NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT CA1213F-CM-N

San Francisco Bay, Belmont Slough to Ravenswood Slough, California

Introduction

NOAA Coastal Mapping Program (CMP) Project CA1213F-CM-N provides highly accurate coastal feature data of San Francisco Bay from Belmont Slough to Ravenswood Slough, in California. Project CA1213F-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 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.

GPS Data Reduction

GPS/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 in May and November 2013, and in March 2014 using Applanix POSPac MMS (ver. 6.1.0 and 6.2)

software. For further information refer to the Airborne Positioning and Orientation Report (APOR) that is on file with other project data within the RSD Electronic Data Library.

Aerotriangulation

Routine softcopy aerotriangulation methods were applied to establish a network of precise camera positions and other control for mapping, and to provide model parameters and orientation elements required for digital compilation. This work was performed by RSD Applications Branch (AB) personnel in March 2018 utilizing a Digital Photogrammetric Workstation (DPW), which is a configuration of computer hardware, modular software components, and other associated peripheral devices. For subproject CA1213F-CM-N, a subset of 332 images from five flight lines were measured and adjusted as a single block using the Multi-Sensor Triangulation (MST) module of BAE Systems SOCET SET (ver. 5.6) software. Upon successful completion of this process, the MST module provided the standard deviations for all aerotriangulated ground points, which were used to compute a predicted horizontal circular error of 0.28 meters based on a 95% confidence level. An Aerotriangulation Report was written 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 (NAD83).

Compilation

The data compilation phase of this project was accomplished by AB personnel in April 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 CA1213F-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 0.6 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 aerotriangulation statistics.

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	
04/17/2013	19:23 – 19:26	13NC13	2623 – 2636	13NR09	1853– 1866	0.1
04/17/2013	19:31 – 19:34	13NC13	2637 – 2654	13NR09	1867 – 1884	0.1 – 0.2
04/17/2013	19:45 – 19:47	13NC13	2690 – 2707	13NR09	1920 – 1927	0.0 – 0.1
04/17/2013	19:53 – 19:56	13NC13	2708 – 2725	13NR09	1938 – 1955	0.0 – 0.2
04/26/2013	20:39 – 20:41	13NC20	4445 – 4458	13NR16	3669 – 3682	1.9 – 2.2

04/26/2013	20:46 – 20:49	13NC20	4459 – 4473	13NR16	3683 – 3697	1.9 – 2.2
04/26/2013	20:58 – 21:00	13NC20	4508 – 4525	13NR16	3732 – 3749	2.0 – 2.2
04/26/2013	21:05 – 21:07	13NC20	4526 – 4543	13NR16	3750 – 3767	2.0 – 2.1
04/26/2013	21:17 – 21:19	13NC20	4569 – 4586	13NR16	3793 – 3810	2.0 – 2.2
05/01/2013	20:10 – 20:12	13NC27	5393 – 5407	13NR22	4548 – 4562	-0.1 – 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 2.07 – 2.38 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 April 2018. The review process included analysis of the 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 Esri's ArcGIS (ver. 10.5) 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

End Products and Deliverables

The following specifies the location and identification of the products generated during the completion of this project:

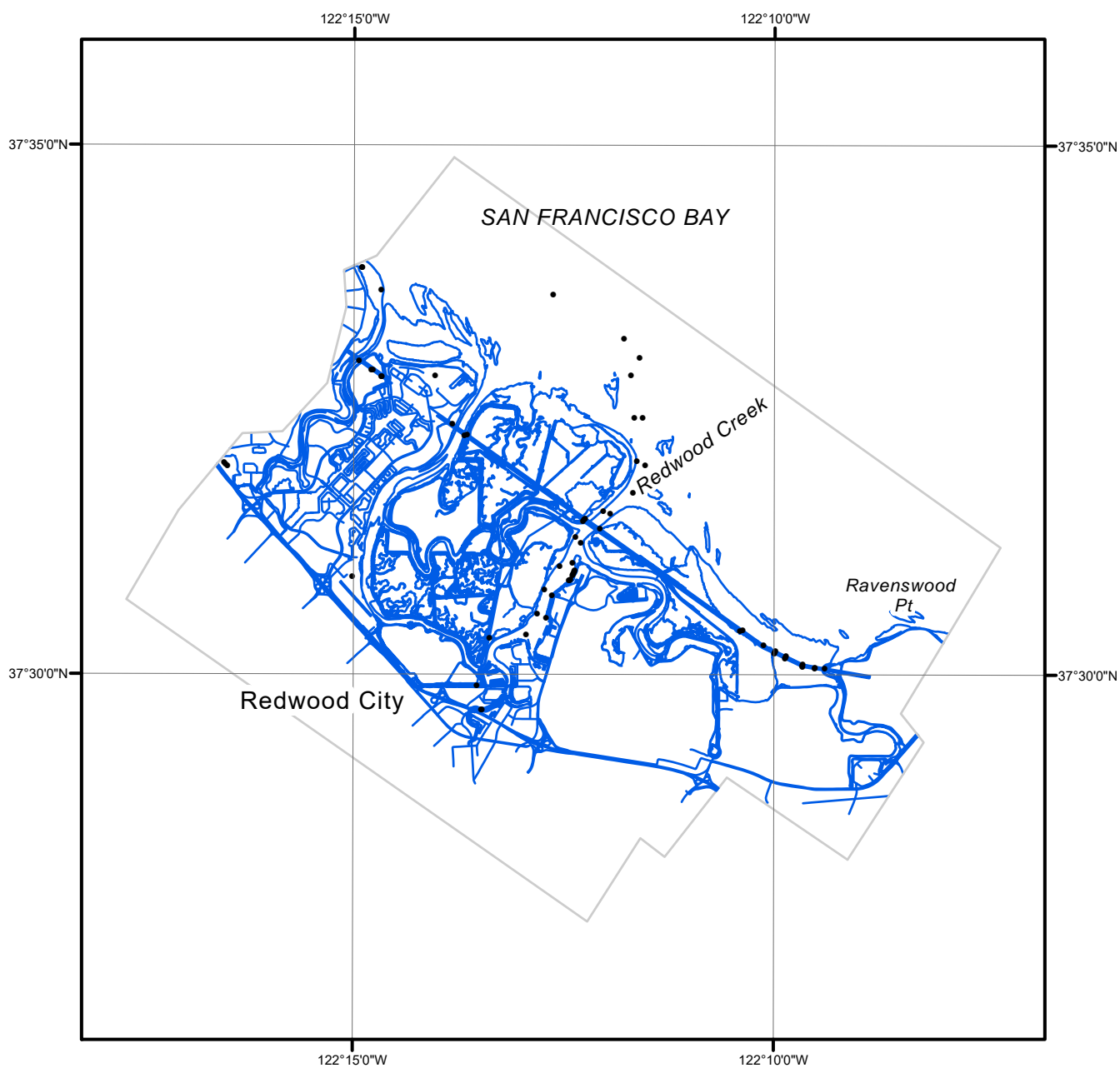**Remote Sensing Division Electronic Data Library**
  - Project database
  - Airborne Positioning and Orientation Reports (APOR)
  - Aerotriangulation Report
  - GC11407 in shapefile format
  - Project Completion Report (PCR)
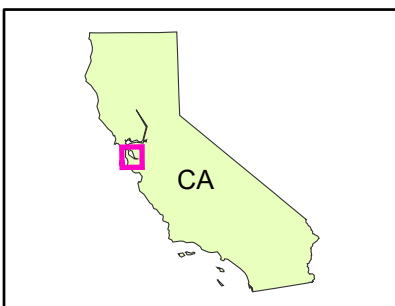 - CEF in shapefile format

NOAA Shoreline Data Explorer
  - GC11407 in shapefile format
  - Metadata file for GC11407
  - Digital copy of the PCR in Adobe PDF format

End of Report

SAN FRANCISCO BAY, BELMONT SLOUGH

TO RAVENSWOOD SLOUGH, CALIFORNIA

122°15'0"W

122°10'0"W

37°35'0"N

37°35'0"N

SAN FRANCISCO BAY

Redwood Creek

Ravenswood Pt.

37°30'0"N

37°30'0"N

Redwood City

122°15'0"W

122°10'0"W

Overview

CA

CA1213F-CM-N

GC11407