

C. HORIZONTAL AND VERTICAL CONTROL

A complete description of horizontal and vertical control for survey H11656 can be found in the OPR-E349-KR-07 *Horizontal and Vertical Control Report*^{*}, submitted under separate cover. A summary of horizontal and vertical control for this survey follows.

C1. Vertical Control

The vertical datum for this project is Mean Lower-Low Water (MLLW). The operating National Water Level Observation Network (NWLON) primary water level station at Windmill Point, Virginia (863-6580) served as control for datum determination. A subordinate water level station was installed at the Rappahannock Front Range Light, Virginia (863-2837) and served as the primary source for water level reducers for all zones for survey H11656.

Water level data was reduced to MLLW using water level files from the station at Windmill Point and the station at the Rappahannock Front Range Light. All raw pressure observations from the Rappahannock Front Range Light station were corrected for water density to determine "true" 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 these comparisons Monthly Means were then computed. The Rappahannock Front Range Light station datum (adjusted to MLLW) was then applied to the smoothed water level file.

C2. Discussion of Tide Zoning

Evaluation of tides 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 CUBE grids for artifacts at zone boundaries. Several zoning scenarios using data from the Windmill Point (863-6580) and the Rappahannock Front Range Light (863-2837) stations were evaluated to determine which station and zoning correctors most appropriately adjusted survey data within each of the six tide zones that cover the H11656 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 station 863-2837 from -36 minutes (zoned from 863-6580) to zero minutes. Similarly, the range corrector was adjusted from 1.47 minutes to 1.00 minutes. 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 SCB65). 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 HIPS zone definition file (ZDF) was then created that used station 863-2837 as the primary

station for all zones except for SCB 94 and SCB 88 which used 863-6580 as the primary station. Table 5 includes the zoning information for each zone used for the survey.

Table 5. Tide Zones

Zone	Reference Station	Corrector (min.)	Ratio
SCB85	8632837	36	0.97
SCB86	8632837	36	0.88
SCB96	8632837	54	0.88
SCB97	8632837	54	0.97

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; well within the 20 cm to 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 cannot be accounted for by zoning.