

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

## ***PROJECT WI1001H-CM-N***

### ***Green Bay, Menominee to Little Bay de Noc, Wisconsin and Michigan***

#### **Introduction**

NOAA Coastal Mapping Program (CMP) Project WI1001H-CM-N provides a highly accurate database of new digital shoreline data for Green Bay, from Menominee to Little Bay de Noc, in Wisconsin and Michigan. Project WI1001H-CM-N is a sub-project of a larger project, WI1001-CM-N, which includes shoreline mapping from Burns Waterway Harbor, at the southern end of Lake Michigan to Little Bay de Noc, including Green Bay and Door Peninsula. 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 Project 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) and Inertial Measurement Unit (IMU) 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's flight management system.

#### **Field Operations**

The field operations consisted of the collection of static and kinematic GPS/IMU data and the acquisition of digital aerial imagery. Aerial survey operations were conducted with the NOAA King Air (N68RF) aircraft from August 6th, 2010 through September 30th, 2010. All imagery was flown at a nominal altitude of 10,000 feet resulting in an approximate ground sample distance (GSD) of 0.35 meters. The overall acquisition project included 151 flight lines of natural color (RGB) and near-infrared (NIR) imagery acquired concurrently using an Applanix DSS-439 dual camera system. Of these, 22 flight lines were used for sub-project WI1001H-CM-N.

AeroMetric, Inc. was contracted by RSD to locate new photo control and check points within the project area. The control points and check points were photo-identifiable features located at well-defined locations. Refer to the Ground Survey Report for a listing of final coordinates, elevations, descriptions and a site map of the points.

#### **GPS Data Reduction**

GPS and IMU data was collected and 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 airborne kinematic data was processed using POSPAC version 5.4.0 GPS and IMU processing software. For further information refer to the Airborne Positioning and Orientation Reports (APOR) that are on file with other project data within the Remote Sensing Division Electronic Data Library.

## **Aerotriangulation**

The softcopy analytical aerotriangulation was accomplished by AeroMetric personnel using the Zeiss Image Station Automatic Triangulation (ISAT) program. The ISAT program includes automatic point matching (measuring) and the PhotoT least-squares-simultaneous-robust bundle-block adjustment. The point matching and bundle adjustment were done as one block. The automatic point matching was done in photos along a strip and in photos of overlapping strips. The photo coordinates from point matching are used with the ABGPS exposure stations and ground-surveyed control in the robust bundle-block adjustment, which automatically detects and removes any large point-matching errors. The RGB images and the NIR images were auto-measured in separate sub-blocks, then each sub-block was checked for completeness and errors were corrected. Points were measured manually in weak areas and in models with little land area (mostly water). The two sub-blocks were then merged into one block and all ground-surveyed control points and checkpoints were manually measured. A pattern of tie points was manually measured to tie the RGB and NIR together. The RGB aerotriangulation was used to obtain computed coordinates for the tie points between the RGB and the NIR, and these points were used as ground control for the NIR. The root mean square (RMS) of the standard deviations of the residuals for each aerotriangulated ground point were used to compute a predicted horizontal circular error of 0.4 meters based on a 95% confidence level. An Aerotriangulation Report was completed and is on file with other project data within the RSD Electronic Data Library. Positional data is referenced to the North American Datum of 1983 (NAD 83).

## **Compilation**

The data compilation phase of the project was initiated by AeroMetric, Inc. in March 2012. Digital feature extraction was completed in a softcopy stereo environment using DAT/EM Systems International Summit Evolution software (ver. 5.5), and Bentley Systems MicroStation V8. All coding and classification of features occurred within the MicroStation environment as features were collected, and was based on interpretation of the project imagery, and on information extracted from the appropriate 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 WI1001H-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 0.8 meters at the 95% confidence level. The predicted accuracy of

compiled, well defined points is calculated by doubling the circular error derived from the aerotriangulation statistics.

The table below provides information on aerial photographs used in the project completion:

Date	Time (UTC)	Strip	Color Imagery		Infrared Imagery		Lake Level*
			Roll	Images	Roll	Images	
9/13/2010	14:00 – 14:04	50-124	10NC26	11041 – 11065	10NR20	10040 – 10064	176.0
9/13/2010	14:10 – 14:14	50-123	10NC26	11066 – 11092	10NR20	10065 – 10091	176.0
9/18/2010	19:06 – 19:14	53-132	10NC21	9270 – 9323	10NR21	10465 – 10518	176.2
9/18/2010	19:19 – 19:26	53-131	10NC21	9324 – 9372	10NR21	10519 – 10567	176.2
9/18/2010	19:35 – 19:42	53-133	10NC21	9373 – 9422	10NR21	10568 – 10617	176.2
9/18/2010	19:48 – 19:52	53-135	10NC21	9423 – 9452	10NR21	10618 – 10647	176.2
9/18/2010	19:57 – 20:01	53-134	10NC21	9453 – 9483	10NR21	10648 – 10678	176.2
9/18/2010	20:07 – 20:10	53-141	10NC21	9484 – 9509	10NR21	10679 – 10704	176.2
9/18/2010	20:14 – 20:16	53-143	10NC21	9510 – 9527	10NR21	10705 – 10722	176.2
9/18/2010	20:22 – 20:25	53-142	10NC21	9528 – 9544	10NR21	10723 – 10739	176.2
9/18/2010	20:29 – 20:34	53-147	10NC21	9545 – 9579	10NR21	10740 – 10774	176.2
9/18/2010	20:39 – 20:44	53-146	10NC21	9580 – 9616	10NR21	10775 – 10811	176.2
9/18/2010	20:49 – 20:53	53-145	10NC21	9617 – 9643	10NR21	10812 – 10838	176.2
9/18/2010	20:58 – 21:00	53-144	10NC21	9644 – 9661	10NR21	10839 – 10856	176.2
9/18/2010	21:02 – 21:03	53-136	10NC21	9662 – 9670	10NR21	10857 – 10865	176.2
9/18/2010	21:08 – 21:11	53-140	10NC21	9671 – 9688	10NR21	10866 – 10883	176.2
9/18/2010	21:15 – 21:17	53-139	10NC21	9689 – 9703	10NR21	10884 – 10898	176.2
9/18/2010	21:21 – 21:22	53-138	10NC21	9704 – 9715	10NR21	10899 – 10910	176.2
9/18/2010	21:26 – 21:28	53-137	10NC21	9716 – 9725	10NR21	10911 – 10920	176.2
9/22/2010	15:24 – 15:27	50-120	10NC22	9919 – 9935	10NR15	6217 – 6233	176.1
9/22/2010	15:33 – 15:38	50-121	10NC22	9936 – 9969	10NR15	6234 – 6267	176.1
9/22/2010	18:15 – 18:20	50-122	10NC22	10289 – 10322	10NR15	6587 – 6620	176.1

\* Lake levels are given in meters above IGLD and are based on verified observations at the NOS gauge in Green Bay, WI at the time of imagery. The Low Water Datum (LWD) for Lake Michigan is 176.0 meters above IGLD 1985.

## Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion. The final QC review was completed in June 2012. 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 10.5 software. All project data was evaluated for compliance to CMP requirements.

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

- 14908, Dutch Johns Point to Fishery Point, MI, 1:80,000 scale, 19<sup>th</sup> Ed., Jan. 2016
- 14909, Upper Green Bay, MI/WI, 1:80,000 scale, 21<sup>st</sup> Ed., Feb. 2016
- 14915, Little Bay De Noc, MI, 1:30,000 scale, 26<sup>th</sup> Ed., Mar. 2014
- 14917, Menominee and Marinette Harbors, MI/WI, 1:15,000 scale, 25<sup>th</sup> Ed., Sep. 2012

## **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 Survey Report
- Airborne Positioning and Orientation Reports (APOR)
- Aerotriangulation Report
- Project database
- GC10925 in shapefile format
- Project Completion Report (PCR)
- CEF in shapefile format

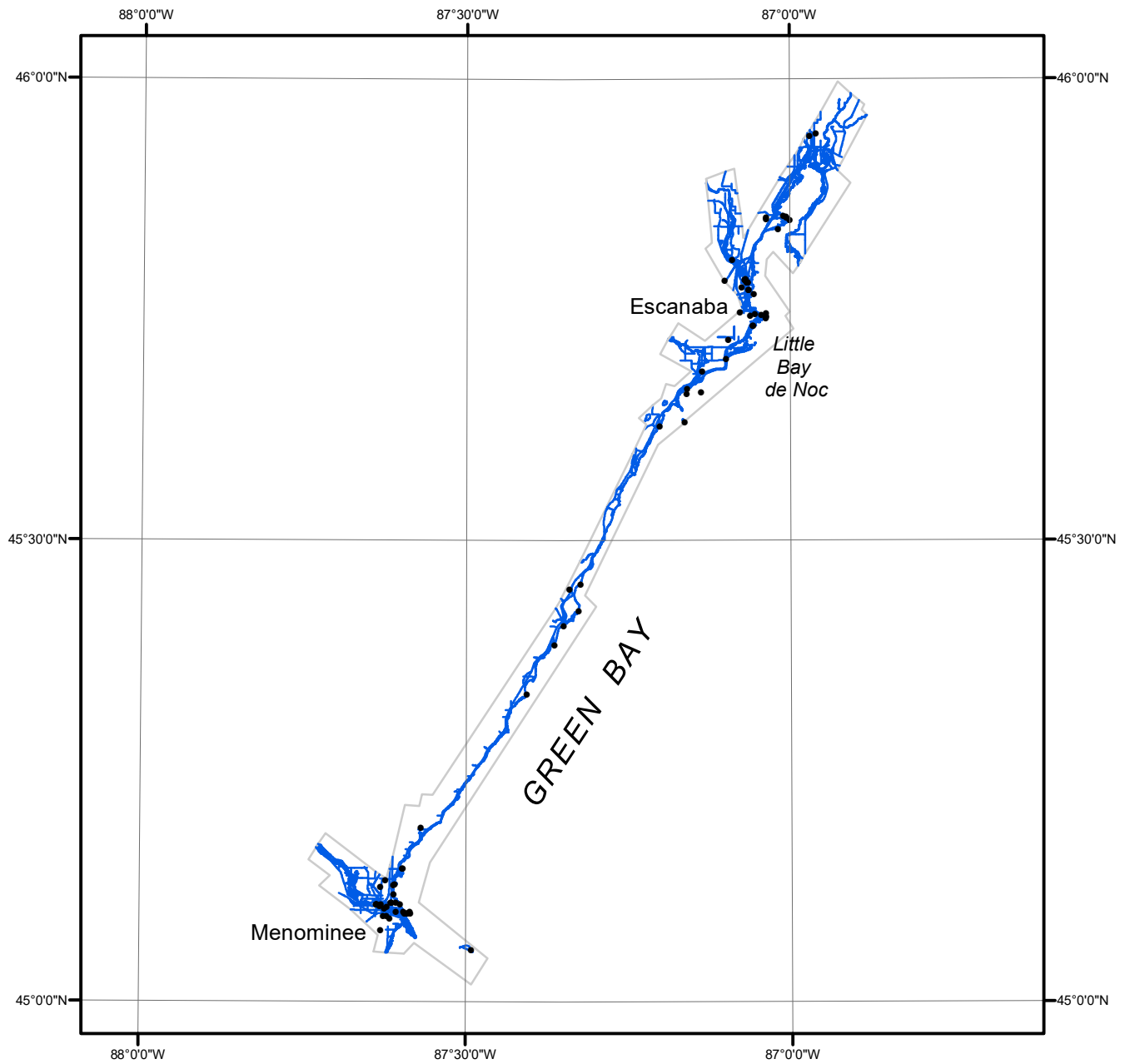
### **NOAA Shoreline Data Explorer**

- GC10925 in shapefile format
- Metadata file for GC10925
- PCR in Adobe PDF format

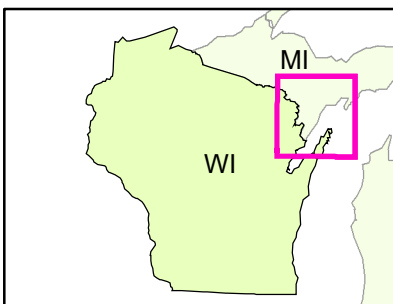
## **End of Report**

# GREEN BAY, MENOMINEE TO LITTLE BAY DE NOC

## WISCONSIN AND MICHIGAN



Overview



WI1001H-CM-N

GC10925