

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT MD0501C

Portions of the Middle, Gunpowder and Bush Rivers, Maryland

Introduction

NOAA Coastal Mapping Program (CMP) Project MD0501C provides a highly accurate database of new digital shoreline data of the Chesapeake Bay from Galloway Point to Church Point, MD, including portions of the Middle, Gunpowder and Bush Rivers. The project area covers the portion of the Middle River extending up the Frog Mortar Creek; Bird River and shoreline in the vicinity of Joppatowne along the Gunpowder River; and Otter Point Creek to Church Creek that enters into the Bush River.

Due to flight restrictions imposed by security at Aberdeen Proving Ground there are several gaps in the compiled shoreline for this project. Please refer to project MD0901 *Northern Chesapeake Bay, Concord Point to Galloway Point, MD* for shoreline adjacent to this project area.

Project MD0501C is a subproject of a larger project, MD0501, which includes the northwestern shore of the Chesapeake Bay from Saunders Point MD in the south to Carpenter Point MD in the north, including a portion of the Susquehanna River, but excluding the shore of Aberdeen Proving Ground.

Successful completion of the project resulted in a densification of the National Spatial Reference System (NSRS), a set of controlled metric-quality aerial photographs and digital feature data of the coastal zone which complements the Nautical Charting Program (NCP) as well as geographic information systems (GIS) for a variety of coastal zone management applications.

The project database consists of information measured and extracted from aerial photography and metadata related to photogrammetric compilation. Base mapping was conducted in a digital environment using stereo softcopy photogrammetry and associated cartographic practices.

Project Design

Tuck Mapping Solutions, Inc. (TMSI) designed the photographic missions for this project using the guidelines of the Coastal Mapping Program Specifications for Shoreline Mapping and the Project Instructions prepared by the Remote Sensing Division (RSD) of the National Geodetic Survey, NOAA, on June 1, 2005. The guidelines discussed the project's purpose, geographic area of coverage, scope and priority; photographic and ground control requirements; flight line priority, tide and sun angle coordination; Global Positioning Systems (GPS) data collection procedures and guidelines for both kinematic and static surveys; data recording and handling instructions; and contact and communication information.

The project limits were provided by NOAA on hardcopy nautical charts. These sources were used to depict the approximate locations of the shoreline to be mapped. TMSI created a Project Layout Diagram, flight maps and input files for the aircraft's flight management system.

Field Operations

TMSI acquired imagery for the MD0501 suite of subprojects on June 9 & 23, 2005; April 20 & 28, 2006; May 23, 2006; May 24, 2007; September 25, 2007; October 30 & 31, 2007; and March 24, 2009. Aerial photographic coverage of the project site consisted of natural color and black & white infrared photographs at nominal scales of 1:30,000 and 1:12,000. A waiver to utilize a 700nm filter during the acquisition of the B&W IR photography was approved previously by NOAA without requiring a new camera calibration report by the USGS. Tide-coordinated, black and white infrared imagery was collected at both the mean high water (MHW) and mean lower low water (MLLW) tide stages. Natural color imagery was acquired during a period when MHW was not being exceeded. All photography was acquired using a Leica RC30 camera (NOAA camera designation number 20) at an approximate altitude of 15,000 feet for the 1:30,000 scale imagery, and at an approximate altitude of 6,000 feet for the 1:12,000 scale imagery.

TMSI performed the necessary GPS surveys to locate aerial control and checkpoints. Multiple two hour sessions observed by TMSI were submitted for OPUS solutions, and a mean of the values was used to determine the control and checkpoint coordinates. For more information please refer to the Photographic Flight Reports and Ground Control Reports.

GPS Data Reduction

GPS data was collected and processed to provide precise positions of the camera centers for application as photogrammetric control in the aerotriangulation phase of the project. Data was downloaded from the NSG CORS web site for Horn Point Enviro CORS ARP, CORS ID HNPT (PID AI3494) for all flights through September 25, 2007. All remaining flights on this project were based on ground occupied non-NGS station Aberdeen Proving Ground 105. After the flight missions, the project data was downloaded and processed using NovAtel's Waypoint GrafNav (version 7.80.2517 and 8.10.2313) software. Forward and reverse trajectories were compared during the processing phase to ensure accuracy. Camera event file data was then applied to the final trajectory to obtain coordinates for the photo centers. A GPS Data Processing Report was written and is on file with other project data within the RSD Applications Branch (AB) Project Archive.

Aerotriangulation

Routine softcopy aerotriangulation methods were applied to extend the network of precise camera positions and other control for mapping, and to provide model parameters and orientation elements required for digital compilation. TMSI personnel initiated the softcopy aerotriangulation work in April 2008, utilizing a digital photogrammetric workstation (DPW), which is a configuration of computer processor and monitor, BAE Systems SOCET SET photogrammetric software (ver. 5.3 and 5.4), stereo viewing equipment, and peripheral devices.

Aerotriangulation of the photography collected between June 2005 and October 2007 was divided into two blocks each of color photography and B&W IR (both MHW and MLLW) photography. Block 1 is the larger of the two and consists of ten lines of exposures located between Saunders Point and Aberdeen, MD. Block 2 consists of three lines of exposures covering the area around the mouth of the Susquehanna River and Havre De Grace, MD. The aerotriangulation work for these photographs was completed in May 2008. The photography collected in March 2009, consisting of three lines of MLLW IR exposures only, was aerotriangulated separately as a third block in June 2009.

The color imagery was measured and then ground control applied to produce an acceptable solution. The MHW imagery was measured, and then all tie points were passed to the MLLW imagery. The ground control points, along with several photo identifiable points from the color imagery, were used to control the IR imagery. Upon successful completion of the block adjustment, BAE Systems' SOCET SET Multi-Sensor Triangulation (MST) module provided the RMS of the standard deviations for all aerotriangulated ground points, which were used to compute a predicted horizontal circular error of 0.8 meters for both blocks of the color photographs. Block 1 of the B&W IR photographs had a predicted horizontal circular error of 0.6 meters and Block 2 of the B&W IR photographs had a predicted horizontal circular error of 0.7 meters. MLLW imagery acquired on March 24, 2009 was measured independently, and controlled using the ground control points along with several photo identifiable points from the color imagery. These MLLW B&W IR photographs had a predicted horizontal circular error of 0.8 meters. An Aerotriangulation Report is on file with other project data within the RSD AB Project Archive.

The project database consists of camera calibration data, interior orientation parameters for each frame, airborne GPS antenna position and offset data, adjusted exterior orientation parameters for each frame, positional listing of all measured points, the control file and refined image coordinates as listed in the Project Database section of the Aerotriangulation Report. Positional data is based on the North American Datum of 1983 (NAD 83), referenced to UTM Zone 18.

Compilation

The data compilation phase of the project was accomplished by TMSI in June 2009. Digital mapping was performed using Digital Photogrammetric Workstations (DPWs) in conjunction with BAE SOCET SET ver. 5.4. Feature identification and the assignment of cartographic codes were based on image analysis of natural color photography and B&W IR photography and information extracted from appropriate NOAA Nautical Charts and the US Coast Guard Light List. Cartographic feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST) as required.

Cartographic features were compiled to meet a horizontal accuracy of 1.6 meters at the 95% confidence level. This predicted accuracy of compiled, well-defined points is derived by doubling the circular error derived from aerotriangulation statistics.

See Table 1 below for information on all aerial photographs used for project MD0501C.

Table 1 - Compilation Sources

Date	Time (UTC)	Roll Number	Frames	Scale (nominal)	Tide Level * (m)
04/28/2006	19:09 – 19:10	0620R03	0341 – 0343	1:30000	-0.1**
05/24/2007	17:50 – 17:53	0720R01	0019 – 0025	1:12000	0.4
05/24/2007	18:19 – 18:20	0720R01	0044 – 0046	1:30000	0.5
09/25/2007	16:48 – 16:49	0720CN01	0001 – 0007	1:12000	0.3
09/25/2007	16:54 – 16:56	0720CN01	0008 – 0017	1:12000	0.3
09/25/2007	17:12 – 17:16	0720CN01	0018 – 0024	1:30000	0.3
09/25/2007	17:21 – 17:22	0720CN01	0026 – 0028	1:30000	0.3
09/25/2007	17:27 – 17:28	0720CN01	0029 – 0031	1:30000	0.3
10/30/2007	19:15 – 19:16	0720R02	0276 – 0278	1:30000	0.1**
10/31/2007	16:07	0720R02	0333	1:30000	0.4
10/31/2007	16:14 – 16:15	0720R02	0342 – 0343	1:30000	0.4
10/31/2007	16:36 – 16:37	0720R02	0344 – 0353	1:12000	0.4
10/31/2007	16:44 – 16:46	0720R02	0354 – 0360	1:30000	0.4
03/24/2009	17:35 – 17:37	0920R01	0001 – 0007	1:12000	-0.1**
03/24/2009	17:42 – 17:44	0920R01	0008 – 0017	1:12000	-0.1**
03/24/2009	18:05 – 18:08	0920R01	0018 – 0024	1:30000	-0.1

* The reference station used to determine tidal heights within this project is Baltimore, MD (857-4680). Tide levels for all photos are given in meters relative to MLLW, and are based on verified observations adjusted for CO-OPS Tidal Zoning. The relative difference between MHW and MLLW for the Baltimore station is 0.4 meters. ** Tide levels for these photos slightly exceeded the standard tolerance for MLLW tide coordination, but the photos were deemed acceptable for Approximate MLLW delineation.

Quality Control / Final Review

A TMSI team completed the quality control and final review in January 2010. The Geographic Cell (GC) was evaluated for completeness and accuracy. The review process included analysis of aerotriangulation results and assessment of the identification and attribution of cartographic features 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 GIS software. All project data was evaluated for compliance to CMP requirements.

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

- 12273 57th Ed. Jan. 05/08 1:80,000 Chesapeake Bay
- 12274 35th Ed. Dec 15/07 1:40,000 Head of Chesapeake Bay
- 12278 76th Ed. Dec. 07 1:40,000 Chesapeake Bay Approaches to Baltimore Harbor

End Products and Deliverables

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

RSD Applications Branch Project Archive:

- Hard copy of the Airborne Positioning and Orientation Report (APOR)
- Hard copy of the Aerotriangulation Report
- Hard copy of the Project Completion Report (PCR)
- Page-size graphic plot of GC10728 file contents, attached to the PCR

RSD Electronic Data Library:

- Project Database
- GC10728 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- CEF in shapefile format

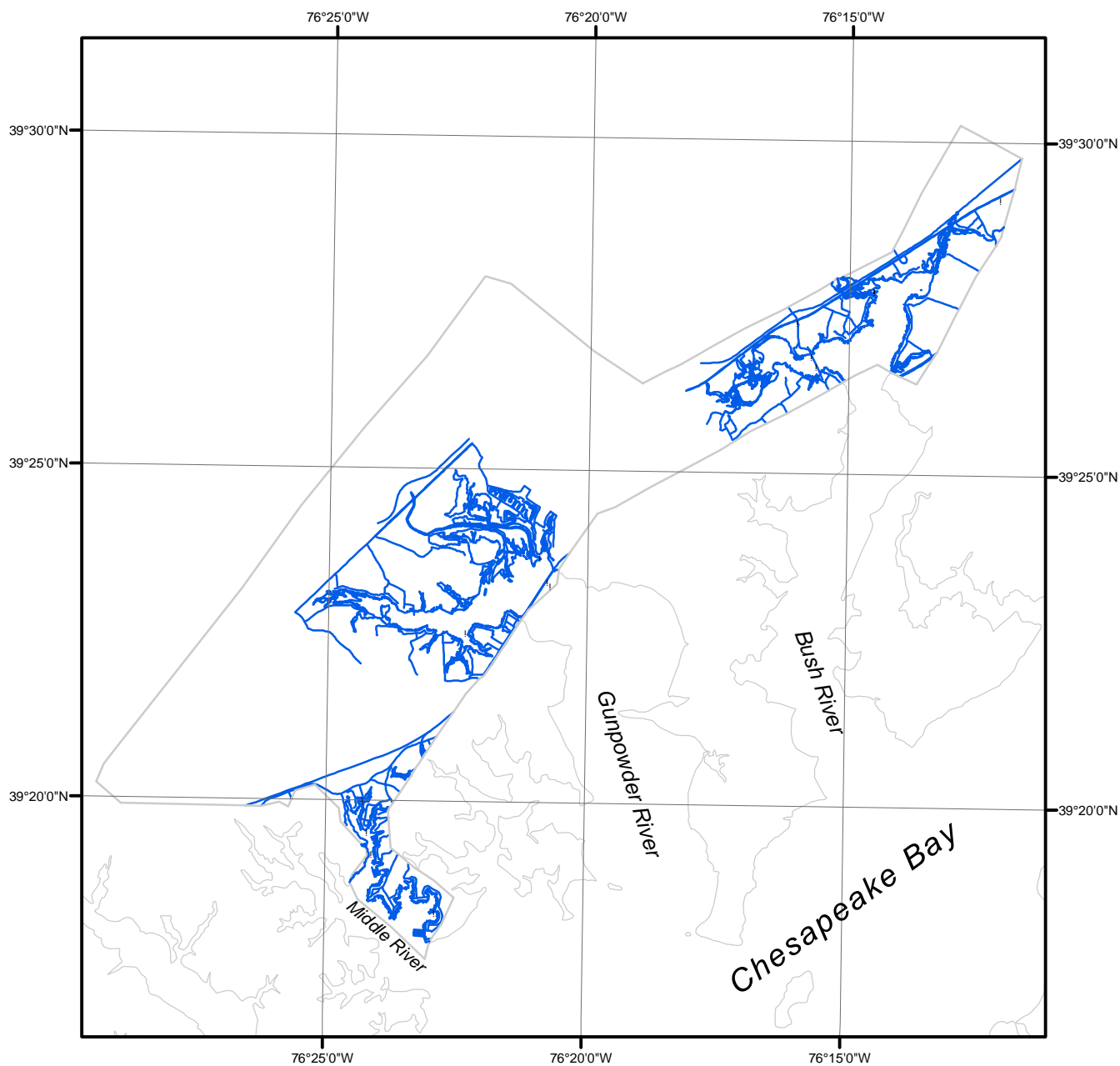
NOAA Shoreline Data Explorer:

- GC10728 in shapefile format
- Metadata file for GC10728
- Digital Copy of the PCR in Adobe PDF format

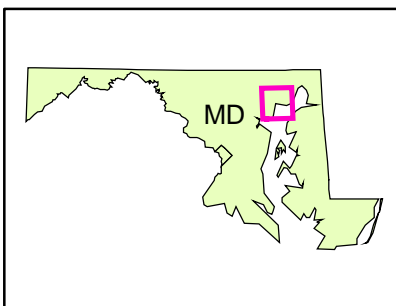
End of Report

PORTIONS OF THE MIDDLE, GUNPOWDER, & BUSH RIVERS

MARYLAND



Overview



MD0501C

GC10728