U.S. DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

HORIZONTAL AND VERTICAL CONTROL REPORT

Type of Survey Navigable Area

Project No. OPR-R341-KR-19

Time Frame June – October, 2019

LOCALITY

State Alaska

General Locality Kuskokwim Bay, AK

2019

CHIEF OF PARTY

ANDREW ORTHMANN

LIBRARY & ARCHIVES

DATE

Horizontal and Vertical Control Report

OPR-R341-KR-19

Kuskokwim Bay, AK & Vicinity

December 14th, 2019

Ishkowik Tide Station Shack

Project Name:	***Kuskokwim Bay, AK & Vicinity***
General Locality:	***Kuskokwim Bay, AK***
Sub Localities:	***H13246 – 29 NM SE of Kwigillingok*** ***H13247 – 28 NM SW of Kwigillingok*** ***H13248 – Kuskokwim River Approaches*** ***H13249 – Cape Mendenhall, Nunivak*** ***H13250 – Kwigillingok to Kongiganak Approaches*** ***H13251 – Kwigillingok to Kulvagavik*** ***F00770 – Cape Corwin, Nunivak***
Vessel(s):	***R/V Qualifier 105 and ASV C-Worker 5***
Field Unit:	***TerraSond Limited***
Lead Hydrographer:	***Andrew Orthmann***

A. Vertical Control

Mean lower low water (MLLW) was the vertical control datum for this survey. All soundings are referenced to MLLW.

All time measurements were made in Universal Time Coordinated (UTC). The local time zone was offset from UTC by eight hours (Alaska Daylight Time = UTC – 8 hours). No measurements were made using local time.

A.1. Tide Corrector Stations

The Tides Statement of Work required the installation of nine tide stations in a mix of offshore (submerged) as well as on-shore gauges. These were meant to support not only the hydrography collected during OPR-R341-KR-19, but to provide tide data across the Bristol Bay to Nunivak Island region.

The stations installed are summarized in the table below.

Tide Station (AK)	Station No.	Latitude (NAD83)	Longitude (NAD83)	Julian Days of Operation (2019)	Configuration
Port Moller	9463502	55-59-14.2 N	160-33-45.1 W	164 - 283	1 GNSS Buoy + 2 BMPG
Cape Pierce	9465137	58-37-36.8 N	161-50-10.4 W	178 - 267	1 BMPG + 1 RBR + 1 GNSS R
Naknek	9465203	58-43-55.4 N	156-59-00.0 W	197 - 292	2 Bubblers
Kulukak Point	9465265	58-50-22.1 N	159-38-58.8 W	178 - 266	1 BMPG + 1 RBR
Levelock	9465419	59-06-26.7 N	156-51-40.1 W	188 – 289	2 Bubblers
Ishkowik	9465993	60-01-05.8 N	162-44-16.4 W	160 - 257	2 Bubblers
Cape Mendenhall	AAAAAAA	59-50-19.6 N	166-02-49.3 W	186 - 271	2 BMPG
SW Kuskokwim Bay	BBBBBBB	59-17-33.0 N	163-41-27.0 W	182 - 270	2 BMPG
Cape Corwin	CCCCCCC	60-00-16.7 N	165-36-27.5 W	198 - 258	GNSS Buoy

Table 1 – Tide Stations

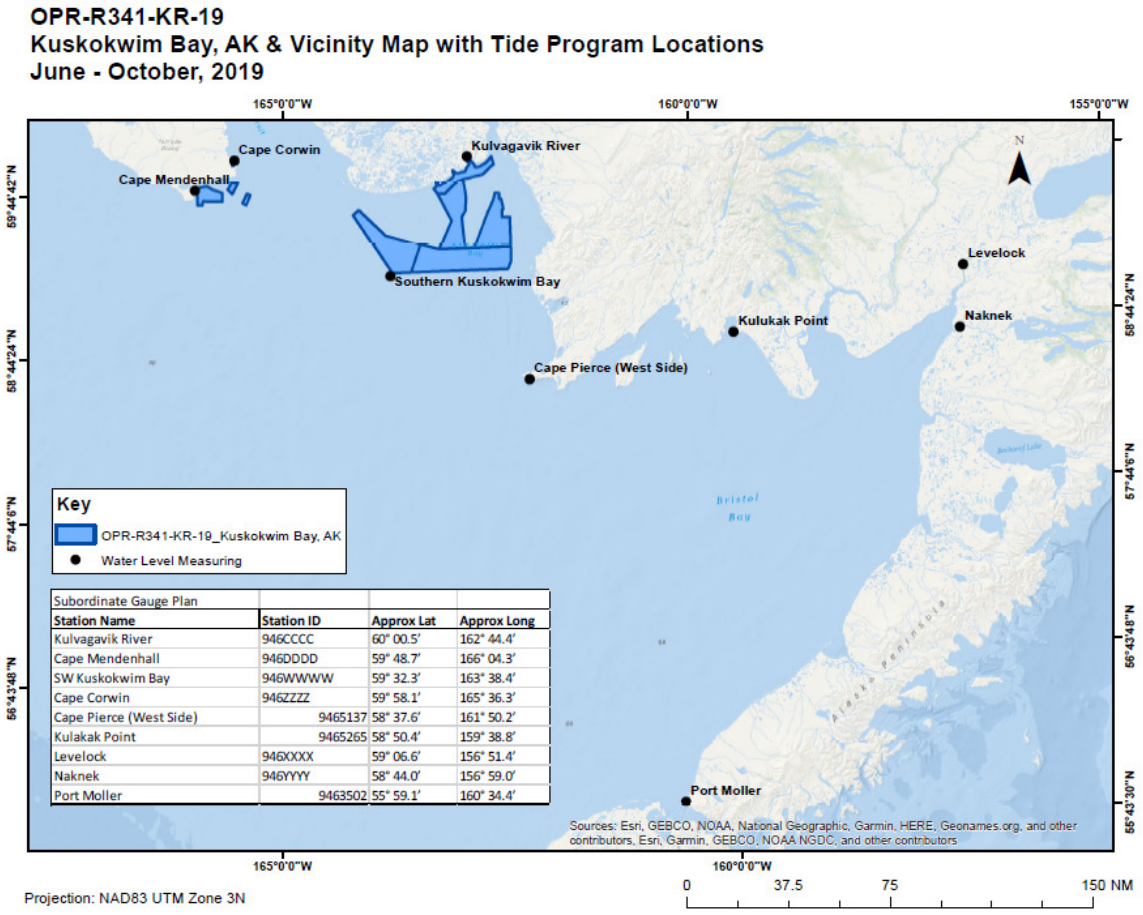

Figure 1 – Project overview including tide station locations (from Work Instructions).

TerraSond contracted JOA Surveys, LLC (JOA) for tide support. JOA handled all tasks associated with the on-shore gauges as well as processing of tide data, datum computations, providing smoothed/verified final tides, derivation of tide zones, and tide report compilation. TerraSond deployed and recovered all offshore tide stations as well as the GPS Buoy at Cape Corwin.

A.2. Tide Equipment

A wide range of tide and supporting equipment were utilized on this project. These are summarized in the table below. Refer to the tide reports in Appendix I for details on specific equipment at each site as well as processing of tide data.

Port Moller	9465302	NexSens	CB-150 buoy hull	Floatation of GNSS	Tide Gauge	N/A	N/A
Port Moller	9465302	Septentrio	PolaNt-x	GNSS Antenna	Tide Gauge	15531	N/A
Port Moller	9465302	Septentrio	PolaRx5	GNSS Reciever	Tide Gauge	3047773	N/A
Port Moller	9465302	Sea-Bird Scientific	SBE26+	Water Level Measurement	Tide Gauge	0219	4/16/2018
Port Moller	9465302	Sea-Bird Scientific	SBE26+	Water Level Measurement	Tide Gauge	0188	7/5/2018
Port Moller	9465302	Sea-Bird Scientific	4M	Conductivity Sensor	Conductivity	41924	6/22/2018
Port Moller	9465302	HOBO	U20	Barometer	Barometer	20183154	N/A
Cape Pierce	9465137	RBR	solo3D	Water Level Measurement	Tide Gauge	201780	5/13/2019
Cape Pierce	9465137	Sea-Bird Scientific	SBE26+	Water Level Measurement	Tide Gauge	1049	5/17/2019
Cape Pierce	9465137	Sea-Bird Scientific	SBE37SMP	Conductivity Sensor	Conductivity	03711494	5/30/2019
Cape Pierce	9465137	HOBO	U20L-04	Barometer	Barometer	2061872	N/A
Cape Pierce	9465137	Septentrio	Sepchoke	GNSS Antenna	Tide Gauge	5614	N/A
Cape Pierce	9465137	Septentrio	PolaRx5	GNSS Reciever	Tide Gauge	4502788	N/A
Naknek	9465203	DAA	H350XL	Water Level Measurement	Tide Gauge	1043	5/15/2019
Naknek	9465203	DAA	H350XL	Water Level Measurement	Tide Gauge	1353	N/A
Naknek	9465203	DAA	H-522	GOES Transmitter	Tide Gauge	N/A	N/A
Naknek	9465203	DAA	H-522	GOES Transmitter	Tide Gauge	1238	N/A
Naknek	9465203	DAA	H-355	Pump for DCP	Tide Gauge	5568	N/A
Naknek	9465203	DAA	H-355	Pump for DCP	Tide Gauge	1801	N/A
Kulukak Point	9465265	RBR	solo3D	Water Level Measurement	Tide Gauge	201779	5/13/2019
Kulukak Point	9465265	Sea-Bird Scientific	SBE26+	Water Level Measurement	Tide Gauge	0189	5/19/2019
Kulukak Point	9465265	Septentrio	Sepchoke	GNSS Antenna	Tide Gauge	5610	N/A
Kulukak Point	9465265	Septentrio	PolaRx	GNSS Reciever	Tide Gauge	3048310	N/A
Kulukak Point	9465265	Sea-Bird Scientific	SBE37SMP	Conductivity Sensor	Conductivity	013711496	5/22/2019
Kulukak Point	9465265	HOBO	U20L-04	Barometer	Barometer	20618763	N/A
Levelock	9465419	Sutron	Xpert	Water Level Measurement	Tide Gauge	N/A	N/A
Levelock	9465419	Sutron	Satlink	GOES Transmitter	Tide Gauge	N/A	N/A

Levelock	9465419	DAA	H-355	Pump for DCP	Tide Gauge	5593	N/A
Levelock	9465419	Paros	6000-30G	Water Level Measurement	Tide Gauge	100336	3/21/2019
Levelock	9465419	Sutron	Xpert	Water Level Measurement	Tide Gauge	N/A	N/A
Levelock	9465419	Sutron	Satlink	GOES Transmitter	Tide Gauge	N/A	N/A
Levelock	9465419	DAA	H-355	Pump for DCP	Tide Gauge	5598	N/A
Levelock	9465419	Paros	6000-30G	Water Level Measurement	Tide Gauge	121287	3/21/2019
Ishkowik River Entrance	9465993	DAA	350XL	Water Level Measurement	Tide Gauge	1635	3/22/2019
Ishkowik River Entrance	9465993	DAA	H-222	GOES Transmitter	Tide Gauge	3804	N/A
Ishkowik River Entrance	9465993	DAA	H355	Pump for DCP	Tide Gauge	2877	N/A
Ishkowik River Entrance	9465993	DAA	350XL	Water Level Measurement	Tide Gauge	5449	3/29/2019
Ishkowik River Entrance	9465993	DAA	H-222	GOES Transmitter	Tide Gauge	1085	N/A
Ishkowik River Entrance	9465993	DAA	H355	Pump for DCP	Tide Gauge	2869	N/A
Cape Mendenhall	AAAAAAA	Sea-Bird Scientific	SBE26+	Water Level Measurement	Tide Gauge	1155	4/28/2019
Cape Mendenhall	AAAAAAA	Sea-Bird Scientific	SBE37SMP	Conductivity Sensor	Conductivity	037-11493	5/31/2019
Cape Mendenhall	AAAAAAA	Sea-Bird Scientific	SBE26+	Water Level Measurement	Tide Gauge	1156	4/28/2019
Cape Mendenhall	AAAAAAA	AML	Cxchange	Conductivity Sensor	Conductivity	450408	N/A
Cape Mendenhall	AAAAAAA	AML	Txchange	Conductivity Sensor	Conductivity	450408	N/A
Cape Mendenhall	AAAAAAA	HOBO	U20	Barometer	Barometer	20599096	N/A
SW Kuskokwim Bay	BBBBBBB	Sea-Bird Scientific	SBE26+	Water Level Measurement	Tide Gauge	1158	4/28/2019
SW Kuskokwim Bay	BBBBBBB	Sea-Bird Scientific	SBE37SMP	Conductivity Sensor	Conductivity	037-11495	4/11/2018
SW Kuskokwim Bay	BBBBBBB	Sea-Bird Scientific	SBE26+	Water Level Measurement	Tide Gauge	1120	4/28/2019
SW Kuskokwim Bay	BBBBBBB	AML	Cxchange	Conductivity Sensor	Conductivity	450425	N/A
SW Kuskokwim Bay	BBBBBBB	AML	Txchange	Conductivity Sensor	Conductivity	450425	N/A
SW Kuskokwim Bay	BBBBBBB	HOBO	U20	Barometer	Barometer	N/A	N/A
Cape Corwin	CCCCCCC	Septentrio	AsteRx-SB	GNSS Reciever	Tide Gauge	5101175	N/A
Cape Corwin	CCCCCCC	Septentrio	PolaNT-x MF	GNSS Antenna	Tide Gauge	15531	N/A

A.3. Tide Correctors

Tidal corrections for hydrography was accomplished using ERS methodology. The NAD83 to MLLW grid file "R341KR2019_ERTDM_NAD83-MLLW.csar" provided by NOAA was used for all corrections. The grid file has an estimated uncertainty of 0.13 m at one standard deviation. Refer to the DRs for correspondence relating to this grid file.

A.4. Tide Comparisons

For comparison purposes, an Ellipsoid Referenced Zoned Tide (ERZT) model was computed in CARIS HIPS for each survey using tide zones generated by JOA that utilized all project tide stations. This ZDF ("OPRR341KR19_20191208b.zdf") is included with the survey deliverables.

This ERZT separation model was created at a 100 m resolution in CARIS CSAR format using all available survey lines. The ERTDM separation model was then differenced from the ERZT model in CARIS, and the results were analyzed. A summary of the results is shown in the following table.

Survey	ERZT minus ERTDM Mean Difference*	1 StDev
F00770	0.044	0.023
H13246	0.057	0.227
H13247	-0.054	0.131
H13248	0.242	0.349
H13249	-0.350	0.094
H13250	0.127	0.280
H13251	0.232	0.260
Combined	**0.033**	**0.271**
**A positive difference means the ERZT separation value is larger*		

Table 2 – ERZT versus ERTDM comparison results

There is generally good agreement between the ERZT and ERTDM separation models. Their project-wide agreement is 0.033 m on average with a standard deviation of 0.271.

Of the individual survey areas, H13246 and H13247, at 0.057 and -0.054 average agreement respectively, have the best agreement between the models. These two sheets are the furthest offshore of the seven in the project.

The worst agreement is in H13249 at -0.350. This sheet has a more complicated tidal regime and it is likely zoned water levels do not capture tidal change as well as the other sheets.

Greater than 95% of all grid cells agree within allowable TVU for their depth.

Refer to Appendix II for JOA's "Vertical Control Analysis Report", which contains an analysis of the tidal data as well as the tide comparisons for each survey. The ERTDM separation model is available with the survey deliverables.

B. Horizontal Control

The horizontal control datum used for this survey was NAD83 (2011). All final positions are NAD83 (2011).

Vessel positions were post-processed. Corrections for post-processing were supplied primarily by the Trimble PP-RTX service in Applanix POSPac post-processing software, supplemented by Applanix Smart Base (ASB) network solutions when necessary. QC reports generated by the POSPac software are included in Appendix III.

Real-time positions were provided by a Hemisphere Atlas SmartLink antenna on the ASV-CW5. The Atlas system was configured to receive L-band SBAS corrections using Hemipshere's H10 subscription service, which provided RTK level corrections. Real-time correctors on the Q105 utilized FAA WAAS. Note that all real-time corrections were replaced in post-processing.

Refer to the DAPR for details on positioning results and methodology.

Vessel position confidence checks were performed by comparing PPRTX and ASB results. These checks are available with each DR.

Correspondence relating to tides and confidence checks on vessel positioning are available with the project DRs.

Post-processed positioning data and GPS processing files are available with the survey deliverables.

APPROVAL SHEET

For

Horizontal and Vertical Control Report: F00770 and H13246 through H13251

This report and the accompanying digital data are respectfully submitted.

Field operations contributing to the completion of this project 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 and Project Work Instructions. Other reports submitted with this survey include the Descriptive Report (one for each survey sheet) and the Data Acquisition and Processing Report.

This survey is complete and adequate for its intended purpose.

Andrew Orthmann

Digitally signed by Andrew Orthmann
Date: 2019.12.14 14:54:24 -09'00'

Andrew Orthmann
NSPS/THSOA Certified Hydrographer (2005), Certificate No. 225
Charting Program Manager
TerraSond Limited