

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT WA1002C-CM-N

Fidalgo Island to Southern Whidbey Island, Washington

Introduction

NOAA Coastal Mapping Program (CMP) Project WA1002C-CM-N provides a highly accurate database of new digital shoreline data extending from western Fidalgo Island southward to Mutiny Bay and Langley, near the southern end of Whidbey Island. This project is a subproject of a larger acquisition project, WA1002-CM-N, covering an area of eastern Puget Sound from Shannon Point to Priest Point, and including Whidbey Island in its entirety. 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 Requirements Branch (RB) of the Remote Sensing Division (RSD) formulated the photographic mission instructions for WA1002-CM-N following the guidelines of the Photo Mission Standard Operating Procedure. The instructions discussed the project's purpose, geographic area of coverage, scope and priority; photographic requirements; flight line priority; global positioning system (GPS) data collection procedures and guidelines for both kinematic and static surveys; data recording and handling instructions; and contact and communication information. RB created a Project Layout Diagram, flight maps and input files for the aircraft's flight management system.

Field Operations

The field operations for WA1002-CM-N consisted of the collection of static and kinematic GPS data and the acquisition of digital aerial imagery. Aerial survey operations were conducted with the NOAA King Air (N68RF) aircraft from August 2013 to July 2014. A total of 26 flight lines of aerial imagery were acquired in coordination with both Mean High Water (MHW) and Mean Lower Low Water (MLLW) tide stages. In each flight both natural color (RGB) and black & white near-infrared (NIR) imagery were collected concurrently using an Applanix DSS 439 dual camera system. For this subproject, portions of 15 flight lines (2416 images in all) were used. All imagery was acquired at a nominal altitude of 10,000 feet, resulting in an approximate ground sample distance (GSD) of 0.35 meters.

GPS Data Processing

GPS/IMU data were processed by RSD personnel to yield precise camera positions and orientations for direct georeferencing (DG) of the imagery and for application as photogrammetric control in the aerotriangulation (AT) 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 between November 2013 and August 2014 using POSPac

MMS (ver. 6.1 and 6.2) processing software. 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 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 (CE95) was calculated to be 1.6 meters.

NGS third order geodetic control points were used to test the horizontal integrity of the DG data. All stereo models were examined and found to have acceptable levels of parallax for mapping purposes. All positional data is referenced to the North American Datum of 1983 (NAD 83).

Aerotriangulation

Aerotriangulation was performed using a subset of the imagery near the center of the project area, surrounding Penn Cove and Oak and Crescent Harbors, to improve the horizontal accuracy in the areas covered by large-scale charts. This work was completed by RSD personnel in May 2020 utilizing a softcopy photogrammetric workstation with BAE Systems' SOCET SET (ver. 5.6) photogrammetric software. All of the imagery in the subset area were measured and adjusted as two separate blocks, one consisting of the MHW images, and the other consisting of the MLLW images. Upon successful completion of the AT process, the standard deviations of the residuals for each adjusted ground point were extracted and used to compute a predicted horizontal circular error at the 95% confidence level of 0.36 meters for the MHW imagery and 0.38 meters for the MLLW imagery. An AT Report was completed and is on file with other project data within the RSD Electronic Data Library.

The project database consists of project parameters and options, camera calibration data, interior orientation parameters, ground control parameters, adjusted exterior orientation parameters, and positional listing of all measured points.

Compilation

The data compilation phase of the project was initiated by RSD personnel in June 2020. Cartographic feature data was extracted using BAE Systems' SOCET GXP software. 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, U.S. Coast Guard Light List 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 WA1002C-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. In the AT subset area cartographic features were compiled to meet a horizontal accuracy of 0.7 meters for features compiled from the MHW imagery, and 0.8 meters for features compiled from the MLLW imagery, based on a

doubling of the circular error derived from the AT statistics. In the rest of the project area, cartographic features were compiled to meet a horizontal accuracy of 3.2 meters, based on a doubling of the uncertainty calculated using the EO-TPU tool. These are predicted accuracies of well-defined points at the 95% confidence level.

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

Date	Time (UTC)	Roll #	Strip / Photo #s	Tide Level*
08-22-2013	00:07 – 00:13	13NC53 13NR48	550003 / 11394 – 11439 250003 / 10069 – 10114	2.3 – 2.9 m
08-22-2013	00:18 – 00:25	13NC53 13NR48	550004 / 11440 – 11486 250004 / 10115 – 10161	2.3 – 3.3 m
08-22-2013	18:44 – 18:45	13NC54 13NR49	650001 / 11815 – 11822 350001 / 10490 – 10497	0.0 m
08-22-2013	18:50 – 18:51	13NC54 13NR49	650002 / 11823 – 11830 350002 / 10498 – 10505	0.0 m
08-22-2013	18:56 – 19:02	13NC54 13NR49	650003 / 11831 – 11876 350003 / 10506 – 10551	0.0 – 0.1 m
08-23-2013	00:06 – 00:07	13NC55 13NR50	550002 / 12280 – 12287 250002 / 10955 – 10962	2.2 m
08-23-2013	00:11 – 00:12	13NC55 13NR50	550001 / 12288 – 12295 250001 / 10963 – 10970	2.2 – 2.3 m
05-01-2014	19:59 – 20:06	14NC41 14NR34	650007 / 09141 – 09193 350007 / 06221 – 06273	-0.3 – -0.1 m
05-01-2014	20:11 – 20:18	14NC41 14NR34	650005 / 09194 – 09243 350005 / 06274 – 06323	-0.3 – -0.1 m
05-01-2014	20:24 – 20:30	14NC41 14NR34	650004 / 09257 – 09303 350004 / 06337 – 06383	-0.3 – 0.0 m
05-01-2014	20:35 – 20:42	14NC41 14NR34	650006 / 09304 – 09354 350006 / 06384 – 06434	-0.2 – 0.1 m
05-01-2014	20:50 – 20:58	14NC41 14NR34	650011 / 09392 – 09450 350011 / 06472 – 06530	-0.2 – 0.1 m
05-01-2014	21:03 – 21:06	14NC41 14NR34	650012 / 09451 – 09478 350012 / 06531 – 06558	-0.2 – 0.1 m
05-01-2014	21:25 – 21:31	14NC41 14NR34	650013 / 09574 – 09614 350013 / 06654 – 06694	-0.1 – 0.2 m
06-25-2014	23:01 – 23:08	14NC56 14NR47	550005 / 11602 – 11651 250005 / 08353 – 08402	2.1 – 2.9 m
06-25-2014	23:13 – 23:21	14NC56 14NR47	550006 / 11652 – 11702 250006 / 08403 – 08453	2.1 – 3.0 m
06-25-2014	23:32 – 23:40	14NC56 14NR47	550007 / 11746 – 11798 250007 / 08497 – 08549	2.2 – 3.1 m
06-25-2014	23:45 – 23:54	14NC56 14NR47	550008 / 11799 – 11852 250008 / 08550 – 08603	2.2 – 3.2 m
06-26-2014	00:04 – 00:12	14NC56 14NR47	550009 / 11892 – 11947 250009 / 08643 – 08698	2.2 – 3.3 m
07-26-2014	17:11 – 17:17	14NC58 14NR49	650008 / 12532 – 12576 350008 / 09283 – 09327	-0.1 – 0.5 m
07-26-2014	17:25 – 17:31	14NC58 14NR49	650009 / 12597 – 12641 350009 / 09348 – 09392	-0.2 – 0.4 m

07-26-2014	17:40 – 17:46	14NC58 14NR49	650010 / 12678 – 12722 350010 / 09429 – 09473	-0.2 – 0.3 m
07-27-2014	00:17 – 00:22	14NC60 14NR51	550010 / 13130 – 13169 250010 / 09878 – 09917	3.0 m
07-27-2014	00:43 – 00:45	14NC60 14NR51	550010 / 13208 – 13226 250010 / 09956 – 09974	2.1 – 3.1 m
07-27-2014	00:50 – 00:54	14NC60 14NR51	550011 / 13227 – 13251 250011 / 09975 – 09999	2.1 – 3.2 m
07-27-2014	00:57 – 00:58	14NC60 14NR51	550011 / 13278 – 13285 250011 / 10026 – 10033	2.1 – 3.2 m
07-27-2014	17:04 – 17:05	14NC61 14NR52	650008 / 13319 – 13327 350008 / 10067 – 10075	-0.1 – 0.5 m
07-27-2014	17:10 – 17:11	14NC61 14NR52	650009 / 13328 – 13338 350009 / 10076 – 10086	-0.2 – 0.4 m
07-27-2014	17:16 – 17:17	14NC61 14NR52	650010 / 13339 – 13350 350010 / 10087 – 10098	-0.2 – 0.3 m
07-27-2014	17:59 – 18:05	14NC61 14NR52	650014 / 13459 – 13499 350014 / 10207 – 10247	-0.2 – 0.0 m
07-27-2014	18:10 – 18:16	14NC61 14NR52	650015 / 13500 – 13541 350015 / 10248 – 10289	-0.2 – -0.1 m
07-28-2014	00:29 – 00:33	14NC62 14NR53	550012 / 14051 – 14078 250012 / 10799 – 10826	2.0 – 2.8 m
07-28-2014	00:38 – 00:43	14NC62 14NR53	550013 / 14079 – 14119 250013 / 10827 – 10867	1.9 – 2.9 m
07-28-2014	01:01 – 01:06	14NC62 14NR53	550014 / 14213 – 14253 250014 / 10961 – 11001	2.0 – 3.1 m
07-28-2014	01:11 – 01:16	14NC62 14NR53	550015 / 14254 – 14295 250015 / 11002 – 11043	2.0 – 3.1 m

* Tide levels given in meters above MLLW and were calculated using the Pydro software tool with a TCARI grid referenced to verified water level observations at NOS gauges. The height of the MHW tidal datum in the project area ranges from 2.18 to 3.10 meters 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 September 2020. The review process included analysis of 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 ArcGIS (ver. 10.8.1) software. All project data was evaluated for compliance to CMP requirements.

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

- 18427, Anacortes to Skagit Bay, WA, 25th Ed., Oct. 2019
- 18428, Oak and Crescent Harbors, WA, 10th Ed., Oct. 2010
- 18429, Rosario Strait South Part, WA, 11th Ed., May 2014
- 18441, Puget Sound, Northern Part, WA, 48th Ed., Jan. 2017

- 18464, Port Townsend, WA, 25th Ed., Jul. 2006
- 18471, Approaches to Admiralty Inlet, WA, 11th Ed., Dec. 2007
- 18473, Oak Bay to Shilshole Bay Puget Sound, WA, 9th Ed., Apr. 2016

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)
- AT Report
- Project Completion Report (PCR)
- Project database
- GC11658 in shapefile format
- CEF in shapefile format

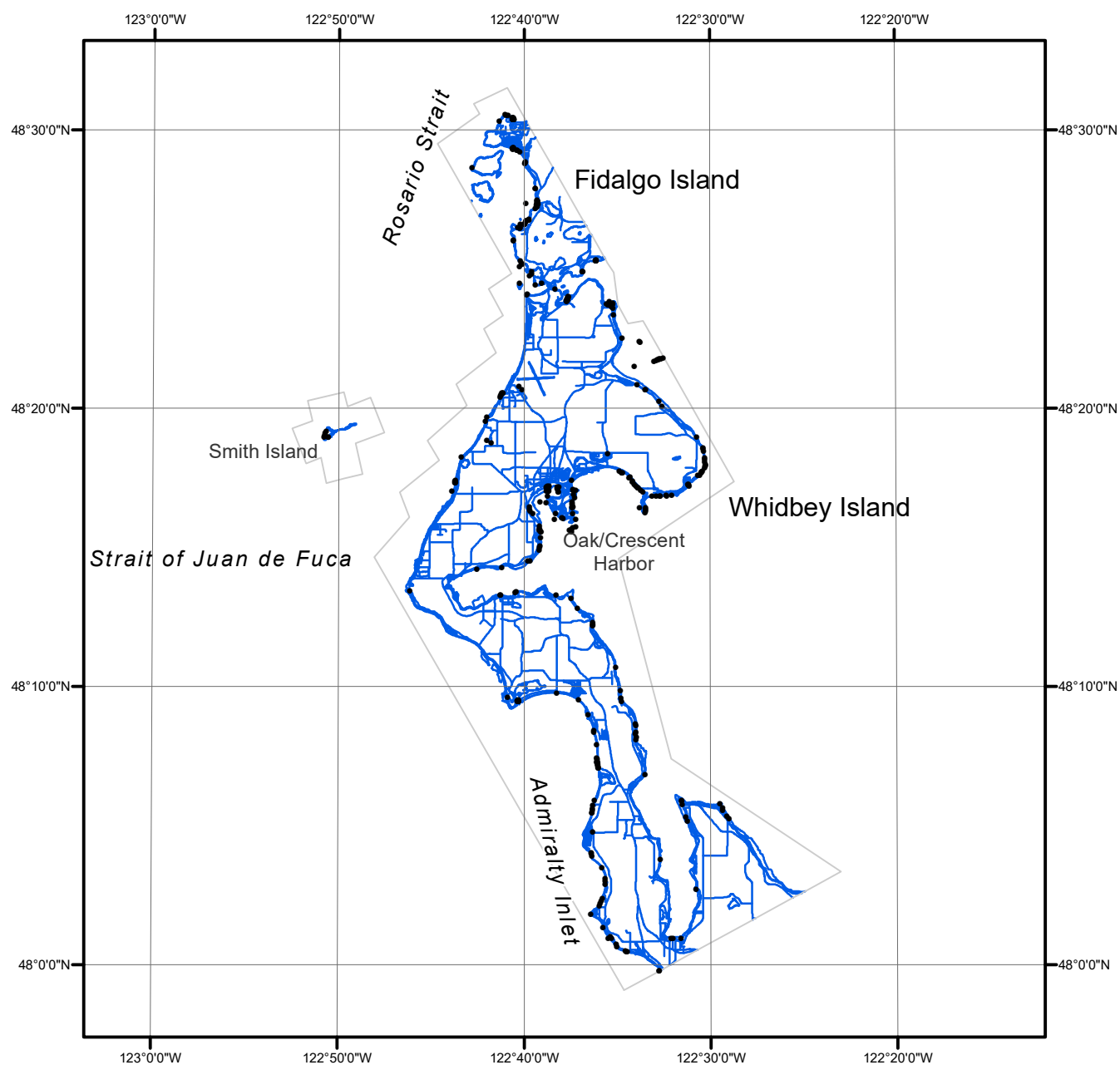
NOAA Shoreline Data Explorer

- GC11658 in shapefile format
- Metadata file for GC11658
- PCR in Adobe PDF format

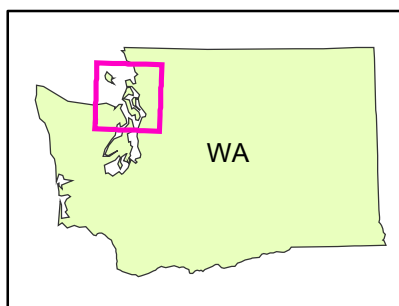
End of Report

FIDALGO ISLAND TO SOUTHERN WHIDBEY ISLAND

WASHINGTON



Overview



WA1002C-CM-N

GC11658