NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT TX1803D-TB-C

Matagorda Bay to East Matagorda Bay, Texas

Introduction

NOAA Coastal Mapping Program (CMP) Project TX1803D-TB-C provides highly accurate digital shoreline data for Matagorda Bay and East Matagorda Bay, including portions of the Gulf Coast and Intracoastal Waterway, in Texas. Project TX1803D-TB-C is a subproject of a larger acquisition project, TX1803-TB-C, which extends from Corpus Christi Bay to Bolivar Peninsula, Texas.

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 NOAA National Geodetic Survey (NGS) Remote Sensing Division (RSD) designed Project TX1803-TB-C and formulated project instructions following the guidelines of the "Scope of Work, Shoreline Mapping for the Coastal Mapping Program" (SOW), Version 14A. 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. RSD provided a shapefile and maps of the project area, and tide coordination time windows for data acquisition.

Dewberry Inc. was contracted to provide lidar acquisition, processing, classification and ground survey activities including checkpoints for use in independent vertical accuracy testing. Dewberry tasked the lidar acquisition and data calibration to their sub-contractor Leading Edge Geomatics, LLC (LEG).

Fugro EarthData, Inc. (Fugro) was separately contracted to provide planning for the aerial imagery acquisition, imagery acquisition and processing, ground surveys for aerial imagery checkpoints, aerotriangulation, feature compilation, and quality control.

Field Operations

Lidar acquisition was conducted by Dewberry sub-contractor Leading Edge Geomatics, LLC (LEG) from October 22, 2018 thru May 31, 2019 and consisted of 1,240 passes using a Piper Navajo (Tail #GKCN) aircraft at a nominal altitude of 400 meters. The topobathy lidar data was

collected with a Leica Chiroptera II topobathy lidar system with an Aggregate Nominal Point Density (ANPD) of 21.18 pulses per square meter, with a nominal swath width of 291 meters and a 55% swath overlap. Ground surveys for the lidar portion of the project were performed by Dewberry, Inc., which included seventy-two independent survey checkpoints. For further information regarding lidar processing refer to the TX1803-TB-C Topobathy Lidar Project Report.

Fugro Inc. performed the acquisition of digital aerial imagery, static and kinematic GPS data, and Inertial Measurement Unit (IMU) data. Fugro's subcontractor TerraSurv, Inc. performed the ground surveys for the aerial imagery acquisition. Aerial survey operations included the acquisition of 28 strips of color (RGB) and near-infrared (NIR) imagery collected concurrently. The images were acquired using the Leica ADS100 4-band camera system in December 2018. All aerial imagery acquisition was accomplished with Fugro's Cessna 411 Conquest II aircraft flying at an altitude of 12,300 feet, giving a Ground Sample Distance (GSD) of 0.30 meters. The imagery was intended to be collected when water levels were within 25% of the mean range of tide around Mean Lower Low Water (MLLW), but some images were collected outside of this specification.

As a subcontractor to Fugro, TerraSurv Inc. established 55 photo identifiable survey points, consisting of 20 ground control points and 35 checkpoints. Since the TX1803-TB-C project area falls in both UTM zones 14 and 15, the survey data was processed in both coordinate systems to provide accurate control for the aerial imagery covering each zone. For further information refer to the TX1803-TB-C Hurricane Harvey Imagery Ground Control Report.

GPS Data Processing

GPS/IMU data were processed by Fugro personnel to yield precise sensor positions and orientations of the imagery. The aircraft used to acquire data was equipped with a Novatel SPAN IMU unit to collect ABGPS and IMU data. Each collection relied on a single fixed ground base station and two CORS stations to calculate the differential (DGPS) solution and final photo center locations. Novatel Inertial Explorer (ver. 8.5) software was used to process the data, and obtain a tightly coupled GNSS/INS solution, for each collection. For further information refer to the Airborne Positioning and Orientation Report (APOR).

Lidar Data Processing

LEG performed the initial processing and quality control of the lidar swath data, including calibration and refraction correction, using Leica/AHAB Lidar Survey Studio (LSS) software. The calibrated lidar swath data was then delivered to Dewberry for further processing.

Dewberry utilized a variety of software for lidar data processing, including Terrascan, ESRI ArcGIS, GeoCue, LAStools, Global Mapper, and proprietary Dewberry tools. 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:

- Project Extents including boundary and tile grid (shapefiles)
- Final classified lidar tiles (LAS)
- Tiled topobathymetric DEMs with voids enforced (IMG)

- Void layer (shapefile)
- Tiled standard deviation confidence rasters (IMG)
- Temporal polygons (shapefile)
- FGDC compliant metadata files
- Final Project Report

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 TX1803-TB-C project area to determine the uncertainty of the derived vectors. Based on this assessment, RSD personnel determined that the MHW lidar-derived shoreline vectors meet horizontal accuracies of 2.6 meters for both lidar blocks 4 and 5 at the 95% confidence level, and the MLLW lidar-derived shoreline vectors meet horizontal accuracies of 2.8 meters (block 4) and 3.2 meters (block 5) at the 95% confidence level.

Aerotriangulation

Fugro performed the aerotriangulation (AT) for this project using a softcopy photogrammetric system to establish the network of control required for the compilation phase. All image point and ground control measurements were directly observed in a digital (softcopy) environment. With the RGB and NIR imagery being collected concurrently, the AT for this project was performed in a single block. The softcopy system hardware consisted of a Windows-based photogrammetric workstation. Leica Xpro (ver. 6.4.2) software was used for project setup, point measurement, and AT. Upon successful completion of the aerotriangulation process, the RMS of the standard deviations (both x & y) for all of the adjusted ground points were used to compute a predicted horizontal circular error (95% confidence level) of 0.19 meters for the block. In addition, 35 checkpoints were measured in the imagery and compared to their surveyed positions, resulting in an RMS of 0.19 meters for the checkpoint residuals.

The project database consists of project parameters and options, camera calibration data, ground control parameters, and positional listing of all measured points. Positional data is referenced to the North American Datum of 1983, (NAD83/2011). An Aerotriangulation Report was completed and is on file with other project data within the RSD Electronic Data Library.

Compilation

The feature compilation phase of this project was completed by Fugro in June 2020. RSD supplied the lidar-derived MHW and MLLW shapefiles to be edited and attributed by Fugro. Additional features were manually compiled from stereo imagery using SOCET SET (ver. 5.6) stereo softcopy workstations with the SOCET for ArcGIS software module and Esri's ArcGIS (ver. 10.3) software. Feature identification, segmentation, and attribution within the GC were based on image analysis of the project imagery and information extracted from the appropriate

NOAA nautical charts, US 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 TX1803D-TB-C were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features compiled from the stereo imagery were compiled to meet a horizontal accuracy of 0.4 meters at the 95% confidence level, a predicted accuracy of compiled, well-defined points derived by doubling the circular error calculated from the aerotriangulation statistics. The lidar-derived features had horizontal accuracies that varied based on location and shoreline type, ranging from 2.6 to 3.2 meters as described above.

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

Date	Time (UTC)	Flight Line	Photo ID	Tide Level *
12/04/2018	16:22 – 16:27	013	1 – 16	0.2 m
12/04/2018	16:35 – 16:43	012	28 – 4	0.2 – 0.3 m
12/04/2018	16:50 – 16:54	014	1 – 12	0.2 m
12/04/2018	16:59 – 17:01	015	7 – 1	0.2 m
12/10/2018	15:31 – 15:34	017	54 – 64	0.0 m
12/10/2018	15:39 – 15:44	010	1 – 16	0.0 m
12/10/2018	16:44 – 16:49	001	16 – 1	0.0 m
12/10/2018	16:58 – 17:03	016	84 – 68	0.0 – 0.1 m
12/10/2018	19:20 – 19:29	011	70 – 97	-0.1 – 0.0 m
12/10/2018	19:48 – 19:50	002	1 – 7	-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 elevation of the MHW tidal datum in the project area varies from 0.15 – 0.24 m above MLLW.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a senior member of Fugro, Inc. The final QC review was completed in July 2020. The review process included an 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 natural color images and compiled project data resulted in creation of the Chart Evaluation File (CEF). The following nautical charts were used in the comparison process:

- 11316, Matagorda Bay and Approaches, 42nd Ed., Jun. 2011
- 11317, Matagorda Bay, 33rd Ed., May 2014
- 11319, Cedar Lakes to Espiritu Santo Bay, 34th Ed., Sep. 2012
- 11321, San Luis Pass to East Matagorda Bay, 30th Ed., Jul. 2004

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)
- TX1803-TB-C Hurricane Harvey Imagery Ground Control Report
- TX1803-TB-C Topobathy Lidar Project Report.
- Aerotriangulation Report
- GC11521 in shapefile format
- Project Completion Report (PCR)
- CEF in shapefile format

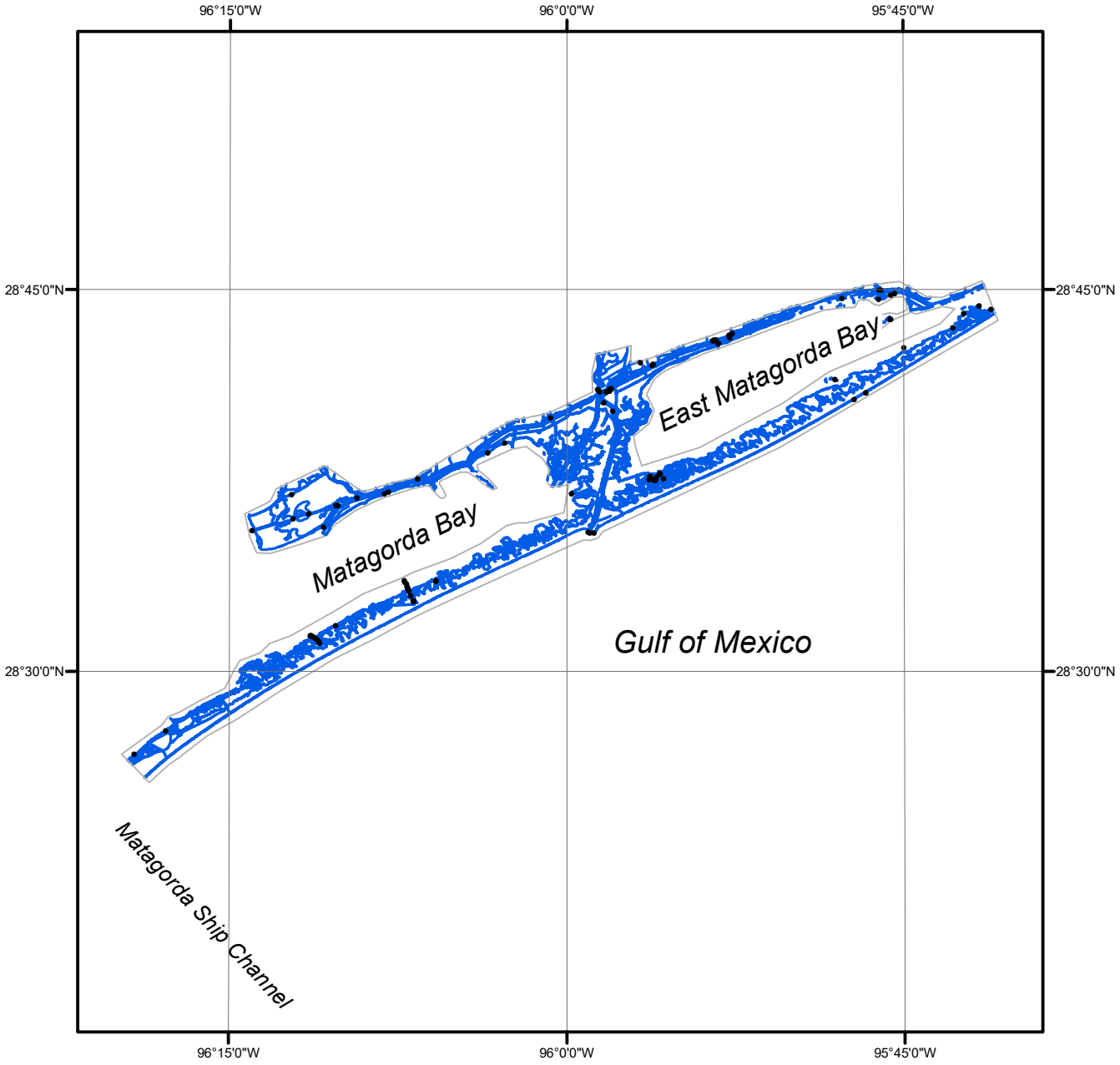
NOAA Shoreline Data Explorer

- GC11521 in shapefile format
- Metadata file for GC11521
- PCR in Adobe PDF format

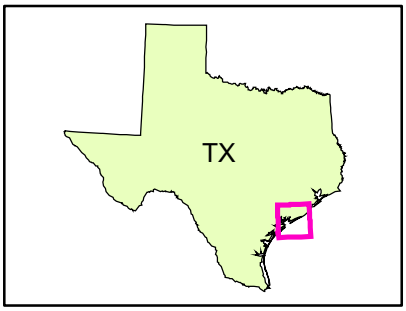
End of Report

MATAGORDA BAY TO EAST MATAGORDA BAY

TEXAS



Overview



TX1803D-TB-C

GC11521