H12948

NOAA Form 76-35A

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Survey

DESCRIPTIVE REPORT

Type of Survey: Navigable Area

Registry Number: H12948

LOCALITY

State: Alaska

General Locality: Bering Sea

Sub-locality: 9 NM East of Nunivak Island

2016

CHIEF OF PARTY
Andrew Orthmann

LIBRARY & ARCHIVES

Date:

NOAA FORM 77-28 (11-72)	U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET		**H12948**

INSTRUCTIONS: The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

State:	**Alaska**
General Locality:	**Bering Sea**
Sub-Locality:	**9 NM East of Nunivak Island**
Scale:	**1: 40,000**
Dates of Survey:	**07/16/2016 to 08/03/2016**
Instructions Dated:	**07/20/2016**
Project Number:	**OPR-R300-KR-16**
Field Unit:	**TerraSond Limited**
Chief of Party:	**Andrew Orthmann**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Side Scan Sonar**
Verification by:	**Pacific Hydrographic Branch**
Soundings Acquired in:	**meters at Mean Lower Low Water**
H-Cell Compilation Units:	***meters at Mean Lower Low Water***

Remarks:

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. Any revisions to the Descriptive Report (DR) generated during office processing are shown in bold red italic text. The processing branch maintains the DR as a field unit product, therefore, all information and recommendations within the body of the DR are considered preliminary unless otherwise noted. The final disposition of surveyed features is represented in the OCS nautical chart update products. All pertinent records for this survey, including the DR, are archived at the National Centers for Envitronmental Information (NCEI) and can be retrieved via http://www.ncei.noaa.gov/.

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Descriptive Report to Accompany Survey H12948

Project: OPR-R300-KR-16

Locality: Bering Sea

Sublocality: 9 NM East of Nunivak Island

Scale: 1:40000

July 2016 - August 2016

TerraSond Limited

Chief of Party: Andrew Orthmann

A. Area Surveyed

A navigable area survey (H12948) was conducted in the area 9 NM East of Nunivak Island, Alaska, in accordance with the NOAA, National Ocean Service, Statement of Work (SOW), OPR-R300-KR-16, dated July 15th, 2016 and Hydrographic Survey Project Instructions dated July 20th, 2016. Hydrographic survey data was acquired from July 16th through August 3rd, 2016. Tidal data was collected from mid-June through late September, 2016. Note that this survey area was a part of a modification to the original task order (work instructions dated May 12th) and added four additional survey sheets to the four previously assigned.

An additional contract modification, "Mod2", issued February 17th, 2017, extended the deliverables submission deadline to March 13th, 2017, due to delays associated with issuance of the final TCARI tide grid.

The survey area is located at the south approach to Etolin Strait, a navigable passage off of the southwest Alaska coast. Nunivak Island lies to the west, with Nelson Island and mainland Alaska to the east. This relatively remote region of the Arctic is covered or heavily influenced by sea ice for a large portion of the year, presenting a limited ice-free season with open navigable water from approximately June through October.

Vessel traffic in the region primarily consists of barges serving nearby communities or transiting through the area to other points along Alaska's west and north coasts, bringing fuel and supplies, as well as some freighter traffic. Nunivak Island provides some of the only protection available for vessels transiting Alaska's southwest coast, a region that frequently experiences inclement weather and poor sea conditions. Traffic is relatively sparse, but has been increasing in recent years along with economic and scientific interest in the Arctic.

Nearby communities are small and primarily subsistence-based. The region is not connected to the road system and communities depend on air services for connections to Bethel and on to Anchorage. No facilities exist nearby for supporting or servicing larger vessels, with Bethel (approximately 200 NM transit) and Nome (approximately 250 NM transit) the closest port options for fueling or limited services. During this

survey--which utilized a 105' research vessel--Bethel was used for resupply, largely due to a more protected transit route. However, larger or deeper drafted vessels may favor Nome.

TerraSond conducted multibeam echosounder (MBES) and side scan sonar (SSS) operations in the area in accordance with the project instructions, which specified areas requiring complete coverage (100% SSS with concurrent complete coverage MBES) and areas requiring set-spaced MBES-only. Other requirements included tidal data collection and bottom sampling.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
60° 10' 46.19" N 165° 30' 30" W	60° 1' 48.18" N 165° 12' 21.48" W

Table 1: Survey Limits

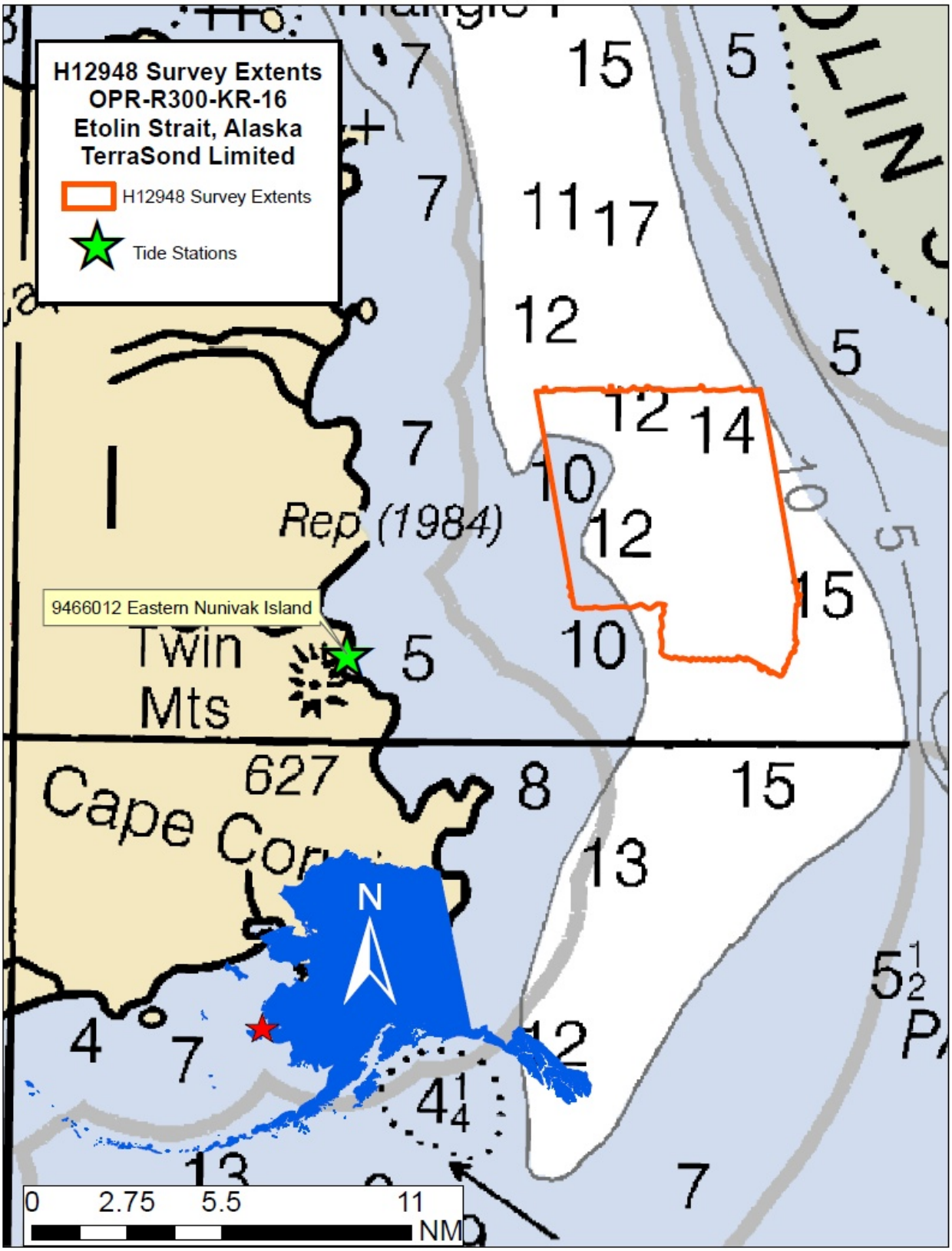

Figure 1: Survey extents and overview.

Survey Limits were acquired in accordance with the requirements in the Project Instructions and the HSSD, with any exceptions noted below.

1. Survey extents were modified on the southwest side from the extents provided in the Project Reference File (PRF) with the Project Instructions. In the set-spaced area only, south of approximately 60-04-04 N, 165-25-34, an area was excluded from the planned extents of this survey and instead included within the junctioning sheet to the south, H12949, which was conducted concurrently. This was done to optimize line plans prior to commencement of survey operations. This made H12948 slightly smaller than planned (and H12949 larger). Regardless, the affected area received survey to identical specifications.

Survey limits for both the 2 km wide corridor (requiring full coverage) and the set-spaced areas were achieved. Note that the western-most line in the set-spacing area was not acquired under H12948. It was acquired instead under junctioning survey H12868.

The specified inshore limit of hydrography (farthest offshore of either the 4 m depth contour or the line defined by the distance seaward from the MHW line, which is equivalent to 0.8 mm at the scale of the largest scale nautical chart) was not encountered in this survey area.

A.2 Survey Purpose

The purpose of this project is to provide contemporary surveys to update National Ocean Service (NOS) nautical charting products. The project (of which this survey sheet is one of eight separate, adjacent sheets) covered approximately 570 SNM of seafloor, all Priority 2 area as identified in the 2012 NOAA Hydrographic Survey Priorities document. There is an emerging need to provide modern hydrography in the Arctic to update nautical chart products.

In this project area, east of Nunivak Island, deep-draft traffic is operating in relatively shoal areas that have not been surveyed in over 100 years. A 600' chemical tanker (Champion Ebony) grounded on an uncharted shoal in this survey area on June 24th, 2016, just days before survey operations were scheduled to commence. Fortunately no discharge occurred, but the incident emphasized the need for chart updates in the area. Refer to the concurrently collected survey H12950 for more information on the grounding incident.

Survey data from this project is intended to supersede all prior survey data in the common area and support larger scale nautical chart products.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

A.4 Survey Coverage

The following table lists the coverage requirements for this survey as assigned in the project instructions:

Water Depth	Coverage Required
All waters in defined survey corridor	Full coverage: 100% Side Scan Sonar with concurrent Multibeam and Backscatter
All survey areas outside of defined survey corridor	Set-spaced MBES: 500 m set line spacing Multibeam and Backscatter

Coverage requirements were met for all areas. Lead Hydrographer's notes applicable to coverage review are as follows.

Full coverage (corridor) area:

Full coverage was achieved in the defined survey corridor. Coverage in the corridor area conforms with HSSD requirements described in Section 5.2.2.3, Option B: 100% SSS coverage with concurrent MBES, with any notes or exceptions below.

* In a few cases, SSS coverage shows small along-track gaps. These were examined and filled with MBES data to ensure full coverage, sometimes re-accepting high quality soundings that were auto-rejected during the MBES filtering process. All received complete coverage.

* In isolated cases, SSS coverage does not extend completely to the survey boundary, cutting off just short due to early file cut-off during SSS acquisition when the SSS towfish position aft of the vessel was not fully accounted for. Since these were at the sheet boundary, coverage from junctioning surveys was examined and in the majority of the cases, fully covered the missing data. In one case, MBES coverage was used to fill the gap. All received complete coverage.

* A small (10 m) along-track gap exists in the 2 m MBES surface at 60-02-15.7 N, 165-15-50.2 W in the corridor area. The area received 100% SSS coverage and no bottom features or hazards exist here.

Set-spacing area:

MBES-only data was acquired at 500 m spacing in all assigned areas outside the corridor to set-spacing standards. Note that the western-most line in the set-spacing area was run in junctioning survey H12868.

SSS was not collected in the set-spaced areas.

Splits:

Bathymetric line splits were not acquired to investigate charted depths because charted depths shoaler than survey depths did not fall between two survey lines given the scale of the affected chart. Shoals, contours, and significant deeps were also adequately defined by the mainscheme lines.

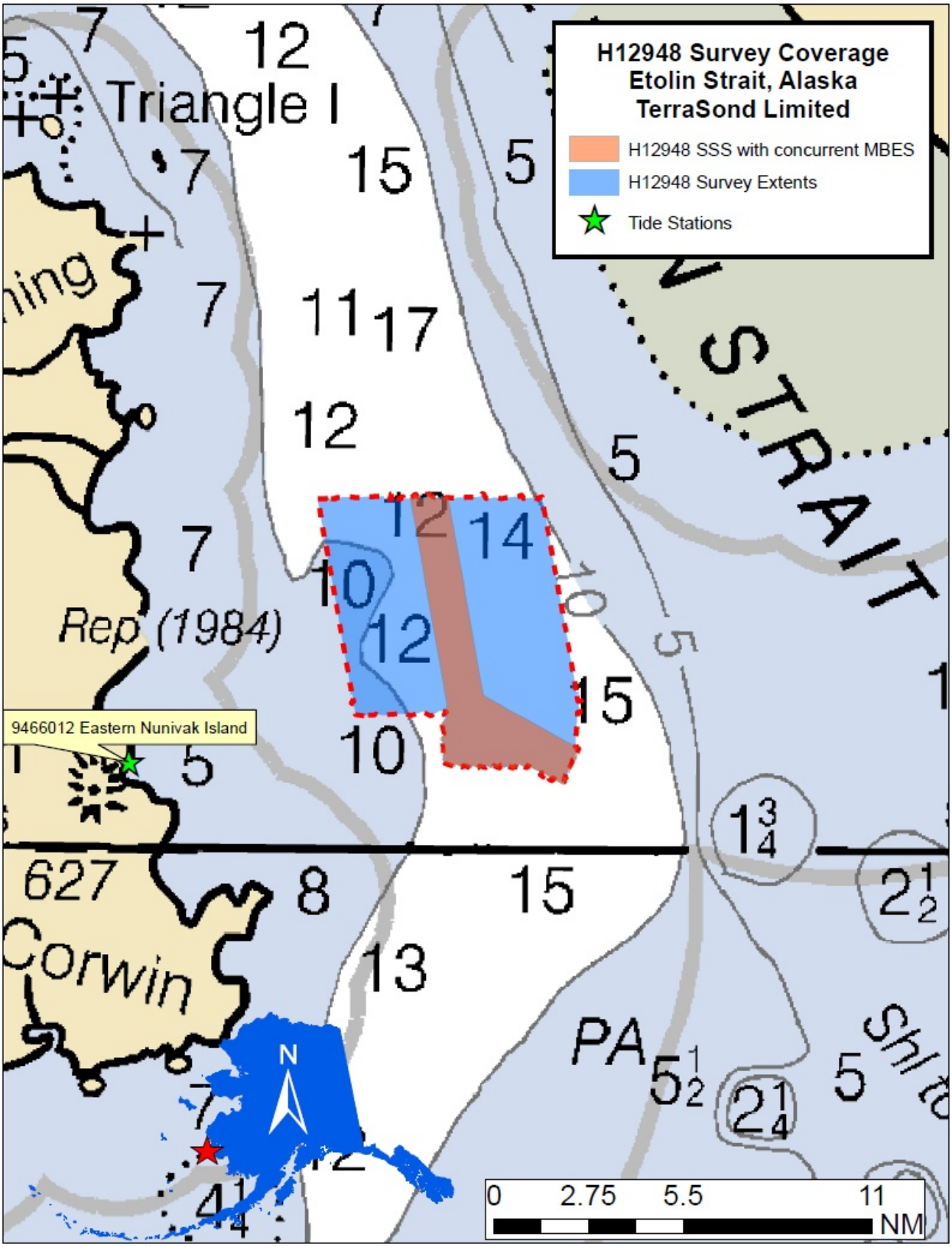

Figure 2: Survey overview showing coverage.

A.5 Survey Statistics

The following table lists the mainscheme and crossline acquisition mileage for this survey:

	HULL ID	*Qualifier 105*	*ASV-CW5*	*Total*
LNM	**SBES Mainscheme**	0	0	0
	MBES Mainscheme	59	72	131
	Lidar Mainscheme	0	0	0
	SSS Mainscheme	0	0	0
	SBES/SSS Mainscheme	0	0	0
	MBES/SSS Mainscheme	69	61	130
	SBES/MBES Crosslines	12	11	23
	Lidar Crosslines	0	0	0
Number of Bottom Samples				3
Number Maritime Boundary Points Investigated				0
Number of DPs				0
Number of Items Investigated by Dive Ops				0
Total SNM				47

Table 2: Hydrographic Survey Statistics

The following table lists the specific dates of data acquisition for this survey:

Survey Dates	Day of the Year
07/16/2016	198
07/17/2016	199
07/19/2016	201
08/03/2016	216

Table 3: Dates of Hydrography

B. Data Acquisition and Processing

B.1 Equipment and Vessels

Refer to the Data Acquisition and Processing Report (DAPR) for a complete description of data acquisition and processing systems, survey vessels, quality control procedures, and data processing methods. Additional information to supplement sounding and survey data and any deviations from the DAPR are discussed in the following sections.

B.1.1 Vessels

The following vessels were used for data acquisition during this survey:

Hull ID	***Qualifier 105***	***ASV-CW5***
LOA	32 meters	5.5 meters
Draft	1.8 meters	0.5 meters

Table 4: Vessels Used

The Qualifier 105 (Q105) is a 32 m aluminum hull vessel owned and operated by Support Vessels of Alaska. The Q105 acquired all multibeam data and provided housing and facilities for on-site data processing. The vessel also collected bottom samples, deployed BMPG tide gauges, and deployed/recovered the ASV-CW5 vessel.

The ASV-CW5 (C-Worker 5) is a 5.5 m aluminum hull Autonomous Surface Vessel (ASV) owned and operated by ASV Global. The ASV was operated in an unmanned, but monitored mode, collecting SSS and MBES data in close proximity to the Q105.

Refer to the DAPR for vessel photos, offset diagrams, and more information on vessel operations.

B.1.2 Equipment

The following major systems were used for data acquisition during this survey:

Manufacturer	Model	Type
Teledyne Reson	Seabat 7101	MBES
Applanix	POSMV 320 V5	Positioning and Attitude
Applanix	POSMV 320 V4	Positioning and Attitude
Valeport	Rapid SVT 200Bar	Sound Speed Profiler
Teledyne Oceanscience	RapidCAST	Sound Speed Profiler Deployment System
Trimble	5700	Base Station
Sea-Bird Electronics	SBE 26+	Submerged Tide Gauge
DAA (YSI - Xylem)	WaterLOG H-350XL	Vented Tide Gauge
AML Oceanographic	MinosX with Xchange Sensors	Conductivity and Temperature Gauges
EdgeTech	4200-MP	SSS

Table 5: Major Systems Used

Details on equipment specifications, configurations, quality control methodology, and methods of operation are described in the DAPR.

B.2 Quality Control

B.2.1 Crosslines

Crosslines acquired for this survey totaled 8.81% of mainscheme acquisition.

Crosslines were acquired in accordance with the requirements described in Section 5.2.4.3 of the 2016 HSSD. Effort was made to ensure crosslines had good temporal and geographic distribution, were run so as to enable maximal nadir-to-nadir comparisons, and percent of mainscheme LNM requirements were achieved (4% for complete coverage areas, and 8% for set-spacing coverage areas). Since the complete coverage areas utilized SSS, and therefore, had minimal MBES swath overlap in many locations, the higher standard of 8% was assumed (and achieved) sheet-wide.

Crosslines were conducted with both vessels to ensure there was ample overlap for inter-vessel comparisons, with each vessel crossing the other's mainscheme lines. Since the two vessels worked in close proximity and ran parallel lines, crosslines were usually collected in sets, with one vessel on each adjacent line.

The crossline analysis was conducted using CARIS HIPS “QC Report” routine. Every crossline was selected and run through the process, which calculated the depth difference between each accepted crossline sounding and a QC BASE (CUBE-type, 2 m resolution) surface’s depth layer created from the mainscheme data. QC BASE surfaces were created with the same parameters used for 2 m surfaces as the final surfaces, with the important distinction that the QC BASE surfaces did not include crosslines so as to not bias the QC report results. Differences in depth were grouped by beam number and statistics computed, which included the percentage of soundings with differences from the BASE surface falling within IHO Order 1. When at least 95% of the sounding differences exceed IHO Order 1, the crossline was considered to “pass,” but when less than 95% of the soundings compare within IHO Order 1, the crossline was considered to “fail.” A 5% (or less) failure rate was considered acceptable since this approach compares soundings to a surface, instead of a surface to a surface.

Results: Agreement between the BASE surfaces and crossline soundings is excellent. All crossline comparisons pass with 95% (or more) of soundings comparing to within IHO Order 1.

Refer to Separate II: Digital Data for the detailed Crossline QC Reports.

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Measured	Zoning	Method
0.038 meters	0.148 meters	TCARI

Table 6: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Surface
Qualifier 105	0 meters/second	0.911 meters/second	0.025 meters/second
ASV-CW5	0 meters/second	0.911 meters/second	0.025 meters/second

Table 7: Survey Specific Sound Speed TPU Values.

All soundings were assigned a horizontal and vertical value for estimated total propagated uncertainty (TPU). Refer to the DAPR for more detail concerning the parameters and methods used for computation of sounding uncertainty.

Note that fixed tide error values (0.038 m measured, 0.148 m zoning) entered during TPU computation were project-wide error averages for tide zones that were ignored by CARIS during TPU computation in favor of real-time tide error estimates loaded coincident with the TCARI model. Therefore, these static error estimates for tide zoning error did not affect final TPU computations.

Real-time error estimates for attitude, positioning, and tide were used over fixed error estimates defined in the HVF. Exceptions, if they exist, are listed in Section B.3 of this report.

The BASE surfaces were finalized in CARIS HIPS so that the final uncertainty value for each grid cell is the greater of either standard deviation or uncertainty. The uncertainty layer of each final surface was then examined for areas of uncertainty that exceeded IHO Order 1. Uncertainty for the surfaces ranged from 0.21 m to 0.65 m for the 2 m surface and 0.20 m to 0.81 m for the 4 m surface.

The vast majority of grid cells have uncertainty values within IHO Order 1. Few exceeded IHO Order 1. Highest uncertainties were found in areas of varying bottom topography such as slopes and near bottom features and sandwaves where high standard deviations are caused by the wide depth ranges of soundings contributing to each grid cell, outer edges of multibeam swathes without adjacent line overlap, and areas exhibiting sound speed or motion artifact error. Despite elevated TPU values for these grid cells, the data is within specifications.

B.2.3 Junctions

This survey junctions with three contemporary surveys -- H12868, H12949, and H12951 -- which were conducted concurrently with this survey as part of the overall project, OPR-R300-KR-16.

Difference surface methodology was used for the junction comparison. The depth layer from 2 m resolution CUBE surfaces from each survey were differenced from each other in CARIS HIPS, resulting in a difference surface. Values were extracted and statistics generated to quantify agreement. Any areas of significant disagreement, generally those exceeding IHO Order 1, were investigated to determine the cause.

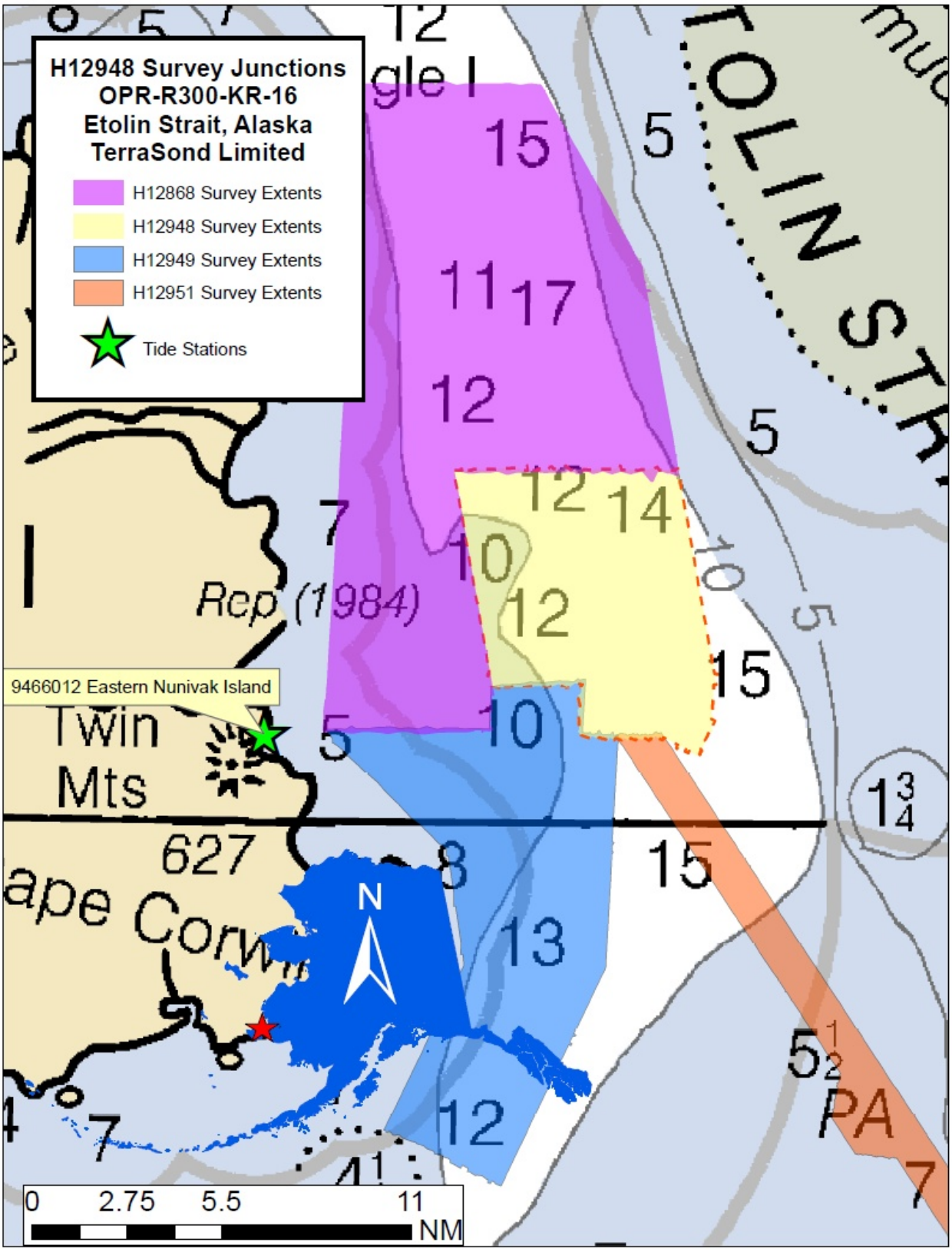

Figure 3: Survey junctions with this sheet.

The following junctions were made with this survey:

Registry Number	Scale	Year	Field Unit	Relative Location
H12868	1:40000	2016	TerraSond	NW
H12949	1:40000	2016	TerraSond	SW
H12951	1:40000	2016	TerraSond	SE

Table 8: Junctioning Surveys

H12868

Agreement is excellent, averaging 0.052 m, with a standard deviation of 0.183 m, with differences falling in a range of -0.833 to 0.518 m. Few exceed IHO Order 1. Disagreement was investigated and the cause was determined to be a tide bust between three adjacent pairs of lines (A7FS11 and E4FS10, A7FS10 and E3FS09, A7FS09 and E4FS08). Additionally, only isolated or small groupings of grid cells in the difference surface where these lines overlapped failed to meet specifications, rather than the entire line.

H12949

Agreement is excellent, averaging 0.044 m, with a standard deviation of 0.091 m, with differences falling in a range of -0.351 to 0.351 m. None exceeded IHO Order 1.

H12951

Agreement is excellent, averaging 0.040 m, with a standard deviation of 0.108 m, with differences falling in a range of -0.369 to 0.361 m. None exceeded IHO Order 1.

B.2.4 Sonar QC Checks

Echosounder confidence checks consisting of bar checks, lead lines, and inter-vessel acoustic comparisons were undertaken on this project. Results were good, with agreement averaging 0.009 m for bar checks, 0.190 m for lead lines, and 0.059 m for inter-vessel acoustic comparisons . Refer to the bar check, lead line, and echosounder depth comparison logs available in Separate I: Acquisition and Processing Logs for specific results. Refer to the project DAPR for more information regarding QC checks methodology.

B.2.5 Equipment Effectiveness

7101 Beam Pattern

A distinct beam pattern was obvious in the data set in certain areas, with a fuzziness or “horn” like features on both sides of nadir on multibeam swaths, coinciding with the bottom detection shift from phase to amplitude detection. The pattern is common with Reson 8101/7101 multibeam echosounders in certain bottom types. Power and range settings were adjusted in acquisition to minimize the issue, with little effect. However, the “horns,” which can be as great as 0.20 m in height, appear to be largely ignored by the CUBE algorithm during surface creation, with minimal effect on the final surfaces.

7101 Errant Pings

Errant or bad pings is evident periodically in the multibeam swath data. This occurred regularly on both 7101 systems. The issue manifests itself as a single ping, or swath, that is skewed (or rolled) from the seafloor at an angle. The cause is unknown, but does not correlate to any spikes in attitude data. These were normally removed manually during swath edit review, resulting in small along-track gaps as viewed in swath editor plan view. However, since only single pings were affected and ping rates were high (generally 10 or more per second), there is no significant detrimental effect on data density. Unrejected errant pings in the dataset may remain, but do not have significant detrimental effect on final surface quality.

B.2.6 Factors Affecting Soundings

Sound Speed Error

A general downward or upward across-track cupping in multibeam data, indicative of sound speed error, is present sporadically in the data set. The sound speed error adversely affected outer beams by up to 0.20 m in places. To minimize the error, sound speed profiles were collected every 2 hours during multibeam operations, and filters were used in processing to remove the outermost beams. The effect of sound speed error on final surfaces is relatively minor, normally not exceeding 0.10 m, and is within specifications.

Motion Artifact

Motion artifact is occasionally visible in the final multibeam surfaces. This is the result of uncompensated effects of motion, particularly due to roll. The primary contributer was motion induced on the survey vessels by poor sea states (often 1.5 m or greater), a common and unavoidable condition in this highly exposed area. A survey-grade Applanix POSMV 320 was used for motion compensation but residual error within the manufacturer specifications for the system remains nonetheless. The problem was addressed in processing by identifying lines with the greatest error and iteratively applying more aggressive outer beam filters, in some instances rejecting beams greater than 55 degrees either side of nadir. No adjustments to line spacing were made in acquisition to compensate for the rejected outer beam data because complete MBES coverage was not required. Following the additional filtering, the effect on the final surface is normally 0.25 m or less, which is within specifications.

Note that the ASV-CW5, at 3.5 m in length was a much smaller survey platform than the Q105 at 32 m in length, and therefore, experienced greater induced motion at the same sea states, resulting in more motion artifact for lines run simultaneously.

Tide Error

Although not as prevalent as in other sheets surveyed concurrently with this sheet, periodic vertical offsets or “busts,” indicative of tide error, is present sporadically in the data set. The majority of lines show good matchup with crosslines or adjacent lines, but busts of up to 0.2 m are occasionally present and attributable primarily to tide error.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: 2 hours

Sound speed profiles, or casts, were acquired aboard the Q105 while underway with an Oceanscience RapidCAST system, which utilized a Valeport sound speed profiler. The interval between subsequent casts was normally 2 hours. The sound speed sensor was lowered as close as possible to the seafloor, and then retracted to the vessel and downloaded. When surveying lines covering widely varying water depths, casts were favored in the deeper portions to ensure the entire water column was captured.

The ASV-CW5 vessel was not equipped to collect sound speed profiles. Instead, the profile data collected aboard the Q105 was used to correct all ASV-CW5 data. This was possible because the ASV-CW5 worked simultaneously and in close proximity (usually within 200 - 800 m) of the Q105 at all times.

Up and down portions of the profiles were averaged and a combined profile at a standardized 0.10 m depth increment was output to CARIS SVP format with time and position. Sound speed profiles were applied with the “nearest in distance within time” method in CARIS HIPS, with time set to 2 hours. Exceptions, if they occurred, are listed in section B.3 of this report.

B.2.8 Coverage Equipment and Methods

Refer to the DAPR, section B.2.4 "Data Coverage and Density," for details on the equipment, software, and methodology used to meet object detection, coverage, and data density requirements.

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

Corrections applied to echo soundings are detailed in the project DAPR. No deviations occurred, except those shown below. Note that despite exceptions, affected data is within specifications.

Sound speed exception: The following lines required correction for sound speed that was different than the project standard of nearest in distance within 2 hours.

Nearest in distance within 3 hours

0306-ASV-201-E4FS08_-_0002
0369-Q105-201-E4FS07_-_0001
0369-Q105-201-E4FS07_-_0002

Nearest in distance within 4 hours

0307-ASV-201-E4FS10_-_0001
0307-ASV-201-E4FS10_-_0002
0370-Q105-201-E4FS09_-_0001
0370-Q105-201-E4FS09_-_0002

Post-processed exception: The following lines did not receive application of post-processed POS data (TrueHeave or Delayed Heave, SBET, or SMRMSG), because no raw POS file was logged during acquisition. Real-time heave, positioning, and motion was used instead. For TPU computations, static values from the HVF were used in place of SMRMSG values.

0505-Q105-216-EXL21_-_0001
0505-Q105-216-EXL21_-_0002
0506-Q105-216-E2XL14_-_0001
0507-Q105-216-E2XL10_-_0001
0396-ASV-216-EXL22_-_0001
0396-ASV-216-EXL22_-_0002
0397-ASV-216-E2XL13_-_0001
0398-ASV-216-E2XL09_-_0001

B.3.2 Calibrations

Calibrations were undertaken as described in the DAPR. No deviations occurred.

B.4 Backscatter

Multibeam backscatter was logged at all times during this survey, but not processed. Raw DB and XTF files, submitted with the survey deliverables, contain the backscatter records.

B.5 Data Processing

B.5.1 Primary Data Processing Software

The following Feature Object Catalog was used: V5.4
There were no software configuration changes after the DAPR was submitted.

B.5.2 Surfaces

The following surfaces and/or BAGs were submitted to the Processing Branch:

Surface Name	Surface Type	Resolution	Depth Range	Surface Parameter	Purpose
H12948_MB_4m_MLLW_Final	CUBE	4 meters	0 meters - 80 meters	NOAA_4m	Set-spaced MBES
H12948_MB_2m_MLLW_Final	CUBE	2 meters	18 meters - 40 meters	NOAA_2m	Complete MBES
H12948_SSS_1m_100-E1	SSS Mosaic	1 meters	0 meters - 40 meters	N/A	100% SSS, block E1
H12948_SSS_1m_100-E2	SSS Mosaic	1 meters	0 meters - 40 meters	N/A	100% SSS, block E2

Table 9: Submitted Surfaces

The final depth information for this survey was submitted as two CARIS BASE surfaces (CSAR format) and two georeferenced SSS mosaic images, which best represented the seafloor at the time of the 2016 survey. The surfaces and images were created from fully processed data with all final corrections applied.

MBES Data:

The MBES surfaces were created using NOAA CUBE parameters and resolutions in conformance with the 2016 HSSD. Corridor (full coverage) area surfaces were generated in accordance with section 5.2.2.3 (Complete Coverage) while the set-spacing area surface was generated in accordance with section 5.2.2.4 (Set Line Spacing). Surfaces were finalized, and designated soundings were applied where applicable. Horizontal projection was selected as UTM Zone 3 North, WGS84. Note that a 1 m surface was not submitted because minimum depths in the complete coverage area were 20 m or greater.

Non-finalized versions of the CSAR surfaces are also included. These do not have the _Final designation in the filename.

File names for final surfaces was done in accordance with section 8.3.2 (Bathymetric Data) of the 2016 HSSD for MBES data.

SSS Data:

SSS mosaics were exported from SonarWiz as georeferenced TIFF images at 1 m resolution. These are projected as WGS84 UTM Zone 3N. A world file (.TFW) accompanies each TIFF image to provide the georeferencing.

SSS filenames are as specified in section 8.2.1, with the addition of an area or block designation at the end of filenames. Singular SSS images for this survey was not practical due to extremely large GeoTIFF file sizes that would result from combined images. Therefore, images were created by survey block, and the block name added as a suffix to the filenames.

For this survey, block "E1" denoted the north portion of the corridor area, while "E2" denoted the south portion of the corridor area.

Supplementary Data:

A CARIS HOB file was submitted (H12948_FFF.HOB) with the survey deliverables as well. The final feature file (FFF) contains meta-data and other data not readily represented by the final surfaces, including DTONs that were submitted previously during the course of the survey (if applicable), and bottom samples.

A CARIS HOB file containing SSS contacts (H12948_SSS_Contacts.HOB) was also submitted. This file contains significant contacts, if any, found during SSS review. Significant contacts were those identified in the SSS record as having height above the seafloor of 1 m, or greater, in depths less than 20 m, and heights of 10%, or greater, of water depth in depths 20 m and deeper. The 10% allowance is an exception granted for this project by NOAA (see correspondence) to the 5% requirement described in the 2016 HSSD. In this area, contacts were more common in deep water than in shallow water, and this exception was made to limit the number of contacts requiring multibeam development in deeper water, and therefore, facilitate the survey of additional areas over performing multibeam developments. This was considered acceptable given that vessels of 20 m draft are extremely unlikely to attempt transiting this area given its shoal approaches.

Each object is encoded with mandatory S-57 attributes, additional attributes, and NOAA Extended Attributes (V#5.4).

C. Vertical and Horizontal Control

Additional information discussing the vertical or horizontal control for this survey can be found in the accompanying HVCR.

C.1 Vertical Control

The vertical datum for this project is Mean Lower Low Water.

Traditional Methods Used:

TCARI

The following subordinate water level stations were established for this survey:

Station Name	Station ID
Nelson Island	9466298
Eastern Nunivak Island	9466012
Kipnuk	9465953
Offshore South Nunivak	9465683

Table 10: Subordinate Tide Stations

There was no Water Level file associated with this survey.

File Name	Status
r300kr2016_rev.tc	Final

Table 11: Tide Correctors (.zdf or .tc)

In addition to the subordinate tide station installed to support the project, submerged BMPG (bottom mounted pressure gauges) were also deployed throughout the survey area to capture zoning characteristics. These zoning gauges were used for QC purposes only. All data has been submitted to CO-OPS.

A final TCARI grid covering the survey area was issued on January 13th, 2017. However, the grid file was revised and reissued (filename "r300kr2016_rev.tc") on January 26th, 2017. This revised grid "r300kr2016_rev.tc" demonstrated better results in general and was applied to all data.

C.2 Horizontal Control

The horizontal datum for this project is WGS84.

The projection used for this project is UTM Zone 3N.

The following PPK methods were used for horizontal control:

Single Base

The project base continuously logged GPS data at 1 Hz and was utilized to post-process position data in Applanix POSPac MMS software. The Continually Operating Reference Station (CORS) site at Mekoryuk, station ID "AB08," was used for preliminary post-processing in the field, quality control checks for the project base station, and for final positions in rare instances where the project base station experienced outages. All real-time positions for both vessels were replaced in processing with post-processed kinematic (PPK) solutions, with few exceptions (noted if applicable earlier in this report).

Quality control confidence checks were performed at least weekly on the survey vessels as well as the base station position. RMS error estimates for positioning results were very good, with RMS error estimated at 0.10 m (or better). Refer to the project DAPR for additional details on quality control checks and results.

WAAS was used for real-time corrections in the field, but was replaced in post-processing with the PPK solution, as described in the DAPR.

Note: Final positions are WGS84 (instead of NAD83) per Section 2.1 of the 2016 HSSD, which was the governing guidance during the time of field operations.

The following user installed stations were used for horizontal control:

HVCR Site ID	Base Station ID
0056	Toksook Bay

Table 12: User Installed Base Stations

D. Results and Recommendations

D.1 Chart Comparison

The chart comparison was performed by examining all Raster Navigational Charts (RNCs) and Electronic Navigational Charts (ENCs) that intersect the survey area. The latest editions available at the time of the review (February 10th, 2017) were used.

The chart comparison was accomplished by overlaying the finalized BASE surfaces with shoal-biased soundings, and a final feature file on the charts in CARIS HIPS. The general agreement between charted soundings and survey soundings was then examined, and a more detailed comparison was undertaken for any shoals or other dangerous features. In areas where a large scale chart overlapped with a small scale chart, only the larger scale chart was examined. Results are shown in the following sections.

It is recommended that in all cases of disagreement, this survey supersedes charted data.

USCG Notice to Mariners (NM) and USCG Local Notice to Mariners (LNM) were checked for updates affecting the area. None were found that were issued subsequent to issuance date of the project instructions, nor prior to the completion of operations that affect the survey area.

D.1.1 Raster Charts

The following are the largest scale raster charts, which cover the survey area:

Chart	Scale	Edition	Edition Date	LNM Date	NM Date
16006	1:1534076	37	12/2015	01/17/2017	01/21/2017

Table 13: Largest Scale Raster Charts

16006

This survey fully intersects only a small number of charted soundings. Overall sounding agreement is good, within 1 fathom, with exceptions noted below:

1. Depth in the vicinity of charted 14 fathom sounding at 60-09-08 N, 165-19-02 W was found to be approximately 16 fathoms.

Agreement was also examined for significant trends. None was noted.

See included figure that shows soundings from this survey overlaid on chart 16006.

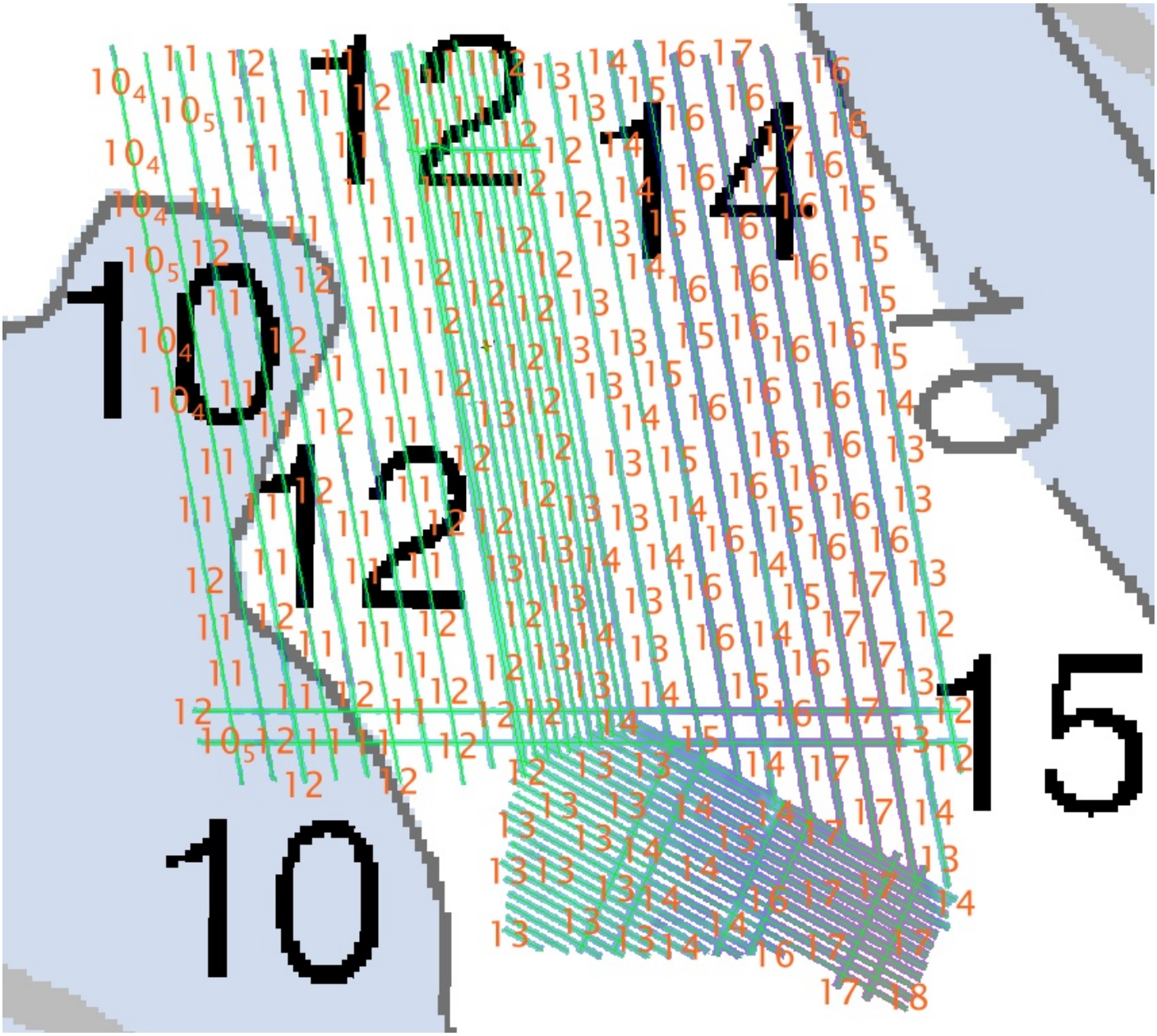

Figure 4: Soundings from this survey overlaid on chart 16006. Survey soundings (orange) are shown in fathoms and feet. Charted soundings (black) are shown in fathoms and fractional fathoms.

D.1.2 Electronic Navigational Charts

The following are the largest scale ENCs, which cover the survey area:

ENC	Scale	Edition	Update Application Date	Issue Date	Preliminary?
US2AK95M	1:1534076	4	08/29/2016	08/29/2016	NO

Table 14: Largest Scale ENCs

US2AK95M

The same differences observed for the RNC apply to the ENC.

D.1.3 Maritime Boundary Points

No maritime boundary points were assigned for this survey.

D.1.4 Charted Features

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

A 10 fathom sounding is labeled as "Rep (1984)" on chart 16006, at 60-07-39.3 N, 165-28-10.4 W. This survey found depths of 10 1/2 fathoms in the vicinity. Therefore, the "Rep." depth is generally correct. Recommend the "reported" notation be removed from the chart and soundings be updated to reflect this survey.

D.1.5 Uncharted Features

No uncharted features were found during this survey.

D.1.6 Dangers to Navigation

No DTONs were found during this survey.

D.1.7 Shoal and Hazardous Features

No shoals or hazardous features exist in the survey area.

D.1.8 Channels

No channels exist in the survey area.

D.1.9 Bottom Samples

Bottom samples were collected for this survey.

3 sample locations were assigned in the Project Reference File (PRF) supplied with the Work Instructions.

Samples were successfully obtained at all assigned locations. Samples returned a range of primary constituents, from fine black silt, to medium black cobbles, and broken black shells.

Samples were not retained. However, photos were taken of most samples prior to discarding. Bottom characteristics were encoded as SBDARE objects in the FFF, with any applicable photos in the accompanying "multimedia" directory, with the survey deliverables.

D.2 Additional Results

D.2.1 Shoreline

This survey did not intersect shoreline, and shoreline investigation was not assigned.

D.2.2 Prior Surveys

Comparison with prior surveys was not required. However, Junction analysis, described previously in this report, was undertaken for overlapping contemporary surveys.

D.2.3 Aids to Navigation

No ATONs were observed in the survey area, and none were assigned for investigation.

D.2.4 Overhead Features

No overhead features existed within the survey area.

D.2.5 Submarine Features

There are no submarine features of special note.

D.2.6 Ferry Routes and Terminals

Ferry routes and terminals do not exist within the survey area.

D.2.7 Platforms

Platforms do not exist within the survey area.

D.2.8 Significant Features

Any significant features and conditions encountered have been described previously.

D.2.9 Construction and Dredging

No construction or dredging was occurring within the survey extents, nor are there any known future plans for construction or dredging in the survey area.

D.2.10 New Survey Recommendation

No new surveys are recommended in this area.

D.2.11 Inset Recommendation

No new chart insets are recommended in this area.

E. Approval Sheet

Field operations contributing to the completion of survey H12948 were conducted under my direct supervision with frequent personal checks of progress, integrity, and adequacy.

This report, digital data, and all other accompanying records are approved. All records are respectfully submitted and forwarded for final review.

The survey data was collected in accordance with the project Work Instructions and Statement of Work, and meets or exceeds the requirements set in the 2016 NOS Hydrographic Surveys and Specifications Deliverables (HSSD) document. This data is adequate to supersede charted data in common areas. This survey is complete and no additional work is required with the exception of any deficiencies, if any, noted in this Descriptive Report. The Data Acquisition and Processing Report (DAPR) and Horizontal and Vertical Control Report (HVCR) were submitted concurrently with this report and the survey deliverables. Other significant required reports or data packages submitted separately, but not already described, are listed below.

Report Name	Report Date Sent
Coast Pilot Review (OPR-R300-KR-16_Coast Pilot Review Report)	2017-02-13
NCEI Sound Speed Data	2016-12-20
Trained Marine Mammal Observers Logsheet	2016-11-21
Marine Mammal Observation Logs	2016-11-17
Tides and Water Levels Package and Reports (one for each project tide station)	2016-10-21

Approver Name	Approver Title	Approval Date	Signature
Andrew Orthmann, C.H.	TerraSond Charting Program Manager	03/05/2017	

F. Table of Acronyms

Acronym	Definition
AHB	Atlantic Hydrographic Branch
AST	Assistant Survey Technician
ATON	Aid to Navigation
AWOIS	Automated Wreck and Obstruction Information System
BAG	Bathymetric Attributed Grid
BASE	Bathymetry Associated with Statistical Error
CO	Commanding Officer
CO-OPS	Center for Operational Products and Services
CORS	Continually Operating Reference Staiton
CTD	Conductivity Temperature Depth
CEF	Chart Evaluation File
CSF	Composite Source File
CST	Chief Survey Technician
CUBE	Combined Uncertainty and Bathymetry Estimator
DAPR	Data Acquisition and Processing Report
DGPS	Differential Global Positioning System
DP	Detached Position
DR	Descriptive Report
DTON	Danger to Navigation
ENC	Electronic Navigational Chart
ERS	Ellipsoidal Referenced Survey
ERZT	Ellipsoidally Referenced Zoned Tides
FFF	Final Feature File
FOO	Field Operations Officer
FPM	Field Procedures Manual
GAMS	GPS Azimuth Measurement Subsystem
GC	Geographic Cell
GPS	Global Positioning System
HIPS	Hydrographic Information Processing System
HSD	Hydrographic Surveys Division
HSSD	Hydrographic Survey Specifications and Deliverables

Acronym	Definition
HSTP	Hydrographic Systems Technology Programs
HSX	Hypack Hysweep File Format
HTD	Hydrographic Surveys Technical Directive
HVCR	Horizontal and Vertical Control Report
HVF	HIPS Vessel File
IHO	International Hydrographic Organization
IMU	Inertial Motion Unit
ITRF	International Terrestrial Reference Frame
LNM	Local Notice to Mariners
LNM	Linear Nautical Miles
MCD	Marine Chart Division
MHW	Mean High Water
MLLW	Mean Lower Low Water
NAD 83	North American Datum of 1983
NAIP	National Agriculture and Imagery Program
NALL	Navigable Area Limit Line
NM	Notice to Mariners
NMEA	National Marine Electronics Association
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NRT	Navigation Response Team
NSD	Navigation Services Division
OCS	Office of Coast Survey
OMAO	Office of Marine and Aviation Operations (NOAA)
OPS	Operations Branch
MBES	Multibeam Echosounder
NWLON	National Water Level Observation Network
PDBS	Phase Differencing Bathymetric Sonar
PHB	Pacific Hydrographic Branch
POS/MV	Position and Orientation System for Marine Vessels
PPK	Post Processed Kinematic
PPP	Precise Point Positioning
PPS	Pulse per second

Acronym	Definition
PRF	Project Reference File
PS	Physical Scientist
PST	Physical Science Technician
RNC	Raster Navigational Chart
RTK	Real Time Kinematic
SBES	Singlebeam Echosounder
SBET	Smooth Best Estimate and Trajectory
SNM	Square Nautical Miles
SSS	Side Scan Sonar
ST	Survey Technician
SVP	Sound Velocity Profiler
TCARI	Tidal Constituent And Residual Interpolation
TPE	Total Propagated Error
TPU	Topside Processing Unit
USACE	United States Army Corps of Engineers
USCG	United Stated Coast Guard
UTM	Universal Transverse Mercator
XO	Executive Officer
ZDA	Global Positiong System timing message
ZDF	Zone Definition File

APPROVAL PAGE

H12948

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 NCEI for archive

- H12948_DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records
- H12948_GeoImage.pdf

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

Approved: Digitally signed by Peter Holmberg
Reason: I am approving this document
Date: 2017.12.18 11:07:47 -08'00'

Peter Holmberg
Cartographic Team Lead, Pacific Hydrographic Branch

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

Approved: Digitally signed by HAUSER.OLIVIA.A.1275636009
Date: 2017.12.18 10:44:46 -08'00'

LCDR Olivia Hauser, NOAA
Chief, Pacific Hydrographic Branch