H12166

NOAA FORM 76-35A

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

DESCRIPTIVE REPORT

Type of Survey Hydrographic Survey

Field No. N/A

Registry No. H12166

LOCALITY

State Alaska

General Locality Kuskokwim River

Sublocality West of Helmick Point

2010

CHIEF OF PARTY

Andrew Orthmann, TerraSond, Ltd.

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DATE

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

HYDROGRAPHIC TITLE SHEET

REGISTRY No **H12166**

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 Alaska

General Locality Kuskokwim River

Sub-Locality West of Helmick Point

Scale 1:10,000 **Date of Survey** 6/27/2010 to 8/22/2010

Instructions dated 3/11/2010 **Project No.** OPR-R341-KR-10

Vessel M/V JELLA SEA (AK7395AC) , M/V DUCER (AK4059M), M/V LATENT SEA (AK6828AK)

Chief of party Andrew Orthmann

Surveyed by Terrasond Personnel

Soundings by Reson SeaBat 8101 (pole mounted), ODOM Echotrac CVM/CV100 (hull mounted)

SAR by Adam Argento Compilation by Kurt Brown

Soundings compiled in Fathoms

REMARKS: All times are UTC. UTM Zone 3

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/.

A. *Area Surveyed*

A navigable area survey was conducted west of Helmick Point in the Kuskokwim River, Alaska, in accordance with the NOAA, National Ocean Service, *Statement of Work* (SOW), OPR-R341-KR-10, dated March 11, 2010. Survey data collection for H12166 began June 27th, 2010, and ended August 22nd, 2010.

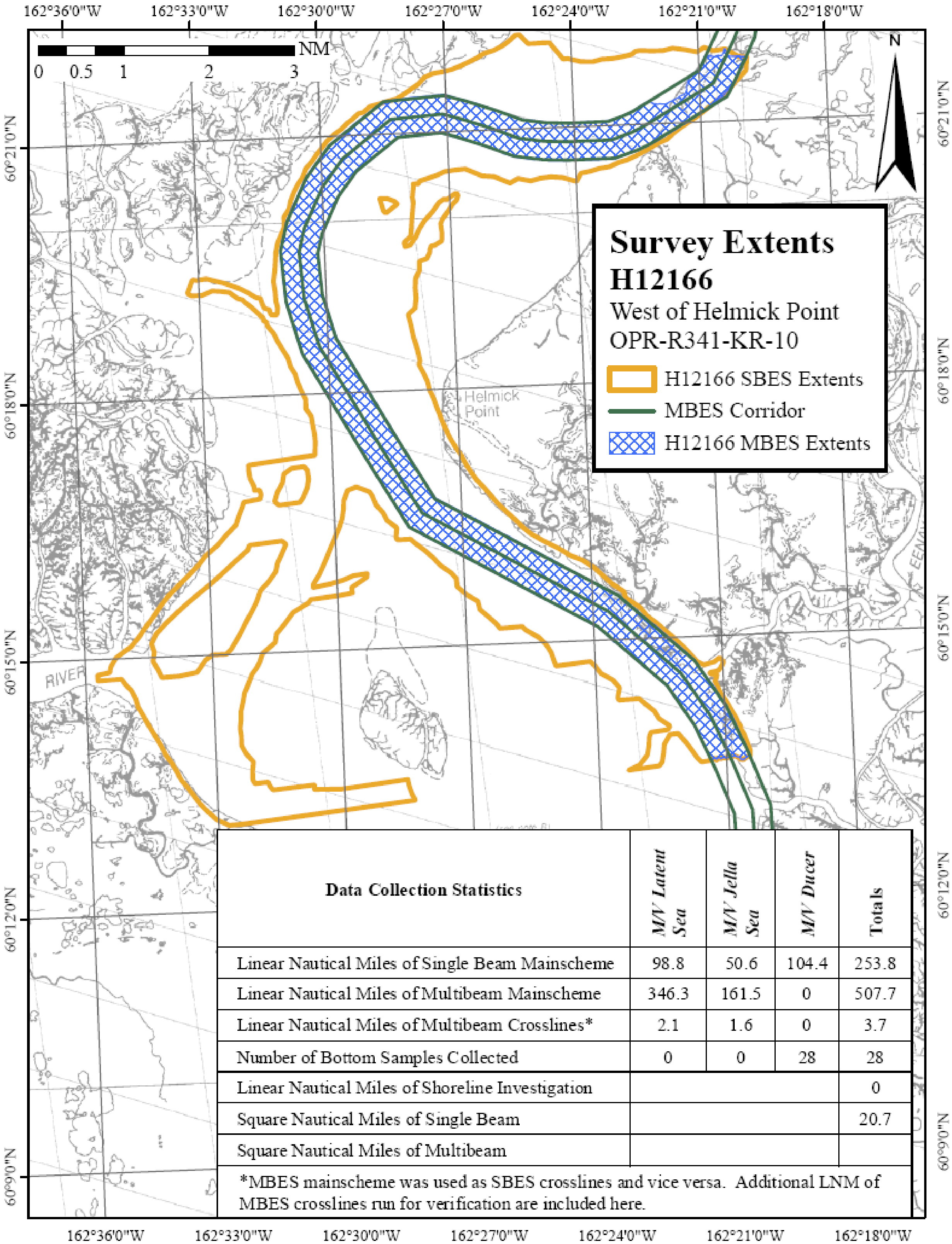
At the time of this survey, the best scale chart (16304) is a preliminary chart with no bathymetric data. Chart 16304 covers the area from the mouth of the Kuskokwim River to the City of Bethel. Bethel is the supply hub for this region of the state and large numbers of tug and barge traffic transit the river, bringing fuel, gravel, and other supplies to Bethel and other sites further upstream during the limited ice free season (generally June through September). Vessels with drafts of up to 4 meters are common.

Single-beam echosounder (SBES) and multibeam echosounder (MBES) data was collected on this project[1]. The single-beam data was collected prior to multibeam data collection and assisted with determining the best utilization of budgeted multibeam linear nautical miles.

Single-beam lines were run at a 200-meter interval perpendicular to river flow. This pattern transected any existing channels and provided soundings to define the primary navigation channel (or deepest continuous route). Single-beam lines terminated at the 1-meter depth contour or the limit of safe navigation—whichever came first. Survey boundaries also dictated the extents of the single-beam data in the southern part of this sheet.

Subsequent to single-beam data collection, extents for the multibeam data were defined and agreed upon with NOAA. These limits consisted of a roughly 800-meter-wide “corridor” that followed the deeper portions of the river, best-fit to the primary navigation channel. The area within these extents was surveyed with multibeam sonar, terminating at the 4-meter depth contour, the corridor boundary, or the limit of safe navigation—whichever came first. This approach was designed to ensure a continuous channel received complete multibeam coverage from the river mouth to Bethel.

The river is a highly changeable area. Severe bank erosion was evident during field operations, and changes in bottom depth and topography were common over the course of the survey[2].



Data Collection Statistics	*M/V Latent Sea*	*M/V Jella Sea*	*M/V Ducer*	**Totals**
Linear Nautical Miles of Single Beam Mainscheme	98.8	50.6	104.4	253.8
Linear Nautical Miles of Multibeam Mainscheme	346.3	161.5	0	507.7
Linear Nautical Miles of Multibeam Crosslines*	2.1	1.6	0	3.7
Number of Bottom Samples Collected	0	0	28	28
Linear Nautical Miles of Shoreline Investigation				0
Square Nautical Miles of Single Beam				20.7
Square Nautical Miles of Multibeam				

*MBES mainscheme was used as SBES crosslines and vice versa. Additional LNM of MBES crosslines run for verification are included here.

Figure 1 – H12166 Survey Extents and Statistics

Month	Dates (2010)
June	27^{th}—30^{th}
July	3^{rd}, 7^{th} – 11^{th}, 13^{th} – 15^{th}, 18^{th} – 21^{st}, 23^{rd} – 27^{th}
August	2^{nd} – 4^{th}, 20^{th} – 22^{nd}

Table 1 - Specific Dates of Data Acquisition

For complete survey limits, refer to Figure 1 above and *Appendix III: Final Progress Sketch and Survey Outline* of this report.

B. Data Acquisition and Processing

B.1. Equipment

Bathymetry for this survey was acquired using the hydrographic survey vessels *M/V Latent Sea*, *M/V Jella Sea*, and *M/V Ducer*.

M/V Latent Sea

The *M/V Latent Sea* is aluminum-hulled vessel 7.01 meters length overall with a 2.62 meter beam and a 0.51 meter draft. It was outfitted to acquire both multibeam and single-beam data. Major systems used on the *M/V Latent Sea* are listed in Table 2.

M/V Latent Sea **LOA: 7.01 m, BEAM 2.62 m, DRAFT: 0.51 m**	
Equipment	**Manufacturer & Model**
Multibeam sonar	Reson SeaBat 8101
Single-beam sonar	Odom Echotrac CV100
Positioning	Applanix POSMV 320 V4
Vessel attitude	Applanix POSMV 320 V4
Sound speed	Applied Microsystems SV Plus v2

Table 2 - Major systems used aboard the M/V Latent Sea.

M/V Jella Sea

The *M/V Jella Sea* is an aluminum-hulled vessel, 7.62 meters length overall with a 2.62 meter beam and a 0.61 meter draft. It was outfitted to acquire both multibeam and single-beam data. Major systems used on *M/V Jella Sea* are listed in the table below.

M/V Jella Sea **LOA: 7.62 m, BEAM 2.62 m, DRAFT: 0.61 m**	
Equipment	**Manufacturer & Model**
Multibeam sonar	Reson SeaBat 8101
Single-beam sonars	Odom Echotrac CVM Odom Echotrac CV100
Positioning	Applanix POSMV 320 V4
Vessel attitude	Applanix POSMV 320 V4
Sound speed	Applied Microsystems SV Plus v2

Table 3 - Major systems used aboard the M/V Jella Sea.

M/V Ducer

The *M/V Ducer* is an aluminum-hulled vessel, 5.79 meters length overall with a 2.13 meter beam and a 0.46 meter draft. It was outfitted to acquire single-beam data only, and to assist with shore operations. Major systems used on *M/V Ducer* are listed in the table below.

M/V Ducer **LOA: 5.79 m, BEAM 2.13 m, DRAFT: 0.46 m**	
Equipment	**Manufacturer & Model**
Single-beam sonar	Odom Echotrac CV100
Positioning	Applanix POSMV 320 V4
Vessel attitude	Applanix POSMV 320 V4
Sound speed	Odom Digibar Pro

Table 4 - Major systems used aboard the M/V Ducer.

Additional information and equipment performance details are provided in the Data Acquisition and Processing Report (DAPR), *Sections A: Equipment* and *B: Quality Control*.

B.2. Quality Control

Internal data consistency and quality is high. Regular confidence checks on all survey systems returned good results, usually comparing to 0.05 m or better. Additionally, agreement of mainscheme data is excellent between the multiple survey systems when the data was collected within the same time frame, typically comparing to 0.10 m or better[3].

However, due to constantly changing river bottom, mismatches or busts between overlapping data sets that sometimes exceed specifications occur in the data set. These are typically associated with single-beam transects that were run days to weeks before the multibeam data, multibeam mainscheme in which acquisition of overlapping lines was separated by numerous days, and gap or infill lines run days to weeks after the multibeam mainscheme[4]. More information and examples of these and other issues are discussed in section *B.2.5* of this report.

B.2.1. Crosslines

This project was exempted from the conventional crossline linear nautical mileage requirements outlined in the 2010 NOAA Hydrographic Surveys Specifications and Deliverables (HSSD), per prior agreement with NOAA. For crossline analysis purposes single-beam mainscheme lines served as the crosslines for multibeam data and vice versa. This was possible since the two data types intersect each other at regular intervals. See *Appendix V: Supplemental Survey Records and Correspondence* and the TerraSond work plan in *Separate III: Hydrographic Survey Project Instructions* for more information[5].

Single-beam lines that intersected the multibeam lines were considered “crosslines” for QC report purposes and were compared to the 1-meter BASE surface created from the multibeam data. In general, every other single-beam line was selected as a crossline. Of the 253.8 nautical miles of single beam collected, 32.3 nautical miles that transected the multibeam were utilized as crosslines. This translates into 6.4% of the multibeam mileage, which exceeds the 4.0% specified in the HSSD for multibeam crosslines[6].

Multibeam lines that intersected the single-beam lines were considered “crosslines” for QC report purposes and were compared to the 4 meter BASE surface created from the single-beam data. Random, spatially distributed multibeam lines were selected as crosslines. Of the 507.7 nautical miles of multibeam collected, 28.2 nautical miles that transected the single beam was utilized as crossline. This translates into 11.1% of the single-beam mileage, which exceeds the 8.0% specified in the HSSD for single-beam crosslines[7].

A limited number of conventional crosslines were collected as an additional QC tool. These were generally collected during the same day as the mainscheme lines they intersect and used as additional evidence of good data matchup when data was collected close in time.

The crossline analysis was conducted using CARIS HIPS’ QC Report routine. Each crossline was selected and run through the process, which calculated the difference between each accepted crossline sounding and a BASE surface created from the mainscheme data. The differences in depth were grouped by beam number and statistics computed which included the percentage of soundings compared whose differences from the BASE surface fall within IHO survey Order 1.

This survey experiences large numbers of QC failures, with many beams not comparing to the surface within IHO Order 1 at the 95% confidence interval or better. The failures correlate to large differences in times of acquisition between the single beam and multibeam data (which were acquired as much as 50 days apart). Bottom change is also evident in the crosslines that fail, which show large differences in bottom topography, typically associated with sand waves or eroding banks. However, the conventional multibeam crosslines (run close in time to the mainscheme) generally pass at 95% or better[8]. The following table summarizes the results. Refer to *Separate IV: Crossline Comparisons* for the detailed QC Reports.

Type	**Surface Type**	**Crossline Type**	**Number of Crosslines**	**Crosslines with at least one beam failure**
MBES QC Report	MBES 1m Mainscheme	SBES (Mainscheme)	60	48
		MBES (Crossline)	12	3
SBES QC Report	SBES 4m Mainscheme	MBES (Mainscheme)	8	8
		SBES (Crossline)	8	3

Table 5 – QC Report Summary

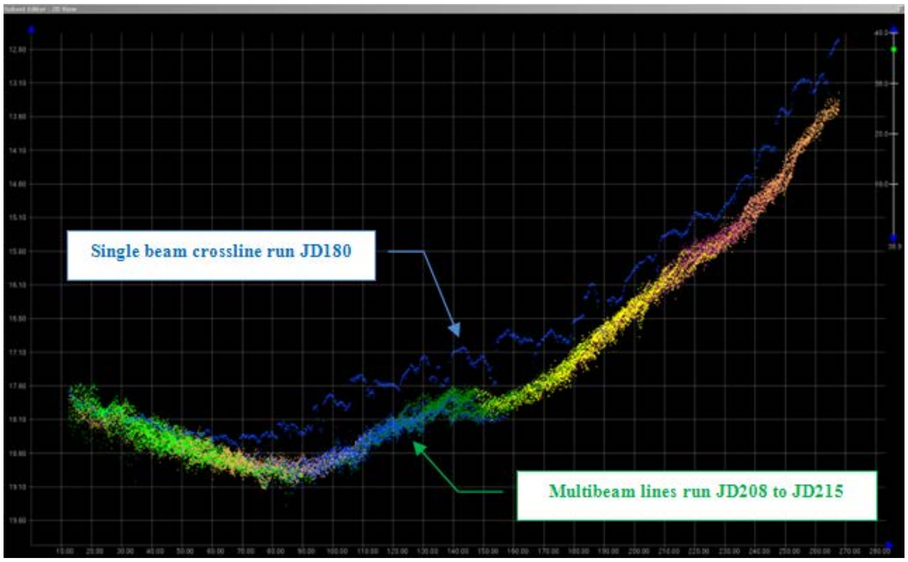


Figure 2 – Example from CARIS subset of a SBES vs MBES crossline comparison that fails due to bottom change. The crossline (single beam 1C-01-SB07120 shown in blue) differs from the multibeam lines by up to 0.80 meter along most of its length. About 30 days separate times of acquisition. Vertical scale is 0.50 m.

B.2.2. Uncertainty Values

All soundings were assigned a horizontal and vertical uncertainty value. The parameters used during computation of sounding uncertainty are detailed in the project DAPR. No deviations from this report occurred except as follows:

- Uncertainty associated with sound speed was entered as 2 m/s during TPU computation for single beam lines (multibeam lines used 1 m/s). These values were determined by analyzing the difference between subsequent casts for 12-hour (SBES ops) and 4-hour (MBES ops) cast intervals. 12-hour cast intervals showed average variability above 1 m/s but less than 2 m/s, while 4-hour cast intervals showed average variable of less than 1 m/s.
- Uncertainty associated with tide zoning was entered as 0.077 m during TPU computation. This value was selected as it was the average of uncertainties of the mean lower low water (MLLW) to ellipsoid separation model within this sheet, which ranged from 0.039 m to 0.110 m. See the Horizontal and Vertical Control Report (HVCR) for more information regarding separation model uncertainties.

Surfaces were finalized in CARIS HIPS so that the final uncertainty value for the each grid cell is the greater of either standard deviation or uncertainty. The uncertainty layer of the final surface was then examined for areas of uncertainty that exceeded IHO Order 1.

For the final single-beam surface, the vast majority of grid cells have uncertainties in the 0.23 to 0.25 m range, well within IHO Order 1. Those that exceeded IHO Order 1 were found to be on extremely steep slopes – typically the cut river bank – where a high standard deviation is computed due to a large range in depths spread over the relatively large grid cell size (4-meter). Despite a high TPU of these grid cells, the contributing soundings have TPU's that are well within IHO Order 1[9].

For the final multibeam surfaces, the bulk of the grid cells have uncertainties in the 0.22 to 0.24 m range. Relatively few exceed IHO Order 1. Those that exceeded IHO Order 1 were found to be on extremely steep slopes and/or in areas showing bottom change, creating a high standard deviation of the soundings. Despite a high TPU of these grid cells, the contributing soundings have TPU's that are well within IHO Order 1[10].

B.2.3. Contemporary Survey Junctions

This survey junctions with two other contemporary surveys. The junction is described in the following table and figure[11].

Survey Registry Number	Project Number	Scale	Date	Junction with H12166 Edge
H12167	OPR-R341-KR-10	1:10,000	August 2010	North
H12165	OPR-R341-KR-10	1:10,000	July 2010	South

Table 6 - Contemporary survey junctions with H12166.

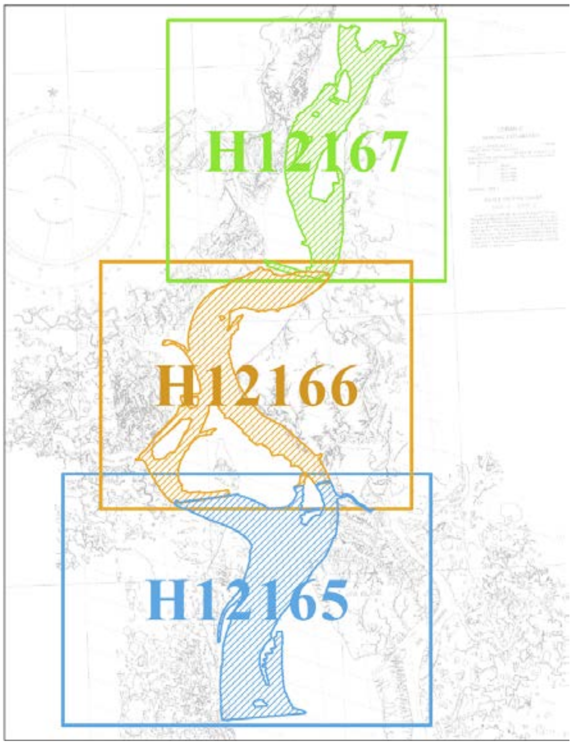


Figure 3 – Junction of H12166 (orange) with H12165 (blue) and H12167 (green) from this project (OPR-R341-KR-10) on chart 16304 (2nd edition, January 2005).

In CARIS HIPS the finalized BASE surfaces for each survey sheet were opened. The tool tip feature was then used to spot check the differences between sounding values for each sheet at multiple locations along the survey junction. Junction lines were also loaded into HIPS subset and examined.

For the junction with H12165, the surfaces are in good general agreement between the surveys, with the majority of grid cells checked agreeing to 0.10 m or better[12]. There is some disagreement of up to 0.30 meters due to bottom change when lines were not run in the same time frame.

For the junction with H12167, the soundings are also in good general agreement between the surveys, with the majority agreeing to better then 0.20 m[13]. Larger offset is observed (up to 0.80 m) between Julian days 208 and 216, attributed to bottom change.

B.2.4. Sonar System Quality Control Checks

Weekly confidence checks were conducted between all echosounders on the *M/V Latent Sea, M/V Jella Sea and M/V Ducer* to verify proper operation of the multibeam and single-beam suites. A survey line was established in an area of mixed bottom topography and each vessel would in turn run the line in both directions at an average survey speed. The *M/V Jella Sea* and *M/V Latent Sea* would log simultaneous multibeam and single-beam data while the *M/V Ducer* would log single beam only.

After standard processing including application of PPK-derived tide corrections the agreement between all systems was examined in HIPS subset editor and the results noted in an echosounder comparison logsheet. All systems agreed to within 0.10 m of each other, but agreement was typically better than 0.05 m.

As an absolute check of depth measurement system accuracy, bar checks were also performed periodically throughout the survey on all echosounders. Sonar system depths always agreed to the bar depth to better then 0.10 m, but usually compared to better then 0.03 m.

Refer to the echosounder comparison logs and the bar check result logs available in *Separate I: Acquisition and Processing Logs* for specific results. More information detailing the procedures used to acquire and process the sonar system quality control checks (and other QC checks) is available in the *Data Acquisition and Processing Report.*

B.2.5. Unusual Conditions Encountered and Data Quality Issues

In general, the survey equipment used during this survey performed well. No conditions with the potential for adversely affecting data integrity were encountered with the survey equipment except the following:

- Single beam lines run before Julian day 184 were affected by an issue that was later fully corrected in processing, whereby incorrect travel times were written to XTF by QPS QINSy and read by CARIS HIPS resulting in an incorrect depth. The affected lines were fixed by re-exporting XTFs that used correct sound speed values out of QINSy and re-importing into CARIS HIPS. There is no negative impact on the final survey data from this issue[14]. The issue is described in more detail in section *C.2* of the DAPR.

The following environmental issues adversely affected the data set:

- Bottom changes due to sediment transport were identified as the primary cause of busts between adjacent data sets and artifacts in the BASE surfaces[15]. Significant changes are apparent in various locations whenever large periods of time (days to weeks) separate times of data collection. The issue is more common when comparing single-beam data to multibeam data, and multibeam mainscheme with multibeam in-fills, due to the differences in times of acquisition. An example from sand wave migration is shown below.

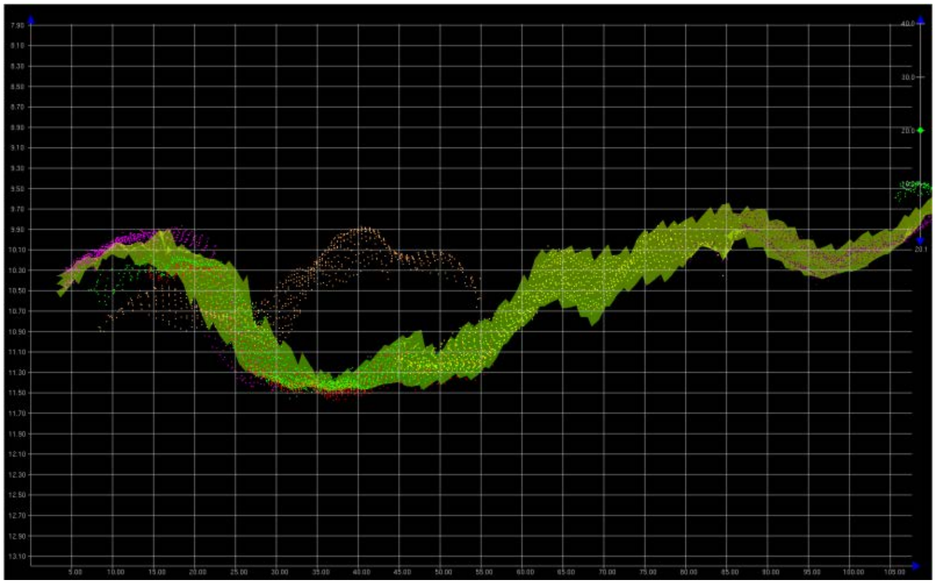


Figure 4 – Example from CARIS subset of commonly observed sand wave movement in H12166. BASE surface shown in green. Up to 1.4 meters of vertical difference. Vertical scale is 0.20 m. Note no edits were done since shoaler portions of the BASE surface exist within 2mm at survey scale (20 meters).

- Dramatic changes in bottom occur along the banks which are rapidly eroding and sloughing off into the river[16]. An example at 60-21-24 N, 162-20-16 W is shown below, where the survey vessel returned to complete infills on the 4-meter contour but surveyed a different bottom altogether:

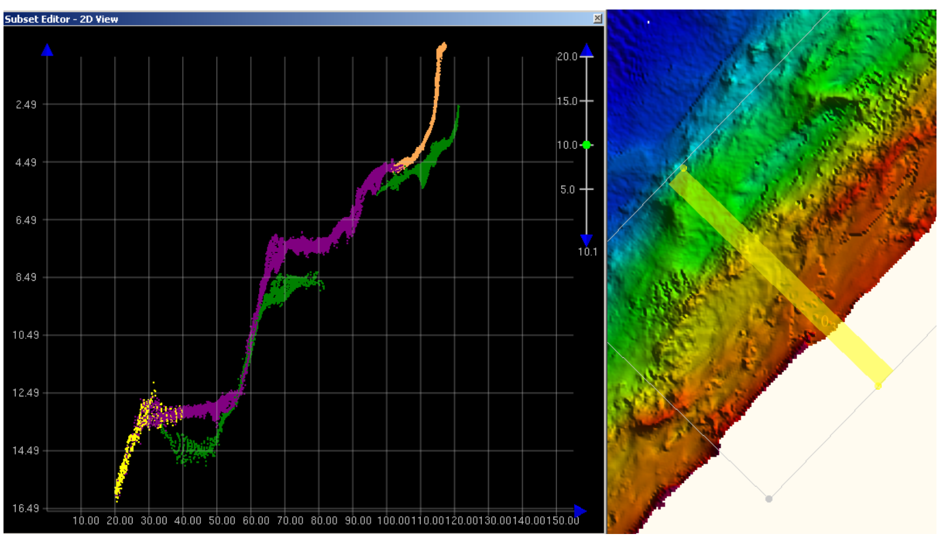


Figure 5 – Example from CARIS subset and the BASE surface of rapidly eroding river bank showing change over 20 days. Data is colored by day: Green lines were infill lines run on JD234 while the other lines were run between JD214 and JD216. Up to 7 meters of bank disappeared during this time period. Vertical scale is 2.0 m, horizontal scale is 10 m.

- Overlapping mainscheme data also frequently demonstrates busts when there are large differences in times of acquisition. This is especially apparent in the area in the vicinity of 60-21-21 N, 162-21-19 W where the survey vessel returned to acquire additional infills for the 4 meter contour but found the area had deepened and preceded to collect a large area of new mainscheme:

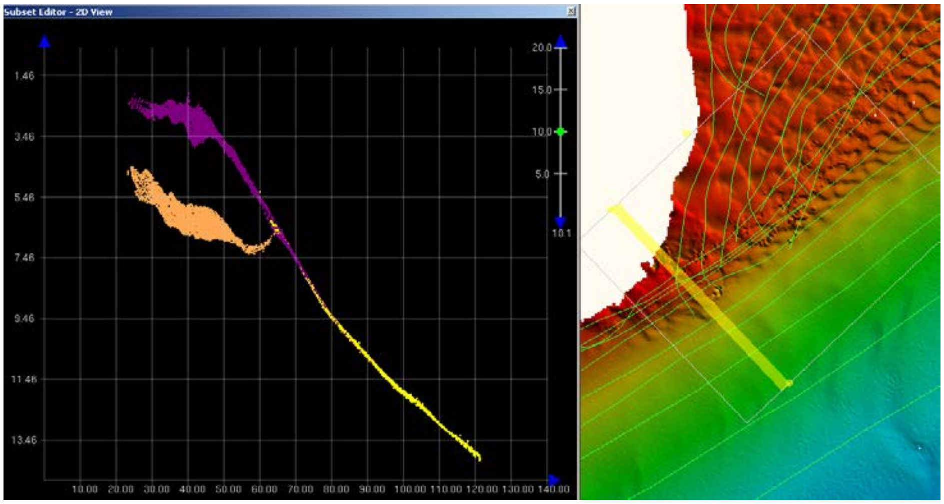


Figure 6 – Example from CARIS subset and the BASE surface of changes between mainscheme data. Data is colored by day: Orange lines were run on JD234, purple and yellow lines were run 20 days earlier on JD214 and JD215. Up to 3 meters of vertical change (with newer data deeper) occurred here. Vertical scale is 2 meters.

- In some cases shoal areas disappeared over the course of the survey altogether. In the following example at 60-20-57 N, 162-28-27 W, the survey vessel originally stopped surveying when it had reached the 4-meter contour, but when it returned 16 days later to complete infills in the area it found the area had deepened by a meter and the bottom was re-surveyed:

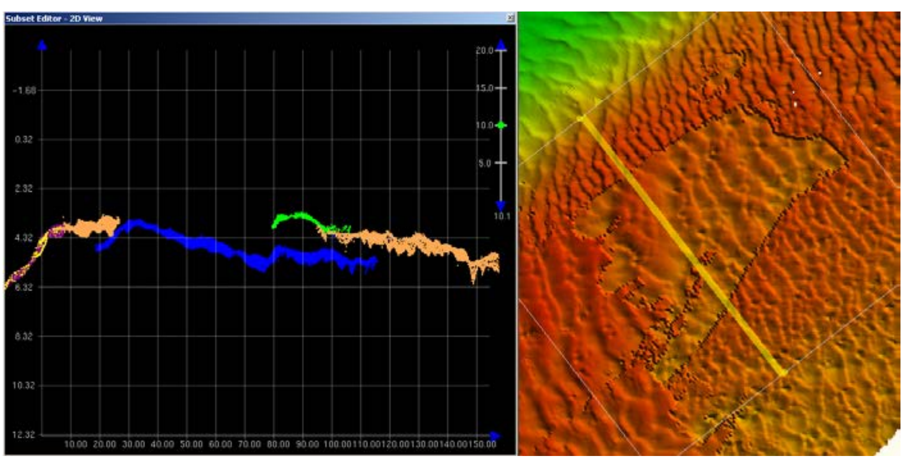


Figure 7 – Example from CARIS subset and the BASE surface of changes between mainscheme data. Data is colored by day: Green line was run on JD205, orange lines on JD216. Blue lines were run later on JD232. Area deepened by up to 1.5 meters between JD216 and JD232. Vertical scale is 0.50 meters.

When busts were identified, the associated positioning data was reviewed thoroughly to rule out positioning error. This was done by checking settings used to create the smooth best estimate of trajectory file (SBET), positioning quality, and all other ancillary data types and offsets that contribute. Overlap with adjacent lines run closer in time was checked for agreement as well. Lines where survey error was identified as the source of the bust were either fixed in processing or rejected and re-run as necessary. Data with busts due to bottom change were not re-run.

The BASE surface does not always honor the shoalest soundings in areas with busts due to bottom change, especially in sand wave areas. In these cases the same criteria for designated soundings was applied during editing, whereby no action was taken if a shoaler part of the BASE surface existed within 2 mm at survey scale (20 meters). Therefore edits on areas of bottom change busts were rare.

To provide crosslines that were run closer in time to mainscheme, additional unplanned multibeam crosslines were collected. Effort was made to collect these as close as possible in time to acquisition of mainscheme, usually the same day. Indeed, these pass QC at a much higher rate than lines more separate in time. See the section above in this report detailing crossline comparisons for more information.

Note that in one portion of the survey, the weekly echosounder comparison was done on the same line consecutively five times, from Julian days 179 to 207. All show excellent agreement between vessels and echosounders, but when all five days are plotted together, significant bottom change is apparent. During this time sand waves shift up to 4 meters horizontally and appear and disappear altogether[17]. An example from the echosounder comparisons is shown below.

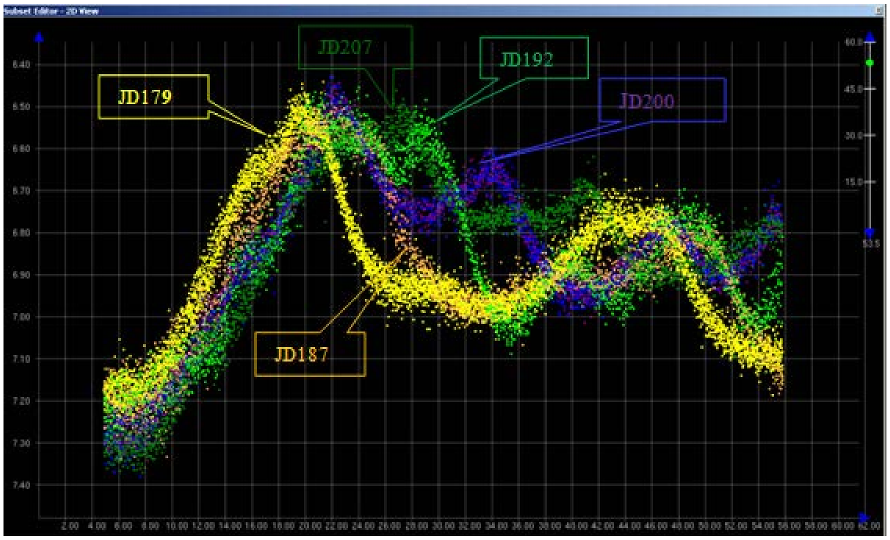


Figure 8 – Example from CARIS subset of JD179 to JD207 echosounder comparisons. Lines are colored by day. Matchup is poor – sand waves shift up to 4 meters, causing up to 0.50 meters of vertical shift. Vertical grid spacing is 0.10 m.

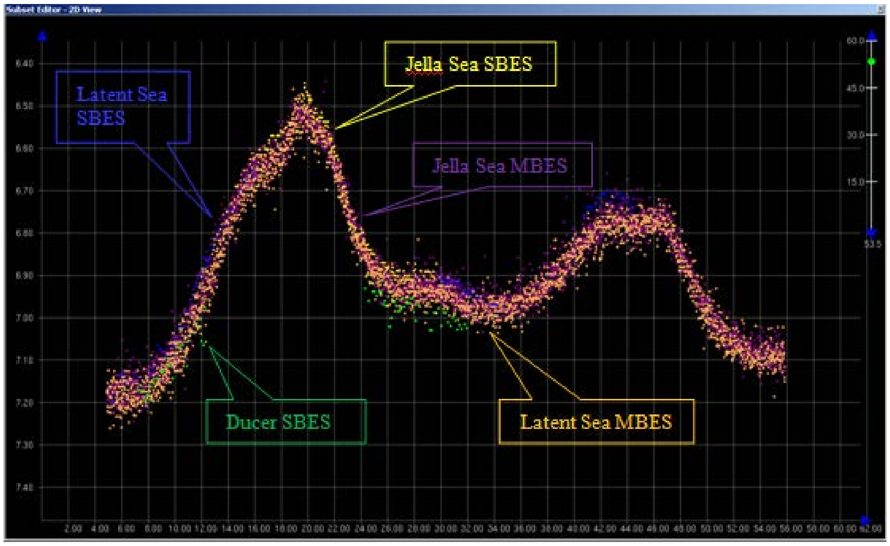


Figure 9 – Example from CARIS subset of JD179 echosounder comparison data only, same area as above figure. Lines are colored by vessel, and consist of the three single-beam echosounders and two multibeam sonars, showing good agreement. Vertical grid spacing is 0.10 m.

- Error due to sound speed is also apparent from time to time. This error, which shows up as an across track upward or downward cupping of the data (and along-track artifact in the BASE surface in flat areas) is minor, with effect on the multibeam BASE surface typically not exceeding 0.05 m. Despite the error the data is well within specifications[18].

More details of any data quality issues noted during final surface review in CARIS subset mode are included in the subset review logsheet located in *Separate I: Acquisition and Processing Logs.*

B.2.6. Sound Speed

The Kuskokwim River is a dynamic area with strong river and tidal currents. Sound speed measurements throughout the area varied both spatially and temporally. To minimize sound speed errors, sound speed casts were taken normally every 4 hours during multibeam acquisition, and every 12 hours during single beam acquisition. This frequency was determined in the field by review of data quality and sound speed profile variance. Sound speed profiles were taken as deep as possible and met the specifications in HSSD, *Section 5.1.3.3*.

The water column in this sheet was generally well mixed, which minimized error due to sound speed. Conservative line spacing with generous overlap also helped minimized the effect of sound speed errors on the final BASE surfaces. Section *B.2.5* of this report discusses the sound speed error in more detail.

All sound speed profiles were applied with the “nearest in distance within time” method in CARIS HIPS, with time set to 4 hours when correcting multibeam data and 12 hours when correcting single-beam data, with no exceptions for this sheet.

B.2.7. Requirements for Object Detection and Coverage

The *M/V Latent Sea* and the *M/V Jella Sea* were each outfitted with Reson SeaBat 8101 multibeam sonars. Multibeam operations were conducted in accordance with the "Complete Multibeam Coverage" category described in section 5.2.2.2 of the HSSD.

During acquisition, vessel speed was kept low—typically below 8 knots—to minimize along-track ping spacing. The smallest effective sonar range scale was selected to maximize ping rate. A 1-meter coverage grid updated in real time by the QINSy acquisition software was utilized continuously to adjust line spacing as necessary to ensure overlap and fill gaps.

Following processing and cleaning of erroneous soundings, surfaces compliant with the resolutions specified in the HSSD section 5.2.1.2 were created and examined. CUBE parameters that ensured a maximum propagation distance of $\sqrt{2}$ were used in creating the surface. The surface was examined for gaps and infill lines were created and run by the acquisition vessels as necessary. The surface data density layer was examined to ensure 95% or more of the nodes were populated with at least 5 soundings.

The boundaries of complete multibeam coverage for this project were the multibeam corridor boundary, the 4-meter contour, or the limit of safe navigation – whichever came first. Note that gaps or holidays may exist in the multibeam data outside of the corridor boundaries, or in incidental data in water shoaler then 4 meters[19]. As these areas were considered to be outside the survey limits, no effort was made to infill holidays in them in the field. The multibeam corridor boundary polygons agreed upon with NOAA are included in *Separate III* (filename "MBES_Corridor_071310.dxf", and correspondence relating to them is included in *Appendix IV*[20].

The boundaries of single-beam data for this project were the 1-meter contour or the limit of safe navigation, whichever came first. The project extents also limited single beam lines to the Kuskokwim River in this sheet (lines were not continued up tributaries).

Specific notes concerning coverage achievement for this survey:

- Multibeam coverage was achieved to the corridor boundary over the majority of this sheet, except in the north part of the survey where the river begins to narrow and coverage was constrained by the 4 meter contour[21].
- Single beam coverage to the 1 meter contour was achieved on most lines[22]. Some soundings that were 1 meter or shoaler with preliminary tide corrections were no longer at 1 meter with final corrections (discussed below). Additionally, in rare instances in this sheet 1 meter could not be achieved against steep undercut banks with overhanging bushes.

Note that in the field during both multibeam and single-beam data processing, a preliminary MLLW to ellipsoid separation model was used to assist with determining when the required MLLW depth had been achieved (1 meter for single beam, 4 meters for multibeam). The values used to derive the model were provided by JOA and were the best available at the time due to limited tidal data series and lack of computed tide datums for the area. After the field season ended and all tide data became available, JOA provided a final separation model that differed slightly from the preliminary. This was due to increased data availability including longer data series and additional data points. The final separation model shifted soundings deeper in this sheet by an average of 0.206 m. Therefore some final soundings may no longer meet the minimum depth requirements. Refer to the project HVCR for more information regarding the final separation model[23].

B.3. Corrections to Echo Soundings

Survey H12166 was performed in conjunction with six other surveys in Project OPR-R341-KR-10. Corrections applied to echo soundings are described in detail in the project DAPR. No deviations from the DAPR occurred except those listed here.

All lines were loaded with delta draft except the following:

Vessel / Sensor	Julian Day	Line Name	Comment
3-LatentSea_8101	2010-215	3C-01-MBXL0056	Engine RPM's were N/A for these lines. Speed-based corrections in HVF used instead.
		0036_-_3C01 to 0063_-_3C01	
	2010-216	0064_-_3C01 to 0131_-_3C01	
		3C-02-216-Gap-MB06 3C-02-216-Gap-MB-06A 3C-04-216-GAP-MB05 3C-06-216-GAP-MB01 3C-06-216-GAP-MB02 3C-06-216-GAP-MB03 3C-06-216-GAP-MB04	
1-JellaSea_Singlebeam	2010-180	1C-01-SB07120 1C-01-SB06930 1C-01-SB06740	
2-Ducer_Singlebeam	2010-179	2C-06-SB06631 2C-06-SB00000 2C-06-SB00000a 2C-06-SB00190 2C-06-SB00380	

Table 7 – Lines without Delta Draft loaded

B.4. Data Processing

The final depth information for this survey was submitted as a collection of CARIS BASE surfaces which best represented the seafloor at the time of the 2010 survey. The surfaces were created from fully processed soundings with all final corrections applied. The surfaces were finalized with depth-appropriate thresholds and designated soundings applied.

Two final BASE surfaces grids of varying resolution were created for H12166. These consist of one single-beam and one multibeam surface, in CARIS CSAR format[24]. Component fieldsheets used in computing the final surfaces are also included. Grid resolutions for multibeam data were chosen based on the threshold requirements for complete multibeam coverage described in the HSSD Section 5.2.2.2. However, a 2-meter surface was not created because maximum depths in this sheet were only marginally deeper (to 27 meters) then the cutoff recommended in the HSSD for 1-meter surfaces (22 meters), and holidays exceeding 3 nodes were not observed in the 1-meter surface at the deeper depths. The grid resolution for single beam was chosen based on the requirements for set line spacing described in HSSD Section 5.2.2.3 and agreed upon in advance with NOAA. All BASE surfaces are projected as UTM Zone 3 North, NAD 1983.

Data Type	Surface Type	Depth Thresholds	Resolution	Name
Single beam	Uncertainty	None	4 m	H12166_4m _MLLW_1of2
Multibeam	CUBE	None	1 m	H12166_1m_MLLW_2of2

Table 8 – Finalized BASE surfaces included with the survey deliverables

A single S-57 (.000) file was submitted (H12166_Final_Features_File.000) with the survey deliverables as well. The S-57 file contains feature information and meta-data not represented in the depth grid, including nature of the seabed from bottom samples, tide rips, caution areas and sand wave areas[25]. Each S-57 feature is encoded with mandatory S-57 attributes and additional attributes required by the HSSD.

The DAPR contains detailed discussion of the steps followed when acquiring and processing the 2010 survey data including the surface creation and finalizing processes. See *Appendix V* for correspondence regarding selection of single-beam surface resolution.

C. Vertical And Horizontal Control

The vertical control datum of this project is mean lower low water (MLLW). The horizontal control datum is the North American Datum of 1983 (NAD83). All soundings are therefore corrected to MLLW, and all positions are on NAD83. Fieldsheets were projected into UTM Zone 3 North.

Sounding data were tide corrected using final MLLW to NAD83 ellipsoid separation values. A separation model was developed by JOA that utilized the GPS to MLLW datum separations computed at installed tide stations at Quinhagak, AK (946-5831) and Popokamute, AK (946-6057) and new stations at Bethel, AK (946-6477), Lomavik Slough, AK (946-6328) and Helmick Point, AK (946-6153). Short duration tide gauges were installed at the project RTK sites and their separation values computed and utilized in the model as well. The separation model, which is included with the project CARIS deliverables, was applied using CARIS HIPS' "Compute GPSTide" routine to all lines.

The separation model's filename is "JOA_Final_MLLW_Sep_Model_20101206.txt". MLLW to NAD83 ellipsoid separations in this sheet ranged from 10.911 m to 11.622 m.

Tide zones were not provided by NOAA for this project. JOA computed tide zones and provided verified, smoothed tides for project but these were not used on the final data. They were used for comparison purposes only.

Preliminary positions were determined using Real Time Kinematic (RTK) GPS. NAD83-based position corrections were broadcast from project base stations. The base stations also logged dual frequency GPS data at a 1 Hz interval which was periodically downloaded and used to post-process the positions.

Final positions were post-processed in Applanix POSPac, which utilized inertial and dual frequency GPS data logged continuously on the survey vessels along with the base station data to produce a post-processed kinematic (PPK) smoothed best estimate of trajectory (SBET) file. PPK SBETs were loaded into all survey lines except as noted in the table below. This replaced all RTK navigation and GPS heights with the PPK solution.

Vessel / Sensor	**Julian Day**	**Line Name**	**Comment**
3-LatentSea_8101	2010-199	0030_-_3C06 to 0036_-_3C06	Applicable SBET not readable by HIPS. However, the navigation and GPS height records were exported to text file and loaded into the lines in HIPS' Generic Data Parser.
		3C-199-MBXL01	

Table 9 – Lines that were loaded with GPS height and navigation through Generic Data Parser

Refer to the project DAPR for more information regarding PPK processing methods. Refer to the project HVCR for details regarding specific base stations, base station confidence checks, and derivation of the MLLW separation model.

D. *Results And Recommendations*

D.1. *Chart Comparison*

The chart comparison for H12166 was performed by examining all Raster Navigational Charts (RNCs) and Electronic Navigation Charts (ENCs) in the survey area.

Discrepancies are discussed in context of the largest scale chart available and assumed to apply to the smaller scale charts unless specifically mentioned. Survey data was compared to the data published in the RNCs and ENCs listed in the table below. Note that the best scale chart covering the survey area—chart 16304—is a preliminary chart with no bathymetry.

Chart	Type	Scale	Edition	Issue Date	NM / LNM Updates Through
16304	RNC	1:100,000	2nd	January, 2005	January, 2005
US4AK85M (16304)	ENC	N/A	2nd	May 4th, 2009	February 2009

Table 10 - Charts examined during chart comparisons.

Notices to Mariners (NM) and Local Notice to Mariners (LNM) issued from March 2010 through September 2010 (from issuance of SOW to completion of survey) that affected the survey were examined as well, ending with NM and LNM 36/10. No discrepancies were found.

The chart comparison was accomplished by generating shoal-biased soundings and overlaying them along with the finalized BASE surfaces on the latest edition NOAA charts. The general agreement between charted soundings and H12166 soundings was then examined and a more detailed comparison was undertaken for any shoals or other dangerous features. Results are shown in the following sections.

D.1.1. New Features

No new features were found in this survey area. Possible rock features are evident in the multibeam BASE surfaces and have been designated when they meet the requirements described for designated soundings in the HSSD[26].

D.1.2. Charted Features

There are no features on the affected charts to compare to this survey[27].

D.1.3. Soundings

There are no soundings on the affected charts to compare to this survey. Recommend soundings from this survey be applied to all affected charts[28].

D.1.4. Trends and Changeable Areas

The survey area is located at the mouth of a major river and experienced swift currents and large amounts of sediment transport. Current was frequently nearly as swift in the up-stream direction during flood tides due to the large tidal range experienced in the area. Severe bank erosion was evident during field operations, and changes in bottom depth and topography were common over the course of the survey. A CTNARE (Caution Area) object that covers the multibeam survey extents is included in the included S-57 deliverable, with the “inform” field as “Changeable Area”. It is recommended existing charts be updated to include a warning concerning the changeable nature of the area[29].

Shoreline detail on the existing chart is poor, with bathymetry frequently extending over shoreline data. An example is shown below.

- Survey data shows up to 800 meters of discrepancy with shoreline as portrayed on chart 16304 in the vicinity of 60-21-14 N, 162-20-39 W, due to significant erosion of the river bank. This survey was not tasked with shoreline verification; recommend updating shoreline detail[30]. See figure below.

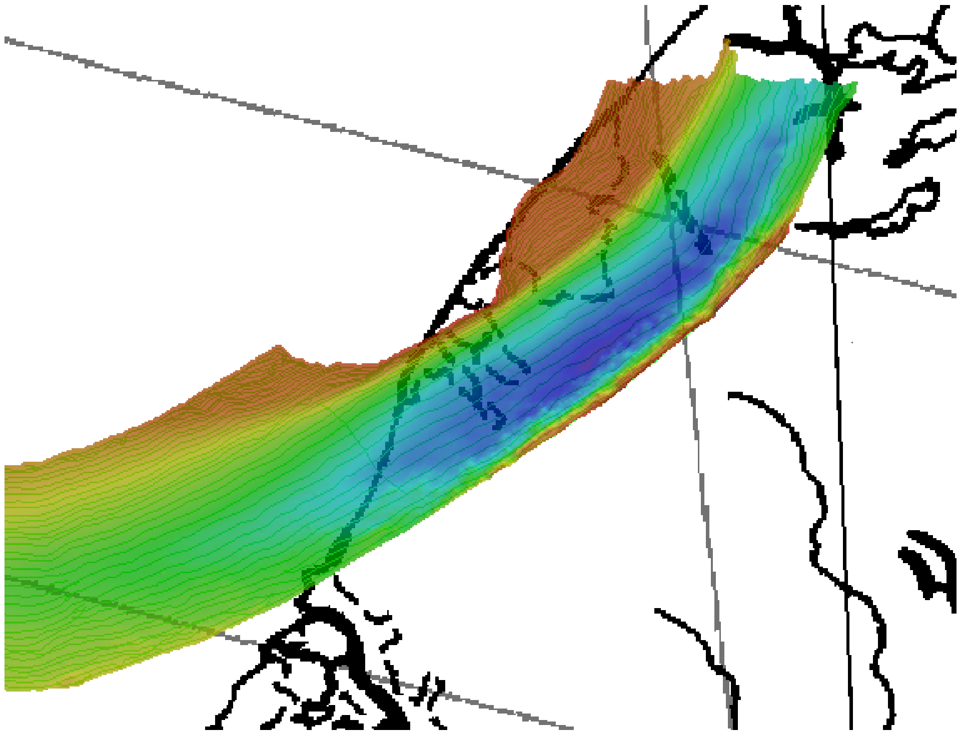


Figure 10 – Example of shoreline discrepancy on chart 16304. Multibeam data and navigation channel is plotted on top of the charted MHW.

D.1.5. AWOIS Items Summary

As stated in the project instructions, no Automated Wreck and Obstruction Information System (AWOIS) items were included in the area of this survey[31].

D.1.6. Features Labeled PA, ED, PD or rep.

There are no charted features labeled PA, ED, PD, or “rep.” within the survey extents of H12166[32].

D.2. Additional Results

D.2.1. Shoreline Verification

Shoreline verification was not required for this survey[33].

D.2.2. Aids to Navigation

Seasonal aids to navigation that marked the approximate navigation channel were observed in the survey area. However, due to the fact that the river and surrounding sea freezes in the winter, the aids to navigation are normally removed each fall by the U.S.

Coast Guard and re-deployed following breakup in the spring. Because of their temporary nature, the aids to navigation were not investigated by this survey, per instructions from NOAA. See *Appendix V* for communications regarding ATONs.

It is recommended that survey data be forwarded to the U.S. Coast Guard to assist with placement of the seasonal ATONs, as existing ATON placement appeared to frequently be sub-optimal in regards to water depth[34].

D.2.3. Drilling Structures

An investigation of drilling structures is not required for this survey. Drilling structures do not exist within the project area[35].

D.2.4. Comparison with Prior Surveys

A comparison with prior surveys was not required under this task order[36]. See *Section D.1* of this report for a comparison to the existing nautical charts.

D.2.5. Bottom Samples

Twenty-eight bottom samples were collected in H12166. The samples were distributed on an approximately 2-kilometer interval to obtain representation of the bottom characteristics as specified in 2009 HSSD[37].

Note that bottom sample requirements from the 2009 HSSD were used instead of the requirements of the 2010 HSSD. This was because the TerraSond technical proposal/work plan was submitted to and agreed upon with NOAA prior to release of the 2010 HSSD, which significantly modified bottom sample requirements and would have resulted in a change in project scope.

A listing and description of the bottom samples is provided in *Appendix V* of this report. The bottom samples are also portrayed as seabed area (SBDARE) objects in the accompanying S-57 feature file.

D.2.6. Bridges and Overhead Cables

There are no bridges or overhead cables in the survey area[38].

D.2.7. Submarine Cables and Pipelines

There are no charted submarine cables in the survey area. None are evident in the multibeam coverage4[39].

D.2.8. Additional Information

None to note.

D.2.9. Additional Recommendations

There are no additional recommendations to note.

APPROVAL SHEET

For

H12166

This report and the accompanying digital data are respectfully submitted.

Field operations contributing to the completion of survey H12166 were conducted under my direct supervision with frequent personal checks of progress and adequacy. This report, digital data, and accompanying records have been closely reviewed and are considered complete and adequate per the *Statement of Work*. Other reports submitted with this survey include the Data Acquisition and Processing Report and the Horizontal and Vertical Control Report.

This survey is complete and adequate for its intended purpose.

Andrew Orthmann

Digitally signed by Andrew Orthmann
DN: CN = Andrew Orthmann, C = US, O = TerraSond Ltd
Reason: I attest to the accuracy and integrity of this document
Location: Palmer, Alaska
Date: 2010.12.21 12:32:29 -09'00'

Andrew Orthmann (ACSM Certified)
Lead Hydrographer
TerraSond Ltd.

Date December 21st, 2010

Revisions and Corrections Compiled During Processing and Certification

[1] The single beam data consists of 200 meter spaced lines and no developments. Single beam data was compiled throughout the survey area as there are no charted soundings.
[2] A caution area noting the changeable nature of the survey area is included in HCell H12166.
[3] Concur
[4] See endnote 2.
[5] See attached coorespondence.
[6] Concur
[7] Concur
[8] Concur
[9] Concur
[10] Concur
[11] A common junction was made with survey H12165 and a junction with H12167 will be made during its compilation.
[12] Concur
[13] Concur
[14] Concur
[15] See endnote 2.
[16] See endnote 2.
[17] Sandwave areas are included in HCell H12166.
[18] Concur
[19] The gaps in coverage outside the multibeam corridor are the result of single-beam data collected at 200 meter line-spacing. These gaps were not shown in the HCell and a single M_QUAL area covers both multibeam and singlebeam data. The soundings can be distinguished by their TECSOU.
[20] Concur with clarification. Appendix IV was not submitted with survey. The correspondence referred to is attached.
[21] Concur
[22] Concur
[23] The data is adequate for charting.
[24] A single combined surface, H12166_MBVB_4m_Combined was created during the SAR and was used for compilation.
[25] Concur with clarification. The submitted hob file was used in the compilation of HCell H12166. During compilation, some modifications were made to features. Chart features as depicted in HCell H12166.
[26] Concur. Chart as depicted in HCell H12166.
[27] Concur
[28] Concur.
[29] Concur with clarification. The submitted caution area did not cover the entire survey area. The caution area was expanded to cover all the data. Chart as depicted in HCell H12166.
[30] Concur. Update shoreline with latest GC from RSD.
[31] Concur

[32] Concur
[33] Concur
[34] Concur. Use latest ATONIS information.
[35] Concur
[36] Concur
[37] There are no previously charted bottom samples. All bottom samples from the survey have been included in HCell H12166.
[38] Concur
[39] Concur

Correspondence

Correspondence between TerraSond and NOAA that directly affected survey operations during this project are included for reference here.

From: Mark.T.Lathrop [mailto:Mark.T.Lathrop@noaa.gov]
Sent: Friday, April 30, 2010 7:19 AM
To: Kathleen Mildon
Subject: Re: Project Instruction Questions

Katie,

Please see my responses in red below.

Mark

Kathleen Mildon wrote:

Mark,

After reading through the project instructions we have some questions.

- To which hydrographic branch do we submit our product this year, AHB or PHB? PHB
- Would you send us the excel template mentioned in the progress report section? I'll get this to you soon.
- Will you please address the following points in the project instructions? This will make our mission clear when we turn the project into the hydrographic branch to avoid confusion after submittal.
  - A statement concerning the approval of the use of PPK GPS methods instead of traditional tides to correct final data to MLLW if conventional tides and zones are determined to be inadequate by us. There will not be any tide zoning for this project. Please see the attached Tides SOW.
  - A statement pertaining to the crossline variance that we discussed on the phone. We will be using Single Beam mainscheme lines as a crossline check with Multibeam mainscheme lines and vice versa to help reduce the cost of running extra crosslines. Singlebeam and multibeam will be sufficient to crosscheck one another for the Kuskokwim project.
- Will you please verify we will be surveying to the 1m curve for our single beam acquisition and not to the project limits? Due to the discrepancy between the charted and actual shoreline the project limits shall be the shoreline. However, the inshore limit of the survey shall be the 1m curve.
- We noticed that there is a delivery date of March 1, 2011 is this the date in which our full submittal of all digital data and reports are due? This is correct.

I also just wanted to check on our task order being signed. We are sending crews to the field in the near feature for the installation of our RTK sites. We are in the process of completing our presurvey tasks and will be sending four vessels to the field in 3 weeks. I would also like to stress that we do not want any of our items to hold up the task order processing and that if needed we can deal with these items once we start the survey.

Thank you for your time,

Katie

Katie Mildon
Charting Program Manager

TerraSond Ltd

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From:	Mark.T.Lathrop [Mark.T.Lathrop@noaa.gov]	Sent:	Wed 7/21/2010 11:16 AM
To:	Andrew Orthmann		
Cc:			
Subject:	Re: topics discussed during visit		
Attachments:			

Andy,

Here are my responses to the topics we discussed in red.

Mark

Andrew Orthmann wrote:
Hey Mark, would you mind confirming the following items that we discussed while you were on the Dream Catcher, so we can have a record to append to the survey reports in case any questions come up later.

1. Regarding DTON's:

* No DTONs are to be submitted for this project due to the complete absence of charted data to base them upon. I agree that submitting a DTON in an area without charted soundings would be difficult especially when it comes to natural shoaling. However, I don't want to rule the possibility that you could still have a danger to navigation. As the hydrographer-in-charge you still have to make that call. A wreck in an area that vessels might encounter would be an example.

2. Regarding MBES boundaries:

* We will use the budgeted 2500 LNM of MBES within the 800-meter corridor we discussed, which is best-fit to the deepest, continuous channel to Bethel (dxf file "MBES_Corridor_071310.dxf" attached), as well as the main channel on the other side of the island near Bethel in H12170. In addition to the attached dxf, the corridor is also shown in the GeoTifs provided to you separately. Concur.

* We will achieve the "complete coverage" category of MBES within the corridor. Concur.

* Boundaries for MBES coverage are the 4m contour, or edge of the corridor, whichever comes first except in the two cases we discussed where the channel shoals to shallower then 4m for a short distance. In those areas we will survey with MBES an area of approximate width of the nearby channel, even though it is less then 4m deep. These areas are also shown in the provided GeoTifs and in the attached dxf. Concur.

* If there are extra MBES miles you prefer they be used to widen the approach to H12164. Concur.

3. Regarding bottom changes:

* We discussed how much the bottom is changing here and that we expect many of our SBES-MBES QC crossings to fail spec because of the changing bottom. You suggested we document this well in our final reports, and we discussed that we are planning to run a short MBES crossline each day to help show that agreement is good in cases where there isn't a lot of time difference between the crosslines and mainlines. Concur.

4. Regarding GPS-derived tides:

* We discussed our on-going use of, and plans to deliver final deliverables, corrected to MLLW using GPS methods instead of tides and tide zone corrections. We will plan to do a comparison between the two methods after we get final separations and tide data from JOA. See the Tides SOW. It is probably beat to discuss any deliverables questions with CO-OPS and cc me.

5. Regarding areas of questionable navigational significance:

* We showed you some examples of "dead-end" sloughs, where often it is deeper then 1m but dead-ends behind a sand bar, and we end up spending time developing the 1m in these areas where the navigational significance is questionable. You recommended we contact you when we encounter these areas and get your guidance, on a case-by-case basis, if you want us to develop these areas or not. Concur.

Thanks Mark,

Andy

From: Mark.T.Lathrop [mailto:Mark.T.Lathrop@noaa.gov]
Sent: Tuesday, April 20, 2010 9:32 AM
To: Kathleen Mildon
Subject: Re: Kuskokwim Sheet limits

Katie,

It's pretty late to change the sheet layout as I would have to resubmit the Project Instructions to the Contract Office delaying the process. We might be able to modify it later. I'll see what we can do. In a survey such as this the survey limits are for reference. You will survey to the 1m curve. If you discover any branching channels you will of course make every attempt to survey it within the limits of the Project Instructions. I've attached the PIs and SOW.

Mark

Kathleen Mildon wrote:

Mark,

As a follow up attached you will find our proposal for the four survey sheets.

Thanks

Katie

From: Kathleen Mildon
Sent: Tuesday, April 20, 2010 7:32 AM
To: 'Mark.T.Lathrop'
Cc: James DePasquale
Subject: Kuskokwim Sheet limits

TERRASOND

Mark,

Sorry about the barrage of emails the past couple of days but as we get closer to field season we are trying to wrap up all the loose ends.

Today's questions are:

ıre wondering if we can request to have 4 sheets instead of 7. It would be more efficient for both acquisition and processing.

ılso proposed new survey limits in our work plan have those been accepted as the new limits?

ıingle beam do we work to the survey limit or the 1m curve whichever comes first? As we have done in the past.

ɔur work instructions and sow available?

Thank You

Katie Mildon
Charting Program Manager

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From: Mark.T.Lathrop [Mark.T.Lathrop@noaa.gov] **Sent:** Thu 6/17/2010 9:29 AM
To: Andrew Orthmann
Cc:
Subject: Re: atons and dton guidance for kuskokwim
Attachments:

Andy,

You do not have any requirement to position the temporary buoys. As you said, they are seasonal and not on the chart. I actually got the positions from the CG from the last few years when I was researching the river channel, confirming their movement from year to year.

As for the DTONs, you are the hydrographer and will have to be the best judge of whether or not something is a danger to navigation. We could try to set up some sort of criteria but ultimately there is no substitution for being in the field and making that call. Feel free to share any questionable items with me as they come up. I am planning on making a site visit to Bethel after July 4 so we can discuss any issues more directly then.

Mark

Andrew Orthmann wrote:
> Hey Mark,
>
> A couple questions for you concerning ATONs and DTONs for this project.
>
> ATONs: Do we need to investigate/position temporary channel marker buoys? The USCG deploys channel marker buoys every spring after the ice goes out on the river, and they recover them before the river freezes in the fall. Additionally, according to locals, many of them end up on the beach over the summer. The project instructions require us to investigate all fixed and floating aids to navigation within the survey limits. My guess is that you would not require us to position these seasonal buoys (since by the time the deliverables are submitted, the buoys will be long gone) but could you confirm this.
>
> DTONs: The 2010 specs and deliverables have a note on DTONs in uncharted areas, where there are no charted depths in the survey area -- like this area. The specs provide no detail on this, other then to consult with the COTR to develop DTON selection criteria appropriate to the navigation use of the area. Can you provide some guidance on what will constitute a DTON in this area?
>
> Thanks Mark.
>
>
>
>
> Andrew Orthmann, ACSM
> Lead Hydrographer
>
> TerraSond Ltd
> Precision Geospatial Solutions SM
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From: Mark.T.Lathrop [mailto:Mark.T.Lathrop@noaa.gov]
Sent: Tuesday, April 20, 2010 7:12 AM
To: Kathleen Mildon
Subject: Re: Terrasond VBES questions

Katie,

The 2010 specs will be out later this week. The scenario for the Kuskokwim should be that we'd be looking for the VBES data in an independent 4m grid (i.e., separate from the MB), with a clean shoal surface. Under this scenario, you'd need to fill any along track holiday greater than 3 nodes (12m) in length.

Mark

Kathleen Mildon wrote:

Mark,

I would like to touch base with you regarding our upcoming survey, OPR-R341-KR-10. We will be collecting a significant amount of VBES data and I would like to avoid a few of the pitfalls we encountered during OPR-J977-TE-08.

I have a couple of questions:

The 2009 NOAA FPM states "The Survey Manager should consult, through his/her chain-of-command, OCS's Hydrographic Surveys Division for the most current guidance on incorporating VBES data into BASE surface data". Can we expect more detail in the 2010 NOS Hydro Specs and Deliverables WRT developing CUBE surfaces from VBES data? Are there different CUBE parameters for VBES than MBES data?

Can you give us any advice on how to identify gaps (i.e. areas requiring infills) while we are still in the field? During OPR-J977-TE-08, since the VBES BASE surface deliverable was a 5m resolution surface, we determined that any along track gap in soundings 15m or greater required an infill. This was extremely labor intensive to determine and in subsequent conversations, you and I discussed that this was a bit "overkill" considering the dense, along track resolution of VBES soundings vs. the small percentage of those which actually make it to the chart. Any advice along these lines would be a big help.

Should we clean the VBES CUBE surface to the shoal layer? I believe we had some problems with OPR-J977-TE-08 in that we cleaned to the depth layer of the surface and so the shoal layer honored flyers which needed to be edited.

Thank you,

Katie

Katie Mildon
Charting Program Manager

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H12166 HCell Report

Kurt Brown, Physical Scientist
Pacific Hydrographic Branch

1. Specifications, Standards and Guidance Used in HCell Compilation

HCell compilation of survey H12166 used:

Office of Coast Survey HCell Specifications: Version: 4.0, 2 June, 2010.
HCell Reference Guide: Version 2.0, 2 June, 2010.

2. Compilation Scale

Depths and features for HCell H12166 were compiled to the largest scale raster charts shown below:

Chart	Scale	Edition	Edition Date	NTM Date
16304	1:100,000	2nd	01/01/2005	04/16/2011

The following ENCs were also used during compilation:

Chart	Scale
US4AK85M	1:100,000

3. Soundings

A survey-scale sounding (SOUNDG) feature object layer was built from the 4-meter Combined Surface in CARIS BASE Editor. A shoal-biased selection was made at 1:10,000 survey scale using a Radius of 5 meters.

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. As no charted sounding data exists on chart 16304, the smaller scale chart 16300 was used to estimate sounding density. 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 Fathoms from Chart 16304	Metric Equivalent to Chart Fathoms, Arithmetically Rounded	Metric Equivalent of Chart Fathoms, with NOAA Rounding Applied	Fathoms with NOAA Rounding Applied	Fathoms with NOAA Rounding Removed for Display on H12166_SS.000
0	0	0.228	0.125	0
3	5.4864	5.715	3.125	3
5	9.144	9.3726	5.125	5
10	18.288	18.517	10.125	10

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 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 area is included in HCell H12166:

M_QUAL

The Meta area object was 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. Spatial Framework

7.1 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.

7.2 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):	Fathoms and 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.

7. 3 S-57 Object Classes

The CS HCell contains the following Object Classes:

$CSYMB	Blue Notes (points) —Notes to the MCD chart Compiler
CNTARE	Caution area for changeable area
DEPCNT	Modified surveyed MLLW
M_QUAL	Data quality Meta object
SBDARE	Bottom samples
SNDWAV	Sand wave area
SOUNDG	Soundings at chart scale density
WATTUR	Water turbulence—Tide rips

The SS HCell contains the following Object Classes:

DEPCNT	Generalized contours at chart scale intervals (See table under section 4.)
SOUNDG	Soundings at the survey scale density (See table under section 3.)

8. Data Processing Notes

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

9. QA/QC and ENC Validation Checks

H12166 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.

10. Products

10.1 HSD, MCD and CGTP Deliverables

H12166_CS.000	Base Cell File, Chart Units, Soundings and features compiled to 1:100,000
H12166 _SS.000	Base Cell File, Chart Units, Soundings and Contours compiled to 1:10,000
H12166 _DR.pdf	Descriptive Report including end notes compiled during office processing and certification, the HCell Report, and supplemental items
H12166 _outline.gml	Survey outline
H12166 _outline.xsd	Survey outline

10.2 Software

CARIS HIPS Ver. 7.0	Inspection of Combined BASE Surfaces
CARIS BASE Editor Ver. 2.3	Creation of soundings and bathy-derived features, meta area objects, and Blue Notes; Survey evaluation and verification; Initial HCell assembly.
CARIS S-57 Composer Ver. 2.2	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.

11. Contacts

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

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Seattle, WA
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kurt.brown@noaa.gov

APPROVAL SHEET
H12166

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.

Kurt Brown
2011.05.23
11:20:46 -07'00'

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.

Katie J. Reser

Katie Reser
2011.05.23
11:28:26 -07'00'

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
NELSON.GARY.C.1365885318
DN: c=US, o=U.S. Government,
ou=DoD, ou=PKI, ou=OTHER,
cn=NELSON.GARY.C.1365885318
Date: 2011.05.23 12:55:42 -07'00'