

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT SC0801D

Beaufort River, Broad River to Ladys Island, South Carolina

Introduction

NOAA Coastal Mapping Program (CMP) Project SC0801D provides highly accurate digital shoreline data for Beaufort River and nearby tributaries near the coast of South Carolina. SC0801D is a subproject of the larger project SC0801 which extends from St. Helena Sound inland to Huspa Creek and south from Port Royal Sound inland to Coosawhatchie River. 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 photographic mission instructions for this project following standard mission guidelines. 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.

Subsequent to the compilation and review phases of project completion, a commercial satellite image was obtained and incorporated into the project in order to provide the latest alignment of a newly expanded bridge within the project. One orthorectified, pan-sharpened natural color GeoEye-1 image was obtained from Digital Globe, Inc. for this purpose. The image has a ground sample distance (GSD) of 0.42 meters and was found to match the spatial positioning of project aerial imagery very well with no need of further georeferencing tasks. Compilation from this source was performed by RSD personnel.

Field Operations

The field operations consisted of the collection of static and kinematic GPS data, Inertial Measurement Unit (IMU) data, and the acquisition of aerial imagery. The photographic mission operations were conducted from October 2009 through February 2013 with the NOAA Citation II (N52RF) and King Air (N68RF) aircraft. Twenty-six flight lines of color and near-infrared (NIR) digital images were acquired concurrently with an Applanix Digital Sensor System (DSS) 439 aerial camera system with one set of color and NIR digital images acquired within tolerance of Mean High Water (MHW) and another set of color and NIR digital images acquired within tolerance of the Mean Lower Low Water (MLLW). All imagery was acquired at a nominal altitude of 10,000 feet, resulting in an approximate GSD of 0.35 meters.

Quantum Spatial, Inc. (QSI) was contracted by RSD to survey ground control points (GCPs). Two GCPs were established within subproject SC0801D using static GPS techniques. Survey field work was performed between August and October 2017. A Ground Photo Control Report was written and is on file with other project data within the RSD Electronic Data Library.

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. 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 final processing of kinematic GPS data using Applanix POSPAC MMS (ver. 6.1) was in performed March 2013. For more information refer to the Airborne Positioning and Orientation Reports (APOR) on file in the RSD Electronic Data Library.

Aerotriangulation

Routine softcopy aerotriangulation (AT) 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 QSI personnel in January 2018 utilizing a digital photogrammetric workstation (DPW), which consists of a stereo-enabled PC-based graphics workstation running the Windows 7 operating system and a suite of digital photogrammetric software known as DAT/EM Summit Evolution (ver. 7.5). The DAT/EM software was used to import the photo measurements, while the Match AT software system (ver. 5.6) was used to perform tie point measurements, both automatic and interactive, and to perform the final block adjustment. Color and NIR images were measured and adjusted as two separate blocks. The final adjustment of the blocks was accomplished by using a rigorous simultaneous least squares bundle adjustment, and analysis tools within Match AT were used to refine the AT solution and to evaluate the accuracy of the adjustment. Upon successful completion of this process, Match AT provided the standard deviations for each aerotriangulated ground point, which were used to compute a predicted horizontal circular error of 0.47 meters for the color images and 1.54 meters for the NIR images. Both of these values are based on a 95% confidence level. An AT 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 initiated by QSI personnel in February 2018. DAT/EM Summit Evolution Professional (ver. 7.5) photogrammetric software was used to extract feature data from stereo imagery, and feature identification, capture, segmentation, and attribution occurred within an ArcMap (ver. 10.4.1) file geodatabase using DAT/EM's stereo module. 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), 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 SC0801D were determined according to standard Federal Geographic Data Committee (FGDC) practices. Most cartographic features were compiled to meet a horizontal accuracy of 0.9 meters. The MLLW depth contour features extracted from the NIR imagery were compiled to meet a horizontal accuracy of 3.1 meters. These predicted accuracies of compiled well-defined points, computed at the 95% confidence level, are derived by doubling the horizontal uncertainties calculated from the AT statistics. Additional features compiled from satellite imagery using Esri's ArcGIS (ver. 10.7.1), were compiled to the same accuracy as the majority of the project indicated above.

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

Aerial Imagery						
Date	Time (UTC)	Color		NIR		Tide Level*
		Roll	Strip/Images	Roll	Strip/Images	
11-04-09	15:43-15:44	09NC19	50-005 / 05553-05562	09NR20	50-005 / 05397-05406	2.2 – 2.3 m
11-04-09	15:56-15:58	09NC19	50-028 / 05605-05619	09NR20	50-028 / 05449-05463	2.1 – 2.7 m
11-04-09	16:02-16:03	09NC19	50-029 / 05620-05631	09NR20	50-029 / 05464-05475	2.3 – 2.6 m
11-04-09	16:08-16:09	09NC19	50-030 / 05632-05642	09NR20	50-030 / 05476-05486	2.5 m
11-04-09	16:13-16:14	09NC19	50-031 / 05643-05650	09NR20	50-031 / 05487-05494	2.4 – 2.5 m
11-04-09	16:45-16:47	09NC19	50-020 / 05744-05755	09NR20	50-020 / 05588-05599	2.2 – 2.4 m
11-06-09	17:31-17:34	09NC12	50-027 / 04077-04101	09NR13	50-027 / 03921-03945	2.1 – 2.7 m
11-06-09	17:39-17:42	09NC12	50-026 / 04103-04127	09NR13	50-026 / 03947-03971	2.1 – 2.7 m
11-06-09	17:48-17:51	09NC12	50-022 / 04137-04161	09NR13	50-022 / 03981-04005	2.3 – 2.7 m
11-06-09	17:57-17:59	09NC12	50-021 / 04167-04184	09NR13	50-021 / 04011-04028	2.3 – 2.6 m
11-07-09	15:18-15:21	09NC21	50-025 / 05926-05951	09NR22	50-025 / 05770-05795	1.9 – 2.3 m
11-07-09	15:35-15:37	09NC21	50-014 / 05976-05993	09NR22	50-014 / 05820-05837	1.8 – 2.4 m
11-08-09	19:09-19:13	09NC23	50-024 / 06665-06691	09NR24	50-024 / 06509-06535	2.0 – 2.6 m
11-08-09	19:17-19:21	09NC23	50-023 / 06694-06721	09NR24	50-023 / 06538-06565	2.1 – 2.5 m
03-24-10	13:46-13:47	10NC36	50-031 / 16458-16465	10NR27	50-031 / 13854-13861	0.1 m
03-24-10	13:52-13:53	10NC36	50-030 / 16466-16476	10NR27	50-030 / 13862-13872	0.1 m
03-24-10	13:58-14:00	10NC36	50-029 / 16477-16488	10NR27	50-029 / 13873-13884	0.1 m
03-25-10	15:23-15:25	10NC37	50-021 / 16676-16693	10NR28	50-021 / 14072-14089	0.1 – 0.2 m
03-25-10	15:33-15:34	10NC37	50-020 / 16702-16713	10NR28	50-020 / 14098-14109	0.1 – 0.2 m
03-30-10	20:49-20:53	10NC38	50-024 / 17029-17055	10NR29	50-024 / 14425-14451	-0.1 – 0.0 m
03-30-10	20:58-21:02	10NC38	50-022 / 17058-17082	10NR29	50-022 / 14454-14478	-0.2 – 0.0 m
03-31-10	20:21-20:23	10NC39	50-028 / 17091-17105	10NR30	50-028 / 14487-14501	-0.2 – 0.0 m
03-31-10	21:08-21:10	10NC39	50-014 / 17203-17217	10NR30	50-014 / 14599-14613	-0.3 – 0.1 m

04-01-10	20:06-20:07	10NC41	50-005 / 17507-17515	10NR32	50-005 / 14903-14911	-0.2 – 0.2 m
04-01-10	20:42-20:46	10NC41	50-027 / 17623-17647	10NR32	50-027 / 15019-15043	-0.3 – 0.3 m
04-01-10	20:52-20:56	10NC41	50-026 / 17649-17673	10NR32	50-026 / 15045-15069	-0.3 – 0.2 m
01-20-12	17:25-17:26	12NC03	50-014 / 00580-00583	12NR02	50-014 / 00239-00242	0.1 m
03-06-12	17:39-17:41	12NC19	50-025 / 04979-04989	12NR10	50-025 / 02018-02028	0.1 – 0.2 m
03-10-12	20:07-20:08	12NC20	50-023 / 05187-05199	12NR11	50-023 / 02226-02238	0.2 – 0.4 m
03-10-12	21:06-21:08	12NC20	50-025 / 05305-05319	12NR11	50-025 / 02344-02358	0.0 – 0.1 m
09-24-12	14:01-14:04	12NC77	50-023 / 28352-28368	12NR60	50-023 / 15117-15133	0.3 – 0.7 m
Satellite Imagery						
Date	Time (UTC)	Source File (Tile) Name				Tide Level
11-13-19	16:13	20191113_GE01_ORI_R1C1.jp2				n/a

* 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 NOS gauges throughout the project area. The height of the MHW tidal datum in the project area ranges between 1.97 – 2.48 meters above MLLW.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a senior member of QSI. The final QC review was completed in February 2019. The review process included analysis of AT 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 software. All project data was evaluated for compliance to CMP requirements.

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

- 11513, St Helena Sound to Savannah River, 28th Ed., Jul. 2018
- 11516, Port Royal Sound and Inland Passages, 32nd Ed., Dec. 2013
- 11519, Parts of Coosaw and Broad Rivers, 13th Ed., May 2014

End Products and Deliverables

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

Remote Sensing Division Electronic Data Library

- Project database
- Ground Photo Control Report
- Airborne Positioning and Orientation Report (APOR)
- Aerotriangulation Report
- GC11323 in shapefile format
- Project Completion Report (PCR)
- CEF in shapefile format

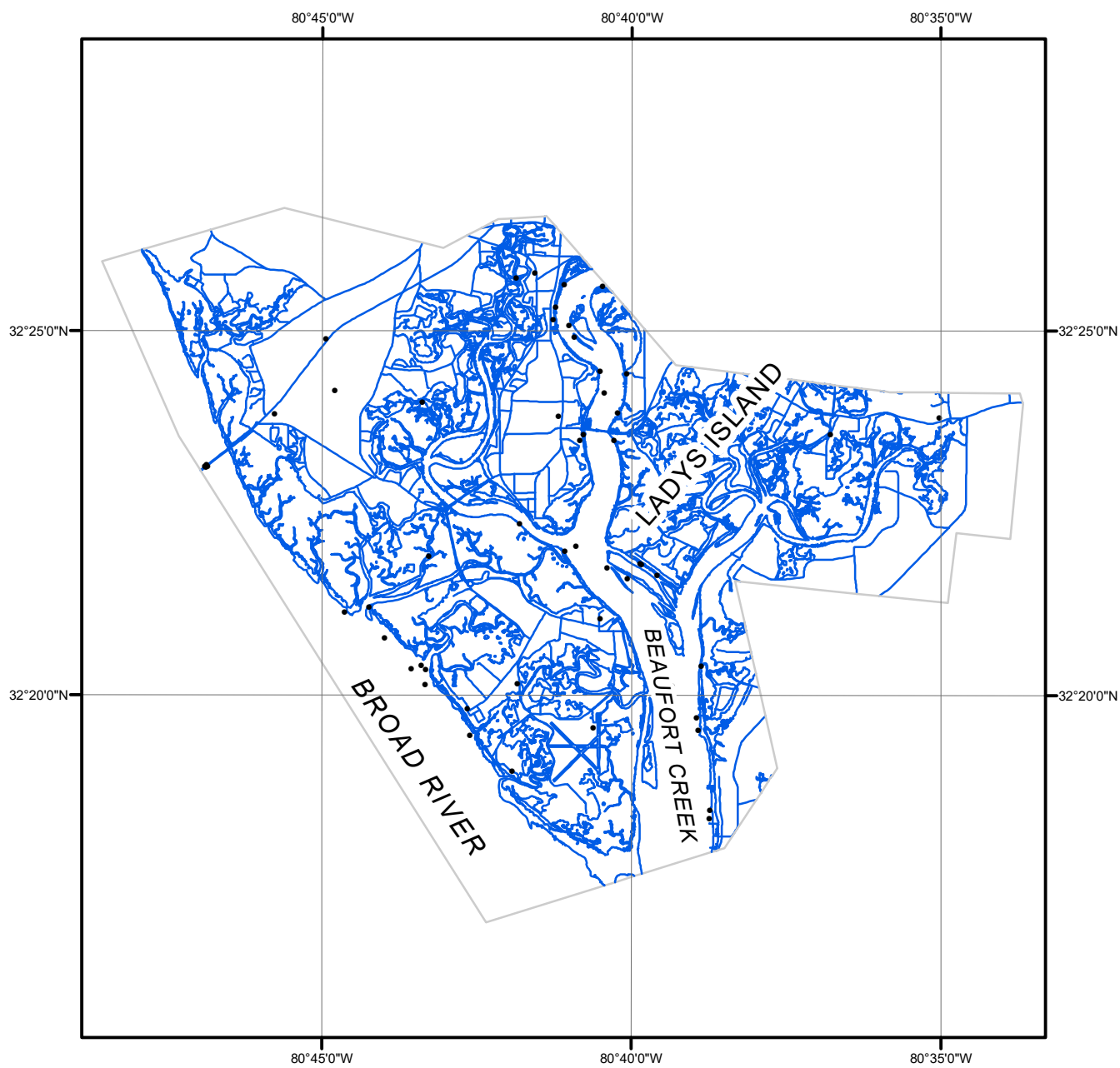
NOAA Shoreline Data Explorer

- GC11323 in shapefile format
- Metadata file for GC11323
- PCR in Adobe PDF format

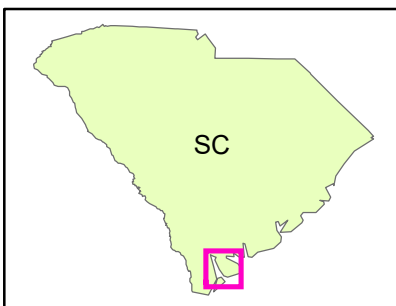
End of Report

BEAUFORT RIVER, BROAD RIVER TO LADYS ISLAND

SOUTH CAROLINA



Overview



SC0801D

GC11323