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 stations at Windmill Point, Virginia (863-6580) and Lewisetta, Virginia (863-5750) served as control for datum determination and provided water level correctors for the project. ***Concur.***

C2. Discussion of Tide Zoning

Tide zoning was included within the Tide and Water Levels Instructions for OPR-E349-KR-2009. A modified version of the HIPS Zone Definition File (ZDF) *E349KR2009_RevisedCORP* provided by CO-OPS was used to apply zoned tides to the multibeam data. The modified file, named *E349KR2009_RevisedCORP*_1s, used a HIPS Interval value of 1 second rather than the default value of 360 seconds which was used in the file received by CO-OPS. The interval value controls the frequency of tide zoning interpolation. The default value of 360 seconds is too infrequent to properly correct for the assigned zoning boundaries where it would be possible for the survey vessel to pass through a zone without a zoned tide corrector being applied if the vessel was not within the zone boundary for longer than 359 seconds. No modifications were made to zone boundaries or time and range correctors. ***Concur.***

Table 6 includes the zoning information for each zone used for the survey.

Table 6. Tide Zones

Zone	Reference Station	Corrector (min.)	Ratio
SCB94	8636580	18	0.99
SCB95	8636580	18	1.12
SCB103	8636580	30	1.12
SCB104	8636580	36	0.99
SCB107	8636580	48	0.99
SCB108	8636580	48	1.12

It is difficult to associate a precise vertical error due to tides. However, this survey included the logging of GPS water levels and follow-on deliverables will include soundings reduced to chart datum from GPS observations. 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 as this survey is relatively close to the Windmill Point NWLON station. In some extreme cases errors approach 25 cm however this is 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. The hydrographer strongly recommends the application of GPS tides to improve vertical accuracy when applying this survey to the nautical chart. ***Concur.***