H13413

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

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	H13413

LOCALITY

State(s):	Washington
General Locality:	Elliott Bay
Sub-locality:	Elliott Bay

2020

CHIEF OF PARTY
Michelle M. Levano, LTJG/NOAA

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Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13413**

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):	**Washington**
General Locality:	**Elliott Bay**
Sub-Locality:	**Elliott Bay**
Scale:	**5000**
Dates of Survey:	**10/27/2020 to 12/07/2020**
Instructions Dated:	**10/23/2020**
Project Number:	**S-N923-NRT3-20**
Field Unit:	**NOAA Navigation Response Team - Seattle**
Chief of Party:	**Michelle M. Levano, LTJG/NOAA**
Soundings by:	**EM 2040C Multibeam Echo Sounder Multibeam Echo Sounder**
Imagery by:	**Multibeam Echo Sounder Backscatter**
Verification by:	**Pacific 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 10N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

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Descriptive Report to Accompany Survey H13413

Project: S-N923-NRT3-20

Locality: Elliott Bay

Sublocality: Elliott Bay

Scale: 1:5000

October 2020 - December 2020

NOAA Navigation Response Team - Seattle

Chief of Party: Michelle M. Levano, LTJG/NOAA

A. Area Surveyed

The survey area is located in Puget Sound, WA within the sub locality of Elliott Bay. (Figure 1). The name of the bay was changed to Elliott Bay after a member of Lieutenant Charles Wilkes expedition exploring Puget Sound in 1841.

Earlier charts of the area show the bay named Duwamish Bay (Figure 2) after the indigenous people living in the area known as the Duwamish (dx#d#w#abš). From tribal historian David Buerge : "Whulj (means) saltwater. The people who lived beside the Whulj and had adapted most to its traits and resources were the Whulja'hbsh, "Saltwater people," sometimes written as Swhulja'hbash, the 's' signalling, 'here comes a noun'. Sometimes parts of Puget Sound, or rather its shore, had separate names describing its particular shape. The name Txwduwa'hbsh, 'Where it goes inside,' particularly the morpheme duw, 'inside', referred in passing to the river entrance's big bay, extensive mudflats and clutch of delta islands as the tide funneled from the bay into the estuary for many miles to the point where, at periods of high water, the inflow reversed the direction of the Black River so that it entered Lake Washington." The River entering into Elliott Bay from the south still bares this name and the Duwamish have a Longhouse and cultural center on its banks despite the current lack of federal recognition as a tribe.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
47° 37' 58.66" N 122° 23' 47.42" W	47° 34' 59.42" N 122° 20' 13.73" W

Table 1: Survey Limits

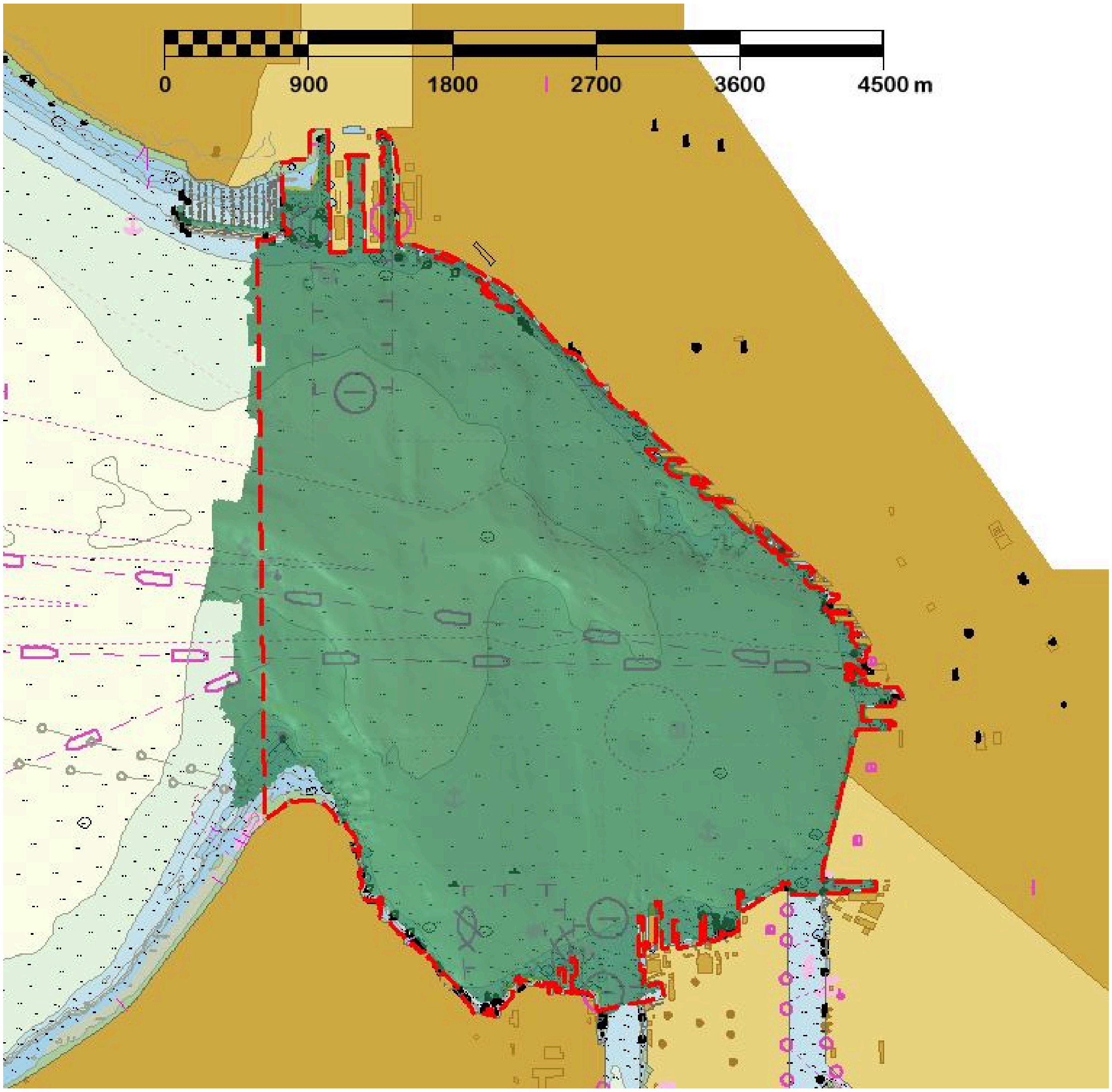
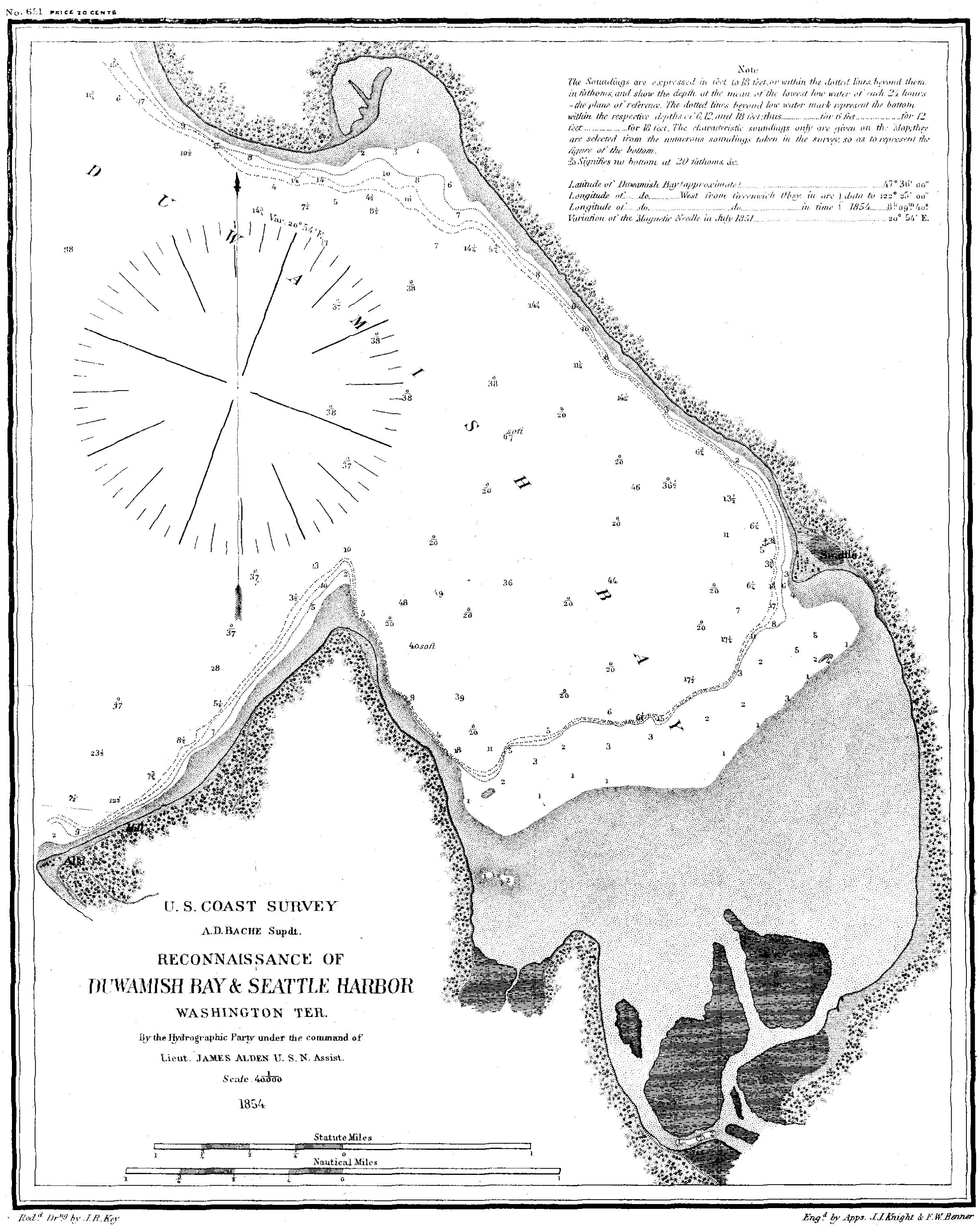


Figure 1: H13413 sheet limits on ENC US5WA15M



From the Image Archives of the Historical Map & Chart Collection
Office of Coast Survey/National Ocean Service/NOAA

Figure 2: 1854 Survey of Duwamish Bay and Seattle Harbor

Data were acquired to the survey limits in accordance with the requirements in the Project Instructions and the May 2020 NOS Hydrographic Surveys Specifications and Deliverables (HSSD) with the exceptions noted bellow.

In all areas where the 3.5 meter depth contour or the sheet limits were not met, the Navigable Area Limit Line (NALL) was defined as the inshore limit of bathymetry due to the risks of maneuvering the survey vessel in close proximity to the shoreline, shoreline construction and obstructions (Figure 3). Most of the inshore limits of H13413 are defined by developed shoreline.

In addition to the inshore limits, there are two places in deeper water where the survey bounds where not fully reached due to sonar and/or hydrographer error that were not noticed prior to leaving the survey grounds. (Figure 4)

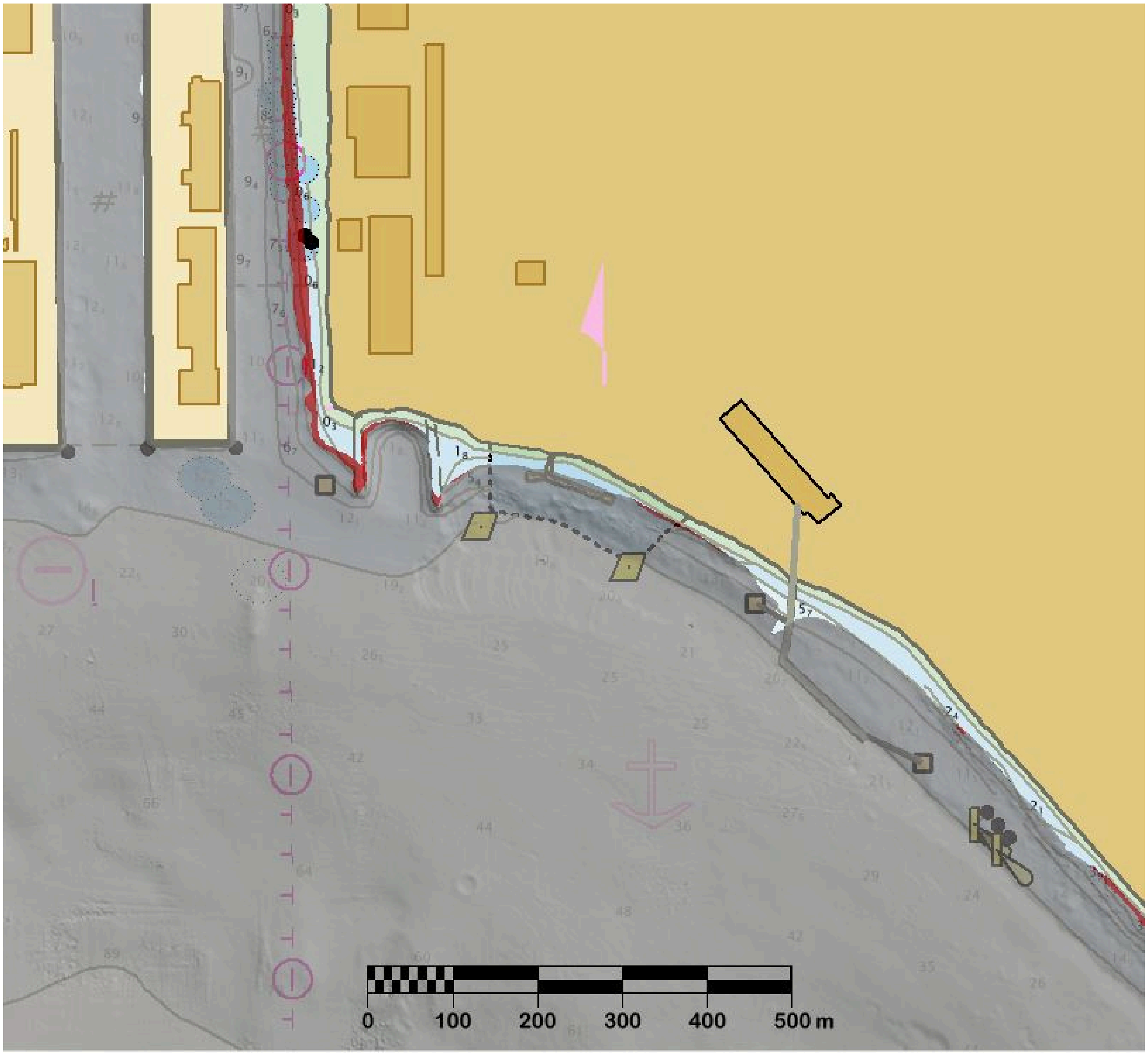


Figure 3: An example of areas where NALL is defined by shoreline and maneuverability (gray up to edge)and areas where the inshore limit of 3.5 was met (in red).

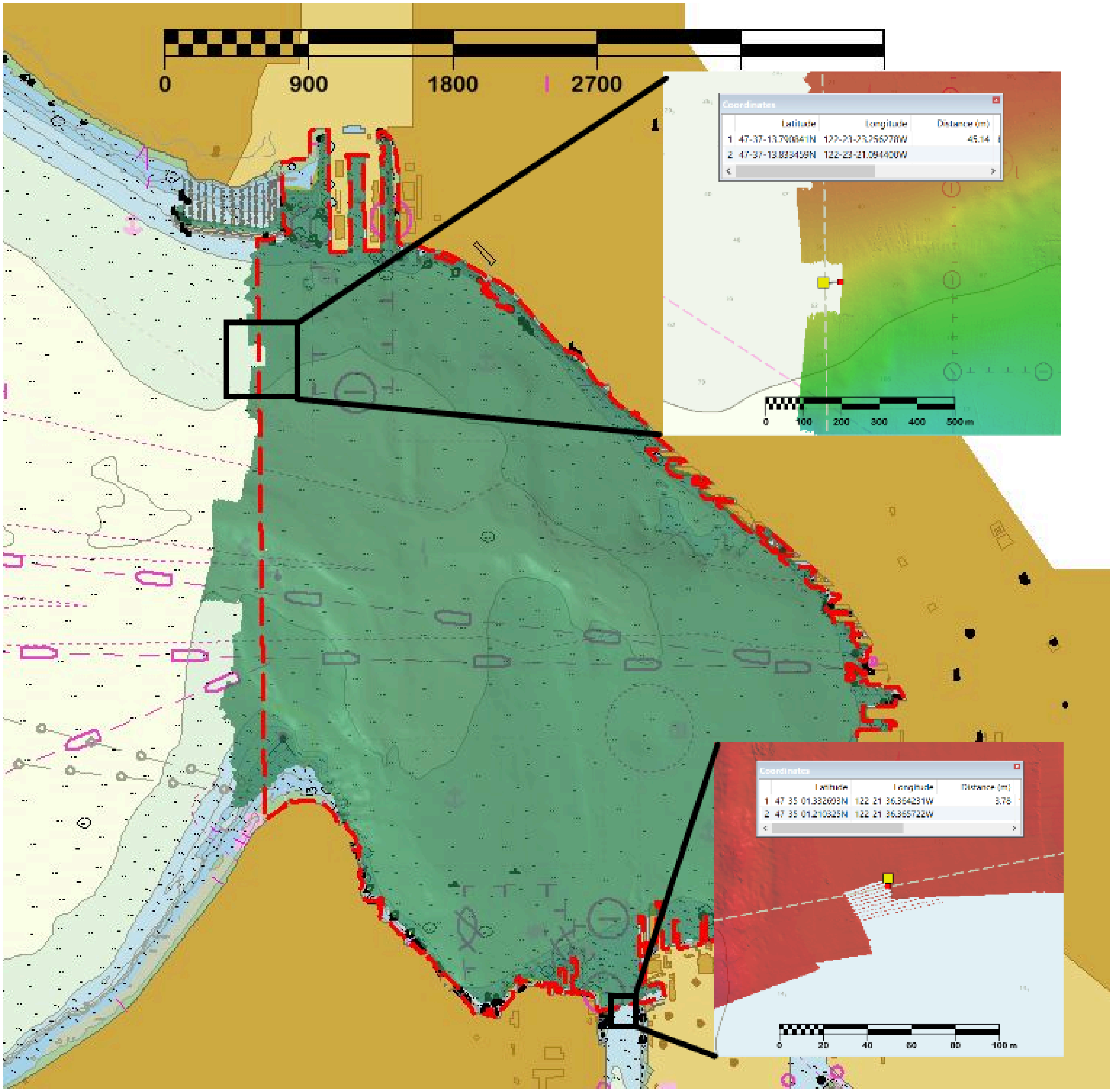


Figure 4: Locations where H13413 assigned sheet limits not meet due to hydrographer error (NW) and sonar error (S central).

A.2 Survey Purpose

Pilots have requested a hydrographic survey near Seattle in Elliott Bay due to larger draft vessels and cruise ships transiting to the port of Seattle. There are reports of shoaling in the area and under keel clearance issues. Survey data from this project is intended to supersede all prior survey data in the common area.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

Data acquired in H13413 meets multibeam echo sounder (MBES) coverage requirements for object detection, as required by the HSSD. This includes crosslines (see Section B.2.1), NOAA allowable uncertainty (see Section B.2.10), and density requirements (see Section B.2.11).

The surface was analyzed using the HydrOffice QC Tools Grid QA feature (Figure 5-6). Density requirements for h13413 were achieved with at least 99.5% of surface nodes containing five or more soundings as required by HSSD Section 5.2.2.3. The few nodes that did not meet density requirements are due to sparse data in the outer beams, slopes and rocky areas where acoustic shadowing occurred, and at the edges of the survey limits.

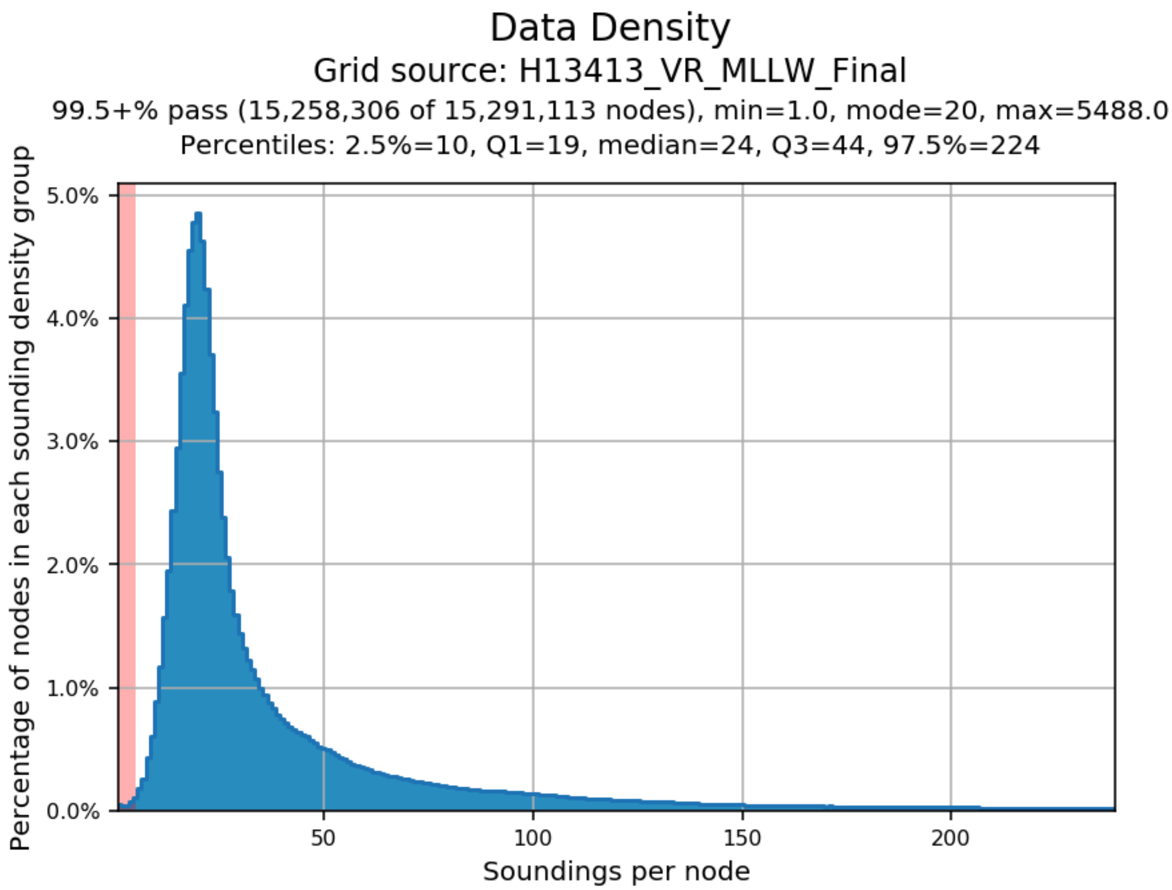


Figure 5: Pydro derived histogram plot showing HSSD object detection compliance for H13413 MBES within the finalized CUBE surface.

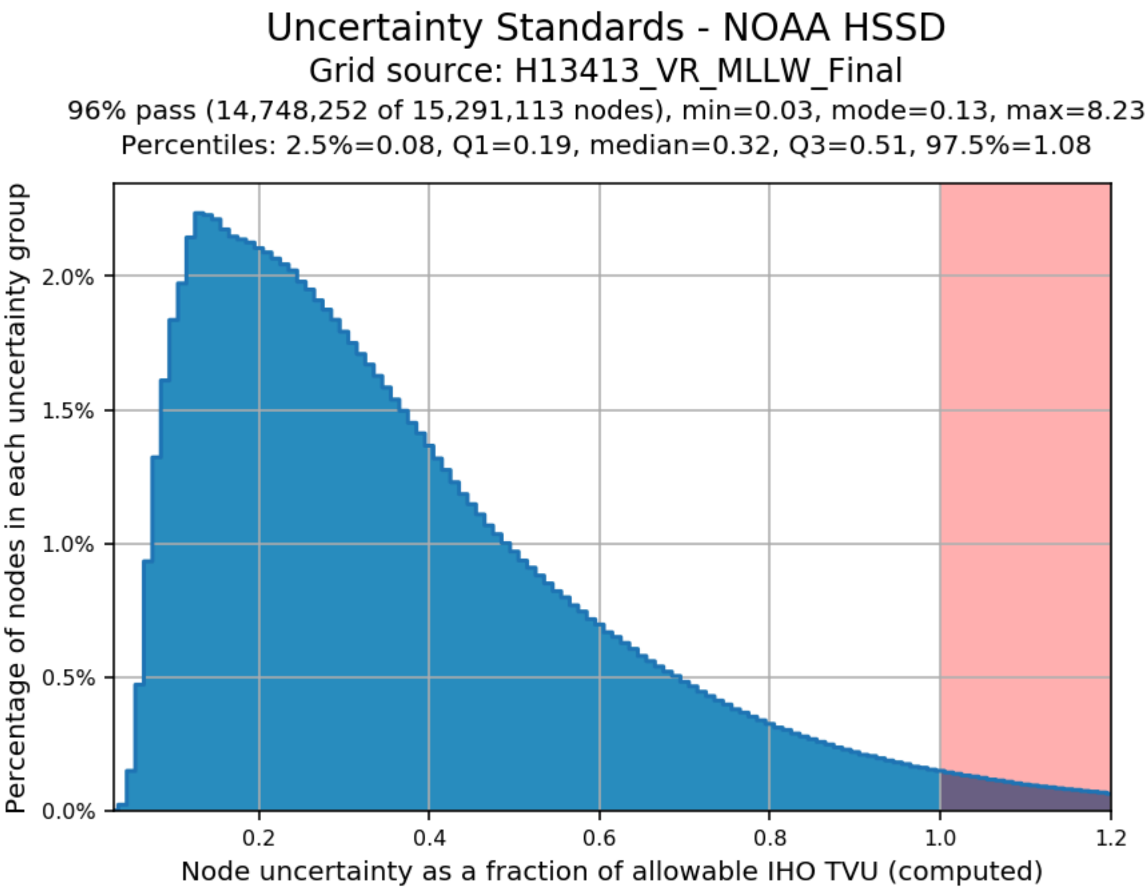


Figure 6: Uncertainty distribution for H13413

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 survey area	Object Detection Coverage (Refer to HSSD Section 5.2.2.2)

Table 2: Survey Coverage

Data were acquired for H13413 in accordance with the requirements in the Project Instructions and the May 2020 NOS HSSD (Figure 6) with the exceptions noted bellow.

H13413 data were reviewed in CARIS HIPS and SIPS for holidays in accordance with Section 5.2.2.3 of the HSSD. HydrOffice QC Tools Holiday Finder tool identified 186 holidays using 'object detection' settings. This tool automatically scans the surface for holidays as defined in the HSSD and was run in conjunction with a visual inspection of the surface by the hydrographer.

The vast majority of gaps in coverage are present at the inshore limits of H13413. The shoreline of Elliott Bay is heavily developed with piers, floating docks, piles, breakwaters and other shoreline construction. Bearing features from shoreline construction where manually removed from the data resulting in the majority of the data gaps flagged by flier finder in and around shoreline construction (Figure 8). Near shore gaps in coverage are also present as a result of sparse outer beam data developing the inshore limit of safe navigation (NALL). These gaps were not met due to the proximity of the shoreline and safety concerns.
The presence of moored vessels also lead to data gaps and restricted inshore limits. Reasonable attempts were made to cover all gaps in coverage that resulted from moored vessels but some data gaps remain as their presence prohibited further collection of data in and around them (Figure 9).

Additional data gaps are present in the shallower areas of the survey but fall within areas otherwise designated as foul ground (Figure 10) or sea grass areas (Figure 21). These areas are included in the Final Feature File (FFF).

The remaining data gaps are due to lack of density of coverage in deeper waters (Figure 11). The surfaces were carefully reviewed and no navigational significant features were noted in the vicinity of the density holidays and given the depths the surface is deemed sufficient to supersede previous data.

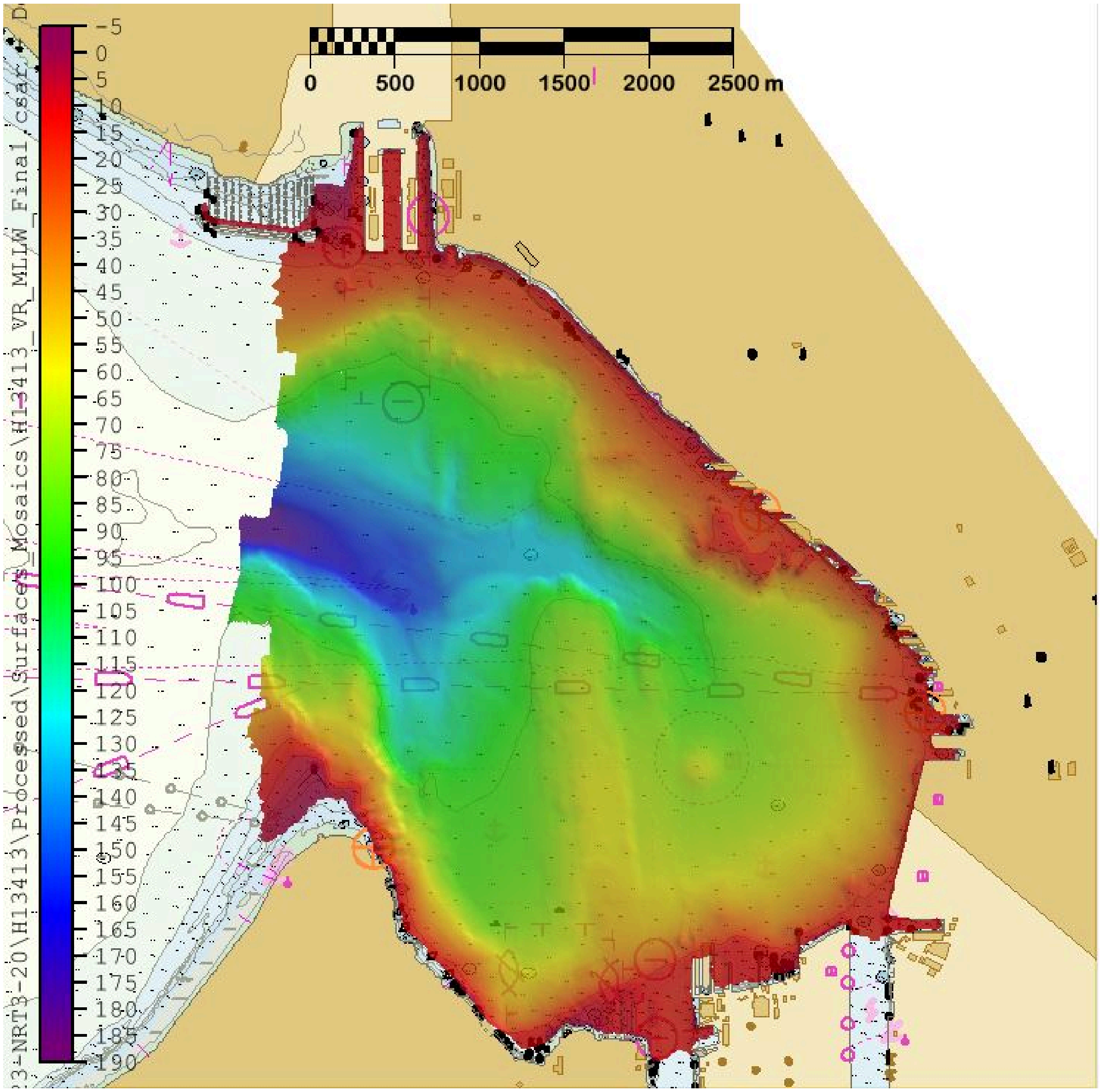


Figure 7: H13413 survey coverage on ENC US5WA15M

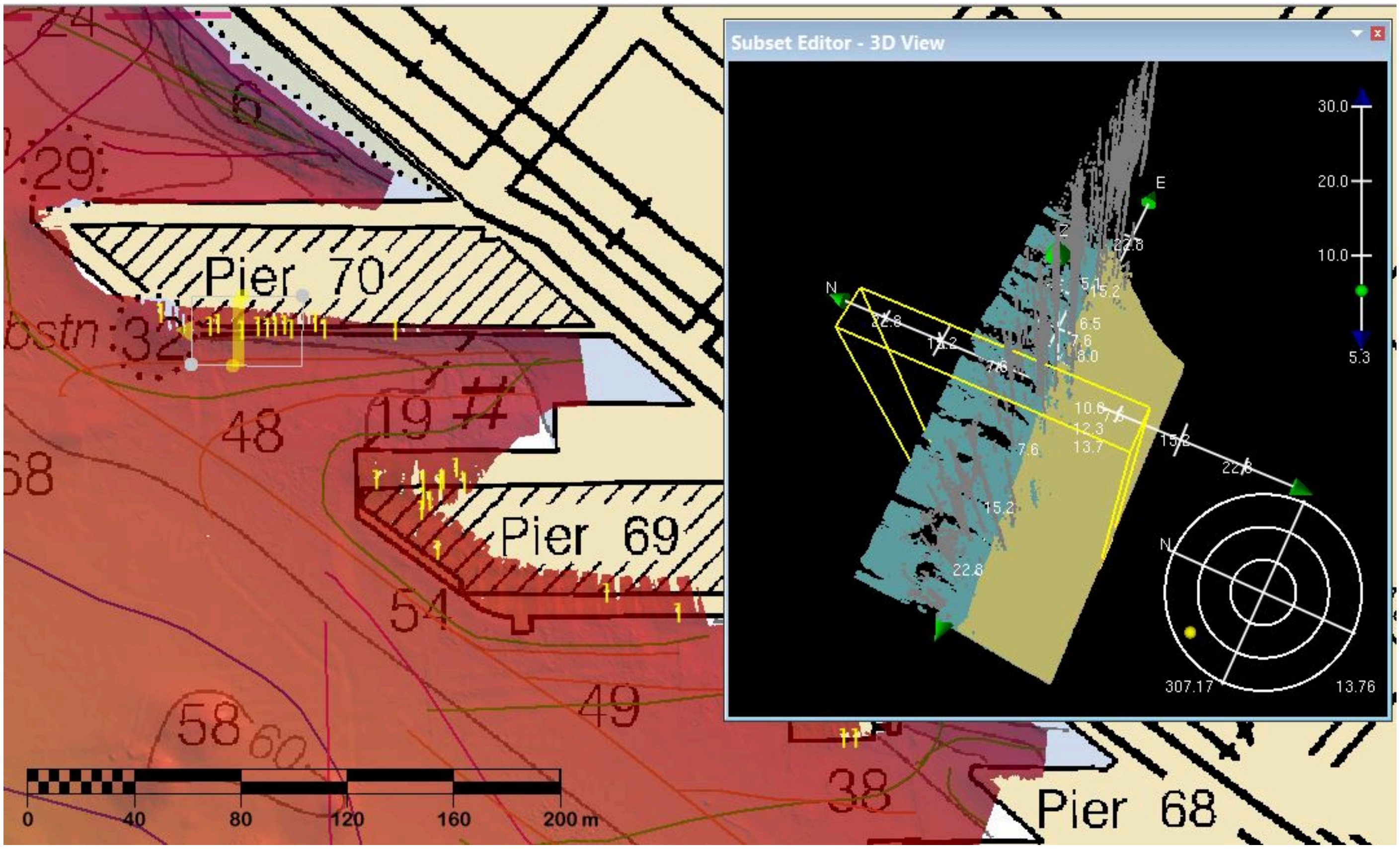


Figure 8: Inshore data gaps around shoreline construction. Yellow '1' show locations of gaps. Subset window on right shows piles cleaned out of data in gray.

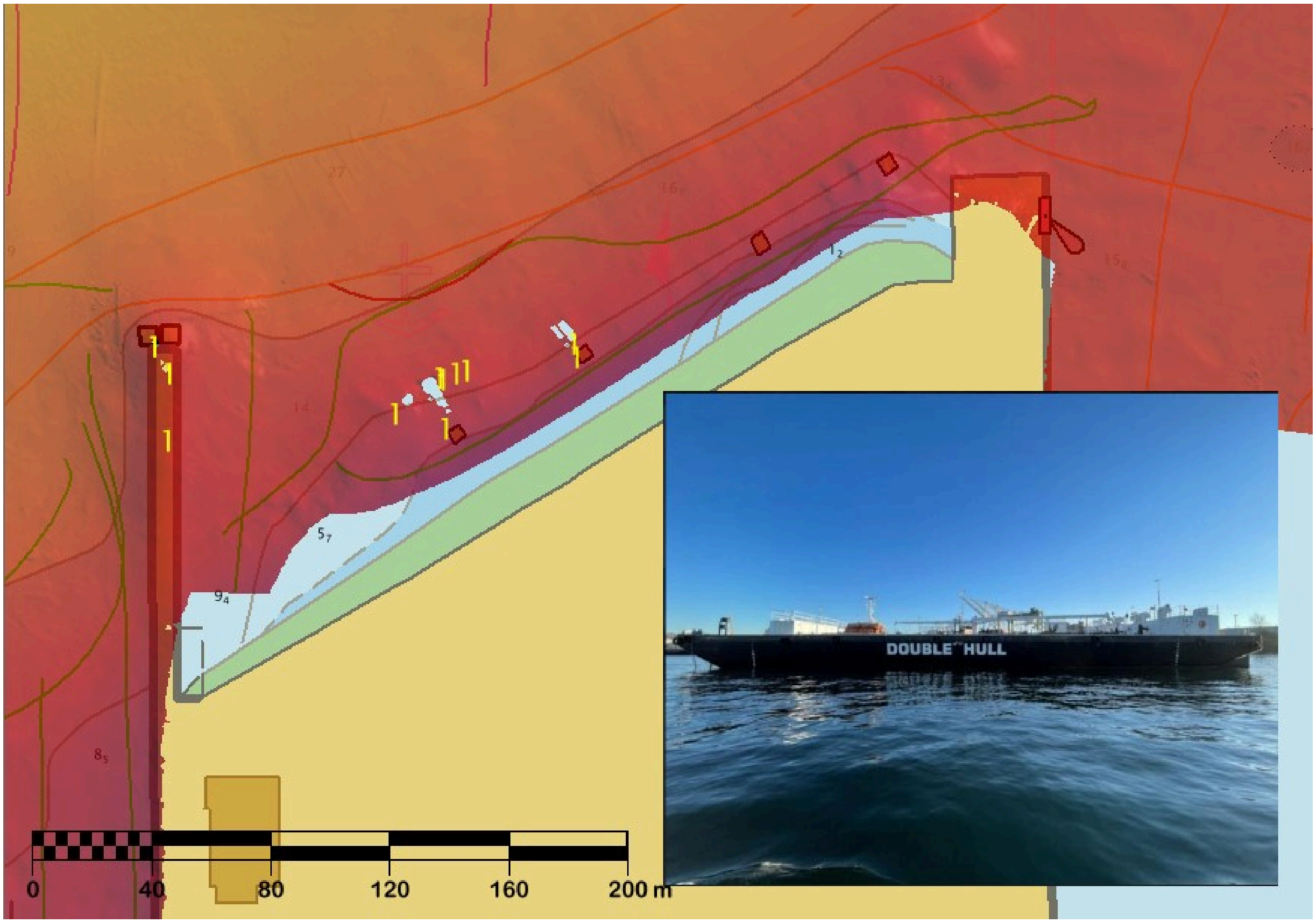


Figure 9: Gaps in coverage near charted dolphins on along the southern end of the sheet due to moored barge.

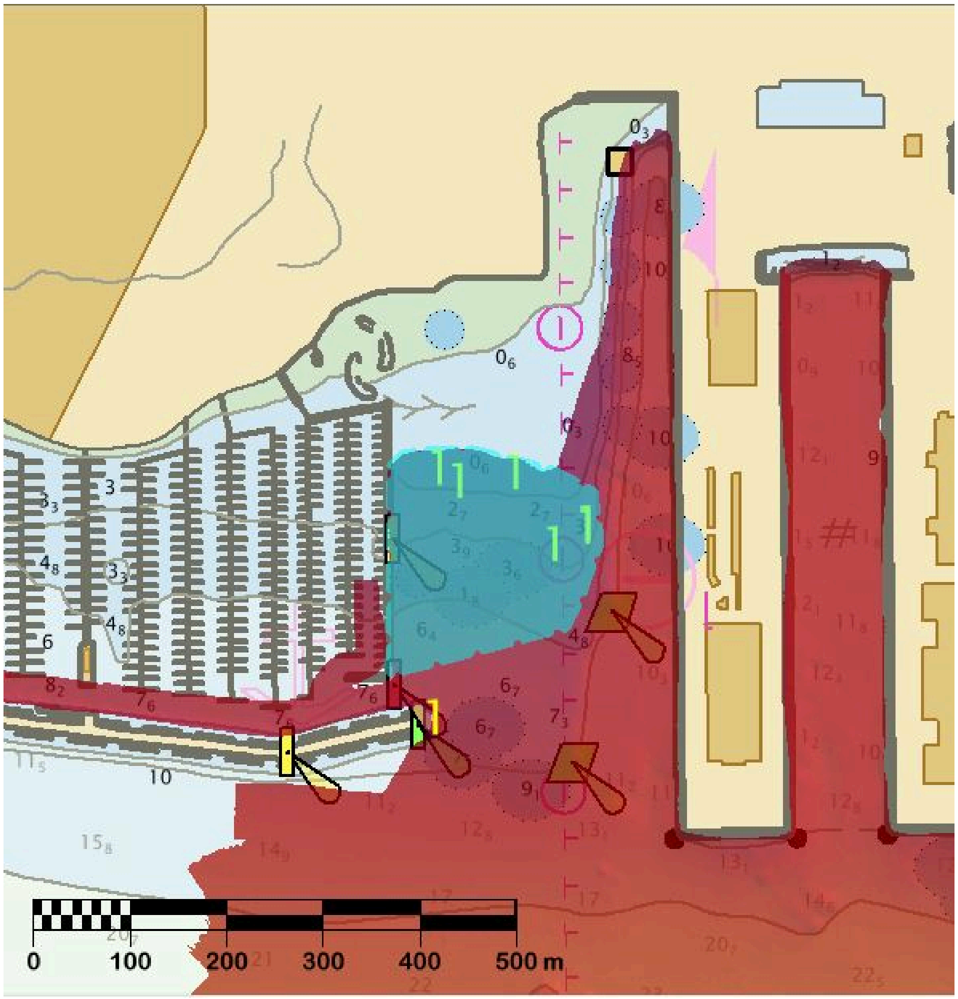


Figure 10: Data gaps in Foul Ground area (blue highlight) near Elliott Bay Marina on the North of the sheet. Yellow '1' show locations of gaps.

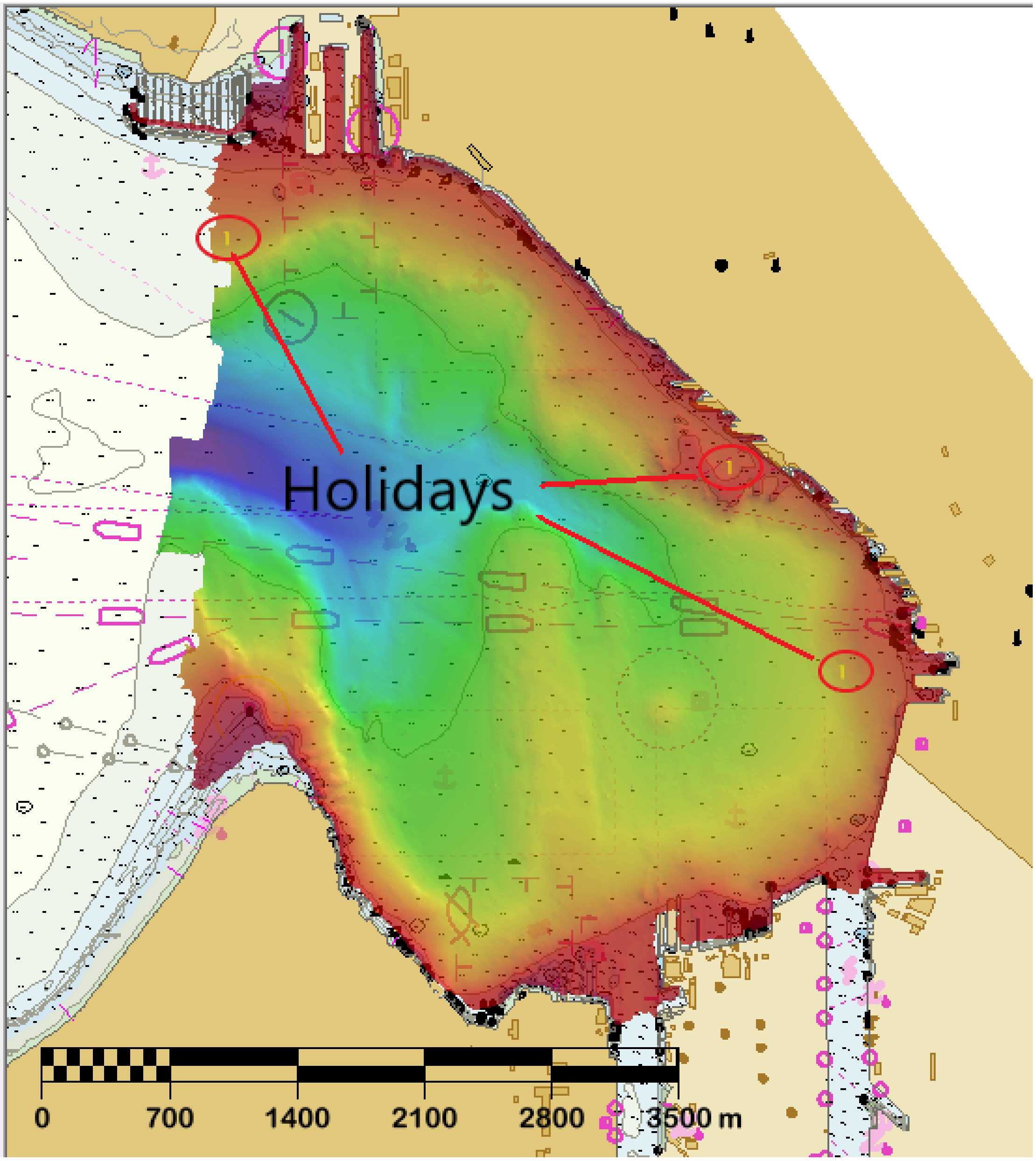


Figure 11: Location of Density data gaps in deeper waters

A.6 Survey Statistics

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

	HULL ID	*NRT3_S3006*	*Total*
LNM	**SBES Mainscheme**	0	0
	MBES Mainscheme	97.913	97.913
	Lidar Mainscheme	0	0
	SSS Mainscheme	0.0	0.0
	SBES/SSS Mainscheme	0	0
	MBES/SSS Mainscheme	0	0
	SBES/MBES Crosslines	11.4943	11.4943
	Lidar Crosslines	0	0
Number of Bottom Samples			0
Number Maritime Boundary Points Investigated			0
Number of DPs			0
Number of Items Investigated by Dive Ops			0
Total SNM			3.94

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
10/27/2020	301
10/28/2020	302

Survey Dates	Day of the Year
10/29/2020	303
11/02/2020	307
11/03/2020	308
11/09/2020	314
11/10/2020	315
11/16/2020	321
11/18/2020	323
11/25/2020	330
12/01/2020	336
12/02/2020	337
12/03/2020	338
12/04/2020	339
12/07/2020	342

Table 4: Dates of Hydrography

This survey was collected from 10/27 to 12/07 with NRT-Seattle team members, with the additional assistance of ENS Samuel "Harper" Umfress and ENS Patrick Faha.

B. Data Acquisition and Processing

B.1 Equipment and Vessels

Refer to the S-N923-NRT3-20 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	***NRT3_S3006***
LOA	10.5 meters
Draft	1.2 meters

Table 5: Vessels Used

Figure 12: S3006

B.1.2 Equipment

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

Manufacturer	Model	Type
Kongsberg Maritime	EM 2040C	MBES
AML Oceanographic	MicroX SV	Sound Speed System
YSI	CastAway-CTD	Conductivity, Temperature, and Depth Sensor
Applanix	POS MV 320 v5	Positioning and Attitude System

Table 6: Major Systems Used

The equipment was installed on S3006. The vessel is equipped with POS MV v5 system for positioning and attitude, Kongsberg EM 2040C for MBES, AML Oceanographic MicroX SVS surface sound speed sensor, and YSI CastAway-CTD casts.

B.2 Quality Control

B.2.1 Crosslines

Multibeam crosslines were collected by S3006 across a variety of depth ranges, water masses, and Days. Crosslines were collected, processed and compared in accordance with Section 5.2.4.2 of the HSSD. A Variable Resolution (VR) surface was created of only mainscheme lines, and a second VR surface was created of only crosslines (Figure 13). A difference surface was generated in Pydro tool's Compare Grids by subtracting the crossline only surface from the mainscheme surface (mainscheme- crosslines= difference surface), from which statistics were derived. Statistics show the mean difference between the depths derived from mainscheme data and crossline data was 0.02 meters (with mainscheme being shoaler) and 95% of nodes falling within 0.95 meters (Figure 14)

For the respective depths, the difference surface was compared to the allowable NOAA uncertainty standards (Figure 15). In total, 99% of the depth differences between H13413 mainscheme and crossline data were within allowable NOAA uncertainties (Figure 16). The coloring represents areas where the TVU max error tolerance in exceeded; red, orange and yellow colors represent areas where mainscheme data is deeper than crossline data; the blue shades represent where crossline data is deeper than mainscheme data. The largest differences exhibited are in the outer beams of multibeam and areas where the geologic structure of the seafloor is dynamic, such as steep sand waves and rocks.

The analysis was performed on H13413 MBES data reduced to MLLW using ERS methods. The original mainscheme only, crossline only, and difference surface is included with the submission of this survey as Digital Data in the Crossline Comparisons.

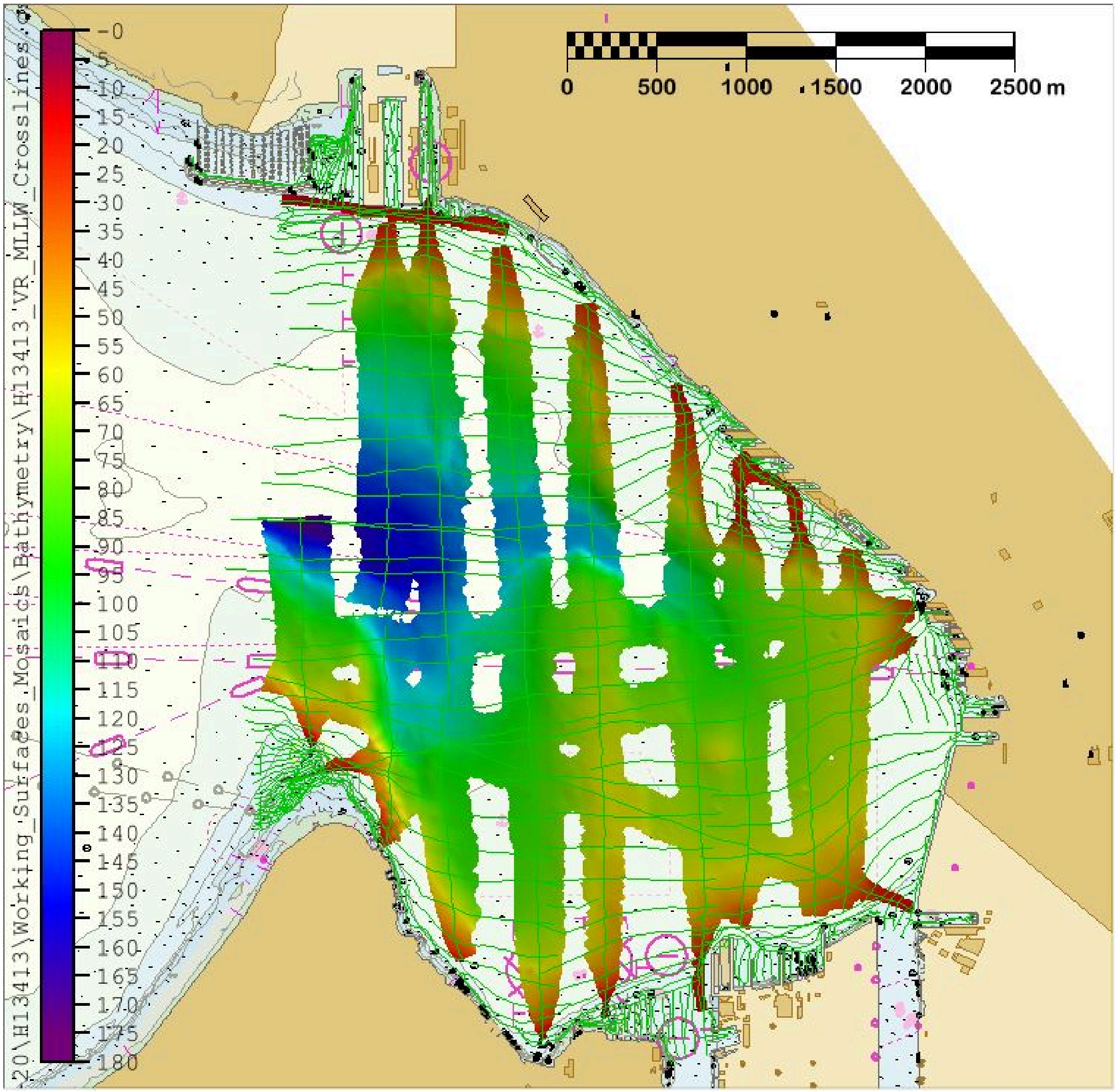
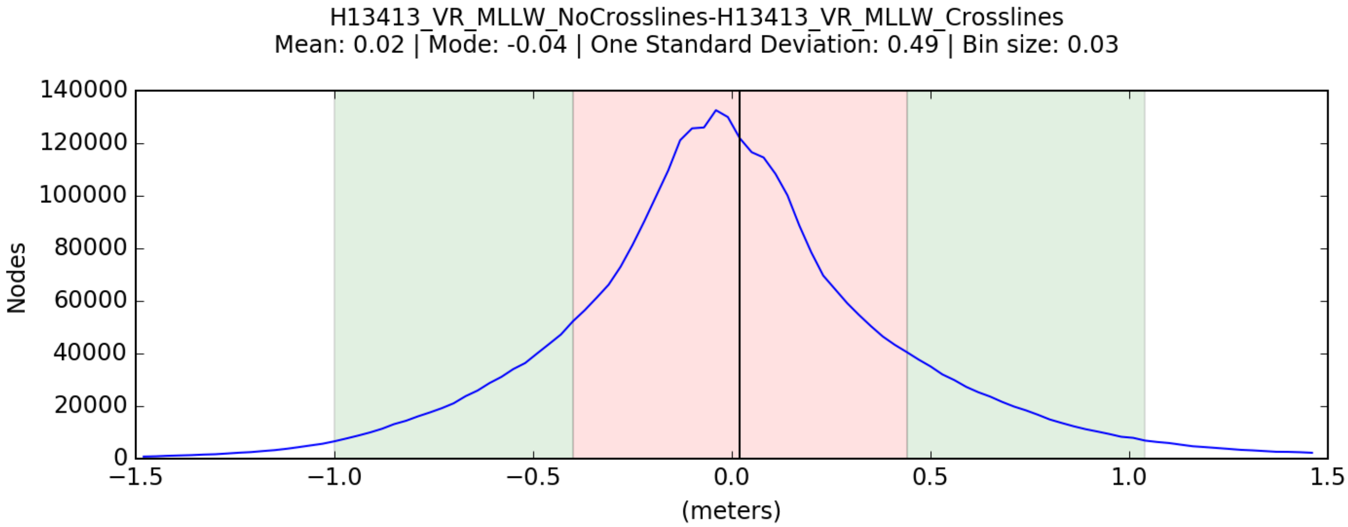
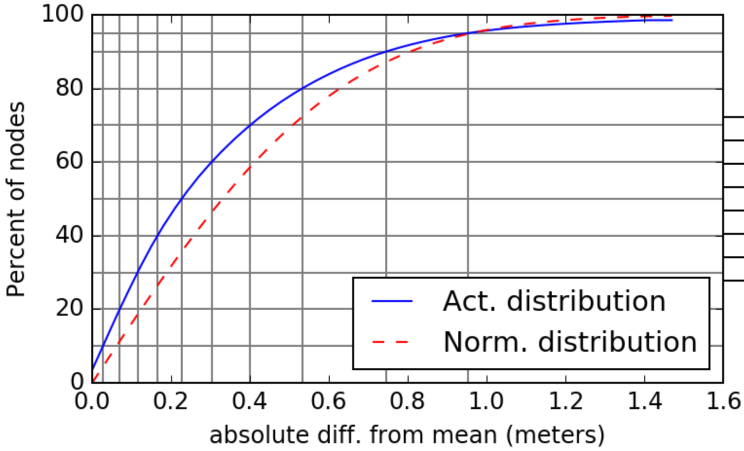


Figure 13: H13413 Crosslines





Percent of nodes	Deviation (m)
50%	+/- 0.23
60%	+/- 0.30
70%	+/- 0.40
80%	+/- 0.53
90%	+/- 0.74
95%	+/- 0.95

Figure 14: The statistics and distribution summary plot of the difference between H13413 mainscheme and crossline data.

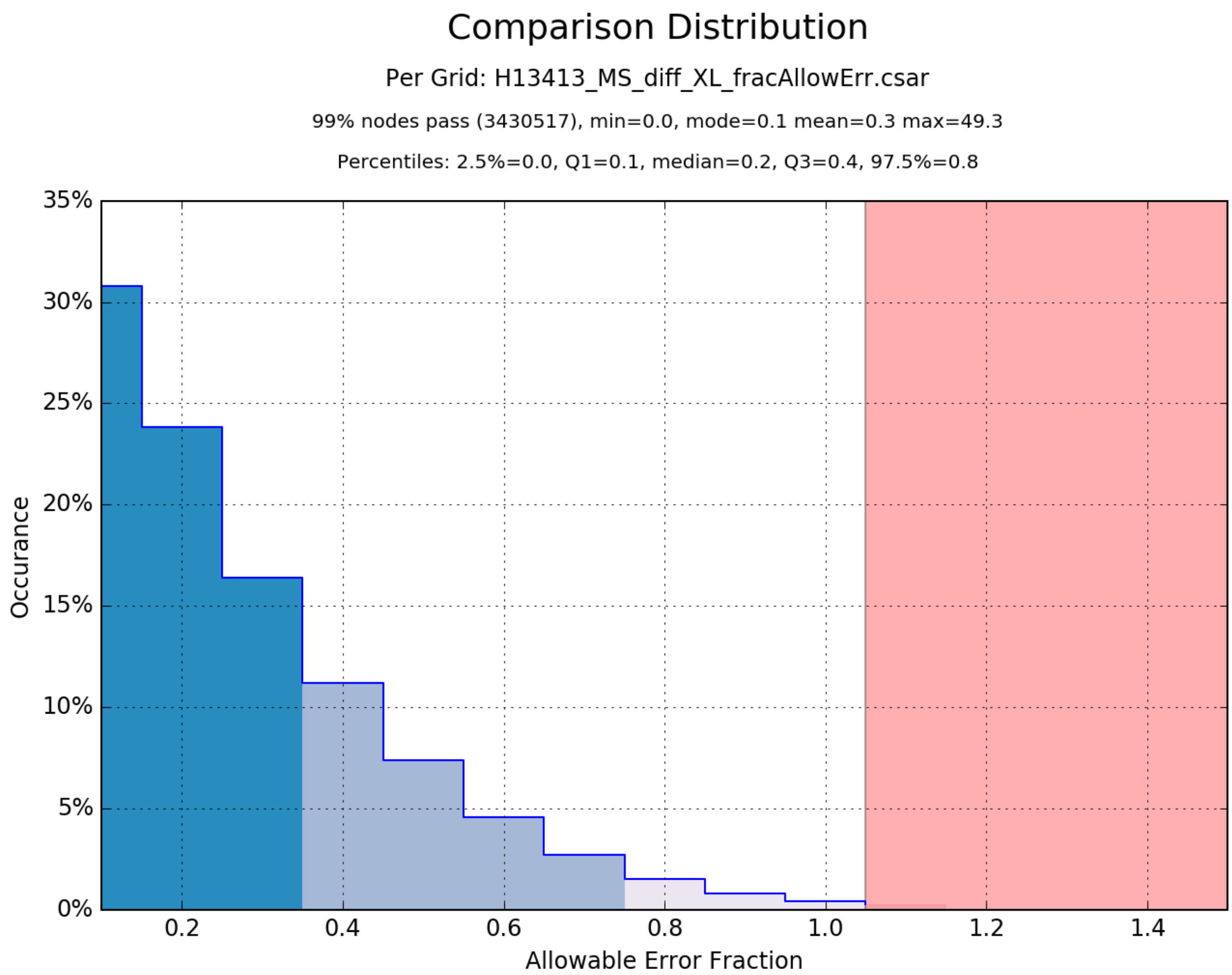


Figure 15: Histogram plot utilizing the magnitude of the Allowable Error Fraction to show the indication of what percentage of the total number of comparisons pass the TVU max test for H13413

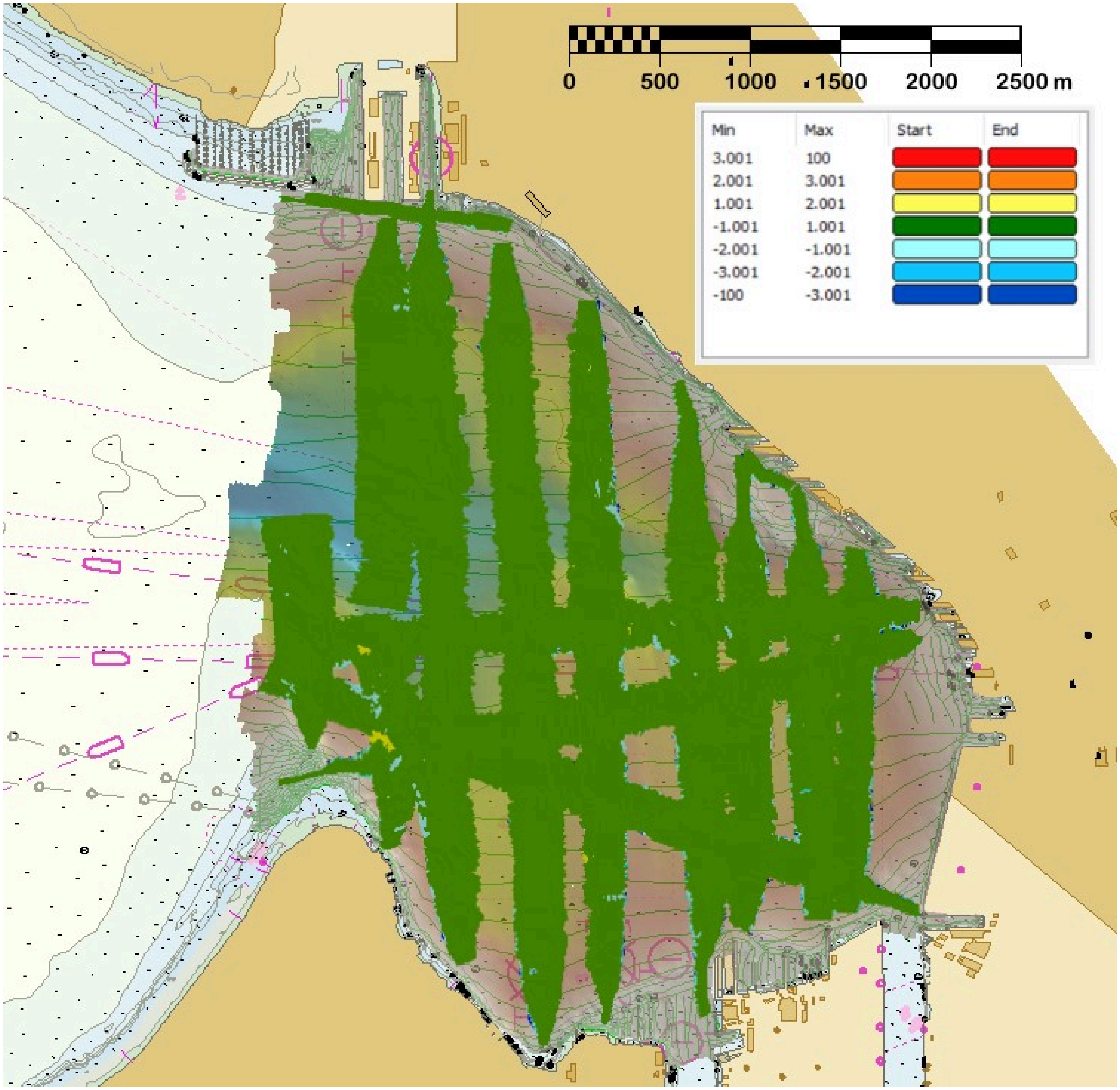


Figure 16: Depth differences between H13413 mainscheme and crossline data as compared to NOAA allowable uncertainty standards for the associated depths.

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via VDATUM	N/A	0.095 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Measured - XBT	Surface
S3006	4.0 meters/second	N/A	N/A	0.5 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

Total Propagated Uncertainty (TPU) values for H13413 were derived from a combination of fixed values for equipment and vessel characteristics, as well as field assigned values for sound speed uncertainties. The uncertainty for the VDatum model was provided to the field unit. A visual inspection of the Uncertainty layer revealed the areas of higher uncertainty occurred in the outer beams of survey lines and over the many snags on the sea floor located within H13413.

In addition to the usual a priori estimates of uncertainty provided via device models for vessel motion, ERS, real time and post processed uncertainty sources were also incorporated into the depth estimates of H13413. Real-time uncertainties from the Kongsberg 2040C MBES sonars were incorporated and applied during post processing. Uncertainties associated with vessel roll, gyro, and navigation were applied real-time. H13413 utilized SmartBase positioning service. The recorded delayed heave Applanix files included an estimate of the heave uncertainty and were applied during post processing. All of the aforementioned uncertainties were applied in CARIS. H13413 is an ellipsoidally referenced survey (ERS) and the tidal component was accomplished via separation model.

The surface was analyzed using the HydrOffice QC Tools Grid QA feature to determine compliance with specifications. Overall, 96% of nodes within the surface meet NOAA Allowable Uncertainty specifications for H13413. (Figure 18)

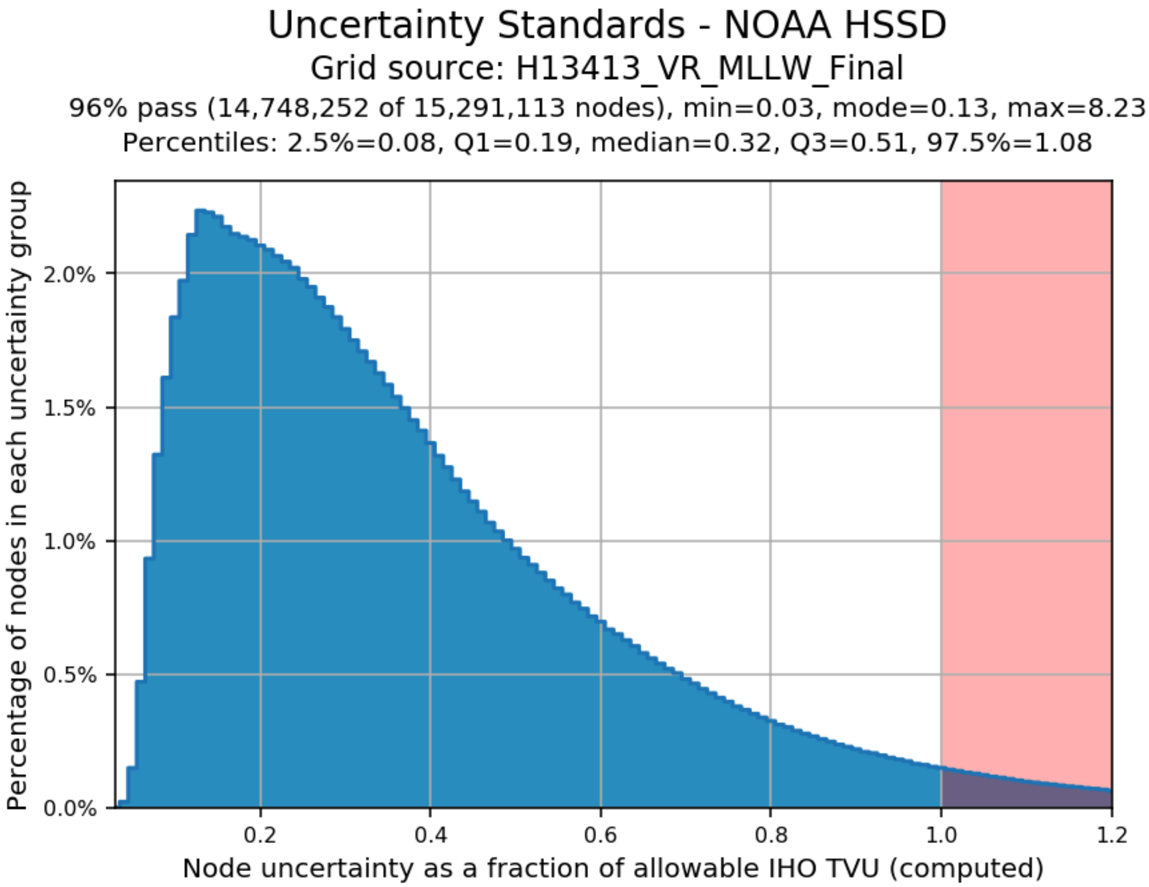


Figure 17: H13413 Node Uncertainty as a fraction of Allowable

B.2.3 Junctions

There are no contemporary surveys that junction with this survey.

B.2.4 Sonar QC Checks

Sonar system quality control checks were conducted as detailed in the quality control section of the DAPR.

B.2.5 Equipment Effectiveness

There were no conditions or deficiencies that affected equipment operational effectiveness.

B.2.6 Factors Affecting Soundings

<u>Sound Velocity</u>

Sound speed issues were apparent across the survey area, particularly on the southern end of the sheet where the Duwamish River enters into the bay and the bathymetry drops off quickly (Figures 19-20). Surface sound speed was monitored during survey acquisition and efforts where made to take casts whenever surface sound velocity values differed significantly from the surface sound velocity value from the previous cast. However, smiles and frowns were still noted in the processed data. Some casts were extended but doing so did not significantly improve sound velocity issues in the deeper waters.

In some areas the difference between lines exceeds allowable uncertainty at that point and the difference is visible in the final surfaces, however the surfaces overall still meet NOAA allowable uncertainty parameters from HSSD Section 5.1.3, and as such, the data remain sufficient to supersede previous data.

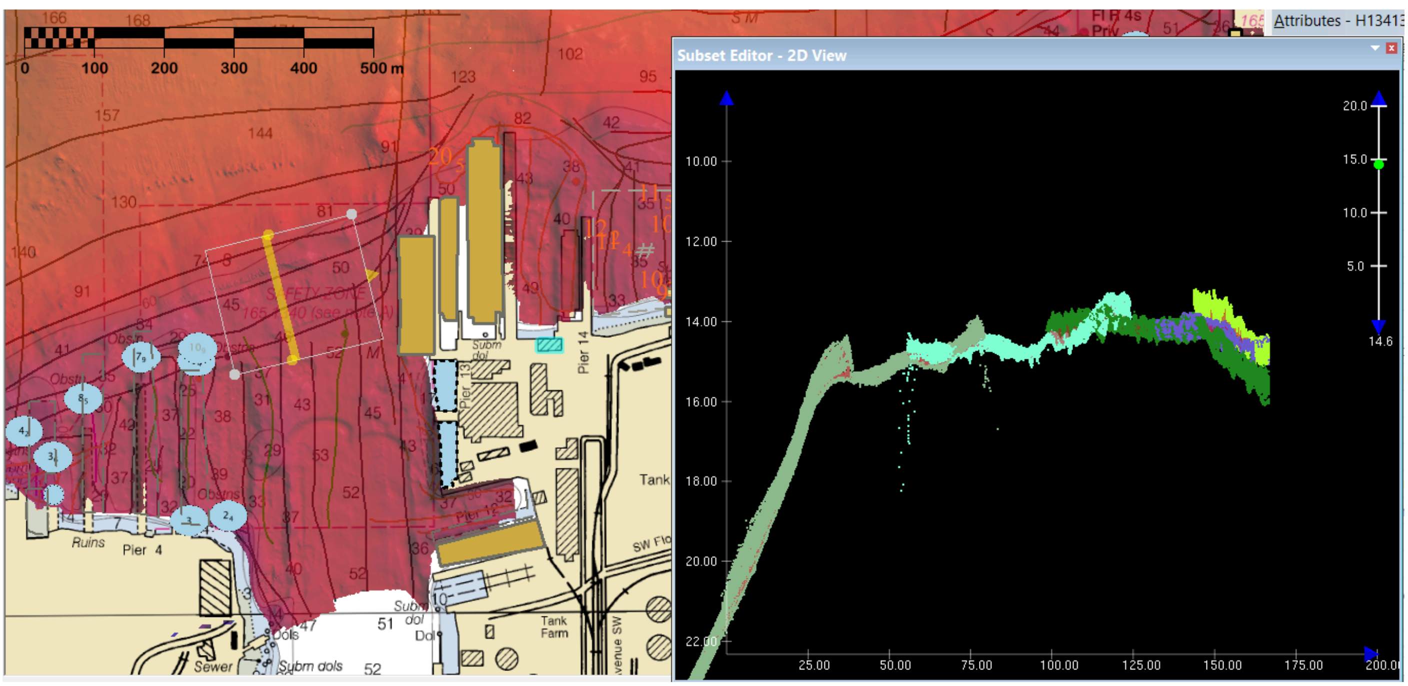


Figure 18: Sound Velocity errors visible in subset editor near Duwamish River West Waterway entrance.

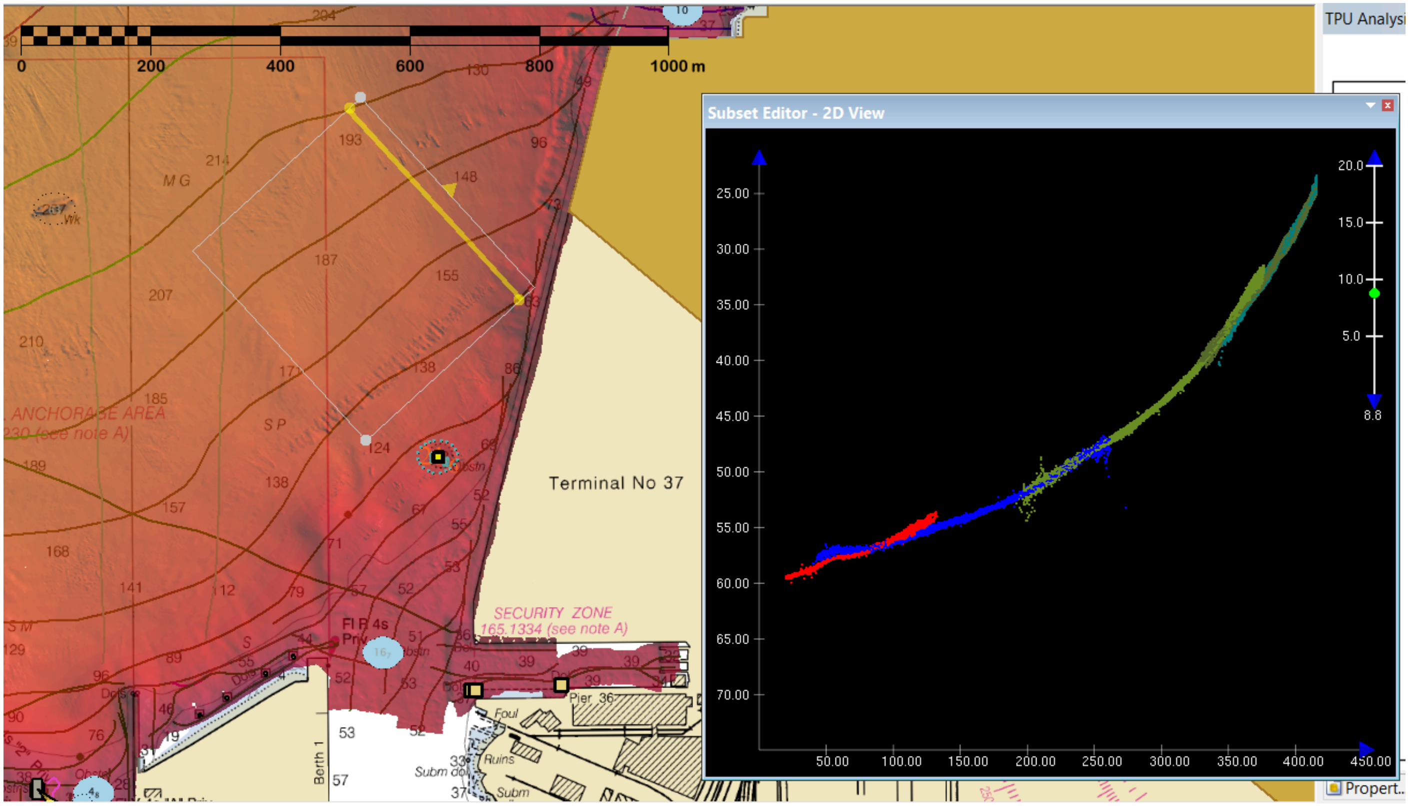


Figure 19: Sound Velocity errors visible in subset editor near Duwamish River East Waterway entrance.

Sea grass

Sea grass and aquatic vegetation was present off the tip of Duwamish Head. The density was such that it was indistinguishable from the seafloor (Figure 21). A Seabed Area was digitized from the multibeam data showing the limits and is included in the Final Feature File (FFF).

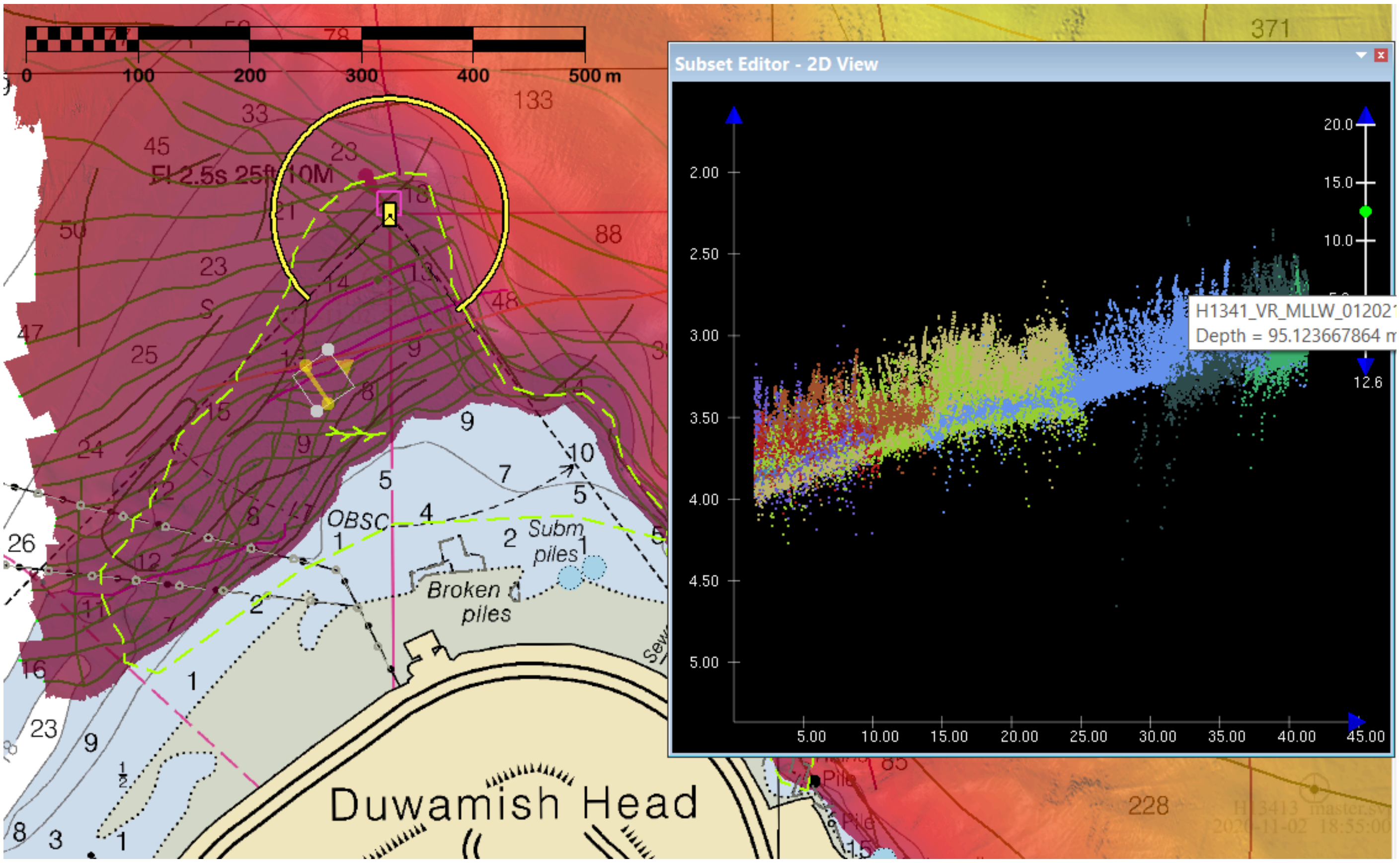


Figure 20: Sea grass in shallows off Duwamish head. Dashed green line shows Seabed Area feature digitized in FFF

<u>Motion artifacts</u>

Additional offsets are visible in the data in various locations throughout the survey area. Locations of offsets are most easily identified using the Hypothesis_Count layer of the CUBE surfaces and are most notably on slopes. Careful review of the data revealed no readily identifiable systematic cause of the offsets. S3006 is known to be a highly sensitive to motion artifacts and the offsets are therefore most likely do to roll, sea state, etc. SBETs were carefully reviewed and in some cases reprocessed but the artifacts remained.

In some areas the difference between lines exceeds allowable uncertainty at a given point and the difference is visible in the final surfaces, however the surfaces overall still meet NOAA allowable uncertainty parameters from HSSD Section 5.1.3, and as such, the data remain sufficient to supersede previous data.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: Every four hours

Casts were conducted at a minimum of one every four hours in the deeper waters nearest to the active survey area during launch acquisition. Casts were conducted more frequently in areas where the influx of freshwater had an effect on the speed of sound in the water column, when there was a change in surface sound speed greater than four meters per second, and over varying depths (Figure 22).

SVP casts were applied to the MBES lines in CARIS using the "nearest in distance within time of 4 hours" method. All sound speed methods were used as detailed in the DAPR.

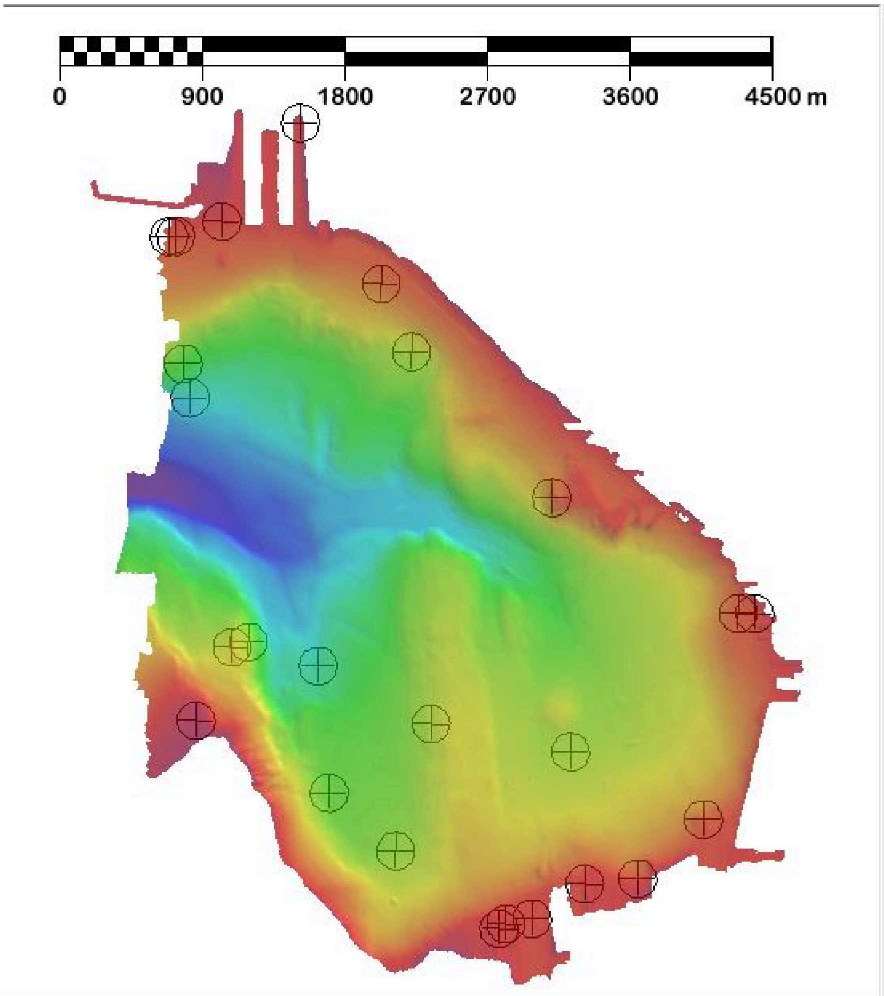


Figure 21: H13413 Sound speed cast Locations

B.2.8 Coverage Equipment and Methods

All equipment and survey methods were used as detailed in the DAPR.

B.2.9 Density

The surface was analyzed using the HydrOffice QC Tools Grid QA feature (Figure 23). Density requirements for H13413 were achieved with at least 99.5% of surface nodes containing five or more soundings as required by HSSD Section 5.2.2.3. The few nodes that did not meet density requirements are due to sparse data in the outer beams, especially near steep slopes and rocky areas where acoustic shadowing occurred, and at the edges of the survey limits.

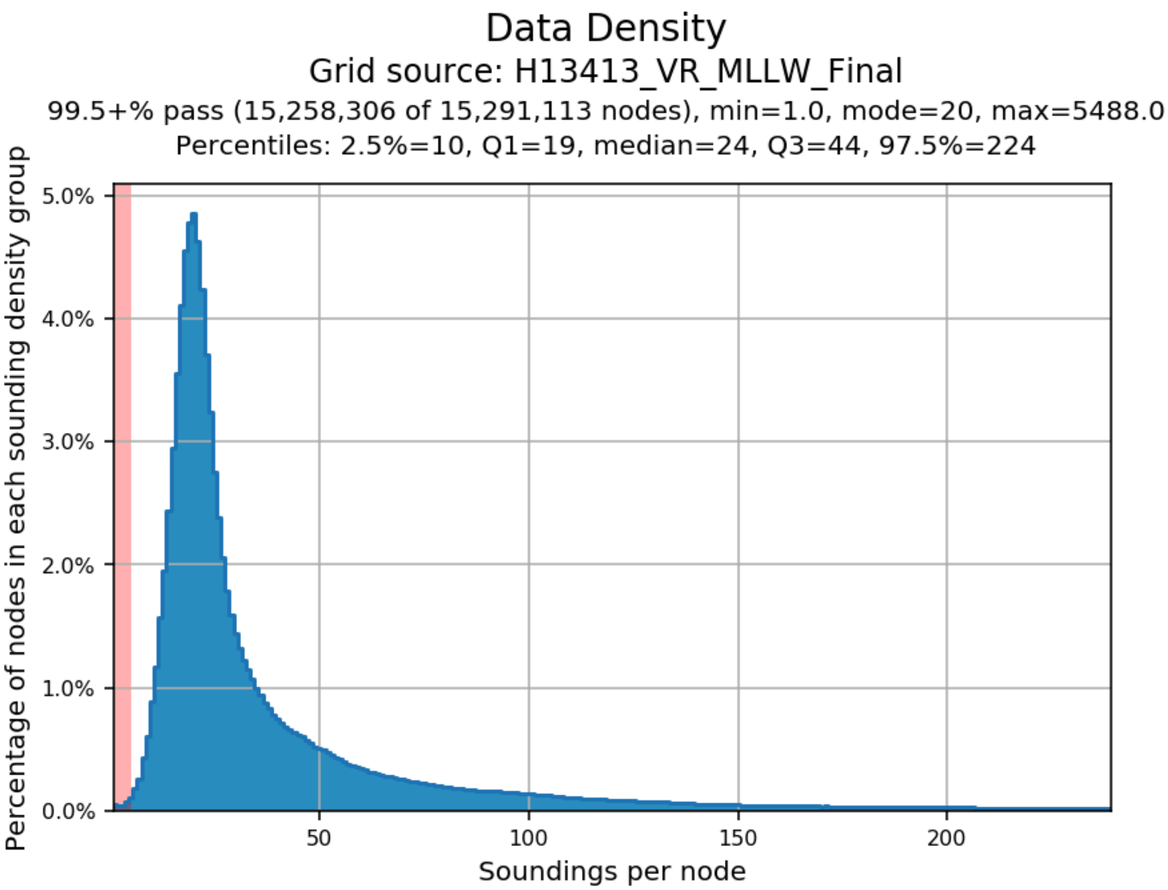


Figure 22: H13413 data density

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

All data reduction procedures conform to those detailed in the DAPR.

B.3.2 Calibrations

All sounding systems were calibrated as detailed in the DAPR.

B.4 Backscatter

Raw backscatter data is logged as .all file for delivery to NOAA's Pacific Hydrographic Branch. NOAA's Navigation Response Branch field units are waived from producing backscatter mosaics for the 2020 field season. All equipment and survey methods were used as detailed in the DAPR.

During Branch review, the backscatter was processed to GSF files and a floating point mosaic was created via QPS FMGT 7.9.6 .

B.5 Data Processing

B.5.1 Primary Data Processing Software

The following software program was the primary program used for bathymetric data processing:

Manufacturer	Name	Version
CARIS	HIPS and SIPS	11.3.1

Table 9: Primary bathymetric data processing software

The following Feature Object Catalog was used: **NOAA Extended Attribute Files Version 2020**

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
H13413_VR_MLLW	CARIS VR Surface (CUBE)	VR meters	-1.890 meters - 186.846 meters	NOAA_VR	Object Detection

Surface Name	Surface Type	Resolution	Depth Range	Surface Parameter	Purpose
H13413_VR_MLLW_Final	CARIS VR Surface (CUBE)	VR meters	-1.890 meters - 186.846 meters	NOAA_VR	Object Detection

Table 10: Submitted Surfaces

The NOAA CUBE parameters defined in the HSSD were used for the creation of all CUBE surfaces for H13413. The surfaces have been reviewed where noisy data, or "fliers," are incorporated into the gridded solutions causing the surface to be shoaler or deeper than the true sea floor. Where these spurious soundings cause the gridded surface to be shoaler or deeper than the reliably measured seabed by greater than the maximum allowable Total Vertical Uncertainty at that depth, the noisy data have been rejected by the hydrographer and the surface recomputed. Thirteen 'fliers' remain in the finalized surface. With the exception of one area under pier 67 (Figure 23) where the potential noise and offsets (Section B.2.6) prohibit the ability to adequately determine the true seafloor, the remaining "fliers" all fall within one of the many foul ground areas (Section D.2.8) or correlate to designated soundings on obstructions or features in said foul ground areas (Figure 25).

H13413 contains 102 designated soundings in accordance with HSSD Section 5.2.1.2.3. No designated soundings represent DTONs. All designated soundings were selected to accurately represent the seafloor. The majority of designated soundings (52) are on shoal points within foul ground areas where the CUBE surface did not accurately depict all the logs and debris on the seafloor. Designated soundings in these foul areas were initially created to help identify the extents of the areas but where then paired down to only the shoalest features within 10m or greater (2mm at 1:5000 survey scale) radius (Figure 26-27). See Section D.2.8 for more information on foul ground areas. The remaining designated sounding (50) are were selected over submerged addressed features included in the FFF.

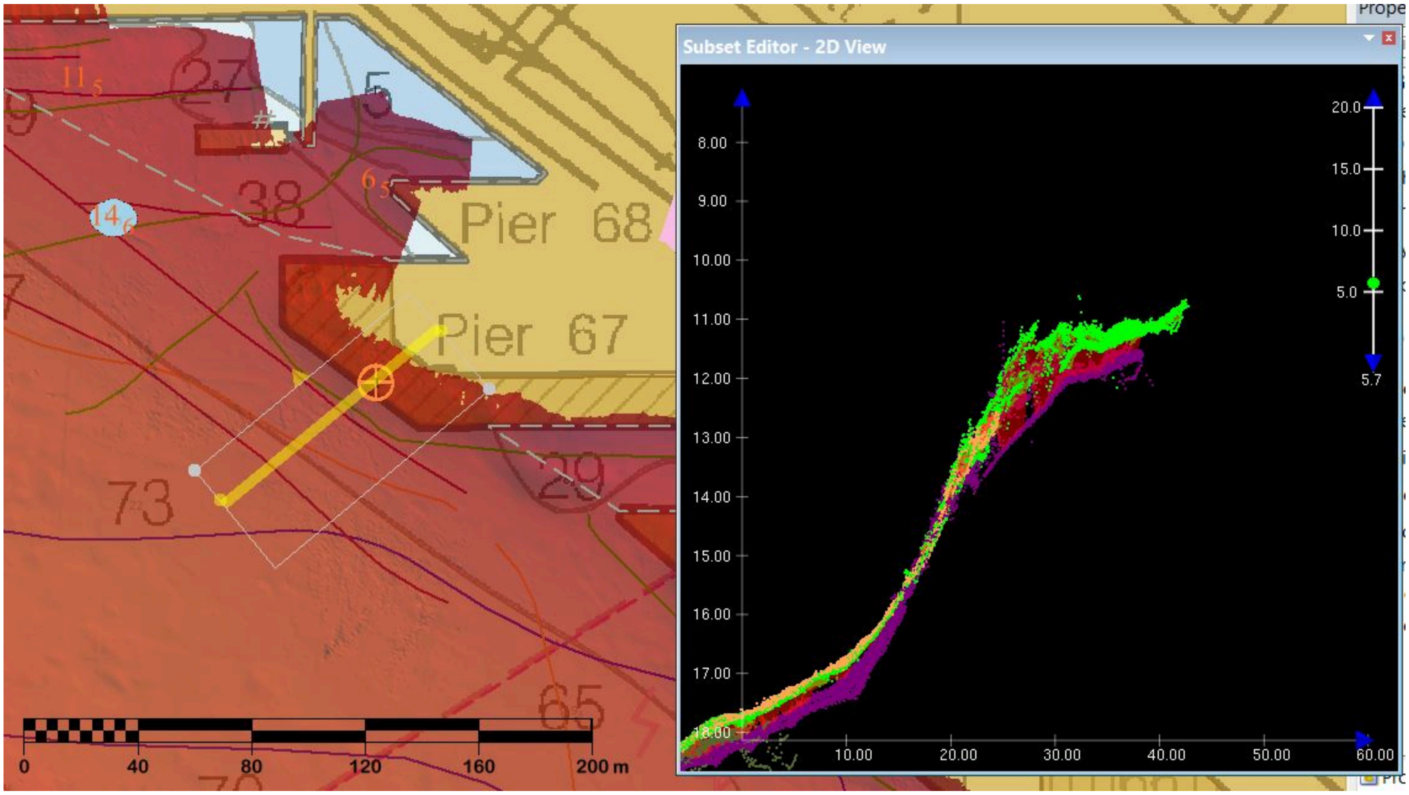


Figure 23: Flier finder "flier" under Pier 67 in subset on right.

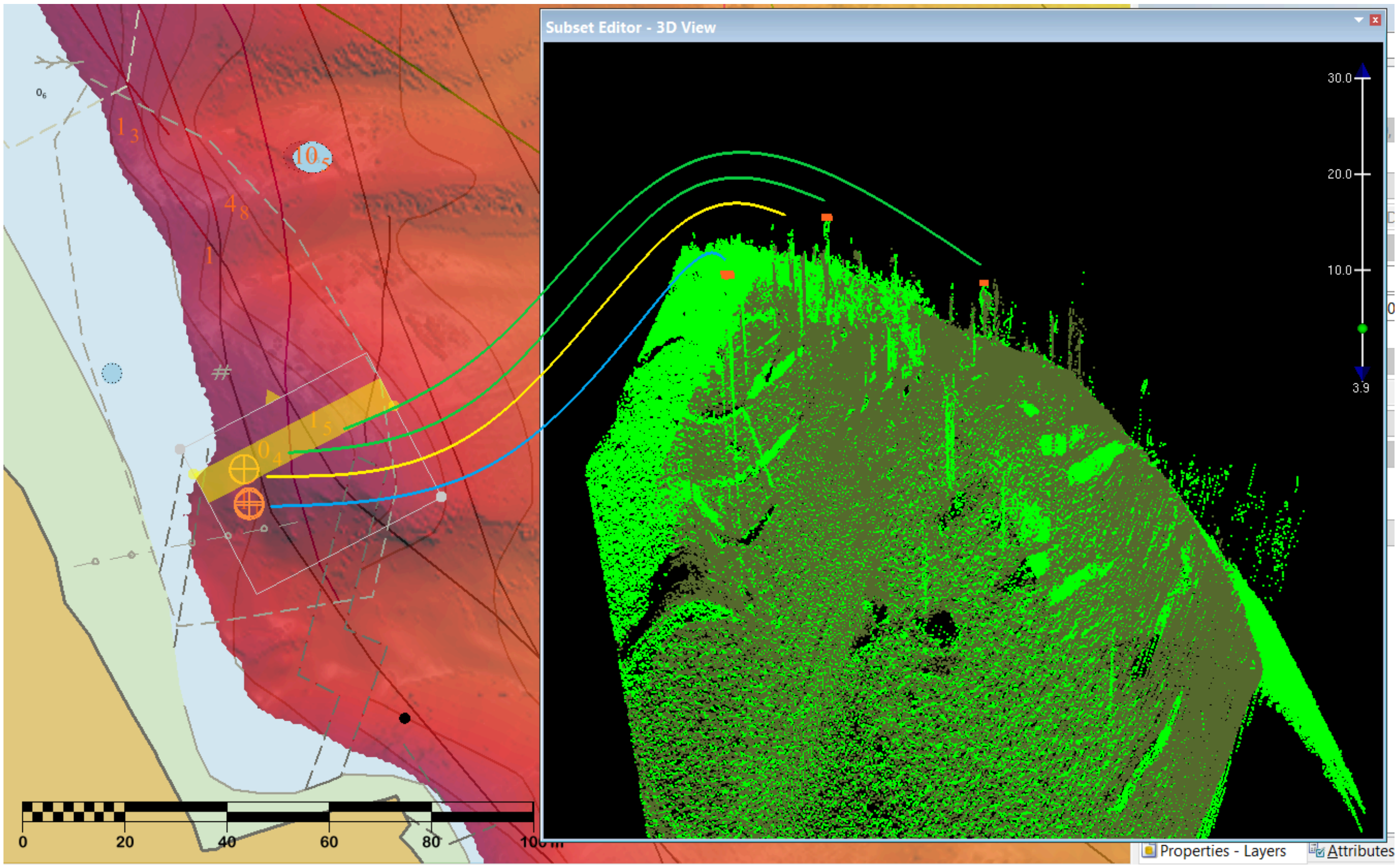


Figure 24: Flier finder "fliers" in foul ground area. Foul ground boundary is gray dashed line. "Fliers" are orange circles with cross hairs. Designated soundings are orange numbers/dots. The Blue line shows a Flier finder "flier" and the corresponding designated point in Subset editor. The yellow line shows a "flier" and an undesginated feature due to scale. Green line show two other designated features selected at survey scale.

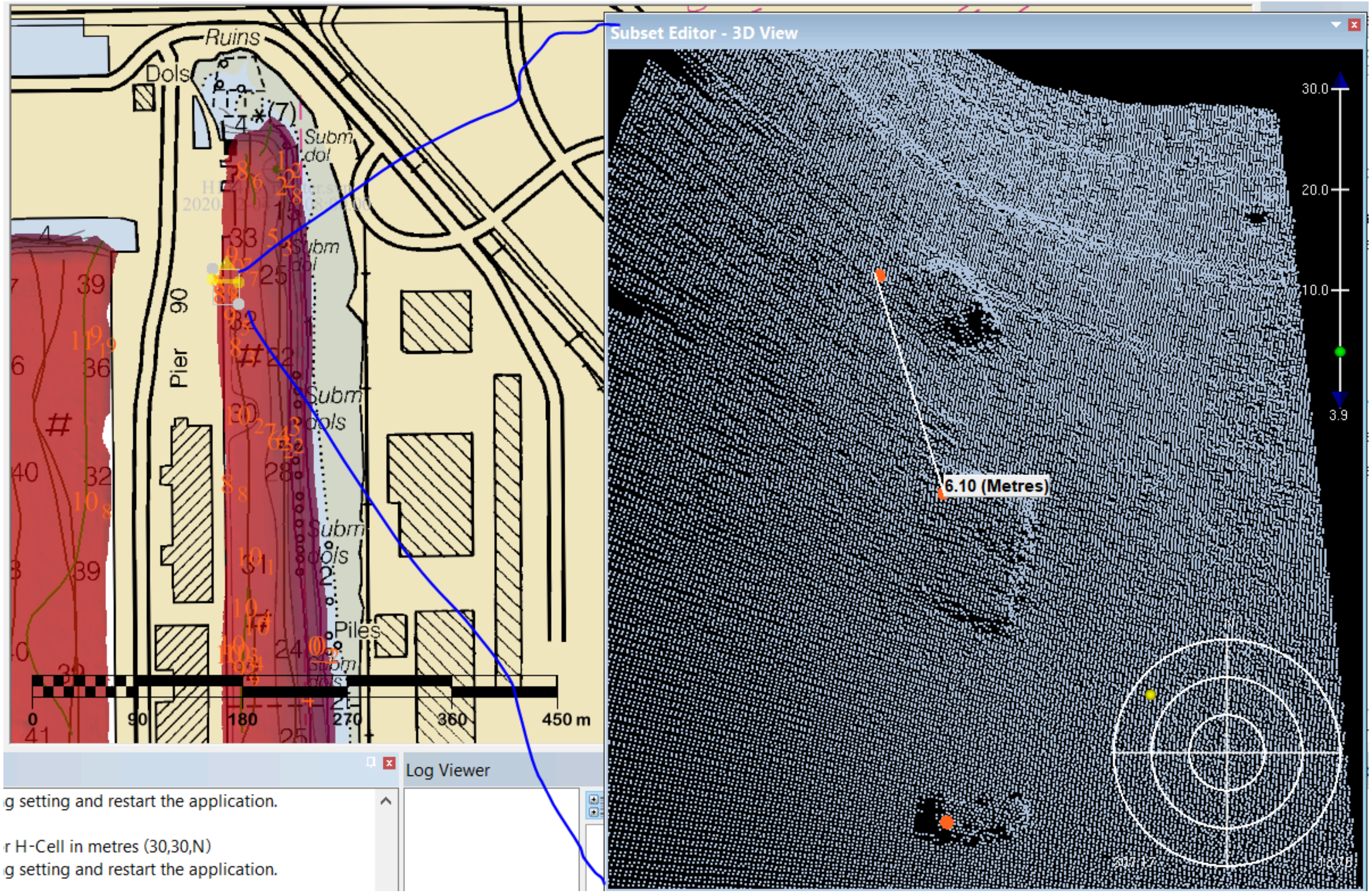


Figure 25: Designated soundings displaying as orange numbers on left and orange dots in subset on right, in a foul ground area before reducing to survey scale.

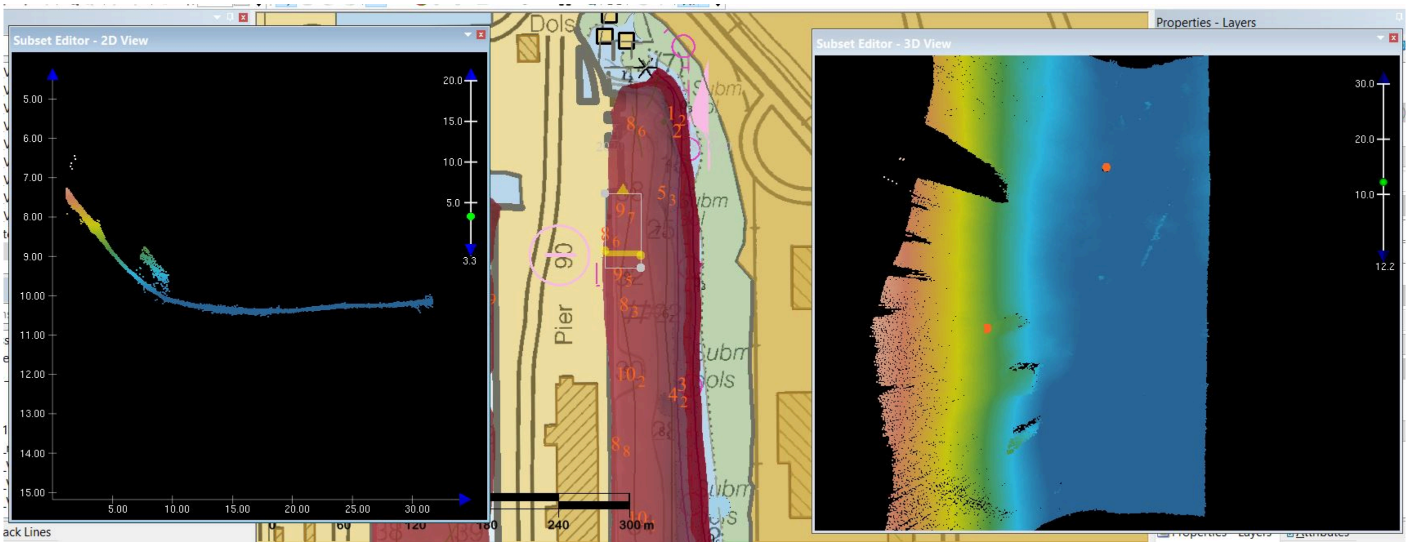


Figure 26: Designated soundings soundings displaying as orange numbers in center and and orange dots in subset on right and left, in a foul ground area after reducing to survey scale.

C. Vertical and Horizontal Control

Per Section 5.2.2.1.3 of the 2020 Field Procedures Manual, no Horizontal and Vertical Control Report has been generated for H13413.

C.1 Vertical Control

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

ERS Datum Transformation

The following ellipsoid-to-chart vertical datum transformation was used:

Method	Ellipsoid to Chart Datum Separation File
ERS via ERZT	S-N923_Vdatum_100m_NAD83-MLLW_geoid12b.csar

Table 11: ERS method and SEP file

Elliposidal Referenced Survey (ERS) methods were used as the final means of reducing H13413 to MLLW Datum for submission. VDatum separation model was provided with the project instructions. Sounding elevations relative to the ellipsoid were post-processed with the daily logged POSPac data to create a best statistical estimate of trajectory (SBET) file, as detailed in the DAPR. All of H13413 meets HSSD vertical accuracy requirements.

C.2 Horizontal Control

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 10.

The following PPK methods were used for horizontal control:

- Smart Base

Precise Positioning-SmartBase processing methods were used in Applanix POSpac MMS 8.4 software to produce SBETs for post-processing horizontal correction. All of H13413 meets HSSD horizontal accuracy requirements.

C.3 Additional Horizontal or Vertical Control Issues

C.3.1 DN314 Heave

During processing, DN314 encountered an error when processing delayed heave via the POS file due to a change in the output time in the POS log for an unknown reason. With the reference point as the transducer, and offset values entered into POS, DN314 was processed in without delayed heave (Charlene applied SVC and ERS "w/ Heave" instead of "w/ delayed Heave"). No heave errors appear in the data and this issue did not occur on any other days of acquisition. Correspondence regarding the issue is included in survey correspondence folder

D. Results and Recommendations

D.1 Chart Comparison

A comparison was performed between survey H13413 and ENC US5WA15M using CARIS HIPS and SIPS sounding and contour layers derived from the finalized VR surface. The contours and soundings were overlaid on the charts to assess differences between the surveyed soundings and charted depths. ENCs were compared by extracting all soundings from the chart for general agreement and to identify areas of significant change.

All data from H13413 should supersede charted data. In general, surveyed soundings and contours agree with the majority of charted depths. Some shoaling is noted in the inshore area of Smith Cove where the surveyed contours differ by over 44 meters (Figure 27).

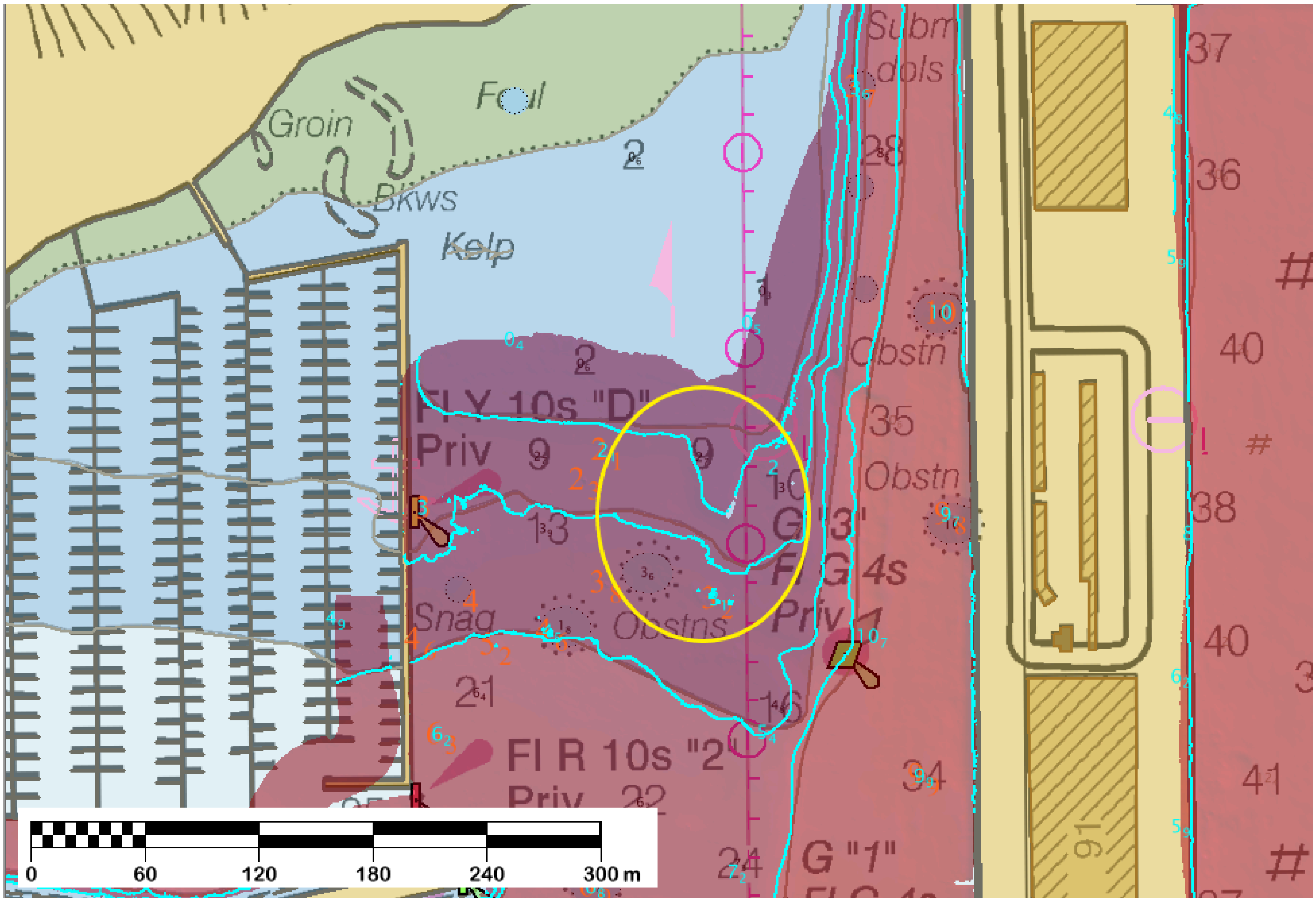


Figure 27: H13413 contours in blue overlapped on ENC US5WA15M. Area circled in yellow shows the largest difference from charted where the survey 6 fm contour is 44m offshore charted.

D.1.1 Electronic Navigational Charts

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

ENC	Scale	Edition	Update Application Date	Issue Date
US5WA15M	1:10000	27	05/21/2020	05/21/2020

Table 12: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

No new shoals or potentially hazardous features exist for this survey.

D.1.3 Charted Features

No charted features labeled PA, ED, PD, or Rep exist for this survey.

D.1.4 Uncharted Features

Survey H13413 has 64 new features that are addressed in the H13413 Final Feature File. Of these features, there are 35 new Obstructions, 0 new Seabed Areas, 0 new Underwater Rocks. of which 0 are submitted as DTONs.

New shoreline construction and a floating pier facility was completed at Pier 50, south of Colman Dock and the Washington State Ferry Terminal, on August 12, 2019. The new facility serves King County Water Taxi routes to Vashon Island and West Seattle as well Kitsap Fast Ferry routes to Kingston and Bremerton.The locations of new piles for floating pier were visible and digitized from multibeam data and included in the FFF. Recommend shoreline be updated from current or new aerial photography in the area or other authoritative source. (Figure 28)

A visually conspicuous orange elevated walkway exists as part of a Joe Block Park at the NW corner of Terminal 5 on the south of the sheet in the vicinity of currently charted but non-existing tanks. A landmark feature was included for this feature in the FFF. (Figure 29)

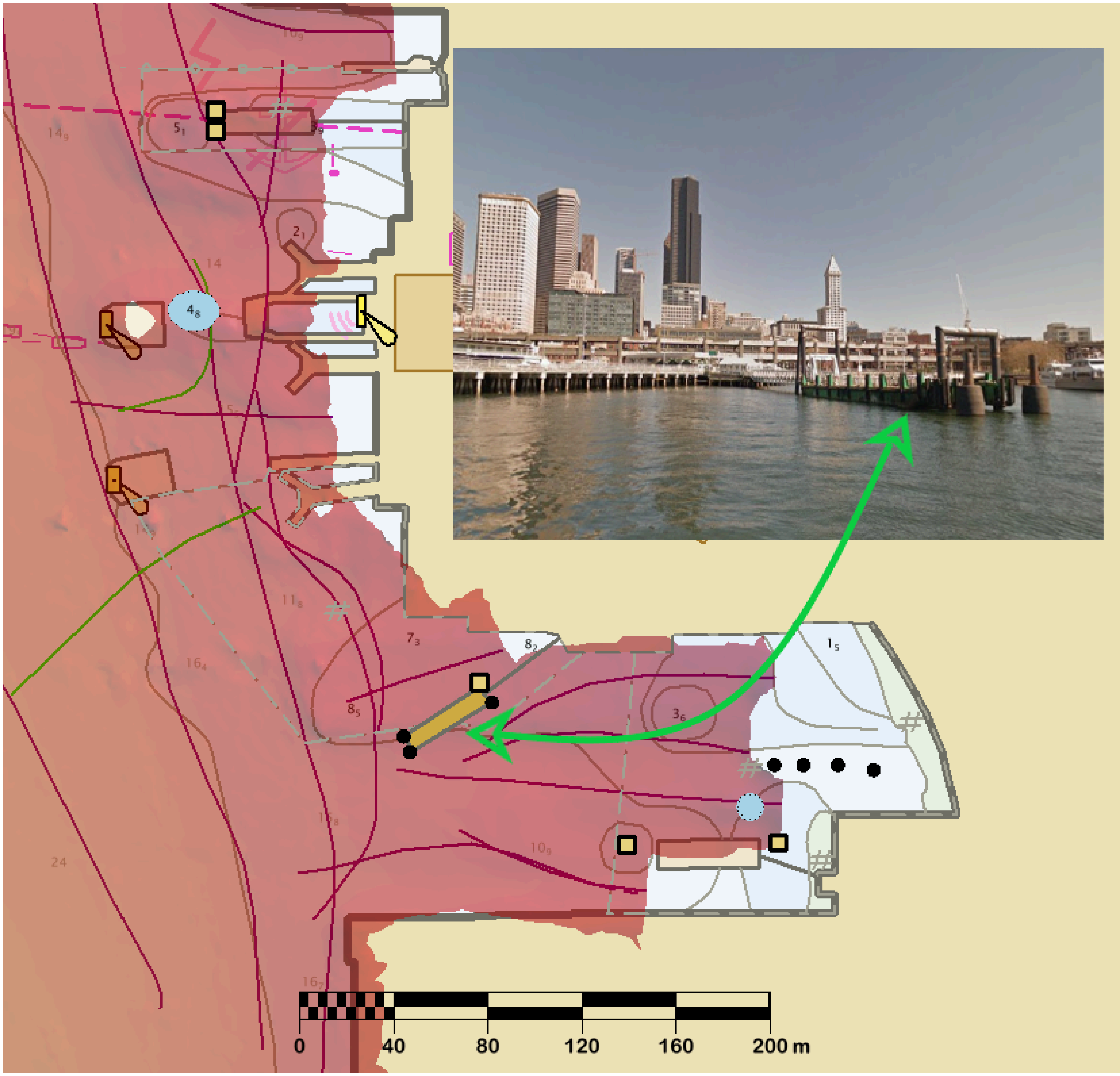


Figure 28: New foating dock at Pier 50 included in FFF

Figure 29: Orange Elevated walkway with tower vissible on the left of the photo, looking south towards Joe Block Park.

D.1.5 Channels

No channels exist within the survey area.

No traffic separation schemes, pilot boarding areas, or channel lines are within the survey limits.

There are designated anchorages, precautionary areas, and safety fairways that were not specifically investigated and should remain as charted. Sounding from H13413 are adequate to supersede charted soundings within these areas.

D.2 Additional Results

D.2.1 Aids to Navigation

A series of black can buoys existed around the charted Fish Haven south of the grain elevator offshore Myrtle Edwards Park (Figure 30). The can buoys differ from those visible in photography from 2016 so it is likely that they are transient and vary depending on the type of fish haven being deployed. As such the can buoys are not included in the FFF. Permanent navigational lights exist at the location on piles and are charted correctly, serving their intended purpose, and included in the FFF.

Two private charted buoys off the Myrtle Edwards fishing pier were found not to exist and three additional charted ATONs on the south of the sheet were found to be mispositioned. All are included in the FFF and have been reported to the USCG per HSSD Section 1.6.

Figure 30: Black can buoys around fish haven south of the Grain Elevator off Myrtle Edwards Park.

D.2.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.2.3 Bottom Samples

No bottom samples were required for this survey.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

Several cable areas and pipelines exist within the survey area and are addressed in the FFF.

During Branch processing, a charted pipeline (47.618240N, 122.360741W) was found to be unburied and sitting approximately 2-4 meters above the seafloor. The pipeline's horizontal position is accurately charted and lies within charted depths. The pipeline was reported to the Bureau of Safety and Environmental Enforcement per the HSSD.

D.2.6 Platforms

No platforms exist for this survey.

D.2.7 Ferry Routes and Terminals

A new ferry terminal and floating dock exists for walk-on ferries for King County Water Taxi routes to Vashon Island and West Seattle as well Kitsap Fast Ferry routes to Kingston and Bremerton at Pier 50 in downtown Seattle (See Section D.1.4 above). More information on the routes can be obtained from the King Country Water Taxis site at https://www.kingcounty.gov/depts/transportation/water-taxi/colman-dock.aspx and from Kitsap Transit at https://www.kitsaptransit.com/service/fast-ferry

D.2.8 Abnormal Seafloor or Environmental Conditions

Much of the inshore areas of the Elliott Bay, particularly areas in between piers, are foul with logs, debris and ruins of old infrastructure. Especially In the case of the logs, it is very difficult to determine the permanence of these features. An effort was made to select soundings on the most prominent of features in these areas but given the shear number and potential transience of the features, foul ground areas were created to more adequately represent them. ENC US5WA15M contained 8 previously charted foul ground areas within the surveyed area. Two of these were inshore of the NALL and not addressed, 3 are recommended retained as charted and, 3 have recommended updated extents. An addition 10 new foul ground areas were digitized from the multibeam extents and are included in the FFF. (Figures 31-34).

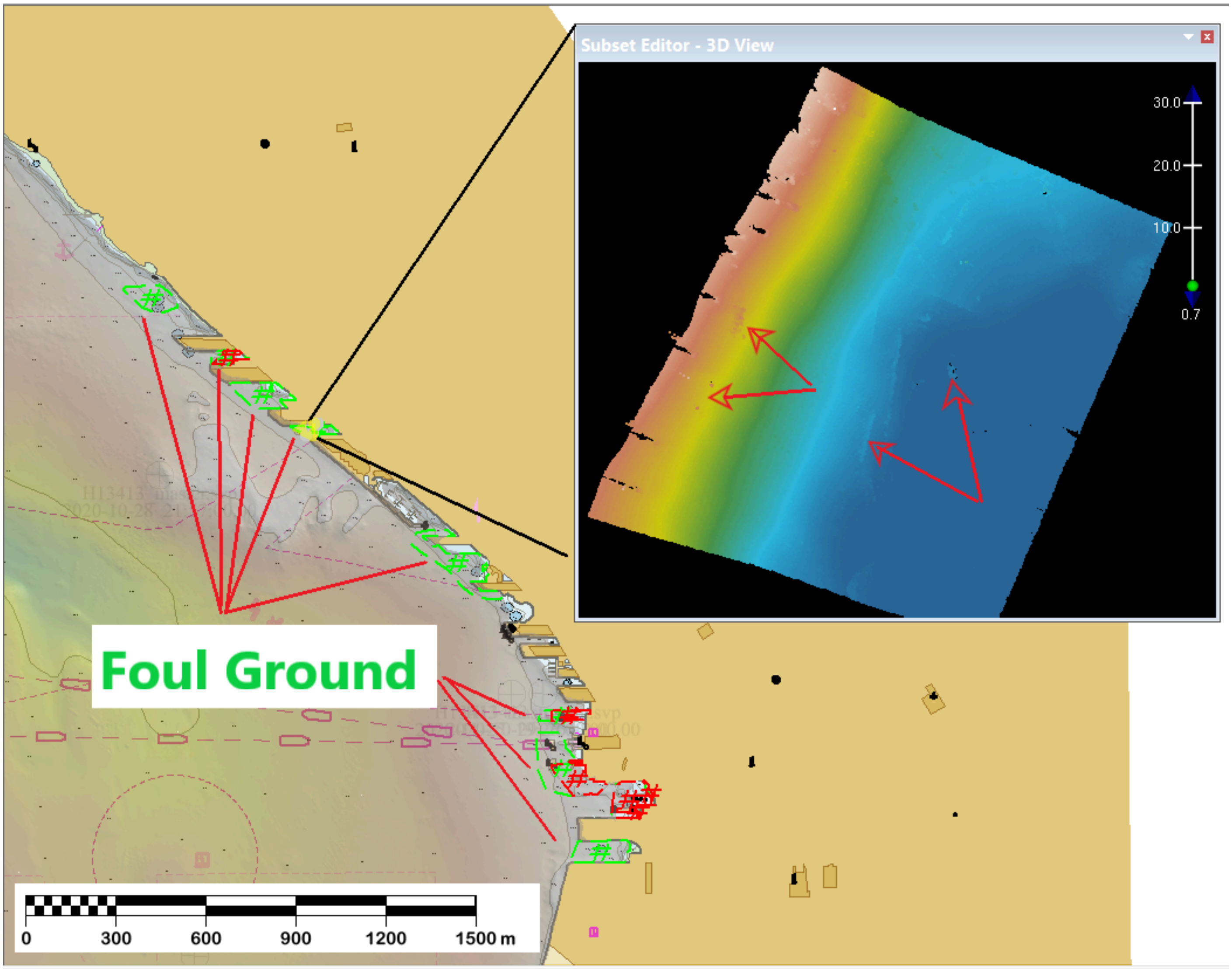


Figure 31: Foul ground areas (#) along downtown Seattle waterfront. Green areas are new or updated foul ground and red are previously charted foul ground. Subset editor inset shows a representative area with many visible features.

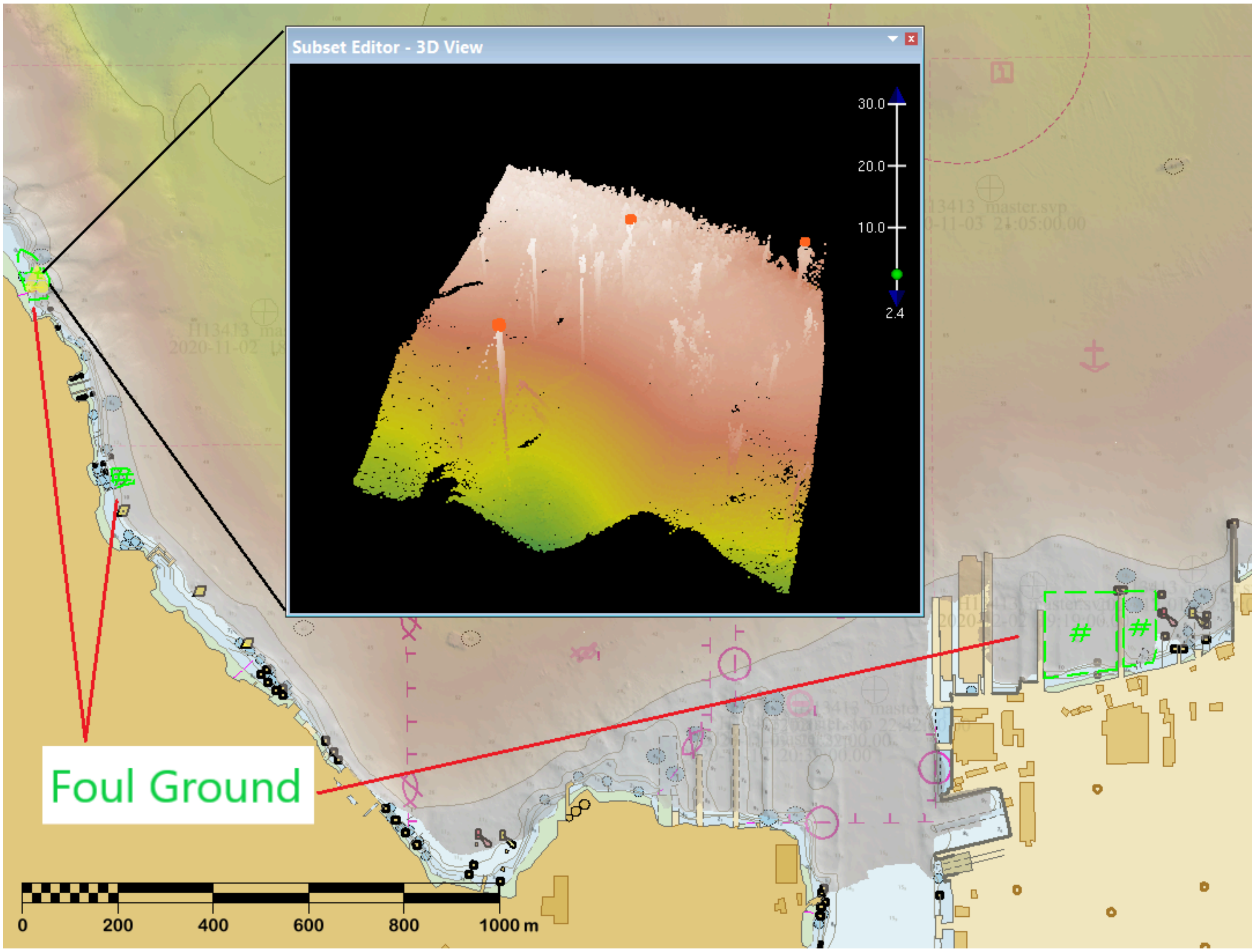


Figure 32: Foul ground areas (#) along the S and SW of the sheet. Green areas are new or updated foul ground. Subset editor inset shows a representative area with many visible features.

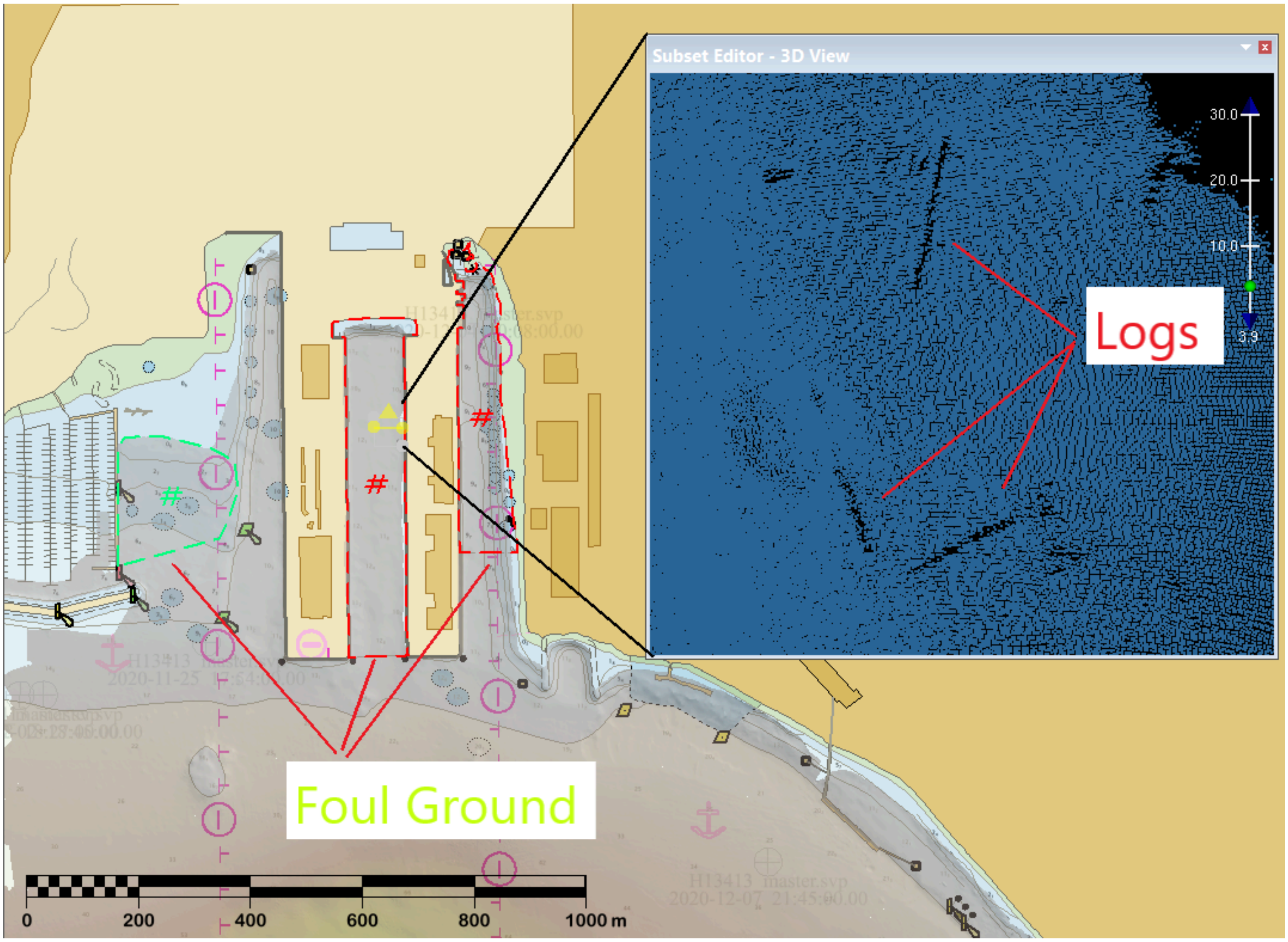


Figure 33: Foul ground areas (#) on the N of the sheet near Piers 90-91. Green areas are new or updated foul ground and red are previously charted foul ground. Subset editor inset shows a representative area with many visible features.

D.2.9 Construction and Dredging

Pier 58 in downtown Seattle collapsed into the water during repair work on September 13, 2020. Work to remove debris and repair the pier was on going during survey operations. Due to the construction the area around the pier was not accessible for survey operations.

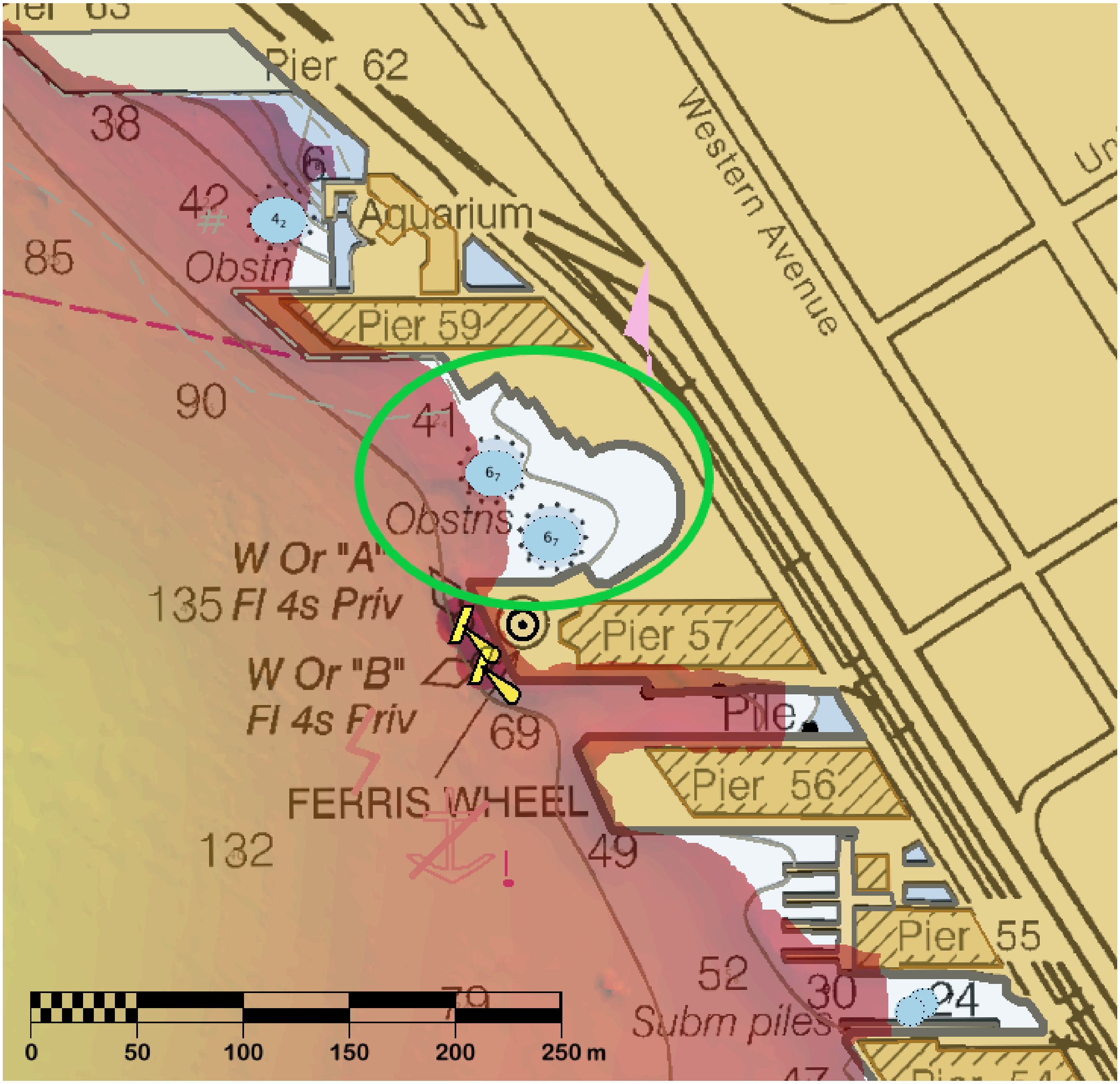


Figure 34: Location of Pier 58 collapse and construction circled in green.

D.2.10 New Survey Recommendations

No new surveys or further investigations are recommended for this area.

D.2.11 ENC Scale Recommendations

No new ENC scales are recommended for this area.

E. Approval Sheet

As Chief of Party, field operations for this hydrographic survey were conducted under my direct supervision, with frequent personal checks of progress and adequacy. I have reviewed the attached survey data and reports.

All field sheets, this Descriptive Report, and all accompanying records and data are approved. All records are forwarded for final review and processing to the Processing Branch.

The survey data meets or exceeds requirements as set forth in the NOS Hydrographic Surveys Specifications and Deliverables, Field Procedures Manual, Letter Instructions, and all HSD Technical Directives. These data are adequate to supersede charted data in their common areas. This survey is complete and no additional work is required with the exception of deficiencies noted in the Descriptive Report.

Approver Name	Approver Title	Approval Date	Signature
Michelle M. Levano, LTJG/NOAA	Chief of Party	02/26/2021	Digitally signed by LEVANO.MICHELLE.MARIE.1516645888 Date: 2021.02.26 12:28:25 -08'00'
Annemieke Raymond	Physical Science Tech	02/26/2021	RAYMOND.ANNEMIEKE.SMITH.1365883048 Digitally signed by RAYMOND.ANNEMIEKE.SMITH.1365883048 Date: 2022.03.17 12:49:51 -07'00'

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	Continuously Operating Reference Station
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
ERTDM	Ellipsoidally Referenced Tidal Datum Model
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

Acronym	Definition
HSSD	Hydrographic Survey Specifications and Deliverables
HSTB	Hydrographic Systems Technology Branch
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	Linear Nautical Miles
MBAB	Multibeam Echosounder Acoustic Backscatter
MCD	Marine Chart Division
MHW	Mean High Water
MLLW	Mean Lower Low Water
NAD 83	North American Datum of 1983
NALL	Navigable Area Limit Line
NTM	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
RNC	Raster Navigational Chart
RTK	Real Time Kinematic
RTX	Real Time Extended
SBES	Singlebeam Echosounder
SBET	Smooth Best Estimate and Trajectory
SNM	Square Nautical Miles
SSS	Side Scan Sonar
SSSAB	Side Scan Sonar Acoustic Backscatter
ST	Survey Technician
SVP	Sound Velocity Profiler
TCARI	Tidal Constituent And Residual Interpolation
TPU	Total Propagated Uncertainty
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
UTM	Universal Transverse Mercator
XO	Executive Officer
ZDF	Zone Definition File