

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

## **PROJECT CA1212E-CM-N**

### ***San Francisco Bay, Tiburon Peninsula to San Pablo Bay, California***

#### **Introduction**

NOAA Coastal Mapping Program (CMP) Project CA1212E-CM-N provides a highly accurate dataset of shoreline feature data for San Francisco Bay, from Tiburon Peninsula to San Pablo Bay, in California. Project CA1212E-CM-N is a subproject of a larger project CA1212-CM-N, which covers the western and northern portions of San Francisco Bay from the 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 seven flight lines (50-004, 005, 006, 007, 008, 009 and 010) used for subproject CA1212E-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 CA1212E-CM-N was processed using POSpac MMS (ver. 6.1 & 6.2) GPS/IMU software between May 2013 and March 2014. For further information refer to the Airborne Positioning and Orientation Reports (APOR) on file with other project data within the RSD Electronic Data Library.

For Project CA1212E-CM-N, no aerial triangulation processing was conducted. 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 1.36 meters for the imagery subset used to compile data for CA1212E-CM-N. Stereo models were examined for parallax and found to be acceptable.

## Compilation

The data compilation phase of this project was accomplished by RSD Applications Branch personnel in March 2020. 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 CA1212E-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 2.7 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	17:39 – 17:41	13NC22	4854 – 4867	13NR18	4078 – 4091	-0.1 m
4-28-2013	17:48 – 17:49	13NC22	4878 – 4887	13NR18	4102 – 4111	-0.1 m
4-28-2013	17:54 – 17:55	13NC22	4888 – 4895	13NR18	4112 – 4119	(-0.1) – 0.0 m
4-28-2013	17:59 – 18:01	13NC22	4896 – 4907	13NR18	4120 – 4131	0.0 – (-0.1) m
5-01-2013	00:12 – 00:14	13NC25	5227 – 5240	13NR21	4451 – 4464	1.5 m
5-01-2013	00:19 – 00:20	13NC25	5241 – 5248	13NR21	4465 – 4472	1.5 m
5-01-2013	00:31 – 00:33	13NC25	5249 – 5260	13NR21	4473 – 4484	1.5 m
5-01-2013	00:37 – 00:39	13NC25	5261 – 5270	13NR21	4485 – 4494	1.5 m
8-27-2013	00:29 – 00:31	13NC58	13009 – 13022	13NR53	11644 – 11657	1.8 m
9-03-2013	18:44 – 18:46	13NC60	13099 – 13113	13NR55	11734 – 11748	1.4 – 1.5 m
9-03-2013	18:50 – 18:51	13NC60	13116 – 13119	13NR55	11751 – 11754	1.5 m

2-24-2014	22:16 – 22:17	14NC22	5709 – 5712	14NR17	2868 – 2871	0.1 m
2-24-2014	22:22 – 22:24	14NC22	5715 – 5729	14NR17	2874 – 2888	0.1 m
2-24-2014	22:29 – 22:31	14NC22	5730 – 5743	14NR17	2889 – 2902	0.1 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 from various NOS gauges in the vicinity of the project. The elevation of the MHW tidal datum in the project area ranges between 1.58 – 1.65 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 April 2020. 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. 10.8.1) 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, 68<sup>th</sup> Ed., Jun. 2013  
18653, Angel Island to Point San Pedro, 12<sup>th</sup> Ed., Oct. 2012  
18654, San Pablo Bay, 45<sup>th</sup> Ed., Jan. 2011

## 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
- GC11567 in shapefile format
- CEF in shapefile format

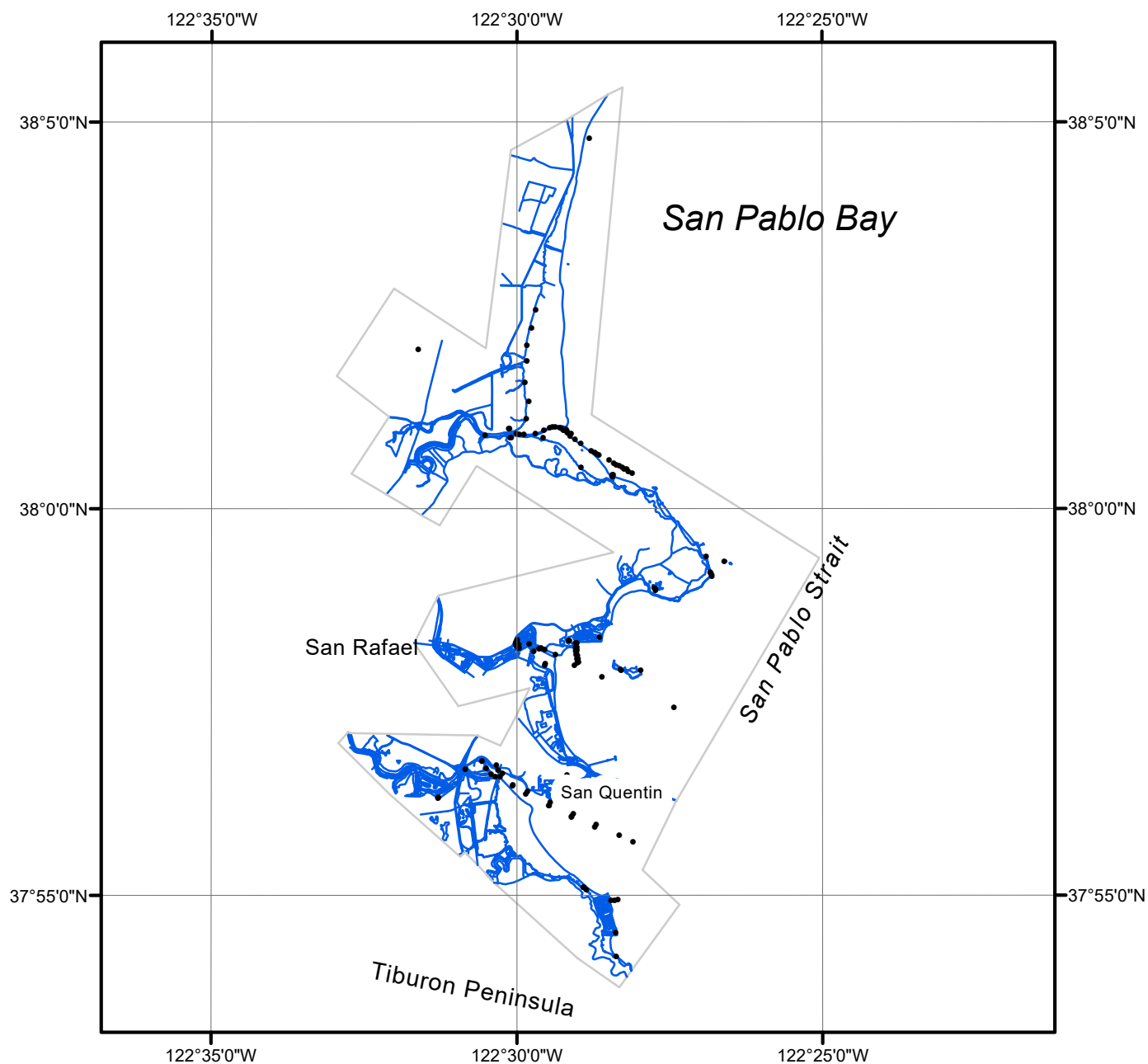
### NOAA Shoreline Data Explorer

- GC11567 in shapefile format
- Metadata file for GC11567
- PCR in Adobe PDF format

## End of Report

# SAN FRANCISCO BAY, TIBURON PENINSULA TO SAN PABLO BAY

## CALIFORNIA



Overview



CA1212E-CM-N

GC11567