NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT MI0804

Lac La Belle Harbor, Michigan

Introduction

NOAA Coastal Mapping Program (CMP) Project MI0804 provides a highly accurate database of new digital shoreline data for a portion of Bete Grise Bay, Michigan on the Keweenaw Peninsula of southern Lake Superior, including Lac La Belle in its entirety.

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 feature data of the coastal zone which complements 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 digital aerial images 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 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 Procedure. The instructions discussed the project's purpose, geographic area of coverage, scope and priority; image requirements; flight line priority; Global Positioning System (GPS) data collection procedures and guidelines for both kinematic and static surveys; data recording and handling instructions; and contact and communication information. RB created a Project Layout Diagram, flight maps and input files for the aircraft's flight management system.

Field Operations

The field operations consisted of the collection of static and kinematic GPS and Inertial Measurement Unit (IMU) data and the acquisition of digital aerial imagery. The photographic mission operations were conducted on May 8, 2008, with the NOAA Cessna Citation II (N52RF) aircraft. Two strips of natural color digital images consisting of eleven images each, for a total of twenty-two (22) images, were acquired with an approximate ground sample distance (GSD) of 0.34 meters using an Applanix DSS 439 digital camera with a dual 60 mm lenses. Black & White Infrared (IR) images were also collected in tandem with the color imagery, but they were not used in this project.

A temporary GPS base station was established at the Sawyer International Airport (MQT) using static GPS positioning techniques. Airborne kinematic GPS/IMU data was collected to determine precise camera positions and orientations in order to establish a control network necessary for aerotriangulation. Data collection operations were conducted in accordance with the GPS Controlled Photogrammetry Field Operations Manual. No ground control survey operations were required for this project.

GPS Data Reduction

GPS and IMU data were processed by RSD personnel to provide precise positions of camera centers for application as photogrammetric control in the aerotriangulation phase of project completion. The static GPS base station data was processed in May 2008 using the NGS Online Processing User Service (OPUS). The airborne kinematic data was processed using Applanix POSPAC (ver. 4.4) software in June 2008. For further information refer to the 08SAW129 Airborne Positioning & Orientation Report (APOR) on file with other project data within the RSD Applications Branch (AB) Project Archive.

Aerotriangulation

Routine softcopy aerotriangulation methods were applied to establish a network of precise camera positions and other control for mapping, and to provide model parameters and orientation elements required for digital compilation. This work was initiated by RSD personnel in November 2008 utilizing a Digital Photogrammetric Workstation (DPW), which is a configuration of computer hardware, modular software components, and other associated peripheral devices. The color photographs were measured and adjusted as a single block using BAE Systems SOCET SET (version 5.4.1) photogrammetric suite in conjunction with the Multi-Sensor Triangulation (MST) software module. Upon successful completion of the aerotriangulation process, the MST software provided the standard deviations of the residuals for each aerotriangulated ground point, which were used to compute a predicted horizontal circular error of 0.7 meters for the images based on a 95% confidence level. An Aerotriangulation Report was written and is on file with other project data within the RSD Project Archive.

The project database consists of project parameters and options, camera calibration data, interior orientation parameters, ground control parameters, adjusted exterior orientation parameters, and positional listing of all measured points. Positional data is referenced to the North American Datum of 1983 (NAD 83).

Compilation

The data compilation phase of this project was initiated by RSD in November 2008. Digital mapping was performed using a DPW in conjunction with the SOCET SET Feature Extraction software module. Feature identification and attribution within the Geographic Cell (GC) were based on image analysis of the aerial photographs and information extracted from the appropriate NOAA nautical charts, US Coast Guard Light List, 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 MI0804 were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 1.4 meters at the 95% confidence level. The predicted accuracy of compiled, well defined points is derived by doubling the circular error calculated from the aerotriangulation statistics.

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

Date	Time (UTC)	Roll Number	Photo Numbers	Resolution (GSD)	Lake Level*
05-08-08	17:38 - 17:39	08NC14	3154 – 3164	0.34 m	183.2 m
05-08-08	17:43 - 17:44	08NC14	3165 – 3175	0.34 m	183.2 m

* Lake levels are given in meters above IGLD 1985 and are based on actual observations recorded by the NOS gauge at Marquette Coast Guard Station, Michigan at the time of photography.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a senior member of AB. The final QC review was completed in January 2009. The review process included analysis of aerotriangulation 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 9.2 software. All project data was evaluated for compliance to CMP requirements.

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

14964, Big Bay Point to Redridge, 1:120,000, 21st Ed., March 2004
and the Lac La Belle Harbor, 1:20,000 inset

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 Airborne Positioning and Orientation Report (APOR)
- Hardcopy of the Aerotriangulation Report
- Hardcopy of the Project Completion Report (PCR)
- Page-size graphic plot of GC10752 file contents, attached to PCR

Remote Sensing Division Electronic Data Library

- Project database

- GC10752 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- Chart Evaluation File in shapefile format

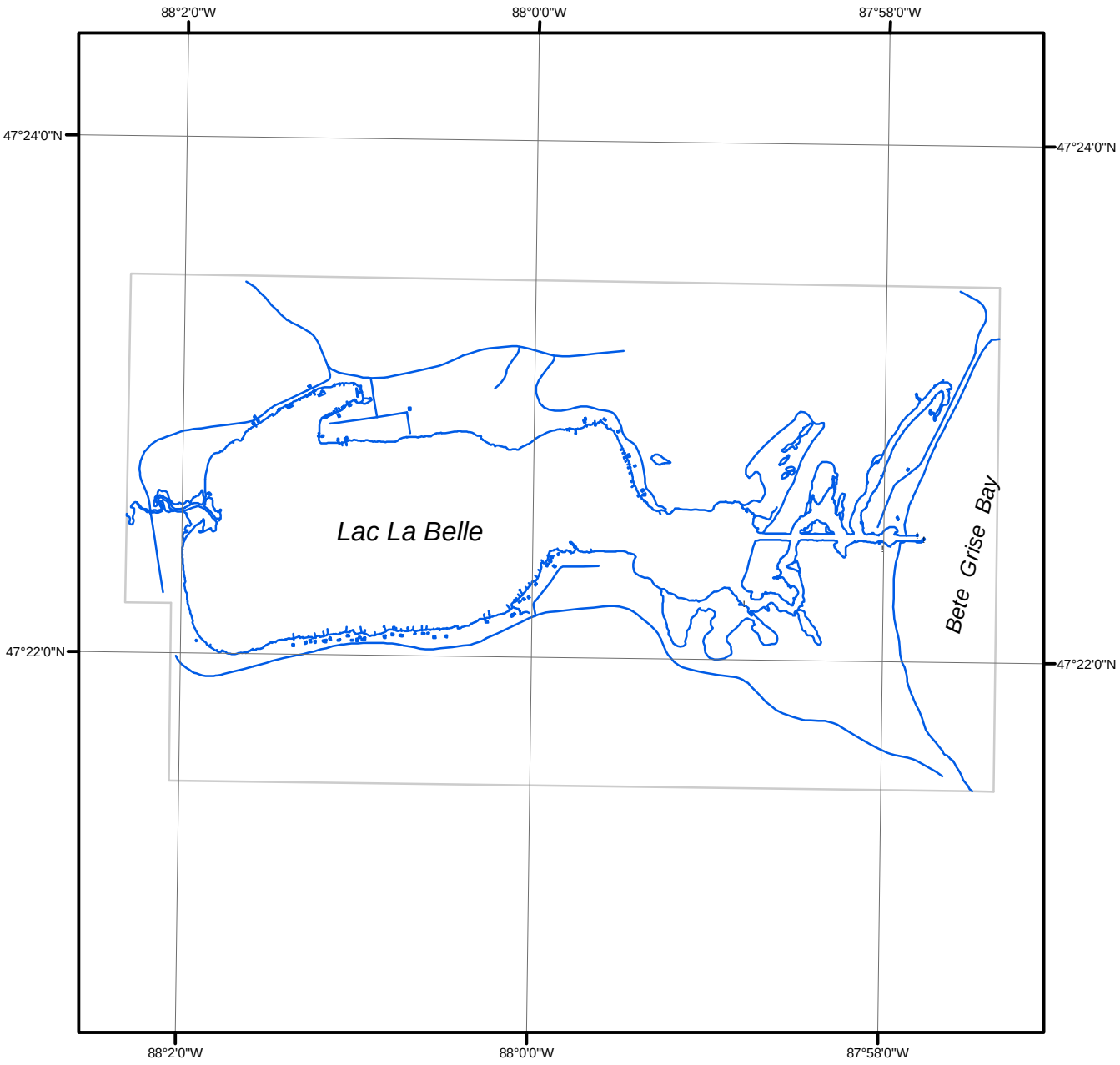
NOAA Shoreline Data Explorer

- GC10752 in shapefile format
- Metadata file for GC10752
- Digital copy of the PCR in Adobe PDF format

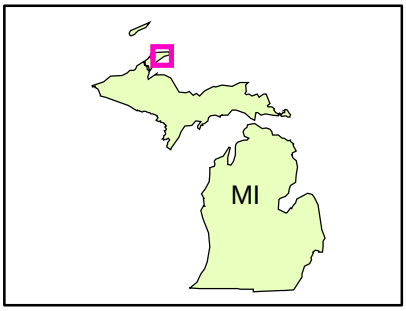
End of Report

LAC LA BELLE HARBOR

MICHIGAN



Overview



MI0804

GC10752