NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT SC1601H-TB-C

Murphy Island to Winyah Bay, South Carolina

Introduction

NOAA Coastal Mapping Program (CMP) Project SC1601H-TB-C provides a highly accurate database of new digital shoreline data for portions of the outer coast of South Carolina from Murphy Island to Winyah Bay. Project SC1601H-TB-C is a subproject of a larger project, SC1601-TB-C, which extends from Wassaw Sound to Winyah Bay. 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

NOAA's National Geodetic Survey (NGS) Remote Sensing Division (RSD) formulated the Project Instructions for this project following the guidelines of the "Scope of Work, Shoreline Mapping for the Coastal Mapping Program" (SOW), Version 14A, dated October 24, 2012. The instructions discussed the project's purpose, geographic area of coverage, scope and priority; data acquisition, processing, accuracy, and compilation requirements; product delivery and reporting instructions; and contact and communication information. NOAA also provided shapefiles depicting the shoreline to be mapped and the boundaries of the main project area.

Quantum Spatial, Inc. (QSI) was responsible for the planning, acquisition, and processing of all imagery and lidar data in order to support feature compilation. This includes the establishment of ground control and the post-processing of airborne GPS data. In addition, QSI provided shapefiles of the flight lines and exposure centers of the imagery to be used for compilation.

Field Operations

All of the field operations for SC1601-TB-C were conducted by QSI which included the planning, acquisition and post-processing of aerial imagery and lidar data to support photogrammetric processing and feature compilation, as well as the establishment of ground control, the post-processing of airborne GPS data and calibration of the lidar data.

A total of 280 ground control points (GCPs) were established in project SC1601-TB-C using a combination of traditional static, fast-static, rapid-static, real-time kinematic, and post-processed kinematic GPS techniques. Six additional photo-identifiable check points were also occupied at well-defined, discrete locations. Survey field work was performed between July 2016 and February 2017. A Ground Survey Report is on file with other project data within the RSD Electronic Data Library.

The aerial photography acquisition phase of the project was conducted by QSI's subcontractor Richard Crouse and Associates (RCA) between December 2016 and March 2017. A total of 27 flight lines of color-infrared imagery were acquired and tide-coordinated within 25% of the

Mean Range of tide around Mean Lower Low Water (MLLW). Of these flight lines, five were used for the SC1601H-TB-C subproject. Imagery was captured at a nominal altitude of 16,175 feet with an approximate ground sample distance (GSD) of 30 cm, through the use of an Intergraph Z/I Digital Mapping Cameras (DMC IIe) with a focal length of 92 mm and equipped with forward motion compensation and a stabilized camera mount. For further information see the Orthoimagery Project Report on file within the RSD Electronic Data Library.

The lidar acquisition was conducted between December 2016 and March 2017 and consisted of a total of 988 lines flown over 46 lidar acquisition missions with an average point density of 14 pulses per square meter and a nominal swath width of 291 meters and a 30% swath overlap. Topographic/bathymetric (topobathy) green and near-infrared (NIR) lidar data was collected through the use of a Riegl VQ-880-G sensor. The topobathy data was used to derive the Mean High Water (MHW) and MLLW shorelines, while the NIR data was used as an aid to developing the water surface model necessary for applying refraction corrections to the topobathy data. The flight lines were required to be collected within 20% of the mean range of MLLW. For further information about all field operations see the "Topobathymetric Lidar and Shoreline Mapping Report" on file within the RSD Electronic Data Library.

GPS Data Processing

Each acquisition aircraft used by QSI was equipped with either a POSAV Applanix Model 510 Inertial Measurement Unit (IMU) or a dual frequency Trimble BD960 to collect the airborne GPS and IMU data. NGS Continuously Operated Reference Stations (CORS) and several cooperative CORS stations were used for base stations on the project, with at least two of these CORS stations being used to process each POSAV dataset to achieve the final image center locations. For further information refer to the Airborne Positioning and Orientation Report (APOR) on file with other project data within the RSD Electronic Data Library.

Lidar Data Processing

QSI collected the raw topobathymetric lidar data for Project SC1601-TB-C and performed the initial processing and quality control, including calibration, checks for data voids, relative swath accuracy, refraction correction, and preliminary vertical accuracy assessment. Initial processing confirmed that the lidar data products meet or exceed the requirements set out in the Statement of Work.

QSI utilized a variety of software for lidar data processing, including POSPac MMS, RiProcess, TerraMatch, TerraModeler, TerraScan, Esri ArcGIS, Geographic Calculator, and QSI's proprietary lidar processing tool, LasMonkey. Data processing included additional quality checks and accuracy assessments of the preliminary swath data, breakline creation to define the land/water interface, point classification, automated and manual editing of the lidar tiles, QA/QC, and final formatting of the LAS tiles. The final processed lidar products that were delivered to NOAA included breaklines, classified LAS tiles, topobathy DEM tiles, void polygon layer, intensity image tiles, and FGDC compliant metadata files.

NGS received the classified lidar tiles covering the project area and used NOAA VDatum software to convert the vertical datum of the lidar points from NAD83 ellipsoid to local Mean High Water (MHW) and MLLW tidal datums. NGS used QTModeler and custom ArcGIS scripts to produce bare earth MHW and MLLW digital elevation models at a 1 meter grid resolution,

and to create and format the MHW and MLLW vectors into shapefile format. NOAA supplied the lidar-derived MHW and MLLW shapefiles to be segmented, edited, and attributed by QSI. For further information refer to the Topobathymetric Lidar and Shoreline Mapping Report on file with other project data within the RSD Electronic Data Library.

Aerotriangulation

The aerotriangulation (AT) phase of project SC1601-TB-C was performed by QSI using digital AT methods to establish the network of photogrammetric control required for the compilation phase. Bingo software (ver. 6.9) was used to perform automatic point measurements and interactive point measurements of tie points.

The Root Mean Square (RMS) of the standard deviations in both X and Y directions were calculated and used to determine a predicted horizontal circular error of 0.4 meters at the 95% confidence level. An AT Report 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. Positional data is referenced to the North American Datum of 1983 (NAD 83) and the North American Vertical Datum of 1988 (NAVD88).

Compilation

The data compilation phase of the project was initiated by QSI in September 2017. Digital mapping was performed with the DAT/EM Summit Evolution (ver. 7.5) digital photogrammetric software. Feature identification, segmentation, and attribution were based on imagery analysis of the processed digital images and information extracted from the appropriate NOAA Nautical Charts, the 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 subproject SC1601H-TB-C were determined according to standard Federal Geographic Data Committee (FGDC) practices. Stereo compiled cartographic features were compiled to meet a horizontal accuracy of 0.8 meters at the 95% confidence level. This predicted accuracy of compiled, well defined points is derived by doubling the circular error calculated from the AT statistics. The lidar derived features had horizontal accuracies that varied depending on location and shoreline type ranging from 1.5 meters to 2.4 meters.

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

Date	Time (UTC)	Roll ID	Strip ID	Image IDs	Tide Level *
03-03-2017	20:15 – 20:16	1741M03	54-010	0001 – 0009	0.6
03-03-2017	20:20 – 20:25	1741M03	54-009	0030 – 0016	0.5
03-03-2017	20:37 – 20:40	1741M03	54-008	0016 – 0031	0.4
03-03-2017	20:43 – 20:49	1741M03	54-007	0032 – 0016	0.3 – 0.4

03-03-2017	21:00 – 21:02	1741M03	54-006	0011 – 0019	0.2

* Water levels are given in meters above MLLW and are based on verified observations recorded by the NOS tide gauge at Oyster Landing (N Inlet Estuary) in South Carolina. The elevation of the MHW tidal datum at the Oyster Landing gauge is 1.45 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 December 2018. 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 (ver. 10.4) software. All project data was evaluated for compliance to CMP requirements.

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

11532, Winyah Bay, 23rd Ed., Sep. 2019

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
- Ground Survey Report
- Aerotriangulation Report
- Orthoimagery Project Report
- Topobathymetric Lidar and Shoreline Mapping Report
- GC11264 in shapefile format
- Project Completion Report (PCR)
- CEF in shapefile format

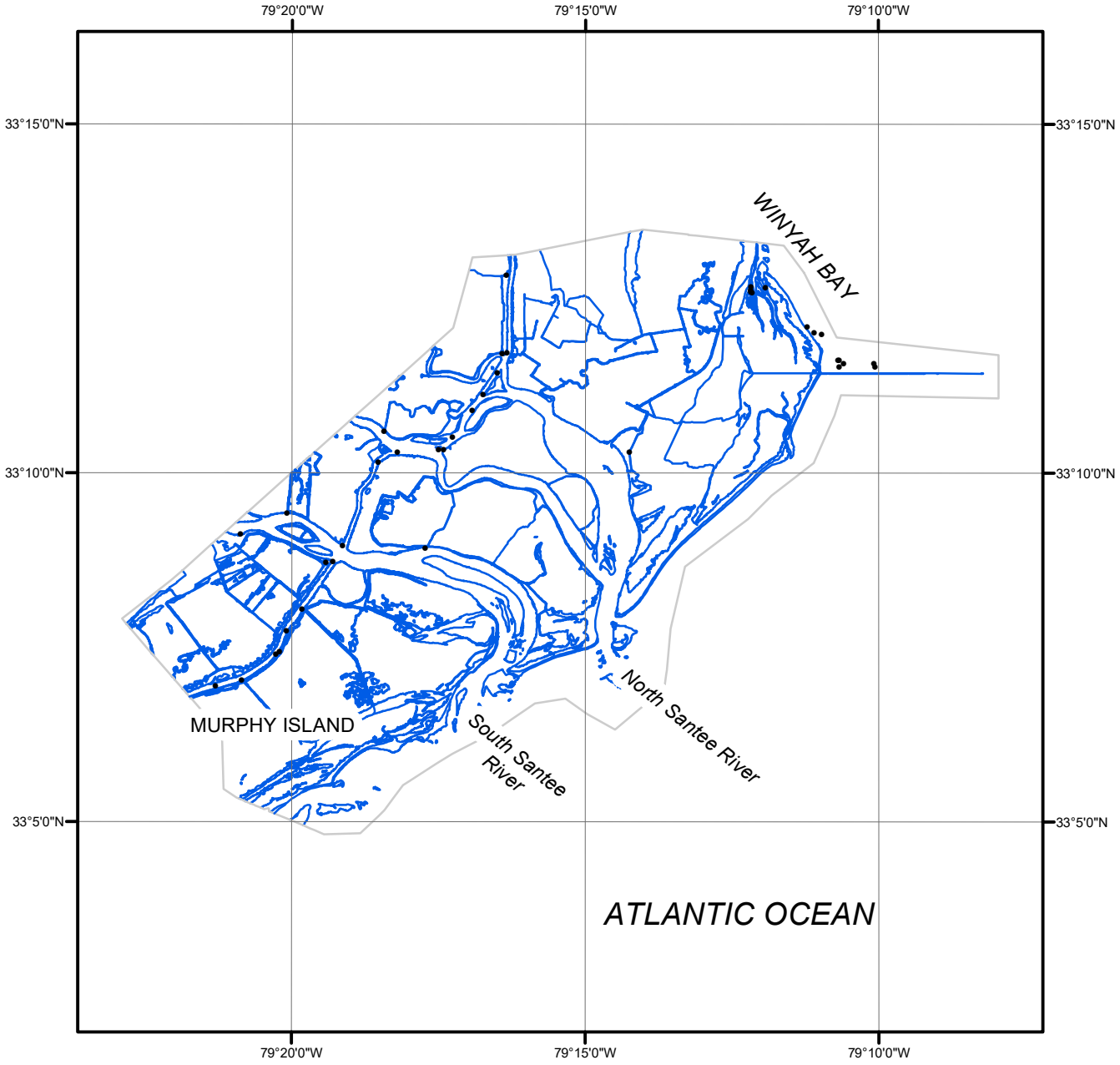
NOAA Shoreline Data Explorer

- GC11264 in shapefile format
- Metadata file for GC11264
- PCR in Adobe PDF format

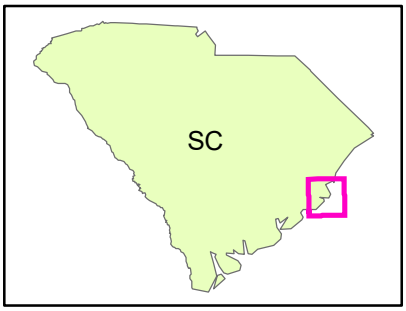
End of Report

MURPHY ISLAND TO WINYAH BAY

SOUTH CAROLINA



Overview



SC1601H-TB-C

GC11264