

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

## ***PROJECT MI1001B-CM-N***

### ***Seul Choix Point to Pointe aux Chenes, Michigan***

#### **Introduction**

NOAA Coastal Mapping Program (CMP) Project MI1001B-CM-N provides highly accurate digital shoreline data for a portion of Lake Michigan from Seul Choix Point to Pointe aux Chenes, Michigan including the Beaver Island group, Fox Island and various additional islands and tributaries. MI1001B-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 MI1001B-CM-N, only thirty-nine strips of each the color imagery and IR imagery were used.

Photo Science, Inc. (PSI) was contracted by RSD to collect ground control points (GCPs). A total of eleven (11) GCPs were established for MI1001B-CM-N using static GPS techniques. Two (2) additional photo-identifiable check points were also occupied at well-defined discrete locations. Survey field work was performed between April 30<sup>th</sup> and May 9<sup>th</sup>, 2013.

#### **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 (AT) 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 PSI personnel in August 2013 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. 5.1) which was used to perform automatic point measurements and interactive point measurements of tie points. The photo measurements were then exported into BAE Systems BINGO aerotriangulation software (v. 6.2) within SOCET SET to perform the final bundle block adjustment. The analysis tools within BINGO were used to further refine the AT solution and to evaluate the accuracy of the adjustment. Upon successful completion of the aerotriangulation process, the BINGO software provided the RMS of the standard deviations of the residuals for each aerotriangulated ground point which were used to compute a predicted horizontal circular error of 1.0 meters based on a 95% confidence level. As a final check, each of the ground control check points were measured and the coordinates compared to the coordinates of the surveyed points. 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 PSI personnel in August 2013. The work was accomplished using a Digital Photogrammetric Workstation (DPW), which is a configuration of computer hardware, modular software components and other associated peripheral devices. The Feature Extraction module was used within BAE Systems' SOCET SET (version 5.6) photogrammetric 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 MI1001B-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 2.0 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	
6-29-2011	19:19-19:20	11NC47	13617-13625	11NR26	7551-7559	176.2 m
6-29-2011	19:24-19:25	11NC47	13626-13634	11NR26	7560-7568	176.2 m
6-29-2011	19:30-19:35	11NC47	13635-13668	11NR26	7569-7602	176.2 m
6-29-2011	19:39-19:44	11NC47	13669-13701	11NR26	7603-7635	176.2 m
6-29-2011	19:48-19:51	11NC47	13702-13721	11NR26	7636-7655	176.2 m
6-29-2011	19:56-19:57	11NC47	13722-13731	11NR26	7656-7665	176.2 m
6-29-2011	20:02-20:08	11NC47	13732-13771	11NR26	7666-7705	176.2 m
6-29-2011	20:13-20:14	11NC47	13772-13783	11NR26	7706-7717	176.2 m
6-29-2011	20:20-20:22	11NC47	13784-13800	11NR26	7718-7734	176.2 m
6-29-2011	20:26-20:27	11NC47	13801-13809	11NR26	7735-7743	176.2 m
6-29-2011	20:31-20:33	11NC47	13810-13818	11NR26	7744-7752	176.2 m
6-29-2011	20:36-20:38	11NC47	13819-13834	11NR26	7753-7768	176.2 m
6-29-2011	20:43-20:45	11NC47	13835-13847	11NR26	7769-7781	176.2 m
6-29-2011	20:49-20:51	11NC47	13848-13858	11NR26	7782-7792	176.2 m
6-29-2011	20:55-20:57	11NC47	13859-13871	11NR26	7793-7805	176.2 m
6-29-2011	21:01-21:03	11NC47	13872-13885	11NR26	7806-7819	176.2 m
6-29-2011	21:07-21:08	11NC47	13886-13900	11NR26	7820-7834	176.2 m
6-29-2011	21:15-21:16	11NC47	13901-13910	11NR26	7835-7844	176.2 m
6-29-2011	21:20-21:22	11NC47	13911-13921	11NR26	7845-7855	176.2 m
6-29-2011	21:26-21:28	11NC47	13922-13939	11NR26	7856-7873	176.2 m
6-29-2011	21:33-21:35	11NC47	13940-13955	11NR26	7874-7889	176.2 m
6-29-2011	21:40-21:46	11NC47	13956-13995	11NR26	7890-7929	176.2 m
6-30-2011	22:41-22:42	11NC49	15598-15603	11NR28	9532-9537	176.3 m
6-30-2011	22:46-22:47	11NC49	15604-15609	11NR28	9538-9543	176.3 m
7-3-2011	16:33-16:37	11NC43	11688-11720	11NR22	5622-5654	176.3 m
7-3-2011	16:45-16:47	11NC43	11737-11753	11NR22	5671-5687	176.3 m
7-5-2011	17:37-17:39	11NC52	17311-17324	11NR31	11245-11258	176.2 m
7-5-2011	17:43-17:44	11NC52	17325-17336	11NR31	11259-11270	176.2 m
7-5-2011	17:49-17:51	11NC52	17337-17349	11NR31	11271-11283	176.2 m

7-7-2011	13:15-13:20	11NC44	12340-12370	11NR23	6273-6304	176.2 m
7-7-2011	13:24-13:28	11NC44	12371-12401	11NR23	6305-6336	176.2 m
7-7-2011	13:39-13:47	11NC44	12422-12482	11NR23	6356-6416	176.2 m
7-7-2011	13:52-14:01	11NC44	12483-12540	11NR23	6417-6474	176.2 m
7-7-2011	14:07-14:11	11NC44	12541-12565	11NR23	6475-6499	176.2 m
7-7-2011	14:16-14:18	11NC44	12566-12578	11NR23	6500-6512	176.2 m
7-7-2011	14:25-14:27	11NC44	12579-12594	11NR23	6513-6528	176.2 m
7-7-2011	14:35-14:41	11NC44	12595-12640	11NR23	6529-6574	176.2 m
7-7-2011	16:43-16:44	11NC44	12977-12986	11NR23	6911-6920	176.2 m
7-7-2011	16:50-16:51	11NC44	12987-12999	11NR23	6921-6933	176.2 m
7-7-2011	17:06-17:06	11NC44	13033-13034	11NR23	6966-6967	176.2 m
9-18-2011	15:07-15:13	11NC45	13287-13329	11NR24	7221-7263	176.1 m

\*Lake water levels are given in meters above IGLD 1985 and are based on verified observations at the Port Inland station in Michigan. The Low Water Datum (LWD) for Lake Michigan is 176.0 meters.

## Quality Control / Final Review

Quality control (QC) tasks were conducted during all phases of project completion by a senior member of PSI. The final QC review was completed in March 2014. 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 10.1 software. All project data were evaluated for compliance to CMP requirements.

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

14881, De Tour Passage to Waugoshance Point, 1:80,000 scale, 34<sup>th</sup> edition, Jun. 2014  
14911, Waugoshance Point to Seul Choix Point, 1:80,000 scale, 22<sup>nd</sup> edition, Feb. 2016  
- Including Port Inland (1:10,000 scale) and St. James Harbor (1:15,000 scale) insets  
14912, Platte Bay to Leland, 1:80,000 scale, 18<sup>th</sup> 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
- GC10982 in shapefile format
- Chart Evaluation File in shapefile format

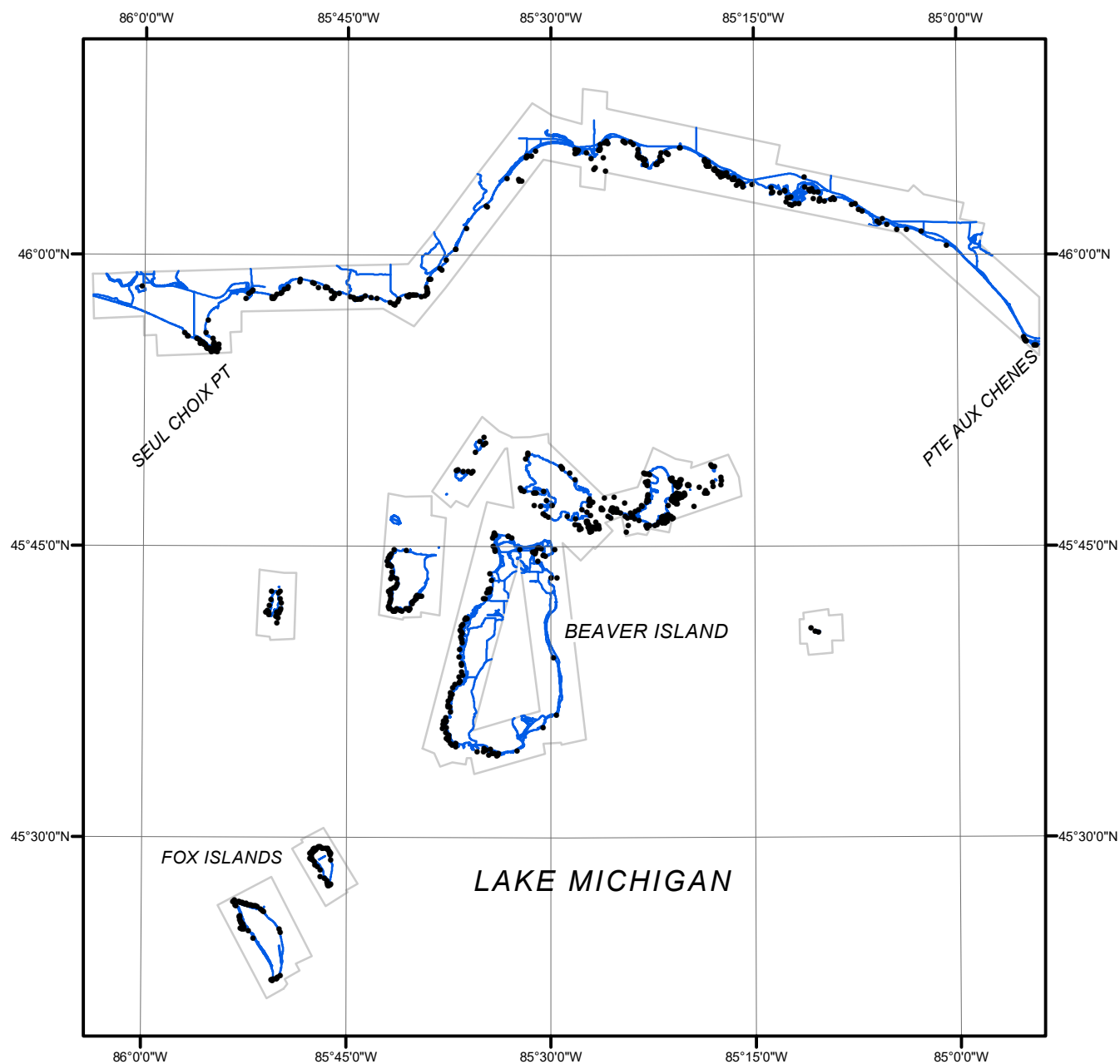
#### **NOAA Shoreline Data Explorer**

- GC10982 in shapefile format
- Metadata file for GC10982
- Digital copy of the PCR in Adobe PDF format

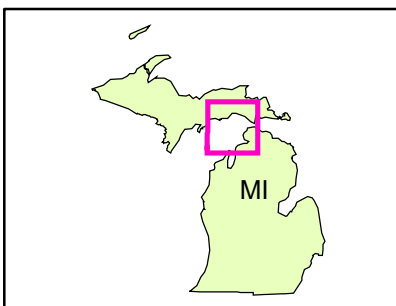
**End of Report**

# SEUL CHOIX POINT TO POINTE AUX CHENES

## MICHIGAN



Overview



MI1001B-CM-N

GC10982