

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT CA1213H-CM-N

San Francisco Bay, San Leandro to Johnson Landing, California

Introduction

NOAA Coastal Mapping Program (CMP) Project CA1213H-CM-N provides highly accurate coastal feature data of San Francisco Bay from San Leandro Channel to Johnson Landing, in California. Project CA1213H-CM-N is a subproject of a larger project, CA1213-CM-N, which covers the southern and eastern portions of San Francisco Bay from the Golden Gate to Carquinez Strait. 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

Photographic mission instructions for CA1213-CM-N were formulated by the Requirements Branch (RB) of the Remote Sensing Division (RSD) following the guidelines of RSD's 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) 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 flight management system.

Field Operations

Field operations for CA1213-CM-N consisted of the collection of static and kinematic GPS data, Inertial Measurement Unit (IMU) data, and acquisition of digital aerial imagery. Aerial survey operations were conducted in April, May, and August 2013, and February 2014 with the NOAA King Air aircraft (N68RF) using an Applanix Digital Sensor System (DSS) dual camera at a nominal altitude of 10,000 feet, resulting in an approximate ground sample distance (GSD) of 0.35 meters. Thirty-four flight lines each of natural color and near-infrared (NIR) imagery were acquired concurrently in coordination with the Mean Lower Low Water (MLLW) and Mean High Water (MHW) tide levels.

Direct Georeferencing Data Processing

GPS/IMU data were processed by RSD personnel to yield precise camera positions and orientations for direct georeferencing (DG) of the imagery. 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 Applanix POSPAC (ver. 6.1 and 6.2) software in May and November 2013 through March 2014. For further information refer to the Airborne Positioning and Orientation Reports (APOR) that are on file with other project data within the RSD 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 for subproject CA1213H-CM-N was determined by propagating sensor EO and image measurement uncertainties for a subset of 235 images from 4 flight lines 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 0.6 meters.

NGS third order geodetic control points were used to verify the horizontal integrity of the DG data. All stereo-models were examined and found to have acceptable levels of parallax for mapping purposes.

Compilation

The data compilation phase of this project was accomplished by RSD Applications Branch (AB) personnel in December 2018. Digital mapping was performed using the Feature Extraction software module within SOCET SET (ver. 5.6). Feature identification and attribution within the GC were based on analysis of the aerial imagery and information extracted from the largest scale 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 CA1213H-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 measured during the compilation phase was derived by doubling the circular error computed from the EO-TPU tool.

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

Date	Time (UTC)	Color Imagery		NIR Imagery		Tide Level*
		Roll	Images	Roll	Images	
04/23/2013	18:22 – 18:25	13NC16	50-014/3649 – 3671	13NR13	50-014/2868 – 2890	1.8 – 1.9
04/23/2013	18:28 – 18:31	13NC16	50-013/3672 – 3688	13NR13	50-013/2891 – 2908	1.8 – 1.9
04/23/2013	18:35 – 18:36	13NC16	50-019/3691 – 3699	13NR13	50-019/2910 – 2918	1.8 – 1.9
04/23/2013	18:46 – 18:47	13NC16	50-018/3735 – 3743	13NR13	50-018/2954 – 2962	1.8 – 1.9
05/01/2013	20:25 – 20:28	13NC27	50-013/5408 – 5425	13NR22	50-013/4563 – 4580	-0.1 – 0.1
05/02/2013	18:48 – 18:51	13NC28	50-014/5439 – 5461	13NR23	50-014/4594 – 4616	0.0 – 0.1
02/24/2014	21:35 – 21:37	14NC22	50-019/5633 – 5641	14NR17	50-019/2792 – 2800	0.1
02/24/2014	21:55 – 21:56	14NC22	50-018/5680 – 5688	14NR17	50-018/2839 – 2847	0.0

* Tide levels are given in meters above MLLW and were calculated using Pydro software with a TCARI grid referenced to verified water level observations at the time of photography from NOS gauges in the vicinity of the project. The elevation of the MHW tidal datum in the project area varies between 1.86 – 2.15 m. above MLLW.

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 March 2019. The review process included analysis of the georeferencing 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 Esri's ArcGIS (ver. 10.6.1) software. All project data was evaluated for compliance to CMP requirements.

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

- 18651, San Francisco Bay Southern Part, 45th Ed., Dec. 2013
- 18650, San Francisco Bay Northern Part, 58th Ed., Jan. 2017

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

- Project database
- Airborne Positioning and Orientation Reports (APOR)
- GC11453 in shapefile format
- Project Completion Report (PCR)
- CEF in shapefile format

NOAA Shoreline Data Explorer

- GC11453 in shapefile format
- Metadata file for GC11453
- PCR in Adobe PDF format

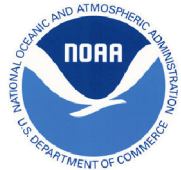
End of Report

SAN FRANCISCO BAY, SAN LEANDRO TO JOHNSON LANDING

CALIFORNIA



Overview



CA1213H-CM-N

GC11453