

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT CA1212D-CM-N

San Francisco Bay, Golden Gate to Point Chauncey, California

Introduction

NOAA Coastal Mapping Program (CMP) Project CA1212D-CM-N provides a highly accurate dataset of shoreline feature data for San Francisco Bay, from Golden Gate to Point Chauncey, in California. Project CA1212D-CM-N is a subproject of a larger project CA1212-CM-N, which covers the western and northern portions of San Francisco Bay from Golden Gate to the Sacramento and San Joaquin Rivers. 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 CA1212-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 CA1212-CM-N consisted of the collection of static and kinematic GPS data and Inertial Measurement Unit (IMU) data, and the acquisition of digital aerial imagery. Aerial survey operations were conducted from April 2013 through April 2014 with the NOAA King Air aircraft (N68RF). All project imagery was acquired with an Applanix DSS 439 dual camera system in coordination with both MLLW and MHW tide levels. Fifty-four flight lines of natural color and near-infrared (NIR) imagery were acquired concurrently for CA1212-CM-N, with five flight lines (50-001, 002, 003, 004 and 053) used for subproject CA1212D-CM-N. All imagery was acquired at a nominal altitude of 10,000 feet, resulting in an approximate ground sample distance (GSD) of 0.35 meters.

Direct Georeferencing Data Processing

The GPS/IMU data for Project CA1212-CM-N were processed by RSD personnel to yield precise camera positions and orientations for direct georeferencing (DG) of the imagery. GPS base stations were established for use as reference stations for kinematic GPS processing. The positions of the base stations were determined using the NGS Online Processing User Service (OPUS), which computed fixed baseline solutions from nearby CORS stations. Kinematic data for imagery used for CA1212D-CM-N were processed using POSpac MMS (ver. 6.1) GPS/IMU software in May 2013. For further information refer to the Airborne Positioning and Orientation Reports (APOR) on file with other project data within the RSD Electronic Data Library.

Upon completion of the processing of GPS/IMU data, the processed data were used to derive precise exterior orientation (EO) values of the camera centers required for digital feature extraction. A predicted horizontal accuracy of the imagery was determined by propagating sensor EO and image measurement uncertainties through the photogrammetric collinearity equations using the 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 1.4 meters for the imagery subset used to compile data for CA1212D-CM-N. Five NGS 3rd Order geodetic control stations were used to assess the horizontal integrity of the DG data, and the stereo-models were examined for excessive parallax. The imagery was determined to be suitable for mapping purposes.

Compilation

The data compilation phase of this project was accomplished by RSD Applications Branch personnel in July 2019. Digital mapping was performed using the Feature Extraction module within BAE's SOCET SET (ver. 5.6) photogrammetric software suite. Feature identification and attribution within the GC were based on image 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 CA1212D-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 2.8 meters at the 95% confidence level. This predicted accuracy of well-defined points measured during the compilation phase 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)	Color Imagery		Infrared Imagery		Tide Level*
		Roll	Images	Roll	Images	
4-28-2013	17:17 – 17:18	13NC22	4809 – 4823	13NR18	4033 – 4047	(-0.1) m
4-28-2013	17:25 – 17:26	13NC22	4824 – 4838	13NR18	4048 – 4062	(-0.1) m
4-28-2013	17:32 – 17:33	13NC22	4840 – 4853	13NR18	4064 – 4077	0.0 m
4-28-2013	17:41 – 17:43	13NC22	4866 – 4877	13NR18	4090 – 4101	(-0.1) – 0.0 m
4-30-2013	18:39 – 18:40	13NC24	5030 – 5039	13NR20	4254 – 4263	(-0.1) – 0.0 m
4-30-2013	23:41 – 23:43	13NC25	5162 – 5176	13NR21	4386 – 4400	1.4 – 1.5 m
4-30-2013	23:47 – 23:49	13NC25	5177 – 5191	13NR21	4401 – 4415	1.5 m
4-30-2013	23:55 – 23:56	13NC25	5192 – 5205	13NR21	4416 – 4429	1.5 m
5-01-2013	00:10 – 00:12	13NC25	5217 – 5228	13NR21	4441 – 4452	1.5 m
9-05-2013	20:27 – 20:29	13NC62	13224 – 13233	13NR57	11859 – 11868	1.5 – 1.6 m

* Tide levels are given in meters above MLLW and were calculated using the Pydro software tool with a TCARI grid referenced to verified water level observations at the time of photography from various NOS gauges in the vicinity of the project. The elevation of the MHW tidal datum in the project area is 1.46 – 1.66 m above MLLW.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a senior member of RSD. The final QC review was completed in September 2019. The review process included analysis of the 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 Esri's ArcGIS (ver. 10.7.1) desktop GIS software. All project data was evaluated for compliance to CMP requirements.

A Chart Evaluation File (CEF) resulted from the comparison of source imagery and compiled project data with the largest scale NOAA nautical charts covering the project area:

- 18649, Entrance to San Francisco Bay, 68th Ed., Jun. 2013
- 18650, Candlestick Point to Angel Island, 58th Ed., Jan. 2017
- 18653, Angle Island to Point San Pedro, 12th Ed., Oct. 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

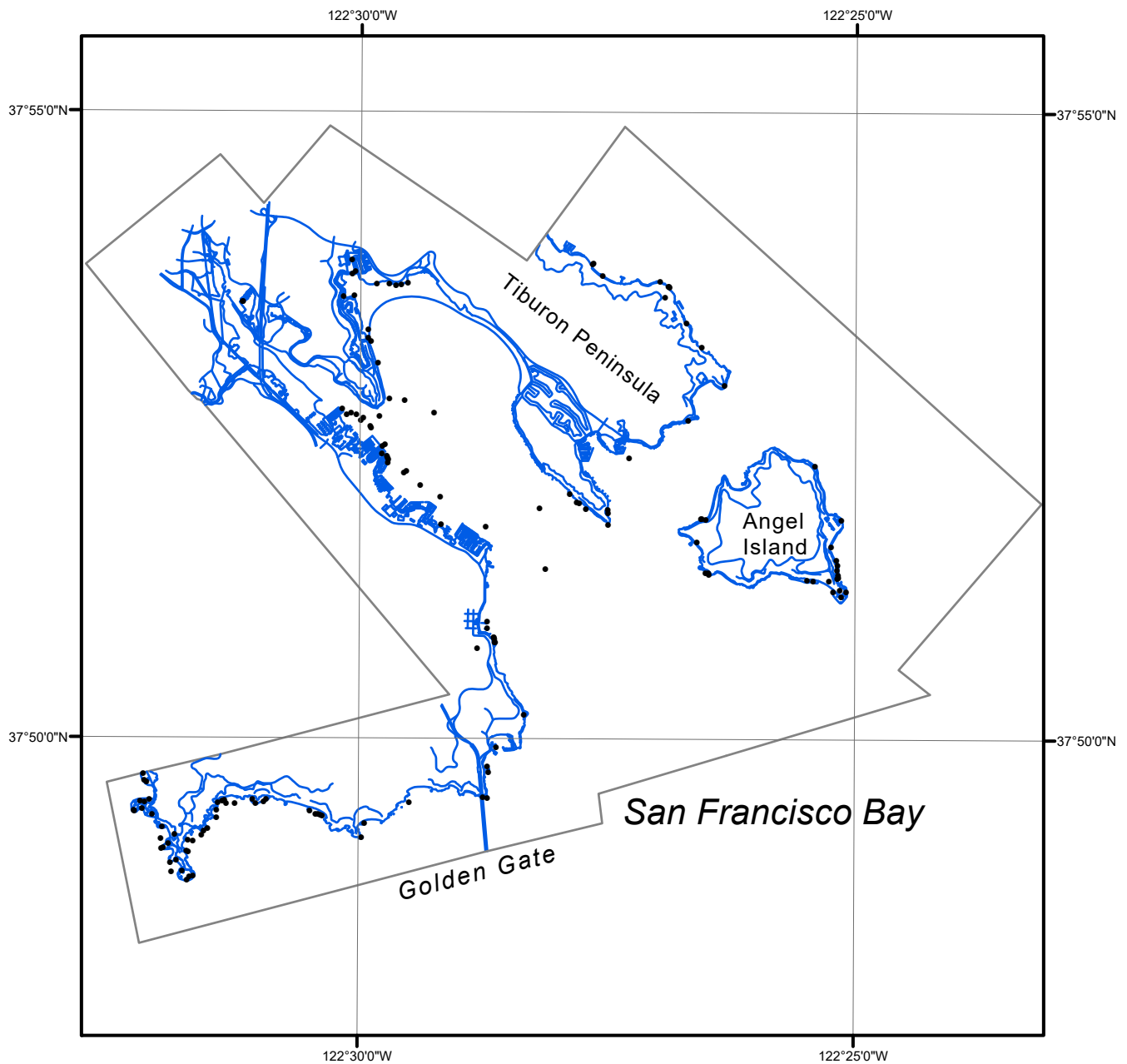
- Data Acquisition Summary Report for CA1212
- Airborne Positioning and Orientation Reports (APOR)
- Project Completion Report (PCR)
- Project database
- GC11477 in shapefile format
- CEF in shapefile format

NOAA Shoreline Data Explorer

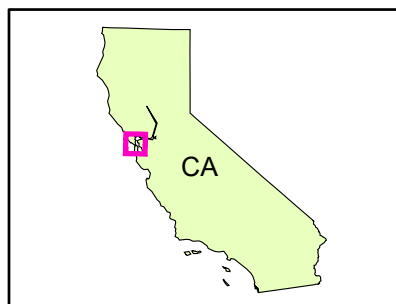
- GC11477 in shapefile format
- Metadata file for GC11477
- PCR in Adobe PDF format

End of Report

SAN FRANCISCO BAY, GOLDEN GATE TO POINT CHAUNCEY CALIFORNIA



Overview



CA1212D-CM-N

GC11477