F00586

NOAA FORM 76-35A

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

DESCRIPTIVE REPORT

Type of Survey Field Examination

Field No. N/A

Registry No. F00586

LOCALITY

State Oregon

General Locality Columbia River

Sublocality Hood River

2009

CHIEF OF PARTY
Nicholas A. Forfinski

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DATE

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

REGISTRY No

HYDROGRAPHIC TITLE SHEET

F00586

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: N/A

State Oregon

General Locality Columbia River

Sub-Locality Hood River

Scale 1:10,000 **Date of Survey** 12/13/2009 - 12/16/2009

Instructions dated 12/3/2009 **Project No.** OPR-N338-NRT-09

Vessel S1212 (NRT3)

Chief of party Nick Forfinski

Surveyed by N. Forfinski, B. Jackson, D. Jacobs

Soundings by Kongsberg EM3002 Multibeam Echosounder

SAR by Kurt Mueller **Compilation by** Russ Davies

Soundings compiled in Feet

REMARKS: All times are UTC. UTM Zone 10

The purpose of this survey is to provide contemporary surveys to update National Ocean Service (NOS) nautical charts. All separates are filed with the hydrographic data. Revisions and end notes in red were generated during office processing. Page numbering may be interrupted or non sequential.

All pertinent records for this survey, including the Descriptive Report, are archived at the National Geophysical Data Center (NGDC) and can be retrieved via http://www.ngdc.noaa.gov/.

Descriptive Report
to Accompany F00586
OPR-N338-NRT3-09
Columbia River, OR
Hood River

A. AREA SURVEYED

F00586 is the sole survey in project OPR-N338-NRT3-09, which was assigned as the result of barge groundings near the dynamic shoal at the mouth of the Hood River, near Columbia River mile 170. As per the project instructions, F00586 was conducted as an ellipsoidally referenced survey (ERS). F00586 was an ideal candidate for ERS because the local chart datum is a non-tidal datum based on the normal operating level of the Bonneville Pool segment of the Columbia River. F00586 addresses only general bathymetry, with limited shoreline verification. All charted features (e.g., piles, piers, and rocks) within the survey limits are to be retained as charted. [1]

The total area of hydrography is approximately 0.76 square nautical miles, as shown in Figure 1. The project instructions required complete multibeam echosounder (MBES) coverage for depths greater than 8 meters and fixed 25-meter MBES line spacing for depths both less than 8 meters and greater than the inshore limit of hydrography; however, with the exception of the encircled (purple) region, complete MBES coverage was achieved throughout the assigned priority and secondary areas (see Fig. 2). Although the obtained coverage fulfills the intent of the survey, the inshore limit of hydrography, i.e., the navigable area limit line (NALL), was not fully achieved along certain edges of the secondary area (see Fig. 2). The survey outline, included in Appendix III, was emailed to survey.outlines@noaa.gov on 2/12/10. [2] See table 1 for summary acquisition statistics.

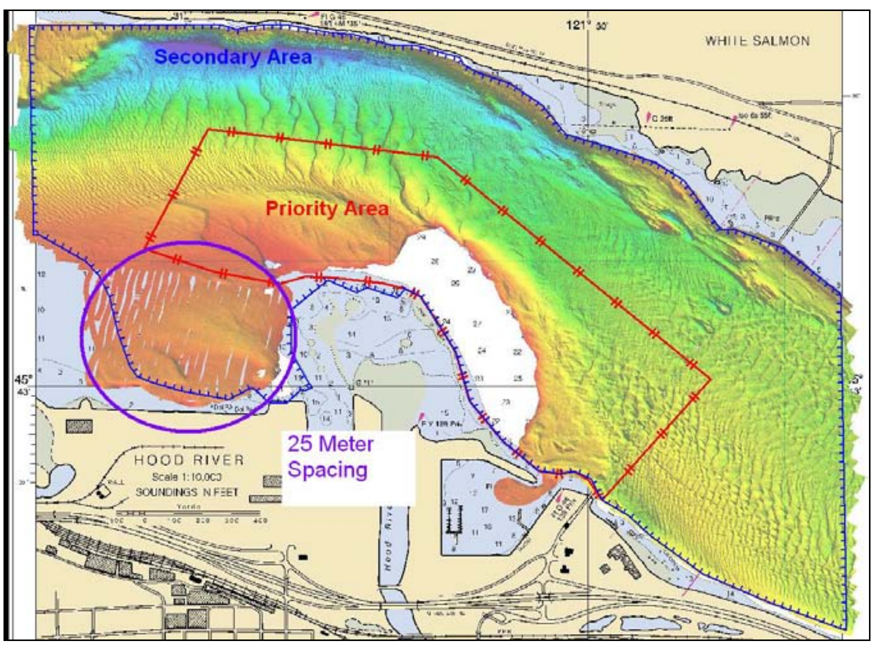

Figure 1: Survey Limits

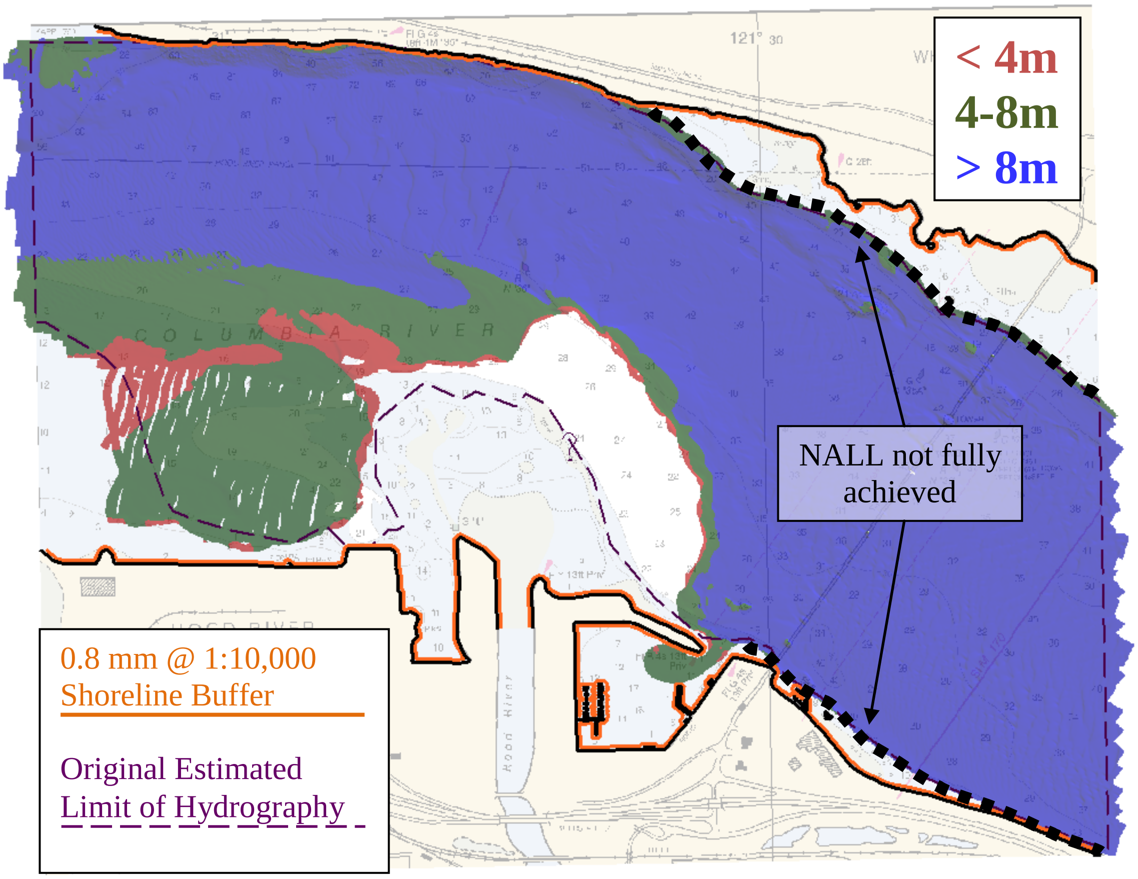

Figure 2: MBES coverage according to depth range

Table 1: Acquisition Summary Statistics

Total Linear Nautical Miles	54.32
Mainscheme Multibeam	54.32
Side Scan Sonar	0
Development	0
Crosslines	0
Square Nautical Miles MBES	.76
Square Nautical Miles SSS	0
Velocity Casts	8
Bottom Samples	0
AWOIS Items	0
Tide Stations Installed	0

B. DATA ACQUISITION AND PROCESSING

Data acquisition was conducted from December 13, 2009 (DN 347) through December 16, 2009 (DN 350) in Hood River, Oregon.

B.1. Equipment and Vessels

Launch S1212 is a 30-foot SeaArk Commander (SAMA115510000) powered by two 150-horsepower Yamaha four-stroke outboards. The launch is eight feet wide, displaces 4.8 tons, and has a static draft of 0.4 meters.

The survey system used for F00586 was different than that described in the 2009 NRT3 DAPR. The major difference was the use of an EM3002 multibeam sonar rather than an EM3000 multibeam sonar. Seattle-based Federal Marine replaced the previous, problematic EM3000 with the EM3002 in early December 2009. No structural modifications of the boat hull were necessary to install the EM3002, which has the same physical dimensions and mounting configuration as the EM3000. The processing unit (PU) was also replaced. Unlike the EM3000, which was controlled via a device-specific controller in Hypack, the EM3002 was controlled with the Kongsberg acquisition software SIS (Seafloor Information System); however, the data were still logged as .hsx files in Hypack (version 2009a). The acquisition computer was also replaced earlier in December 2009.

A hand-held Trimble GeoXH L1/L2 GPS receiver was used to acquire shoreline data, which was processed with Pathfinder Office.

No vertical beam echosounder (VBES) or side scan sonar (SSS) data were acquired as part of F00586.

See the Data Acquisition and Processing Report (DAPR) for more detailed documentation of the remaining components of the survey system, including the POS/MV intertial-navigtion system.

B.2. Quality Control

<u>Crossline Data</u>
No crossline data were acquired as part of F00586; however, the PPK MBES data show excellent internal consistency throughout the entire survey area. In general, vertical differences between overlapping lines is less than 0.1m. [3]

<u>Systematic Artifacts</u>
No significant artifacts were observed in the mainscheme MBES data, but two insignificant systematic artifacts were observed. The first insignificant systematic artifact is a pair of along-track downward spikes, approximately 9-12° on either side of nadir, is seen throughout the dataset (see Fig. 3). This 0.1-0.2m artifact is negligible in the final BASE surface. [4] A possible explanation for this artifact is the inconsistency associated with the transition from amplitude bottom detection to phase bottom detection.

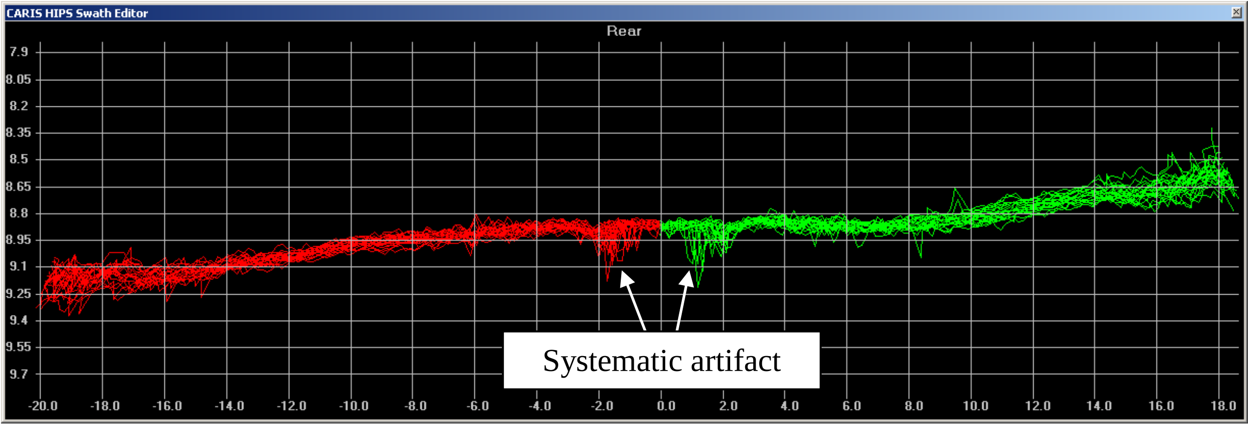

Figure 3: Along-track systematic artifact

The second insignificant systematic artifact is a downwardly angled flare on the upslope side of numerous swaths paralleling contours (see Fig. 4). One possible explanation for this artifact, which is generally 1-3 meters in amplitude, is that upslope outer beams are consistently negatively affected, i.e., "chopped off", by the automatic range-scale selection algorithm in SIS.

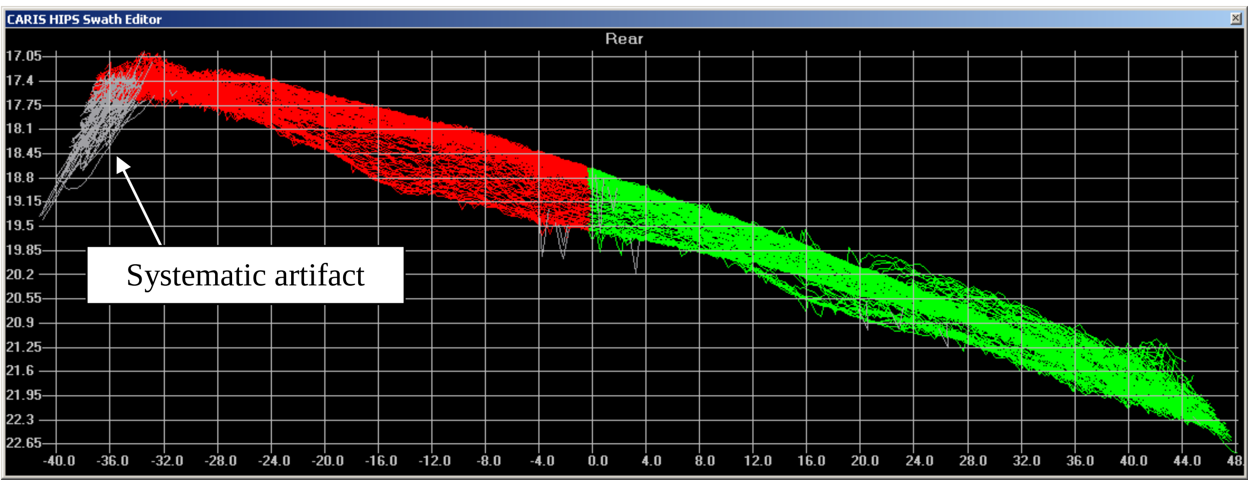

Figure 4: Outer-angle systematic artifact

Uncertainty

Final uncertainty values for 99.998% of the final grid nodes were within IHO order 1 vertical uncertainty requirements. Figure 5 shows the spatial variation of the final uncertainties. As expected, three general artifacts are apparent. First, along-track stripping is noticeable, due to across-track variations in uncertainty. Second, the uncertainties grow with increasing depth. Third, sand wave patterns are superimposed on the uncertainty layer, as a result of selecting the "greater of the two" uncertainty option during the finalization of the surface; the standard deviations of the grid nodes near the slopes of the sand waves are generally greater than the corresponding uncertainties. No significant adverse systematic artifacts or anomalies were observed in the uncertainty layer. [5] See Figure 6 for a histogram and summary of the final uncertainties.

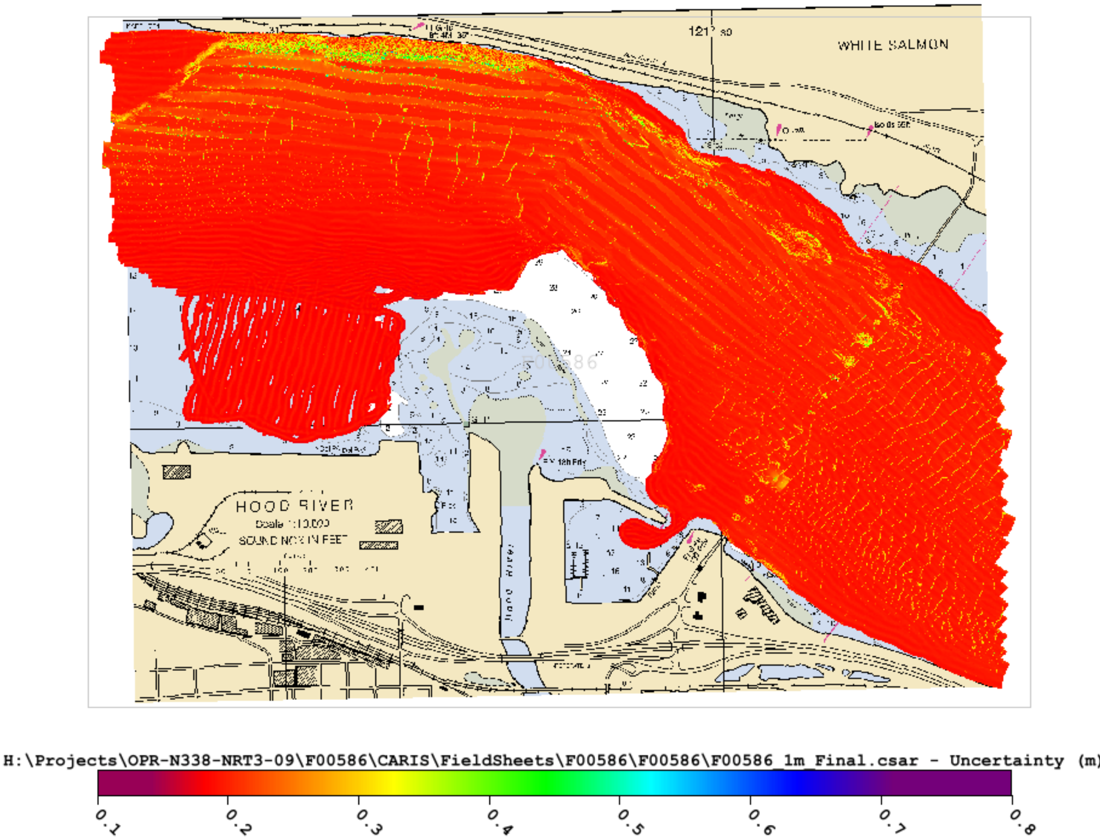

Figure 5: Final uncertainty layer

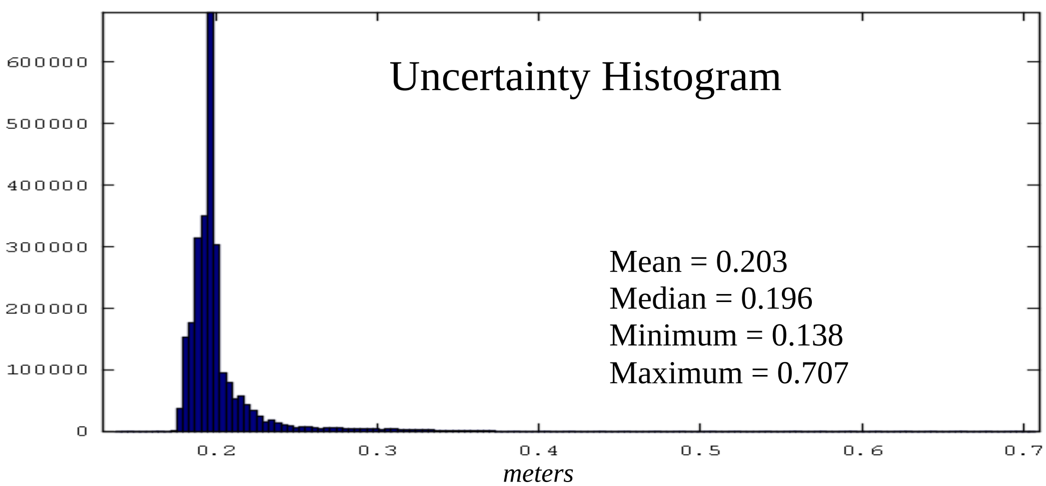

Figure 6: Uncertainty Histogram

Figure 7 summarizes the percent of the allowable special-order and order-1 error achieved for each grid node. IHO compliance was characterized by dividing the final uncertainty by the allowable error. Figure 8 shows a histogram of IHO-compliance values for special order and order 1. Values greater than 1 mean that the allowed error was exceeded.

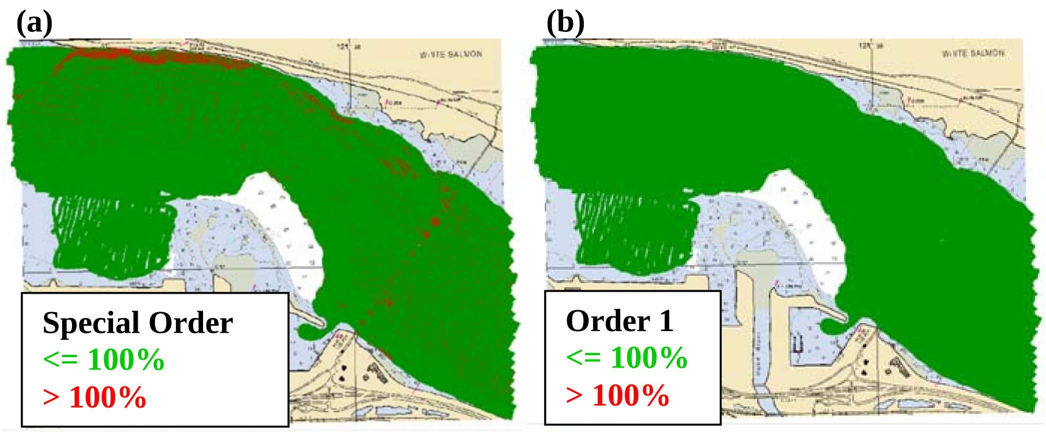

Figure 7: (a) Percent of special-order error achieved (b) Percent of order-I error achieved

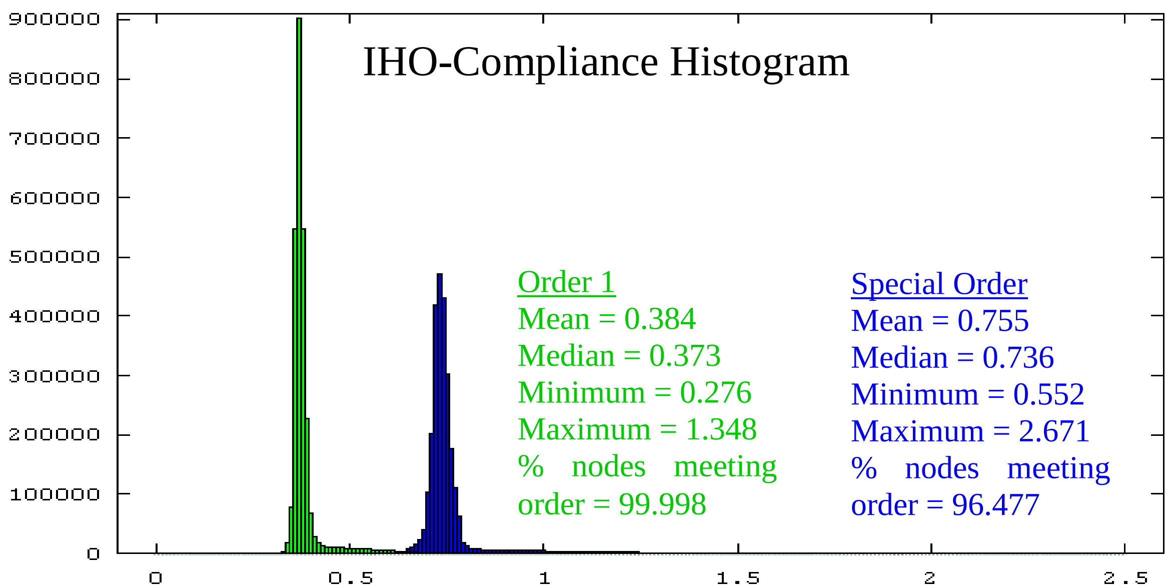

Figure 8: IHO-compliance histogram

Most of the uncertainties described in the 2009 NRT3 DAPR apply to F00586. One significant exception is the exclusion of uncertainties to account for water levels, or "tides", and the associated zoning; however, the *tide measured* TPE parameter, which would otherwise not be applicable in a non-tidally influenced survey, was utilized in F00586 to account for the vertical uncertainties associated with determining the chart-datum/ellipsoid separation. As an immediate, practical alternative to a potentially time-consuming, theoretically rigorous estimation technique, two values were simply added to determine the redefined *tide measured* TPE value. The published nominal VERTCON (the NAVD88/NAVD29 separation) uncertainty of 0.02 m was added to the variation of the GEOID09 model over the survey area (0.04m), for a final value of 0.06m. [6]

Junctions
F00586 has no junctions. See section D.2. *Prior Surveys*.

Environmental Conditions
The river environment presented two operational challenges; however, environmental conditions did not adversely impact the final quality of the data. First, small eddies near the mouth of the Hood River resulted in noticeable crabbing. Second, a noticeable difference in dynamic draft was observed when steering up river compared to when steering down river. The difference in dynamic draft was not an issue in the final data set because the final sounding data were referenced to the ellipsoid; however, before being reduced to the ellipsoid, the data did show significant vertical internal inconsistencies due to an inadequate HVF dynamic draft model.

River Levels
The hydrographer retroactively contacted the Portland District of the U.S. Army Corps to verify the river levels during the times of hydrography. Table 2 contains the approximate morning and afternoon water levels of the Bonneville Pool, as noted by an on-duty attendant at the Bonneville Dam control room. The levels (in feet) are determined using a fixed staff with gradations referenced to NGVD29. The USACE-observed pool levels bounding the times of survey are consistent with the expected pool levels as calculated based on the calculated chart-datum/ellipsoid separation value and the observed vessel ellipsoid heights.

Table 2: Approximate Bonneville Pool Levels (decimal ft)

Day	*0700 Pool Level*	*1700 Pool Level*
2009_347	76.2	76.7
2009_348	75.6	76.1
2009_349	76.1	76.5
2009_350	76.9	77.3

B.3. Corrections to Echo Soundings

The processing paradigm used for F00586 was significantly different than the conventional paradigm documented in the 2009 NRT3 DAPR. The general difference is that F00586 was conducted as an ellipsoidally referenced survey (ERS) in a non-tidal area. Rather than apply water-level correctors to reduce the survey data to MLLW, an ellipsoid-to-chart-datum separation value was applied to the ellipsoid heights of the sounding data to reduce the data to chart datum, which is defined to be 72 feet above MSL (NGVD29).

Unlike in the conventional NRT3 workflow, waterline, sound speed, heave, and attitude were not applied during post processing in Caris. Sound speed, heave, and attitude were applied real-time by the Kongsberg processing unit (PU). A waterline value of 0.5m was also applied to the data real-time, but the 0.5-m value was later deemed to be an error for two reasons. First, a value of

0.0 should have been used because the waterline measurements were inherent in the ellipsoid heights. Second, were the waterline measurements not inherent in the ellipsoid heights, the correct waterline value would have been approximately 2cm. To account for this error, an “Apply Height Correction” value of -0.5m was applied during the “Compute GPS Tide” routine.[7]

The HVF transducer lever arm remained unchanged after the replacement of the EM3000 with the EM3002, but a patch test was conducted. The new patch test values were accounted for during post processing in Caris.

B.4. Data Processing

A single BASE surface was generated to fulfill the complete-MBES coverage requirements:

Table 3: BASE Surface(s)

Surface Name	*Depth Range (m)*	*Resolution (m)*
F00586_1m_Final.csar	0-35	1

The BASE surface was created using the NOAA 1-m CUBE parameters for the 2009 field season (CUBEParams_NOAA.xml).

See the 2009 NRT3 Data Acquisition and Processing Report for additional documentation on BASE surface processing techniques.

C. VERTICAL AND HORIZONTAL CONTROL

C.1. Horizontal Control

Horizontal control was obtained using post-processed kinematic (PPK) positioning based on a single base station established at a recovered reference mark (CLOVER RM3). The NGS reference mark datasheet and the observation logs for the base station are included in Appendix 5. The base station was assembled and disassembled at the beginning and end, respectively, of each survey day. The reference mark was not occupied continuously throughout the period of the survey because of limited daily battery life and limited site security.

PPK horizontal processing was in accordance with the single-base procedures documented in the NOAA ellipsoidally referenced survey (ERS) standard operating procedure (SOP), which is included in Appendix 5.

Because the base station was not occupied for a continuous 24-hour period, the position entered into the ‘Coordinate Manager’ was not a single OPUS-calculated position, but a weighted average of the OPUS-calculated positions for each individual occupation. The average was weighted by the number of observations in each occupation. The weighted average position of the base station was 45.71127585° N, 121.5019697° W. The OPUS reports for each occupation are included in Appendix 5.

Table 4 lists the latitude and longitude, with corresponding uncertainties, of the OPUS solution for each base station occupation.

Table 4: OPUS solution positions and uncertainties for daily occupations

Day	*Latitude*	*Peak-to-Peak Error (m)*	*Longitude*	*Peak-to-Peak Error (m)*	*Overall RMS (m)*
2009_345*	45° 42' 40.59270"	0.009	121° 30' 7.09117"	0.008	0.016
2009_346*	45° 42' 40.59274"	0.008	121° 30' 7.09088"	0.005	0.018
2009_347	45° 42' 40.59273"	0.007	121° 30' 7.09124"	0.014	0.017
2009_348	45° 42' 40.59284"	0.003	121° 30' 7.09090"	0.020	0.018
2009_349	45° 42' 40.59356"	0.011	121° 30' 7.09022"	0.037	0.022
2009_350	45° 42' 40.59340"	0.000	121° 30' 7.09011"	0.006	0.018

**No hydrography was acquired on these days, but the OPUS solutions were incorporated into the final weighted-average benchmark position.*

All of the resulting PPK navigation data are well within NOS horizontal positioning requirements. Figure 9 shows the north and east position RMS (root mean square) errors throughout the times of survey. Relative outliers do exist in the RMS data, but positioning RMS errors nominally range from approximately 0.005 to 0.009 m. The most egregious spikes are attributable to two factors: filtering initialization artifacts and satellite dropouts. Figure 10 shows an example of a filtering initialization artifact common to the beginnings and ends of SBET (smooth best estimate of trajectory) files. Figure 10 also shows an example of a spike resulting from satellite dropouts and the resulting low PDOP (position dilution of precision). The spikes in this particularly noisy example correspond to vessel turns near the Hood River-to-White Salmon Bridge.

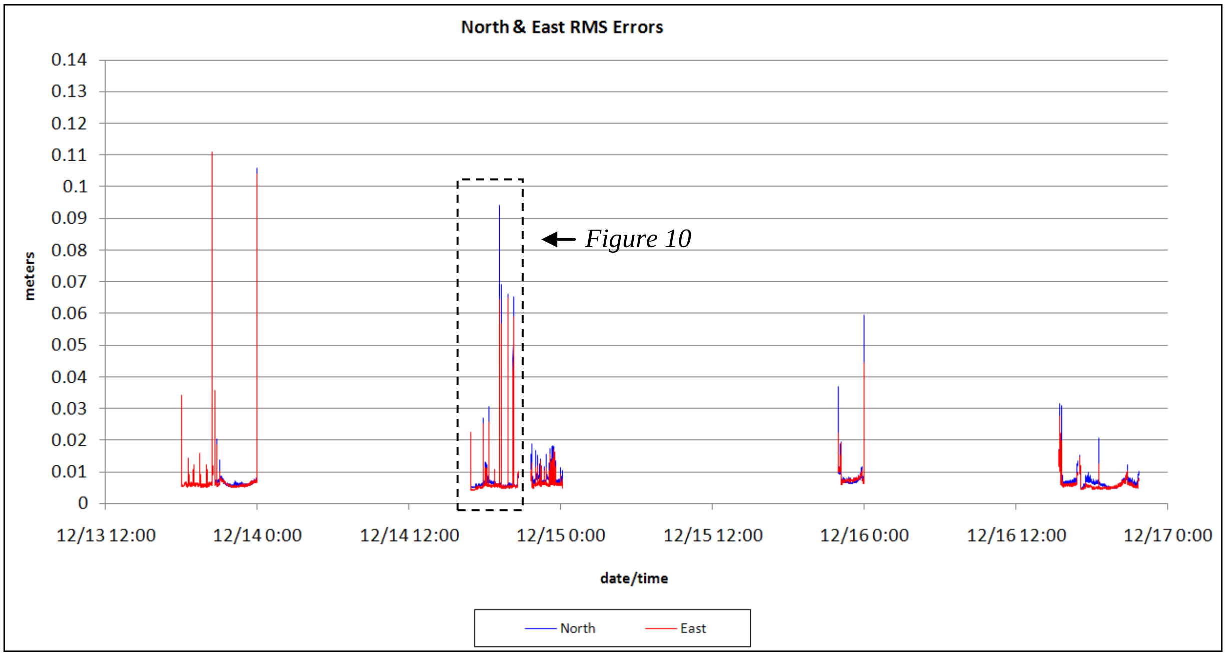

Figure 9: North, East, & Down RMS Errors

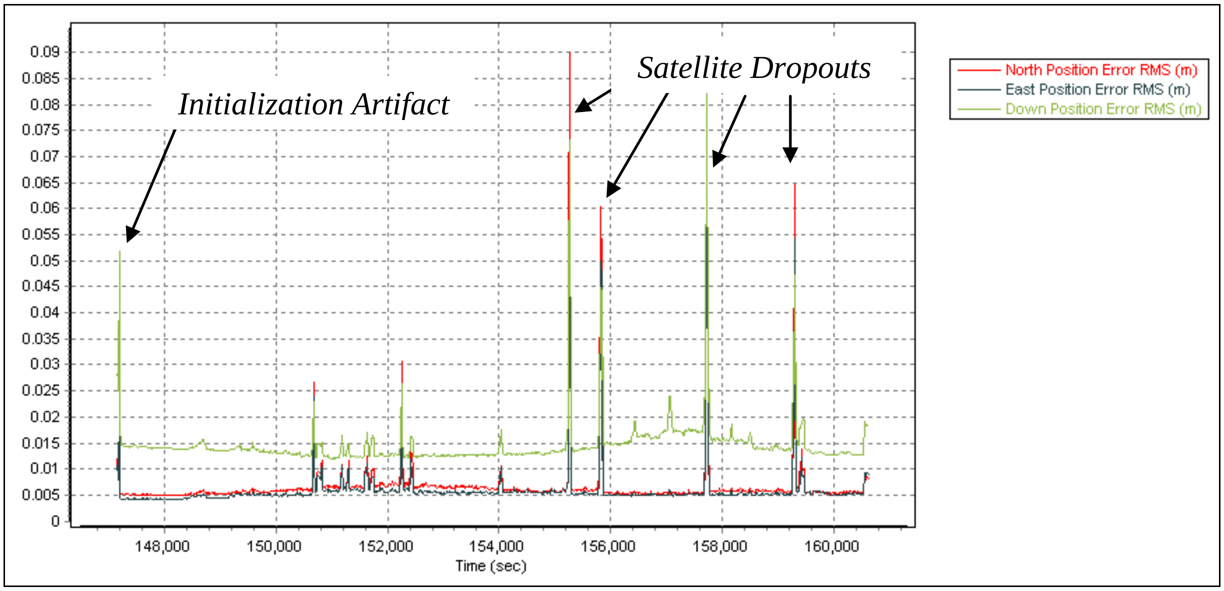

Figure 10: Example RMS-Error Outliers

C.2. Vertical Control

F00586 was conducted as an ellipsoidally referenced survey (ERS). The vertical relationship between the ellipsoid (GRS80) and NGVD29 was used to reduce ellipsoidally referenced survey soundings to the non-tidal chart datum, which is defined as 72 feet above "mean sea level" (NGVD29).

To simplify the vertical datum transformations, the ellipsoid/NAVD88 separation (GEOID09) and the NGVD29/NAVD88 separation were assumed to be constant over the small survey area. In reality, the ellipsoid/NAVD88 separation, or the GEOID09 model, does indeed vary by approximately 4 cm over the survey area; however, this difference was not considered to be significant. The Caris TPE model was adjusted to account for this simplifying assumption (see section B.2).

Similar to the position, the final ellipsoid height of the base station was set to be a weighted average of the OPUS-derived ellipsoid heights for each occupation. The final weighted-average ellipsoid height of the weighted-average reference mark position was 5.9005m. In turn, the NGVD29 height of the recovered reference mark was calculated, using VDatum 2.2.7, to be 26.3222m. The resulting ellipsoid/chart-datum separation value was 1.5241m. See Figure 11 for a schematic illustrating relationship among the various data.

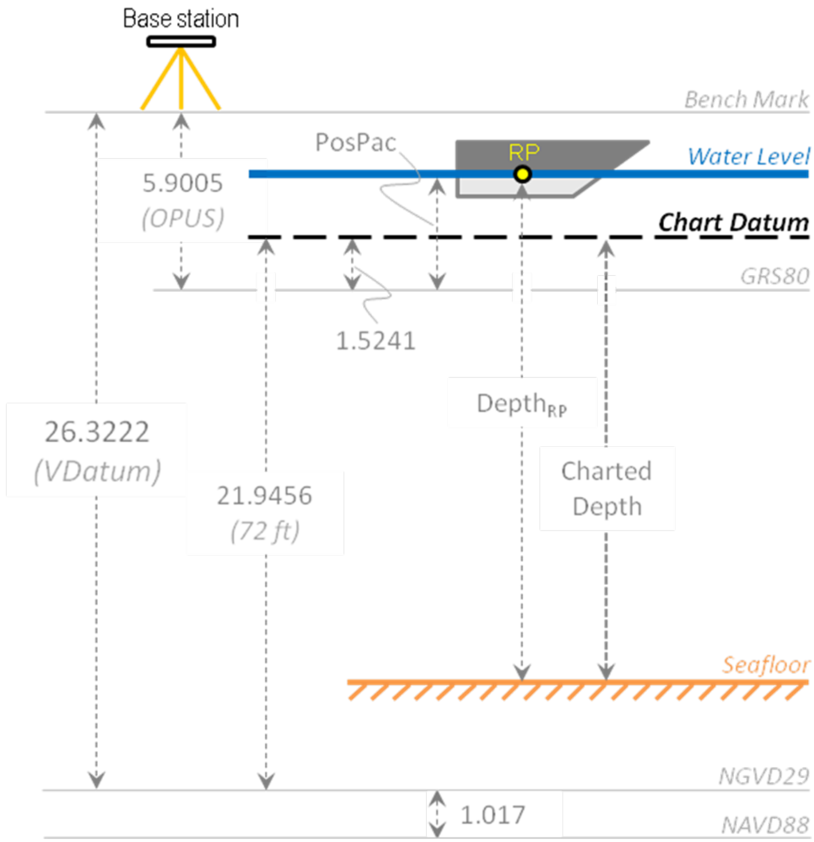

Figure 11: Schematic of data relationships

The CLOVER RM 3 benchmark does not have a published ellipsoid height to compare with the field-determined weighted-average ellipsoid height; however, CLOVER RM 3 does have a published NAVD88 height. The field-calculated NAVD88 benchmark height (27.3392m), based on the weighted-average ellipsoid height of the benchmark, is 7.2 cm lower than the published NAVD88 benchmark height (27.411m). This 7.2-cm offset is within the same order of magnitude as the peak-to-peak error of the NAVD88 heights as reported in each OPUS solution (see Table 5).

Table 5: OPUS solution heights for daily occupations

Day	Ellipsoid Height (m)	*Peak-to-Peak Error (m)*	NAVD88 Height (m)	*Peak-to-Peak Error (m)*
2009_345*	5.877	0.011	27.316	0.081
2009_346*	5.898	0.051	27.337	0.096
2009_347	5.891	0.057	27.330	0.099
2009_348	5.904	0.033	27.343	0.087
2009_349	5.917	0.112	27.356	0.138
2009_350	5.923	0.063	27.362	0.102

The RMS errors for the vertical component of the navigation solution are shown in Figure 12. As with the horizontal components, filter-initialization artifacts and satellite-dropout outliers are observed, but, the down RMS errors generally range from approximately 0.01 to 0.02m.

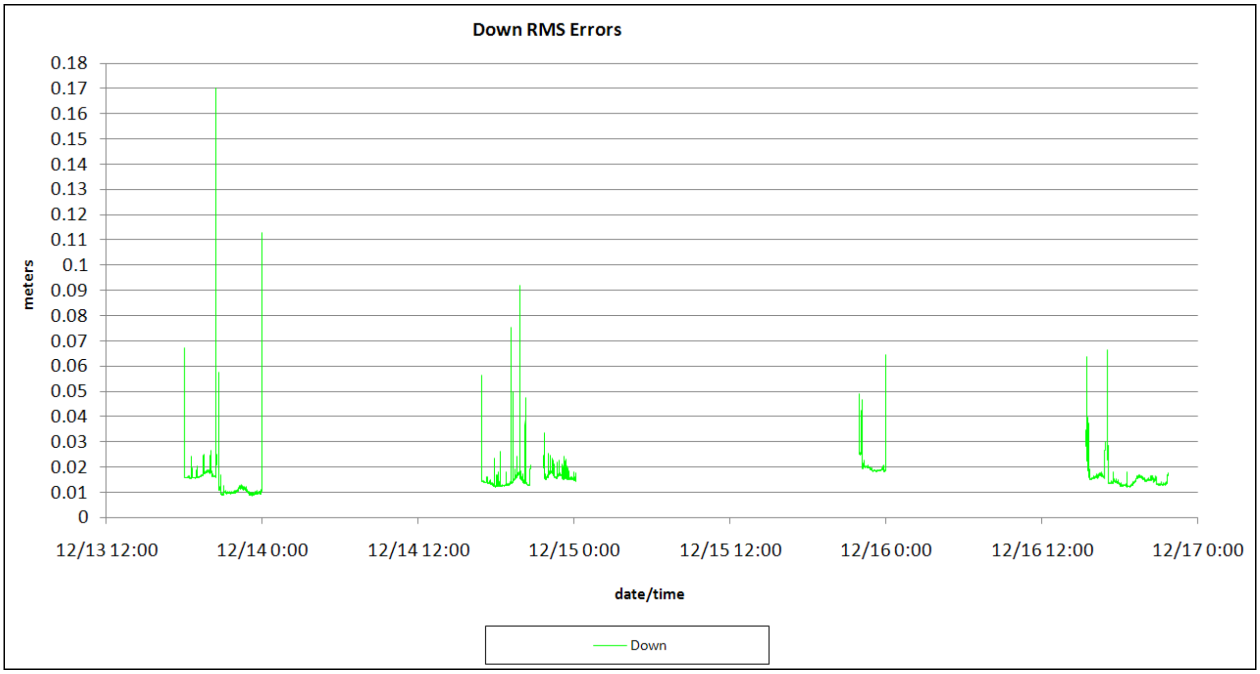

Figure 12: Down RMS Errors

D. RESULTS AND RECOMMENDATIONS

D.1. Chart Comparison

F00586 was compared with the following editions of the largest scale charts affected by the survey:

Table 6: Affected RNCs

Chart No.	*Kapp No.*	*Edition*	*Edition Date*	*Scale*	*LNM*	*NTM*
18532_1	1754	21	05/01/06	1:10,000	01/19/10	02/06/10

Table 7: Affected ENCs

ENC Cell	*Edition*	*Update Application Date*	*Issue Date*
US5OR30M	5	Null	2009-08-07

Comparison of Soundings

F00586 survey "soundings" (grid node depths) differed drastically from the charted depths. Figure 13 shows the spatial distribution of the differences, which were calculated using grid subtraction in Global Mapper. The charted-depths surface was created using a TIN (triangular irregular network) algorithm (in Global Mapper) to interpolate XYZ depth data derived from the ENC, which had parity with the RNC.

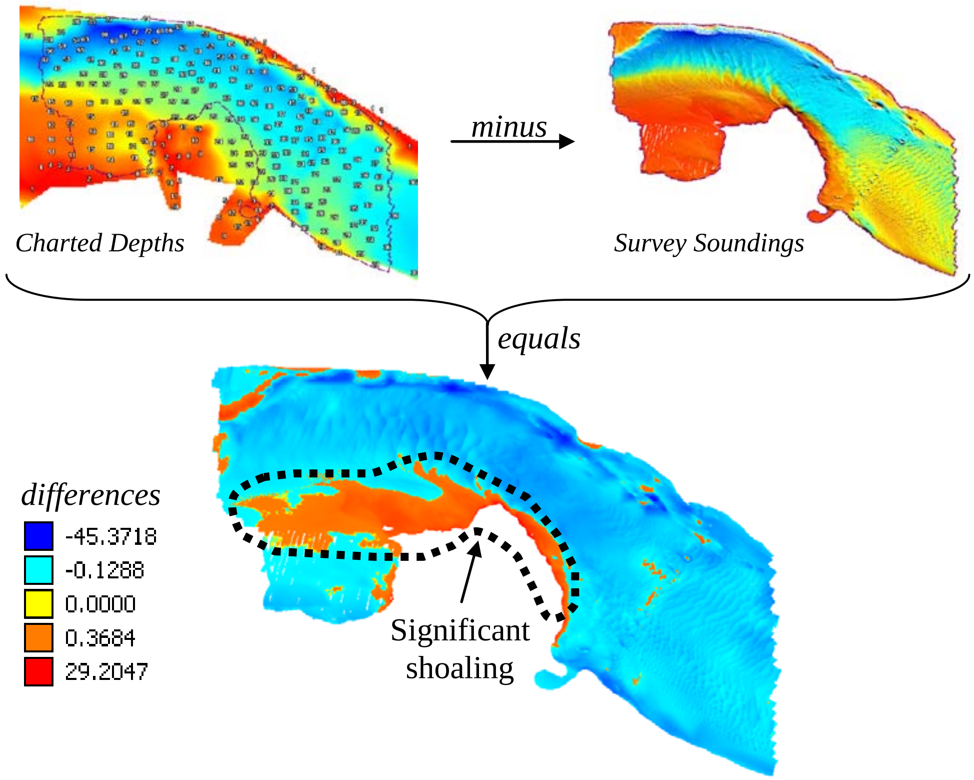

Figure 13: Survey "Soundings"/Charted Depths Comparison

The difference map reveals two large-scale (broad) trends. First, there is significant shoaling at the mouth of the Hood River, as outlined by the black, dashed line in Figure 13. A portion of this shoaling was submitted to MCD as a DtoN (see section D.1. *Dangers to Navigation*). Second, 86% of the survey area is deeper than charted. This general deepening trend is reflected by a (-)7m bias in the somewhat normally distributed histogram of the differences (Fig. 14). These two major trends are consistent with two expected fluvial geomorphologic processes: (1) sedimentation downstream of sediment sources and (2) erosion in the outer regions of a river bend. [8]

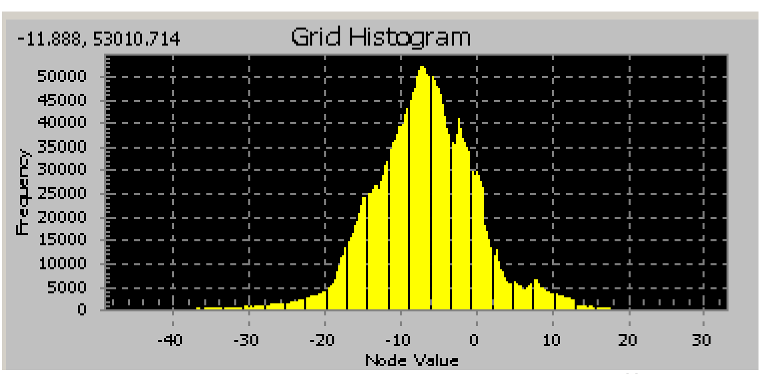

Figure 14: Charted Depths/Survey "Soundings" Differences

Comparison of Non-Sounding Features

As per the project instructions, F00586 included limited shoreline verification. No point features were positioned, but the general trend of the shoreline near the mouth of the Hood River was delineated by walking along the water's edge with a hand-held L1/L2 Trimble GeoXH GPS receiver. The surveyed shoreline was significantly different from the then-charted shoreline (see Fig. 15). As discussed in section D.1. *Dangers to Navigation*, the surveyed shoreline was submitted as part of a DtoN report and has since been applied to the chart. [9]

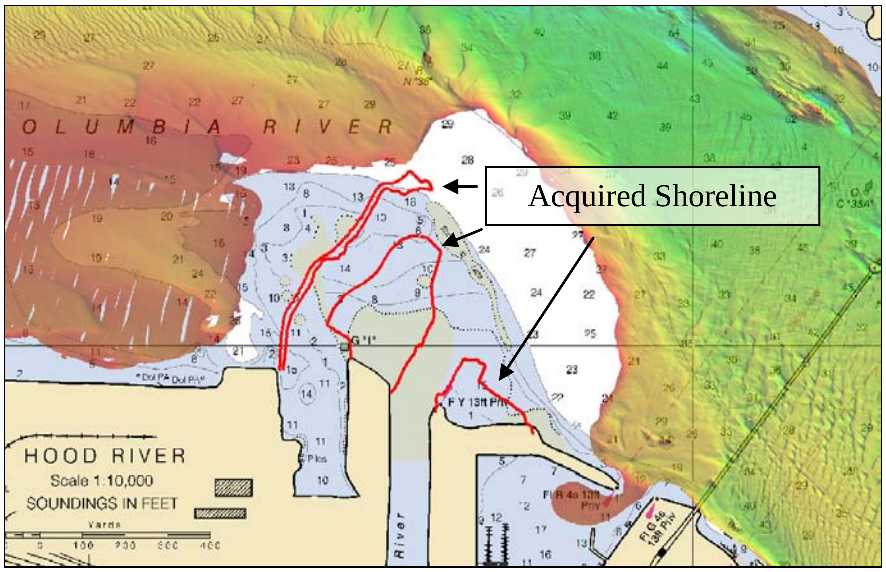

Figure 15: Acquired shoreline data & RNC 18352_1 prior to DtoN application

The surveyed "shoreline" was not technically at chart datum, because the pool level was approximately 4 feet above chart datum at the time of data acquisition; however, the acquired shoreline was vastly more representative of the actual shoreline than what was charted. [10] Also see section D.1. *Dangers to Navigation*.

AWOIS Items

There were no AWOIS items assigned to F00586. [11]

Dangers to Navigation

One DTON report, attached to this report, was submitted to MCD, on 12/22/09. The DtoN report described the broad area of shoaling at the mouth of the Hood River, including the significant shoreline changes. MCD acknowledged receipt of the DtoN on 12/23/09 (see Appendix V). The DtoN report has been applied to the chart, as seen in Figure 16. In addition to charting selected soundings, MCD charted the shoreline data as unsurveyed coastline. Although the Trimble GeoXH L1/L2 GPS receiver offers high accuracy position, the hydrographer recommends retaining the shoreline as unsurveyed coastline (a black dashed line) because the "shoreline" data was acquired when the pool level was approximately 4 feet above chart datum. [12]

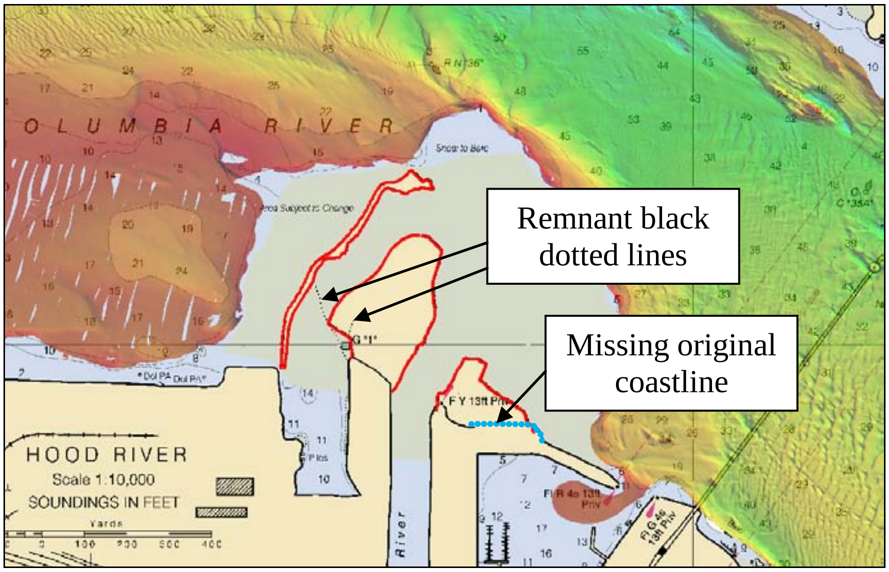

Figure 16: Chart 18352_1 after DtoN application

The updated RNC 18352_1 contains remnant black dotted lines in the green tint area near the mouth of the Hood River (see Fig 16.). The hydrographer recommends deleting the remnant black dashed lines. [13] Additionally, the updated RNC 18352_1 contains an inconsistency with the charted coastline (black solid line); certain portions of the existing coastline were retained after DtoN application, but other portions were not (see Fig 16.). The hydrographer recommends maintaining local consistency with the charted shoreline. [14]

D.2. Additional Results

Prior Surveys

F00586 overlaps a portion of a 2008 U.S. Army Corps of Engineers (USACE) vertical beam survey (included in Appendix V). The datum for the original USACE survey was 70 feet above NGVD29, not 72 feet above NGVD29. Two feet were added to the USACE survey soundings before they were compared to F00586. Significant differences exist between F00586 and the USACE survey. Also refer to section D.1. for a comparison of F00586 to the chart.

To characterize the difference between the 2008 USACE survey and F00586, a difference surface was generated, using Vertical Mapper. The USACE surface was generated, using Global Mapper 7, by gridding the XYZ data, using the “tightest” gridding option for importing ASCII point data. Figure 17 shows a map of the vertical differences between F00586 and the USACE survey.

Three major factors limit the meaningful analysis of the differences between the 2008 USACE survey and the 2009 NOAA survey: (1) minimal documentation of the USACE survey, (2) the complex fluvial dynamics of the Hood River/Columbia River confluence, and (3) gridding and grid-differencing artifacts. Despite these three major limitations, two general observations are worth noting. First, there is an area of shoaling downriver from the mouth of the Hood River (outlined by the black dashed line in Fig. 17). This shoaling is consistent with the expected outflow of the Hood River. Second, an approximately 1-m bias is observed in the histogram of the differences (see Fig. 18 on the following page). The bias shows that F00586 is generally deeper than the 2008 USACE survey. No definitive explanation is evident, but two possible scenarios are (1) an actual overall deepening of the river and (2) an unidentified offset error. Given the excellent internal consistency of the PPK ERS F00586 MBES data, the hydrographer recommends that F00586 supersede the 2008 USACE VBES data in the common area. [15]

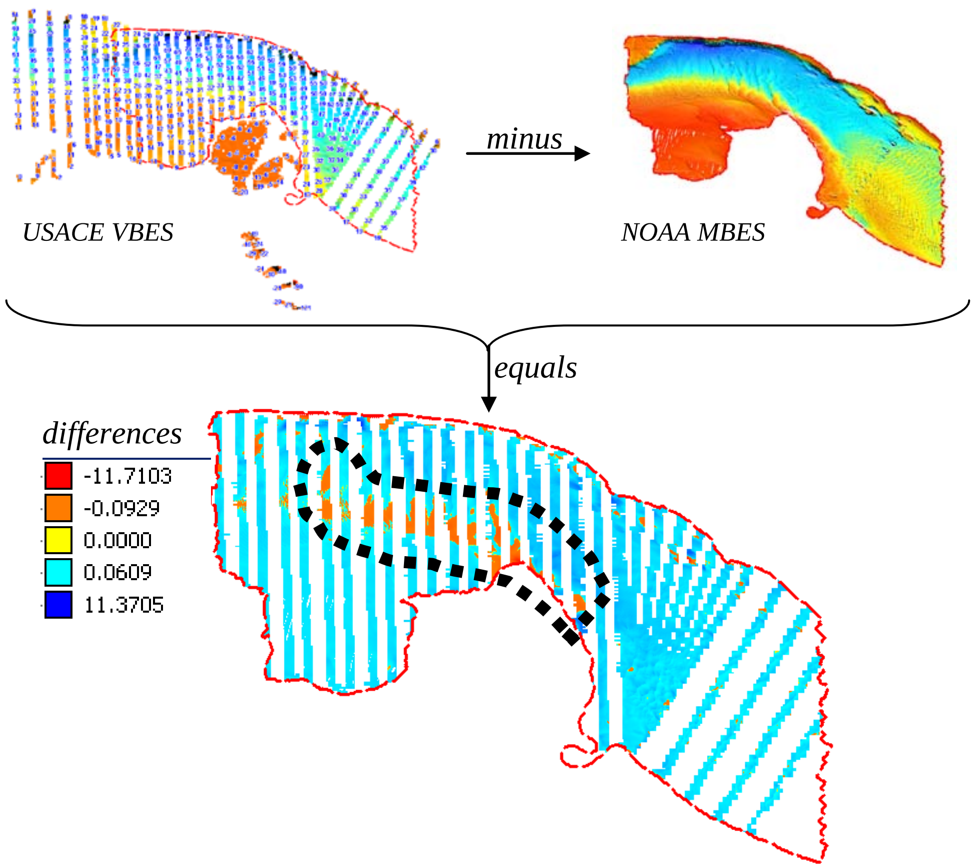

Figure 17: 2008 USACE VBES/2009 NOAA MBES comparison

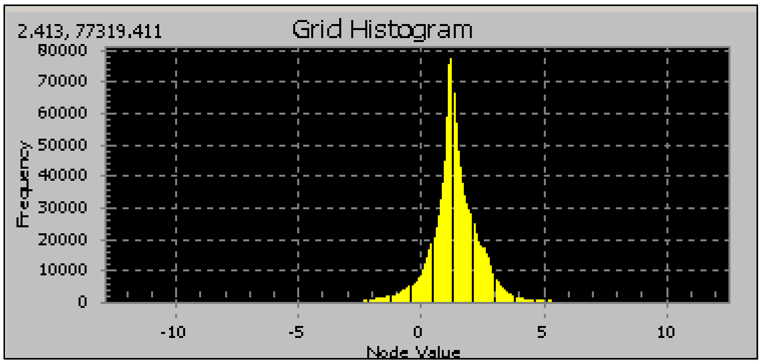

Figure 18: USACE/NOAA difference histogram

Aids to Navigation
Aids to navigation were observed to be on target and fulfilling the intended purpose. [16]

Bridges, Cables, Pipelines
A charted cable area and bridge are within the survey limits. No evidence of cables was seen in the data, and the position of the bridge was found to be accurately charted. The clearance heights of the associated lift section of the bridge were not verified.[17]

E. APPROVAL SHEET

Standard field surveying and processing procedures were followed in producing this survey in accordance with the Navigation Response Branch Operations Manual, the Field Procedures Manual, and NOS Hydrographic Surveys Specifications and Deliverables.

The data were reviewed daily during acquisition and processing.

The digital data and supporting records have been reviewed by me, are considered complete and adequate for charting purposes, and are approved. All records are forwarded to Atlantic Hydrographic Branch and should be attached to F00586 for final review and processing.

Approved and forwarded,

Nicholas A. Forfinski

Nicholas A. Forfinski
Team Lead, NOAA NRT3

Revisions Compiled During Office Processing and Certification:

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[1] Concur
[2] The final outline will be submitted with this survey.
[3] Concur
[4] Concur
[5] Concur with hydrographer’s comments
[6] Concur with hydrographer’s comments
[7] A constant 0.5 meter offset was mistakenly applied by the field party during the compute-GPS-tide computation in CARIS, resulting in deeper than actual depths throughout the survey (See 'F00586_DR_Supplement'). On recommendation of the hydrographer, the reviewer shifted the depth layer of the final BASE surface by -0.5 meter to account for the error, i.e., the surface was moved "up" by half a meter.
[8] Concur with hydrographer’s comments
[9] Concur
[10] Concur
[11] Concur
[12] Concur
[13] Concur, see blue notes on the HCell for charting recommendations.
[14] Concur
[15] See endnote 7
[16] Concur, use the latest ATONIS information for the Aids to Navigation.
[17] Retain as charted

F00586 Descriptive Report Supplement
OPR-N338-NRT3-09
Columbia River, OR
Hood River

The multibeam bathymetry data and the final gridded surface that were submitted to AHB as part of the F00586 submission package (transmitted by NRT3 on 2/20/10 and received by AHB on 2/24/10) contain a systematic vertical error. The submitted data, both the HDCS processed depths and the single, 1-m BASE surface, are 0.5 meter deeper than what they should be.

Originating with an erroneous 0.5-meter water-line value entered into the EM3002 controller (a limited-functionality instance of Kongsberg's Seafloor Information System, or SIS), the vertical error ultimately resulted from a misunderstanding of how the Hysweep option "Use Combined EM/draft heave" (in the EM3002 Hysweep driver) affected the data logged to the HSX files. With this option unchecked, as it was during data acquisition, the logged data did not include the erroneous 0.5-meter water-line value; however, the hydrographer mistakenly believed that the logged data did indeed reflect the erroneous water-line value and therefore, to compensate, applied (mistakenly) a constant 0.5-meter offset during the compute-GPS-tide computation in Caris (see DR section B.3).

The systematic vertical error is illustrated in Figure 1 below, using the shoalest sounding from the survey (ping 1252/beam 254 from line Nav000_2138) as an example. The vertical error is represented by the thin red arrow. The correct charted depth is the ellipsoid height of the vessel (at the time of the sounding) minus the sum of the transducer's Z offset, the observed depth, and the chart-datum/ellipsoid separation.

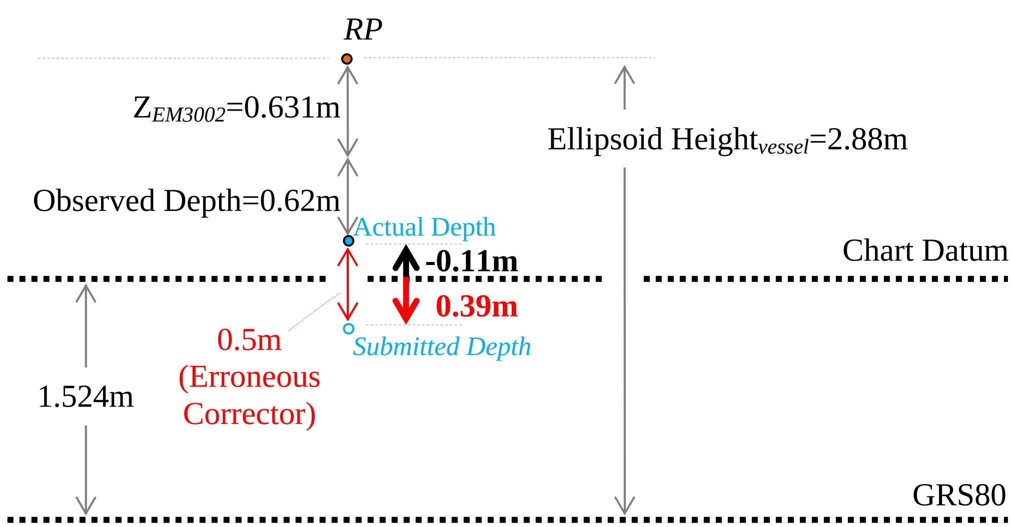

Figure 1: *The thin red arrow represents the 0.5-meter corrector that was mistakenly applied to the multibeam data. The correct charted depth is the ellipsoid height of the RP minus the sum of the z-component of the sonar lever arm, the observed depth, and the chart-datum/ellipsoid separation.*

The hydrographer recommends that the AHB survey acceptance review (SAR) reviewer shift the depth layer of the final BASE surface by -0.5 meters to account for the constant 0.5 error, i.e., move the surface “up” by half a meter, before the survey data are compiled to the H-Cell. The hydrographer also recommends that the uncertainty layer be retained as submitted. The horizontal and vertical total propagated uncertainty (TPU) for each sounding and, in turn, the uncertainty layer in the finalized BASE surface, were artificially inflated because of the constant 0.5-meter error, but the effect is deemed insignificant. Even slightly inflated, the submitted uncertainty values are well within specifications (see DR section B.2).

F00586 DtoN Report

Registry Number: F00586
State: Oregon
Locality: Columbia River
Sub-locality: Hood River
Project Number: OPR-N338-NRT3-09
Survey Date: 12/13/2009

Charts Affected

Number	Edition	Date	Scale (RNC)	RNC Correction(s)*
18532	21st	05/01/2006	1:10,000 (18532_1)	USCG LNM: 08/04/2009 (10/20/2009) CHS NTM: None (09/25/2009) NGA NTM: None (11/07/2009)
18532	21st	05/01/2006	1:40,000 (18532_4)	[L]NTM: ?
18003	20th	11/01/2006	1:736,560 (18003_1)	[L]NTM: ?
18007	33rd	02/01/2009	1:1,200,000 (18007_1)	[L]NTM: ?
501	12th	11/01/2002	1:3,500,000 (501_1)	[L]NTM: ?
530	32nd	06/01/2007	1:4,860,700 (530_1)	[L]NTM: ?
50	6th	06/01/2003	1:10,000,000 (50_1)	[L]NTM: ?

* Correction(s) - *source: last correction applied (last correction reviewed--"cleared date")*

Features

No.	Name	Feature Type	Survey Depth	Survey Latitude	Survey Longitude	AWOIS Item
1.1	Hood River Shoaling	Shoal	0.42 m	45° 43' 16.5" N	121° 30' 21.3" W	---

Generated by Pydro v9.10 (r2735) on Wed Dec 23 03:05:58 2009 [UTC]

1.1) Hood River Shoaling

DANGER TO NAVIGATION

Survey Summary

Survey Position:	45° 43' 16.5" N, 121° 30' 21.3" W
Least Depth:	0.42 m (= 1.38 ft = 0.230 fm = 0 fm 1.38 ft)
TPU (±1.96σ):	**THU (TPEh)** ±1.378 m ; **TVU (TPEv)** ±0.158 m
Timestamp:	2009-347.21:39:30.856 (12/13/2009)
Survey Line:	f00586 / nrt3_hoodriver_em3002 / 2009-347 / nav000_2138
Profile/Beam:	1252/254
Charts Affected:	18532_1, 18532_4, 18003_1, 18007_1, 501_1, 530_1, 50_1

Remarks:

There is significant shoaling over a broad area at the mouth of the Hood River. The surrounding navigable area was covered with a combination of (1) 100% complete-coverage MBES data and (2) fixed-25-meter-line-spacing MBES data (EM3002). The preliminary MBES data are relative to chart datum, which is 72 ft above "mean sea level" (NGVD29). Additionally, the coastline was defined along various sections by "walking the shoreline" with an L1/L2 Trimble Geo XH GPS receiver. The survey sounding and shoreline data are included in this DtoN submission as an S57-format .000 file (HUNI and DUNI = feet). (The current bathy feature, sounding 1252/254, was designated for the purpose of being able to generate a DtoN report in Pydro.)

Feature Correlation

Address	Feature	Range	Azimuth	Status
f00586/nrt3_hoodriver_em3002/2009-347/nav000_2138	1252/254	0.00	000.0	Primary

Hydrographer Recommendations

(1) Chart the preliminary survey soundings near the mouth of the Hood River. (2) Chart the area encompassed by the acquired shoreline as land. (3) Chart the areas between the acquired shoreline and MBES data as "Shoal to Bare". (4) Add the annotation "Area subject to change" to reflect the dynamic nature of the area.

Cartographically-Rounded Depth (Affected Charts):

1ft (18532_1, 18532_4)

0 ¼fm (18003_1, 18007_1, 530_1)

.4m (501_1, 50_1)

S-57 Data

[None]

Feature Images

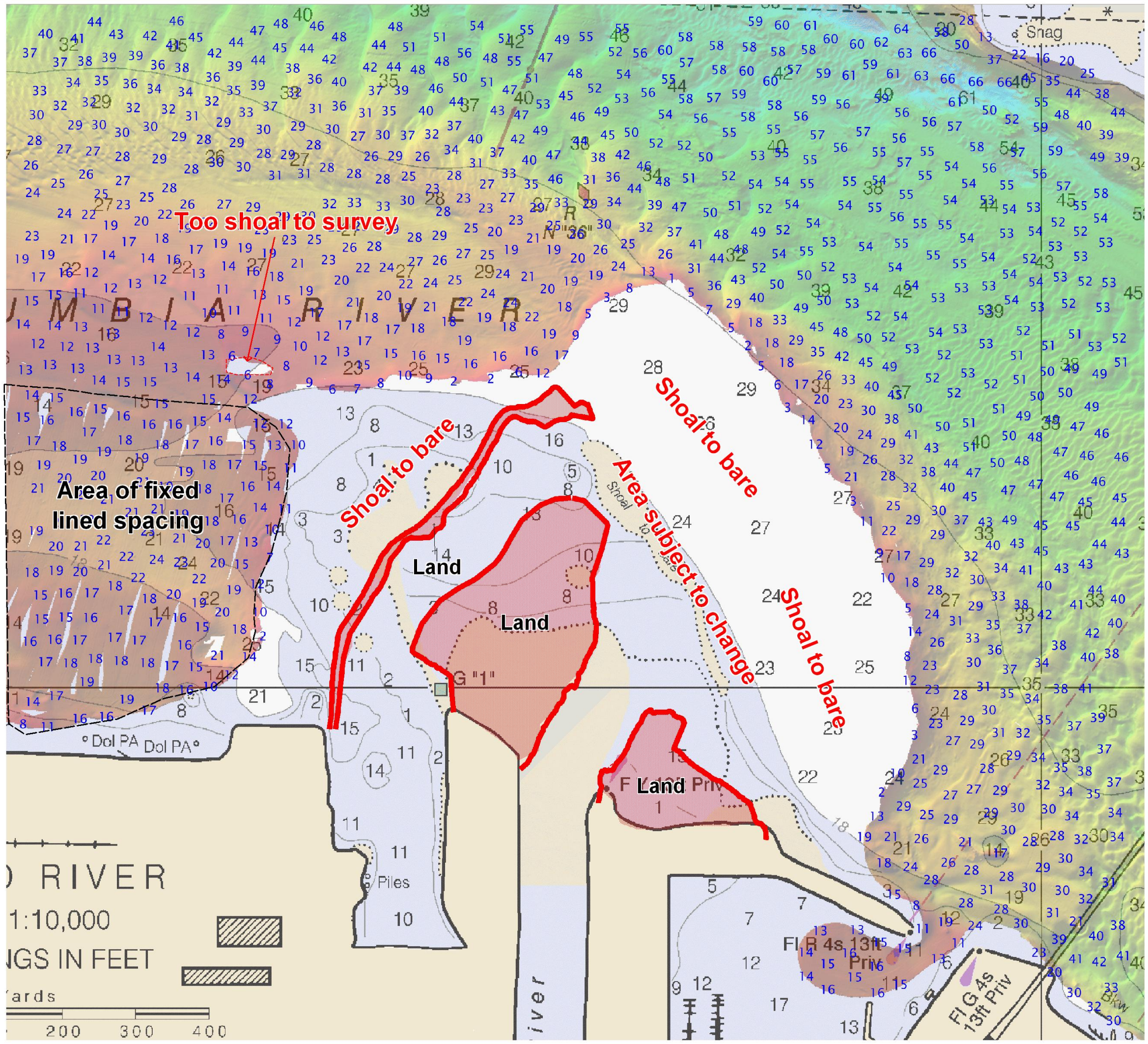

Figure 1.1.1

F00586 HCell Report

Russ Davies, Cartographer
Pacific Hydrographic Branch

1. Specifications, Standards and Guidance Used in HCell Compilation

HCell compilation of survey F00586 used:

Office of Coast Survey HCell Specifications: Draft, Version: 4.0, 17 March, 2010.
HCell Reference Guide: Version 2.0, 22 February, 2010.

2. Compilation Scale

Depths and features for HCell F00586 were compiled to the largest scale raster charts shown below:

Chart	Scale	Edition	Edition Date	NM Date
18532_1	1:10,000	21st	05/2006	05/20/2006

The following ENCs were also used during compilation:

Chart	Scale
US5OR30M	1:10,000

3. Soundings

A survey-scale sounding (SOUNDG) feature object layer was built from the 1-meter Combined Surface in CARIS BASE Editor. A shoal-biased selection was made at 1:10,000 survey scale using a Radius Table file with values shown in the table, below.

Shoal Limit (m)	Deep Limit (m)	Radius (mm)
-1.0	10	3
10	20	4
20	50	4.5
50	100	5

In CARIS BASE Editor soundings were manually selected from the high density sounding layers (SS) and imported into a new layer (CS) created to accommodate chart density depths. Manual selection was used to accomplish a density and distribution that closely represents the seafloor morphology.

4. Depth Contours

Depth contours at the intervals on the largest scale chart are included in the *_SS HCell for MCD raster charting division to use for guidance in creating chart contours. The metric and fathom equivalent contour values are shown in the table below.

Chart Contour Intervals in Feet from Chart 18532	Metric Equivalent to Chart Feet, Arithmetically Rounded	Metric Equivalent of Chart Feet, with NOAA Rounding Applied	Feet with NOAA Rounding Applied	Feet with NOAA Rounding Removed for Display on F00586_SS.000
0	0	0.000	0.000	0
6	1.8288	2.0574	6.125	6
12	3.6576	3.8862	12.750	12
18	5.4864	5.715	18.750	18
30	9.144	9.3726	30.750	30

With the exception of the zero contours included in the *_CS file, contours have not been deconflicted against shoreline features, soundings and hydrography, as all other features in the *_CS file and soundings in the *_SS have been. This may result in conflicts between the *_SS file contours and HCell features at or near the survey limits. Conflicts with M_QUAL and SBDARE objects, and with DEPCNT objects representing MLLW, should be expected. HCell features should be honored over *_SS.000 file contours in all cases where conflicts are found.

5. Meta Areas

The following Meta object areas are included in HCell F00586:

M_QUAL

The Meta area objects were constructed on the basis of the limits of the hydrography.

6. Features

Features addressed by the field units are delivered to PHB where they are deconflicted against the hydrography and the largest scale chart. These features, as well as features to be retained from the chart and features digitized from the Base Surface, are included in the HCell. The geometry of these features may be modified to emulate chart scale per the HCell Reference Guide on compiling features to the chart scale HCell.

7. S-57 Objects and Attributes

The *_CS HCell contains the following Objects:

$CSYMB	Blue Notes-Notes to the MCD chart Compiler
DEPCNT	Modified GC MLLW
M_QUAL	Data quality Meta object
SBDARE	Rocky seabed areas
SOUNDG	Soundings at the chart scale density
SNDWAV	Sand waves area
UWTROC	Rocks

The *_SS HCell contains the following Objects:

DEPCNT	Generalized contours at chart scale intervals
SOUNDG	Soundings at the survey scale density

8. Spatial Framework

8.1 Coordinate System

All spatial map and base cell file deliverables are in an LLDG geographic coordinate system, with WGS84 horizontal, MHW vertical, and MLLW (1983-2001 NTDE) sounding datums.

8.2 Horizontal and Vertical Units

DUNI, HUNI and PUNI are used to define units for depth, height and horizontal position in the chart units HCell, as shown below.

Chart Unit Base Cell Units:

Depth Units (DUNI):	Feet
Height Units (HUNI):	Feet
Positional Units (PUNI):	Meters

During creation of the HCell in CARIS BASE Editor and CARIS S-57 Composer, all soundings and features are maintained in metric units with as high precision as possible. Depth units for soundings measured with sonar maintain millimeter precision. Depths on rocks above MLLW and heights on islets above MHW are typically measured with range finder, so precision is less. Units and precision are shown below.

BASE Editor and S-57 Composer Units:

Sounding Units:	Meters rounded to the nearest millimeter
Spot Height Units:	Meters rounded to the nearest decimeter

See the HCell Reference Guide for details of conversion from metric to charting units, and application of NOAA rounding.

9. Data Processing Notes

There were no significant deviations from the standards and protocols given in the HCell Specification and HCell Reference Guide.

10. QA/QC and ENC Validation Checks

F00586 was subjected to QA checks in S-57 Composer prior to exporting to the metric HCell base cell (000) file. The millimeter precision metric S-57 HCell was converted to chart units and NOAA rounding applied. dKart Inspector was then used to further check the data set for conformity with the S-58 ver. 2 standard (formerly Appendix B.1 Annex C of the S-57 standard). All tests were run and warnings and errors investigated and corrected unless they are MCD approved as inherent to and acceptable for HCells.

11. Products

11.1 HSD, MCD and CGTP Deliverables

F00586_CS.000	Base Cell File, Chart Units, Soundings and features compiled to 1:10,000
F00586 _SS.000	Base Cell File, Chart Units, Soundings and Contours compiled to 1:10,000
F00586 _DR.pdf	Descriptive Report including end notes compiled during office processing and certification, the HCell Report, and supplemental items
F00586 _outline.gml	Survey outline
F00586_outline.xsd	Survey outline

11.2 Software

CARIS HIPS Ver. 6.1	Inspection of Combined BASE Surfaces
CARIS BASE Editor Ver. 2.3	Creation of soundings and bathy-derived features, creation of the depth area, meta area objects, and Blue Notes; Survey evaluation and verification; Initial HCell assembly.
CARIS S-57 Composer Ver. 2.1	Final compilation of the HCell, correct geometry and build topology, apply final attributes, export the HCell, and QA.
CARIS GIS 4.4a	Setting the sounding rounding variable for conversion of the metric HCell to NOAA charting units with NOAA rounding.
CARIS HOM Ver. 3.3	Perform conversion of the metric HCell to NOAA charting units with NOAA rounding.
HydroService AS, dKart Inspector Ver. 5.1, SP 1	Validation of the base cell file.
Northport Systems, Inc., Fugawi View ENC Ver.1.0.0.3	Independent inspection of final HCells using a COTS viewer.

12. Contacts

Inquiries regarding this HCell content or construction should be directed to:

Russ Davies
Cartographer
Pacific Hydrographic Branch
Seattle, WA
206-526-6854
Russ.Davies@NOAA.GOV

APPROVAL SHEET
F00586

Initial Approvals:

The survey evaluation and verification has been conducted according to branch processing procedures and the HCell compiled per the latest OCS HCell Specifications.

Russ Davies

Digitally signed by Russ Davies
Date: 2011.02.14 15:58:13 -08'00'

The survey and associated records have been inspected with regard to survey coverage, delineation of the depth curves, development of critical depths, S-57 classification and attribution of soundings and features, cartographic characterization, and verification or disproval of charted data within the survey limits. The survey records and digital data comply with OCS requirements except where noted in the Descriptive Report and are adequate to supersede prior surveys and nautical charts in the common area.

Kurt Brown

Digitally signed by Kurt Brown
Date: 2011.02.14 15:46:34 -08'00'

I have reviewed the HCell, accompanying data, and reports. This survey and accompanying digital data meet or exceed OCS requirements and standards for products in support of nautical charting except where noted in the Descriptive Report.

Gary C. Nelson

Digitally signed by Gary C. Nelson
DN: cn=Gary C. Nelson, o=NOAA, ou=Pacific Hydrographic Branch, email=gary.nelson@noaa.gov, c=US
Date: 2011.02.14 15:42:58 -08'00'

Christopher Hare

Christopher Hare
HQ Survey Review
2011.02.17 14:54:21 -05'00'