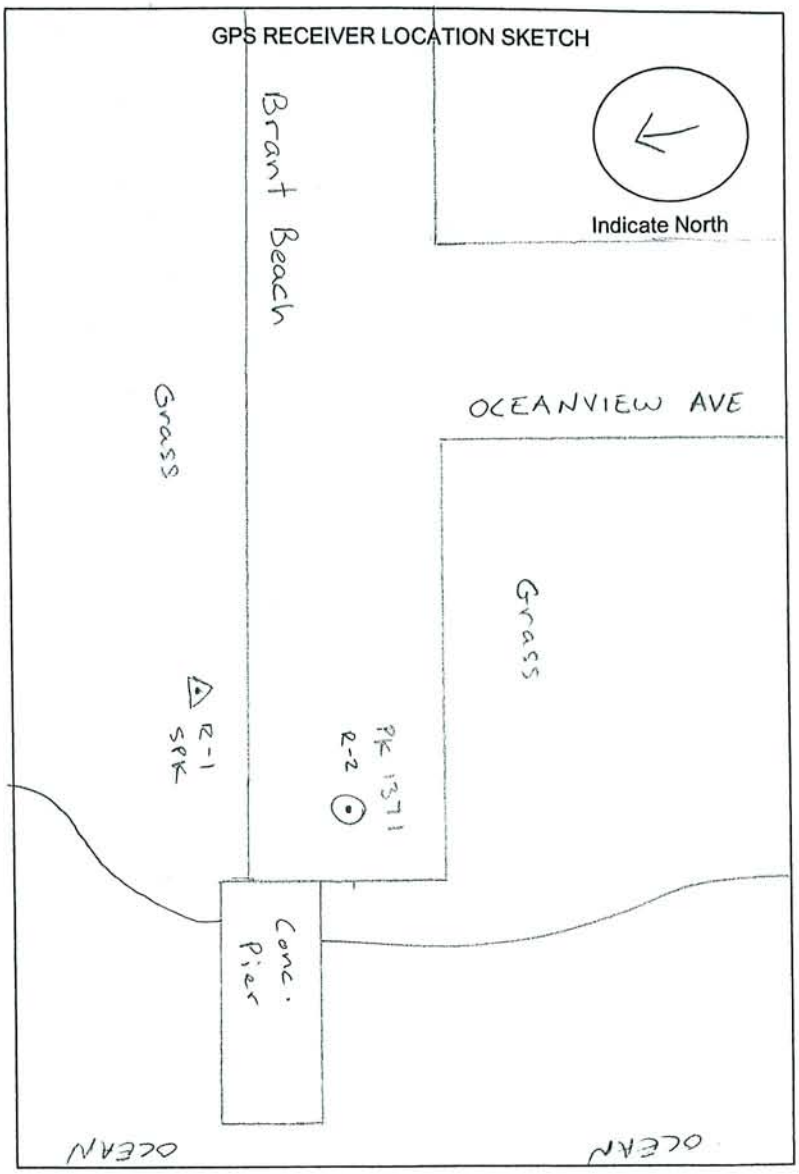
$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

Session Information

Planned Observation
Start Time: 10:00 AM
End Time: 12:30 PM

Actual Observation
Start Time: 10:01 AM
End Time: 12:30 PM

GPS RECEIVER LOCATION SKETCH



Site Description:

Comments:

G-8

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 2 OF 2
OBSERVER KS, KR DATE 1/2/07
TEMPERATURE _____ WEATHER Sunny
STATION NAME _____
LOCATION Mattapoisett, MASS

Station/Monument Designation: G-8

Receiver Number: R-2 Session: B

Receiver Model: Topcon HIPER GD

Receiver S/N: _____

Slant Height: 1.585 (m) 5.19 (ft)

ARP vertical offset: 0.0305 (m) 0.10 (ft)

ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.555 (m) 5.09 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

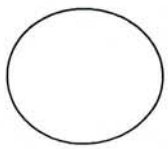
$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

Session Information

Planned Observation
Start Time: 1:00 PM
End Time: 3:30 PM

Actual Observation
Start Time: 1:17 PM
End Time: 3:45 PM

GPS RECEIVER LOCATION SKETCH



Indicate North

Site Description:

Comments:

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 2 OF 2
OBSERVER KS, KR DATE 12/29/06
TEMPERATURE _____ WEATHER Cloudy
STATION NAME _____
LOCATION Fairhaven, Mass

Station/Monument Designation: G-9

Receiver Number: R-2 Session: A

Receiver Model: Topcon HIPER GD

Receiver S/N: _____

Slant Height: 1.37 (m) 4.48 (ft)

ARP vertical offset: 0.0305 (m) 0.10 (ft)

ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.34 (m) 4.38 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

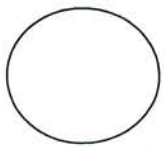
$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

Session Information

Planned Observation
Start Time: 9:30AM
End Time: 12:00 PM

Actual Observation
Start Time: 9:23AM
End Time: 11:56AM

GPS RECEIVER LOCATION SKETCH



Indicate North

Site Description:

Comments:

G-10

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 2 OF 2
OBSERVER KS, KR DATE 12/29/06
TEMPERATURE _____ WEATHER Sunny
STATION NAME _____
LOCATION Fairhaven, MASS

Station/Monument Designation: G-10

Receiver Number: R-2 Session: B

Receiver Model: Topcon HIPER GD

Receiver S/N: _____

Slant Height: 1.38 (m) 4.52 (ft)

ARP vertical offset: 0.0305 (m) 0.10 (ft)

ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.35 (m) 4.42 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

GPS RECEIVER LOCATION SKETCH

Indicate North

Session Information

Planned Observation
Start Time: 12:30 PM
End Time: 2:00 PM

Actual Observation
Start Time: 12:23 PM
End Time: 2:54

Site Description:

Comments:

P-1

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 1 OF 2
OBSERVER KS, KR DATE 1/8/07
TEMPERATURE WEATHER RAINY
STATION NAME Point Independence
LOCATION WAREHAM, MASS

Station/Monument Designation: P-1
Receiver Number: R2 Session: A
Receiver Model: Topcon HIPER GD
Receiver S/N:

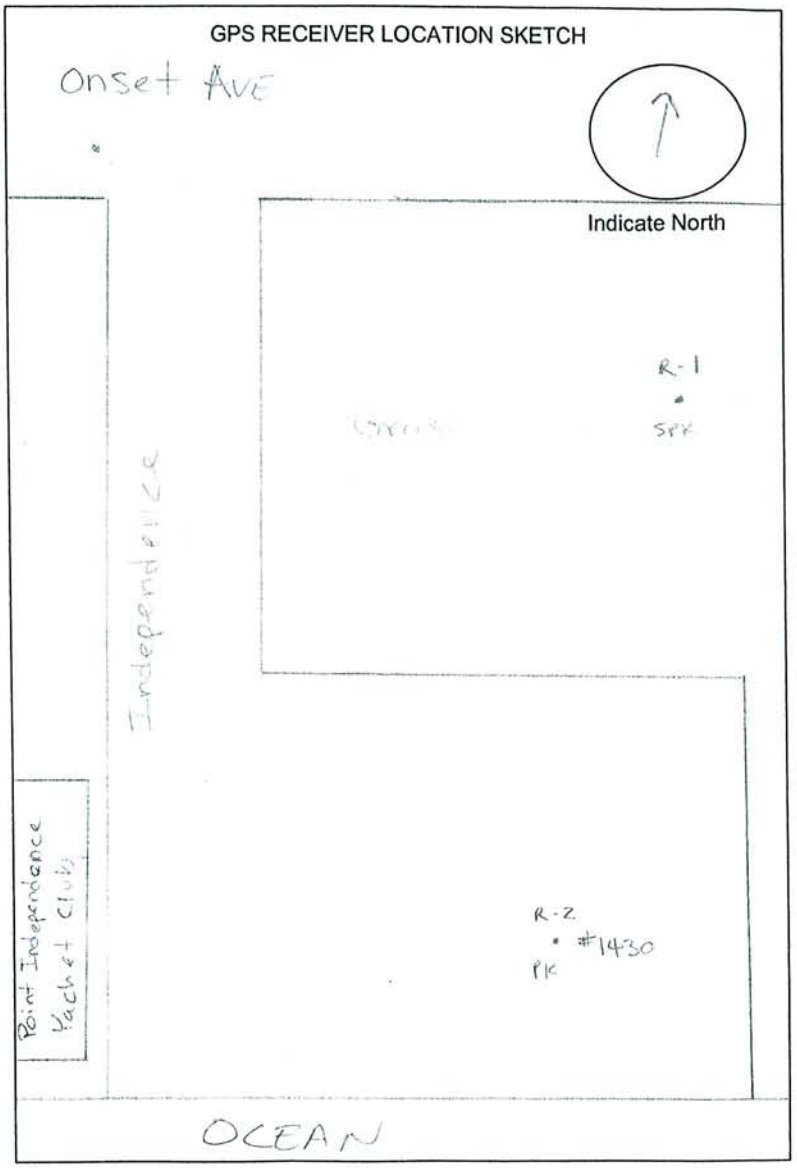
Slant Height: 1.495 (m) 4.91 (ft)
ARP vertical offset: 0.0305 (m) 0.10 (ft)
ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.465 (m) 4.81 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

GPS RECEIVER LOCATION SKETCH



Session Information

Planned Observation
Start Time: 10:00AM
End Time: 12:30PM

Actual Observation
Start Time: 10:07AM
End Time: 12:41 PM

Site Description:

Comments:

P-2

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 2 OF 2
OBSERVER KS, KR DATE 1/8/07
TEMPERATURE _____ WEATHER _____
STATION NAME _____
LOCATION WAREHAM, MASS

Station/Monument Designation: P-2

Receiver Number: R-2 Session: B

Receiver Model: Topcon HIPER GD

Receiver S/N: _____

Slant Height: 1.375 (m) 4.51 (ft)

ARP vertical offset: 0.0305 (m) 0.10 (ft)

ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.345 (m) 4.41 (ft)

$ARP\,Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

$ARP\,Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

Session Information

Planned Observation
Start Time: 1:00 PM
End Time: 3:30 PM

Actual Observation
Start Time: 1:20 PM
End Time: 3:40 PM

GPS RECEIVER LOCATION SKETCH

Indicate North

Site Description:

Comments:

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 2 OF 2
OBSERVER KS, KR DATE 1/3/07
TEMPERATURE _____ WEATHER Cloudy
STATION NAME Planting Island
LOCATION MARION, MASS

Station/Monument Designation: P-3

Receiver Number: R-1 Session: A

Receiver Model: Topcon HIPER GD

Receiver S/N: _____

Slant Height: 1.47 (m) 4.82 (ft)

ARP vertical offset: 0.0305 (m) 0.10 (ft)

ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.44 (m) 4.72 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

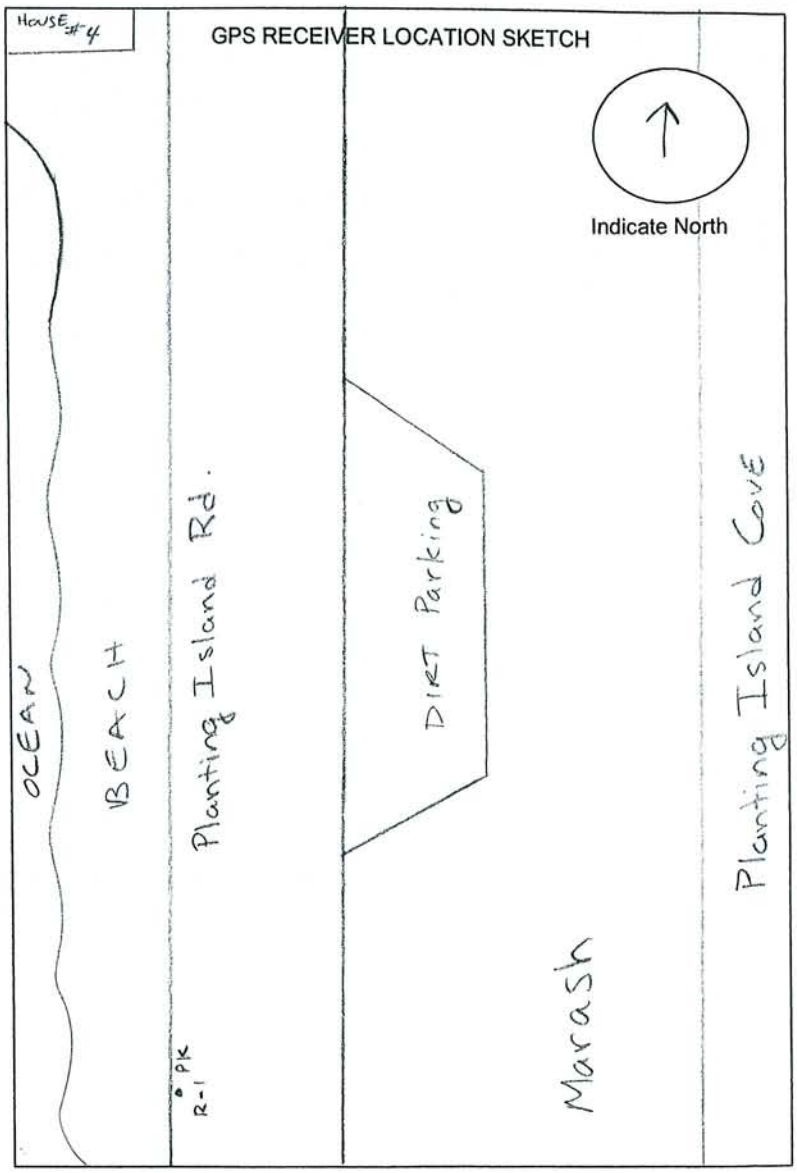
$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

Session Information

Planned Observation
Start Time: 10:00 AM
End Time: 12:30 PM

Actual Observation
Start Time: 10:11 AM
End Time: 12:41 PM

GPS RECEIVER LOCATION SKETCH



Site Description:

Comments:

P-4

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 1 OF 8
OBSERVER KS, KR. DATE 1/3/07
TEMPERATURE _____ WEATHER Cloudy
STATION NAME _____
LOCATION MARION, MASS

Station/Monument Designation: P-4

Receiver Number: R-2 Session: B

Receiver Model: Topcon HIPER GD

Receiver S/N: _____

Slant Height: 1.54 (m) 5.05 (ft)

ARP vertical offset: 0.0305 (m) 0.10 (ft)

ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.51 (m) 4.95 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

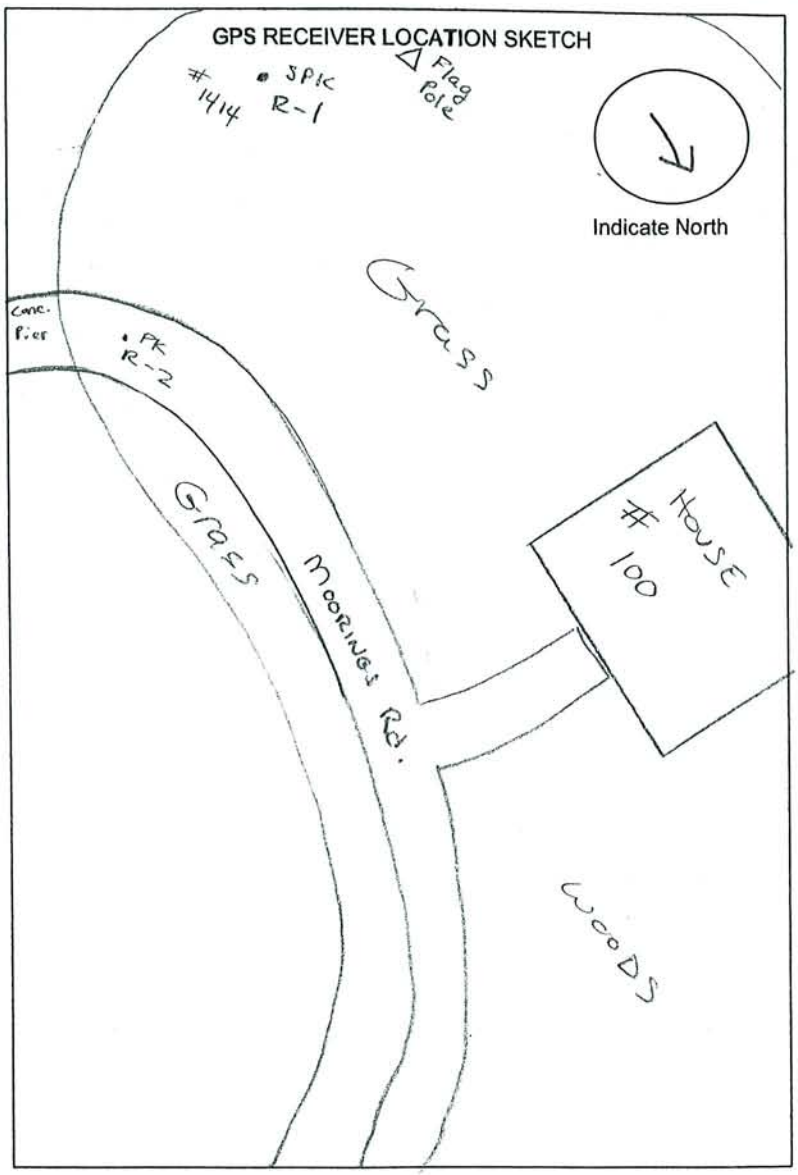
$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

Session Information

Planned Observation
Start Time: 1:00 PM
End Time: 3:30 PM

Actual Observation
Start Time: 1:08 PM
End Time: 3:39

GPS RECEIVER LOCATION SKETCH



Site Description:

Comments:

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 2 OF 2
OBSERVER KS, KR DATE 12/28/06
TEMPERATURE 42°F WEATHER Sunny
STATION NAME
LOCATION New Bidford, MA

Station/Monument Designation: P-5

Receiver Number: R-2 Session: A

Receiver Model: Topcon HIPER GD

Receiver S/N:

Slant Height: 1.50 (m) 4.93 (ft)

ARP vertical offset: 0.0305 (m) 0.10 (ft)

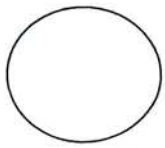
ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.47 (m) 4.82 (ft)

$ARP\,Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

$ARP\,Height = \sqrt{Slantheigh\,t^2 - 0.25^2} - 0.10$ ENGLISH

GPS RECEIVER LOCATION SKETCH



Indicate North

Session Information

Planned Observation
Start Time: 9:30AM
End Time: 12:00 PM

Actual Observation
Start Time: 9:38 AM
End Time: 12:10 PM

Site Description:

Comments:

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 2 OF 2
OBSERVER KS, KR DATE 12/28/06
TEMPERATURE 40°F WEATHER Sunny
STATION NAME
LOCATION New Bedford, MA

Station/Monument Designation: P-6
Receiver Number: R-2 Session: B
Receiver Model: Topcon HIPER GD
Receiver S/N:

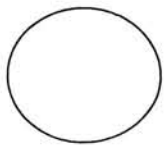
Slant Height: 1.37 (m) 4.49 (ft)
ARP vertical offset: 0.0305 (m) 0.10 (ft)
ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.34 (m) 4.39 (ft)

$ARP\,Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

$ARP\,Height = \sqrt{Slantheigh\,t^2 - 0.25^2} - 0.10$ ENGLISH

GPS RECEIVER LOCATION SKETCH



Indicate North

Session Information

Planned Observation
Start Time: 3:00 PM
End Time: 5:30 PM

Actual Observation
Start Time: 3:11 PM
End Time: 5:41 PM

Site Description:

Comments:

P-7

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 2 OF 2
OBSERVER KS, KR DATE 1/2/07
TEMPERATURE _____ WEATHER Sunny
STATION NAME _____
LOCATION _____

Station/Monument Designation: P-7

Receiver Number: R-2 Session: A

Receiver Model: Topcon HIPER GD

Receiver S/N: _____

Slant Height: 1.53 (m) 5.02 (ft)

ARP vertical offset: 0.0305 (m) 0.10 (ft)

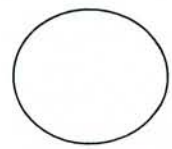
ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.50 (m) 4.92 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

GPS RECEIVER LOCATION SKETCH



Indicate North

Session Information

Planned Observation
Start Time: 10:00 AM
End Time: 12:30 PM

Actual Observation
Start Time: 10:02 AM
End Time: 12:30 PM

Site Description:

Comments:

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue **Unit 25**
MEDFORD, **MA 02155**

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 1 OF 2
OBSERVER KS, KR DATE 1/2/07
TEMPERATURE ~~TEMPERATURE~~ WEATHER Sunny
STATION NAME Nye's Cove
LOCATION Mattapoisett, MASS

Station/Monument Designation: P-8

Receiver Number: R-1 Session: B

Receiver Model: Topcon HIPER GD

Receiver S/N:

Slant Height:	1.59 (m)	5.21 (ft)
ARP vertical offset:	0.0305 (m)	0.10 (ft)
ARP horizontal offset:	0.0763 (m)	0.25 (ft)
ARP Height:	1.56 (m)	5.11 (ft)

$$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305 \quad \text{METRIC}$$

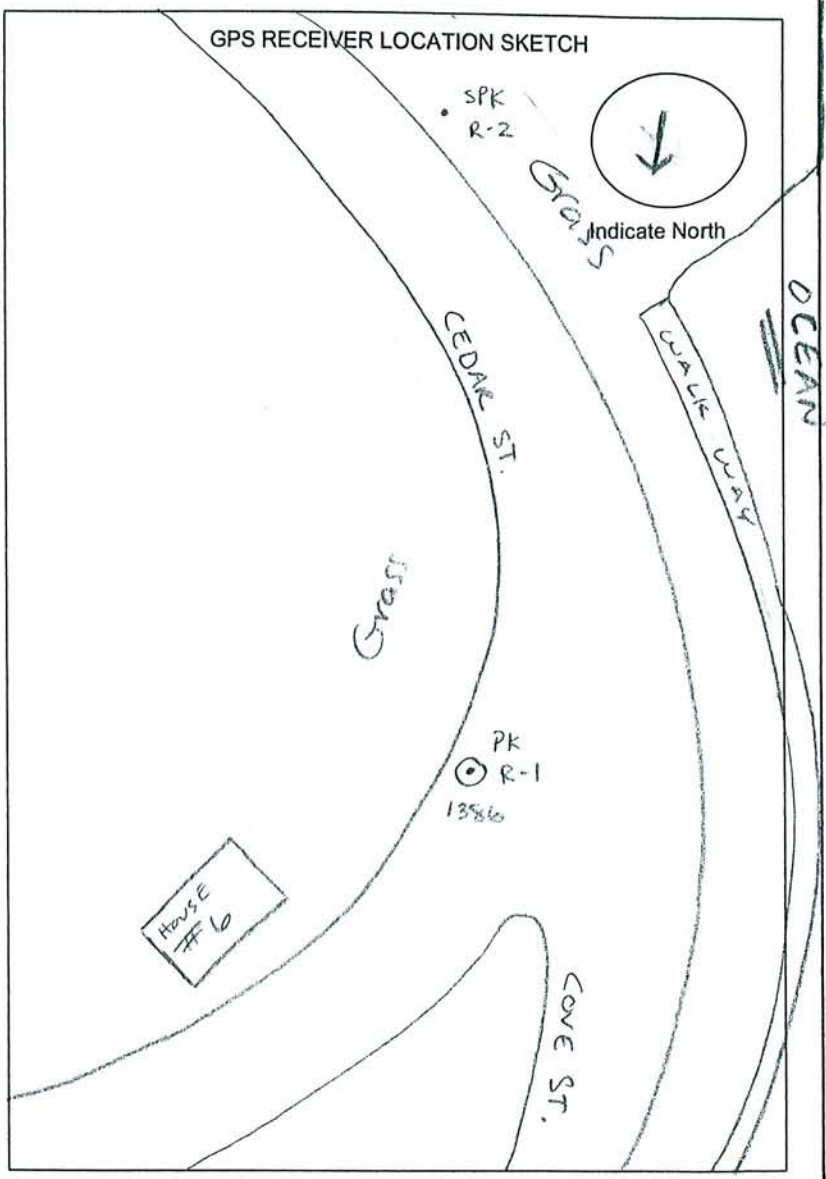
$$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10 \quad \text{ENGLISH}$$

Session Information

Planned Observation
Start Time: 1:00 PM
End Time: 3:30 PM

Actual Observation
Start Time: 1:15 PM
End Time: 3:45 PM

GPS RECEIVER LOCATION SKETCH



Site Description:

Comments:

P-9

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - **GPS Control**
SHEET NO. 1 OF 2
OBSERVER KS, KR DATE 12/29/06
TEMPERATURE _____ WEATHER Cloudy
STATION NAME Prince Henry The Navigator Park
LOCATION Fairhaven, Mass

Station/Monument Designation: P-9
Receiver Number: R-1 Session: A
Receiver Model: Topcon HIPER GD
Receiver S/N: _____

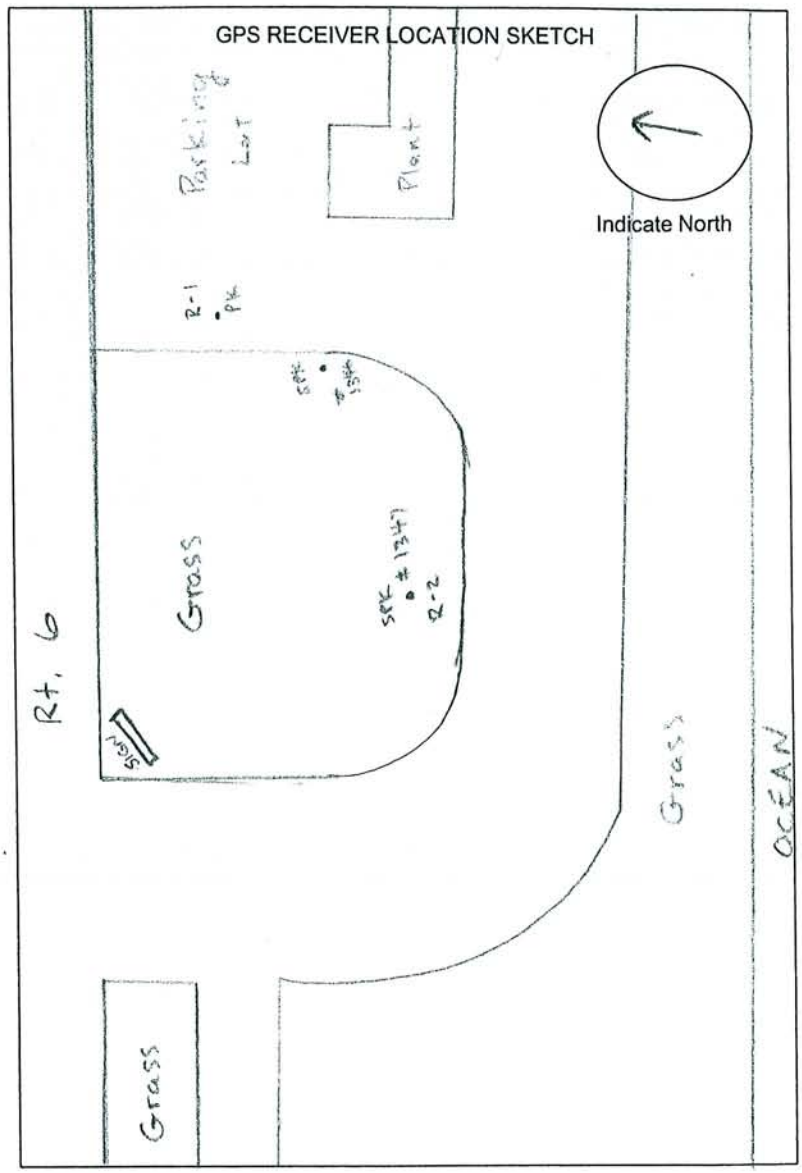
Slant Height: 1.445 (m) 4.75 (ft)
ARP vertical offset: 0.0305 (m) 0.10 (ft)
ARP horizontal offset: 0.0763 (m) 0.25 (ft)

ARP Height: 1.415 (m) 4.65 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

GPS RECEIVER LOCATION SKETCH



Session Information

Planned Observation
Start Time: 9:30AM
End Time: 12:00PM

Actual Observation
Start Time: 9:24AM
End Time: 11:56AM

Site Description:

Comments:

P-10

GREEN INTERNATIONAL AFFILIATES, INC.
Engineers and Planners
407 R Mystic Avenue Unit 25
MEDFORD, MA 02155

JOB 2320.018 FEMA Plymouth and Bristol Counties MA - GPS Control
SHEET NO. 1 OF 2
OBSERVER KS, KR DATE 12/29/06
TEMPERATURE ____ WEATHER Sunny
STATION NAME Sconticut Neck
LOCATION Fairhaven, MASS

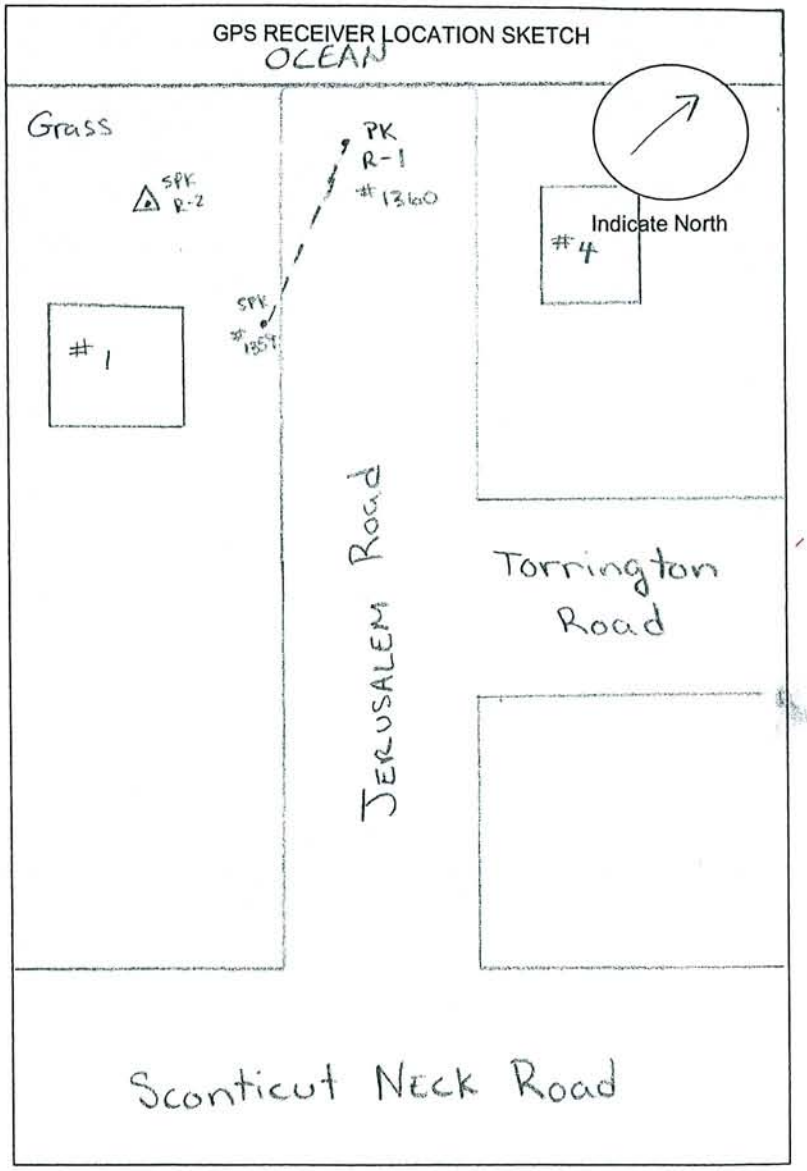
Station/Monument Designation: P-10
Receiver Number: R-1 Session: B
Receiver Model: Topcon HIPER GD
Receiver S/N: ____

Slant Height: 1.34 (m) 4.40 (ft)
ARP vertical offset: 0.0305 (m) 0.10 (ft)
ARP horizontal offset: 0.0763 (m) 0.25 (ft)
ARP Height: 1.31 (m) 4.30 (ft)

$ARP\ Height = \sqrt{Slantheight^2 - 0.0763^2} - 0.0305$ METRIC

$ARP\ Height = \sqrt{Slantheigh\ t^2 - 0.25^2} - 0.10$ ENGLISH

GPS RECEIVER LOCATION SKETCH



Session Information

Planned Observation
Start Time: 12:30 PM
End Time: 3:00 PM

Actual Observation
Start Time: 12:22 PM
End Time: 2:52

Site Description:

Comments:

NGS Data Base Stations
"Backup Information"

G-1

Sean Abedi

From: opus@ngs.noaa.gov
Sent: Friday, January 12, 2007 5:13 PM
To: Sean Abedi
Subject: OPUS solution : R1_0108a.tps 000060110

Wareham R1 - a

FILE: R1_0108a.tps 000060110

NGS OPUS SOLUTION REPORT
==========

USER: sabedi@greenintl.com
RINEX FILE: r1_0008p.07o

DATE: January 12, 2007
TIME: 22:13:22 UTC

SOFTWARE: page5 0612.06 master3.pl
EPHEMERIS: igr14091.eph [rapid]
NAV FILE: brdc0080.07n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.445

START: 2007/01/08 15:10:00
STOP: 2007/01/08 17:44:00
OBS USED: 3848 / 4082 : 94%
FIXED AMB: 29 / 29 : 100%
OVERALL RMS: 0.018(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2007.0211)	
X:	1579312.413(m)	0.006(m)	1579311.692(m)	0.006(m)
Y:	-4496853.787(m)	0.012(m)	-4496852.344(m)	0.012(m)
Z:	4224236.022(m)	0.012(m)	4224235.950(m)	0.012(m)
LAT:	41 44 30.57397	0.002(m)	41 44 30.60677	0.002(m)
E LON:	289 21 5.29861	0.009(m)	289 21 5.28986	0.009(m)
W LON:	70 38 54.70139	0.009(m)	70 38 54.71014	0.009(m)
EL HGT:	-21.856(m)	0.016(m)	-23.098(m)	0.016(m)
ORTHO HGT:	6.708(m)	0.030(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4622425.252	832747.753
Easting (X) [meters]	362920.165	270828.093
Convergence [degrees]	-1.09771975	0.57195805
Point Scale	0.99983124	0.99999641
Combined Factor	0.99983466	0.99999984

US NATIONAL GRID DESIGNATOR: 19TCG6292022425(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	104552.2
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	62174.1
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	19833.9

NEAREST NGS PUBLISHED CONTROL POINT

LW4781	LONG NECK	N414420.010	W0703843.614	414.9

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1713        -0.0190         0.0421  VEL TIMES 10.0199 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9457 -4518935.4007 4237355.6854  L1 PHS CEN @ 2007.0211
XYZ         0.0001        -0.0000        -0.0001  + XYZ ADJUSTMENTS
XYZ   1477963.9458 -4518935.4007 4237355.6853  NEW L1 PHS CEN @ 2007.0211
XYZ   1477963.9211 -4518935.3254 4237355.6142  NEW ARP @ 2007.0211
XYZ   1477963.9211 -4518935.3254 4237355.6142  NEW MON @ 2007.0211
LLH  41 53 58.92143  288  6 39.09975     55.9742  NEW L1 PHS CEN @ 2007.0211
LLH  41 53 58.92143  288  6 39.09975     55.8677  NEW ARP @ 2007.0211
LLH  41 53 58.92143  288  6 39.09975     55.8677  NEW MON @ 2007.0211

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                  S/N=0220108551
XYZ   1531392.4521 -4531473.9597 4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000         0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1653        -0.0250         0.0331  VEL TIMES 10.0199 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3316 -4531474.1175 4204982.7081  L1 PHS CEN @ 2007.0211
XYZ        -0.0000        -0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1531392.3316 -4531474.1175 4204982.7080  NEW L1 PHS CEN @ 2007.0211
XYZ   1531392.3058 -4531474.0411 4204982.6367  NEW ARP @ 2007.0211
XYZ   1531392.2868 -4531473.9848 4204982.5840  NEW MON @ 2007.0211
LLH  41 30 35.44814  288 40 20.86543    -12.9075  NEW L1 PHS CEN @ 2007.0211
LLH  41 30 35.44814  288 40 20.86543    -13.0152  NEW ARP @ 2007.0211
LLH  41 30 35.44814  288 40 20.86543    -13.0946  NEW MON @ 2007.0211

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                  S/N=60052145
XYZ   1560550.6359 -4503284.5346 4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1703        -0.0190         0.0461  VEL TIMES 10.0199 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4854 -4503284.6110 4224398.1250  L1 PHS CEN @ 2007.0211
XYZ         0.0000        -0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4854 -4503284.6110 4224398.1250  NEW L1 PHS CEN @ 2007.0211
XYZ   1560550.4656 -4503284.5537 4224398.0709  NEW ARP @ 2007.0211
XYZ   1560550.4656 -4503284.5537 4224398.0709  NEW MON @ 2007.0211
LLH  41 44 36.82972  289  6 46.96361      5.3219  NEW L1 PHS CEN @ 2007.0211
LLH  41 44 36.82972  289  6 46.96361      5.2406  NEW ARP @ 2007.0211
LLH  41 44 36.82972  289  6 46.96361      5.2406  NEW MON @ 2007.0211

                        REMOTE STATION INFORMATION

STATION NAME: r1_0       1
 ANTENNA: TPSHIPER_GD     NONE                                  S/N=UNKNOWN
XYZ   1579314.7798 -4496853.4540 4224236.4399  MON @ 2007.0209 (M)
NEU         0.0000        -0.0000         1.4450  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3573        -1.0173         0.9620  MON TO ARP
XYZ         0.0262        -0.0746         0.0706  ARP TO L1 PHASE CENTER
XYZ   1579315.1633 -4496854.5459 4224237.4725  L1 PHS CEN @ 2007.0211

BASELINE NAME:    ctpu  r1_0
```

```
XYZ        -3.0840          1.1130          -0.4911  + XYZ ADJUSTMENTS
XYZ   1579312.0793  -4496853.4329   4224236.9814  NEW L1 PHS CEN @ 2007.0211
XYZ   1579312.0531  -4496853.3583   4224236.9108  NEW ARP @ 2007.0211
XYZ   1579311.6958  -4496852.3410   4224235.9488  NEW MON @ 2007.0211
LLH  41 44 30.60677  289 21  5.29006    -21.5491  NEW L1 PHS CEN @ 2007.0211
LLH  41 44 30.60677  289 21  5.29006    -21.6551  NEW ARP @ 2007.0211
LLH  41 44 30.60677  289 21  5.29006    -23.1001  NEW MON @ 2007.0211

BASELINE NAME:   npri  r1_0
XYZ        -3.0887          1.1151          -0.4955  + XYZ ADJUSTMENTS
XYZ   1579312.0746  -4496853.4308   4224236.9770  NEW L1 PHS CEN @ 2007.0211
XYZ   1579312.0484  -4496853.3562   4224236.9064  NEW ARP @ 2007.0211
XYZ   1579311.6911  -4496852.3389   4224235.9444  NEW MON @ 2007.0211
LLH  41 44 30.60674  289 21  5.28990    -21.5546  NEW L1 PHS CEN @ 2007.0211
LLH  41 44 30.60674  289 21  5.28990    -21.6606  NEW ARP @ 2007.0211
LLH  41 44 30.60674  289 21  5.28990    -23.1056  NEW MON @ 2007.0211

BASELINE NAME:   acu5  r1_0
XYZ        -3.0898          1.1031          -0.4833  + XYZ ADJUSTMENTS
XYZ   1579312.0735  -4496853.4428   4224236.9892  NEW L1 PHS CEN @ 2007.0211
XYZ   1579312.0473  -4496853.3682   4224236.9187  NEW ARP @ 2007.0211
XYZ   1579311.6900  -4496852.3509   4224235.9566  NEW MON @ 2007.0211
LLH  41 44 30.60680  289 21  5.28968    -21.5383  NEW L1 PHS CEN @ 2007.0211
LLH  41 44 30.60680  289 21  5.28968    -21.6443  NEW ARP @ 2007.0211
LLH  41 44 30.60680  289 21  5.28968    -23.0893  NEW MON @ 2007.0211
```

G-FILES

```
Axx2007 1 8   7 1 8
B2007 1 815 9   7 1 81744 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003         NGS   20061004
C00090001-1013477747   17 -220829843   37  131196654   33 X0087AR1_0X0087ACTPU
D  1  2 -7017855  1  3  6447626  2  3 -9484650

Axx2007 1 8   7 1 8
B2007 1 815 9   7 1 81744 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003         NGS   20061004
C00090002 -479194044   16 -346216458   36 -192533603   30 X0087AR1_0X0087ANPRI
D  1  2 -7283161  1  3  7907254  2  3 -9315167

Axx2007 1 8   7 1 8
B2007 1 815 9   7 1 81744 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003         NGS   20061004
C00090003 -187612245   19  -64322028   39    1621142   34 X0087AR1_0X0087AACU5
D  1  2 -7138880  1  3  7032888  2  3 -9376188
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     02     04     08     09     11     17     19     20
ctpu-r1_0|  0.018    ...  0.016  0.021  0.023  0.018    ...    ...  0.015
              27     28
ctpu-r1_0|  0.036  0.013

           OVERALL     02     04     08     09     11     17     19     20
npri-r1_0|  0.016    ...  0.014  0.019  0.024  0.016    ...    ...  0.017
              27     28
npri-r1_0|  0.019  0.013

           OVERALL     02     04     08     09     11     17     19     20
acu5-r1_0|  0.019    ...  0.016  0.025  0.027  0.018    ...    ...  0.017
              27     28
acu5-r1_0|  0.035  0.014
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     02     04     08     09     11     17     19     20
ctpu-r1_0|   1314    ...    195    146     82    270    ...    ...    257
```

```
                27      28
ctpu-r1_0|      61     303
           OVERALL      02      04      08      09      11      17      19      20
npri-r1_0|    1265     ...     188     139      74     271     ...     ...     253
                27      28
npri-r1_0|      38     302
           OVERALL      02      04      08      09      11      17      19      20
acu5-r1_0|    1269     ...     195     127      39     273     ...     ...     275
                27      28
acu5-r1_0|      57     303
```

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000020133	-0.0000003089	0.0000002657
-0.0000003089	0.0000093022	-0.0000007572
0.0000002657	-0.0000007572	0.0000069889

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000026205	0.0000013514	-0.0000015252
0.0000013514	0.0000069428	-0.0000007505
-0.0000015252	-0.0000007505	0.0000087411

Horizontal network accuracy = 0.00558 meters.
Vertical network accuracy = 0.00580 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-101347.77177	-22082.97427	13119.66632	2002.00
NPRI	-47919.40888	-34621.63782	-19253.35643	2002.00
ACU5	-18761.22656	-6432.20883	162.12105	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2732106.586
Easting (X) [feet]	888541.835
Convergence [degrees]	0.57195805
Point Scale	0.99999641
Combined Factor	0.99999984

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

Sean Abedi G-2

From: opus@ngs.noaa.gov
Sent: Friday, January 12, 2007 5:20 PM
To: Sean Abedi
Subject: OPUS solution : R1_0108b.tps 000060111

Wareham R1 b

FILE: R1_0108b.tps 000060111

NGS OPUS SOLUTION REPORT
==========

USER: sabedi@greenintl.com
RINEX FILE: r1_0008s.07o
DATE: January 12, 2007
TIME: 22:19:53 UTC

SOFTWARE: page5 0612.06 master22.pl
EPHEMERIS: igr14091.eph [rapid]
NAV FILE: brdc0080.07n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.323
START: 2007/01/08 18:16:00
STOP: 2007/01/08 20:40:00
OBS USED: 5416 / 5577 : 97%
FIXED AMB: 29 / 33 : 88%
OVERALL RMS: 0.018(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2007.0214)	
X:	1574994.015(m)	0.062(m)	1574993.294(m)	0.062(m)
Y:	-4497665.019(m)	0.101(m)	-4497663.576(m)	0.101(m)
Z:	4224975.409(m)	0.057(m)	4224975.337(m)	0.057(m)
LAT:	41 45 2.77545	0.008(m)	41 45 2.80825	0.008(m)
E LON:	289 17 57.30898	0.090(m)	289 17 57.30017	0.090(m)
W LON:	70 42 2.69102	0.090(m)	70 42 2.69983	0.090(m)
EL HGT:	-24.640(m)	0.095(m)	-25.882(m)	0.095(m)
ORTHO HGT:	4.009(m)	0.098(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4623502.918	833699.163
Easting (X) [meters]	358597.467	266475.147
Convergence [degrees]	-1.13270090	0.53688082
Point Scale	0.99984605	0.99999519
Combined Factor	0.99984991	0.99999905

US NATIONAL GRID DESIGNATOR: 19TCG5859723503(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	100102.3
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	58684.7
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	15508.8

NEAREST NGS PUBLISHED CONTROL POINT

LW4537	WAREHAM STACK	N414513.823	W0704236.700	855.7

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1713        -0.0190         0.0421  VEL TIMES 10.0202 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9457  -4518935.4007   4237355.6854  L1 PHS CEN @ 2007.0214
XYZ         0.0001         0.0001         0.0001  + XYZ ADJUSTMENTS
XYZ   1477963.9458  -4518935.4005   4237355.6855  NEW L1 PHS CEN @ 2007.0214
XYZ   1477963.9212  -4518935.3252   4237355.6143  NEW ARP @ 2007.0214
XYZ   1477963.9212  -4518935.3252   4237355.6143  NEW MON @ 2007.0214
LLH  41 53 58.92144  288  6 39.09976     55.9741  NEW L1 PHS CEN @ 2007.0214
LLH  41 53 58.92144  288  6 39.09976     55.8676  NEW ARP @ 2007.0214
LLH  41 53 58.92144  288  6 39.09976     55.8676  NEW MON @ 2007.0214

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                  S/N=0220108551
XYZ   1531392.4521  -4531473.9597   4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000         0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1653        -0.0251         0.0331  VEL TIMES 10.0202 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3316  -4531474.1175   4204982.7081  L1 PHS CEN @ 2007.0214
XYZ        -0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1531392.3316  -4531474.1174   4204982.7081  NEW L1 PHS CEN @ 2007.0214
XYZ   1531392.3058  -4531474.0410   4204982.6367  NEW ARP @ 2007.0214
XYZ   1531392.2867  -4531473.9847   4204982.5841  NEW MON @ 2007.0214
LLH  41 30 35.44814  288 40 20.86543    -12.9075  NEW L1 PHS CEN @ 2007.0214
LLH  41 30 35.44814  288 40 20.86543    -13.0152  NEW ARP @ 2007.0214
LLH  41 30 35.44814  288 40 20.86543    -13.0946  NEW MON @ 2007.0214

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                  S/N=60052145
XYZ   1560550.6359  -4503284.5346   4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1703        -0.0190         0.0461  VEL TIMES 10.0202 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4854  -4503284.6110   4224398.1250  L1 PHS CEN @ 2007.0214
XYZ        -0.0000        -0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4854  -4503284.6110   4224398.1250  NEW L1 PHS CEN @ 2007.0214
XYZ   1560550.4655  -4503284.5536   4224398.0709  NEW ARP @ 2007.0214
XYZ   1560550.4655  -4503284.5536   4224398.0709  NEW MON @ 2007.0214
LLH  41 44 36.82972  289  6 46.96361      5.3219  NEW L1 PHS CEN @ 2007.0214
LLH  41 44 36.82972  289  6 46.96361      5.2406  NEW ARP @ 2007.0214
LLH  41 44 36.82972  289  6 46.96361      5.2406  NEW MON @ 2007.0214
```

REMOTE STATION INFORMATION

```
STATION NAME: r1_0       1
 ANTENNA: TPSHIPER_GD     NONE                                  S/N=UNKNOWN
XYZ   1574996.1762  -4497664.4223   4224975.6422  MON @ 2007.0213 (M)
NEU         0.0000        -0.0000         1.3230  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3262        -0.9316         0.8810  MON TO ARP
XYZ         0.0261        -0.0746         0.0706  ARP TO L1 PHASE CENTER
XYZ   1574996.5285  -4497665.4285   4224976.5938  L1 PHS CEN @ 2007.0214

BASELINE NAME:    ctpu  r1_0
```

```
XYZ        -2.8411          0.9104         -0.3411  + XYZ ADJUSTMENTS
XYZ   1574993.6875  -4497664.5181   4224976.2527  NEW L1 PHS CEN @ 2007.0214
XYZ   1574993.6613  -4497664.4434   4224976.1821  NEW ARP @ 2007.0214
XYZ   1574993.3351  -4497663.5119   4224975.3011  NEW MON @ 2007.0214
LLH  41 45  2.80839  289 17 57.30276    -24.5119  NEW L1 PHS CEN @ 2007.0214
LLH  41 45  2.80839  289 17 57.30276    -24.6179  NEW ARP @ 2007.0214
LLH  41 45  2.80839  289 17 57.30276    -25.9409  NEW MON @ 2007.0214

BASELINE NAME:   npri  r1_0
XYZ        -2.9007          0.8090         -0.2842  + XYZ ADJUSTMENTS
XYZ   1574993.6278  -4497664.6195   4224976.3096  NEW L1 PHS CEN @ 2007.0214
XYZ   1574993.6017  -4497664.5449   4224976.2390  NEW ARP @ 2007.0214
XYZ   1574993.2755  -4497663.6133   4224975.3580  NEW MON @ 2007.0214
LLH  41 45  2.80813  289 17 57.29888    -24.4173  NEW L1 PHS CEN @ 2007.0214
LLH  41 45  2.80813  289 17 57.29888    -24.5233  NEW ARP @ 2007.0214
LLH  41 45  2.80813  289 17 57.29888    -25.8463  NEW MON @ 2007.0214

BASELINE NAME:   acu5  r1_0
XYZ        -2.9035          0.8204         -0.2901  + XYZ ADJUSTMENTS
XYZ   1574993.6250  -4497664.6081   4224976.3037  NEW L1 PHS CEN @ 2007.0214
XYZ   1574993.5989  -4497664.5335   4224976.2331  NEW ARP @ 2007.0214
XYZ   1574993.2727  -4497663.6019   4224975.3521  NEW MON @ 2007.0214
LLH  41 45  2.80824  289 17 57.29892    -24.4299  NEW L1 PHS CEN @ 2007.0214
LLH  41 45  2.80824  289 17 57.29892    -24.5359  NEW ARP @ 2007.0214
LLH  41 45  2.80824  289 17 57.29892    -25.8589  NEW MON @ 2007.0214
```

G-FILES

```
Axx2007 1 8   7 1 8
B2007 1 81815   7 1 82040 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003         NGS   20061004
C00090001 -970294140   20 -212718133   49  123803132   47 X0087AR1_0X0087ACTPU
D  1  2 -7327792  1  3  7016692  2  3 -9509898

Axx2007 1 8   7 1 8
B2007 1 81815   7 1 82040 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003         NGS   20061004
C00090002 -436009888   14 -338103714   44 -199927739   35 X0087AR1_0X0087ANPRI
D  1  2 -6400405  1  3  7603483  2  3 -9135813

Axx2007 1 8   7 1 8
B2007 1 81815   7 1 82040 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003         NGS   20061004
C00090003 -144428071   12  -56209517   31   -5772812   28 X0087AR1_0X0087AACU5
D  1  2 -6701830  1  3  7123660  2  3 -9387556
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     02     04     05     10     12     13     17     20
ctpu-r1_0|  0.020    ...  0.013    ...  0.012  0.019  0.024  0.019  0.024
              23     24     28     30
ctpu-r1_0|  0.023  0.021  0.038  0.026

           OVERALL     02     04     05     10     12     13     17     20
npri-r1_0|  0.017    ...  0.009    ...  0.014  0.017  0.019  0.016  0.014
              23     24     28     30
npri-r1_0|  0.021  0.010  0.015  0.035

           OVERALL     02     04     05     10     12     13     17     20
acu5-r1_0|  0.015    ...  0.009  0.012  0.011  0.013  0.017  0.016  0.016
              23     24     28     30
acu5-r1_0|  0.020  0.009  0.021  0.030
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     02     04     05     10     12     13     17     20
ctpu-r1_0|   1762    ...    287    ...    151    286    188    287     80
```

	23	24	28	30					
ctpu-r1_0|	141	193	40	109					
	OVERALL	02	04	05	10	12	13	17	20
npri-r1_0|	1699	...	282	...	146	281	185	264	81
	23	24	28	30					
npri-r1_0|	146	189	19	106					
	OVERALL	02	04	05	10	12	13	17	20
acu5-r1_0|	1955	...	282	238	146	263	188	281	81
	23	24	28	30					
acu5-r1_0|	152	188	40	96					

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000016444	-0.0000003026	0.0000002826
-0.0000003026	0.0000117733	-0.0000009804
0.0000002826	-0.0000009804	0.0000093733

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000025621	0.0000018962	-0.0000022252
0.0000018962	0.0000090144	-0.0000006138
-0.0000022252	-0.0000006138	0.0000112147

Horizontal network accuracy = 0.00625 meters.
Vertical network accuracy = 0.00657 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-97029.37377	-21271.74227	12380.27932	2002.00
NPRI	-43601.01088	-33810.40582	-19992.74343	2002.00
ACU5	-14442.82856	-5620.97683	-577.26595	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2735228.004
Easting (X) [feet]	874260.545
Convergence [degrees]	0.53688082
Point Scale	0.99999519
Combined Factor	0.99999905

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

G-3

Sean Abedi

From: opus@ngs.noaa.gov
Sent: Friday, January 12, 2007 10:30 AM
To: Sean Abedi
Subject: OPUS solution : R2_0103a.tps 000059771

Marion A

FILE: R2_0103a.tps 000059771

NGS OPUS SOLUTION REPORT
==========

USER: sabedi@greenintl.com
RINEX FILE: r2_0003p.07o

DATE: January 12, 2007
TIME: 15:29:51 UTC

SOFTWARE: page5 0612.06 master22.pl
EPHEMERIS: igr14083.eph [rapid]
NAV FILE: brdc0030.07n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.5

START: 2007/01/03 15:03:00
STOP: 2007/01/03 17:34:00
OBS USED: 3987 / 4050 : 98%
FIXED AMB: 25 / 25 : 100%
OVERALL RMS: 0.014(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2007.0073)	
X:	1573763.683(m)	0.002(m)	1573762.962(m)	0.002(m)
Y:	-4502863.834(m)	0.006(m)	-4502862.390(m)	0.006(m)
Z:	4219926.325(m)	0.004(m)	4219926.253(m)	0.004(m)
LAT:	41 41 23.53623	0.004(m)	41 41 23.56900	0.004(m)
E LON:	289 15 52.79606	0.002(m)	289 15 52.78723	0.002(m)
W LON:	70 44 7.20394	0.002(m)	70 44 7.21277	0.002(m)
EL HGT:	-25.291(m)	0.006(m)	-26.535(m)	0.006(m)
ORTHO HGT:	3.489(m)	0.026(m)	[Geoid03 NAVD88]	

	UTM COORDINATES (Zone 19)	STATE PLANE COORDINATES (2001 MA M)
Northing (Y) [meters]	4616798.692	826909.058
Easting (X) [meters]	355585.432	263659.212
Convergence [degrees]	-1.15436712	0.51364779
Point Scale	0.99985665	1.00000403
Combined Factor	0.99986061	1.00000800

US NATIONAL GRID DESIGNATOR: 19TCG5558516799(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	98689.3
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	53265.5
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	13955.1

NEAREST NGS PUBLISHED CONTROL POINT

LW4831	PEAK OF BOATHOUSE	N414127.488	W0704506.115	1365.8

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ          -0.0171          -0.0019           0.0042  VEL (M/YR)
NEU           0.0000           0.0000           0.0000  MON TO ARP (M)
NEU          -0.0000           0.0000           0.1065  ARP TO L1 PHASE CENTER (M)
NEU          -0.0000           0.0000           0.1258  ARP TO L2 PHASE CENTER (M)
XYZ          -0.1711          -0.0190           0.0420  VEL TIMES 10.0062 YRS
XYZ           0.0000           0.0000           0.0000  MON TO ARP
XYZ           0.0246          -0.0753           0.0711  ARP TO L1 PHASE CENTER
XYZ     1477963.9459  -4518935.4007    4237355.6853  L1 PHS CEN @ 2007.0073
XYZ           0.0002          -0.0001          -0.0001  + XYZ ADJUSTMENTS
XYZ     1477963.9461  -4518935.4007    4237355.6853  NEW L1 PHS CEN @ 2007.0073
XYZ     1477963.9215  -4518935.3254    4237355.6141  NEW ARP @ 2007.0073
XYZ     1477963.9215  -4518935.3254    4237355.6141  NEW MON @ 2007.0073
LLH   41 53 58.92142   288  6 39.09977      55.9742  NEW L1 PHS CEN @ 2007.0073
LLH   41 53 58.92142   288  6 39.09977      55.8677  NEW ARP @ 2007.0073
LLH   41 53 58.92142   288  6 39.09977      55.8677  NEW MON @ 2007.0073

STATION NAME: npri  a     6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                    S/N=0220108551
XYZ     1531392.4521  -4531473.9597    4204982.5510  MON @ 1997.0000 (M)
XYZ          -0.0165          -0.0025           0.0033  VEL (M/YR)
NEU          -0.0000           0.0000           0.0794  MON TO ARP (M)
NEU          -0.0000           0.0000           0.1077  ARP TO L1 PHASE CENTER (M)
NEU          -0.0000           0.0000           0.1273  ARP TO L2 PHASE CENTER (M)
XYZ          -0.1651          -0.0250           0.0330  VEL TIMES 10.0062 YRS
XYZ           0.0190          -0.0563           0.0526  MON TO ARP
XYZ           0.0258          -0.0764           0.0714  ARP TO L1 PHASE CENTER
XYZ     1531392.3319  -4531474.1174    4204982.7080  L1 PHS CEN @ 2007.0073
XYZ           0.0000          -0.0001          -0.0001  + XYZ ADJUSTMENTS
XYZ     1531392.3319  -4531474.1175    4204982.7079  NEW L1 PHS CEN @ 2007.0073
XYZ     1531392.3060  -4531474.0411    4204982.6366  NEW ARP @ 2007.0073
XYZ     1531392.2870  -4531473.9848    4204982.5839  NEW MON @ 2007.0073
LLH   41 30 35.44814   288 40 20.86544     -12.9075  NEW L1 PHS CEN @ 2007.0073
LLH   41 30 35.44814   288 40 20.86544     -13.0152  NEW ARP @ 2007.0073
LLH   41 30 35.44814   288 40 20.86544     -13.0946  NEW MON @ 2007.0073

STATION NAME: acu5  a     2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG     SCIT                                    S/N=60052145
XYZ     1560550.6359  -4503284.5346    4224398.0248  MON @ 1997.0000 (M)
XYZ          -0.0170          -0.0019           0.0046  VEL (M/YR)
NEU           0.0000           0.0000           0.0000  MON TO ARP (M)
NEU          -0.0000           0.0000           0.0813  ARP TO L1 PHASE CENTER (M)
NEU          -0.0000           0.0000           0.0689  ARP TO L2 PHASE CENTER (M)
XYZ          -0.1701          -0.0190           0.0460  VEL TIMES 10.0062 YRS
XYZ           0.0000           0.0000           0.0000  MON TO ARP
XYZ           0.0199          -0.0573           0.0541  ARP TO L1 PHASE CENTER
XYZ     1560550.4857  -4503284.6109    4224398.1250  L1 PHS CEN @ 2007.0073
XYZ           0.0000          -0.0000          -0.0000  + XYZ ADJUSTMENTS
XYZ     1560550.4857  -4503284.6109    4224398.1250  NEW L1 PHS CEN @ 2007.0073
XYZ     1560550.4658  -4503284.5536    4224398.0708  NEW ARP @ 2007.0073
XYZ     1560550.4658  -4503284.5536    4224398.0708  NEW MON @ 2007.0073
LLH   41 44 36.82971   289  6 46.96362       5.3219  NEW L1 PHS CEN @ 2007.0073
LLH   41 44 36.82971   289  6 46.96362       5.2406  NEW ARP @ 2007.0073
LLH   41 44 36.82971   289  6 46.96362       5.2406  NEW MON @ 2007.0073

                        REMOTE STATION INFORMATION

STATION NAME: r2_0        1
 ANTENNA: TPSHIPER_GD     NONE                                    S/N=UNKNOWN
XYZ     1573765.8623  -4502863.2494    4219926.5853  MON @ 2007.0072 (M)
NEU           0.0000          -0.0000           1.5000  MON TO ARP (M)
NEU          -0.0000           0.0000           0.1060  ARP TO L1 PHASE CENTER (M)
NEU          -0.0000           0.0000           0.1012  ARP TO L2 PHASE CENTER (M)
XYZ           0.3696          -1.0574           0.9976  MON TO ARP
XYZ           0.0261          -0.0747           0.0705  ARP TO L1 PHASE CENTER
XYZ     1573766.2580  -4502864.3815    4219927.6534  L1 PHS CEN @ 2007.0073

BASELINE NAME:    ctpu  r2_0
```

```
XYZ         -2.9002          0.8570         -0.3301  + XYZ ADJUSTMENTS
XYZ    1573763.3578  -4502863.5245   4219927.3233  NEW L1 PHS CEN @ 2007.0073
XYZ    1573763.3317  -4502863.4498   4219927.2528  NEW ARP @ 2007.0073
XYZ    1573762.9621  -4502862.3924   4219926.2552  NEW MON @ 2007.0073
LLH   41 41 23.56900   289 15 52.78720    -24.9256  NEW L1 PHS CEN @ 2007.0073
LLH   41 41 23.56900   289 15 52.78720    -25.0316  NEW ARP @ 2007.0073
LLH   41 41 23.56900   289 15 52.78720    -26.5316  NEW MON @ 2007.0073

BASELINE NAME:   npri  r2_0
XYZ         -2.8990          0.8592         -0.3343  + XYZ ADJUSTMENTS
XYZ    1573763.3590  -4502863.5223   4219927.3192  NEW L1 PHS CEN @ 2007.0073
XYZ    1573763.3329  -4502863.4476   4219927.2487  NEW ARP @ 2007.0073
XYZ    1573762.9633  -4502862.3902   4219926.2510  NEW MON @ 2007.0073
LLH   41 41 23.56894   289 15 52.78728    -24.9297  NEW L1 PHS CEN @ 2007.0073
LLH   41 41 23.56894   289 15 52.78728    -25.0357  NEW ARP @ 2007.0073
LLH   41 41 23.56894   289 15 52.78728    -26.5357  NEW MON @ 2007.0073

BASELINE NAME:   acu5  r2_0
XYZ         -2.9010          0.8634         -0.3327  + XYZ ADJUSTMENTS
XYZ    1573763.3570  -4502863.5181   4219927.3208  NEW L1 PHS CEN @ 2007.0073
XYZ    1573763.3309  -4502863.4434   4219927.2503  NEW ARP @ 2007.0073
XYZ    1573762.9613  -4502862.3860   4219926.2526  NEW MON @ 2007.0073
LLH   41 41 23.56908   289 15 52.78726    -24.9320  NEW L1 PHS CEN @ 2007.0073
LLH   41 41 23.56908   289 15 52.78726    -25.0380  NEW ARP @ 2007.0073
LLH   41 41 23.56908   289 15 52.78726    -26.5380  NEW MON @ 2007.0073
```

G-FILES

```
Axx2007 1 3   7 1 3
B2007 1 315 2   7 1 31733 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090001 -957990406   19 -160729330   36  174293589   33 X0037AR2_0X0037ACTPU
D  1  2 -6763964  1  3  6760650  2  3 -9376716

Axx2007 1 3   7 1 3
B2007 1 315 2   7 1 31733 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090002 -423706763   13 -286115946   32 -149436671   28 X0037AR2_0X0037ANPRI
D  1  2 -6355677  1  3  7257222  2  3 -8943493

Axx2007 1 3   7 1 3
B2007 1 315 2   7 1 31733 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090003 -132124955   16   -4221676   28   44718182   26 X0037AR2_0X0037AACU5
D  1  2 -6902917  1  3  6309321  2  3 -9432026
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     04     08     09     11     17     19     20     27
ctpu-r2_0|  0.017  0.020  0.013    ...  0.014  0.015  0.025  0.019  0.018
              28
ctpu-r2_0|    ...

           OVERALL     04     08     09     11     17     19     20     27
npri-r2_0|  0.013  0.017  0.011    ...  0.012  0.011  0.020  0.015  0.015
              28
npri-r2_0|    ...

           OVERALL     04     08     09     11     17     19     20     27
acu5-r2_0|  0.012  0.015  0.012    ...  0.011  0.011  0.017  0.013  0.010
              28
acu5-r2_0|    ...
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     04     08     09     11     17     19     20     27
ctpu-r2_0|   1341    132    208    ...    301    301     68    214    117
```

```
                28
ctpu-r2_0|     ...
          OVERALL     04     08     09     11     17     19     20     27
npri-r2_0|   1317    135    202    ...    301    301     64    205    109
                28
npri-r2_0|     ...
          OVERALL     04     08     09     11     17     19     20     27
acu5-r2_0|   1329    135    208    ...    301    301     72    195    117
                28
acu5-r2_0|     ...
```

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000017467	-0.0000002303	0.0000002112
-0.0000002303	0.0000068978	-0.0000005782
0.0000002112	-0.0000005782	0.0000056644

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000021639	0.0000009501	-0.0000010610
0.0000009501	0.0000054118	-0.0000003299
-0.0000010610	-0.0000003299	0.0000067331

Horizontal network accuracy = 0.00494 meters.
Vertical network accuracy = 0.00509 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-95799.04177	-16072.92727	17429.36332	2002.00
NPRI	-42370.67888	-28611.59082	-14943.65943	2002.00
ACU5	-13212.49656	-422.16183	4471.81805	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2712950.801
Easting (X) [feet]	865021.931
Convergence [degrees]	0.51364779
Point Scale	1.00000403
Combined Factor	1.00000800

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

Sean Abedi G-4

From: opus@ngs.noaa.gov
Sent: Friday, January 12, 2007 9:40 AM
To: Sean Abedi
Subject: OPUS solution : R1_0103b.tps 000059723

Marion B

FILE: R1_0103b.tps 000059723

NGS OPUS SOLUTION REPORT
==========

USER: sabedi@greenintl.com
RINEX FILE: r1_0003s.07o
DATE: January 12, 2007
TIME: 14:40:17 UTC

SOFTWARE: page5 0612.06 master2.pl
EPHEMERIS: igr14083.eph [rapid]
NAV FILE: brdc0030.07n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.51
START: 2007/01/03 18:12:00
STOP: 2007/01/03 20:44:00
OBS USED: 6007 / 6091 : 99%
FIXED AMB: 35 / 35 : 100%
OVERALL RMS: 0.013(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2007.0077)	
X:	1573445.845(m)	0.004(m)	1573445.124(m)	0.004(m)
Y:	-4504331.518(m)	0.002(m)	-4504330.074(m)	0.002(m)
Z:	4218486.365(m)	0.004(m)	4218486.292(m)	0.004(m)
LAT:	41 40 21.07351	0.003(m)	41 40 21.10625	0.003(m)
E LON:	289 15 18.89110	0.005(m)	289 15 18.88226	0.005(m)
W LON:	70 44 41.10890	0.005(m)	70 44 41.11774	0.005(m)
EL HGT:	-26.345(m)	0.003(m)	-27.589(m)	0.003(m)
ORTHO HGT:	2.471(m)	0.025(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4614888.097	824975.039
Easting (X) [meters]	354762.611	262892.234
Convergence [degrees]	-1.16023974	0.50732142
Point Scale	0.99985958	1.00000675
Combined Factor	0.99986371	1.00001088

US NATIONAL GRID DESIGNATOR: 19TCG5476314888(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	98417.6
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	51841.9
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	14223.7

NEAREST NGS PUBLISHED CONTROL POINT

LW4801	BLAKE POINT FLAGPOLE	N414020.590	W0704441.859	22.9

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171         -0.0019          0.0042  VEL (M/YR)
NEU         0.0000          0.0000          0.0000  MON TO ARP (M)
NEU        -0.0000          0.0000          0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000          0.0000          0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1711         -0.0190          0.0420  VEL TIMES 10.0066 YRS
XYZ         0.0000          0.0000          0.0000  MON TO ARP
XYZ         0.0246         -0.0753          0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9459  -4518935.4007    4237355.6854  L1 PHS CEN @ 2007.0077
XYZ         0.0000         -0.0001         -0.0000  + XYZ ADJUSTMENTS
XYZ   1477963.9459  -4518935.4007    4237355.6853  NEW L1 PHS CEN @ 2007.0077
XYZ   1477963.9213  -4518935.3254    4237355.6142  NEW ARP @ 2007.0077
XYZ   1477963.9213  -4518935.3254    4237355.6142  NEW MON @ 2007.0077
LLH  41 53 58.92143  288  6 39.09976      55.9742  NEW L1 PHS CEN @ 2007.0077
LLH  41 53 58.92143  288  6 39.09976      55.8677  NEW ARP @ 2007.0077
LLH  41 53 58.92143  288  6 39.09976      55.8677  NEW MON @ 2007.0077

STATION NAME: npri  a     6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                  S/N=0220108551
XYZ   1531392.4521  -4531473.9597    4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165         -0.0025          0.0033  VEL (M/YR)
NEU        -0.0000          0.0000          0.0794  MON TO ARP (M)
NEU        -0.0000          0.0000          0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000          0.0000          0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1651         -0.0250          0.0330  VEL TIMES 10.0066 YRS
XYZ         0.0190         -0.0563          0.0526  MON TO ARP
XYZ         0.0258         -0.0764          0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3318  -4531474.1175    4204982.7080  L1 PHS CEN @ 2007.0077
XYZ        -0.0000         -0.0000         -0.0000  + XYZ ADJUSTMENTS
XYZ   1531392.3318  -4531474.1175    4204982.7080  NEW L1 PHS CEN @ 2007.0077
XYZ   1531392.3060  -4531474.0411    4204982.6366  NEW ARP @ 2007.0077
XYZ   1531392.2870  -4531473.9847    4204982.5840  NEW MON @ 2007.0077
LLH  41 30 35.44814  288 40 20.86544     -12.9075  NEW L1 PHS CEN @ 2007.0077
LLH  41 30 35.44814  288 40 20.86544     -13.0152  NEW ARP @ 2007.0077
LLH  41 30 35.44814  288 40 20.86544     -13.0946  NEW MON @ 2007.0077

STATION NAME: acu5  a     2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG     SCIT                                  S/N=60052145
XYZ   1560550.6359  -4503284.5346    4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170         -0.0019          0.0046  VEL (M/YR)
NEU         0.0000          0.0000          0.0000  MON TO ARP (M)
NEU        -0.0000          0.0000          0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000          0.0000          0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1701         -0.0190          0.0460  VEL TIMES 10.0066 YRS
XYZ         0.0000          0.0000          0.0000  MON TO ARP
XYZ         0.0199         -0.0573          0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4857  -4503284.6109    4224398.1250  L1 PHS CEN @ 2007.0077
XYZ         0.0000         -0.0000         -0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4857  -4503284.6109    4224398.1249  NEW L1 PHS CEN @ 2007.0077
XYZ   1560550.4658  -4503284.5536    4224398.0708  NEW ARP @ 2007.0077
XYZ   1560550.4658  -4503284.5536    4224398.0708  NEW MON @ 2007.0077
LLH  41 44 36.82971  289  6 46.96362      5.3219  NEW L1 PHS CEN @ 2007.0077
LLH  41 44 36.82971  289  6 46.96362      5.2406  NEW ARP @ 2007.0077
LLH  41 44 36.82971  289  6 46.96362      5.2406  NEW MON @ 2007.0077

                        REMOTE STATION INFORMATION

STATION NAME: r1_0        1
 ANTENNA: TPSHIPER_GD      NONE                                  S/N=UNKNOWN
XYZ   1573448.0989  -4504330.9433    4218486.7424  MON @ 2007.0076 (M)
NEU         0.0000         -0.0000          1.5100  MON TO ARP (M)
NEU        -0.0000          0.0000          0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000          0.0000          0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3720         -1.0648          1.0040  MON TO ARP
XYZ         0.0261         -0.0747          0.0705  ARP TO L1 PHASE CENTER
XYZ   1573448.4970  -4504332.0829    4218487.8168  L1 PHS CEN @ 2007.0077

BASELINE NAME:    ctpu  r1_0
```

```
XYZ        -2.9750          0.8697         -0.4483  + XYZ ADJUSTMENTS
XYZ   1573445.5220  -4504331.2132   4218487.3685  NEW L1 PHS CEN @ 2007.0077
XYZ   1573445.4959  -4504331.1384   4218487.2980  NEW ARP @ 2007.0077
XYZ   1573445.1239  -4504330.0736   4218486.2941  NEW MON @ 2007.0077
LLH  41 40 21.10631  289 15 18.88226    -25.9718  NEW L1 PHS CEN @ 2007.0077
LLH  41 40 21.10631  289 15 18.88226    -26.0778  NEW ARP @ 2007.0077
LLH  41 40 21.10631  289 15 18.88226    -27.5878  NEW MON @ 2007.0077

BASELINE NAME:   npri  r1_0
XYZ        -2.9776          0.8684         -0.4510  + XYZ ADJUSTMENTS
XYZ   1573445.5194  -4504331.2145   4218487.3658  NEW L1 PHS CEN @ 2007.0077
XYZ   1573445.4933  -4504331.1397   4218487.2953  NEW ARP @ 2007.0077
XYZ   1573445.1213  -4504330.0749   4218486.2914  NEW MON @ 2007.0077
LLH  41 40 21.10624  289 15 18.88214    -25.9734  NEW L1 PHS CEN @ 2007.0077
LLH  41 40 21.10624  289 15 18.88214    -26.0794  NEW ARP @ 2007.0077
LLH  41 40 21.10624  289 15 18.88214    -27.5894  NEW MON @ 2007.0077

BASELINE NAME:   acu5  r1_0
XYZ        -2.9732          0.8707         -0.4526  + XYZ ADJUSTMENTS
XYZ   1573445.5237  -4504331.2122   4218487.3643  NEW L1 PHS CEN @ 2007.0077
XYZ   1573445.4976  -4504331.1374   4218487.2938  NEW ARP @ 2007.0077
XYZ   1573445.1257  -4504330.0726   4218486.2898  NEW MON @ 2007.0077
LLH  41 40 21.10621  289 15 18.88235    -25.9749  NEW L1 PHS CEN @ 2007.0077
LLH  41 40 21.10621  289 15 18.88235    -26.0809  NEW ARP @ 2007.0077
LLH  41 40 21.10621  289 15 18.88235    -27.5909  NEW MON @ 2007.0077
```

G-FILES

```
Axx2007 1 3   7 1 3
B2007 1 31811   7 1 32044 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090001 -954812026   12 -146052518   29  188693201   25 X0037AR1_0X0037ACTPU
D  1  2 -6609335  1  3  6315673  2  3 -9425944

Axx2007 1 3   7 1 3
B2007 1 31811   7 1 32044 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090002 -420528343   10 -271439098   25 -135037074   22 X0037AR1_0X0037ANPRI
D  1  2 -6460149  1  3  7585056  2  3 -9069101

Axx2007 1 3   7 1 3
B2007 1 31811   7 1 32044 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090003 -128946599   10   10455190   23   59117810   21 X0037AR1_0X0037AACU5
D  1  2 -7117381  1  3  5730162  2  3 -9276303
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
            OVERALL     02     04     05     09     10     12     13     17
 ctpu-r1_0|  0.014  0.012    ...  0.013    ...  0.013  0.013  0.018  0.012
               20     23     24     28     30
 ctpu-r1_0|  0.012  0.013  0.014  0.023  0.023

            OVERALL     02     04     05     09     10     12     13     17
 npri-r1_0|  0.013  0.009    ...  0.014    ...  0.014  0.010  0.013  0.009
               20     23     24     28     30
 npri-r1_0|  0.011  0.018  0.014  0.015  0.016

            OVERALL     02     04     05     09     10     12     13     17
 acu5-r1_0|  0.012  0.010    ...  0.010    ...  0.011  0.011  0.013  0.009
               20     23     24     28     30
 acu5-r1_0|  0.012  0.011  0.014  0.017  0.023
```

OBS BY SATELLITE VS. BASELINE

```
            OVERALL     02     04     05     09     10     12     13     17
 ctpu-r1_0|   2002    303    ...    236    ...    120    253    155    303
```

	20	23	24	28	30				
ctpu-r1_0|	140	165	184	79	64				
	OVERALL	02	04	05	09	10	12	13	17
npri-r1_0|	1993	302	...	236	...	120	245	150	303
	20	23	24	28	30				
npri-r1_0|	140	170	184	69	74				
	OVERALL	02	04	05	09	10	12	13	17
acu5-r1_0|	2012	299	...	228	...	119	248	161	303
	20	23	24	28	30				
acu5-r1_0|	142	179	184	79	70				

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000007644	-0.0000001234	0.0000001059
-0.0000001234	0.0000044333	-0.0000003623
0.0000001059	-0.0000003623	0.0000034444

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000010866	0.0000006781	-0.0000007963
0.0000006781	0.0000033629	-0.0000002847
-0.0000007963	-0.0000002847	0.0000041927

Horizontal network accuracy = 0.00384 meters.
Vertical network accuracy = 0.00401 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-95481.20377	-14605.24327	18869.32332	2002.00
NPRI	-42052.84088	-27143.90682	-13503.69943	2002.00
ACU5	-12894.65856	1045.52217	5911.77805	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2706605.607
Easting (X) [feet]	862505.604
Convergence [degrees]	0.50732142
Point Scale	1.00000675
Combined Factor	1.00001088

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

G-5

Ali Kowsari

From: opus@ngs.noaa.gov
Sent: Thursday, January 04, 2007 9:20 AM
To: Ali Kowsari
Subject: OPUS solution : R1_1228a.tps 000055002 New Bedford A

FILE: R1_1228a.tps 000055002

NGS OPUS SOLUTION REPORT
==========

USER: akowsari@greenintl.com
RINEX FILE: r1_1362o.06o

DATE: January 04, 2007
TIME: 14:19:40 UTC

SOFTWARE: page5 0612.06 master4.pl
EPHEMERIS: igr14074.eph [rapid]
NAV FILE: brdc3620.06n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.380

START: 2006/12/28 14:37:00
STOP: 2006/12/28 17:10:00
OBS USED: 4058 / 4186 : 97%
FIXED AMB: 21 / 22 : 95%
OVERALL RMS: 0.014(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2006.9909)	
X:	1561471.413(m)	0.046(m)	1561470.693(m)	0.046(m)
Y:	-4513540.701(m)	0.047(m)	-4513539.257(m)	0.047(m)
Z:	4213124.604(m)	0.025(m)	4213124.530(m)	0.025(m)
LAT:	41 36 28.53404	0.003(m)	41 36 28.56668	0.003(m)
E LON:	289 4 59.51164	0.058(m)	289 4 59.50264	0.058(m)
W LON:	70 55 0.48836	0.058(m)	70 55 0.49736	0.058(m)
EL HGT:	-26.703(m)	0.038(m)	-27.949(m)	0.038(m)
ORTHO HGT:	2.520(m)	0.046(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4608020.620	817688.460
Easting (X) [meters]	340280.685	248614.320
Convergence [degrees]	-1.27308210	0.39175060
Point Scale	0.99991394	1.00001769
Combined Factor	0.99991812	1.00002188

US NATIONAL GRID DESIGNATOR: 19TCG4028108021(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	87118.5
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	35953.5
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	15267.6

NEAREST NGS PUBLISHED CONTROL POINT

LW4925	LANE 1887	N413643.258	W0705458.392	457.9

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

XYZ	-0.0171	-0.0019	0.0042	VEL (M/YR)
NEU	0.0000	0.0000	0.0000	MON TO ARP (M)
NEU	-0.0000	0.0000	0.1065	ARP TO L1 PHASE CENTER (M)
NEU	-0.0000	0.0000	0.1258	ARP TO L2 PHASE CENTER (M)
XYZ	-0.1708	-0.0190	0.0420	VEL TIMES 9.9897 YRS
XYZ	0.0000	0.0000	0.0000	MON TO ARP
XYZ	0.0246	-0.0753	0.0711	ARP TO L1 PHASE CENTER
XYZ	1477963.9462	-4518935.4006	4237355.6853	L1 PHS CEN @ 2006.9909
XYZ	-0.0002	0.0000	0.0001	+ XYZ ADJUSTMENTS
XYZ	1477963.9460	-4518935.4006	4237355.6853	NEW L1 PHS CEN @ 2006.9909
XYZ	1477963.9213	-4518935.3253	4237355.6142	NEW ARP @ 2006.9909
XYZ	1477963.9213	-4518935.3253	4237355.6142	NEW MON @ 2006.9909
LLH	41 53 58.92143	288 6 39.09976	55.9741	NEW L1 PHS CEN @ 2006.9909
LLH	41 53 58.92143	288 6 39.09976	55.8676	NEW ARP @ 2006.9909
LLH	41 53 58.92143	288 6 39.09976	55.8676	NEW MON @ 2006.9909

STATION NAME: npri a 6 (Naval Station Newport; Newport, Rhode Island U.S.
S/N=0220108551
ANTENNA: TRM29659.00 UNAV

XYZ	1531392.4521	-4531473.9597	4204982.5510	MON @ 1997.0000 (M)
XYZ	-0.0165	-0.0025	0.0033	VEL (M/YR)
NEU	-0.0000	0.0000	0.0794	MON TO ARP (M)
NEU	-0.0000	0.0000	0.1077	ARP TO L1 PHASE CENTER (M)
NEU	-0.0000	0.0000	0.1273	ARP TO L2 PHASE CENTER (M)
XYZ	-0.1648	-0.0250	0.0330	VEL TIMES 9.9897 YRS
XYZ	0.0190	-0.0563	0.0526	MON TO ARP
XYZ	0.0258	-0.0764	0.0714	ARP TO L1 PHASE CENTER
XYZ	1531392.3321	-4531474.1174	4204982.7080	L1 PHS CEN @ 2006.9909
XYZ	0.0000	-0.0000	0.0000	+ XYZ ADJUSTMENTS
XYZ	1531392.3321	-4531474.1174	4204982.7080	NEW L1 PHS CEN @ 2006.9909
XYZ	1531392.3063	-4531474.0410	4204982.6366	NEW ARP @ 2006.9909
XYZ	1531392.2873	-4531473.9847	4204982.5840	NEW MON @ 2006.9909
LLH	41 30 35.44814	288 40 20.86545	-12.9075	NEW L1 PHS CEN @ 2006.9909
LLH	41 30 35.44814	288 40 20.86545	-13.0152	NEW ARP @ 2006.9909
LLH	41 30 35.44814	288 40 20.86545	-13.0946	NEW MON @ 2006.9909

STATION NAME: acu5 a 2 (ACUSHNET 5; Acushnet, Massachusetts USA)
S/N=60052145
ANTENNA: TRM41249USCG SCIT

XYZ	1560550.6359	-4503284.5346	4224398.0248	MON @ 1997.0000 (M)
XYZ	-0.0170	-0.0019	0.0046	VEL (M/YR)
NEU	0.0000	0.0000	0.0000	MON TO ARP (M)
NEU	-0.0000	0.0000	0.0813	ARP TO L1 PHASE CENTER (M)
NEU	-0.0000	0.0000	0.0689	ARP TO L2 PHASE CENTER (M)
XYZ	-0.1698	-0.0190	0.0460	VEL TIMES 9.9897 YRS
XYZ	0.0000	0.0000	0.0000	MON TO ARP
XYZ	0.0199	-0.0573	0.0541	ARP TO L1 PHASE CENTER
XYZ	1560550.4859	-4503284.6109	4224398.1249	L1 PHS CEN @ 2006.9909
XYZ	-0.0000	0.0000	-0.0000	+ XYZ ADJUSTMENTS
XYZ	1560550.4859	-4503284.6109	4224398.1249	NEW L1 PHS CEN @ 2006.9909
XYZ	1560550.4661	-4503284.5536	4224398.0708	NEW ARP @ 2006.9909
XYZ	1560550.4661	-4503284.5536	4224398.0708	NEW MON @ 2006.9909
LLH	41 44 36.82971	289 6 46.96363	5.3219	NEW L1 PHS CEN @ 2006.9909
LLH	41 44 36.82971	289 6 46.96363	5.2406	NEW ARP @ 2006.9909
LLH	41 44 36.82971	289 6 46.96363	5.2406	NEW MON @ 2006.9909

REMOTE STATION INFORMATION

STATION NAME: r1_1 1
S/N=UNKNOWN
ANTENNA: TPSHIPER_GD NONE

XYZ	1561473.5177	-4513540.0133	4213124.8435	MON @ 2006.9907 (M)
NEU	0.0000	-0.0000	1.3800	MON TO ARP (M)
NEU	-0.0000	0.0000	0.1060	ARP TO L1 PHASE CENTER (M)
NEU	-0.0000	-0.0000	0.1012	ARP TO L2 PHASE CENTER (M)
XYZ	0.3373	-0.9751	0.9164	MON TO ARP
XYZ	0.0259	-0.0749	0.0704	ARP TO L1 PHASE CENTER
XYZ	1561473.8810	-4513541.0633	4213125.8302	L1 PHS CEN @ 2006.9909

BASELINE NAME: ctpu r1_1

```
XYZ        -2.8549          0.7266         -0.2994  + XYZ ADJUSTMENTS
XYZ   1561471.0260  -4513540.3367   4213125.5308  NEW L1 PHS CEN @ 2006.9909
XYZ   1561471.0001  -4513540.2618   4213125.4604  NEW ARP @ 2006.9909
XYZ   1561470.6628  -4513539.2867   4213124.5441  NEW MON @ 2006.9909
LLH  41 36 28.56663  289  4 59.50099    -26.4399  NEW L1 PHS CEN @ 2006.9909
LLH  41 36 28.56663  289  4 59.50099    -26.5459  NEW ARP @ 2006.9909
LLH  41 36 28.56663  289  4 59.50099    -27.9259  NEW MON @ 2006.9909

BASELINE NAME:   npri  r1_1
XYZ        -2.8094          0.7735         -0.3240  + XYZ ADJUSTMENTS
XYZ   1561471.0715  -4513540.2898   4213125.5063  NEW L1 PHS CEN @ 2006.9909
XYZ   1561471.0456  -4513540.2149   4213125.4359  NEW ARP @ 2006.9909
XYZ   1561470.7083  -4513539.2398   4213124.5195  NEW MON @ 2006.9909
LLH  41 36 28.56667  289  4 59.50350    -26.4781  NEW L1 PHS CEN @ 2006.9909
LLH  41 36 28.56667  289  4 59.50350    -26.5841  NEW ARP @ 2006.9909
LLH  41 36 28.56667  289  4 59.50350    -27.9641  NEW MON @ 2006.9909

BASELINE NAME:   acu5  r1_1
XYZ        -2.8098          0.7694         -0.3180  + XYZ ADJUSTMENTS
XYZ   1561471.0711  -4513540.2939   4213125.5122  NEW L1 PHS CEN @ 2006.9909
XYZ   1561471.0452  -4513540.2190   4213125.4419  NEW ARP @ 2006.9909
XYZ   1561470.7079  -4513539.2439   4213124.5255  NEW MON @ 2006.9909
LLH  41 36 28.56674  289  4 59.50343    -26.4714  NEW L1 PHS CEN @ 2006.9909
LLH  41 36 28.56674  289  4 59.50343    -26.5774  NEW ARP @ 2006.9909
LLH  41 36 28.56674  289  4 59.50343    -27.9574  NEW MON @ 2006.9909
```

G-FILES

```
Axx20061228   61228
B200612281436   612281710 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003         NGS   20061004
C00090001 -835067415   17  -53960386   36  242310701   35 X3626AR1_1X3626ACTPU
D  1  2 -6587073  1  3  6109233  2  3 -9292171

Axx20061228   61228
B200612281436   612281710 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003         NGS   20061004
C00090002 -300784210   10 -179347449   24  -81419356   22 X3626AR1_1X3626ANPRI
D  1  2 -6338126  1  3  7042218  2  3 -9291408

Axx20061228   61228
B200612281436   612281710 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003         NGS   20061004
C00090003   -9202418   10  102546903   27  112735453   24 X3626AR1_1X3626AACU5
D  1  2 -8209669  1  3  7976237  2  3 -8507167
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
            OVERALL     03     04     08     11     17     19     20     27
 ctpu-r1_1|  0.018    ...  0.015  0.019    ...  0.015  0.026  0.018  0.016
               28
 ctpu-r1_1|  0.017

            OVERALL     03     04     08     11     17     19     20     27
 npri-r1_1|  0.011    ...  0.024  0.010    ...  0.011  0.012  0.017  0.008
               28
 npri-r1_1|  0.008

            OVERALL     03     04     08     11     17     19     20     27
 acu5-r1_1|  0.011  0.016  0.026  0.010    ...  0.011  0.012  0.013  0.011
               28
 acu5-r1_1|  0.008
```

OBS BY SATELLITE VS. BASELINE

```
            OVERALL     03     04     08     11     17     19     20     27
 ctpu-r1_1|   1370    ...     39    296    ...    235    169    116    211
```

```
                28
ctpu-r1_1|     304
          OVERALL      03      04      08      11      17      19      20      27
npri-r1_1|   1331     ...      39     287     ...     235     167     120     179
                28
npri-r1_1|     304
          OVERALL      03      04      08      11      17      19      20      27
acu5-r1_1|   1357      22      39     281     ...     235     168     116     193
                28
acu5-r1_1|     303
```

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000010867	-0.0000001726	0.0000001577
-0.0000001726	0.0000057800	-0.0000004917
0.0000001577	-0.0000004917	0.0000050778

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000014817	0.0000008607	-0.0000009934
0.0000008607	0.0000047000	-0.0000000880
-0.0000009934	-0.0000000880	0.0000057628

Horizontal network accuracy = 0.00452 meters.
Vertical network accuracy = 0.00471 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-83506.77177	-5396.06027	24231.08432	2002.00
NPRI	-30078.40888	-17934.72382	-8141.93843	2002.00
ACU5	-920.22656	10254.70517	11273.53905	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2682699.556
Easting (X) [feet]	815662.148
Convergence [degrees]	0.39175060
Point Scale	1.00001769
Combined Factor	1.00002188

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

Ali Kowsari

From: opus@ngs.noaa.gov
Sent: Thursday, January 04, 2007 9:32 AM
To: Ali Kowsari
Subject: OPUS solution : R1_1228b.tps 000055007 NewBedford B

FILE: R1_1228b.tps 000055007

NGS OPUS SOLUTION REPORT
==========

USER: akowsari@greenintl.com
RINEX FILE: r1_1362r.06o
DATE: January 04, 2007
TIME: 14:31:47 UTC

SOFTWARE: page5 0612.06 master29.pl
EPHEMERIS: igr14074.eph [rapid]
NAV FILE: brdc3620.06n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.305
START: 2006/12/28 17:36:00
STOP: 2006/12/28 20:06:00
OBS USED: 4585 / 4638 : 99%
FIXED AMB: 35 / 36 : 97%
OVERALL RMS: 0.013(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2006.9912)	
X:	1562807.755(m)	0.003(m)	1562807.035(m)	0.003(m)
Y:	-4514002.496(m)	0.003(m)	-4514001.052(m)	0.003(m)
Z:	4212142.509(m)	0.005(m)	4212142.435(m)	0.005(m)
LAT:	41 35 45.93256	0.006(m)	41 35 45.96520	0.006(m)
E LON:	289 5 47.52428	0.002(m)	289 5 47.51530	0.002(m)
W LON:	70 54 12.47572	0.002(m)	70 54 12.48470	0.002(m)
EL HGT:	-25.623(m)	0.001(m)	-26.869(m)	0.001(m)
ORTHO HGT:	3.594(m)	0.025(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4606682.126	816381.835
Easting (X) [meters]	341363.048	249735.230
Convergence [degrees]	-1.26392653	0.40070934
Point Scale	0.99990970	1.00001983
Combined Factor	0.99991372	1.00002385

US NATIONAL GRID DESIGNATOR: 19TCG4136306682(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	88647.6
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	36653.1
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	16435.8

NEAREST NGS PUBLISHED CONTROL POINT

LW0072	TIDAL 7 STA 88	N413538.	W0705403.	328.9

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1708        -0.0190         0.0420  VEL TIMES 9.9901 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9462 -4518935.4006 4237355.6853  L1 PHS CEN @ 2006.9912
XYZ         0.0000        -0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1477963.9462 -4518935.4006 4237355.6853  NEW L1 PHS CEN @ 2006.9912
XYZ   1477963.9216 -4518935.3253 4237355.6141  NEW ARP @ 2006.9912
XYZ   1477963.9216 -4518935.3253 4237355.6141  NEW MON @ 2006.9912
LLH  41 53 58.92142  288  6 39.09977      55.9742  NEW L1 PHS CEN @ 2006.9912
LLH  41 53 58.92142  288  6 39.09977      55.8677  NEW ARP @ 2006.9912
LLH  41 53 58.92142  288  6 39.09977      55.8677  NEW MON @ 2006.9912

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                  S/N=0220108551
XYZ   1531392.4521 -4531473.9597 4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000         0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1648        -0.0250         0.0330  VEL TIMES 9.9901 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3321 -4531474.1174 4204982.7080  L1 PHS CEN @ 2006.9912
XYZ        -0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1531392.3321 -4531474.1174 4204982.7080  NEW L1 PHS CEN @ 2006.9912
XYZ   1531392.3063 -4531474.0410 4204982.6366  NEW ARP @ 2006.9912
XYZ   1531392.2873 -4531473.9847 4204982.5840  NEW MON @ 2006.9912
LLH  41 30 35.44814  288 40 20.86545     -12.9075  NEW L1 PHS CEN @ 2006.9912
LLH  41 30 35.44814  288 40 20.86545     -13.0152  NEW ARP @ 2006.9912
LLH  41 30 35.44814  288 40 20.86545     -13.0946  NEW MON @ 2006.9912

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                  S/N=60052145
XYZ   1560550.6359 -4503284.5346 4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1698        -0.0190         0.0460  VEL TIMES 9.9901 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4859 -4503284.6109 4224398.1249  L1 PHS CEN @ 2006.9912
XYZ        -0.0000        -0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4859 -4503284.6109 4224398.1249  NEW L1 PHS CEN @ 2006.9912
XYZ   1560550.4661 -4503284.5536 4224398.0708  NEW ARP @ 2006.9912
XYZ   1560550.4661 -4503284.5536 4224398.0708  NEW MON @ 2006.9912
LLH  41 44 36.82971  289  6 46.96363       5.3219  NEW L1 PHS CEN @ 2006.9912
LLH  41 44 36.82971  289  6 46.96363       5.2406  NEW ARP @ 2006.9912
LLH  41 44 36.82971  289  6 46.96363       5.2406  NEW MON @ 2006.9912

                        REMOTE STATION INFORMATION

STATION NAME: r1_1       1
 ANTENNA: TPSHIPER_GD     NONE                                  S/N=UNKNOWN
XYZ   1562809.9282 -4514001.8461 4212142.7157  MON @ 2006.9911 (M)
NEU         0.0000        -0.0000         1.3050  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3193        -0.9222         0.8664  MON TO ARP
XYZ         0.0259        -0.0749         0.0704  ARP TO L1 PHASE CENTER
XYZ   1562810.2734 -4514002.8432 4212143.6524  L1 PHS CEN @ 2006.9912

BASELINE NAME:   ctpu  r1_1
```

```
XYZ        -2.8922          0.7932         -0.2826  + XYZ ADJUSTMENTS
XYZ   1562807.3812  -4514002.0501   4212143.3699  NEW L1 PHS CEN @ 2006.9912
XYZ   1562807.3553  -4514001.9752   4212143.2995  NEW ARP @ 2006.9912
XYZ   1562807.0360  -4514001.0529   4212142.4331  NEW MON @ 2006.9912
LLH  41 35 45.96513  289  5 47.51533    -25.4580  NEW L1 PHS CEN @ 2006.9912
LLH  41 35 45.96513  289  5 47.51533    -25.5640  NEW ARP @ 2006.9912
LLH  41 35 45.96513  289  5 47.51533    -26.8690  NEW MON @ 2006.9912

BASELINE NAME:   npri  r1_1
XYZ        -2.8926          0.7940         -0.2828  + XYZ ADJUSTMENTS
XYZ   1562807.3809  -4514002.0493   4212143.3696  NEW L1 PHS CEN @ 2006.9912
XYZ   1562807.3549  -4514001.9743   4212143.2993  NEW ARP @ 2006.9912
XYZ   1562807.0356  -4514001.0521   4212142.4329  NEW MON @ 2006.9912
LLH  41 35 45.96514  289  5 47.51533    -25.4588  NEW L1 PHS CEN @ 2006.9912
LLH  41 35 45.96514  289  5 47.51533    -25.5648  NEW ARP @ 2006.9912
LLH  41 35 45.96514  289  5 47.51533    -26.8698  NEW MON @ 2006.9912

BASELINE NAME:   acu5  r1_1
XYZ        -2.8953          0.7963         -0.2782  + XYZ ADJUSTMENTS
XYZ   1562807.3781  -4514002.0470   4212143.3742  NEW L1 PHS CEN @ 2006.9912
XYZ   1562807.3522  -4514001.9721   4212143.3038  NEW ARP @ 2006.9912
XYZ   1562807.0329  -4514001.0498   4212142.4375  NEW MON @ 2006.9912
LLH  41 35 45.96532  289  5 47.51525    -25.4581  NEW L1 PHS CEN @ 2006.9912
LLH  41 35 45.96532  289  5 47.51525    -25.5641  NEW ARP @ 2006.9912
LLH  41 35 45.96532  289  5 47.51525    -26.8691  NEW MON @ 2006.9912
```

G-FILES

```
Axx20061228   61228
B200612281735   6122820 6 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003         NGS   20061004
C00090001 -848431144   13  -49342724   27  252131810   24 X3626AR1_1X3626ACTPU
D  1  2 -6355419  1  3  5083472  2  3 -9241996

Axx20061228   61228
B200612281735   6122820 6 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003         NGS   20061004
C00090002 -314147484   12 -174729325   26  -71598489   23 X3626AR1_1X3626ANPRI
D  1  2 -6214033  1  3  6747828  2  3 -9197756

Axx20061228   61228
B200612281735   6122820 6 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003         NGS   20061004
C00090003  -22565668    9  107164963   26  122556333   23 X3626AR1_1X3626AACU5
D  1  2 -8728662  1  3  7106517  2  3 -7597116
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     02     04     05     09     11     12     13     17
ctpu-r1_1|  0.014  0.011    ...  0.013  0.019  0.017  0.012  0.024  0.008
              20     23     24     28
ctpu-r1_1|  0.013  0.026  0.014  0.013

           OVERALL     02     04     05     09     11     12     13     17
npri-r1_1|  0.013  0.013    ...  0.015  0.017  0.016  0.013  0.019  0.008
              20     23     24     28
npri-r1_1|  0.010  0.020  0.016  0.011

           OVERALL     02     04     05     09     11     12     13     17
acu5-r1_1|  0.012  0.014    ...  0.012  0.015  0.022  0.011  0.015  0.008
              20     23     24     28
acu5-r1_1|  0.012  0.018  0.013  0.010
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     02     04     05     09     11     12     13     17
ctpu-r1_1|   1556    190    ...    114    119     68    129     26    298
```

	20	23	24	28					
ctpu-r1_1|	261	55	87	209					
	OVERALL	02	04	05	09	11	12	13	17
npri-r1_1|	1525	195	...	108	87	69	125	26	298
	20	23	24	28					
npri-r1_1|	261	60	87	209					
	OVERALL	02	04	05	09	11	12	13	17
acu5-r1_1|	1504	197	...	108	67	70	117	26	298
	20	23	24	28					
acu5-r1_1|	262	64	86	209					

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000008756	-0.0000001380	0.0000001093
-0.0000001380	0.0000046244	-0.0000003563
0.0000001093	-0.0000003563	0.0000036311

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000011915	0.0000006848	-0.0000007967
0.0000006848	0.0000035579	-0.0000002894
-0.0000007967	-0.0000002894	0.0000043817

Horizontal network accuracy = 0.00396 meters.
Vertical network accuracy = 0.00410 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-84843.11377	-4934.26527	25213.17932	2002.00
NPRI	-31414.75088	-17472.92882	-7159.84343	2002.00
ACU5	-2256.56856	10716.50017	12255.63405	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2678412.737
Easting (X) [feet]	819339.667
Convergence [degrees]	0.40070934
Point Scale	1.00001983
Combined Factor	1.00002385

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

Ali Kowsari G-7

From: opus@ngs.noaa.gov
Sent: Friday, January 05, 2007 9:06 AM
To: Ali Kowsari
Subject: OPUS solution : R1_0102a.tps 000055741

FILE: R1_0102a.tps 000055741

NGS OPUS SOLUTION REPORT
==========

USER: akowsari@greenintl.com
RINEX FILE: r1_0002p.07o

DATE: January 05, 2007
TIME: 14:06:13 UTC

SOFTWARE: page5 0612.06 master28.pl
EPHEMERIS: igr14082.eph [rapid]
NAV FILE: brdc0020.07n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.400

START: 2007/01/02 15:01:00
STOP: 2007/01/02 17:29:30
OBS USED: 3995 / 4060 : 98%
FIXED AMB: 25 / 25 : 100%
OVERALL RMS: 0.013(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2007.0046)	
X:	1567680.518(m)	0.007(m)	1567679.798(m)	0.007(m)
Y:	-4510057.810(m)	0.021(m)	-4510056.366(m)	0.021(m)
Z:	4214538.739(m)	0.022(m)	4214538.666(m)	0.022(m)
LAT:	41 37 29.84722	0.005(m)	41 37 29.87990	0.005(m)
E LON:	289 10 2.18958	0.013(m)	289 10 2.18068	0.013(m)
W LON:	70 49 57.81042	0.013(m)	70 49 57.81932	0.013(m)
EL HGT:	-26.766(m)	0.027(m)	-28.011(m)	0.027(m)
ORTHO HGT:	2.278(m)	0.037(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4609759.310	819631.418
Easting (X) [meters]	347326.974	255607.915
Convergence [degrees]	-1.21762577	0.44822767
Point Scale	0.99988685	1.00001468
Combined Factor	0.99989104	1.00001888

US NATIONAL GRID DESIGNATOR: 19TCG4732709759(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	92996.7
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	43206.7
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	13924.5

NEAREST NGS PUBLISHED CONTROL POINT

LW4880	NASK	N413727.773	W0705006.508	211.0

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1711        -0.0190         0.0420  VEL TIMES 10.0034 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9460 -4518935.4006 4237355.6853  L1 PHS CEN @ 2007.0046
XYZ         0.0000        -0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1477963.9460 -4518935.4007 4237355.6853  NEW L1 PHS CEN @ 2007.0046
XYZ   1477963.9214 -4518935.3253 4237355.6142  NEW ARP @ 2007.0046
XYZ   1477963.9214 -4518935.3253 4237355.6142  NEW MON @ 2007.0046
LLH  41 53 58.92143  288  6 39.09976     55.9742  NEW L1 PHS CEN @ 2007.0046
LLH  41 53 58.92143  288  6 39.09976     55.8677  NEW ARP @ 2007.0046
LLH  41 53 58.92143  288  6 39.09976     55.8677  NEW MON @ 2007.0046

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                    S/N=0220108551
XYZ   1531392.4521 -4531473.9597 4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000         0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1651        -0.0250         0.0330  VEL TIMES 10.0034 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3319 -4531474.1174 4204982.7080  L1 PHS CEN @ 2007.0046
XYZ         0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1531392.3319 -4531474.1174 4204982.7080  NEW L1 PHS CEN @ 2007.0046
XYZ   1531392.3061 -4531474.0410 4204982.6366  NEW ARP @ 2007.0046
XYZ   1531392.2871 -4531473.9847 4204982.5840  NEW MON @ 2007.0046
LLH  41 30 35.44814  288 40 20.86544    -12.9075  NEW L1 PHS CEN @ 2007.0046
LLH  41 30 35.44814  288 40 20.86544    -13.0152  NEW ARP @ 2007.0046
LLH  41 30 35.44814  288 40 20.86544    -13.0946  NEW MON @ 2007.0046

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                    S/N=60052145
XYZ   1560550.6359 -4503284.5346 4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1701        -0.0190         0.0460  VEL TIMES 10.0034 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4857 -4503284.6109 4224398.1249  L1 PHS CEN @ 2007.0046
XYZ         0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4857 -4503284.6109 4224398.1249  NEW L1 PHS CEN @ 2007.0046
XYZ   1560550.4658 -4503284.5536 4224398.0708  NEW ARP @ 2007.0046
XYZ   1560550.4658 -4503284.5536 4224398.0708  NEW MON @ 2007.0046
LLH  41 44 36.82971  289  6 46.96362     5.3219  NEW L1 PHS CEN @ 2007.0046
LLH  41 44 36.82971  289  6 46.96362     5.2406  NEW ARP @ 2007.0046
LLH  41 44 36.82971  289  6 46.96362     5.2406  NEW MON @ 2007.0046
```

REMOTE STATION INFORMATION

```
STATION NAME: r1_0       1
 ANTENNA: TPSHIPER_GD     NONE                                    S/N=UNKNOWN
XYZ   1567682.7100 -4510057.2053 4214539.0685  MON @ 2007.0045 (M)
NEU         0.0000        -0.0000         1.4000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3436        -0.9885         0.9300  MON TO ARP
XYZ         0.0260        -0.0748         0.0704  ARP TO L1 PHASE CENTER
XYZ   1567683.0796 -4510058.2686 4214540.0689  L1 PHS CEN @ 2007.0046

BASELINE NAME:    ctpu  r1_0
```

```
XYZ        -2.9082          0.8509         -0.4160  + XYZ ADJUSTMENTS
XYZ   1567680.1714  -4510057.4178   4214539.6529  NEW L1 PHS CEN @ 2007.0046
XYZ   1567680.1454  -4510057.3429   4214539.5825  NEW ARP @ 2007.0046
XYZ   1567679.8018  -4510056.3544   4214538.6525  NEW MON @ 2007.0046
LLH  41 37 29.87978  289 10  2.18100     -26.5211  NEW L1 PHS CEN @ 2007.0046
LLH  41 37 29.87978  289 10  2.18100     -26.6271  NEW ARP @ 2007.0046
LLH  41 37 29.87978  289 10  2.18100     -28.0271  NEW MON @ 2007.0046

BASELINE NAME:   npri  r1_0
XYZ        -2.9151          0.8304         -0.3940  + XYZ ADJUSTMENTS
XYZ   1567680.1645  -4510057.4382   4214539.6748  NEW L1 PHS CEN @ 2007.0046
XYZ   1567680.1385  -4510057.3634   4214539.6044  NEW ARP @ 2007.0046
XYZ   1567679.7949  -4510056.3749   4214538.6745  NEW MON @ 2007.0046
LLH  41 37 29.87995  289 10  2.18043     -26.4938  NEW L1 PHS CEN @ 2007.0046
LLH  41 37 29.87995  289 10  2.18043     -26.5998  NEW ARP @ 2007.0046
LLH  41 37 29.87995  289 10  2.18043     -27.9998  NEW MON @ 2007.0046

BASELINE NAME:   acu5  r1_0
XYZ        -2.9132          0.8353         -0.3979  + XYZ ADJUSTMENTS
XYZ   1567680.1664  -4510057.4333   4214539.6710  NEW L1 PHS CEN @ 2007.0046
XYZ   1567680.1404  -4510057.3585   4214539.6006  NEW ARP @ 2007.0046
XYZ   1567679.7968  -4510056.3700   4214538.6706  NEW MON @ 2007.0046
LLH  41 37 29.87994  289 10  2.18058     -26.4993  NEW L1 PHS CEN @ 2007.0046
LLH  41 37 29.87994  289 10  2.18058     -26.6053  NEW ARP @ 2007.0046
LLH  41 37 29.87994  289 10  2.18058     -28.0053  NEW MON @ 2007.0046
```

G-FILES

```
Axx2007 1 2   7 1 2
B2007 1 215 0   7 1 21729 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 5IFDDFX
Iant_info.003        NGS   20061004
C00090001 -897158804   15  -88789709   30  228169616   27 X0027AR1_0X0027ACTPU
D  1  2 -6648773  1  3  5866526  2  3 -9389919

Axx2007 1 2   7 1 2
B2007 1 215 0   7 1 21729 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 5IFDDFX
Iant_info.003        NGS   20061004
C00090002 -362875079   11 -214176098   26  -95560904   24 X0027AR1_0X0027ANPRI
D  1  2 -6319979  1  3  7110702  2  3 -9082037

Axx2007 1 2   7 1 2
B2007 1 215 0   7 1 21729 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 5IFDDFX
Iant_info.003        NGS   20061004
C00090003  -71293309   13   67718164   30   98594002   23 X0027AR1_0X0027AACU5
D  1  2 -9112498  1  3  7074770  2  3 -8648132
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
          OVERALL     04     08     09     11     17     19     20     27
ctpu-r1_0|  0.015  0.017  0.011  0.011  0.012  0.012  0.025  0.021  0.015
             28
ctpu-r1_0|    ...

          OVERALL     04     08     09     11     17     19     20     27
npri-r1_0|  0.012  0.015  0.011    ...  0.011  0.012  0.014  0.013  0.015
             28
npri-r1_0|    ...

          OVERALL     04     08     09     11     17     19     20     27
acu5-r1_0|  0.012  0.013  0.012    ...  0.011  0.010  0.017  0.012  0.014
             28
acu5-r1_0|    ...
```

OBS BY SATELLITE VS. BASELINE

```
          OVERALL     04     08     09     11     17     19     20     27
ctpu-r1_0|   1348    119    220     21    296    296     71    196    129
```

	28								
ctpu-r1_0|	...								
	OVERALL	04	08	09	11	17	19	20	27
npri-r1_0|	1309	119	209	...	296	296	76	191	122
	28								
npri-r1_0|	...								
	OVERALL	04	08	09	11	17	19	20	27
acu5-r1_0|	1338	117	219	...	294	295	85	199	129
	28								
acu5-r1_0|	...								

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000011444	-0.0000001856	0.0000001415
-0.0000001856	0.0000055022	-0.0000004276
0.0000001415	-0.0000004276	0.0000040756

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000014991	0.0000007930	-0.0000009085
0.0000007930	0.0000040982	-0.0000004760
-0.0000009085	-0.0000004760	0.0000051250

Horizontal network accuracy = 0.00427 meters.
Vertical network accuracy = 0.00444 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-89715.87677	-8878.95127	22816.94932	2002.00
NPRI	-36287.51388	-21417.61482	-9556.07343	2002.00
ACU5	-7129.33156	6771.81417	9859.40405	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2689074.077
Easting (X) [feet]	838606.968
Convergence [degrees]	0.44822767
Point Scale	1.00001468
Combined Factor	1.00001888

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

Ali Kowsari G-8

From: opus@ngs.noaa.gov
Sent: Friday, January 05, 2007 9:02 AM
To: Ali Kowsari
Subject: OPUS solution : R2_0102b.tps 000055746

FILE: R2_0102b.tps 000055746

NGS OPUS SOLUTION REPORT
==========

USER: akowsari@greenintl.com
INDX FILE: r2_0002s.07o
DATE: January 05, 2007
TIME: 14:01:29 UTC

SOFTWARE: page5 0612.06 master.pl
EPHEMERIS: igr14082.eph [rapid]
NAV FILE: brdc0020.07n
ANT NAME: TPSHIPER_GD NONE
ANT HEIGHT: 1.555

START: 2007/01/02 18:17:00
STOP: 2007/01/02 20:45:30
OBS USED: 5882 / 5941 : 99%
FIXED AMB: 34 / 34 : 100%
OVERALL RMS: 0.012(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2007.0050)	
X:	1572506.685(m)	0.003(m)	1572505.964(m)	0.003(m)
Y:	-4506509.688(m)	0.007(m)	-4506508.244(m)	0.007(m)
Z:	4216522.171(m)	0.005(m)	4216522.098(m)	0.005(m)
LAT:	41 38 55.87185	0.004(m)	41 38 55.90457	0.004(m)
E LON:	289 14 9.53387	0.004(m)	289 14 9.52501	0.004(m)
W LON:	70 45 50.46613	0.004(m)	70 45 50.47499	0.004(m)
EL HGT:	-26.897(m)	0.008(m)	-28.142(m)	0.008(m)
ORTHO HGT:	1.983(m)	0.026(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4612293.032	822332.460
Easting (X) [meters]	353105.018	261310.613
Convergence [degrees]	-1.17251155	0.49437996
Point Scale	0.99986554	1.00001061
Combined Factor	0.99986976	1.00001483

US NATIONAL GRID DESIGNATOR: 19TCG5310512293(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DI5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	97604.6
DG0785	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	49465.0
DG0776	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	14675.1

NEAREST NGS PUBLISHED CONTROL POINT

AI 42	ANGEL RESET	N413829.660	W0704554.433	815.7

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -2.8474          0.7999         -0.4232  + XYZ ADJUSTMENTS
XYZ   1572506.3730  -4506509.4117   4216523.2000  NEW L1 PHS CEN @ 2007.0050
XYZ   1572506.3469  -4506509.3369   4216523.1296  NEW ARP @ 2007.0050
XYZ   1572505.9641  -4506508.2398   4216522.0962  NEW MON @ 2007.0050
LLH  41 38 55.90461  289 14  9.52507    -26.4852  NEW L1 PHS CEN @ 2007.0050
LLH  41 38 55.90461  289 14  9.52507    -26.5912  NEW ARP @ 2007.0050
LLH  41 38 55.90461  289 14  9.52507    -28.1462  NEW MON @ 2007.0050

BASELINE NAME:   npri  r2_0
XYZ        -2.8490          0.7930         -0.4185  + XYZ ADJUSTMENTS
XYZ   1572506.3714  -4506509.4186   4216523.2048  NEW L1 PHS CEN @ 2007.0050
XYZ   1572506.3453  -4506509.3438   4216523.1343  NEW ARP @ 2007.0050
XYZ   1572505.9625  -4506508.2467   4216522.1009  NEW MON @ 2007.0050
LLH  41 38 55.90460  289 14  9.52491    -26.4776  NEW L1 PHS CEN @ 2007.0050
LLH  41 38 55.90460  289 14  9.52491    -26.5836  NEW ARP @ 2007.0050
LLH  41 38 55.90460  289 14  9.52491    -28.1386  NEW MON @ 2007.0050

BASELINE NAME:   acu5  r2_0
XYZ        -2.8456          0.7942         -0.4234  + XYZ ADJUSTMENTS
XYZ   1572506.3749  -4506509.4173   4216523.1998  NEW L1 PHS CEN @ 2007.0050
XYZ   1572506.3488  -4506509.3425   4216523.1294  NEW ARP @ 2007.0050
XYZ   1572505.9659  -4506508.2455   4216522.0960  NEW MON @ 2007.0050
LLH  41 38 55.90448  289 14  9.52506    -26.4810  NEW L1 PHS CEN @ 2007.0050
LLH  41 38 55.90448  289 14  9.52506    -26.5870  NEW ARP @ 2007.0050
LLH  41 38 55.90448  289 14  9.52506    -28.1420  NEW MON @ 2007.0050
```

G-FILES

```
Axx2007 1 2   7 1 2
B2007 1 21816   7 1 22045 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 5IFDDFX
Iant_info.003        NGS   20061004
C00090001 -945420429   11 -124270856   28  208335180   25 X0027AR2_0X0027ACTPU
D  1  2 -6570320  1  3  6158174  2  3 -9408086

Axx2007 1 2   7 1 2
B2007 1 21816   7 1 22045 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 5IFDDFX
Iant_info.003        NGS   20061004
C00090002 -411136755    9 -249657380   24 -115395169   21 X0027AR2_0X0027ANPRI
D  1  2 -6418487  1  3  7526994  2  3 -9112815

Axx2007 1 2   7 1 2
B2007 1 21816   7 1 22045 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 5IFDDFX
Iant_info.003        NGS   20061004
C00090003 -119555001   10   32236918   24   78759748   22 X0027AR2_0X0027AACU5
D  1  2 -7555017  1  3  5376299  2  3 -8999318
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     02     04     05     09     10     12     13     17
ctpu-r2_0|  0.014  0.011    ...  0.012    ...  0.014  0.011  0.020  0.010
              20     23     24     28     30
ctpu-r2_0|  0.013  0.019  0.011  0.025  0.012

           OVERALL     02     04     05     09     10     12     13     17
npri-r2_0|  0.012  0.010    ...  0.010    ...  0.013  0.010  0.015  0.008
              20     23     24     28     30
npri-r2_0|  0.011  0.014  0.010  0.019  0.014

           OVERALL     02     04     05     09     10     12     13     17
acu5-r2_0|  0.012  0.010    ...  0.011    ...  0.011  0.010  0.015  0.009
              20     23     24     28     30
acu5-r2_0|  0.011  0.014  0.012  0.017  0.021
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     02     04     05     09     10     12     13     17
ctpu-r2_0|   1959    295    ...    231    ...    115    248    150    295
```

	20	23	24	28	30				
ctpu-r2_0|	137	166	183	72	67				
	OVERALL	02	04	05	09	10	12	13	17
npri-r2_0|	1950	290	...	231	...	115	246	149	295
	20	23	24	28	30				
npri-r2_0|	137	170	183	71	63				
	OVERALL	02	04	05	09	10	12	13	17
acu5-r2_0|	1973	293	...	228	...	114	235	155	295
	20	23	24	28	30				
acu5-r2_0|	140	179	183	81	70				

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000006711	-0.0000001161	0.0000000955
-0.0000001161	0.0000043022	-0.0000003540
0.0000000955	-0.0000003540	0.0000034444

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000009930	0.0000006678	-0.0000007959
0.0000006678	0.0000033164	-0.0000002208
-0.0000007959	-0.0000002208	0.0000041083

Horizontal network accuracy = 0.00380 meters.
Vertical network accuracy = 0.00397 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-94542.04377	-12427.07327	20833.51732	2002.00
NPRI	-41113.68088	-24965.73682	-11539.50543	2002.00
ACU5	-11955.49856	3223.69217	7875.97205	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2697935.746
Easting (X) [feet]	857316.569
Convergence [degrees]	0.49437996
Point Scale	1.00001061
Combined Factor	1.00001483

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

Ali Kowsari G-9

From: opus@ngs.noaa.gov
Sent: Thursday, January 04, 2007 9:32 AM
To: Ali Kowsari
Subject: OPUS solution : R2_1229a.tps 000055014 Fairhaven A

FILE: R2_1229a.tps 000055014

NGS OPUS SOLUTION REPORT
==========

USER: akowsari@greenintl.com
RINEX FILE: r2_1363o.06o
DATE: January 04, 2007
TIME: 14:32:27 UTC

SOFTWARE: page5 0612.06 master23.pl
EPHEMERIS: igr14075.eph [rapid]
NAV FILE: brdc3630.06n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.340
START: 2006/12/29 14:23:00
STOP: 2006/12/29 16:57:00
OBS USED: 4158 / 4183 : 99%
FIXED AMB: 22 / 22 : 100%
OVERALL RMS: 0.011(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2006.9936)	
X:	1560883.060(m)	0.005(m)	1560882.340(m)	0.005(m)
Y:	-4511248.356(m)	0.012(m)	-4511246.913(m)	0.012(m)
Z:	4215778.156(m)	0.008(m)	4215778.083(m)	0.008(m)
LAT:	41 38 23.61224	0.000(m)	41 38 23.64491	0.000(m)
E LON:	289 5 7.87004	0.008(m)	289 5 7.86103	0.008(m)
W LON:	70 54 52.12996	0.008(m)	70 54 52.13897	0.008(m)
EL HGT:	-27.306(m)	0.012(m)	-28.550(m)	0.012(m)
ORTHO HGT:	1.861(m)	0.028(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4611565.494	821240.109
Easting (X) [meters]	340552.961	248783.485
Convergence [degrees]	-1.27233774	0.39331021
Point Scale	0.99991286	1.00001212
Combined Factor	0.99991715	1.00001640

US NATIONAL GRID DESIGNATOR: 19TCG4055311565(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	86024.2
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	37354.3
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	11739.4

NEAREST NGS PUBLISHED CONTROL POINT

LW4943	USE 20 1935	N413831.991	W0705502.290	349.7

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1709        -0.0190         0.0420  VEL TIMES 9.9924 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9462  -4518935.4006   4237355.6853  L1 PHS CEN @ 2006.9936
XYZ         0.0000        -0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1477963.9462  -4518935.4006   4237355.6853  NEW L1 PHS CEN @ 2006.9936
XYZ   1477963.9215  -4518935.3253   4237355.6142  NEW ARP @ 2006.9936
XYZ   1477963.9215  -4518935.3253   4237355.6142  NEW MON @ 2006.9936
LLH  41 53 58.92143  288  6 39.09977     55.9742  NEW L1 PHS CEN @ 2006.9936
LLH  41 53 58.92143  288  6 39.09977     55.8677  NEW ARP @ 2006.9936
LLH  41 53 58.92143  288  6 39.09977     55.8677  NEW MON @ 2006.9936

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                  S/N=0220108551
XYZ   1531392.4521  -4531473.9597   4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000         0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1649        -0.0250         0.0330  VEL TIMES 9.9924 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3321  -4531474.1174   4204982.7080  L1 PHS CEN @ 2006.9936
XYZ        -0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1531392.3321  -4531474.1174   4204982.7080  NEW L1 PHS CEN @ 2006.9936
XYZ   1531392.3063  -4531474.0410   4204982.6366  NEW ARP @ 2006.9936
XYZ   1531392.2872  -4531473.9847   4204982.5840  NEW MON @ 2006.9936
LLH  41 30 35.44814  288 40 20.86545    -12.9075  NEW L1 PHS CEN @ 2006.9936
LLH  41 30 35.44814  288 40 20.86545    -13.0152  NEW ARP @ 2006.9936
LLH  41 30 35.44814  288 40 20.86545    -13.0946  NEW MON @ 2006.9936

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                  S/N=60052145
XYZ   1560550.6359  -4503284.5346   4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1699        -0.0190         0.0460  VEL TIMES 9.9924 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4859  -4503284.6109   4224398.1249  L1 PHS CEN @ 2006.9936
XYZ         0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4859  -4503284.6109   4224398.1249  NEW L1 PHS CEN @ 2006.9936
XYZ   1560550.4660  -4503284.5536   4224398.0708  NEW ARP @ 2006.9936
XYZ   1560550.4660  -4503284.5536   4224398.0708  NEW MON @ 2006.9936
LLH  41 44 36.82971  289  6 46.96363     5.3219  NEW L1 PHS CEN @ 2006.9936
LLH  41 44 36.82971  289  6 46.96363     5.2406  NEW ARP @ 2006.9936
LLH  41 44 36.82971  289  6 46.96363     5.2406  NEW MON @ 2006.9936
```

REMOTE STATION INFORMATION

```
STATION NAME: r2_1       1
 ANTENNA: TPSHIPER_GD     NONE                                  S/N=UNKNOWN
XYZ   1560885.3307  -4511247.7711   4215778.5543  MON @ 2006.9934 (M)
NEU         0.0000        -0.0000         1.3400  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3274        -0.9464         0.8904  MON TO ARP
XYZ         0.0259        -0.0749         0.0704  ARP TO L1 PHASE CENTER
XYZ   1560885.6840  -4511248.7923   4215779.5151  L1 PHS CEN @ 2006.9936

BASELINE NAME:   ctpu  r2_1
```

```
XYZ        -2.9880          0.8645         -0.4762  + XYZ ADJUSTMENTS
XYZ   1560882.6961  -4511247.9278   4215779.0389  NEW L1 PHS CEN @ 2006.9936
XYZ   1560882.6702  -4511247.8530   4215778.9685  NEW ARP @ 2006.9936
XYZ   1560882.3427  -4511246.9066   4215778.0781  NEW MON @ 2006.9936
LLH  41 38 23.64490  289  5  7.86123    -27.1111  NEW L1 PHS CEN @ 2006.9936
LLH  41 38 23.64490  289  5  7.86123    -27.2171  NEW ARP @ 2006.9936
LLH  41 38 23.64490  289  5  7.86123    -28.5571  NEW MON @ 2006.9936

BASELINE NAME:   npri  r2_1
XYZ        -2.9927          0.8529         -0.4684  + XYZ ADJUSTMENTS
XYZ   1560882.6914  -4511247.9394   4215779.0467  NEW L1 PHS CEN @ 2006.9936
XYZ   1560882.6655  -4511247.8646   4215778.9763  NEW ARP @ 2006.9936
XYZ   1560882.3380  -4511246.9182   4215778.0859  NEW MON @ 2006.9936
LLH  41 38 23.64489  289  5  7.86087    -27.0989  NEW L1 PHS CEN @ 2006.9936
LLH  41 38 23.64489  289  5  7.86087    -27.2049  NEW ARP @ 2006.9936
LLH  41 38 23.64489  289  5  7.86087    -28.5449  NEW MON @ 2006.9936

BASELINE NAME:   acu5  r2_1
XYZ        -2.9905          0.8558         -0.4694  + XYZ ADJUSTMENTS
XYZ   1560882.6935  -4511247.9366   4215779.0456  NEW L1 PHS CEN @ 2006.9936
XYZ   1560882.6676  -4511247.8617   4215778.9752  NEW ARP @ 2006.9936
XYZ   1560882.3402  -4511246.9153   4215778.0849  NEW MON @ 2006.9936
LLH  41 38 23.64490  289  5  7.86100    -27.1011  NEW L1 PHS CEN @ 2006.9936
LLH  41 38 23.64490  289  5  7.86100    -27.2071  NEW ARP @ 2006.9936
LLH  41 38 23.64490  289  5  7.86100    -28.5471  NEW MON @ 2006.9936
```

G-FILES

```
Axx20061229   61229
B200612291422   612291657 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090001 -829184212   13  -76884187   28  215775361   26 X3636AR2_1X3636ACTPU
D  1  2 -6512629  1  3  6217007  2  3 -9519846

Axx20061229   61229
B200612291422   612291657 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090002 -294900508    9 -202270665   25 -107955019   22 X3636AR2_1X3636ANPRI
D  1  2 -6375192  1  3  7187081  2  3 -9306740

Axx20061229   61229
B200612291422   612291657 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090003   -3318741    8   79623618   24   86199859   21 X3636AR2_1X3636AACU5
D  1  2 -8112125  1  3  7946038  2  3 -8680869
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     03     04     08     11     17     19     20     27
ctpu-r2_1|  0.012    ...  0.023  0.009    ...  0.011  0.017  0.020  0.010
              28
ctpu-r2_1|  0.010

           OVERALL     03     04     08     11     17     19     20     27
npri-r2_1|  0.011    ...  0.023  0.009    ...  0.011  0.010  0.015  0.011
              28
npri-r2_1|  0.009

           OVERALL     03     04     08     11     17     19     20     27
acu5-r2_1|  0.011  0.018  0.020  0.009    ...  0.011  0.012  0.015  0.009
              28
acu5-r2_1|  0.009
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     03     04     08     11     17     19     20     27
ctpu-r2_1|   1376    ...     21    307    ...    217    189     98    237
```

	28								
ctpu-r2_1|	307								
	OVERALL	03	04	08	11	17	19	20	27
npri-r2_1|	1361	...	21	307	...	217	189	84	236
	28								
npri-r2_1|	307								
	OVERALL	03	04	08	11	17	19	20	27
acu5-r2_1|	1421	43	21	306	...	216	191	101	237
	28								
acu5-r2_1|	306								

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000006978	-0.0000001192	0.0000001080
-0.0000001192	0.0000044111	-0.0000003650
0.0000001080	-0.0000003650	0.0000035578

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000010211	0.0000006846	-0.0000008013
0.0000006846	0.0000034127	-0.0000002159
-0.0000008013	-0.0000002159	0.0000042328

Horizontal network accuracy = 0.00385 meters.
Vertical network accuracy = 0.00403 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-82918.41877	-7688.40527	21577.53232	2002.00
NPRI	-29490.05588	-20227.06882	-10795.49043	2002.00
ACU5	-331.87356	7962.36017	8619.98705	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2694351.924
Easting (X) [feet]	816217.150
Convergence [degrees]	0.39331021
Point Scale	1.00001212
Combined Factor	1.00001640

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

Ali Kowsari G-10

From: opus@ngs.noaa.gov
Sent: Thursday, January 04, 2007 9:39 AM
To: Ali Kowsari
Subject: OPUS solution : R2_1229b.tps 000055021 Fairhaven B

FILE: R2_1229b.tps 000055021

NGS OPUS SOLUTION REPORT
==========

USER: akowsari@greenintl.com
RINEX FILE: r2_1363r.06o

DATE: January 04, 2007
TIME: 14:38:32 UTC

SOFTWARE: page5 0612.06 master30.pl
EPHEMERIS: igr14075.eph [rapid]
NAV FILE: brdc3630.06n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.350

START: 2006/12/29 17:24:00
STOP: 2006/12/29 19:54:00
OBS USED: 4365 / 4500 : 97%
FIXED AMB: 33 / 33 : 100%
OVERALL RMS: 0.013(m) Hold

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2006.9939)	
X:	1565130.780(m)	0.003(m)	1565130.060(m)	0.003(m)
Y:	-4511773.622(m)	0.016(m)	-4511772.178(m)	0.016(m)
Z:	4213655.185(m)	0.014(m)	4213655.111(m)	0.014(m)
LAT:	41 36 51.54923	0.008(m)	41 36 51.58189	0.008(m)
E LON:	289 7 53.83431	0.003(m)	289 7 53.82537	0.003(m)
W LON:	70 52 6.16569	0.003(m)	70 52 6.17463	0.003(m)
EL HGT:	-27.160(m)	0.019(m)	-28.406(m)	0.019(m)
ORTHO HGT:	1.966(m)	0.032(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4608641.899	818427.253
Easting (X) [meters]	344331.124	252645.444
Convergence [degrees]	-1.24106383	0.42427770
Point Scale	0.99989821	1.00001655
Combined Factor	0.99990247	1.00002081

US NATIONAL GRID DESIGNATOR: 19TCG4433108642(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	90614.4
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	40020.1
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	14436.9

NEAREST NGS PUBLISHED CONTROL POINT

LW4876	YELLOW HOUSE CHIMNEY	N413553.137	W0705135.371	1941.5

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ          -0.0171          -0.0019           0.0042  VEL (M/YR)
NEU           0.0000           0.0000           0.0000  MON TO ARP (M)
NEU          -0.0000           0.0000           0.1065  ARP TO L1 PHASE CENTER (M)
NEU          -0.0000           0.0000           0.1258  ARP TO L2 PHASE CENTER (M)
XYZ          -0.1709          -0.0190           0.0420  VEL TIMES 9.9928 YRS
XYZ           0.0000           0.0000           0.0000  MON TO ARP
XYZ           0.0246          -0.0753           0.0711  ARP TO L1 PHASE CENTER
XYZ     1477963.9462 -4518935.4006  4237355.6853  L1 PHS CEN @ 2006.9939
XYZ           0.0001           0.0000          -0.0000  + XYZ ADJUSTMENTS
XYZ     1477963.9462 -4518935.4006  4237355.6853  NEW L1 PHS CEN @ 2006.9939
XYZ     1477963.9216 -4518935.3253  4237355.6142  NEW ARP @ 2006.9939
XYZ     1477963.9216 -4518935.3253  4237355.6142  NEW MON @ 2006.9939
LLH   41 53 58.92143  288  6 39.09977     55.9742  NEW L1 PHS CEN @ 2006.9939
LLH   41 53 58.92143  288  6 39.09977     55.8677  NEW ARP @ 2006.9939
LLH   41 53 58.92143  288  6 39.09977     55.8677  NEW MON @ 2006.9939

STATION NAME: npri  a     6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                    S/N=0220108551
XYZ     1531392.4521 -4531473.9597  4204982.5510  MON @ 1997.0000 (M)
XYZ          -0.0165          -0.0025           0.0033  VEL (M/YR)
NEU          -0.0000           0.0000           0.0794  MON TO ARP (M)
NEU          -0.0000           0.0000           0.1077  ARP TO L1 PHASE CENTER (M)
NEU          -0.0000           0.0000           0.1273  ARP TO L2 PHASE CENTER (M)
XYZ          -0.1649          -0.0250           0.0330  VEL TIMES 9.9928 YRS
XYZ           0.0190          -0.0563           0.0526  MON TO ARP
XYZ           0.0258          -0.0764           0.0714  ARP TO L1 PHASE CENTER
XYZ     1531392.3321 -4531474.1174  4204982.7080  L1 PHS CEN @ 2006.9939
XYZ           0.0000           0.0000          -0.0000  + XYZ ADJUSTMENTS
XYZ     1531392.3321 -4531474.1174  4204982.7080  NEW L1 PHS CEN @ 2006.9939
XYZ     1531392.3063 -4531474.0410  4204982.6366  NEW ARP @ 2006.9939
XYZ     1531392.2872 -4531473.9847  4204982.5840  NEW MON @ 2006.9939
LLH   41 30 35.44814  288 40 20.86545    -12.9075  NEW L1 PHS CEN @ 2006.9939
LLH   41 30 35.44814  288 40 20.86545    -13.0152  NEW ARP @ 2006.9939
LLH   41 30 35.44814  288 40 20.86545    -13.0946  NEW MON @ 2006.9939

STATION NAME: acu5  a     2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                    S/N=60052145
XYZ     1560550.6359 -4503284.5346  4224398.0248  MON @ 1997.0000 (M)
XYZ          -0.0170          -0.0019           0.0046  VEL (M/YR)
NEU           0.0000           0.0000           0.0000  MON TO ARP (M)
NEU          -0.0000           0.0000           0.0813  ARP TO L1 PHASE CENTER (M)
NEU          -0.0000           0.0000           0.0689  ARP TO L2 PHASE CENTER (M)
XYZ          -0.1699          -0.0190           0.0460  VEL TIMES 9.9928 YRS
XYZ           0.0000           0.0000           0.0000  MON TO ARP
XYZ           0.0199          -0.0573           0.0541  ARP TO L1 PHASE CENTER
XYZ     1560550.4859 -4503284.6109  4224398.1249  L1 PHS CEN @ 2006.9939
XYZ           0.0000           0.0000           0.0000  + XYZ ADJUSTMENTS
XYZ     1560550.4859 -4503284.6109  4224398.1249  NEW L1 PHS CEN @ 2006.9939
XYZ     1560550.4660 -4503284.5536  4224398.0708  NEW ARP @ 2006.9939
XYZ     1560550.4660 -4503284.5536  4224398.0708  NEW MON @ 2006.9939
LLH   41 44 36.82971  289  6 46.96363      5.3219  NEW L1 PHS CEN @ 2006.9939
LLH   41 44 36.82971  289  6 46.96363      5.2406  NEW ARP @ 2006.9939
LLH   41 44 36.82971  289  6 46.96363      5.2406  NEW MON @ 2006.9939
```

REMOTE STATION INFORMATION

```
STATION NAME: r2_1        1
 ANTENNA: TPSHIPER_GD     NONE                                    S/N=UNKNOWN
XYZ     1565132.9991 -4511772.9673  4213655.3825  MON @ 2006.9938 (M)
NEU           0.0000          -0.0000           1.3500  MON TO ARP (M)
NEU          -0.0000           0.0000           0.1060  ARP TO L1 PHASE CENTER (M)
NEU          -0.0000           0.0000           0.1012  ARP TO L2 PHASE CENTER (M)
XYZ           0.3308          -0.9536           0.8966  MON TO ARP
XYZ           0.0260          -0.0749           0.0704  ARP TO L1 PHASE CENTER
XYZ     1565133.3559 -4511773.9957  4213656.3494  L1 PHS CEN @ 2006.9939

BASELINE NAME:    ctpu  r2_1
```

```
XYZ        -2.9390          0.7967         -0.2801  + XYZ ADJUSTMENTS
XYZ   1565130.4169  -4511773.1990   4213656.0693  NEW L1 PHS CEN @ 2006.9939
XYZ   1565130.3909  -4511773.1241   4213655.9989  NEW ARP @ 2006.9939
XYZ   1565130.0601  -4511772.1706   4213655.1024  NEW MON @ 2006.9939
LLH  41 36 51.58183  289  7 53.82548    -26.9606  NEW L1 PHS CEN @ 2006.9939
LLH  41 36 51.58183  289  7 53.82548    -27.0666  NEW ARP @ 2006.9939
LLH  41 36 51.58183  289  7 53.82548    -28.4166  NEW MON @ 2006.9939

BASELINE NAME:   npri  r2_1
XYZ        -2.9369          0.7806         -0.2690  + XYZ ADJUSTMENTS
XYZ   1565130.4190  -4511773.2151   4213656.0805  NEW L1 PHS CEN @ 2006.9939
XYZ   1565130.3930  -4511773.1402   4213656.0101  NEW ARP @ 2006.9939
XYZ   1565130.0622  -4511772.1867   4213655.1135  NEW MON @ 2006.9939
LLH  41 36 51.58176  289  7 53.82533    -26.9413  NEW L1 PHS CEN @ 2006.9939
LLH  41 36 51.58176  289  7 53.82533    -27.0473  NEW ARP @ 2006.9939
LLH  41 36 51.58176  289  7 53.82533    -28.3973  NEW MON @ 2006.9939

BASELINE NAME:   acu5  r2_1
XYZ        -2.9403          0.7901         -0.2664  + XYZ ADJUSTMENTS
XYZ   1565130.4156  -4511773.2057   4213656.0831  NEW L1 PHS CEN @ 2006.9939
XYZ   1565130.3896  -4511773.1308   4213656.0127  NEW ARP @ 2006.9939
XYZ   1565130.0588  -4511772.1772   4213655.1161  NEW MON @ 2006.9939
LLH  41 36 51.58203  289  7 53.82533    -26.9471  NEW L1 PHS CEN @ 2006.9939
LLH  41 36 51.58203  289  7 53.82533    -27.0531  NEW ARP @ 2006.9939
LLH  41 36 51.58203  289  7 53.82533    -28.4031  NEW MON @ 2006.9939
```

G-FILES

```
Axx20061229   61229
B200612291723   612291954 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090001 -871661385   14  -71631547   28  237005118   26 X3636AR2_1X3636ACTPU
D  1  2 -6456764  1  3  5268756  2  3 -9282281

Axx20061229   61229
B200612291723   612291954 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090002 -337377749   12 -197017980   26  -86725295   23 X3636AR2_1X3636ANPRI
D  1  2 -6556583  1  3  7008258  2  3 -9194200

Axx20061229   61229
B200612291723   612291954 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090003  -45795928   10   84876236   26  107429547   23 X3636AR2_1X3636AACU5
D  1  2 -8819408  1  3  5914404  2  3 -7617994
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     02      04      05      09      11      12      13      17
ctpu-r2_1|  0.015  0.012     ...   0.017   0.016   0.020   0.016     ...   0.009
              20      23      24      28
ctpu-r2_1|  0.013  0.022   0.013   0.018

           OVERALL     02      04      05      09      11      12      13      17
npri-r2_1|  0.013  0.013     ...   0.017   0.017   0.015   0.015     ...   0.008
              20      23      24      28
npri-r2_1|  0.011  0.016   0.013   0.012

           OVERALL     02      04      05      09      11      12      13      17
acu5-r2_1|  0.012  0.011     ...   0.016   0.015   0.017   0.013   0.024   0.009
              20      23      24      28
acu5-r2_1|  0.012  0.017   0.014   0.010
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     02      04      05      09      11      12      13      17
ctpu-r2_1|   1500    181     ...      97     118      81     113     ...     300
```

	20	23	24	28					
ctpu-r2_1|	279	39	66	226					
	OVERALL	02	04	05	09	11	12	13	17
npri-r2_1|	1439	167	...	86	83	87	112	...	300
	20	23	24	28					
npri-r2_1|	272	44	66	222					
	OVERALL	02	04	05	09	11	12	13	17
acu5-r2_1|	1426	180	...	90	38	88	96	20	300
	20	23	24	28					
acu5-r2_1|	279	48	66	221					

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000009778	-0.0000001527	0.0000001158
-0.0000001527	0.0000047467	-0.0000003736
0.0000001158	-0.0000003736	0.0000038533

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000012881	0.0000006830	-0.0000007938
0.0000006830	0.0000037207	-0.0000002406
-0.0000007938	-0.0000002406	0.0000045690

Horizontal network accuracy = 0.00405 meters.
Vertical network accuracy = 0.00419 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-87166.13877	-7163.13927	23700.50332	2002.00
NPRI	-33737.77588	-19701.80282	-8672.51943	2002.00
ACU5	-4579.59356	8487.62617	10742.95805	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2685123.413
Easting (X) [feet]	828887.594
Convergence [degrees]	0.42427770
Point Scale	1.00001655
Combined Factor	1.00002081

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

Sean Abedi

From: opus@ngs.noaa.gov
Sent: Friday, January 12, 2007 5:21 PM
To: Sean Abedi
Subject: OPUS solution : R2_0108a.tps 000060113

Wareham R2-A

FILE: R2_0108a.tps 000060113

NGS OPUS SOLUTION REPORT
==========

USER: sabedi@greenintl.com
RINEX FILE: r2_0008p.07o
DATE: January 12, 2007
TIME: 22:20:39 UTC

SOFTWARE: page5 0612.06 master24.pl
EPHEMERIS: igr14091.eph [rapid]
NAV FILE: brdc0080.07n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.465

START: 2007/01/08 15:07:00
STOP: 2007/01/08 17:41:00
OBS USED: 3884 / 4111 : 94%
FIXED AMB: 37 / 38 : 97%
OVERALL RMS: 0.018(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2007.0211)	
X:	1579312.610(m)	0.010(m)	1579311.889(m)	0.010(m)
Y:	-4496901.145(m)	0.007(m)	-4496899.702(m)	0.007(m)
Z:	4224180.758(m)	0.014(m)	4224180.686(m)	0.014(m)
LAT:	41 44 28.27179	0.012(m)	41 44 28.30459	0.012(m)
E LON:	289 21 4.62752	0.007(m)	289 21 4.61878	0.007(m)
W LON:	70 38 55.37248	0.007(m)	70 38 55.38122	0.007(m)
EL HGT:	-25.260(m)	0.012(m)	-26.502(m)	0.012(m)
ORTHO HGT:	3.305(m)	0.028(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4622354.547	832676.574
Easting (X) [meters]	362903.303	270813.296
Convergence [degrees]	-1.09783019	0.57183283
Point Scale	0.99983129	0.99999650
Combined Factor	0.99983525	1.00000046

US NATIONAL GRID DESIGNATOR: 19TCG6290322355(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	104549.3
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	62130.8
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	19819.3

NEAREST NGS PUBLISHED CONTROL POINT

LW4781	LONG NECK	N414420.010	W0703843.614	372.6

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1713        -0.0190         0.0421  VEL TIMES 10.0199 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9457  -4518935.4007   4237355.6854  L1 PHS CEN @ 2007.0211
XYZ        -0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1477963.9457  -4518935.4007   4237355.6855  NEW L1 PHS CEN @ 2007.0211
XYZ   1477963.9210  -4518935.3253   4237355.6143  NEW ARP @ 2007.0211
XYZ   1477963.9210  -4518935.3253   4237355.6143  NEW MON @ 2007.0211
LLH  41 53 58.92143  288  6 39.09975     55.9742  NEW L1 PHS CEN @ 2007.0211
LLH  41 53 58.92143  288  6 39.09975     55.8677  NEW ARP @ 2007.0211
LLH  41 53 58.92143  288  6 39.09975     55.8677  NEW MON @ 2007.0211

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                    S/N=0220108551
XYZ   1531392.4521  -4531473.9597   4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000         0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1653        -0.0250         0.0331  VEL TIMES 10.0199 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3316  -4531474.1175   4204982.7081  L1 PHS CEN @ 2007.0211
XYZ        -0.0000         0.0001         0.0001  + XYZ ADJUSTMENTS
XYZ   1531392.3316  -4531474.1174   4204982.7081  NEW L1 PHS CEN @ 2007.0211
XYZ   1531392.3058  -4531474.0410   4204982.6368  NEW ARP @ 2007.0211
XYZ   1531392.2867  -4531473.9847   4204982.5841  NEW MON @ 2007.0211
LLH  41 30 35.44815  288 40 20.86543    -12.9075  NEW L1 PHS CEN @ 2007.0211
LLH  41 30 35.44815  288 40 20.86543    -13.0152  NEW ARP @ 2007.0211
LLH  41 30 35.44815  288 40 20.86543    -13.0946  NEW MON @ 2007.0211

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                    S/N=60052145
XYZ   1560550.6359  -4503284.5346   4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1703        -0.0190         0.0461  VEL TIMES 10.0199 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4854  -4503284.6110   4224398.1250  L1 PHS CEN @ 2007.0210
XYZ        -0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4854  -4503284.6110   4224398.1250  NEW L1 PHS CEN @ 2007.0210
XYZ   1560550.4656  -4503284.5536   4224398.0709  NEW ARP @ 2007.0210
XYZ   1560550.4656  -4503284.5536   4224398.0709  NEW MON @ 2007.0210
LLH  41 44 36.82972  289  6 46.96361     5.3219  NEW L1 PHS CEN @ 2007.0210
LLH  41 44 36.82972  289  6 46.96361     5.2406  NEW ARP @ 2007.0210
LLH  41 44 36.82972  289  6 46.96361     5.2406  NEW MON @ 2007.0210

                    REMOTE STATION INFORMATION

STATION NAME: r2_0       1
 ANTENNA: TPSHIPER_GD     NONE                                    S/N=UNKNOWN
XYZ   1579315.0177  -4496900.7606   4224181.2720  MON @ 2007.0209 (M)
NEU         0.0000        -0.0000         1.4650  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3622        -1.0314         0.9753  MON TO ARP
XYZ         0.0262        -0.0746         0.0706  ARP TO L1 PHASE CENTER
XYZ   1579315.4061  -4496901.8666   4224182.3179  L1 PHS CEN @ 2007.0211

BASELINE NAME:    ctpu  r2_0
```

```
XYZ        -3.1260          1.0580         -0.5782  + XYZ ADJUSTMENTS
XYZ   1579312.2801  -4496900.8085   4224181.7398  NEW L1 PHS CEN @ 2007.0211
XYZ   1579312.2539  -4496900.7339   4224181.6692  NEW ARP @ 2007.0211
XYZ   1579311.8917  -4496899.7026   4224180.6938  NEW MON @ 2007.0211
LLH  41 44 28.30474  289 21  4.61888    -24.9252  NEW L1 PHS CEN @ 2007.0211
LLH  41 44 28.30474  289 21  4.61888    -25.0312  NEW ARP @ 2007.0211
LLH  41 44 28.30474  289 21  4.61888    -26.4962  NEW MON @ 2007.0211

BASELINE NAME:   npri  r2_0
XYZ        -3.1254          1.0560         -0.5923  + XYZ ADJUSTMENTS
XYZ   1579312.2807  -4496900.8106   4224181.7256  NEW L1 PHS CEN @ 2007.0211
XYZ   1579312.2545  -4496900.7360   4224181.6551  NEW ARP @ 2007.0211
XYZ   1579311.8923  -4496899.7046   4224180.6797  NEW MON @ 2007.0211
LLH  41 44 28.30436  289 21  4.61887    -24.9330  NEW L1 PHS CEN @ 2007.0211
LLH  41 44 28.30436  289 21  4.61887    -25.0390  NEW ARP @ 2007.0211
LLH  41 44 28.30436  289 21  4.61887    -26.5040  NEW MON @ 2007.0211

BASELINE NAME:   acu5  r2_0
XYZ        -3.1351          1.0626         -0.5876  + XYZ ADJUSTMENTS
XYZ   1579312.2711  -4496900.8040   4224181.7303  NEW L1 PHS CEN @ 2007.0210
XYZ   1579312.2449  -4496900.7294   4224181.6597  NEW ARP @ 2007.0210
XYZ   1579311.8826  -4496899.6980   4224180.6844  NEW MON @ 2007.0210
LLH  41 44 28.30467  289 21  4.61857    -24.9370  NEW L1 PHS CEN @ 2007.0210
LLH  41 44 28.30467  289 21  4.61857    -25.0430  NEW ARP @ 2007.0210
LLH  41 44 28.30467  289 21  4.61857    -26.5080  NEW MON @ 2007.0210
```

G-FILES

```
Axx2007 1 8   7 1 8
B2007 1 815 6   7 1 81741 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090001-1013479707   18 -220356228   39  131749205   34 X0087AR2_0X0087ACTPU
D  1  2 -7116559  1  3  6691089  2  3 -9467149

Axx2007 1 8   7 1 8
B2007 1 815 6   7 1 81741 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090002 -479196055   16 -345742801   39 -191980956   32 X0087AR2_0X0087ANPRI
D  1  2 -7081286  1  3  7725569  2  3 -9238675

Axx2007 1 8   7 1 8
B2007 1 815 6   7 1 81741 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090003 -187614171   17  -63848556   35    2173865   31 X0087AR2_0X0087AACU5
D  1  2 -6963655  1  3  6930683  2  3 -9337277
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     04     08     09     11     17     19     20     27
ctpu-r2_0|  0.018  0.013  0.023  0.022  0.017    ...  0.044  0.015  0.031
              28
ctpu-r2_0|  0.012

           OVERALL     04     08     09     11     17     19     20     27
npri-r2_0|  0.018  0.015  0.018  0.037  0.014    ...  0.017  0.016  0.030
              28
npri-r2_0|  0.014

           OVERALL     04     08     09     11     17     19     20     27
acu5-r2_0|  0.018  0.015  0.026  0.022  0.016    ...    ...  0.017  0.032
              28
acu5-r2_0|  0.013
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     04     08     09     11     17     19     20     27
ctpu-r2_0|   1314    188    160     69    277    ...     20    246     61
```

```
                28
ctpu-r2_0|     293
          OVERALL      04      08      09      11      17      19      20      27
npri-r2_0|    1286     188     141      58     278     ...      20     252      57
                28
npri-r2_0|     292
          OVERALL      04      08      09      11      17      19      20      27
acu5-r2_0|    1284     189     153      30     280     ...     ...     272      63
                28
acu5-r2_0|     297
```

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000019311	-0.0000003013	0.0000002601
-0.0000003013	0.0000094822	-0.0000007603
0.0000002601	-0.0000007603	0.0000069800

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000025718	0.0000014050	-0.0000015951
0.0000014050	0.0000070012	-0.0000008275
-0.0000015951	-0.0000008275	0.0000088203

Horizontal network accuracy = 0.00559 meters.
Vertical network accuracy = 0.00582 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-101347.96877	-22035.61627	13174.93032	2002.00
NPRI	-47919.60588	-34574.27982	-19198.09243	2002.00
ACU5	-18761.42356	-6384.85083	217.38505	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2731873.060
Easting (X) [feet]	888493.289
Convergence [degrees]	0.57183283
Point Scale	0.99999650
Combined Factor	1.00000046

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

Sean Abedi p-2

From: opus@ngs.noaa.gov
Sent: Friday, January 12, 2007 5:16 PM
To: Sean Abedi
Subject: OPUS solution : R2_0108b.tps 000060115

Wareham R2_b

FILE: R2_0108b.tps 000060115

NGS OPUS SOLUTION REPORT
==========

USER: sabedi@greenintl.com
RINEX FILE: r2_0008s.07o
DATE: January 12, 2007
TIME: 22:15:36 UTC

SOFTWARE: page5 0612.06 master.pl
EPHEMERIS: igr14091.eph [rapid]
NAV FILE: brdc0080.07n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.345
START: 2007/01/08 18:19:00
STOP: 2007/01/08 20:39:00
OBS USED: 4912 / 5180 : 95%
FIXED AMB: 29 / 38 : 76%
OVERALL RMS: 0.019(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2007.0214)	
X:	1574997.315(m)	0.062(m)	1574996.594(m)	0.062(m)
Y:	-4497656.658(m)	0.092(m)	-4497655.215(m)	0.092(m)
Z:	4224982.459(m)	0.060(m)	4224982.387(m)	0.060(m)
LAT:	41 45 3.09270	0.004(m)	41 45 3.12550	0.004(m)
E LON:	289 17 57.56339	0.088(m)	289 17 57.55458	0.088(m)
W LON:	70 42 2.43661	0.088(m)	70 42 2.44542	0.088(m)
EL HGT:	-25.019(m)	0.089(m)	-26.261(m)	0.089(m)
ORTHO HGT:	3.630(m)	0.093(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4623512.587	833709.006
Easting (X) [meters]	358603.537	266480.933
Convergence [degrees]	-1.13265577	0.53692829
Point Scale	0.99984603	0.99999517
Combined Factor	0.99984995	0.99999910

US NATIONAL GRID DESIGNATOR: 19TCG5860423513(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	100106.4
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	58694.4
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	15515.2

NEAREST NGS PUBLISHED CONTROL POINT

LW4537	WAREHAM STACK	N414513.823	W0704236.700	857.3

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1713        -0.0190         0.0421  VEL TIMES 10.0202 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9457  -4518935.4007   4237355.6854  L1 PHS CEN @ 2007.0214
XYZ         0.0001         0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1477963.9458  -4518935.4007   4237355.6854  NEW L1 PHS CEN @ 2007.0214
XYZ   1477963.9212  -4518935.3253   4237355.6142  NEW ARP @ 2007.0214
XYZ   1477963.9212  -4518935.3253   4237355.6142  NEW MON @ 2007.0214
LLH  41 53 58.92143  288  6 39.09976     55.9742  NEW L1 PHS CEN @ 2007.0214
LLH  41 53 58.92143  288  6 39.09976     55.8677  NEW ARP @ 2007.0214
LLH  41 53 58.92143  288  6 39.09976     55.8677  NEW MON @ 2007.0214

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                  S/N=0220108551
XYZ   1531392.4521  -4531473.9597   4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000         0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000        -0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1653        -0.0251         0.0331  VEL TIMES 10.0202 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3316  -4531474.1175   4204982.7081  L1 PHS CEN @ 2007.0214
XYZ         0.0000        -0.0000        -0.0001  + XYZ ADJUSTMENTS
XYZ   1531392.3317  -4531474.1175   4204982.7080  NEW L1 PHS CEN @ 2007.0214
XYZ   1531392.3058  -4531474.0411   4204982.6366  NEW ARP @ 2007.0214
XYZ   1531392.2868  -4531473.9848   4204982.5840  NEW MON @ 2007.0214
LLH  41 30 35.44814  288 40 20.86543    -12.9076  NEW L1 PHS CEN @ 2007.0214
LLH  41 30 35.44814  288 40 20.86543    -13.0153  NEW ARP @ 2007.0214
LLH  41 30 35.44814  288 40 20.86543    -13.0947  NEW MON @ 2007.0214

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                  S/N=60052145
XYZ   1560550.6359  -4503284.5346   4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1703        -0.0190         0.0461  VEL TIMES 10.0202 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4854  -4503284.6110   4224398.1250  L1 PHS CEN @ 2007.0214
XYZ        -0.0000        -0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4854  -4503284.6110   4224398.1250  NEW L1 PHS CEN @ 2007.0214
XYZ   1560550.4655  -4503284.5536   4224398.0709  NEW ARP @ 2007.0214
XYZ   1560550.4655  -4503284.5536   4224398.0709  NEW MON @ 2007.0214
LLH  41 44 36.82972  289  6 46.96361     5.3219  NEW L1 PHS CEN @ 2007.0214
LLH  41 44 36.82972  289  6 46.96361     5.2406  NEW ARP @ 2007.0214
LLH  41 44 36.82972  289  6 46.96361     5.2406  NEW MON @ 2007.0214

                        REMOTE STATION INFORMATION

STATION NAME: r2_0       1
 ANTENNA: TPSHIPER_GD     NONE                                  S/N=UNKNOWN
XYZ   1574999.5236  -4497656.2465   4224982.8925  MON @ 2007.0213 (M)
NEU         0.0000        -0.0000         1.3450  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3316        -0.9470         0.8956  MON TO ARP
XYZ         0.0261        -0.0746         0.0706  ARP TO L1 PHASE CENTER
XYZ   1574999.8814  -4497657.2682   4224983.8587  L1 PHS CEN @ 2007.0214

BASELINE NAME:   ctpu  r2_0
```

```
XYZ        -2.9044          1.0769         -0.5350  + XYZ ADJUSTMENTS
XYZ   1574996.9770  -4497656.1913   4224983.3237  NEW L1 PHS CEN @ 2007.0214
XYZ   1574996.9509  -4497656.1167   4224983.2532  NEW ARP @ 2007.0214
XYZ   1574996.6192  -4497655.1696   4224982.3575  NEW MON @ 2007.0214
LLH  41 45  3.12553  289 17 57.55626    -24.8553  NEW L1 PHS CEN @ 2007.0214
LLH  41 45  3.12553  289 17 57.55626    -24.9613  NEW ARP @ 2007.0214
LLH  41 45  3.12553  289 17 57.55626    -26.3063  NEW MON @ 2007.0214

BASELINE NAME:   npri  r2_0
XYZ        -2.9194          1.0333         -0.5066  + XYZ ADJUSTMENTS
XYZ   1574996.9620  -4497656.2349   4224983.3522  NEW L1 PHS CEN @ 2007.0214
XYZ   1574996.9359  -4497656.1603   4224983.2816  NEW ARP @ 2007.0214
XYZ   1574996.6042  -4497655.2132   4224982.3859  NEW MON @ 2007.0214
LLH  41 45  3.12544  289 17 57.55502    -24.8094  NEW L1 PHS CEN @ 2007.0214
LLH  41 45  3.12544  289 17 57.55502    -24.9154  NEW ARP @ 2007.0214
LLH  41 45  3.12544  289 17 57.55502    -26.2604  NEW MON @ 2007.0214

BASELINE NAME:   acu5  r2_0
XYZ        -2.9661          0.9854         -0.4749  + XYZ ADJUSTMENTS
XYZ   1574996.9153  -4497656.2828   4224983.3838  NEW L1 PHS CEN @ 2007.0214
XYZ   1574996.8891  -4497656.2081   4224983.3132  NEW ARP @ 2007.0214
XYZ   1574996.5575  -4497655.2611   4224982.4176  NEW MON @ 2007.0214
LLH  41 45  3.12556  289 17 57.55243    -24.7661  NEW L1 PHS CEN @ 2007.0214
LLH  41 45  3.12556  289 17 57.55243    -24.8721  NEW ARP @ 2007.0214
LLH  41 45  3.12556  289 17 57.55243    -26.2171  NEW MON @ 2007.0214
```

G-FILES

```
Axx2007 1 8   7 1 8
B2007 1 81818   7 1 82039 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090001 -970326981   20 -212801557   49  123732567   46 X0087AR2_0X0087ACTPU
D  1  2 -7435652  1  3  7313284  2  3 -9479295

Axx2007 1 8   7 1 8
B2007 1 81818   7 1 82039 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090002 -436043174   21 -338187715   52 -199998019   42 X0087AR2_0X0087ANPRI
D  1  2 -4507808  1  3  6189879  2  3 -9120325

Axx2007 1 8   7 1 8
B2007 1 81818   7 1 82039 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090003 -144460919   12  -56292926   32   -5843467   29 X0087AR2_0X0087AACU5
D  1  2 -6278900  1  3  6519643  2  3 -9409750
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
          OVERALL     02     04     05     10     12     13     17     20
ctpu-r2_0|  0.021    ...  0.017    ...  0.014  0.020  0.021  0.019  0.028
             23     24     28     30
ctpu-r2_0|  0.027  0.027  0.032  0.024

          OVERALL     02     04     05     10     12     13     17     20
npri-r2_0|  0.018    ...  0.015    ...  0.010  0.017  0.018  0.018  0.023
             23     24     28     30
npri-r2_0|  0.020  0.022  0.028  0.023

          OVERALL     02     04     05     10     12     13     17     20
acu5-r2_0|  0.016    ...  0.011  0.014  0.014  0.014  0.017  0.015  0.020
             23     24     28     30
acu5-r2_0|  0.021  0.015  0.026  0.028
```

OBS BY SATELLITE VS. BASELINE

```
          OVERALL     02     04     05     10     12     13     17     20
ctpu-r2_0|   1607    ...    278    ...    149    278    186    278     63
```

	23	24	28	30					
ctpu-r2_0|	45	190	33	107					
	OVERALL	02	04	05	10	12	13	17	20
npri-r2_0|	1528	...	273	...	139	273	162	273	64
	23	24	28	30					
npri-r2_0|	36	187	23	98					
	OVERALL	02	04	05	10	12	13	17	20
acu5-r2_0|	1777	...	273	225	144	263	186	272	58
	23	24	28	30					
acu5-r2_0|	45	186	28	97					

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000021889	-0.0000003249	0.0000003213
-0.0000003249	0.0000136200	-0.0000011115
0.0000003213	-0.0000011115	0.0000104911

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000032348	0.0000021490	-0.0000025207
0.0000021490	0.0000102609	-0.0000008956
-0.0000025207	-0.0000008956	0.0000128042

Horizontal network accuracy = 0.00671 meters.
Vertical network accuracy = 0.00702 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-97032.67377	-21280.10327	12373.22932	2002.00
NPRI	-43604.31088	-33818.76682	-19999.79343	2002.00
ACU5	-14446.12856	-5629.33783	-584.31595	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2735260.297
Easting (X) [feet]	874279.528
Convergence [degrees]	0.53692829
Point Scale	0.99999517
Combined Factor	0.99999910

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

Sean Abedi P-3

From: opus@ngs.noaa.gov
Sent: Friday, January 12, 2007 9:49 AM
To: Sean Abedi
Subject: OPUS solution : R1_0103a.tps 000059721

Marion A

FILE: R1_0103a.tps 000059721

NGS OPUS SOLUTION REPORT
==========

USER: sabedi@greenintl.com
RINEX FILE: r1_0003p.07o
DATE: January 12, 2007
TIME: 14:48:55 UTC

SOFTWARE: page5 0612.06 master29.pl
EPHEMERIS: igr14083.eph [rapid]
NAV FILE: brdc0030.07n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.44
START: 2007/01/03 15:11:00
STOP: 2007/01/03 17:41:00
OBS USED: 4028 / 4078 : 99%
FIXED AMB: 23 / 24 : 96%
OVERALL RMS: 0.012(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2007.0074)	
X:	1573905.428(m)	0.003(m)	1573904.707(m)	0.003(m)
Y:	-4502847.841(m)	0.009(m)	-4502846.397(m)	0.009(m)
Z:	4219889.072(m)	0.008(m)	4219889.000(m)	0.008(m)
LAT:	41 41 21.95178	0.001(m)	41 41 21.98455	0.001(m)
E LON:	289 15 58.81038	0.000(m)	289 15 58.80155	0.000(m)
W LON:	70 44 1.18962	0.000(m)	70 44 1.19845	0.000(m)
EL HGT:	-26.418(m)	0.012(m)	-27.661(m)	0.012(m)
ORTHO HGT:	2.360(m)	0.028(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4616747.026	826861.425
Easting (X) [meters]	355723.484	263798.730
Convergence [degrees]	-1.15324546	0.51477001
Point Scale	0.99985616	1.00000410
Combined Factor	0.99986030	1.00000824

US NATIONAL GRID DESIGNATOR: 19TCG5572316747(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	98836.1
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	53376.5
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	14101.8

NEAREST NGS PUBLISHED CONTROL POINT

LW4831	PEAK OF BOATHOUSE	N414127.488	W0704506.115	1508.9

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1711        -0.0190         0.0420  VEL TIMES 10.0062 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9459  -4518935.4007   4237355.6853  L1 PHS CEN @ 2007.0074
XYZ         0.0001        -0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1477963.9460  -4518935.4007   4237355.6853  NEW L1 PHS CEN @ 2007.0074
XYZ   1477963.9214  -4518935.3253   4237355.6142  NEW ARP @ 2007.0074
XYZ   1477963.9214  -4518935.3253   4237355.6142  NEW MON @ 2007.0074
LLH  41 53 58.92143  288  6 39.09976     55.9742  NEW L1 PHS CEN @ 2007.0074
LLH  41 53 58.92143  288  6 39.09976     55.8677  NEW ARP @ 2007.0074
LLH  41 53 58.92143  288  6 39.09976     55.8677  NEW MON @ 2007.0074

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                  S/N=0220108551
XYZ   1531392.4521  -4531473.9597   4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000         0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1651        -0.0250         0.0330  VEL TIMES 10.0062 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3319  -4531474.1174   4204982.7080  L1 PHS CEN @ 2007.0074
XYZ         0.0000        -0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1531392.3319  -4531474.1175   4204982.7080  NEW L1 PHS CEN @ 2007.0074
XYZ   1531392.3060  -4531474.0411   4204982.6366  NEW ARP @ 2007.0074
XYZ   1531392.2870  -4531473.9847   4204982.5840  NEW MON @ 2007.0074
LLH  41 30 35.44814  288 40 20.86544    -12.9075  NEW L1 PHS CEN @ 2007.0074
LLH  41 30 35.44814  288 40 20.86544    -13.0152  NEW ARP @ 2007.0074
LLH  41 30 35.44814  288 40 20.86544    -13.0946  NEW MON @ 2007.0074

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                  S/N=60052145
XYZ   1560550.6359  -4503284.5346   4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1701        -0.0190         0.0460  VEL TIMES 10.0062 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4857  -4503284.6109   4224398.1250  L1 PHS CEN @ 2007.0074
XYZ         0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4857  -4503284.6109   4224398.1250  NEW L1 PHS CEN @ 2007.0074
XYZ   1560550.4658  -4503284.5536   4224398.0708  NEW ARP @ 2007.0074
XYZ   1560550.4658  -4503284.5536   4224398.0708  NEW MON @ 2007.0074
LLH  41 44 36.82971  289  6 46.96362      5.3219  NEW L1 PHS CEN @ 2007.0074
LLH  41 44 36.82971  289  6 46.96362      5.2406  NEW ARP @ 2007.0074
LLH  41 44 36.82971  289  6 46.96362      5.2406  NEW MON @ 2007.0074

                        REMOTE STATION INFORMATION

STATION NAME: r1_0       1
 ANTENNA: TPSHIPER_GD     NONE                                  S/N=UNKNOWN
XYZ   1573907.5643  -4502847.1876   4219889.4511  MON @ 2007.0072 (M)
NEU         0.0000         0.0000         1.4400  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3548        -1.0151         0.9577  MON TO ARP
XYZ         0.0261        -0.0747         0.0705  ARP TO L1 PHASE CENTER
XYZ   1573907.9452  -4502848.2774   4219890.4793  L1 PHS CEN @ 2007.0074

BASELINE NAME:   ctpu  r1_0
```

```
XYZ        -2.8577          0.7923         -0.4537  + XYZ ADJUSTMENTS
XYZ   1573905.0876  -4502847.4851   4219890.0257  NEW L1 PHS CEN @ 2007.0074
XYZ   1573905.0615  -4502847.4104   4219889.9552  NEW ARP @ 2007.0074
XYZ   1573904.7066  -4502846.3953   4219888.9974  NEW MON @ 2007.0074
LLH  41 41 21.98453  289 15 58.80156    -26.1182  NEW L1 PHS CEN @ 2007.0074
LLH  41 41 21.98453  289 15 58.80156    -26.2242  NEW ARP @ 2007.0074
LLH  41 41 21.98453  289 15 58.80156    -27.6642  NEW MON @ 2007.0074

BASELINE NAME:   npri  r1_0
XYZ        -2.8587          0.7944         -0.4546  + XYZ ADJUSTMENTS
XYZ   1573905.0865  -4502847.4831   4219890.0248  NEW L1 PHS CEN @ 2007.0074
XYZ   1573905.0604  -4502847.4083   4219889.9543  NEW ARP @ 2007.0074
XYZ   1573904.7056  -4502846.3932   4219888.9965  NEW MON @ 2007.0074
LLH  41 41 21.98456  289 15 58.80155    -26.1205  NEW L1 PHS CEN @ 2007.0074
LLH  41 41 21.98456  289 15 58.80155    -26.2265  NEW ARP @ 2007.0074
LLH  41 41 21.98456  289 15 58.80155    -27.6665  NEW MON @ 2007.0074

BASELINE NAME:   acu5  r1_0
XYZ        -2.8553          0.7859         -0.4462  + XYZ ADJUSTMENTS
XYZ   1573905.0899  -4502847.4915   4219890.0331  NEW L1 PHS CEN @ 2007.0074
XYZ   1573905.0638  -4502847.4168   4219889.9626  NEW ARP @ 2007.0074
XYZ   1573904.7090  -4502846.4017   4219889.0049  NEW MON @ 2007.0074
LLH  41 41 21.98456  289 15 58.80156    -26.1081  NEW L1 PHS CEN @ 2007.0074
LLH  41 41 21.98456  289 15 58.80156    -26.2141  NEW ARP @ 2007.0074
LLH  41 41 21.98456  289 15 58.80156    -27.6541  NEW MON @ 2007.0074
```

G-FILES

```
Axx2007 1 3   7 1 3
B2007 1 31510   7 1 31741 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090001 -959407853   17 -160889301   31  174666167   29 X0037AR1_0X0037ACTPU
D  1  2 -6802215  1  3  6879940  2  3 -9341203

Axx2007 1 3   7 1 3
B2007 1 31510   7 1 31741 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090002 -425124186   11 -286275915   25 -149064125   22 X0037AR1_0X0037ANPRI
D  1  2 -6584187  1  3  7399780  2  3 -9089642

Axx2007 1 3   7 1 3
B2007 1 31510   7 1 31741 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003        NGS   20061004
C00090003 -133542432   13   -4381519   23   45090660   21 X0037AR1_0X0037AACU5
D  1  2 -7506695  1  3  6963286  2  3 -9436345
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     04     08     09     11     17     19     20     27
ctpu-r1_0|  0.014  0.013  0.014  0.016  0.015  0.010  0.024  0.014  0.016
              28
ctpu-r1_0|    ...

           OVERALL     04     08     09     11     17     19     20     27
npri-r1_0|  0.011  0.011  0.009  0.020  0.012  0.008  0.016  0.011  0.015
              28
npri-r1_0|    ...

           OVERALL     04     08     09     11     17     19     20     27
acu5-r1_0|  0.010  0.010  0.010    ...  0.010  0.006  0.015  0.011  0.014
              28
acu5-r1_0|    ...
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     04     08     09     11     17     19     20     27
ctpu-r1_0|   1371    149    192     52    299    299     53    228     99
```

	28								
ctpu-r1_0|	...								
	OVERALL	04	08	09	11	17	19	20	27
npri-r1_0|	1331	149	180	25	299	299	49	229	101
	28								
npri-r1_0|	...								
	OVERALL	04	08	09	11	17	19	20	27
acu5-r1_0|	1326	149	192	...	299	299	56	232	99
	28								
acu5-r1_0|	...								

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000012867	-0.0000001698	0.0000001574
-0.0000001698	0.0000047000	-0.0000003990
0.0000001574	-0.0000003990	0.0000039244

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000015525	0.0000006292	-0.0000006856
0.0000006292	0.0000037228	-0.0000002007
-0.0000006856	-0.0000002007	0.0000046358

Horizontal network accuracy = 0.00411 meters.
Vertical network accuracy = 0.00422 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-95940.78677	-16088.92027	17466.61632	2002.00
NPRI	-42512.42388	-28627.58382	-14906.40643	2002.00
ACU5	-13354.24156	-438.15483	4509.07105	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2712794.525
Easting (X) [feet]	865479.667
Convergence [degrees]	0.51477001
Point Scale	1.00000410
Combined Factor	1.00000824

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

Sean Abedi P-4

From: opus@ngs.noaa.gov
Sent: Friday, January 12, 2007 10:44 AM
To: Sean Abedi
Subject: OPUS solution : R2_0103b.tps 000059779

Marion B

FILE: R2_0103b.tps 000059779

NGS OPUS SOLUTION REPORT
==========

USER: sabedi@greenintl.com
RINEX FILE: r2_0003s.07o
DATE: January 12, 2007
TIME: 15:43:43 UTC

SOFTWARE: page5 0612.06 master28.pl
EPHEMERIS: igr14083.eph [rapid]
NAV FILE: brdc0030.07n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.51
START: 2007/01/03 18:08:00
STOP: 2007/01/03 20:39:00
OBS USED: 5896 / 5955 : 99%
FIXED AMB: 35 / 35 : 100%
OVERALL RMS: 0.013(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2007.0077)	
X:	1573437.171(m)	0.003(m)	1573436.450(m)	0.003(m)
Y:	-4504313.901(m)	0.007(m)	-4504312.457(m)	0.007(m)
Z:	4218508.052(m)	0.005(m)	4218507.979(m)	0.005(m)
LAT:	41 40 22.01864	0.004(m)	41 40 22.05138	0.004(m)
E LON:	289 15 18.78825	0.005(m)	289 15 18.77941	0.005(m)
W LON:	70 44 41.21175	0.005(m)	70 44 41.22059	0.005(m)
EL HGT:	-26.485(m)	0.006(m)	-27.729(m)	0.006(m)
ORTHO HGT:	2.331(m)	0.026(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4614917.294	825004.177
Easting (X) [meters]	354760.823	262889.597
Convergence [degrees]	-1.16026471	0.50730223
Point Scale	0.99985959	1.00000671
Combined Factor	0.99986374	1.00001087

US NATIONAL GRID DESIGNATOR: 19TCG5476114917(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	98407.6
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	51849.7
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	14205.6

NEAREST NGS PUBLISHED CONTROL POINT

LW4801	BLAKE POINT FLAGPOLE	N414020.590	W0704441.859	46.6

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1711        -0.0190         0.0420  VEL TIMES 10.0066 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9459  -4518935.4007   4237355.6854  L1 PHS CEN @ 2007.0077
XYZ        -0.0000         0.0001         0.0001  + XYZ ADJUSTMENTS
XYZ   1477963.9459  -4518935.4006   4237355.6854  NEW L1 PHS CEN @ 2007.0077
XYZ   1477963.9213  -4518935.3253   4237355.6143  NEW ARP @ 2007.0077
XYZ   1477963.9213  -4518935.3253   4237355.6143  NEW MON @ 2007.0077
LLH  41 53 58.92143  288  6 39.09976     55.9742  NEW L1 PHS CEN @ 2007.0077
LLH  41 53 58.92143  288  6 39.09976     55.8677  NEW ARP @ 2007.0077
LLH  41 53 58.92143  288  6 39.09976     55.8677  NEW MON @ 2007.0077

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                  S/N=0220108551
XYZ   1531392.4521  -4531473.9597   4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000         0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1651        -0.0250         0.0330  VEL TIMES 10.0066 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3318  -4531474.1174   4204982.7080  L1 PHS CEN @ 2007.0077
XYZ         0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1531392.3319  -4531474.1174   4204982.7080  NEW L1 PHS CEN @ 2007.0077
XYZ   1531392.3060  -4531474.0410   4204982.6367  NEW ARP @ 2007.0077
XYZ   1531392.2870  -4531473.9847   4204982.5840  NEW MON @ 2007.0077
LLH  41 30 35.44814  288 40 20.86544    -12.9075  NEW L1 PHS CEN @ 2007.0077
LLH  41 30 35.44814  288 40 20.86544    -13.0152  NEW ARP @ 2007.0077
LLH  41 30 35.44814  288 40 20.86544    -13.0946  NEW MON @ 2007.0077

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                  S/N=60052145
XYZ   1560550.6359  -4503284.5346   4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000        -0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1701        -0.0190         0.0460  VEL TIMES 10.0066 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4857  -4503284.6109   4224398.1250  L1 PHS CEN @ 2007.0077
XYZ         0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4857  -4503284.6109   4224398.1250  NEW L1 PHS CEN @ 2007.0077
XYZ   1560550.4658  -4503284.5536   4224398.0708  NEW ARP @ 2007.0077
XYZ   1560550.4658  -4503284.5536   4224398.0708  NEW MON @ 2007.0077
LLH  41 44 36.82971  289  6 46.96362     5.3219  NEW L1 PHS CEN @ 2007.0077
LLH  41 44 36.82971  289  6 46.96362     5.2406  NEW ARP @ 2007.0077
LLH  41 44 36.82971  289  6 46.96362     5.2406  NEW MON @ 2007.0077

                        REMOTE STATION INFORMATION

STATION NAME: r2_0       1
 ANTENNA: TPSHIPER_GD     NONE                                  S/N=UNKNOWN
XYZ   1573439.4614  -4504313.2710   4218508.5198  MON @ 2007.0075 (M)
NEU         0.0000         0.0000         1.5100  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3720        -1.0648         1.0040  MON TO ARP
XYZ         0.0261        -0.0747         0.0705  ARP TO L1 PHASE CENTER
XYZ   1573439.8595  -4504314.4106   4218509.5942  L1 PHS CEN @ 2007.0077

BASELINE NAME:    ctpu  r2_0
```

```
XYZ        -3.0117          0.8126         -0.5375  + XYZ ADJUSTMENTS
XYZ   1573436.8478  -4504313.5980   4218509.0567  NEW L1 PHS CEN @ 2007.0077
XYZ   1573436.8216  -4504313.5232   4218508.9862  NEW ARP @ 2007.0077
XYZ   1573436.4497  -4504312.4584   4218507.9823  NEW MON @ 2007.0077
LLH  41 40 22.05143  289 15 18.77938    -26.1104  NEW L1 PHS CEN @ 2007.0077
LLH  41 40 22.05143  289 15 18.77938    -26.2164  NEW ARP @ 2007.0077
LLH  41 40 22.05143  289 15 18.77938    -27.7264  NEW MON @ 2007.0077

BASELINE NAME:   npri  r2_0
XYZ        -3.0128          0.8105         -0.5420  + XYZ ADJUSTMENTS
XYZ   1573436.8466  -4504313.6000   4218509.0523  NEW L1 PHS CEN @ 2007.0077
XYZ   1573436.8205  -4504313.5253   4218508.9818  NEW ARP @ 2007.0077
XYZ   1573436.4486  -4504312.4605   4218507.9778  NEW MON @ 2007.0077
LLH  41 40 22.05129  289 15 18.77930    -26.1121  NEW L1 PHS CEN @ 2007.0077
LLH  41 40 22.05129  289 15 18.77930    -26.2181  NEW ARP @ 2007.0077
LLH  41 40 22.05129  289 15 18.77930    -27.7281  NEW MON @ 2007.0077

BASELINE NAME:   acu5  r2_0
XYZ        -3.0102          0.8174         -0.5425  + XYZ ADJUSTMENTS
XYZ   1573436.8492  -4504313.5931   4218509.0517  NEW L1 PHS CEN @ 2007.0077
XYZ   1573436.8231  -4504313.5184   4218508.9812  NEW ARP @ 2007.0077
XYZ   1573436.4512  -4504312.4536   4218507.9773  NEW MON @ 2007.0077
LLH  41 40 22.05140  289 15 18.77951    -26.1167  NEW L1 PHS CEN @ 2007.0077
LLH  41 40 22.05140  289 15 18.77951    -26.2227  NEW ARP @ 2007.0077
LLH  41 40 22.05140  289 15 18.77951    -27.7327  NEW MON @ 2007.0077
```

G-FILES

```
Axx2007 1 3   7 1 3
B2007 1 318 7   7 1 32039 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003         NGS   20061004
C00090001 -954725284   12 -146228668   29  188476320   26 X0037AR2_0X0037ACTPU
D  1  2 -6500549  1  3  6169475  2  3 -9419211

Axx2007 1 3   7 1 3
B2007 1 318 7   7 1 32039 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003         NGS   20061004
C00090002 -420441616    9 -271615242   24 -135253938   21 X0037AR2_0X0037ANPRI
D  1  2 -6345989  1  3  7558681  2  3 -9086931

Axx2007 1 3   7 1 3
B2007 1 318 7   7 1 32039 1 page5 v0612.06IGS     222 1 2 27NGS   2007 112IFDDFX
Iant_info.003         NGS   20061004
C00090003 -128859854   11   10279000   25   58900936   22 X0037AR2_0X0037AACU5
D  1  2 -7200614  1  3  5793394  2  3 -9274003
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     02     04     05     09     10     12     13     17
ctpu-r2_0|  0.014  0.010    ...  0.013    ...  0.013  0.014  0.019  0.009
              20     23     24     28     30
ctpu-r2_0|  0.011  0.023  0.013  0.017  0.024

           OVERALL     02     04     05     09     10     12     13     17
npri-r2_0|  0.012  0.008    ...  0.013    ...  0.013  0.013  0.014  0.007
              20     23     24     28     30
npri-r2_0|  0.010  0.012  0.014  0.014  0.019

           OVERALL     02     04     05     09     10     12     13     17
acu5-r2_0|  0.013  0.008    ...  0.013    ...  0.012  0.013  0.014  0.008
              20     23     24     28     30
acu5-r2_0|  0.012  0.017  0.012  0.013  0.032
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     02     04     05     09     10     12     13     17
ctpu-r2_0|   1967    300    ...    226    ...    110    243    145    300
```

	20	23	24	28	30				
ctpu-r2_0|	147	165	174	95	62				
	OVERALL	02	04	05	09	10	12	13	17
npri-r2_0|	1965	299	...	226	...	102	243	146	300
	20	23	24	28	30				
npri-r2_0|	147	170	170	98	64				
	OVERALL	02	04	05	09	10	12	13	17
acu5-r2_0|	1964	296	...	218	...	109	238	151	300
	20	23	24	28	30				
acu5-r2_0|	149	178	174	97	54				

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000007689	-0.0000001247	0.0000001057
-0.0000001247	0.0000045378	-0.0000003729
0.0000001057	-0.0000003729	0.0000035578

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000011011	0.0000006952	-0.0000008213
0.0000006952	0.0000034580	-0.0000002741
-0.0000008213	-0.0000002741	0.0000043054

Horizontal network accuracy = 0.00389 meters.
Vertical network accuracy = 0.00407 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-95472.52977	-14622.86027	18847.63632	2002.00
NPRI	-42044.16688	-27161.52382	-13525.38643	2002.00
ACU5	-12885.98456	1027.90517	5890.09105	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2706701.204
Easting (X) [feet]	862496.953
Convergence [degrees]	0.50730223
Point Scale	1.00000671
Combined Factor	1.00001087

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

Ali Kowsari P-5

From: opus@ngs.noaa.gov
Sent: Thursday, January 04, 2007 9:27 AM
To: Ali Kowsari
Subject: OPUS solution : R2_1228a.tps 000055005 New Bedford A

FILE: R2_1228a.tps 000055005

NGS OPUS SOLUTION REPORT
==========

USER: akowsari@greenintl.com
RINEX FILE: r2_1362o.06o
DATE: January 04, 2007
TIME: 14:26:42 UTC

SOFTWARE: page5 0612.06 master23.pl
EPHEMERIS: igr14074.eph [rapid]
NAV FILE: brdc3620.06n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.470
START: 2006/12/28 14:38:00
STOP: 2006/12/28 17:10:00
OBS USED: 4081 / 4163 : 98%
FIXED AMB: 20 / 23 : 87%
OVERALL RMS: 0.014(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2006.9909)	
X:	1561475.360(m)	0.032(m)	1561474.640(m)	0.032(m)
Y:	-4513545.884(m)	0.023(m)	-4513544.440(m)	0.023(m)
Z:	4213117.510(m)	0.027(m)	4213117.436(m)	0.027(m)
LAT:	41 36 28.22891	0.018(m)	41 36 28.26155	0.018(m)
E LON:	289 4 59.59955	0.038(m)	289 4 59.59055	0.038(m)
W LON:	70 55 0.40045	0.038(m)	70 55 0.40945	0.038(m)
EL HGT:	-26.787(m)	0.027(m)	-28.032(m)	0.027(m)
ORTHO HGT:	2.436(m)	0.036(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4608011.165	817679.060
Easting (X) [meters]	340282.511	248616.420
Convergence [degrees]	-1.27306376	0.39176701
Point Scale	0.99991393	1.00001771
Combined Factor	0.99991813	1.00002191

US NATIONAL GRID DESIGNATOR: 19TCG4028308011(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	87124.0
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	35952.6
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	15276.5

NEAREST NGS PUBLISHED CONTROL POINT

LW4925	LANE 1887	N413643.258	W0705458.392	467.0

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1708        -0.0190         0.0420  VEL TIMES 9.9897 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9462  -4518935.4006   4237355.6853  L1 PHS CEN @ 2006.9909
XYZ         0.0001        -0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1477963.9463  -4518935.4006   4237355.6853  NEW L1 PHS CEN @ 2006.9909
XYZ   1477963.9217  -4518935.3253   4237355.6141  NEW ARP @ 2006.9909
XYZ   1477963.9217  -4518935.3253   4237355.6141  NEW MON @ 2006.9909
LLH  41 53 58.92142  288  6 39.09978     55.9742  NEW L1 PHS CEN @ 2006.9909
LLH  41 53 58.92142  288  6 39.09978     55.8677  NEW ARP @ 2006.9909
LLH  41 53 58.92142  288  6 39.09978     55.8677  NEW MON @ 2006.9909

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                  S/N=0220108551
XYZ   1531392.4521  -4531473.9597   4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000         0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1648        -0.0250         0.0330  VEL TIMES 9.9897 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3321  -4531474.1174   4204982.7080  L1 PHS CEN @ 2006.9909
XYZ        -0.0000        -0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1531392.3321  -4531474.1174   4204982.7080  NEW L1 PHS CEN @ 2006.9909
XYZ   1531392.3063  -4531474.0410   4204982.6366  NEW ARP @ 2006.9909
XYZ   1531392.2872  -4531473.9847   4204982.5840  NEW MON @ 2006.9909
LLH  41 30 35.44814  288 40 20.86545    -12.9075  NEW L1 PHS CEN @ 2006.9909
LLH  41 30 35.44814  288 40 20.86545    -13.0152  NEW ARP @ 2006.9909
LLH  41 30 35.44814  288 40 20.86545    -13.0946  NEW MON @ 2006.9909

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                  S/N=60052145
XYZ   1560550.6359  -4503284.5346   4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1698        -0.0190         0.0460  VEL TIMES 9.9897 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4859  -4503284.6109   4224398.1249  L1 PHS CEN @ 2006.9909
XYZ         0.0000         0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4859  -4503284.6109   4224398.1249  NEW L1 PHS CEN @ 2006.9909
XYZ   1560550.4661  -4503284.5536   4224398.0707  NEW ARP @ 2006.9909
XYZ   1560550.4661  -4503284.5536   4224398.0707  NEW MON @ 2006.9909
LLH  41 44 36.82971  289  6 46.96363      5.3219  NEW L1 PHS CEN @ 2006.9909
LLH  41 44 36.82971  289  6 46.96363      5.2406  NEW ARP @ 2006.9909
LLH  41 44 36.82971  289  6 46.96363      5.2406  NEW MON @ 2006.9909

                        REMOTE STATION INFORMATION

STATION NAME: r2_1       1
 ANTENNA: TPSHIPER_GD     NONE                                  S/N=UNKNOWN
XYZ   1561477.5303  -4513545.3355   4213117.8251  MON @ 2006.9907 (M)
NEU        -0.0000        -0.0000         1.4700  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3594        -1.0387         0.9761  MON TO ARP
XYZ         0.0259        -0.0749         0.0704  ARP TO L1 PHASE CENTER
XYZ   1561477.9156  -4513546.4491   4213118.8716  L1 PHS CEN @ 2006.9909

BASELINE NAME:   ctpu  r2_1
```

```
XYZ        -2.9115          0.8834         -0.3718  + XYZ ADJUSTMENTS
XYZ   1561475.0041  -4513545.5657   4213118.4998  NEW L1 PHS CEN @ 2006.9909
XYZ   1561474.9782  -4513545.4908   4213118.4294  NEW ARP @ 2006.9909
XYZ   1561474.6188  -4513544.4521   4213117.4533  NEW MON @ 2006.9909
LLH  41 36 28.26188  289  4 59.58951    -26.4413  NEW L1 PHS CEN @ 2006.9909
LLH  41 36 28.26188  289  4 59.58951    -26.5473  NEW ARP @ 2006.9909
LLH  41 36 28.26188  289  4 59.58951    -28.0173  NEW MON @ 2006.9909

BASELINE NAME:   npri  r2_1
XYZ        -2.8795          0.8951         -0.3956  + XYZ ADJUSTMENTS
XYZ   1561475.0361  -4513545.5540   4213118.4760  NEW L1 PHS CEN @ 2006.9909
XYZ   1561475.0102  -4513545.4791   4213118.4056  NEW ARP @ 2006.9909
XYZ   1561474.6508  -4513544.4404   4213117.4295  NEW MON @ 2006.9909
LLH  41 36 28.26131  289  4 59.59098    -26.4576  NEW L1 PHS CEN @ 2006.9909
LLH  41 36 28.26131  289  4 59.59098    -26.5636  NEW ARP @ 2006.9909
LLH  41 36 28.26131  289  4 59.59098    -28.0336  NEW MON @ 2006.9909

BASELINE NAME:   acu5  r2_1
XYZ        -2.8797          0.9066         -0.3987  + XYZ ADJUSTMENTS
XYZ   1561475.0358  -4513545.5426   4213118.4729  NEW L1 PHS CEN @ 2006.9909
XYZ   1561475.0099  -4513545.4677   4213118.4025  NEW ARP @ 2006.9909
XYZ   1561474.6506  -4513544.4289   4213117.4264  NEW MON @ 2006.9909
LLH  41 36 28.26147  289  4 59.59114    -26.4678  NEW L1 PHS CEN @ 2006.9909
LLH  41 36 28.26147  289  4 59.59114    -26.5738  NEW ARP @ 2006.9909
LLH  41 36 28.26147  289  4 59.59114    -28.0438  NEW MON @ 2006.9909
```

G-FILES

```
Axx20061228   61228
B200612281438   612281710 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090001 -835106971   17  -53908732   35  242381608   34 X3626AR2_1X3626ACTPU
D  1  2 -5761746  1  3  5258637  2  3 -9438882

Axx20061228   61228
B200612281438   612281710 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090002 -300823635   10 -179295443   24  -81348455   23 X3626AR2_1X3626ANPRI
D  1  2 -6458845  1  3  7267801  2  3 -9277500

Axx20061228   61228
B200612281438   612281710 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090003   -9241845   10  102598754   27  112806444   24 X3626AR2_1X3626AACU5
D  1  2 -8190479  1  3  7864342  2  3 -8596918
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     03     04     08     11     17     19     20     27
ctpu-r2_1|  0.017    ...  0.026  0.013    ...  0.014  0.022  0.025  0.018
              28
ctpu-r2_1|  0.013

           OVERALL     03     04     08     11     17     19     20     27
npri-r2_1|  0.011    ...  0.018  0.009    ...  0.010  0.016  0.015  0.011
              28
npri-r2_1|  0.008

           OVERALL     03     04     08     11     17     19     20     27
acu5-r2_1|  0.012  0.026  0.021  0.011    ...  0.009  0.015  0.015  0.011
              28
acu5-r2_1|  0.010
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     03     04     08     11     17     19     20     27
ctpu-r2_1|   1355    ...     39    291    ...    226    167    116    214
```

```
                28
ctpu-r2_1|     302
            OVERALL      03      04      08      11      17      19      20      27
npri-r2_1|    1342     ...      24     298     ...     229     166     120     203
                28
npri-r2_1|     302
            OVERALL      03      04      08      11      17      19      20      27
acu5-r2_1|    1384      20      39     298     ...     230     170     114     212
                28
acu5-r2_1|     301


Covariance Matrix for the xyz OPUS Position (meters^2).
   0.0000010867    -0.0000001598     0.0000001466
  -0.0000001598     0.0000056222    -0.0000004872
   0.0000001466    -0.0000004872     0.0000050244

Covariance Matrix for the enu OPUS Position (meters^2).
   0.0000014727     0.0000008284    -0.0000009704
   0.0000008284     0.0000046127    -0.0000000416
  -0.0000009704    -0.0000000416     0.0000056479

Horizontal network accuracy =    0.00448 meters.
Vertical network accuracy   =    0.00466 meters.


                    Derivation of NAD 83 vector components


  Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).
                Xa(m)            Ya(m)            Za(m)
      CTPU   1477964.64123  -4518936.76127   4237355.68832    2002.00
      NPRI   1531393.02312  -4531475.48112   4204982.71817    2002.00
      ACU5   1560551.18644  -4503285.99583   4224398.14305    2002.00

  Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).
                Xr(m)            Yr(m)            Zr(m)
      CTPU   1477964.64123  -4518936.76127   4237355.68832    2002.00
      NPRI   1531393.00412  -4531475.42482   4204982.66557    2002.00
      ACU5   1560551.18644  -4503285.99583   4224398.14305    2002.00

  Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).
                Vx (m/yr)        Vy (m/yr)        Vz (m/yr)
      CTPU        0.00000          -0.00000         -0.00010
      NPRI        0.00050          -0.00060         -0.00120
      ACU5        0.00000          -0.00000          0.00000

  Vectors from unknown station monument to reference station monument
  in NAD_83(CORS96)(EPOCH:2002.0000).
              Xr-X= DX(m)      Yr-Y= DY(m)      Zr-Z= DZ(m)
      CTPU   -83510.71877      -5390.87727      24238.17832    2002.00
      NPRI   -30082.35588     -17929.54082      -8134.84443    2002.00
      ACU5     -924.17356      10259.88817      11280.63305    2002.00

      STATE PLANE COORDINATES - U.S. Survey Foot
        SPC (2001    MA M)
Northing (Y) [feet]         2682668.716
Easting  (X) [feet]          815669.038
Convergence  [degrees]       0.39176701
Point Scale                  1.00001771
Combined Factor              1.00002191

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

Ali Kowsari

From: opus@ngs.noaa.gov
Sent: Thursday, January 04, 2007 9:24 AM
To: Ali Kowsari
Subject: OPUS solution : R2_1228b.tps 000055008 New Bedford B

FILE: R2_1228b.tps 000055008

NGS OPUS SOLUTION REPORT
==========

USER: akowsari@greenintl.com
RINEX FILE: r2_1362u.06o

DATE: January 04, 2007
TIME: 14:23:51 UTC

SOFTWARE: page5 0612.06 master4.pl
EPHEMERIS: igr14074.eph [rapid]
NAV FILE: brdc3620.06n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.340

START: 2006/12/28 20:11:00
STOP: 2006/12/28 22:41:00
OBS USED: 6829 / 7001 : 98%
FIXED AMB: 38 / 38 : 100%
OVERALL RMS: 0.014(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2006.9915)	
X:	1562794.964(m)	0.007(m)	1562794.244(m)	0.007(m)
Y:	-4514008.766(m)	0.018(m)	-4514007.322(m)	0.018(m)
Z:	4212140.672(m)	0.008(m)	4212140.598(m)	0.008(m)
LAT:	41 35 45.85059	0.016(m)	41 35 45.88322	0.016(m)
E LON:	289 5 46.91379	0.003(m)	289 5 46.90481	0.003(m)
W LON:	70 54 13.08621	0.003(m)	70 54 13.09519	0.003(m)
EL HGT:	-25.541(m)	0.012(m)	-26.787(m)	0.012(m)
ORTHO HGT:	3.677(m)	0.028(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4606679.910	816379.207
Easting (X) [meters]	341348.858	249721.110
Convergence [degrees]	-1.26403862	0.40059543
Point Scale	0.99990975	1.00001983
Combined Factor	0.99991376	1.00002384

US NATIONAL GRID DESIGNATOR: 19TCG4134906680(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	88635.6
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	36638.8
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	16439.5

NEAREST NGS PUBLISHED CONTROL POINT

LW0072	TIDAL 7 STA 88	N413538.	W0705403.	336.7

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1708        -0.0190         0.0420  VEL TIMES 9.9903 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9462  -4518935.4006   4237355.6853  L1 PHS CEN @ 2006.9915
XYZ        -0.0000        -0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1477963.9462  -4518935.4007   4237355.6853  NEW L1 PHS CEN @ 2006.9915
XYZ   1477963.9215  -4518935.3253   4237355.6142  NEW ARP @ 2006.9915
XYZ   1477963.9215  -4518935.3253   4237355.6142  NEW MON @ 2006.9915
LLH  41 53 58.92143  288  6 39.09977     55.9742  NEW L1 PHS CEN @ 2006.9915
LLH  41 53 58.92143  288  6 39.09977     55.8677  NEW ARP @ 2006.9915
LLH  41 53 58.92143  288  6 39.09977     55.8677  NEW MON @ 2006.9915

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                  S/N=0220108551
XYZ   1531392.4521  -4531473.9597   4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000         0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1648        -0.0250         0.0330  VEL TIMES 9.9903 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3321  -4531474.1174   4204982.7080  L1 PHS CEN @ 2006.9915
XYZ         0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1531392.3321  -4531474.1174   4204982.7080  NEW L1 PHS CEN @ 2006.9915
XYZ   1531392.3063  -4531474.0410   4204982.6366  NEW ARP @ 2006.9915
XYZ   1531392.2873  -4531473.9847   4204982.5840  NEW MON @ 2006.9915
LLH  41 30 35.44814  288 40 20.86545    -12.9075  NEW L1 PHS CEN @ 2006.9915
LLH  41 30 35.44814  288 40 20.86545    -13.0152  NEW ARP @ 2006.9915
LLH  41 30 35.44814  288 40 20.86545    -13.0946  NEW MON @ 2006.9915

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                  S/N=60052145
XYZ   1560550.6359  -4503284.5346   4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1698        -0.0190         0.0460  VEL TIMES 9.9903 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4859  -4503284.6109   4224398.1249  L1 PHS CEN @ 2006.9915
XYZ         0.0000         0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4859  -4503284.6109   4224398.1249  NEW L1 PHS CEN @ 2006.9915
XYZ   1560550.4661  -4503284.5536   4224398.0708  NEW ARP @ 2006.9915
XYZ   1560550.4661  -4503284.5536   4224398.0708  NEW MON @ 2006.9915
LLH  41 44 36.82971  289  6 46.96363      5.3219  NEW L1 PHS CEN @ 2006.9915
LLH  41 44 36.82971  289  6 46.96363      5.2406  NEW ARP @ 2006.9915
LLH  41 44 36.82971  289  6 46.96363      5.2406  NEW MON @ 2006.9915

                        REMOTE STATION INFORMATION

STATION NAME: r2_1       1
 ANTENNA: TPSHIPER_GD     NONE                                  S/N=UNKNOWN
XYZ   1562797.1719  -4514008.1789   4212141.0021  MON @ 2006.9913 (M)
NEU         0.0000        -0.0000         1.3400  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3278        -0.9470         0.8896  MON TO ARP
XYZ         0.0259        -0.0749         0.0704  ARP TO L1 PHASE CENTER
XYZ   1562797.5257  -4514009.2008   4212141.9621  L1 PHS CEN @ 2006.9915

BASELINE NAME:   ctpu  r2_1
```

```
XYZ        -2.9312          0.8677         -0.4041  + XYZ ADJUSTMENTS
XYZ   1562794.5945  -4514008.3330   4212141.5579  NEW L1 PHS CEN @ 2006.9915
XYZ   1562794.5686  -4514008.2581   4212141.4876  NEW ARP @ 2006.9915
XYZ   1562794.2407  -4514007.3112   4212140.5980  NEW MON @ 2006.9915
LLH  41 35 45.88347  289  5 46.90483    -25.3493  NEW L1 PHS CEN @ 2006.9915
LLH  41 35 45.88347  289  5 46.90483    -25.4553  NEW ARP @ 2006.9915
LLH  41 35 45.88347  289  5 46.90483    -26.7953  NEW MON @ 2006.9915

BASELINE NAME:   npri  r2_1
XYZ        -2.9296          0.8552         -0.3999  + XYZ ADJUSTMENTS
XYZ   1562794.5960  -4514008.3455   4212141.5622  NEW L1 PHS CEN @ 2006.9915
XYZ   1562794.5701  -4514008.2706   4212141.4918  NEW ARP @ 2006.9915
XYZ   1562794.2423  -4514007.3237   4212140.6022  NEW MON @ 2006.9915
LLH  41 35 45.88331  289  5 46.90472    -25.3372  NEW L1 PHS CEN @ 2006.9915
LLH  41 35 45.88331  289  5 46.90472    -25.4432  NEW ARP @ 2006.9915
LLH  41 35 45.88331  289  5 46.90472    -26.7832  NEW MON @ 2006.9915

BASELINE NAME:   acu5  r2_1
XYZ        -2.9238          0.8492         -0.4079  + XYZ ADJUSTMENTS
XYZ   1562794.6019  -4514008.3515   4212141.5541  NEW L1 PHS CEN @ 2006.9915
XYZ   1562794.5759  -4514008.2766   4212141.4837  NEW ARP @ 2006.9915
XYZ   1562794.2481  -4514007.3297   4212140.5942  NEW MON @ 2006.9915
LLH  41 35 45.88295  289  5 46.90487    -25.3369  NEW L1 PHS CEN @ 2006.9915
LLH  41 35 45.88295  289  5 46.90487    -25.4429  NEW ARP @ 2006.9915
LLH  41 35 45.88295  289  5 46.90487    -26.7829  NEW MON @ 2006.9915
```

G-FILES

```
Axx20061228   61228
B200612282011   612282240 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090001 -848303192   13  -49280141   28  252150162   25 X3626AR2_1X3626ACTPU
D  1  2 -7095562  1  3  6251340  2  3 -9430153

Axx20061228   61228
B200612282011   612282240 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090002 -314019550   10 -174666610   24  -71580183   21 X3626AR2_1X3626ANPRI
D  1  2 -6903667  1  3  7825565  2  3 -9159705

Axx20061228   61228
B200612282011   612282240 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090003  -22437820    9  107227761   27  122574766   22 X3626AR2_1X3626AACU5
D  1  2 -9141790  1  3  7471167  2  3 -7493715
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     02     04     05     06     07     10     12     13
ctpu-r2_1|  0.015    ...  0.010  0.014  0.019    ...  0.012  0.011  0.017
              17     23     24     26     29     30
ctpu-r2_1|  0.019  0.022  0.012    ...  0.017  0.017

           OVERALL     02     04     05     06     07     10     12     13
npri-r2_1|  0.013    ...  0.009  0.013  0.017    ...  0.012  0.012  0.013
              17     23     24     26     29     30
npri-r2_1|  0.013  0.013  0.011    ...  0.015  0.016

           OVERALL     02     04     05     06     07     10     12     13
acu5-r2_1|  0.014    ...  0.012  0.014  0.019    ...  0.013  0.012  0.015
              17     23     24     26     29     30
acu5-r2_1|  0.014  0.017  0.011    ...  0.015  0.016
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     02     04     05     06     07     10     12     13
ctpu-r2_1|   2311    ...    299    245     93    ...    290    267    278
```

	17	23	24	26	29	30			
ctpu-r2_1|	145	100	299	...	56	239			
	OVERALL	02	04	05	06	07	10	12	13
npri-r2_1|	2248	...	296	237	90	...	296	248	267
	17	23	24	26	29	30			
npri-r2_1|	136	95	296	...	57	230			
	OVERALL	02	04	05	06	07	10	12	13
acu5-r2_1|	2270	...	295	240	78	...	295	261	275
	17	23	24	26	29	30			
acu5-r2_1|	146	102	295	...	51	232			

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000007778	-0.0000001436	0.0000001145
-0.0000001436	0.0000046422	-0.0000003482
0.0000001145	-0.0000003482	0.0000034444

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000011026	0.0000007113	-0.0000008152
0.0000007113	0.0000034627	-0.0000003872
-0.0000008152	-0.0000003872	0.0000042992

Horizontal network accuracy = 0.00390 meters.
Vertical network accuracy = 0.00407 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-84830.32277	-4927.99527	25215.01632	2002.00
NPRI	-31401.95988	-17466.65882	-7158.00643	2002.00
ACU5	-2243.77756	10722.77017	12257.47105	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2678404.115
Easting (X) [feet]	819293.342
Convergence [degrees]	0.40059543
Point Scale	1.00001983
Combined Factor	1.00002384

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

Ali Kowsari P-7

From: opus@ngs.noaa.gov
Sent: Friday, January 05, 2007 8:59 AM
To: Ali Kowsari
Subject: OPUS solution : R2_0102a.tps 000055743

FILE: R2_0102a.tps 000055743

NGS OPUS SOLUTION REPORT
========================

USER: akowsari@greenintl.com
RINEX FILE: r2_0002p.07o
DATE: January 05, 2007
TIME: 13:59:19 UTC

SOFTWARE: page5 0612.06 master2.pl
EPHEMERIS: igr14082.eph [rapid]
NAV FILE: brdc0020.07n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.50
START: 2007/01/02 15:02:00
STOP: 2007/01/02 17:31:00
OBS USED: 3999 / 4055 : 99%
FIXED AMB: 23 / 24 : 96%
OVERALL RMS: 0.013(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2007.0046)	
X:	1567688.109(m)	0.008(m)	1567687.389(m)	0.008(m)
Y:	-4510059.740(m)	0.007(m)	-4510058.296(m)	0.007(m)
Z:	4214533.707(m)	0.018(m)	4214533.634(m)	0.018(m)
LAT:	41 37 29.63238	0.011(m)	41 37 29.66507	0.011(m)
E LON:	289 10 2.47195	0.010(m)	289 10 2.46306	0.010(m)
W LON:	70 49 57.52805	0.010(m)	70 49 57.53694	0.010(m)
EL HGT:	-26.883(m)	0.014(m)	-28.128(m)	0.014(m)
ORTHO HGT:	2.161(m)	0.029(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4609752.546	819624.841
Easting (X) [meters]	347333.368	255614.503
Convergence [degrees]	-1.21757221	0.44828036
Point Scale	0.99988682	1.00001469
Combined Factor	0.99989104	1.00001891

US NATIONAL GRID DESIGNATOR: 19TCG4733309753(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	93005.1
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	43211.0
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	13932.9

NEAREST NGS PUBLISHED CONTROL POINT

LW4880	NASK	N413727.773	W0705006.508	215.4

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1711        -0.0190         0.0420  VEL TIMES 10.0034 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9460  -4518935.4006   4237355.6853  L1 PHS CEN @ 2007.0046
XYZ         0.0001        -0.0001        -0.0001  + XYZ ADJUSTMENTS
XYZ   1477963.9461  -4518935.4007   4237355.6852  NEW L1 PHS CEN @ 2007.0046
XYZ   1477963.9214  -4518935.3254   4237355.6141  NEW ARP @ 2007.0046
XYZ   1477963.9214  -4518935.3254   4237355.6141  NEW MON @ 2007.0046
LLH  41 53 58.92142  288  6 39.09976     55.9742  NEW L1 PHS CEN @ 2007.0046
LLH  41 53 58.92142  288  6 39.09976     55.8677  NEW ARP @ 2007.0046
LLH  41 53 58.92142  288  6 39.09976     55.8677  NEW MON @ 2007.0046

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                  S/N=0220108551
XYZ   1531392.4521  -4531473.9597   4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000         0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1651        -0.0250         0.0330  VEL TIMES 10.0034 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3319  -4531474.1174   4204982.7080  L1 PHS CEN @ 2007.0046
XYZ        -0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1531392.3319  -4531474.1174   4204982.7080  NEW L1 PHS CEN @ 2007.0046
XYZ   1531392.3061  -4531474.0410   4204982.6366  NEW ARP @ 2007.0046
XYZ   1531392.2870  -4531473.9847   4204982.5840  NEW MON @ 2007.0046
LLH  41 30 35.44814  288 40 20.86544    -12.9075  NEW L1 PHS CEN @ 2007.0046
LLH  41 30 35.44814  288 40 20.86544    -13.0152  NEW ARP @ 2007.0046
LLH  41 30 35.44814  288 40 20.86544    -13.0946  NEW MON @ 2007.0046

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                  S/N=60052145
XYZ   1560550.6359  -4503284.5346   4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1701        -0.0190         0.0460  VEL TIMES 10.0034 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4857  -4503284.6109   4224398.1249  L1 PHS CEN @ 2007.0046
XYZ         0.0000         0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4857  -4503284.6109   4224398.1249  NEW L1 PHS CEN @ 2007.0046
XYZ   1560550.4658  -4503284.5536   4224398.0708  NEW ARP @ 2007.0046
XYZ   1560550.4658  -4503284.5536   4224398.0708  NEW MON @ 2007.0046
LLH  41 44 36.82971  289  6 46.96362      5.3219  NEW L1 PHS CEN @ 2007.0046
LLH  41 44 36.82971  289  6 46.96362      5.2406  NEW ARP @ 2007.0046
LLH  41 44 36.82971  289  6 46.96362      5.2406  NEW MON @ 2007.0046

                        REMOTE STATION INFORMATION

STATION NAME: r2_0       1
 ANTENNA: TPSHIPER_GD     NONE                                  S/N=UNKNOWN
XYZ   1567690.3242  -4510059.0316   4214534.0398  MON @ 2007.0045 (M)
NEU         0.0000        -0.0000         1.5000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3681        -1.0591         0.9964  MON TO ARP
XYZ         0.0260        -0.0748         0.0704  ARP TO L1 PHASE CENTER
XYZ   1567690.7184  -4510060.1655   4214535.1066  L1 PHS CEN @ 2007.0046

BASELINE NAME:    ctpu  r2_0
```

```
XYZ        -2.9301          0.7376         -0.4157  + XYZ ADJUSTMENTS
XYZ   1567687.7883  -4510059.4279   4214534.6909  NEW L1 PHS CEN @ 2007.0046
XYZ   1567687.7622  -4510059.3531   4214534.6205  NEW ARP @ 2007.0046
XYZ   1567687.3941  -4510058.2940   4214533.6241  NEW MON @ 2007.0046
LLH  41 37 29.66483  289 10  2.46329    -26.5284  NEW L1 PHS CEN @ 2007.0046
LLH  41 37 29.66483  289 10  2.46329    -26.6344  NEW ARP @ 2007.0046
LLH  41 37 29.66483  289 10  2.46329    -28.1344  NEW MON @ 2007.0046

BASELINE NAME:   npri  r2_0
XYZ        -2.9384          0.7310         -0.3981  + XYZ ADJUSTMENTS
XYZ   1567687.7800  -4510059.4346   4214534.7085  NEW L1 PHS CEN @ 2007.0046
XYZ   1567687.7540  -4510059.3597   4214534.6380  NEW ARP @ 2007.0046
XYZ   1567687.3858  -4510058.3006   4214533.6417  NEW MON @ 2007.0046
LLH  41 37 29.66518  289 10  2.46286    -26.5140  NEW L1 PHS CEN @ 2007.0046
LLH  41 37 29.66518  289 10  2.46286    -26.6200  NEW ARP @ 2007.0046
LLH  41 37 29.66518  289 10  2.46286    -28.1200  NEW MON @ 2007.0046

BASELINE NAME:   acu5  r2_0
XYZ        -2.9380          0.7377         -0.4028  + XYZ ADJUSTMENTS
XYZ   1567687.7803  -4510059.4278   4214534.7038  NEW L1 PHS CEN @ 2007.0046
XYZ   1567687.7543  -4510059.3530   4214534.6334  NEW ARP @ 2007.0046
XYZ   1567687.3862  -4510058.2939   4214533.6370  NEW MON @ 2007.0046
LLH  41 37 29.66520  289 10  2.46297    -26.5218  NEW L1 PHS CEN @ 2007.0046
LLH  41 37 29.66520  289 10  2.46297    -26.6278  NEW ARP @ 2007.0046
LLH  41 37 29.66520  289 10  2.46297    -28.1278  NEW MON @ 2007.0046
```

G-FILES

```
Axx2007 1 2   7 1 2
B2007 1 215 1   7 1 21730 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 5IFDDFX
Iant_info.003        NGS   20061004
C00090001 -897234727   19  -88770314   35  228219900   33 X0027AR2_0X0027ACTPU
D  1  2 -6811940  1  3  6447420  2  3 -9393723

Axx2007 1 2   7 1 2
B2007 1 215 1   7 1 21730 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 5IFDDFX
Iant_info.003        NGS   20061004
C00090002 -362950988   10 -214156841   24  -95510576   21 X0027AR2_0X0027ANPRI
D  1  2 -6296069  1  3  7097217  2  3 -9056622

Axx2007 1 2   7 1 2
B2007 1 215 1   7 1 21730 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 5IFDDFX
Iant_info.003        NGS   20061004
C00090003  -71369203   12   67737403   27   98644338   20 X0027AR2_0X0027AACU5
D  1  2 -9124194  1  3  7066728  2  3 -8626208
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     04     08     09     11     17     19     20     27
ctpu-r2_0|  0.018  0.014  0.013  0.012  0.015  0.010  0.041  0.023  0.015
              28
ctpu-r2_0|    ...

           OVERALL     04     08     09     11     17     19     20     27
npri-r2_0|  0.010  0.012  0.009    ...  0.008  0.009  0.011  0.012  0.015
              28
npri-r2_0|    ...

           OVERALL     04     08     09     11     17     19     20     27
acu5-r2_0|  0.010  0.010  0.012    ...  0.009  0.008  0.014  0.011  0.013
              28
acu5-r2_0|    ...
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     04     08     09     11     17     19     20     27
ctpu-r2_0|   1358    122    217     24    296    296     78    199    126
```

```
                28
ctpu-r2_0|     ...
           OVERALL     04     08     09     11     17     19     20     27
npri-r2_0|    1309    122    199    ...    296    296     73    197    126
                28
npri-r2_0|     ...
           OVERALL     04     08     09     11     17     19     20     27
acu5-r2_0|    1332    120    216    ...    294    295     82    199    126
                28
acu5-r2_0|     ...
```

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000013444	-0.0000001999	0.0000001606
-0.0000001999	0.0000056222	-0.0000004461
0.0000001606	-0.0000004461	0.0000042889

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000016816	0.0000007781	-0.0000008735
0.0000007781	0.0000042547	-0.0000004354
-0.0000008735	-0.0000004354	0.0000053192

Horizontal network accuracy = 0.00438 meters.
Vertical network accuracy = 0.00452 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-89723.46777	-8877.02127	22821.98132	2002.00
NPRI	-36295.10488	-21415.68482	-9551.04143	2002.00
ACU5	-7136.92256	6773.74417	9864.43605	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2689052.499
Easting (X) [feet]	838628.582
Convergence [degrees]	0.44828036
Point Scale	1.00001469
Combined Factor	1.00001891

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

Ali Kowsari

From: opus@ngs.noaa.gov
Sent: Friday, January 05, 2007 9:00 AM
To: Ali Kowsari
Subject: OPUS solution : R1_0102b.tps 000055744

Mattapoiselt

FILE: R1_0102b.tps 000055744

NGS OPUS SOLUTION REPORT
==========

USER: akowsari@greenintl.com
RINEX FILE: r1_0002s.07o
DATE: January 05, 2007
TIME: 14:00:26 UTC

SOFTWARE: page5 0612.06 master2.pl
EPHEMERIS: igr14082.eph [rapid]
NAV FILE: brdc0020.07n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.56
START: 2007/01/02 18:15:00
STOP: 2007/01/02 20:45:00
OBS USED: 5887 / 5965 : 99%
FIXED AMB: 36 / 37 : 97%
OVERALL RMS: 0.015(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2007.0050)	
X:	1572473.488(m)	0.013(m)	1572472.767(m)	0.013(m)
Y:	-4506498.887(m)	0.045(m)	-4506497.443(m)	0.045(m)
Z:	4216546.158(m)	0.016(m)	4216546.085(m)	0.016(m)
LAT:	41 38 56.90808	0.023(m)	41 38 56.94080	0.023(m)
E LON:	289 14 8.33313	0.006(m)	289 14 8.32427	0.006(m)
W LON:	70 45 51.66687	0.006(m)	70 45 51.67573	0.006(m)
EL HGT:	-26.749(m)	0.042(m)	-27.994(m)	0.042(m)
ORTHO HGT:	2.132(m)	0.049(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4612325.559	822364.189
Easting (X) [meters]	353077.896	261282.553
Convergence [degrees]	-1.17273995	0.49415592
Point Scale	0.99986564	1.00001057
Combined Factor	0.99986984	1.00001476

US NATIONAL GRID DESIGNATOR: 19TCG5307812326(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	97568.7
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	49448.4
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	14632.8

NEAREST NGS PUBLISHED CONTROL POINT

LW4842	ANGEL RESET	N413829.660	W0704554.433	845.0

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1711        -0.0190         0.0420  VEL TIMES 10.0038 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9460 -4518935.4006   4237355.6853  L1 PHS CEN @ 2007.0050
XYZ         0.0003        -0.0002        -0.0002  + XYZ ADJUSTMENTS
XYZ   1477963.9463 -4518935.4008   4237355.6851  NEW L1 PHS CEN @ 2007.0050
XYZ   1477963.9217 -4518935.3255   4237355.6140  NEW ARP @ 2007.0050
XYZ   1477963.9217 -4518935.3255   4237355.6140  NEW MON @ 2007.0050
LLH  41 53 58.92142  288  6 39.09977     55.9742  NEW L1 PHS CEN @ 2007.0050
LLH  41 53 58.92142  288  6 39.09977     55.8677  NEW ARP @ 2007.0050
LLH  41 53 58.92142  288  6 39.09977     55.8677  NEW MON @ 2007.0050

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                    S/N=0220108551
XYZ   1531392.4521 -4531473.9597   4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000         0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1651        -0.0250         0.0330  VEL TIMES 10.0038 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3319 -4531474.1174   4204982.7080  L1 PHS CEN @ 2007.0050
XYZ         0.0000         0.0001         0.0001  + XYZ ADJUSTMENTS
XYZ   1531392.3319 -4531474.1174   4204982.7081  NEW L1 PHS CEN @ 2007.0050
XYZ   1531392.3061 -4531474.0410   4204982.6367  NEW ARP @ 2007.0050
XYZ   1531392.2871 -4531473.9846   4204982.5841  NEW MON @ 2007.0050
LLH  41 30 35.44814  288 40 20.86544    -12.9075  NEW L1 PHS CEN @ 2007.0050
LLH  41 30 35.44814  288 40 20.86544    -13.0152  NEW ARP @ 2007.0050
LLH  41 30 35.44814  288 40 20.86544    -13.0946  NEW MON @ 2007.0050

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                    S/N=60052145
XYZ   1560550.6359 -4503284.5346   4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1701        -0.0190         0.0460  VEL TIMES 10.0038 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4857 -4503284.6109   4224398.1249  L1 PHS CEN @ 2007.0050
XYZ        -0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4857 -4503284.6109   4224398.1250  NEW L1 PHS CEN @ 2007.0050
XYZ   1560550.4658 -4503284.5536   4224398.0708  NEW ARP @ 2007.0050
XYZ   1560550.4658 -4503284.5536   4224398.0708  NEW MON @ 2007.0050
LLH  41 44 36.82971  289  6 46.96362     5.3219  NEW L1 PHS CEN @ 2007.0050
LLH  41 44 36.82971  289  6 46.96362     5.2406  NEW ARP @ 2007.0050
LLH  41 44 36.82971  289  6 46.96362     5.2406  NEW MON @ 2007.0050

                    REMOTE STATION INFORMATION

STATION NAME: r1_0       1
 ANTENNA: TPSHIPER_GD     NONE                                    S/N=UNKNOWN
XYZ   1572475.7352 -4506498.2341   4216546.5599  MON @ 2007.0048 (M)
NEU         0.0000        -0.0000         1.5600  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3840        -1.1006         1.0367  MON TO ARP
XYZ         0.0261        -0.0748         0.0704  ARP TO L1 PHASE CENTER
XYZ   1572476.1453 -4506499.4095   4216547.6671  L1 PHS CEN @ 2007.0050

BASELINE NAME:    ctpu  r1_0
```

```
XYZ        -2.9603          0.7636         -0.4662  + XYZ ADJUSTMENTS
XYZ   1572473.1851  -4506498.6458   4216547.2009  NEW L1 PHS CEN @ 2007.0050
XYZ   1572473.1590  -4506498.5711   4216547.1304  NEW ARP @ 2007.0050
XYZ   1572472.7749  -4506497.4705   4216546.0937  NEW MON @ 2007.0050
LLH  41 38 56.94039  289 14  8.32420    -26.3008  NEW L1 PHS CEN @ 2007.0050
LLH  41 38 56.94039  289 14  8.32420    -26.4068  NEW ARP @ 2007.0050
LLH  41 38 56.94039  289 14  8.32420    -27.9668  NEW MON @ 2007.0050

BASELINE NAME:   npri  r1_0
XYZ        -2.9733          0.7997         -0.4819  + XYZ ADJUSTMENTS
XYZ   1572473.1720  -4506498.6098   4216547.1852  NEW L1 PHS CEN @ 2007.0050
XYZ   1572473.1459  -4506498.5350   4216547.1147  NEW ARP @ 2007.0050
XYZ   1572472.7619  -4506497.4344   4216546.0780  NEW MON @ 2007.0050
LLH  41 38 56.94084  289 14  8.32418    -26.3399  NEW L1 PHS CEN @ 2007.0050
LLH  41 38 56.94084  289 14  8.32418    -26.4459  NEW ARP @ 2007.0050
LLH  41 38 56.94084  289 14  8.32418    -28.0059  NEW MON @ 2007.0050

BASELINE NAME:   acu5  r1_0
XYZ        -2.9701          0.8089         -0.4773  + XYZ ADJUSTMENTS
XYZ   1572473.1753  -4506498.6006   4216547.1898  NEW L1 PHS CEN @ 2007.0050
XYZ   1572473.1492  -4506498.5258   4216547.1193  NEW ARP @ 2007.0050
XYZ   1572472.7651  -4506497.4252   4216546.0826  NEW MON @ 2007.0050
LLH  41 38 56.94112  289 14  8.32444    -26.3424  NEW L1 PHS CEN @ 2007.0050
LLH  41 38 56.94112  289 14  8.32444    -26.4484  NEW ARP @ 2007.0050
LLH  41 38 56.94112  289 14  8.32444    -28.0084  NEW MON @ 2007.0050
```

G-FILES

```
Axx2007 1 2   7 1 2
B2007 1 21814   7 1 22045 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 5IFDDFX
Iant_info.003        NGS   20061004
C00090001 -945088533   14 -124378550   36  208095203   33 X0027AR1_0X0027ACTPU
D  1  2 -6401854  1  3  5621849  2  3 -9375276

Axx2007 1 2   7 1 2
B2007 1 21814   7 1 22045 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 5IFDDFX
Iant_info.003        NGS   20061004
C00090002 -410804748   10 -249765503   27 -115634939   23 X0027AR1_0X0027ANPRI
D  1  2 -6433871  1  3  7548952  2  3 -9148113

Axx2007 1 2   7 1 2
B2007 1 21814   7 1 22045 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 5IFDDFX
Iant_info.003        NGS   20061004
C00090003 -119222993   11   32128716   27   78519882   24 X0027AR1_0X0027AACU5
D  1  2 -7574967  1  3  5409424  2  3 -9002259
```

POST-FIT RMS BY SATELLITE VS. BASELINE

	OVERALL	02	04	05	09	10	12	13	17
ctpu-r1_0|	0.017	0.011	...	0.016	...	0.021	0.014	0.022	0.013
	20	23	24	28	30				
ctpu-r1_0|	0.026	0.019	0.011	0.022	0.015				

	OVERALL	02	04	05	09	10	12	13	17
npri-r1_0|	0.013	0.009	...	0.012	...	0.013	0.013	0.017	0.009
	20	23	24	28	30				
npri-r1_0|	0.015	0.018	0.015	0.014	0.014				

	OVERALL	02	04	05	09	10	12	13	17
acu5-r1_0|	0.013	0.009	...	0.014	...	0.015	0.014	0.014	0.009
	20	23	24	28	30				
acu5-r1_0|	0.016	0.018	0.012	0.014	0.018				

OBS BY SATELLITE VS. BASELINE

	OVERALL	02	04	05	09	10	12	13	17
ctpu-r1_0|	1968	298	...	230	...	110	247	149	298

	20	23	24	28	30				
ctpu-r1_0	131	166	180	90	69				
	OVERALL	02	04	05	09	10	12	13	17
npri-r1_0	1950	293	...	230	...	110	240	150	298
	20	23	24	28	30				
npri-r1_0	131	168	182	88	60				
	OVERALL	02	04	05	09	10	12	13	17
acu5-r1_0	1969	296	...	227	...	113	230	154	298
	20	23	24	28	30				
acu5-r1_0	132	178	182	90	69				

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000009267	-0.0000001603	0.0000001280
-0.0000001603	0.0000061200	-0.0000005034
0.0000001280	-0.0000005034	0.0000048756

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000013906	0.0000009528	-0.0000011464
0.0000009528	0.0000047042	-0.0000003235
-0.0000011464	-0.0000003235	0.0000058274

Horizontal network accuracy = 0.00452 meters.
Vertical network accuracy = 0.00473 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-94508.84677	-12437.87427	20809.53032	2002.00
NPRI	-41080.48388	-24976.53782	-11563.49243	2002.00
ACU5	-11922.30156	3212.89117	7851.98505	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2698039.843
Easting (X) [feet]	857224.509
Convergence [degrees]	0.49415592
Point Scale	1.00001057
Combined Factor	1.00001476

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

From: opus@ngs.noaa.gov
Sent: Thursday, January 04, 2007 9:25 AM
To: Ali Kowsari
Subject: OPUS solution : R1_1229a.tps 000055010 Fair haven A

FILE: R1_1229a.tps 000055010

NGS OPUS SOLUTION REPORT
==========

USER: akowsari@greenintl.com
RINEX FILE: r1_1363o.06o

DATE: January 04, 2007
TIME: 14:25:28 UTC

SOFTWARE: page5 0612.06 master4.pl
EPHEMERIS: igr14075.eph [rapid]
NAV FILE: brdc3630.06n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.415

START: 2006/12/29 14:24:00
STOP: 2006/12/29 16:56:00
OBS USED: 4108 / 4129 : 99%
FIXED AMB: 22 / 22 : 100%
OVERALL RMS: 0.011(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2006.9936)	
X:	1560896.530(m)	0.006(m)	1560895.810(m)	0.006(m)
Y:	-4511233.995(m)	0.013(m)	-4511232.552(m)	0.013(m)
Z:	4215788.685(m)	0.010(m)	4215788.612(m)	0.010(m)
LAT:	41 38 24.06472	0.002(m)	41 38 24.09739	0.002(m)
E LON:	289 5 8.62297	0.007(m)	289 5 8.61396	0.007(m)
W LON:	70 54 51.37703	0.007(m)	70 54 51.38604	0.007(m)
EL HGT:	-27.161(m)	0.016(m)	-28.405(m)	0.016(m)
ORTHO HGT:	2.006(m)	0.030(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4611579.062	821254.188
Easting (X) [meters]	340570.691	248800.814
Convergence [degrees]	-1.27220182	0.39345070
Point Scale	0.99991280	1.00001210
Combined Factor	0.99991706	1.00001636

US NATIONAL GRID DESIGNATOR: 19TCG4057111579(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	86035.8
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	37375.7
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	11722.3

NEAREST NGS PUBLISHED CONTROL POINT

LW4943	USE 20 1935	N413831.991	W0705502.290	351.7

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ        -0.0171        -0.0019         0.0042  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1258  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1709        -0.0190         0.0420  VEL TIMES 9.9924 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0246        -0.0753         0.0711  ARP TO L1 PHASE CENTER
XYZ   1477963.9462 -4518935.4006 4237355.6853  L1 PHS CEN @ 2006.9936
XYZ         0.0000        -0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1477963.9462 -4518935.4006 4237355.6853  NEW L1 PHS CEN @ 2006.9936
XYZ   1477963.9216 -4518935.3253 4237355.6142  NEW ARP @ 2006.9936
XYZ   1477963.9216 -4518935.3253 4237355.6142  NEW MON @ 2006.9936
LLH  41 53 58.92142  288  6 39.09977     55.9742  NEW L1 PHS CEN @ 2006.9936
LLH  41 53 58.92142  288  6 39.09977     55.8677  NEW ARP @ 2006.9936
LLH  41 53 58.92142  288  6 39.09977     55.8677  NEW MON @ 2006.9936

STATION NAME: npri  a    6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00     UNAV                                  S/N=0220108551
XYZ   1531392.4521 -4531473.9597 4204982.5510  MON @ 1997.0000 (M)
XYZ        -0.0165        -0.0025         0.0033  VEL (M/YR)
NEU        -0.0000        -0.0000         0.0794  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1077  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1273  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1649        -0.0250         0.0330  VEL TIMES 9.9924 YRS
XYZ         0.0190        -0.0563         0.0526  MON TO ARP
XYZ         0.0258        -0.0764         0.0714  ARP TO L1 PHASE CENTER
XYZ   1531392.3321 -4531474.1174 4204982.7080  L1 PHS CEN @ 2006.9936
XYZ         0.0000         0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ   1531392.3321 -4531474.1174 4204982.7080  NEW L1 PHS CEN @ 2006.9936
XYZ   1531392.3063 -4531474.0410 4204982.6366  NEW ARP @ 2006.9936
XYZ   1531392.2872 -4531473.9847 4204982.5840  NEW MON @ 2006.9936
LLH  41 30 35.44814  288 40 20.86545    -12.9075  NEW L1 PHS CEN @ 2006.9936
LLH  41 30 35.44814  288 40 20.86545    -13.0152  NEW ARP @ 2006.9936
LLH  41 30 35.44814  288 40 20.86545    -13.0946  NEW MON @ 2006.9936

STATION NAME: acu5  a    2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG    SCIT                                  S/N=60052145
XYZ   1560550.6359 -4503284.5346 4224398.0248  MON @ 1997.0000 (M)
XYZ        -0.0170        -0.0019         0.0046  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1699        -0.0190         0.0460  VEL TIMES 9.9924 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ         0.0199        -0.0573         0.0541  ARP TO L1 PHASE CENTER
XYZ   1560550.4859 -4503284.6109 4224398.1249  L1 PHS CEN @ 2006.9936
XYZ         0.0000         0.0000         0.0000  + XYZ ADJUSTMENTS
XYZ   1560550.4859 -4503284.6109 4224398.1249  NEW L1 PHS CEN @ 2006.9936
XYZ   1560550.4660 -4503284.5536 4224398.0708  NEW ARP @ 2006.9936
XYZ   1560550.4660 -4503284.5536 4224398.0708  NEW MON @ 2006.9936
LLH  41 44 36.82971  289  6 46.96363      5.3219  NEW L1 PHS CEN @ 2006.9936
LLH  41 44 36.82971  289  6 46.96363      5.2406  NEW ARP @ 2006.9936
LLH  41 44 36.82971  289  6 46.96363      5.2406  NEW MON @ 2006.9936
```

REMOTE STATION INFORMATION

```
STATION NAME: r1_1       1
 ANTENNA: TPSHIPER_GD     NONE                                  S/N=UNKNOWN
XYZ   1560898.6259 -4511233.3412 4215789.0542  MON @ 2006.9934 (M)
NEU        -0.0000        -0.0000         1.4150  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1060  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1012  ARP TO L2 PHASE CENTER (M)
XYZ         0.3458        -0.9993         0.9402  MON TO ARP
XYZ         0.0259        -0.0749         0.0704  ARP TO L1 PHASE CENTER
XYZ   1560898.9976 -4511234.4154 4215790.0648  L1 PHS CEN @ 2006.9936

BASELINE NAME:   ctpu  r1_1
```

```
XYZ        -2.8156          0.7975          -0.4478  + XYZ ADJUSTMENTS
XYZ   1560896.1820  -4511233.6179   4215789.6170  NEW L1 PHS CEN @ 2006.9936
XYZ   1560896.1561  -4511233.5431   4215789.5466  NEW ARP @ 2006.9936
XYZ   1560895.8103  -4511232.5437   4215788.6064  NEW MON @ 2006.9936
LLH  41 38 24.09742  289  5  8.61409    -26.8935  NEW L1 PHS CEN @ 2006.9936
LLH  41 38 24.09742  289  5  8.61409    -26.9995  NEW ARP @ 2006.9936
LLH  41 38 24.09742  289  5  8.61409    -28.4145  NEW MON @ 2006.9936

BASELINE NAME:   npri  r1_1
XYZ        -2.8183          0.7840          -0.4403  + XYZ ADJUSTMENTS
XYZ   1560896.1792  -4511233.6315   4215789.6246  NEW L1 PHS CEN @ 2006.9936
XYZ   1560896.1533  -4511233.5566   4215789.5541  NEW ARP @ 2006.9936
XYZ   1560895.8076  -4511232.5572   4215788.6139  NEW MON @ 2006.9936
LLH  41 38 24.09735  289  5  8.61379    -26.8796  NEW L1 PHS CEN @ 2006.9936
LLH  41 38 24.09735  289  5  8.61379    -26.9856  NEW ARP @ 2006.9936
LLH  41 38 24.09735  289  5  8.61379    -28.4006  NEW MON @ 2006.9936

BASELINE NAME:   acu5  r1_1
XYZ        -2.8126          0.7854          -0.4378  + XYZ ADJUSTMENTS
XYZ   1560896.1850  -4511233.6300   4215789.6271  NEW L1 PHS CEN @ 2006.9936
XYZ   1560896.1591  -4511233.5552   4215789.5566  NEW ARP @ 2006.9936
XYZ   1560895.8133  -4511232.5558   4215788.6164  NEW MON @ 2006.9936
LLH  41 38 24.09739  289  5  8.61404    -26.8775  NEW L1 PHS CEN @ 2006.9936
LLH  41 38 24.09739  289  5  8.61404    -26.9835  NEW ARP @ 2006.9936
LLH  41 38 24.09739  289  5  8.61404    -28.3985  NEW MON @ 2006.9936
```

G-FILES

```
Axx20061229   61229
B200612291423   612291656 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090001 -829318887   13  -77027816   28  215670078   27 X3636AR1_1X3636ACTPU
D  1  2 -6545964  1  3  6255771  2  3 -9525735

Axx20061229   61229
B200612291423   612291656 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090002 -295035203   10 -202414274   25 -108060300   23 X3636AR1_1X3636ANPRI
D  1  2 -6401580  1  3  7209906  2  3 -9286927

Axx20061229   61229
B200612291423   612291656 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090003   -3453473    8   79480022   24   86094543   21 X3636AR1_1X3636AACU5
D  1  2 -8111600  1  3  7933485  2  3 -8688660
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     03     04     08     11     17     19     20     27
ctpu-r1_1|  0.012    ...  0.017  0.010    ...  0.013  0.016  0.018  0.012
              28
ctpu-r1_1|  0.008

           OVERALL     03     04     08     11     17     19     20     27
npri-r1_1|  0.010    ...  0.029  0.008    ...  0.013  0.009  0.013  0.011
              28
npri-r1_1|  0.007

           OVERALL     03     04     08     11     17     19     20     27
acu5-r1_1|  0.010  0.013  0.016  0.007    ...  0.012  0.009  0.014  0.011
              28
acu5-r1_1|  0.008
```

OBS BY SATELLITE VS. BASELINE

```
           OVERALL     03     04     08     11     17     19     20     27
ctpu-r1_1|   1356    ...     19    303    ...    213    187     96    235
```

	28								
ctpu-r1_1|	303								
	OVERALL	03	04	08	11	17	19	20	27
npri-r1_1|	1352	...	19	303	...	214	188	100	225
	28								
npri-r1_1|	303								
	OVERALL	03	04	08	11	17	19	20	27
acu5-r1_1|	1400	41	19	302	...	213	189	99	235
	28								
acu5-r1_1|	302								

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000007400	-0.0000001231	0.0000001153
-0.0000001231	0.0000044111	-0.0000003760
0.0000001153	-0.0000003760	0.0000037756

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000010564	0.0000006763	-0.0000007870
0.0000006763	0.0000035254	-0.0000001098
-0.0000007870	-0.0000001098	0.0000043449

Horizontal network accuracy = 0.00391 meters.
Vertical network accuracy = 0.00409 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-82931.88877	-7702.76627	21567.00332	2002.00
NPRI	-29503.52588	-20241.42982	-10806.01943	2002.00
ACU5	-345.34356	7947.99917	8609.45805	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2694398.115
Easting (X) [feet]	816274.004
Convergence [degrees]	0.39345070
Point Scale	1.00001210
Combined Factor	1.00001636

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

Ali Kowsari P-10

From: opus@ngs.noaa.gov
Sent: Thursday, January 04, 2007 9:33 AM
To: Ali Kowsari
Subject: OPUS solution : R1_1229b.tps 000055017 Fairhaven B

FILE: R1_1229b.tps 000055017

NGS OPUS SOLUTION REPORT
==========

USER: akowsari@greenintl.com
RINEX FILE: r1_1363r.06o
DATE: January 04, 2007
TIME: 14:33:14 UTC

SOFTWARE: page5 0612.06 master23.pl
EPHEMERIS: igr14075.eph [rapid]
NAV FILE: brdc3630.06n
ANT NAME: TPSHIPER_GD NONE
ARP HEIGHT: 1.310
START: 2006/12/29 17:22:00
STOP: 2006/12/29 19:52:00
OBS USED: 4257 / 4454 : 96%
FIXED AMB: 38 / 38 : 100%
OVERALL RMS: 0.015(m)

REF FRAME:	NAD_83(CORS96)(EPOCH:2002.0000)		ITRF00 (EPOCH:2006.9939)	
X:	1565116.166(m)	0.003(m)	1565115.446(m)	0.003(m)
Y:	-4511767.881(m)	0.010(m)	-4511766.437(m)	0.010(m)
Z:	4213665.934(m)	0.007(m)	4213665.860(m)	0.007(m)
LAT:	41 36 52.02957	0.001(m)	41 36 52.06223	0.001(m)
E LON:	289 7 53.31923	0.005(m)	289 7 53.31029	0.005(m)
W LON:	70 52 6.68077	0.005(m)	70 52 6.68971	0.005(m)
EL HGT:	-27.657(m)	0.011(m)	-28.903(m)	0.011(m)
ORTHO HGT:	1.469(m)	0.027(m)	[Geoid03 NAVD88]	

	UTM COORDINATES UTM (Zone 19)	STATE PLANE COORDINATES SPC (2001 MA M)
Northing (Y) [meters]	4608656.972	818441.984
Easting (X) [meters]	344319.523	252633.409
Convergence [degrees]	-1.24116216	0.42418159
Point Scale	0.99989826	1.00001653
Combined Factor	0.99990260	1.00002087

US NATIONAL GRID DESIGNATOR: 19TCG4432008657(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH5837	CTPU PUTNAM CORS ARP	N415358.888	W0715320.889	90597.9
AI3285	NPRI NAVAL STATION NEW CORS ARP	N413035.415	W0711939.125	40013.0
DI0876	ACU5 ACUSHNET 5 CORS ARP	N414436.796	W0705313.027	14420.9

NEAREST NGS PUBLISHED CONTROL POINT

LW4891	EGG ISLAND BEACON	N413633.474	W0705327.008	1943.7

BASE STATION INFORMATION

STATION NAME: ctpu a 2 (Putnam; Putnam, Connecticut USA)
ANTENNA: TRM29659.00 SCIS S/N=0220262514
XYZ 1477964.0924 -4518935.3063 4237355.5722 MON @ 1997.0000 (M)

```
XYZ         -0.0171         -0.0019          0.0042  VEL (M/YR)
NEU          0.0000          0.0000          0.0000  MON TO ARP (M)
NEU         -0.0000          0.0000          0.1065  ARP TO L1 PHASE CENTER (M)
NEU         -0.0000          0.0000          0.1258  ARP TO L2 PHASE CENTER (M)
XYZ         -0.1709         -0.0190          0.0420  VEL TIMES 9.9928 YRS
XYZ          0.0000          0.0000          0.0000  MON TO ARP
XYZ          0.0246         -0.0753          0.0711  ARP TO L1 PHASE CENTER
XYZ    1477963.9462  -4518935.4006    4237355.6853  L1 PHS CEN @ 2006.9939
XYZ         -0.0000         -0.0000         -0.0000  + XYZ ADJUSTMENTS
XYZ    1477963.9462  -4518935.4007    4237355.6853  NEW L1 PHS CEN @ 2006.9939
XYZ    1477963.9215  -4518935.3253    4237355.6141  NEW ARP @ 2006.9939
XYZ    1477963.9215  -4518935.3253    4237355.6141  NEW MON @ 2006.9939
LLH   41 53 58.92142   288  6 39.09977      55.9742  NEW L1 PHS CEN @ 2006.9939
LLH   41 53 58.92142   288  6 39.09977      55.8677  NEW ARP @ 2006.9939
LLH   41 53 58.92142   288  6 39.09977      55.8677  NEW MON @ 2006.9939

STATION NAME: npri  a     6 (Naval Station Newport; Newport, Rhode Island  U.S.
 ANTENNA: TRM29659.00      UNAV                                  S/N=0220108551
XYZ    1531392.4521  -4531473.9597    4204982.5510  MON @ 1997.0000 (M)
XYZ         -0.0165         -0.0025          0.0033  VEL (M/YR)
NEU         -0.0000          0.0000          0.0794  MON TO ARP (M)
NEU         -0.0000          0.0000          0.1077  ARP TO L1 PHASE CENTER (M)
NEU         -0.0000          0.0000          0.1273  ARP TO L2 PHASE CENTER (M)
XYZ         -0.1649         -0.0250          0.0330  VEL TIMES 9.9928 YRS
XYZ          0.0190         -0.0563          0.0526  MON TO ARP
XYZ          0.0258         -0.0764          0.0714  ARP TO L1 PHASE CENTER
XYZ    1531392.3321  -4531474.1174    4204982.7080  L1 PHS CEN @ 2006.9939
XYZ         -0.0000         -0.0000         -0.0000  + XYZ ADJUSTMENTS
XYZ    1531392.3321  -4531474.1174    4204982.7080  NEW L1 PHS CEN @ 2006.9939
XYZ    1531392.3062  -4531474.0410    4204982.6366  NEW ARP @ 2006.9939
XYZ    1531392.2872  -4531473.9847    4204982.5840  NEW MON @ 2006.9939
LLH   41 30 35.44814   288 40 20.86545     -12.9075  NEW L1 PHS CEN @ 2006.9939
LLH   41 30 35.44814   288 40 20.86545     -13.0152  NEW ARP @ 2006.9939
LLH   41 30 35.44814   288 40 20.86545     -13.0946  NEW MON @ 2006.9939

STATION NAME: acu5  a     2 (ACUSHNET 5; Acushnet, Massachusetts  USA)
 ANTENNA: TRM41249USCG     SCIT                                  S/N=60052145
XYZ    1560550.6359  -4503284.5346    4224398.0248  MON @ 1997.0000 (M)
XYZ         -0.0170         -0.0019          0.0046  VEL (M/YR)
NEU          0.0000          0.0000          0.0000  MON TO ARP (M)
NEU         -0.0000         -0.0000          0.0813  ARP TO L1 PHASE CENTER (M)
NEU         -0.0000         -0.0000          0.0689  ARP TO L2 PHASE CENTER (M)
XYZ         -0.1699         -0.0190          0.0460  VEL TIMES 9.9928 YRS
XYZ          0.0000          0.0000          0.0000  MON TO ARP
XYZ          0.0199         -0.0573          0.0541  ARP TO L1 PHASE CENTER
XYZ    1560550.4859  -4503284.6109    4224398.1249  L1 PHS CEN @ 2006.9939
XYZ          0.0000         -0.0000         -0.0000  + XYZ ADJUSTMENTS
XYZ    1560550.4859  -4503284.6109    4224398.1249  NEW L1 PHS CEN @ 2006.9939
XYZ    1560550.4660  -4503284.5536    4224398.0708  NEW ARP @ 2006.9939
XYZ    1560550.4660  -4503284.5536    4224398.0708  NEW MON @ 2006.9939
LLH   41 44 36.82971   289  6 46.96363       5.3219  NEW L1 PHS CEN @ 2006.9939
LLH   41 44 36.82971   289  6 46.96363       5.2406  NEW ARP @ 2006.9939
LLH   41 44 36.82971   289  6 46.96363       5.2406  NEW MON @ 2006.9939

                        REMOTE STATION INFORMATION

STATION NAME: rl_1        1
 ANTENNA: TPSHIPER_GD      NONE                                  S/N=UNKNOWN
XYZ    1565118.3815  -4511767.2775    4213666.0473  MON @ 2006.9938 (M)
NEU         -0.0000         -0.0000          1.3100  MON TO ARP (M)
NEU         -0.0000         -0.0000          0.1060  ARP TO L1 PHASE CENTER (M)
NEU         -0.0000         -0.0000          0.1012  ARP TO L2 PHASE CENTER (M)
XYZ          0.3210         -0.9253          0.8700  MON TO ARP
XYZ          0.0260         -0.0749          0.0704  ARP TO L1 PHASE CENTER
XYZ    1565118.7285  -4511768.2777    4213666.9877  L1 PHS CEN @ 2006.9939

BASELINE NAME:    ctpu  rl_1
```

```
XYZ        -2.9334          0.8458         -0.1910  + XYZ ADJUSTMENTS
XYZ   1565115.7951  -4511767.4319   4213666.7967  NEW L1 PHS CEN @ 2006.9939
XYZ   1565115.7691  -4511767.3570   4213666.7263  NEW ARP @ 2006.9939
XYZ   1565115.4481  -4511766.4317   4213665.8563  NEW MON @ 2006.9939
LLH  41 36 52.06223  289  7 53.31045    -27.4927  NEW L1 PHS CEN @ 2006.9939
LLH  41 36 52.06223  289  7 53.31045    -27.5987  NEW ARP @ 2006.9939
LLH  41 36 52.06223  289  7 53.31045    -28.9087  NEW MON @ 2006.9939

BASELINE NAME:   npri  r1_1
XYZ        -2.9350          0.8363         -0.1837  + XYZ ADJUSTMENTS
XYZ   1565115.7935  -4511767.4414   4213666.8040  NEW L1 PHS CEN @ 2006.9939
XYZ   1565115.7675  -4511767.3665   4213666.7336  NEW ARP @ 2006.9939
XYZ   1565115.4465  -4511766.4412   4213665.8636  NEW MON @ 2006.9939
LLH  41 36 52.06223  289  7 53.31025    -27.4815  NEW L1 PHS CEN @ 2006.9939
LLH  41 36 52.06223  289  7 53.31025    -27.5875  NEW ARP @ 2006.9939
LLH  41 36 52.06223  289  7 53.31025    -28.8975  NEW MON @ 2006.9939

BASELINE NAME:   acu5  r1_1
XYZ        -2.9369          0.8395         -0.1860  + XYZ ADJUSTMENTS
XYZ   1565115.7915  -4511767.4382   4213666.8017  NEW L1 PHS CEN @ 2006.9939
XYZ   1565115.7656  -4511767.3633   4213666.7313  NEW ARP @ 2006.9939
XYZ   1565115.4446  -4511766.4380   4213665.8613  NEW MON @ 2006.9939
LLH  41 36 52.06225  289  7 53.31022    -27.4858  NEW L1 PHS CEN @ 2006.9939
LLH  41 36 52.06225  289  7 53.31022    -27.5918  NEW ARP @ 2006.9939
LLH  41 36 52.06225  289  7 53.31022    -28.9018  NEW MON @ 2006.9939
```

G-FILES

```
Axx20061229   61229
B200612291721   612291951 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090001 -871515266   15  -71688936   31  236897578   28 X3636AR1_1X3636ACTPU
D  1  2 -6477570  1  3  5250547  2  3 -9280802

Axx20061229   61229
B200612291721   612291951 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090002 -337231593   14 -197075435   30  -86832797   26 X3636AR1_1X3636ANPRI
D  1  2 -6515687  1  3  6991646  2  3 -9198301

Axx20061229   61229
B200612291721   612291951 1 page5 v0612.06IGS     222 1 2 27NGS   2007 1 4IFDDFX
Iant_info.003        NGS   20061004
C00090003  -45649785   12   84818844   28  107322095   26 X3636AR1_1X3636AACU5
D  1  2 -8797096  1  3  5883601  2  3 -7602753
```

POST-FIT RMS BY SATELLITE VS. BASELINE

	OVERALL	02	04	05	09	11	12	13	17
ctpu-r1_1	0.016	0.013	...	0.017	0.018	0.024	0.018	...	0.008
	20	23	24	28					
ctpu-r1_1	0.013	0.031	0.023	0.016					

	OVERALL	02	04	05	09	11	12	13	17
npri-r1_1	0.015	0.015	...	0.019	0.017	0.022	0.016	...	0.007
	20	23	24	28					
npri-r1_1	0.012	0.026	0.025	0.014					

	OVERALL	02	04	05	09	11	12	13	17
acu5-r1_1	0.014	0.013	...	0.011	0.019	0.023	0.015	...	0.007
	20	23	24	28					
acu5-r1_1	0.012	0.019	0.023	0.012					

OBS BY SATELLITE VS. BASELINE

	OVERALL	02	04	05	09	11	12	13	17
ctpu-r1_1	1463	160	...	93	118	76	109	...	299

	20	23	24	28					
ctpu-r1_1|	282	35	62	229					
	OVERALL	02	04	05	09	11	12	13	17
npri-r1_1|	1403	174	...	85	82	86	95	...	299
	20	23	24	28					
npri-r1_1|	272	40	42	228					
	OVERALL	02	04	05	09	11	12	13	17
acu5-r1_1|	1391	159	...	70	63	89	92	...	299
	20	23	24	28					
acu5-r1_1|	282	44	62	231					

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000012556	-0.0000001934	0.0000001464
-0.0000001934	0.0000058778	-0.0000004614
0.0000001464	-0.0000004614	0.0000047467

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000016322	0.0000008367	-0.0000009679
0.0000008367	0.0000045967	-0.0000003140
-0.0000009679	-0.0000003140	0.0000056510

Horizontal network accuracy = 0.00451 meters.
Vertical network accuracy = 0.00466 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.02312	-4531475.48112	4204982.71817	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
CTPU	1477964.64123	-4518936.76127	4237355.68832	2002.00
NPRI	1531393.00412	-4531475.42482	4204982.66557	2002.00
ACU5	1560551.18644	-4503285.99583	4224398.14305	2002.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
CTPU	0.00000	-0.00000	-0.00010
NPRI	0.00050	-0.00060	-0.00120
ACU5	0.00000	-0.00000	0.00000

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
CTPU	-87151.52477	-7168.88027	23689.75432	2002.00
NPRI	-33723.16188	-19707.54382	-8683.26843	2002.00
ACU5	-4564.97956	8481.88517	10732.20905	2002.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (2001 MA M)

Northing (Y) [feet]	2685171.743
Easting (X) [feet]	828848.109
Convergence [degrees]	0.42418159
Point Scale	1.00001653
Combined Factor	1.00002087

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

Drawing Name: bristol-plymouth check points
Project Name: Bristol-Plymouth Check Points
Project Path: F:\Projects\2320\2320018 bristol-plymouth ma\Survey\Bristol-Plymouth Check Points\
Username: AKaplan

Number	Northing	Easting	Elevation	Raw Desc	Full Desc
1317	2682721.3494	815644.8393	8.61	SPK	SPK
1318	2682668.7007	815669.0414	8.07	P5	P5
1319	2682699.5560	815662.1480	8.31	G5	G5
1320	2682777.7727	815654.2332	7.96	OS@BIT@CLRD	OS@BIT@CLRD
1321	2682727.3834	815682.0935	7.80	OS@BIT@CLRD	OS@BIT@CLRD
1322	2682598.0555	815704.6603	8.12	OS@CONC.SW	OS@CONC.SW
1323	2682641.5889	815683.6459	8.06	OS@CONC.SW	OS@CONC.SW
1324	2682705.6688	815649.9020	8.24	OS@CONC.SW	OS@CONC.SW
1325	2682759.2467	815620.5755	8.21	OS@CONC.SW	OS@CONC.SW
1326	2682709.0691	815642.2801	8.59	OS@GRASS	OS@GRASS
1327	2682651.2026	815671.0355	8.40	OS@GRASS	OS@GRASS
1328	2682616.1044	815703.8906	8.27	OS@GRASS	OS@GRASS
1329	2682655.7422	815685.2608	8.16	OS@GRASS	OS@GRASS
1330	2682726.3176	815654.5404	8.08	OS@GRASS	OS@GRASS
1331	2678373.3605	819333.4916	11.53	CONCNAIL	CONCNAIL
1332	2678404.1150	819293.3420	12.06	P6	P6
1333	2678412.7318	819339.6388	11.79	G6	G6
1334	2678315.6994	819378.4191	10.62	OS@BIT	OS@BIT
1335	2678433.3611	819378.1229	11.37	OS@BIT	OS@BIT
1336	2678446.9338	819302.2288	11.08	OS@BIT	OS@BIT
1337	2678423.6896	819236.8299	11.57	OS@BIT	OS@BIT
1338	2678394.0268	819246.7104	12.66	OS@GRASS	OS@GRASS
1339	2678384.2253	819287.1312	11.77	OS@GRASS	OS@GRASS
1340	2678349.8270	819310.4041	10.29	OS@GRASS	OS@GRASS
1341	2678337.2579	819329.9134	11.38	OS@GRASS	OS@GRASS
1342	2678336.0433	819354.2817	11.64	OS@GRASS	OS@GRASS
1343	2678392.6202	819357.6016	11.53	OS@GRASS	OS@GRASS
1344	2678427.9928	819320.0578	11.37	OS@GRASS	OS@GRASS
1345	2678322.5054	819335.6238	11.34	OS@BIT	OS@BIT
1346	2694366.2174	816275.8704	6.14	SPK	SPK
1347	2694351.8960	816217.1156	6.10	G9	G9
1348	2694398.1150	816274.0040	6.58	P9	P9
1349	2694342.5763	816258.7317	5.67	OS@GRASS	OS@GRASS
1350	2694350.7130	816168.6463	6.12	OS@GRASS	OS@GRASS
1351	2694409.5172	816170.1849	7.10	OS@GRASS	OS@GRASS
1352	2694442.4416	816219.3873	8.07	OS@GRASS	OS@GRASS
1353	2694390.2810	816237.4622	6.93	OS@GRASS	OS@GRASS
1354	2694464.6101	816273.5063	7.65	OS@BIT	OS@BIT
1355	2694427.0952	816329.2404	5.96	OS@BIT	OS@BIT
1356	2694371.8726	816302.2715	5.69	OS@BIT	OS@BIT
1357	2694330.0901	816315.9235	5.41	OS@BIT	OS@BIT
1358	2694312.6843	816240.9079	5.34	OS@BIT	OS@BIT
1359	2685160.0397	828908.8569	6.63	SPK	SPK
1360	2685171.7430	828848.1090	4.75	P10	P10
1361	2685123.4054	828887.6002	6.45	G10	G10
1362	2685086.4450	828885.3456	6.68	OS@GRASS	OS@GRASS
1363	2685073.1640	828917.6530	6.43	OS@WOODS	OS@WOODS
1364	2685115.7763	828919.4753	6.05	OS@GRASS	OS@GRASS
1365	2685158.3187	828947.1182	6.25	OS@GRASS	OS@GRASS
1366	2685185.4738	828928.3090	6.35	OS@BIT	OS@BIT
1367	2685176.6210	828875.1681	5.37	OS@BIT	OS@BIT
1368	2685163.5844	828815.3052	4.32	OS@BIT	OS@BIT
1369	2732041.5629	888506.2188	19.58	SPK	SPK
1370	2689115.1433	838619.9618	8.20	SPK	SPK
1371	2689052.4898	838628.5912	7.13	P7	P7
1372	2689074.0769	838606.9680	7.49	G7	G7
1373	2689211.8066	838580.2206	11.68	OS@BIT	OS@BIT
1374	2689159.8387	838596.8937	10.03	OS@BIT	OS@BIT

Number	Northing	Easting	Elevation	Raw Desc	Full Desc
1375	2689096.9602	838615.6832	8.07	OS@BIT	OS@BIT
1376	2689043.1375	838631.9277	6.97	OS@BIT	OS@BIT
1377	2689041.5159	838612.5016	6.44	OS@GRASS	OS@GRASS
1378	2689092.2602	838600.5320	7.74	OS@GRASS	OS@GRASS
1379	2689139.3218	838517.7314	6.56	OS@GRASS	OS@GRASS
1380	2689094.1113	838534.7392	7.66	OS@GRASS	OS@GRASS
1381	2689125.6890	838568.9432	8.51	OS@GRASS	OS@GRASS
1382	2689180.7219	838607.1431	10.28	OS@GRASS	OS@GRASS
1383	2689149.9269	838633.5561	8.99	OS@GRASS	OS@GRASS
1384	2689097.5141	838651.1378	7.38	OS@GRASS	OS@GRASS
1385	2697966.4284	857244.6225	6.27	SPK	SPK
1386	2698039.8430	857224.5090	6.97	P8	P8
1387	2697935.7786	857316.5401	6.54	G8	G8
1388	2697957.7028	857352.3676	8.24	OS@DIRT	OS@DIRT
1389	2697957.1279	857292.8277	6.81	OS@DIRT	OS@DIRT
1390	2697986.8971	857234.9012	5.98	OS@BIT	OS@BIT
1391	2698035.7667	857217.1123	6.79	OS@BIT	OS@BIT
1392	2698088.5134	857213.1867	8.92	OS@BIT	OS@BIT
1393	2698068.2988	857225.0836	7.67	OS@GRASS	OS@GRASS
1394	2698008.4864	857235.3910	6.31	OS@GRASS	OS@GRASS
1395	2697953.3868	857273.5803	6.30	OS@GRASS	OS@GRASS
1396	2697941.0835	857343.7677	7.21	OS@GRASS	OS@GRASS
1397	2697900.5627	857361.4321	6.24	OS@GRASS	OS@GRASS
1398	2697965.0699	857325.6493	7.93	OS@GRASS	OS@GRASS
1399	2712860.0237	865172.8120	3.01	SPK	SPK
1400	2712950.7980	865021.9397	11.45	G3	G3
1401	2712932.5135	864974.5354	10.91	OS@GRASS	OS@GRASS
1402	2712968.5821	865001.8917	12.32	OS@GRASS	OS@GRASS
1403	2712974.4934	865058.6931	13.09	OS@GRASS	OS@GRASS
1404	2712952.9024	865099.9433	11.75	OS@GRASS	OS@GRASS
1405	2712921.8420	865073.6752	10.11	OS@GRASS	OS@GRASS
1406	2712927.4676	865026.1533	10.46	OS@GRASS	OS@GRASS
1407	2712899.4651	865343.4499	7.89	OS@BIT	OS@BIT
1408	2712854.2016	865411.6722	8.23	OS@BIT	OS@BIT
1409	2712808.6788	865474.8089	7.99	OS@BIT	OS@BIT
1410	2712752.1739	865561.6944	8.13	OS@BIT	OS@BIT
1411	2712718.6806	865636.5991	8.17	OS@BIT	OS@BIT
1412	2712794.5250	865479.6670	7.77	P3	P3
1413	2706731.1007	862557.9280	5.92	SPK	SPK
1414	2706605.6070	862505.6040	8.13	G4	G4
1415	2706701.2144	862496.9521	7.63	P4	P4
1416	2706742.1130	862470.2630	8.68	OS@BIT	OS@BIT
1417	2706808.9047	862465.3147	8.17	OS@BIT	OS@BIT
1418	2706894.8622	862435.0847	7.23	OS@BIT	OS@BIT
1419	2706860.9572	862440.5141	7.89	OS@WOODS	OS@WOODS
1420	2706793.8276	862453.6366	8.87	OS@WOODS	OS@WOODS
1421	2706765.1945	862436.2972	10.36	OS@WOODS	OS@WOODS
1422	2706718.6496	862435.6119	10.58	OS@GRASS	OS@GRASS
1423	2706647.4793	862438.0527	10.02	OS@GRASS	OS@GRASS
1424	2706580.0813	862453.4162	9.84	OS@GRASS	OS@GRASS
1425	2706556.7924	862494.4558	8.18	OS@GRASS	OS@GRASS
1426	2706626.2303	862516.5888	7.72	OS@GRASS	OS@GRASS
1427	2706669.1423	862490.8721	8.59	OS@GRASS	OS@GRASS
1428	2706706.9762	862517.7182	6.71	OS@BIT	OS@BIT
1429	2732041.5629	888506.2188	19.58	SPK	SPK
1430	2731873.0583	888493.2886	10.80	P1	P1
1431	2732106.5860	888541.8350	22.01	G1	G1
1432	2732138.6430	888548.6415	18.75	OS@GRASS	OS@GRASS
1433	2732171.7397	888496.7365	21.57	OS@GRASS	OS@GRASS
1434	2732106.4043	888494.4130	18.24	OS@GRASS	OS@GRASS
1435	2732038.8229	888464.7789	15.65	OS@GRASS	OS@GRASS
1436	2732003.7458	888537.1788	13.15	OS@GRASS	OS@GRASS

Number	Northing	Easting	Elevation	Raw Desc	Full Desc
1437	2731943.0520	888501.9958	10.81	OS@BIT	OS@BIT
1438	2731908.7928	888479.3058	9.30	OS@BIT	OS@BIT
1439	2731831.6198	888484.2900	5.23	OS@BIT	OS@BIT
1440	2731736.9555	888479.9384	2.11	OS@BIT	OS@BIT
1441	2731779.1658	888423.9022	2.03	OS@BIT	OS@BIT
1442	2731838.0295	888440.4556	6.84	OS@BIT	OS@BIT
1443	2731918.0245	888432.4031	11.01	OS@BIT	OS@BIT
1444	2735253.7607	874240.3353	13.12	SPK	SPK
1445	2735260.2971	874279.5797	11.96	P2	P2
1446	2735228.0955	874260.4900	13.15	G2	G2
1447	2735208.7641	874296.3955	12.57	os@bit	os@bit
1448	2735230.7268	874329.0849	12.43	os@bit	os@bit
1449	2735295.0558	874330.8709	12.97	os@bit	os@bit
1450	2735327.0885	874289.0070	13.31	os@bit	os@bit
1451	2735292.6840	874246.4755	12.63	os@bit	os@bit
1452	2735281.2730	874236.2219	13.07	os@grass	os@grass
1453	2735234.8807	874249.6007	13.07	os@grass	os@grass
1454	2735185.4531	874291.1613	13.13	os@grass	os@grass
1455	2735133.6402	874338.8545	12.89	os@grass	os@grass

DIGITAL FLOOD INSURANCE
RATE MAP TASK FOR COASTAL ANALYSIS
PLYMOUTH AND BRISTOL COUNTIES (MA)

FEMA CONTRACT NO. EME-2003-CO-0340 (TASK ORDER #18)
CDM SUBCONTRACT NO. 2809-999-002-CS (TASK ORDER #10)

TRANSECT SURVEY
DATA REPORT

for

Marion/Mattapoisett/Wareham

PLYMOUTH AND BRISTOL COUNTIES, MA

Prepared for:

Camp Dresser & McKee, Inc.

July 16, 2007

Prepared By:

Green International Affiliates, Inc.

GREEN INTERNATIONAL AFFILIATES, INC.
407R MYSTIC AVENUE, UNIT 25, MEDFORD, MA 02155
(781) 391-5757 FAX (781) 391-8889

July 16, 2007

Ronald Miner, P.E.
Camp Dresser & McKee, Inc.
50 Hampshire Street
Cambridge, MA 02139

Subject: **Transects Survey in Marion, Mattapoisett and Wareham**
Plymouth and Bristol Counties (MA)
FEMA Contract No.
EME-2003-CO-340 (Task Order No. 18)

Dear Ron:

Enclosed please find the Transect survey report for the above referenced project. The transect survey was performed for three communities in Plymouth and Bristol Counties, Massachusetts for five (5) locations in Marion, seven (7) locations in Mattapoisett, and nine (9) locations in Wareham. Green International Affiliates, Inc. (Green) established x, y and z coordinates for these points using Global Position System (GPS) equipment (TPS Hiper GD integrated antenna/receiver) in conformance with FEMA Standards.

The GPS data was processed using the online positioning user services from the National Geodetic Survey (NGS) and the National Oceanic and Atmospheric Administration (NOAA) website. The horizontal coordinates (northing and easting) are referenced to the Universal Transverse Mercator (UTM) Zone 19 and to the North American Datum NAD 83 Coordinate System, Massachusetts, Mainland State Plane Coordinate (SPC 2001 MA-M) (U.S. English units in the NGS date reports).

Elevations are referenced to the North American Vertical Datum (NAVD 88) (U.S. English units).

Please refer to Appendix A for a summary of the survey shots for each transect.

Please feel free to contact me should you have any questions regarding this matter.

Sincerely,

Green International Affiliates, Inc.

Peter A. Richardson

Peter A. Richardson, P.E., CFM
Vice President

SMS/sase

Appendix A

Point #	SPC (NAD 83) 2001 MA-M State Coordinate System		Elevation (ft) NAVD 88	Description
	Northing (ft)	Easting (ft)		
Marion - MR7				
172	867211.935	2711751.967	31.35	MR-7/@CL.RD
173	867205.057	2711744.146	31.29	MR-7/@EDGE.RD
174	867203.846	2711742.552	31.18	MR-7/@GARD.RAILL
175	867201.781	2711740.824	30.53	MR-7/@GRASS
176	867196.171	2711734.786	29.18	MR-7/@GRASS
177	867189.884	2711729.221	28.48	MR-7/@GRASS
178	867186.035	2711725.882	26.35	MR-7/@GRASS
179	867184.966	2711724.789	25.55	MR-7/@TOPBANK
180	867163.687	2711706.098	10.02	MR-7/@ONSLOP
181	867160.545	2711703.271	9.89	MR-7/@T.STONE.WALL
182	867154.029	2711696.787	4.92	MR-7/@B.STONE.WALL
183	867145.608	2711688.399	3.40	MR-7/@BEACH
184	867136.875	2711678.727	2.17	MR-7/@BEACH
185	867126.817	2711668.358	0.45	MR-7/@BEACH
186	867125.323	2711666.120	0.06	MR-7/@BEACH
Marion - MR9				
159	865056.781	2713027.112	13.55	MR-9/@CL.RD
160	865060.216	2712992.898	13.17	MR-9/@GRASS
161	865062.817	2712947.126	11.44	MR-9/@GRASS
162	865064.718	2712924.162	10.11	MR-9/@GRASS
163	865065.353	2712920.701	9.61	MR-9/@EDGE.STONE.WALL
164	865065.638	2712918.613	10.11	MR-9/@T.STONE.WALL
165	865066.318	2712914.806	9.52	MR-9/@T.STONE.WALL
166	865067.338	2712909.330	7.32	MR-9/@T.STONE.WALL
167	865069.401	2712905.991	4.72	MR-9/@B.STONE.WALL
168	865071.854	2712890.866	3.46	MR-9/@BEACH
169	865074.603	2712879.031	3.37	MR-9/@BEACH
170	865077.176	2712866.425	2.33	MR-9/@BEACH
171	865078.827	2712857.132	1.16	MR-9/@BEACH
Marion - MR10				
146	862334.440	2716975.498	-0.67	MR-10/@BEACH
147	862334.615	2716975.490	-0.67	MR-10/@BEACH
148	862333.908	2716992.815	1.10	MR-10/@BEACH
149	862333.089	2716999.461	1.69	MR-10/@BEACH
150	862331.710	2717006.205	4.39	MR-10/@B.STONE.WALL
151	862330.987	2717009.278	5.47	MR-10/@B.STONE.WALL
152	862331.133	2717008.958	8.41	MR-10/@T.STONE.WALL
153	862331.280	2717007.232	8.32	MR-10/@T.STONE.WALL
154	862329.340	2717048.146	6.23	MR-10/@GRASS
155	862331.635	2717097.629	7.20	MR-10/@GRASS
156	862331.698	2717143.402	8.04	MR-10/@GRASS
157	862336.849	2717193.306	8.45	MR-10/@GRASS
158	862341.672	2717270.596	8.34	MR-10/@GRAVL.DR

Point #	SPC (NAD 83) 2001 MA-M State		Elevation (ft)	Description
	Northing (ft)	Easting (ft)	NAVD 88	
Marion - MR12				
133	859530.593	2715101.647	-0.04	MR-12/@BEACH
134	859519.616	2715120.534	1.46	MR-12/@BEACH
135	859508.936	2715139.713	3.09	MR-12/@BEACH
136	859504.707	2715146.732	3.70	MR-12/@GRASS
137	859497.813	2715158.165	5.15	MR-12/@T.STONE.STAP
138	859495.451	2715162.629	7.02	MR-12/@B.STONE.WALL
139	859493.868	2715164.432	8.21	MR-12/@B.STONE.WALL
140	859493.995	2715164.395	10.61	MR-12/@T.STONE.WALL
141	859494.989	2715162.694	10.52	MR-12/@T.STONE.WALL
142	859481.450	2715188.941	8.92	MR-12/@GRASS
143	859451.676	2715239.005	9.77	MR-12/@GRASS
144	859422.152	2715293.072	10.10	MR-12/@GRASS
145	859396.274	2715337.119	10.26	MR-12/@GRASS
Marion - MR14				
122	862431.675	2707498.186	6.89	MR-14/@CL.RD
123	862468.729	2707463.096	6.01	MR-14/@CL.RD
124	862488.873	2707441.217	6.09	MR-14/@EDGE.RD
125	862502.931	2707425.049	6.31	MR-14/@GRASS
126	862530.196	2707400.245	6.65	MR-14/@B.CONC.WALL
127	862532.142	2707397.895	5.47	MR-14/@B.CONC.WALL
128	862530.380	2707399.986	7.49	MR-14/@T.CONC.WALL
129	862531.897	2707398.275	7.43	MR-14/@T.CONC.WALL
130	862532.786	2707397.361	6.96	MR-14/@T.STONE.WALL
131	862546.654	2707386.527	0.77	MR-14/@B.STONE.WALL
132	862562.046	2707375.497	-1.07	MR-14/@BEACH

Point #	SPC (NAD 83) 2001 MA-M State		Elevation	Description
	Northing (ft)	Easting (ft)	(ft) NAVD	
Mattapoisett - MT2				
108	858707.493	2704937.755	5.68	MT-2/@CL.RD
109	858729.698	2704937.257	5.54	MT-2/@GRAVL.DR
110	858781.664	2704930.773	6.51	MT-2/@GRAVL.DR
111	858829.073	2704924.875	6.95	MT-2/@GRAVL.DR
112	858868.579	2704921.572	7.43	MT-2/@GRASS
113	858890.591	2704918.110	8.34	MT-2/@GRASS
114	858912.055	2704915.520	8.57	MT-2/@GRAVL.DR
115	858966.747	2704917.351	7.20	MT-2/@GRASS
116	858979.393	2704919.244	6.11	MT-2/@EDGE.CRASH.STONE
117	858982.132	2704919.954	6.69	MT-2/@.CRASH.STONE
118	858985.989	2704920.456	6.86	MT-2/@.CRASH.STONE
119	858989.676	2704919.969	7.51	MT-2/@T.STONE.WALL
120	858999.917	2704921.169	-0.05	MT-2/@B.STONE.WALL
121	859009.293	2704925.133	-0.99	MT-2/@BEACH
Mattapoisett - MT4				
96	858369.188	2701669.342	21.81	MT-4/@BIT.RD
97	858420.595	2701677.365	20.91	MT-4/@BIT.RD
98	858470.878	2701685.310	19.83	MT-4/@BIT.RD
99	858521.489	2701693.881	18.78	MT-4/@BIT.RD
100	858573.890	2701702.063	17.21	MT-4/@BIT.RD
101	858618.511	2701709.459	15.95	MT-4/@BIT.RD
102	858663.403	2701714.582	15.21	MT-4/@GRASS
103	858709.241	2701722.258	11.07	MT-4/@GRASS
104	858747.993	2701726.768	9.73	MT-4/@T.STONE.WALL
105	858758.297	2701729.771	7.38	MT-4/@.STONE.WALL
106	858769.420	2701730.372	2.54	MT-4/@B.STONE.WALL
107	858778.515	2701731.921	1.26	MT-4/@BEACH
Mattapoisett - MT5				
83	859351.322	2699325.973	1.38	MT-5/@STONE.BEACH
84	859321.062	2699343.763	1.97	MT-5/@STONE.BEACH
85	859298.165	2699358.837	2.38	MT-5/@STONE.BEACH
86	859289.299	2699364.510	3.19	MT-5/@B.STONE.WALL
87	859275.132	2699372.722	9.32	MT-5/@T.STONE.WALL
88	859270.011	2699375.630	9.43	MT-5/@T.STONE.WALL
89	859261.722	2699379.114	9.45	MT-5/@T.STONE.WALL
90	859257.032	2699381.010	8.87	MT-5/@T.STONE.WALL
91	859253.993	2699382.289	6.44	MT-5/@B.STONE.WALL
92	859247.227	2699388.143	6.27	MT-5/@GRASS
93	859222.012	2699406.330	6.54	MT-5/@GRASS
94	859184.128	2699425.338	6.10	MT-5/@GRASS
95	859179.063	2699427.066	6.27	MT-5/@FENCE.WOOD

Point #	SPC (NAD 83) 2001 MA-M State		Elevation	Description
	Northing (ft)	Easting (ft)	(ft) NAVD	
Mattapoisett - MT7				
72	857738.684	2697938.652	0.65	MT-7/@BECH
73	857716.586	2697949.656	3.15	MT-7/@B.STONE.WALL
74	857712.014	2697952.006	8.82	MT-7/@T.STONE.WALL
75	857707.869	2697956.090	9.14	MT-7/@T.STONE.WALL
76	857704.201	2697959.773	6.45	MT-7/@B.STONE.WALL
77	857683.311	2697969.786	7.11	MT-7/@GRASS
78	857651.685	2697981.594	8.42	MT-7/@GRASS
79	857627.063	2697993.490	8.77	MT-7/@FENCE.WOOD
80	857616.477	2697997.799	9.61	MT-7/@EDGE.RD
81	857599.816	2698007.059	10.02	MT-7/@EDGE.RD
82	857591.262	2698012.056	10.30	MT-7/@GRASS
Mattapoisett - MT12				
56	844663.677	2701324.740	9.91	MT-12/@CL.RD
57	844678.141	2701307.245	9.30	MT-12/@EDGE.RD
58	844682.796	2701300.702	9.61	MT-12/@B.STON.WALL
59	844684.014	2701298.155	9.12	MT-12/@B.STON.WALL
60	844683.620	2701299.193	12.15	MT-12/@T.STON.WALL
61	844700.879	2701278.295	7.35	MT-12/@GRASS
62	844729.167	2701254.954	5.41	MT-12/@GRASS
65	844749.830	2701194.898	4.55	MT-12/@GRASS
66	844767.057	2701149.655	4.37	MT-12/@GRASS
67	844779.822	2701123.117	4.52	MT-12/@GRASS
68	844796.430	2701098.775	5.16	MT-12/@FENCE
69	844798.066	2701096.559	5.53	MT-12/@BIT
70	844806.389	2701081.814	5.35	MT-12/@BIT
71	844814.267	2701069.177	4.73	MT-12/@T.STONE.WALL
XX	844814.267	2701069.177	-2.28	MT-12/@B.STONE.WALL

Point #	SPC (NAD 83) 2001 MA-M State		Elevation	Description
	Northing (ft)	Easting (ft)	(ft) NAVD	
Mattapoisett - MT13				
22	841150.683	2699035.401	-0.56	MT-13/@BECH
23	841136.402	2699033.756	1.07	MT-13/@BECH
24	841115.755	2699031.262	3.15	MT-13/@BECH
25	841084.764	2699028.060	5.98	MT-13/@BECH
26	841072.057	2699025.953	5.53	MT-13/@GS
27	841055.272	2699024.344	5.26	MT-13/@GS
28	841050.752	2699024.817	4.74	MT-13/@EDGE.RD
29	841034.856	2699024.045	4.59	MT-13/@EDGE.RD
30	841001.224	2699025.658	4.05	MT-13/@GRASS
31	840963.905	2699027.502	4.36	MT-13/@GRASS
32	840932.911	2699028.979	6.48	MT-13/@GRASS
33	840906.057	2699030.812	6.97	MT-13/@GRASS
34	840898.852	2699031.389	6.87	MT-13/@EDGE.RD
35	840876.650	2699033.057	6.71	MT-13/@EDGE.RD
36	840854.530	2699034.686	6.45	MT-13/@EDGE.RD
37	840836.492	2699036.091	5.98	MT-13/@EDGE.RD
38	840822.890	2699036.445	7.04	MT-13/@GRASS
39	840810.312	2699036.893	5.60	MT-13/@GRASS
40	840791.199	2699037.653	3.61	MT-13/@GRASS
41	840752.290	2699045.409	3.29	MT-13/@GRASS
42	840712.643	2699052.169	2.82	MT-13/@GRASS
43	840694.633	2699056.038	3.23	MT-13/@PLAY.GROUND
44	840660.050	2699064.308	3.26	MT-13/@PLAY.GROUND
45	840642.777	2699067.903	2.93	MT-13/@GRASS
46	840618.902	2699073.583	3.29	MT-13/@FENCE.WOOD
47	840613.542	2699075.010	3.71	MT-13/@EDGE.RD
48	840600.024	2699077.789	3.54	MT-13/@EDGE.RD
49	840583.763	2699080.875	2.90	MT-13/@PARKING
50	840549.709	2699088.024	2.61	MT-13/@PARKING
51	840513.472	2699097.477	2.28	MT-13/@PARKING
52	840490.237	2699103.055	2.32	MT-13/@GRASS
53	840478.093	2699105.510	2.03	MT-13/@BOTTOM
54	840461.962	2699113.247	6.85	MT-13/@TOP
55	840454.307	2699120.164	6.71	MT-13/@CL.PAD
Mattapoisett - MT17				
10	838898.005	2689329.952	15.00	MT-17/@CL.RD
11	838901.448	2689320.695	14.98	MT-17/@EDGE.RD
12	838902.829	2689317.187	15.35	MT-17/@CL.DR.WAY
13	838914.134	2689287.408	14.92	MT-17/@GRASS
14	838929.898	2689238.787	14.51	MT-17/@GRASS
15	838941.169	2689202.906	11.50	MT-17/@GRASS
16	838954.250	2689161.416	9.23	MT-17/@GRASS
17	838961.847	2689137.458	8.39	MT-17/@GRASS
18	838963.488	2689132.167	7.98	MT-17/@EDGE.CONC.PAD
19	838966.193	2689120.119	7.09	MT-17/@EDGE.CONC.PAD@T.WALL
20	838967.434	2689112.514	0.81	MT-17/@B.WALL
21	838972.967	2689098.796	-0.60	MT-17/@BEACH

Point #	SPC (NAD 83) 2001 MA-M State		Elevation	Description
	Northing (ft)	Easting (ft)	(ft) NAVD	
Wareham - WH2				
305	895368.155	2734390.150	6.22	WH-2/@EDGE.RD
306	895360.398	2734370.774	6.49	WH-2/@CL.RD
307	895336.401	2734322.604	7.92	WH-2/@CL.RD
308	895311.243	2734270.363	9.12	WH-2/@CL.RD
309	895286.536	2734219.968	9.27	WH-2/@CL.RD
310	895267.627	2734175.407	10.82	WH-2/@BOTTOM.BANK
311	895258.540	2734140.631	14.40	WH-2/@EDGE.RR
312	895256.734	2734137.517	14.58	WH-2/@CL.RR
313	895252.971	2734132.021	14.55	WH-2/@GS
314	895248.506	2734126.653	14.77	WH-2/@CL.RR
315	895246.417	2734123.100	14.86	WH-2/@TOP.BANK
316	895236.776	2734110.901	7.63	WH-2/@BOTTOM.BANK
317	895231.368	2734101.105	5.20	WH-2/@GS
318	895226.704	2734092.714	3.34	WH-2/@GS
319	895223.171	2734086.771	2.87	WH-2/@BEACH
320	895216.851	2734074.788	1.43	WH-2/@BEACH
321	895213.367	2734069.810	0.78	WH-2/@BEACH
322	895211.048	2734068.657	0.54	WH-2/@BEACH
323	895207.621	2734060.901	-0.27	WH-2/@BEACH
Wareham - WH3				
287	893745.211	2733397.865	24.50	WH-3/@CL.RD
288	893722.280	2733305.724	17.21	WH-3/@GRASS
289	893705.118	2733261.303	11.94	WH-3/@GRASS
290	893691.412	2733211.916	7.38	WH-3/@GRASS
291	893691.111	2733166.433	2.63	WH-3/@GRASS
292	893694.537	2733116.728	2.27	WH-3/@GRASS
293	893685.802	2733069.535	3.05	WH-3/@GRASS
294	893675.840	2733035.447	6.20	WH-3/@GRASS
295	893675.919	2733031.106	7.09	WH-3/@TOP.BANK
296	893672.973	2733023.222	9.85	WH-3/@TOP.BANK
297	893674.187	2733018.921	9.66	WH-3/@TOP.BANK
298	893674.272	2733012.074	7.19	WH-3/@BOTTOM.BANK
299	893674.101	2733000.739	4.49	WH-3/@BOTTOM.BANK
300	893674.063	2733002.623	5.87	WH-3/@TOP.BANK
301	893672.592	2732988.754	2.80	WH-3/@BEACH
302	893671.166	2732976.088	1.35	WH-3/@BEACH
303	893670.775	2732958.763	0.09	WH-3/@BEACH
304	893669.850	2732955.970	-0.08	WH-3/@BEACH

Point #	SPC (NAD 83) 2001 MA-M State		Elevation	Description
	Northing (ft)	Easting (ft)	(ft) NAVD	
Wareham - WH5				
274	891320.544	2730077.632	4.75	WH-5/@CL.RD
275	891323.488	2730024.714	4.32	WH-5/@GRAV.RD
276	891325.675	2729956.235	4.47	WH-5/@GRAV.RD
277	891326.035	2729904.033	4.97	WH-5/@GRAV.RD
278	891328.407	2729847.933	5.46	WH-5/@GRAV.RD
279	891326.619	2729801.535	5.04	WH-5/@GRAV.RD
280	891324.345	2729790.658	4.35	WH-5/@GRASS
282	891330.710	2729781.507	3.95	WH-5/@GRASS
283	891329.921	2729768.005	2.34	WH-5/@BEACH
284	891329.913	2729768.004	2.35	WH-5/@BEACH
285	891329.969	2729753.610	1.25	WH-5/@BEACH
286	891329.857	2729734.397	-0.27	WH-5/@BEACH
Wareham - WH10				
266	889399.834	2727130.699	10.25	WH-10/@TOP.BANK
267	889401.123	2727126.357	9.24	WH-10/@TOP.STON
268	889404.781	2727118.195	5.52	WH-10/@STON
269	889406.416	2727116.321	2.77	WH-10/@BOTTOM.STON
270	889413.544	2727106.430	1.42	WH-10/@BEACH
271	889418.208	2727100.569	0.59	WH-10/@BEACH
272	889425.896	2727091.620	-1.48	WH-10/@BEACH
273	889397.983	2727142.614	10.72	WH-10/@GRASS
Wareham - WH11				
244	887594.027	2727230.728	5.72	WH-11/@EDGE.RD
245	887597.041	2727220.020	5.72	WH-11/@EDGE.RD
246	887598.627	2727212.931	5.08	WH-11/@GRASS
247	887604.256	2727189.990	2.90	WH-11/@GRASS
248	887606.668	2727160.132	2.13	WH-11/@T.BROOK
249	887606.907	2727159.083	1.30	WH-11/@B.BROOK
250	887609.239	2727155.640	1.12	WH-11/@B.BROOK
251	887609.601	2727154.637	2.00	WH-11/@T.BROOK
252	887611.357	2727121.689	1.89	WH-11/@GRASS
253	887616.555	2727090.410	2.13	WH-11/@T.BROOK
254	887617.442	2727088.762	1.66	WH-11/@B.BROOK
255	887618.406	2727084.750	1.31	WH-11/@B.BROOK
256	887619.143	2727083.318	2.07	WH-11/@T.BROOK
257	887622.436	2727068.385	1.92	WH-11/@GRASS
258	887625.750	2727055.309	2.74	WH-11/@GRASS
259	887629.236	2727042.079	2.70	WH-11/@GRASS
260	887634.310	2727031.036	1.18	WH-11/@GRASS
261	887640.552	2727014.060	0.59	WH-11/@GRASS/WATER
262	887648.949	2727004.189	0.13	WH-11/@WATER
263	887650.714	2727001.483	-1.48	WH-11/@WATER
264	887673.210	2726961.209	-1.06	WH-11/@WATER
265	887678.413	2726950.569	-1.49	WH-11/@WATER

Point #	SPC (NAD 83) 2001 MA-M State		Elevation	Description
	Northing (ft)	Easting (ft)	(ft) NAVD	
Wareham - WH12				
235	884208.551	2723117.954	42.30	WH-12/@GRASS
236	884193.859	2723104.023	41.06	WH-12/@TOP.BANK
237	884172.680	2723078.659	12.63	WH-12/@TOPROCK
238	884171.493	2723074.447	9.29	WH-12/@BOTTOMROCK
239	884163.611	2723064.183	7.24	WH-12/@GS
240	884154.464	2723055.752	5.96	WH-12/@GS
241	884143.026	2723043.281	2.68	WH-12/@BEACH
242	884131.011	2723027.974	0.83	WH-12/@BEACH
243	884125.951	2723021.005	-0.09	WH-12/@BEACH
Wareham - WH16				
213	873490.673	2732923.791	7.23	WH-16/@RD
214	873471.250	2732912.528	7.20	WH-16/@RD
215	873461.520	2732906.038	7.22	WH-16/@EDGE.RD
216	873459.440	2732904.568	7.25	WH-16/@GRASS
217	873449.110	2732890.999	6.76	WH-16/@GRASS
218	873392.899	2732860.707	5.49	WH-16/@GRASS
219	873380.123	2732849.942	4.39	WH-16/@GRASS
220	873371.888	2732843.292	3.36	WH-16/@GRASS
221	873367.544	2732837.599	2.25	WH-16/@GRASS
222	873351.532	2732821.945	1.65	WH-16/@GRASS
223	873334.157	2732802.060	2.18	WH-16/@GRASS
224	873308.034	2732780.192	3.11	WH-16/@GRASS
225	873279.823	2732754.730	2.67	WH-16/@GRASS
226	873253.388	2732733.806	2.90	WH-16/@GRASS
227	873244.309	2732728.863	3.54	WH-16/@GRASS
228	873211.702	2732702.100	3.64	WH-16/@GRASS
229	873193.548	2732688.582	3.27	WH-16/@GRASS
230	873184.164	2732682.666	1.88	WH-16/@GRASS
231	873157.611	2732667.080	0.77	WH-16/@GRASS
232	873134.958	2732658.874	0.60	WH-16/@GRASS
233	873117.938	2732653.032	0.55	WH-16/@GRASS
234	873095.994	2732647.924	-0.12	WH-16/@WATER
Wareham - WH17				
197	870818.331	2731832.532	6.76	WH-17/@GRAV.DR
198	870830.693	2731794.530	9.71	WH-17/@GRAV.DR
199	870841.400	2731769.795	11.12	WH-17/@GRAV.DR
200	870855.417	2731742.197	12.65	WH-17/@GRASS
201	870857.145	2731739.374	13.07	WH-17/@GRASS
202	870861.003	2731731.960	12.86	WH-17/@GRASS
203	870862.210	2731729.832	13.04	WH-17/@TSTONE
204	870863.561	2731725.359	11.77	WH-17/@STONE
205	870865.915	2731718.514	9.73	WH-17/@STONE
206	870866.467	2731717.409	8.34	WH-17/@STONE
207	870867.117	2731716.115	8.00	WH-17/@STONE
208	870867.976	2731715.034	6.95	WH-17/@STONE
209	870868.402	2731714.524	1.01	WH-17/@BSTONE
210	870878.944	2731699.715	0.62	WH-17/@GRASS
211	870889.793	2731684.171	0.56	WH-17/@GRASS
212	870900.960	2731666.055	-0.06	WH-17/@GRASS

Point #	SPC (NAD 83) 2001 MA-M State		Elevation	Description
	Northing (ft)	Easting (ft)	(ft) NAVD	
Wareham - WH18				
187	869145.179	2730387.870	4.35	WH-18/@CL.CL
188	869160.398	2730339.238	4.60	WH-18/@CL.RD
189	869178.488	2730292.051	5.00	WH-18/@CL.RD
190	869195.511	2730246.777	5.31	WH-18/@CL.RD
191	869212.702	2730201.297	5.21	WH-18/@CL.RD
192	869223.841	2730172.373	4.49	WH-18/@TCONC.SLAB
193	869224.043	2730171.918	3.05	WH-18/@BCONC.SLAB
194	869232.144	2730149.429	2.62	WH-18/@BEACH
195	869240.027	2730125.558	0.30	WH-18/@BEACH
196	869242.004	2730118.553	-0.54	WH-18/@BEACH

DIGITAL FLOOD INSURANCE RATE MAP TASK FOR COASTAL ANALYSIS PLYMOUTH AND BRISTOL COUNTIES (MA)

FEMA CONTRACT NO. EME-2003-CO-0340 (TASK ORDER #18)
CDM SUBCONTRACT NO. 2809-999-002-CS (TASK ORDER #10)

TRANSECT SURVEY DATA REPORT

for

HULL/HINGHAM/WESTPORT/DARTMOUTH/FAIRHAVEN

PLYMOUTH AND BRISTOL COUNTIES, MA

Prepared for:

Camp Dresser & McKee, Inc.

July 31, 2007

Prepared By:

Green International Affiliates, Inc.

GREEN INTERNATIONAL AFFILIATES, INC.
407R MYSTIC AVENUE, UNIT 25, MEDFORD, MA 02155
(781) 391-5757 FAX (781) 391-8889

July 31, 2007

Ronald Miner, P.E.
Camp Dresser & McKee, Inc.
50 Hampshire Street
Cambridge, MA 02139

Subject: **Transects Survey in Hull, Hingham, Westport, Dartmouth, and Fairhaven Plymouth and Bristol Counties (MA) FEMA Contract No. EME-2003-CO-340 (Task Order No. 18)**

Dear Ron:

Enclosed please find the Transect survey report for the above referenced project. The transect survey was performed for five communities in Plymouth and Bristol Counties, Massachusetts for five (5) locations in Hull, two (2) locations in Hingham, four (4) locations in Westport, nine (9) locations in Dartmouth, and six (6) locations in Fairhaven. Green International Affiliates, Inc. (Green) established x, y and z coordinates for these points using Global Position System (GPS) equipment (TPS Hiper GD integrated antenna/receiver) in conformance with FEMA Standards.

The GPS data was processed using the online positioning user services from the National Geodetic Survey (NGS) and the National Oceanic and Atmospheric Administration (NOAA) website. The horizontal coordinates (northing and easting) are referenced to the Universal Transverse Mercator (UTM) Zone 19 and to the North American Datum NAD 83 Coordinate System, Massachusetts, Mainland State Plane Coordinate (SPC 2001 MA-M) (U.S. English units in the NGS date reports).

Elevations are referenced to the North American Vertical Datum (NAVD 88) (U.S. English units).

Please refer to Appendix A for a summary of the survey shots for each transect.

Please feel free to contact me should you have any questions regarding this matter.

Sincerely,

Green International Affiliates, Inc.

Peter A. Richardson

Peter A. Richardson, P.E., CFM
Vice President

SMS/sase

Appendix A

Point #	SPC (NAD 83) 2001 MA-M State Coordinate System		Elevation (ft) NAVD 88	Description
	Northing (ft)	Easting (ft)		
Hull - HL5				
324	2937572.036	816302.619	61.90	HL-5/@CLRD
325	2937586.279	816303.054	61.52	HL-5/@EDGERD
326	2937598.196	816302.766	60.22	HL-5/@TOPBANK
327	2937622.319	816294.668	45.65	HL-5/@SLOP
328	2937660.142	816288.909	26.68	HL-5/@SLOP
329	2937702.757	816284.506	12.66	HL-5/@BOTTOM
330	2937712.561	816282.566	10.91	HL-5/@EDGEROCK
331	2937736.511	816276.509	8.70	HL-5/@ROCK
332	2937771.180	816272.164	0.93	HL-5/@EDGEROCK
333	2937789.700	816272.124	-1.30	HL-5/@WATER
Hull - HL7				
334	2938372.028	822049.814	31.51	HL-7/@CLRD
335	2938384.167	822048.619	30.56	HL-7/@EDGERD
336	2938394.960	822041.986	29.81	HL-7/@GRASS
337	2938451.326	822037.800	25.13	HL-7/@GRASS
338	2938466.285	822035.420	23.77	HL-7/@TOPBANK
339	2938486.848	822031.361	16.13	HL-7/@BOTTOMBANK
340	2938494.454	822028.991	16.05	HL-7/@GS
341	2938502.993	822027.626	14.92	HL-7/@B.CONC.WALL
342	2938503.389	822027.582	17.76	HL-7/@T.CONC.WALL
343	2938507.865	822026.289	17.75	HL-7/@T.CONC.WALL
344	2938508.243	822025.402	10.53	HL-7/@B.CONC.WALL
345	2938513.516	822024.009	10.03	HL-7/@T.STONE.WALL
346	2938526.543	822022.027	2.44	HL-7/@B.STONE.WALL
347	2938565.910	822013.547	-0.62	HL-7/@BEACH.STONE
Hull - HL11				
348	2925659.833	829177.005	13.22	HL-11/@CL.RD
349	2925672.589	829191.980	13.00	HL-11/@EDGE.RD
350	2925672.594	829191.997	13.00	HL-11/@EDGE.RD
351	2925675.306	829195.604	13.50	HL-11/@BIT
352	2925682.175	829203.083	13.63	HL-11/@BC
353	2925682.281	829203.192	14.25	HL-11/@TC
354	2925686.765	829207.961	14.04	HL-11/@B.CONC.WALL
355	2925686.808	829208.278	15.39	HL-11/@T.CONC.WALL
356	2925688.879	829210.595	15.38	HL-11/@T.CONC.WALL
357	2925689.336	829210.893	9.10	HL-11/@B.CONC.WALL
358	2925693.899	829216.511	7.41	HL-11/@BEACH
359	2925708.250	829233.201	5.67	HL-11/@BEACH
360	2925729.426	829257.872	2.39	HL-11/@BEACH

Point #	SPC (NAD 83) 2001 MA-M State Coordinate System		Elevation (ft) NAVD 88	Description
	Northing (ft)	Easting (ft)		
Hull - HL13				
361	2923056.367	834756.855	14.37	HL-13/@CL.RD
362	2923070.513	834755.191	14.25	HL-13/@EDGE.RD
363	2923070.978	834755.332	14.09	HL-13/@T.CONC.WALL
364	2923072.370	834755.401	14.18	HL-13/@T.CONC.WALL
365	2923073.172	834755.578	8.62	HL-13/@B.CONC.WALL
366	2923076.683	834755.411	7.67	HL-13/@BEACH
367	2923110.657	834751.814	6.00	HL-13/@BEACH
368	2923122.261	834749.911	6.04	HL-13/@BEACH
369	2923122.016	834750.003	6.00	HL-13/@BEACH
370	2923147.860	834744.132	4.49	HL-13/@BEACH
Hull - HL14				
371	2922943.540	835718.306	6.37	HL-14/@CL.RD
372	2922956.380	835723.631	6.02	HL-14/@EDGE.RD
373	2922972.559	835729.861	6.58	HL-14/@GRAV
374	2923016.151	835745.379	7.57	HL-14/@GRAV
375	2923063.392	835762.063	8.56	HL-14/@GRAV
376	2923108.582	835776.879	9.22	HL-14/@GRAV
377	2923142.944	835788.130	9.20	HL-14/@GRAV
378	2923162.387	835794.698	9.19	HL-14/@B.CONC.WALL
379	2923163.383	835795.041	15.10	HL-14/@T.CONC.WALL
380	2923166.109	835796.366	15.26	HL-14/@T.CONC.WALL
381	2923166.976	835796.603	7.40	HL-14/@B.CONC.WALL
382	2923174.269	835799.502	6.36	HL-14/@STONE
383	2923183.046	835802.785	4.82	HL-14/@STONE
384	2923195.120	835806.399	1.21	HL-14/@TOP.STONE
385	2923196.900	835807.563	-3.55	HL-14/@BOTTOM.STONE

Point #	SPC (NAD 83) 2001 MA-M State Coordinate System		Elevation (ft) NAVD 88	Description
	Northing (ft)	Easting (ft)		
Hingham - HI7				
386	2920228.985	819709.668	10.35	HI-7@CL.RD
387	2920222.230	819716.603	9.95	HI-7@EDGE.RD
388	2920216.473	819724.189	9.65	HI-7@CL.BIT.SW
389	2920214.913	819726.021	9.35	HI-7@T.CONC.WALL
390	2920214.333	819726.613	9.33	HI-7@T.CONC.WALL
391	2920214.118	819726.656	4.02	HI-7@B.CONC.WALL
392	2920212.922	819728.425	3.91	HI-7@TOP.BANK
393	2920209.465	819732.910	3.09	HI-7@GS
394	2920206.046	819738.111	2.19	HI-7@GS
395	2920202.096	819742.875	0.59	HI-7@GS
396	2920197.462	819747.956	-0.79	HI-7@EDGE.GRASS
397	2920192.075	819754.411	-2.19	HI-7@BEACH
398	2920180.302	819769.914	-3.76	HI-7@BEACH
Hingham - HI9				
399	2920918.938	817916.107	43.85	HI-9@CL.BIT.DR
400	2920923.393	817919.564	43.75	HI-9@GRASS
401	2920931.553	817924.090	41.83	HI-9@GRASS
402	2920939.391	817929.026	39.42	HI-9@GRASS
403	2920945.923	817932.505	36.71	HI-9@GRASS
404	2920961.974	817942.707	33.08	HI-9@GRASS
405	2921018.693	817983.559	9.71	HI-9@BOTTOM.BANK
406	2921022.056	817985.458	9.25	HI-9@EDGE.TOP.WALL.STONE
407	2921026.366	817986.921	9.04	HI-9@TOP.WALL.STONE
408	2921034.397	817990.666	4.52	HI-9@BOTTOM.WALL.STONE
409	2921037.865	817993.029	3.86	HI-9@EDGE.GRASS
410	2921061.486	818004.414	0.70	HI-9@EDGE.GRASS
411	2921069.432	818007.361	-0.25	HI-9@BEACH
412	2921089.361	818014.389	-2.03	HI-9@BEACH
413	2921105.590	818021.894	-3.65	HI-9@BEACH
414	2920989.363	817963.113	29.19	HI-9@TOP.BANK

Point #	SPC (NAD 83) 2001 MA-M State Coordinate System		Elevation (ft) NAVD 88	Description
	Northing (ft)	Easting (ft)		
Westport - WP1				
509	2644826.233	786779.091	7.16	WP-1/CL.RD
510	2644814.777	786783.400	7.07	WP-1/EDGE.RD
511	2644795.157	786790.944	7.53	WP-1/GRAV.
512	2644792.126	786791.828	7.93	WP-1/GRAV.
513	2644788.699	786792.979	7.05	WP-1/GRAV.
514	2644776.646	786797.217	6.10	WP-1/GRAV.
515	2644767.141	786800.896	5.07	WP-1/GRAV.
516	2644760.986	786803.265	5.37	WP-1/GRAV.
517	2644755.911	786805.031	5.32	WP-1/GRAV.
518	2644749.305	786807.341	4.03	WP-1/GRAV.
519	2644744.279	786808.811	3.60	WP-1/GRAV.
520	2644736.453	786811.489	2.64	WP-1/GRAV.
521	2644728.988	786813.839	1.61	WP-1/GRAV.
522	2644722.690	786816.124	0.84	WP-1/BEACH
523	2644705.664	786822.104	-0.89	WP-1/BEACH
524	2644700.397	786823.876	-1.35	WP-1/BEACH
Westport - WP2				
525	2643784.840	784403.213	5.10	WP-2/@CL.RD
526	2643774.991	784407.997	4.99	WP-2/@EDGE.RD.MAG/R-1
527	2643767.813	784411.798	5.66	WP-2/@GRAV
528	2643745.307	784425.552	6.26	WP-2/@GRAV
529	2643735.842	784430.836	7.01	WP-2/@GRAV
530	2643722.339	784438.485	6.67	WP-2/@GRAV
531	2643711.264	784444.513	5.88	WP-2/@GRAV
532	2643702.315	784448.494	4.85	WP-2/@GRAV
533	2643687.452	784456.575	3.67	WP-2/@BEACH
534	2643673.181	784463.377	2.53	WP-2/@BEACH
535	2643651.142	784473.693	0.52	WP-2/@BEACH
536	2643638.206	784479.576	-0.82	WP-2/@BEACH
537	2643631.223	784482.533	-1.69	WP-2/@BEACH
Westport - WP3				
538	2642284.042	782756.833	6.66	WP-3/@CL.RD
539	2642281.591	782769.299	6.74	WP-3/@EDGE.RD
540	2642260.426	782805.341	8.27	WP-3/@GRASS
541	2642256.056	782811.818	8.08	WP-3/@GRASS
542	2642255.174	782814.144	7.61	WP-3/@GRAV.
543	2642253.881	782817.205	6.60	WP-3/@GRAV.
544	2642249.971	782824.226	5.67	WP-3/@GRAV.
545	2642245.668	782831.236	5.43	WP-3/@GRAV.
546	2642239.611	782840.562	4.33	WP-3/@BEACH
547	2642233.815	782848.509	3.41	WP-3/@BEACH
548	2642230.995	782852.376	3.31	WP-3/@BEACH
549	2642225.517	782860.238	2.11	WP-3/@BEACH
550	2642211.903	782879.613	-0.98	WP-3/@BEACH
551	2642208.807	782884.127	-1.85	WP-3/@BEACH

Point #	SPC (NAD 83) 2001 MA-M State Coordinate System		Elevation (ft) NAVD 88	Description
	Northing (ft)	Easting (ft)		
Westport - WP15				
552	2642018.380	761200.691	21.44	WP-15/@CL.RD
553	2641981.488	761208.644	20.69	WP-15/@CL.RD.EDGE.
554	2641973.401	761209.795	21.07	WP-15/@GRASS
555	2641920.650	761219.188	20.10	WP-15/@GRASS
556	2641894.257	761223.383	19.43	WP-15/@GRASS
557	2641872.400	761224.246	19.80	WP-15/@GRASS
558	2641869.786	761224.772	19.77	WP-15/@TOP.STONE
559	2641852.484	761224.307	12.05	WP-15/@STONE
560	2641838.507	761222.442	2.49	WP-15/@BOTTOM.STONE
561	2641818.457	761219.283	-0.37	WP-15/@STONE.BEACH
562	2641771.591	761215.445	-0.95	WP-15/@STONE.BEACH
563	2641734.655	761206.838	-1.86	WP-15/@STONE.BEACH

Point #	SPC (NAD 83) 2001 MA-M State Coordinate System		Elevation (ft) NAVD 88	Description
	Northing (ft)	Easting (ft)		
Dartmouth - DM10				
484	2658163.065	810406.957	8.59	DM-10/@GRASS
485	2658153.212	810408.949	7.18	DM-10/@GRASS
486	2658146.495	810409.805	6.33	DM-10/@BEACH
487	2658124.640	810413.125	4.58	DM-10/@BEACH
488	2658120.095	810413.661	3.21	DM-10/@BEACH
489	2658112.790	810414.837	2.63	DM-10/@BEACH.T.S.STONE
490	2658100.437	810416.546	0.18	DM-10/@BEACH.T.S.STONE
491	2658082.682	810418.028	-1.07	DM-10/@BEACH.T.S.STONE
Dartmouth - DM11				
475	2657342.723	807925.264	6.89	DM-11/@GRASS.TOP
476	2657340.816	807927.030	4.91	DM-11/@BOTTOM.
477	2657331.881	807934.830	3.94	DM-11/@BEACH
478	2657324.304	807940.145	3.20	DM-11/@BEACH
479	2657308.796	807954.590	3.08	DM-11/@BEACH
480	2657295.766	807967.926	3.27	DM-11/@BEACH
481	2657289.682	807974.646	3.11	DM-11/@BEACH
482	2657280.890	807986.949	1.52	DM-11/@BEACH
483	2657272.404	807997.532	-0.12	DM-11/@BEACH
Dartmouth - DM12				
464	2655143.710	807344.010	12.99	DM-12/@EDGE.RD
465	2655120.027	807370.299	11.03	DM-12/@GRASS
466	2655094.867	807399.485	9.72	DM-12/@GRASS
467	2655084.783	807411.367	9.67	DM-12/@GRASS
468	2655083.379	807413.379	9.29	DM-12/@B.STONE
469	2655080.696	807416.492	10.62	DM-12/@.STONE
470	2655077.663	807419.120	10.27	DM-12/@T.STONE
471	2655071.197	807425.536	2.79	DM-12/@B.STONE
472	2655063.337	807432.100	1.56	DM-12/@STONE
473	2655053.427	807443.986	-0.05	DM-12/@STONE
474	2655041.799	807455.028	-1.51	DM-12/@STONE.WATER
Dartmouth - DM13				
456	2654114.217	806696.498	6.86	DM-13/@GS.GRAV
457	2654093.975	806707.059	7.16	DM-13/@GS.GRAV
458	2654077.973	806710.519	4.83	DM-13/@BEACH
459	2654061.123	806714.003	3.99	DM-13/@BEACH
460	2654045.382	806716.395	1.85	DM-13/@BEACH
461	2654031.179	806719.124	0.04	DM-13/@BEACH
462	2654020.613	806721.463	-1.10	DM-13/@BEACH
463	2654018.248	806722.117	-1.48	DM-13/@WATER
Dartmouth - DM14				
450	2648623.033	805756.111	23.24	DM-14/@GS
451	2648612.327	805755.518	22.81	DM-14/@GS
452	2648606.966	805755.750	21.96	DM-14/@T.STONE
453	2648591.132	805753.958	13.61	DM-14/@STONE
454	2648580.135	805754.417	5.00	DM-14/@STONE
455	2648574.190	805753.541	-0.95	DM-14/@BOTTOM.STONE

Point #	SPC (NAD 83) 2001 MA-M State Coordinate System		Elevation (ft) NAVD 88	Description
	Northing (ft)	Easting (ft)		
Dartmouth - DM16				
439	2655591.065	800823.987	5.91	DM-16/@EDGE.RD
440	2655584.647	800832.826	5.90	DM-16/@EDGE.RD
441	2655583.039	800835.385	5.91	DM-16/@EDGE.ROCK.BOTTOM
442	2655581.115	800837.525	7.74	DM-16/@TOP.ROCK
443	2655580.249	800838.936	7.90	DM-16/@TOP.ROCK
444	2655576.561	800844.620	5.28	DM-16/@.ROCK
445	2655571.851	800850.606	3.48	DM-16/@.ROCK
446	2655568.030	800853.581	0.50	DM-16/@BOTTOM.EDGE.ROCK
447	2655565.253	800856.986	0.63	DM-16/@GRASS
448	2655556.890	800863.744	-0.88	DM-16/@GRASS
449	2655547.103	800874.529	-1.97	DM-16/@WATER
Dartmouth - DM18				
416	2652197.349	797999.178	8.02	DM-18/@T.BANK
417	2652190.514	798009.611	5.48	DM-18/@B.BANK
418	2652188.840	798013.313	5.64	DM-18/@B.BANK
419	2652186.772	798016.787	7.34	DM-18/@T.GRAV
420	2652182.506	798023.244	7.86	DM-18/@T.GRAV
421	2652178.929	798028.687	5.17	DM-18/@B.GRAV
422	2652171.089	798041.678	3.49	DM-18/@B.GRAV.BEACH
423	2652168.240	798046.802	3.62	DM-18/@B.GRAV.BEACH
424	2652161.073	798060.717	1.69	DM-18/@B.GRAV.BEACH
425	2652156.457	798069.694	0.67	DM-18/@B.GRAV.BEACH
426	2652151.315	798078.716	-0.68	DM-18/@B.GRAV.BEACH
427	2652131.552	798112.021	-1.60	DM-18/@B.GRAV.BEACH
Dartmouth - DM19				
428	2649788.454	797778.380	-1.57	DM-19/@GRAV.BEACH
429	2649799.505	797758.109	-0.46	DM-19/@GRAV.BEACH
430	2649802.444	797751.230	0.59	DM-19/@GRAV.BEACH
431	2649807.563	797740.249	1.87	DM-19/@GRAV.BEACH
432	2649811.135	797730.888	2.48	DM-19/@GRAV.BEACH
433	2649812.702	797726.225	3.55	DM-19/@GRAV.BEACH
434	2649814.167	797720.398	3.80	DM-19/@GRAV.BEACH
435	2649815.336	797715.913	4.73	DM-19/@GRAV.BEACH
436	2649817.609	797709.209	4.86	DM-19/@GRAV.BEACH
437	2649821.018	797698.775	7.33	DM-19/@GRAV.TOP
438	2649828.148	797672.872	7.32	DM-19/@GRAV
Dartmouth - DM21				
492	2647310.515	789095.431	3.53	DM-21/@GRAV.DR
493	2647266.723	789107.171	5.80	DM-21/@GRAV.DR
494	2647218.332	789110.993	7.24	DM-21/@GRAV.DR
495	2647171.185	789111.098	8.00	DM-21/@GRAV.DR
496	2647136.922	789113.250	8.27	DM-21/@GRAV.DR
497	2647121.421	789114.931	7.49	DM-21/@GRAV.GS
498	2647107.922	789114.771	8.00	DM-21/@GRAV.GS
499	2647097.965	789115.610	7.63	DM-21/@GRAV.GS
500	2647083.020	789117.706	5.69	DM-21/@GRAV.GS
501	2647074.692	789118.959	5.17	DM-21/@GRAV.GS
502	2647066.049	789120.961	5.65	DM-21/@GRAV.GS
503	2647056.628	789122.835	3.89	DM-21/@GRAV.GS
504	2647049.604	789124.150	2.72	DM-21/@BEACH
505	2647039.582	789126.268	2.13	DM-21/@BEACH
506	2647032.185	789128.229	1.67	DM-21/@BEACH
507	2647006.851	789133.784	-0.85	DM-21/@BEACH
508	2647001.150	789135.461	-1.33	DM-21/@BEACH

Point #	SPC (NAD 83) 2001 MA-M State Coordinate System		Elevation (ft) NAVD 88	Description
	Northing (ft)	Easting (ft)		
Fairhaven - FH6				
564	2678788.990	837225.462	4.07	FH-6/@EDGE.RD
565	2678778.453	837215.819	4.43	FH-6/@CL.RD
566	2678767.728	837208.204	4.25	FH-6/@EDGE.RD
567	2678767.144	837207.861	4.59	FH-6/@TC
568	2678762.959	837204.705	4.74	FH-6/@BSW
569	2678762.429	837204.435	5.14	FH-6/@TC
570	2678761.834	837204.098	4.81	FH-6/@GS@MARSH
571	2678740.412	837188.597	3.95	FH-6/@GS@MARSH
572	2678715.367	837172.669	3.91	FH-6/@GS@MARSH
573	2678691.067	837153.668	5.01	FH-6/@GS
574	2678667.933	837135.008	6.00	FH-6/@GS
575	2678645.788	837114.363	5.29	FH-6/@GS
576	2678639.643	837110.707	5.57	FH-6/@GS
577	2678632.300	837105.702	4.74	FH-6/@GS
578	2678628.753	837102.979	4.18	FH-6/@GS
579	2678623.187	837098.204	2.79	FH-6/@BEACH
580	2678613.700	837090.133	2.16	FH-6/@BEACH
581	2678603.433	837081.013	1.37	FH-6/@BEACH
582	2678593.468	837072.090	-0.22	FH-6/@BEACH
583	2678584.544	837063.608	-1.02	FH-6/@BEACH
Fairhaven - FH7				
584	2676544.603	838417.016	10.85	FH-7/@CL.RD
585	2676537.812	838405.336	10.13	FH-7/@EDGE.RD
586	2676535.071	838400.655	9.84	FH-7/@GRAV.RD
587	2676510.209	838358.138	8.22	FH-7/@GRAV.RD
588	2676488.413	838317.920	7.12	FH-7/@GRAV.RD
589	2676466.832	838276.724	6.08	FH-7/@GRAV.RD
590	2676443.232	838236.737	5.82	FH-7/@GRAV.RD
591	2676437.457	838226.364	5.64	FH-7/@GRAV.RD
592	2676430.375	838213.997	6.29	FH-7/@BEACH
593	2676426.294	838205.988	4.34	FH-7/@BEACH
594	2676420.098	838194.749	3.27	FH-7/@BEACH
595	2676413.377	838182.922	1.14	FH-7/@BEACH
596	2676404.200	838165.878	-0.55	FH-7/@BEACH
597	2676393.776	838147.751	-1.57	FH-7/@BEACH
Fairhaven - FH8				
598	2674572.261	841569.064	3.35	FH-8/@BEACH
599	2674574.719	841584.289	4.36	FH-8/@GRASS
600	2674578.559	841607.789	4.40	FH-8/@GRASS
601	2674580.180	841627.856	5.05	FH-8/@GRASS
602	2674580.558	841637.214	4.34	FH-8/@BEACH
603	2674579.328	841664.406	2.99	FH-8/@BEACH
604	2674578.721	841673.925	2.24	FH-8/@BEACH
605	2674578.166	841679.464	1.62	FH-8/@BEACH
606	2674577.060	841696.272	-0.46	FH-8/@BEACH
607	2674576.079	841705.679	-1.73	FH-8/@WATER

Point #	SPC (NAD 83) 2001 MA-M State Coordinate System		Elevation (ft) NAVD 88	Description
	Northing (ft)	Easting (ft)		
Fairhaven - FH9				
608	2676076.913	833203.245	3.31	FH-9/@EDGE.RD
609	2676072.952	833216.492	3.30	FH-9/@EDGE.RD
610	2676069.109	833224.363	3.82	FH-9/@GS
611	2676061.380	833239.529	4.23	FH-9/@GS
612	2676047.083	833267.489	4.87	FH-9/@GS
613	2676033.957	833293.044	4.43	FH-9/@GS
614	2676023.054	833312.325	4.30	FH-9/@B.CONCE.WALL
615	2676022.218	833313.515	3.16	FH-9/@B.CONCE.WALL
616	2676021.769	833314.661	2.10	FH-9/@B.CONCE.WALL
617	2676022.978	833312.372	5.57	FH-9/@T.CONCE.WALL
618	2676022.321	833313.494	5.55	FH-9/@T.CONCE.WALL
619	2676021.824	833314.465	3.15	FH-9/@T.CONCE.WALL
620	2676019.405	833318.623	1.42	FH-9/@BEACH
621	2676011.626	833330.573	0.17	FH-9/@BEACH
622	2675998.893	833348.457	-1.84	FH-9/@WATER
Fairhaven - FH10				
623	2673369.768	832823.903	-0.83	FH-10/@WATER
624	2673394.697	832833.691	-0.33	FH-10/@WATER.STONE.BEACH
625	2673417.726	832841.122	0.45	FH-10/@WATER.STONE.BEACH
626	2673434.502	832841.902	1.03	FH-10/@BOTTOM.STONE
627	2673450.032	832844.359	7.23	FH-10/@TOP.STONE@CONCF
628	2673454.320	832845.498	7.21	FH-10/@EDGE.CONCE
629	2673457.163	832846.048	7.07	FH-10/@ROCK
630	2673461.053	832847.041	6.52	FH-10/@EDGE.ROCK
631	2673484.816	832849.756	6.54	FH-10/@GRASS
632	2673513.620	832849.989	6.38	FH-10/@GRASS
633	2673532.678	832849.419	6.73	FH-10/@GRASS
634	2673551.001	832848.611	6.94	FH-10/@EDGE.RD
Fairhaven - FH11				
635	2676392.933	831585.173	6.10	FH-11/@GS
636	2676385.629	831553.534	5.87	FH-11/@GS
637	2676385.567	831552.107	5.90	FH-11/@CONC
638	2676382.181	831539.802	5.66	FH-11/@CONC
639	2676379.513	831530.046	4.80	FH-11/@CONC
640	2676375.130	831513.389	2.38	FH-11/@CONC
641	2676374.563	831509.469	1.54	FH-11/@CONC
642	2676373.782	831504.466	-0.11	FH-11/@CONC
643	2676372.224	831497.088	-1.79	FH-11/@WATER

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