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Group Chair's Factual Report

SEARCH AND RECOVERY

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Attachment 1 - SEI Search Report
(44 pages)

Transair Flight 810 Debris Survey

Offshore Ewa Beach, Oahu, Hawaii

July 2021



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1. INTRODUCTION

On July 2, 2021, Transair Flight 810 originating from Honolulu International Airport bound for Kahului International Airport was ditched in the waters of Māmalā Bay offshore from Ewa Beach after the crew reported engine issues. The cargo plane was severely damaged and sank after the pilots were rescued by the US Coast Guard and Honolulu Airport Fire Department.

Sea Engineering Inc. (SEI) was contracted by AIG Aerospace to complete a survey of the crash site to locate the plane with guidance and observation during the survey from the National Transportation Safety Board (NTSB). The primary objective of the survey was to locate and record the position of the major portions of the airplane. The flight data recorders are of significant interest to the NTSB to help determine the cause of the accident.

1.1 Project Location

Māmalā Bay is located offshore of Ewa Beach on O‘ahu. A radar derived path of the of Flight 810 was downloaded from FlightAware.com to identify the initial search area (<https://flightaware.com/live/flight/RDS810/history/20210702/1100Z/PHNL/PHOG/tracklog>). The track starts at 1:33AM HST at the Honolulu International Airport and concludes at an altitude of 50 ft at 1:45AM HST. The path is shown in Figure 1 and in tabular form in Appendix E . Additional data, collected from the Coast Guard Helicopter that rescued one of the pilots noted that the pilot was pulled off the tail section of the plane at Latitude 21 ° 16.642’ N and Longitude 158° 1.736’ W. This is to the east of the end of the flight path and is shown as the red indicator in Figure 1.

Surface currents were looked up on a forecast model provide by the Pacific Island Ocean Observation System (PacIOOS -<https://www.pacioos.hawaii.edu/currents/model-oahu/>). The prevailing surface current, shown in Figure 2, at 2:00 am on July 2nd was noted to be toward the west. The PacIOOS website was also referenced for wave observations at the Pearl Harbor Entrance Channel. The observed wave height of 3.15ft from the south is shown in Figure 3 (<https://www.pacioos.hawaii.edu/waves/buoy-pearl/>).



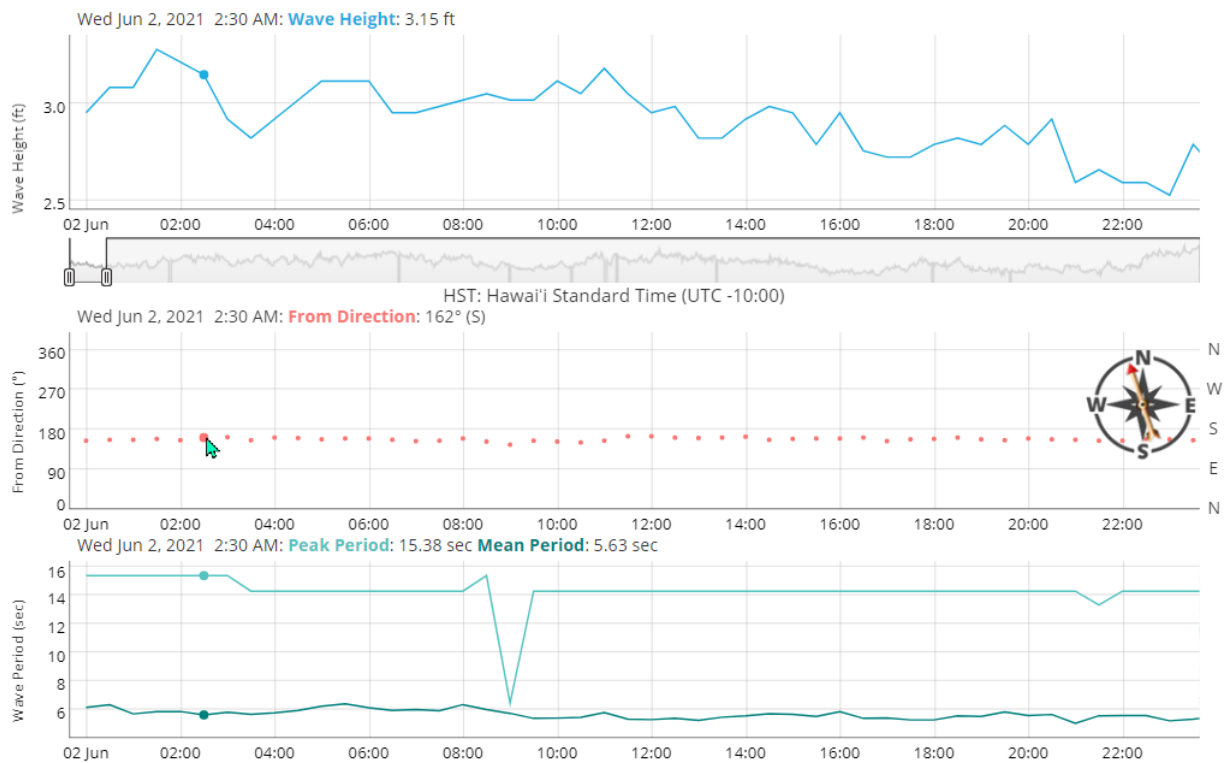


Figure 3 Waves Conditions at the Pearl Harbor Entrance Channel

1.2 Survey Methodology

SEI's survey plan included utilization of their 43ft work boat, 'Huki Pono', C-Max CM2 Side Scan Sonar and Seamor Chinook Remote Operated Vehicle (ROV) to locate and conduct a visual inspection of the airframe and debris on the seafloor. Utilization of side scan sonar, in combination with ROV, allowed for efficient wide swath coverage of the project area to identify targets of interest. Once targets of interest were identified, ROV operations allowed for visual confirmation of targets and visual inspection of airframe and debris on the seafloor.

1.2.1 Vessel- Huki Pono

SEI's *Huki Pono*, shown in Figure 4, is outfitted with A-frame, interior working space for computers and equipment. The survey vessel provided space for crew and observers to monitor results of the survey in real-time. The specification sheet is included in Appendix A . The survey started from Pier 26 in Honolulu Harbor each day. Transit time to the site was roughly 1 hour and 25 minutes.



Figure 4. SEI 43' Delta Marine "Huki Pono"

1.2.2 Side Scan Sonar – C-Max CM-2

A side scan sonar transmits acoustic signals with wide vertical beam widths out both side of the sonar towfish and records signals reflected back from the seafloor. Hard bottom areas and man-made features generally produce higher intensity reflections than soft sediments and allows for identification of objects or features with high relief, resulting in a plan view acoustic image of seafloor characteristics

A C-Max Side Scan Sonar system was used for the survey (Figure 5). The system contains dual 325 and 780 kHz transducers. The 325 kHz transducer has greater range than the 780 kHz transducer and was chosen for use in order to cover a wide swath of seafloor. The sonar range was set at range of 150m to 200m per side. Xylem's Hypack/Hysweep 2021 navigation and data collection software was used for the collection of sonar and all other device data, and for integration of the data with vessel position. Points of interest were marked during the survey in Hypack. The specification sheet for the C-Max CM2 side scan sonar is shown in Appendix B .



Figure 5. C-Max side scan sonar towfish

1.2.3 Global Positioning System – Trimble SPS-461

A Trimble SPS 461 was used for vessel navigation and positioning, and side scan towfish positioning was calculated using the towfish.dll algorithm in Hypack. The survey data was collected in the Universal Transverse Mercator (UTM), Zone 4 (meter) coordinate system. Survey lines were conducted parallel to the bottom contours where possible.

The Trimble SPS 461 is a differential GPS (DGPS) that utilizes corrections to improve the calculated position. These corrections were provided by the Omnistar service.

1.2.4 Remotely Operated Vehicle (ROV) – Seamor Chinook ROV

A Seamor Chinook ROV was used to confirm the points of interest identified during the side scan sonar operations on the seafloor. The Seamor Chinook is shown in Figure 6. The ROV is outfitted with a forward camera that can tilt to aide in searching for debris. The ROV is propelled by four horizontally and two vertically oriented thrusters. The ROV is attached to the survey vessel by the tether that carries the power and data required to operate the ROV. The specification sheet for the Seamor Chinook ROV is shown in Appendix C .

The position of the ROV was tracked with an Applied Acoustics EasyTrack USBL. The system consists of a transducer attached to the survey vessel and a transponder attached to the ROV. The transducer will acoustically ping the transponder on a given frequency. The transponder will reply to the ping on a different frequency. The transducer can record the direction from which the reply was received giving the bearing to the ROV. The time between the initial ping and the reply ping and the speed of sound in water is used to determine the range to the ROV. The Applied Acoustics transducer attached to a pivoting pole is shown in Figure 7. The transponder is the black cylinder on the upper left of Figure 6. The specification sheet for the Applied Acoustics Easy Track USBL is shown in Appendix G .



Figure 6 Seamor Chinook ROV



Figure 7 Applied Acoustics USBL Transponder



2. SURVEY PROGRESSION AND RESULTS

After the crash of Transair 810 on July 2nd, SEI was notified to proceed with survey operations on July 3rd, 2021. SEI crew began mobilization Honolulu Harbor on July 4th, 2021. Work included creating a Hypack base map, with flight path and USCG information overlayed on the chart as well as mobilization of the ROV, USBL and Side Scan Sonar equipment onto the *Huki Pono*. The equipment was setup up and tested on July 5th, 2021, and survey operations began on July 6, 2021. A daily safety meeting and operations plan detailing the specific hazards of the day's tasks was conducted.

2.1 Survey Day One - July 6, 2021

Sea state conditions on the first day of survey operations were not ideal for data collection with winds of 15 to 20 mph, and gusts to 25 mph, and wind waves of 5 to 6ft. Conditions made piloting the survey vessel along straight lines difficult, as can be observed in the track line figures below.

The initial survey plan included a side scan survey over a wide area centered around the end of the flight path and the GPS coordinate provide by the USCG helicopter. Figure 8 shows the tracklines of the *Huki Pono* (black line) and the side scan sonar (redline). The position of the tail section of the plane on the surface was updated from a new source to place it just to the west of the end of the flight path. This is indicated by the green arrow in Figure 8. The last radar tracking point is shown by the airplane symbol enclosed in a circle. The first survey lines were run from Northeast to Southwest to follow the contour lines of the bathymetry. As the survey progressed potential targets were marked and are denoted by triangles in Figure 9. During day one, there were few high priority targets. Later additional cross lines were run from Northwest to Southeast to focus on the targets being marked. After completing Side Scan Sonar operations, ROV inspection of the highest priority targets were conducted. Day one targets were determined to be a hardpan ledge running through the survey area and large rock outcropping (orange cross in Figure 9).

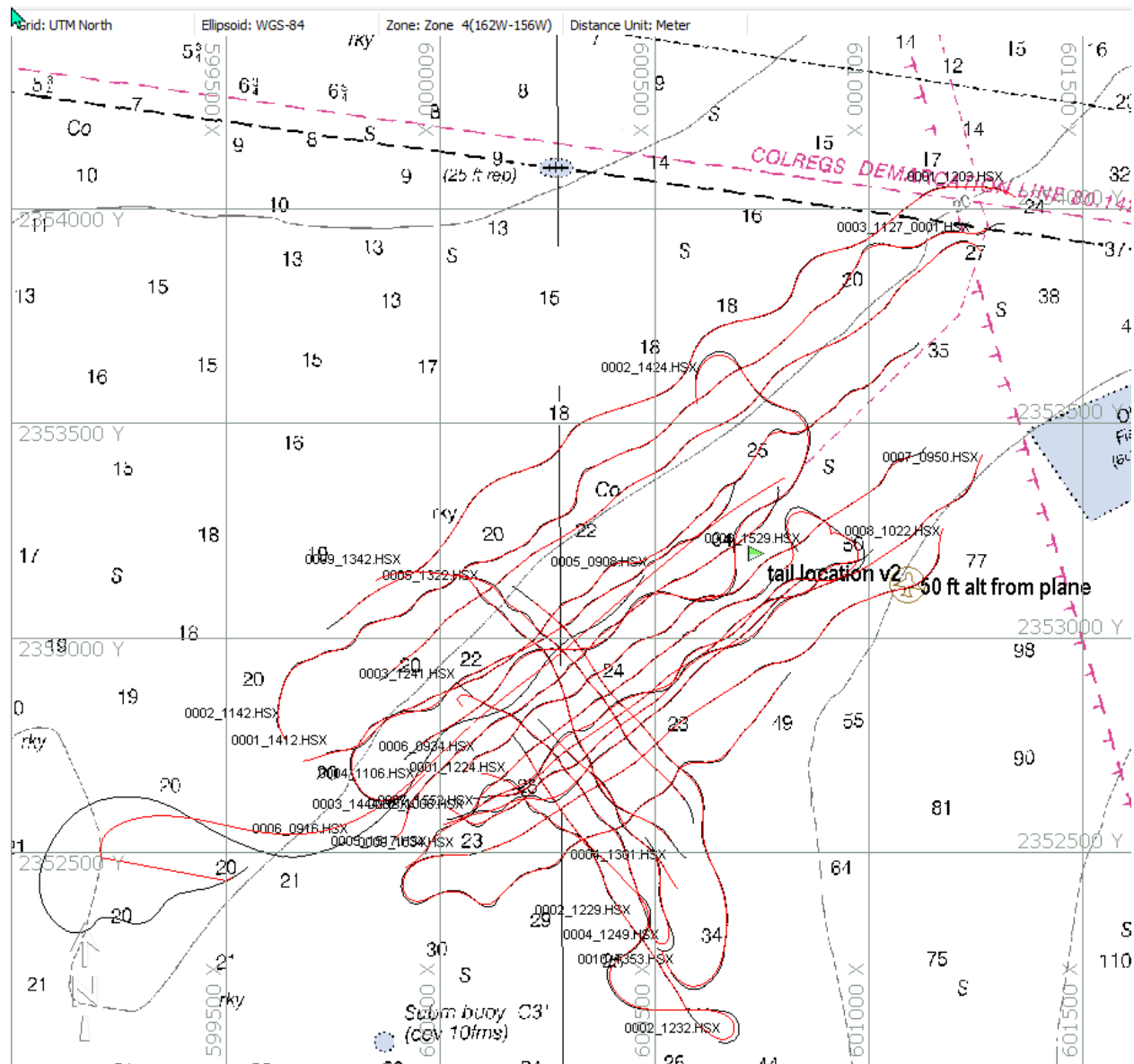


Figure 8 Track lines from Side Scan Sonar Survey 2021-07-06

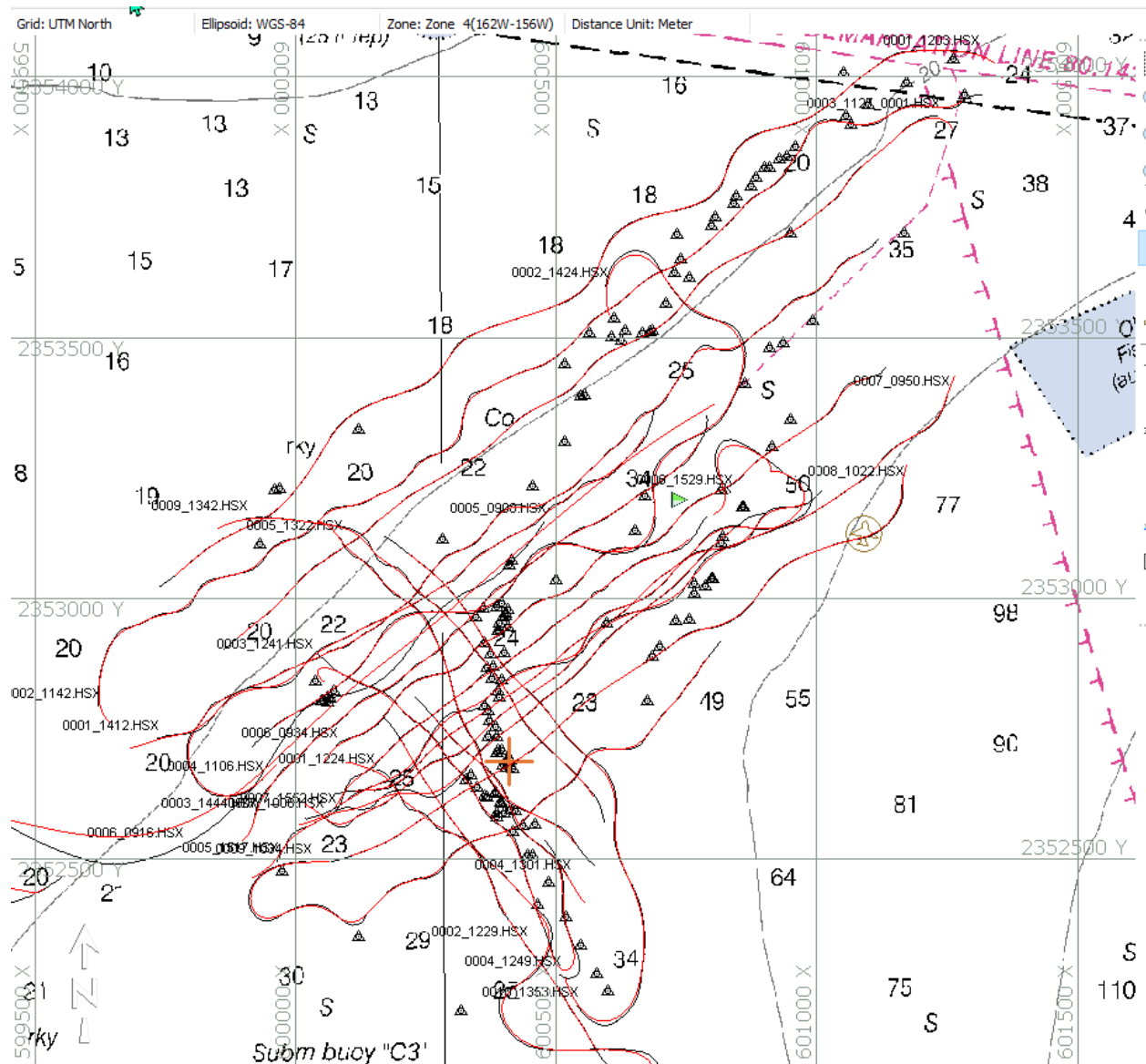


Figure 9 Marked Points of Interest

2.2 Survey Day Two - July 7, 2021

Weather conditions on day two were similar to the first day of survey operations, with winds in the 15 to 20 mph range, with gusts to 25 mph, and wind waves of 5 to 6ft.

Boeing was able to provide a RJE PRS-275 handheld pinger receiver, which receives a signal from the underwater locator beacons (ULB) on the flight recorders in the tail of the plane, to aid in location efforts for the second day of surveying. The pinger receiver was dropped at multiple locations to triangulate a bearing to the ULB. Figure 10 shows the team using the pinger locator. Thirteen bearings, shown in Figure 11, were measured around the survey site. The Huki Pono held position while the team lowered the pinger locator into the water and listened for pings from the ULBs in the rear of the plane. The pinger locator would be rotated until the received pings were loudest. This angle was noted as the bearing to the ULBs in the tail section of the plane.

These bearings were compiled and plotted to focus survey area.

Additional side scan surveying was completed in the refined search area. Prior to deploying the side scan sonar, it was determined that water depths at the refined search area required the side scan sonar to be deeper in the water column. To assist in getting the side scan deeper, a 12-foot chain was attached to the tow cable for the side scan sonar (Figure 12).

The focused side scan survey lines identified a primary target of the aft section of the plane (shown Figure 13). The ROV was deployed and confirmed the aft of the plane (Figure 14). ROV inspection of the target identified that the forward fuselage and engines had detached from the aft section of the plane and a limited amount of debris surrounded the area.

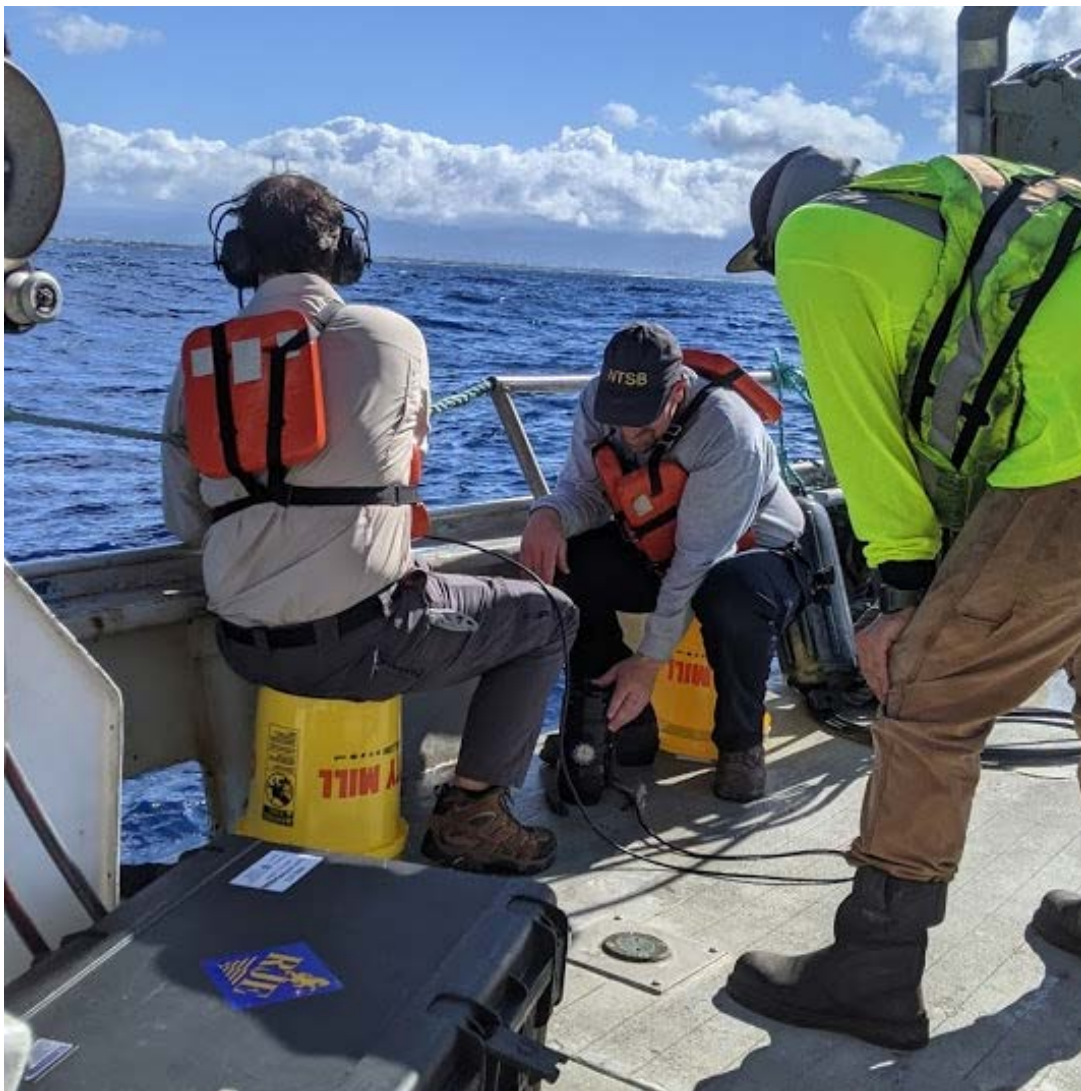


Figure 10 Team using the Hydrophone to Locate a Bearing to the Pinger

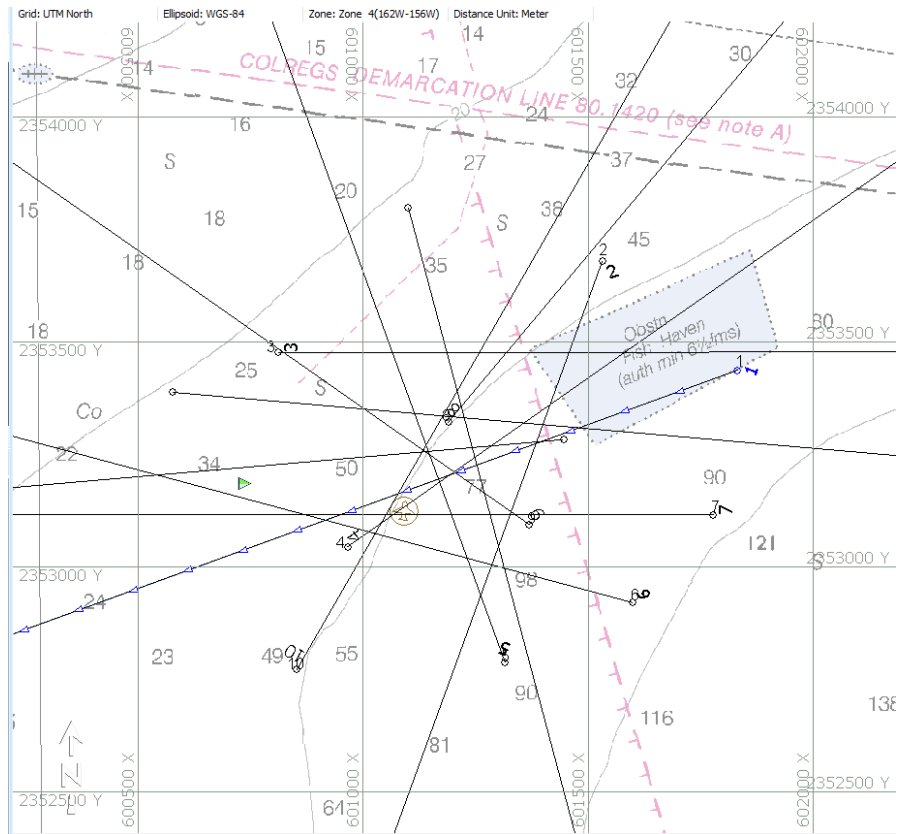


Figure 11 Bearings Recorded by the Hydrophone



Figure 12 Chain Attached the Side Scan Sonar Tow Cable

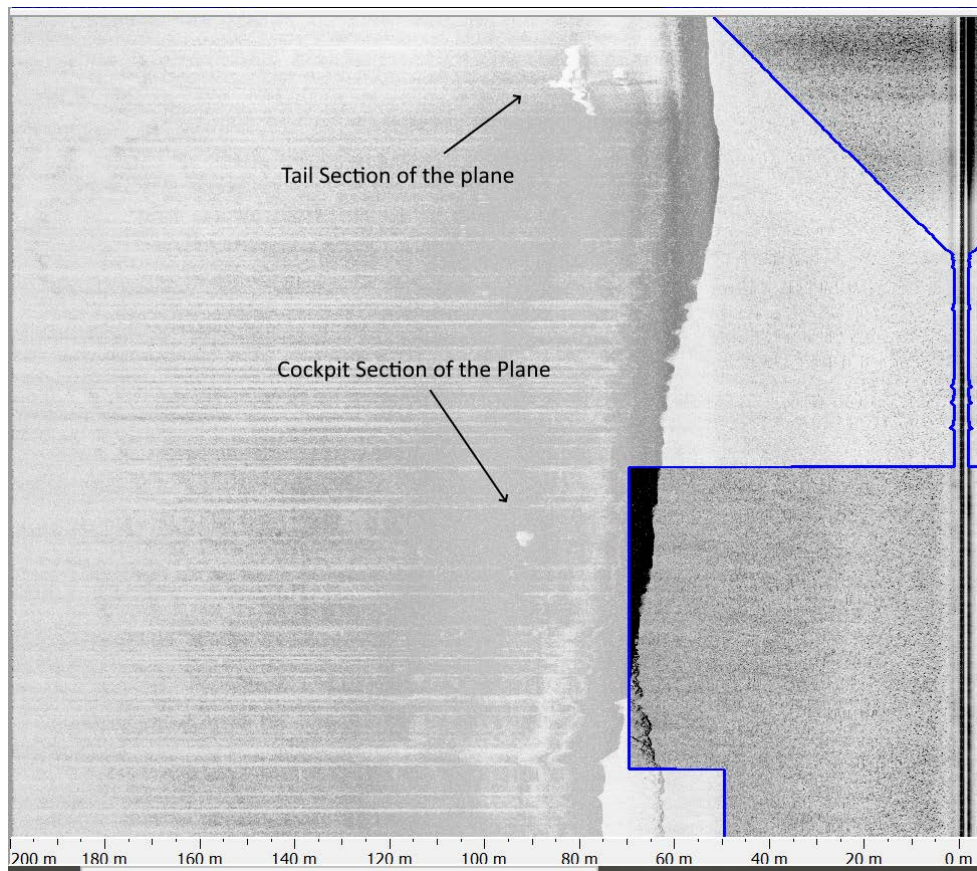


Figure 13 Side Scan Image of Plane Tail Section and Cockpit



Figure 14 Tail Section of Transair Flight 810

2.3 Survey Day Three - July 8, 2021

Weather conditions on day three were more favorable than the first two days of survey operations, with winds in the 10 to 15 mph range and waves of 4ft.

The third day of surveying included ROV inspection of the remaining targets identified on day two of the survey. Beginning with the next highest priority target, the ROV located the forward fuselage and cockpit (shown in Figure 13), followed by both engines, nose landing gear, cargo containers and miscellaneous debris associated with the crash. NTSB personnel determined that all plane components had been identified over the second and third days of surveying. SEI demobilized survey equipment and the vessel on July 9th, 2021.

Positions from the USBL and ROV are noted in Table 1. These coordinates are subject to error ± 10 -15 feet. Appendix G gives a description of this error. For the USBL to calculate a range to the pinger it must use the speed of sound. An estimate for the speed of sound was used in this case instead of taking time to complete a speed of sound profile of the water column. The coordinates in Table 1 are averages of the coordinate calculated by the USBL for 15 seconds while the ROV was near the object.

In general, the larger items of the debris field cover an area of about 850ft x 500ft with smaller debris extending further afield. The forward fuselage section of the plane is ~450 ft from tail section of the plane. The seafloor is generally flat hard bottom with some coarse sand in places.



Figure 15 Cockpit of Transair Flight 810



Table 1 Target Coordinates from USBL Data

Target Name	X	Y	Latitude	Longitude	Depth (Ft)	Video time
Tail Section (with Main Wings)	601212.42	2353304.38	21° 16' 43.2873" N	158° 01' 27.6581" W		7/7/2021 16:45:36
Aft of Tail Section	601236.97	2353292.74	21° 16' 42.9038" N	158° 01' 26.8086" W	363	7/7/2021 16:56:41
Forward of Tail Section	601203.03	2353317.23	21° 16' 43.707" N	158° 01' 27.9811" W	340	7/7/2021 17:01:06
APU	601111.13	2353168.36	21° 16' 38.8839" N	158° 01' 31.2017" W	366	7/8/2021 9:19:12
Engine Parts	601111.84	2353172.94	21° 16' 39.0325" N	158° 01' 31.176" W	366	7/8/2021 9:21:30
Nose Landing Gear	601115.93	2353177.83	21 °16' 39.1909" N	158° 01' 31.0332" W	354.5	7/8/2021 9:29:28
Forward of Forward Fuselage	601122.79	2353184.31	21° 16' 39.4002" N	158° 01' 30.7938" W	363.5	7/8/2021 9:33:16
Aft of Forward Fuselage	601135.39	2353198.86	21° 16' 39.871" N	158° 01' 30.3533" W	364	7/8/2021 9:36:25
Thrust Reverser Engine 1	601154.04	2353136.19	21° 16' 37.829" N	158° 01' 29.7198" W	437	7/8/2021 9:58:48
Forward Engine Case	601160.42	2353123.46	21° 16' 37.4135" N	158° 01' 29.5009" W	440	7/8/2021 10:06:15
Tires	601202.36	2353202.37	21° 16' 39.9715" N	158° 01' 28.029" W	432	7/8/2021 10:24:50
FedEx Cargo Can (SAA 34562 FX)	601158.96	2353256.42	21 °16' 41.7382" N	158° 01' 29.5234" W	341	7/8/2021 10:36:19
TransAir Cargo Can (SAA 4054 TXHA)	601154.91	2353244.99	21° 16' 41.3671" N	158° 01' 29.6662" W	345	7/8/2021 10:39:18
Keel Beam	601087.2	2353202.52	21° 16' 40" N	158° 01' 32.0246" W	350	7/8/2021 13:52:59
X and Y coordinates are UTM North Zone 4 meters. Depth is from ROV pressure sensor.						

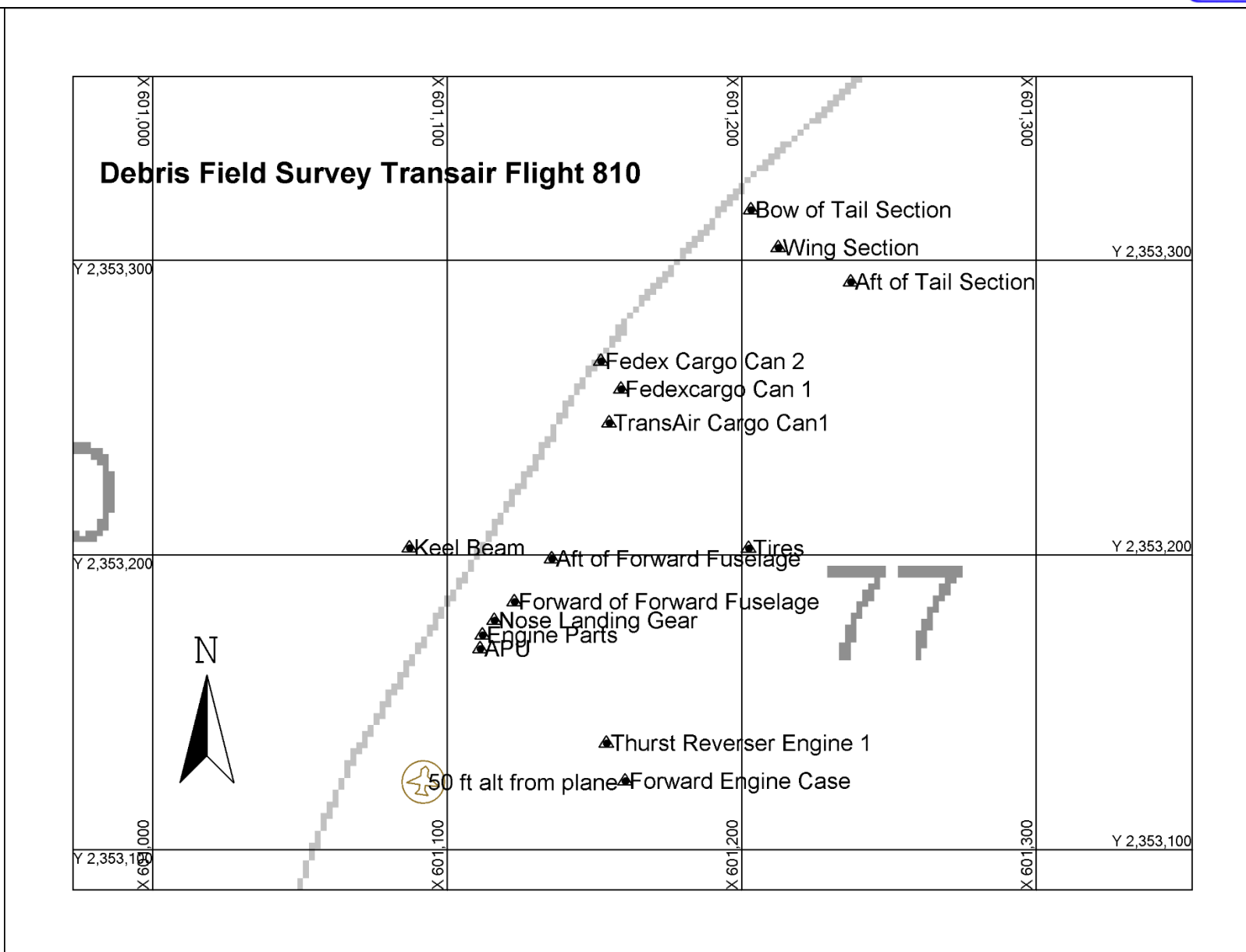


Figure 16 Locations of the Debris

3. IDENTIFIED PLANE AND DEBRIS

ROV surveyed airframe and debris included: (1) tail section, including the wings, of the plane (2) forward fuselage, including cockpit, of the plane, (3) smaller debris including engines, thrust reversers, inlets, nose landing gear, keel beam, and cargo debris. Items are discussed in greater detail below.

3.1 Tail Section of Plane

The tail section of the plane was found on the second day of surveying. It is oriented on the bottom with a heading of 285°, and resting on hard bottom. The water depth ranges from 340ft at the front of the aft fuselage and 363ft at the rear of the aft fuselage. Both the engines were not attached to the wings. The area under the wings was clear and both wings were off the bottom. The leading edge of the wings is damaged near the fuselage. The bottom of the plane was significantly damaged and the exterior skin is crumpled at the rear of the plane. Figures pertaining to the aft fuselage are listed below:

- Figure 14 Tail Section of Transair Flight 810
- Figure 17 Left Wing
- Figure 18 Right Wing
- Figure 19 Aircraft Registration Number
- Figure 20 Tail of Plane
- Figure 21 Cargo Container inside the Cabin



Figure 17 Left Wing



Figure 18 Right Wing



Figure 19 Aircraft Registration Number



Figure 20 Tail of Plane



Figure 21 Cargo Container inside the Cabin

3.2 Forward Fuselage and Cockpit Section of Plane

The forward fuselage section of the plane was found on the third day of the survey. The forward fuselage was located in 364 ft of water and is sitting on hard bottom. The forward fuselage is oriented with a heading of 200°. The forward fuselage resides in a debris field including the nose landing gear, engines, thrust reversers and a section of the keel beam, along with hundreds of smaller pieces of debris. The forward fuselage exhibits damage to the belly of the fuselage and the radome is missing. The open rear of the forward fuselage section has exposed wire and cabling. The main deck cargo door is closed but the left door is ajar. The figures listed below pertain to the cockpit section of the plane.

- Figure 22 Forward Fuselage from Above
- Figure 23 Forward Fuselage Side View
- Figure 24 Forward Fuselage from Stern



Figure 22 Forward Fuselage from Above



Figure 23 Forward Fuselage Side View



Figure 24 Forward Fuselage from Stern

3.3 General Debris

The jet engines were not attached to the plane. The engine components are in two separate locations on the seafloor. The first location shown in Figure 25 has three large pieces. One of those has visible part number labels shown in Figure 26. A forward engine case, thrust reverser, and keel beam are shown in Figure 27, Figure 28, and Figure 29, respectively. The detached nose landing gear is shown in Figure 30.

The debris field also consist of cargo from the plane as well, including two cargo canisters on the seafloor. Both were empty and severely damaged. Survey crew also noted at least a dozen tires on the seafloor, some of which are shown m in Figure 34.



Figure 25 Engine Parts



Figure 26 Engine Parts - Number



Figure 27 Forward Engine Case



Figure 28 Engine Parts -Thrust Reverser



Figure 29 Keel Beam



Figure 30 Nose Landing Gear



Figure 31 FedEx Cargo Can (SAA 34562 FX)



Figure 32 FedEx Cargo Can (SAA 34562 FX)



Figure 33 Transair Cargo Can (SAA 4054 TXHA)



Figure 34 Field of Tires



4. DISCUSSION

Noteworthy considerations stemming from the Transair search operations that may aid in future search and recovery efforts are outlined below:

1. The initial data provided by emergency search and rescue teams for the survey location may not be accurate and may be subject to change. The location of the tail of the plane while on the surface was provided prior to the start of the survey and then modified just before the start of the survey.
2. Provided data may be misleading. The position of the tail section was recorded by a rescue helicopter pilot when the pilot was recovered. This tail position was initially to the east of the last radar location, then it was changed to the west of the radar position. A western location would correspond to the prevailing current at the time of the crash. The survey area was picked in part due to agreement of the last known radar position, the position of the tail on the surface, and the westward surface currents. Ultimately the plane debris field and both parts of the fuselage were found very near the last known radar location.
3. Seafloor characteristics are an important factor for interpreting side scan sonar results. The side scan survey imagery revealed a number of geographic features on the seafloor, one of which was chosen for an ROV inspection. Very detailed bathymetry charts would have allowed the team to rule out these geographic features.
4. The side scan sonar flipped three over 3-4 times requiring the survey team to recover the unit and redeploy. This occurred during turns between survey lines in general. This was likely caused by large wave induced heaving pulls on a slackening cable during survey line turns. Larger radius turns were used to maintain adequate tension on the tow cable and remedy the overturning issue.

Appendix A Huki Pono Specification Sheet



863 N. Nimitz Hwy • Honolulu, Hawaii 96817 / 1770 Viking St. • Alameda, California 94501
Website: www.seaengineering.com

Huki Pono – Honolulu, HI.

The 'Huki Pono' is a 43-foot twin screw workboat set up to support diving and marine survey operations in the Hawaiian Islands. The vessel has two steering stations and a large, air-conditioned deckhouse ideal for use as a support center for survey or ROV operations.

Specifications

- LOA: 43'-0"
- Beam: 14'-0"
- Draft/Light: 4'-3"
- Hull: Fiberglass, semi-displacement, hard chine
- Manufacturer: Delta Marine, Seattle, WA. (1985)
- Steering Stations: Two (Wheelhouse and back deck)
- Open Aft Deck: 180 sqft.



Propulsion

- Engine(s): Twin Caterpillar 3208 marine diesels, 320 hp/ea.
- Fuel: 500 Gallons
- Cruising Speed: 8 knots
- Range: 400 nautical miles

Notable Facilities/Equipment

- Air conditioned wheelhouse and 110 sqft. Deckhouse
- 18 kW generator
- Hydraulic System: 25 gpm, 2500 psi, quick disconnect, ports on deck for winches and equipment
- Articulating stern A-frame (2,000 lb. capacity) with 4000 lb. winch
- Stern swim step

Accommodations

- Four single berths forward
- Refrigerator and microwave oven
- Enclosed head
- 75 gallons potable water

Safety

- DBC 8 Man SOLAS lift raft
- EPIRB
- Flares
- Life Jackets
- High water level alarm
- Halon system in engine compartment
- Pacer hydraulic bilge pump

Electronics

- Furuno Depth Sounder
- Furuno 1650 DGPS
- VHF
- Mathers Controls

Appendix B C-Max CM2 Side Scan Sonar Specification Sheet

Specification

CM2 SIDESCAN SONAR, TOWFISH SPECIFICATION Issue 10, October '15

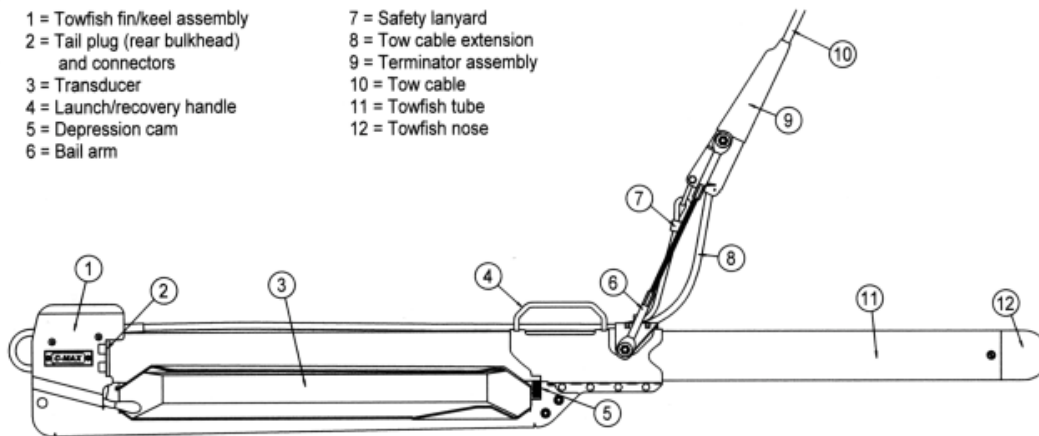
1. GENERAL

The CM2 digital towfish is the instrument that acquires the data from which the sonar image is derived. It is towed, and provided with power and digital telemetry services, by a reinforced or armoured 2-conductor tow cable. CM2 towfish are available in two different dual-frequency versions, both inter-operable with all CM2 data acquisition subsystems. A DeepTow version is also available (see CM2 DeepTow Specification).



- 1 = Towfish fin/keel assembly
- 2 = Tail plug (rear bulkhead) and connectors
- 3 = Transducer
- 4 = Launch/recovery handle
- 5 = Depression cam
- 6 = Bail arm

- 7 = Safety lanyard
- 8 = Tow cable extension
- 9 = Terminator assembly
- 10 = Tow cable
- 11 = Towfish tube
- 12 = Towfish nose



2. ACOUSTICS

Acoustic frequencies

DF type: 100/325kHz dual frequency (CHIRP)

EDF type: 325/780kHz dual frequency (CHIRP)

Ranges (left and right)

100m, 200m, 300m, 400m, 500m at 100kHz

25m, 50m, 75m, 100m, 150m at 325kHz

12.5m, 25m, 37.5m, 50m at 780kHz

Acoustic pulse rates, pings per second (at range)

780kHz: 25.4(12.5m); 25.4(25m); 17.8(37.5m); 13.8(50m)

325kHz: 25.4(25m); 13.8(50m); 9.4(75m); 7.2(100m); 4.8(150m)

100kHz: 7.2(100m); 3.7(200m); 2.45(300m); 1.85(400m); 1.49(500m)

Array length and beamwidths (2-way 3dB points)

0.41m at 325kHz & 100kHz; 0.3m at 780kHz

horizontal 0.3° at 325kHz; 1.0° at 100kHz; 0.2° at 780kHz

vertical, full coverage -5° left through -90° to -5° right

Lateral resolution

18mm at 780kHz; 39mm at 325kHz (18mm at 25m range); 78mm at 100kHz

C-MAX



Specification

Beam depression (of maximum sensitivity axis)
10° or 20°, adjustable without tools

3. OTHER SENSORS

Towfish altitude, from integral echo sounder, 78mm resolution
Water temperature
Heading (option)
Depth (option)

4. MAGNETOMETER INTERFACE

Optional interface to Marine Magnetics Explorer and SeaSpy magnetometers, allowing the magnetometer towfish to be powered from the CM2 towfish and utilise the CM2 tow cable telemetry; this avoids the need for the magnetometer to use a separate tow cable.

5. WING DEPRESSOR

Optional CM2 Wing Depressor can be fitted to increase towing depth by up to 50% for the same cable length and towing speed.

6. SAFETY FEATURES

Breakaway mechanism, using standard C-MAX breakable washers, releases to give tail-first towing if tow force exceeds a nominal 0.75kN (75kg)

7. ENVIRONMENT

Operating depth
0-2000m
Operating speed
1-8 knots (but note that the physical limitations of cable drag and layback may limit operating speed)
Maximum towing speed
12 knots

8. MECHANICAL

Construction
stainless steel (no aluminium)
Towfish dimensions and weights
1.24m length
DF type: 18.0kg in air, 12.2kg in seawater
EDF type: 17.1kg in air, 11.3kg in seawater
Towfish temperature range
-10 to +45°C operating
-20 to +50°C non-operating

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C-MAX



Appendix C Seamor Chinook ROV Specification Sheet

Sea Engineering, Inc. – Seamoor Chinook Inspection ROV



Seamoor Chinook Inspection ROV

Sea Engineering, Inc. Seamoor Chinook ROV is an industrial grade inspection ROV with capability to 1,000ft/300 meters. The chinooks compact profile allows for ease of use with minimal crew and mobilization onto smaller vessels of opportunity.

Standard Equipment and Hardware

- High Resolution Color, Zoom Camera with Pan and Tilt and Aft Camera
- Auto Depth and Heading
- Tether-launchable
- Applied Acoustics USBL
- 6ea. 150W Electric Thrusters with 4 at Stern for Higher Waterflow Capacity
- Dual Function Gripper
- 2ea. 1,500 Lumens Dimmable Lights

Optional Equipment

- CT / UT Probe Integration
- Cutter
- Scanning Sonar



Capabilities and Support

- Operates On Standard 120 Volt Power
- Immediate Mobilization and Ease of Deployment and Recovery from Vessels of Opportunity
- High Resolution Inspection Camera
- Basic Manipulator Functionality for Seafloor Object Recovery

www.seaengineering.com

863 N. Nimitz Hwy, Honolulu, HI 96817

808-563-3603



Appendix D Applied Acoustics EasyTrack USBL System Specification Sheet



Applied Acoustic Engineering Ltd
Marine House, Marine Park, Gapton Hall Road, Great Yarmouth, NR31 0NB, United Kingdom

Easytrak Lite USBL System, Model 2661



Key Features

- Accurate and stable USBL system
- Easy to operate
- Tracks on the horizontal
- Approved for military use

Easytrak Lite is an Ultra Short Baseline (USBL) underwater positioning and tracking system centred on a multi-element, single transducer that transmits and receives acoustic signals to dynamic subsea targets from which range, bearing and depth information can be determined. Designed for installation in a vessel's operations room, the main transmit and receive electronics power supply and digital signal processing have all been mounted within a rugged 2U enclosure for connection to a laptop or desktop PC.



Technical Specification

EASYTRAK LITE, MODEL 2661

Dimensions	19" Rackmount. 2U. 482 x 88 x 345mm
Serial communications	RS-232. USB to RS-232 adaptors available
Power requirements	90-250Vac at 50VA
PC requirements (min)	1.2GHz running Windows XP, Windows 7. USB or up to 3 x RS-232 port. Colour display, 1024 x 768. CD Rom drive
Data Output	AAE format, TP-2EC TP-EC W/PR, Simrad 300P, Simrad 309 (binary) \$PSIMSSB, \$PSIMSNS (One string after the other for each fix) \$GPRMC (Suitable for Coda Octopus 460P and others) KLEIN 3000, \$GPGGA and \$GPVTG
Compass Input	TCM-2.X, SGB-HTDS, SGB-HTDt, \$HEHDT, \$HDHDM, \$HDHDT, \$HDHdg
VRU Input	TCM-2.X, \$HCXDR, TSS1
GPS / DGPS Input	NMEA; GLL, GGA, RMC
Sync. Input	TTL type 5 Volt pulse. Triggers on rising edge.
Responder Output	Positive 12V pulse 5ms long



Easytrak Lite Technical Specification continued...

TRANSDUCER, TYPE ETM902C

Aluminium-Bronze transducer. May be tilted by 20° for towfish tracking

Dimensions	375 mm long x 100 mm diameter
Weight in air/water	9.5kg / 7 kg
Depth Rating	50 metres

TRANSDUCER CABLE

Diameter	12.8 mm nominal
Colour	Yellow
Length	20 – 60 metres standard lengths available
Connectors	Supplied
SWL	20 kg (Allows transducer to be deployed from cable)

ACCURACY/PERFORMANCE

(Accuracy is based on the correct speed of sound being entered, no ray bending and an acceptable S/N ratio)

Slant Range accuracy	10 cm
Position accuracy, standard	1.40° drms. 2.5% of slant range Acoustic accuracy excludes heading errors
Position accuracy, high	0.60° drms. 1.04% of slant range. Acoustic accuracy excludes heading errors
Bearing Resolution	0.1° displayed. Internally calculated to 0.01°
Heading sensor accuracy	0.8° rms standard. +/- 0.1° resolution/repeatability
Pitch/Roll sensor accuracy	+/- 0.2° rms. +/- 0.1° resolution/repeatability
Channels	4 channels displayed from 134 stored
Frequency Band (MF)	Reception 22 - 32kHz Transmission 17 - 26kHz
Tracking Beam Pattern	> Hemispherical
Beacon Types	Transponders, Responders and Pingers
Interrogation Rate	0.5 - 30 seconds or external key
Transmit Power	178/185/190dB software controlled
CE Marking	Externally assessed for immunity and missions. Conforms to 89/336/EEC



APPLIED ACOUSTICS
Underwater Technology

Due to continual product improvement, specification information may be subject to change without notice.
Easytrak lite, Model 2661/June 2015
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Appendix E Flight Aware Track for Flight 810

Time (EDT)	Latitude	Longitude	Course	kts	mph	feet	Rate	Reporting Facility
Fri 07:33:58 AM Departure (HNL) @ Friday 01:33:58 AM HST								FA FlightAware ADS-B (JRF / PHJR)
Fri 07:33:58 AM	21.3063	-157.9229	→ 94°	138	159	500		FA FlightAware ADS-B (JRF / PHJR)
Fri 07:34:14 AM	21.3054	-157.9109	→ 95°	139	160	1,000	↑ 938	FA FlightAware ADS-B (PHNL)
Fri 07:34:30 AM	21.3012	-157.8996	↘ 117°	167	192	1,000	↑ 422	FA FlightAware ADS-B (PHHI)
Fri 07:34:46 AM	21.2904	-157.8889	↘ 146°	201	231	1,225	↑ 1,219	FA FlightAware ADS-B (PHNL)
Fri 07:35:02 AM	21.2775	-157.8829	↓ 161°	213	245	1,650	↑ 1,641	FA FlightAware ADS-B (PHIK)
Fri 07:35:18 AM	21.2602	-157.8817	↓ 184°	232	267	2,100	↑ 422	FA FlightAware ADS-B (PHIK)
Fri 07:35:34 AM	21.2416	-157.8875	↗ 202°	272	313	1,875	↓ -107	FA FlightAware ADS-B (BSF / PHSF)
Fri 07:36:00 AM	21.2148	-157.9056	↗ 218°	282	325	2,025	↑ 200	FA FlightAware ADS-B (OGG / PHOG)
Fri 07:36:19 AM	21.1971	-157.9234	↗ 228°	278	320	2,025	↓ -385	FA FlightAware ADS-B (OGG / PHOG)
Fri 07:36:39 AM	21.1779	-157.9454	↗ 230°	276	318	1,775	↓ -415	FA FlightAware ADS-B (PHHI)
Fri 07:37:06 AM	21.1622	-157.9753	↗ 245°	264	304	1,700	↑ 59	FA FlightAware ADS-B (OGG / PHOG)
Fri 07:37:30 AM	21.1518	-158.004	← 250°	240	276	1,825	↑ 263	FA FlightAware ADS-B (PHNL)
Fri 07:37:46 AM	21.1463	-158.0201	← 250°	225	259	1,875	↓ -107	FA FlightAware ADS-B (PHNL)
Fri 07:38:12 AM	21.1351	-158.047	↗ 241°	215	247	1,750	↓ -125	FA FlightAware ADS-B (JRF / PHJR)
Fri 07:38:34 AM	21.1274	-158.0663	← 256°	202	232	1,775	↓ -154	FA FlightAware ADS-B (OGG / PHOG)
Fri 07:38:51 AM	21.1223	-158.083	↗ 245°	197	227	1,650	↓ -600	FA FlightAware ADS-B (PHNL)
Fri 07:39:09 AM	21.1148	-158.0996	← 250°	203	234	1,425	↓ -608	FA FlightAware ADS-B (PHNL)
Fri 07:39:28 AM	21.1144	-158.1171	← 286°	198	228	1,275	↓ -486	FA FlightAware ADS-B (PHNL)
Fri 07:39:46 AM	21.1233	-158.1331	← 309°	191	220	1,125	↓ -214	FA FlightAware ADS-B (PHHI)
Fri 07:40:03 AM	21.1329	-158.1429	↘ 323°	174	200	1,150	↓ -529	FA FlightAware ADS-B (OGG / PHOG)
Fri 07:40:20 AM	21.1452	-158.1494	↑ 342°	173	199	825	↓ -833	FA FlightAware ADS-B (PHNL)
Fri 07:40:39 AM	21.1597	-158.1521	↑ 356°	173	199	650	↓ -257	FA FlightAware ADS-B (OGG / PHOG)
Fri 07:40:55 AM	21.1727	-158.1505	↑ 16°	157	181	675	↓ -132	FA FlightAware ADS-B (PHNL)
Fri 07:41:13 AM	21.1835	-158.1445	↗ 35°	151	174	575	↓ -353	FA FlightAware ADS-B (PHNL)
Fri 07:41:29 AM	21.1918	-158.1365	↗ 46°	151	174	475	↓ -188	FA FlightAware ADS-B (JRF / PHJR)
Fri 07:41:45 AM	21.1988	-158.1277	↗ 50°	145	167	475	↓ -188	FA FlightAware ADS-B (PHHI)
Fri 07:42:01 AM	21.2064	-158.1192	↗ 45°	146	168	375	↓ -188	FA FlightAware ADS-B (PHHI)
Fri 07:42:17 AM	21.214	-158.111	↗ 46°	142	163	375	↓ -94	FA FlightAware ADS-B (PHNL)
Fri 07:42:33 AM	21.221	-158.1025	↗ 49°	137	158	325	↓ -234	FA FlightAware ADS-B (PHHI)
Fri 07:42:49 AM	21.2276	-158.0951	↗ 45°	139	160	250	↓ -94	FA FlightAware ADS-B (PHNL)
Fri 07:43:05 AM	21.2355	-158.0871	↗ 43°	132	152	275	↓ -47	FA FlightAware ADS-B (PHNL)
Fri 07:43:21 AM	21.2425	-158.0796	↗ 47°	132	152	225	↓ -47	FA FlightAware ADS-B (PHNL)
Fri 07:43:37 AM	21.2477	-158.072	↗ 58°	125	144	250	↓ -94	FA FlightAware ADS-B (JRF / PHJR)
Fri 07:43:53 AM	21.2511	-158.0634	→ 71°	126	145	175	↓ -188	FA FlightAware ADS-B (PHIK)
Fri 07:44:09 AM	21.2542	-158.0531	→ 72°	124	143	150		FA FlightAware ADS-B (PHNL)
Fri 07:44:25 AM	21.2572	-158.0447	→ 68°	114	131	175	↓ -141	FA FlightAware ADS-B (PHHI)
Fri 07:44:41 AM	21.2613	-158.0358	↗ 57°	118	136	75	↓ -156	FA FlightAware ADS-B (PHNL)
Fri 07:44:57 AM	21.2671	-158.0294	↗ 36°	120	138		↓ -47	FA FlightAware ADS-B (PHNL)
Fri 07:45:13 AM	21.2748	-158.0259	↑ 14°	113	130	50	↑ 188	FA FlightAware ADS-B (OGG / PHOG)
Arrival (OGG) @ Friday 02:06:16 AM HST								FA FlightAware

<https://flightaware.com/live/flight/RDS810/history/20210702/1100Z/PHNL/PHOG/tracklog>

Appendix F Additional Side Scan Survey Results and Discussion

The side scan survey was conducted in less-than-ideal conditions. Sea state, combined with the requirement to keep the survey vessel at lower speeds to obtain the proper depth for the side scan sonar, resulted in challenges for the captain to follow straight survey lines. These conditions limited the ability of the side scan processing software to provide the standard map mosaic in Hypack.

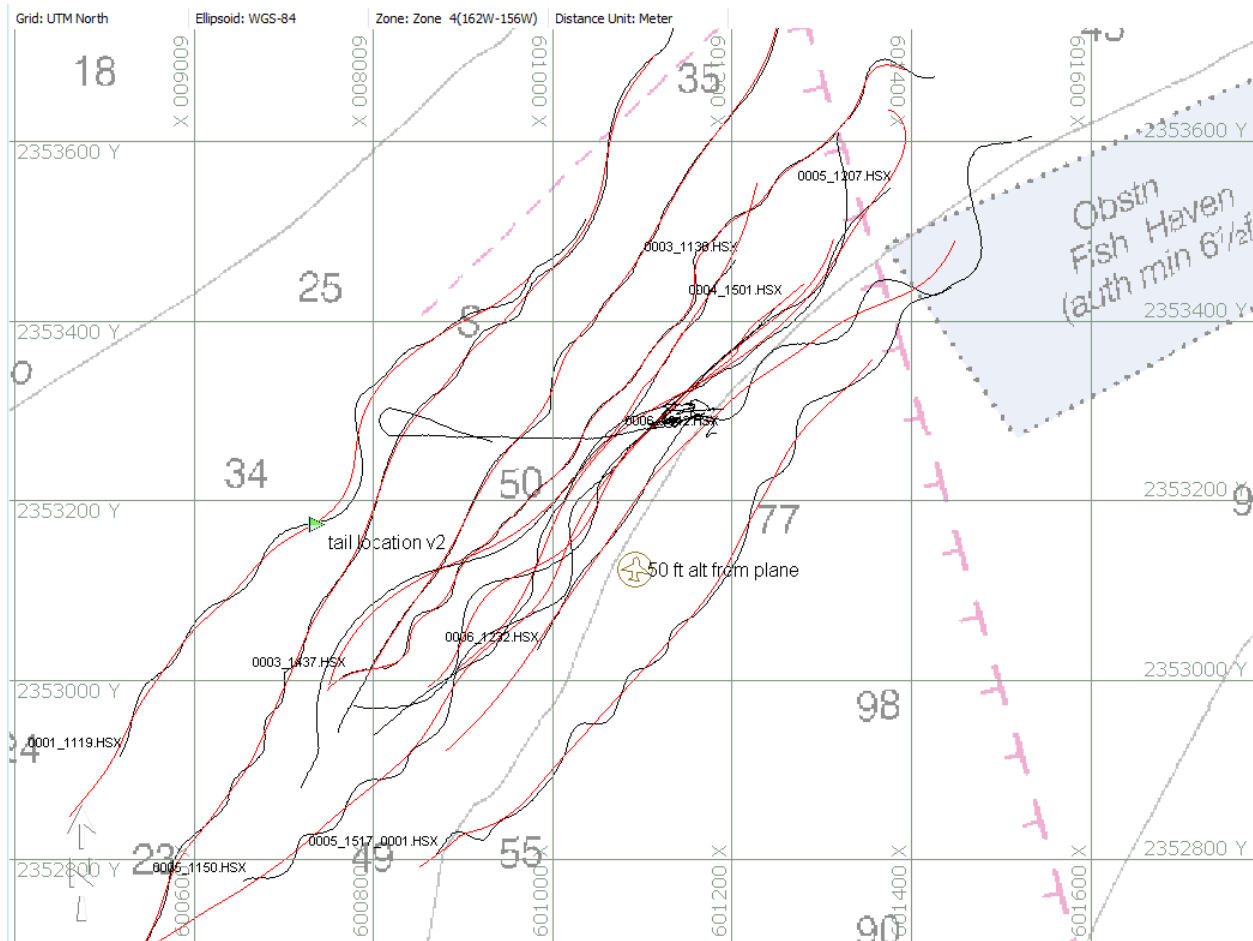


Figure 35 Tracklines from Side Scan Survey on Day 2

Initial side scan survey operations were conducted in shallower waters than the final resting place of the tail and cockpit sections. Additionally, the depths of the tail and cockpit were near the maximum survey depths for the C-MAX side scan unit. The addition of weight of the chain attached to the cable allowed the sonar to fly deeper in the water column. Images of the tail section and cockpit without the chain are not identifiable. Figure 36 and Figure 37 show the side scan images of the plane from downslope and upslope survey lines, respectively.

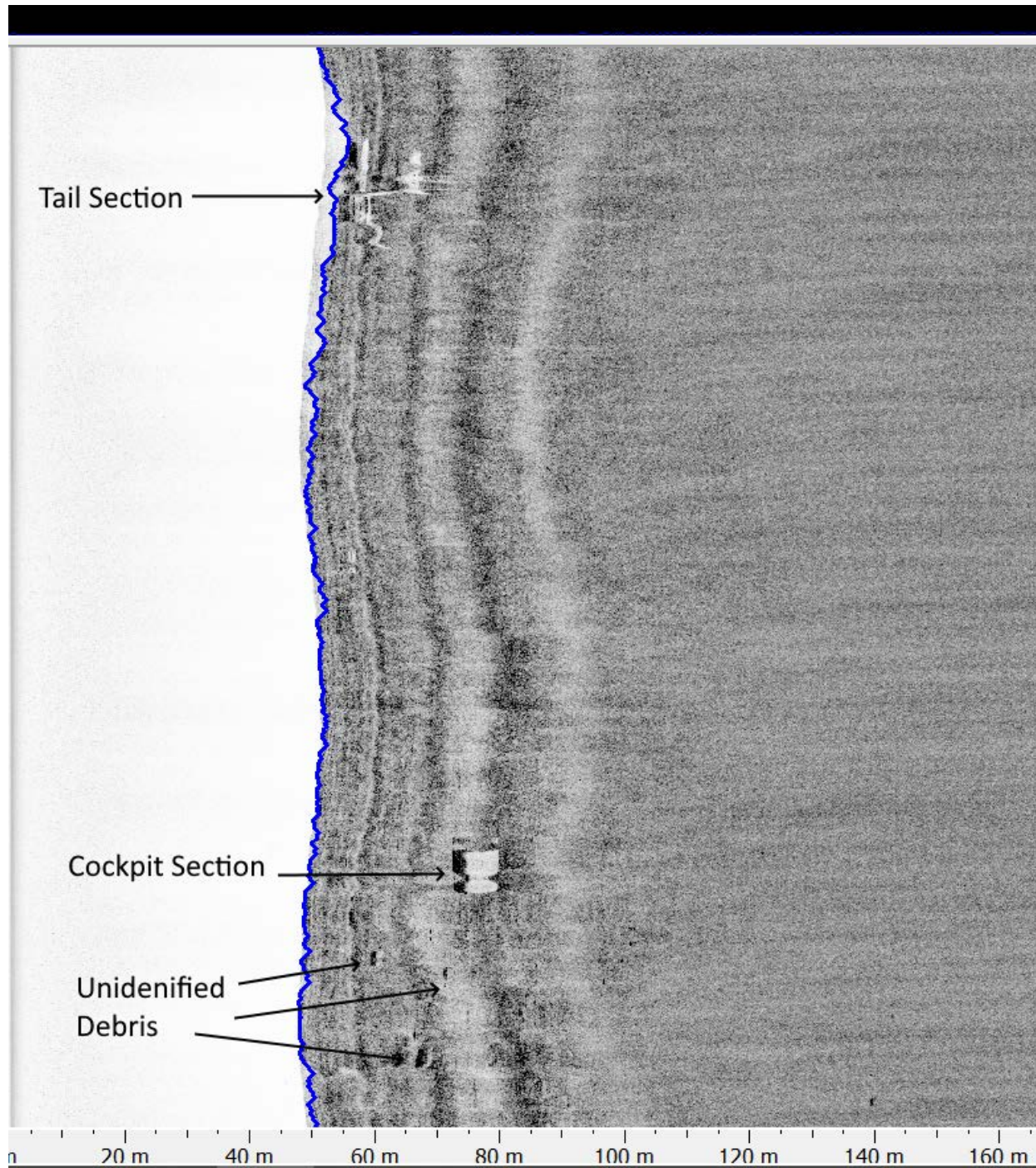


Figure 36 Side Scan Survey Image (down slope)

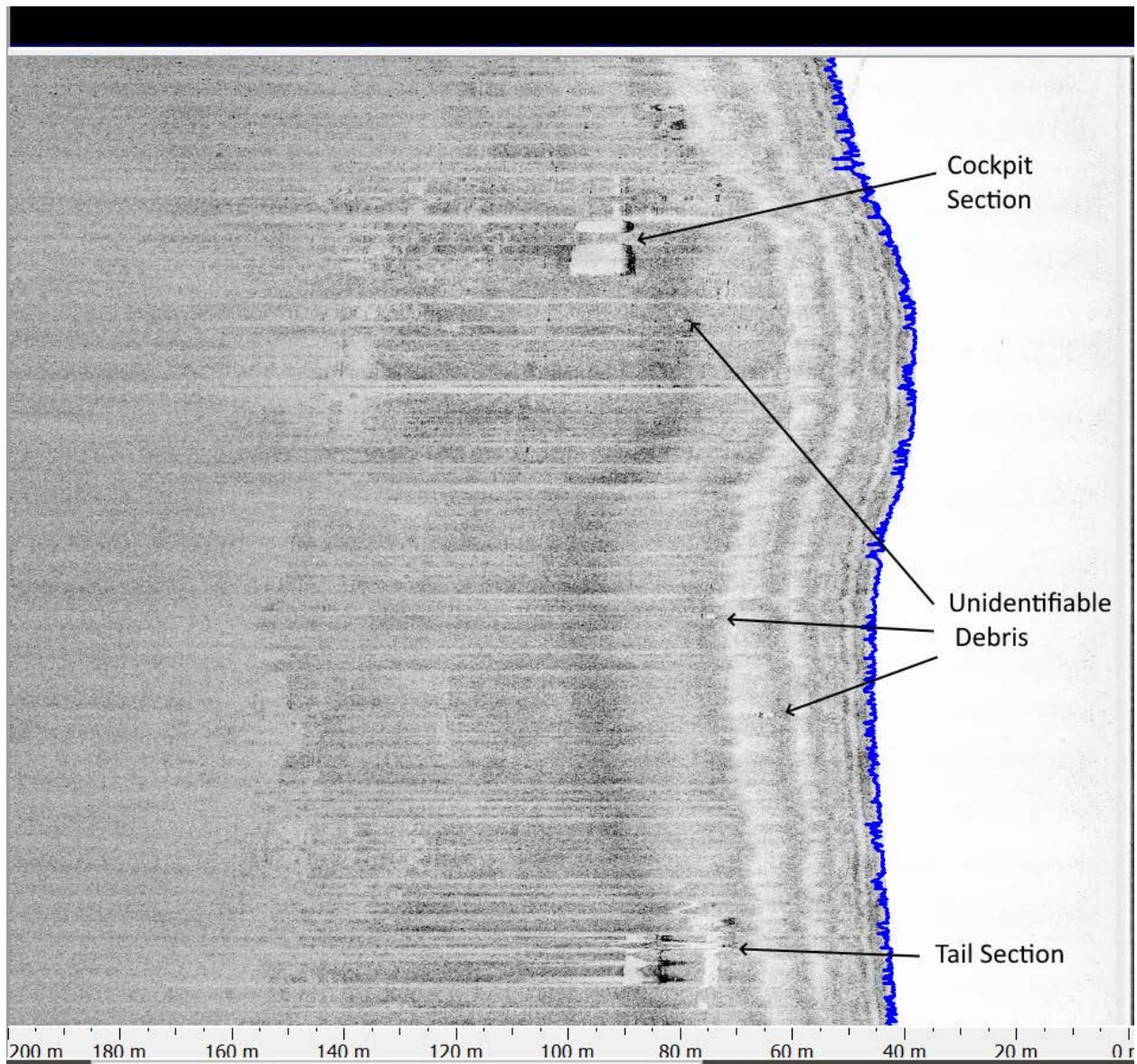


Figure 37 Side Scan Survey Image (Upslope)

Appendix G USBL Tracking Data

The black line in Figure 38 shows the ROV position for the last two days of the ROV survey. The targets are labeled in light blue. The tracklines for the ROV are quite jittery. This is due to the multiple sensors used to calculate a position. The USBL's hydrophone must determine the direction/bearing and slant angle from the return ping produced by the transponder on the ROV. Additionally, the constantly variable orientation of the hydrophone must be accounted for in the calculation. The speed of sound is used to calculate the range/distance to the ROV. An estimate for the speed of sound was used rather than completing sound speed profile that would have taken time from the other survey operations.

A simple way to improve the position data is to average position over time. The positions reported are averaged over 15 seconds.

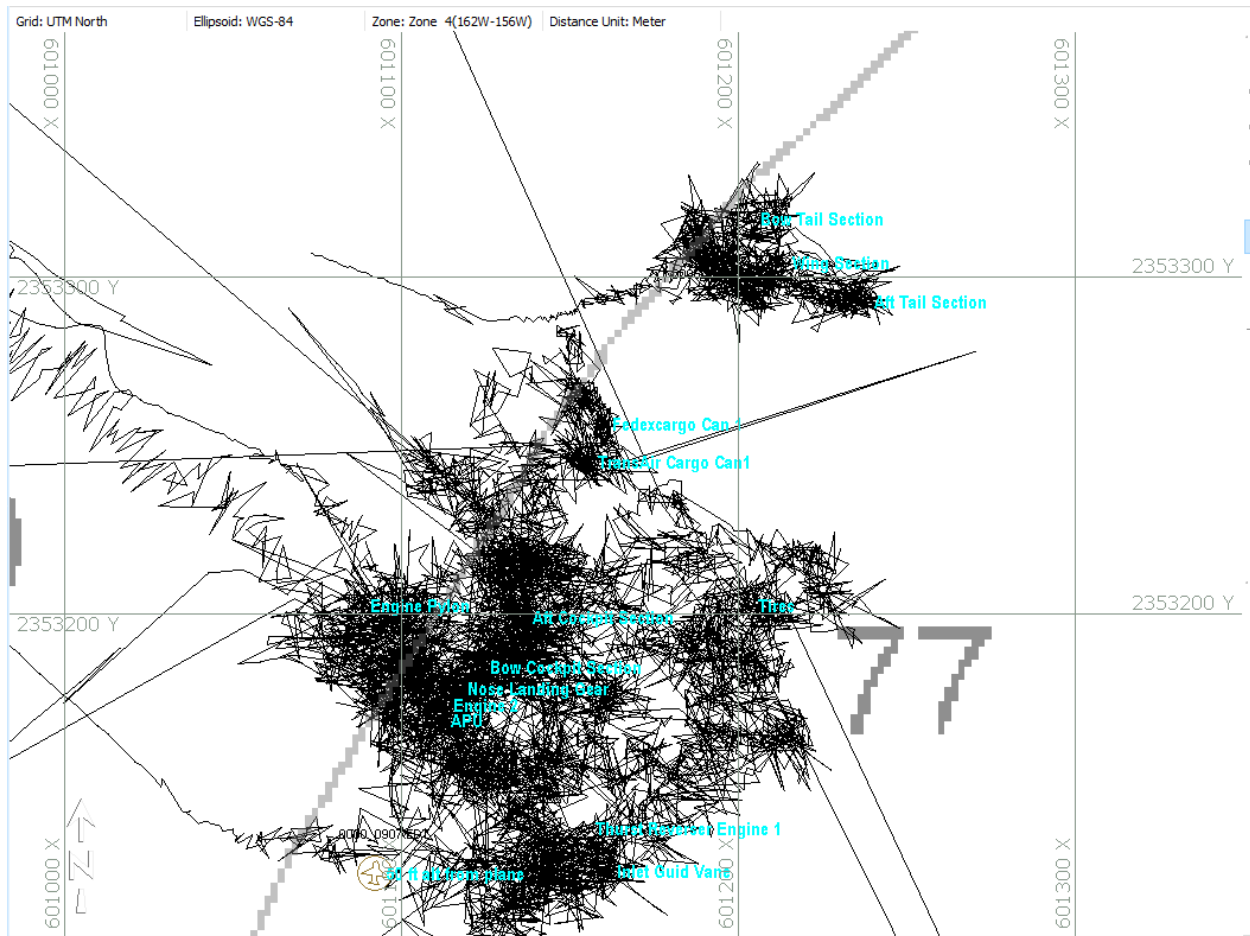


Figure 38 USBL Trackline Data