

# **NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT**

## ***PROJECT MA0401C***

### ***Massachusetts Bay, Nahant Bay to Ipswich Bay, Massachusetts***

#### **Introduction**

Coastal Mapping Program (CMP) Project MA0401C provides a highly accurate database of new digital shoreline data of Massachusetts Bay from Nahant Bay in the south to Ipswich Bay in the north. Project MA0401C is a sub-project of a larger project, MA0401, which includes areas of Massachusetts and Ipswich Bays from Green Harbor River to Castle Neck on Cape Ann.

Successful completion of this project resulted in a densification of the National Spatial Reference System (NSRS), a set of controlled metric-quality aerial photographs, and digital cartographic data of the coastal zone which compliments the Nautical Charting Program (NCP) as well as geographic information systems (GIS) for a variety of coastal zone management applications.

The project database consists of information measured and extracted from aerial photographs and metadata related to photogrammetric compilation. Base mapping was conducted in a digital environment using stereo softcopy photogrammetry and associated cartographic practices.

#### **Project Design**

The design of project MA0401 was based on a comparison of image analysis to cartographic detail depicted on the pertinent NOAA nautical charts of the project site. The Remote Sensing Division (RSD) of the National Geodetic Survey (NGS), NOAA, formulated the MA0401 Project Instructions dated June 9, 2004 which contain the specific field and photo mission operational guidelines. The instructions, as provided to NOVA Digital Systems, Inc., discussed the project's purpose, geographic area of coverage, scope and priority; photographic and ground control requirements; flight line priority; tide and sun angle coordination; Global Positioning Systems (GPS) data collection procedures and guidelines for both kinematic and static surveys; data recording and handling instructions; and contact communication information.

RSD created a Project Layout Diagram and flight maps. NOVA created the input files for the aircraft's flight management system and provided copies of the descriptions of potential geodetic control stations at the bases of operation.

## **Field Operations**

The field operations consisted of the collection of static and kinematic GPS data and the acquisition of aerial photographs. Sanborn, a sub consultant of NOVA, conducted the photographic mission operation on May 05, 2005 and June 23, 2005 utilizing their Cessna T206 aircraft and a Wild RC-30 camera. Natural color photographs and black and white infrared (B&W IR) photographs were acquired at a nominal scale of 1:30,000 using airborne GPS.

Ground base stations “MY0497” and “NEW POINT” were established for differential correction of the real time kinematic data. Prior to the collection of photography, sixteen GPS ground control points were set up and paneled for photo identification. Twelve of these points were used to supplement the Airborne GPS controlled imagery and four were check points not used in the aerotriangulation adjustment. Additional information concerning the Field operations and results can be found in the Ground Control Report, the Aerotriangulation Report, and the Final Photo Mission Report.

## **GPS Data Reduction**

Global Positioning System (GPS) data was collected and processed to provide precise positions of camera centers for application as photogrammetric control in the aerotriangulation phase of project completion. Both the static GPS dataset acquired from reference stations and the kinematic ABGPS dataset were executed in compliance with the Shoreline Mapping SOW, version 12. The static GPS data from the WMTS CORS station was processed using Trimble® Office Geomatics software. The kinematic ABGPS dataset was processed by Sanborn using GrafNav V.7.50 software. Precise satellite ephemerides and standard meteorological data were applied during the data reduction process. GPS data reduction was completed by NOVA Digital Systems, Inc. Please refer to the Airborne Positioning and Orientation Report for additional information.

## **Aerotriangulation**

All photographs of the project were bridged using a softcopy stereo photogrammetric system in a Windows XP environment in order to establish the network of control required for the compilation phase. A multi-block AT strategy was implemented based on emulsion/data type (Color, MHW IR, and MLLW IR) and completed in September 2005. The B&W IR MLLW photography measurements were made using the aerotriangulation module within Z/I Imaging software, version 2.0.2.16. The B&W IR MHW and Natural Color photography measurements were made using the Multi-Sensor Triangulation module within BAE’s Socet Set software, version 4.4.0. After the final analytical adjustment was performed, the RMS of the standard deviations for each triangulated ground point was computed using the ISDM and Multi-Sensor Triangulation (MST) modules. These values were then used to compute a predicted horizontal circular error of 0.5 meters based upon a 95% confidence level. See the Aerotriangulation report for more information.

The project database consists of information measured and extracted from aerial photographs and metadata related to photogrammetric compilation. Base mapping was

conducted in a digital environment using stereo softcopy photogrammetry and associated cartographic practices. Project survey data is referenced to the North American Datum of 1983 (NAD 83).

## Compilation

The compilation phase of the project was completed by NOVA Digital Systems, Inc. in July 2006. Digital mapping was accomplished using a Digital Photogrammetric Workstation (DPW) in conjunction with the Feature Extraction software module within BAE's Socet Set software, version 4.4.0. Feature identification was based on information extracted from the appropriate NOAA Nautical Charts and image analysis of 1:30,000 scale natural color and tide coordinated B&W Infrared photographs. Cartographic feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST) as required.

Spatial data accuracies for Project MA0401 were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 1.0 meters at the 95% confidence level. This predicted accuracy of compiled, well defined points is derived by doubling the circular error derived from the statistical results of the aerotriangulation adjustment.

The following table provides information on all aerial photographs used for Project MA0401. It should be noted that the actual frames used to compile feature data for subproject MA0401A represent a subset of the photography acquired for the larger project area.

**Table1: Compilation Sources**

Date	Time (UTC)	Roll Number	Photo Numbers	Film Type	Scale (nominal)	Tide Level* (meters)
6-23-05	1438-1510	0526CN01	0001-0043	NC	1:30,000	2.3
6-23-05	1515-1529	0526CN01	0044-0060	NC	1:30,000	2.6
6-23-05	1535-1647	0526CN01	0061-0126	NC	1:30,000	2.9
5-5-05	1242-1433	0526R01	0001-0107	IR	1:30,000	3.0
5-5-05	1839-2036	0526R01	0108-0234	IR	1:30,000	0.1
6-23-05	1659-1728	0526R02	0157-0181	IR	1:30,000	3.0

\*NOTE: The tidal levels for the above photographs are referenced to the MLLW datum. The verified observation heights above the MLLW datum were recorded at the Boston Tide Station at the time of photography.

## Quality Control / Final Review

Quality control operations of all the project phases were conducted by NOVA personnel. After completion of the compilation phase, the process included review of the identification and attribution of cartographic features based on image analysis and criteria defined in C-COAST. The quality control process concluded with an inspection of topological connectivity within the GC using ArcGIS software. All project data was evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with natural color photographs and compiled data resulted in creation of the Chart Evaluation File (CEF). The following NOAA nautical charts and their insets were used for chart comparison:

- 13274 Portsmouth Harbor to Boston Harbor, 1:40,000, 26th Ed., Apr 2005
- 13275 Salem and Lynn Harbors, 1:25,000, 29th Ed., Oct. 2004  
Manchester Harbor inset, 1:10,000
- 13276 Salem, Marblehead and Beverly Harbors, 1:10,000, 22nd Ed., Jul. 2003
- 13279 Ipswich Bay to Gloucester Harbor, 1:20,000, 31st Ed., Aug. 2004  
Rockport Harbor inset, 1:5,000
- 13281 Gloucester Harbor and Annisquam River, 1:10,000, 17th Ed., May 2000
- 13282 Newburyport Harbor and Plum Island Sound, 1:20,000, 11th Ed., Apr 2003

## **End Products and Deliverables**

The following specifies the location and identification of the products generated during the completion of this project:

### **RSD Applications Branch Archive**

- Hardcopy of the Aerotriangulation Report
- Hardcopy of the Project Completion Report (PCR)
- Page-size graphic plot of GC10606 file contents, attached to PCR

### **Remote Sensing Division Electronic Data Library**

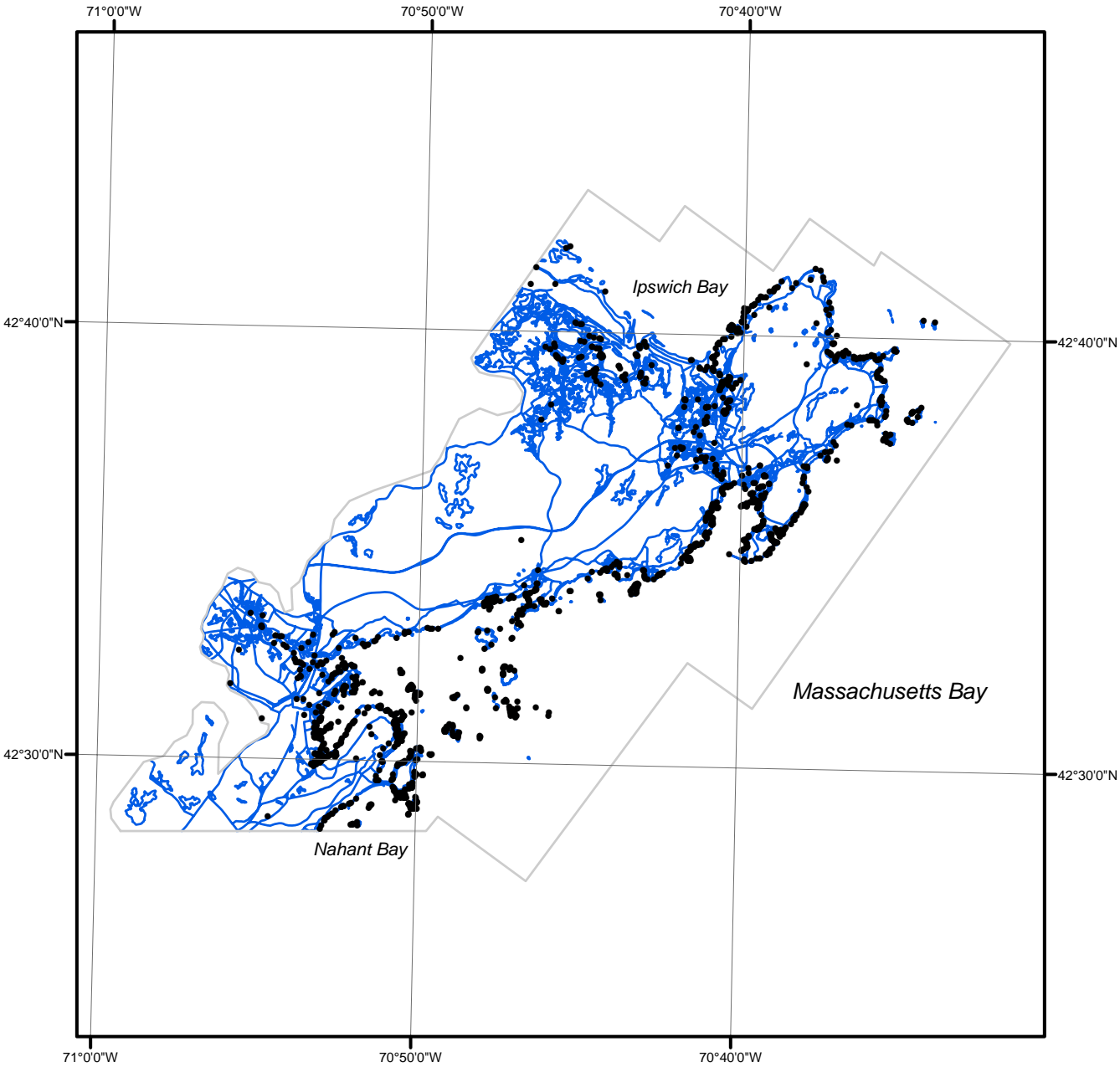
- Project database
- GC10606 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- CEF in shapefile format

### **NOAA Shoreline Data Explorer**

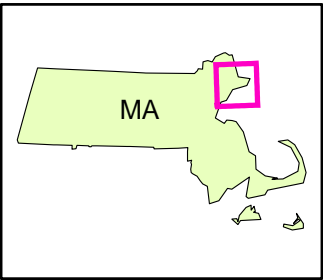
- GC10606 in shapefile format
- Metadata file for GC10606
- Digital copy of the PCR in Adobe PDF format

## **End of report**

MASSACHUSETTS BAY, NAHANT BAY TO IPSWICH BAY,  
MASSACHUSETTS



Overview



MA0401C

GC10606