NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT FL1606E-TB-N

Gasparilla Sound to Pine Island, Florida

Introduction

NOAA Coastal Mapping Program (CMP) Project FL1606E-TB-N provides highly accurate digital shoreline data for a portion of Florida's Gulf Coast from Gasparilla Sound to Pine Island, including the mouth of Charlotte Harbor. Project FL1606E-TB-N is a subproject of a larger acquisition project, FL1606-TB-N, which extends from Fort Desoto to Siesta Key, in Florida. 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

Project FL1606-TB-N was designed by the Requirements Branch (RB) of the Remote Sensing Division (RSD) to provide topographic-bathymetric (topobathy) lidar-derived elevation products in addition to standard GCs. RB formulated the photographic mission instructions for this project following the guidelines of the Photo Mission Standard Operating Procedures. The instructions discussed the project's purpose, geographic area of coverage, scope and priority, imagery and lidar 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

The field operations consisted of acquisition of topobathy lidar data, digital aerial imagery, static and kinematic GPS data, and Inertial Measurement Unit (IMU) data. Static GPS data were collected to support aerial data acquisition and processing operations, as well as to assess the accuracy of post-processed lidar data.

Lidar Data Acquisition

A total of 541 lines of topographic/bathymetric (topobathy) lidar were planned. Lidar data was acquired from May 2016 through November 2017 using a Riegl VQ880G lidar system on board the NOAA Twin Otter Aircraft (N57RF). The data was collected at a nominal altitude of 1,300 feet with a 50% swath overlap (planned single swath point density = 9 pt/m^2).

Digital Aerial Imagery Acquisition

54 lines of natural color (RGB) and near-infrared (NIR) digital aerial imagery were collected in February 2018 using an Applanix Digital Sensor System DSS580/560 camera onboard the NOAA King Air aircraft (N68RF). 17 lines were collected at a nominal altitude of 4,500 feet with ground sample distances (GSD) of 0.14 (RGB) and 0.17 (NIR) meters, and 37 lines were collected at 7,500 feet with GSD of 0.24 (RGB) and 0.27 (NIR) meters. The imagery was

collected within +/- 2 hours of the MLW tide stage. 12 lines were used for this subproject, including 5 flown at the lower altitude and 7 at the higher altitude. The NIR imagery was not used.

Direct Georeferencing Data Processing

GPS and IMU data were processed by RSD personnel to yield precise sensor 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 using Applanix POSPac MMS (ver. 8.2) software in February and March 2018. For further information refer to the Airborne Positioning and Orientation Reports (APOR) 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 digital aerial imagery 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 0.52 meters. Stereo models were examined in order to verify the quality of the DG data and ensure acceptable levels of parallax for mapping purposes.

Lidar Data Processing

Processing of lidar point cloud data was completed in September 2016 using the following RSD lidar data processing workflow. Riegl RiProcess software was utilized to transform the lidar point cloud into a mapping projection and to check the calibration stability. Terrasolid software was used to assess relative and absolute accuracies between overlapping flight missions and relative with each mission, initial point cloud classification, editing of the lidar point cloud, and for classification of water surface, erroneous returns, bathymetric surface and bare earth points. Refraction correction was performed through RB Lidar Processor. Additional quality control (QC), point classification, and formatting were performed with GeoCue, Terrasolid, and Global Mapper software packages. NOAA VDatum software was used to transform the vertical reference of the lidar points from NAD83 ellipsoid to local MHW and MLLW tidal datums. QTModeler and custom ArcGIS scripts were used to produce bare earth MHW and MLLW digital elevation models (DEMs) at a 1-meter grid resolution, and to create and format the MHW and MLLW vectors into shapefile format.

The lidar point cloud was compared to ground control points of a higher accuracy in order to assess vertical uncertainty, and then combined with the morphologic slope around the derived shoreline to assess corresponding horizontal uncertainties. Based on this assessment, the MHW lidar-derived shoreline vectors meet a horizontal accuracy of 1.6 meters, and the MLLW lidar-derived vectors meet a horizontal accuracy of 2.8 meters, both at the 95% confidence level.

Compilation

The data compilation phase of the project was initiated by RSD personnel in April 2019, and was

accomplished in two phases: automated extraction from topobathy lidar and manual extraction using digital stereo imagery.

1) Automated/lidar approach: MHW and MLLW shoreline vectors (in shapefile format) were delineated using the approach described in the preceding section of this report. Subsequently, project orthoimagery was used to review, edit, and attribute the vectors. The lidar-derived shoreline data were limited to terrain features at the land/water interface.
2) Manual/imagery approach: MHW ("Shoreline") and MLLW ("Contour") lidar-extracted shapefiles were then reviewed, and additional features significant to nautical charting, such as engineered, elevated features, bulkheads, piers, bridges, landmarks, etc., were compiled from stereoscopic imagery using the Feature Extraction module of BAE's SOCET SET (ver. 5.6) photogrammetric software. Selected features were further modified with additional descriptive information to refine general classification. All shapefiles were integrated into a single GC using Esri's ArcGIS (ver. 10.7) software. Cartographic features compiled from the stereo imagery were compiled to meet a horizontal accuracy of 1.0 meters at the 95% confidence level. This predicted accuracy of well-defined points is derived by doubling the horizontal uncertainty computed using the EO-TPU tool discussed above.

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

Date	Time (UTC)	Color Imagery		Tide Level*
		Roll	Strip / Images	
02-08-2018	15:52 – 15:54	18VC13	27-046 / 2978 – 2999	0.2 m
02-08-2018	15:59 – 16:01	18VC13	27-047 / 3000 – 3021	0.2 m
02-08-2018	16:10 – 16:10	18VC13	27-060 / 3022 – 3029	0.2 m
02-08-2018	16:31 – 16:34	18VC13	27-059 / 3030 – 3069	0.2 m
02-08-2018	16:39 – 16:43	18VC13	27-058 / 3070 – 3109	0.3 – 0.2 m
02-15-2018	16:07 – 16:09	18VC15	45-023 / 3372 – 3385	0.2 m
02-15-2018	16:26 – 16:30	18VC15	45-027 / 3428 – 3452	0.2 – 0.1 m
02-15-2018	16:38 – 16:41	18VC15	45-028 / 3476 – 3500	0.2 – 0.1 m
02-15-2018	16:45 – 16:48	18VC15	45-029 / 3501 – 3525	0.1 – 0.2 m
02-15-2018	16:52 – 16:56	18VC15	45-030 / 3526 – 3550	0.4 – 0.1 m
02-16-2018	16:17 – 16:19	18VC16	45-025 / 3929 – 3942	0.3 – 0.2 m
02-17-2018	14:42 – 14:45	18VC17	45-026 / 4015 – 4039	0.1 m

* 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 the time of photography from various NOS gauges in the vicinity of the project. The height of the MHW tidal datum in the project area ranges between 0.38 – 0.61 meters above MLLW.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by senior CMP personnel. The final QC review was completed in November 2019. The review process included analysis of DG results and assessment of the identification and attribution of 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 project imagery and compiled project data resulted in creation of the Chart Evaluation File (CEF). The following nautical charts were used in the comparison process:

- 11425, Intracoastal Waterway - Charlotte Harbor to Tampa Bay, 40th Ed., Jan. 2017
- 11426, Estero Bay to Lemon Bay, including Charlotte Harbor, 39th Ed., Nov. 2015
- 11427, Fort Myers to Charlotte Harbor and Wiggins Pass, 38th Ed., Apr. 2018

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 Reports (APOR)
- Project database
- GC11490 in shapefile format
- Project Completion Report (PCR)
- CEF in shapefile format

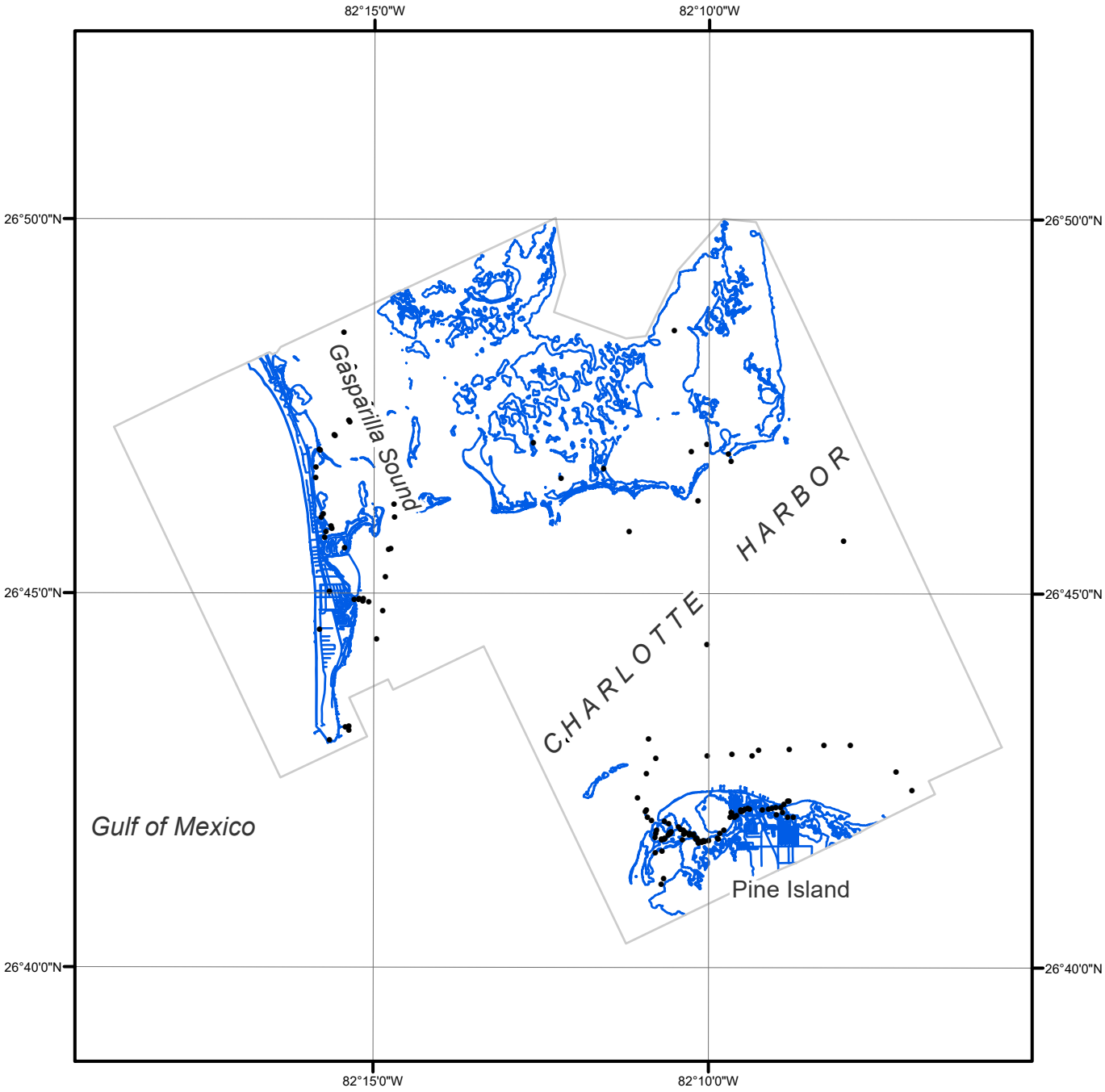
NOAA Shoreline Data Explorer

- GC11490 in shapefile format
- Metadata file for GC11490
- PCR in Adobe PDF format

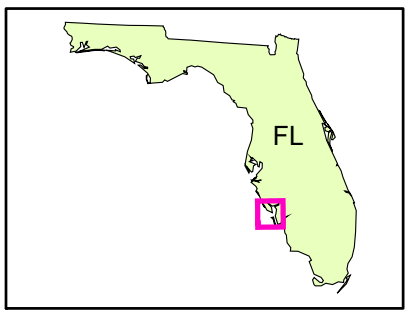
End of Report

GASPARILLA SOUND TO PINE ISLAND

FLORIDA



Overview



FL1606E-TB-N

GC11490