

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

## **CM9303C CHARLEVOIX to MACKINAW CITY MICHIGAN**

### **Introduction**

Coastal Mapping Program (CMP) Project CM9303C provides a highly accurate database of new digital shoreline data for the Michigan northeastern shore of Lake Michigan, from Charlevoix to Mackinaw City, including Little Traverse Bay and Lake Charlevoix. Project CM9303C is a sub-project of the larger project CM9303 which provided aerial photographs of from Ludington to Mackinaw City, Michigan.

The completion of this project resulted in a densification of the National Spatial Reference System (NSRS), a set of controlled metric-quality aerial photographs, and a Digital Cartographic Feature File (DCFF) of the coastal zone which compliment the Nautical Charting Program (NCP) and other geographic information systems.

The project database consists of information measured and extracted from digital scans of aerial photographs and metadata related to photogrammetric compilation. Base mapping was conducted in a digital environment using stereo softcopy methods and associated cartographic practices. Project survey data is referenced to the North American Datum 1983 (NAD 83).

### **Project Design**

The Requirements Branch (RB) of the Remote Sensing Division (RSD) formulated the photographic mission instructions for this project following standard operating guidelines. The instructions discussed the project's purpose, geographic area of coverage, scope, and products, photographic requirements, flight line priority, Global Positioning System (GPS) survey data collection procedures and guidelines for both kinematic and static surveys, data recording and handling instructions, and contact and communication information.

The RB created a Project Layout Diagram, flight maps, and input files for the aircraft's flight management system. A briefing was held with the mission personnel to discuss overall requirements and to provide them with additional information on airport operations and geodetic control.

Additional project requirements were submitted by the Office of Coast Survey (OCS) regarding Electronic Navigational Chart (ENC) production which had the effect on increasing the level of feature inclusion.

## **Field Operations**

Field operations consisted of field survey activities to recover/establish horizontal control and the acquisition of aerial photography. Photopanel positions by GPS survey were the primary means of controlling photography. To establish a control network necessary for aerotriangulation, during the photo mission airborne kinematic GPS data was collected to determine precise camera positions. GPS data collection operations were conducted in accordance with the GPS Controlled Photogrammetry Field Operations Manual (10/25/99). A GPS Processing Report was written and is on file with other project data within the RSD AB project archive.

Aerial photographic survey operations were conducted on July 1993. The aerial photographic platform was the NOAA Cessna Citation II aircraft which contained a Wild RC-20 camera with the NOS "A" lens cone. Six strips of natural color photographs were acquired at the nominal scale of 1:40,000.

## **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. An airport reference station was established, and static and airborne kinematic GPS datasets were acquired in compliance with GPS Controlled Photogrammetry Field Operations Manual, a RSD operational manual. The reference station was positioned using static GPS survey techniques in June 1993, and was entered in the NGS Database (PID: PL0601). Refer to the CM9303 Field Survey Report on file with other project related documents in the RSD AB Project Archive for details. The airborne kinematic data acquired via the flight on July 6, 1993 was processed using Trimble GPSurvey (ver. 2.30) software in May 2000. The NGS computed precise satellite ephemeris and standard meteorologic data were applied during the data reduction process. The solution output was reformatted for use in the ORIMA aerotriangulation software in September 2002 in support of this project. A GPS Data Processing Report was written and is on file with other project data within the RSD AB Project Archive.

## **Aerotriangulation**

Routine softcopy aerotriangulation methods were applied to establish the 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 the RSD AB CMP personnel in November 2002. Six strips of aerial photographs were measured and adjusted as one block utilizing a Digital Photogrammetric Workstation (DPW) running BAE SYSTEMS' SOCET SET (ver. 4.4.1), and LHSYSTEMS' ORIMA (v.6.0) software to perform the aerotriangulation. The RMS of the standard deviations of the residuals for all ground points were used to compute a predicted horizontal circular error of 1.0 meters based on a 95% confidence level. An Aerotriangulation Report was written and is on file with other project data within the RSD AB Project Archive.

The project database consists of project parameters and option, camera calibration data, interior orientation parameters, adjusted exterior orientation parameters, and positional listing of all measured points.

Positional data is based on the North American Datum 1983 (NAD83), and was measured in the Universal Transverse Mercator (UTM) Coordinate System, Zone 16N.

### Compilation

The data compilation phase of this project was accomplished by the RSD Applications Branch (AB) in August of 2003. Digital mapping was accomplished using a DPW in conjunction with the SOCET SET Feature Extraction module. Feature identification and the assignment of cartographic codes were assigned in compliance with the Features Extraction Specification file (coastal\_v5.spc), and based on the image analysis of 1:40,000 scale natural color photographs and information extracted from the appropriate NOAA Nautical Charts, U.S. Coast Guard Light List, and U.S. Geological Survey quadrangles. Cartographic feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST). Nomenclature was assigned to selected cartographic features to refine general classification.

Cartographic features were compiled to meet a horizontal accuracy of 2.0 meters at the 95% confidence level. This predicted accuracy of compiled, well defined points is derived by doubling the circular error derived from aerotriangulation statistics.

The following provides information on aerial photographs used in the compilation phase:

#### Source Data for Compilation

Date	Time (UTC)	Roll #	Photo #	Scale	Lake Level
7-6-1993	1639-1644	00ACN17	2684-2694	1:40,000	176.9 m
7-6-1993	1712-1719	00ACN17	2695-2709	1:40,000	176.9 m
7-6-1993	1744-1755	00ACN17	2717-2736	1:40,000	176.9 m
7-6-1993	1800-1805	00ACN17	2737-2752	1:40,000	176.9 m
7-6-1993	1817-1827	00ACN17	2753-2769	1:40,000	176.9 m
7-6-1993	1843-1849	00ACN17	2770-2781	1:40,000	176.9 m

In the Great Lakes, non-tidal waters, the shoreline represents the land/water interface at the current water levels at the time of photography. The current water level for the project area was interpolated from the observations recorded by the NOS gauges at Ludington and Mackinaw City, Michigan at 1716 GMT on July 6, 1993. The water level for Ludington gauge was 176.89 m and Mackinaw gauge was 176.9 m (IGLD 85).

The dynamic elevation for each of the Great Lakes are referred to the depths of the navigational charts. All elevations of Lake Michigan and the Great Lakes are referred to the International

Great Lakes Datum (IGLD 85), also known as Low Water Datum. Lake Michigan and Huron Low Water Datum is 176.0 meters (577.5 feet). IGLD 1985 has its zero base at Rimouski, Quebec near the mouth of the St. Lawrence River (approximately sea level).

## **Final Review**

The final review was completed by a senior AB CMP team member in September 2003. The Digital Cartographic Feature Files (DCFF) were evaluated for completeness and accuracy. Data review consisted of an on-line and off-line evaluation of digital compilation and hard copy products. The on-line review consisted of reviewing stereo models on a DPW for cartographic feature code selection, positional accuracies of features, and nomenclature. The cartographic feature attribution was judged to conform to C-COAST specification. The offline evaluation compared hard copy plots of the project data with the largest scale nautical charts available and the natural color photographs. A copy of the following NOAA nautical charts were used for chart comparison purposes:

14913 Grand Traverse Bay to Little Travers Bay 1:80,000, 17<sup>th</sup> ed.,  
14942 Lake Charlevoix 1:30,000, 25<sup>th</sup> ed.,  
14911 Waughoshance Point to Seul Choix Point, 1:80,000, 20<sup>th</sup> ed.,  
14881 De Tour Passage to Waughoshance Point, 1:80,000, 31<sup>st</sup> ed.

## **Project Final Data and Products**

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

### RSD Applications Branch Project Archive

- Hard copy of GPS Processing Report
- Hard copy of Aerotriangulation Report
- Hard copy of the Project Completion Report (PCR)
- Page size graphic plot of DCFF contents

### RSD Electronic Data Library

- Project Database
- Digital Cartographic Feature File (DCFF): GC-10500
- Digital copy of DCFF in ESRI Shapefile format
- Digital copy of the PCR in Adobe Acrobat (pdf) format

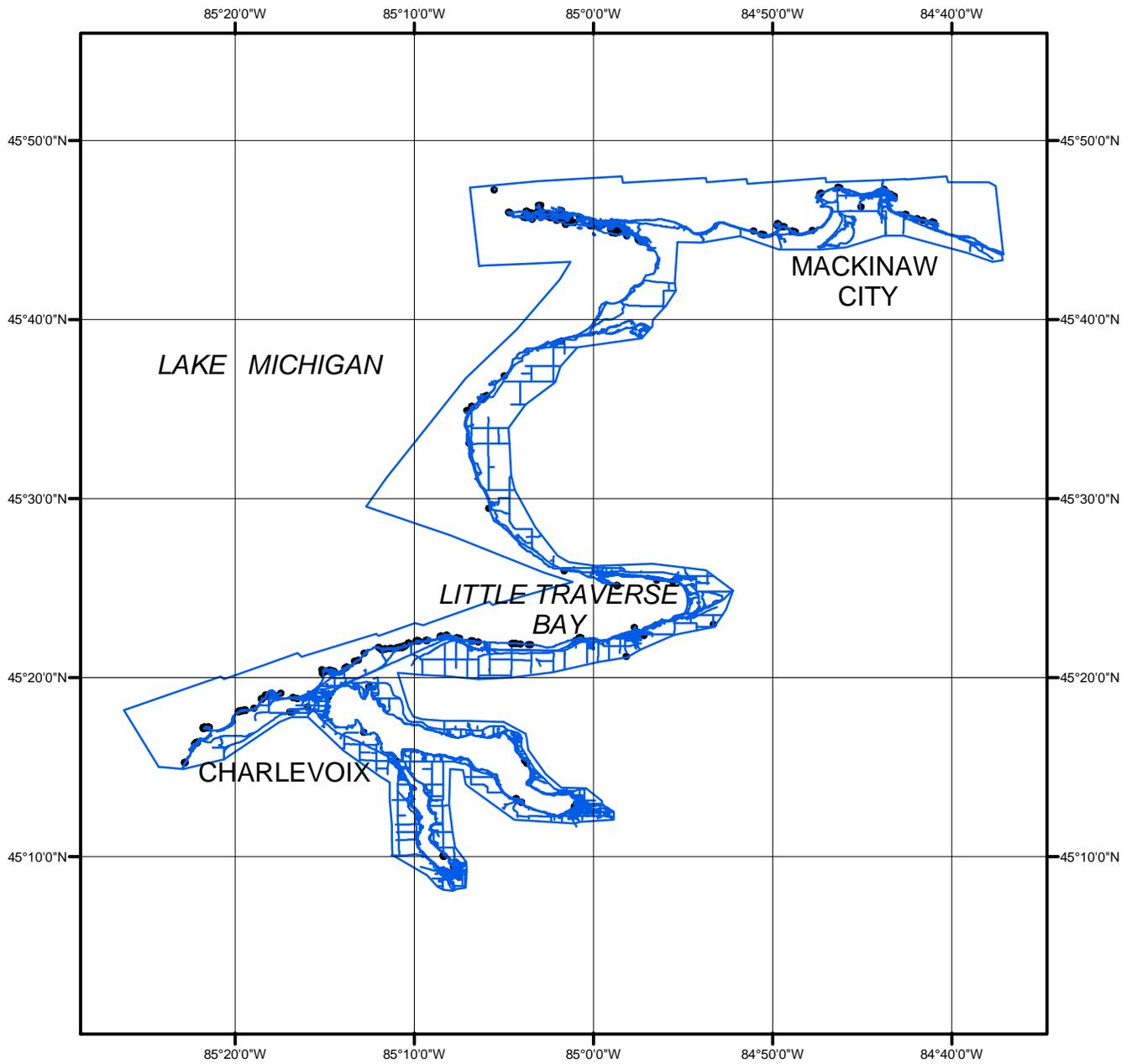
### NOAA Shoreline Data Explorer

- DCFF: GC-10500
- Metadata file for GC-10500
- Digital copy of the PCR in Adobe Acrobat (pdf) format

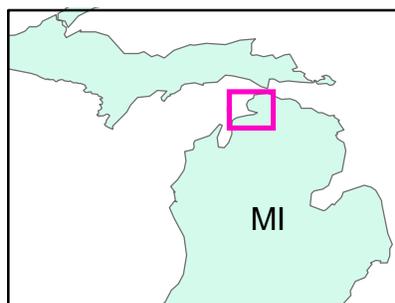
## **End of Report**

# CHARLEVOIX to MACKINAW CITY

## MICHIGAN



Overview



CM9303C

GC10533