W00707

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

DESCRIPTIVE REPORT

Type of Survey:	Basic Hydrographic Survey
Registry Number:	W00707

LOCALITY

State(s):	Alaska
General Locality:	Pribilof Islands
Sub-locality:	St George Island

2018

CHIEF OF PARTY
Jack Grunder, USACE JALBTCX

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

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

W00707

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(s):	**Alaska**
General Locality:	**Pribilof Islands**
Sub-Locality:	**St George Island**
Scale:	**20000**
Dates of Survey:	**08/20/2018 to 08/27/2018**
Instructions Dated:	**N/A**
Project Number:	**ESD-AHB-23**
Field Unit:	**eTrac**
Chief of Party:	**Jack Grunder, USACE JALBTCX**
Soundings by:	**R2Sonic 2022 MBES and Riegl VZ400 Laser Scanner**
Imagery by:	**N/A**
Verification by:	**Atlantic Hydrographic Branch**
Soundings Acquired in:	**meters at Mean Lower Low Water**

Remarks:

Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of survey data is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/. Products created during office processing were generated in NAD83 UTM 2N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

DESCRIPTIVE REPORT MEMO

January 10, 2024

MEMORANDUM FOR: john.b.grunder@usace.army.mil

FROM: Report prepared by AHB on behalf of field unit
Jack Grunder
PLS, U.S. Army Corps of Engineers, Alaska District, USACE
JALBTCX

SUBJECT: Submission of Survey W00707

Multibeam Bathymetric and Topographic LiDAR survey along the shoreline to the north and west of the city of St. George located on St. George Island, Alaska.

There were no products created for this survey.

All soundings were reduced to Mean Lower Low Water using ERZT. The horizontal datum for this project is North American Datum of 1983 (NAD 83). The projection used for this project is Universal Transverse Mercator (UTM) Zone 2.

The data obtained was an XYZ file in State Plane Alaska Zone 9, MLLW, US survey feet. The data was converted to NAD83 (2011) UTM 2N using the Vdatum tool. Depths were converted to meters via the Caris Info file upon import into BDB.

There was no DAPR for this project.

All data were reviewed for DTONs and none were identified in this survey.

USACE JALBTCX acquired the data outlined in this report. Additional documentation from the data provider may be attached to this report.

ETrac summary report added to the end of this DR Memo.

This survey does meet charting specifications and is adequate to supersede prior data.

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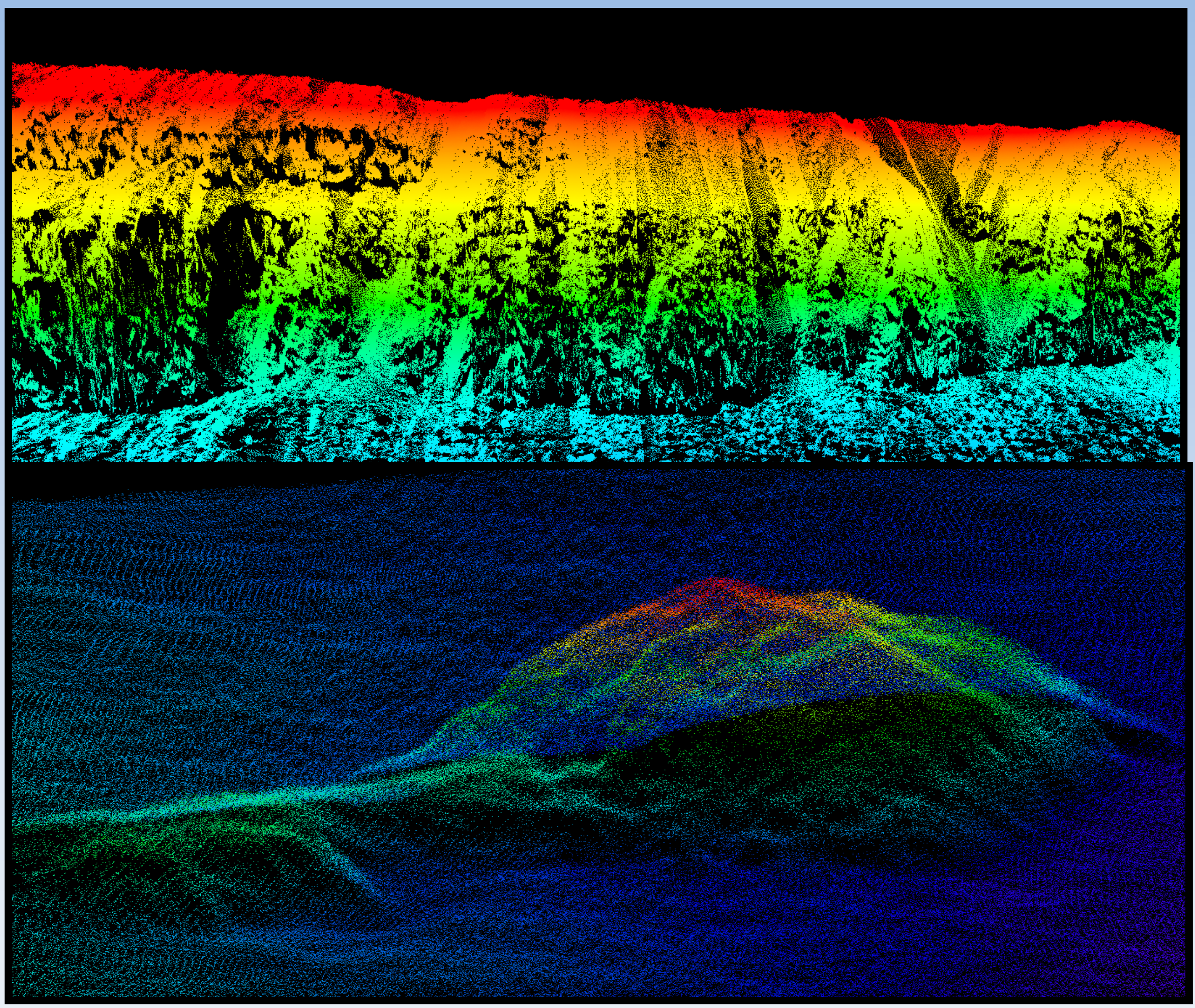
Wasilla, AK 99654

p: (415) 462-0421
F: (415) 480-2032
www.etracinc.com

STG001 – St. George Harbor

Multibeam Bathymetric and Topographic LiDAR Survey

St. George, Alaska



SUMMARY REPORT

Prepared for: R&M Consultants, Inc.

Attn: Dave Hale, PLS.
9101 Vanguard Dr.
Anchorage, Alaska 99507

Survey Period – August 19-28, 2018

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FIGURES AND TABLES

1. EXECUTIVE SUMMARY

On August 20 and August 27, 2018 eTrac Inc. completed a high-resolution Multibeam Bathymetric and Topographic LiDAR Survey along the shoreline to the north and west of the city of St. George located on St. George Island, Alaska.

Vertical and Horizontal control was provided by R&M Consultants.

Within the survey limits, depths in the bathymetry data ranged from -70ft to a least safely navigable depth of -7ft MLLW. LiDAR data showed elevations from +1ft to approximately +115ft MLLW. No *Obstructions to Navigation* larger than 2ft in any one dimension were located.

From August 21 to August 26, the project was placed on weather hold. eTrac attempted data collection when possible but were turned around on several occasions due to rough conditions. Seas during this time varied from 5-15 ft with winds up to 35 kt.

2. ABBREVIATIONS

°	Degree(s)
°F	Degree(s) Fahrenheit
3D	Three Dimensional
CMR (+)	Compact Measurement Record
CORS	Continuously Operating Reference Station
Ft	Feet
GLONASS	GLObal NAvigation Satellite System (Russia)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System (U.S.A)
Hz	Hertz
IHO	International Hydrographic Organization
LiDAR	Light Detection and Ranging
MBES	Multibeam Echosounder System
MTLS	Mobile Terrestrial Laser Scanning
MLLW	Mean Lower Low Water
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NOAA	National Oceanic Atmospheric Administration
OPUS	Online Positioning User Service
POSMV	Position and Orientation System for Marine Vessels
PPK	Post Processed Kinematic
QA	Quality Assurance
QC	Quality Control
QPS	Quality Positioning Systems
RTK	Real Time Kinematic
SBET	Smoothed Best Estimate of Trajectory
SV	Sound Velocity
USM	Universal Sonar Mount
VOOP	Vessel of Opportunity

3. INTRODUCTION

eTrac Inc., acting as a subcontractor for R&M Consultants under Contract No. W911KB-16-D-0007, performed a Multibeam Bathymetric and Topographic LiDAR Survey in St. George, AK. The project area was located on the north side of St. George Island, northwest of the village. The project location is shown below in Figure 1.

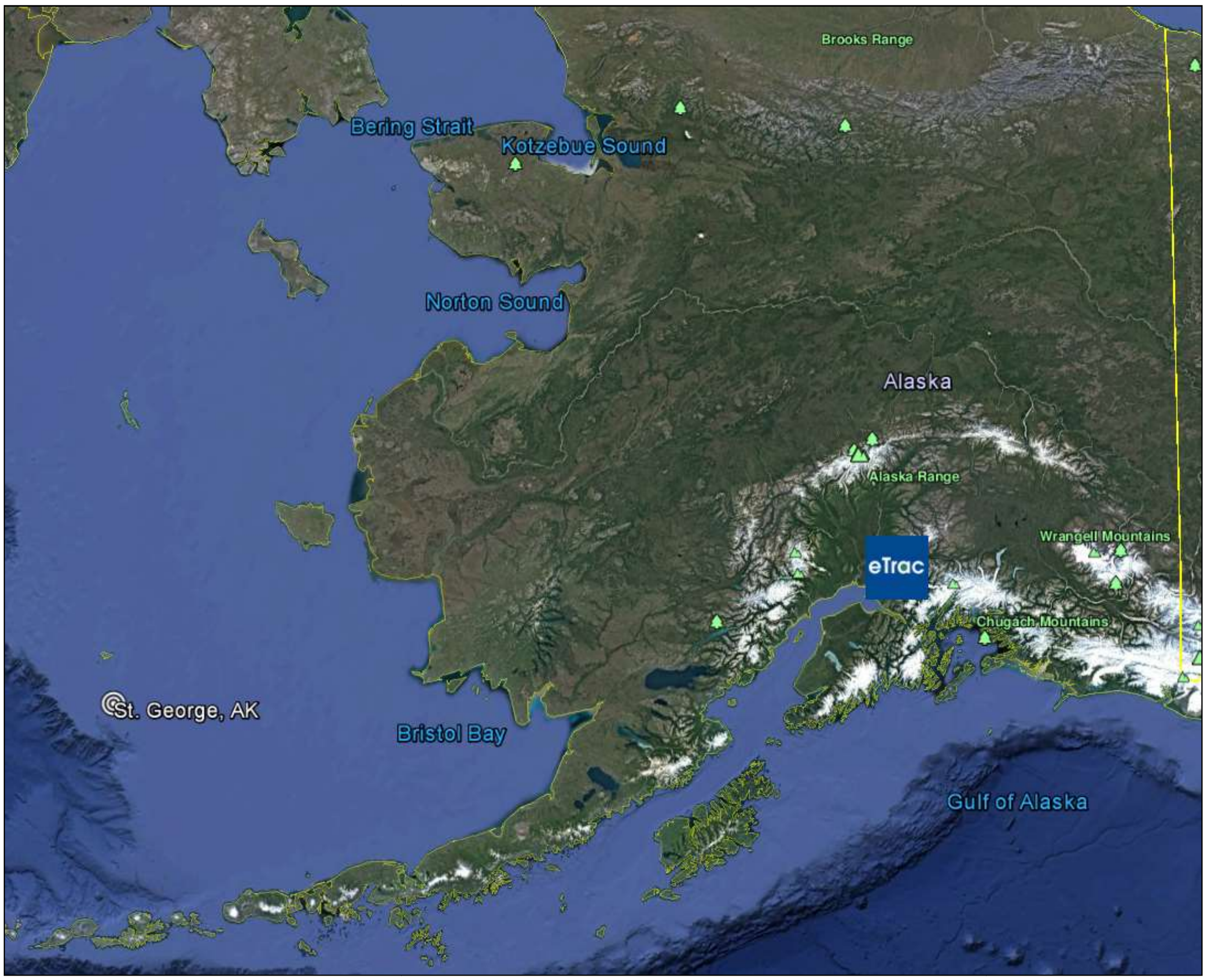

Figure 1 Project Location

The survey limits, supplied by USACE, can be seen below in Figure 2.

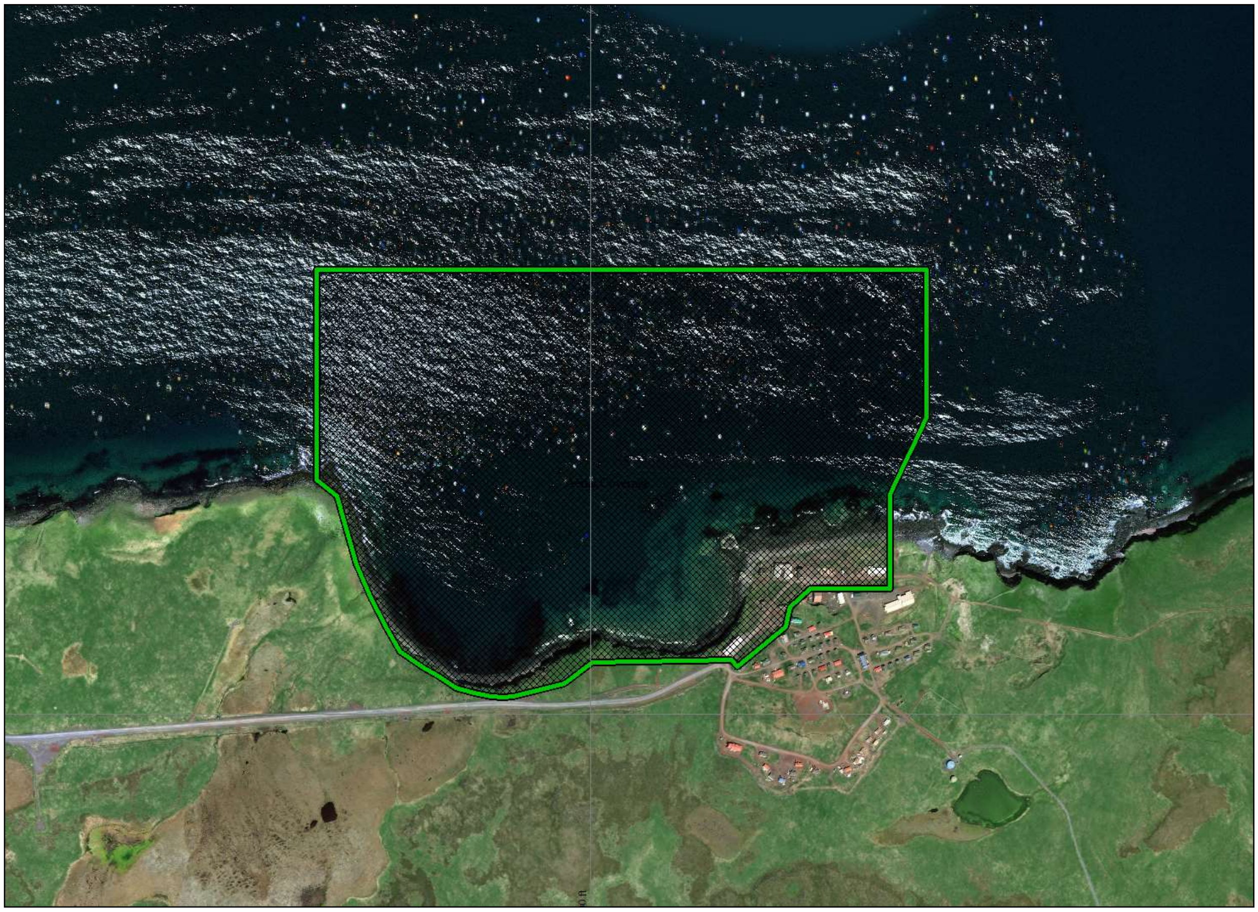

Figure 2 St. George Survey Limits

The major tasks associated with the survey are described below:

- Complete a full-coverage Multibeam Bathymetric Survey within the provided survey limits
- Complete a full-coverage Topographic LiDAR Survey within the provided survey limits
- Located any obstruction on the subsea surface greater than 2ft in any one dimension

4. METHODOLOGY

a. MOBILIZATION

All work was completed onboard a local Vessel of Opportunity (VOOP) named *WaveDancer*. The vessel was a single-engine, 28ft Aluminum Bowpicker. A positioning and motion detection system was installed on the vessel with a long antenna base allowing for maximum heading accuracy and better results in areas with low GNSS coverage.

Figure 3 Local Vessel of Opportunity – 28ft Bowpicker, *WaveDancer*

The survey equipment was mounted to a portable Universal Sonar Mount (USM) Expeditionary kit, a specially engineered mounting system for vessels of opportunity. The Expeditionary Kit was used to house the R2Sonic 2022 MBES, POSMV Wavemaster V5 INS, and the Riegl VZ400 Laser Scanner with fixed and repeatable lever arms and mounting angles. The complete setup can be viewed below in Figure 4.

Figure 4 eTrac VOOP with mounted with R2Sonic 2022 & Riegl VZ-400

b. GEODESY

All data was collected in reference to NAD83 (2011) Epoch 2010.00, State Plane, Alaska Zone 9, U.S. Survey ft. Horizontal control was established by R&M Consultants and provided to eTrac Inc. for the Hydrographic and Topographic Survey.

The vertical datum for the project is Mean Lower Low Water (MLLW), U.S. Survey Feet. Vertical control was established by R&M Consultants by holding the published MLLW elevation of *3885 E* (39.09ft) from NOAA Tidal Station *946 3885, Zapadni Bay, St. George Island, Pribolof Island, Alaska* published April 05, 1995.

In Table 1 below, the R&M provided control coordinates were held as fixed for data acquisition and processing.

R&M Provided Control Coordinates			
Name	**Northing**	**Easting**	**Elevation**
STG 4	949,985.00	1,729,774.68	103.68
STG 5	950,098.32	1,728,253.35	79.19

Table 1 R&M Provided Horizontal and Vertical Control Points

Prior to, and post data collection, Real Time Kinematic (RTK) check-in observations of a second benchmark were acquired in order to verify the base station setup.

c. ACQUISITION

Multibeam data was acquired August 20 and August 27, 2018. All multibeam data and positioning of the vessel data was acquired in QINSy software. Vessel positioning data was logged in POSView software. Real-time sound velocity was measured and monitored at the MBES and SV profiles of the water column were taken throughout the survey area. Changes in the sound velocity were accounted for with frequent sound velocity casts. An overview of the survey area can be seen below in Figure 5 and Figure 7.

Multibeam data acquisition was limited in the shallows due to a number of factors including the presence of an active fur seal rookery, dense kelp, and unfavorable weather. The western portion of the survey area is an active fur seal rookery, which was being monitored by representatives of the National Marine Fisheries Service (NMFS), who advised eTrac to remain at least 300ft from the shore along the active rookery. Bull kelp was present throughout the shallow portions of the survey area and was most dense around the rocky point in the eastern portion of the survey area. During survey acquisition, the kelp repeatedly clogged the cooling intakes of the vessel's sole outboard motor, requiring the crew to stop and manually clear the obstruction. Repeated instances of clogging and overheating impeded survey progress in the dense kelp patches. The final factor was the wind and swell within the survey area. Breaking waves in the surf zone combined with an uneven rocky terrain prevented the safe acquisition of data shallower than -7 ft MLLW.

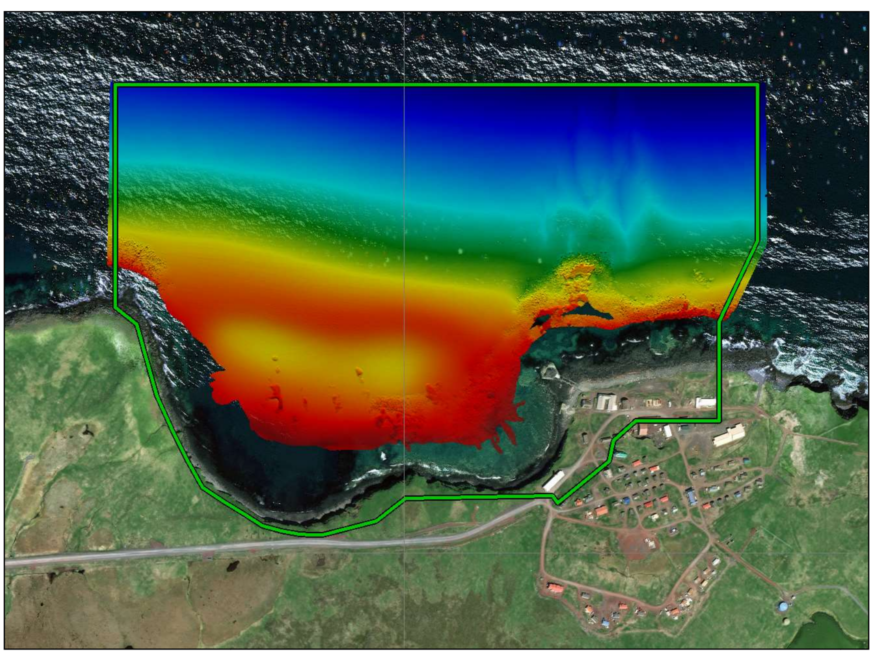

Figure 5 Overview of MBES Data

A Mobile Terrestrial Laser Scanning (MTLS) Survey was conducted August 27, 2018. All MTLS data and positioning of the vessel data was acquired in QINSy software. Vessel positioning data was logged in POSView software. MTLS data was focused on areas where acquisition by multibeam was not possible. Data collection was performed while vessel speed and attitude were kept at minimum to reduce errors associated with motion. An overview of the data can be seen below in Figure 6 and Figure 7.

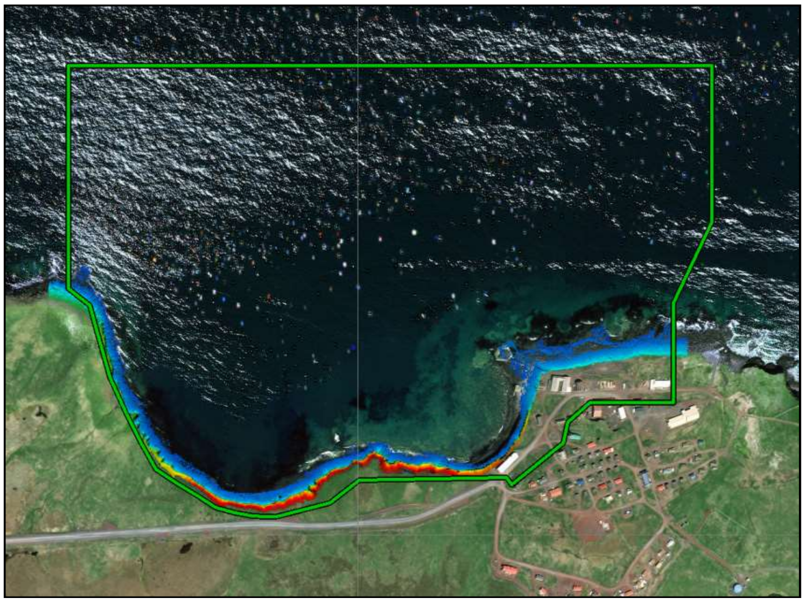

Figure 6 Overview of MTLS Data

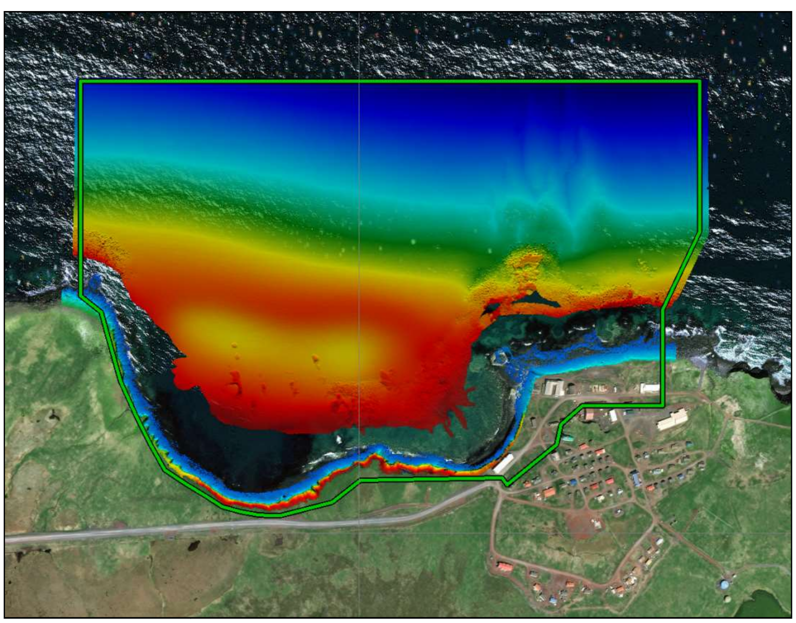

Figure 7 Overview of MBES & MTLS Data

d. EQUIPMENT

The vessel was mobilized with a POS MV WaveMaster, R2Sonic 2022 high-resolution wideband multibeam echo sounder (MBES), Riegl VZ-400 3D Terrestrial Scanner, AML Base X, and a combination of Trimble Receivers, Radios, and Controllers were used for this project.

i. Positioning System

A POS MV WaveMaster V5 (Figure 8) was used to provide accurate attitude, heading, heave position and velocity data for the survey vessel. The POS MV WaveMaster blends GNSS data with angular rate and acceleration data from an IMU and heading from the GNSS Azimuth Measurement Subsystem (GAMS) to produce a robust and accurate full six degrees-of-freedom position and orientation solution.

Figure 8 POS MV WaveMaster V5

Specification Details

Position Accuracy, Horizontal: +/-(10mm + 1 ppm x baseline length)
Position Accuracy, Vertical: +/-(20mm + 1 ppm x baseline length)
Roll and Pitch Accuracy: 0.03° Post processed to 0.015°
Heading Accuracy: 0.03°
Heave Accuracy: 5 cm

ii. Multibeam Echo Sounder

The subsea surface was surveyed using a R2 Sonic 2022 (Figure 9). The 2022 utilizes 256 discrete beams with a maximum swath width of 160°. The system was operated at 400 kHz with a 120° swath width which provided the highest quality and allowed for the best imagery of the seabed.

Figure 9 R2Sonic 2022

<u>Specification Details</u>

Frequency: 200-400 kHz
Bandwidth: Up to 60 kHz
Beamwidth: 256 discrete 1 ° x 1° (at 450 kHz)
Swatch Sector: Up to 160° (Run at 120°)
Ping Rate: Up to 60 Hz

iii. 3D Terrestrial Laser Scanner

The surface above water level was mapped using a Riegl VZ-400 3D Terrestrial Laser Scanning Unit (Figure 10). The VZ-400 uses a narrow infrared laser beam and fast scanning mechanism to provide a measurement rate of up to 122,000 measurements per second.

Figure 10 Riegl VZ-400 Laser Scanner

<u>Specification Details</u>

Frequency: 300 kHz (High Speed Mode)
Measurement Rate: 122,000Hz (High Speed Mode)
Range: 350 meters (High Speed Mode)
Scan Angle Sector: 100°
Accuracy / Precision: 5mm / 3mm

iv. Sound Velocity

Sound velocity profiles were obtained at pre-planned intervals during all surveys to adjust the computation of MBES and ranging of data due to speed of sound variation in the water column. Sound velocity profiles were acquired using an AML Base X Sound Velocity Profiler seen below in Figure 11.

Figure 11 AML Base X Sound Velocity Profiler

<u>Specification Details</u>

Depth Range: up to 100 meters
Sound Velocity Range: 1375 to 1625 m/s
Sound Velocity Precision (+/-): 0.006 m/s
Sound Velocity Accuracy (+/-): 0.025 m/s
Sound Velocity Resolution: 0.001 m/s
Pressure Range: Up to 6000 dBar

v. Horizontal and Vertical Control

Horizontal and Vertical Control for the duration of the MBES Survey was established using a Trimble R8 Model 3 Receiver (Primary Base), a Trimble R8 Model 2 Receiver (Backup Base), and (2) Trimble Trimmark III Radios. Figure 12 and Figure 13 below show examples of a typical set up.

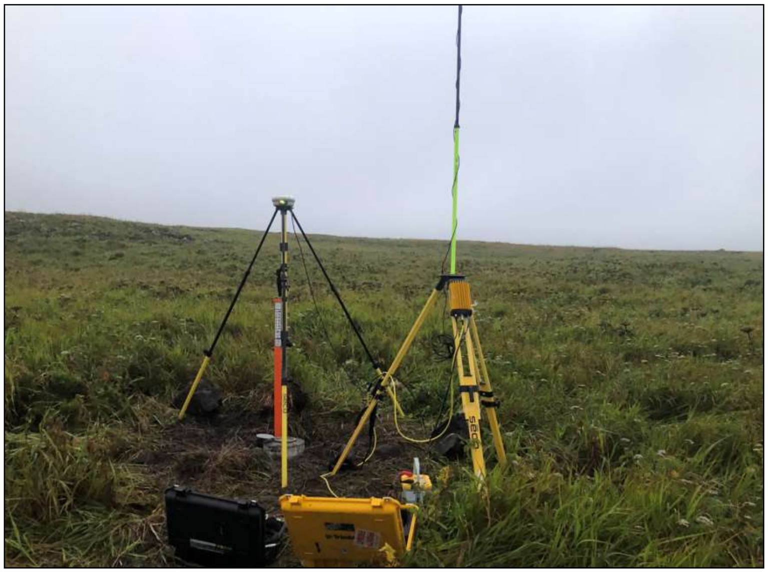

Figure 12 Trimble R8 Model 3 Receiver as a Base Station at "STG-4"

Figure 13 Trimble R8 Model 2 Receiver as a Backup Base at "STG-5"

e. PROCESSING and ANALYSIS METHODS

i. Vessel Position Data

Position data was post-processed in Applanix POSPac MMS Inertial processing software using both the vessel data file and receiver file (RINEX). This allowed the creation of a more accurate and robust Smoothed Best Estimate of Trajectory (SBET) solution which was applied to the MBES and MTLS data for positioning corrections and horizontal and vertical control throughout the duration of the surveys. Prior to applying corrections, the SBET was analyzed for errors as seen below in Figure 14. After the data was analyzed for errors, the full motion and position solution of the SBET was applied to both datasets to maximize overall accuracy.

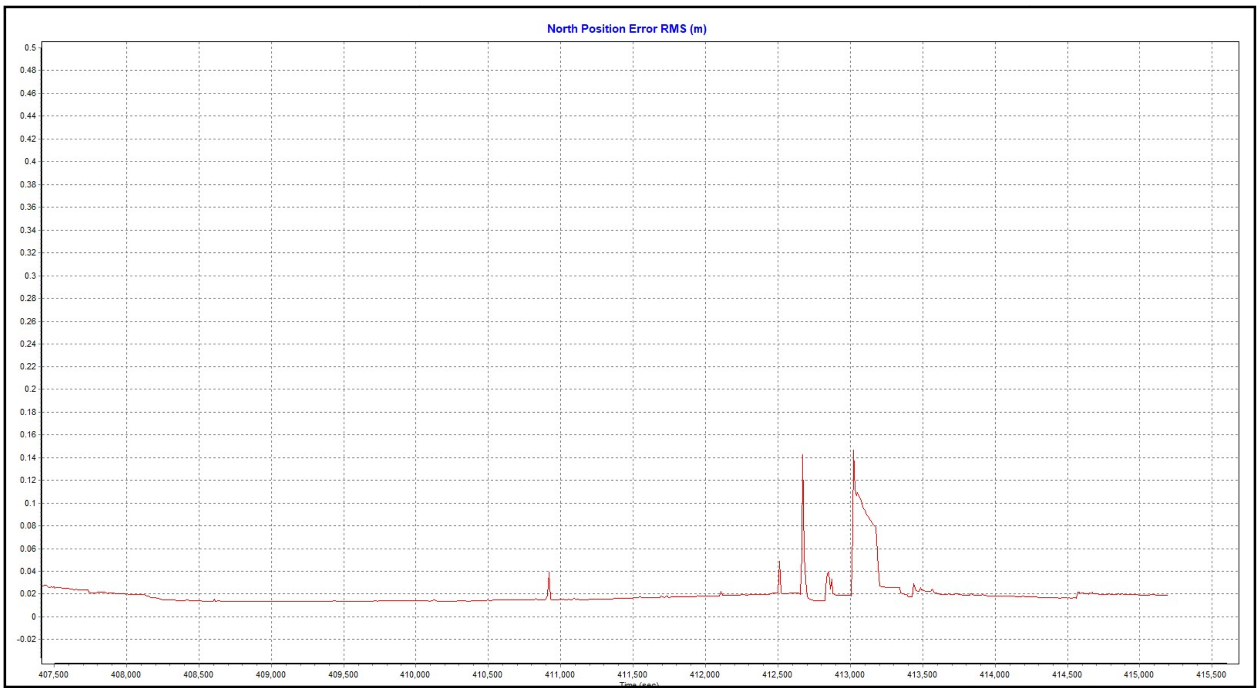

Figure 14 Typical North Position Error for the MBES Surveys

ii. Multibeam Bathymetry Data

All MBES bathymetry data was processed in Qimera. The position SBET was applied to the data. Data was then cleaned of spurious soundings caused by noise in the water column. Sound velocity corrections were checked and further processed where a more appropriate cast to that which was used online, was found in processing.

Multibeam data was analyzed in both a 3D point cloud environment, which showed the full sounding data, as well as being down sampled as a gridded dataset. This gives the ability to fully analyze features and environments. The gridded dataset gives a representation of the general bathymetry. Depths and geological features can be understood by looking at the grid in a 3D environment. Figure 15 shows a 3D view from the software used to view the bathymetry data to look for geological features and understand depths.

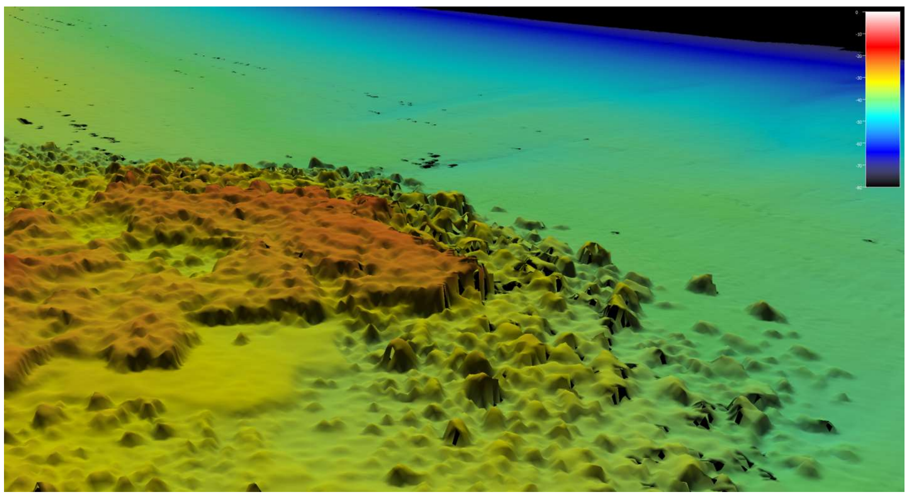

Figure 15 Typical Bathymetry gridded surface in 3D environment (5x vertical exaggeration)

Data was gridded at the highest resolution that the data coverage allowed. The resulting grid cell size was 1.5ft. A view of the full-density point cloud data can be seen below in Figure 16.

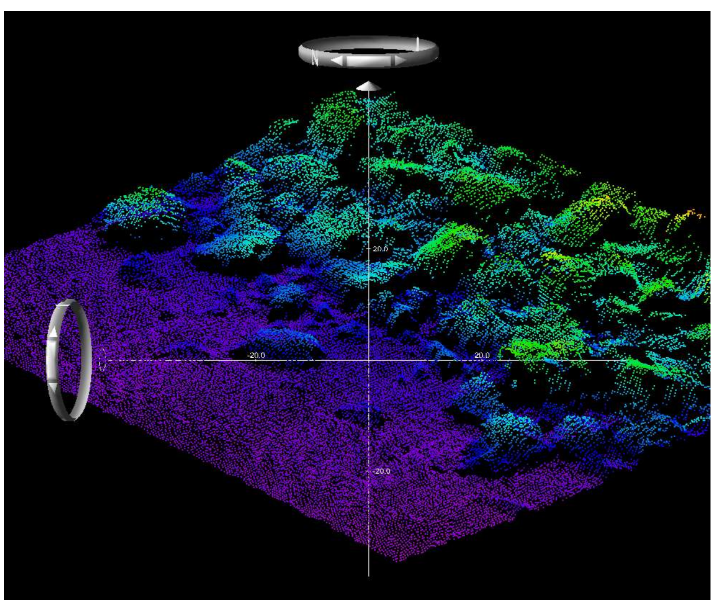

Figure 16 Point cloud of MBES data (3x vertical exaggeration)

iii. Mobile Terrestrial Laser Scanning Data

All MTLS data was processed in QINSy, Qimera, and RiScan Pro. A post-processed trajectory solution was computed using Applanix PosPac, which supplied a Post-Processed Kinematic (PPK) solution using the full 200 Hz update rate from the IMU. After initial application of the PPK trajectory, a "bore-sight" calibration was performed using specific pairs of lines collected during survey operations. The Pre- and Post-Calibration can be seen below in Figure 17 and Figure 18.

A "bore-sight" calibration is the MTLS equivalent to a hydrographic "patch test" in which the misalignment angles between a scanner and the IMU is determined. During the survey, specific planned lines are run along fixed objects such as piers, navigation aids, or flag poles. Based on various vessel and scanner orientations, each of the three misalignment angles (Roll, Pitch, and Yaw) can be isolated and corrected.

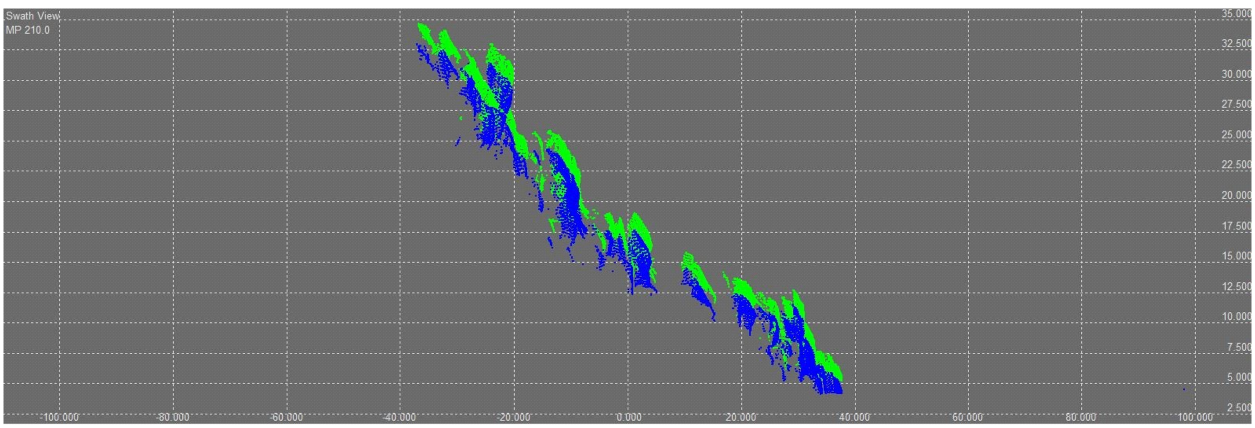

Figure 17 Pre-Boresight Calibration

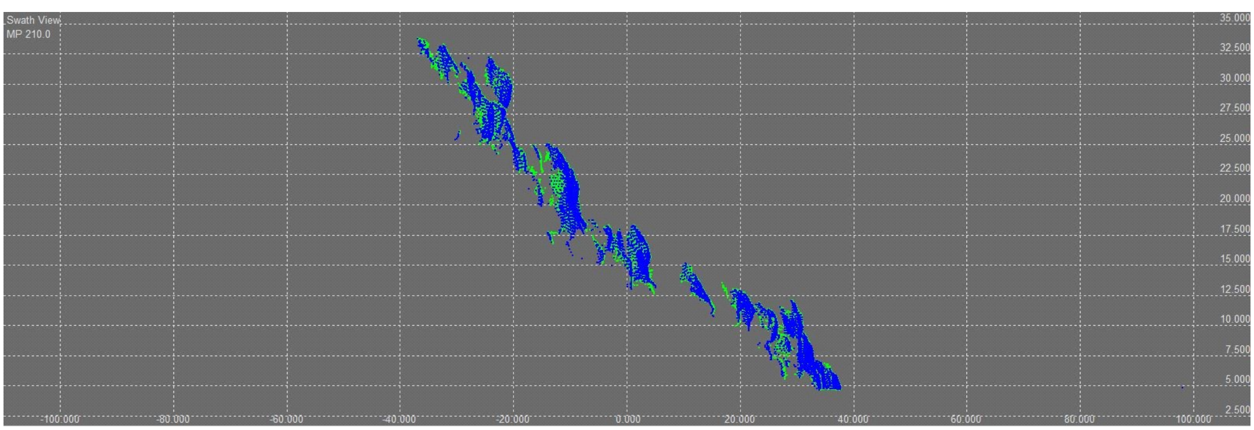

Figure 18 Post-Boresight Calibration

MTLS data was analyzed in a 3D point cloud environment, which showed the full sounding dataset. This gives the ability to fully analyze features and environments. Geological features are better understood by looking at the dataset in a 3D environment. Figure 19 and Figure 20 show 3D views from RiScan Pro.

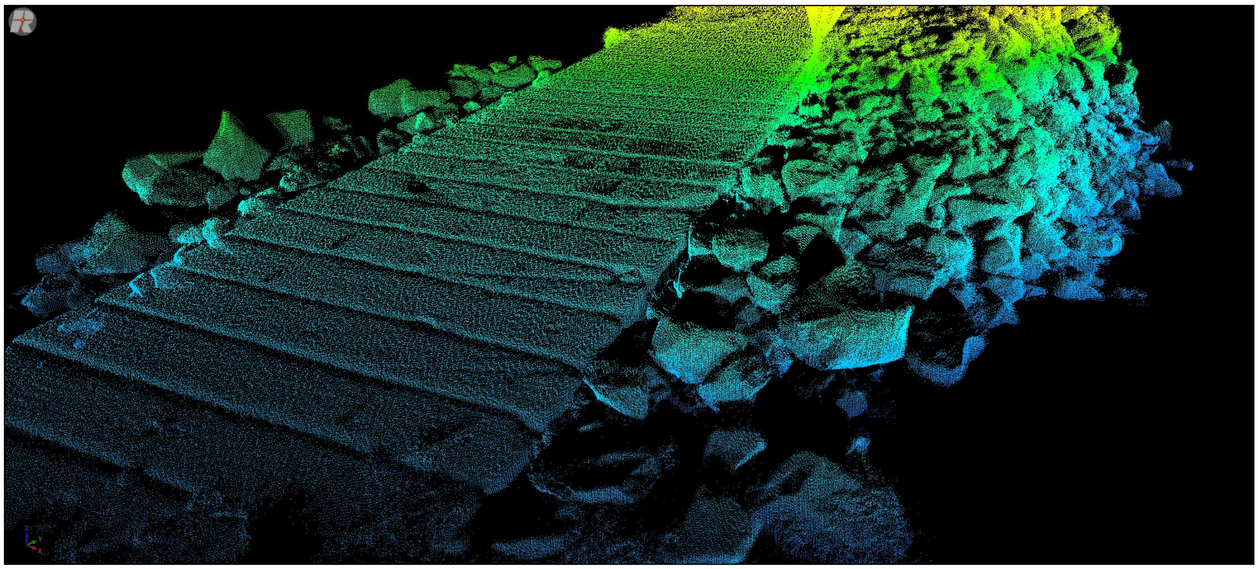

Figure 19 3D Point Cloud of MTLS Data

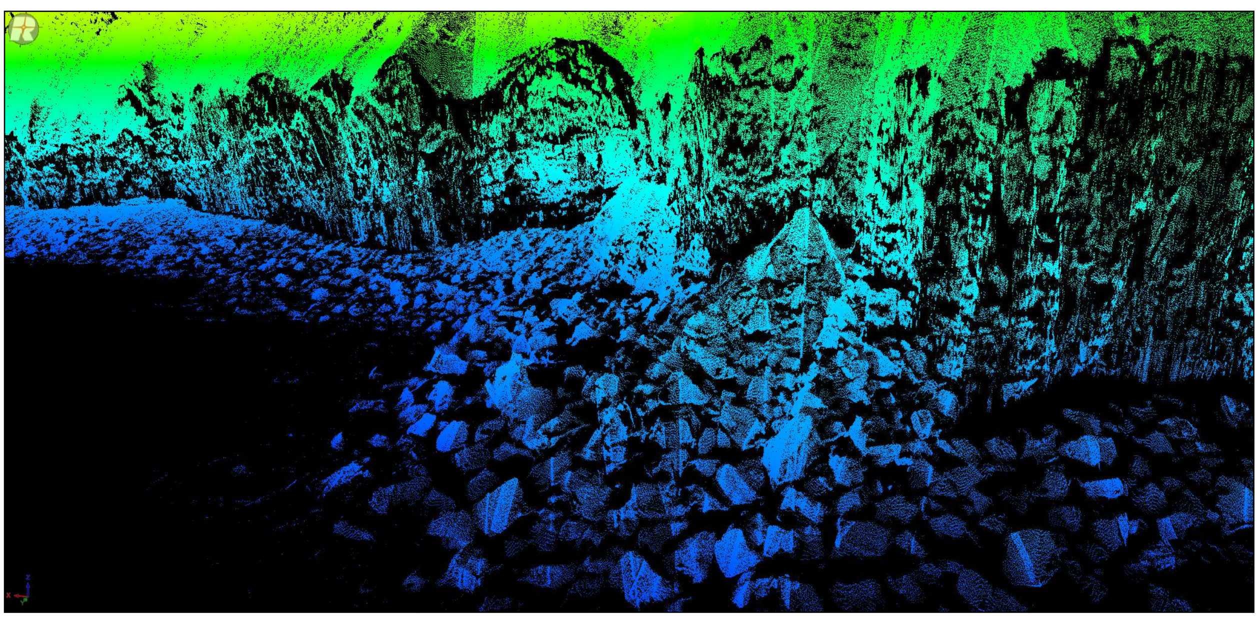

Figure 20 3D Point Cloud of MTLS Data

5. RESULTS

a. Multibeam Bathymetry Data

100% coverage of the survey area up to -7ft MLLW was achieved. -7ft MLLW was deemed the shallowest safely, navigable depth. The multibeam could be gridded at 1.5ft to allow detection of objects 2ft or greater. There were no *Obstructions to Navigation* were located. Depths ranged from -70ft to -7ft MLLW. A 3D and Profile View can be seen below in Figure 21.

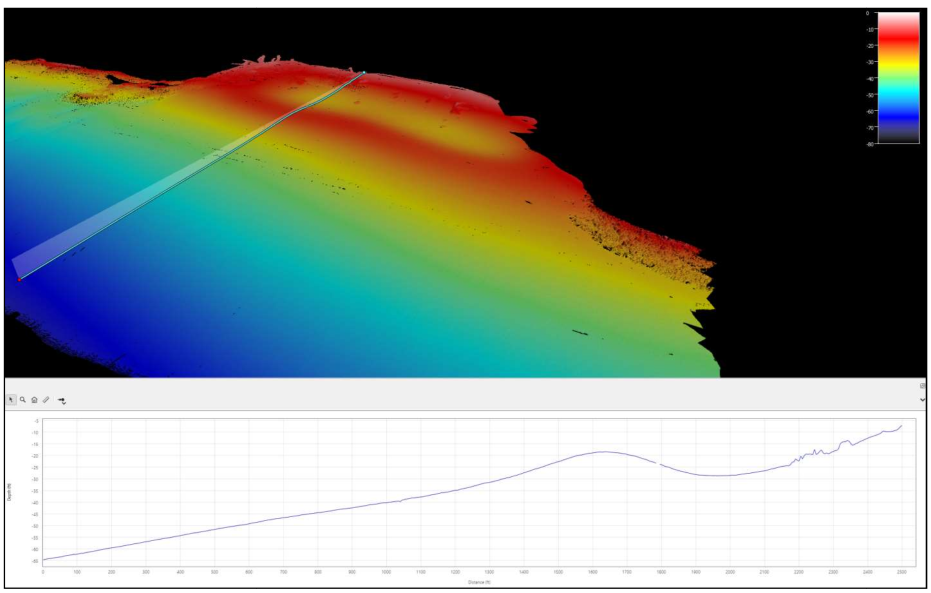

Figure 21 3D and Profile View of the MBES Survey Data

b. Mobile Terrestrial Laser Scanning Data

MTLS data focused on the shoreline and cliffs. Elevations within the MTLS data ranged from +1ft to +115ft MLLW. A 3D and Profile View can be seen below in Figure 22.

The final point cloud (19 million points) was decimated using 3-dimensional gridding routine and exported to the following:

- STG_MTLS_0.5x0.5x0.1 (6,574,284 points)
- STG_MTLS_3x3x0.2 (869,824 points)
- STG_MTLS_12x12x1 (48,515 points)

- STG_MTLS_12x12x2 (27,282 points)
- STG_MTLS_12x12x4 (16,530 points)

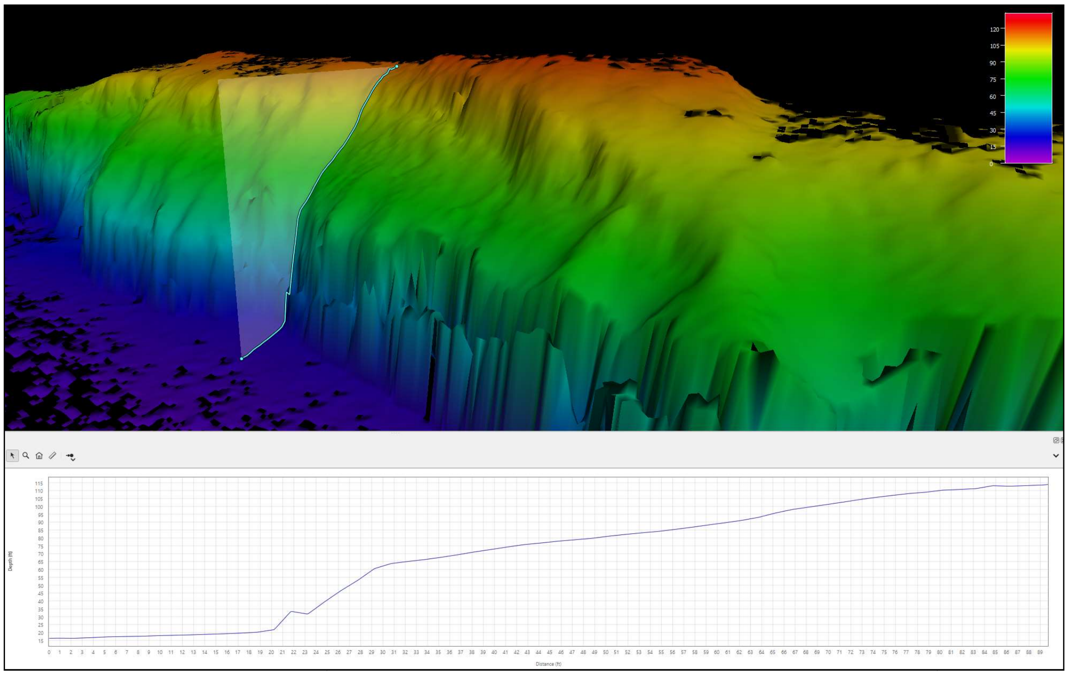

Figure 22 3D and Profile View of MTLS Data

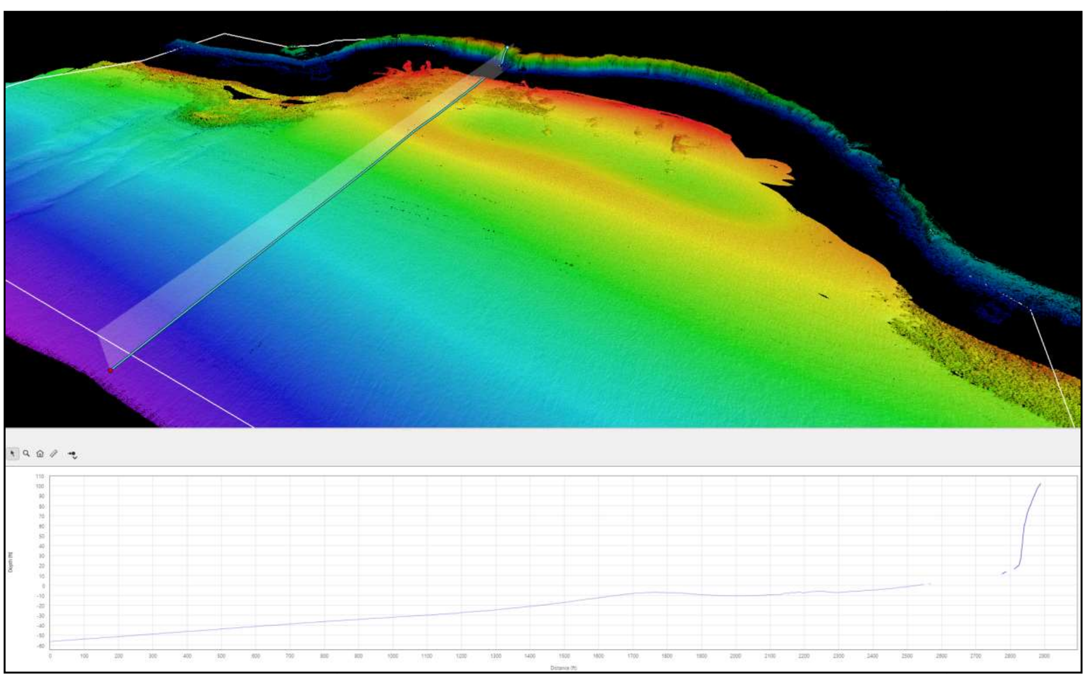

Figure 23 3D and Profile View of MBES & MTLS Data

c. St. George QC Analysis

RTK Observations of the MBES Acoustic Center, MTLS Reference Point, Vessel Reference Point, and Waterline were performed prior to acquisition. The measured values from the RTK rover were compared to the values computed in real-time by the data collection software QINSy. The deltas were computed and checked; all deltas were below 0.05ft.

A patch test was performed in order to determine the MBES alignment angles and a bore-sight was performed to determine the VZ-400 alignment angles. Separate line pairs for roll, pitch, and yaw were conducted. Alignment values were determined and applied prior to MBES data collection. Alignment values for MTLS were determined and applied during post processing.

Real-time standard deviation plots for overlapping survey data were created and monitored throughout the survey.

The final method of Quality Assurance was to compare the MBES, MTLS, and RTK Topographic Data along the ramp in St. George Small Boat Harbor. All three datasets matched to within 0.1'.

Selected images of these observations can be seen below in Figure 24, Figure 25, and Figure 26.

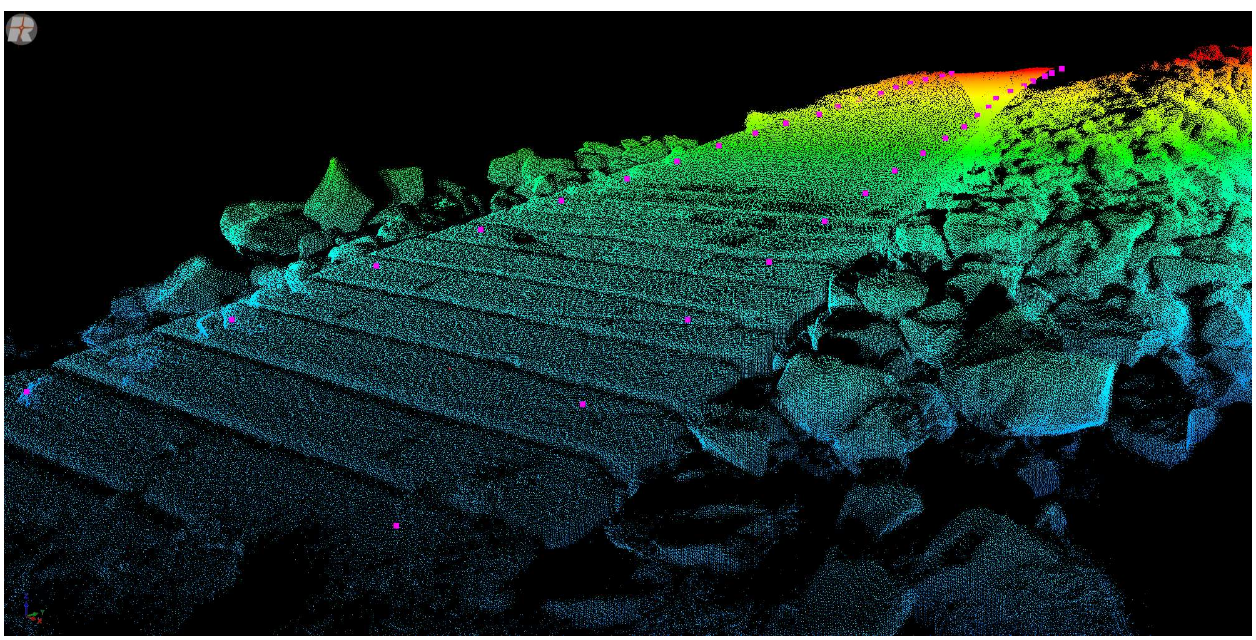

Figure 24 Overview of MTLS and RTK Topographic Datasets

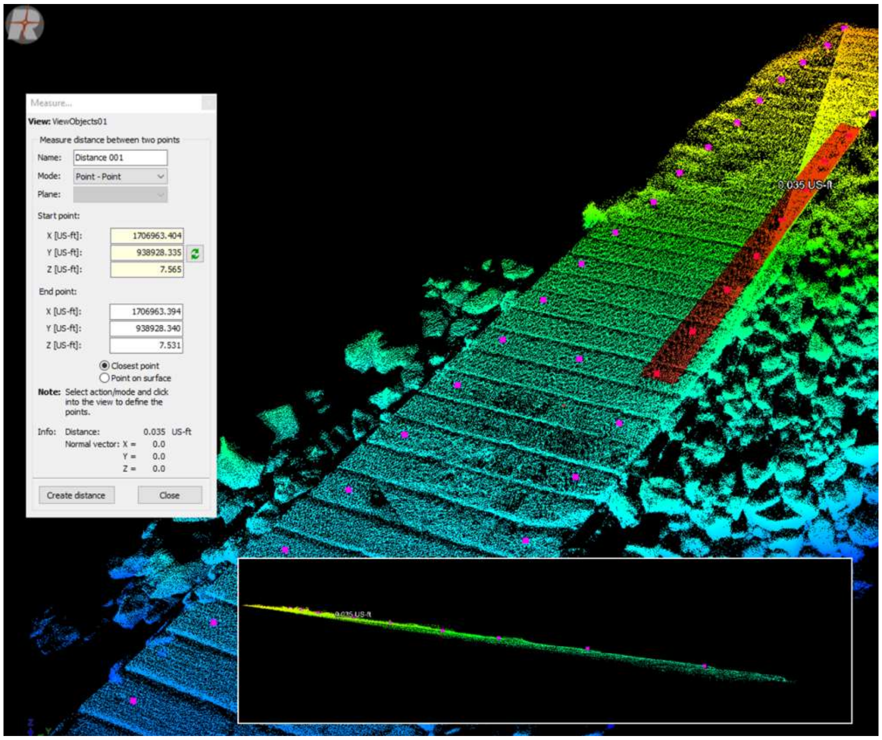

Figure 25 MTLS Data (Depth Colored) vs. RTK Topographic Data (Magenta)

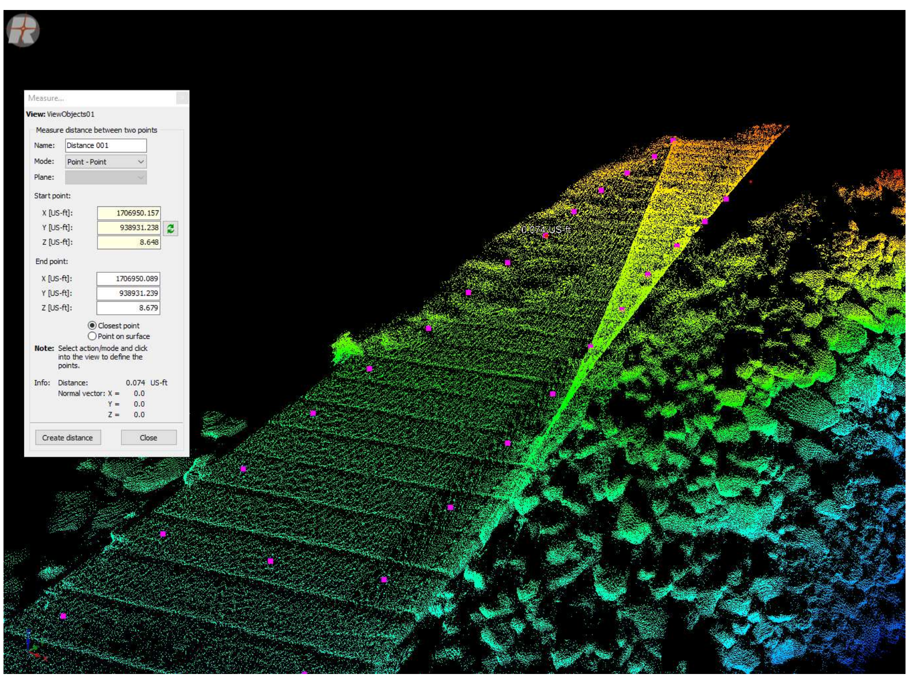

Figure 26 MTLS Data (Depth Colored) vs. RTK Topographic Data (Magenta)

6. HYPACK METADATA

Metadata File Date	Wednesday September 19, 2018
Survey Date	August 20 & 27, 2018
Purpose	Bathymetric & Topographic Survey
Project Name	STG001 – St. George Harbor
Area of Coverage	Survey Limits defined by USACE
Type of Survey	Multibeam Hydrographic & LiDAR Topographic
Access Constraints	None
Progress	Complete
Team Leader	Robert Goughnour
Survey Manager	Greg Gibson
Project Manager	Greg Gibson
Data Contact Person	Greg Gibson
Organization	eTrac Inc
Telephone	
Address	617 S. Knik-Goose Bay Rd., Suite C
City	Wasilla
State	Alaska
Postal Code	99654
Metadata File Author	Robert Goughnour
Organization	eTrac Inc
Telephone	(907) 373-3660
Address	617 S. Knik-Goose Bay Rd., Suite C
City	Wasilla
State	Alaska
Postal Code	99654
QA Person	John Epps
QA Date	September 20, 2018
Projected Coordinate System	Alaska State Plane Coordinate System
Datum Name	NAD 83 (2011) Epoch 2010.00
Horizontal Zone	Alaska Zone 9
Projected Coordinate Units	U.S. Survey Feet
Implied Horizontal Accuracy	0.1 ft
Vertical Reference Datum	Mean Lower Low Water (MLLW)

Table 2 Hypack Metadata File