NOAA FORM 76-35A

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

HORIZONTAL AND VERTICAL CONTROL REPORT

Type of Survey **Hydrographic**

Project No. **OPR-E349-KR-06**

Time Frame **May-September 2006**

LOCALITY

State **VIRGINIA**

General Locality **Central Chesapeake Bay**

2006

CHIEF OF PARTY

Jonathan L. Dasler, PE (OR) , PLS (OR,CA)

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DATE

NOAA FORM 77-28 (11-72)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

HYDROGRAPHIC TITLE SHEET

REGISTRY No

H11503
H11504
H11505
H11535

INSTRUCTIONS – The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

FIELD No

State **Virginia**

General Locality **Central Chesapeake Bay**

Sub-Locality **Off Shore Powells Bluff to Off Shore Shooting Point**

Scale **1:10,000** Date of Survey **May 22, 2006 to September 18, 2006**

Instructions dated **3/28/2006** Project No. **OPR-E349-KR-06**

Vessel **R/V Sealth**

Chief of party **Jonathan L. Dasler, PE (OR) , PLS (OR,CA)**

Surveyed by **Nicholas Lesnikowski, Jason Creech, Benjamin Hocker**

Soundings by echo sounder, hand lead, pole **RESON 7125-B, EdgeTech 4200-FS**

Graphic record scaled by **N/A**

Graphic record checked by **N/A** Automated Plot **N/A**

Verification by

Soundings in **Meters** at **MLLW**

REMARKS: **All times are UTC.**

The purpose of this contract is to provide NOAA with modern, accurate hydrographic survey data with which to update the nautical charts of the assigned area.

SUBCONSULTANTS: **Global Seas, LLC, 2001 Sixth Ave Suite 3420, Seattle, WA 98121**

Coastal-ES, 6830 NE Bothell Way C311, Kenmore, WA 98028

John Oswald and Associates, 2000 E Dowling Road, Suite 10, Anchorage, AK 99507

NOAA FORM 77-28 SUPERSEDES FORM C&GS-537

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Acronyms and Abbreviations

ATC	Average Time Corrector
BAG	Bathymetric Attributed Grid
CO-OPS	Center for Operational Oceanographic Products and Services
CUBE	Combined Uncertainty and Bathymetry Estimator
DEA	David Evans and Associates, Inc.
DGPS	Differential Global Positioning System
GPS	Global Positioning System
HIPS	Hydrographic Information Processing System
kHz	kilo Hertz
MHW	Mean High Water
MLLW	Mean Lower Low Water
NAD83	North American Datum of 1983
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NWLON	National Water Level Observation Network
PSI	Pounds per Square Inch
POS/MV	Position and Orientation System for Marine Vessels
R/V	Research Vessel
SN	Serial Number
SOW	Statement of Work
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
UTC	Coordinated Universal Time
VDC	Volts Direct Current
ZDF	Zone Definition File

Horizontal and Vertical Control Report
Project OPR-E349-KR-06
Central Chesapeake Bay, Virginia
Year 2006
R/V Sealth
David Evans and Associates, Inc
Lead Hydrographer: Jonathan L. Dasler, P.E., P.L.S.

INTRODUCTION

This report applies to surveys H11503, H11504, H11505, and H11535 located in Central Chesapeake Bay, Virginia. These contract surveys were performed under OPR-E349-KR-06 as specified in the *Statement of Work* dated March 28, 2006 with modification T0001 dated April 24, 2006. All survey methods meet or exceed requirements as defined in the *NOS Hydrographic Surveys Specifications and Deliverables DRAFT* February, 2006.

A. VERTICAL CONTROL

The tidal datum for this project is chart datum, Mean Lower Low Water (MLLW) and Mean High Water (MHW). All soundings are referenced to MLLW. No heights were referenced as part of this project. All data (tidal, position, attitude, sonar, survey logs, etc.) were collected in Coordinated Universal Time (UTC).

A1. Tide and Water Level Corrections

The *OPR-E349-KR Statement of Work* specified that the operating National Water Level Observation Network (NWLON) station at Windmill Point, VA (863-6580) serve as datum control for the project. David Evans and Associates, Inc. (DEA) has observed that data from Windmill Point is problematic with data outages and noisy data possibly due to a seiche effect resulting from the narrow entrance into the harbor where the gauge is located. Further, the U.S. Army Corps of Engineers (USACE) which conducts dredging surveys in the Rappahannock channel has reported periodic large errors (close to 1-foot) in tidal zoning from this station. Though not required by the project instructions, a subordinate water level station was installed at the Rappahannock Range Front Light, Virginia (863-2837) to evaluate the severity of the zoning errors from Windmill Point and served as an alternate source for water level reducers for this project. Based on analysis of zoning from both stations, DEA found the water level correctors from the Rappahannock Range Front Light, Virginia (863-2837) provided a more accurate zoning model of localized tidal conditions within the Central Chesapeake survey area. Water level correctors from Rappahannock Range Front Light, Virginia (863-2837) were used for the majority of the zones on this project.

A2. Subordinate Tide Station

The subordinate water level station was installed at Rappahannock Range Front Light (863-2837) in Central Chesapeake Bay, VA by the field unit as a supplemental station to the Windmill Point station. The Rappahannock Range Front Light station is located at 37° 32' 18.73"N, 76° 00' 51.02"W and was operated from May 6, 2006 to September 26, 2006.

The gauges installed at Rappahannock Range Front Light included two Design Analysis digital bubblers; (DAA) H350XL, with H355 pumps, and H222 (Signal Engineering) GOES radios, with Yagi antennas. Both gauges have a range from 0 to 30 psi. A backup was established on June 5, 2006 which consisted of a DAA H360 radar gauge SN1288, H350XL SN: 1043 and GOES telemetry. Each gauge system was powered by two 12VDC batteries and charged with 20 watt solar cells. Separate Global Positioning System (GPS) modules provide time syncing for each gauge.

All raw pressure observations from the Rappahannock Range Front Light station were corrected for water density to determine water levels. Outliers were then removed from the data set by smoothing with a two hour third degree polynomial. Daily high and low readings were then picked from the data set and compared to verified high and low readings from the station at Windmill Point. From the comparisons a Monthly Means was computed. The Rappahannock Range Front Light station datum (adjusted to MLLW) was then applied to the smoothed tide file.

Even with the use of a subordinate tide gauge and associated zoning, tide artifacts are present in the survey data and associated Bathymetric Attributed Grids (BAGs). The open waters of the Chesapeake Bay are notorious for localized wind-driven tides that can not be zoned over significant distances. At times tide error approaches 20 cm, but is typically much less. A tropical storm passed through Chesapeake Bay from August 29th thru September 2nd which created anomalies within the tide data. There were no survey operations during the tropical storm.

Evaluation of water level correctors was accomplished through comparison of zoned water levels from the primary station to the subordinate water level station, crossline comparisons, visually comparing adjacent lines during Caris subset editing, and analysis of the sun-illuminated Combined Uncertainty and Bathymetric Estimator (CUBE) grids for artifacts at zone boundaries. Several zoning scenarios using data from Windmill Point (863-6580) and the Rappahannock Front Range Light (863-2837) were evaluated to determine which gauge and zoning correctors most appropriately adjusted survey data within each of the twenty-six tide zones that cover the OPR-E349-KR-06 survey area. Tide zoning for Rappahannock Front Range Light (863-2837) was created by modifying the Preliminary Center for Operational Oceanographic Products and Services (CO-OPS) zoning files tied to Windmill Point, Virginia (863-6580). Zone boundaries were not modified, but new time and range correctors were back calculated from zone SCB67. Time correctors were calculated by adjusting the average time corrector (ATC) for zone SCB67 which surrounds gauge 863-2837 from -36 minutes (zoned from 863-6580) to zero minutes. Similarly, the range corrector was adjusted from 1.47 to 1.00. From this average time correctors were calculated for each zone relative to 863-2837 by calculating the difference between the ATC relative to 863-6580 for the zone in question and -36 (the ATC for SCB67). Range correctors were calculated by dividing the range corrector for the zone in question by 1.47 (the range value for SCB67 relative to 863-6580). A Hydrographic Information Processing System (HIPS) Zone Definition File (ZDF) was then created that used gauge 863-2837 as the primary gauge for all zones except for SCB 94 and SCB 88 which used 863-6580 as the primary station. Table 1 includes the zoning information for each zone used for the survey.

Table 1. Tide Zones

Zone	Reference Station	Corrector(min.)	Ratio
SCB54	8632837	-30	1.08
SCB55	8632837	-30	1
SCB56	8632837	-30	0.88
SCB57	8632837	-30	0.82
SCB63	8632837	-18	0.79
SCB64	8632837	-18	0.88
SCB65	8632837	-18	1
SCB66	8632837	-12	1.08
SCB67	8632837	0	1
SCB68	8632837	0	0.88
SCB69	8632837	0	0.76
SCB70	8632837	6	0.67
SCB71	8632837	12	0.67
SCB76	8632837	18	0.67
SCB77	8632837	18	0.67
SCB78	8632837	18	0.76
SCB79	8632837	18	0.88
SCB80	8632837	18	0.97
SCB86	8632837	36	0.88
SCB87	8632837	36	0.76
SCB88	8636580	0	0.99
SCB89	8632837	36	0.68
SCB93	8632837	54	0.67
SCB94	8636580	18	0.99
SCB95	8632837	54	0.76
SCB96	8632837	54	0.88

It is difficult to associate a precise vertical error due to tides. Errors observed are a composite from various sources such as measurement error, tides, heave, refraction, transducer draft, and settlement and squat. Though vertical errors are still visible in the data they are small and are generally 10 cm or less and in some extreme cases approach 25 cm; below the 20-45 cm maximum allowable error for tides and water levels. The largest contributing factor to water level errors in the Chesapeake Bay is meteorological influences which can not be accounted for by zoning.

Due to the nature of the small offshore platform, and after consultation with CO-OPS, only three benchmarks were established at the Rappahannock Range Front Light. The benchmarks consisted of a 5/8” bolt for GPS observations and scribed and stamped marks in the steel structure. Elevations were established and leveled based on the National Ocean Service (NOS) publication User’s Guide for the Installation of Bench Marks and Leveling Requirements for Water Level Stations (1987). Three benchmarks were installed and both orifices were measured to directly from the benchmarks. A static GPS survey was used to determine the ellipsoidal

height of the primary benchmark in accordance with CO-OPS Users Guide for GPS Observations. The tide report submitted to CO-OPs comprises Appendix I of this report which includes comparison of monthly means, site description, abstract of leveling, photos, site sketch and a tide report. Table 2 summarizes the final positions of the established tidal benchmarks.

Table 2. Tidal Benchmarks

Station	Benchmark	MLLW (m)	Latitude	Longitude
863-2837	2837 A 2006 (PBM)	12.253	37° 32' 18.73"N	76° 00' 51.02"W
863-2837	2837 B 2006	9.876	37° 32' 18.53"N	76° 00' 51.02"W
863-2837	2837 C 2006	2.509	37° 32' 18.70"N	76° 00' 50.07"W

B. HORIZONTAL CONTROL

No permanent control stations were established during this survey period.

The horizontal datum for this project is North American Datum of 1983 (NAD83). All horizontal positioning for soundings followed the Statement of Work, March 28, 2006, and the NOS Hydrographic Surveys Specifications and Deliverables, Feb. 2006.

No aids to navigation or prominent landmarks were positioned during the survey.

B1. Differential Corrections

Primary positioning for this survey was achieved with an Applanix Position and Orientation System for Marine Vessels (POS/MV) combined inertial and Differential Global Positioning System (DGPS) using differential corrections obtained from the U.S. Coast Guard (USCG) Maritime DGPS Service. The primary beacon was Driver, VA (289 kHz) and Annapolis, MD (301 kHz) beacon was used as a backup source of differential correctors.

During survey operations on July 14th and July 15th outages occurred with both primary and secondary beacons. The US Coast Guard differential beacon at New Bern, NC (294.0 kHz) was used on July 14th (Day Number 195) from 20:39 to 21:47 (UTC) and on July 15th (Day Number 196) from 11:43 to 18:38 (UTC).

B2. Positioning System Confidence Checks

A secondary positioning system consisting of a Trimble DMS132 DGPS was used during the survey to provide real-time quality control. This system also received DGPS correctors from Driver, VA.

A weekly comparison between positions from the primary positioning system (Applanix POS/MV320 version 4, Serial Number PCS2357) and the secondary positioning system (Trimble DMS 132 DGPS, Serial Number 224094182) was documented while the vessel was stationary in port. After accounting for antenna offsets the greatest computed difference between the two positions was 1.44 meters, which is well within the NOS specification of hydrographic

positioning. Appendix II contains the spreadsheet with weekly comparisons of raw observations and computations.

DAVID EVANS
AND ASSOCIATES INC.

LETTER OF APPROVAL

OPR-E349-KR-06

HORIZONTAL AND VERTICAL CONTROL REPORT

This report and the accompanying data are respectfully submitted.

Field operations contributing to the accomplishment of project OPR-E349-KR-06 were conducted under my direct supervision with frequent personal checks of progress and adequacy. This report and associated data have been closely reviewed and are considered complete and adequate as per the Statement of Work.

Jonathan L. Dasler, PE (OR) , PLS (OR,CA)
Lead Hydrographer

David Evans and Associates, Inc.
September 2006

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