

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT FL1604A-TB-N

Little Marco Island to Caxambas Pass, Florida

Introduction

NOAA Coastal Mapping Program (CMP) Project FL1604A-TB-N provides a highly accurate database of new digital shoreline data for the Gulf Coast of Florida from Little Marco Island southward to Caxambas Pass. Project FL1604A-TB-N is a subproject of a larger project, FL1604-TB-N which extends from Little Marco Island to Tripod Key and Cape Romano.

The project database consists of information measured and extracted from aerial photographs and metadata related to photogrammetric compilation. Base mapping was conducted in a digital environment using stereo softcopy photogrammetry and associated cartographic practices, supplemented with lidar-derived Mean High Water (MHW) and Mean Lower Low Water (MLLW) data. 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 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, image 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.

After completion of the acquisition phase, NOAA tasked the data processing and compilation phase of the project to Dewberry. RSD formulated the task order 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 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.

Field Operations

RSD performed field operations for project FL1604-TB-N consisting of the acquisition of aerial photographs and topographic/bathymetric (topobathy) lidar, the surveying of ground control points (GCPs) and checkpoints (CPs) and the establishment of base stations to support aerial collection and real-time kinematic (RTK) survey operations.

A total of 8 GCPs were established in project FL1604-TB-N by RSD using real-time kinematic (RTK) GPS techniques. Ground survey data are on file with other project data within the RSD Electronic Data Library.

The lidar acquisition was conducted by RSD on May 6-17, 2016, consisting of a total of 154 passes using a NOAA DeHavilland Twin Otter aircraft at a nominal altitude of 400 meters. The topobathy lidar data was collected with a Riegl VQ-880-G system with an aggregate nominal point density of 18 pulses per square meter, with a nominal swath width of 287 meters and a 50% swath overlap.

Aerial imagery was acquired by RSD on April 24, 2016. A total of 9 flight lines of imagery were acquired within ± 2 hours of the predicted low tide at Marco Island. Color and near-infrared (NIR) images were acquired concurrently using an Applanix DSS 580/560 dual camera system on the NOAA King Air aircraft, though only the color images were used for this project. All images were acquired at a nominal altitude of 7,500 feet resulting in a ground sample distance of 0.24 meters for the color imagery.

GPS Data Processing

For both the lidar and image acquisitions, airborne GPS/IMU data was collected using an Applanix POSAV Model 510 IMU unit along with a dual-frequency Trimble BD982 receiver. Airborne GPS data was processed using the Applanix POSPac MMS software with tightly coupled processing (IN-Fusion Single Base) to achieve the final image center locations and orientations. Base data for all kinematic processing consisted of a station set up in the survey area collecting ≥ 4 hours of static GPS data with the position derived via NGS Online Positioning Users Service (OPUS). Two base stations were utilized for the lidar acquisition for redundancy purposes. 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

RSD collected the raw topobathymetric lidar data for Project FL1604-TB-N, and performed the initial processing and quality control, including calibration and refraction correction. Dewberry was subsequently contracted by RSD to perform further data processing, accuracy assessment and creation of the deliverable products from the lidar data.

Dewberry utilized a variety of software for lidar data processing, including TerraScan, TerraModeler, Esri's ArcGIS, LAStools, and Dewberry proprietary software. Data processing included additional quality checks and accuracy assessments of the preliminary swath data, 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 RSD included a fully classified point cloud, one meter resolution tiled topobathymetric bare earth models, tiled clipped topobathymetric bare earth models, tiled topobathymetric standard deviation models in ERDAS Imagine format, one meter resolution tiled DZ orthos in GeoTiff format, a bathymetric void polygon shapefile, an area of interest shapefile, a lidar tile index shapefile, a DEM tile index shapefile, and FGDC compliant metadata files.

RSD received 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 MHW and

MLLW tidal datums. QT Modeler and custom ArcGIS Scripts were used 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.

The lidar point cloud was first compared to ground control points of a higher accuracy to determine vertical uncertainties for the data set, then compared to the morphologic slope around the derived shoreline at a large number of sample sites in the FL1604-TB-N project area to determine the uncertainty of the derived vectors. Based on this assessment, the MHW lidar-derived shoreline vectors meet a horizontal accuracy of 1.7 meters at the 95% confidence level, and the MLLW lidar-derived shoreline vectors meet a horizontal accuracy of 2.6 meters at the 95% confidence level. For further information on the lidar processing refer to the Topobathy Lidar Processing Report on file with other project data within the RSD Electronic Data Library.

Aerotriangulation

The aerotriangulation (AT) phase of project FL1604-TB-N was performed by Dewberry using digital AT methods to establish the network of photogrammetric control required for the compilation phase. Inpho Match-AT software was used to perform both automatic and interactive point measurements of tie points, and the Bingo aerotriangulation software was used for the adjustment. The final adjustment of the block was accomplished by using a rigorous simultaneous least-squares bundle adjustment, and analysis tools within Bingo were used to refine the aerotriangulation solution and to evaluate the accuracy of the adjustment. 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 at the 95% confidence level of 0.14 meters. 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

Data compilation for project FL1604A-TB-N was initiated by Dewberry personnel in July 2018. RSD supplied the lidar-derived MHW and MLLW shapefiles to be edited and attributed by Dewberry. Additional features were manually compiled from stereo imagery using a Digital Photogrammetric Workstation (DPW), which consists of a stereo-enabled PC-based graphics workstation running the Windows 2010 operating system and BAE's SOCET SET (ver. 5.6) digital photogrammetric software suite. Feature identification, segmentation, and attribution were performed within an Esri geodatabase using the SOCET for ArcGIS module of SOCET SET, 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 project FL1604A-TB-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Stereo compiled cartographic features

were compiled to meet a horizontal accuracy of 0.3 meters at the 95% confidence level. This predicted accuracy of compiled, well defined points is derived by doubling the circular error calculated from the aerotriangulation statistics. The lidar-derived features had horizontal accuracies that varied depending on location and shoreline type ranging from 1.7 meters to 2.6 meters.

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

Date	Time (UTC)	Roll / Flight Line	Photo ID	Tide Level*
2016-04-24	13:13:17 – 13:16:04	16VC43 / 45-003	11054 – 11073	0.5 m
2016-04-24	13:22:09 – 13:25:17	16VC43 / 45-001	11090 – 11110	0.5 m
2016-04-24	13:29:32 – 13:32:22	16VC43 / 45-004	11111 – 11131	0.5 m
2016-04-24	13:39:16 – 13:42:05	16VC43 / 45-002	11155 – 11175	0.5 m
2016-04-24	13:46:34 – 13:49:33	16VC43 / 45-005	11176 – 11196	0.6 m
2016-04-24	13:58:47 – 14:00:29	16VC43 / 45-007	11232 – 11243	0.6 m
2016-04-24	14:04:44 – 14:06:52	16VC43 / 45-006	11244 – 11259	0.6 m
2016-04-24	14:25:13 – 14:26:39	16VC43 / 45-008	11308 – 11318	0.6 m

* Water levels are given in meters above MLLW and are based on verified observations recorded by the NOS tide gauge at: Naples, FL – Station ID: 8725110. The height of the MHW tidal datum in the project area is 0.80 meters above MLLW.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a senior member of Dewberry. 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 (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 imagery and compiled project data resulted in creation of the Chart Evaluation File (CEF). The following nautical charts were used in the comparison process:

- 11430, Lostmans River to Wiggins Pass, 28th Ed., Nov. 2015

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
- Airborne Positioning and Orientation Report (APOR)
- Topobathy Lidar Processing Report
- AT Report

- GC11374 in shapefile format
- Project Completion Report (PCR)
- CEF in shapefile format

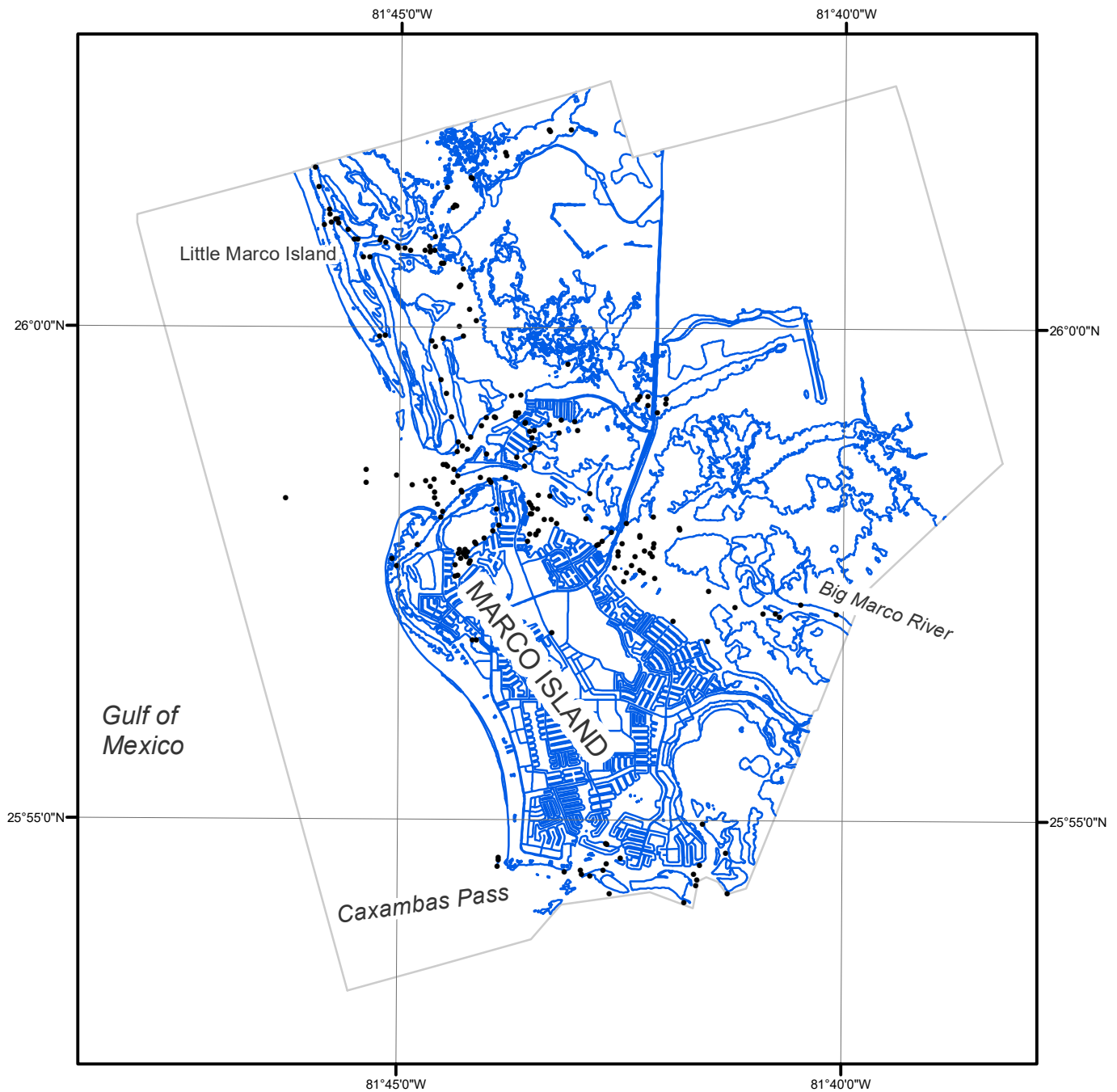
NOAA Shoreline Data Explorer

- GC11374 in shapefile format
- Metadata file for GC11374
- PCR in Adobe PDF format

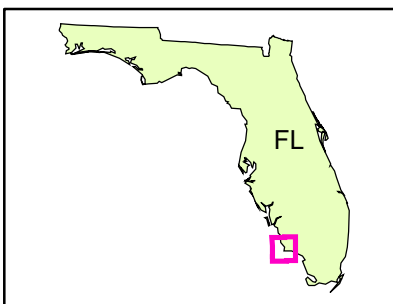
End of Report

LITTLE MARCO ISLAND TO CAXAMBAS PASS

FLORIDA



Overview



FL1604A-TB-N

GC11374