NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT WA1002E-CM-N

Camano Island and Port Susan, Washington

Introduction

NOAA Coastal Mapping Program (CMP) Project WA1002E-CM-N provides a highly accurate database of new digital shoreline data for Camano Island and Port Susan southward to Priest Point. 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 14 flight lines (1908 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.

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 from November 2013 to 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 was calculated to be 1.67 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).

Compilation

The data compilation phase of this project was accomplished by RSD Applications Branch (AB) personnel in March 2021. 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 image analysis of the aerial imagery and information extracted from the largest scale NOAA nautical chart 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 WA1002E-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 3.3 meters at the 95% confidence level. This predicted accuracy of compiled well-defined points is derived by doubling the horizontal uncertainty calculated from the EO-TPU tool.

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

Date	**Time (UTC)**	**Roll #**	**Strip / Photo #s**	**Tide Level***
08-22-13	19:10 – 19:13	13NC54 13NR49	650017 / 11883 – 11905 350017 / 10558 - 10580	0.0 m
08-22-13	19:26 – 19:29	13NC54 13NR49	650018 / 11962 - 11984 350018 / 10637 - 10659	-0.1 – 0.0 m
08-22-13	19:33 – 19:35	13NC54 13NR49	650022 / 11985 - 11999 350022 / 10660 - 10674	n/a **
08-22-13	19:56 – 19:58	13NC54 13NR49	650021 / 12066 - 12080 350021 / 10741 - 10755	n/a **
08-22-13	20:02 – 20:04	13NC54 13NR49	650020 / 12081 - 12096 350020 / 10756 - 10771	n/a **
08-22-13	20:14 – 20:17	13NC54 13NR49	650019 / 12133 - 12155 350019 / 10808 - 10830	0.0 – 0.2 m
04-13-14	23:28 – 23:35	14NC34 14NR27	550016 / 08042 - 08088 250016 / 05122 - 05168	2.9 m

04-13-14	23:48 – 23:51	14NC34 14NR27	550017 / 08144 - 08166 250017 / 05224 - 05246	2.9 m
04-14-14	00:11 – 00:14	14NC34 14NR27	550018 / 08195 - 08217 250018 / 05275 - 05297	2.9 – 3.0 m
04-14-14	00:19 – 00:22	14NC34 14NR27	550019 / 08218 - 08240 250019 / 05298 - 05320	2.9 – 3.0 m
04-14-14	00:32 – 00:34	14NC34 14NR27	550020 / 08277 - 08292 250020 / 05357 - 05372	n/a **
04-30-14	21:04 – 21:10	14NC40 14NR33	650016 / 09035 - 09081 350016 / 06115 - 06161	-0.1 – 0.1 m
05-01-14	20:48 – 20:55	14NC41 14NR34	650011 / 09378 - 09427 350011 / 06458 - 06507	-0.2 m
05-01-14	21:07 – 21:13	14NC41 14NR34	650012 / 09477 - 09526 350012 / 06557 - 06606	-0.2 – 0.0 m
05-01-14	21:19 – 21:25	14NC41 14NR34	650013 / 09527 - 09575 350013 / 06607 - 06655	-0.1 – 0.1 m
05-01-14	21:41 – 21:47	14NC41 14NR34	650014 / 09655 - 09701 350014 / 06735 - 06781	0.0 – 0.3 m
06-26-14	00:06 – 00:09	14NC56 14NR47	550009 / 11904 - 11920 250009 / 08655 - 08671	3.2 m
06-26-14	00:24 – 00:26	14NC56 14NR47	550021 / 11969 - 11983 250021 / 08720 - 08734	n/a **
06-26-14	00:30 – 00:33	14NC56 14NR47	550022 / 11984 - 11998 250022 / 08735 - 08749	n/a **
07-26-14	17:27 – 17:30	14NC58 14NR49	650009 / 12613 - 12629 350009 / 09364 - 09380	-0.1 m
07-26-14	17:41 – 17:45	14NC58 14NR49	650010 / 12684 - 12713 350010 / 09435 - 09464	-0.2 m
07-27-14	00:18 – 00:22	14NC60 14NR51	550010 / 13136 - 13165 250010 / 09884 - 09913	3.0 m
07-27-14	00:54 – 01:01	14NC60 14NR51	550011 / 13250 - 13300 250011 / 10000 - 10048	3.2 m
07-27-14	17:53 – 18:00	14NC61 14NR52	650014 / 13413 - 13459 350014 / 10161 - 10207	-0.1 – 0.0 m
07-27-14	18:16 – 18:22	14NC61 14NR52	650015 / 13540 - 13586 350015 / 10288 - 10334	-0.2 – -0.1 m
07-28-14	00:23 – 00:30	14NC62 14NR53	550012 / 14003 - 14052 250012 / 10751 - 10800	2.8 – 2.9 m
07-28-14	00:43 – 00:50	14NC62 14NR53	550013 / 14118 - 14166 250013 / 10866 - 10914	2.9 – 3.1 m
07-28-14	00:55 – 01:01	14NC62 14NR53	550014 / 14167 - 14213 250014 / 10915 - 10961	3.0 – 3.1 m
07-28-14	01:17 – 01:23	14NC62 14NR53	550015 / 14294 - 14340 250015 / 11042 - 11088	3.1 – 3.2 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 2.20 to 3.11 meters above MLLW.

** Portions of the Stillaguamish River are considered to be non-tidal and water levels were not determined.

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 2021. The review process included analysis of the DG 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:

- 18441, Puget Sound, Northern Part, WA, 48th Ed., Jan. 2017
- 18443, Approaches to Everett, WA, 17th Ed., Jan. 2010

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)
- Project Completion Report (PCR)
- Project database
- GC11675 in shapefile format
- CEF in shapefile format

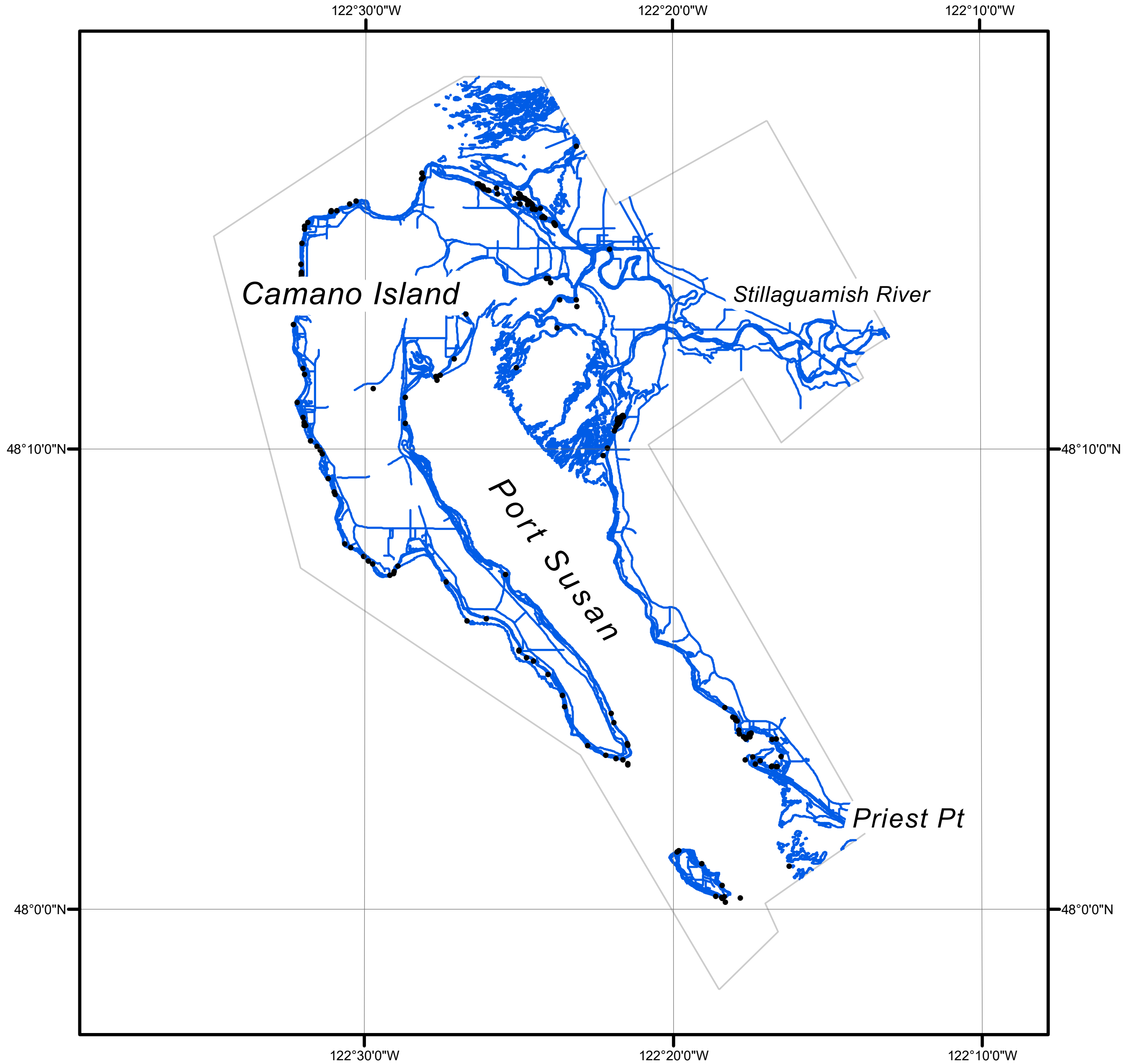
NOAA Shoreline Data Explorer

- GC11675 in shapefile format
- Metadata file for GC11675
- PCR in Adobe PDF format

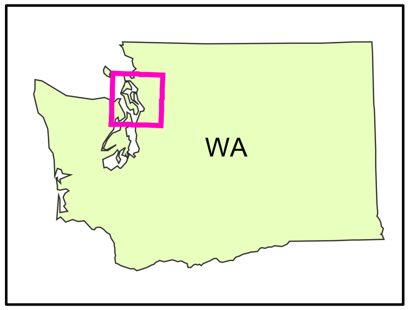
End of Report

CAMANO ISLAND AND PORT SUSAN

WASHINGTON



Overview



WA1002E-CM-N

GC11675