

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT MI1609-CM-N

White Lake, Michigan

Introduction

NOAA Coastal Mapping Program (CMP) Project MI1609-CM-N provides highly accurate digital shoreline data for notable areas of change within White 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 design of Project MI1609-CM-N was accomplished by the Requirements Branch (RB) of the Remote Sensing Division (RSD) in response to a request from the Marine Chart Division (MCD). RB 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 and the acquisition of digital aerial imagery. Photographic mission operations for MI1609-CM-N were conducted on November 13th, 2016 with the NOAA King Air (N68RF) aircraft. Two flight lines of color (RGB) imagery along with simultaneous black & white infrared (IR) imagery were acquired with an Applanix Digital Sensor System (DSS) dual camera at a nominal altitude of 7,500 feet, resulting in an approximate ground sample distance (GSD) of 0.24 meters. The IR images were not used for this project.

Direct Georeferencing Data Processing

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 direct geo-referencing (DG) 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 MMS (ver. 7.1) software in December 2016. For further information refer to the Airborne Positioning and Orientation Report (APOR) on file with other project data within the Remote Sensing Division Electronic Data Library.

The processed GPS/IMU data were used to derive precise exterior orientation (EO) values of the camera centers required for digital feature extraction. The predicted horizontal accuracy of the imagery was determined by propagating sensor EO and image measurement uncertainties through the photogrammetric collinearity equations using an Exterior Orientation Total Propagated Uncertainty (EO-TPU) tool developed by NGS. Using this tool, the predicted horizontal uncertainty at the 95% confidence level was calculated to be 0.74 meters.

NGS third order geodetic control points were used to test the horizontal integrity of the DG data. A comparison between image measurements and the published coordinates for these points revealed offsets in the 0.3 to 1.5 meter range. All stereo-models were examined and found to have acceptable levels of parallax for mapping purposes.

Compilation

The data compilation phase of the project was accomplished by RSD personnel in March 2017. The work was performed 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 (ver. 5.6) photogrammetric software. Project imagery was compared to previously compiled feature data for CMP Project MI1001G-CM-N (GC11086), and significant changes were compiled. Numerous floating piers, previously compiled in GC11086, were likely removed temporarily for the 2016-17 winter season and therefore not present in the imagery for MI1609-CM-N. 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 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 MI1609-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 1.5 meters at the 95% confidence level. This predicted accuracy of well-defined points was derived by doubling the imagery accuracy computed from the EO-TPU tool.

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

Date	Time (UTC)	Roll	Photo #s	Lake Level *
11-13-2016	18:09 – 18:12	16VC91	21242 – 21256	176.6 m
11-13-2016	18:19 – 18:22	16VC91	21257 – 21272	176.6 m

*Lake water levels are given in meters above IGLD 1985 and are based on verified observations at the Ludington 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 RSD. The final QC review was completed in March 2017. The review process included analysis of DG 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 were evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with the 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:

- 14906, South Haven to Stony Lake, MI, 1:120,000 scale, 25th edition, Sep. 2013
- 14935, White Lake, MI, 1:10,000 scale, 22nd edition, Oct. 2015

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

- Airborne Positioning and Orientation Report (APOR)
- Project Completion Report (PCR)
- Project database
- GC11307 in shapefile format
- Chart Evaluation File in shapefile format

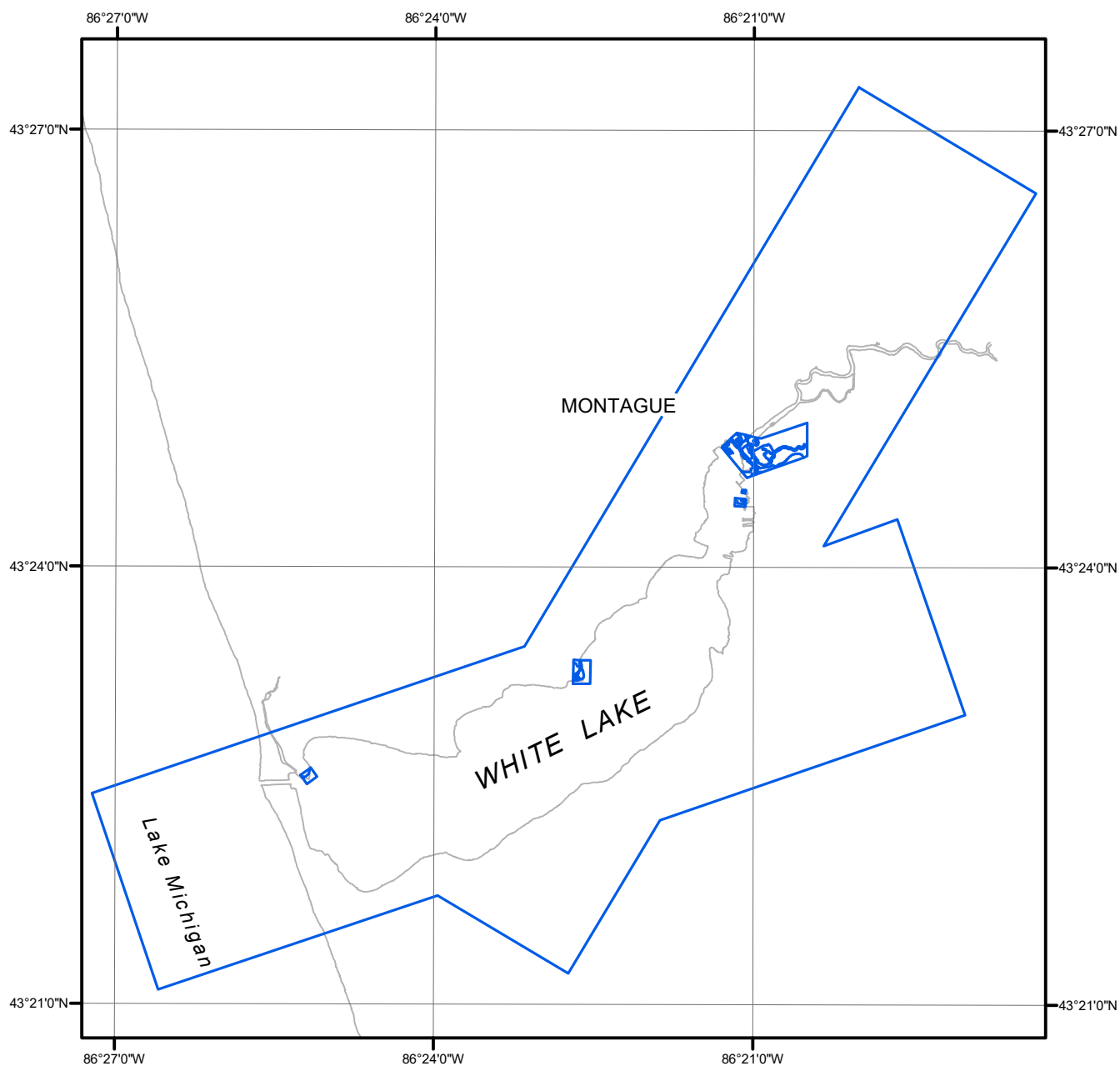
NOAA Shoreline Data Explorer

- GC11307 in shapefile format
- Metadata file for GC11307
- Digital copy of the PCR in Adobe PDF format

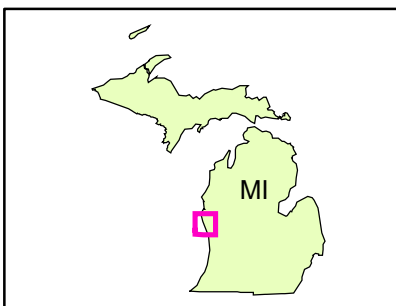
End of Report

WHITE LAKE

MICHIGAN



Overview



MI1609-CM-N

GC11307