

## **C1. Vertical Control**

The vertical datum for this project is the CRD, an adopted low-water gradient datum relative to NAVD88. There are known problems in the NGS level lines between Oregon and Washington due to the long level runs without the ability to run tie lines across the Columbia River. GPS observations have documented large vertical differences in published bench mark elevations across the Columbia River. Whereas CO-OPS water level gauges are located in Oregon and Washington and are directly referenced to NGS published bench mark elevations, and the known issue with the level lines between Oregon and Washington, a decision was jointly made by the US Army Corps of Engineers and NOAA to use NGS OPUS solutions to establish vertical consistency in the relationship of CRD relative to NAVD88. The U. S. Army Corps of Engineers, Portland District (designated stewards of CRD) conducted surveys that established OPUS derived NAVD88 elevations on historic bench marks referencing CRD. A result of these surveys was a profile of Columbia River Datum relative to OPUS derived NAVD 88 elevations which were consistent across the Columbia River. The profile defined CRD relative to NAVD88 for each River Mile (RM) from RM 23 to RM 145 on the Columbia River and RM 0 to RM 26 on the Willamette River. This profile is used by the Portland District for hydrographic surveys and dredging operations to maintain the Federal Channel on the Columbia and Willamette rivers.

To improve vertical accuracy of this survey, soundings were reduced to CRD using GPS water levels measured at the survey vessel. Water levels were derived from post processed GPS heights and application of a separation model of the CRD to NAD83 ellipsoid relationship. Data reduction procedures, including detailed discussions of the CRD model generation and GPS water levels computations, for survey H11859 are detailed in the *OPR-N338-KR-08 DAPR*.

To verify GPS water levels, a comparison was made by vessel static observations adjacent to the CO-OPS water level station 9440083 located in Vancouver, WA and at the contractor installed subordinate gauge 9439221 located at the River Place Marina upriver from the Morrison Bridge on the Willamette River. To obtain water levels at Vancouver, WA (9440083) relative to the CO-OPS defined CRD, the Hydrographer selected Station Datum when downloading data from the CO-OPS web site. This is consistent with obtaining CRD values for any CO-OPS station on the Columbia River above RM 23. Adjustments were required to correct CO-OPS water level data to CRD based on the updated USACE CRD profile used to maintain the Columbia and Willamette rivers. CO-OPS is aware of this issue and is working toward resolving the problem. The subordinate gauge at Morrison Bridge (9439221) output water levels relative to CRD as defined by the USACE therefore requiring no additional corrections during comparisons to vessel static observations. The Primary Bench Mark was changed from KET RM1 to MAR RM1 on January 13, 2009 due to concerns about the accuracy of the posted elevation published for KET RM1. This change was approved by CO-OPS staff. The Morrison Street Bridge station datum elevation was corrected to CRD by subtracting 1.639 meters (NAVD88 to CRD correction based on the river mile at the River Place Marina water level station) from the NGS published NAVD88 height of 10.437 meters.

It should be noted that these adjustments were applied to CO-OPS water level data for comparison purposes of water level data relative to the revised USACE profile relative to OPUS derived NAVD88 elevations. This method was approved for project OPR-N388-KR-08 by the Office of Coast Survey, Hydrographic Surveys Division Chief as it is consistent with the USACE, Portland District, methods for maintaining the Federal Channel in the Columbia and Willamette rivers. Further, CO-OPS should adjust water level stations on Columbia River Datum and part of the Columbia PORTS® system to be consistent with the defined CRD profile by the USACE, Portland District. Table 5 lists corrections to be applied to CO-OPS data in Vancouver to be consistent with the USACE, Portland District CRD profile.

**Table 5. Corrections Applied to 9440083 Vancouver, Washington**

Description of Adjustment	Adjustment (m)
Revised CRD value to 1.576m from 1.610m NAVD88	0.034
<b>Total Adjustment to CO-OPS Data in Vancouver, WA</b>	<b>0.034</b>

Water level observations and gauge comparison data may be found in Appendix IV *Tides and Water Levels*. No configurations used during data acquisition deviated from those described in the *OPR-N338-KR-08 DAPR*.