

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

## ***PROJECT MA0902***

### ***Merrimack River and Plum Island Sound, Massachusetts***

#### **Introduction**

NOAA Coastal Mapping Program (CMP) Project MA0902 provides a highly accurate database of new digital shoreline data for a portion of the coastline along Plum Island and includes Plum Island Sound as well as the Merrimack River from Plum Island to Haverhill, Massachusetts. The Geographic Cell (GC) may be used in support of the NOAA Nautical Charting Program (NCP) as well as geographic information systems (GIS) for a variety of coastal zone management applications.

#### **Project Design**

The Requirements Branch (RB) of the Remote Sensing Division (RSD) formulated the photographic mission instructions for this project following the guidelines of the Photo Mission Standard Operating Procedures. The instructions discussed the project's purpose, geographic area of coverage, scope and priority, image requirements, Global Positioning System (GPS) data collection procedures and guidelines, instructions for data recording and handling, and mission communication protocols. RB created a Project Layout Diagram, flight maps and input files for the aircraft flight management system.

#### **Field Operations**

The field operations consisted of the collection of static and kinematic GPS data and Inertial Measurement Unit (IMU) data, and the acquisition of digital aerial imagery. Aerial survey operations were conducted on June 19, 2011 with the NOAA King Air aircraft (N68RF). Project imagery included nine flight lines of natural color imagery acquired at the Mean Lower Low Water (MLLW) tide stage, nine flight lines of natural color imagery acquired at the Mean High Water (MHW) tide stage, nine flight lines of near-infrared (NIR) imagery acquired at the MLLW tide stage and nine flight lines of near-infrared (NIR) imagery acquired at the MHW tide stage. All imagery was collected using an Applanix DSS-439 Dual Cam camera system at a nominal altitude of 10,000 feet resulting in an approximate ground sample distance (GSD) of 0.35 meters.

#### **Direct Georeferencing Data Processing**

GPS/IMU data were processed by RSD personnel to yield precise camera positions and orientations for direct georeferencing (DG) of the imagery. A local GPS base station was established for use as a reference station for kinematic GPS processing operations. The position of the base station was determined using the NGS Online Processing User Service (OPUS), which computed fixed baseline solutions from nearby CORS stations. The airborne kinematic data was processed using Applanix POSPAC (ver. 5.4) software in December 2012. For further information refer to the Airborne Positioning and Orientation Reports (APOR) on file with other project data within the RSD Applications Branch (AB) Project Archive.

The processed GPS/IMU data were used to derive precise exterior orientation (EO) values of the camera centers required for digital feature extraction. The predicted horizontal accuracy of the imagery was determined by propagating sensor EO and image measurement uncertainties through the photogrammetric collinearity equations using an Excel spreadsheet based Exterior Orientation Total Propagated Uncertainty (EO-TPU) tool developed by NGS. Using this tool the predicted horizontal uncertainty at the 95% confidence level was calculated to be 1.4 meters for the MLLW color images, the MHW color images and the MHW NIR images and 1.3 meters for the MLLW NIR images.

Several third order geodetic control points were used to verify the horizontal integrity of the DG data. All stereo models were examined and found to have acceptable levels of parallax for mapping purposes.

## Compilation

The data compilation phase of this project was accomplished by RSD AB personnel in August 2014. Digital mapping was performed using the Feature Extraction software module within SOCET SET (ver. 5.6). Feature identification and attribution within the Geographic Cell (GC) were based on image analysis of the aerial imagery and information extracted from the largest scale NOAA nautical charts and other ancillary sources. Feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST), which provides the definition and attribution scheme for the full range of cartographic features pertinent to the CMP. Selected features were further modified with additional descriptive information to refine general classification.

Spatial data accuracies for project MA0902 were determined according to standard Federal Geographic Data Committee (FGDC) practices. Most cartographic features were compiled to meet a horizontal accuracy of 2.8 meters with the exception of the MLLW line which was compiled to meet a horizontal accuracy of 2.6 meters. This predicted accuracy of well-defined points measured during the compilation phase was derived by doubling the imagery accuracy computed from the EO-TPU tool.

The following table provides information on the imagery used to complete this project:

<b>Date</b>	<b>Time (UTC)</b>	<b>Roll #</b>	<b>Photo #s</b>	<b>~ GSD</b>	<b>Tide Level*</b>
6/19/2011	12:12 – 12:16	11NC53	17389 – 17411	0.35 m	0
6/19/2011	12:21 – 12:24	11NC53	17412 – 17434	0.35 m	0
6/19/2011	12:45 – 12:48	11NC53	17435 – 17457	0.35 m	0.1 m
6/19/2011	12:56 – 12:59	11NC53	17458 – 17480	0.35 m	0.2 m
6/19/2011	13:05 – 13:07	11NC53	17481 – 17496	0.35 m	0.1 m
6/19/2011	13:13 – 13:15	11NC53	17497 – 17514	0.35 m	0.3 m
6/19/2011	13:20 – 13:24	11NC53	17515 – 17538	0.35 m	0
6/19/2011	13:28 – 13:31	11NC53	17539 – 17561	0.35 m	0.1 m

6/19/2011	13:37 – 13:39	11NC53	17562 – 17573	0.35 m	0.1 m
6/19/2011	12:12 – 12:16	11NR32	11323 – 11345	0.35 m	0
6/19/2011	12:21 – 12:24	11NR32	11346 – 11368	0.35 m	0
6/19/2011	12:45 – 12:48	11NR32	11369 – 11391	0.35 m	0.1 m
6/19/2011	12:56 – 12:59	11NR32	11392 – 11414	0.35 m	0.2 m
6/19/2011	13:05 – 13:07	11NR32	11415 – 11430	0.35 m	0.1 m
6/19/2011	13:13 – 13:15	11NR32	11431 – 11448	0.35 m	0
6/19/2011	13:20 – 13:24	11NR32	11449 – 11472	0.35 m	0
6/19/2011	13:28 – 13:31	11NR32	11473 – 11495	0.35 m	0.1 m
6/19/2011	13:37 – 13:39	11NR32	11496 – 11507	0.35 m	0.1 m
6/19/2011	17:45 – 17:48	11NC54	17574 – 17596	0.35 m	2.8 m
6/19/2011	17:54 – 17:57	11NC54	17597 – 17619	0.35 m	2.8 m
6/19/2011	18:02 – 18:05	11NC54	17620 – 17642	0.35 m	2.7 – 2.9 m
6/19/2011	18:16 – 18:20	11NC54	17643 – 17665	0.35 m	2.8 m
6/19/2011	18:34 – 18:37	11NC54	17666 – 17681	0.35 m	2.8 – 2.5 m
6/19/2011	18:43 – 18:45	11NC54	17682 – 17699	0.35 m	2.5 m
6/19/2011	18:51 – 18:53	11NC54	17700 – 17711	0.35 m	2.5 m
6/19/2011	18:59 – 19:02	11NC54	17712 – 17734	0.35 m	2.5 m
6/19/2011	19:08 – 19:11	11NC54	17735 – 17758	0.35 m	2.5 m
6/19/2011	17:45 – 17:48	11NR33	11508 – 11530	0.35 m	2.8 m
6/19/2011	17:54 – 17:57	11NR33	11531 – 11553	0.35 m	2.8 m
6/19/2011	18:02 – 18:05	11NR33	11554 – 11576	0.35 m	2.8 m
6/19/2011	18:16 – 18:20	11NR33	11577 – 11599	0.35 m	2.8 m
6/19/2011	18:34 – 18:37	11NR33	11600 – 11615	0.35 m	2.8 m
6/19/2011	18:43 – 18:45	11NR33	11616 – 11633	0.35 m	2.5 m
6/19/2011	18:51 – 18:53	11NR33	11634 – 11645	0.35 m	2.5 m
6/19/2011	18:59 – 19:02	11NR33	11646 – 11668	0.35 m	2.5 m
6/19/2011	19:08 – 19:11	11NR33	11669 – 11692	0.35 m	2.5 m

\*Tide levels are given in meters above MLLW and were calculated using the Pydro software tool with a TCARI grid referenced to verified water level observations at the time of photography from various NOS gauges in the vicinity of the project. The elevation of the MHW tidal datum in the project area varies between 1.8 – 2.5 meters above MLLW.

## **Quality Control / Final Review**

Quality control tasks were conducted during all phases of project completion by a member of the Applications Branch. The final QC review was completed in October 2014. The review process included analysis of the DG results and assessment of the identification and attribution of digital feature data within the GC according to image analysis and criteria defined in C-COAST. The quality control process concluded with an inspection of topological connectivity within the GC using ArcGIS 10.1 software. All project data was evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with source imagery and compiled project data resulted in creation of the Chart Evaluation File (CEF). The following nautical charts were used in the comparison process:

- 13274, Portsmouth Harbor to Boston Harbor, 1:40,000, 28<sup>th</sup> Ed., Apr/11
  - Including the Merrimack River Extension, 1:80,000
- 13282, Newburyport Harbor and Plum Island Sound, 1:20,000, 12<sup>th</sup> Ed., Sep/09

## **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 MA0902 Data Acquisition Summary
- Hardcopy of the Airborne Positioning and Orientation Report (APOR)
- Hardcopy of the Project Completion Report (PCR)
- Page-size graphic plot of GC11078 file contents, attached to PCR

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

- Project database
- GC11078 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- CEF in shapefile format

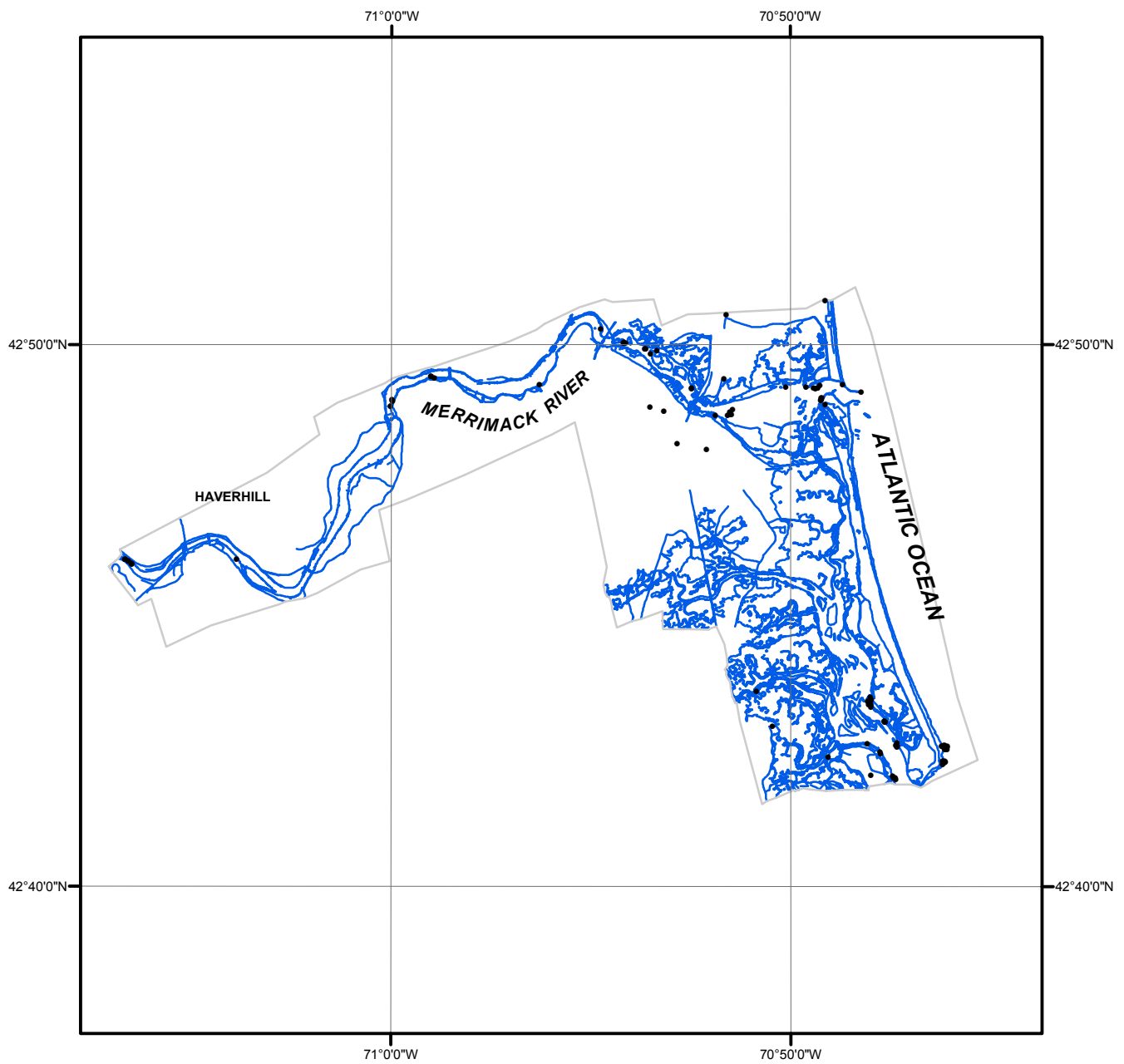
### **NOAA Shoreline Data Explorer**

- GC11078 in shapefile format
- Metadata file for GC11078
- Digital copy of the PCR in Adobe PDF format

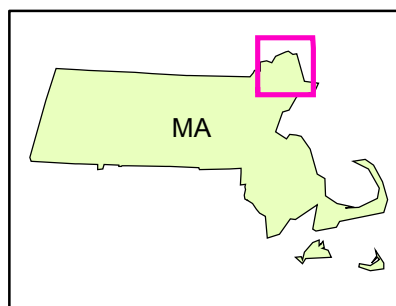
## **End of Report**

# MERRIMACK RIVER AND PLUM ISLAND SOUND

## MASSACHUSETTS



Overview



MA0902

GC11078