H12327

NOAA FORM 76-35A

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

DESCRIPTIVE REPORT

Type of Survey Navigable Area Survey

Field No. N/A

Registry No. H12327

LOCALITY

State Alaska

General Locality Approaches to Kuskokwim River

Sublocality 8 NM West of Kanektok River

2011

CHIEF OF PARTY

Marta Krynytsky

LIBRARY & ARCHIVES

DATE

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

HYDROGRAPHIC TITLE SHEET

REGISTRY No

H12327

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 **Approaches to Kuskokwim River**

Sub-Locality **8 NM West of Kanektok River**

Scale **1:40,000** Date of Survey **July 19 to September 16, 2011**

Instructions dated **5/11/2011** Project No. **OPR-R341-KR-11**

Vessel **M/V Dream Catcher**

Chief of party **Marta Krynytzky**

Surveyed by **Terrasond Personnel**

Soundings by **Reson SeaBat 8101 (Pole Mounted)**

SAR by **Kurt Mueller** Compilation by **Kurt Brown**

Soundings compiled in **Meters**

REMARKS: **All times are UTC. UTM Zone 3N**

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. The processing branch concurs with all information and recomendations in the DR unless otherwise noted. 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

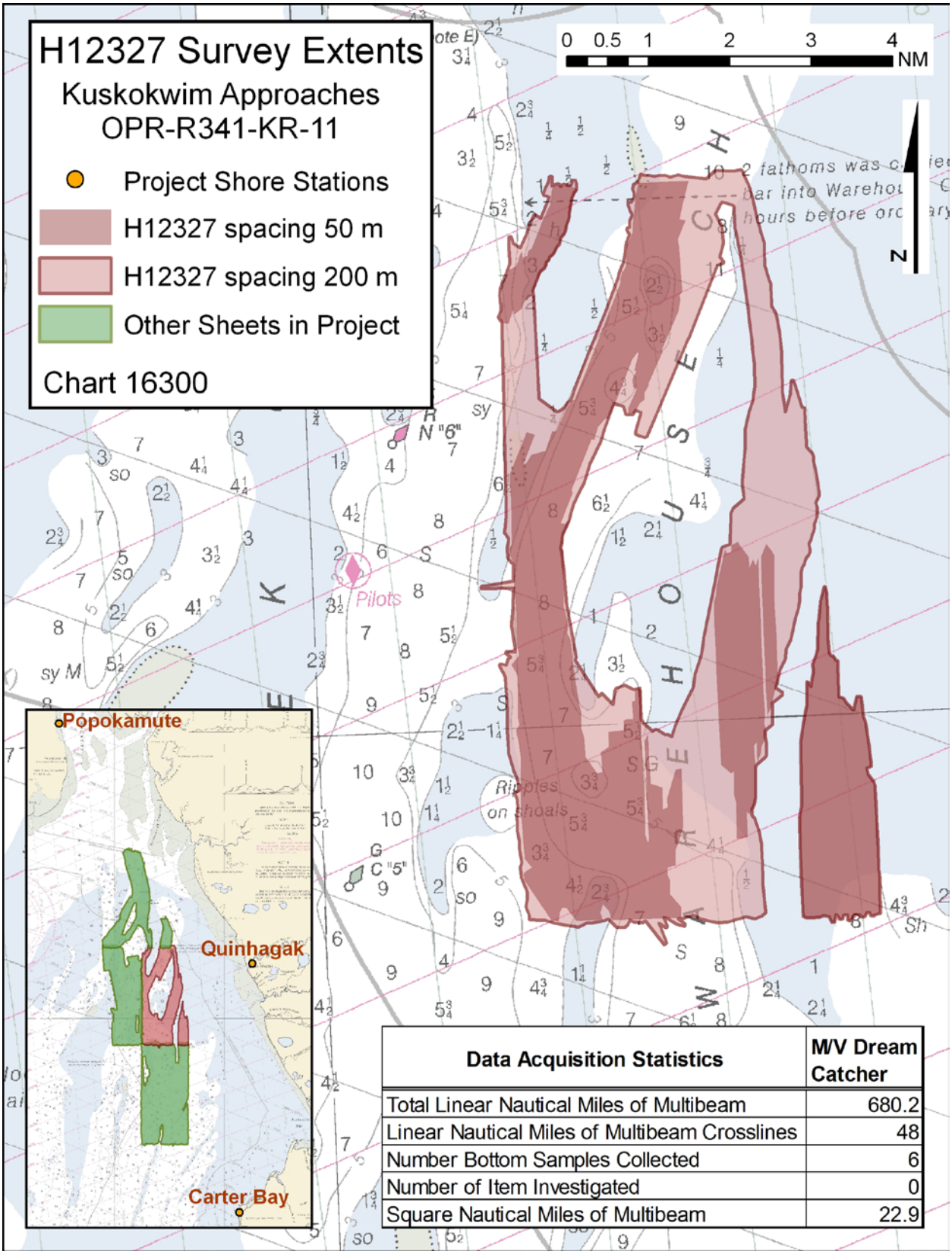
A navigable area survey was conducted 8 NM West of Kanektok River, Alaska, in accordance with the NOAA, National Ocean Service, *Statement of Work* (SOW), OPR-R341-KR-11, dated May 11, 2011. Survey data collection for H12327 began July 19, 2011, and ended September 16, 2011.

At the time of this survey, the best scale (1:200000) chart (number 16300 9th edition, April 2004) covers the approaches to the Kuskokwim River. The chart is out of date with widespread inaccuracies evident.

The survey is in an Arctic area that is partially frozen for more than half of the year. The area is shallow (less than 20 meters) and highly changeable, with numerous shifting sandbars and shoal areas. Strong currents are always prevalent and can be extreme due to the combination of both river and tidal constituents. Unfavorable weather conditions and sea states are common, even in the summer. During the ice-free season (approximately June through September) large amounts of tug-and-barge vessels transit the area, heading upriver primarily to Bethel but also to the many other villages and communities. These vessels, which draft up to 4 meters, commonly haul fuel, gravel, and other supplies. However, vessel traffic through this sheet was mostly limited to the southwest corner, with many vessels choosing a route to the west of this sheet entirely.

Multibeam echosounder (MBES) data was collected on this project. A total project-wide budget of 3,500 linear nautical miles of survey lines was used as efficiently as possible to locate and provide coverage of the navigable areas.

Project instructions called for 200 m line spacing between 4 and 8 m water depths, 50 m spacing between 8 and 20 m, and complete coverage in areas deeper than 20 m. In order to maximize area covered, NOAA instructed that priority was placed on achieving 200 m spacing everywhere over achieving the 50 m spacing and complete coverage categories. In practice this meant that the line budget was exhausted prior to fully achieving 50 m spacing and complete coverage within the designated depth ranges. Crosslines were typically collected perpendicular to the channel direction and current and carried into the 4m curve when conditions allowed.



Data Acquisition Statistics	M/V Dream Catcher
Total Linear Nautical Miles of Multibeam	680.2
Linear Nautical Miles of Multibeam Crosslines	48
Number Bottom Samples Collected	6
Number of Item Investigated	0
Square Nautical Miles of Multibeam	22.9

Figure 1 – H12327 Survey Extents and Statistics

Month	Dates (2011)
July	19th, 21st, 26th-27th, 30th
August	8th, 13th, 17th-19th, 21st, 23rd, 27th-31st
September	1st, 3rd-4th, 13th-16th

Table 1 – Specific Dates of Data Acquisition

Complete survey limits and the final progress sketch are available in *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 vessel *M/V Dream Catcher*.

M/V Dream Catcher

The *M/V Dream Catcher* is aluminum-hulled vessel 28.96 meters length overall with a 7.16 meter beam and a 1.68 meter draft. It was outfitted to acquire multibeam data. Major systems used on the *M/V Dream Catcher* are listed in Table 2.

M/V Dream Catcher **LOA: 7.01 m, BEAM 2.62 m, DRAFT: 0.51 m**	
Equipment	**Manufacturer & Model**
Multibeam sonar	Reson SeaBat 8101
Positioning	Applanix POSMV 320 V4
Vessel attitude	Applanix POSMV 320 V4
Sound speed	Applied Microsystems Micro SV&P

Table 2 – Major systems used aboard the M/V Dream Catcher

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 0.10 m or better. Refer to the DAPR for details and results of the various confidence checks.

B.2.1. Crosslines

Multibeam crosslines were compared to a 1 m BASE surface created from the mainscheme multibeam data. Most crosslines were individually compared to the mainscheme surface. However, crosslines that have minimal overlap with mainscheme data were excluded from crossline analysis. Of the 680.2 nautical miles of multibeam data collected, 48.0 nautical miles were utilized as crosslines. This translates into 7.1% of the multibeam mileage, which exceeds the 4.0% specified in the HSSD for multibeam crosslines. The extra mileage compensates for the fact that the crosslines do not always intersect mainscheme entirely – in the effort to develop the 4 m depth contour, many of the crosslines extend into shallow water beyond the limits of the mainscheme data.

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.

The vast majority of beams pass QC, comparing to the surface within IHO Order 1 at the 95% confidence interval or better. However, this survey experiences a very small number of QC failures, with beams that do not compare to the surface at IHO Order 1 at 95 % or better. The failures were analyzed and found to occur in areas of changeable bottom types, such as sand wave areas and steep slopes. The following table summarizes the results. Refer to *Separate IV: Crossline Comparisons* for the detailed QC Reports.

Crossline	Failing Beams	Bathymetric Observations
0480-C1-X05000	Beams 95-96	Changing sandwave area
0891-C2-X11000	Beam 88	Changing sandwave area
0892-C2-X11000	Beam 1	Changing sandwave area

Table 3 – QC Report Summary

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 3.230 m/s during TPU computation. This value was determined by analyzing the difference between subsequent casts taken at 4-hour intervals and calculating the standard deviation. This sheet demonstrated slightly more variability then the other project sheets, likely due to decreased mixing further from the mouth of the Kuskokwim River.
- Uncertainty associated with tide zoning was entered as 0.198 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 0.183 m to 0.205 m. This was the largest single constituent of the survey data's TPU. 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 surfaces, the vast majority of grid cells have uncertainties in the 0.42 to 0.49 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 sand wave areas showing bottom change, creating a high standard deviation of the soundings contributing to the grid cell. Despite a high uncertainty of these grid cells, the contributing soundings have TPU's that are within IHO Order 1.

B.2.3. Contemporary Survey Junctions

This survey junctions with three other contemporary surveys. The junction is described in the following table and figure.

Survey Registry Number	Project Number	Scale	Date	Junction with H12327 Edge
H12325	OPR-R341-KR-11	1:40,000	Sept 2011	North
H12326	OPR-R341-KR-11	1:40,000	Sept 2011	West
H12328	OPR-R341-KR-11	1:40,000	Sept 2011	South

Table 4 – Contemporary survey junctions with H12327

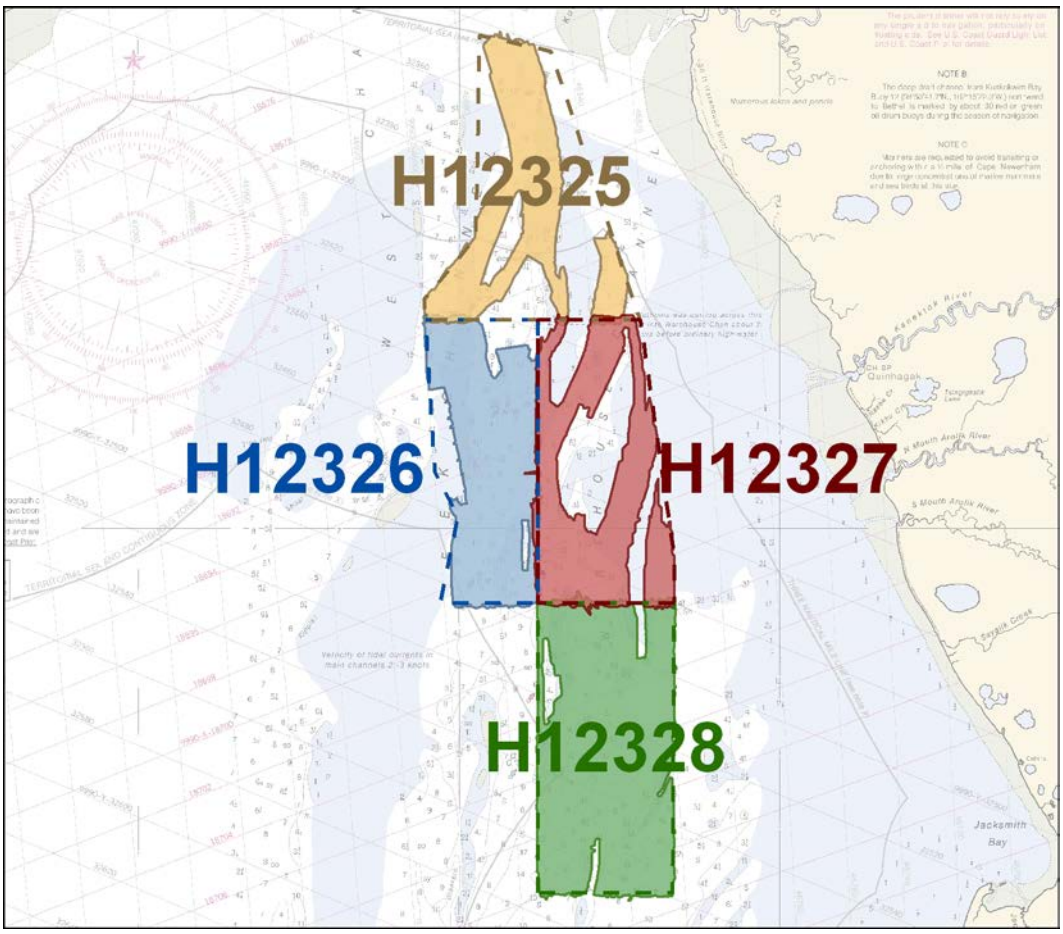


Figure 2 – Junctions of H12325 (beige), H12326 (blue), and H12328 (green) with this survey H12327 (red) on chart 16300 (9th edition, April 2004)

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. Any large differences were examined in subset.

For the junction with H12325, the surfaces are in good general agreement between the surveys, with the majority of grid cells checked agreeing to better then 0.10 m. Some small differences (0.25 m) exist. Lines involved with the junction were run in the same general timeframe which minimized bottom change.

For the junction with H12326, the surfaces are also in good general agreement between the surveys, with the majority of grid cells checked agreeing to better then 0.10 m. Some small differences (0.20 m) exist and are attributable to bottom change due to differences in times of acquisition and sandwaves seen in the surfaces.

For the junction with H12328, the surfaces are also in good general agreement between the surveys, with the majority of grid cells checked agreeing to better then 0.10 m. Some small differences (0.30 m) exist and are attributable to bottom change due to differences in times of acquisition and sandwaves seen in the surfaces.

B.2.4. Sonar System Quality Control Checks

Weekly confidence checks were attempted via lead line or bar check on the *M/V Dream Catcher*. Often strong currents, shoal depths, and poor weather prevented effective sonar checks. In total seven lead line checks and four bar checks were completed throughout the project. Lead line checks typically agreed with echosounder depths to 0.10 m or better, while bar checks agreed to 0.05 m or better.

Refer to the lead line and 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 DAPR.

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 with the exception of the following.

- An along track artifact on the order of 0.05 to 0.10 m is apparent in certain areas of the survey. The artifact is caused by a slightly shoaler nadir or near-nadir bottom detect then surrounding beams. The issue is common with the Reson 8101 and typically bottom-type dependent. The issue was identified in the field and sonar tuning adjusted to minimize the effect. In processing the beams were rejected when they adversely affected the BASE surface by more than ½ the error budget per the HSSD. The issue adversely affects accepted soundings by up to 0.15 m. The effect on the final BASE surface is typically less than 0.10 m. An example is shown below. Despite the error the data is well within specifications.

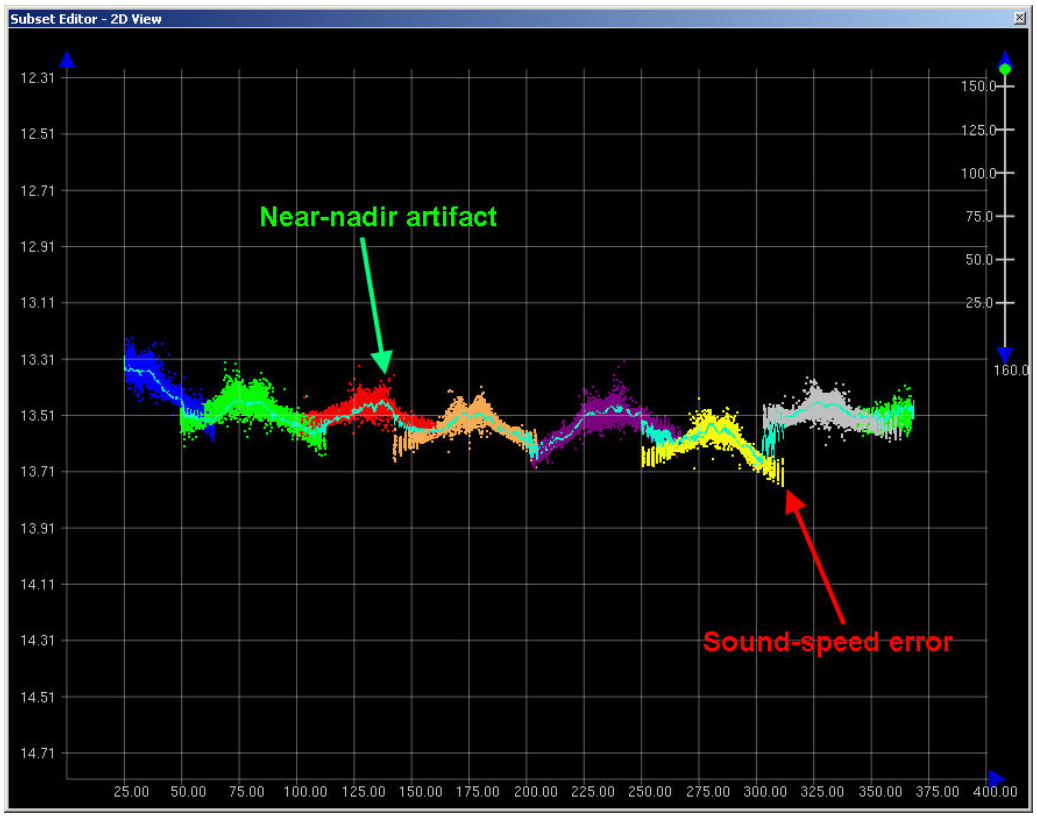


Figure 3 – Common example from CARIS HIPS subset mode from this survey (59-40-44.8 N, 162-14-47.80 W) of Reson 8101 near-nadir error in shallow water. Some sound-speed related error is also apparent. The BASE surface is also shown. Vertical scale is 0.20 m.

In addition to the equipment-related issues described above, environmental issues also existed which caused some adverse impacts to data quality. These are itemized below.

- Sound speed-related error is not widespread in the data but can be observed periodically. This error, which shows up as an across track upward or downward cupping of the data, adversely affects accepted soundings by up to 0.20 m, though its effect on the final BASE surface is typically less. Despite the error the data is well within specifications.
- Bottom changes due to sediment transport were identified as the primary cause of vertical busts between adjacent lines. These were commonly associated with sand wave areas or steep submerged banks and usually correlated with large differences in time of acquisition. An example is shown below.

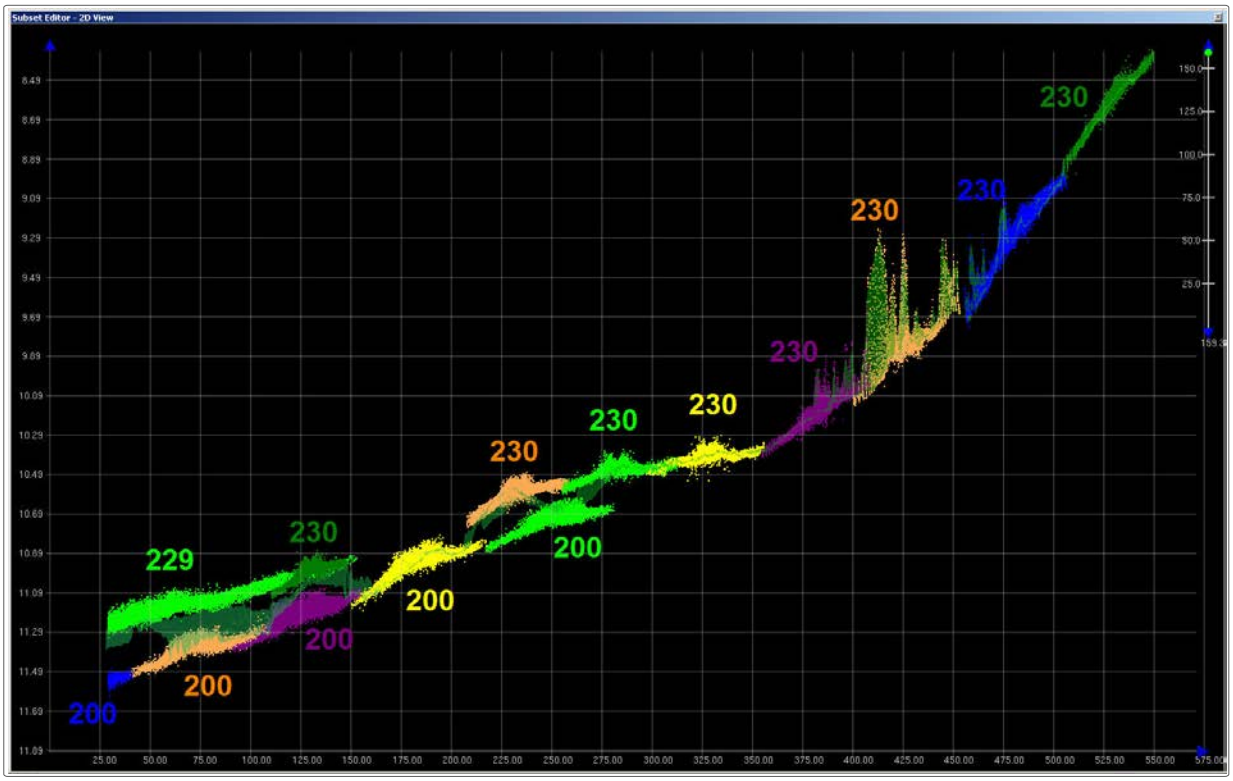


Figure 4 – Example from CARIS HIPS subset mode showing busts due to bottom change. Slope at 59-39-57.5 N, 162-13-54.5 W is shifting with up to 0.25 m vertical change over 30 days. Numbers represent the Julian day each line was run; lines run closer in time relative to each other show better agreement. Vertical scale is 0.20 m.

When busts were identified, the associated positioning data was reviewed to rule out positioning error. This was done by checking settings used to create the smooth best estimate of applicable 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 positioning error was identified as the source of the bust were either fixed in processing, or if they exceeded specifications rejected and re-run as necessary.

SBETs were created and applied in the field using a single-base station methodology, but were generally replaced with SBETs created using the Applanix Smart Base (ASB) method after leaving the field. ASB yielded overall better positioning results due to distances of up to 30 km from base stations. On rare occasion single-base mode SBETs yielded better results and were applied to specific lines. Details of both the single-base and ASB methods used are described in the DAPR.

The following positioning issue had an adverse affect on data quality:

- Some isolated tide busts between adjacent lines are not easily attributable to sediment transport because of their close proximity in time. It was not always possible to pinpoint the cause but was likely due to some component of GPS vertical positioning error. These are also not always easily distinguishable from sediment transport-related bottom change,

which can also occur over short periods of time. Regardless, these typically did not exceed 0.30 m and are within specifications.

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 (80 meters). Therefore edits on areas of bottom change busts were rare.

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 Approaches is a dynamic area with strong river, tidal and wind driven currents. Sound speed measurements throughout the area varied both spatially and temporally. To minimize sound speed errors, sound speed casts were taken normally every four hours during multibeam 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 to meet the specifications described in the HSSD, Section 5.2.3.3.

Sound speed profiles were applied with the “nearest in distance within time” method in CARIS HIPS, with time set to four hours when applying final corrections, with no exceptions for this sheet.

B.2.7. Requirements for Object Detection and Coverage

The *M/V Dream Catcher* was outfitted with a Reson SeaBat 8101 multibeam sonar. Multibeam operations were conducted in accordance with the “Set Line Spacing” described in section the project instructions. These requirements called for 200 m lines spacing in depths of 4 to 8 m, 50 m line spacing in depths of 8 to 20 m, and complete coverage in depths greater than 20 m, with a project-wide mileage budget of 3,500 linear nautical miles. To maximize area covered, priority was placed on achieving 200 m spacing everywhere, with the 50 m and complete coverage categories to be completed as the project-wide line budget allowed. Specific notes regarding achievement of the set line spacing requirements are as follows:

- 200 m spacing was achieved in general throughout this sheet in the 4 m to 8 m depth range, except where shoal areas prevented safe approach. Of specific note is the northeastern part of the sheet where 200 m spacing in the 4 m to 8 m depth range is incomplete; this occurred because the project-wide line budget had been exhausted when this area was reached late in the survey, after the more navigationally significant areas to the west had received coverage. However, in this area, depths of 8 m and greater did receive at least 200 m spacing.
- 50 m spacing was not fully achieved throughout this sheet in the 8 m to 20 m depth range. The project-wide line budget had been exhausted before the 50 m spaced lines could be fully completed. However, the more navigationally significant western part of this sheet did receive 50 m spaced lines in the required depth range.

- No areas deeper than 20 m were encountered in this survey; therefore no areas fell into the "complete" coverage category.
- On JD260 the project-wide mileage cap of 3,500 LNM was exceeded, which ended data acquisition. No additional effort was expended in attempts to further develop 4 m, 50 m spacing, shoal, or other areas.
- For safety reasons, the 4 m minimum water depth requirement was seldom achieved on this survey. Every effort was made to survey to the 4 m contour including the careful utilization of high tides, but only under optimum combinations of tide, weather, current, and bottom slope was it possible to safely do so.

  Though 4 m was sporadically achieved, it was more common to terminate lines in the 4-6 m depth range.

  This probable outcome was discussed prior to the commencement of survey operations in TerraSond's technical proposal and discussed with the NOAA COTR during his on-site visit and correspondence. The COTR emphasized that resources were better utilized identifying and surveying navigable channels then attempting to reach the 4 m contour. For related correspondence and the TerraSond Technical Proposal, See *Appendix V: Supplementary Survey Records and Correspondence*[1].

During acquisition, vessel speed was kept low—typically below 8 knots—to maximize along-track ping density. The sonar range scale was set to acquire the maximum possible swath width for the water depth. A 1 m coverage grid updated in real time by the QINSy acquisition software was used to confirm along-track data coverage. No attempt was made, however, to ensure overlap with adjacent lines or fill gaps since this survey was conducted in a set line spacing scheme.

Following processing and cleaning of erroneous soundings, surfaces with resolutions specified in the HSSD Section 5.2.1.2 were created and examined. CUBE parameters that ensured a maximum propagation distance of √2 were used in creating the surface. However, no attempt was made to ensure 95% or more of the nodes were populated with at least five soundings since this requirement was not compatible with the set line spacing scheme. Outer beams of the multibeam swath typically do not meet density requirements.

Note that in the field during multibeam data processing, a preliminary MLLW to ellipsoid separation model was used to assist with determining when the required MLLW depth had been achieved (4 meters for 200 m spacing, 8 meters for 50 m spacing). The values used to derive the model were provided by JOA Surveys LLC (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 shoaler in this sheet by an average of 0.18 m. Refer to the project HVCR for more information regarding the final separation model.

B.3. Corrections to Echo Soundings

Survey H12327 was performed in conjunction with three other surveys in Project OPR-R341-KR-11. Corrections applied to echo soundings are described in detail in the project DAPR. No deviations from the DAPR occurred except those listed in the table below.

Julian Day	Line Name	Comment
2011-243	1515_-_C1-A01300	RPM logging started late. RPM of 1400 assumed for first 20 seconds of line

Table 5 – Lines with acquisition or processing exceptions

Julian Day	Line Name	SBET loaded
2011-230	0932_-_C2-A01050	2011-230-0005-1C_SINGLE_BASE_QUIN.SBET
2011-230	0933_-_C2-A01000	2011-230-0005-1C_SINGLE_BASE_QUIN.SBET
2011-230	0941_-_C2-A0060	2011-230-0005-1C_SINGLE_BASE_QUIN.SBET
2011-240	1406_-_C2-B04750	2011-240-0003-1C_SINGLE_BASE_QUIN.SBET
2011-240	1409_-_C2-B04950	2011-240-0003-1C_SINGLE_BASE_QUIN.SBET
2011-240	1410_-_C2-B05000	2011-240-0003-1C_SINGLE_BASE_QUIN.SBET
2011-240	1411_-_C2-B05050	2011-240-0003-1C_SINGLE_BASE_QUIN.SBET
2011-240	1412_-_C2-B05250	2011-240-0003-1C_SINGLE_BASE_QUIN.SBET

Table 6 – Lines with Single-base SBETs loaded.

Julian Day	Line Name	Comment
2011-225	0645_-_C2-X08150	Mainscheme line has ‘X’ in naming convention
2011-235	1271_-_C1-X00040	Mainscheme line has ‘X’ in naming convention
2011-235	1272_-_C1-X00051	Mainscheme line has ‘X’ in naming convention
2011-235	1273_-_C1-X00052	Mainscheme line has ‘X’ in naming convention
2011-259	2074_-_C1-X05600	Mainscheme line has ‘X’ in naming convention

Table 7 – Lines with X in naming structure that are mainscheme lines, not crosslines.

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 2011 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 surfaces are provided with the H12327 data deliverables: One referenced to MLLW, the other referenced to the NAD83 ellipsoid.

The MLLW surface is a finalized BASE surface grid of 1 m resolution created from the primary CARIS data set, which is referenced to MLLW through the ellipsoid to MLLW separation model (discussed in Section C below). The source CARIS fieldsheet is also included in case it is necessary to re-compute this surface.

Per the HSSD Section 8.4.2 regarding BASE surfaces supplied with ERS surveys, a second BASE surface grid of 1 m resolution referenced to the NAD83(CORS96) ellipsoid is also provided.

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.

All BASE surfaces were created with a horizontal projection of UTM Zone 3 North, NAD 1983.

Data Type	Surface Type	Resolution	Vertical Datum	Name
Multibeam	CUBE	1 m	MLLW	H12327_1m_MLLW_1of1
Multibeam	CUBE	1 m	NAD83 Ellipsoid	H12327_1m_NAD83(CORS96)_1of1

Table 8 – Finalized BASE surfaces included with the survey deliverables

A single CARIS HOB file was submitted (H12327_Final_Feature_File.HOB) with the survey deliverables as well. The HOB file contains feature information and meta-data not represented in the depth grid, including nature of the seabed from bottom samples, tide rips, and caution and sand wave areas. Each feature is encoded with mandatory S-57 attributes, additional attributes and NOAA Extended Attributes as required by the HSSD.

The DAPR contains detailed discussion of the steps followed when acquiring and processing the 2011 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.

All sounding data was tide corrected using ellipsoid-referenced surveying techniques (ERS) to MLLW using a model of MLLW to NAD83 ellipsoid separation values. This method was successfully employed previously in this region for the 2010 surveys completed by TerraSond under project OPR-R341-KR-10. The use of ERS on those surveys resulted in a large improvement in data quality over discrete tide zone methods.

The separation model was developed by JOA and utilized the ellipsoid to MLLW datum separations computed at installed tide stations at Quinhagak, AK (946-5831), Popokamute, AK (946-6057) and Carter Bay (946-5601). Short duration tide gauges were installed at several sites throughout the project area and their separation values computed and utilized in the model as well. The separation model, which is included with the project CARIS and ERS deliverables, was applied using CARIS HIPS' "Compute GPSTide" routine to all lines. The separation model's filename is "Kuskokwim 2011 SEP Model 20111118.txt." MLLW to NAD83 ellipsoid separations in this sheet ranged from 11.241 m to 11.552 m.

Tide zones were not provided by NOAA for this project. JOA computed tide zones and provided verified, smoothed tides for the project but these were not used on the final data. Note: A "tidal" copy of the CARIS data corrected to MLLW using the conventional, discrete tide zones is supplied with the data deliverables in the "Reference_Only" subdirectory but it must be emphasized here that the tidal data set is 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 without exception. This replaced all RTK navigation and GPS heights with the PPK solution.

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 H12327 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.

Chart	Type	Scale	Edition	Issue Date	NM / LNM Updates Through
16300	RNC	1:200,000	9th	April, 2004	LNM – 2008-09-26 NM – 2011-02-12
US3AK84M	ENC	1:200,000	3rd	August 7th, 2008	April 2004

Table 9 – Charts examined during chart comparisons

Notices to Mariners (NM) and Local Notice to Mariners (LNM) issued from May 2011 through September 2011 (from issuance of SOW to completion of survey) that affected the survey were examined as well, ending with NM and LNM 38/11. No discrepancies were found.

The chart comparison was accomplished by overlaying the finalized BASE surfaces and final feature file on the latest edition NOAA charts. The general agreement between charted soundings and H12327 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.

Significant change is evident between the chart and survey data, therefore changes and features are only detailed in general terms. Because of the widespread change, it is recommended that this survey supersede all charted data where they overlap.

The following figure shows the final feature file and BASE surface overlaid on the chart.

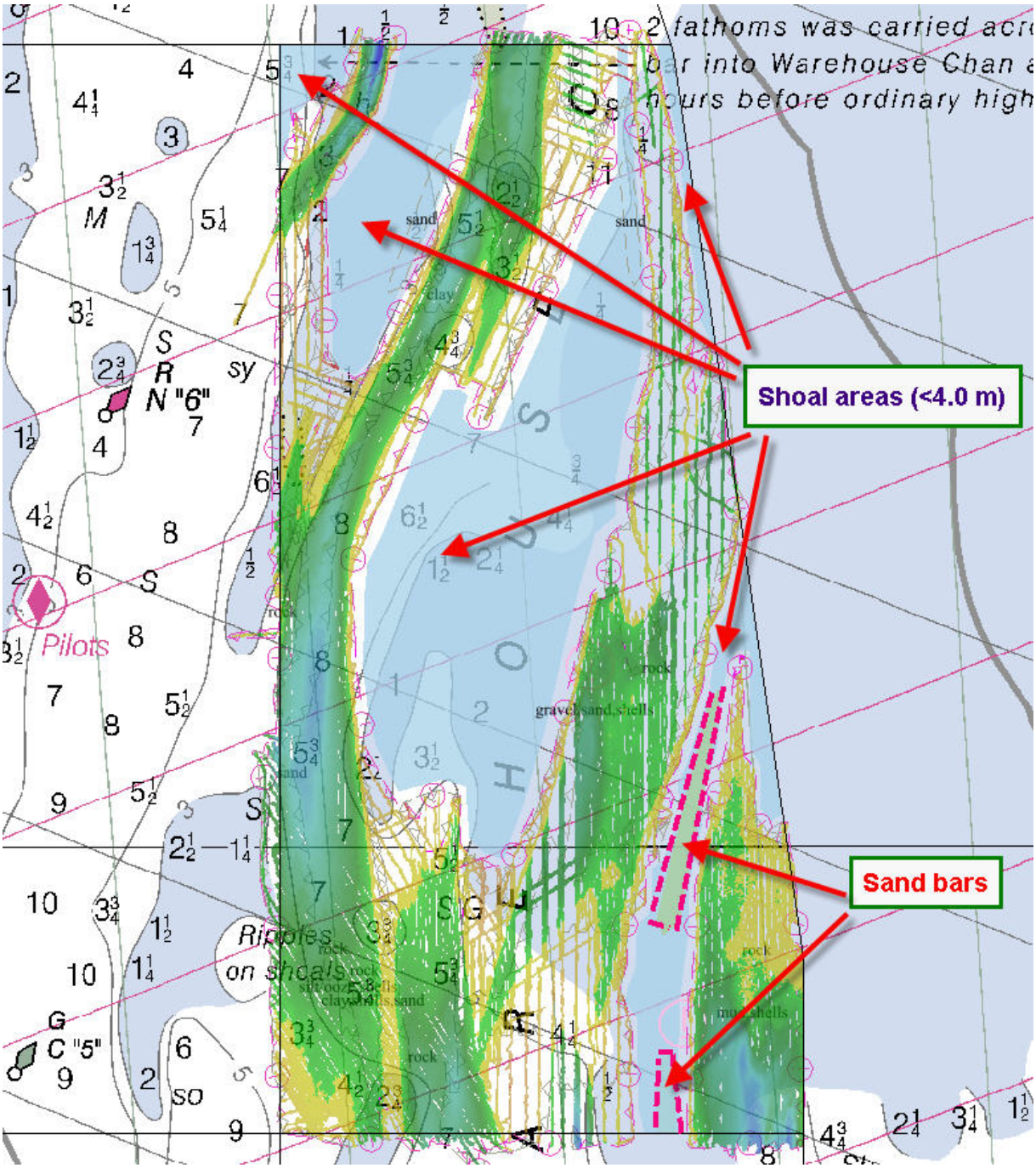


Figure 5 – Final feature file and BASE surface overlaid on chart 16300. BASE surface color map indicates 8-20 m in green and blue, less than 8 m in yellow, 4 m or less in red. Major features from the final feature file are indicated

D.1.1. New Features

- Likely rock features are evident periodically in the multibeam BASE surfaces and have been designated when they meet the requirements described for designated soundings in the HSSD.

- Two new sandbars that extend above MLLW were observed and their approximate boundaries noted[2]. Height was not obtained as shoreline verification was not a requirement of this survey. These are also indicated in the figure above.

  1. New exposed sand bar centered on 59-40-12 N, 162-08-25 W. Sandbar covers and uncovers. Portrayed as a DEPARE area object in the accompanying feature file with DRVAL1 set to -2.0 m and DRVAL2 set to 0.0 m. Recommend charting new sand bar. A photo of this sandbar is shown below.

Figure 6 – Photo of exposed sandbar at 59-40-12 N, 162-08-25 W.

  2. New exposed sand bar centered on 59-37-58 N, 162-08-47 W. Sandbar covers and uncovers. Portrayed as a DEPARE area object in the accompanying feature file with DRVAL1 set to -2.0 m and DRVAL2 set to 0.0 m. Recommend charting new sand bar.

D.1.2. Charted Features

Significant change is evident in all charted features, with major shifts in the positions of sandbars and shoal areas, and it is recommended that all charted features be replaced or modified based on this survey's data. Therefore, these are not thoroughly itemized in this report. Special features of particular note are listed below.

- The charted note "2 fathoms was carried across this bar into Warehouse Chan about 2 hours before ordinary high water" at 59-46-26 N, 162-14-20 W was not confirmed and should be removed. The charted shoal was indicated by the multibeam coverage but depth was too shallow for this survey to confirm the noted depth range across the bar.

D.1.3. Soundings

Very few charted soundings compare well to this survey. No overall trend is apparent with agreement varying on a sounding by sounding basis. It is recommended that soundings from this survey supersede charted soundings where they overlap.

Many charted soundings did not receive multibeam coverage due to their location in areas now too shallow to survey. In these cases it is recommended the charted soundings be removed and replaced with the shoal areas delineated in this survey[3]. Shoal areas are portrayed in the accompanying final feature file (HOB format) as Depth Area (DEPARE) objects with depth ranges of 0.0 to 4.0 m. These DEPARE objects are also indicated in the figure 5 above.

D.1.4. Trends and Changeable Areas

This entire area is a changeable area. The survey area is located near the mouth of a major river and experiences 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 daily tidal range (4 meters on average) experienced in the area. Changes in bottom depth and topography were observed even over the short course of the survey. A CTNARE (Caution Area) object that covers the survey extents is included in the final feature file deliverable, with the "inform" field as "Changeable Area." It is recommended the existing chart be updated to include a warning concerning the changeable nature of the area[4].

The CAUTION Note on chart 16300 which states "Spring freshets change both the depths and positions of the channels, especially so north of latitude 59-40" should be retained.

D.1.5. Assigned Feature File

An Assigned Feature File (AFF) was provided for this survey. However, no objects in the AFF intersected this survey. This file is provided along with the Project Reference File (PFF) for reference in *Separate III*.

D.1.6. AWOIS Items Summary

As stated in the project instructions, no Automated Wreck and Obstruction Information System (AWOIS) items were assigned for this survey. No items were found for inclusion in the AWOIS database.

D.1.7. Features Labeled PA, ED, PD or rep.

There are no charted features labeled PA, ED, PD, or "rep." within the survey extents.

D.2. Additional Results

D.2.1. Shoreline Verification

Shoreline verification was not required for this survey. DEPARE features delineated in the final feature file were estimated from ship-based observations and the extents of the multibeam coverage.

D.2.2. Aids to Navigation

ATONs were not observed in this sheet. ATONs were observed in the adjacent sheet to the west, refer to the DR for H12326 for notes regarding ATONs there.

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.

D.2.4. Comparison with Prior Surveys

A comparison with prior surveys was not required under this Task Order. See Section D.1 of this report for a comparison to the existing nautical charts.

D.2.5. Bottom Samples

Six bottom samples were collected in H12327[5]. 24 samples were assigned project wide with a spacing of approximately 4,800 meters between samples. The project wide distribution of bottom samples was modified after the bathymetric limits of the survey area were determined, ultimately resulting in six bottom samples in H12327.

A listing and description of the bottom samples and related correspondence are provided in *Appendix V* of this report. The bottom samples are also portrayed as seabed area (SBDARE) objects in the accompanying final feature file. Photos of the bottom samples are located in the "Multimedia" directory with the final feature file.

D.2.6. Bridges and Overhead Cables

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

D.2.7. Submarine Cables and Pipelines

There are no charted submarine cables in the survey area. None are evident in the multibeam coverage.

D.2.8. Additional Information

Vessel traffic through this sheet was mostly limited the southwest corner, with many vessels choosing a route to the west of this sheet entirely.

D.2.9. Additional Recommendations

There are no additional recommendations to note[6].

APPROVAL SHEET

For

H12327

This report and the accompanying digital data are respectfully submitted.

Field operations contributing to the completion of survey H12327 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.

Marta Krynytzky

Digitally signed by Marta Krynytzky
DN: CN = Marta Krynytzky, C = US, O = TerraSond Ltd., OU = Charting
Reason: I attest to the accuracy and integrity of this document
Location: Palmer, AK
Date: 2011.12.21 16:47:44 -09'00'

Marta Krynytzky
Lead Hydrographer
TerraSond Ltd.

Andrew Orthmann

Digitally signed by Andrew Orthmann
DN: CN = Andrew Orthmann, C = US, O = TerraSond LLC
Reason: I attest to the accuracy and integrity of this document
Location: Palmer, AK
Date: 2011.12.22 14:27:36 -09'00'

Andrew Orthmann
ACSM Certified Hydrographer (2005), Certificate No. 225
Charting Program Manager
TerraSond Ltd.

Revisions Compiled During Office Processing and Certification

[1] The survey correspondence is attached to the DR.
[2] The sandbars were recommended for charting.
[3] The soundings in the shoal area were recommended to be removed from the chart.
[4] The Caution Areas were recommended for charting.
[5] All bottom samples from the survey were recommended for charting and one charted bottom sample was recommended to be retained.
[6] No DTONs were found during this survey.

Andrew Orthmann

From: Mark.T.Lathrop [Mark.T.Lathrop@noaa.gov]
Sent: Thursday, June 30, 2011 9:01 AM
To: Andrew Orthmann
Subject: Re: Checking in

OPR-R341-KR
ottom samples.zip..

Hi Andy,

Sorry I didn't get back to you on this but it must have slipped my mind. I've attached the bottom sample locations in MapInfo and .dxf.
Let me know if you can't read them. Your spacing between samples will be 4800 meters as per the new specs which will give you 24 samples. The locations are really just guides. We're looking for an even distribution but also a variety of sample sites. If you can't get to a location because of shoals you are free to improvise as you see fit.
Let me know if you have any questions.

The progress sketch template has not changed from 2010 so you can adapt last year's to this year. Remember the Combo only applies to side scan combined with an echosounder, so you won't be using it for your project.

Good luck this year and I'll try to make it out so see you again.

Mark

On 6/30/2011 11:32 AM, Andrew Orthmann wrote:
> Hey Mark,
>
> Just wanted to make sure you received those invoices, and that everything looks okay.
>
> Also have you had a chance to look into the bottom sample locations and progress spreadsheet?
>
> Thank you,
>
> Andy
>
>
> This email contains information that is privileged and confidential. It is intended only for the addressee. If you receive this email in error, please do not read, copy, or disseminate it. Please reply to the sender immediately to inform the sender that the email was misdirected, then erase it from your computer system. Your assistance in correcting the error is appreciated. While we have made effort to make sure this email is free from viruses, we cannot guarantee its safety. We suggest you use every precaution to protect your computer system. This email was scanned and found virus free by GFI on 30/6/2011.
>
>

From: Mark.T.Lathrop [Mark.T.Lathrop@noaa.gov]
To: Thomas Newman
Cc: Andrew Orthmann
Subject: Re: NOAA Extended Attribute Files

Sent: Fri 7/22/2011 6:30 AM

Attachments: R341_KR_PRF.000
R341_KR_AFF.000

Tom, Andy,

Attached are the Assigned Feature File and Prior Reference File for OPR-R341-KR-11. Not much there but then again, there's not much on the chart.

Mark

On 7/21/2011 11:06 AM, Thomas Newman wrote:
Thanks Mark.

Thomas S Newman, PLS, CH
President / Chief Executive Officer
TerraSond Limited
P: (907) 745-7215
C: (907) 232-0890
tnewman@terrasond.com
www.terrasond.com
From my iPad

On Jul 19, 2011, at 11:08 AM, "Mark.T.Lathrop" <Mark.T.Lathrop@noaa.gov> wrote:

Tom,

I'll send your AFF soon, perhaps tomorrow.

Mark

-------- Original Message --------

Subject:NOAA Extended Attribute Files
Date: Tue, 19 Jul 2011 14:47:39 -0400
From:james.m.crocker <James.M.Crocker@noaa.gov>
To:tom@terrasond.com
CC: Mark.T.Lathrop <Mark.T.Lathrop@noaa.gov>, Jeffrey Ferguson <Jeffrey.Ferguson@noaa.gov>, Megan Greenaway <Megan.Greenaway@noaa.gov>

Good Afternoon Tom,

I am sending the attached files to all contractors as a courtesy to provide you with information on how HSD and NOAA field units are implementing the new feature reporting requirements, as documented in the 2011 HSSD, within Caris software. This is by no means an endorsement for Caris products nor is it meant to imply any requirement to use Caris products to process and or deliver hydrographic feature data. For those who utilized Caris software, the attached files contain the guidance and necessary files that HSD provided to the NOAA field units to implement NOAA Extended Attributes in Caris. You are welcome to use NOAA's approach for implementing the NOAA Extended Attributes or establish a different approach that better suits your processes and procedures.

All charted features within the bounds of the assigned project area shall be addressed, documented, per 2011 HSSD section 8.1.4, D.1 Chart comparison, and submitted using the NOAA Extended Attributes as defined in 2011 HSSD section 8.2 and Appendix H. To aid with this requirement I have directed the COTR's to provide an Assigned Feature File in .000 format. This file has been generated from the largest scale ENC covering the project area. You may use this file and update it with your results or generate a new file based on your own process and procedures. If you have not already received this file with your project documents you should expect to receive in the near future. Please let me know if you do not receive this file for your 2011 project.

Finally I would like to note an error that was found in the 2011 HSSD. At the bottom of page 129, section 8.2, the bullet "Least Depth Unknown" should read "Least Depth Known" Please note this change in your copy until an corrected version is published.

Best Regards,
Jim

<CARIS_Support_Files_Ver_5_1.zip>

<Extended Attribute Files_email_to_contractors.docx>

Andrew Orthmann

From:	Mark.T.Lathrop@noaa.gov [Mark.T.Lathrop@noaa.gov]	**Sent:**	Thu 8/11/2011 5:48 PM
To:	Andrew Orthmann		
Cc:	Marta Krynytzky		
Subject:	Re: topics discussed during visit		
Attachments:			

Andy,

My responses to your concerns are listed below:

1) Concur. I believe we are recognizing, in changable survey areas in the Arctic, that resourses can get bogged down surveying shoals that tend to migrate when it is much more expedient to concentrate on identifying and surveying navigable channels.

2) As the hydrographer in the field, you are in the best position to judge whether or not something is a danger to navigation. I agree that it doesn't make much sense to sumit an entire shallow area as a DTON because a channel has shifted since the last survey in 1914. The vessels transiting the area know that there are shoals there and the Coast Guard is placing buoys appropriately.

3) Concur.

4) Concur. You are not required to position ATONs.

Let me know if you need further clarification.

Mark

----- Original Message -----
From: Andrew Orthmann <aorthmann@terrasond.com>
Date: Friday, August 12, 2011 1:33 am
Subject: topics discussed during visit
To: Mark.T.Lathrop@noaa.gov
Cc: Marta Krynytzky <mkrynytzky@terrasond.com>

> Hi Mark, for the purpose of documenting this for the DRs, could you
> respond if you concur with the following topics we discussed during
> your visit with us on 8/10 and 8/11:
>
>
> 1. Difficulty achieving the 4m contour
>
> We discussed the likelihood that for many lines we may not be able to
> achieve the 4 m contour, due to safety concerns. It is recognized that
> time and line budget is better utilized obtaining the 200m and 50m
> line spacing areas.
>
> 2. DTON Guidance
>
> Given the age of the charted data and "Note E", which states that
> charted hydrography is out of date, we will not be issuing DTONs
> unless there is a particularly outstanding danger to navigation found.
> Example include a wreck or pinnacle feature obviously dangerous for
> the vessels transiting the area.

>
> 3. Infill guidance
>
> For this survey in the set-line spacing areas (<20m), infills will be
> considered to be gaps in the data that exceed the set line spacing.
> For example, in the 8m to 20m area, gaps larger then 50m will be
> filled.
>
> 4. ATONS
>
> ATONs in the area are seasonal in nature, therefore we are not
> required to investigate.
>
>
> Andrew Orthmann, ACSM
> Charting Program Manager
>
> TerraSond Ltd
> Precision Geospatial Solutions ®
> 1617 South Industrial Way Suite 3, Palmer, Alaska 99645
> (907) 745-7215 Office (907) 745-7273 FAX (907) 982-5231 Cell
> aorthmann@terrasond.com www.terrasond.com <>
>
>
> This email contains information that is privileged and confidential.
> It is intended only for the addressee. If you receive this email in
> error, please do not read, copy, or disseminate it. Please reply to
> the sender immediately to inform the sender that the email was
> misdirected, then erase it from your computer system. Your assistance
> in correcting the error is appreciated. While we have made effort to
> make sure this email is free from viruses, we cannot guarantee its
> safety. We suggest you use every precaution to protect your computer
> system. This email was scanned and found virus free by GFI on 11/8/2011.
>
>

Marta Krynytzky

From:	Andrew Orthmann	**Sent:**	Wed 8/31/2011 10:12 AM
To:	Marta Krynytzky		
Cc:			
Subject:	FW: remaining areas and mileage		
Attachments:			

I'll forward the PDF I sent to him in a moment as well. Could you save both to the vessel server, NOAA correspondence please.

Andy

From: Mark.T.Lathrop [mailto:Mark.T.Lathrop@noaa.gov]
Sent: Wednesday, August 31, 2011 10:09 AM
To: Andrew Orthmann
Subject: Re: remaining areas and mileage

Andy,

Your plan going forward looks good. If there isn't a 8-meter route through the survey area then let's develop what route there is. 1-3 and 1-4 should be priorities. After that, get 200-meter spacing everywhere you can. If there's anything left, fill in with 50-meter spacing. Make sure you document your priorities well in the DR with regard to line budget and uncertain/changeable nature of the survey area.

Mark

On 8/30/2011 6:15 PM, Andrew Orthmann wrote:

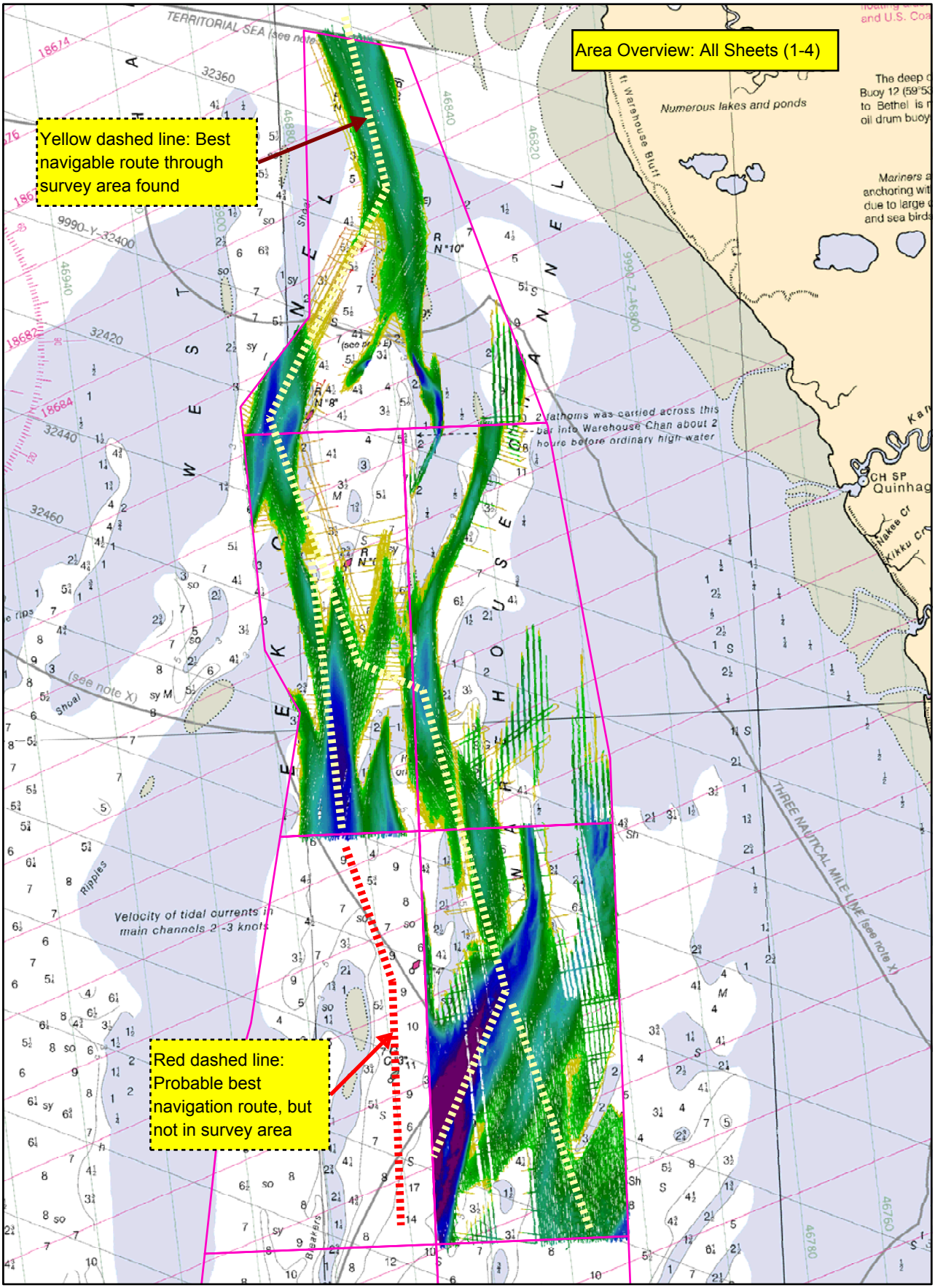
> Hi Mark,
>
> As of yesterday we've collected about 2,800 LNM. By the time you can review this I expect we will be at about 2,950. So we have about 600 to 650 LNM remaining until we reach the max cap of 3,500.At this point it is obvious to me that we will reach the cap prior to having all the areas/lines surveyed. So I want to make sure we have all the priority areas covered that you want covered with the remaining mileage.
>
> No continuous "deep" route exists through the survey area -- deep being 8m or deeper. The main bottleneck is in sheet 1, where a navigable route exists but is not very wide (about 2 km) and not terribly deep (5-7 meters on average).
>
> The attached PDF shows what we've done through yesterday. The color scheme is:
>
> >8m depth: greens and blues
> 4-8m depth area: yellow
> 4m or less: red
>
> As previously discussed, there isn't a lot of "red" since it is unsafe in much of this area to push in to 4m, but it has been achieved when conditions allowed in certain areas.
>
> Could you take a look and let me know what your priorities are with the remaining mileage. I've highlighted and discussed particular areas and assigned them an area number if you want to refer to them by that.
>
> I think we have the most to gain by prioritizing the following areas for the purposes of a developing the navigable route further but want to get your guidance on this:
>
> 1-3 (not much work here)
> 1-4 and possible 1-5 if there is a connection

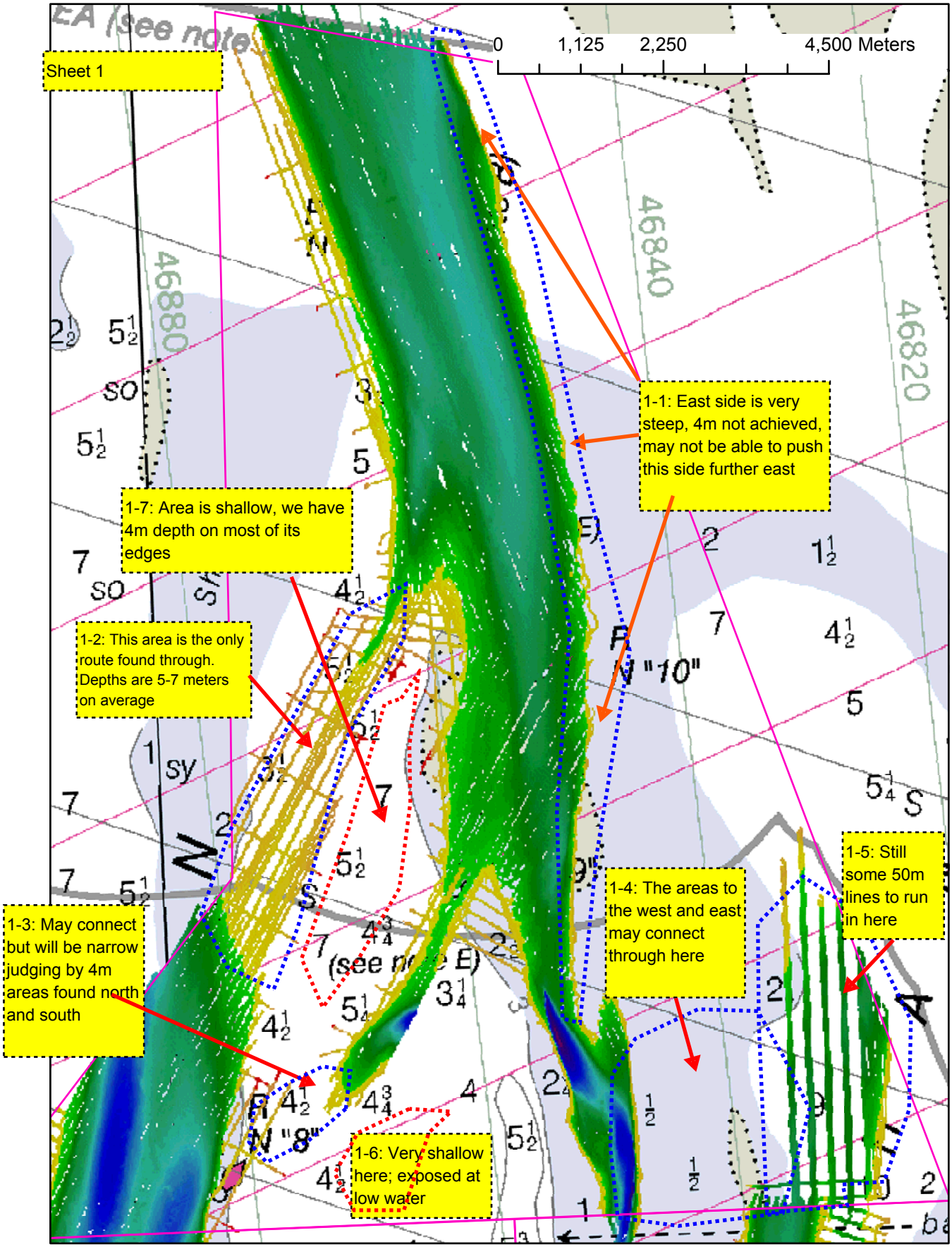
2-2
2-3
3-2
3-4
4-1
4-2
4-3
4-6
4-9
4-10

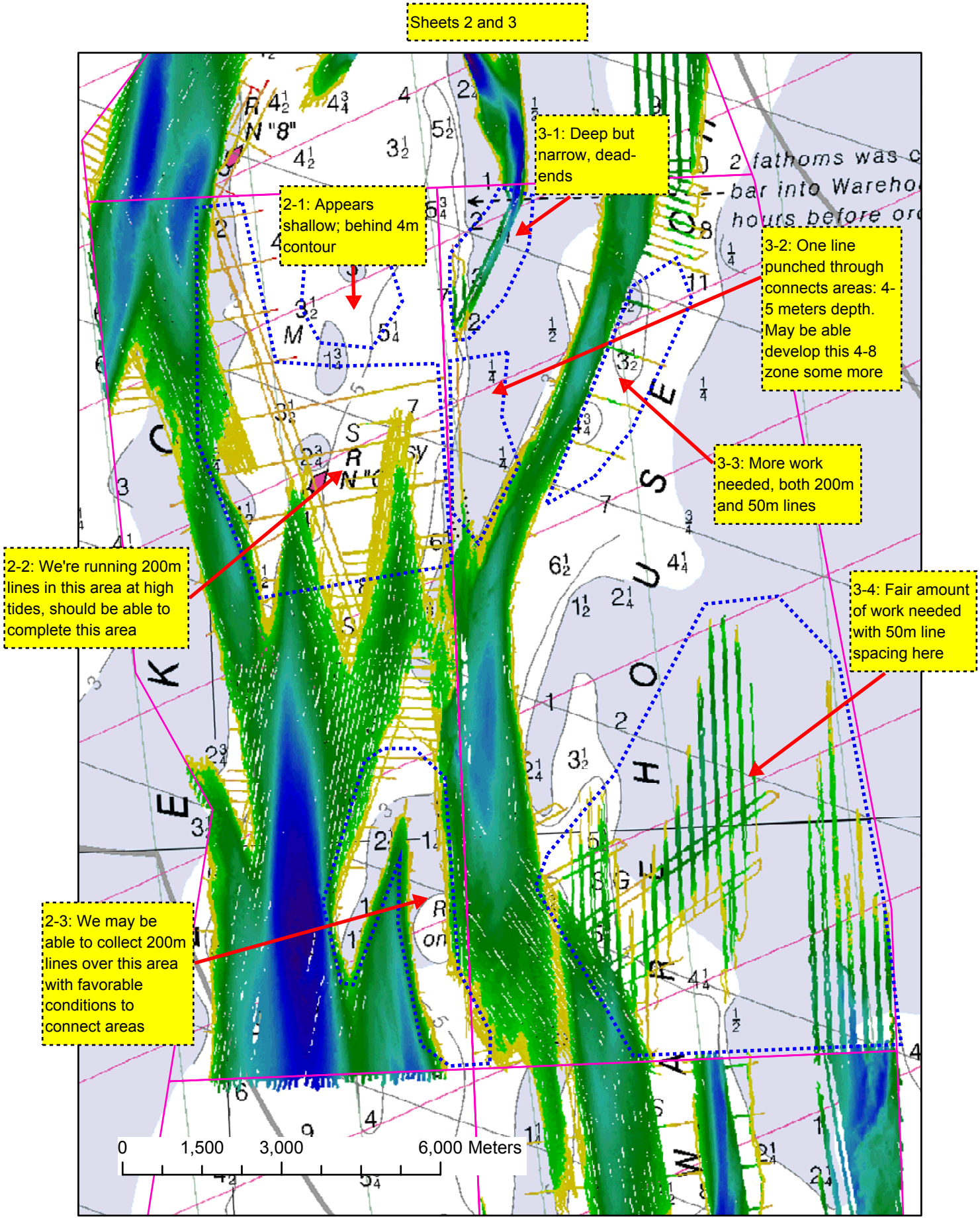
Thanks Mark,

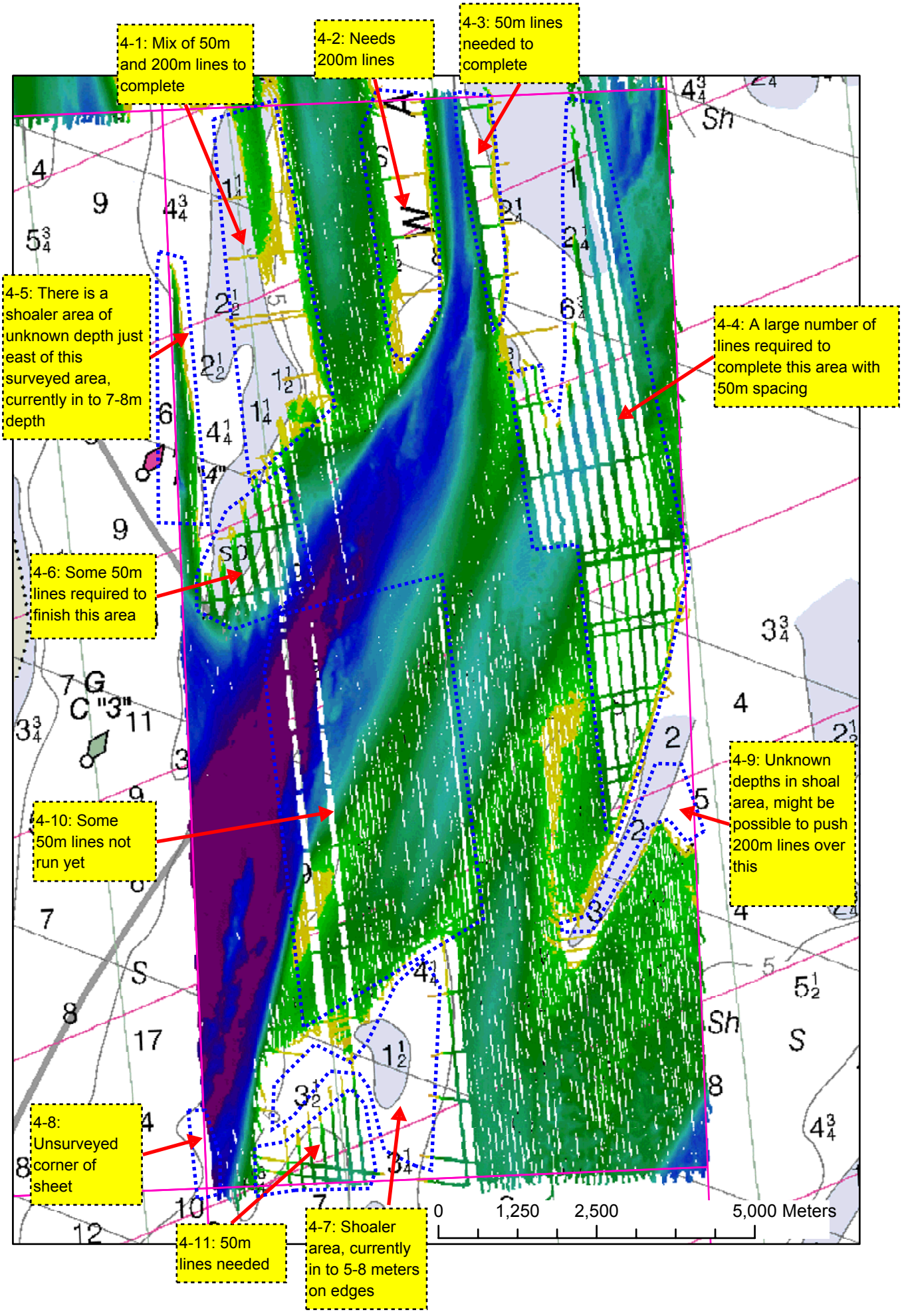
Andrew Orthmann, ACSM
Charting Program Manager

TerraSond Ltd
Precision Geospatial Solutions ®
1617 South Industrial Way Suite 3, Palmer, Alaska 99645
(907) 745-7215 Office (907) 745-7273 FAX (907) 982-5231 Cell
aorthmann@terrasond.com www.terrasond.com


Area Overview: All Sheets (1-4)
Yellow dashed line: Best navigable route through survey area found
Red dashed line: Probable best navigation route, but not in survey area
Numerous lakes and ponds
2 fathoms was carried across this bar into Warehouse Chan about 2 hours before ordinary high water
Velocity of tidal currents in main channels 2 -3 knots
THREE NAUTICAL MILE LINE (see note X)
TERRITORIAL SEA (see note
Ft Warehouse Bluff
CH SP
Quinhag
Nakee Cr
Kikku Cr
Ripples
Shoal
(see note X)
Breakers


Sheet 1
0
1,125
2,250
4,500 Meters
1-1: East side is very steep, 4m not achieved, may not be able to push this side further east
1-2: This area is the only route found through. Depths are 5-7 meters on average
1-3: May connect but will be narrow judging by 4m areas found north and south
1-4: The areas to the west and east may connect through here
1-5: Still some 50m lines to run in here
1-6: Very shallow here; exposed at low water
1-7: Area is shallow, we have 4m depth on most of its edges
46840
46880
46820


Sheets 2 and 3
3-1: Deep but narrow, dead-ends
2-1: Appears shallow; behind 4m contour
3-2: One line punched through connects areas: 4-5 meters depth. May be able develop this 4-8 zone some more
3-3: More work needed, both 200m and 50m lines
2-2: We're running 200m lines in this area at high tides, should be able to complete this area
3-4: Fair amount of work needed with 50m line spacing here
2-3: We may be able to collect 200m lines over this area with favorable conditions to connect areas
0
1,500
3,000
6,000 Meters


4-1: Mix of 50m and 200m lines to complete
4-2: Needs 200m lines
4-3: 50m lines needed to complete
4-5: There is a shoaler area of unknown depth just east of this surveyed area, currently in to 7-8m depth
4-4: A large number of lines required to complete this area with 50m spacing
4-6: Some 50m lines required to finish this area
4-9: Unknown depths in shoal area, might be possible to push 200m lines over this
4-10: Some 50m lines not run yet
4-8: Unsurveyed corner of sheet
4-11: 50m lines needed
4-7: Shoaler area, currently in to 5-8 meters on edges
0
1,250
2,500
5,000 Meters

APPROVAL PAGE

H12327

Data meet or exceed current specifications as certified by the OCS survey acceptance review process. Descriptive Report and survey data except where noted are adequate to supersede prior surveys and nautical charts in the common area.

The following products will be sent to NGDC for archive

- H12327_DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records
- H12327_GeoImage.pdf

The survey evaluation and verification has been conducted according current OCS Specifications.

Approved: Digitally signed by Peter S. Holmberg
DN: cn=Peter S. Holmberg, o, ou, email=peter.holmberg@noaa.gov, c=US
Date: 2012.07.30 09:17:29 -07'00'

Peter Holmberg
Physical Scientist, Pacific Hydrographic Branch

The survey has been approved for dissemination and usage of updating NOAA's suite of nautical charts.

Approved: David Zezula
2012.07.30 09:21:19 -07'00'

LCDR David Zezula, NOAA
Chief, Pacific Hydrographic Branch