

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT MI1001E-CM-N

Leland to Point Betsie, including Manitou Islands, Michigan

Introduction

NOAA Coastal Mapping Program (CMP) Project MI1001E-CM-N provides highly accurate digital shoreline data for a portion of Lake Michigan from Leland to Point Betsie, Michigan including the Manitou Islands. MI1001E-CM-N is a subproject of a larger project, MI1001-CM-N, which covers the entire eastern shore of Lake Michigan. 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, photographic requirements, Global Positioning System (GPS) data collection procedures and guidelines for both kinematic and static surveys, and data recording and handling instructions. RB also created project layout diagrams, 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 data, Inertial Measurement Unit (IMU) data, the acquisition of digital aerial imagery, and the collection of ground control points. Photographic mission operations for MI1001-CM-N were conducted from September 7, 2010 to July 5, 2011 with the NOAA King Air (N68RF) aircraft. Two hundred and four flight lines of color (RGB) imagery, along with simultaneous black & white infrared (IR) imagery, were acquired with an Applanix Digital Sensor System (DSS) 439 aerial camera at a nominal altitude of 10,000 feet, resulting in an approximate ground sample distance (GSD) of 0.35 meters. For subproject MI1001E-CM-N, only sixteen strips of color imagery were used.

Fugro EarthData, Inc. was contracted by RSD to collect ground control points (GCPs). Two GCPs were established for MI1001E-CM-N using static GPS techniques. Two additional photo-identifiable check points were also occupied at a well-defined discrete location. Survey field work was performed on September 23, 2014 and October 7, 2014.

GPS Data Reduction

The GPS/IMU data was processed by RSD personnel to yield precise positions and orientations of camera centers for application as photogrammetric control in the aerotriangulation phase of project completion. 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 kinematic GPS data was processed using Applanix POSPAC (ver. 6.1) software in January 2013. For further information refer to the Airborne Positioning and Orientation Reports (APOR) on file with other project data within the Remote Sensing Division Electronic Data Library. All positional data is referenced to the North American Datum of 1983 (NAD 83).

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 completed by Fugro personnel in January 2015 using a softcopy photogrammetric workstation. The RGB and IR images were measured and adjusted as a single block using Intergraph ImageStation Automatic Triangulation (ISAT) software (v. 13.0) which was used to perform automatic and interactive point measurements of tie points. Upon successful completion of the aerotriangulation process, the RMS of the standard deviations of the residuals for each aerotriangulated ground point were used to compute a predicted horizontal circular error of 0.6 meters for both the color and IR images based on a 95% confidence level. As a final check, the GPS-surveyed check points were measured in the imagery and compared to their surveyed coordinates. An Aerotriangulation Report was completed and is on file with other project data within the RSD Electronic Data Library.

Compilation

The data compilation phase of the project was initiated by Fugro Geospatial, Inc. personnel in January 2015. Digital mapping was performed using the Feature Extraction software module within Intergraph's Stereo Softcopy Kit (SSK) photogrammetric suite of software. Feature identification and the assignment of cartographic codes were based on image analysis of the project digital images and information extracted from the appropriate NOAA Nautical Charts, U.S. Coast Guard Light List and other ancillary sources. Feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST). Selected features were further modified with additional descriptive information to refine general classification.

Spatial data accuracies for Project MI1001E-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 1.2 meters at the 95% confidence level. This predicted accuracy of well-defined points is based on a doubling of the circular error derived from the aerotriangulation statistics.

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

Date	Time (UTC)	Color Imagery		Infrared Imagery		Lake Level
		Roll	Images	Roll	Images	
30-JUN-2011	13:44 – 13:45	11NC48	14292 – 14295	11NR27	08226 – 08229	176.3
30-JUN-2011	13:49 – 13:51	11NC48	14303 – 14315	11NR27	08237 – 08249	176.3
30-JUN-2011	13:56 – 13:57	11NC48	14322 – 14329	11NR27	08256 – 08263	176.3
30-JUN-2011	14:04 – 14:07	11NC48	14346 – 14364	11NR27	08280 – 08298	176.3
30-JUN-2011	14:10 – 14:14	11NC48	14369 – 14396	11NR27	08303 – 08330	176.3
30-JUN-2011	14:19 – 14:23	11NC48	14403 – 14431	11NR27	08337 – 08365	176.3
30-JUN-2011	14:27 – 14:31	11NC48	14437 – 14466	11NR27	08371 – 08402	176.3
30-JUN-2011	14:41 – 14:43	11NC48	14484 – 14499	11NR27	08418 – 08433	176.3
30-JUN-2011	14:48 – 14:52	11NC48	14500 – 14526	11NR27	08434 – 08461	176.3
30-JUN-2011	15:11 – 15:15	11NC48	14589 – 14618	11NR27	08523 – 08552	176.3
3-JUL-2011	22:41 – 22:43	11NC50	15829 – 15844	11NR29	09762 – 09778	176.3
3-JUL-2011	22:47 – 22:49	11NC50	15845 – 15856	11NR29	09779 – 09791	176.3
3-JUL-2011	22:50 – 22:53	11NC50	15860 – 15872	11NR29	09794 – 09806	176.3
3-JUL-2011	22:57 – 23:02	11NC50	15873 – 15905	11NR29	09807 – 09839	176.3
4-JUL-2011	15:31 – 15:34	11NC51	15906 – 15927	11NR30	09840 – 09861	176.3
4-JUL-2011	15:40 – 15:43	11NC51	15932 – 15953	11NR30	09866 – 09887	176.3
4-JUL-2011	15:49 – 15:50	11NC51	15954 – 15959	11NR30	09888 – 09893	176.3

* Lake water levels are given in meters above IGLD 1985 and are based on verified observations at the NOS gauge at Ludington, Michigan. The Low Water Datum (LWD) for Lake Michigan is 176.0 meters.

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 April 2015. The review process included analysis of aerotriangulation results and assessment of the identification and attribution of digital feature data within the Geographic Cell (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 10.3.1 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 project data resulted in creation of the Chart Evaluation File (CEF). The following nautical charts were used in the comparison process:

- 14907, Stony Lake to Point Betsie, MI, 1:120,000 scale, 28th edition, Feb. 2016
- 14912, Platte Bay to Leland, MI, 1:80,000 scale, 18th edition, Jan. 2016

End Products and Deliverables

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

Remote Sensing Division Electronic Data Library

- Ground Control Report
- Airborne Positioning and Orientation Report (APOR)
- Aerotriangulation Report
- Project Completion Report (PCR)
- Project database
- GC11084 in shapefile format
- Chart Evaluation File in shapefile format

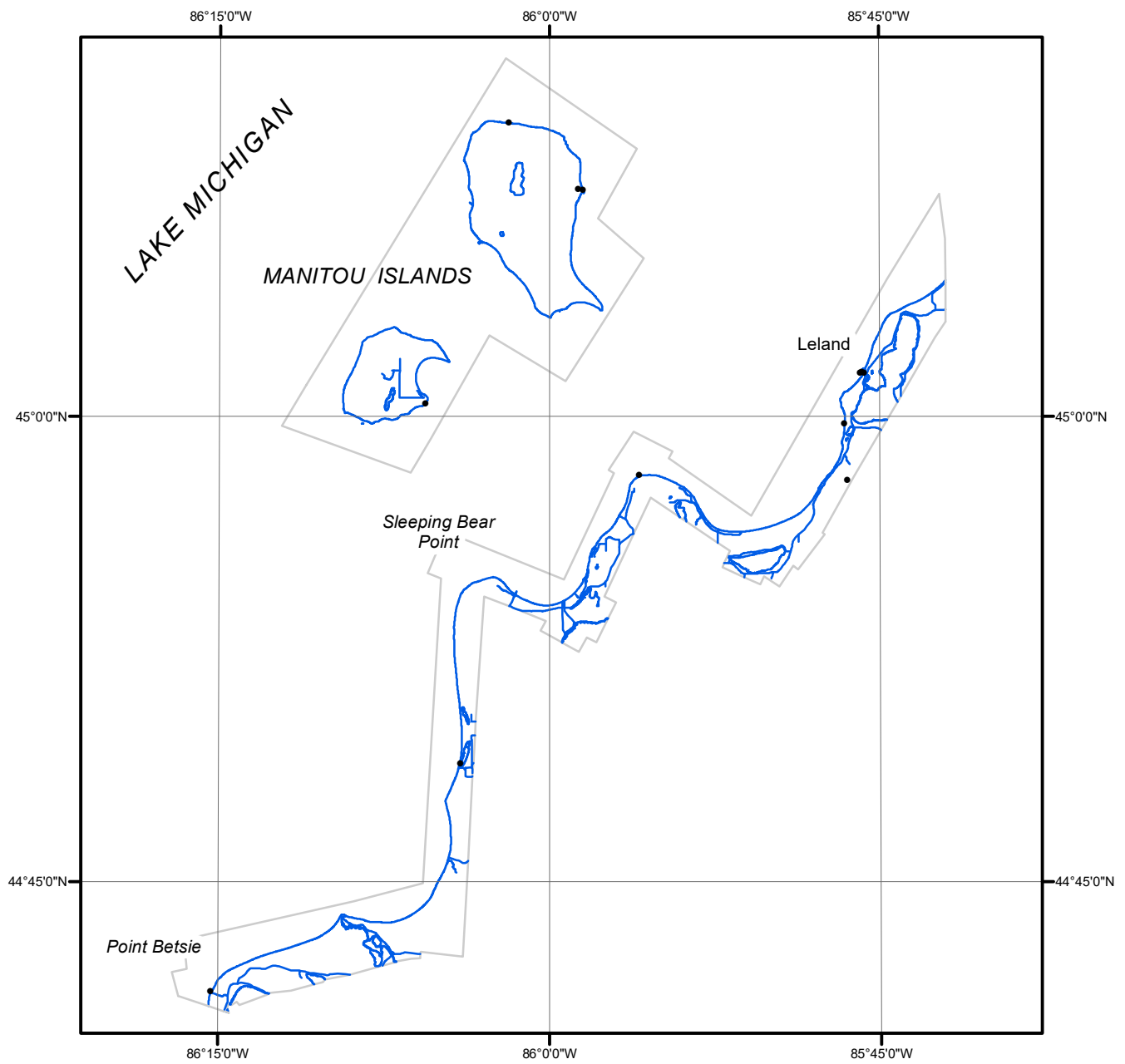
NOAA Shoreline Data Explorer

- GC11084 in shapefile format
- Metadata file for GC11084
- Digital copy of the PCR

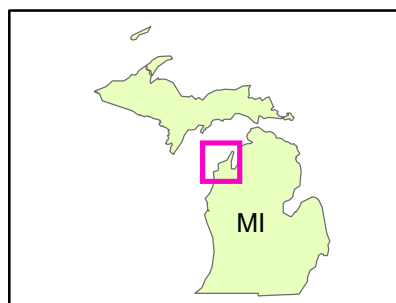
End of Report

LELAND TO POINT BETSIE, INCLUDING MANITOU ISLANDS

MICHIGAN



Overview



MI1001E-CM-N

GC11084