H13388

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

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	H13388

LOCALITY

State(s):	Texas
General Locality:	Houston Ship Channel and Galveston Bay
Sub-locality:	Lower Houston Ship Channel

2020

CHIEF OF PARTY
Jonathan L. Dasler, PE, PLS, CH

LIBRARY & ARCHIVES

Date:

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

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

H13388

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):	**Texas**
General Locality:	**Houston Ship Channel and Galveston Bay**
Sub-Locality:	**Lower Houston Ship Channel**
Scale:	**10000**
Dates of Survey:	**08/06/2020 to 05/15/2021**
Instructions Dated:	**07/02/2020**
Project Number:	**OPR-K375-KR-20**
Field Unit:	**David Evans and Associates, Inc.**
Chief of Party:	**Jonathan L. Dasler, PE, PLS, CH**
Soundings by:	**Multibeam Echo Sounder and Mobile Mapping**
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 15N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

Table of Contents

List of Tables

List of Figures

Descriptive Report to Accompany Survey H13388

Project: OPR-K375-KR-20

Locality: Houston Ship Channel and Galveston Bay

Sublocality: Lower Houston Ship Channel

Scale: 1:10000

August 2020 - May 2021

David Evans and Associates, Inc.

Chief of Party: Jonathan L. Dasler, PE, PLS, CH

A. Area Surveyed

David Evans and Associates, Inc. (DEA) conducted a hydrographic survey of the assigned area in the vicinity of Houston, Texas. Survey H13388 was conducted in accordance with the Statement of Work and Hydrographic Survey Project Instructions dated July 2, 2020, and modifications to Project Instructions issued on December 9, 2020, and February 25, 2021.

The Hydrographic Survey Project Instructions reference the National Ocean Service (NOS) Hydrographic Surveys Specifications and Deliverables Manual (HSSD) (May 2020) as the technical requirements for this project.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
29° 43' 32.41" N 95° 33' 59.48" W	29° 21' 42.48" N 94° 47' 56.79" W

Table 1: Survey Limits

Survey Limits were surveyed in accordance with the requirements in the Project Instructions and the HSSD.

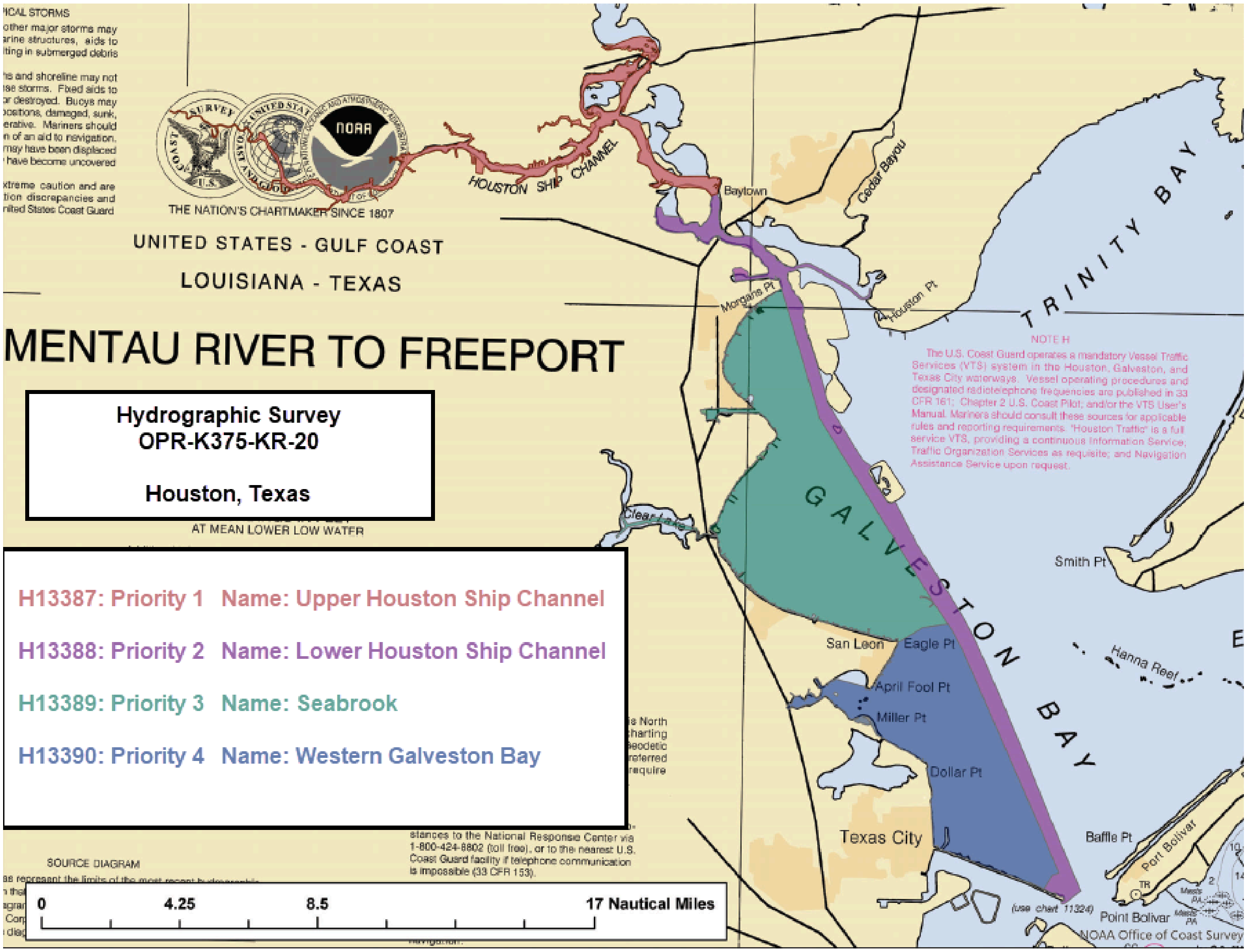


Figure 1: OPR-K375-KR-20 Assigned Survey Areas

Figure 2: OPR-K375-KR-20 Assigned Mobile Mapping Areas

A.2 Survey Purpose

The purpose of this survey, defined in the Project Instructions, is as follows: “The Port of Houston and the Houston Ship Channel accommodate more than 250 million total tons of cargo each year, ranking it second largest by tonnage in the nation.(1) In 2018, the Port of Houston brought in an estimated $339 billion in value to the State of Texas(2), making it a critical corridor for the economy of the region and nation.

The channel itself is maintained by the U.S. Army Corps of Engineers; however, many of the surrounding waterways and bays, which are used by numerous barges, oil services vessels, fishing and pleasure vessels, have not been surveyed in more than fifty years. Modern high-resolution surveys of these areas are important for navigation safety and as a tool to help planners and researchers model and manage issues as diverse as floodwater movement and oyster reef restoration.

This current survey covers an area of approximately 79 square nautical miles of Galveston Bay, Houston Ship Channel and Buffalo Bayou. Survey data from this project are intended to supersede all prior survey data in the common area."

1: Bureau of Transportation Statistics, USDOT: https://www.bts.gov/topics/national-transportation-statistics
2: 2018 Economic Impact of Marine Cargo Activity at the Port of Houston: Executive

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

The channel bottom is continuously changing due to currents, vessel prop wash, dredging activity, construction and/or other factors present in the channel environment. Section B.2.10 of this report further discusses these issues and impacts to the final deliverable data. In all cases, the hydrographer has verified that soundings accurately depicted the channel condition at the time of acquisition.

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 areas Sheet 1 and 2	Object Detection Coverage (HSSD Section 5.2.2.2)
Inshore Limit	For those areas delineated as crane area feature types (CRANES) in the Project Reference File (PRF), navigation limit is the inshore limit of safe navigation for the vessel as determined by the Chief-of-Party. For areas outside of those delineated as CRANES, the inshore limit of hydrography and feature verification for Navigable Area Surveys, the Navigable Area Limit Line (NALL), unless stated otherwise in the Hydrographic Survey Project Instructions, is defined as the most seaward of the following: 1- The surveyed *2.0-meter* depth contour at Mean Lower Low Water (MLLW); 2- The line defined by the distance seaward from the observed Mean High Water (MHW) line, which is equivalent to 0.8 millimeters at the scale of the largest-scale nautical chart covering any portion of the survey area; or 3- The inshore limit of safe navigation for the survey vessel, as determined by the Chief-of-Party. If kelp, rocks, breakers, or other hazards make it unsafe to approach the coast to the limits specified in 1 and 2 above, the NALL shall be defined as the shoreward boundary of the area in which it is safe to survey.

Table 2: Survey Coverage

Project Instructions called for high-resolution charting at 1:10000 survey scale to support NOAA’s Precision Navigation initiative for the Houston Ship Channel, including: Object Detection Coverage for all waters in the survey area to the 2-meter depth contour or the NALL; verification of Aids to Navigation (ATONs); assignment of shoreline and nearshore features (including bridges, overhead wires, assigned existing terminals, and all uncharted features) to be obtained by a vessel-based mobile laser scanner and delivery of processed laser format (LAS) data referenced using ellipsoidally referenced survey (ERS) methods.

Operational challenges included, but were not limited to: conducting surveys in a heavily congested industrial waterway; shoreline surveys in restricted waters with small launch operations in close proximity to terminals, large barge fleets, wrecks, ruins, submerged piles, and numerous snags; dynamic sediment migration; coordinating mapping efforts with ships at berth, ongoing dredging operations; and various navigational trials associated with a heavily trafficked industrial waterway. To mitigate these challenges, and with the volume of shoreline operations required, survey operations were conducted during daylight hours only, automatic identification systems (AIS) and internet vessel tracking systems were utilized, and continuous communications were made to terminal operators and vessel captains by radio and phone.

Object Detection Coverage was obtained over the survey area in depths greater than 2 meters relative to chart datum using 100% multibeam echosounder (MBES) and backscatter unless otherwise discussed in individual sections of this report. This coverage type follows Option A of the Object Detection Coverage requirement specified in Section 5.2.2.2 of the 2020 HSSD.

Unavoidable coverage gaps are evident in some areas and are primarily due to large barge fleeting areas. Other factors that blocked or impeded safe vessel operations resulting in data gaps included: berthed vessels that remained during survey operations; low wires behind structures; mooring lines; in-water facilities; and ongoing construction. Significant efforts were expended to maximize coverage to the extent possible in these areas. Section B.2.10 of this report discusses issues restricting this survey coverage in greater detail.

Figure 3 depicts the H13388 survey outline.

The Project Instructions required the use of mobile laser scanning technology for scanning of bridges, overhead cables, and terminal facilities located in the survey area. These areas, which are depicted in Figure 2 (above), were identified in the PRF as CRANES. Overhead clearances of the assigned bridges and cables, discussed in D.2.3 Overhead Features, were computed from LAS data. Acquisition of mobile lidar data was expanded outside of these assigned areas to encompass the entire survey area in order to facilitate the survey, management, and reporting of all shoreline and nearshore features located within the project area.

Figure 3: H13388 Survey Outline

A.6 Survey Statistics

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

	HULL ID	*S/V Blake*	*R/V Broughton*	*RHIB Sigsbee*	*R/V Sea Scanner*	*Total*
LNM	**SBES Mainscheme**	0	0	0	0	0
	MBES Mainscheme	272.33	238.81	108.66	865.04	1484.84
	Lidar Mainscheme	74.8	3.9	0	0	999
	SSS Mainscheme	0	0	0	0	0
	SBES/SSS Mainscheme	0	0	0	0	0
	MBES/SSS Mainscheme	0	0	0	0	0
	SBES/MBES Crosslines	18.41	18.75	2.41	20.62	60.19
	Lidar Crosslines	0	0	0	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						11.49

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
09/29/2020	273
09/30/2020	274
10/01/2020	275
10/02/2020	276
10/03/2020	277
10/04/2020	278
10/07/2020	281
10/08/2020	282
10/11/2020	285
10/12/2020	286
10/13/2020	287
10/14/2020	288
10/15/2020	289
11/04/2020	309
11/05/2020	310
11/06/2020	311
11/07/2020	312
11/08/2020	313
11/09/2020	314
11/11/2020	316
11/13/2020	318
11/14/2020	319
11/16/2020	321
11/19/2020	324
12/04/2020	339
12/05/2020	340
12/06/2020	341
12/07/2020	342
12/08/2020	343
12/10/2020	345
12/11/2020	346
12/12/2020	347

Survey Dates	Day of the Year
12/17/2020	352
12/18/2020	353
12/19/2020	354
12/20/2020	355
01/08/2021	8
01/09/2021	9
01/12/2021	12
01/13/2021	13
01/14/2021	14
01/16/2021	16
03/04/2021	63
03/06/2021	65
03/08/2021	67
03/09/2021	68
03/12/2021	71
03/13/2021	72
03/19/2021	78
03/20/2021	79
03/27/2021	86
03/29/2021	88
05/07/2021	127
05/15/2021	135

Table 4: Dates of Hydrography

B. Data Acquisition and Processing

B.1 Equipment and Vessels

The OPR-K375-KR-20 Data Acquisition and Processing Report (DAPR), submitted with prior survey H13387, details equipment and vessel information as well as data acquisition and processing procedures. There were no vessel or equipment configurations used during data acquisition that deviated from those described in the DAPR.

B.1.1 Vessels

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

Hull ID	*S/V Blake*	*R/V Broughton*	*RHIB Sigsbee*	*R/V Sea Scanner*
LOA	82 feet	24 feet	18 feet	26 feet
Draft	4.5 feet	2.75 feet	1 feet	2 feet

Table 5: Vessels Used

Figure 4: S/V Blake

Figure 5: R/V Broughton

Figure 6: RHIB Sigsbee

Figure 7: R/V Sea Scanner

B.1.2 Equipment

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

Manufacturer	Model	Type
Teledyne RESON	SeaBat T50-R	MBES
RIEGL	VMX-450	Lidar System
Carlson	Merlin	Lidar System
Applanix	POS MV 320 v5	Positioning and Attitude System
iXblue	Hydrins	Positioning and Attitude System
AML Oceanographic	MicroX SV	Sound Speed System
AML Oceanographic	MVP30-350	Sound Speed System
AML Oceanographic	BaseX2	Sound Speed System
AML Oceanographic	SmartX	Sound Speed System
Trimble	SPS855	Positioning System
Applanix	POS LV 620	Positioning System

Table 6: Major Systems Used

B.2 Quality Control

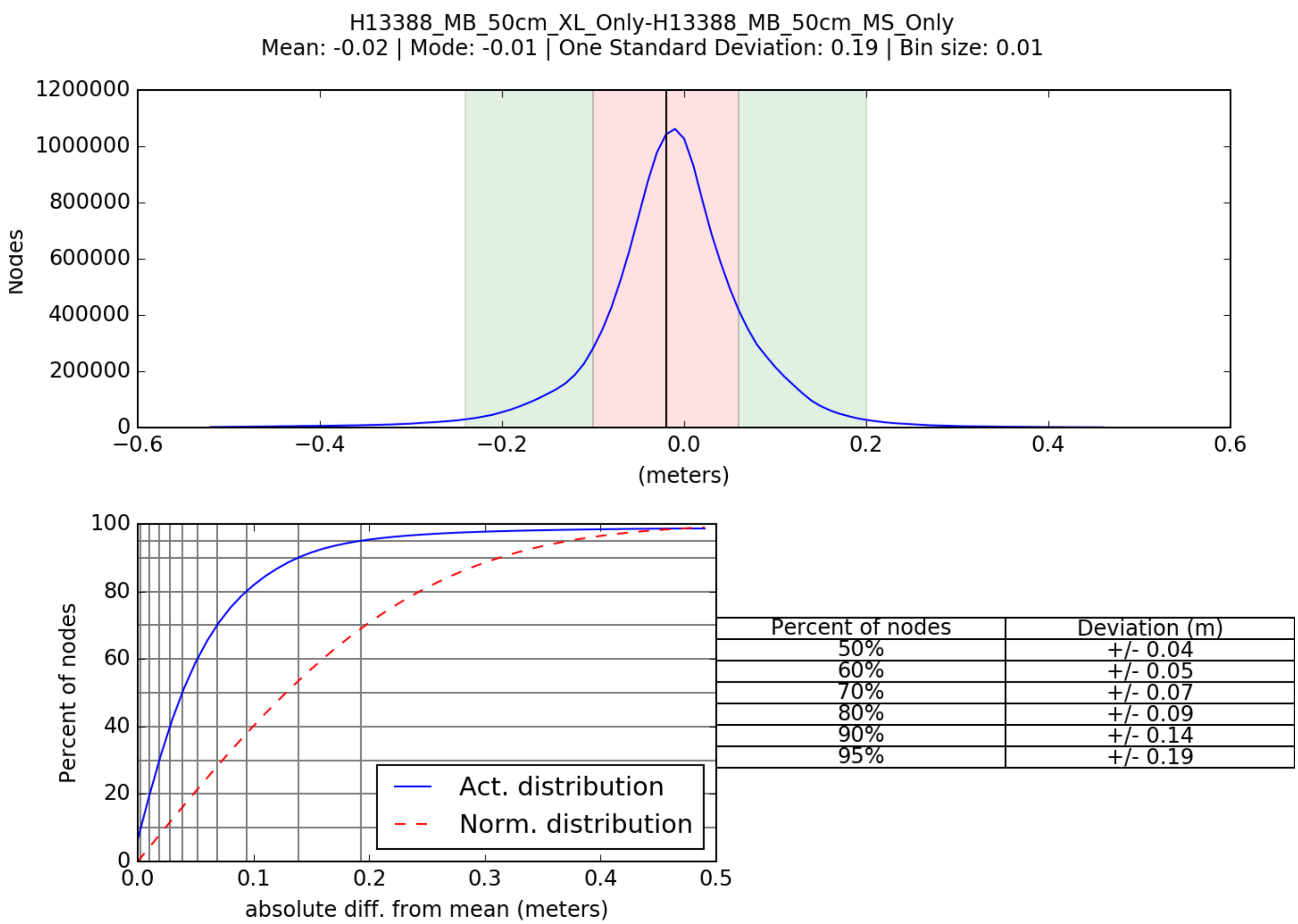
B.2.1 Crosslines

Quality control checks for the mobile lidar system were performed during system mobilization by comparing positions and elevations of scanned features to real-time kinematic (RTK) global navigation satellite system (GNSS) observations.

Multibeam crosslines were run across 4.05% of the entire survey area to provide a varied spatial and temporal distribution for analysis of internal consistency within the survey data.

Crossline analysis was performed using the CARIS Hydrographic Information Processing System (HIPS) Quality Control (QC) Report tool, which compares crossline data to a gridded surface and reports results by beam number. Crosslines were compared to a 50-centimeter CUBE surface encompassing mainscheme, fill, and investigation data for the entire survey area. The QC Report tabular output and plots for all vessels are included in Separate II Crossline Comparison. For the R/V Broughton, RHIB Sigsbee, and R/V Sea Scanner, the output and plot contain data from a dual-head system, with beams 1 to 256 from the port head and 257 to 512 from the starboard head. The S/V Blake is a single-head configuration crossline analysis for 512 beams.

DEA performed an additional crossline analysis using the NOAA Pydro Compare Grids tool to analyze the differences between gridded mainscheme depths and gridded crossline depths. Input grids were 50-centimeter resolution CUBE surfaces of mainscheme and crossline depths. Results from the crossline to mainscheme difference analysis are depicted in Figure 8, with units represented in meters. Figure 9 depicts a difference surface portraying the results of sediment migration, active dredging, and shoaling seen throughout the duration of the survey. This figure details crosslines conducted throughout the survey. Change is significant in the dredge and shoaling areas with horizontal differences of up to 1.5 meters occurring between mainscheme and crossline acquisition. In the crossline difference image, overlaid on the final multibeam hillshade, shades of yellow and red indicate shoaling in meters and shades of blue indicate deepening in meters. Shades of gray indicate areas that meet requirements and are generally outside of dredging areas.



Percent of nodes	Deviation (m)
50%	+/- 0.04
60%	+/- 0.05
70%	+/- 0.07
80%	+/- 0.09
90%	+/- 0.14
95%	+/- 0.19

Figure 8: H13388 Crossline Difference

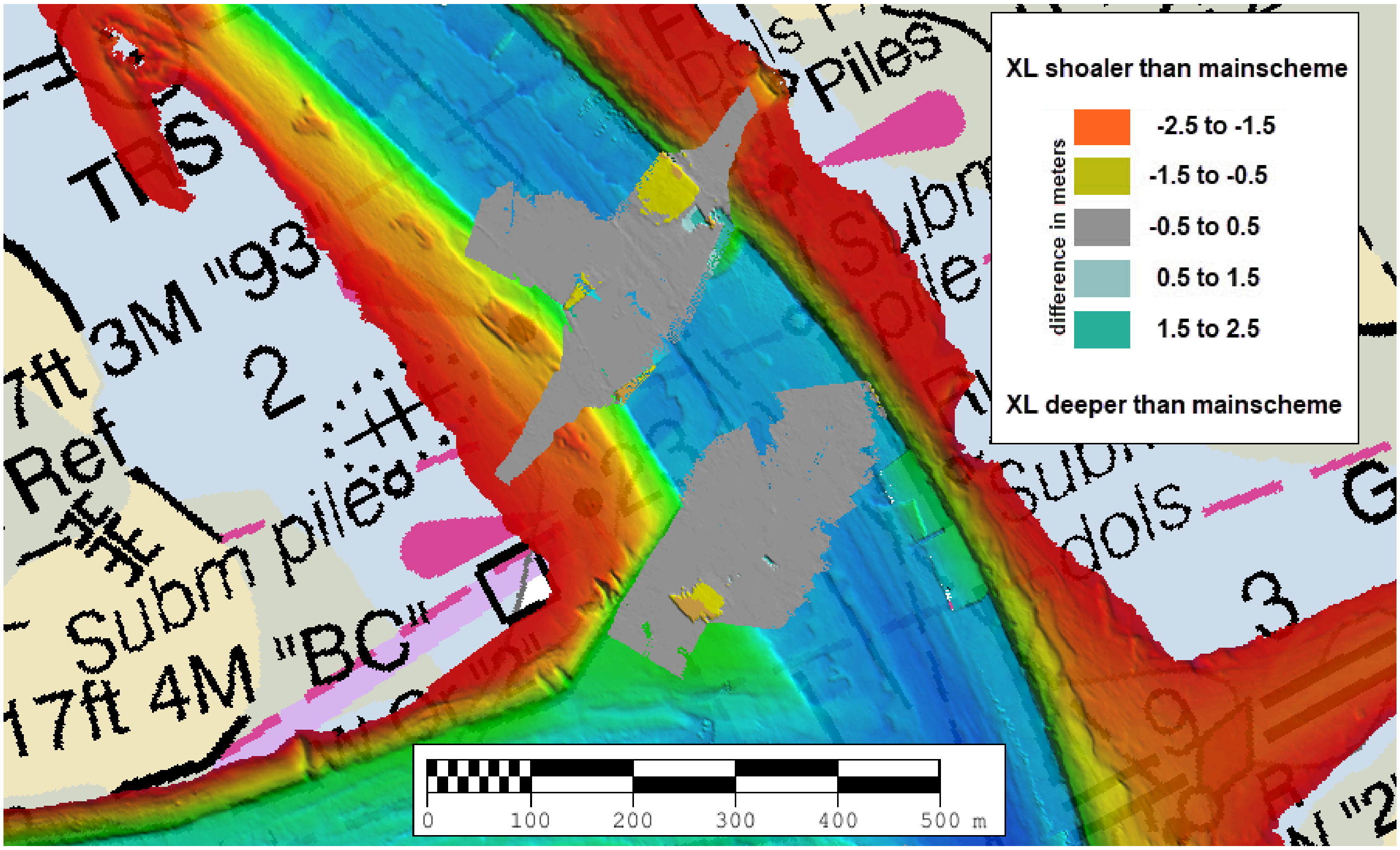


Figure 9: H13388 Crossline Difference Surface Overlayed on the Multibeam Hillshade, Highlighting Shoaling and Dredging

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via VDATUM	0.05 meters	0.0906 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Measured - XBT	Surface
S/V Blake	n/a meters/second	1.0 meters/second	n/a meters/second	0.5 meters/second
R/V Broughton	1.0 meters/second	n/a meters/second	n/a meters/second	0.5 meters/second
RHIB Sigsbee	1.0 meters/second	n/a meters/second	n/a meters/second	0.5 meters/second
R/V Sea Scanner	1.0 meters/second	n/a meters/second	n/a meters/second	0.5 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

Additional discussion of these parameters is included in the DAPR. Sound speed profiles collected from the R/V Broughton, RHIB Sigsbee, and R/V Sea Scanner were acquired with an AML BaseX or an AML SmartX sound speed sensor. The S/V Blake used an AML MVP30-350 with integrated Micro SVP & T to acquire sound speed measurements. The measurement uncertainty for these sensors is listed in the CTD (Conductivity Temperature Depth) column in Table 8.

During surface finalization in HIPS, the "Greater of the two values" option was selected, where the calculated uncertainty from Total Propagated Uncertainty (TPU) is compared to the standard deviation of the soundings influencing the node, and where the greater value is assigned as the final uncertainty of the node. The uncertainty of the finalized surfaces increased for nodes that had a standard deviation greater than TPU.

To determine if the surface grid nodes met International Hydrographic Organization (IHO) Order 1a specification, a ratio of the final node uncertainty to the allowable uncertainty at that depth was determined. As a percentage, this value represents the amount of error budget utilized by the total vertical uncertainty (TVU) at each node. Values greater than 100% indicate nodes exceeding the allowable IHO uncertainty. The resulting calculated TVU values of all nodes in the submitted finalized surface are shown in Figures 10 and 11.

The finalized surface includes occasional large vertical uncertainties that exceed IHO Order 1a allowances. These high uncertainties were caused by introducing areas of high depth standard deviation associated with steep slopes or identified obstructions when finalizing surfaces with the greater-of-the-two option. It is also noted that, on occasion, the real-time uncertainty logged during acquisition included a sounding with an extremely high depth uncertainty, which was well outside of realistic values. During processing, an IHO filter was applied to all sounding data, with rejecting soundings exceeding IHO Order 1a thresholds for TVU. These rejected soundings have at times been re-accepted after thorough review by the hydrographer. This issue appears to have been caused by an unresolved software bug in either the sonar top side unit or acquisition system impacting the reported uncertainty, but not the actual depth.

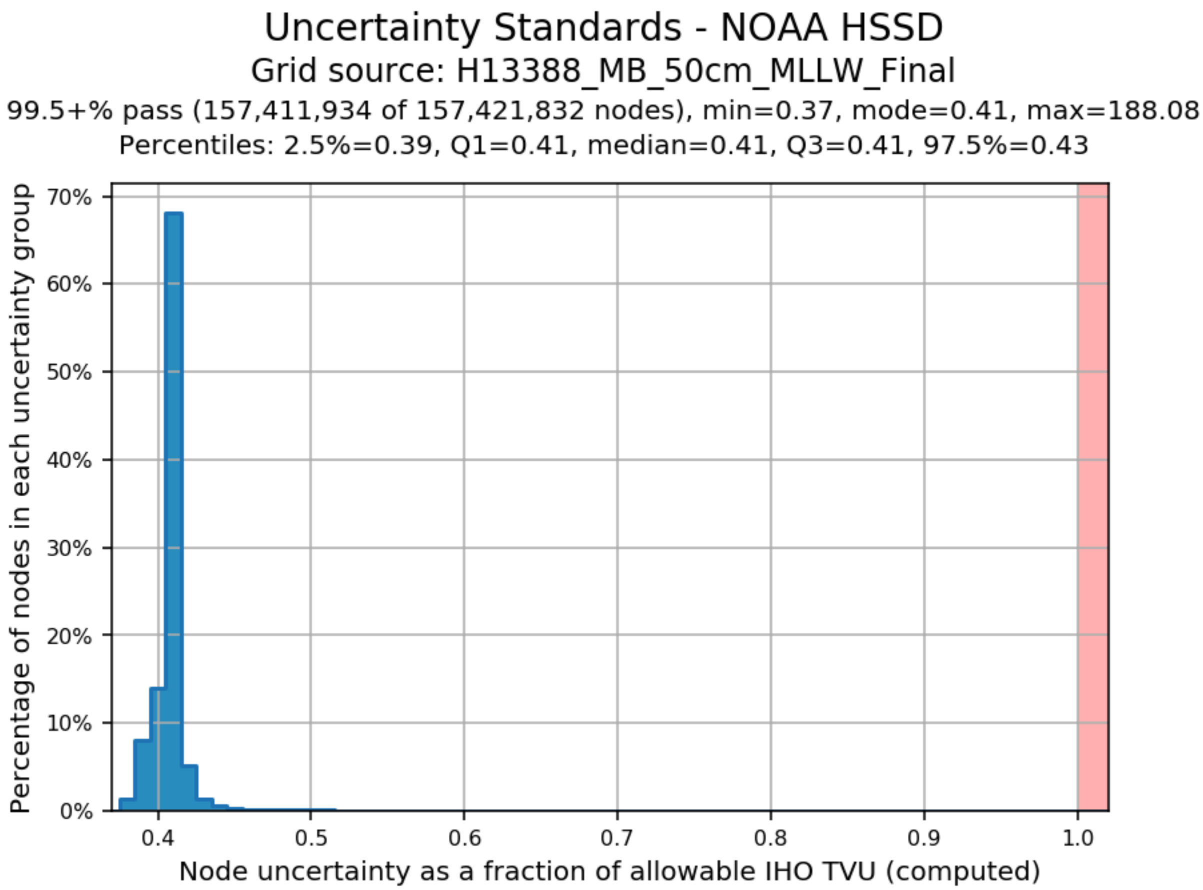


Figure 10: Node TVU Statistics - 50 centimeters, Finalized

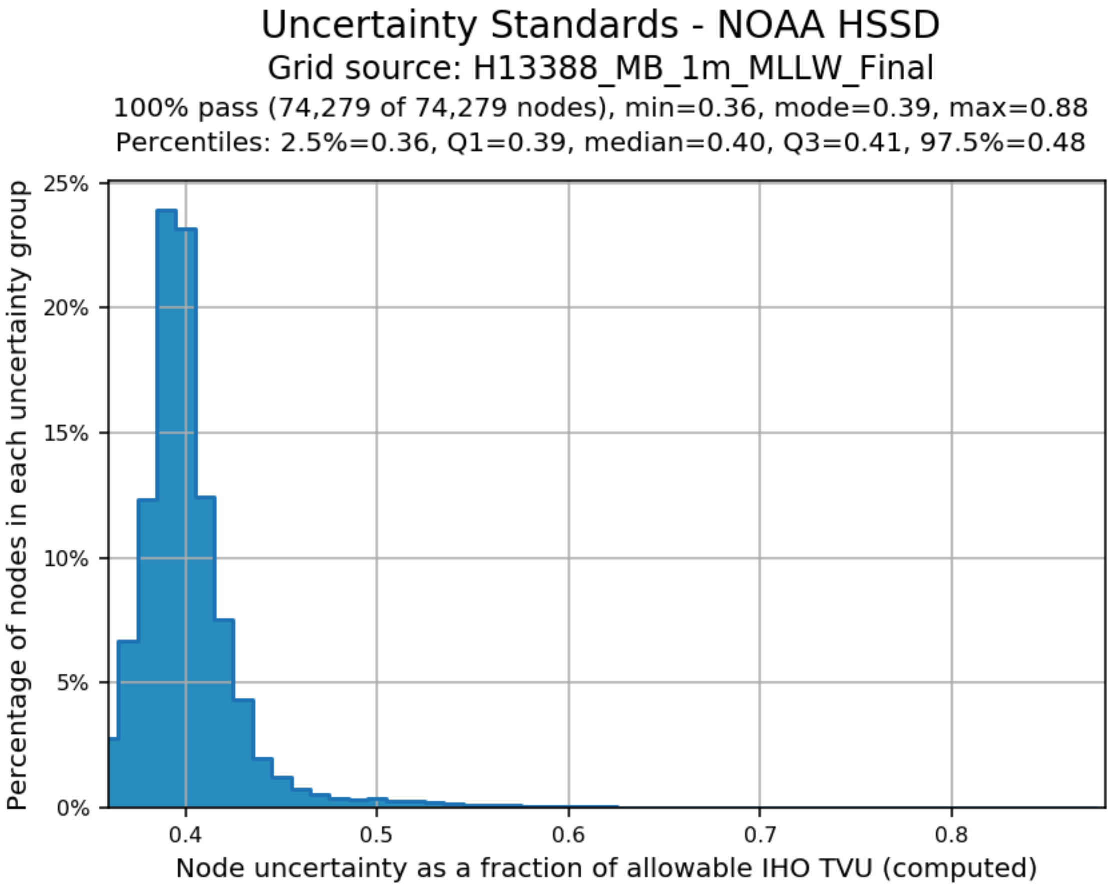


Figure 11: Node TVU Statistics - 1 meter, Finalized

B.2.3 Junctions

Survey H13388 junctions with current surveys H13387, H13389, and H13390, as shown in Figure 12. No prior surveys were specified as junctions in the Project Instructions.

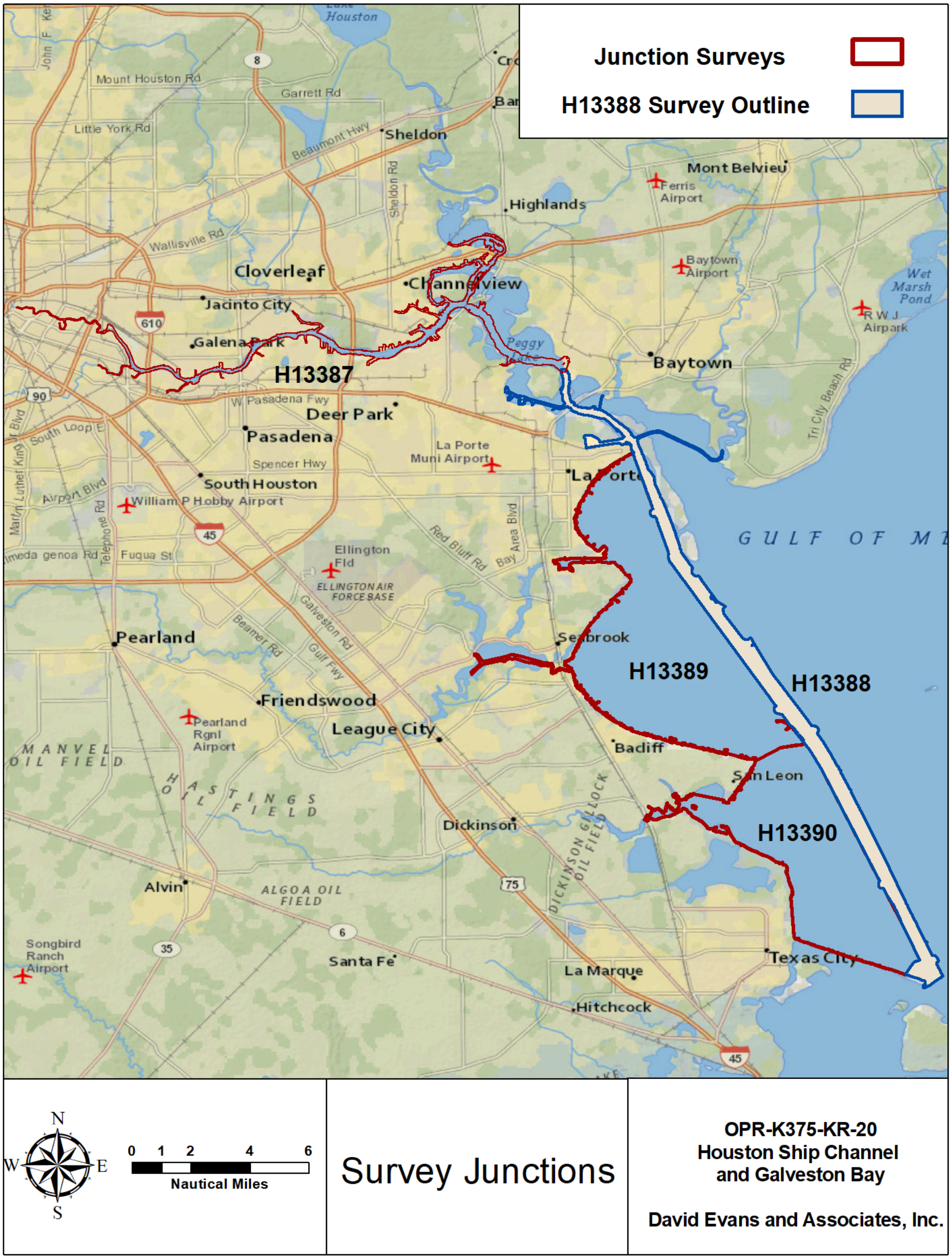


Figure 12: H13388 Survey Junctions

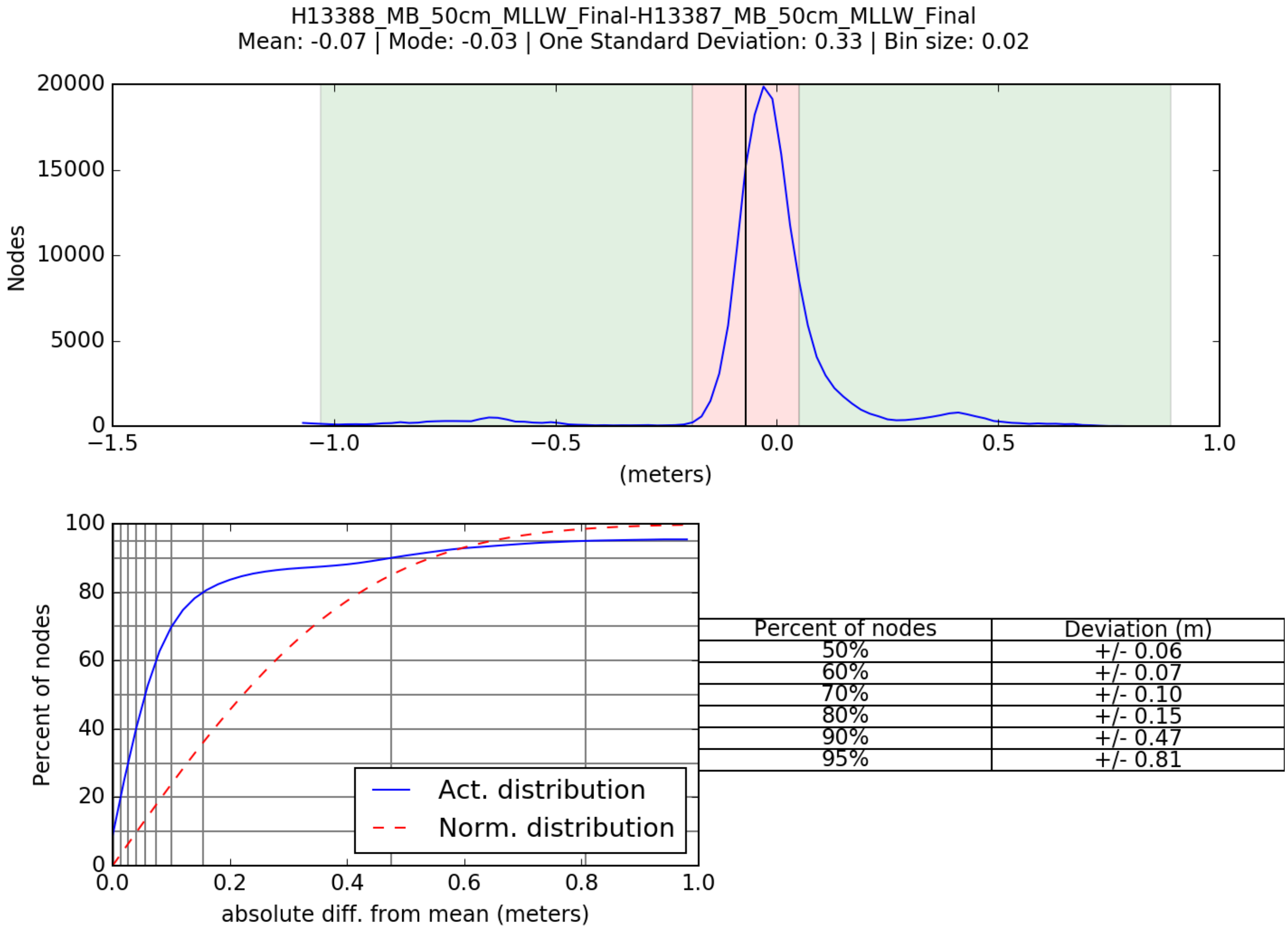
The following junctions were made with this survey:

Registry Number	Scale	Year	Field Unit	Relative Location
H13387	1:5000	2020	David Evans and Associates, Inc.	N
H13389	1:10000	2020	David Evans and Associates, Inc.	W
H13390	1:12500	2020	David Evans and Associates, Inc.	W

Table 9: Junctioning Surveys

H13387

The mean difference between H13388 and H13387 survey depths is 7 centimeters (with H13387 shoaler than H13388), as shown in Figure 13. The greatest differences between the two surveys are in areas where sediment migration occurred during H13387 survey operations, as shown in Figure 14. Section B.2.6 of the H13387 Descriptive Report describes this issue in more detail.



Percent of nodes	Deviation (m)
50%	+/- 0.06
60%	+/- 0.07
70%	+/- 0.10
80%	+/- 0.15
90%	+/- 0.47
95%	+/- 0.81

Figure 13: Distribution Summary Plot of Survey H13388 50-centimeter grid vs H13387 50-centimeter grid

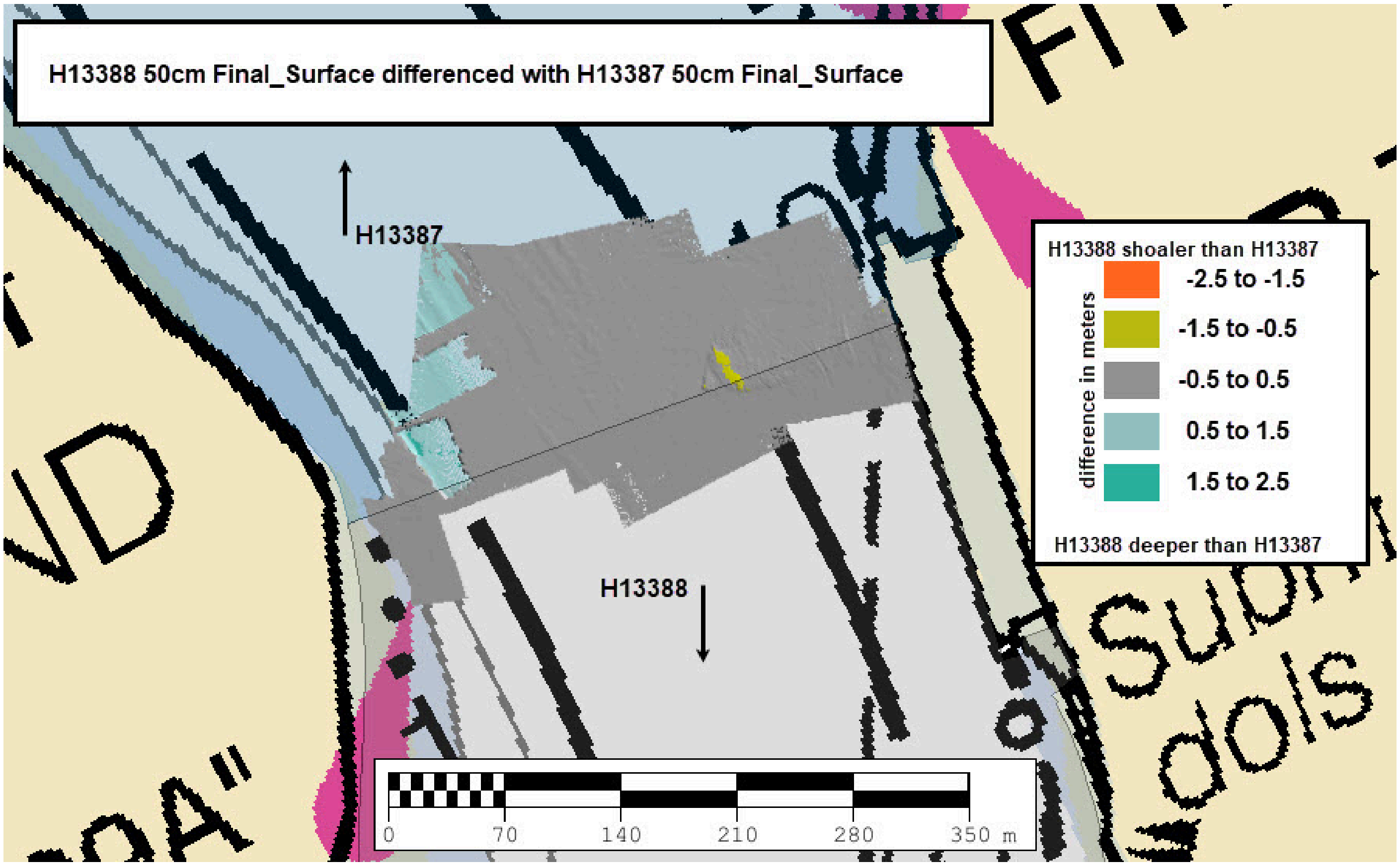


Figure 14: Differences in Depth at the Junction between H13388 and H13387

<u>H13389</u>

At the time of writing, data from survey H13389 was still being processed. The Descriptive Report for H13389 will include the junction analysis with H13388.

<u>H13390</u>

At the time of writing, data from survey H13390 was still being processed. The Descriptive Report for H13390 will include the junction analysis with H13388.

B.2.4 Sonar QC Checks

Quality control is discussed in detail in Section B of the DAPR. Results from project position checks and multibeam bar checks are included in Separate I Acquisition and Processing Logs of this report. Sound speed checks can be found in Separate II Sound Speed Data Summary of this report.

Multibeam data were reviewed at multiple levels of data processing, including: CARIS HIPS conversion, subset editing, and analysis of anomalies revealed in CUBE surfaces.

B.2.5 Equipment Effectiveness

SmartHeave Post-Processing

During the initial setup for RHIB Sigsbee acquisition at the start of the project, a delayed heave message (SmartHeave) was not being output. All Hydrins data collected prior to October 13, 2020, (DN287) were post-processed using DelphINS software. The post-processed solution included the manufacturer's "smart heave" messages, exported in a custom *.txt file format. All data acquired prior to and including DN287 had the delayed heave file reapplied in CARIS using the GDP (Generic Data Parser) application. Post October 13, 2020, a delayed heave message was logged daily to a .log file and applied during processing in Process Designer for all RHIB Sigsbee data acquired for the remainder of the survey.

B.2.6 Factors Affecting Soundings

Bottom changes during survey operations

Changes in the bottom during survey operations caused misalignments between some sounding data. Three scenarios presented themselves when reviewing data and receiving guidance on processing from HSD Operations Branch: newer sounding data were uniformly shoaler or deeper than previously acquired data; sediment migration caused soundings to be inconsistently shoaler and deeper than overlapping data; and there were areas where overlapping data showed the bottom to be deeper than previously collected survey data due to dredging.

In some areas, uniform sediment migration occurred between the acquisition of mainscheme data and subsequent fill and investigation data, causing misalignment between the survey lines. HSD staff provided guidance on this issue, asking that the most recent data in these areas be retained, whether shoaler or deeper, and that older data be rejected in subset editor. After executing, this process contributed to holidays in the deliverable surface. Figure 15 illustrates an example subset view of newer soundings that were uniformly shoaler with older and deeper sounding data that were manually rejected. Impacts from this process that are evident in the deliverable surfaces are highlighted in the H13388_Notes_for_Reviewer.hob file with the cvrage area feature class, submitted in Appendix II of this report.

Sediment migration on the seafloor was evident throughout the course of this survey. At times, overlapping survey data (mainscheme, fill, and crosslines) did not align with previously acquired mainscheme data, exceeding allowable uncertainty requirements. Following guidance from HSD Operations Branch, the hydrographer allowed the CUBE algorithm to estimate a gridded depth in these areas without manually cleaning the sounding data. Soundings deemed to be fliers were rejected while valid sonar returns were retained, though they may have disagreed with adjacent soundings collected at another time. The submitted surface has numerous artifacts resulting from the areas of disagreement. Figure 16 shows an example of horizontal movement (approximately 90 centimeters) in sediment waves that resulted in disagreement for H13388 bathymetric grids. Some areas of the greatest disagreement have been noted in the H13388_Notes_for_Reviewer.hob file with the SNDWAV area feature class, submitted in Appendix II of this report. This is not an exhaustive list, but highlights major surface artifacts resulting from sediment migration that are present in the bathymetric grids.

In some sections of the Houston Ship Channel, there are notable artifacts in the multibeam data and bathymetric grids resulting from dredging activity. Bathymetric data were collected before, during, and after dredging activities, resulting in large disagreements between overlapping swaths. Following guidance from HSD Operations Branch, when disagreements existed due to dredging, data acquired before dredging were manually rejected to retain newer data acquired after dredging. This practice resulted in the creation of holidays in the bathymetric grids submitted with this survey. Artifacts resulting from dredging, sediment migration, and holidays created by rejecting pre-dredge data in the Houston Ship Channel are visible in Figures 15-17. Guidance from HSD is included in Appendix II of this report.

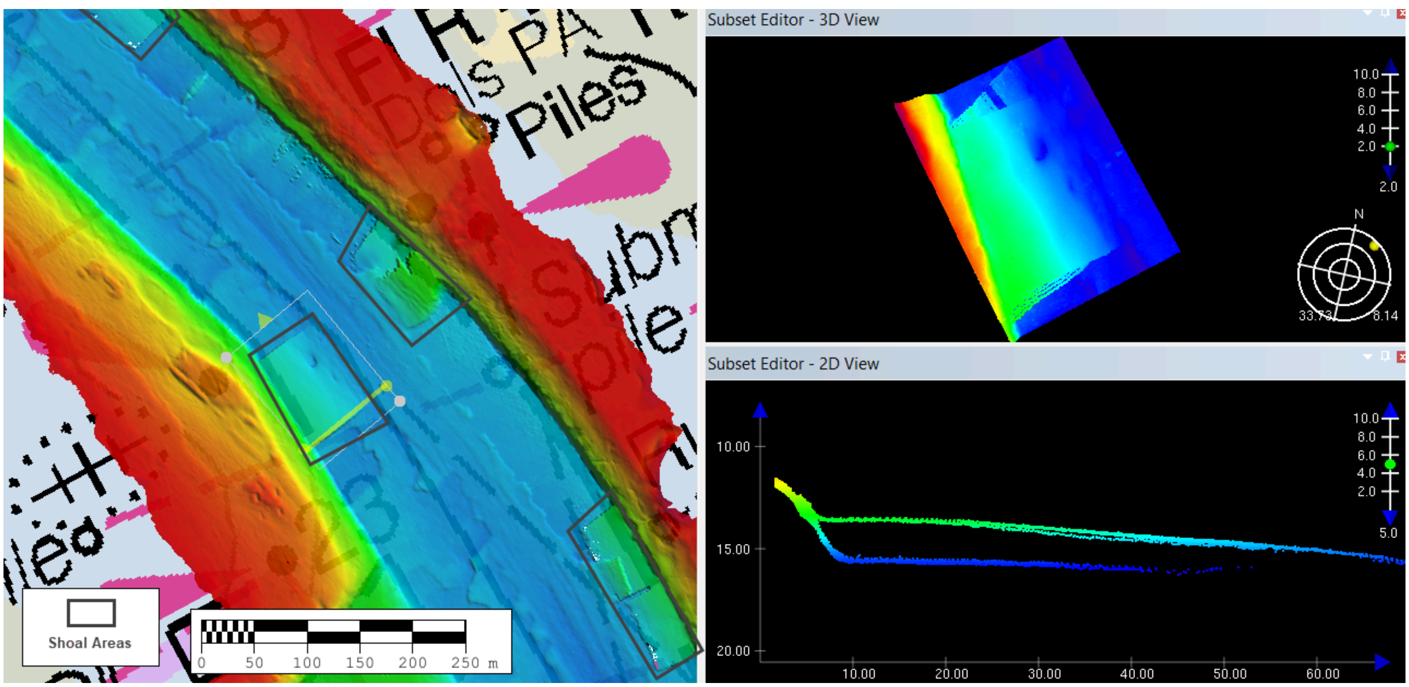


Figure 15: Artifacts from Dredging

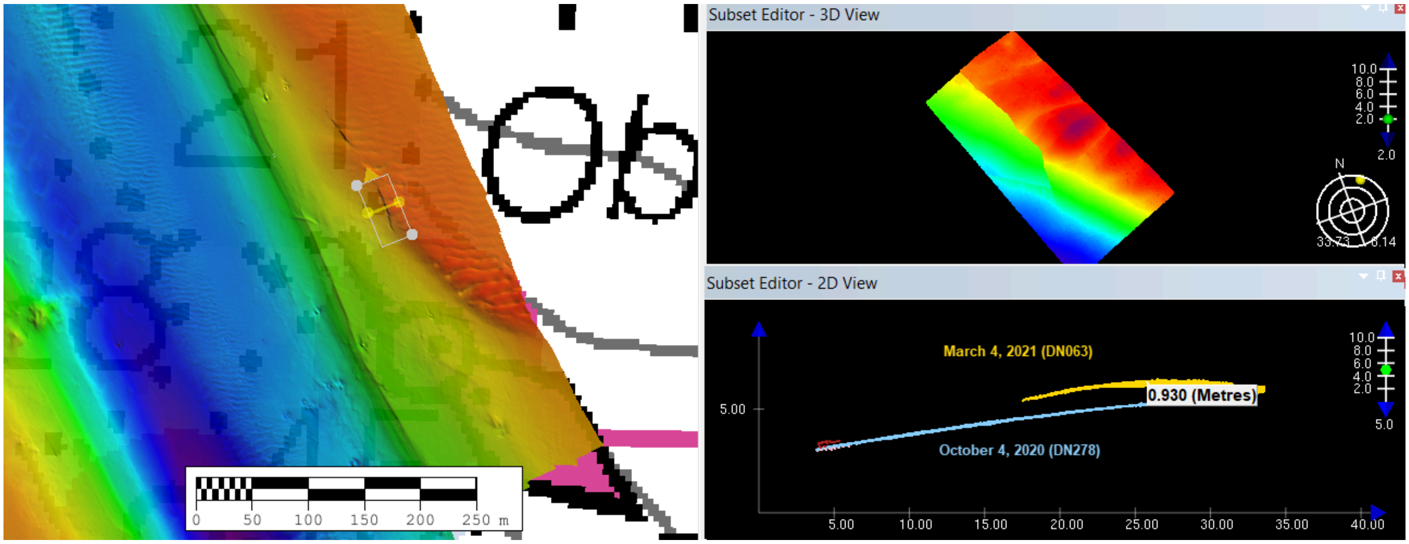


Figure 16: Sediment Migration Artifacts

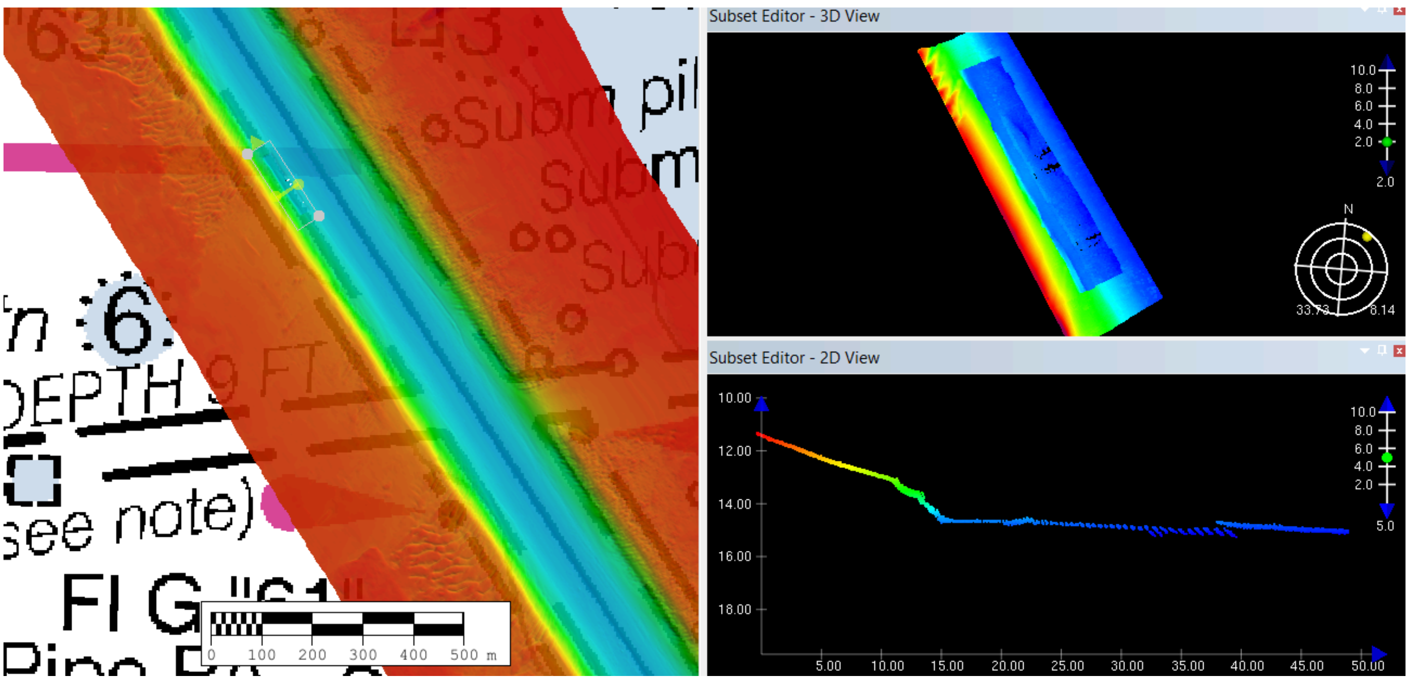


Figure 17: Post-dredge Surface Holidays in Main Channel

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: Approximately one-hour intervals

For H13388 survey operations, casts were distributed both temporally and spatially based on observed changes in sound speed profiles. Sound speed readings were applied in CARIS HIPS using the nearest in distance within a one-hour interval for S/V Blake, R/V Broughton, and R/V Sea Scanner. The RHIB Sigsbee moved around more frequently, acquiring data along the shoreline, which required the application of sound speed casts in CARIS using the nearest in distance within a two-hour interval. The deviation from one hour to two hours between casts had no discernible impact on data quality as casts were relatively consistent. Additional discussion of sound speed methods and equipment can be found in the DAPR.

All cast profiles were made within 500 meters of the survey limits.

B.2.8 Coverage Equipment and Methods

Survey speeds were maintained to meet or exceed along-track sounding density requirements.

Multibeam data were thoroughly reviewed for holidays and areas of poor-quality coverage due to biomass, vessel wakes, barge fleeting, ships at berth, ongoing construction, or other factors. Details impacting survey coverage are detailed in section B.2.10.

Mobile lidar coverage was obtained on assigned overhead features and along the shoreline within the scan area. Mobile lidar was also acquired outside of scan areas to aid in the positioning of baring features.

B.2.9 Density

The sounding density requirement of 95% of all nodes, populated with at least five soundings per node, was verified by analyzing the density layer of the finalized surface. Individual surface results are stated in Figures 18 and 19.

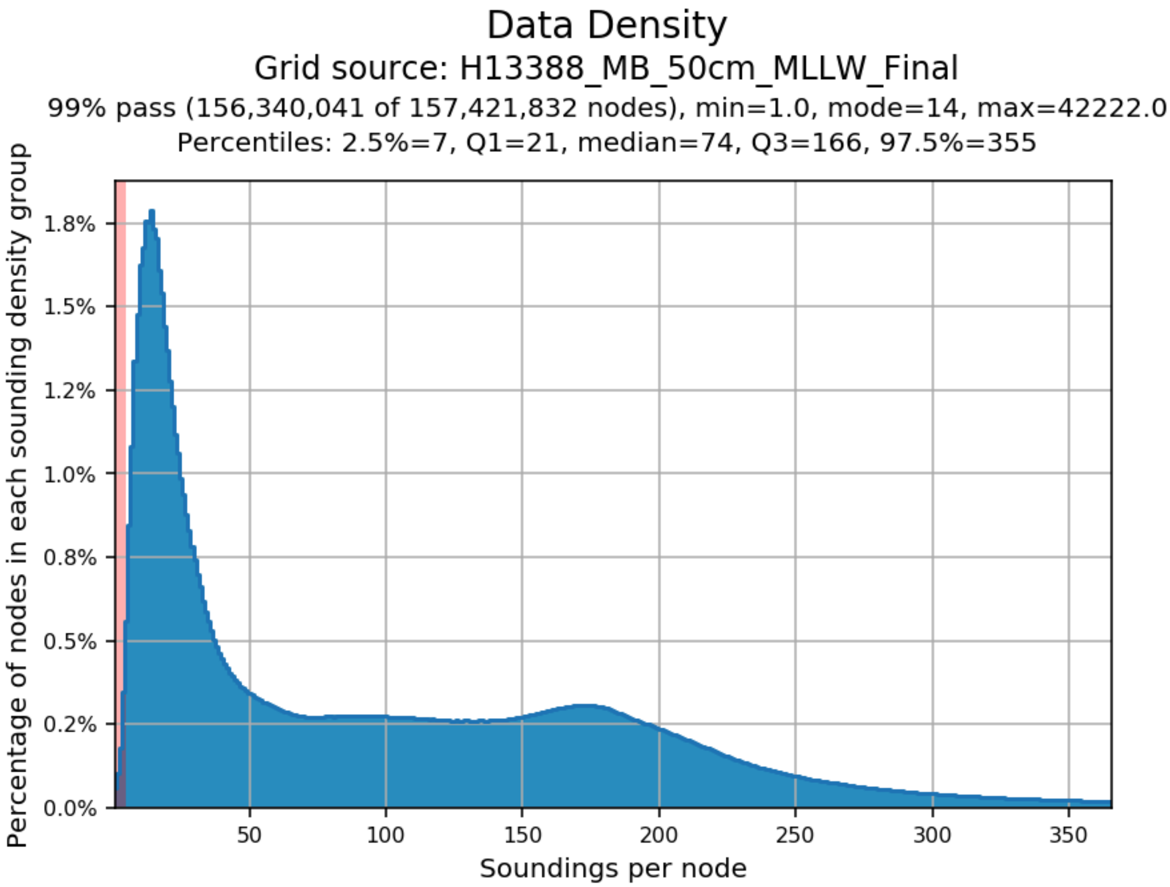


Figure 18: Node Density Statistics - 50 centimeters, Finalized

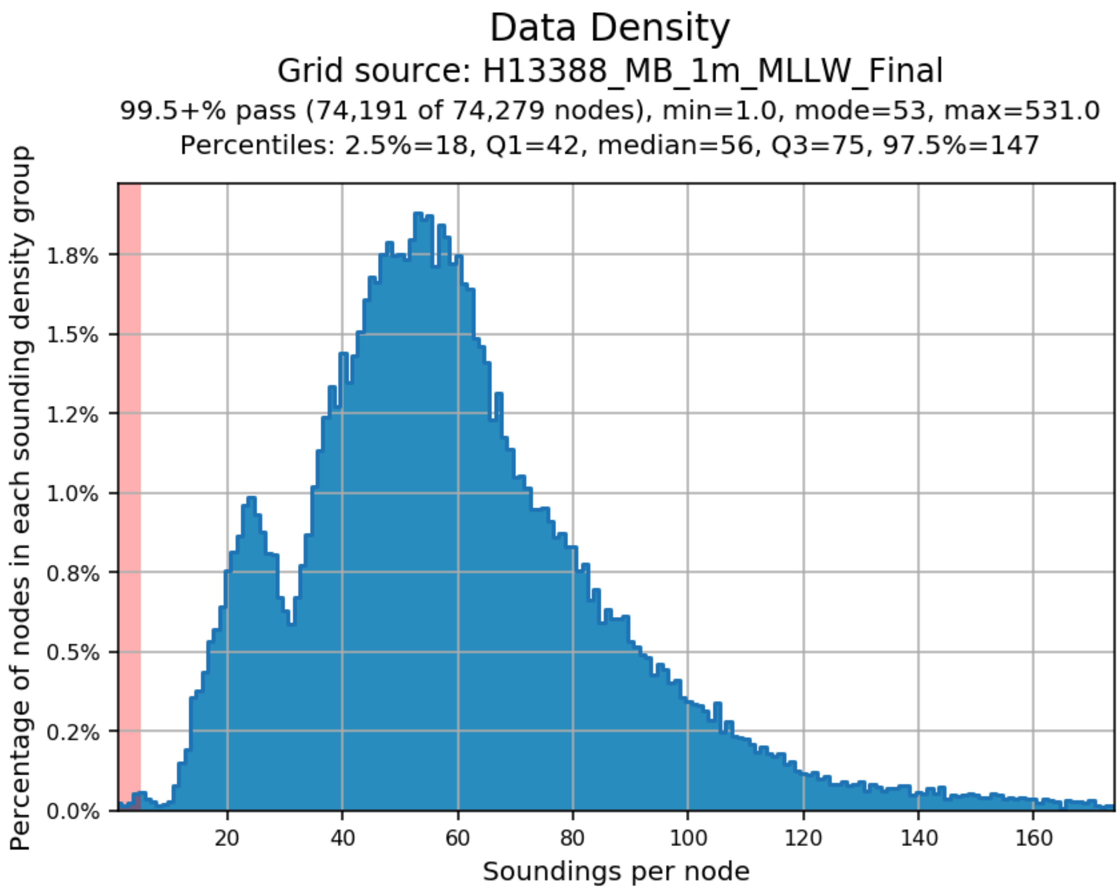


Figure 19: Node Density Statistics - 1 meter, Finalized

B.2.10 Data Gaps in Bathymetric Coverage

Occasional data gaps in the final Object Detection surface exist due to operational restrictions at the time of survey. These data gaps were further analyzed after acquisition and determined to be unattainable due to safety or other factors impacting vessel operations. Significant effort was expended during survey operations to maximize Object Detection Coverage in these areas.

Some of the sources for these data gaps include, but are not limited to:
- Holidays or 2-meter coverage gaps behind pier structures where the field unit was physically unable to operate, or safety concerns limited access.
- Holidays or 2-meter coverage gaps underneath barge fleets or ships at berth. These were revisited at least one additional time on subsequent days. Typically, the field hydrographer would acquire data along the achievable extents of the gap and document the existence of barge fleet or vessel with positioned targets and/or photos. AIS or internet-based vessel tracking tools were used to alert the field unit when vessels were underway.
- Holidays or 2-meter curve (NALL), which were not further investigated due to safety concerns in shallow water.

- Holidays created beneath baring structures that met the area requirements were rejected in the survey area for final delivery.
- Holidays created from rejecting data acquired before dredging when overlap between pre- and post-dredge data existed (see section B.2.6 for detail).

Holidays that exist in the final surface have been noted in the H13388_Notes_for_Reviewer.hob with the cvrage area feature class, submitted in Appendix II, and attributed with remarks stating the contributing factor leading to the data gap. Areas where the assigned 2-meter inshore limit was not met are included in the H13388_Notes_for_Reviewer.hob with brkline features. SNDWAV features were also delineated, noting where sediment movement was observed and resulted in artifacts in the surface. Figures 20 and 21 detail examples of coverage gaps in deliverable data.

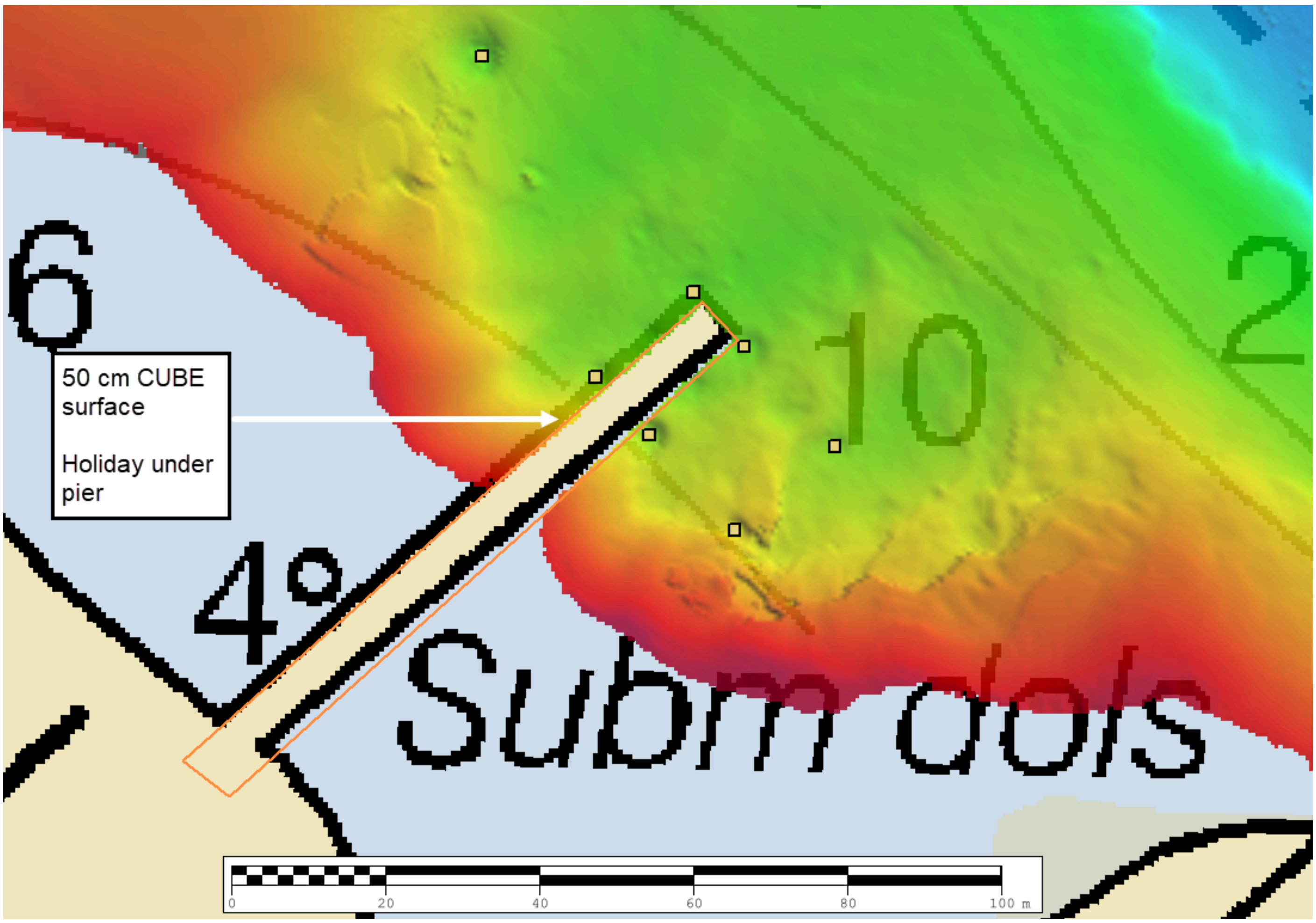


Figure 20: Example of Holidays Created from Rejecting MBES Data on or under Baring Features

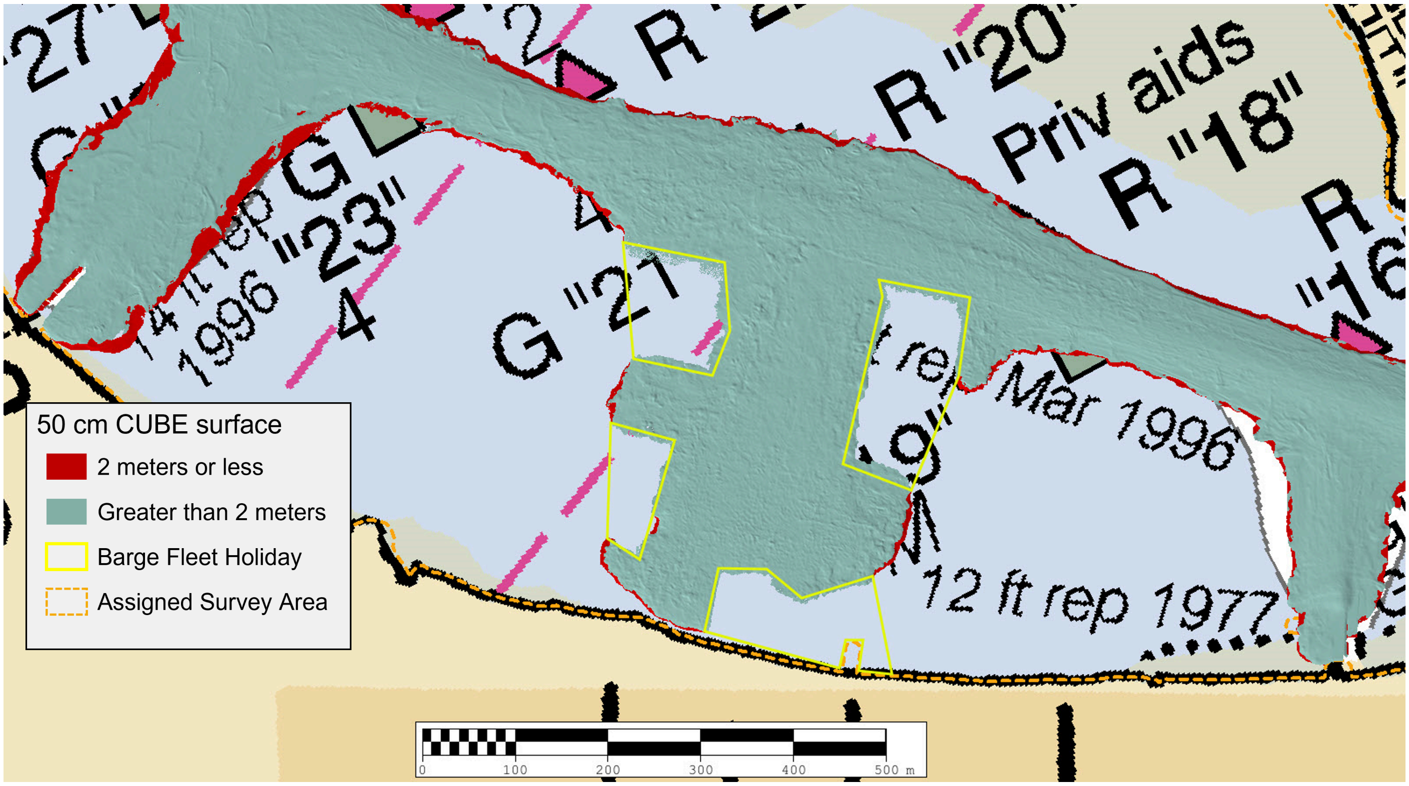


Figure 21: Example of Holidays Resulting from Barge Fleets

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

Data reduction procedures for survey H13388 are detailed in the DAPR.

B.3.2 Calibrations

All sounding systems were calibrated as detailed in the DAPR.

B.4 Backscatter

Multibeam backscatter was logged in HYPACK 7k format and included with the H13387 digital deliverables. Data were processed periodically in CARIS HIPS to evaluate backscatter quality, but the processed data is not included with the deliverables. For data management purposes, the names of multibeam crosslines have been appended with the suffix _XL. This change was made to HIPS files only. The original file names of raw data files (HYPACK HSX and 7k) have been retained.

HYPACK 7k files were not logged during acquisition on September 29, 2020 (DN273). Backscatter data for DN273 has been submitted in RESON s7k format.

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/SIPS	11.3.8

Table 10: Primary bathymetric data processing software

The following Feature Object Catalog was used: NOAA Profile Version 2020v3.

A detailed listing of all data processing software is included in the OPR-K375-KR-20 DAPR.

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
H13388_MB_50cm_MLLW	CARIS Raster Surface (CUBE)	0.5 meters	0.372 meters - 21.619 meters	NOAA_0.5m	Object Detection MBES
H13388_MB_50cm_MLLW_Final	CARIS Raster Surface (CUBE)	0.5 meters	0.372 meters - 20.000 meters	NOAA_0.5m	Finalized Object Detection MBES
H13388_MB_1m_MLLW	CARIS Raster Surface (CUBE)	1 meters	0.384 meters - 21.614 meters	NOAA_1m	Object Detection

Surface Name	Surface Type	Resolution	Depth Range	Surface Parameter	Purpose
H13388_MB_1m_MLLW_Final	CARIS Raster Surface (CUBE)	1 meters	18.000 meters - 21.614 meters	NOAA_1m	Finalized Object Detection

Table 11: Submitted Surfaces

Bathymetric grids were created relative to MLLW in CUBE format using Object Detection resolution requirements as specified in the HSSD.

B.5.3 CARIS HDCS Navigation Sources

During processing of S/V Blake, R/V Broughton, and R/V Sea Scanner HDCS lines, navigation information (delayed heave, motion, and RMS values) was imported from POS M/V .000 files. This navigation source, Applanix.ApplanixGroup1, is automatically applied at georeference when it exists. When a line is renamed, such as with a suffix _XL, the HDCS navSource disappears from the metadata display. This appears to be a display issue only and does not change any navigation sources.

B.5.4 Mobile Lidar Data

Two laser systems were used during acquisition within sheet H13388. A vessel-based Mobile Mapping System (MMS) mobilized on the S/V Blake was used to acquire lidar and imagery data primarily within the assigned scan areas and along both edges of the Houston Ship Channel for positioning aids to navigation. A secondary laser scanner, mounted on the R/V Broughton, was used to acquire fill data where gaps in coverage may have been left as a result of vessels being at berth, or to add to laser coverage outside of the assigned scan areas in order to facilitate the management and reporting of shoreline and nearshore features.

Processed LAS data from the MMS and laser scanner are included with the survey deliverables in the Processed directory. Imagery data collected by the MMS were used for feature interpretation during processing. Photos of individual features were extracted from the imagery data or taken during hydrographic survey operations and populated using the “images” attribute in the Final Feature File (FFF).

B.5.5 Surface Finalizing Not Honoring Designated Soundings

QC checks on the finalized surface (using Pydro QC Tools (VALSOU Check)) identified one location where a designated sounding was not being applied during surface finalization in HIPS. After consultation with Teledyne CARIS, it was determined that a software issue was present. On June 6, 2021, a software fix was provided in a HIPS beta release to be used specifically for finalizing surfaces. After basic testing using nonproduction data, the HIPS beta release was used to finalize the original bathymetric surface for survey H13388. Upon completion, the finalized surface was checked for outstanding issues using Pydro QCTools (VALSOU Check) and the previous issues were no longer identified. Also, the original finalized surface was differenced with the finalized surface created with the beta. The only differences occurred at the location where the designated sounding wasn't being applied in the original finalized surface.

The surface finalization fix has been included in the 11.3.20 official release of HIPS. HIPS 11.3.20 was released June 29, 2021.

B.5.6 Bottom Tracking in Shallow Water

During survey acquisition, it was apparent that the combination of shallow water and the bottom type (an assumption of soft silty mud) made it difficult to get a clean bottom track return from the MBES system. This most frequently was displayed in shallow, flat areas out of the main channel current. To try to mitigate the effect, sonar settings were changed by the hydrographer during acquisition, including changing power, gain, time variable gain (TVG) settings, and pulse length. In the end, no clear solution fixed the issue and the hydrographer continuously tuned the sonar for the best return at the time. This is likely a limitation of the instrument and the acoustic properties of the sediments in the depths being surveyed. The HDCS dataset was well cleaned to mitigate the effects to the final surfaces. However, artifacts within IHO specifications will be apparent in the final delivered surface as shown in Figure 22.

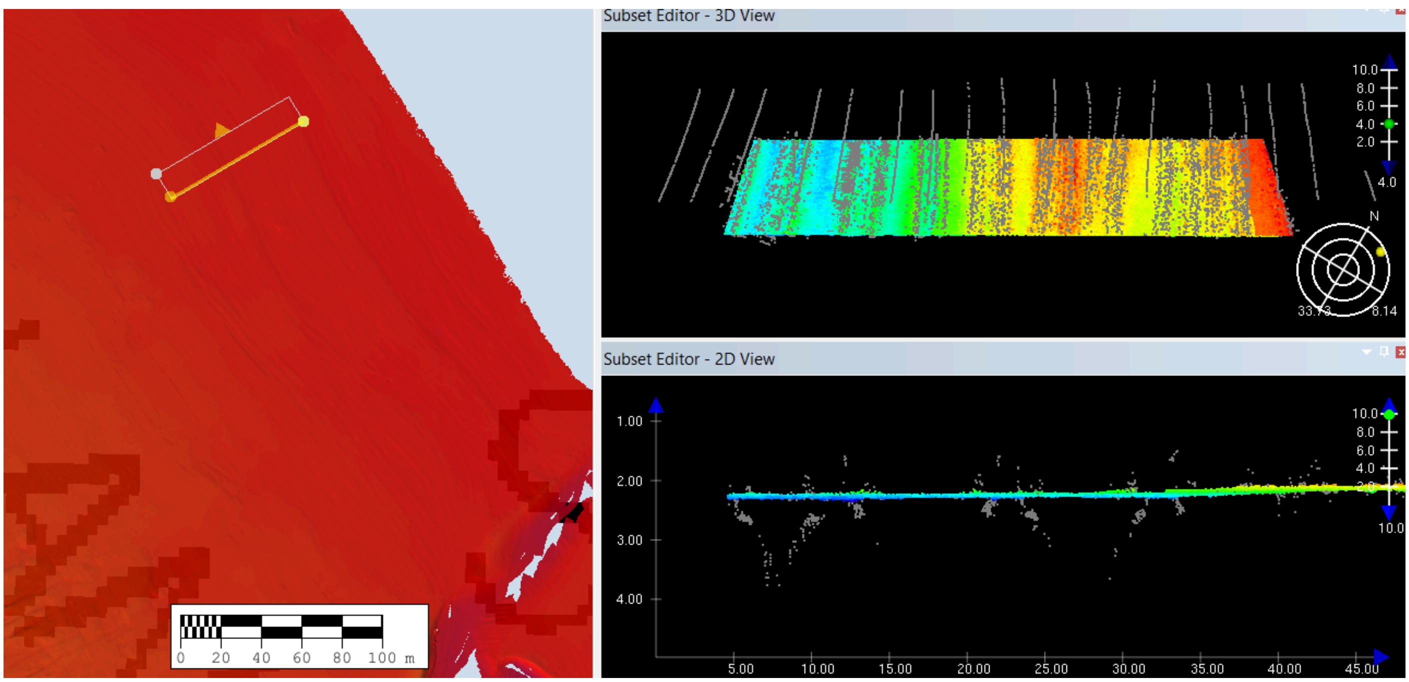


Figure 22: Example of Erroneous Bottom Tracking of Flat Shoal Areas in HDCS Data and Resultant Surface Artifact (Gray Soundings Rejected Manually by Hydrographer to Limit Effects to the Surface)

C. Vertical and Horizontal Control

A summary of the horizontal and vertical control for survey H13388 follows.

C.1 Vertical Control

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

<u>ERS Datum Transformation</u>

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

Method	Ellipsoid to Chart Datum Separation File
ERS via VDATUM	OPR-K375-KR-20_VDatum_NAD83-MLLW_Geoid18.csar OPR-K375-KR-20_VDatum_NAD83-MHW_Geoid18.csar

Table 12: ERS method and SEP file

The MLLW version of the separation file was used to reduce all sounding data to the MLLW chart datum for the survey area. The MHW version of the file was used to transform all mobile laser data to mean high water, the high-water chart datum for the survey area. Both files were provided by the HSD for use on this survey project.

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 15.

<u>The following PPK methods were used for horizontal control:</u>

- Smart Base

An RTK-corrected real-time navigation solution was used during processing of multibeam data unless data quality or correction reception issues impacted the accuracy of the position or height data. This determination was made by reviewing acquisition logs for loss of RTK corrections or operating outside of fixed ambiguity mode as noted by the field party or logged by the HYPACK acquisition system, observing inconsistent global positioning system (GPS) heights when reviewing data in the CARIS HIPS Attitude Editor, or the presence of significant GPS tides artifacts in bathymetric surfaces. When issues with the real-time navigation solutions were identified in a survey line, all survey lines acquired by the survey vessel on the day in question were post-processed using post-processed kinematic (PPK) methods. The post-processing methodology and software used was determined by the navigation system on each survey vessel. Applanix POSPac MMS was used to post-process navigation solutions for survey vessels S/V Blake, R/

V Broughton, and R/V Sea Scanner, which used POS MV OceanMaster GNSS inertial reference systems. NovAtel GrafNav software was used to post-process navigation data from the RHIB Sigsbee, which used a Trimble GNSS receiver integrated with an iXBlue Hydrins. Texas Department of Transportation (TxDOT) Real Time Network (RTN) base station data and published NAD83 (2011) base station positions were used during post-processing. See Section C.4 of the DAPR for additional discussion on post-processed positioning. The following days for survey H13388 have post-processed solutions applied: S/V Blake: October 1, 2020 (DN275), October 3, 2020 (DN277); R/V Broughton: March 13, 2021 (DN072); R/V Sea Scanner: November 14, 2020 (DN319), December 5, 2020 (DN340), December 7, 2020 (DN342), December 10, 2020 (DN345); RHIB Sigsbee: October 11, 2020 (DN285), October 12, 2020 (DN286).

RTK

During acquisition, RTK correctors were obtained from the TxDOT RTN via a dedicated cellular modem. These correctors provided RTK level of accuracy for horizontal and vertical positions for all survey data. When issues with the real-time navigation solutions were identified in a survey line, all survey lines acquired by the survey vessel on the day in question were post-processed. Additional discussion of the TxDOT network, including quality control checks and acquisition and processing procedures, is discussed in the DAPR.

C.3 Additional Horizontal or Vertical Control Issues

C.3.1 Water Level Floats

Water level floats were conducted by the field unit at the location of NOAA National Water Level Observation Network (NWLON) gauges within the OPR-K375-KR-20 project area. Methods, analysis, and results of these floats are further documented in the DAPR.

D. Results and Recommendations

D.1 Chart Comparison

The chart comparison was performed by comparing H13388 survey depths to digital surface generated from the band 5 electronic navigational charts (ENCs) covering the survey area. A 10-meter product surface was generated from a triangular irregular network (TIN) created from the ENC's soundings, depth contours, and depth features. An additional 10-meter HIPS product surface of the entire survey area was generated from the 50-centimeter CUBE surface. The chart comparison was conducted by creating and reviewing a difference surface using the ENC surface and survey surface as inputs. The chart comparison also included a review of all assigned charted features within the survey area. The results of the comparison are detailed below.

The relevant charts used during the comparison were reviewed to check that all United States Coast Guard (USCG) Local Notice to Mariners (LNMs) issued during survey acquisition, and impacting the survey area, were applied and addressed by this survey.

The band 5 ENCs used in the chart comparison are listed in Table 13. Figures 23 through 33 show the magnitude of differences along the comparison area.

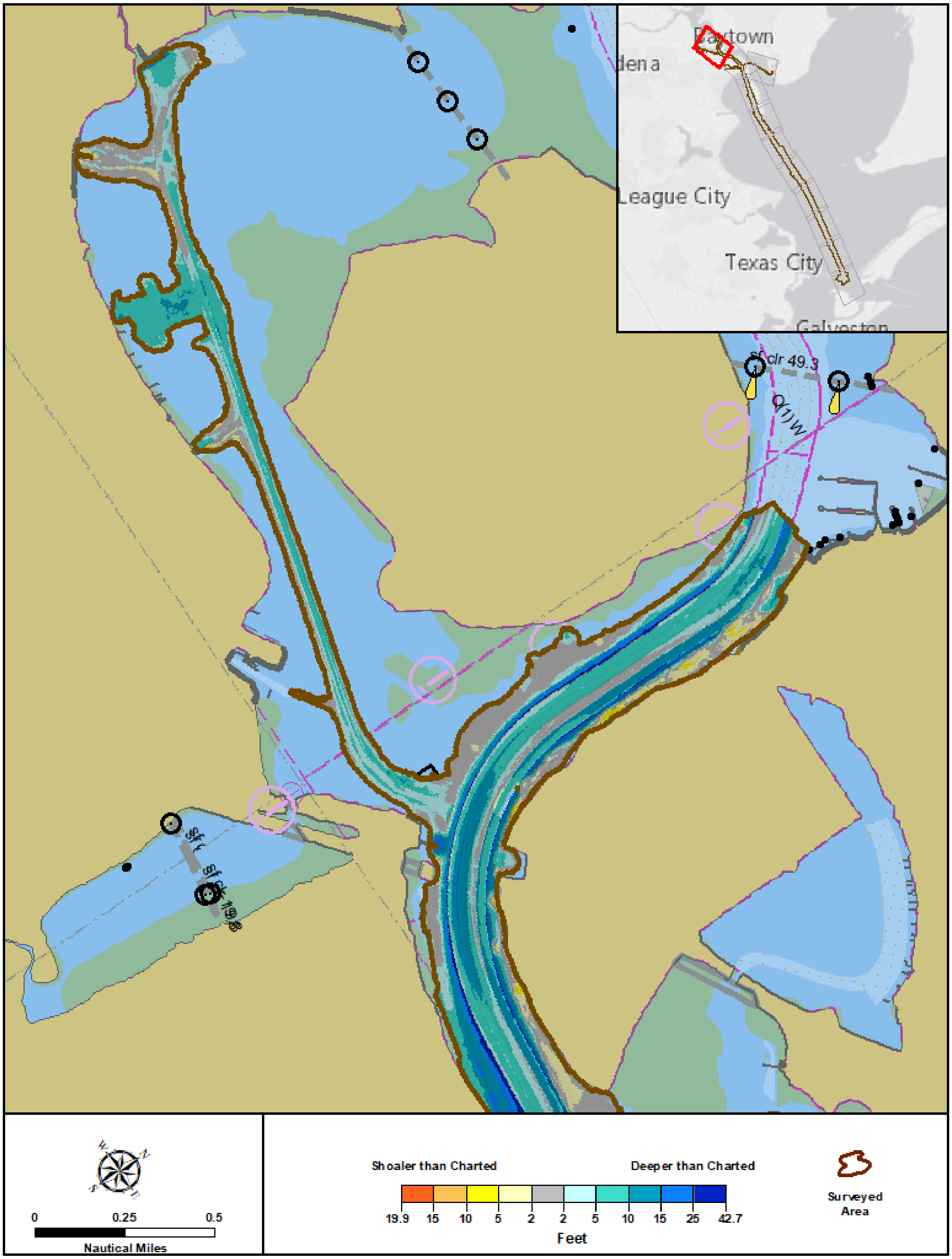


Figure 23: H13388 to Band 5 ENC Depth Difference, Area 1 of 11

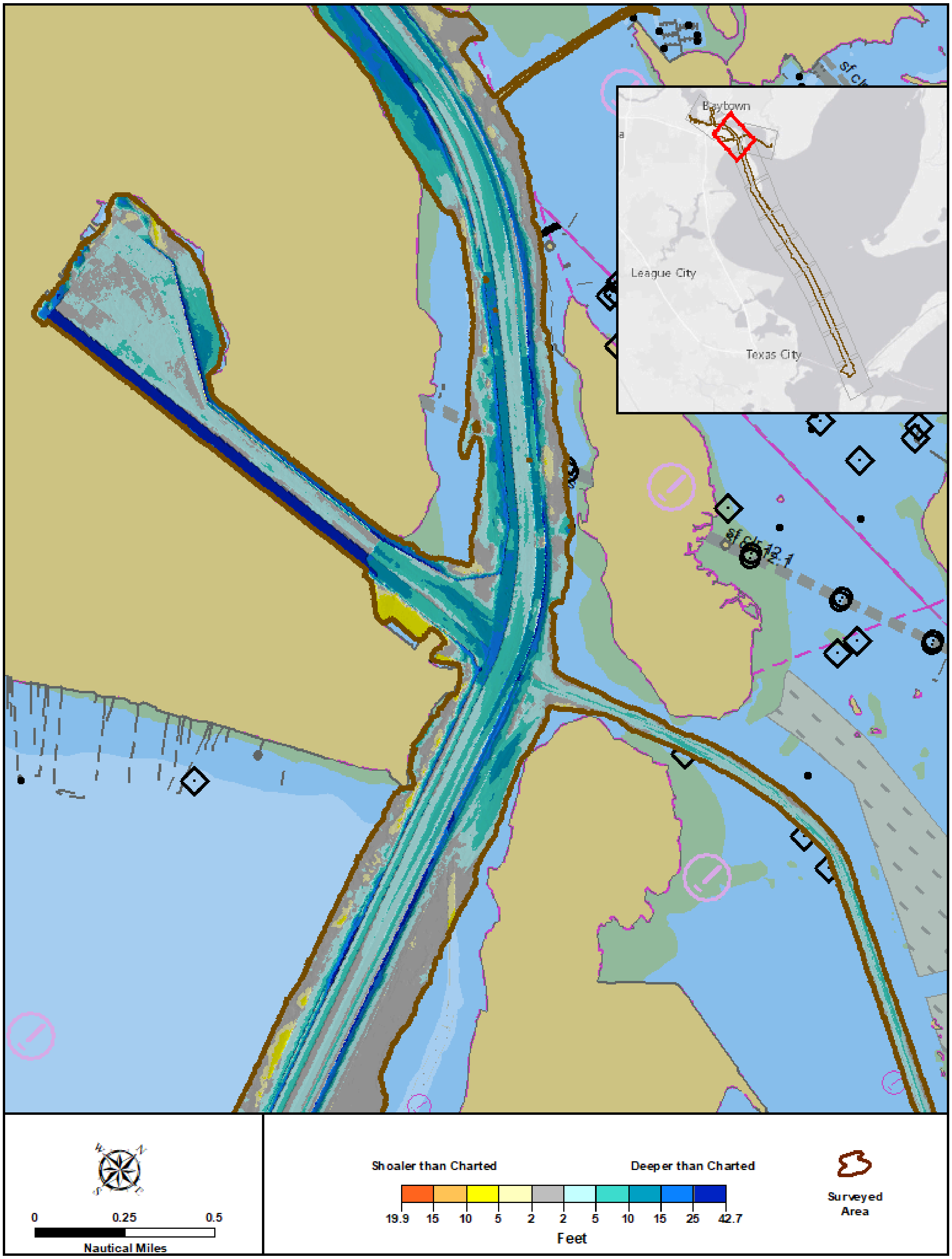


Figure 24: H13388 to Band 5 ENC Depth Difference, Area 2 of 11

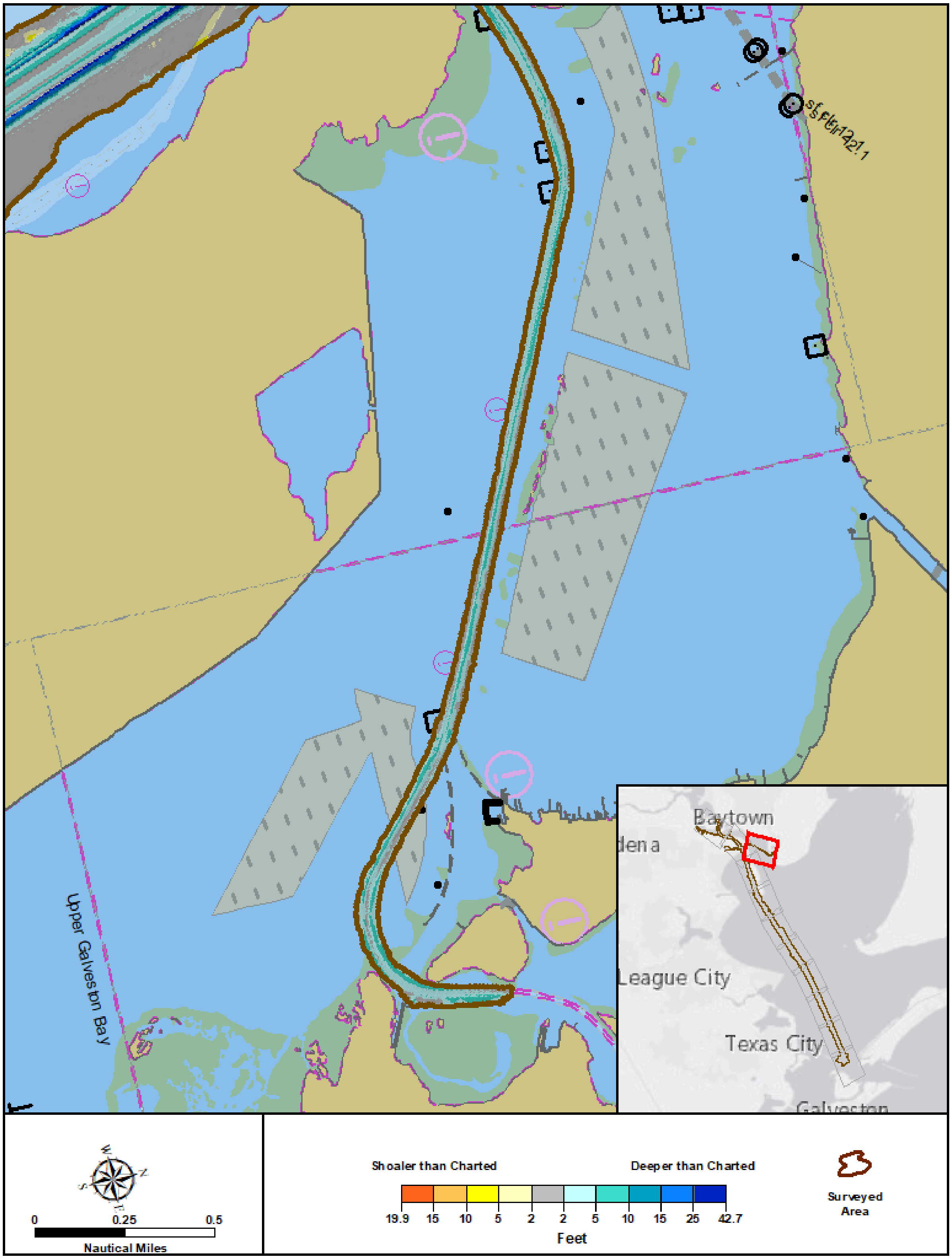


Figure 25: H13388 to Band 5 ENC Depth Difference, Area 3 of 11

Figure 26: H13388 to Band 5 ENC Depth Difference, Area 4 of 11

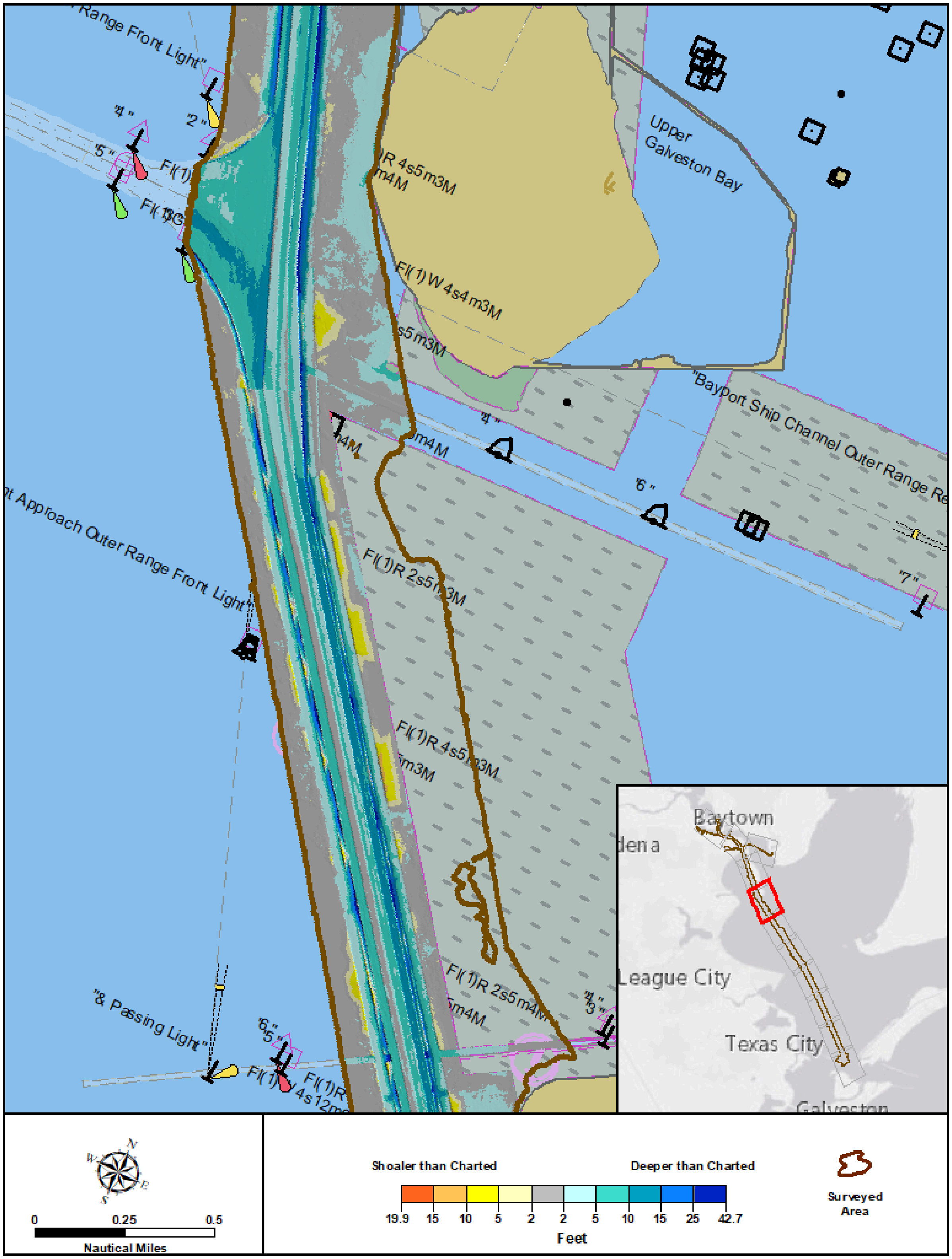


Figure 27: H13388 to Band 5 ENC Depth Difference, Area 5 of 11

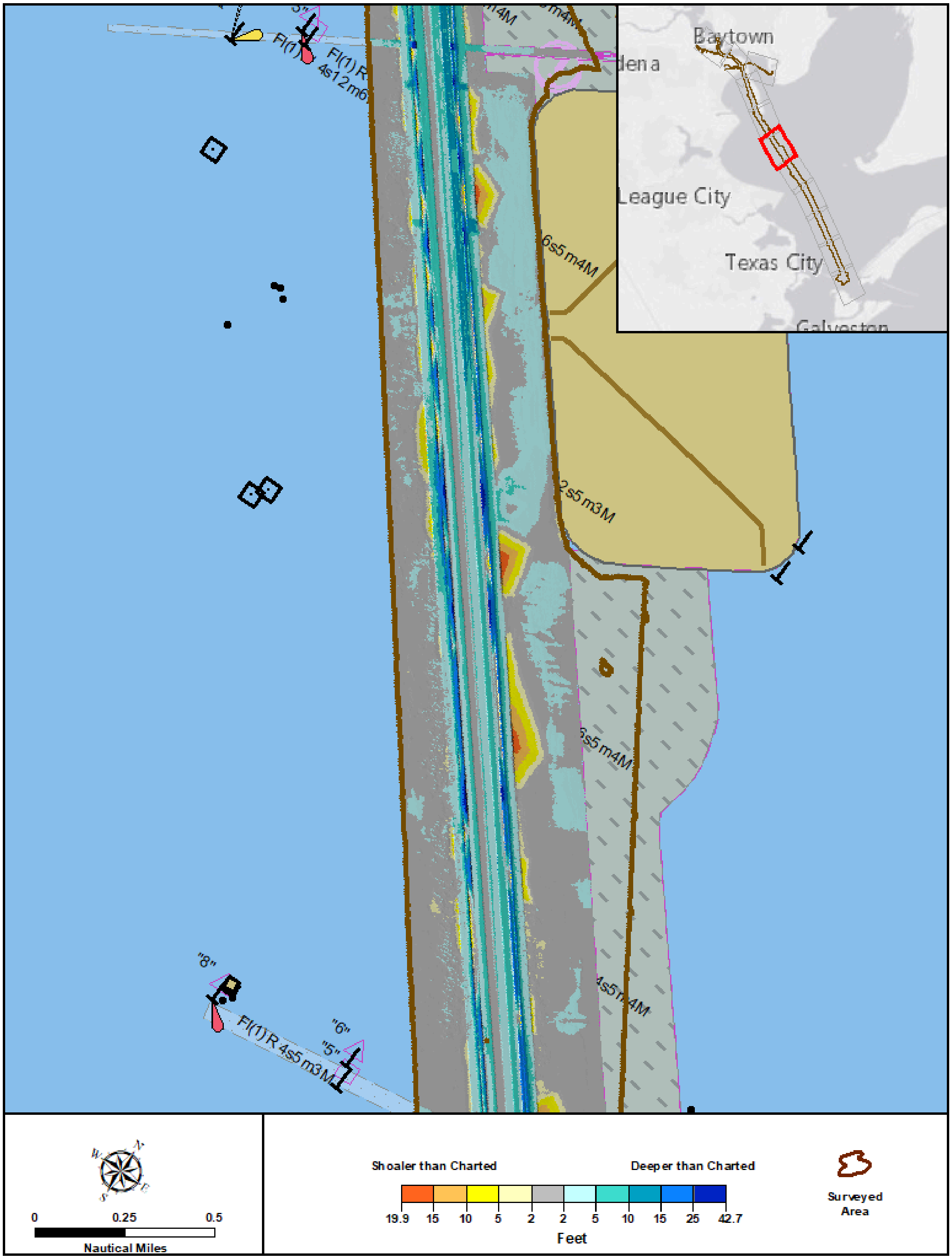


Figure 28: H13388 to Band 5 ENC Depth Difference, Area 6 of 11

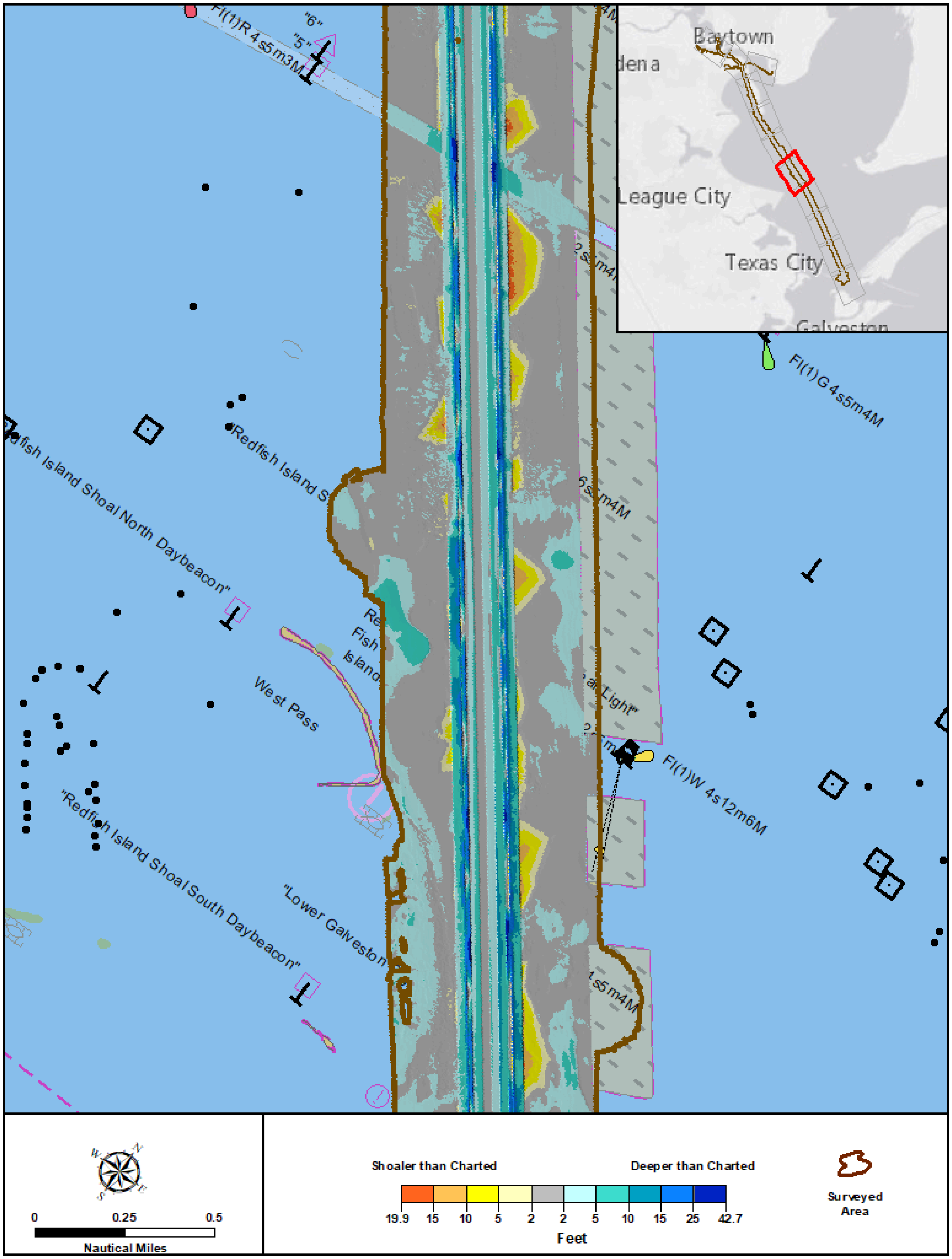


Figure 29: H13388 to Band 5 ENC Depth Difference, Area 7 of 11

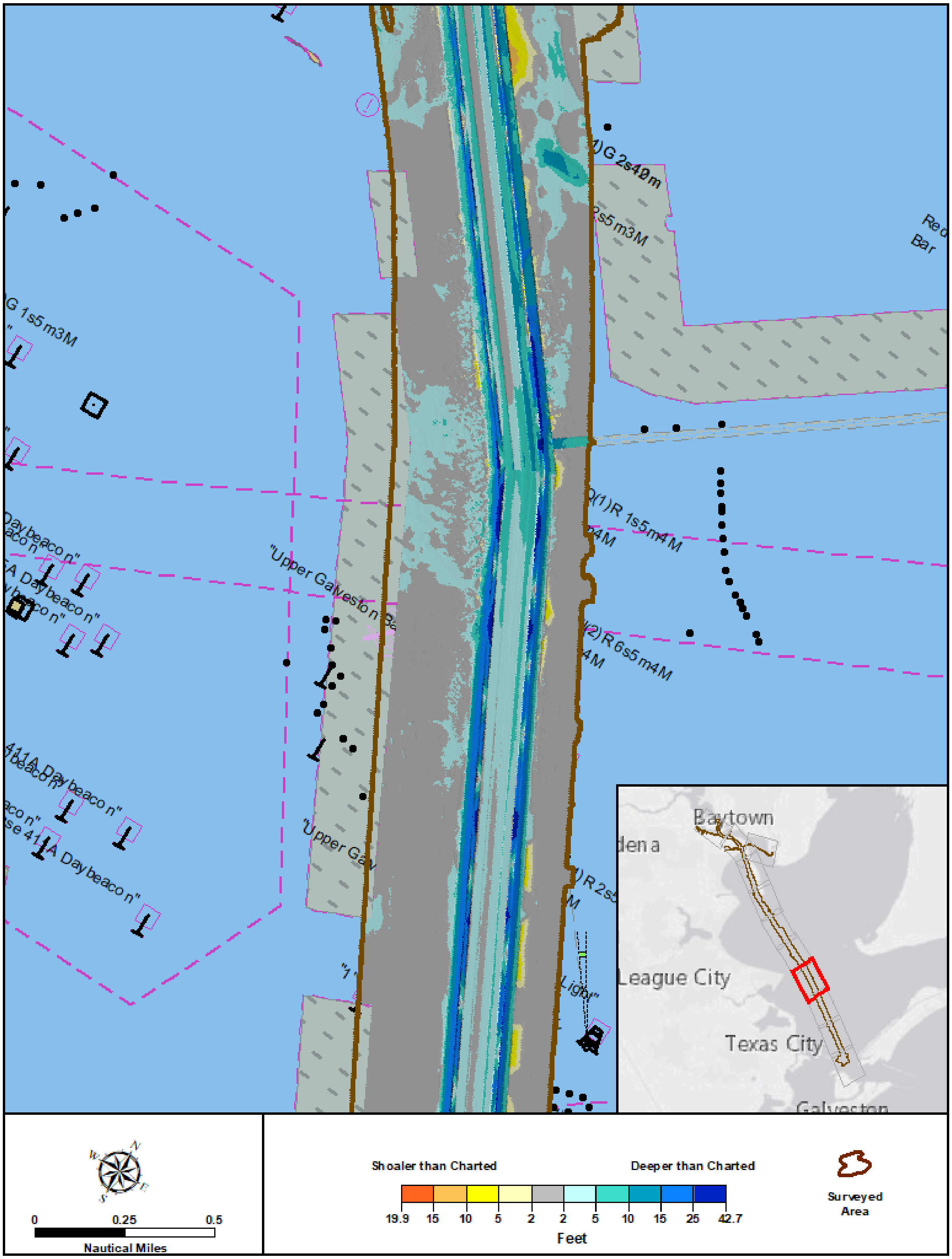


Figure 30: H13388 to Band 5 ENC Depth Difference, Area 8 of 11

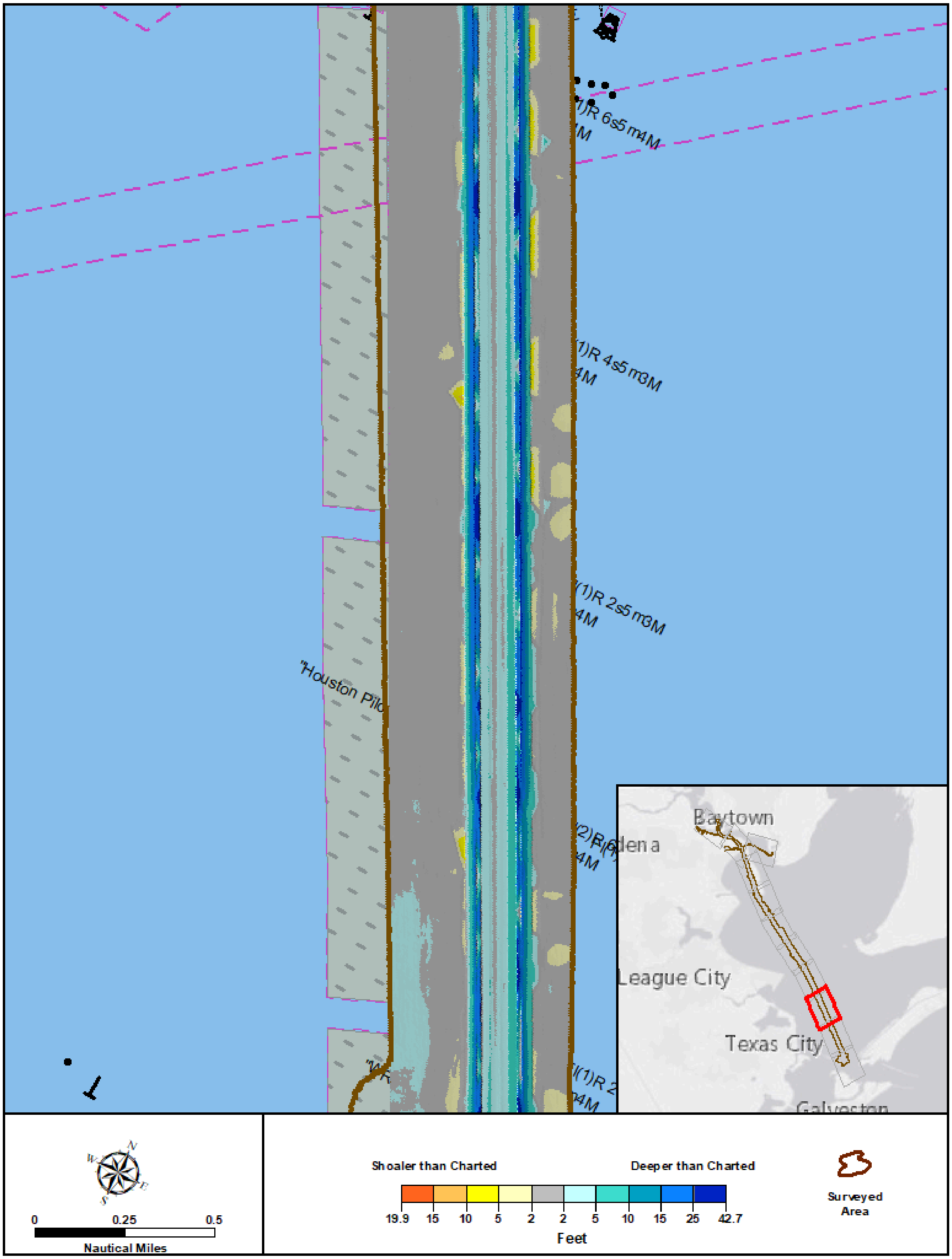


Figure 31: H13388 to Band 5 ENC Depth Difference, Area 9 of 11

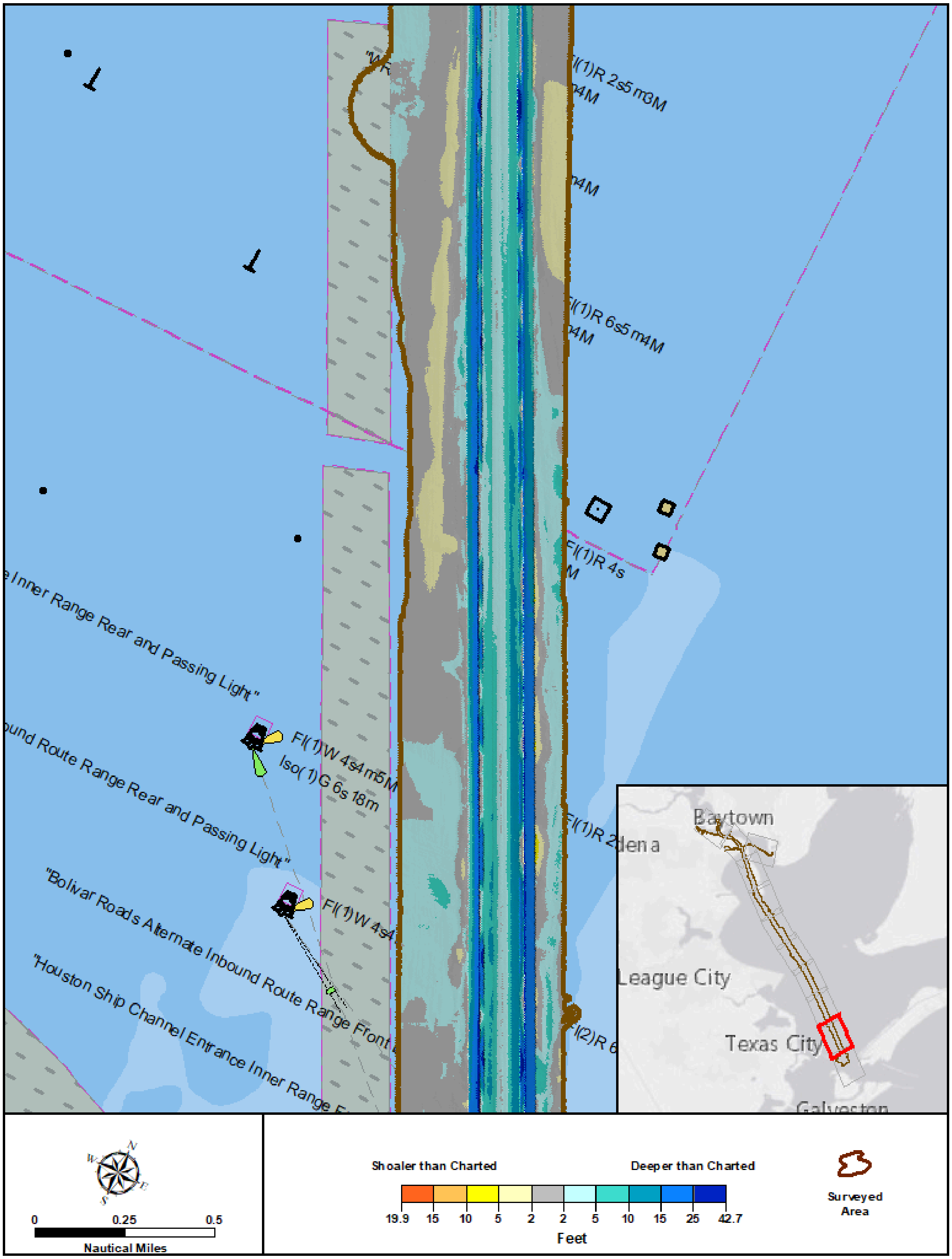


Figure 32: H13388 to Band 5 ENC Depth Difference, Area 10 of 11

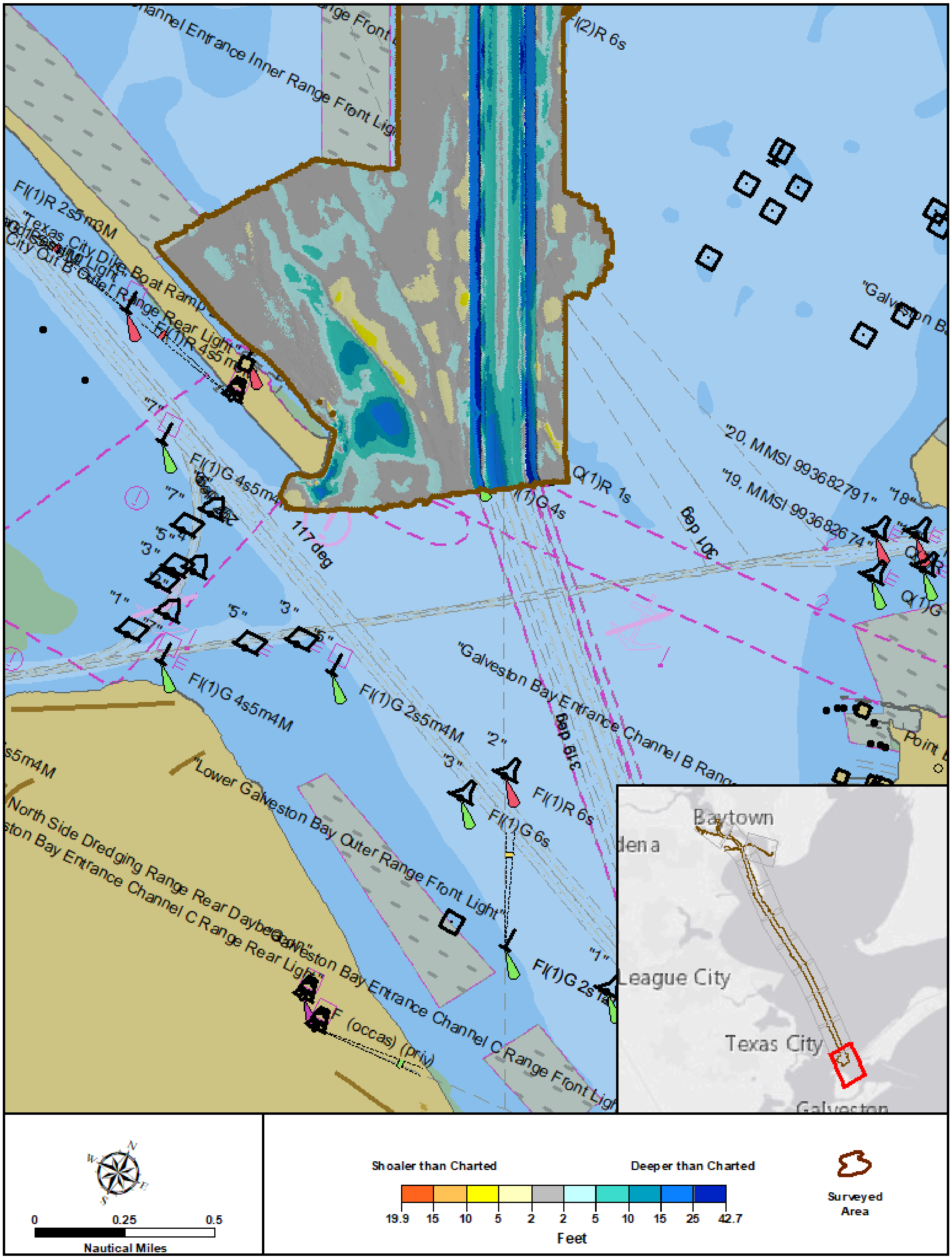


Figure 33: H13388 to Band 5 ENC Depth Difference, Area 11 of 11

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
US5HOUDF	1:10000	1	03/10/2020	04/08/2021
US5HOUDG	1:10000	4	04/08/2021	05/21/2021
US5HOUEF	1:10000	2	08/06/2020	06/22/2021
US5HOUEG	1:10000	2	03/31/2020	03/25/2021
US5TX53M	1:25000	63	03/18/2021	04/26/2021
US5TX54M	1:25000	61	04/08/2021	05/21/2021
US5TX55M	1:10000	39	03/11/2020	10/20/2020
US5TX58M	1:40000	11	04/08/2021	06/14/2021

Table 13: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

Four Danger to Navigation (DtoN) reports were submitted for this survey.

- Survey H13388 DtoN 1, submitted November 9, 2020, reported an uncharted baring obstruction.
- Survey H13388 DtoN 2, submitted December 31, 2020, reported two uncharted obstructions, located on either side of the Houston Ship Channel in the general vicinity of the Bolivar Roads to Red Fish Light 1 channel reach.
- Survey H13388 DtoN 3, submitted March 31, 2021, reported an uncharted baring obstruction, located east of the Houston Ship Channel in the junction area of the Trinity River Channel.
- Survey H13388 DtoN 4, submitted May 19, 2021, reported an uncharted obstruction, located in the vicinity of Barbours Cut Terminal and adjacent to charted shoreline construction (pier).

All DtoNs have been added to the ENCs using preliminary survey data. The hydrographer recommends updating the charts to depict the DtoNs as portrayed in the FFF.

D.1.3 Charted Features

Numerous charted features exist within the limits of Sheet H13388. All assigned features included in the project Composite Source File (CSF) have been addressed by the survey and are included in the FFF. Due to the large scale of the survey (1:10000), many charted features have been recommended for deletion to be replaced by new higher-resolution features digitized from the survey data.

All disproved features have been included in the FFF with a description of "Delete." All new features have been included in the FFF depicting the feature surveyed and with a description "New." The FFF includes assigned features, both baring and submerged, charted shoreward of the NALL that were too hazardous to survey. The baring features were either beyond the detection range of the MMS or obscured by vessel traffic, such as moored vessels or barge fleets. Multiple unsuccessful attempts were made to detect these outstanding obscured features. These features are included in the FFF with a description of "Not Addressed" and a charting recommendation to retain.

D.1.4 Uncharted Features

All uncharted features are portrayed in the FFF as surveyed and attributed with the description of "New." Refer to the FFF for additional information.

D.1.5 Channels

The survey area included multiple channels portrayed on the ENCs as dredged area features (DRGARE). These include federal channels maintained by the United States Army Corps of Engineers (USACE) and other private channels maintained by Port Houston. Figures 34 and 35 list the minimum surveyed depth within each named channel quarter, along with the corresponding ENC channel depth and USACE-authorized channel depth.

During survey operations, the least depth of an object in the Houston Ship Channel that was shoaler than charted depth was reported to the Atlantic Hydrographic Branch (AHB). A copy of the submission email and associated correspondence are included in Appendix II.

Channel Name	USACE Authorized Depth (m)	ENC Depth (m)	Minimum Survey Depth (m)	*Difference Survey vs ENC (m)*
Atkinson Island Barge Mooring Basin	14.0	3.2	1.4	-1.8
Barbour - 001 Flare at Houston Ship Channel LOQ	14.0	12.1	12.4	0.3
Barbour - 001 Flare at Houston Ship Channel MH	14.0	11.2	11.6	0.4
Barbour - 001 Flare at Houston Ship Channel ROQ	14.0	11.2	11.2	0.0
Barbour - 002 Entrance Channel LOQ	14.0	14.6	14.6	0.0
Barbour - 002 Entrance Channel MH	14.0	14.0	14.2	0.2
Barbour - 002 Entrance Channel ROQ	14.0	13.7	13.5	-0.2
Barbour - 003 Turning Basin LOQ	14.0	14.9	15.0	0.1
Barbour - 003 Turning Basin MH	14.0	14.6	14.7	0.1
Barbour - 003 Turning Basin ROQ	14.0	13.7	14.1	0.4
Bayport Channel - Flare at Houston Ship Channel	14.0	11.8	13.1	1.3
BCN 76 to Lower End Morgans Point Cut LIQ	14.0	14.6	14.7	0.1
BCN 76 to Lower End Morgans Point Cut	14.0	12.1	12.1	0.0
BCN 76 to Lower End Morgans Point Cut RIQ	14.0	14.0	14.6	0.6
BCN 76 to Lower End Morgans Point Cut	14.0	12.1	12.3	0.2
Beacon 76 to Lower End Morgans Point Cut (Barge Lane)	4.1	3.6	3.4	-0.2
Beacon 76 to Lower End Morgans Point Cut	14.0	14.6	15.0	0.4
Beacon 76 to Lower End Morgans Point Cut	14.0	11.2	12.5	1.3
Beacon 76 to Lower End Morgans Point Cut	2.7	13.4	13.7	0.3
Beacon 76 to Lower End Morgans Point Cut ROQ	2.7	11.2	12.1	0.9
Bolivar Roads to Red Fish Light 1 (Barge Lane)	4.0	4.2	4.1	-0.1
Bolivar Roads to Red Fish Light 1 LIQ	14.0	14.3	14.6	0.3
Bolivar Roads to Red Fish Light 1 LOQ	14.0	13.7	13.3	-0.4
Bolivar Roads to Red Fish Light 1 RIQ	14.0	14.0	14.7	0.7
Bolivar Roads to Red Fish Light 1 ROQ	14.0	13.1	13.8	0.7
Cedar Bayou, MH	3.7	2.4	2.1	-0.3
Cedar Bayou,LOQ	3.7	1.8	1.8	0.0
Cedar Bayou,ROQ	3.7	1.8	1.7	-0.1
Five Mile Cut	2.7	2.4	2.4	0.0
Morgans Point to Alexander Island LIQ	14.0	14.0	14.0	0.0
Morgans Point to Alexander Island LOQ	14.0	11.2	11.5	0.3
Morgans Point to Alexander Island RIQ	14.0	13.1	13.9	0.8
Morgans Point to Alexander Island ROQ	14.0	10.9	10.9	0.0
North Boat Cut Channel	2.7	2.1	2.3	0.2
Red Fish Light 1 to Beacon 76 (Barge Lane)	4.0	3.1	3.0	-0.1
Red Fish Light 1 to Beacon 76 (Turn) LIQ	14.0	14.9	14.7	-0.2
Red Fish Light 1 to Beacon 76 (Turn) LOQ	14.0	12.9	12.4	-0.5

Figure 34: Channel Results

Channel Name	USACE Authorized Depth (m)	ENC Depth (m)	Minimum Survey Depth (m)	*Difference Survey vs ENC (m)*
Red Fish Light 1 to Beacon 76 (Turn) RIQ	14.0	13.8	14.1	0.3
Red Fish Light 1 to Beacon 76 (Turn) ROQ	14.0	11.6	11.9	0.3
South Boat Cut Channel	2.7	2.1	2.6	0.5
Trinity River Channel LOQ	4.0	0.6	3.3	2.7
Trinity River Channel MH	3.0	0.9	3.3	2.4
Trinity River Channel ROQ	3.0	0.9	3.3	2.4

Figure 35: Channel Results Continued

D.2 Additional Results

D.2.1 Aids to Navigation

Aids to Navigation (AtoNs) were investigated using mobile lidar and visual observations. AtoNs that were missing, damaged, or not serving their intended purpose were reported to USCG via email on May 12, 2021. A copy of the email submittal is included in Appendix II. AtoNs have been included in the sheet's FFF with appropriate comments and recommendations.

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

Both the Raster Nautical Chart (RNC) and ENC for this area include charted clearance heights for bridges and cables. The charted heights for all overhead features match within a decimeter between the RNC and ENC. Both note the vertical datum as MHW.

For the assigned cables and bridges inside scan areas, overhead clearances were determined using LAS data acquired with the RIEGL VMX-450 mobile mapping system using ERS methods and the NOAA-provided custom separation model. All clearances were determined relative to MHW.

D.2.4.1 Overhead Cables and Pipes

Clearance on overhead cables was determined by using CARIS Base Editor to identify the valid LAS point with the lowest elevation at each cable crossing. Because the LAS data often extended onto shore, the search area was limited to the portion of the cable spanning navigable water. Within H13388, there is one assigned laser scan area that cover two assigned overhead cables. As the horizontal distance between the two surveyed cables was only 35 meters, the same minimum observed height for both cables (61.870 meters) was assigned to the HEIGHT attribute of the overhead cable feature in the FFF. The published ENC clearance for these cables was 50.2 meters. There are no other overhead cables or pipes that have been assigned within the sheet limits.

D.2.4.2 Bridge Clearance Analysis

The assigned scan area within H13388 covered one bridge. The Fred Hartman Bridge was evaluated using the Bridge Clearance Analysis procedure outlined in the DAPR. Figure 36 depicts an elevation view of the bridge, with bridge segments colored by minimum elevation, and lights that are included in the FFF. Figure 37 is a diagram published in the “Mariner Guide Navigating the Houston-Galveston Area Waterways,” listing published clearances with the Fred Hartman Bridge at 175-feet above MHW. Both figures depicts an elevation view of the Fred Hartman bridge looking up channel.

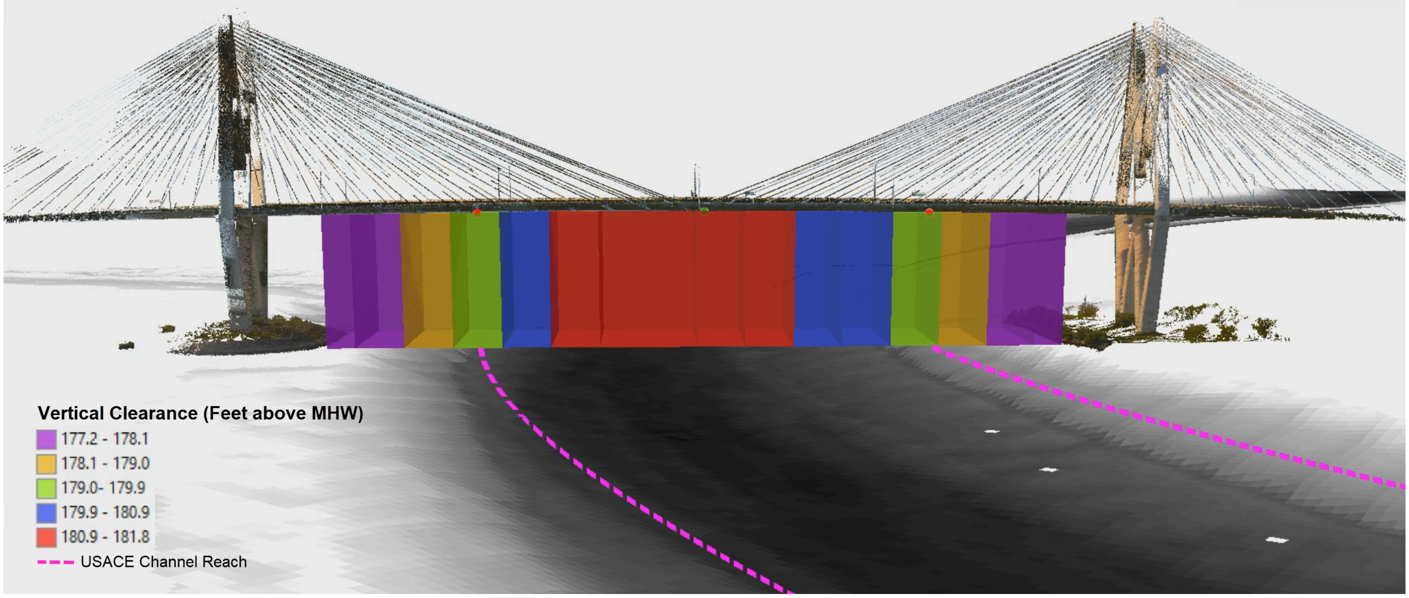


Figure 36: Fred Hartman Bridge Clearance

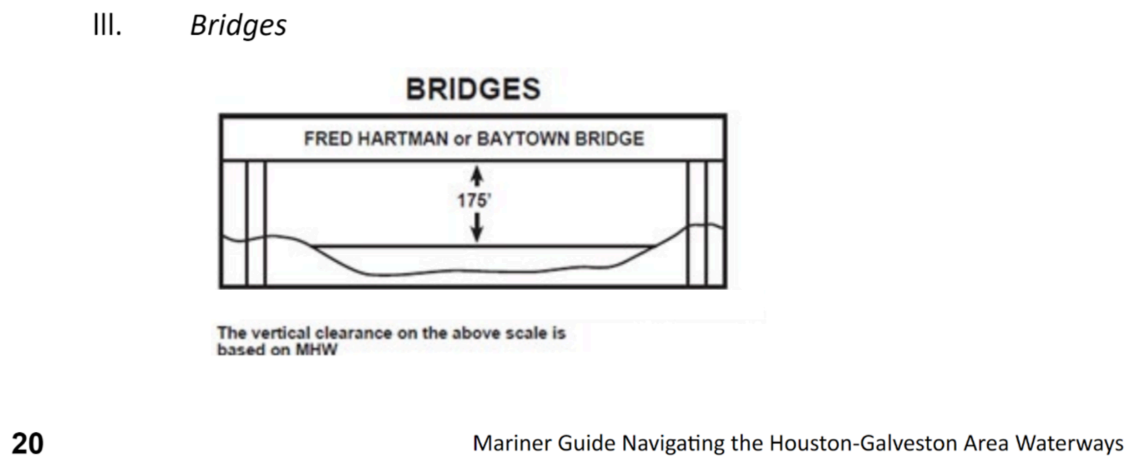


Figure 37: Published Bridge Clearance in Height Above MHW

D.2.5 Submarine Features

Submerged pipelines, submerged pipeline areas, and submerged cable areas where anchoring, trawling, and dragging are restricted, are charted within the survey area. In addition, the ENCs include a caution area referencing the potential presence of uncharted oil and gas infrastructure. When within the NALL, these precautionary areas and features were surveyed using Object Detection Coverage and carefully reviewed for any pipelines or cables that were exposed and posing a risk to navigation.

No pipelines were observed in the survey data that would have warranted reporting using the processes described in the HSSD.

D.2.6 Platforms

See the H13388 FFF for more details.

D.2.7 Ferry Routes and Terminals

No ferry routes or terminals exist for this survey.

D.2.8 Abnormal Seafloor or Environmental Conditions

No abnormal seafloor and/or environmental conditions exist for this survey.

D.2.9 Construction and Dredging

Construction and dredging are common occurrences in the Houston Ship Channel. Dredging activities were observed in the Lower Houston Ship Channel during survey operations with impacts to survey coverage and data quality discussed in Section B.2.6. Construction was observed at the entrance of Barbours Cut Terminal during survey operations. The construction did not impact survey operations.

D.2.10 New Survey Recommendations

Plans are underway for a significant channel expansion project, known as Project 11, which will deepen and widen the Houston Ship Channel. The hydrographer recommends resurveying the area impacted by the expansion project with Object Detection Coverage upon completion.

D.2.11 ENC Scale Recommendations

No new insets 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 and Specifications 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.

Report Name	Report Date Sent
Data Acquisition and Processing Report	2021-06-18

Approver Name	Approver Title	Approval Date	Signature
Jonathan L. Dasler, PE, PLS, CH	NSPS/THSOA Certified Hydrographer, Chief of Party	07/20/2021	Digitally signed by Jon L. Dasler Date: 2021.07.20 08:56:55 -07'00' Adobe Acrobat version: 2021.005.20058
Jason Creech, CH	NSPS/THSOA Certified Hydrographer, Charting Manager / Project Manager	07/20/2021	Digitally signed by Jason Creech Date: 2021.07.20 08:59:52 -07'00' Adobe Acrobat version: 2021.005.20058
Callan McGriff, EIT	IHO Cat-A Hydrographer, Lead Hydrographer	07/20/2021	Digitally signed by Callan McGriff Date: 2021.07.20 09:08:56 -07'00' Adobe Acrobat version: 2021.005.20058
James Guilford	IHO Cat-A Hydrographer, Lead Hydrographer	07/20/2021	Digitally signed by James Guilford Date: 2021.07.20 09:14:23 -07'00' Adobe Acrobat version: 2021.005.20058
Michael Redmayne	IHO Cat-A Hydrographer, Lead Hydrographer	07/20/2021	Digitally signed by Michael Redmayne Date: 2021.07.20 09:18:08 -07'00' Adobe Acrobat version: 2021.005.20058

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

Jason Creech

From: Douglas Wood - NOAA Federal <douglas.wood@noaa.gov>
Sent: Friday, March 5, 2021 3:23 PM
To: Jason Creech
Cc: Jon Dasler; Grant Froelich; Douglas Wood - NOAA Affiliate; Christina Fandel - NOAA Federal; Starla Robinson - NOAA Federal; Castle Parker - NOAA Federal
Subject: Re: Galveston Bay private pier faces; UCF disproval radii

Hi Jason,

we have discussed internally how to address feature management in regards to the many piers, pier ruins and other assigned features for OPR-K375-KR-20 and here are our conclusions.
I hope that this provides adequate guidance to your team while working with the large number of features in this survey.

Don't hesitate to ask if you need more iteration or information; you may submit this email as part of the DR.

1 - If no evidence of a feature or pier ruin in the 100% SSS then it may be disproven by using a 50m radius disproval development unless a different disproval size is specified in the PRF. For a charted pier, cover the area the specified radius offshore and down either side of the charted feature as far as the safe NALL.

2 - If evidence, such as scour, eroded piles, or sediment discoloration, of a ruined pier is found in the mainscheme 100% SSS which is determined by the hydrographer to be the charted item then no further disproval is needed.

3 - Any part of a ruined pier which is shoal of the NALL may be considered to be the NALL at that location. In many cases, a ruined pier may be updated to an obstruction or pile or other feature as the hydrographer determines appropriate.

4 - We do not expect that any ruined piers will be disproven shoal of the NALL.

5 - If a disproval circle overlaps both a Complete Coverage and an Object Detection sheet, the coverage acquired for the Object Detection sheet may be considered toward the disproval. That is, coverage does not need to be duplicated during acquisition of the Complete Coverage sheet. Please document appropriately in the DR.

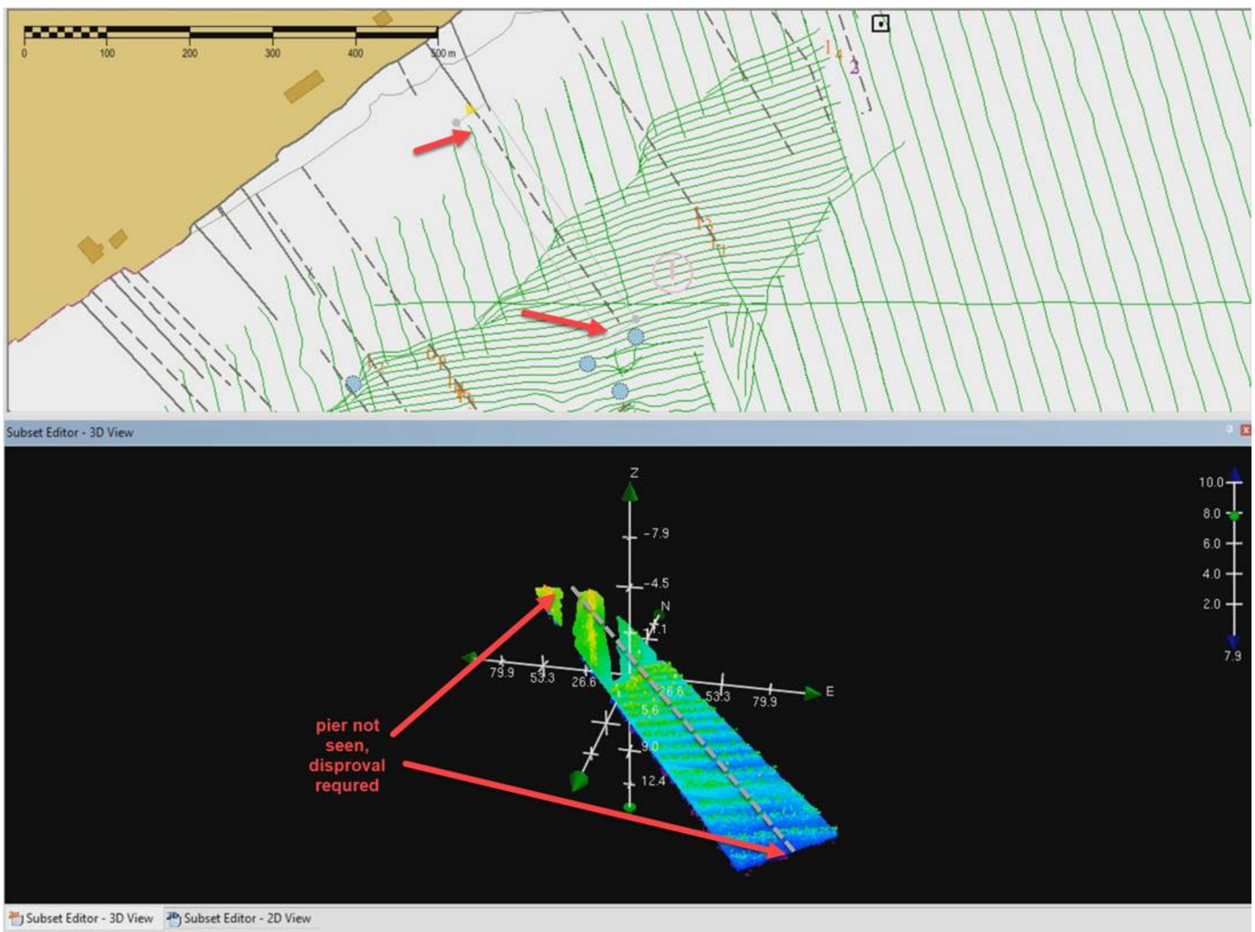
On Fri, Feb 19, 2021 at 12:50 PM Jason Creech <Jasc@deainc.com> wrote:

> Hi Doug
>
> Thanks for this information. It's extremely helpful. We're looking for some additional guidance on what constitutes a pier ruin for the purposes of 1) deciding when and where to end our survey lines at the terminus of the ruins and 2) for depicting these features in our FFF.
>
> We are seeing several scenarios in the data we have collected to date.
>
> - No evidence of the feature in the data

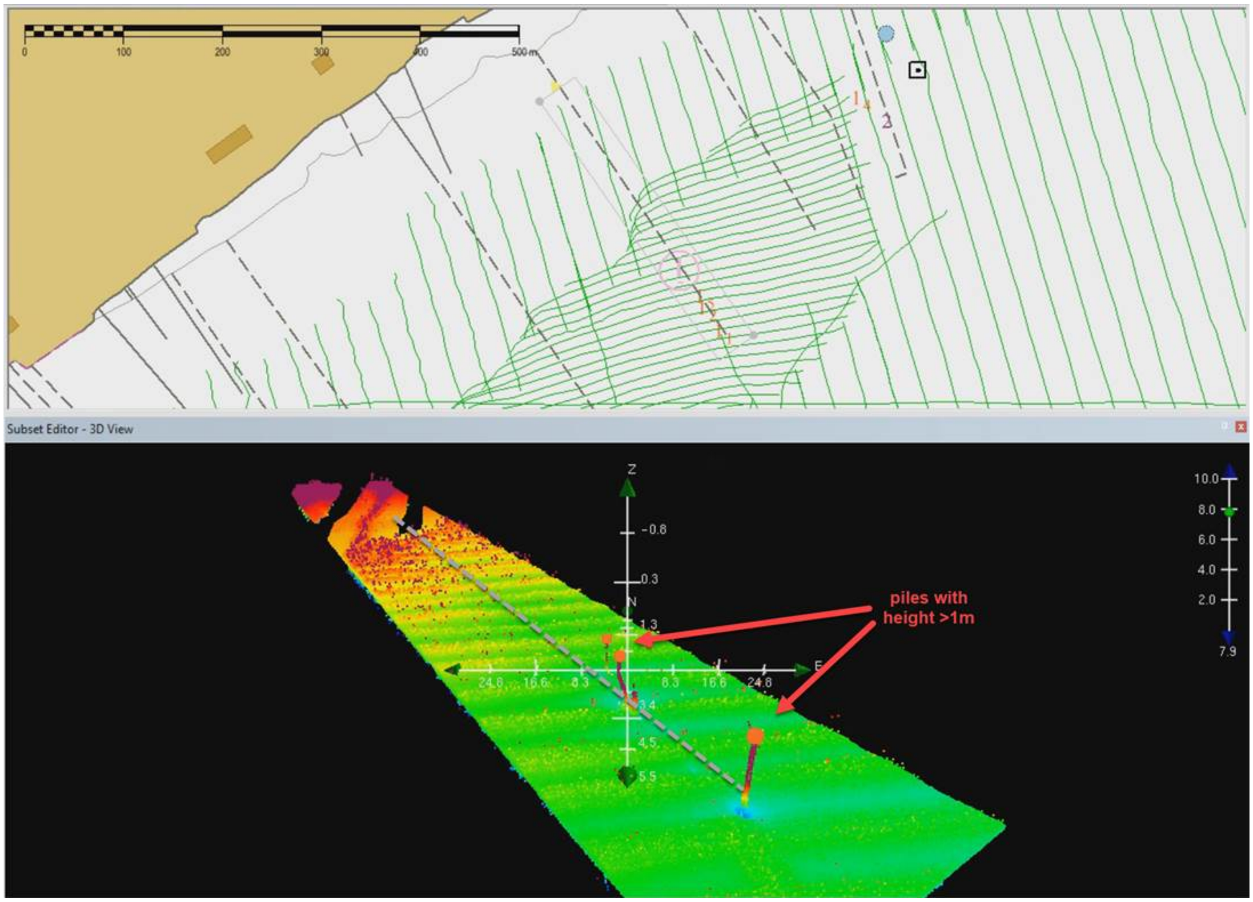
- Evidence of ruins in surface but no objects in sounding data standing proud of the seafloor
- Evidence of ruins in surface with objects in sounding data standing proud of the seafloor with height less than 1 meter
- Evidence of ruins in surface with objects in sounding data standing proud of the seafloor with height greater than 1 meter

For the purposes of making operational decisions to avoid running inshore of submerged pier ruins, we're assuming that the heights of the ruins would need to meet the HSSD feature height requirement of 1m? Is this your intent, or would any height off bottom be sufficient? In some locations, we have likely run farther inshore than required by your new guidance, but it has allowed us to acquire enough data over some ruined pier features to develop the scenarios above and provide a few example screengrabs with questions.

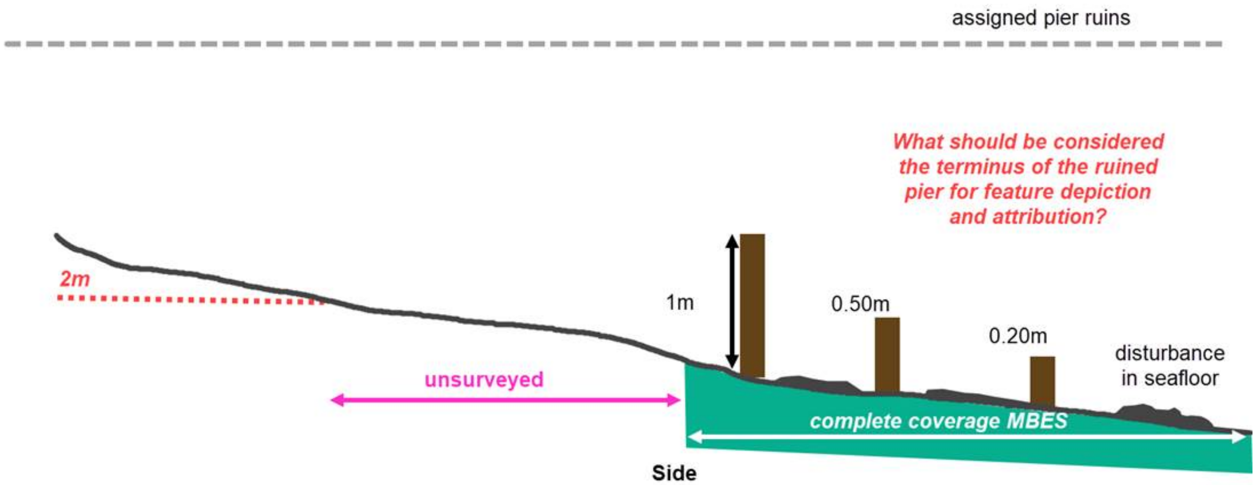
Here is an example of a pier ruin that was not observed in MBES. It's our understanding that we would need to disprove this feature based on the appropriate disproval radius if the proximity of the adjacent piers ruins does not prohibit safe navigation. Is this a correct assumption?



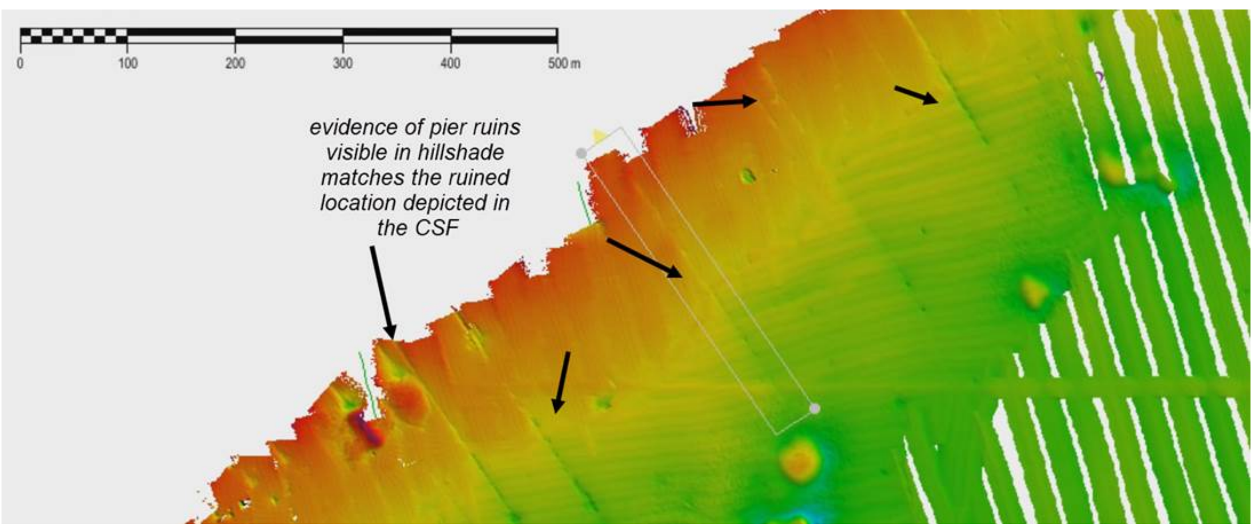
The next example (image below) shows surveyed pier ruins with a height greater than 1 meter. It’s our understanding that we could end operations at the terminus of the ruined pier with height greater than 1 meters. Should a 1-meter height be used to make this determination?



What should be considered the terminus of the ruined pier for feature depiction and attribution? We’re looking for this guidance to help us determine how to update the geometry of these ruined features, construct new features, and properly attribute in the FFF. Is the terminus based on a specific height or the ability to detect evidence of the old pier in the surface? Our Mississippi River surveys contained numerous pile dike linear features where we drew SLCONS (training wall) to the terminus of the surveyed end pile, regardless of its height above bottom. The individual piles were not designated.



In both of our examples, some portion of the surveyed charted ruined features would be disproved. When disproving these features, are we required to fully ensonify (100% MBES or 200% SSS) the disproval radius (buffer), even if we can see evidence of the old piers in the data at their charted locations?



We appreciate your guidance on these features. We want to make sure that the data we acquire enables the charts to be updated in these areas and also want to use this information to manage risk while operating inshore.

While we're discussing disprovals, we'd like to review the investigations requirements for assigned charted features in survey areas H13389 and H13390. There are two investigation requirements for features that have disproval radii included in the PRF.

1. If the feature is not visible in the field, then complete comverage multibeam (HSSD 5.2.2.3 Option A) or 200% side scan sonar coverage with multibeam (HSSD 5.2.2.2 Option B) is required for the entire radii extent.
2. Complete coverage multibeam (HSSD 5.2.2.3 Option A) or 200% side scan sonar coverage with multibeam (HSSD 5.2.2.2 Option B) for the radii extent is required. Pending findings, complete a feature development (HSSD 7.3.3) or disproval (HSSD 7.3.4).

Are we to interpret that disproval radii with investigation requirement number 2 require complete coverage MBES or 200% SSS coverage even if a feature disproval is not required (i.e. feature visible in the MBES data and will be depicted in the FFF as a feature after performing a feature development)?

Thanks for taking these detailed questions. We're happy to provide clarification if and where it is needed.

Thanks,

Jason

Jason Creech, CH | Vice President, Nautical Charting Program Manager

David Evans and Associates, Inc.

2801 SE Columbia Way, Suite 130 | Vancouver, WA, 98661 | www.deainc.com

t: 804.806.4440 | c: 804.516.7829 | jasc@deainc.com

From: Douglas Wood - NOAA Federal <douglas.wood@noaa.gov>
Sent: Monday, February 8, 2021 5:02 PM
To: Jason Creech <Jasc@deainc.com>; Jon Dasler <Jld@deainc.com>; Nicole Lawson - NOAA Federal <nicole.lawson@noaa.gov>; Starla Robinson - NOAA Federal <Starla.Robinson@noaa.gov>; Grant Froelich <grant.froelich@noaa.gov>
Cc: Douglas Wood - NOAA Affiliate <douglas.wood@noaa.gov>
Subject: Galveston Bay private pier faces; UCF disproval radii

Good afternoon Jason and Jon,

The hydrographer has the discretion to determine both the safety NALL and areas of navigational significance within the survey. Based on the meeting Friday, 5th of February, we concur that the areas between the private piers, and areas inshore of the private piers, are not navigationally significant and may compromise safety of the crew as they maneuver in tight quarters. Furthermore, if the hydrographer finds the terminus of a pier to be in ruin, it is safe to assume that the ruin pier extends to where the pier is currently visible. In this case disproval bathymetry does not need to be acquired inshore of the end of the ruined pier. Please continue to apply this judgement to like areas.

In regards to the disproval radii, since it is in the PI as part of the contract, only the Contracting Officer may modify the contract. Please email the request to change the PI language with explanation that there was a change, to Nicole Lawson with the COR CCed. We have briefed her and she will get back to us within the next couple days with next steps.

Doug

--

Douglas Wood
Physical Scientist
Hydrographic Surveys Division
Office of Coast Survey
National Oceanic and Atmospheric Administration
1315 East West Highway
Silver Spring, MD 20910
240-533-0042 -
(Teleworking until further notice, office phone will not be answered)

Jason Creech

From: Douglas Wood - NOAA Federal <douglas.wood@noaa.gov>
Sent: Friday, March 12, 2021 4:28 PM
To: Jason Creech
Cc: castle.e.parker@noaa.gov; Christina Fandel - NOAA Federal; Grant Froelich
Subject: Re: OPR-K375-KR-20 Guidance on bottom change visible in MBES data

Hi Jason,

Yes, I agree that it was a helpful meeting. Again, thank your crew for what they are doing for us.

We will get back to you with some guidance regarding the dynamic riverbed under the San Jacinto.

Here is guidance on the disproval coverage:

*- For a **UCF:** the disproval radii must be filled in with the coverage specified in the invreq attributes. If the radius extends inshore of the NALL, coverage meeting the requirements in the invreq attribute must be obtained from the NALL seaward to the radius line.*

*- For a **non-UCF** assigned feature: if a feature is observed within the disproval radius and there is a reasonable expectation that the charted disproval feature is represented in the real world by the surveyed feature, the hydrographer no longer needs to fill the rest of the radius. If the hydrographer assumes the chart disproval item and the surveyed feature are representing the same real-world feature and then happen to survey an additional feature either in or on the edge of the radius (or indication of a feature such as scour at the edge of coverage) then they need to develop that additional feature as a "New Feature" per HSSD 7.3.2/7.3.3. They do not need to develop a feature or fill in disproval radii inshore of the NALL.*

I hope that this helpful.

Doug

On Fri, Mar 12, 2021 at 4:22 PM Jason Creech <Jasc@deainc.com> wrote:

> Hi Doug
>
> Thanks again for setting up this meeting. It was very helpful; we appreciate you taking the time to clarify our questions.
>
> I've uploaded the video showing the bottom change in H13387 to the project Google drive.

DN031_Pink_data_Preliminary_surface_Green.mp4

We plan to get started on the H13389 feature disprovals this weekend.

Have a great weekend,

Jason

From: Douglas Wood - NOAA Federal <douglas.wood@noaa.gov>
Sent: Thursday, March 11, 2021 10:50 AM
To: Jason Creech <Jasc@deainc.com>
Cc: castle.e.parker@noaa.gov; Christina Fandel - NOAA Federal <christina.fandel@noaa.gov>; Grant Froelich <grant.froelich@noaa.gov>
Subject: Re: OPR-K375-KR-20 Guidance on bottom change visible in MBES data

Hi Jason,

They are invited.

On Thu, Mar 11, 2021 at 10:44 AM Jason Creech <Jasc@deainc.com> wrote:

Hi Doug

Can you add the following?

cemc@deainc.com

james.guilford@deainc.com

jxst@deainc.com

With the sediment change question resolved the feature disproval question below is the only discussion point.

From: Douglas Wood - NOAA Federal <douglas.wood@noaa.gov>
Sent: Thursday, March 11, 2021 8:16 AM
To: Jason Creech <Jasc@deainc.com>
Cc: castle.e.parker@noaa.gov; Christina Fandel - NOAA Federal <christina.fandel@noaa.gov>; Grant Froelich <grant.froelich@noaa.gov>
Subject: Re: OPR-K375-KR-20 Guidance on bottom change visible in MBES data

Hi Jason,

I just invited you and Jon to the meeting for tomorrow; let me know if you would like me to invite anyone else.

Could you forward a list of discussion points?

I am chasing the answer on your question above on assigned features which are observed but off station.

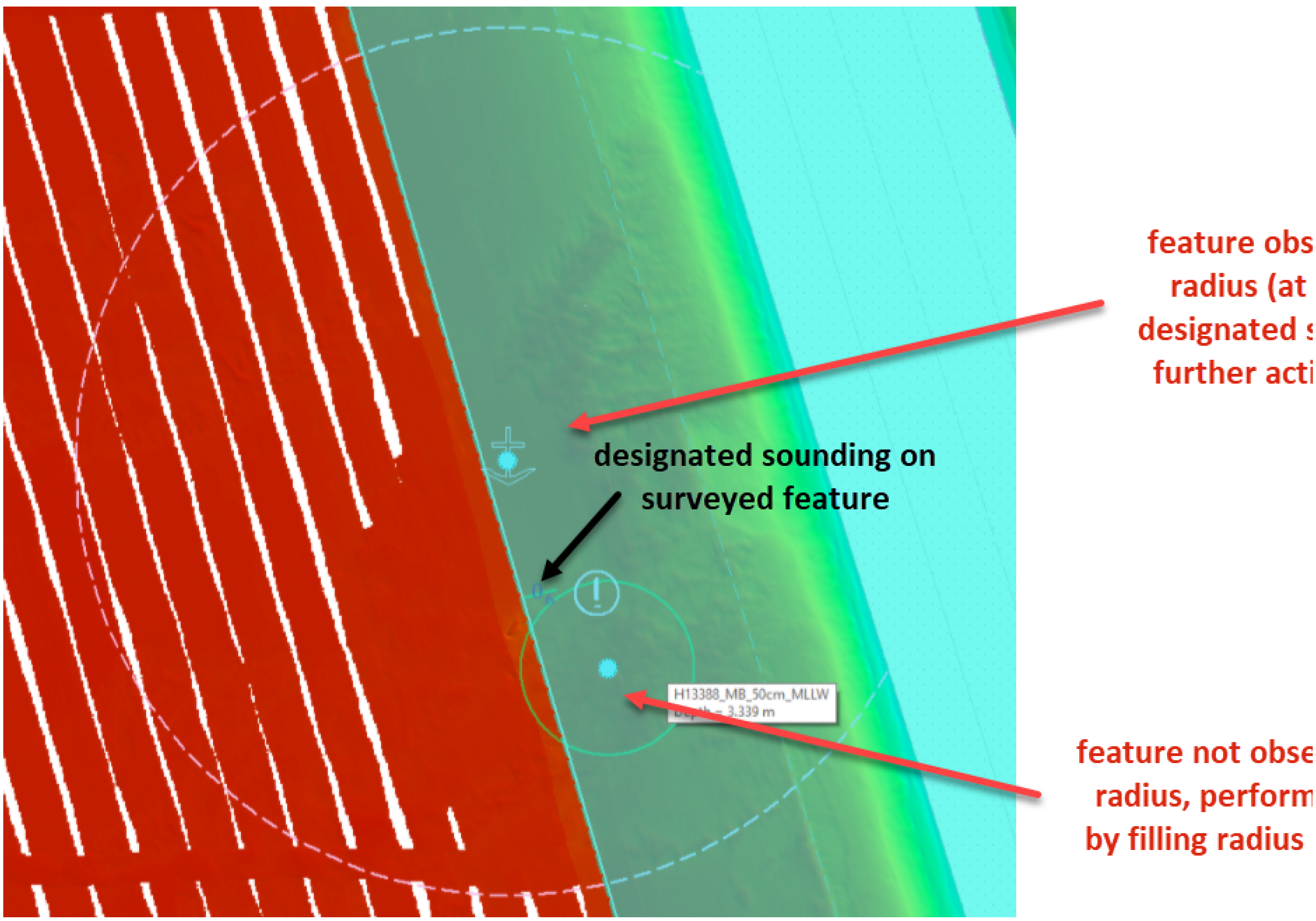
Doug

On Wed, Mar 10, 2021 at 7:53 PM Jason Creech <Jasc@deainc.com> wrote:

> Hi Doug
>
> Thanks for clarification on the manual editing of the bathy in areas of bottom change. We will get going on this and discuss this practice in our DRs. We're going to stick to the areas where the surface is impacted by this disagreement as there are some areas of minor change where the surface honors the shoaler and more recent data.
>
> Friday at 3:30 will work for a meeting. We just wanted to make sure we understand the charted feature disproval requirements for radii that contain a surveyed feature. I've included our question from an email I sent last Friday on this below. Surveys H13389 and H13390 are feature rich, have overlapping disproval radii, and currently have 100% MBES side scan coverage with skunk stripe MBES bathy after the initial mainscheme collect. We're preparing to begin feature disprovals which will involve filling the disproval radii with 100% MBES. It's our assumption that a disproval is not required if we locate a feature inside a radii which appears to be the charted feature (Option B below). This gets a bit more involved when there over overlapping radii.

When a surveyed feature is found within a disproval radius but not at the charted location of the assigned feature, are we to A) run a feature disproval filling the radii with the required coverage or B) are we to assume that the surveyed feature and charted feature are one and the same and just include in the FFF as a delete (charted) / new (surveyed) pair?

I've including a graphic below depicting an example from our survey project. We plan to start running feature disprovals early next week and want to make sure we are on track to do this properly.



Jason Creech, CH | Vice President, Nautical Charting Program Manager

Regarding other issues that you brought up with Christy today; it might be best to schedule a meeting soon. I see a possible hole in our calendars on Friday afternoon at 3:30 eastern time. Could this work for you?

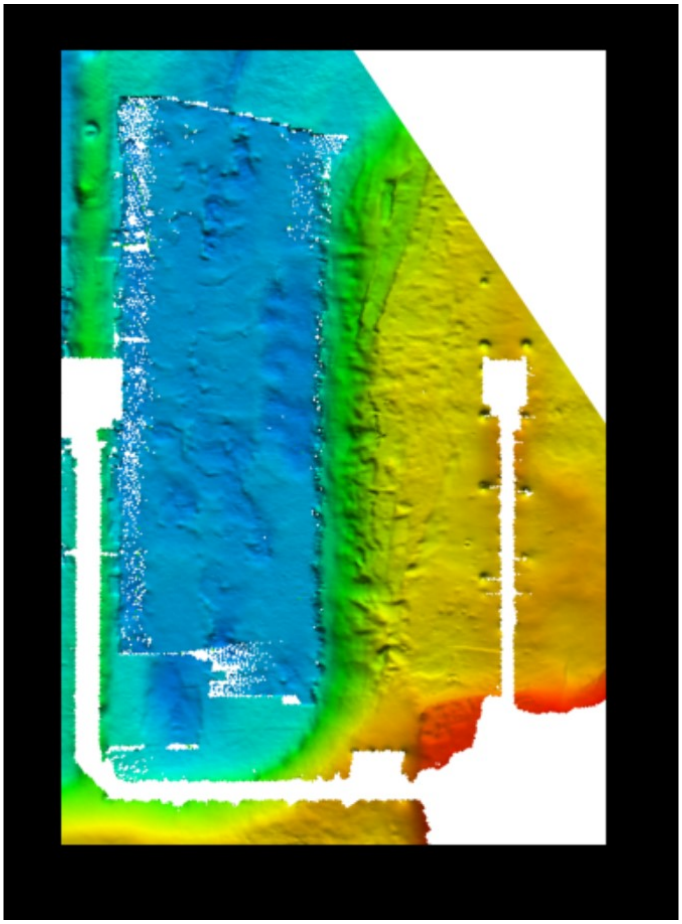
If so, can you forward a list of outstanding questions and issues that you have?

Thanks.

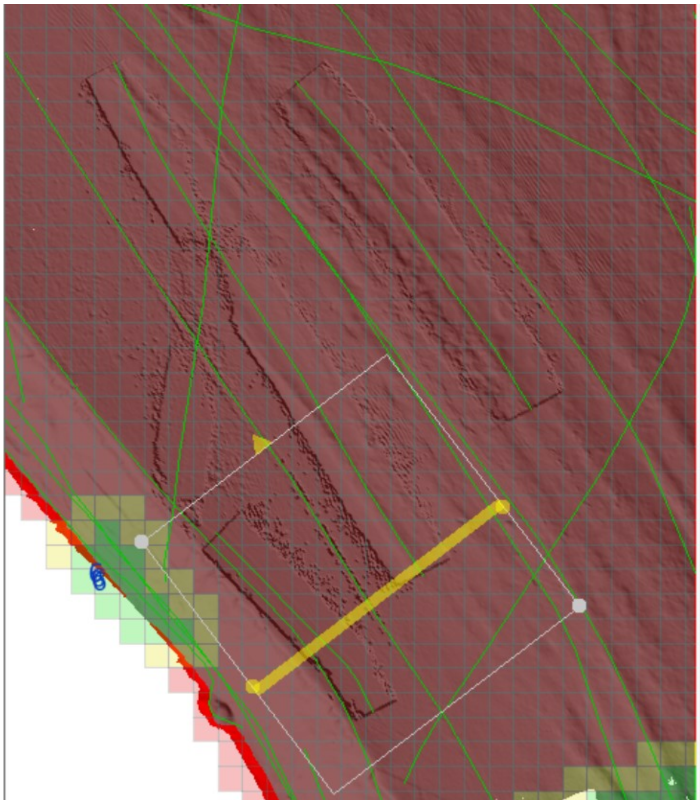
Doug

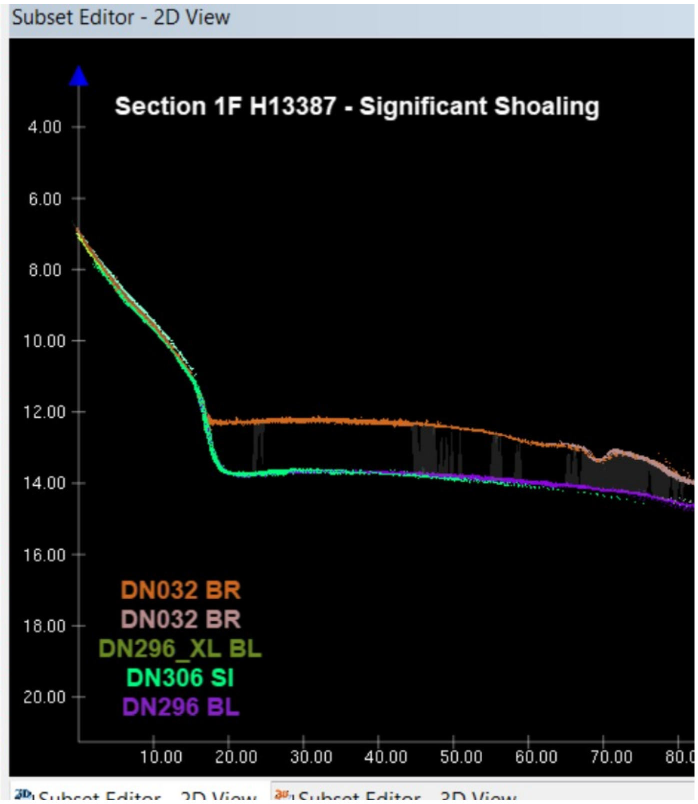
On Tue, Mar 9, 2021 at 4:00 PM Jason Creech <Jasc@deainc.com> wrote:

> Hi Doug
>
> I'm following up after applying this guidance to the BOSCO terminal. We've manually edited out the predredge data at the terminal, and as expected it did leave some holidays which we will discuss in the DR. See below. Manually editing to the new bottom made sense in this instance. There are many other areas where bottom changes occurred, and we want to make sure that your guidance is applicable in those areas before we continue to manually edit the data to depict the most recently observed bottom.



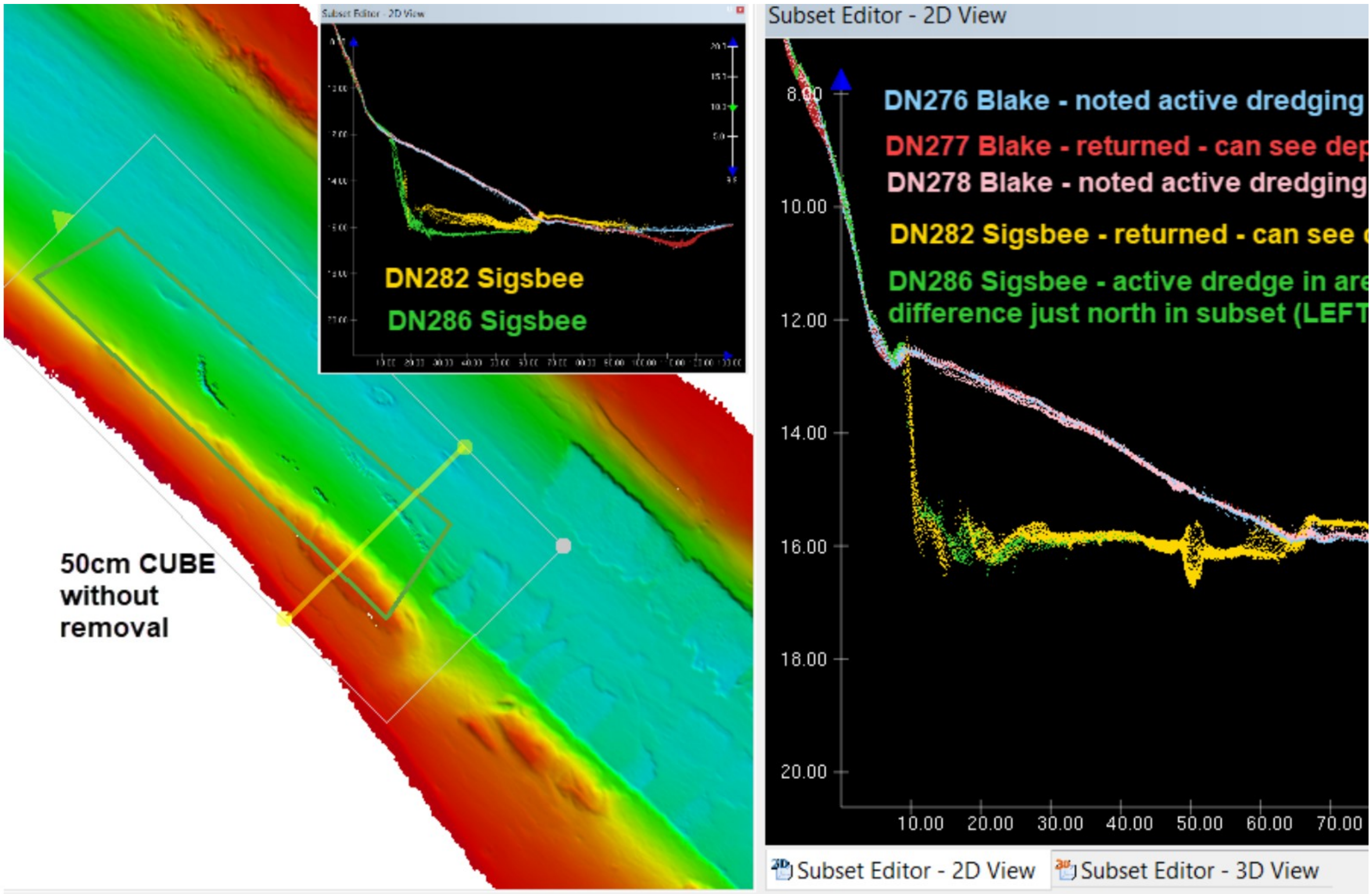
Here is an example (below) of shoaling that occurred between mainscheme acquisition and fill. In these instances, are we to manually edit out the older mainscheme data that falls under each fill line so the surface honors the newer data?





Here is another example where dredging of the channel was occurring during survey operations. In this instance swaths don't match up with neighboring lines due to all of the bottom change that occurred between passes. We can try to manually reject some data to remove the large changes but there will still be some disagreement in areas of overlap due to the bottom changes. Before proceeding with additional manual editing, we want to make sure that we are applying your guidance properly.

If you'd prefer, I'd be happy to set up a web conference to review and discuss.



Thanks,

Jason

Jason Creech, CH | Vice President, Nautical Charting Program Manager

David Evans and Associates, Inc.

2801 SE Columbia Way, Suite 130 | Vancouver, WA, 98661 | www.deainc.com

t: 804.806.4440 | c: 804.516.7829 | jasc@deainc.com

ENERGY | LAND DEVELOPMENT | MARINE SERVICES | SURVEYING AND GEOMATICS | TRANSPORTATION | WATER AND ENVIRONMENT

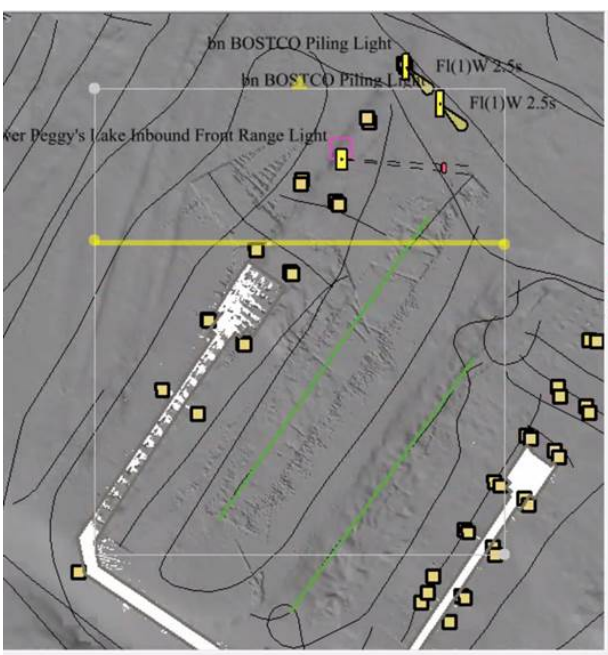
We are seeing evidence of bottom change due to sediment migration and dredging in the MBES data where overlapping swaths do not agree. We experienced similar issues during our surveys of the Mississippi River in 2018 and 2019 (OPR-J347-KR-18) and received guidance from HSD OPS and the Atlantic Hydrographic Branch that we could allow the CUBE algorithm to estimate a gridded depth in these areas without manual cleaning of the sounding data (with the option to manually edit the data if we felt that one line better represented the seafloor). For these surveys, we submitted data without manually editing the areas of overlap (other than removing shoal and deep fliers) which would have required the stitching together disagreeing survey swaths. The submitted surfaces had numerous artifacts resulting from these areas of disagreement.

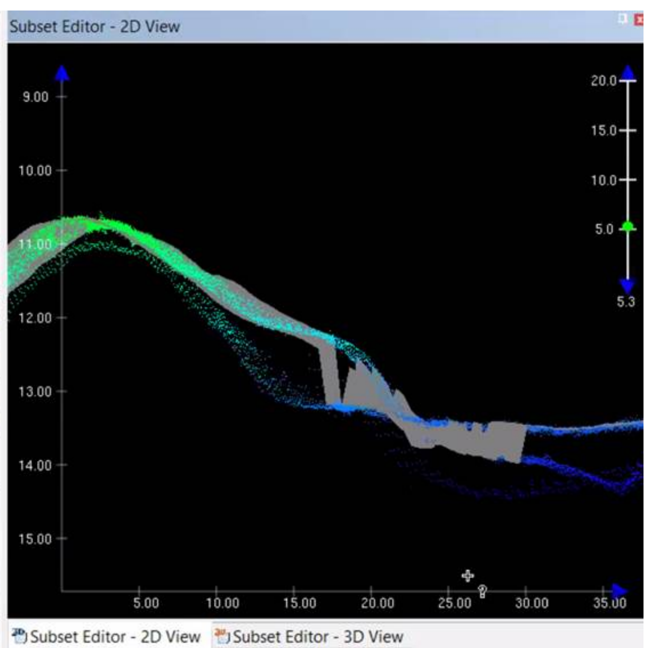
Should we follow this same practice for the Houston surveys (OPR-K375-KR-20)? I have included a few screengrabs below from the BOSTCO fuel oil terminal in the H13387 survey area showing disagreement between MBES swaths due to dredging (assumed) and resulting artifacts in the gridded CUBE surface. We did not observe dredging operations at this location, but we were not at this site for the entirety of the survey.

We are starting to prepare final products for H13387 and want to make sure that we are following the correct protocol when bottom change has occurred and that we have supporting correspondence to include with the deliverables.

Thanks,

Jason





Jason Creech, CH | Vice President, Nautical Charting Program Manager

David Evans and Associates, Inc.

2801 SE Columbia Way, Suite 130 | Vancouver, WA, 98661 | www.deainc.com

t: 804.806.4440 | c: 804.516.7829 | jasc@deainc.com

ENERGY | LAND DEVELOPMENT | MARINE SERVICES | SURVEYING AND GEOMATICS | TRANSPORTATION | WATER AND ENVIRONMENT

Follow us on LinkedIn | Twitter | Facebook | YouTube

DEA's commitment to our employees, clients, partners, and communities remains our priority during the COVID-19 pandemic. Our teams are continually adapting, with a great many working remotely. All of us are focused on achieving and exceeding our clients' expectations. Our mail correspondence is currently routed through our corporate headquarters. Please email me with urgent items to ensure timely response.

APPROVAL PAGE

H13387

The survey data meet or exceed the current requirements of the Office of Coast Survey hydrographic data review process and may be used to update NOAA products. The following survey products will be archived at the National Centers for Environmental Information:

- Descriptive Report
- Collection of Bathymetric Attributed Grids (BAGs)
- Collection of acoustic backscatter mosaics
- Geospatial PDF of survey products

Digitally signed by HOLMBERG.PETER.SCOTT.1365886101
Reason: I am approving this document
Date: 2021.11.17 08:53:04 -08'00'

Approved:______________________________

Peter Holmberg
Products Team Lead, Pacific Hydrographic Branch