2021 Descriptive Report of Seafloor Mapping: Vicinity of Casco Bay

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Maine Coastal Mapping Initiative, July 2022

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For an overview of the Maine Coastal Mapping Initiative (MCMI) information products, including maps, data, imagery, and reports visit: https://www.maine.gov/dmr/mcp/planning/mcmi/index.htm.

Acknowledgements

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Maine Coastal Mapping Initiative
Maine Coastal Program
Department of Marine Resources

DESCRIPTIVE REPORT

Type of Survey: Navigable Area

Registry Number:

LOCALITY

State(s): Maine

General Locality: Gulf of Maine

Sub-Localities: Vicinity of Casco Bay

2021

CHIEF OF PARTY
Peyton Benson, Hydrographer, Contractor to the State of Maine

LIBRARY & ARCHIVES

Date:

MAINE COASTAL MAPPING INITIATIVE MAINE COASTAL PROGRAM	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	

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):	**Maine**
General Locality:	**Gulf of Maine**
Sub-Locality:	**Vicinity of Casco Bay**
Scale:	
Dates of Survey:	**04/15/2021 to 05/02/2022**
Instructions Dated:	
Project Number:	
Field Unit:	***Amy Gale***
Chief of Party:	**Peyton Benson, Hydrographer, Contractor to the State of Maine**
Soundings by:	**Kongsberg EM2040C (MBES)**
Imagery by:	**Kongsberg EM2040C (MBES Backscatter)**
Verification by:	
Soundings in:	**meters at Mean Lower Low Water**

Remarks:

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ABSTRACT

During April-August 2021, the Maine Coastal Mapping Initiative (MCMI) conducted hydrographic surveying using a multibeam echosounder (MBES) in marine waters in the vicinity of the Gulf of Maine, sub-locality Casco Bay, Maine. The surveying efforts were conducted to support efforts to enhance coastal resiliency through identification and characterization of seafloor habitat to provide information necessary to managing the marine environment and economy. The survey also coincides with state and federal efforts to update coastal data sets and increase high resolution bathymetric coverage for Maine's coastal and marine waters. This report serves as a comprehensive summary of data collected for the survey season. During the scope of the season, approximately 37 mi^2 (95.8 km^2) of high-resolution multibeam data were collected in the surveyed area. Throughout the survey period, MCMI also collected sediment samples, water column data, and video at 38 locations in the mainscheme survey area.

1.0 Area Surveyed

The mainscheme survey area mapped during the 2021 season (April 15-August 16) was located in and off Casco Bay in the Gulf of Maine, as shown in Figure 1. The approximately 37 mi^2 mainscheme survey area adjoins the southwestern extent of the area mapped by MCMI in 2016 (NOAA survey registry number W00448) and the northeastern extent of the area mapped by MCMI in 2020 (currently being reviewed for acceptance by NOAA) (Figure 2). These data were not collected in direct accordance with the *NOS Hydrographic Surveys Specifications and Deliverables* and the *Field Procedures Manual* requirements; however, both documents were referenced during acquisition for guidance.

Mainscheme survey limits are listed in Table 1. Specific dates of data acquisition for the mainscheme survey are listed in Appendix A.

Table 1 – 2021 mainscheme survey limits

Southeast Limit	Northwest Limit
43° 33’ 55.831” N	43° 35’ 34.004” N
69° 49’ 07.272” W	70° 00’ 32.193” W

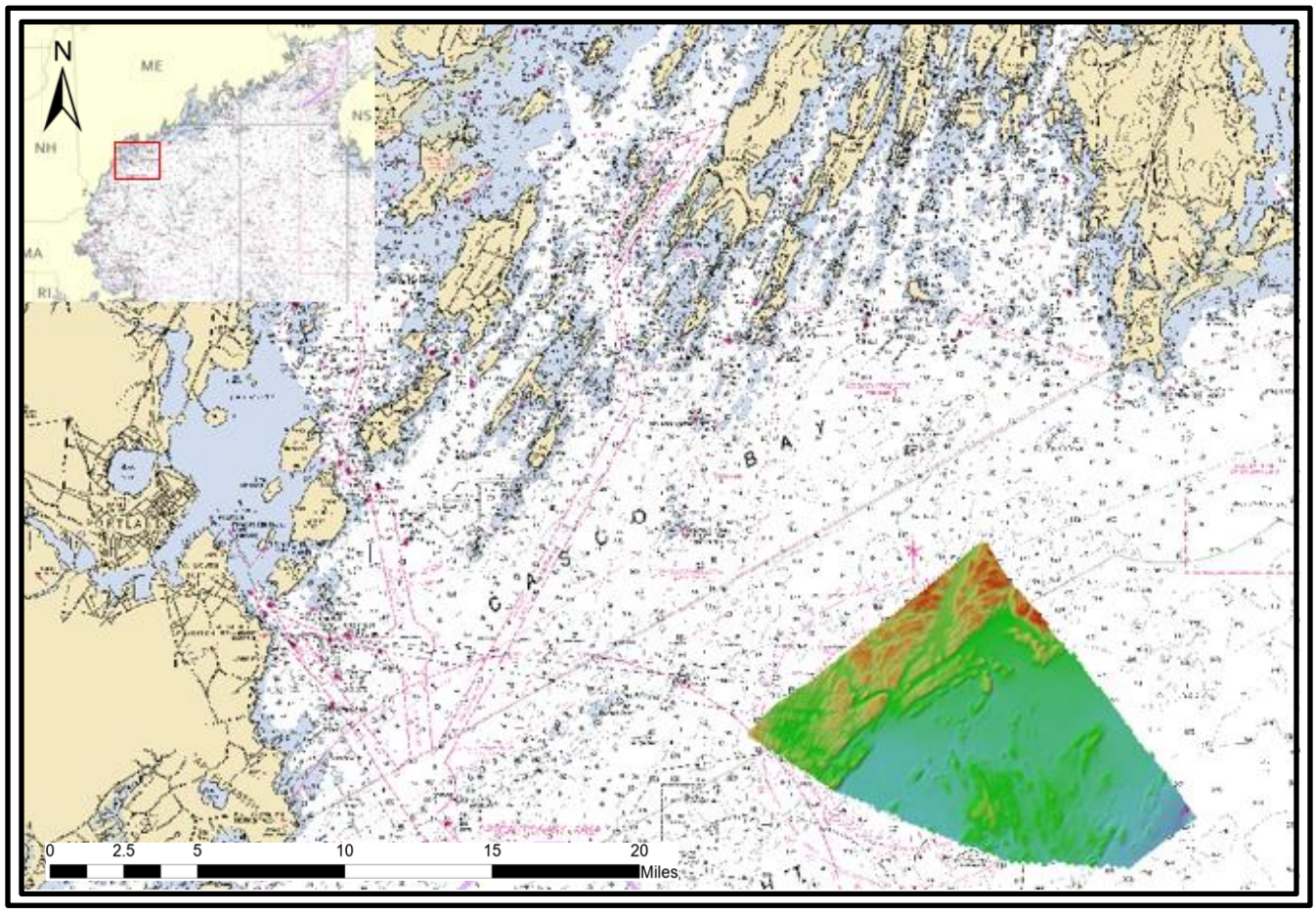


Figure 1 – General locality of 2021 mainscheme survey coverage in Casco Bay, Maine.

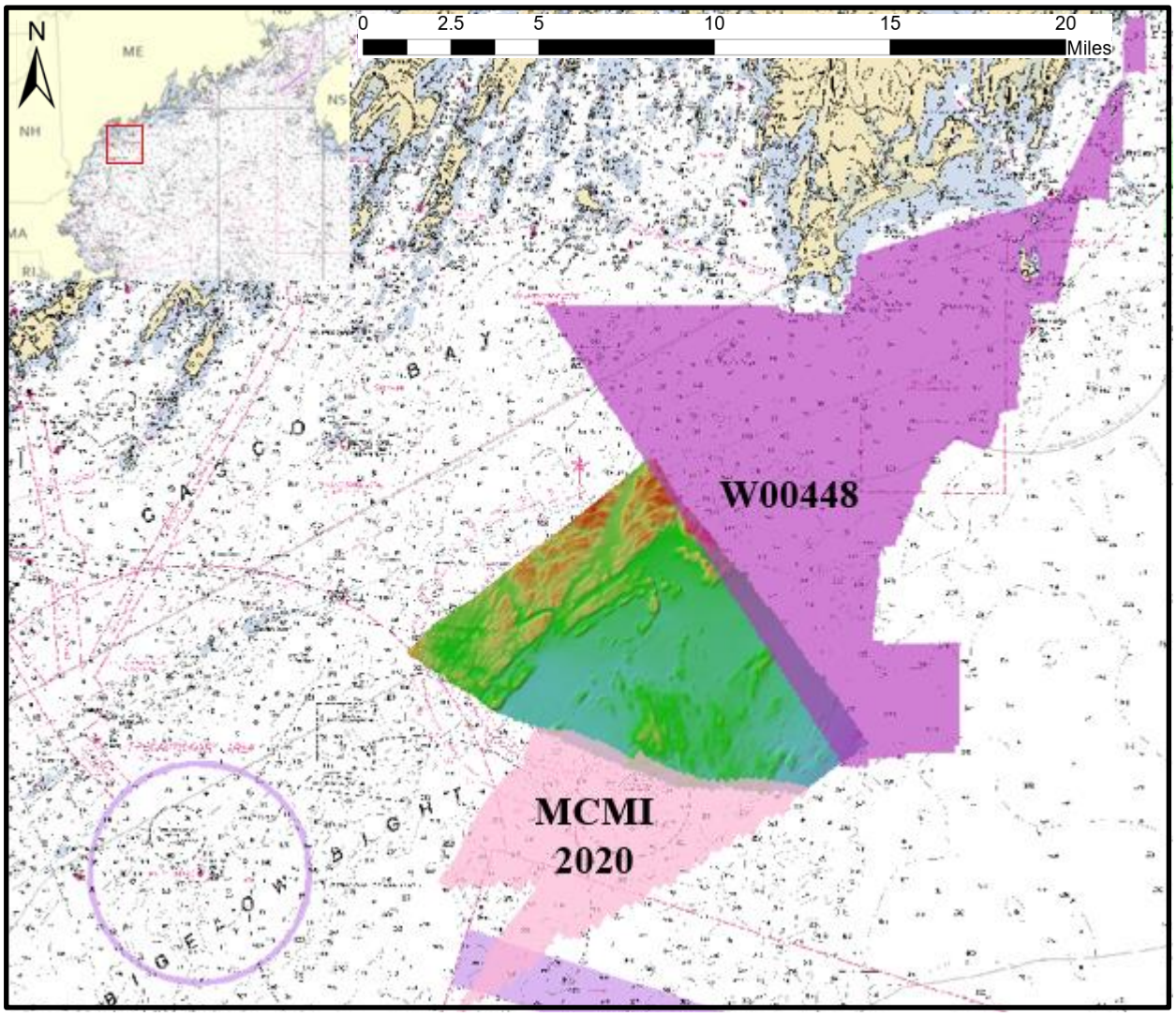


Figure 2 – General locality of 2021 MCMI mainscheme coverage relative to overlapping datasets in the region.

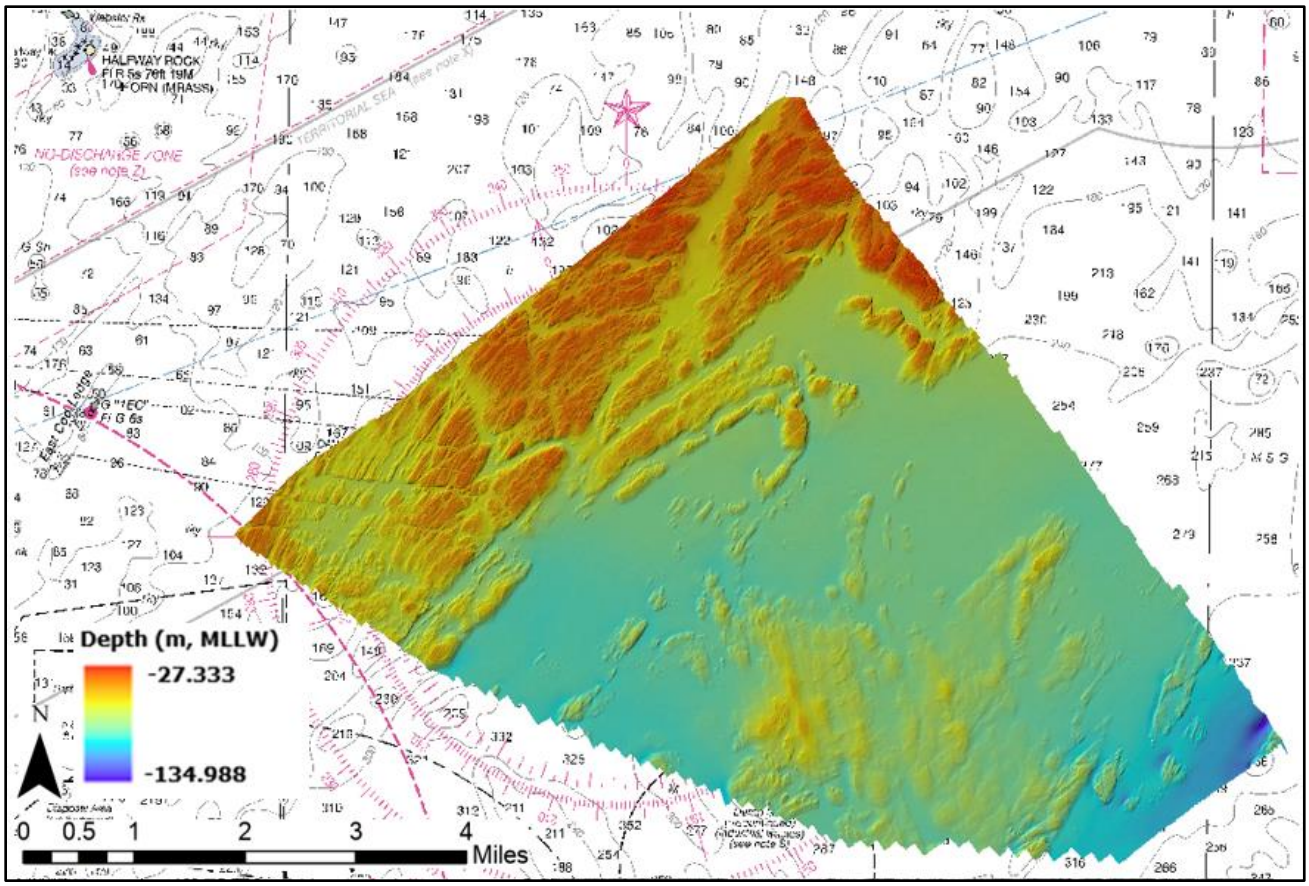


Figure 3 – Shaded relief image of 2021 mainscheme bathymetry data gridded at 4-meter resolution and colored by depth. Data is overlain on NOAA nautical chart 13288.

1.1 Survey Purpose

This survey was conducted by the Maine Coastal Program's Maine Coastal Mapping Initiative (MCMI) as part of a multi-agency cooperative agreement partially funded by the National Oceanic and Atmospheric Administration (NOAA) Office of Coastal Management, The Nature Conservancy (TNC), and the Maine Outdoor Heritage Fund. The purpose of this project is to help inform policy decision-making related to Maine's coastal waters by increasing the volume of available high-quality bathymetric, benthic habitat, geochemical, and geologic data in the mainscheme Casco Bay vicinity area. This project also coincides with state and federal efforts to update coastal data sets for Maine's coastal waters and provides new data in the areas covered by National Oceanic and Atmospheric Administration (NOAA) nautical charts 13286, 13288, and 13290 in the vicinity of Casco Bay. These data were acquired and processed to meet Office of Coast Survey bathymetry standards as best as possible and are shared with the NOAA Office of Coast Survey for review.

1.2 Survey Quality

The entire survey should be adequate to supersede previous data.

1.3 Survey Coverage

Select few small holidays (gaps in MBES coverage) exist within the surveyed area, and normally occurred as sonic shadows in areas of locally high relief and/or highly irregular bathymetry. Analyses of bathymetric data show that the least depths were achieved over all features, and that holidays have not compromised data integrity.

2.0 Data Acquisition

The following sub-sections contain a summary of the systems, software, and general operations used for acquisition and preliminary processing during the 2021 survey season.

2.1 Survey Vessel

All data were collected aboard the Fishing Vessel (F/V) Amy Gale (length = 10.95 m, width = 3.81 m, draft = 0.93 m) (Figures 4, 5, and 6), a former lobster boat converted to a survey vessel and contracted to the MCMI. The vessel was captained by Caleb Hodgdon of Hodgdon Vessel Services. Surveys were based out of ports in Boothbay Harbor and South Portland, ME. The EM2040C transducer, motion reference unit (MRU), AML MicroX surface sound speed probe, and dual GNSS antennas were pole-mounted to the bow; pole raised (for transit) and lowered (for survey) via a pivot point at the edge of the bow. The main cabin of the vessel served as the data collection center and was outfitted with four display monitors for real time visualization of data during acquisition.

Figure 4 – F/V Amy Gale shown with pole-mounted dual GPS antennas, Kongsberg EM2040C multibeam sonar, MRU (not visible), and surface sound speed probe (not visible) in acquisition mode

2.2 Acquisition Systems

The real-time acquisition systems used aboard the F/V Amy Gale during the 2021 surveys are outlined in Table 2. Data acquisition was performed using the Quality Positioning Services (QPS) Qinsy (Quality Integrated

Navigation System; v.9.2.2) acquisition software. The modules within Qinsy integrated all systems and were used for real-time navigation, survey line planning, data time tagging, data logging, and visualization.

Table 2 – Major systems used aboard F/V Amy Gale

Sub-system	Components
Multibeam Sonar	Kongsberg EM2040C and processing unit
Position, Attitude, and Heading Sensor	Seapath 330 processing unit, HMI unit, dual GPS/GLONASS antennas, MRU 5-V motion reference unit (subsea bottle), Fugro 3610 Receiver and AD-341 antenna
Acquisition Software and Workstation	Qinsy software v.9.2.2 and 64-bit Windows 10 PC console
Surface Sound Velocity (SV) Probe	AML Micro X with SV Xchange
Sound Velocity Profiler (SVP)	Teledyne Odom Digibar S sound speed profiler
Ground-truthing/Sediment Sampling Platform	Ponar grab sampler, GoPro Hero 3+ video camera, GoPro Hero 5 Black video camera, dive light, dive lasers, YSI Exo I sonde

2.3 Vessel Configuration Parameters

In 2017, the MCMI contracted Doucet Survey, Inc. to perform high-definition (precision ±5mm) 3D laser scanning of the Amy Gale and all external MBES system components (e.g. MRU, GPS antennas, and EM2040C) (Figures 5 and 6). The purpose of the laser scan survey was to refine and or verify the precision of hand-made vessel reference frame measurements for future surveys. All points were referenced to the center point of the base of the MRU (mounted inside the pole and directly atop the EM2040C transducer) (Figure 8), which served as the origin (e.g. 0,0,0), where 'x' was positive forward, 'y' was positive starboard, and 'z' was positive down. The laser scan survey results only differed from hand-made measurements by ≤ 3mm for all nodes of interest. Reference measurements for each component were entered into the Seapath 330 Navigation Engine (Table 3) and converted so all outgoing datagrams would be relative to the location of the EM2040C transducer (e.g. EM2040C was used as the monitoring point for all outgoing datagrams being received by Qinsy during acquisition). Additional configuration and interfacing of all systems were established during the creation of a template database in the Qinsy console.

These offset values were not changed for the 2021 survey season. See appendices for specific settings as entered in the Seapath 330 Navigation Engine (Appendix B) and for the template database (Appendix C) used during data acquisition while online in Qinsy. Configuration settings of the EM2040C were assigned in the EM Controller module of Qinsy (Appendix D).

Table 3 – 2017 equipment reference frame measurements for Seapath 330

Equipment	x (m)	y (m)	z (m)
MRU	0.000	0.000	0.00
Antenna 1 (port)	0.158	-1.245	-3.000
Antenna 2 (starboard)	0.158	1.252	-3.035
EM2040C	0.036	0.000	0.133

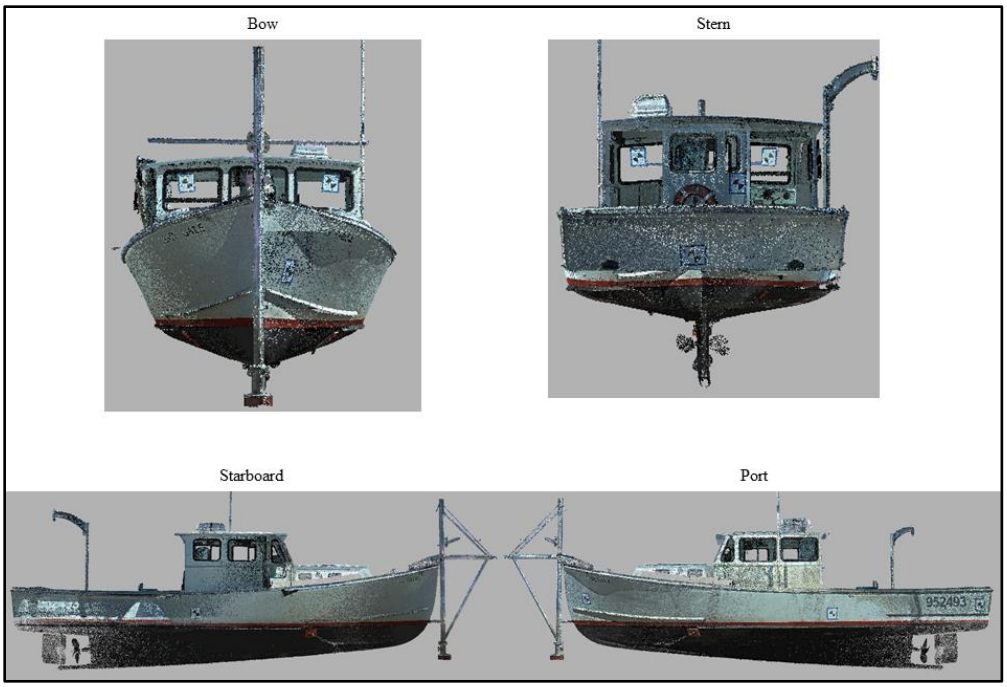


Figure 5 – Amy Gale RGB color images generated from 3D laser scan survey (GPS antennas and external cabling not included in survey) data (.pts file converted to .las for visualization)

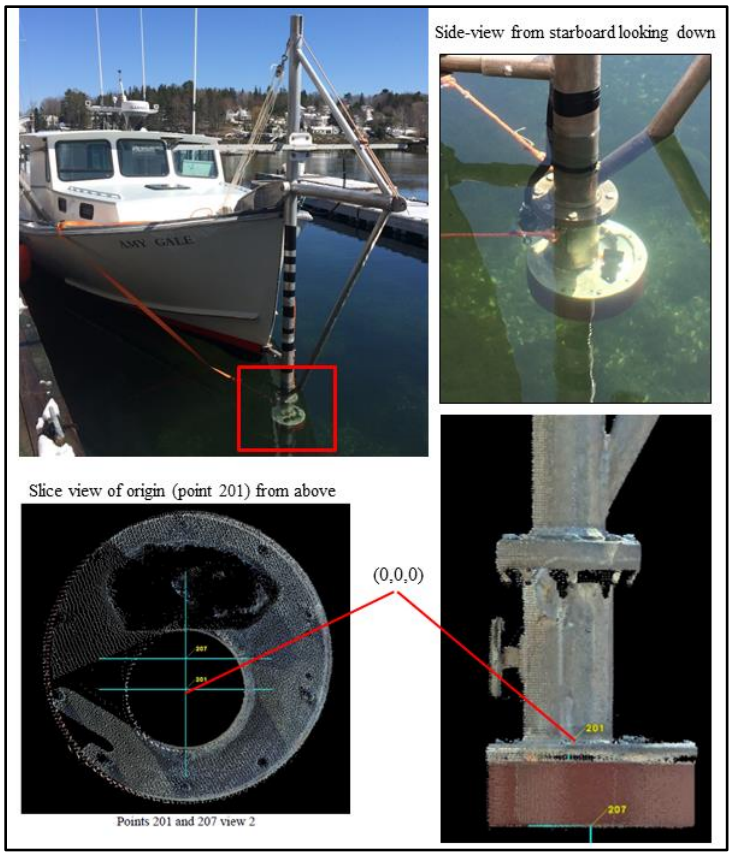


Figure 6 – Amy Gale origin (point 201 in RGB images) for vessel reference frame(s); origin is center point within the base of the pole (center point of base within internally-mounted motion reference unit (MRU) point 201 in images above)

2.4 Survey Operations

The following is a general summary of daily survey operations. Once the survey destination was reached, the sonar pole mount was lowered into survey position and its bracing rods were fastened securely to the hull of the ship via heavy-duty ratchet straps. Electric power to all systems was provided by a 2000-watt Honda *eu2000i* generator. Occasionally two *eu2000i* generators were simultaneously used if any auxiliary equipment needed additional electricity. Immediately following power-up, all interfacing instruments were given time to stabilize (e.g. approximately 30-45 minutes for Seapath to acquire time tag for GPS). Next, the desired Qinsy project (e.g. mainscheme, inshore, etc.) was selected for data acquisition. All files (e.g. raw sonar files, sound speed profiles, grid files, etc.) were recorded and stored within their respective project subfolders on a local drive. Prior to surveying, a sound speed cast was taken and imported into the 'imports' folder of the current project. After confirming a close match between the upcast and downcast data, the profile was applied to the sonar (EM2040C) in the Qinsy Controller module. Data were gridded at 0.5 to 4 meters for real-time visualization, depending on expected water depth range. Raw sonar files were logged in the Qinsy Controller module in .db format and saved directly onto the hydrographic workstation computer. All data were backed up daily on an external hard drive. At the end of each day's survey, sonar and navigation systems were powered down and the pole mount was raised and fastened for transit back to port. Upon arriving at the dock, all external instruments/hardware were visually inspected and rinsed with freshwater to prevent corrosion.

2.5 Survey Planning

Line planning and coverage requirements were designed to meet requirements for NOAA hydrographic standards and in accordance with IHO S-44 6th Edition Order 1a survey (International Hydrographic Organization, 2020 & NOAA Office of Coast Survey, 2021). In the mainscheme area, parallel lines were mostly planned several days prior to surveying and run in a NE-SW or E-W pattern, depending on the location. Lines were spaced at consistent intervals to obtain a minimum of 20% overlap between full swaths. Soundings from beam angles outside of ±60 degrees from the nadir were blocked from visualization during acquisition, thus increasing the true minimum full-swath overlap. This online blocking filter was recommended by QPS field engineers with the intent of eliminating noisy outer beams from the final product, thereby increasing the overall contribution of higher quality soundings. All data were acquired at approximately 6.5-7 knots, although some areas required slower speeds to ensure safe operation of the vessel around obstructions, fishing operations, or in especially rough conditions.

2.6 Calibrations

Several patch tests were conducted aboard the F/V Amy Gale at the beginning of the 2021 survey season to correct for alignment offsets. After an initial application of patch test values data not tide-corrected, a second patch test was applied once verified tide data was available from NOAA. During the test, a series of lines were run to determine the latency, pitch, roll, and heading offset following standard protocol (NOAA Office of Coast Survey, 2021). The patch test data were processed using the Qimera (v.2.4.0) patch test tool. After calibration was complete, offsets (Table 4) were entered into the template database in Qinsy. Additional patch tests were conducted any time a system was removed or reinstalled throughout the survey season. Full built-in self-tests (BIST) were performed at semi-regular intervals throughout the season to determine if any significant deviations in background noise were present at the chosen survey frequency of 300KHz.

Table 4 – 2021 patch test calibration offsets for EM2040C

Type	Offsets 04/15/21	Offsets 05/07/21	Offsets 05/14/21	Offsets 05/18/21	Offsets 06/16/21
Roll (degrees)	0.318	0.317	0.314	0.330	0.363
Pitch (degrees)	0.541	-1.859	-1.159	-1.859	-1.582
Heading (degrees)	2.508	2.388	1.479	2.388	2.388

3.0 Quality Control

3.1 Crosslines

Due to systems failures noted in section 3.3, survey acquisition was delayed significantly in the 2021 season and crosslines were acquired in April and May of 2022. Crosslines were run at 900m spacing and intersected with all mainscheme lines between 60° and 90° in accordance with BOEM requirements (U.S. Department of the Interior, 2014). Crosslines were filtered during post-processing to remove soundings outside 45 degrees from the nadir. After filtering, the two-dimensional surface area totaled approximately 17% of mainscheme acquisition. Crossline sounding agreement with mainscheme data was evaluated by using the crosscheck tool in Qimera 2.4.0, which performs beam-by-beam statistical analysis. The mean difference between soundings was -0.029 meters with a standard deviation of 0.477 meters; 95% of all differences were less than 0.96 meters from the mean (Figure 8). Summary statistics for this analysis are shown in Table 5. Additional statistical plots

are reported in Appendix F. Raw difference data, reference surfaces, and sonar files used for this analysis were submitted with the data in this survey package.

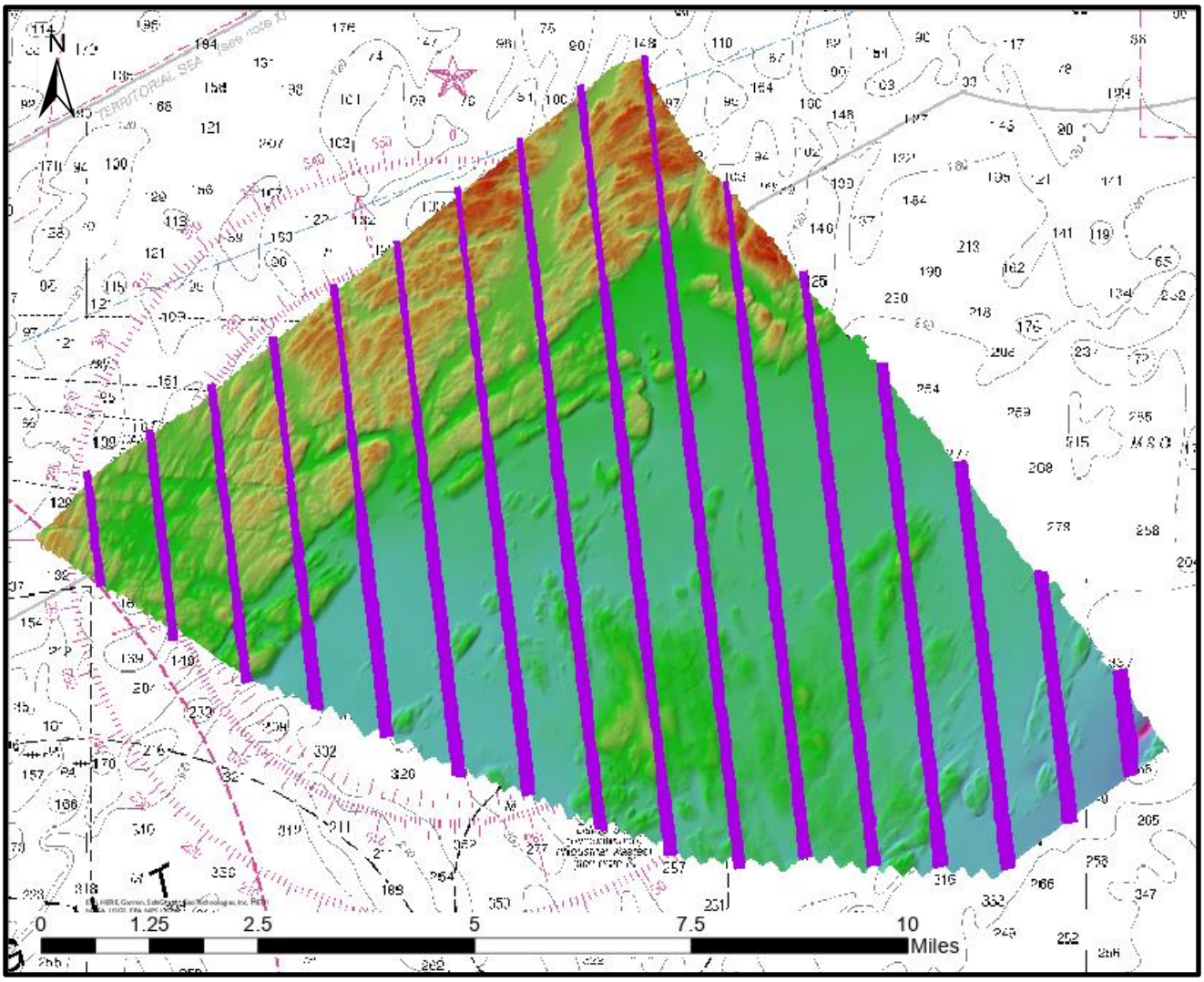


Figure 7 – Location of crosslines (depicted in magenta, with beams filtered outside ±45°) atop mainscheme data

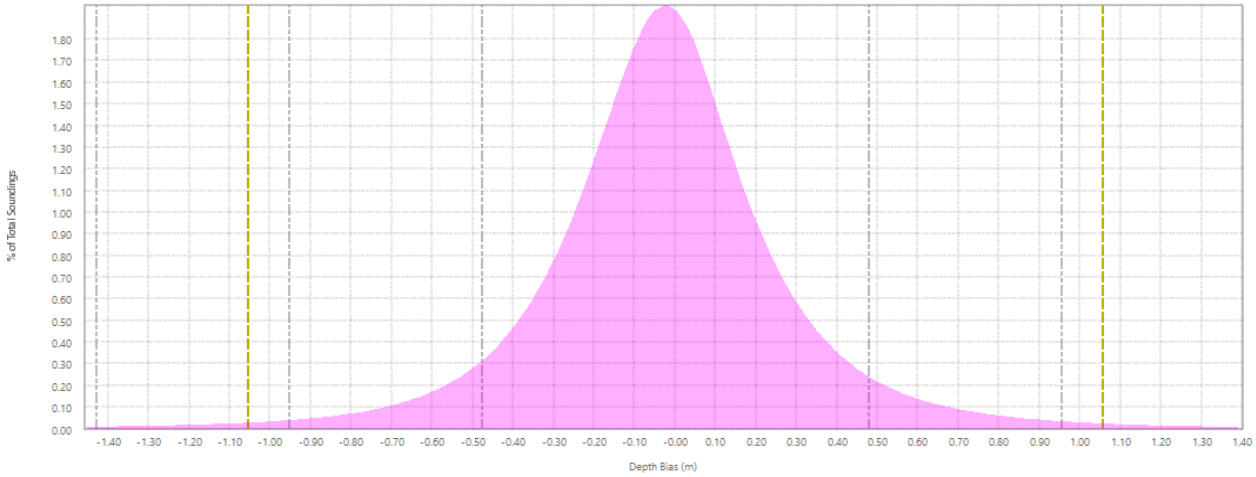


Figure 8 – 2021 crosslines difference histogram; pink areas represent the 95% confidence interval based on normal distribution; yellow dashed lines represent limit of IHO Order 1 test vertical tolerance; gray dashed lines on histogram represent ±sigma 1, 2, and 3

Table 5 – Crossline difference (Qimera crosscheck) summary statistics

# of Points of Comparison	22848609
Data Mean	-71.472299 m
Reference Mean	-71.443698 m
Difference Mean	-0.028601 m
Difference Median	-0.028601 m
Std. Deviation	0.477 m
Data Z - Range	-148.44 m to -28.74 m
Ref. Z - Range	-128.82 m to -29.19 m
Diff Z - Range	-51.878 m to 33.05 m
Mean + 2*stddev	0.982044 m
Median + 2*stddev	0.982044 m
Ord 1 Error Limit	1.054803 m
Ord 1 P-Statistic	0.031272
Ord 1 - # Rejected	714528
Order 1 Survey	ACCEPTED

*Order 1 parameters: a = 0.25 and b = 0.013

3.2 Junctions

The junctions shown in Table 6 were the result of overlap between the 2021 mainscheme survey season and existing surveys in the region. The areas of overlap between the 2021 survey and the junction surveys (NOAA survey ID W00448 and MCMI 2020 mainscheme) were evaluated for sounding agreement by performing surface (4-meter resolution) difference tests in Fledermaus (v.8.4.0, 64-bit), where the existing surfaces were subtracted from the newly collected 2021 surface (re-projected in NAD83). A summary of surface difference test results is shown in Table 7. The extent of overlap between the 2021 base surface and the corresponding

2016 and 2020 junction surfaces are illustrated in Figure 9. The surfaces used for these tests are submitted with the data in these surveys.

Table 6 – 2021 Mainscheme survey junctions

Registry Number	Scale	Year	Field Unit	Relative Location(s)
W00448	1:10,000	2016	Amy Gale	E and N
Pending	1:10,000	2020	Amy Gale	S

Table 7 – Summary of surface difference test results for overlapping (junction) surveys (Fledermaus 8.4.0)

Junction Surface ID	New Surface ID	Mean (m)	Std. Dev. (m)
W00448_MB_8m_MLLW_Combined	AG_MCMI_2021_01_4m_MLLW	0.25	0.39
MCMI_2020_CascoBay_4m_mllw	AG_MCMI_2021_01_4m_MLLW	0.19	0.24

Relatively high standard deviation between overlapping mainscheme surveys is likely attributable to poor agreement in rocky areas, differences in filtering procedures, and survey conditions during acquisition. The most disagreement between surfaces were in areas with a steep, rocky seabed. In addition, the W00448 data included soundings from all beam angles (±65 degrees from the nadir), whereas the 2021 data were filtered to exclude soundings from beams > ±60 degrees from the nadir. The larger accepted range of data from previous surveys as in W00448 would have potential to induce greater uncertainty in soundings due to greater side-lobe interference from outer beams, possibly resulting in a larger departure from recorded values from the 2021 mainscheme (see better agreement with MCMI 2020 where beam filtering was also applied). Furthermore, when compared in Fledermaus, wobble was discerned in older datasets (W00448 and MCMI 2020) that were not as dramatic in the 2021 mainscheme dataset. This wobble is likely the result of excessive motion induced by heavy seas during collection and would also attribute to a difference in surface agreement.

Overlapping surfaces agree on height by an average of less than 1 foot and 95% of data agrees within 2 feet across both junctions, indicating strong agreement and verifies system accuracy to within desired survey parameters in accordance with Order 1a and NOAA HSSD for this region (International Hydrographic Organization, 2020 & NOAA, 2021).

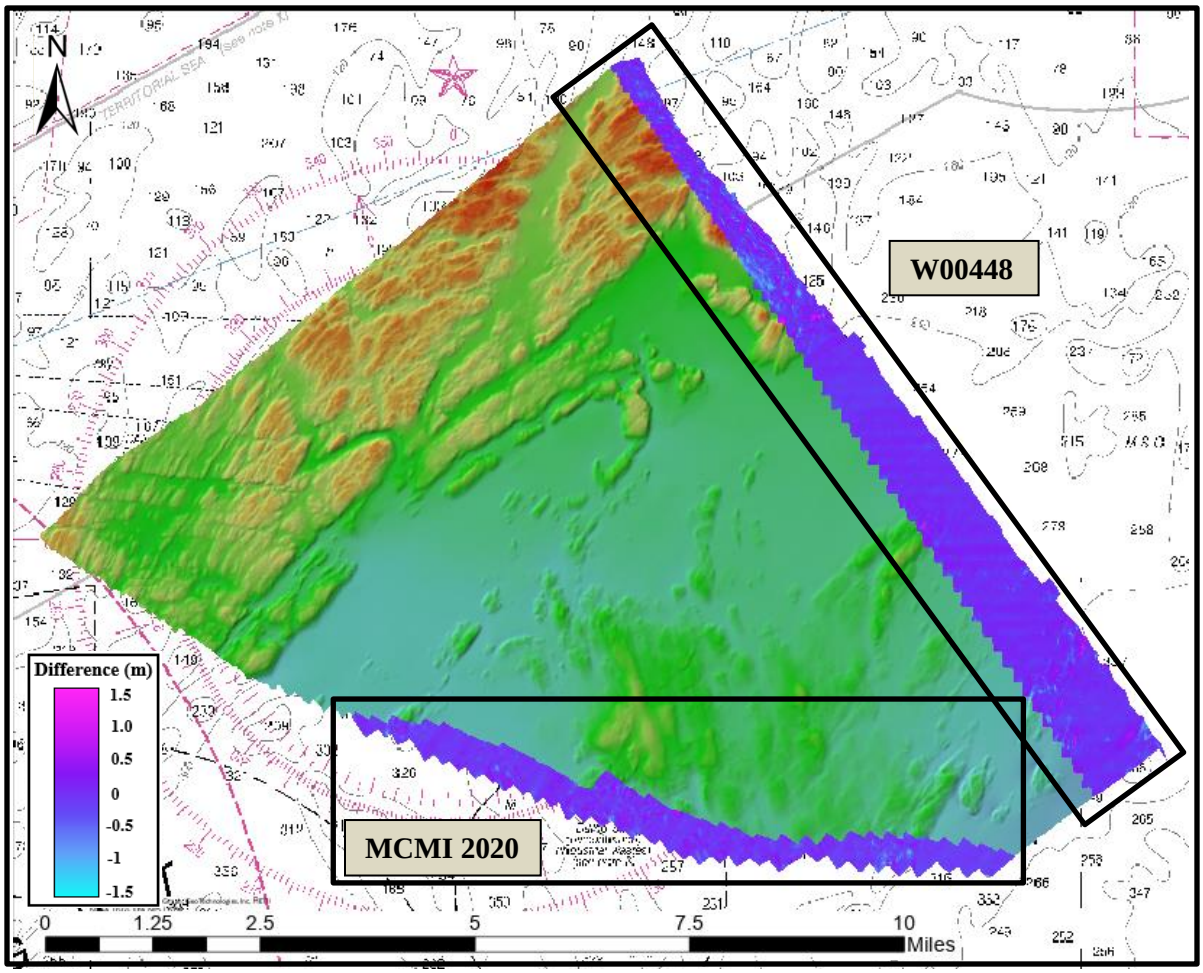


Figure 9 – Junctioning areas between W00448/MCMI 2020 and 2021 mainscheme survey area at scale of 1:50,000

3.3 Equipment Effectiveness

Sonar

Sonar data were acquired with a Kongsberg EM2040C set to a survey frequency of 300 kHz, high-density beam forming, with 400 beams per ping. Although the EM2040C allowed full swath widths at this frequency, lines from previous years' survey run at comparable depths contained considerable noise in outer beams (> ±60 degrees from the nadir as identified by QPS engineers). As a result (and as per QPS recommendation), soundings greater than ±60 degrees from the nadir were not included in final bathymetric surfaces.

Wobble

Early in the survey season, the interim hydrographer noticed wobble in data collected offshore. These visualizations were alleviated in real-time acquisition by patch tests and newly applied offsets. Once data were post-processed, however, the wobble issue was still apparent. Consultations with QPS engineers discovered an issue with the database setup, where tide and RTK application needed reconfiguring seen in Appendix E. This resolved a great deal of the data issues, but future analysis revealed that an additional latency issue existed between the Seapath 330+ system and delivery to Qinsy on the Hydrographic Workstation PC. The latency was found to be due to the presence of a null-modem adapter which induced roughly +0.016-0.018s of delay to the delivery of motion and positioning data. Unfortunately, this was not discovered until after data collection for the season had been completed and was not applied to the database in Qinsy for acquisition in time. Thus, these offsets were retroactively applied to select lines where wobble was especially noticed, via the Qimera wobble analysis tool in version 2.4.0.

Seapath 330+

Several failures of components of the Seapath 330+ occurred throughout the survey season, which required addressing before data collection could continue. Several months were spent coordinating with Kongsberg repair technicians and engineers, who ultimately discovered critical failures in the Seapath HMI motherboard, RAM, and internal battery. As such, the survey season was greatly reduced for 2021, and mainscheme acquisition was not continued after August 16th, 2021. Troubleshooting of these issues did not affect the quality of data collected throughout the survey season, and all data were acquired only when all systems were functioning properly.

Uninterruptible Power Supply

On August 2nd, 2021, the uninterruptible power supply (UPS) failed during acquisition and corrupted line 20210802_131219. All systems simultaneously lost power and a reboot was attempted thereafter. Data collection continued until a second power failure, which occurred between collected lines. The corrupted file has not been included in this data package, and area ensonified was collected again after the replacement of the power supply.

3.4 Sound Speed Methods

Sound speed cast frequency: A total of 64 sound speed casts were taken within the boundaries of the 2021 mainscheme survey. All sound speed cast measurements were collected using the Teledyne Odom Digibar-S profiler. Sound speed casts were taken as needed throughout the survey, which was generally when the

observed surface sound speed (monitored and visualized in real-time using the AML MicroX SV sensor) differed from the surface sound speed in the active profile by more than 2 meters per second. In certain instances, supplemental casts were taken when there was reason to suspect significant changes in the water column (e.g. change in tide, abrupt changes in seafloor relief, etc.). During the collection of sound speed casts, logging was stopped to download and apply the new cast and was resumed when the boat circled around and came back on the survey line. Throughout the duration of the survey, the surface sound speed was observed in real-time (by the AML Micro X SV probe). Sound speed data are recorded and included in raw sonar files submitted with this data package in addition to .bvsp files for reference.

A quality comparison between the AML Micro X SV sensor and the Teledyne Odom Digibar S profiler was not performed. However, real-time comparisons between surface sound speed observed by the AML Micro X SV and the surface sound speed entry in the Digibar-S profile suggested these instruments agreed.

4.0 Data Post-processing

The following is a summary of the procedures used for post-processing and analysis of survey data using Qimera (v.2.4.0, 64-bit edition) and Fledermaus (v.8.4.0, 64-bit edition) software.

4.1 Horizontal Datum

The horizontal datum for these data is WGS 84 projected in UTM zone 19N (meters) (EPSG 32619).

4.2 Vertical Datum and Water Level Corrections

The vertical datum for these data is mean lower-low water (MLLW) level in meters. A tidal zoning file ("Maine_Tide_Zoning.zdf") containing time and range corrections for verified tide station data was provided by NOAA OCS to MCMI in May 2020. This file was used to apply time corrections, tide height offsets, and tide scale (range) for collected data in each zone listed in Table 7. An exception to note in this zoning scheme is that zone NA7 references the Wells, Maine tide station, which has not published water level data since December 2020. In lieu of this reference station, Portland station 8418150 was applied to this zone with the time correction and scale used for the same locus in NOAA surveys W00448 and W00450.

Table 8 – Tide zones and corrections referenced to verified Portland, ME (8418150) tide station data

Survey Area	Tide Station	Zone ID	Time Correction (mins.)	Tide Scale
Mainscheme	8418150	NA7	-6	0.95

4.3 Processing Workflow

The general post-processing workflow in Qimera was as follows:

1. Create project
2. Add raw sonar files (e.g. metadata extracted and processed bathymetry data converted to .qpd, including vessel configuration and sound velocity)
3. Add tide zoning file (.zdf) and associated tide data and integrate into raw files
4. Create dynamic surface with NOAA CUBE settings enabled for desired resolution (e.g. 2-meter, 4 meter)
5. Review and edit soundings/clean surface with slice editor tool, 3D editor tool, and available filters
6. Duplicate surfaces at other grid sizes, if desired
7. Export final surface to .BAG file and CUBE surface
8. Export processed data in. GSF format for backscatter processing

CUBE

A CUBE (Combined Uncertainty and Bathymetry Estimator) surface was created for editing and as a starting point for final products. The corresponding NOAA cube setting (e.g. "NOAA_4m" configuration, Figure 10) was selected for each surface depending on the grid size of the surface.

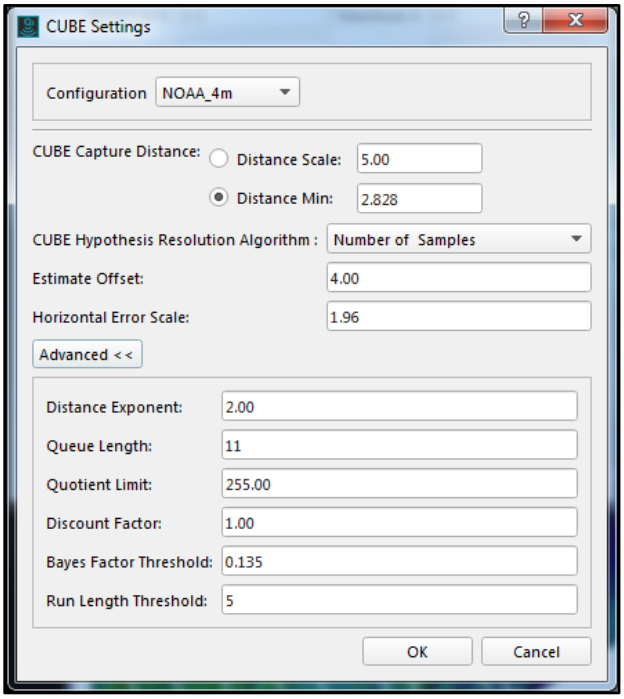


Figure 10 – CUBE settings parameters window shown with settings for NOAA 4-meter grid resolution

4.4 Final Surfaces

The following surfaces and BAGs were submitted with the survey data.

Table 9 – Surfaces submitted with 2021 survey data

Surface Name	Resolution (m)	Depth Range (m)	Surface Parameter
AG_MCMI_21_01_2m_MLLW	2	27 – 135	N/A
AG_MCMI_21_01_4m_MLLW	4	27 – 135	N/A
AG_MCMI_21_01_Crosslines_4m	4	29 - 134	N/A
AG_MCMI_21_01_Junction_W00448	4	N/A	N/A
AG_MCMI_21_01_Junction_MCMI2020	4	N/A	N/A

4.5 Backscatter

Backscatter was logged in the raw .db files. The .db files also hold the navigation record and bottom detections for all lines of surveys. Processed sonar files containing multibeam backscatter data (snippets and beam-average) were exported from Qimera v.2.4.0. in .GSF format. QPS Fledermaus Geocoder Toolbox (FMGT; v.7.8.6, 64-bit edition) was used to import, process, and mosaic time-series backscatter data. Default backscatter processing settings were used to create the mosaic, except for the Angle Varied Gain (AVG) filter and AVG window size, which were set to 'Adaptive' and '100', respectively. Backscatter mosaics of the data were gridded at 2-meter and 4-meter resolution. Mosaics were exported in greyscale and floating-point GeoTIFF format. The mosaics are shown in Table 10 and Figure 11.

Table 10 – Backscatter mosaics submitted with 2021 survey data

Mosaic Name	Pixel Size (m)
AG_MCMI_21_01_2m_gs_backscatter.tiff	2
AG_MCMI_21_01_4m_gs_backscatter.tiff	4
AG_MCMI_21_01_2m_backscatter.tiff	2
AG_MCMI_21_01_4m_backscatter.tiff	4

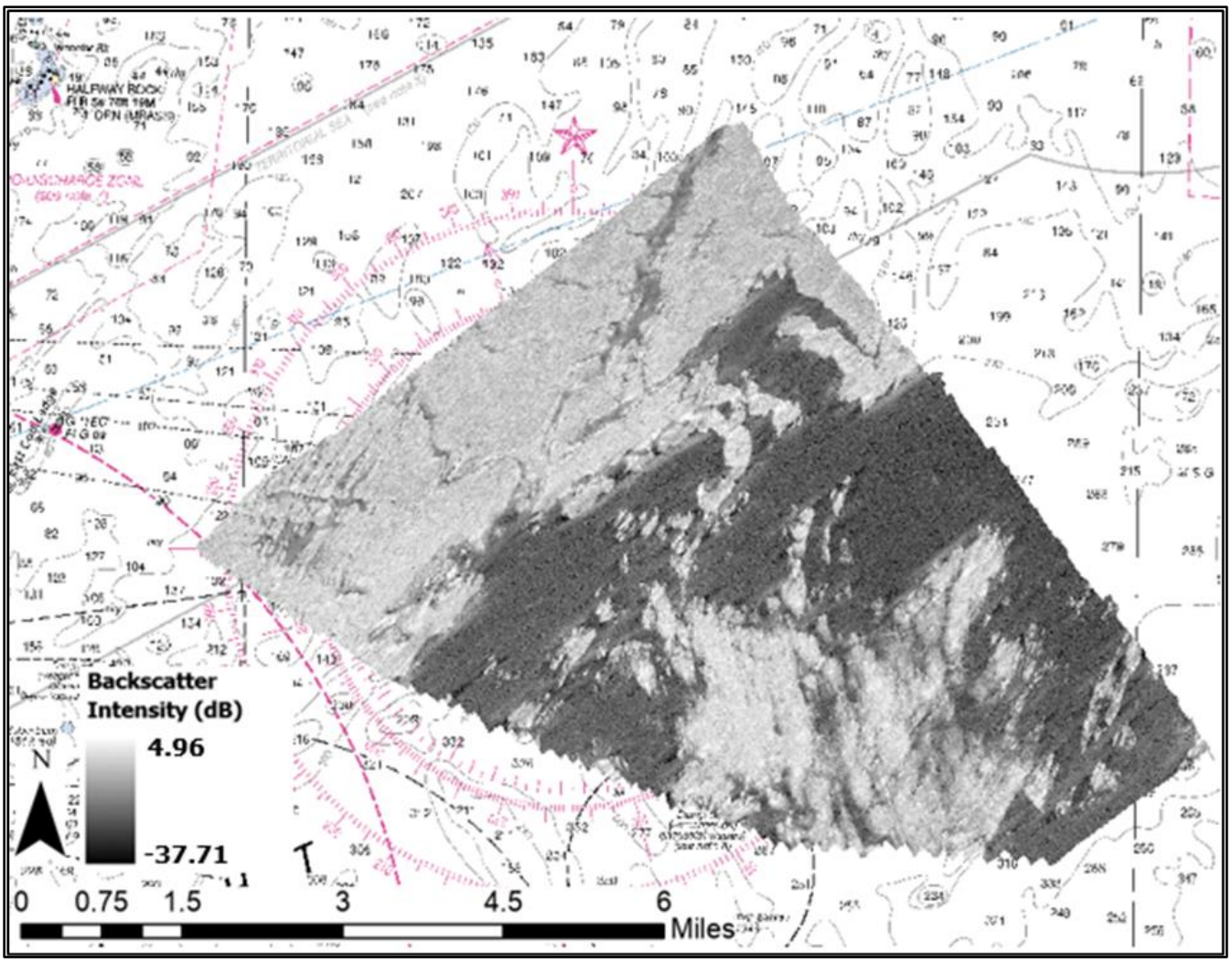


Figure 11 – Backscatter mosaic (4-meter pixel size) of 2021 mainscheme area

5.0 Results

5.1 Charts Comparison

The hydrographer conducted a qualitative comparison of reclassified bathymetry data and depth contours from the surveyed area to the charted soundings and contours. The largest scale raster navigational charts which cover the survey areas are listed in Table 11. Prior hydrographic surveys in the vicinity were conducted by NOAA between 1867 and 1946 and consisted only of partial bottom coverage. These data were not compared with data collected by the MCMI. In addition to the below listed figures, .pdf exports of overlaid contoured bathymetry have been included in this data package for reference.

Table 11 – Largest scale raster charts in survey area

Chart	Scale	Source Edition	Source Date	NTM Date
13286	1:80,000	34	3/19/2019	4/2/2020
13288	1:80,000	44	3/1/2016	4/30/2020
13290	1:40,000	41	10/9/2019	3/18/2021

Chart 13286

Surveyed depths have good overall agreement with charted contours (Figure 12) apart from a deep area roughly 300m by 75m in the southeastern portion of the dataset which was found to exceed 420 ft. This location has a nearest sounding of 326 ft which disagrees with the findings of this survey. This disagreement is most likely due to lack of full bottom coverage during prior surveys rather than over-generalization. All other depths show strong agreement with contours showing only minor discrepancies in placement. It is recommended that contours showing disagreement in this area be revised.

Chart 13288

Surveyed depths have good overall agreement with charted contours (Figure 13) apart from a deep area roughly 300m by 75m in the southeastern portion of the dataset which was found to exceed 420 ft. This location has a nearest sounding of 326 ft which disagrees with the findings of this survey. This disagreement is most likely due to lack of full bottom coverage during prior surveys rather than over-generalization. All other depths show strong agreement with contours showing only minor discrepancies in placement. It is recommended that contours showing disagreement in this area be revised.

Chart 13290

Surveyed depths have good overall agreement with charted contours (Figure 14), although individual soundings may disagree at any given location.

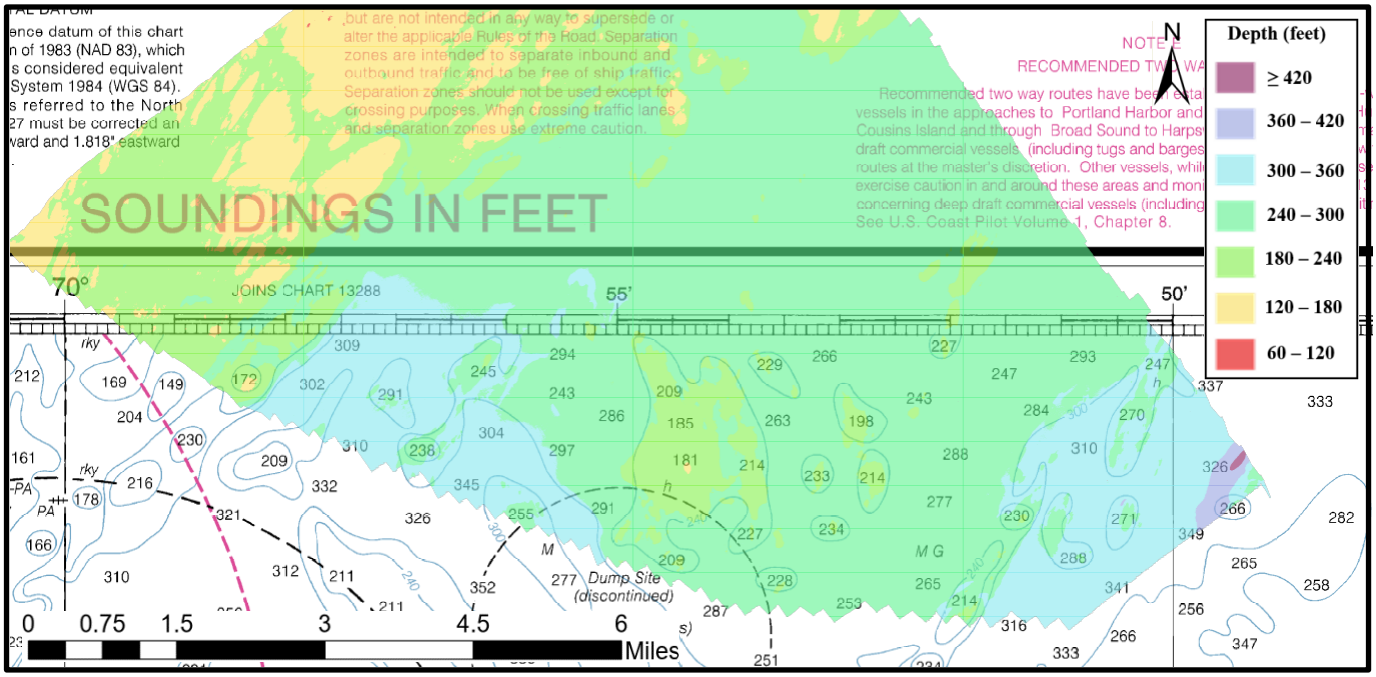


Figure 12 – Comparison between surveyed depth (reclassified at 60-feet intervals) and chart 13286 contours (60-feet interval)

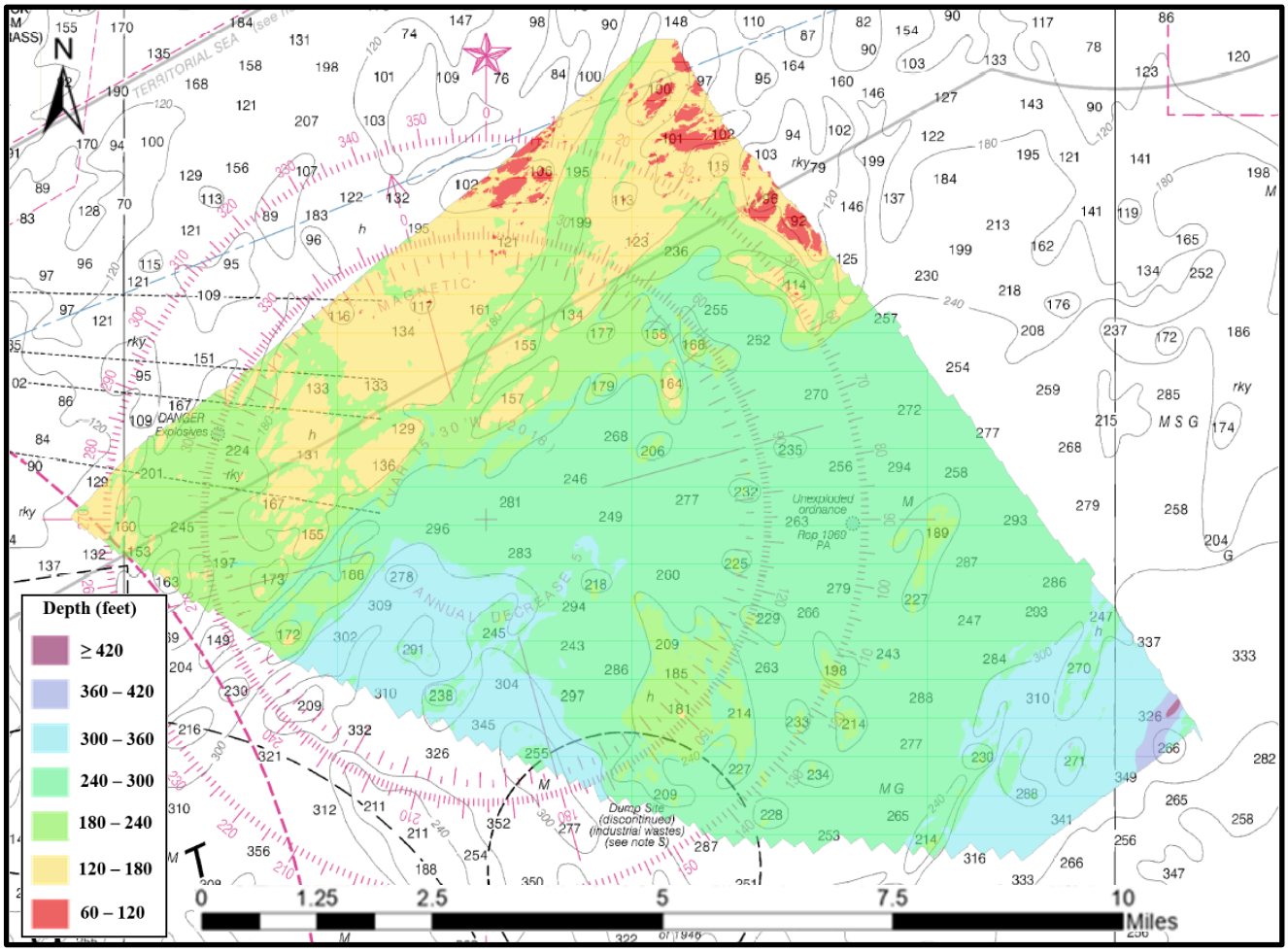


Figure 13 – Comparison between surveyed depth (reclassified at 60-feet intervals) and chart 13288 contours (60-feet interval)

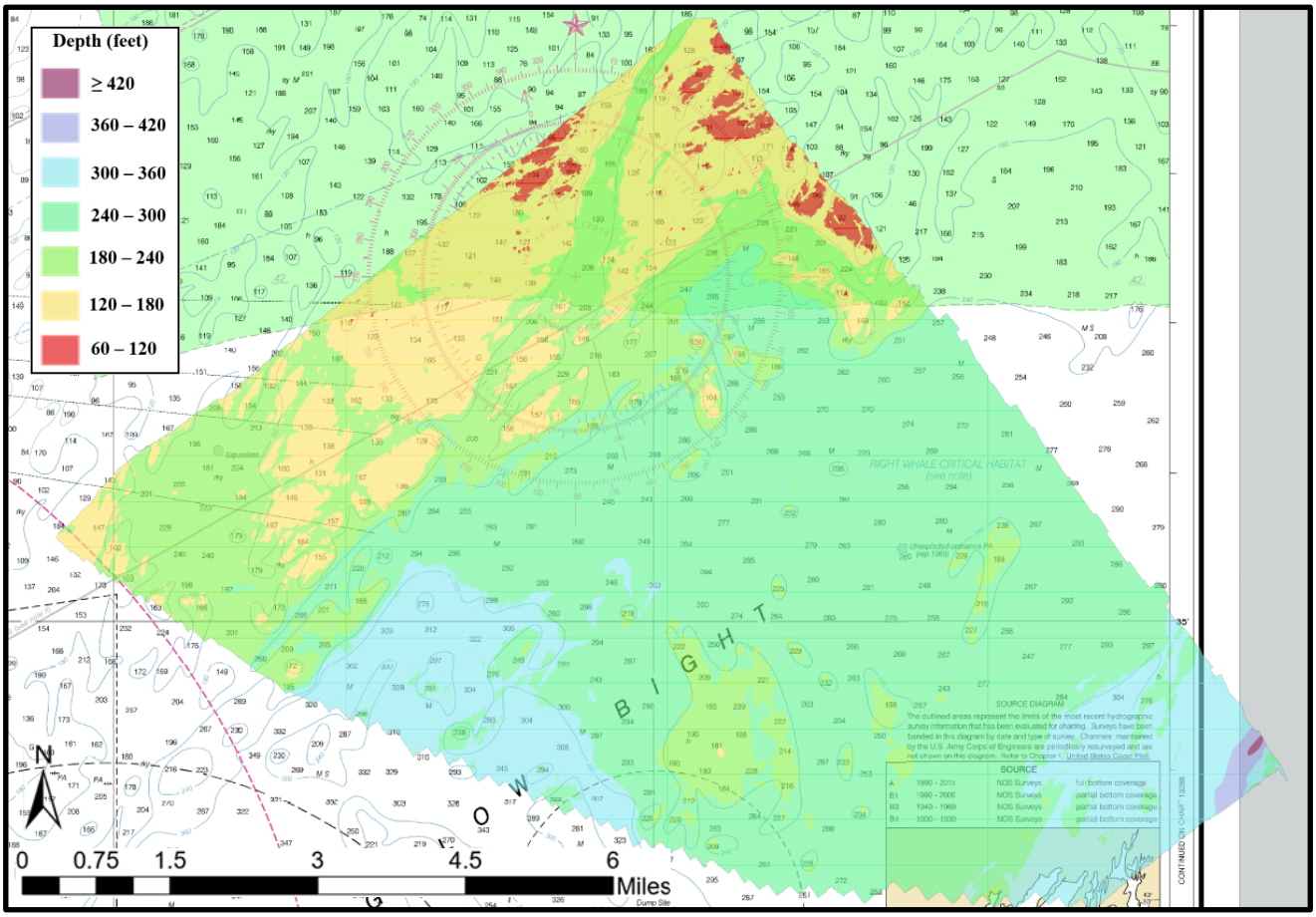


Figure 14 – Comparison between surveyed depth (reclassified at 60-feet intervals) and chart 13290 contours (60-feet interval)

5.2 Bottom Samples

A total of 38 bottom samples were collected throughout the course of the survey season in state and federal waters to supplement existing sediment data collected previously by other agencies (Maine Geological Survey and University of Maine) in the mainscheme area (Figure 15). The results of grain-size and video analyses will be used to calibrate, refine, and digitize interpretations of seafloor substrate. These data are also used to investigate how these data relate to benthic infauna in the survey area.

Additional details on the bottom samples are provided in Table 12. More detailed analysis of grain size composition of these samples and benthic fauna composition will be determined after laboratory processing is complete for the collected samples.

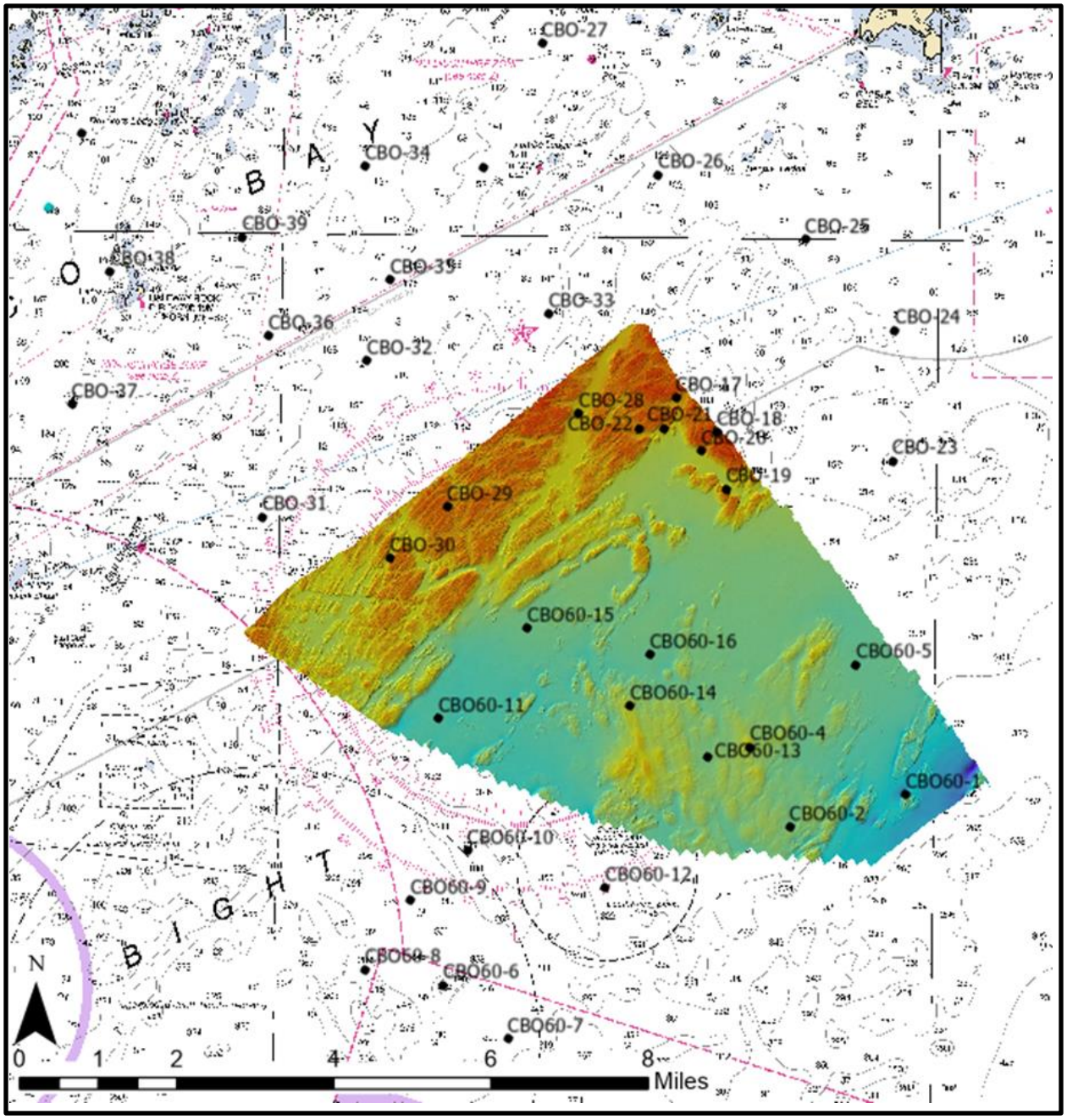


Figure 15 – Bottom sample locations collected over the course of the MCMI 2021 survey season

Table 12 – Grab Sample Information

Site Name	Date	Latitude (decimal degrees N)	Longitude (decimal degrees W)	Depth (m)	Grain Size (field observation)	Backscatter Intensity (dB)
CBO60-1	7/13/21	43.564349	-69.840433	86.7	rock	-8.91
CBO60-2	7/13/21	43.558195	-69.869769	80.0	gravelly muddy sand	-10.16
CBO60-4	7/13/21	43.572898	-69.880058	66.2	muddy gravel	-5.75
CBO60-5	7/13/21	43.588254	-69.853241	89.3	mud with shell hash	-23.39
CBO60-6	7/28/21	43.528288	-69.957010	83.1	rock	-8.59
CBO60-7	7/28/21	43.518502	-69.940640	103.0	silty mud with trace sand	-15.20
CBO60-8	7/28/21	43.531016	-69.977044	89.2	clayey sandy mud with trace sand and gravel	-13.63
CBO60-9	7/28/21	43.543871	-69.965711	105.0	silty mud with trace sand	-17.41
CBO60-10	7/28/21	43.553137	-69.951391	69.8	sandy gravel with mud, assumed atop rock due to low yield	-7.64
CBO60-11	7/28/21	43.577565	-69.959073	93.6	silty mud with trace sand	-20.56
CBO60-12	8/4/21	43.546660	-69.916299	95.8	silty mud with trace sand	-20.87
CBO60-13	8/4/21	43.571006	-69.890589	85.7	clayey silty mud with trace sand	-18.98
CBO60-14	8/4/21	43.580183	-69.910541	70.2	rock	-5.44
CBO60-15	8/4/21	43.594332	-69.936722	88.3	clayey mud with trace sand	-22.76
CBO60-16	8/4/21	43.589701	-69.905621	89.6	clayey silty mud with trace sand	-20.56
CBO-17	8/10/21	43.637261	-69.899735	39.0	rock	-9.22
CBO-18	8/10/21	43.631044	-69.889253	45.4	sand with shell hash and trace gravel	-8.27
CBO-19	8/10/21	43.620496	-69.886797	42.0	rock	3.07
CBO-20	8/10/21	43.627431	-69.893151	60.0	clayey muddy sand	-13.31
CBO-21	8/10/21	43.631602	-69.902709	48.0	rock	-4.49
CBO-22	8/10/21	43.631443	-69.908863	38.0	surficial gravel atop rock	-11.11
CBO-23	9/1/21	43.626016	-69.844616	52.7	rock	N/A
CBO-24	9/1/21	43.650070	-69.844236	37.2	sand	N/A
CBO-25	9/1/21	43.666731	-69.867372	31.7	gravel with shell hash, some mud	N/A
CBO-26	9/1/21	43.678381	-69.904774	42.3	silty clayey mud	N/A
CBO-27	9/1/21	43.702442	-69.934722	36.3	clayey mud	N/A
CBO-28	9/14/21	43.634098	-69.924302	60.9	clayey mud with trace sand and gravel	-16.15
CBO-29	9/14/21	43.616587	-69.957509	40.4	rock	-12.05
CBO-30	9/14/21	43.607036	-69.971878	52.6	gravelly sandy mud with shell hash	-9.22
CBO-31	9/14/21	43.614366	-70.004494	43.7	rock	N/A
CBO-32	9/14/21	43.6433754	-69.97824097	41	muddy gravel with shell hash	N/A
CBO-33	9/14/21	43.65246427	-69.9322708	41.9	surficial mud and shell hash atop rock	N/A
CBO-34	9/21/21	43.6794123	-69.9794058	49.8	clayey mud with trace fine sand	N/A
CBO-35	9/21/21	43.65844131	-69.97264017	55.6	clayey mud with trace fine sand	N/A
CBO-36	9/21/21	43.64777554	-70.00341145	55.1	clayey mud with trace coarse grain sand and gravel	N/A
CBO-37	9/21/21	43.63466854	-70.05312236	42.3	muddy gravel with coarse sand	N/A
CBO-38	9/21/21	43.65930149	-70.04387337	39.3	surficial shell hash atop rock	N/A
CBO-39	9/21/21	43.66597099	-70.01033069	52.2	gravelly muddy sand with shell hash	N/A

6.0 Summary

A total of 37 mi^2 (95.8 km^2) of high-resolution multibeam data were collected in the mainscheme survey area from April to August of 2021. Except for select few small holidays due to seafloor elevation-induced sonic shadows, multibeam coverage was 100% in all areas surveyed. Bathymetry and backscatter data were processed with 4-meter grid resolution, although 2-meter surfaces were produced for the respective surfaces in submission of this report. The bathymetry and backscatter information for the mainscheme survey area are supplemented by seafloor surficial sediment samples, water column data, video, and benthic fauna collection in 38 locations.

Consistency of hydrographic data collected aboard the F/V Amy Gale was reflected in the results of the surface difference tests between crosslines and junction survey data, where mean vertical differences across all tests were less than 1 foot (0.25 meters) and within specifications for Order 1a survey accuracy at the depths ensonified. Standard deviations of all tests were relatively low and comparable to those achieved by small vessels in similar surveys of the area (e.g. *Ferdinand R. Hassler* and previous submissions by *Amy Gale*). Comparisons between mainscheme survey data and the largest scale nautical charts in the vicinity show good agreement in most cases apart from a 300m by 75m deep portion exceeding 420 ft in depth in the southeastern most extent of the survey area. It is recommended that the corresponding charts be updated in this area to reflect this data.

These data were acquired and processed to meet Office of Coast Survey bathymetry standards as best as possible and were shared with the NOAA Office of Coast Survey for review.

Please contact the Maine Coastal Program's Research Coordinator for additional information or data requests.

References

International Hydrographic Organization (2020) IHO Standards for Hydrographic Surveys, Edition 6.0.0, September 2020. Monaco, International Hydrographic Organization, 41pp. (International Hydrographic Organization Special Publication, S-44). DOI: https://doi.org/10.25607/OBP-1354.2

NOAA. (2021). NOS hydrographic surveys specifications and deliverables: U.S Department of Commerce National Oceanic and Atmospheric Administration. 162pp.

NOAA, Office of Coast Survey (2021). Field Procedures Manual, February 2021. Silver Spring, MD, National Oceanic and Atmospheric Administration, Office of Coast Survey, 165pp. DOI: http://dx.doi.org/10.25607/OBP-153.3

U.S. Department of the Interior (2014). Proposed geophysical and geological activities in the Atlantic OCS to identify sand resources and borrow areas north Atlantic, mid-Atlantic, and south Atlantic-Straits of Florida planning areas, *final environmental assessment.* OCS EIS/EA BOEM 2013-219 U.S. Department of the Interior Bureau of Ocean Energy Management Division of Environmental Assessment Herndon, VA, January 2014.

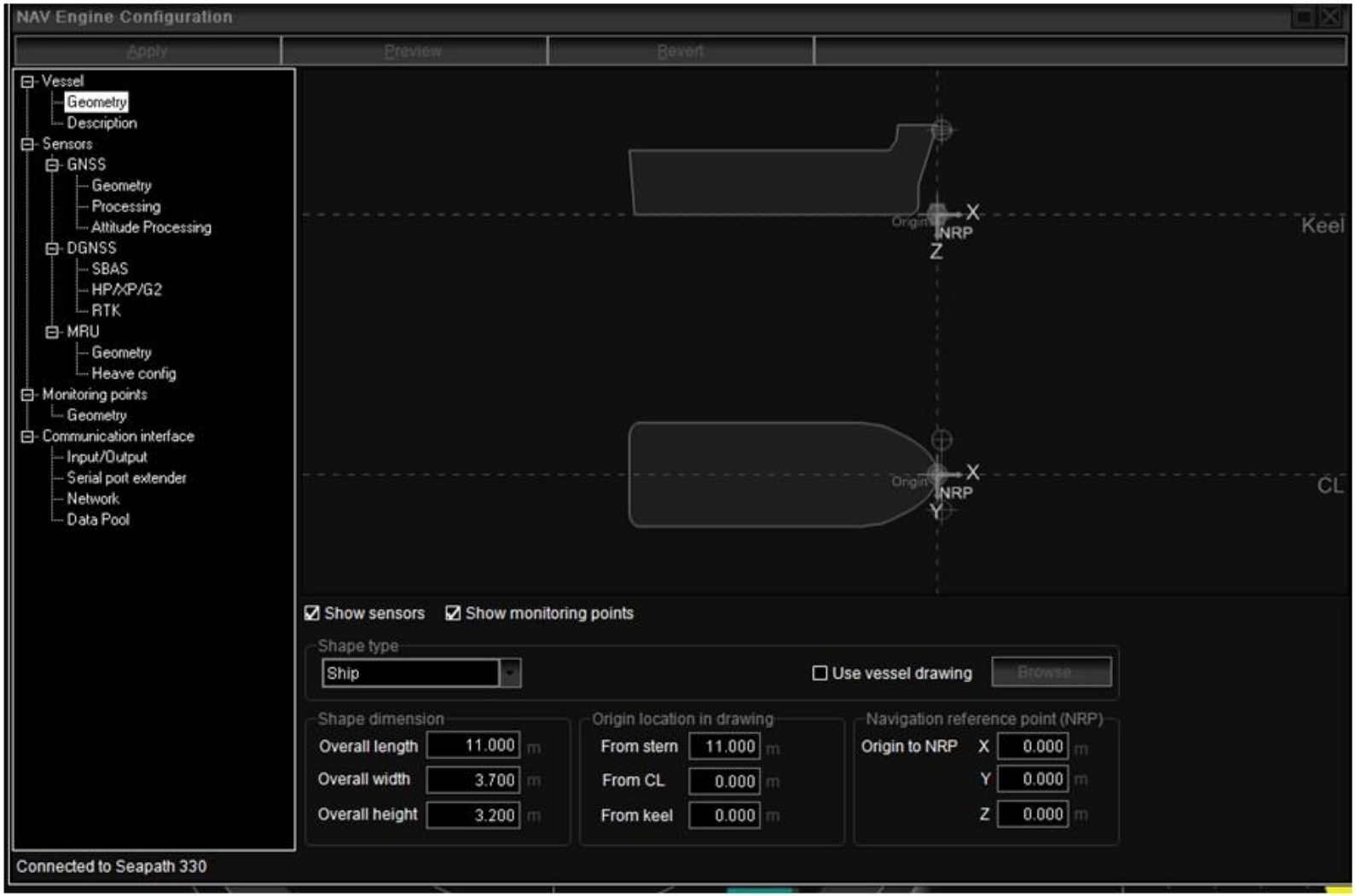
Appendix A – Specific dates of data acquisition for surveys

Dates (mm/dd/yy) of Data Acquisition for 2021 Surveys*

Mainscheme
04/15/21
05/07/21
05/13/21
05/14/21
05/18/21
06/09/21
06/16/21
06/18/21
06/24/21
06/25/21
06/29/21
06/30/21
07/13/21
07/19/21
08/02/21
08/16/21
04/13/22 (Crosslines)
04/27/22 (Crosslines)
05/02/22 (Crosslines)

*Dates of surveys not summarized in this report not listed

Appendix B – 2021 Configuration settings for Seapath 330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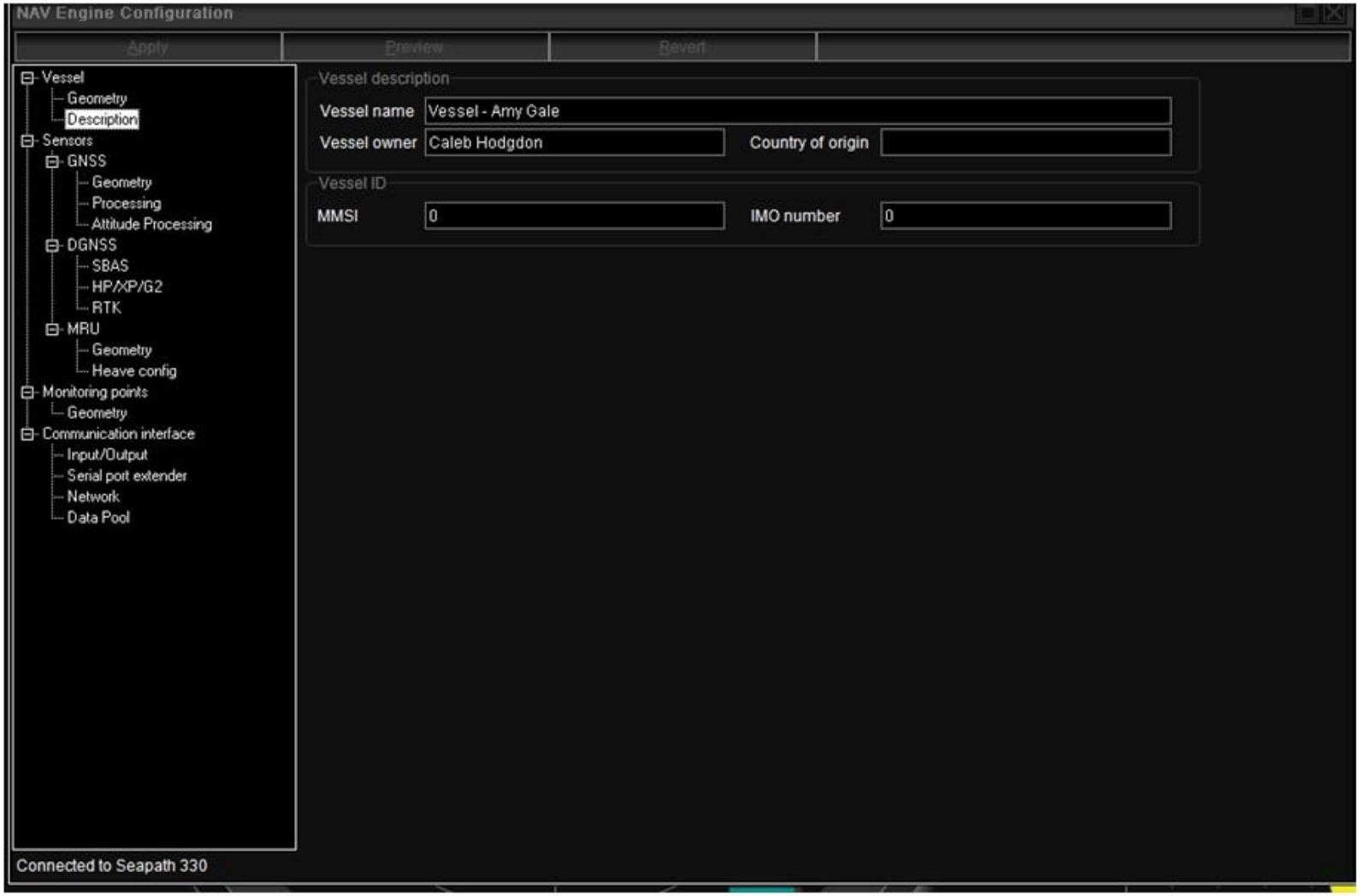
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Origin
NRP
X
Z
Keel
Origin
NRP
X
Y
CL
Show sensors
Show monitoring points
Shape type
Ship
Use vessel drawing
Browse...
Shape dimension
Overall length 11.000 m
Overall width 3.700 m
Overall height 3.200 m
Origin location in drawing
From stern 11.000 m
From CL 0.000 m
From keel 0.000 m
Navigation reference point (NRP)
Origin to NRP X 0.000 m
Y 0.000 m
Z 0.000 m
Connected to Seapath 330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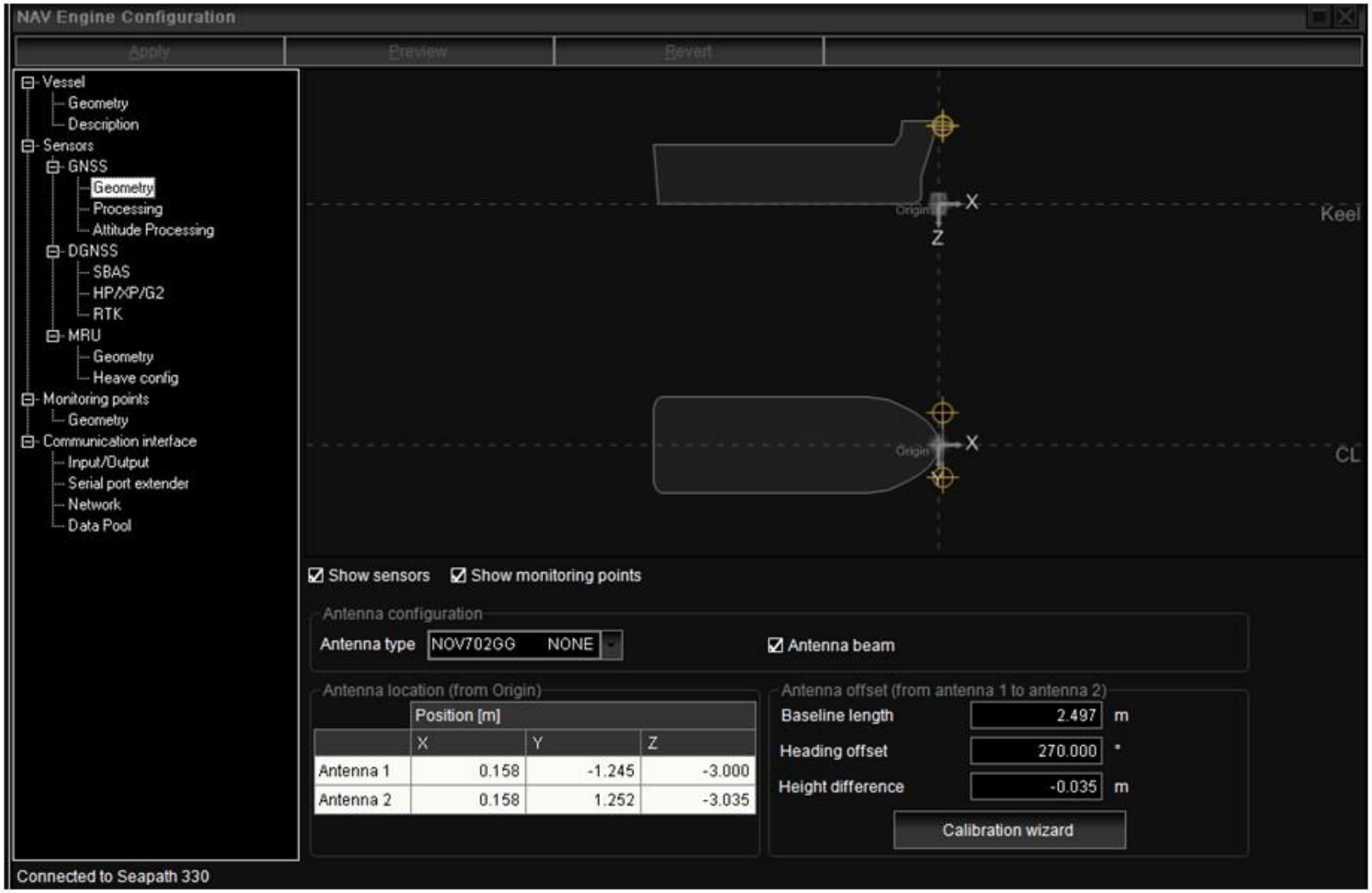
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Vessel description
Vessel name
Vessel - Amy Gale
Vessel owner
Caleb Hodgdon
Country of origin
Vessel ID
MMSI
0
IMO number
0
Connected to Seapath 330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HP/XP/G2
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Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Origin
X
Z
Keel
Origin
X
CL
Show sensors
Show monitoring points
Antenna configuration
Antenna type
NOV702GG NONE
Antenna beam
Antenna location (from Origin)
Position [m]
X
Y
Z
Antenna 1
0.158
-1.245
-3.000
Antenna 2
0.158
1.252
-3.035
Antenna offset (from antenna 1 to antenna 2)
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m
Heading offset
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°
Height difference
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m
Calibration wizard
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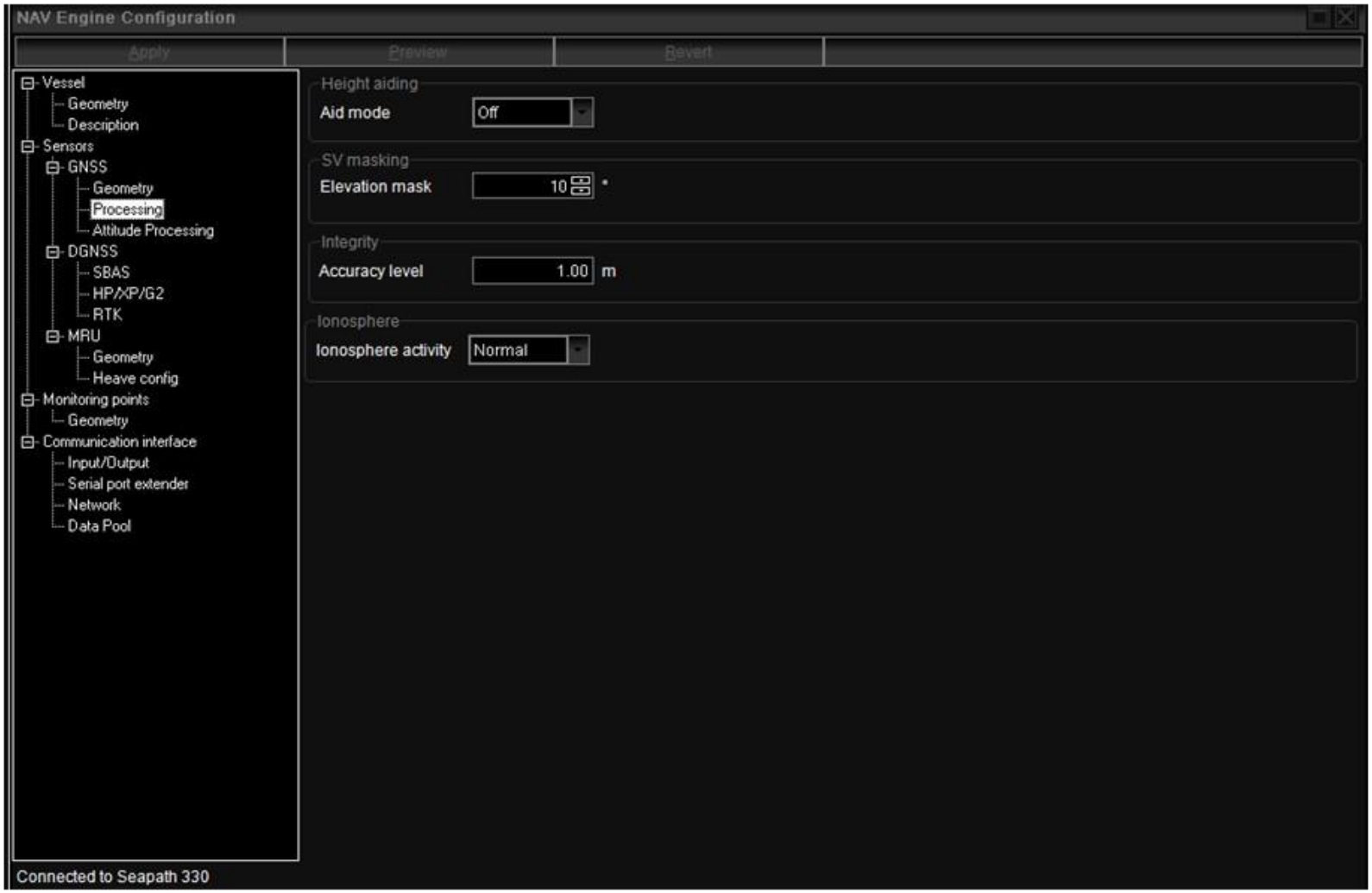
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Heave config
Monitoring points
Geometry
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Input/Output
Serial port extender
Network
Data Pool
Height aiding
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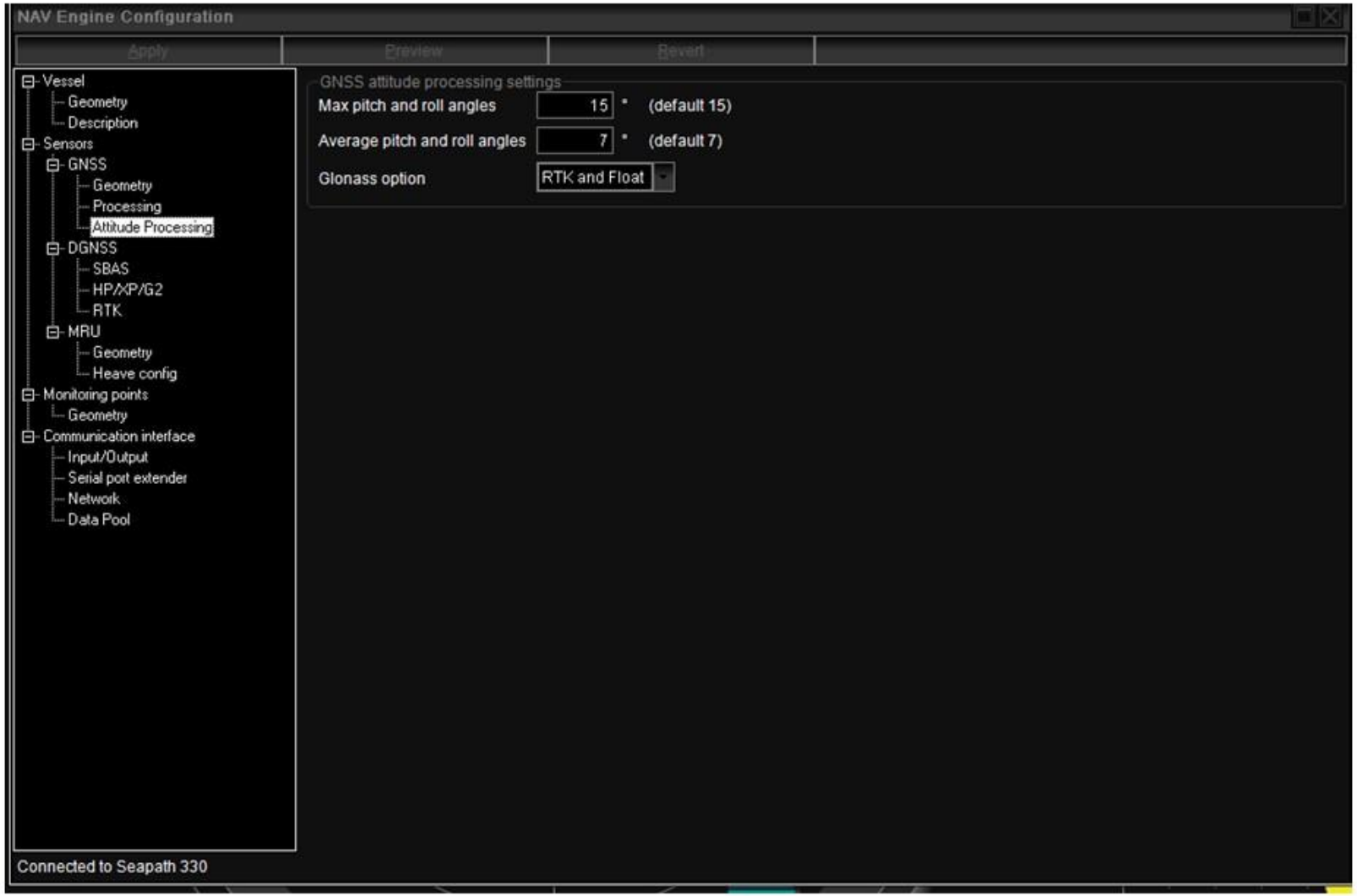
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HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
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Average pitch and roll angles
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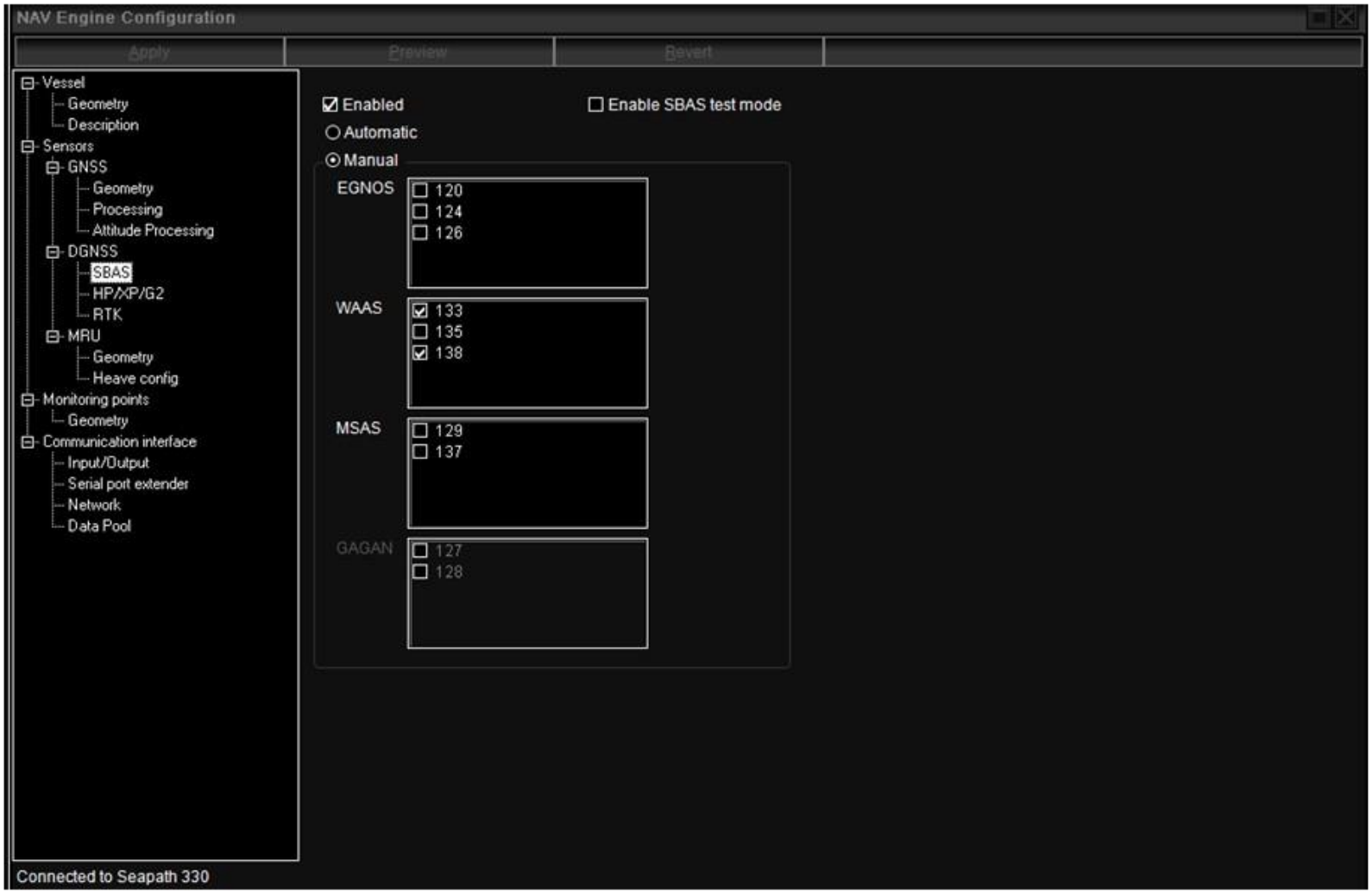
Glonass option
RTK and Float
Connected to Seapath 330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HP/XP/G2
RTK
MRU
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Heave config
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Input/Output
Serial port extender
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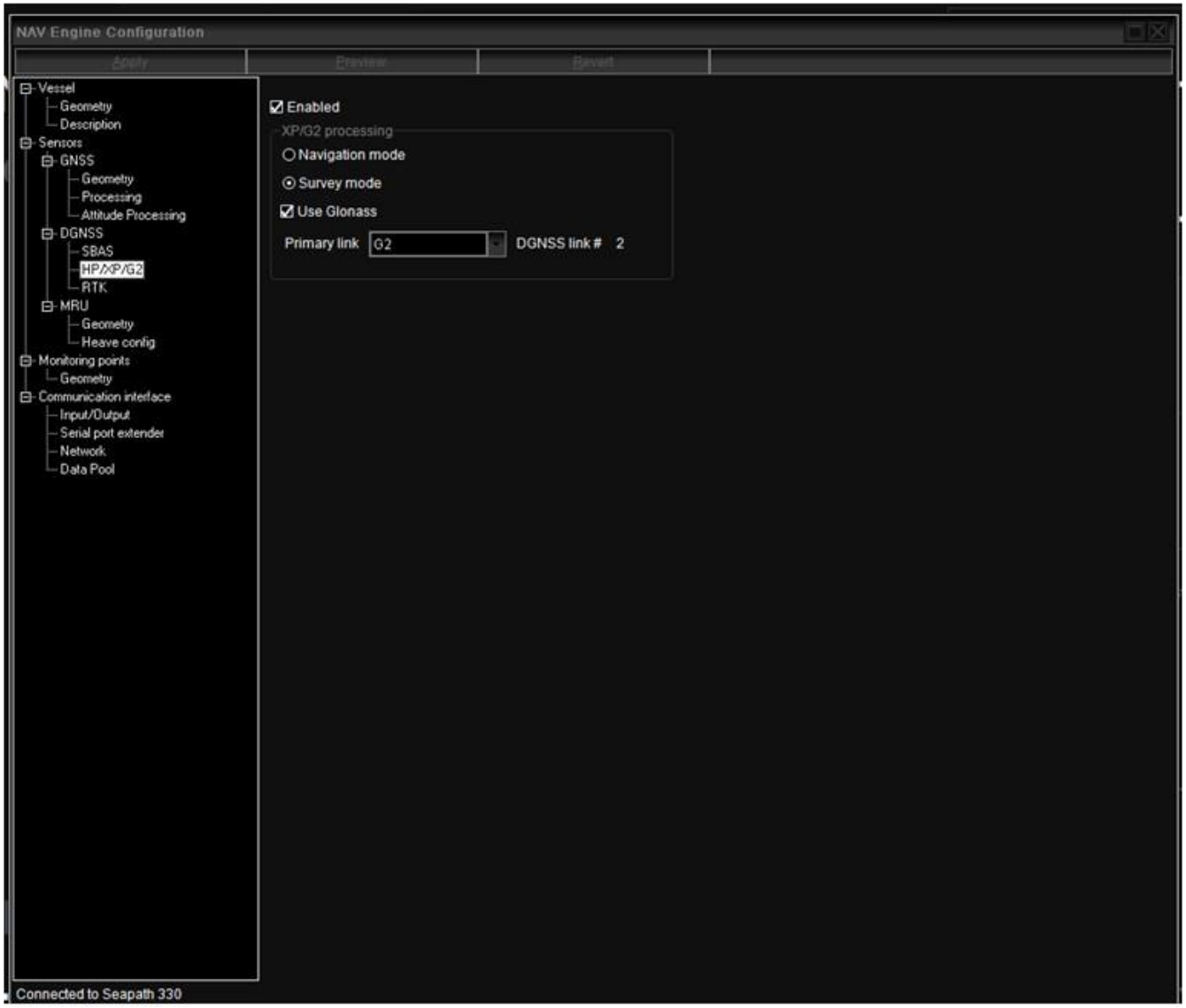
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Communication interface
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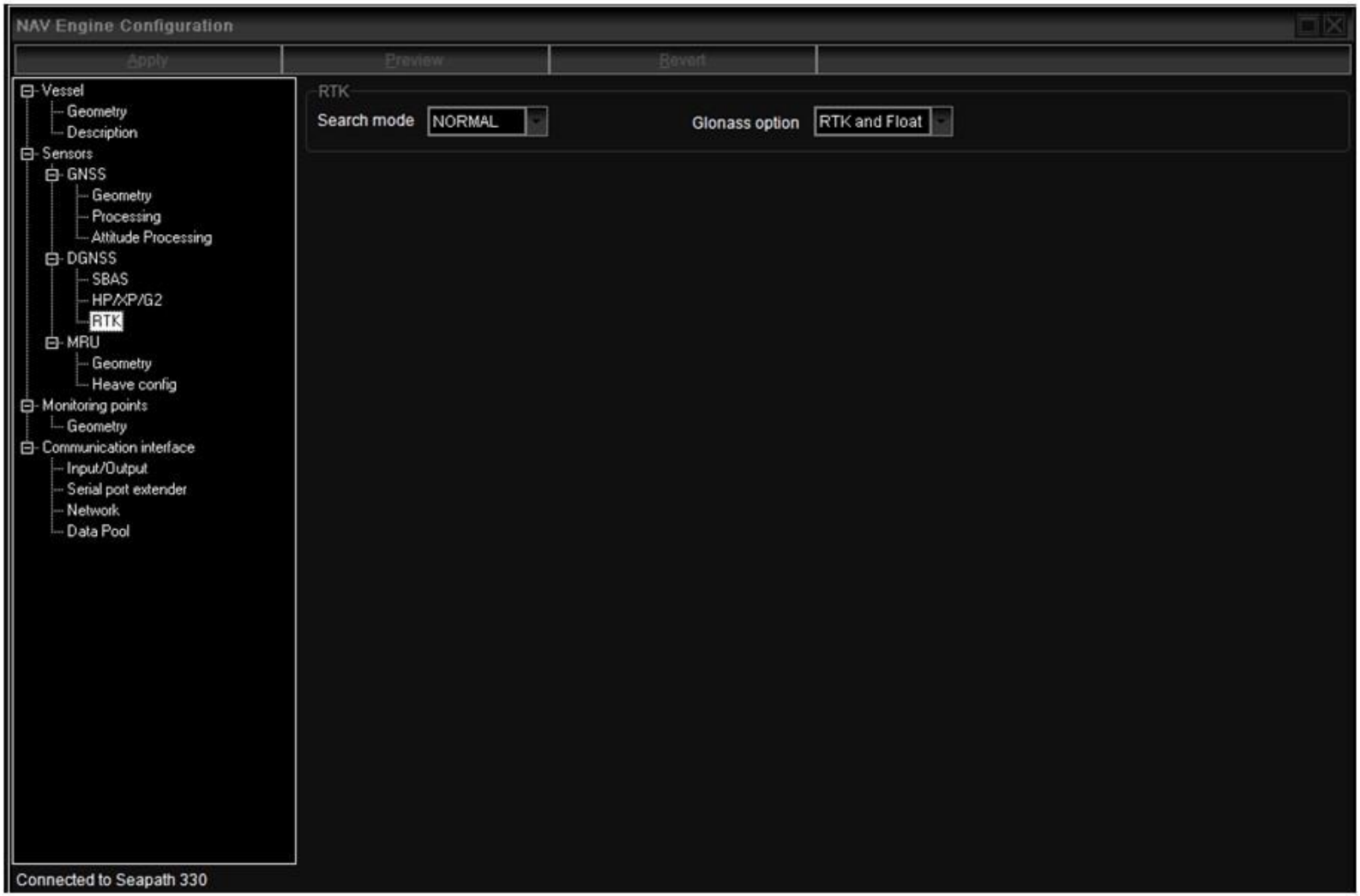
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RTK
MRU
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Heave config
Monitoring points
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Communication interface
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Data Pool
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Search mode
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Glonass option
RTK and Float
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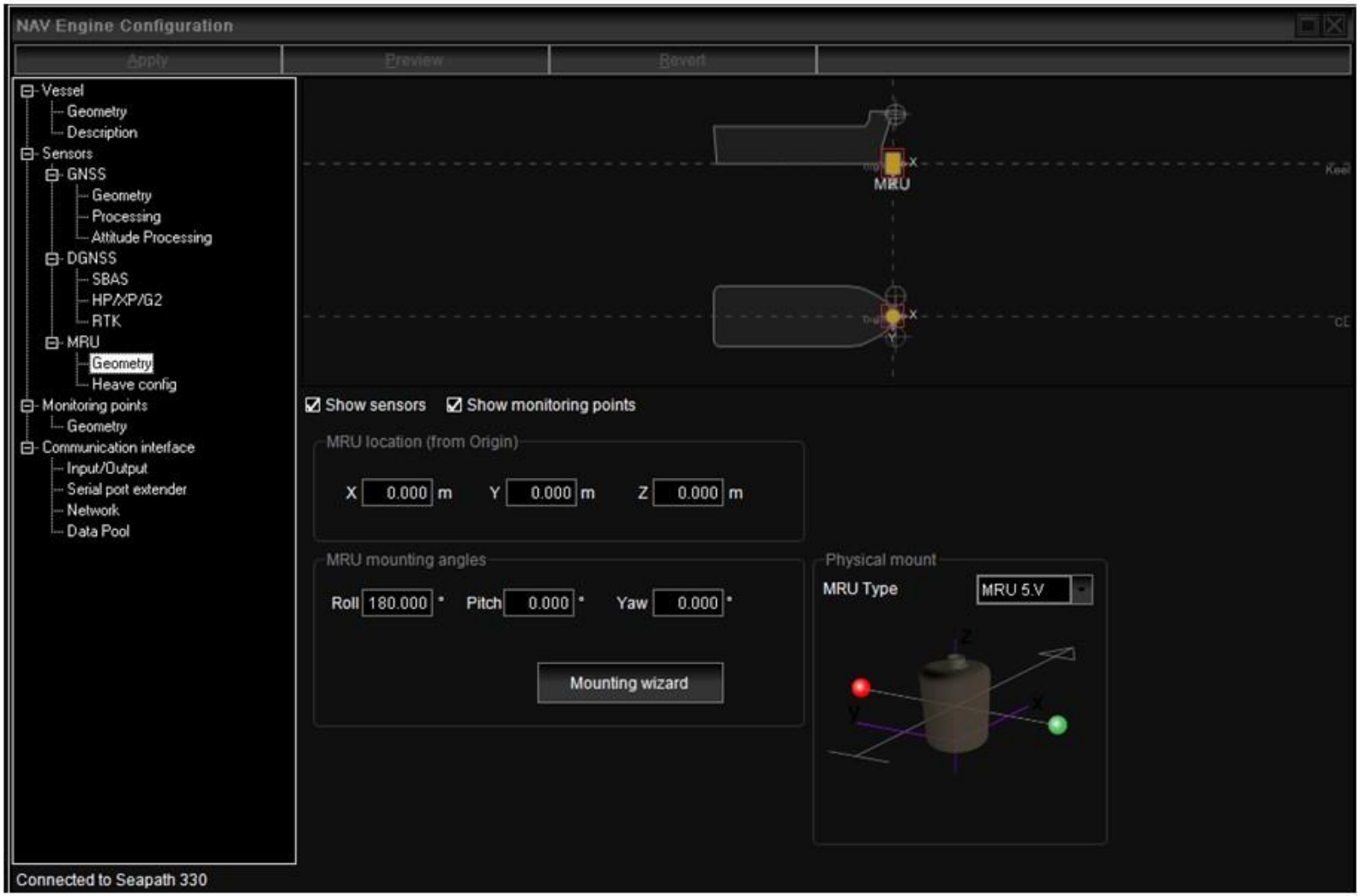
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MRU
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Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
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MRU
Show sensors
Show monitoring points
MRU location (from Origin)
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Y 0.000 m
Z 0.000 m
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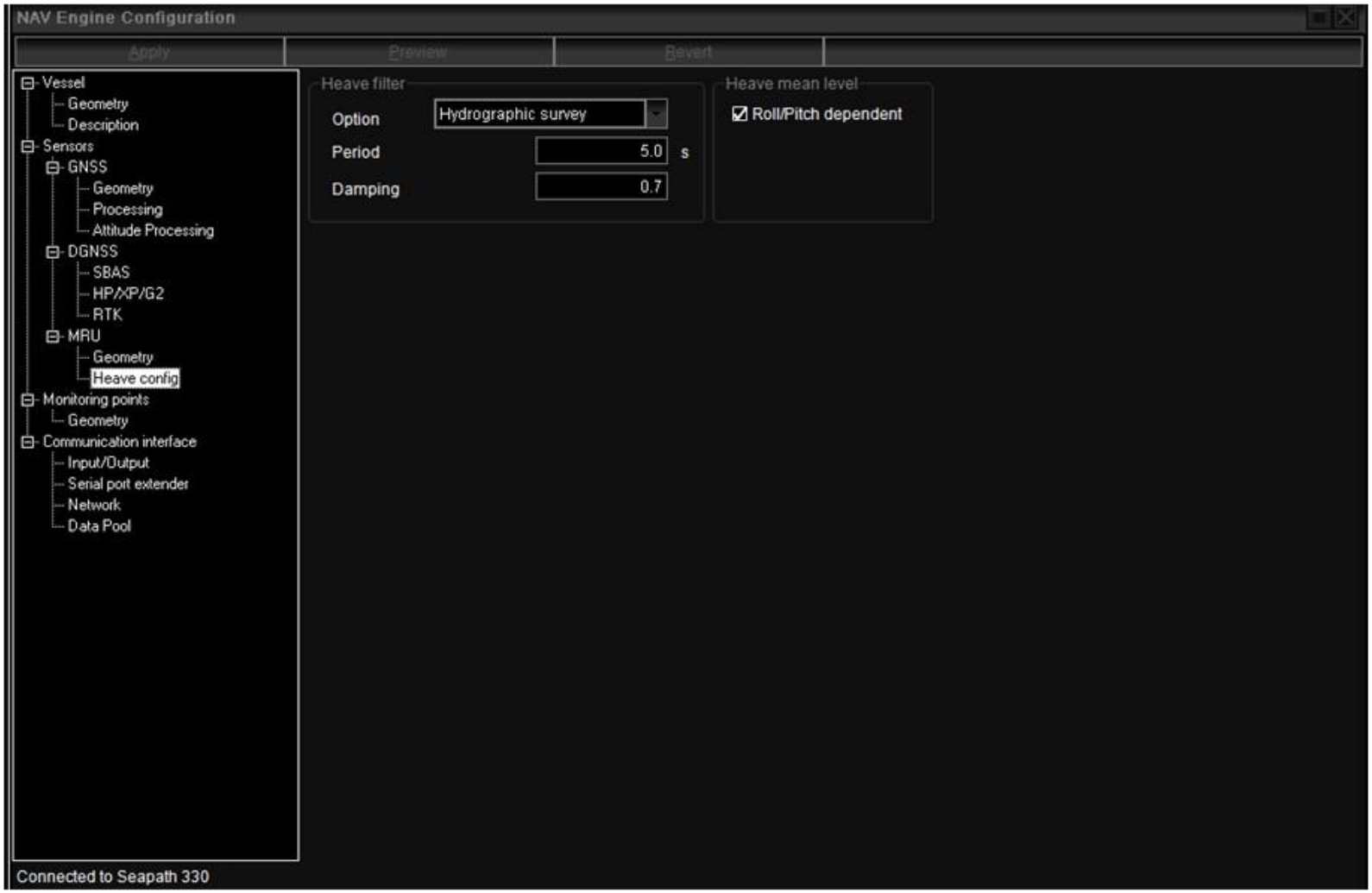
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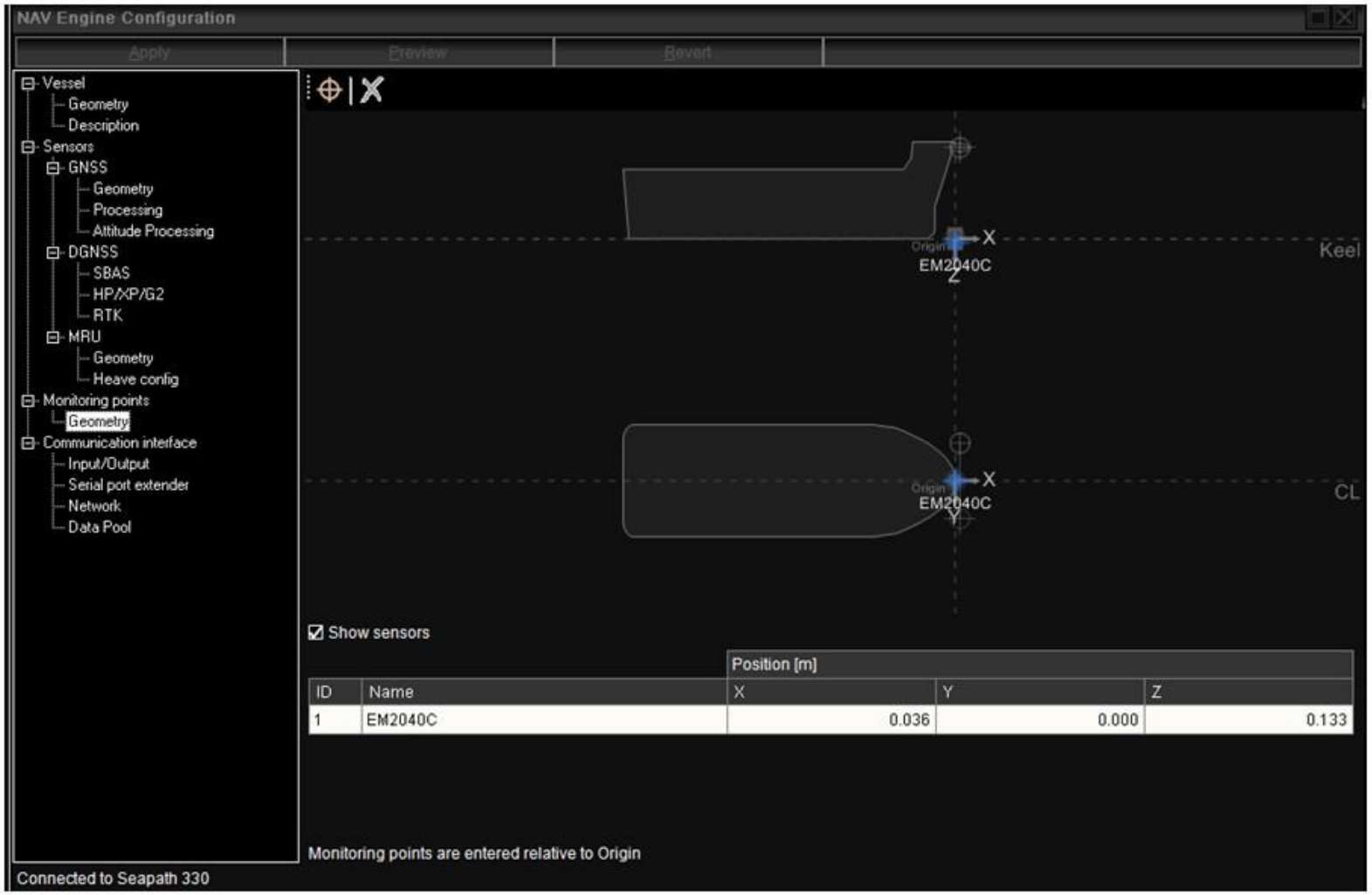
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RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Origin
EM2040C
X
Z
Keel
Origin
EM2040C
X
Y
CL
Show sensors
Position [m]
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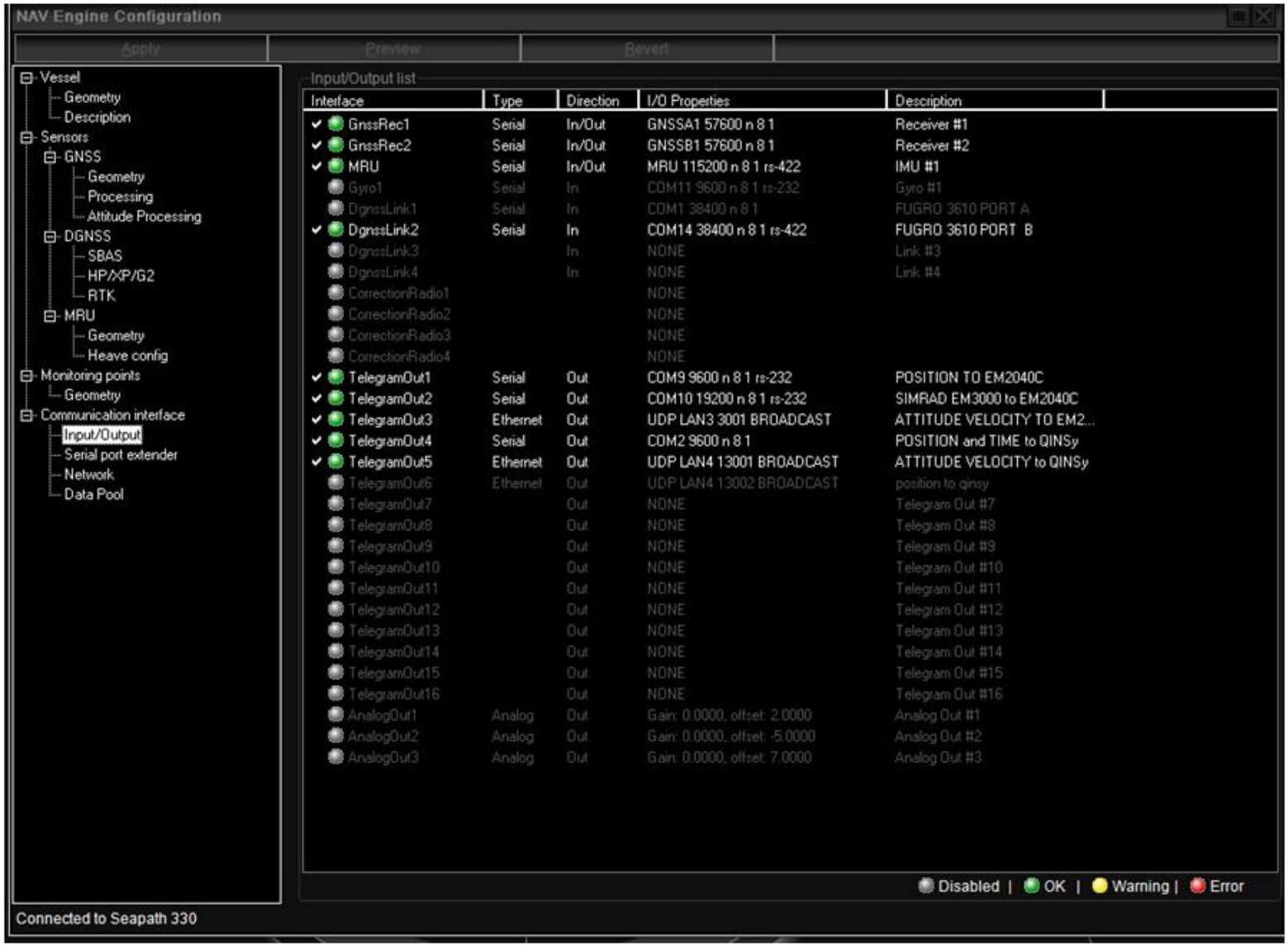
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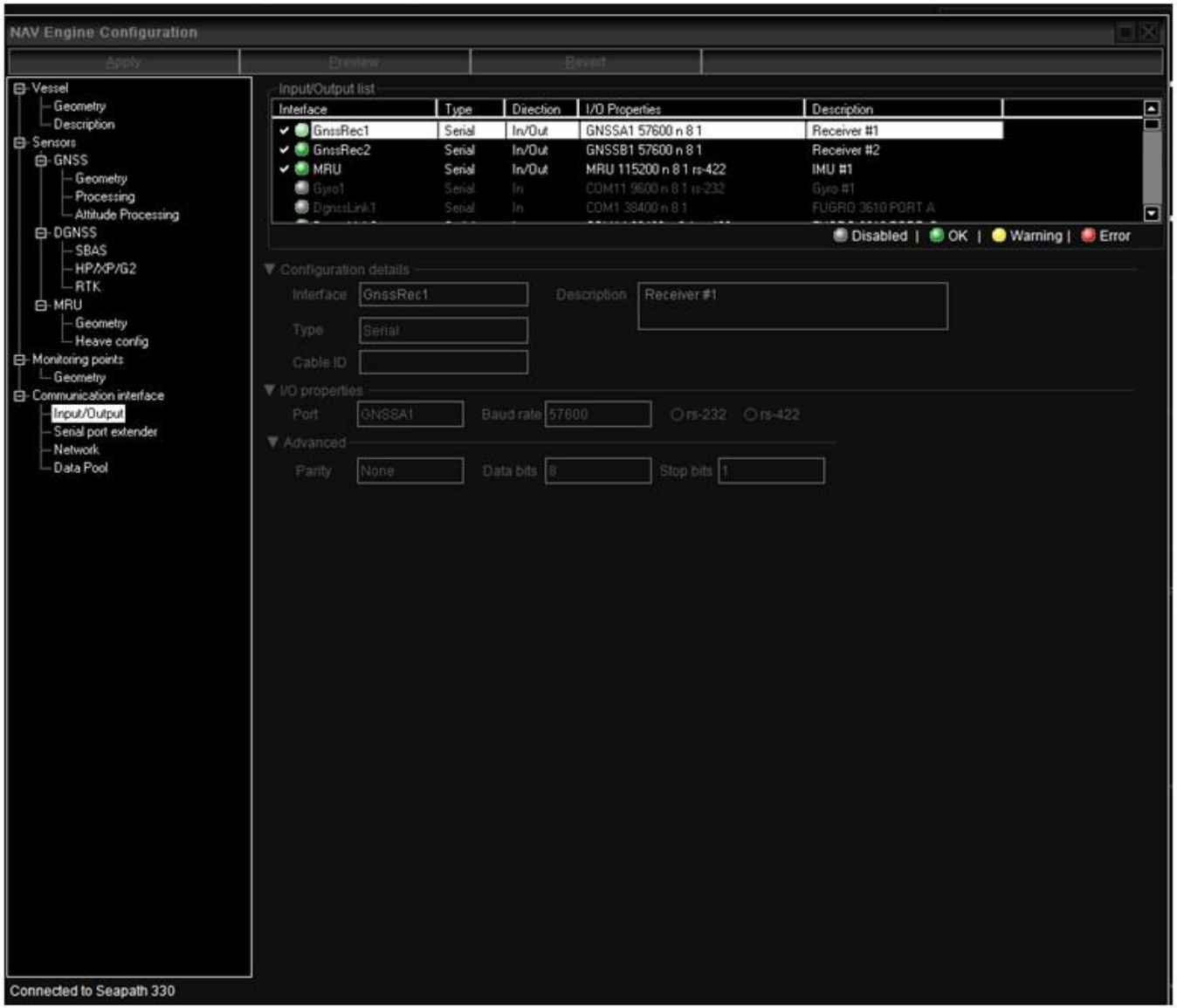
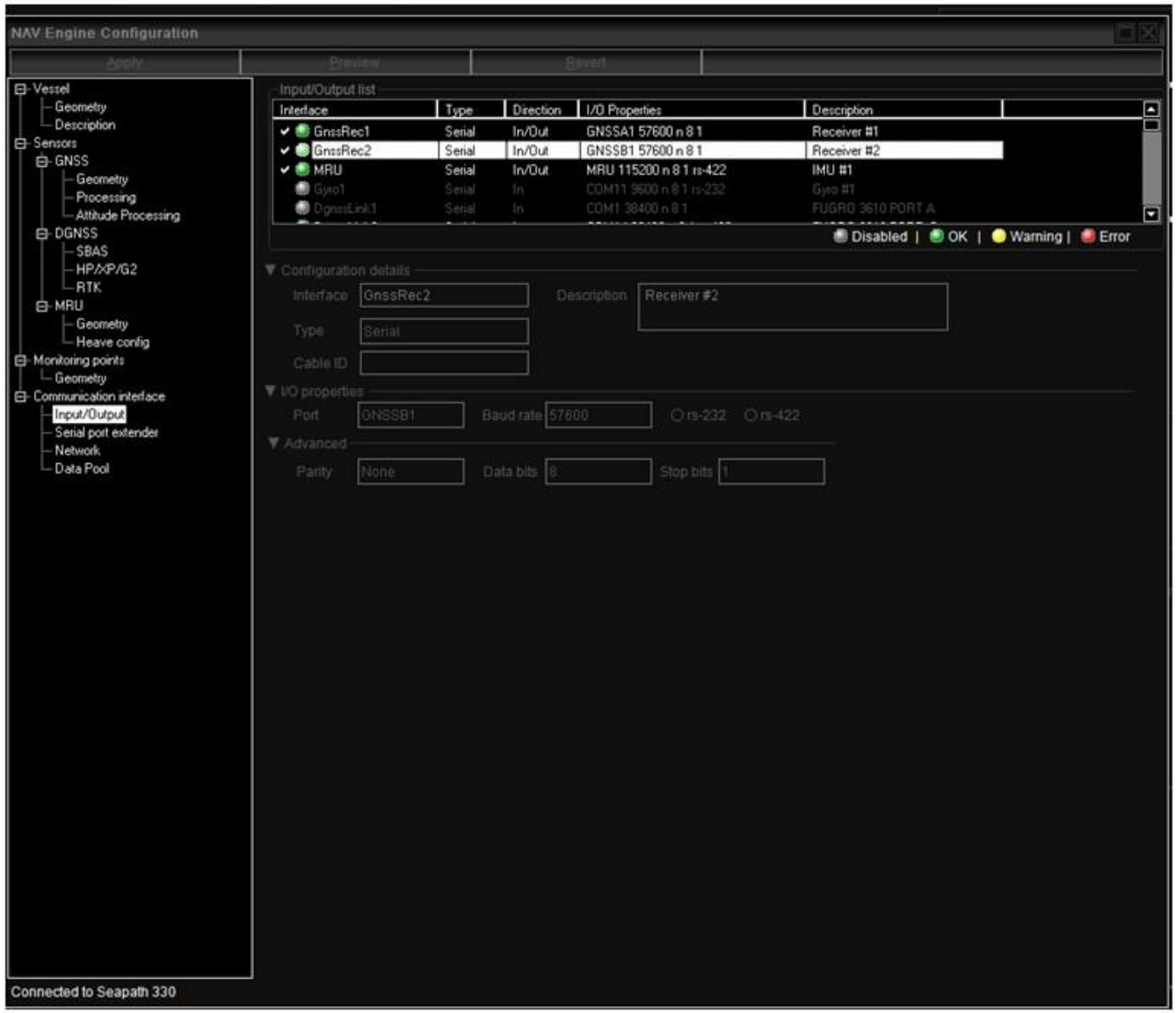
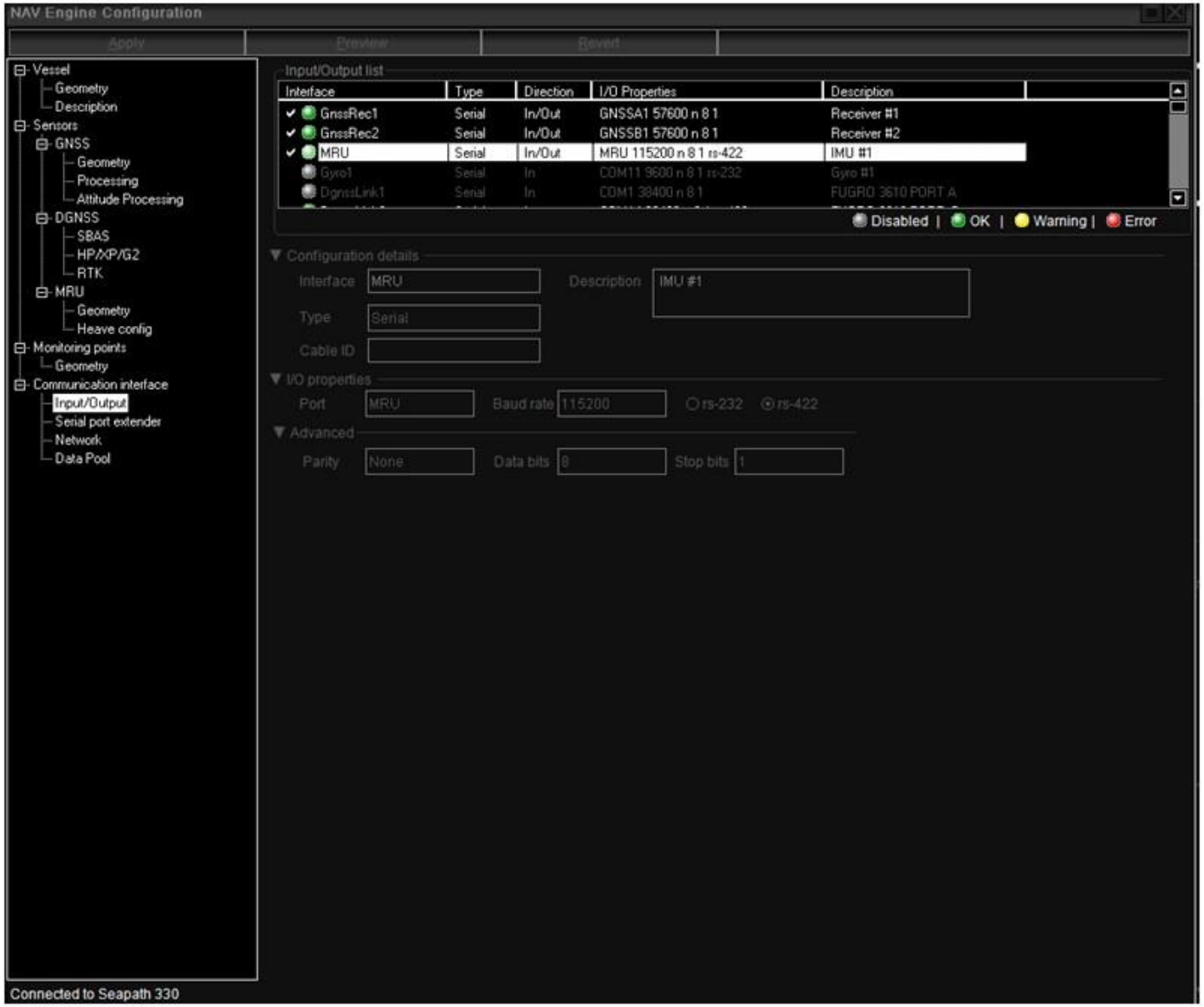
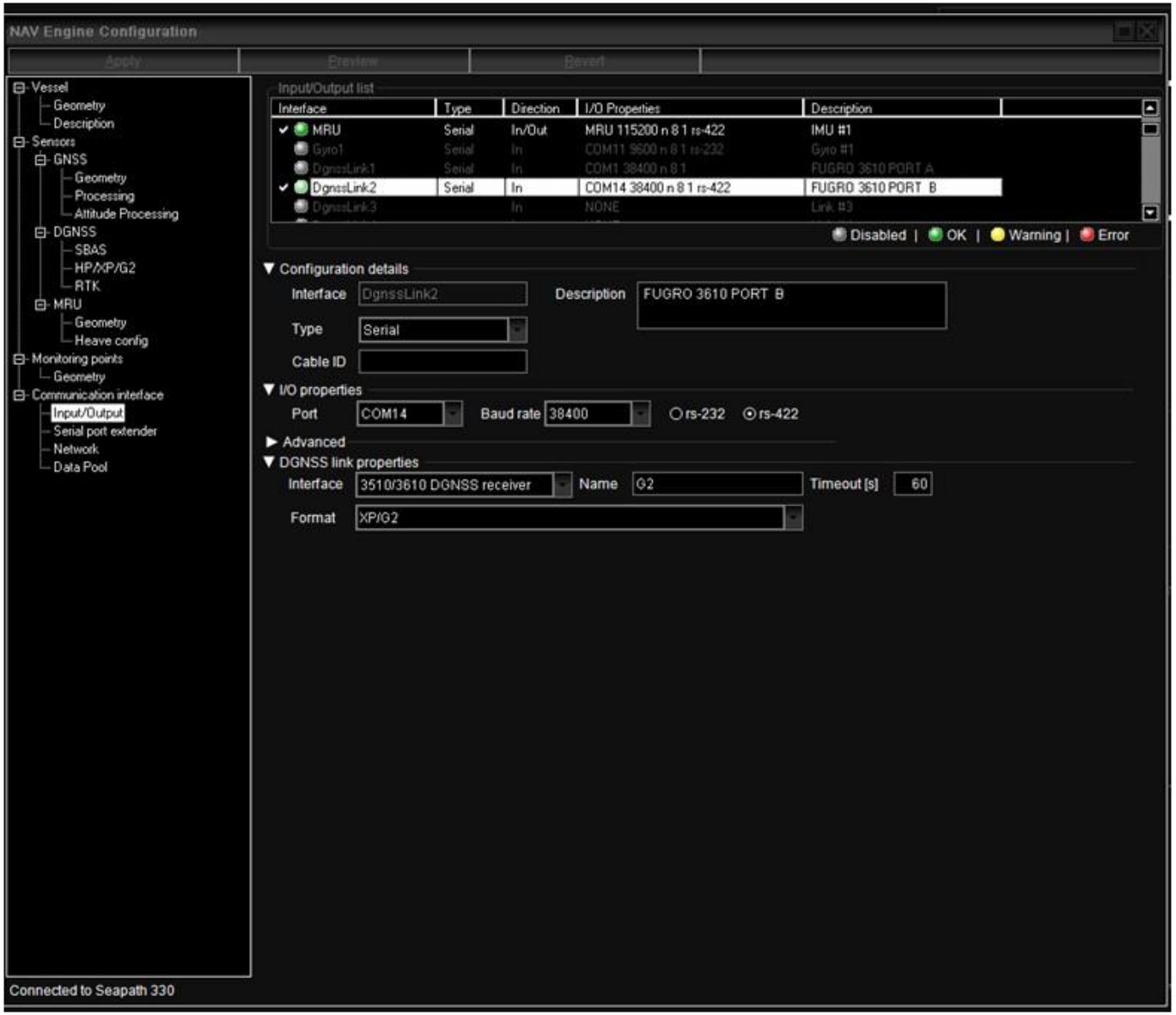
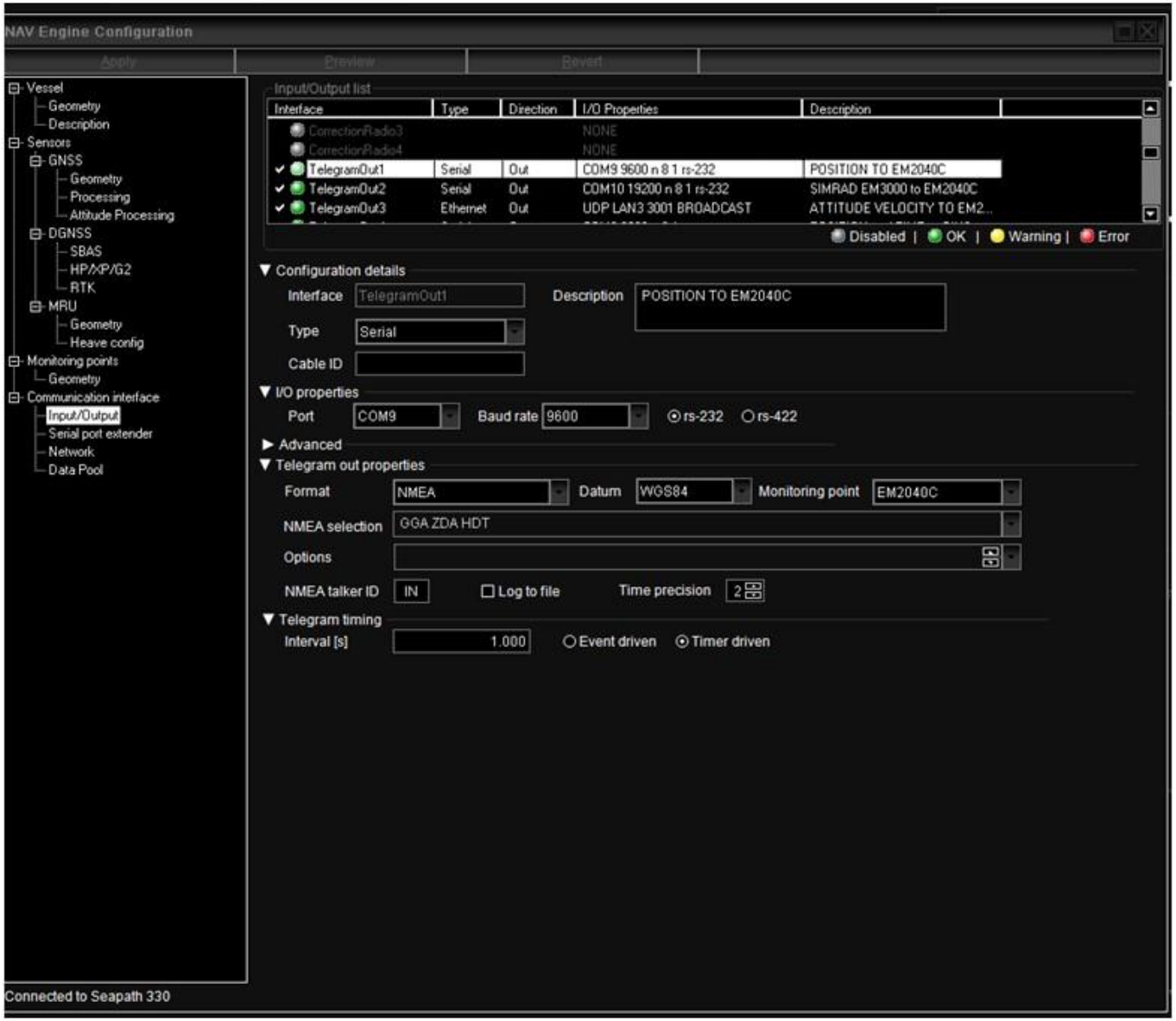
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface | Type | Direction | I/O Properties | Description
GnssRec1 | Serial | In/Out | GNSSA1 57600 n 8 1 | Receiver #1
GnssRec2 | Serial | In/Out | GNSSB1 57600 n 8 1 | Receiver #2
MRU | Serial | In/Out | MRU 115200 n 8 1 rs-422 | IMU #1
Gyro1 | Serial | In | COM11 9600 n 8 1 rs-232 | Gyro #1
DgnssLink1 | Serial | In | COM1 38400 n 8 1 | FUGRO 3610 PORT A
DgnssLink2 | Serial | In | COM14 38400 n 8 1 rs-422 | FUGRO 3610 PORT B
DgnssLink3 | | In | NONE | Link #3
DgnssLink4 | | In | NONE | Link #4
CorrectionRadio1 | | | NONE |
CorrectionRadio2 | | | NONE |
CorrectionRadio3 | | | NONE |
CorrectionRadio4 | | | NONE |
TelegramOut1 | Serial | Out | COM9 9600 n 8 1 rs-232 | POSITION TO EM2040C
TelegramOut2 | Serial | Out | COM10 19200 n 8 1 rs-232 | SIMRAD EM3000 to EM2040C
TelegramOut3 | Ethernet | Out | UDP LAN3 3001 BROADCAST | ATTITUDE VELOCITY TO EM2...
TelegramOut4 | Serial | Out | COM2 9600 n 8 1 | POSITION and TIME to QINSy
TelegramOut5 | Ethernet | Out | UDP LAN4 13001 BROADCAST | ATTITUDE VELOCITY to QINSy
TelegramOut6 | Ethernet | Out | UDP LAN4 13002 BROADCAST | position to qinsy
TelegramOut7 | | Out | NONE | Telegram Out #7
TelegramOut8 | | Out | NONE | Telegram Out #8
TelegramOut9 | | Out | NONE | Telegram Out #9
TelegramOut10 | | Out | NONE | Telegram Out #10
TelegramOut11 | | Out | NONE | Telegram Out #11
TelegramOut12 | | Out | NONE | Telegram Out #12
TelegramOut13 | | Out | NONE | Telegram Out #13
TelegramOut14 | | Out | NONE | Telegram Out #14
TelegramOut15 | | Out | NONE | Telegram Out #15
TelegramOut16 | | Out | NONE | Telegram Out #16
AnalogOut1 | Analog | Out | Gain: 0.0000, offset: 2.0000 | Analog Out #1
AnalogOut2 | Analog | Out | Gain: 0.0000, offset: -5.0000 | Analog Out #2
AnalogOut3 | Analog | Out | Gain: 0.0000, offset: 7.0000 | Analog Out #3
Disabled | OK | Warning | Error
Connected to Seapath 330

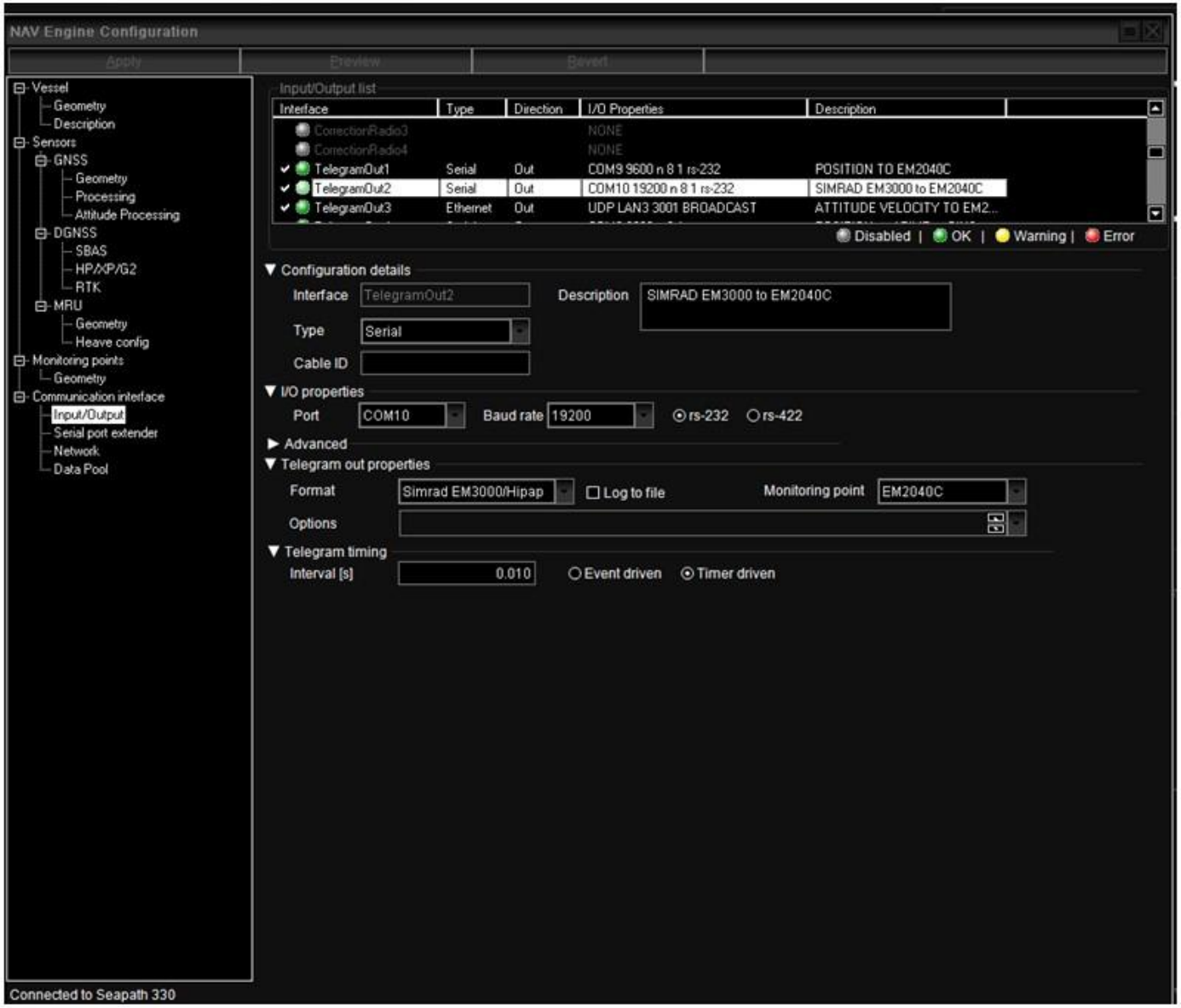

NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface
Type
Direction
I/O Properties
Description
GnssRec1
Serial
In/Out
GNSSA1 57600 n 8 1
Receiver #1
GnssRec2
Serial
In/Out
GNSSB1 57600 n 8 1
Receiver #2
MRU
Serial
In/Out
MRU 115200 n 8 1 rs-422
IMU #1
Gyro1
Serial
In
COM11 9600 n 8 1 rs-232
Gyro #1
DgnssLink1
Serial
In
COM1 38400 n 8 1
FUGRO 3610 PORT A
Disabled | OK | Warning | Error
Configuration details
Interface
GnssRec1
Description
Receiver #1
Type
Serial
Cable ID
I/O properties
Port
GNSSA1
Baud rate
57600
rs-232
rs-422
Advanced
Parity
None
Data bits
8
Stop bits
1
Connected to Seapath 330

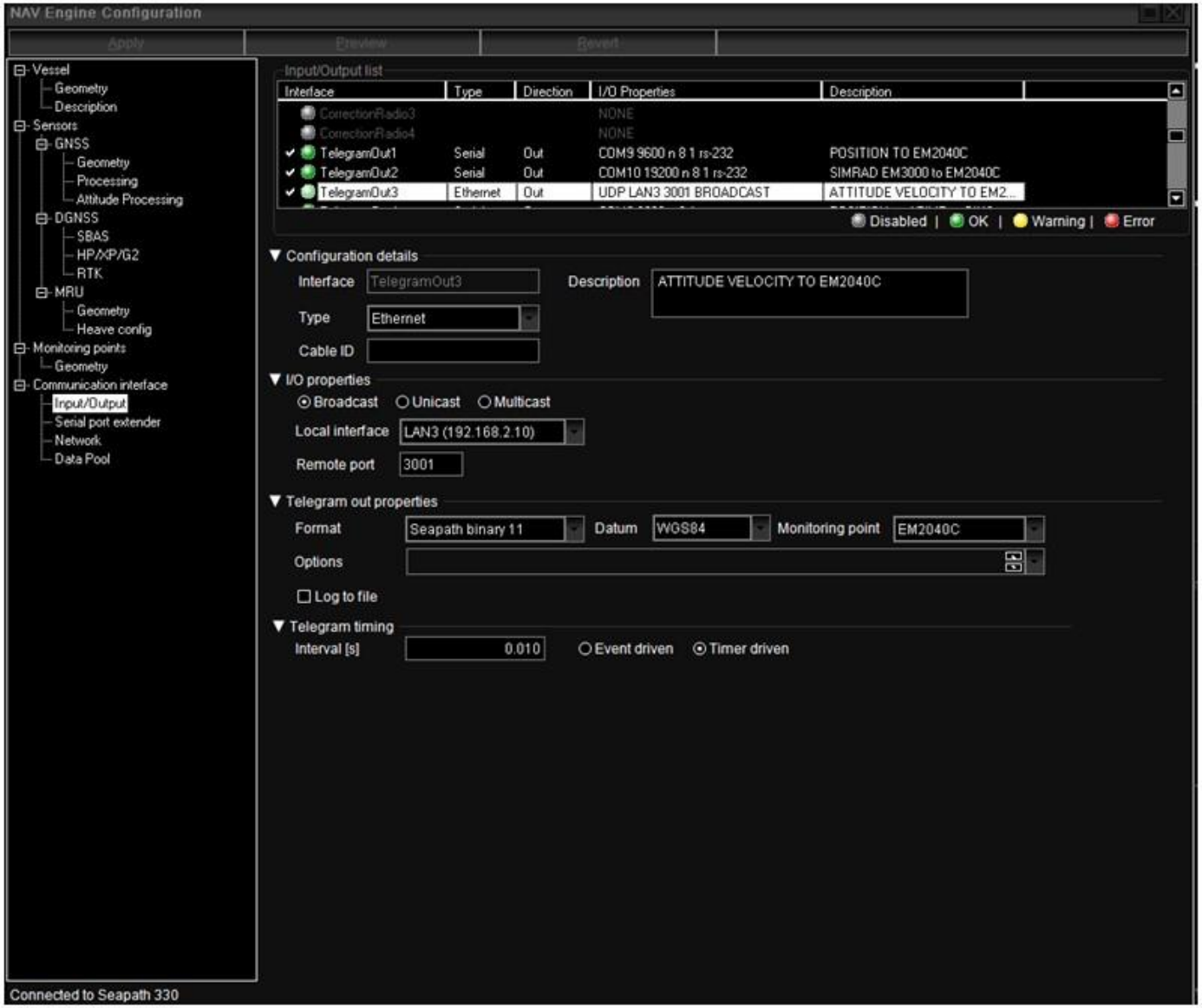

NAV Engine Configuration
Apply
Preview
Saved
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface
Type
Direction
I/O Properties
Description
GnssRec1
Serial
In/Out
GNSSA1 57600 n 8 1
Receiver #1
GnssRec2
Serial
In/Out
GNSSB1 57600 n 8 1
Receiver #2
MRU
Serial
In/Out
MRU 115200 n 8 1 rs-422
IMU #1
Gyro1
Serial
In
COM11 9600 n 8 1 rs-232
Gyro #1
DgnssLink1
Serial
In
COM1 38400 n 8 1
FUGRO 3610 PORT A
Disabled | OK | Warning | Error
Configuration details
Interface
GnssRec2
Description
Receiver #2
Type
Serial
Cable ID
I/O properties
Port
GNSSB1
Baud rate
57600
rs-232
rs-422
Advanced
Parity
None
Data bits
8
Stop bits
1
Connected to Seapath 330

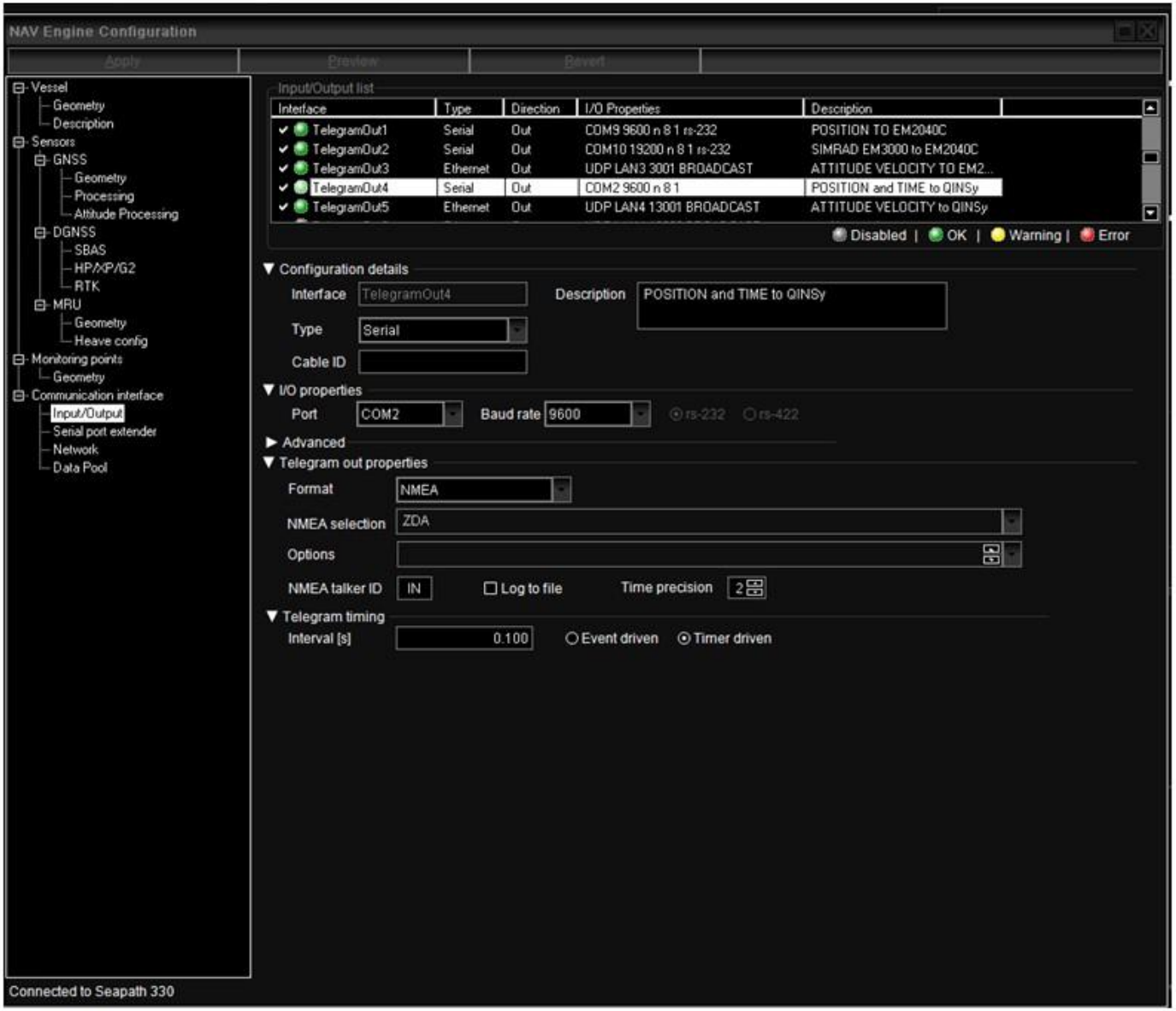

NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface
Type
Direction
I/O Properties
Description
GnssRec1
Serial
In/Out
GNSSA1 57600 n 8 1
Receiver #1
GnssRec2
Serial
In/Out
GNSSB1 57600 n 8 1
Receiver #2
MRU
Serial
In/Out
MRU 115200 n 8 1 rs-422
IMU #1
Gyro1
Serial
In
COM11 9600 n 8 1 rs-232
Gyro #1
DgnssLink1
Serial
In
COM1 38400 n 8 1
FUGRO 3610 PORT A
Disabled | OK | Warning | Error
Configuration details
Interface
MRU
Description
IMU #1
Type
Serial
Cable ID
I/O properties
Port
MRU
Baud rate
115200
rs-232
rs-422
Advanced
Parity
None
Data bits
8
Stop bits
1
Connected to Seapath 330

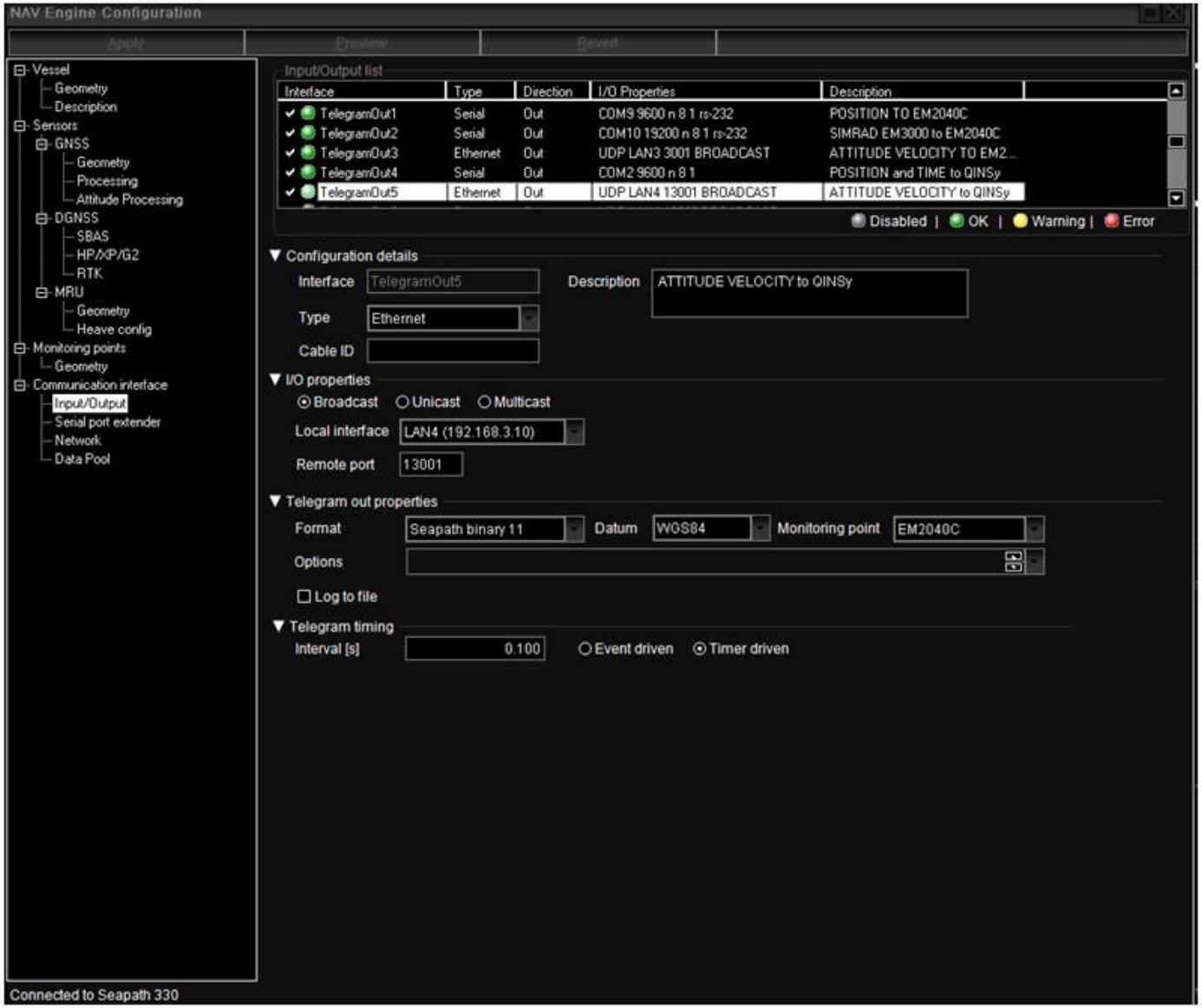

NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface
Type
Direction
I/O Properties
Description
MRU
Serial
In/Out
MRU 115200 n 8 1 rs-422
IMU #1
Gyro1
Serial
In
COM11 9600 n 8 1 rs-232
Gyro #1
DgnssLink1
Serial
In
COM1 38400 n 8 1
FUGRO 3610 PORT A
DgnssLink2
Serial
In
COM14 38400 n 8 1 rs-422
FUGRO 3610 PORT B
DgnssLink3
In
NONE
Link #3
Disabled | OK | Warning | Error
Configuration details
Interface
DgnssLink2
Description
FUGRO 3610 PORT B
Type
Serial
Cable ID
I/O properties
Port
COM14
Baud rate
38400
rs-232
rs-422
Advanced
DGNSS link properties
Interface
3510/3610 DGNSS receiver
Name
G2
Timeout [s]
60
Format
XP/G2
Connected to Seapath 330

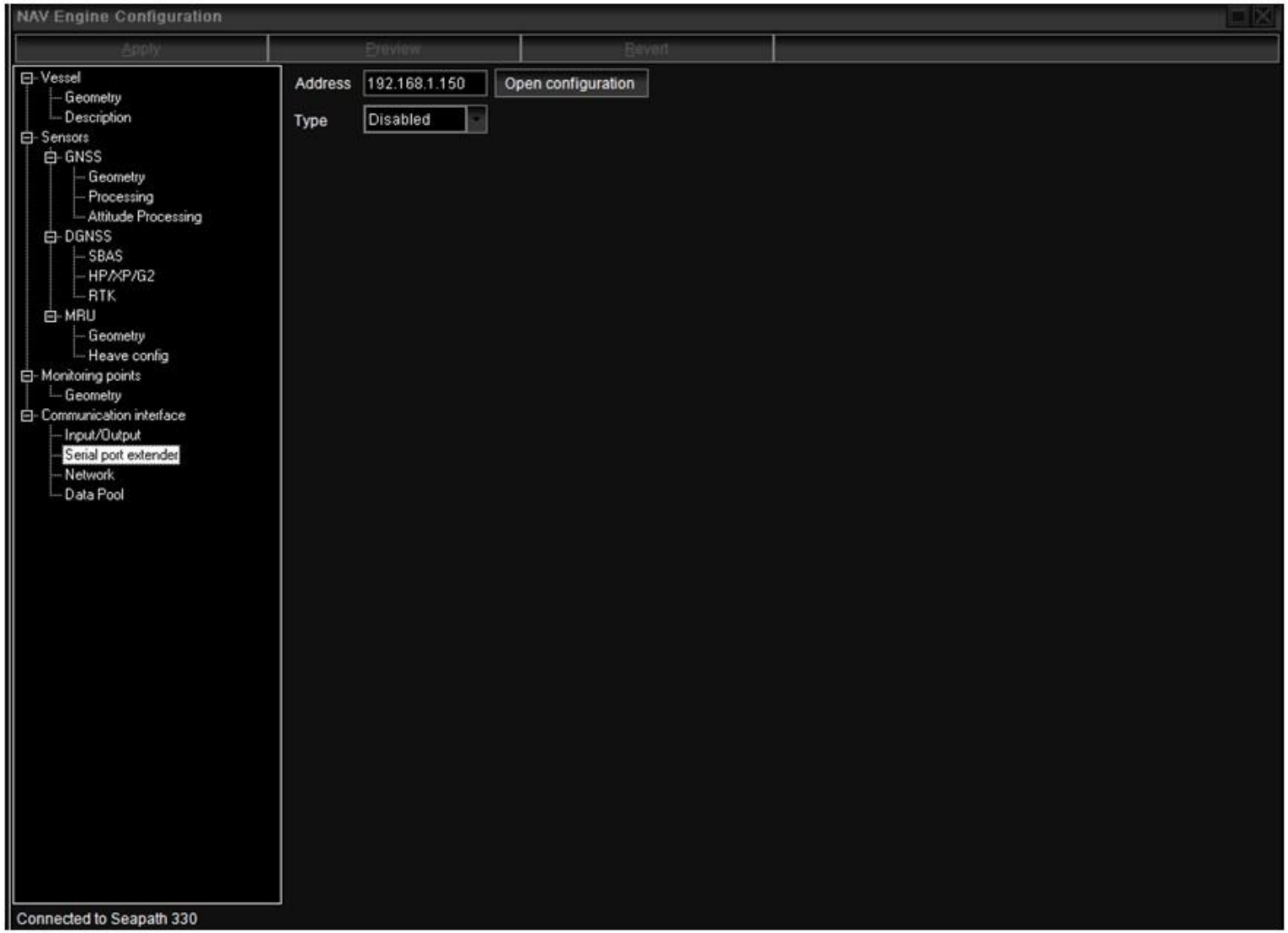

NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface
Type
Direction
I/O Properties
Description
CorrectionRadio3
NONE
CorrectionRadio4
NONE
TelegramOut1
Serial
Out
COM9 9600 n 8 1 rs-232
POSITION TO EM2040C
TelegramOut2
Serial
Out
COM10 19200 n 8 1 rs-232
SIMRAD EM3000 to EM2040C
TelegramOut3
Ethernet
Out
UDP LAN3 3001 BROADCAST
ATTITUDE VELOCITY TO EM2...
Disabled | OK | Warning | Error
Configuration details
Interface
TelegramOut1
Description
POSITION TO EM2040C
Type
Serial
Cable ID
I/O properties
Port
COM9
Baud rate
9600
rs-232
rs-422
Advanced
Telegram out properties
Format
NMEA
Datum
WGS84
Monitoring point
EM2040C
NMEA selection
GGA ZDA HDT
Options
NMEA talker ID
IN
Log to file
Time precision
2
Telegram timing
Interval [s]
1.000
Event driven
Timer driven
Connected to Seapath 330

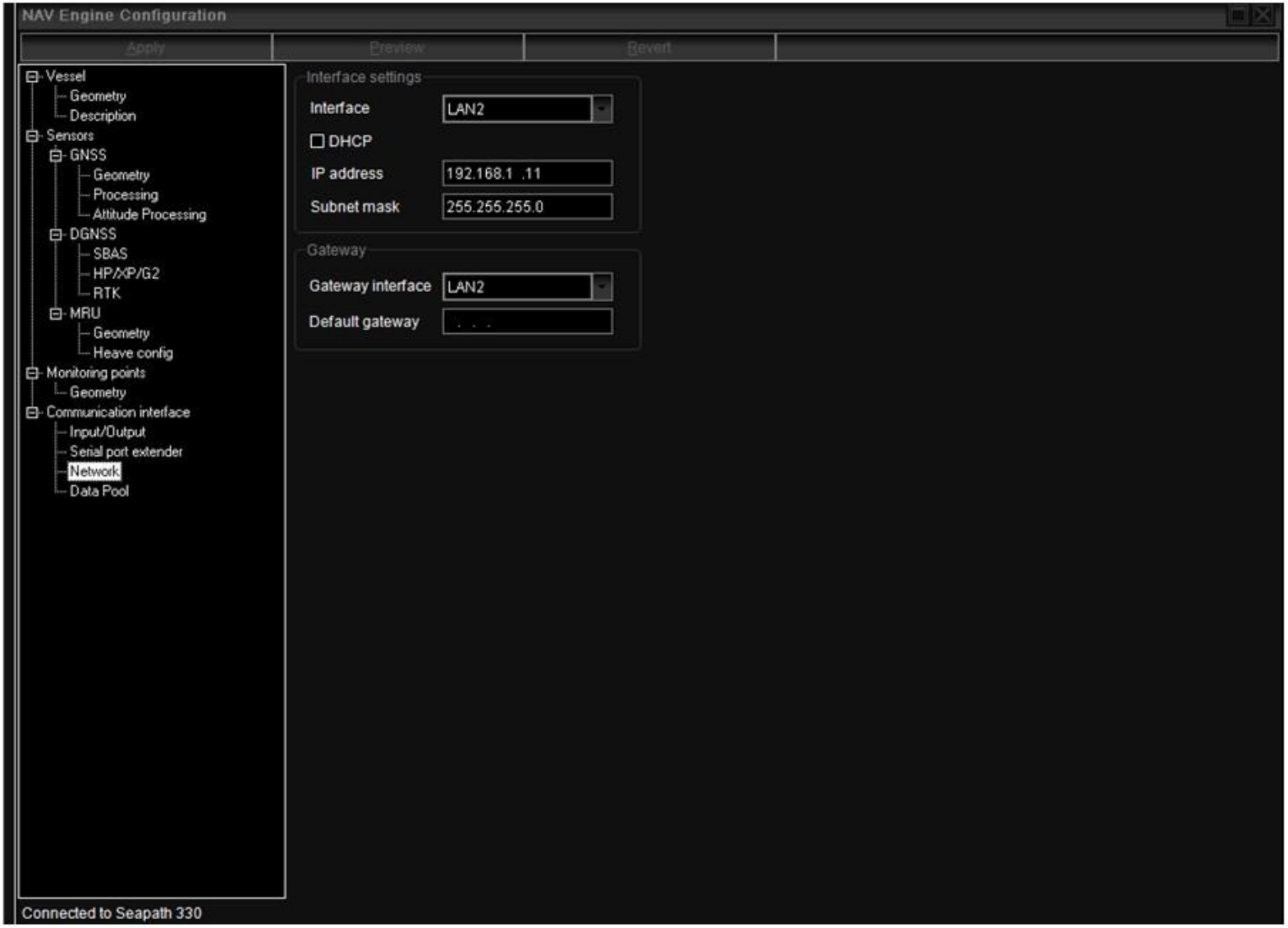

NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface
Type
Direction
I/O Properties
Description
CorrectionRadio3
NONE
CorrectionRadio4
NONE
TelegramOut1
Serial
Out
COM9 9600 n 8 1 rs-232
POSITION TO EM2040C
TelegramOut2
Serial
Out
COM10 19200 n 8 1 rs-232
SIMRAD EM3000 to EM2040C
TelegramOut3
Ethernet
Out
UDP LAN3 3001 BROADCAST
ATTITUDE VELOCITY TO EM2...
Disabled | OK | Warning | Error
Configuration details
Interface
TelegramOut2
Description
SIMRAD EM3000 to EM2040C
Type
Serial
Cable ID
I/O properties
Port
COM10
Baud rate
19200
rs-232
rs-422
Advanced
Telegram out properties
Format
Simrad EM3000/Hipap
Log to file
Monitoring point
EM2040C
Options
Telegram timing
Interval [s]
0.010
Event driven
Timer driven
Connected to Seapath 330

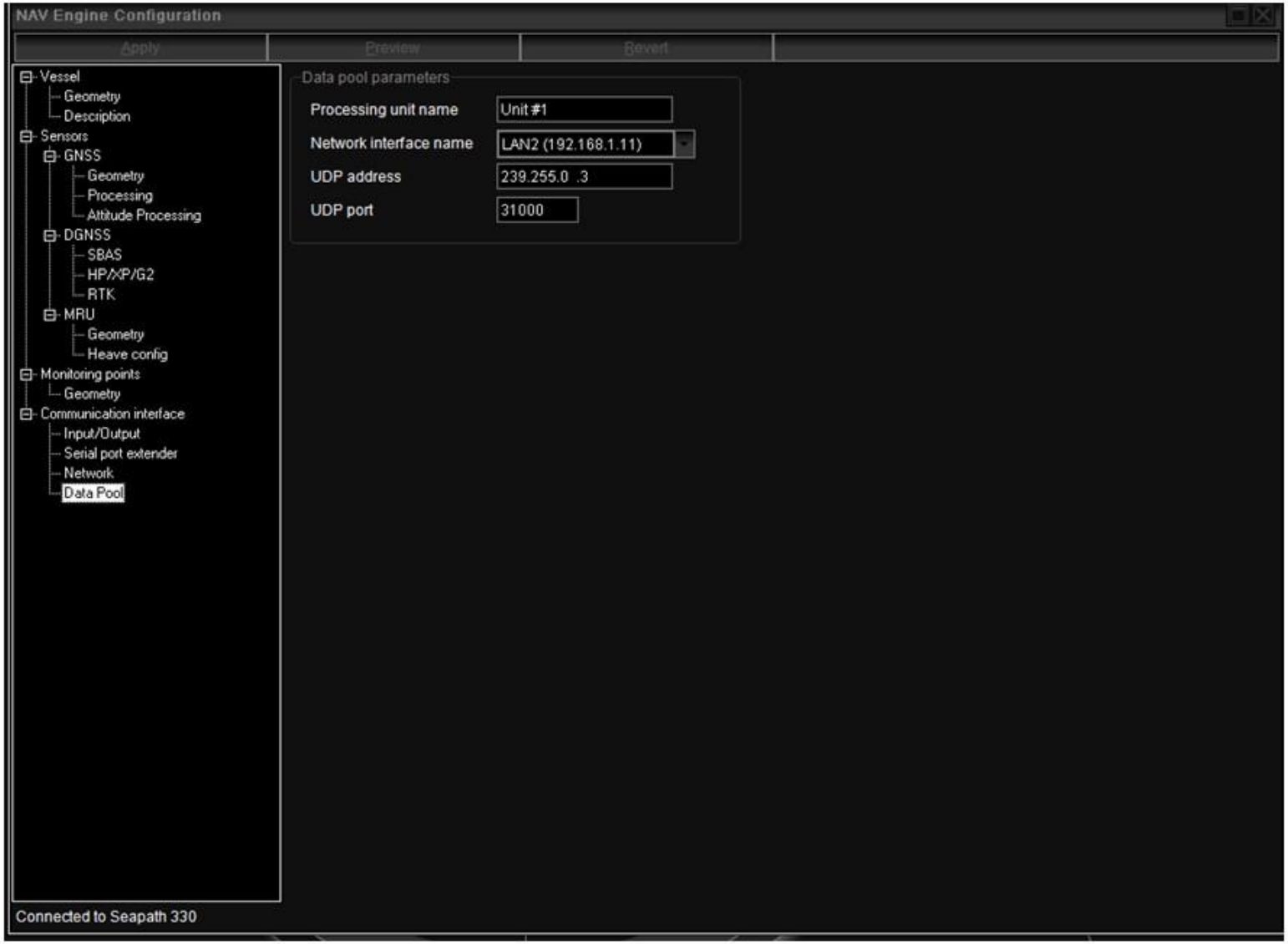

NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface
Type
Direction
I/O Properties
Description
CorrectionRadio3
NONE
CorrectionRadio4
NONE
TelegramOut1
Serial
Out
COM9 9600 n 8 1 rs-232
POSITION TO EM2040C
TelegramOut2
Serial
Out
COM10 19200 n 8 1 rs-232
SIMRAD EM3000 to EM2040C
TelegramOut3
Ethernet
Out
UDP LAN3 3001 BROADCAST
ATTITUDE VELOCITY TO EM2...
Disabled | OK | Warning | Error
Configuration details
Interface
TelegramOut3
Description
ATTITUDE VELOCITY TO EM2040C
Type
Ethernet
Cable ID
I/O properties
Broadcast
Unicast
Multicast
Local interface
LAN3 (192.168.2.10)
Remote port
3001
Telegram out properties
Format
Seapath binary 11
Datum
WGS84
Monitoring point
EM2040C
Options
Log to file
Telegram timing
Interval [s]
0.010
Event driven
Timer driven
Connected to Seapath 330


NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface
Type
Direction
I/O Properties
Description
TelegramOut1 Serial Out COM9 9600 n 8 1 rs-232 POSITION TO EM2040C
TelegramOut2 Serial Out COM10 19200 n 8 1 rs-232 SIMRAD EM3000 to EM2040C
TelegramOut3 Ethernet Out UDP LAN3 3001 BROADCAST ATTITUDE VELOCITY TO EM2...
TelegramOut4 Serial Out COM2 9600 n 8 1 POSITION and TIME to QINSy
TelegramOut5 Ethernet Out UDP LAN4 13001 BROADCAST ATTITUDE VELOCITY to QINSy
Disabled | OK | Warning | Error
Configuration details
Interface TelegramOut4
Description POSITION and TIME to QINSy
Type Serial
Cable ID
I/O properties
Port COM2
Baud rate 9600
rs-232
rs-422
Advanced
Telegram out properties
Format NMEA
NMEA selection ZDA
Options
NMEA talker ID IN
Log to file
Time precision 2
Telegram timing
Interval [s] 0.100
Event driven
Timer driven
Connected to Seapath 330


NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface
Type
Direction
I/O Properties
Description
TelegramOut1 Serial Out COM9 9600 n 8 1 rs-232 POSITION TO EM2040C
TelegramOut2 Serial Out COM10 19200 n 8 1 rs-232 SIMRAD EM3000 to EM2040C
TelegramOut3 Ethernet Out UDP LAN3 3001 BROADCAST ATTITUDE VELOCITY TO EM2...
TelegramOut4 Serial Out COM2 9600 n 8 1 POSITION and TIME to QINSy
TelegramOut5 Ethernet Out UDP LAN4 13001 BROADCAST ATTITUDE VELOCITY to QINSy
Disabled | OK | Warning | Error
Configuration details
Interface TelegramOut5
Description ATTITUDE VELOCITY to QINSy
Type Ethernet
Cable ID
I/O properties
Broadcast Unicast Multicast
Local interface LAN4 (192.168.3.10)
Remote port 13001
Telegram out properties
Format Seapath binary 11
Datum WGS84
Monitoring point EM2040C
Options
Log to file
Telegram timing
Interval [s] 0.100
Event driven
Timer driven
Connected to Seapath 330


NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Address
192.168.1.150
Open configuration
Type
Disabled
Connected to Seapath 330


NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Interface settings
Interface
LAN2
DHCP
IP address
192.168.1 .11
Subnet mask
255.255.255.0
Gateway
Gateway interface
LAN2
Default gateway
Connected to Seapath 330


NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Data pool parameters
Processing unit name
Unit #1
Network interface name
LAN2 (192.168.1.11)
UDP address
239.255.0 .3
UDP port
31000
Connected to Seapath 330

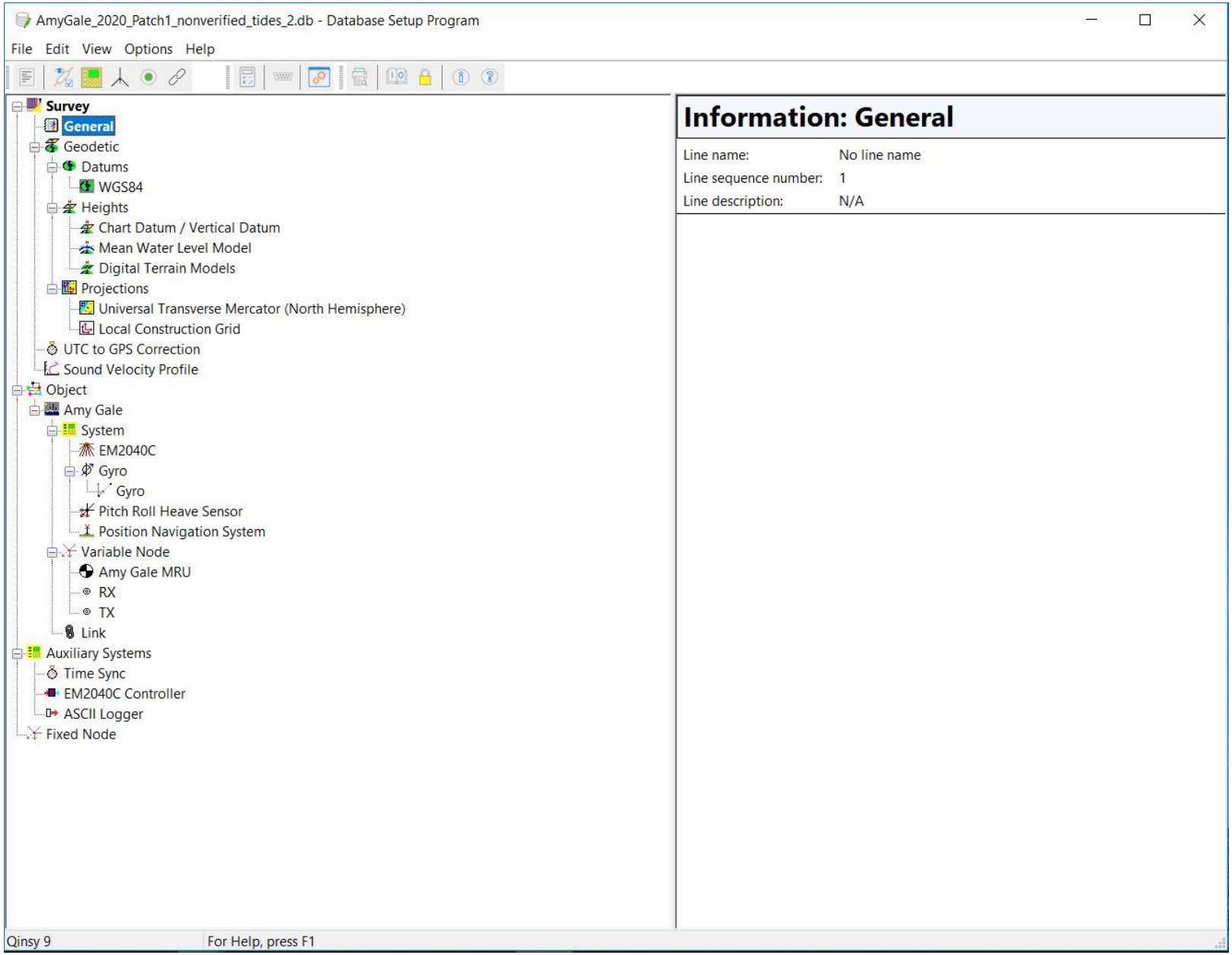
Appendix C – Template database settings in Qinsy (for acquisition)

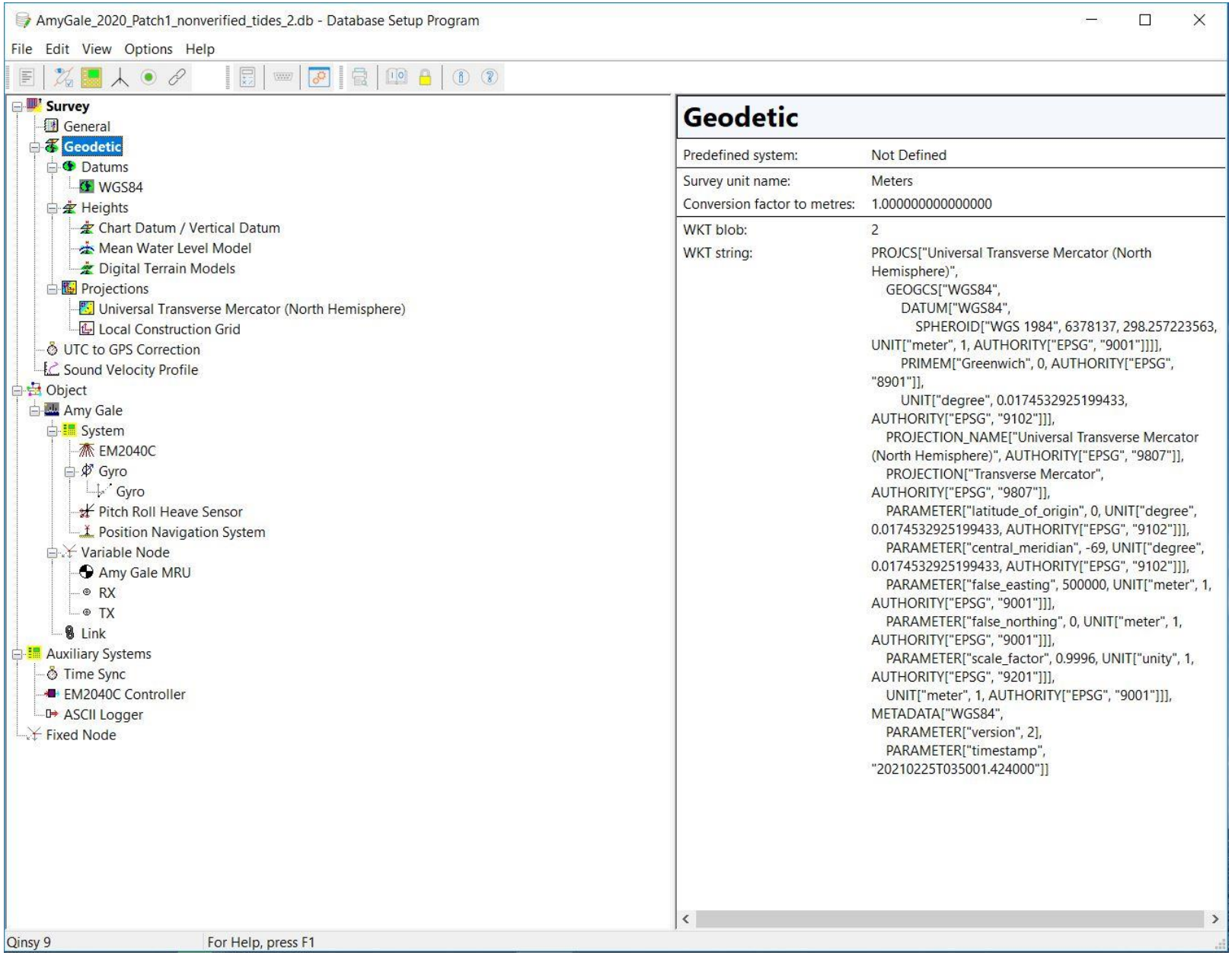
Note: Depicted Qinsy template settings show configuration from a 2020 survey project. All settings remain the same for the 2021 season apart from changes to pitch, roll, heading for EM2040C from patch test results (Table 4), as well as latency offsets applied to Position Navigation Systems and Motion Reference output values.

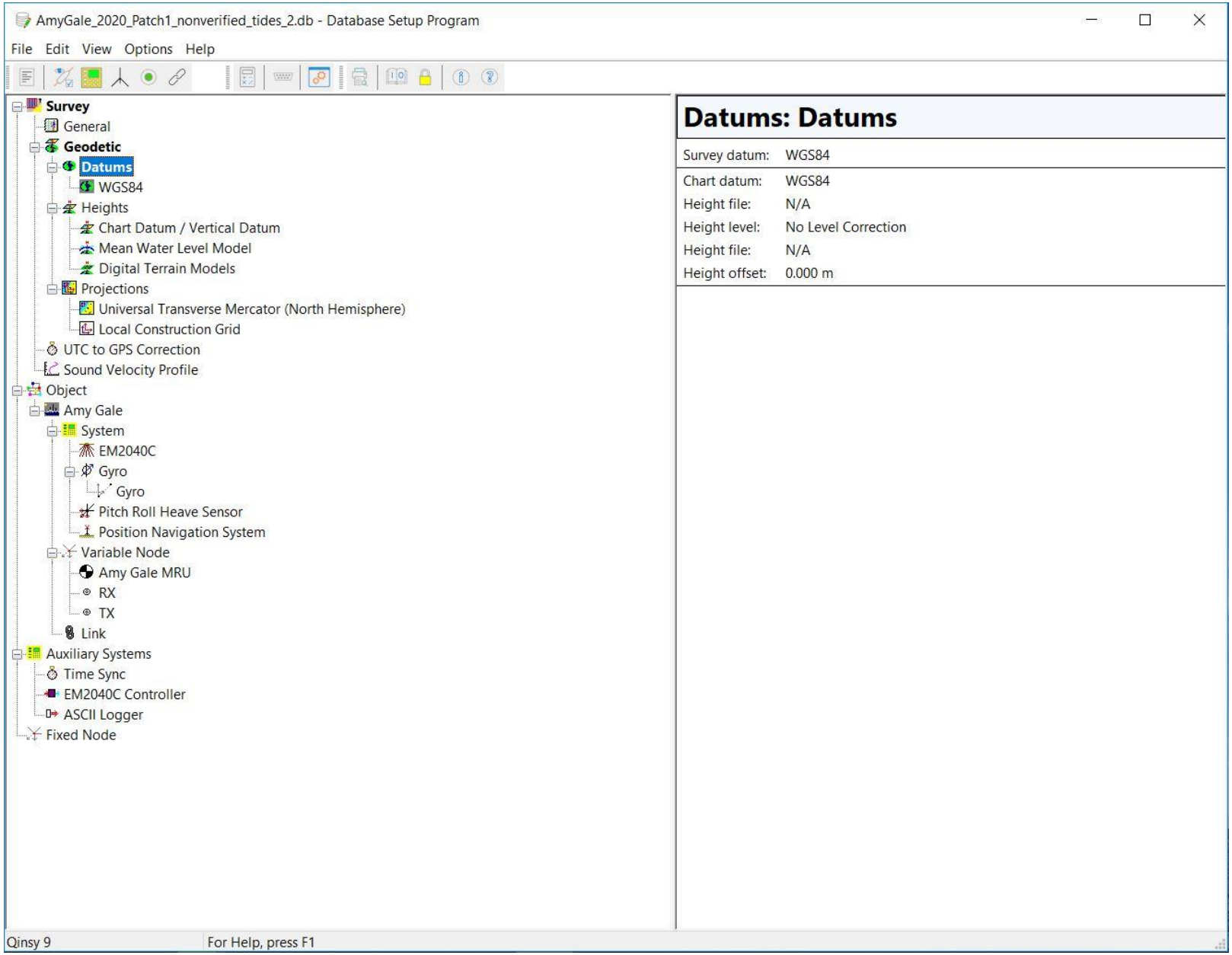
Qinsy uses the following reference frame conventions (these differ from those used by Seapath 330):

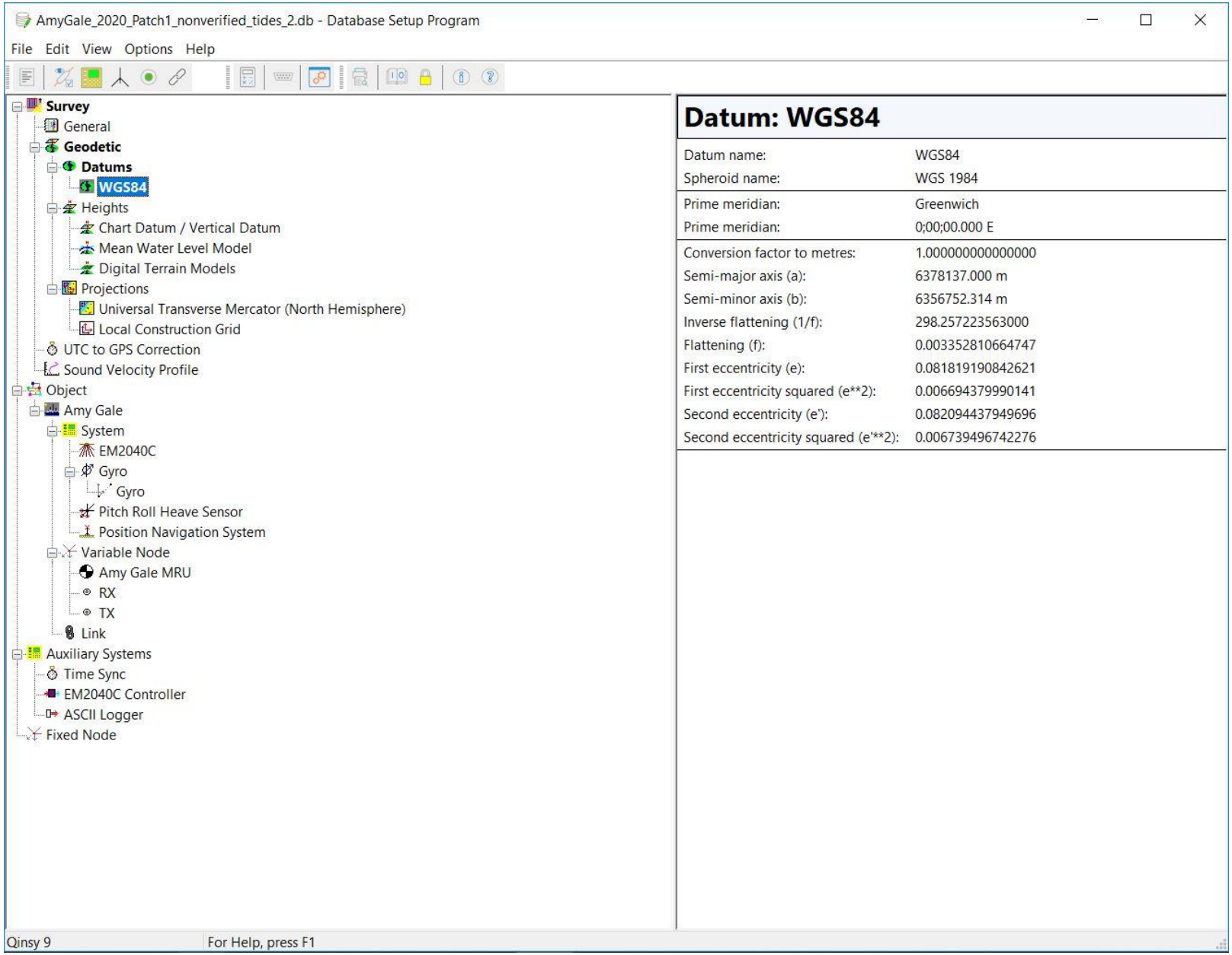
Pitch rotation: + bow up
Roll rotation: + heeling to starboard
Heave: + upwards

X: + to starboard
Y: + towards bow
Z: + up


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Information: General
Line name: No line name
Line sequence number: 1
Line description: N/A
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Geodetic
Predefined system: Not Defined
Survey unit name: Meters
Conversion factor to metres: 1.000000000000000
WKT blob: 2
WKT string: PROJCS["Universal Transverse Mercator (North Hemisphere)", GEOGCS["WGS84", DATUM["WGS84", SPHEROID["WGS 1984", 6378137, 298.257223563, UNIT["meter", 1, AUTHORITY["EPSG", "9001"]]]], PRIMEM["Greenwich", 0, AUTHORITY["EPSG", "8901"]], UNIT["degree", 0.0174532925199433, AUTHORITY["EPSG", "9102"]]], PROJECTION_NAME["Universal Transverse Mercator (North Hemisphere)", AUTHORITY["EPSG", "9807"]], PROJECTION["Transverse Mercator", AUTHORITY["EPSG", "9807"]], PARAMETER["latitude_of_origin", 0, UNIT["degree", 0.0174532925199433, AUTHORITY["EPSG", "9102"]]], PARAMETER["central_meridian", -69, UNIT["degree", 0.0174532925199433, AUTHORITY["EPSG", "9102"]]], PARAMETER["false_easting", 500000, UNIT["meter", 1, AUTHORITY["EPSG", "9001"]]], PARAMETER["false_northing", 0, UNIT["meter", 1, AUTHORITY["EPSG", "9001"]]], PARAMETER["scale_factor", 0.9996, UNIT["unity", 1, AUTHORITY["EPSG", "9201"]]], UNIT["meter", 1, AUTHORITY["EPSG", "9001"]]], METADATA["WGS84", PARAMETER["version", 2], PARAMETER["timestamp", "20210225T035001.424000"]]
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Datums: Datums
Survey datum: WGS84
Chart datum: WGS84
Height file: N/A
Height level: No Level Correction
Height file: N/A
Height offset: 0.000 m
Qinsy 9
For Help, press F1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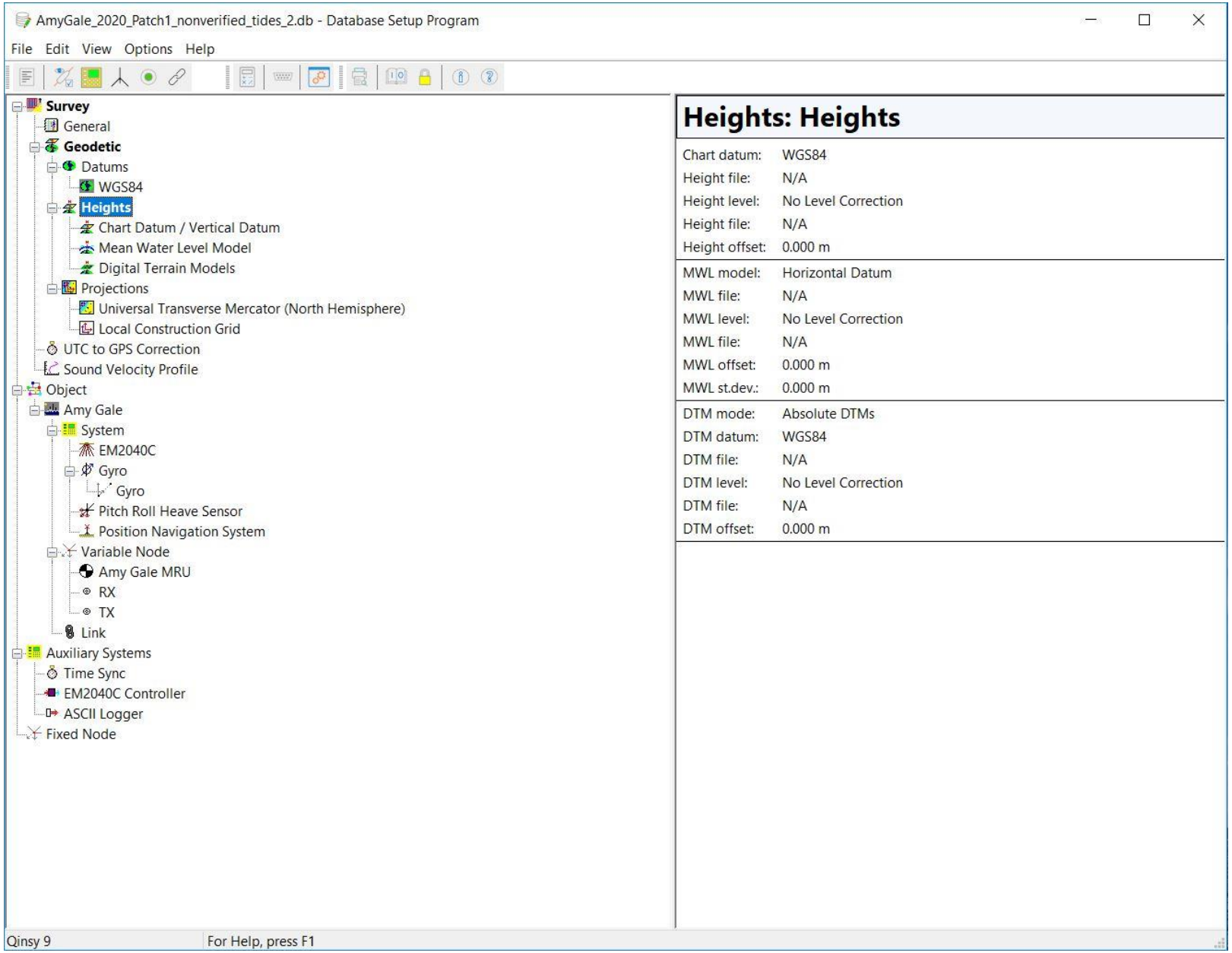
Fixed Node
Datum: WGS84
Datum name: WGS84
Spheroid name: WGS 1984
Prime meridian: Greenwich
Prime meridian: 0;00;00.000 E
Conversion factor to metres: 1.000000000000000
Semi-major axis (a): 6378137.000 m
Semi-minor axis (b): 6356752.314 m
Inverse flattening (1/f): 298.257223563000
Flattening (f): 0.003352810664747
First eccentricity (e): 0.081819190842621
First eccentricity squared (e**2): 0.006694379990141
Second eccentricity (e'): 0.082094437949696
Second eccentricity squared (e'**2): 0.006739496742276
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
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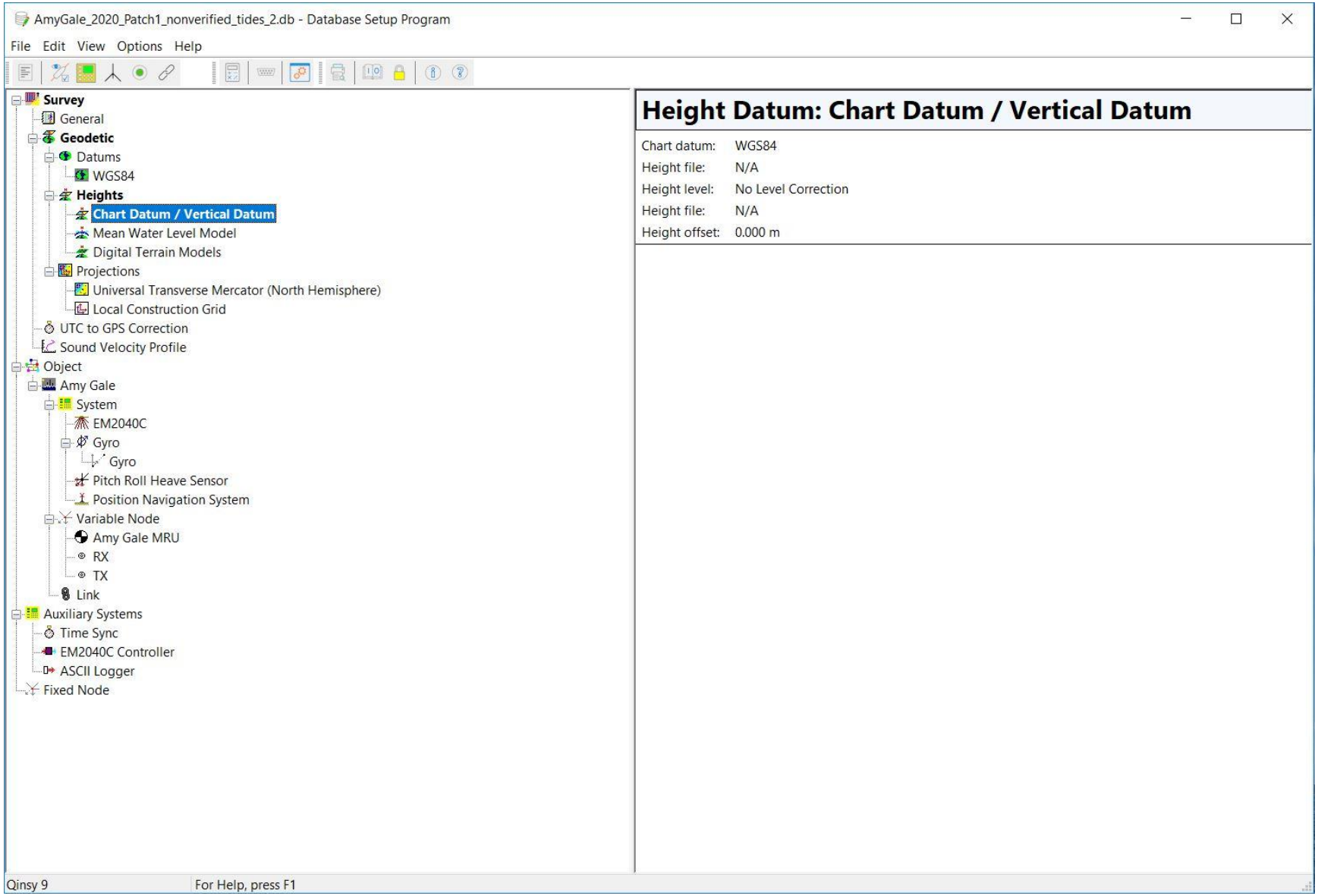
Heights: Heights
Chart datum: WGS84
Height file: N/A
Height level: No Level Correction
Height file: N/A
Height offset: 0.000 m
MWL model: Horizontal Datum
MWL file: N/A
MWL level: No Level Correction
MWL file: N/A
MWL offset: 0.000 m
MWL st.dev.: 0.000 m
DTM mode: Absolute DTMs
DTM datum: WGS84
DTM file: N/A
DTM level: No Level Correction
DTM file: N/A
DTM offset: 0.000 m
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
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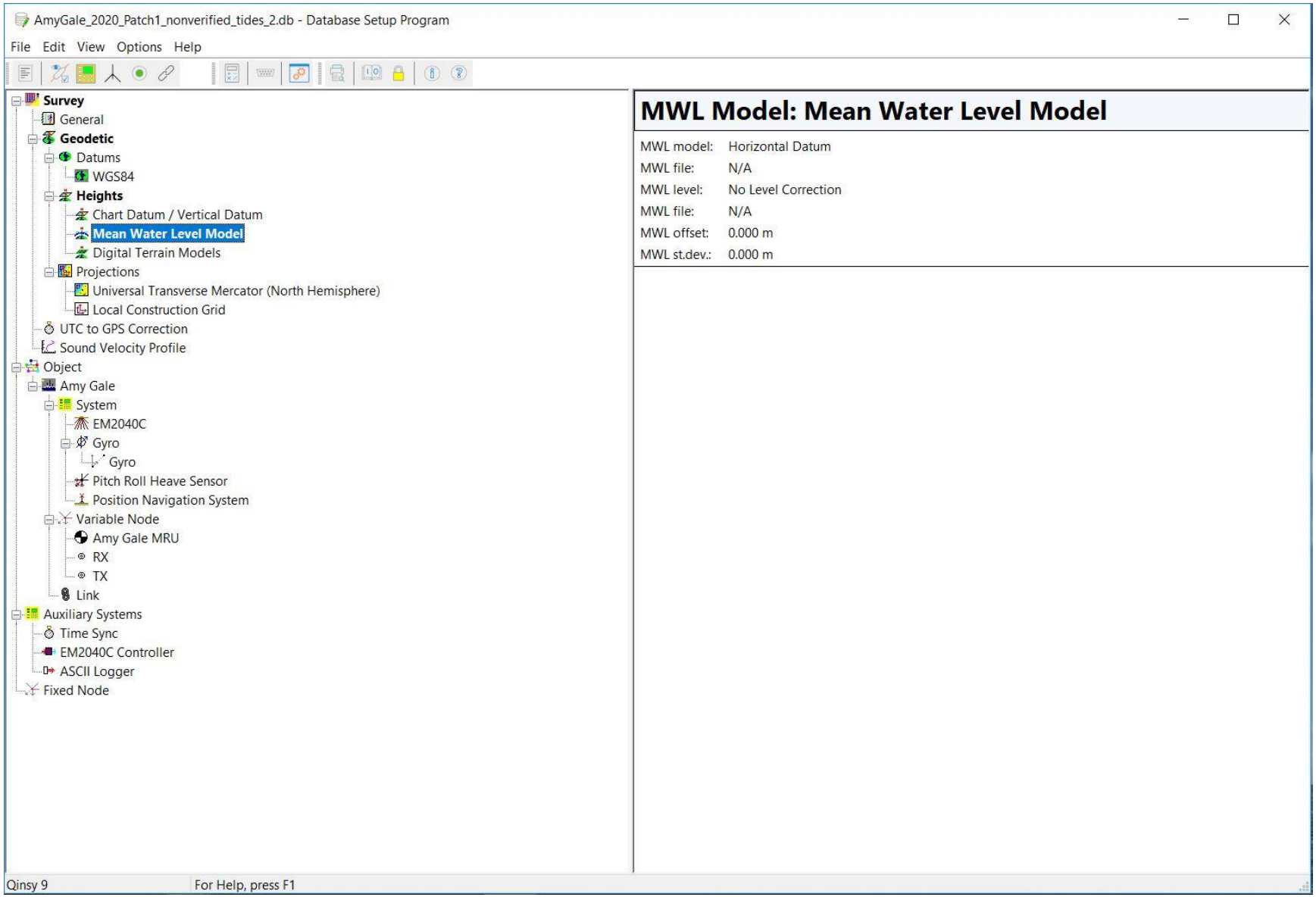
Height Datum: Chart Datum / Vertical Datum
Chart datum: WGS84
Height file: N/A
Height level: No Level Correction
Height file: N/A
Height offset: 0.000 m
Qinsy 9
For Help, press F1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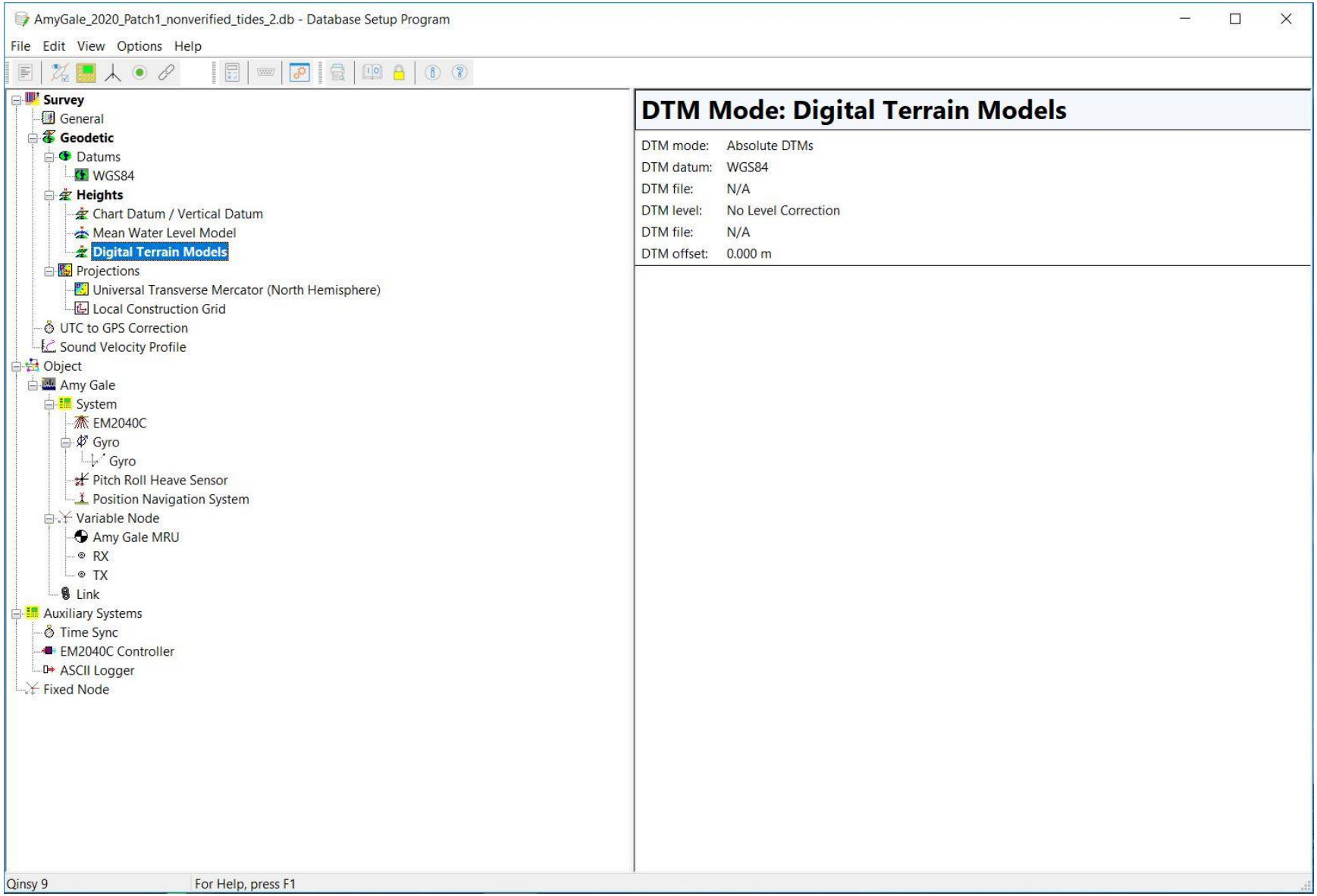
MWL Model: Mean Water Level Model
MWL model: Horizontal Datum
MWL file: N/A
MWL level: No Level Correction
MWL file: N/A
MWL offset: 0.000 m
MWL st.dev.: 0.000 m
Qinsy 9
For Help, press F1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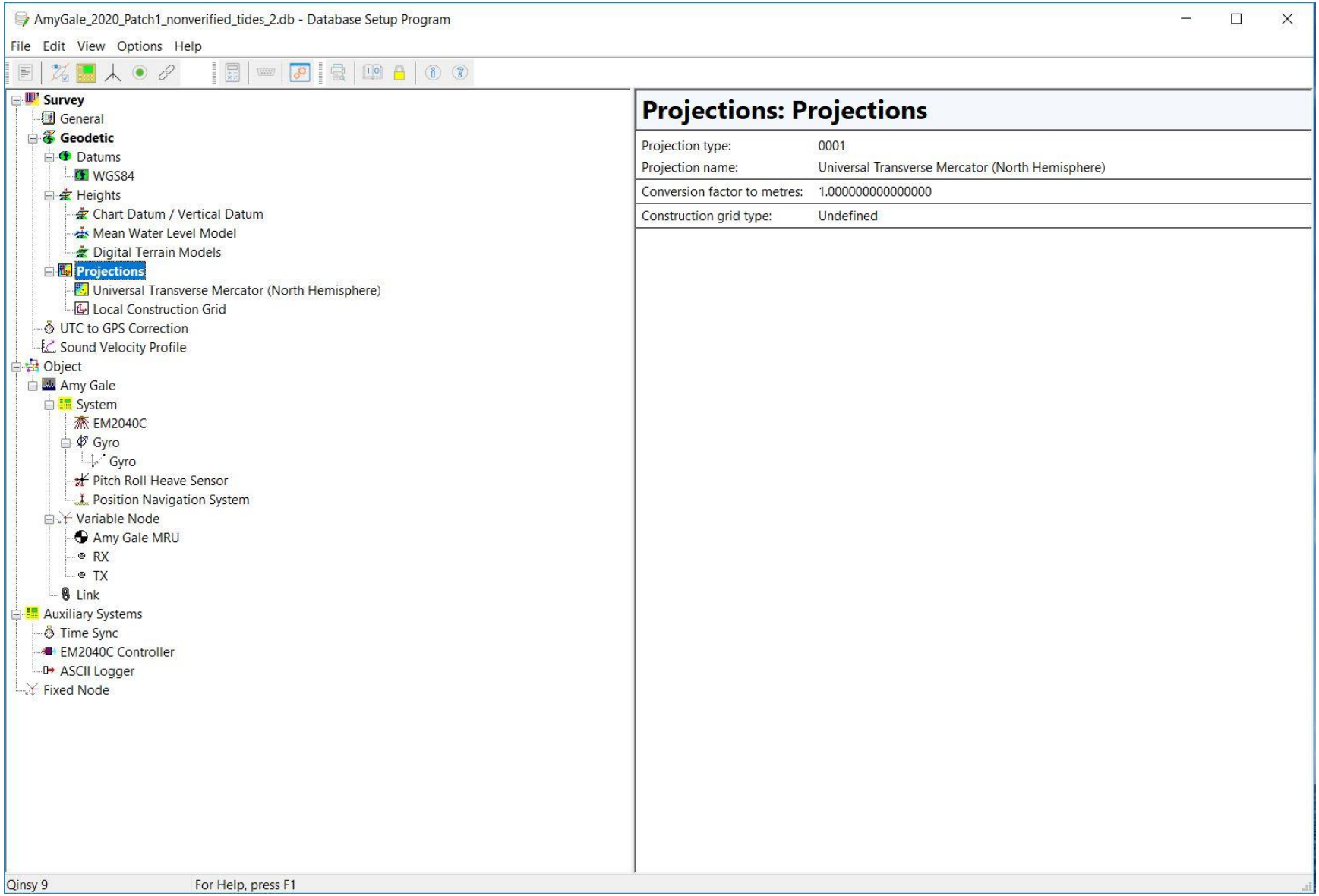
DTM Mode: Digital Terrain Models
DTM mode: Absolute DTMs
DTM datum: WGS84
DTM file: N/A
DTM level: No Level Correction
DTM file: N/A
DTM offset: 0.000 m
Qinsy 9
For Help, press F1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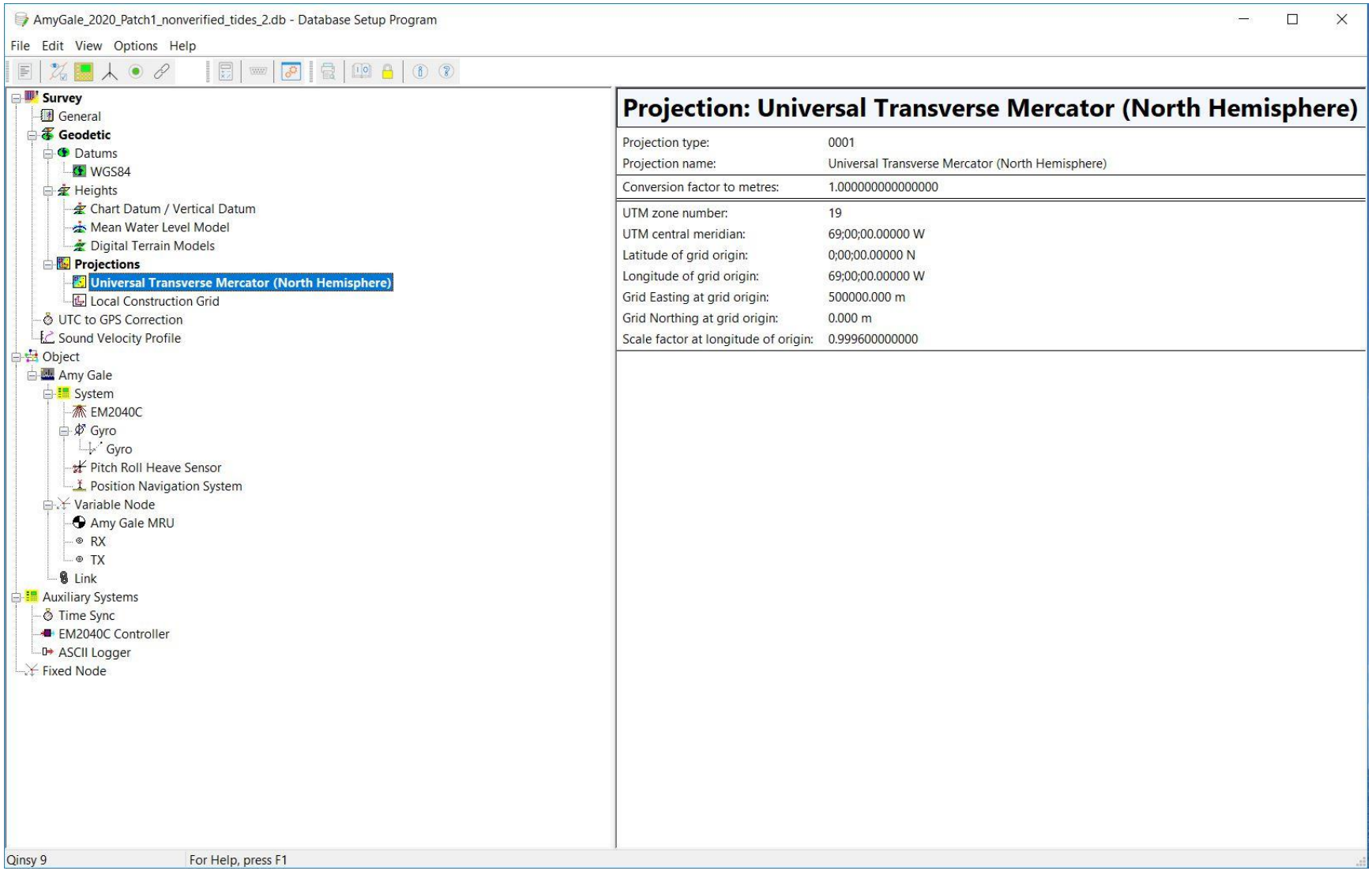
Projections: Projections
Projection type: 0001
Projection name: Universal Transverse Mercator (North Hemisphere)
Conversion factor to metres: 1.000000000000000
Construction grid type: Undefined
Qinsy 9
For Help, press F1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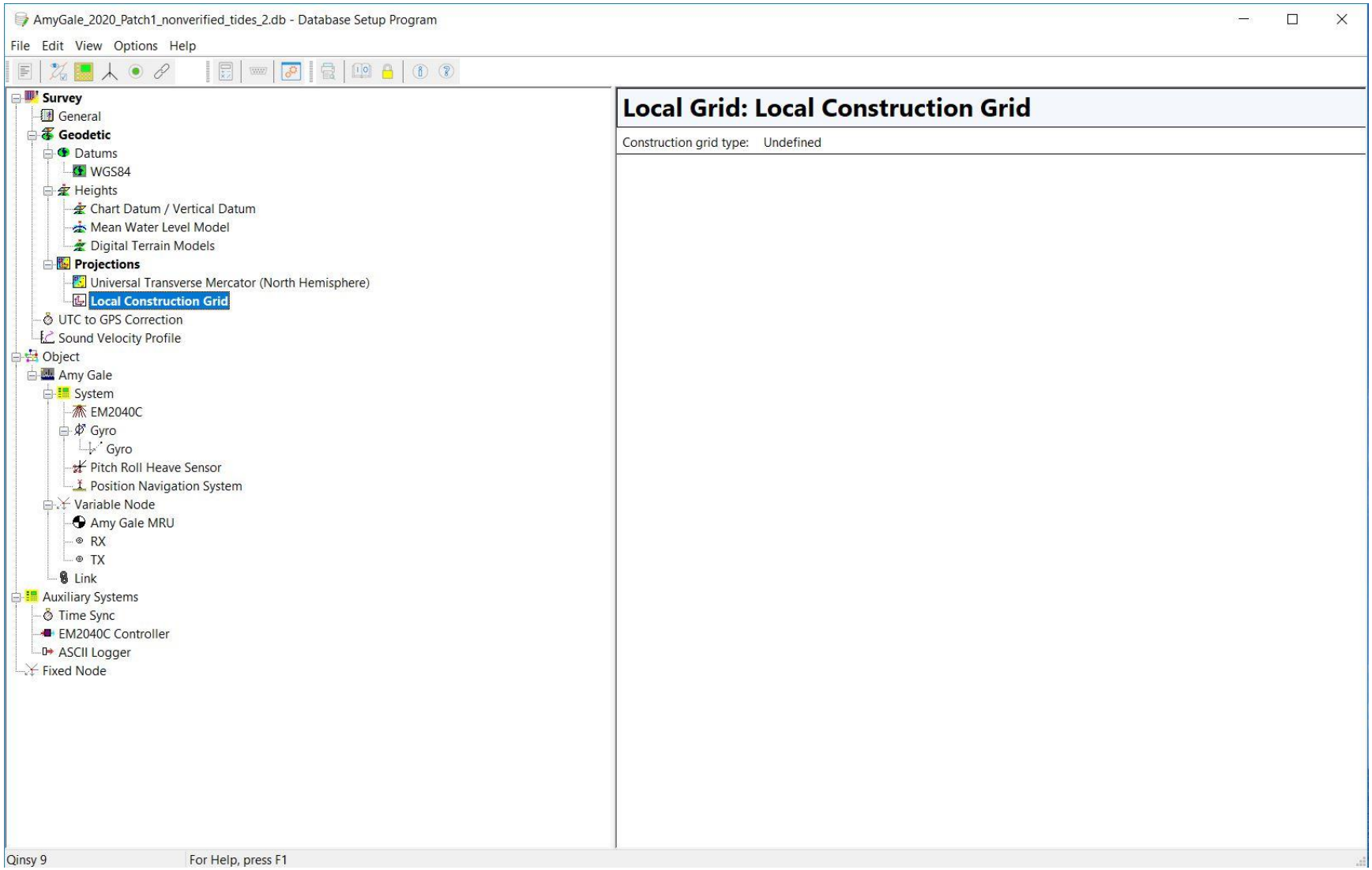
Projection: Universal Transverse Mercator (North Hemisphere)
Projection type: 0001
Projection name: Universal Transverse Mercator (North Hemisphere)
Conversion factor to metres: 1.000000000000000
UTM zone number: 19
UTM central meridian: 69;00;00.00000 W
Latitude of grid origin: 0;00;00.00000 N
Longitude of grid origin: 69;00;00.00000 W
Grid Easting at grid origin: 500000.000 m
Grid Northing at grid origin: 0.000 m
Scale factor at longitude of origin: 0.999600000000
Qinsy 9
For Help, press F1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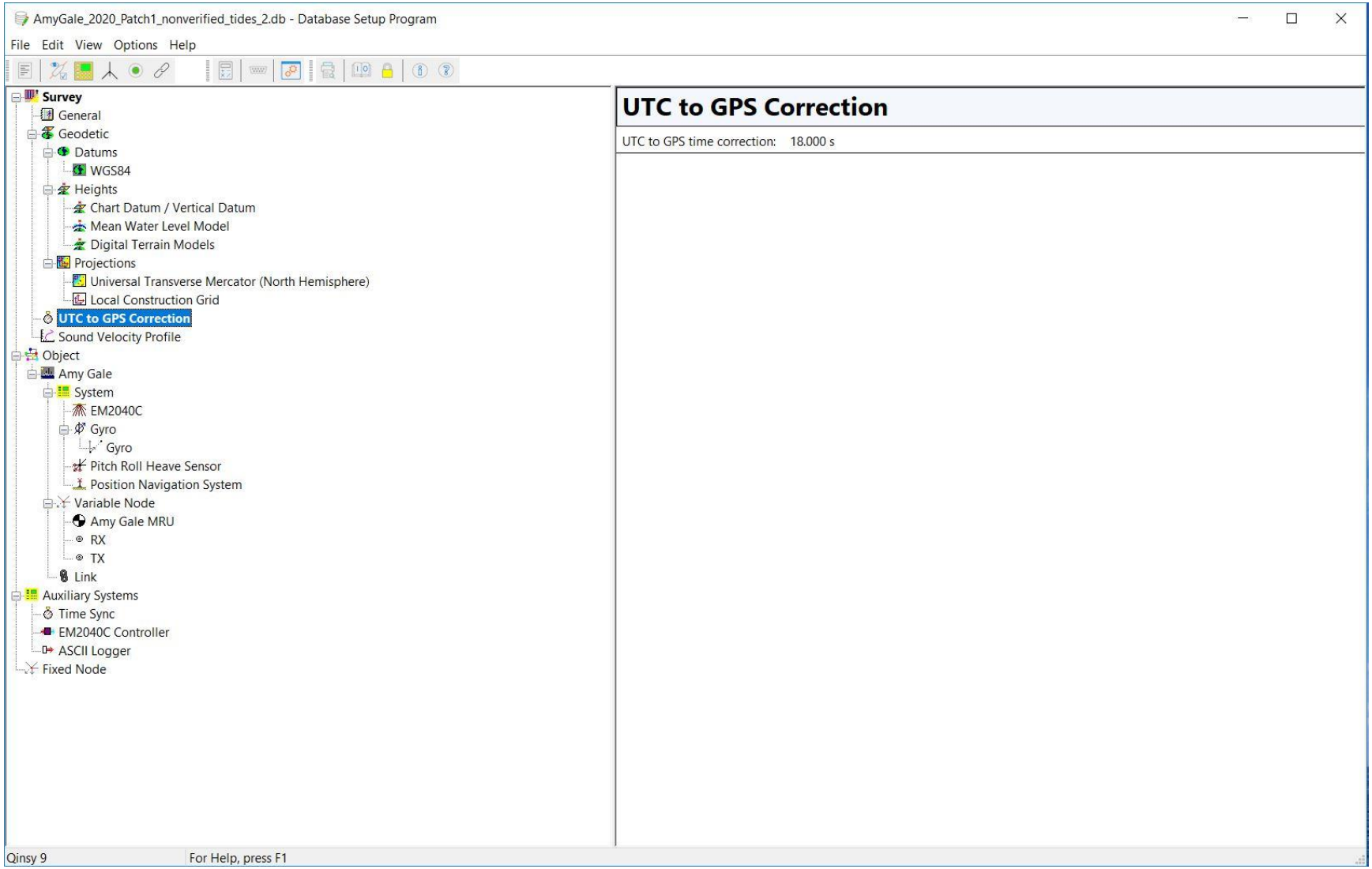
Local Grid: Local Construction Grid
Construction grid type: Undefined
Qinsy 9
For Help, press F1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UTC to GPS time correction: 18.000 s
Qinsy 9
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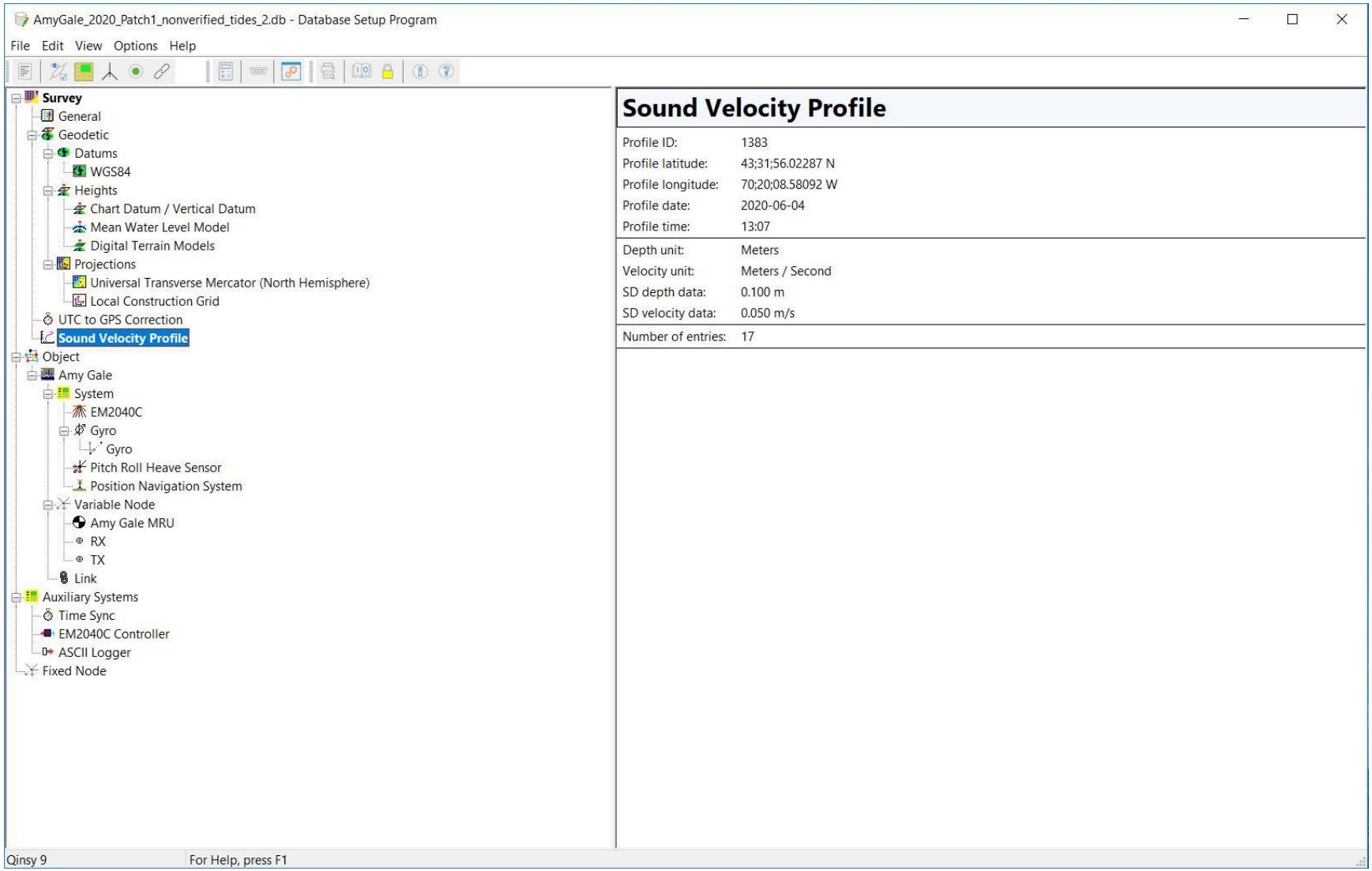
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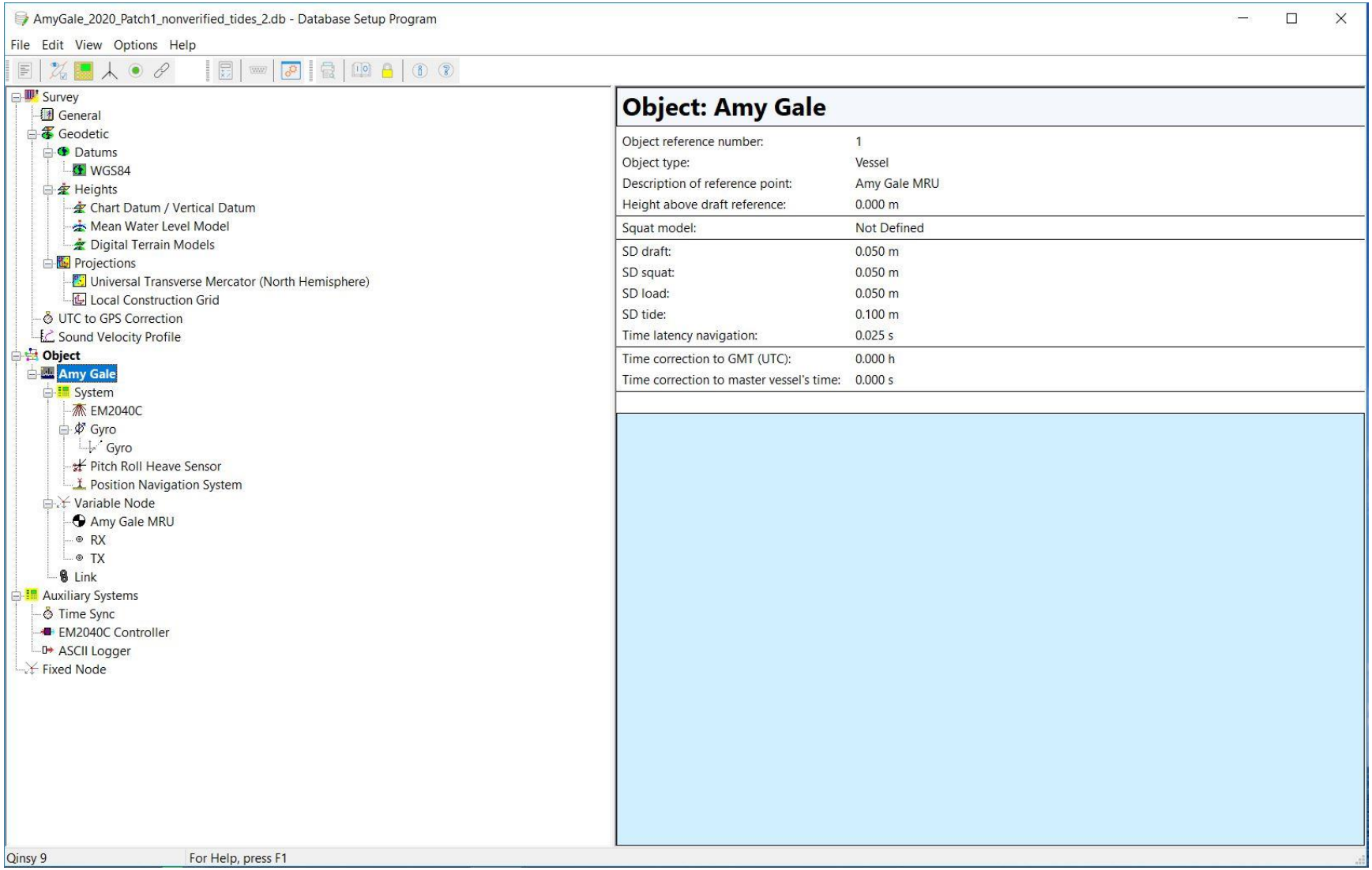
Profile ID: 1383
Profile latitude: 43;31;56.02287 N
Profile longitude: 70;20;08.58092 W
Profile date: 2020-06-04
Profile time: 13:07
Depth unit: Meters
Velocity unit: Meters / Second
SD depth data: 0.100 m
SD velocity data: 0.050 m/s
Number of entries: 17
Qinsy 9
For Help, press F1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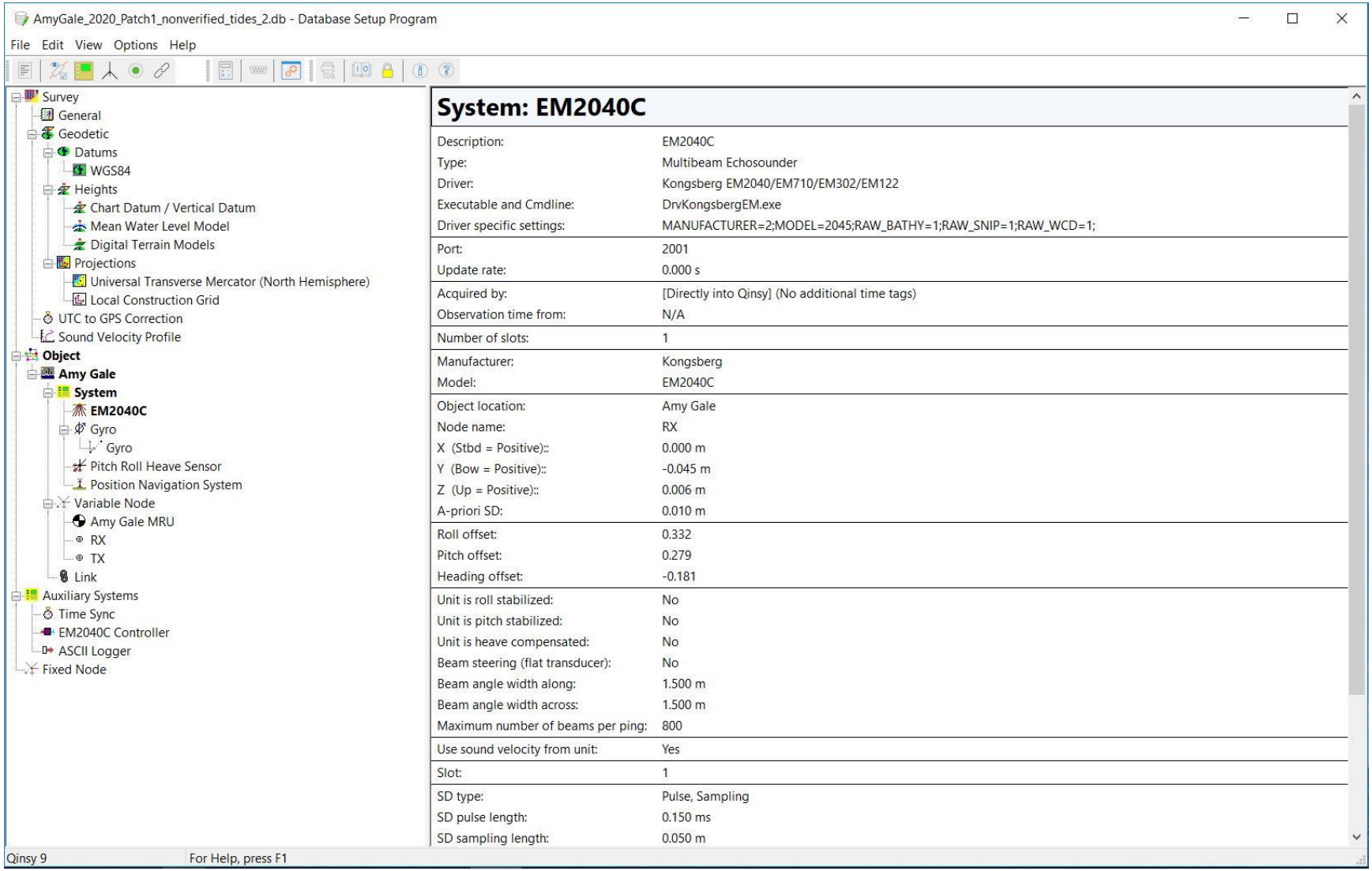
Object: Amy Gale
Object reference number: 1
Object type: Vessel
Description of reference point: Amy Gale MRU
Height above draft reference: 0.000 m
Squat model: Not Defined
SD draft: 0.050 m
SD squat: 0.050 m
SD load: 0.050 m
SD tide: 0.100 m
Time latency navigation: 0.025 s
Time correction to GMT (UTC): 0.000 h
Time correction to master vessel's time: 0.000 s
Qinsy 9
For Help, press F1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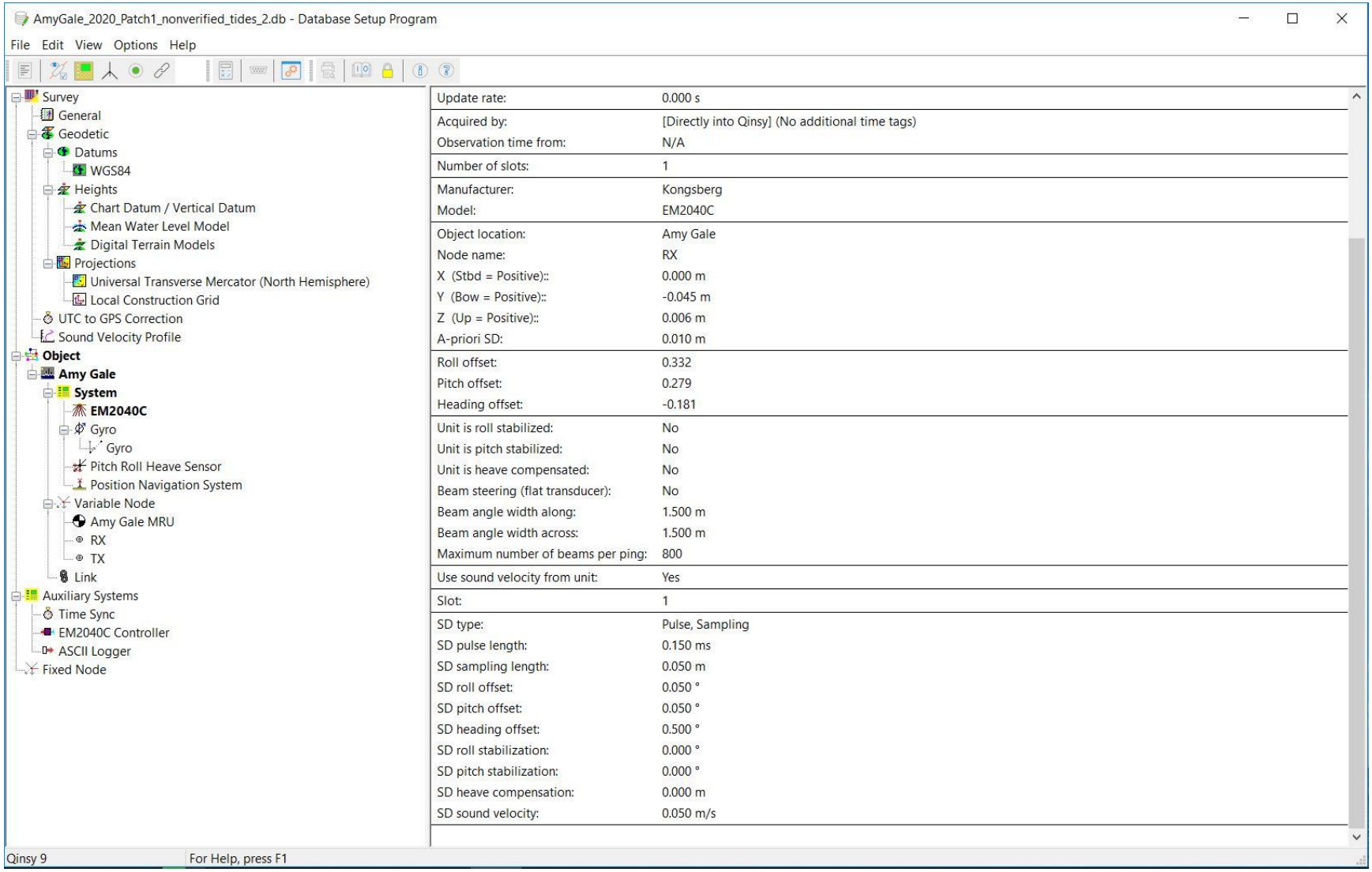
Fixed Node
System: EM2040C
Description: EM2040C
Type: Multibeam Echosounder
Driver: Kongsberg EM2040/EM710/EM302/EM122
Executable and Cmdline: DrvKongsbergEM.exe
Driver specific settings: MANUFACTURER=2;MODEL=2045;RAW_BATHY=1;RAW_SNIP=1;RAW_WCD=1;
Port: 2001
Update rate: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 1
Manufacturer: Kongsberg
Model: EM2040C
Object location: Amy Gale
Node name: RX
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: -0.045 m
Z (Up = Positive):: 0.006 m
A-priori SD: 0.010 m
Roll offset: 0.332
Pitch offset: 0.279
Heading offset: -0.181
Unit is roll stabilized: No
Unit is pitch stabilized: No
Unit is heave compensated: No
Beam steering (flat transducer): No
Beam angle width along: 1.500 m
Beam angle width across: 1.500 m
Maximum number of beams per ping: 800
Use sound velocity from unit: Yes
Slot: 1
SD type: Pulse, Sampling
SD pulse length: 0.150 ms
SD sampling length: 0.050 m
Qinsy 9
For Help, press F1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Update rate: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 1
Manufacturer: Kongsberg
Model: EM2040C
Object location: Amy Gale
Node name: RX
X (Stbd = Positive):: 0.000 m
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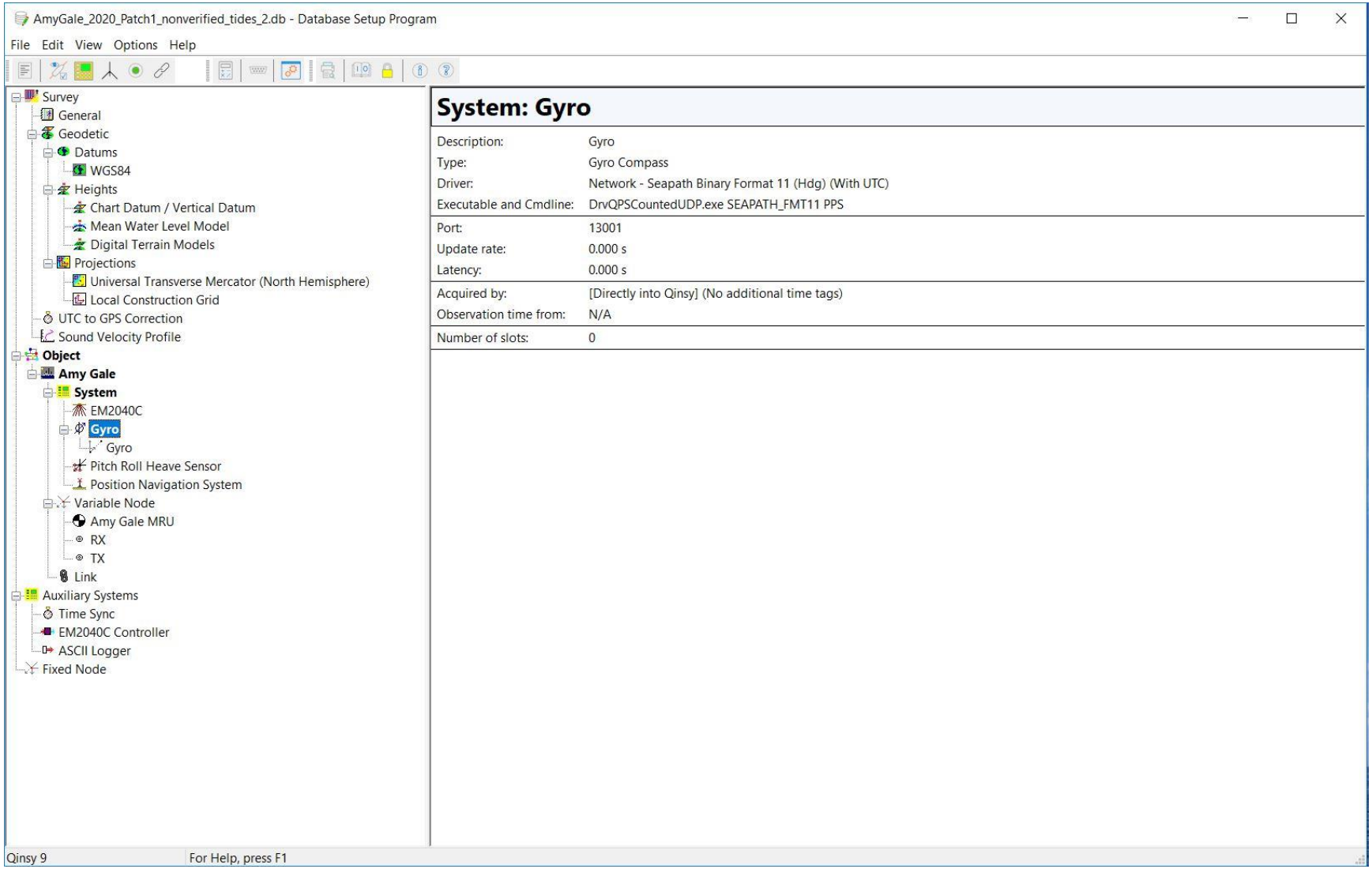
Maximum number of beams per ping: 800
Use sound velocity from unit: Yes
Slot: 1
SD type: Pulse, Sampling
SD pulse length: 0.150 ms
SD sampling length: 0.050 m
SD roll offset: 0.050 °
SD pitch offset: 0.050 °
SD heading offset: 0.500 °
SD roll stabilization: 0.000 °
SD pitch stabilization: 0.000 °
SD heave compensation: 0.000 m
SD sound velocity: 0.050 m/s
Qinsy 9
For Help, press F1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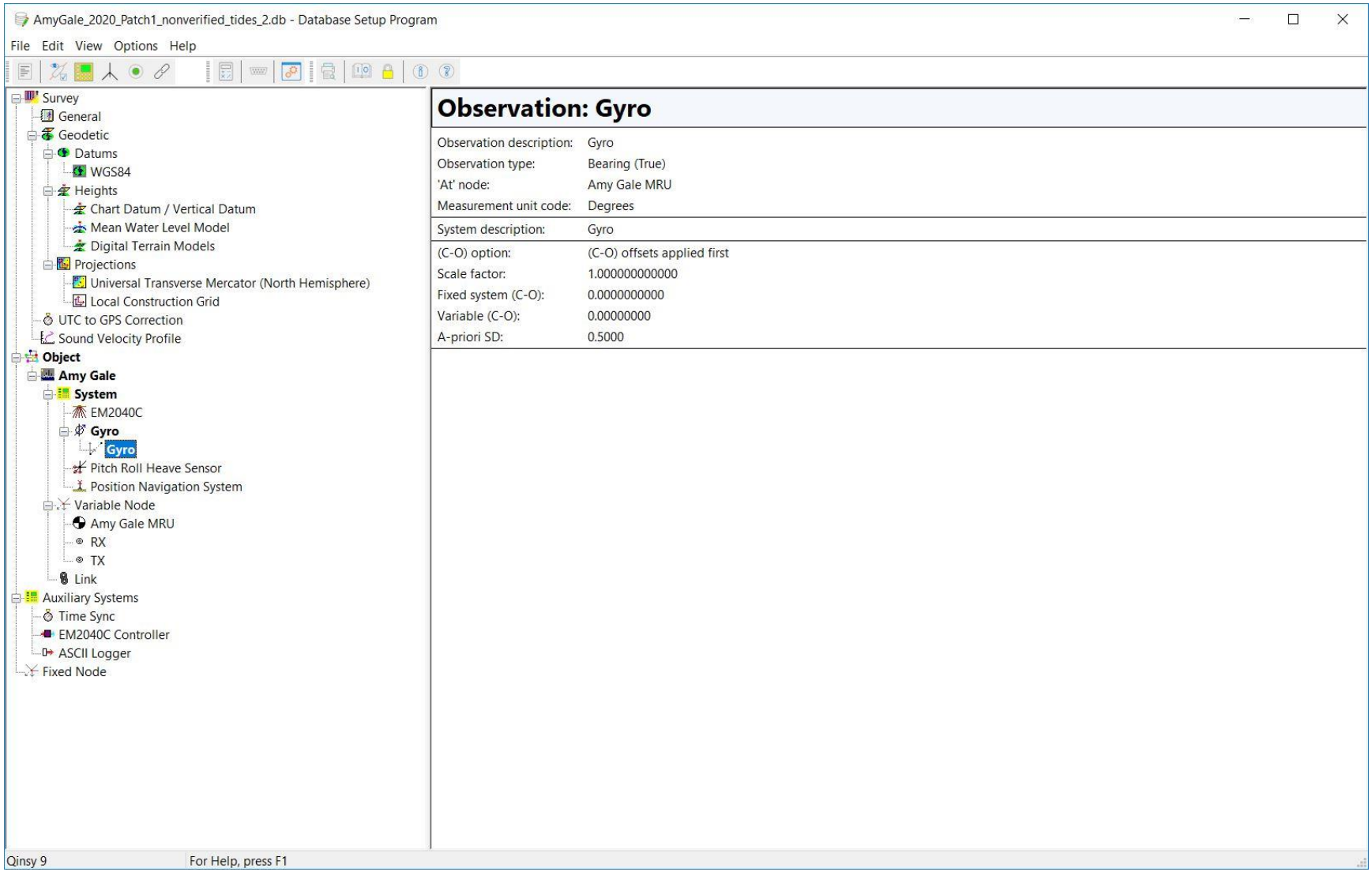
Fixed Node
System: Gyro
Description: Gyro
Type: Gyro Compass
Driver: Network - Seapath Binary Format 11 (Hdg) (With UTC)
Executable and Cmdline: DrvQPSCountedUDP.exe SEAPATH_FMT11 PPS
Port: 13001
Update rate: 0.000 s
Latency: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Qinsy 9
For Help, press F1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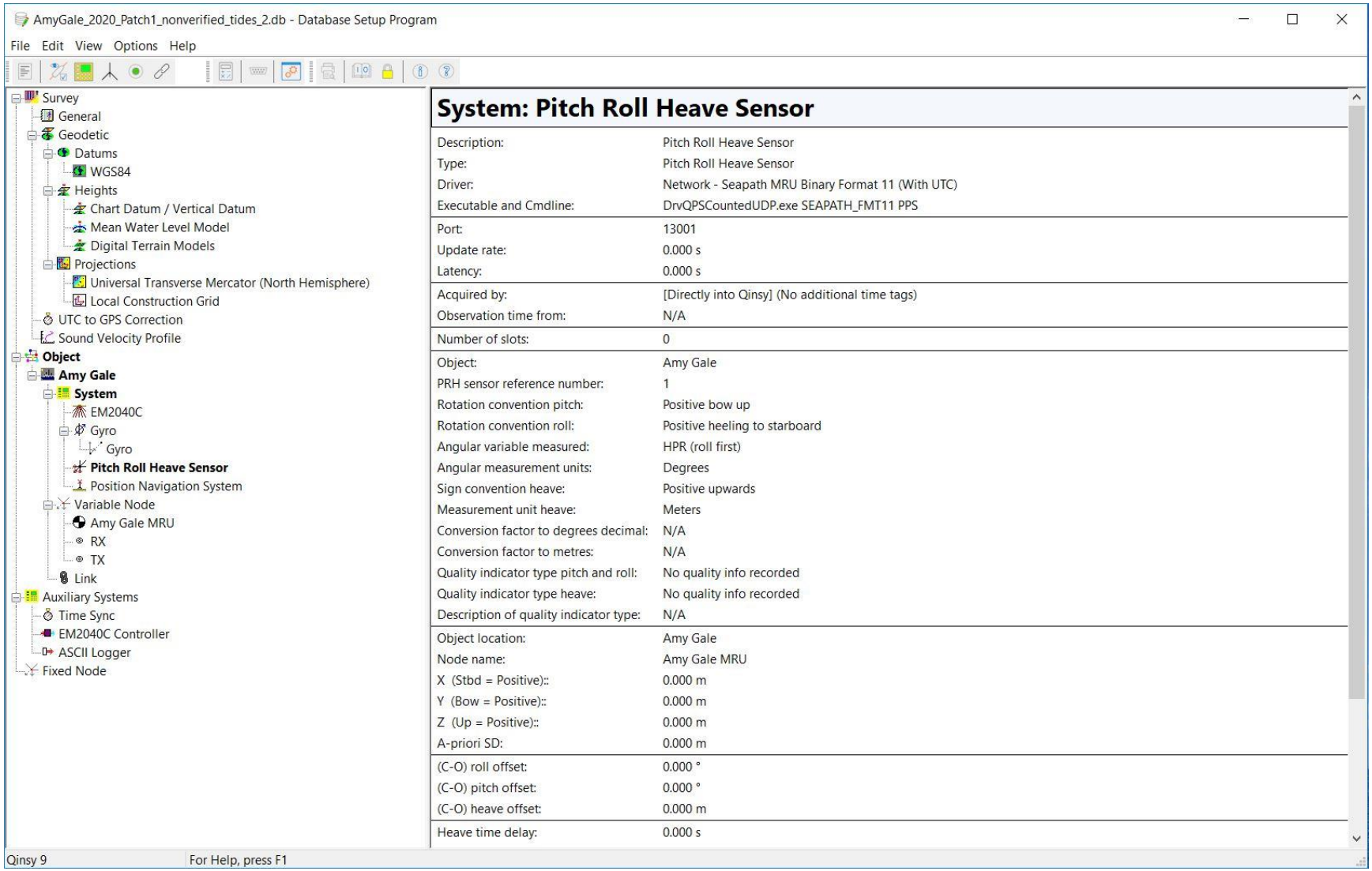
Observation: Gyro
Observation description: Gyro
Observation type: Bearing (True)
'At' node: Amy Gale MRU
Measurement unit code: Degrees
System description: Gyro
(C-O) option: (C-O) offsets applied first
Scale factor: 1.000000000000
Fixed system (C-O): 0.0000000000
Variable (C-O): 0.00000000
A-priori SD: 0.5000
Qinsy 9
For Help, press F1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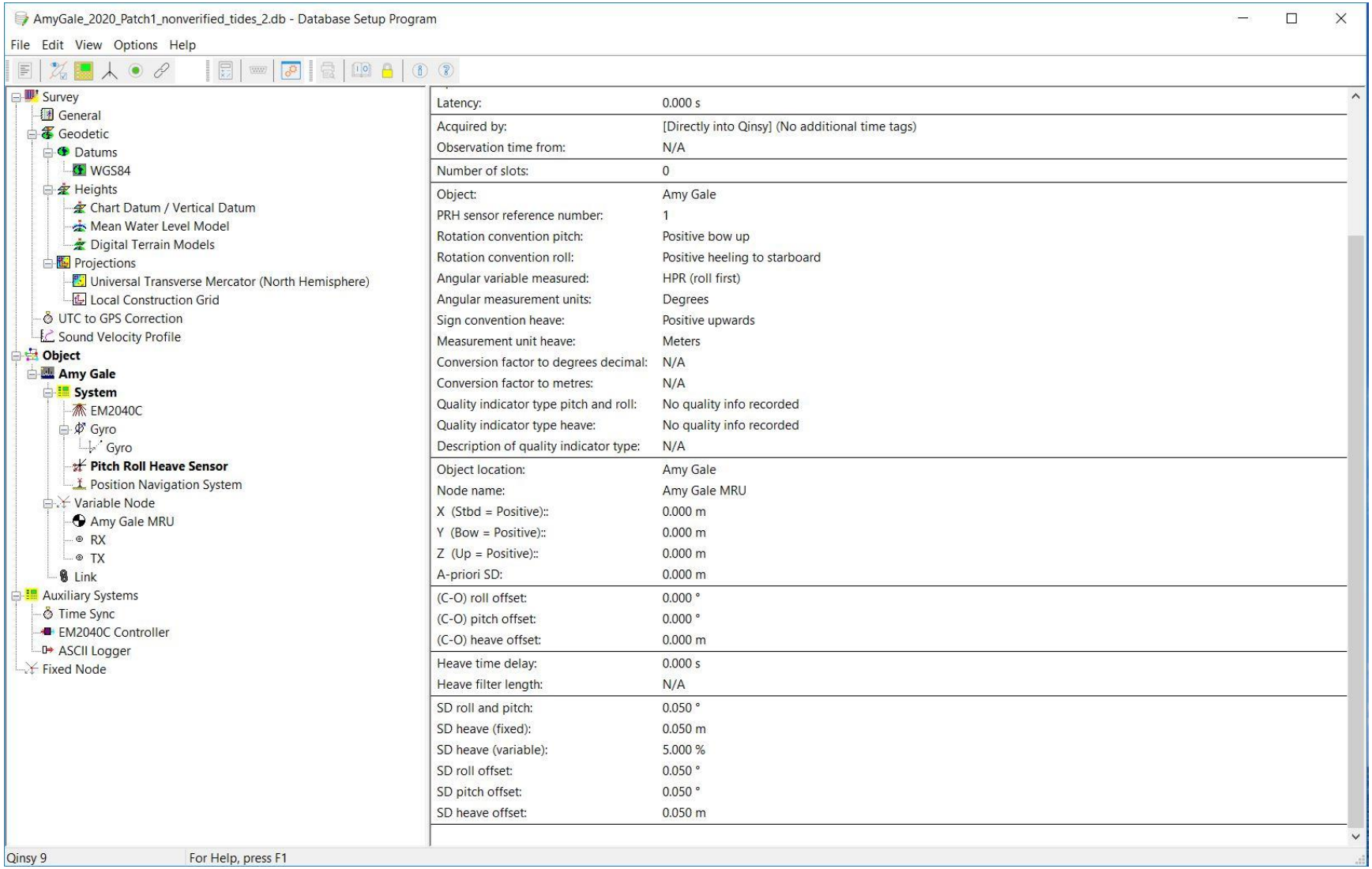
System: Pitch Roll Heave Sensor
Description: Pitch Roll Heave Sensor
Type: Pitch Roll Heave Sensor
Driver: Network - Seapath MRU Binary Format 11 (With UTC)
Executable and Cmdline: DrvQPSCountedUDP.exe SEAPATH_FMT11 PPS
Port: 13001
Update rate: 0.000 s
Latency: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Object: Amy Gale
PRH sensor reference number: 1
Rotation convention pitch: Positive bow up
Rotation convention roll: Positive heeling to starboard
Angular variable measured: HPR (roll first)
Angular measurement units: Degrees
Sign convention heave: Positive upwards
Measurement unit heave: Meters
Conversion factor to degrees decimal: N/A
Conversion factor to metres: N/A
Quality indicator type pitch and roll: No quality info recorded
Quality indicator type heave: No quality info recorded
Description of quality indicator type: N/A
Object location: Amy Gale
Node name: Amy Gale MRU
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: 0.000 m
Z (Up = Positive):: 0.000 m
A-priori SD: 0.000 m
(C-O) roll offset: 0.000 °
(C-O) pitch offset: 0.000 °
(C-O) heave offset: 0.000 m
Heave time delay: 0.000 s
Qinsy 9
For Help, press F1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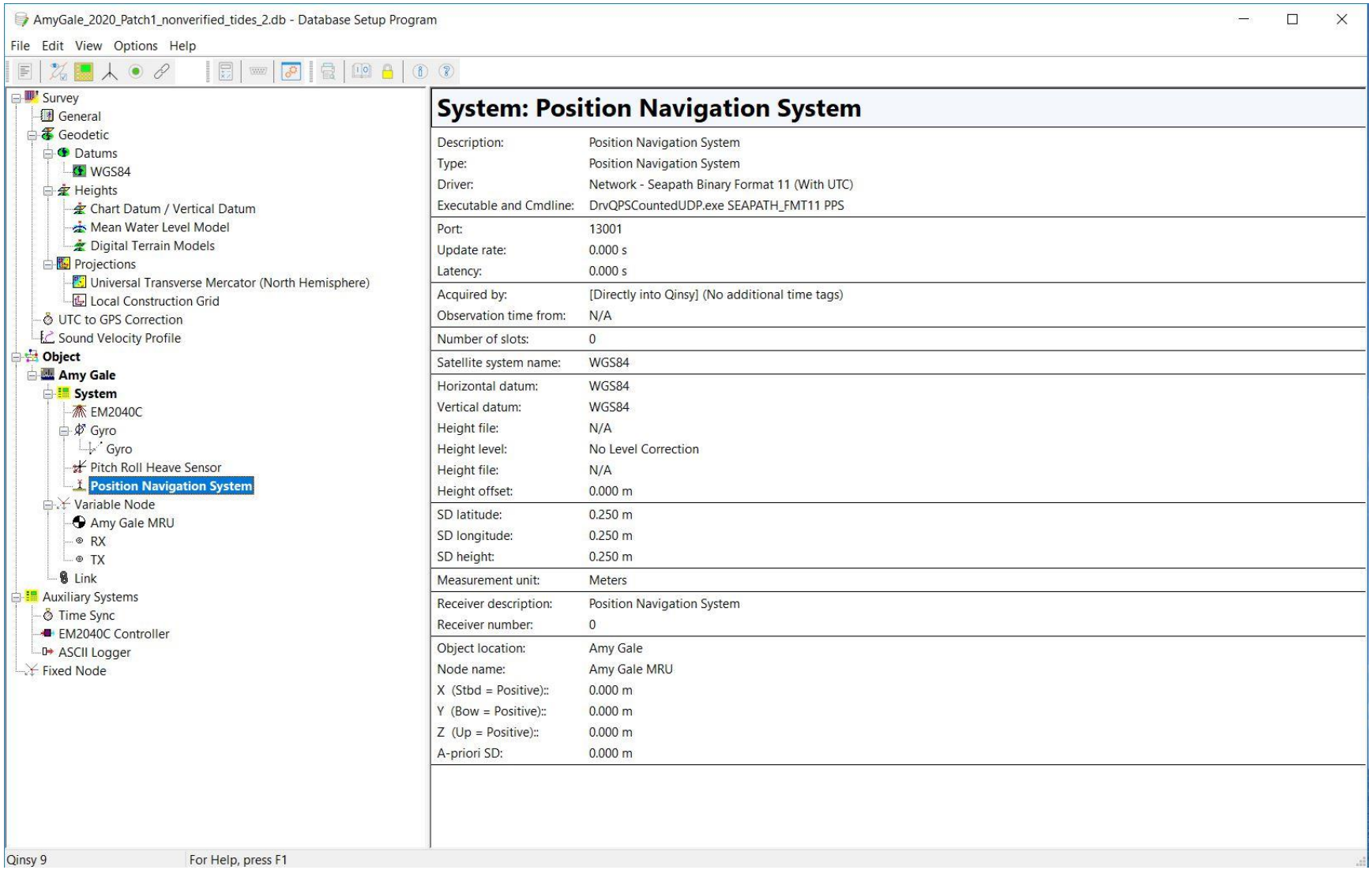
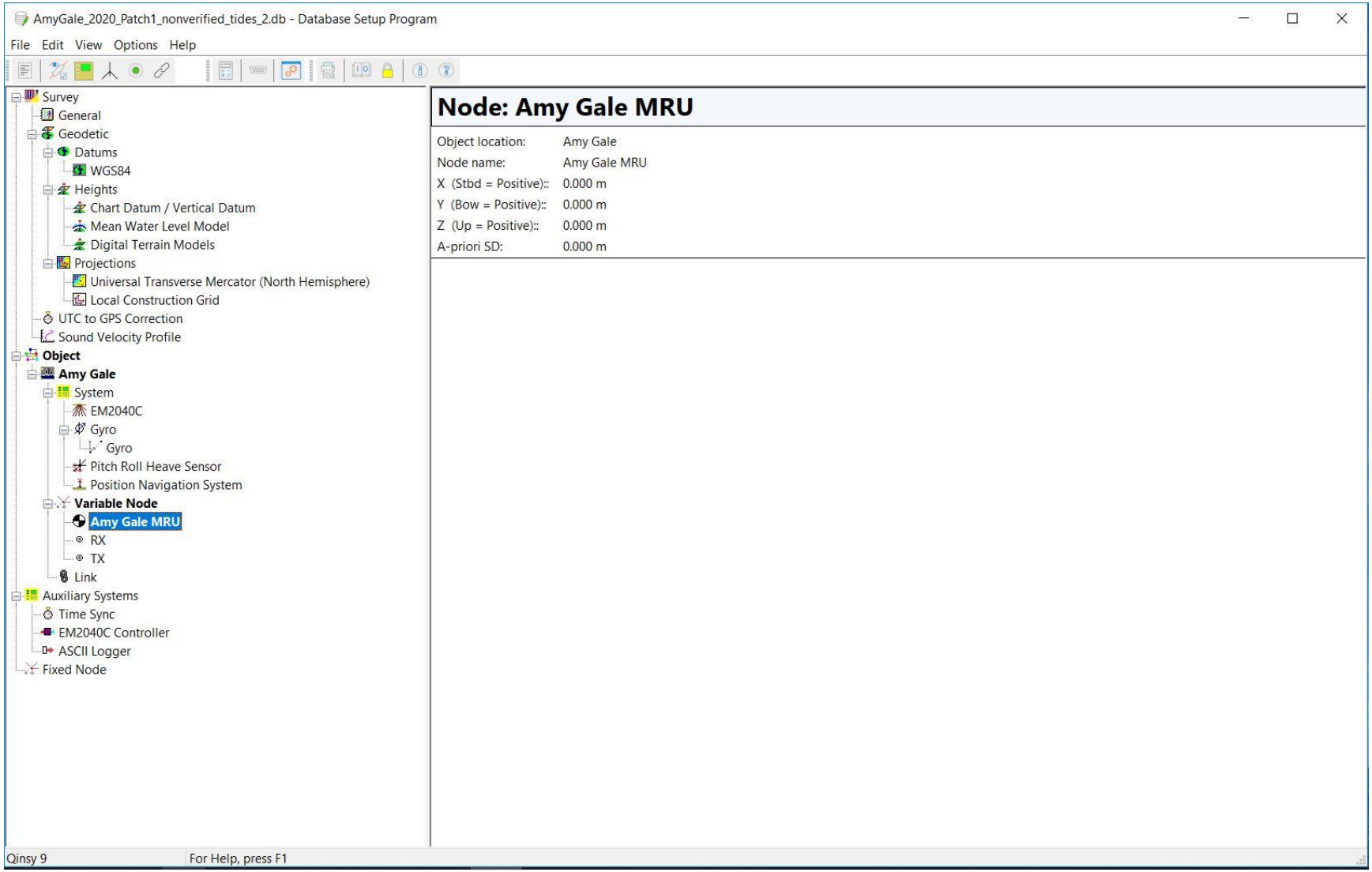
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Latency: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Object: Amy Gale
PRH sensor reference number: 1
Rotation convention pitch: Positive bow up
Rotation convention roll: Positive heeling to starboard
Angular variable measured: HPR (roll first)
Angular measurement units: Degrees
Sign convention heave: Positive upwards
Measurement unit heave: Meters
Conversion factor to degrees decimal: N/A
Conversion factor to metres: N/A
Quality indicator type pitch and roll: No quality info recorded
Quality indicator type heave: No quality info recorded
Description of quality indicator type: N/A
Object location: Amy Gale
Node name: Amy Gale MRU
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: 0.000 m
Z (Up = Positive):: 0.000 m
A-priori SD: 0.000 m
(C-O) roll offset: 0.000 °
(C-O) pitch offset: 0.000 °
(C-O) heave offset: 0.000 m
Heave time delay: 0.000 s
Heave filter length: N/A
SD roll and pitch: 0.050 °
SD heave (fixed): 0.050 m
SD heave (variable): 5.000 %
SD roll offset: 0.050 °
SD pitch offset: 0.050 °
SD heave offset: 0.050 m
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
System: Position Navigation System
Description: Position Navigation System
Type: Position Navigation System
Driver: Network - Seapath Binary Format 11 (With UTC)
Executable and Cmdline: DrvQPSCountedUDP.exe SEAPATH_FMT11 PPS
Port: 13001
Update rate: 0.000 s
Latency: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Satellite system name: WGS84
Horizontal datum: WGS84
Vertical datum: WGS84
Height file: N/A
Height level: No Level Correction
Height file: N/A
Height offset: 0.000 m
SD latitude: 0.250 m
SD longitude: 0.250 m
SD height: 0.250 m
Measurement unit: Meters
Receiver description: Position Navigation System
Receiver number: 0
Object location: Amy Gale
Node name: Amy Gale MRU
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: 0.000 m
Z (Up = Positive):: 0.000 m
A-priori SD: 0.000 m
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
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Datums
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Heights
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Object
Amy Gale
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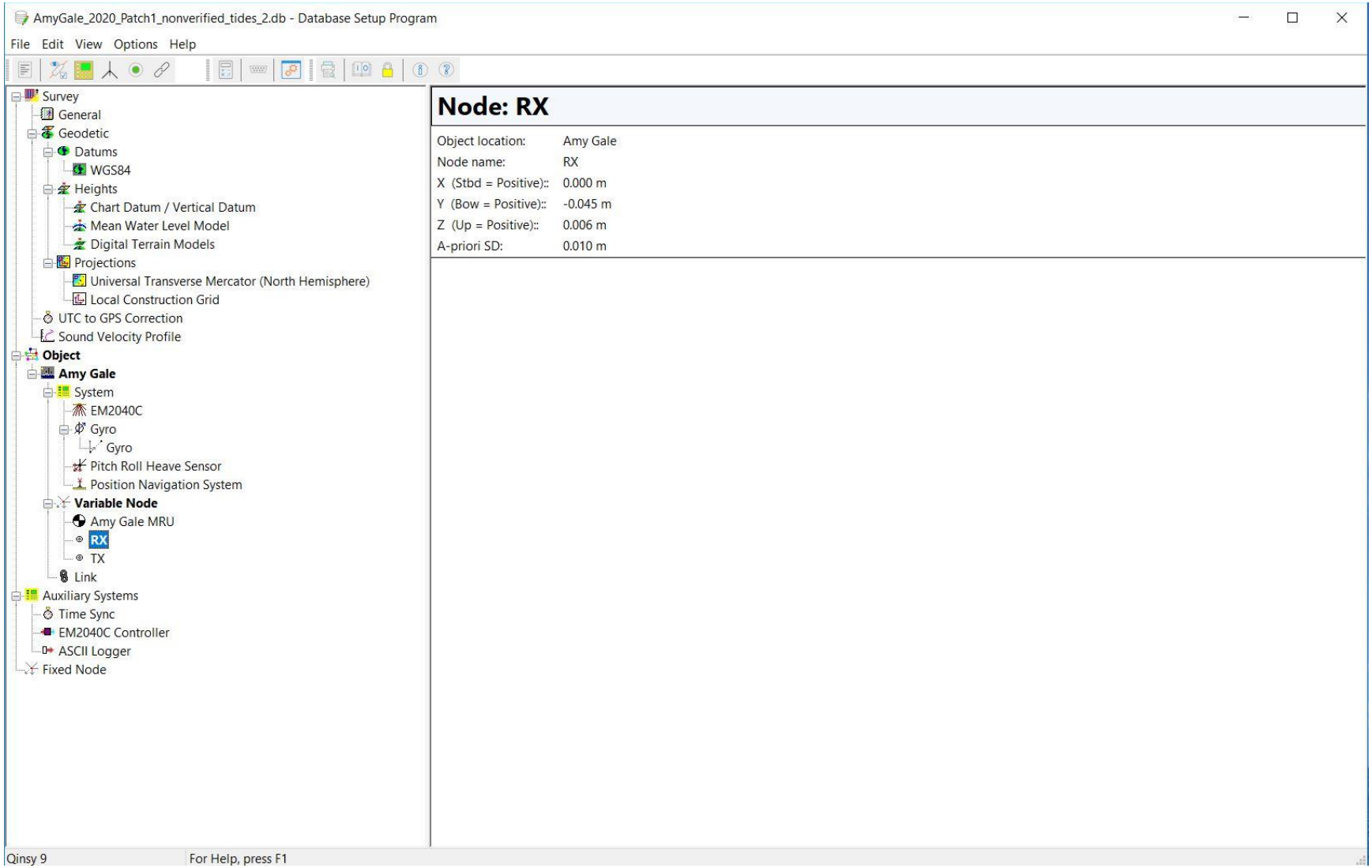
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Node: Amy Gale MRU
Object location: Amy Gale
Node name: Amy Gale MRU
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: 0.000 m
Z (Up = Positive):: 0.000 m
A-priori SD: 0.000 m
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
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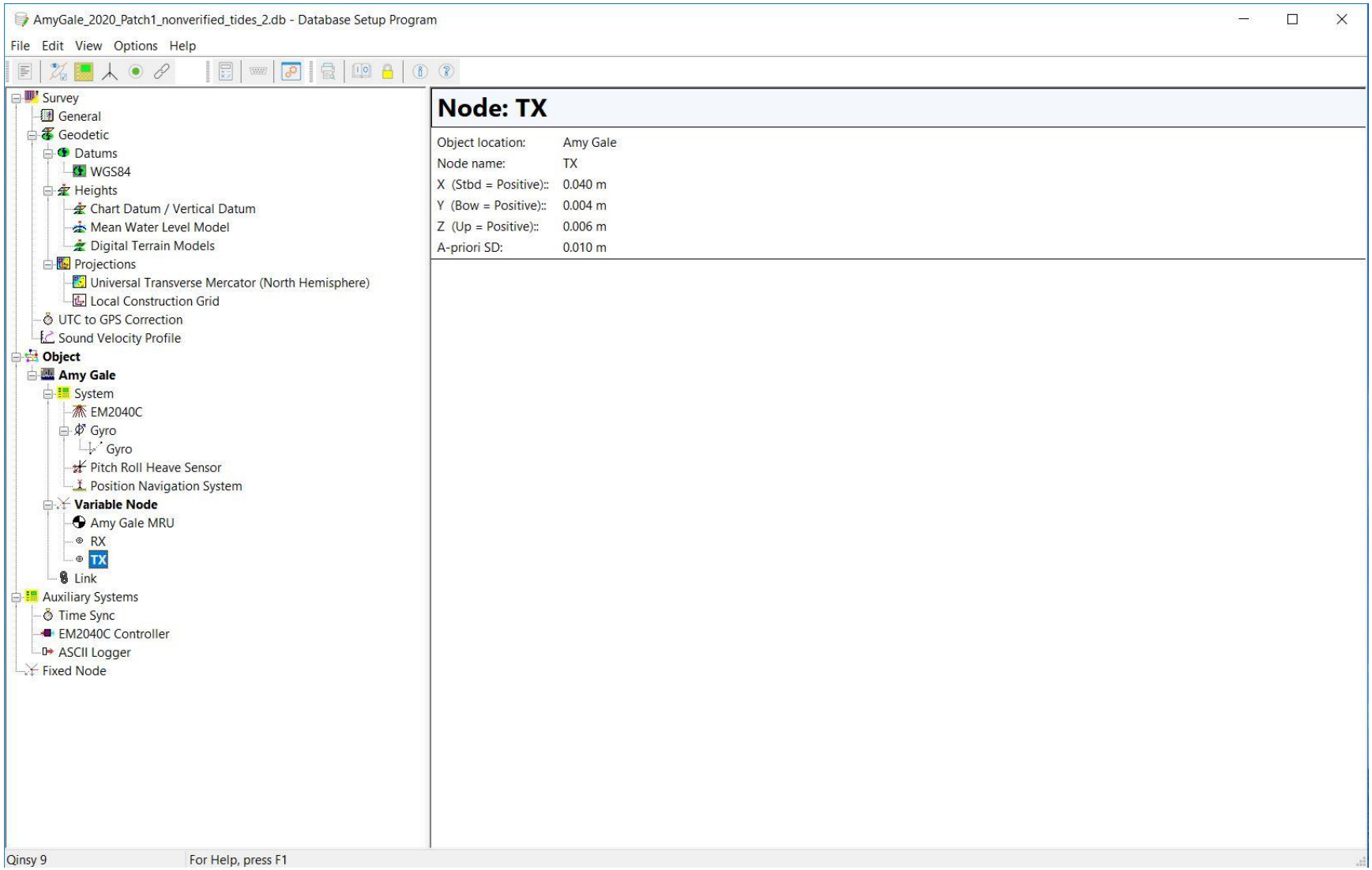
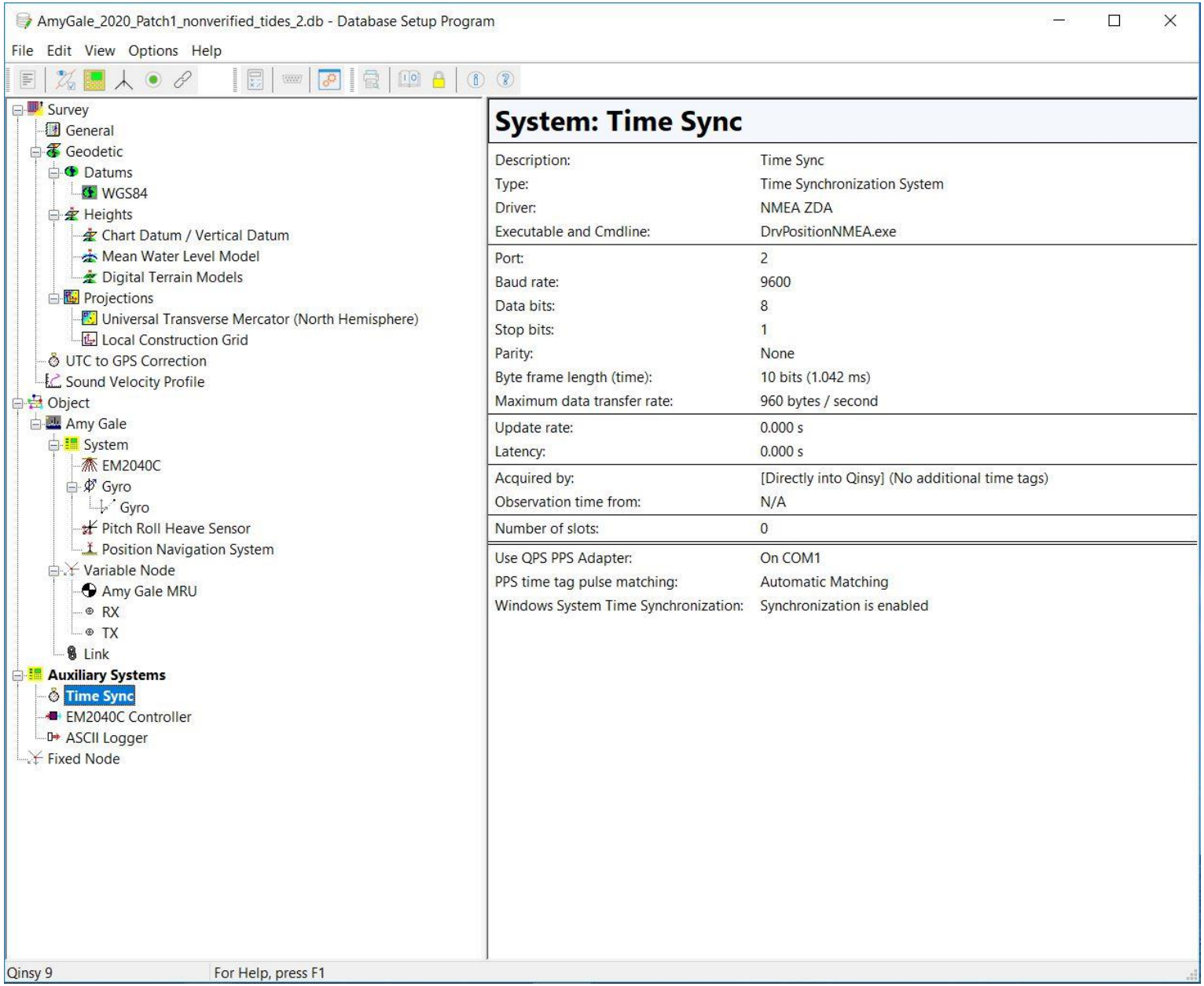
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Node: RX
Object location: Amy Gale
Node name: RX
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: -0.045 m
Z (Up = Positive):: 0.006 m
A-priori SD: 0.010 m
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Node: TX
Object location: Amy Gale
Node name: TX
X (Stbd = Positive):: 0.040 m
Y (Bow = Positive):: 0.004 m
Z (Up = Positive):: 0.006 m
A-priori SD: 0.010 m
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
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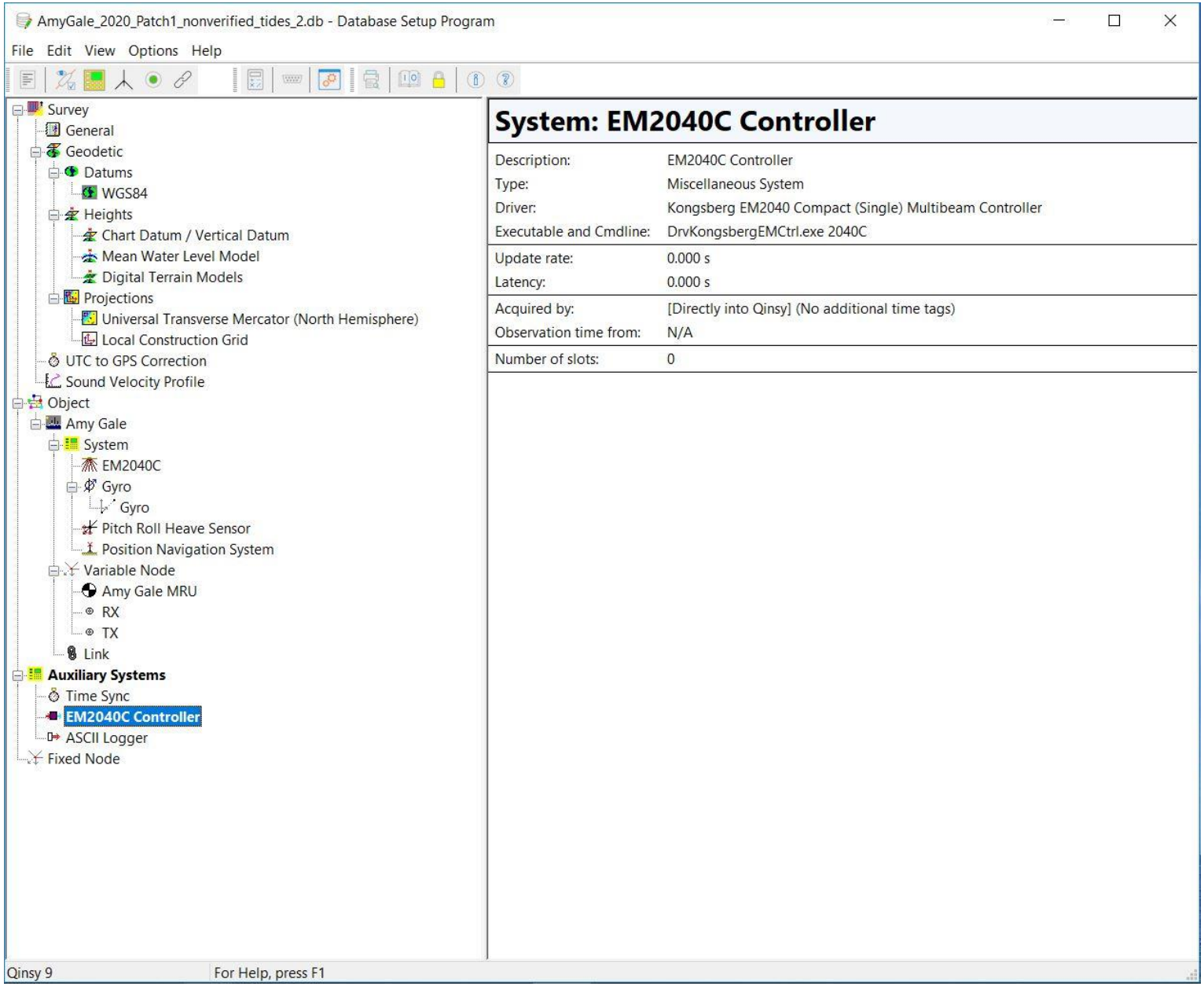
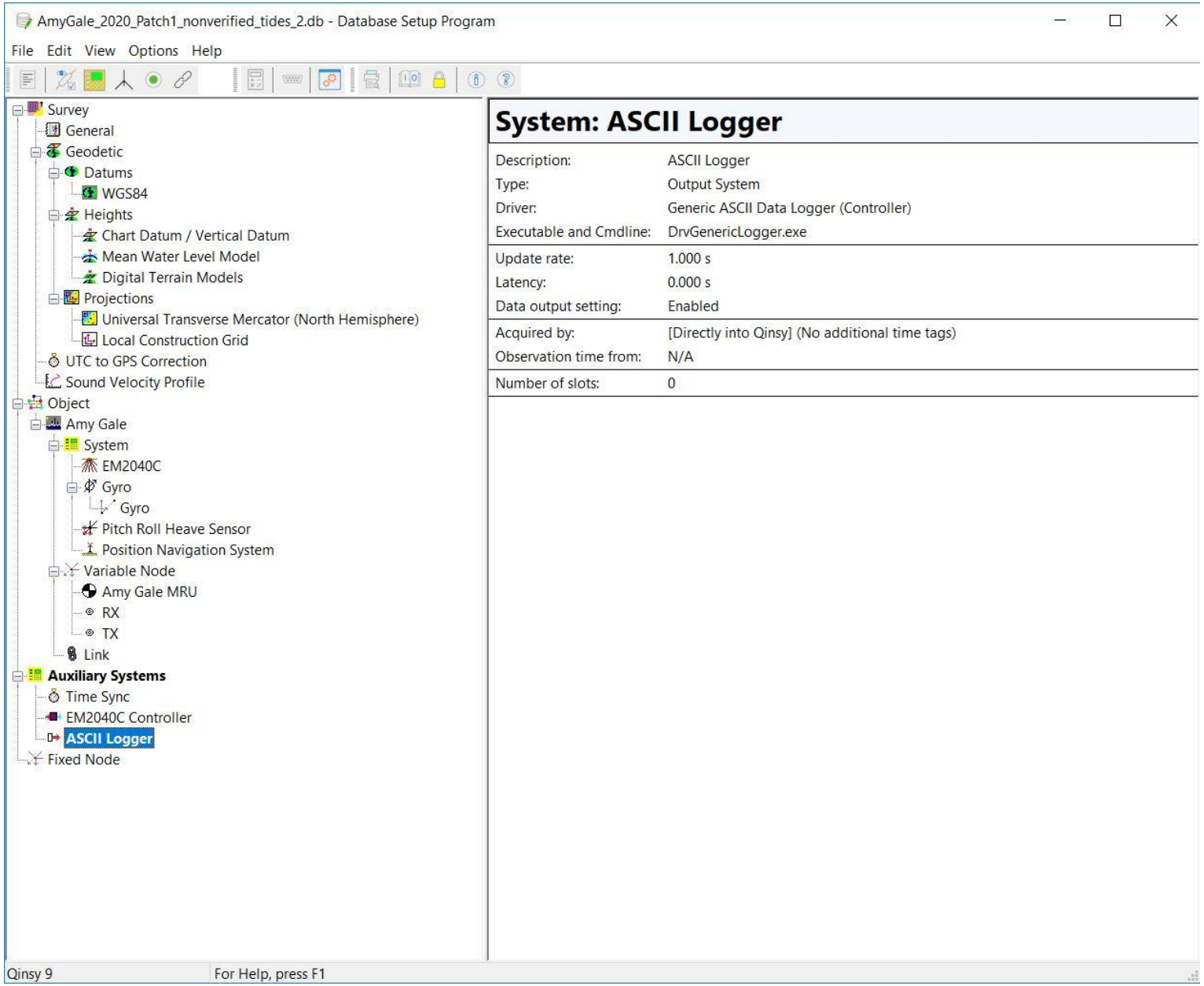
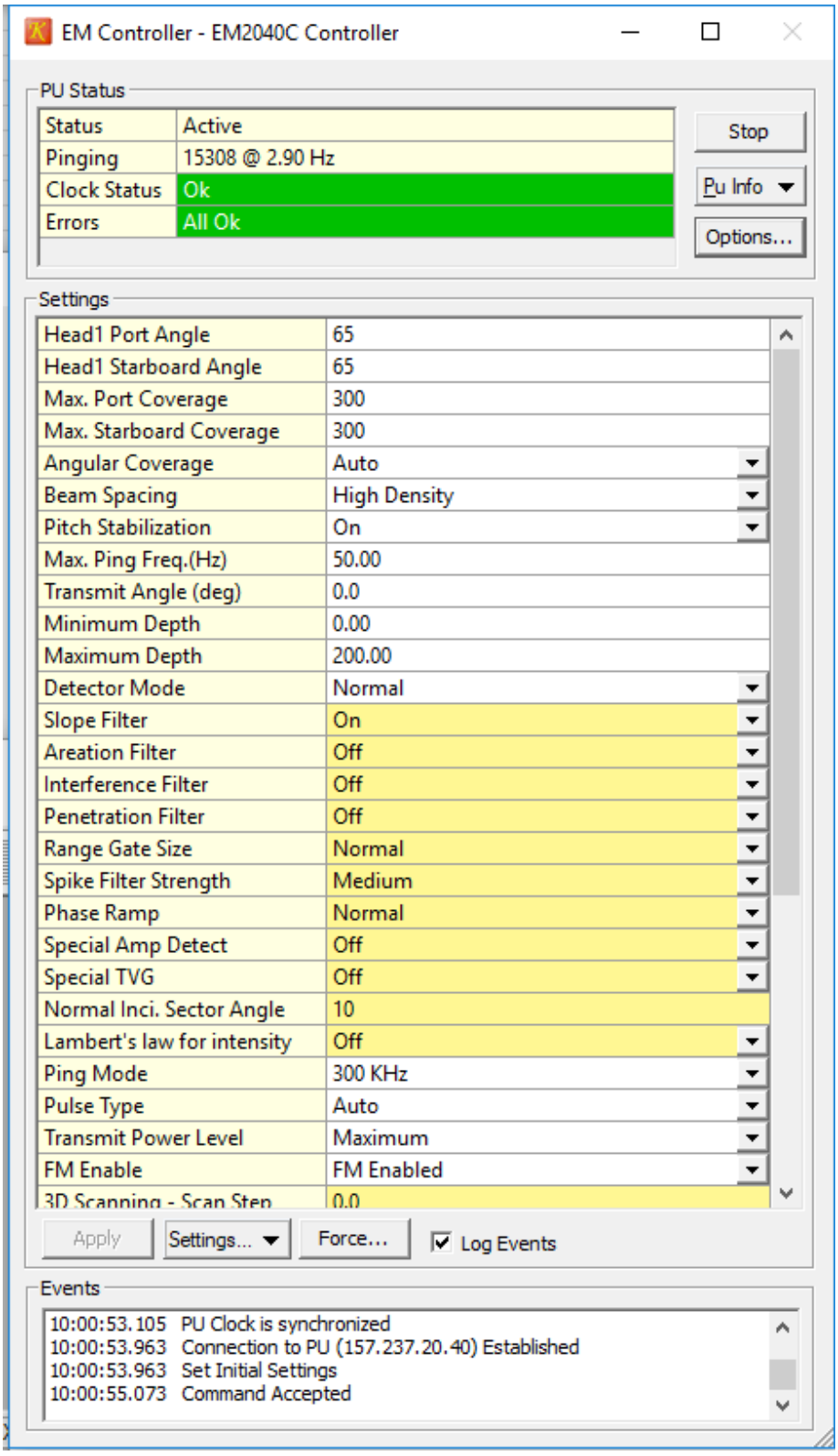
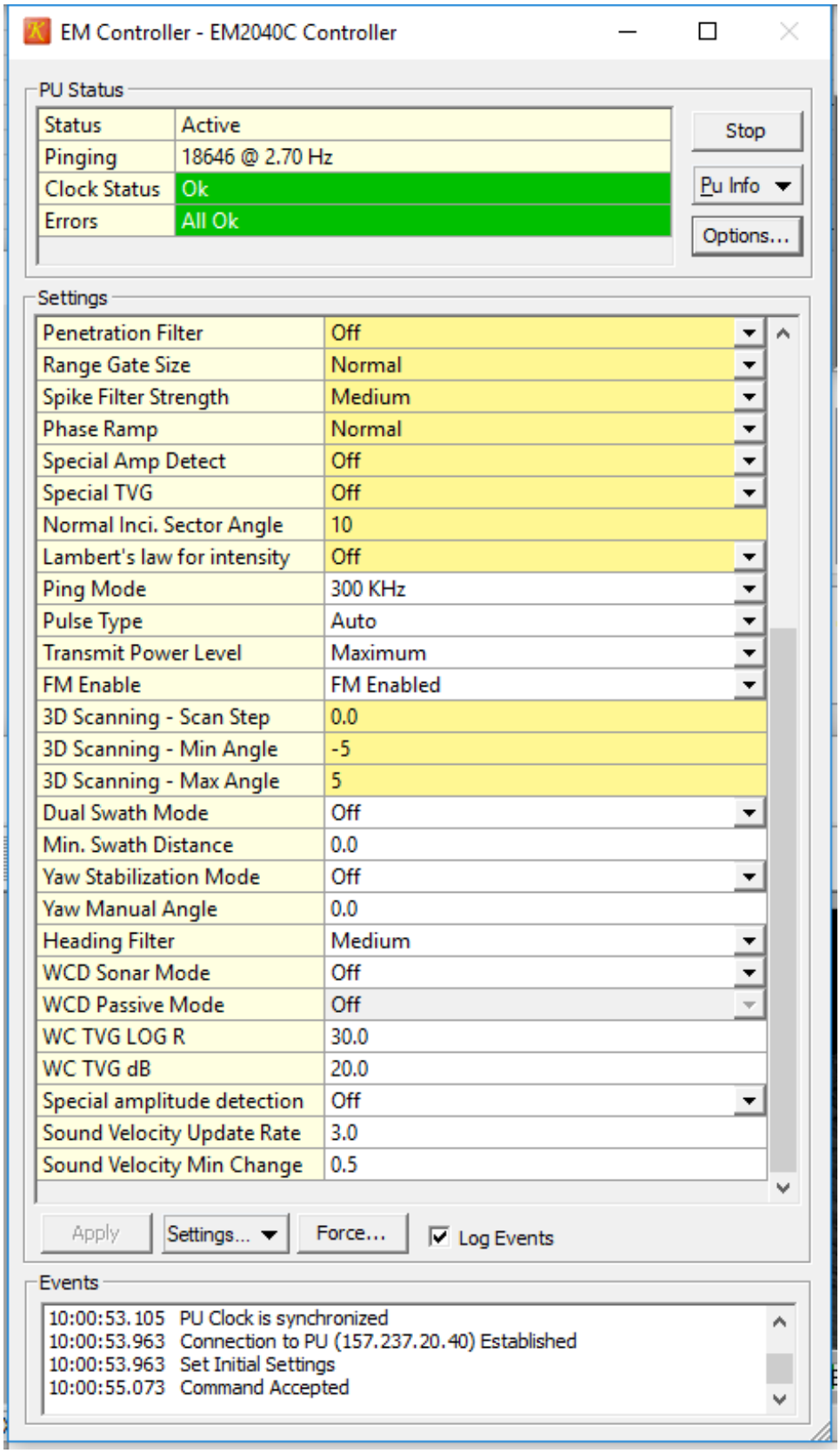
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
System: Time Sync
Description: Time Sync
Type: Time Synchronization System
Driver: NMEA ZDA
Executable and Cmdline: DrvPositionNMEA.exe
Port: 2
Baud rate: 9600
Data bits: 8
Stop bits: 1
Parity: None
Byte frame length (time): 10 bits (1.042 ms)
Maximum data transfer rate: 960 bytes / second
Update rate: 0.000 s
Latency: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Use QPS PPS Adapter: On COM1
PPS time tag pulse matching: Automatic Matching
Windows System Time Synchronization: Synchronization is enabled
Qinsy 9
For Help, press F1

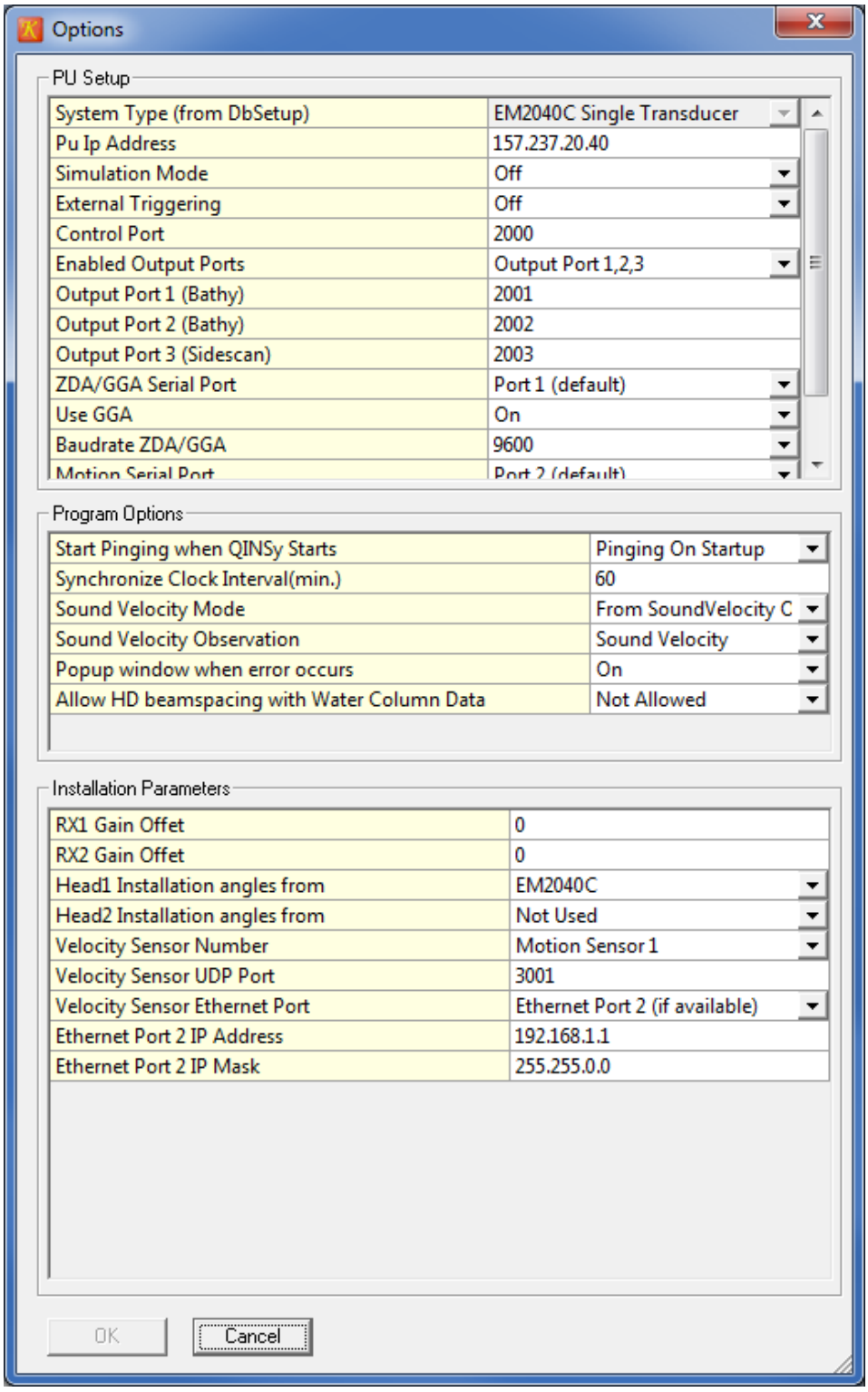

AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
System: EM2040C Controller
Description: EM2040C Controller
Type: Miscellaneous System
Driver: Kongsberg EM2040 Compact (Single) Multibeam Controller
Executable and Cmdline: DrvKongsbergEMCtrl.exe 2040C
Update rate: 0.000 s
Latency: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
System: ASCII Logger
Description: ASCII Logger
Type: Output System
Driver: Generic ASCII Data Logger (Controller)
Executable and Cmdline: DrvGenericLogger.exe
Update rate: 1.000 s
Latency: 0.000 s
Data output setting: Enabled
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Qinsy 9
For Help, press F1

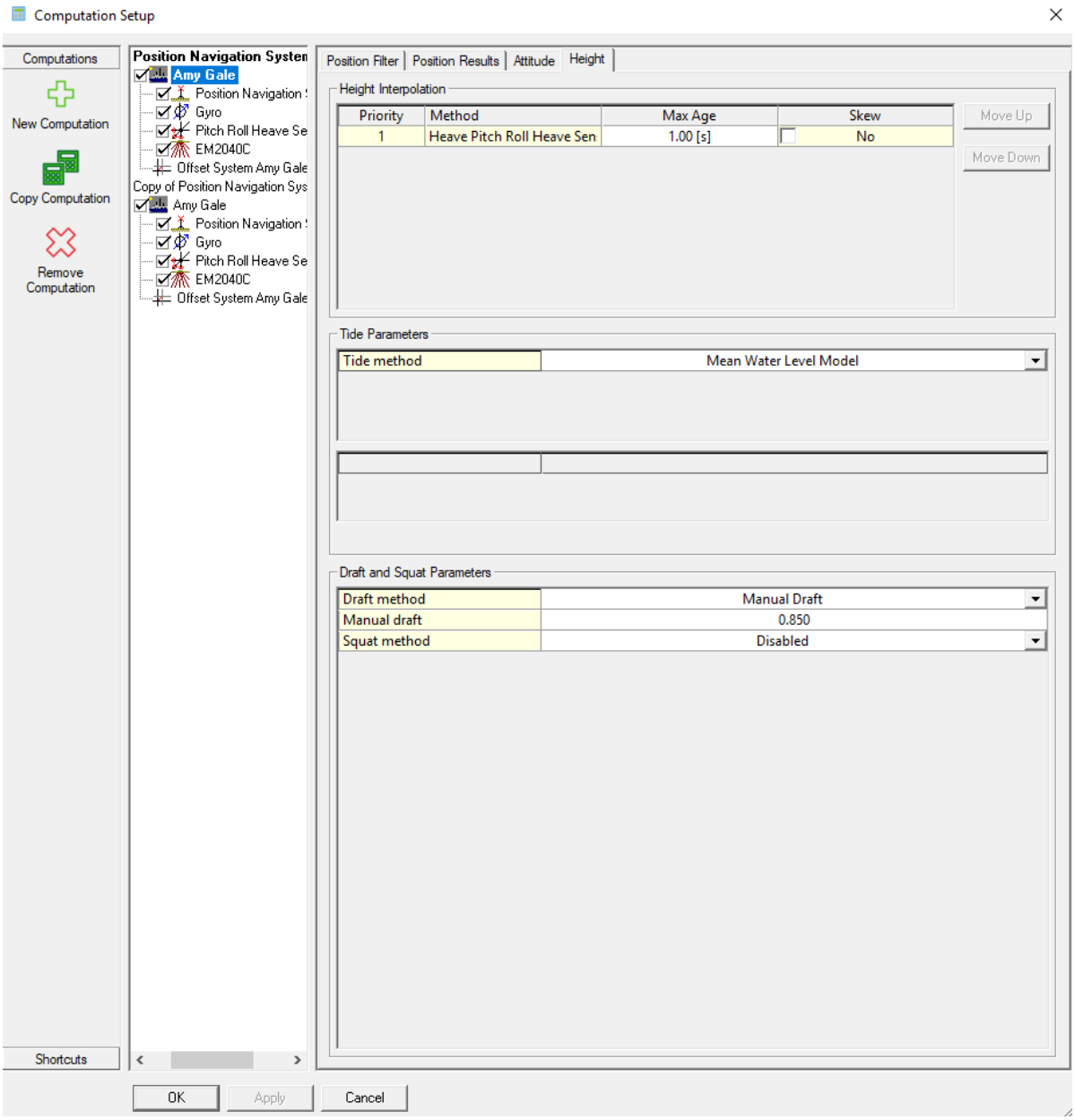
Appendix D – Configuration settings for Qinsy EM controller

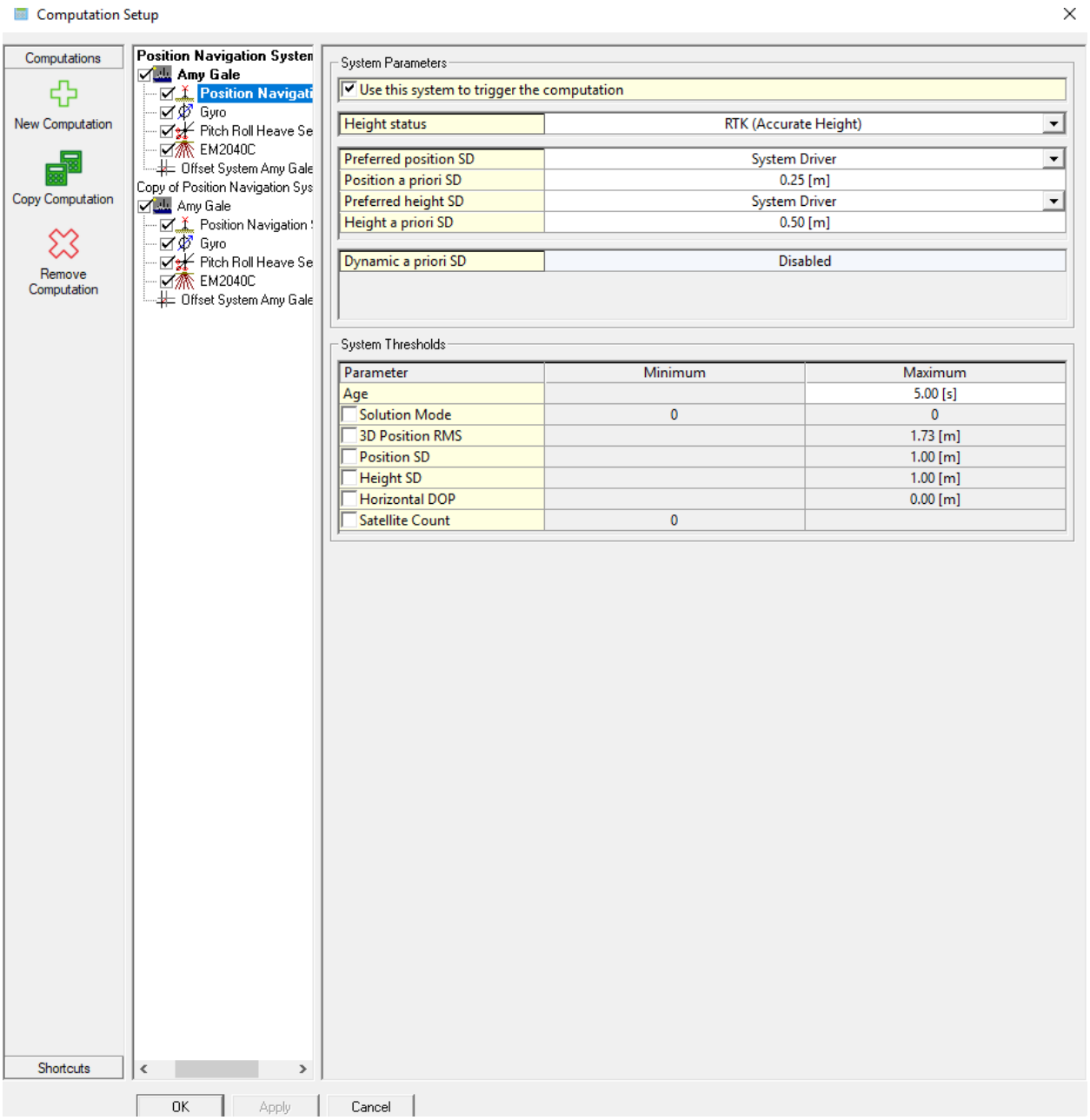


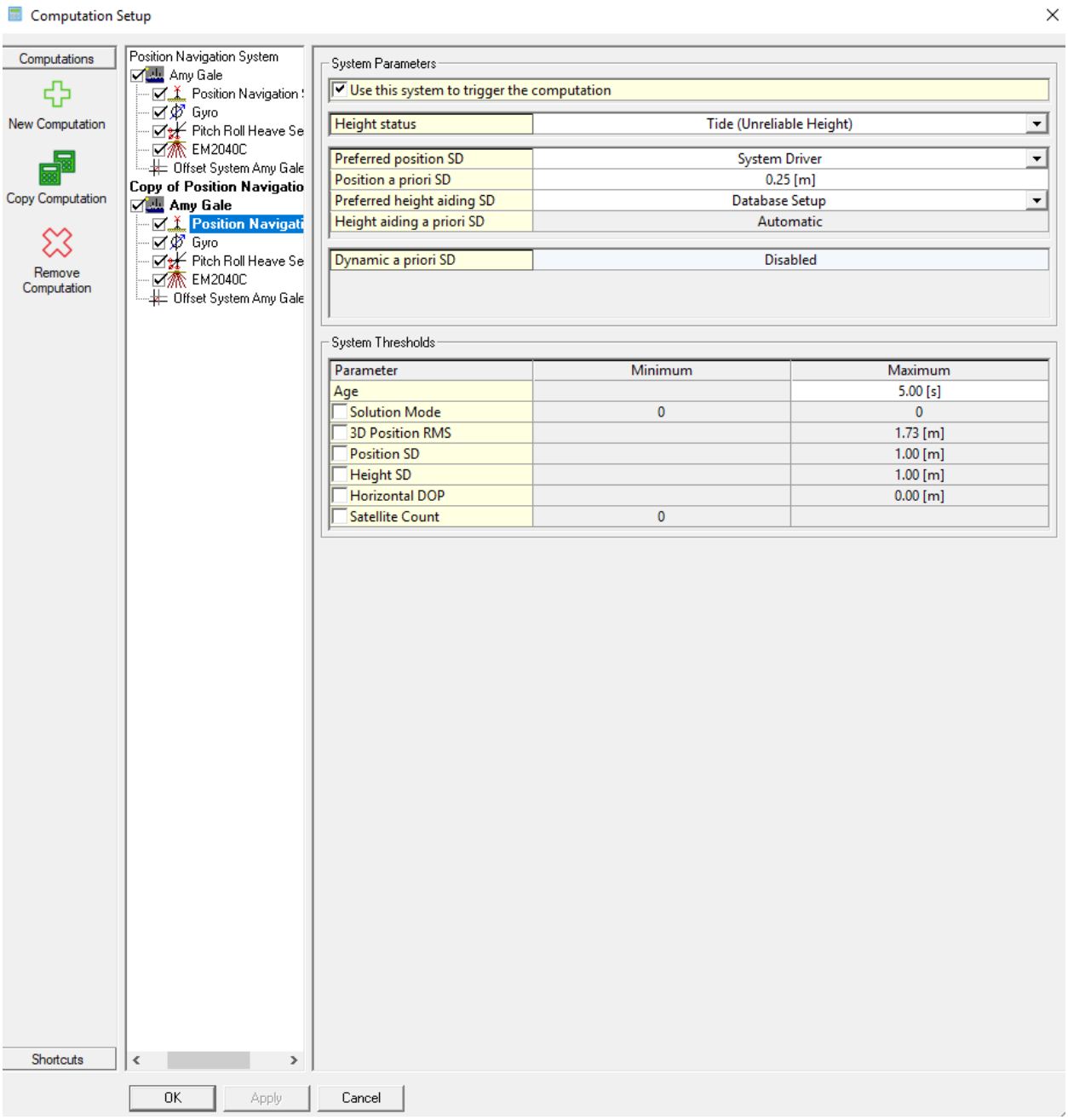

EM Controller - EM2040C Controller
PU Status
Status
Active
Pinging
18646 @ 2.70 Hz
Clock Status
Ok
Errors
All Ok
Stop
Pu Info
Options...
Settings
Penetration Filter
Off
Range Gate Size
Normal
Spike Filter Strength
Medium
Phase Ramp
Normal
Special Amp Detect
Off
Special TVG
Off
Normal Inci. Sector Angle
10
Lambert's law for intensity
Off
Ping Mode
300 KHz
Pulse Type
Auto
Transmit Power Level
Maximum
FM Enable
FM Enabled
3D Scanning - Scan Step
0.0
3D Scanning - Min Angle
-5
3D Scanning - Max Angle
5
Dual Swath Mode
Off
Min. Swath Distance
0.0
Yaw Stabilization Mode
Off
Yaw Manual Angle
0.0
Heading Filter
Medium
WCD Sonar Mode
Off
WCD Passive Mode
Off
WC TVG LOG R
30.0
WC TVG dB
20.0
Special amplitude detection
Off
Sound Velocity Update Rate
3.0
Sound Velocity Min Change
0.5
Apply
Settings...
Force...
Log Events
Events
10:00:53.105 PU Clock is synchronized
10:00:53.963 Connection to PU (157.237.20.40) Established
10:00:53.963 Set Initial Settings
10:00:55.073 Command Accepted

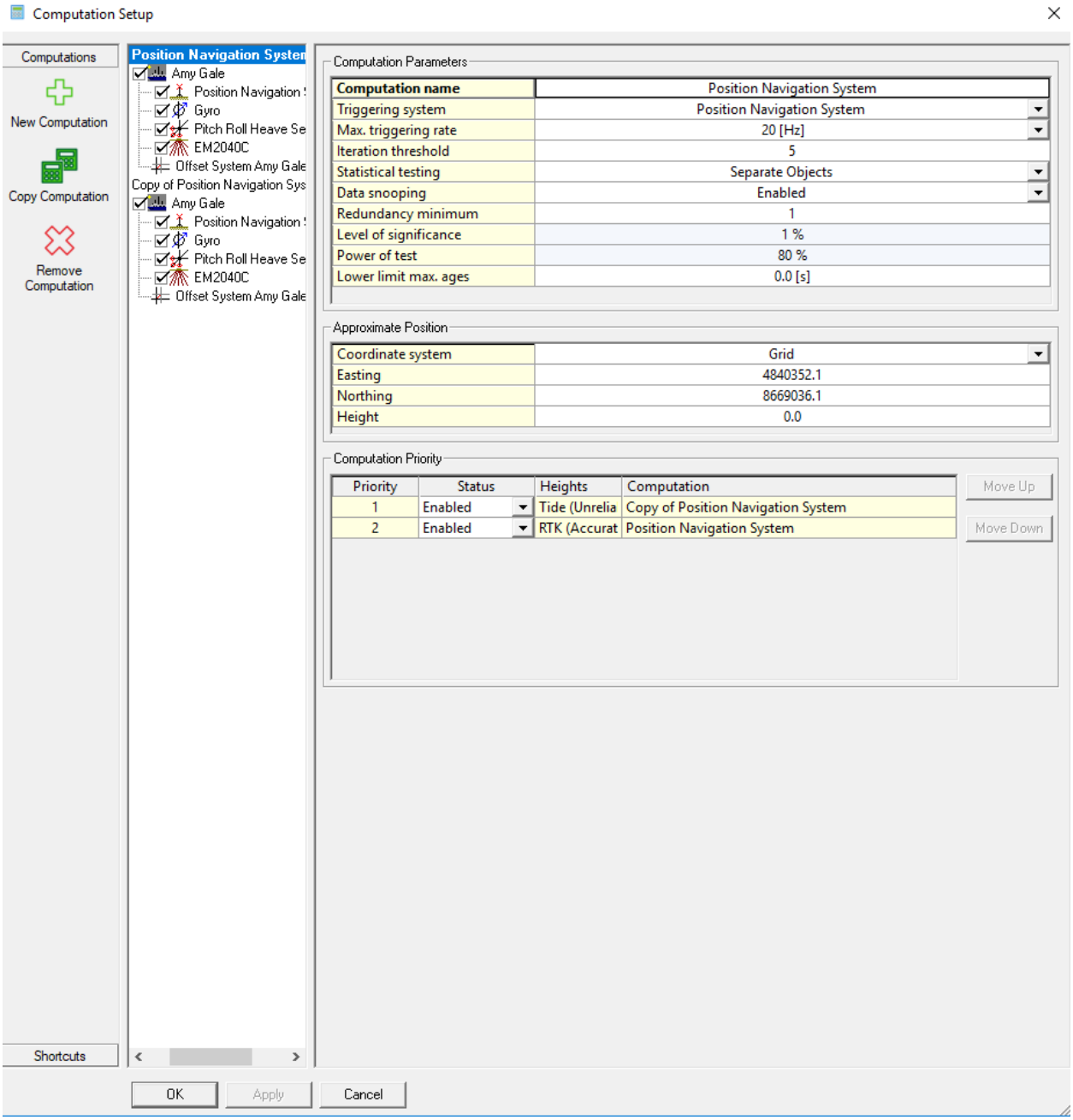

Options
PU Setup
System Type (from DbSetup)
EM2040C Single Transducer
Pu Ip Address
157.237.20.40
Simulation Mode
Off
External Triggering
Off
Control Port
2000
Enabled Output Ports
Output Port 1,2,3
Output Port 1 (Bathy)
2001
Output Port 2 (Bathy)
2002
Output Port 3 (Sidescan)
2003
ZDA/GGA Serial Port
Port 1 (default)
Use GGA
On
Baudrate ZDA/GGA
9600
Program Options
Start Pinging when QINSy Starts
Pinging On Startup
Synchronize Clock Interval(min.)
60
Sound Velocity Mode
From SoundVelocity C
Sound Velocity Observation
Sound Velocity
Popup window when error occurs
On
Allow HD beamspacing with Water Column Data
Not Allowed
Installation Parameters
RX1 Gain Offet
0
RX2 Gain Offet
0
Head1 Installation angles from
EM2040C
Head2 Installation angles from
Not Used
Velocity Sensor Number
Motion Sensor 1
Velocity Sensor UDP Port
3001
Velocity Sensor Ethernet Port
Ethernet Port 2 (if available)
Ethernet Port 2 IP Address
192.168.1.1
Ethernet Port 2 IP Mask
255.255.0.0
OK
Cancel

Appendix E – New Computation Settings for Qinsy Online




Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation Systen
Amy Gale
Position Navigat
Gyro
Pitch Roll Heave Se
EM2040C
Offset System Amy Gale
Copy of Position Navigation Sys
Amy Gale
Position Navigation
Gyro
Pitch Roll Heave Se
EM2040C
Offset System Amy Gale
System Parameters
Use this system to trigger the computation
Height status
RTK (Accurate Height)
Preferred position SD
System Driver
Position a priori SD
0.25 [m]
Preferred height SD
System Driver
Height a priori SD
0.50 [m]
Dynamic a priori SD
Disabled
System Thresholds
Parameter
Minimum
Maximum
Age
5.00 [s]
Solution Mode
0
0
3D Position RMS
1.73 [m]
Position SD
1.00 [m]
Height SD
1.00 [m]
Horizontal DOP
0.00 [m]
Satellite Count
0
OK
Apply
Cancel


Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation
Gyro
Pitch Roll Heave Se
EM2040C
Offset System Amy Gale
Copy of Position Navigatio
Amy Gale
Position Navigati
Gyro
Pitch Roll Heave Se
EM2040C
Offset System Amy Gale
System Parameters
Use this system to trigger the computation
Height status
Tide (Unreliable Height)
Preferred position SD
System Driver
Position a priori SD
0.25 [m]
Preferred height aiding SD
Database Setup
Height aiding a priori SD
Automatic
Dynamic a priori SD
Disabled
System Thresholds
Parameter
Minimum
Maximum
Age
5.00 [s]
Solution Mode
0
0
3D Position RMS
1.73 [m]
Position SD
1.00 [m]
Height SD
1.00 [m]
Horizontal DOP
0.00 [m]
Satellite Count
0
OK
Apply
Cancel


Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation Systen
Amy Gale
Position Navigation
Gyro
Pitch Roll Heave Se
EM2040C
Offset System Amy Gale
Copy of Position Navigation Sys
Amy Gale
Position Navigation
Gyro
Pitch Roll Heave Se
EM2040C
Offset System Amy Gale
Computation Parameters
Computation name
Position Navigation System
Triggering system
Position Navigation System
Max. triggering rate
20 [Hz]
Iteration threshold
5
Statistical testing
Separate Objects
Data snooping
Enabled
Redundancy minimum
1
Level of significance
1 %
Power of test
80 %
Lower limit max. ages
0.0 [s]
Approximate Position
Coordinate system
Grid
Easting
4840352.1
Northing
8669036.1
Height
0.0
Computation Priority
Priority
Status
Heights
Computation
1
Enabled
Tide (Unrelia
Copy of Position Navigation System
2
Enabled
RTK (Accurat
Position Navigation System
Move Up
Move Down
OK
Apply
Cancel

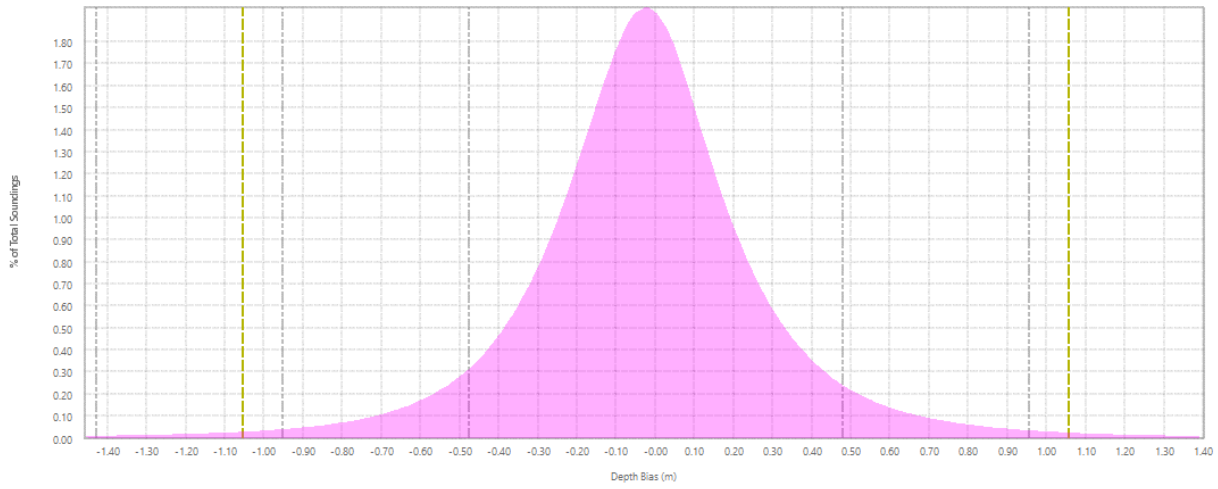
Appendix F – Mainscheme crossline surface difference test statistical plots

Plots (histogram, scatter, and uncertainty)

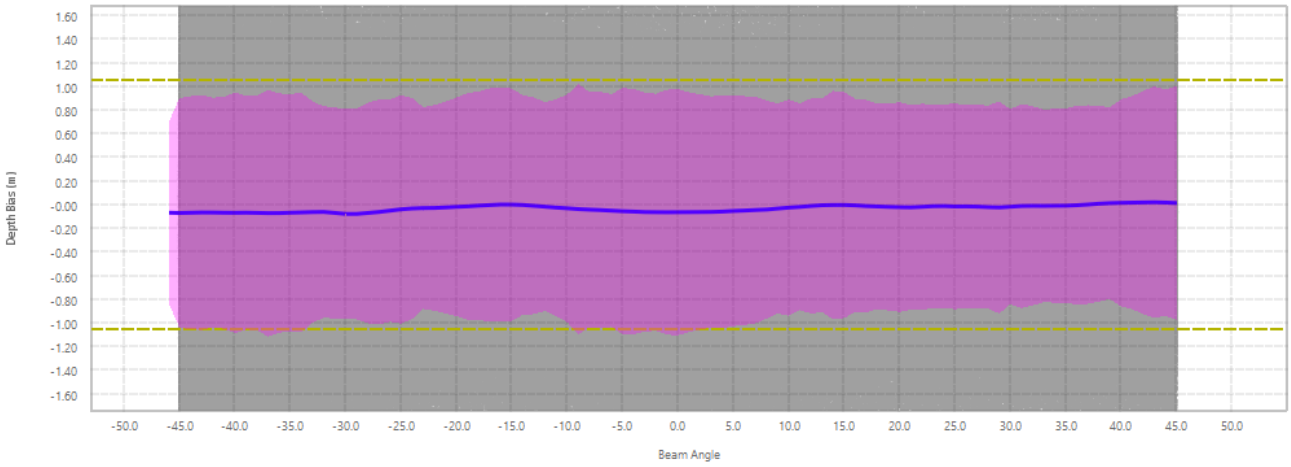
Key for plots:

- Gray dots represent difference in depth between the crossline and the reference surface for individual beam angles or beam numbers
- Purple areas represent the 95% confidence interval (2 standard deviations) based on normal distribution (see histogram)
- Yellow dashed lines represent limit of IHO Order 1 test vertical tolerance
- Gray dashed lines on histogram represent ±sigma 1, 2, and 3
- Blue lines represent the mean value

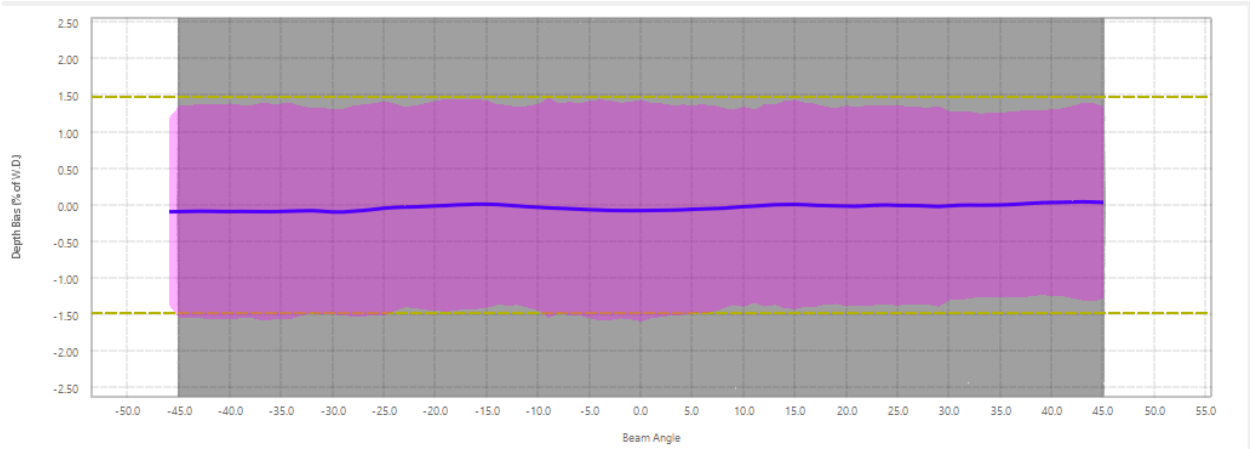
Histogram



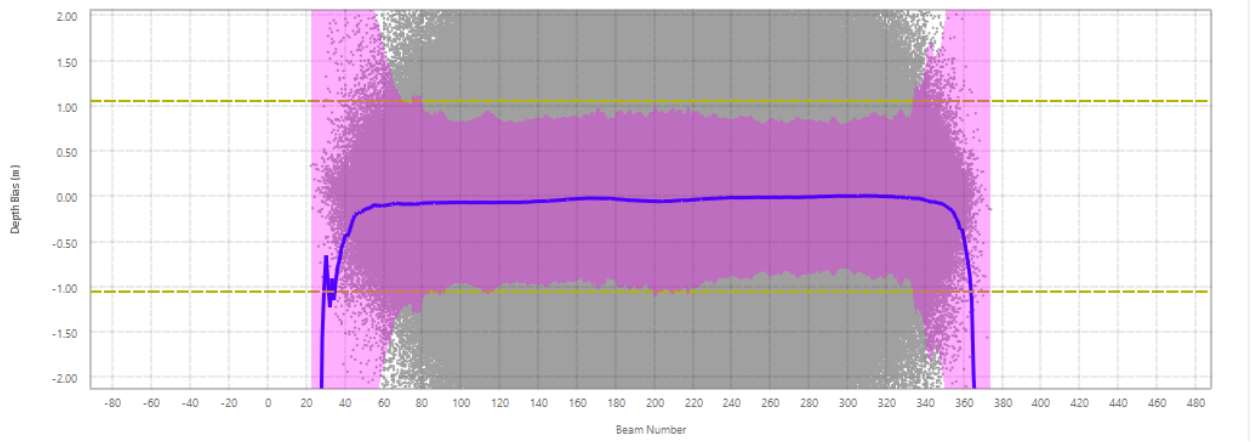
Scatter: Depth Bias (m) vs. Beam Angle (Degrees from Nadir)



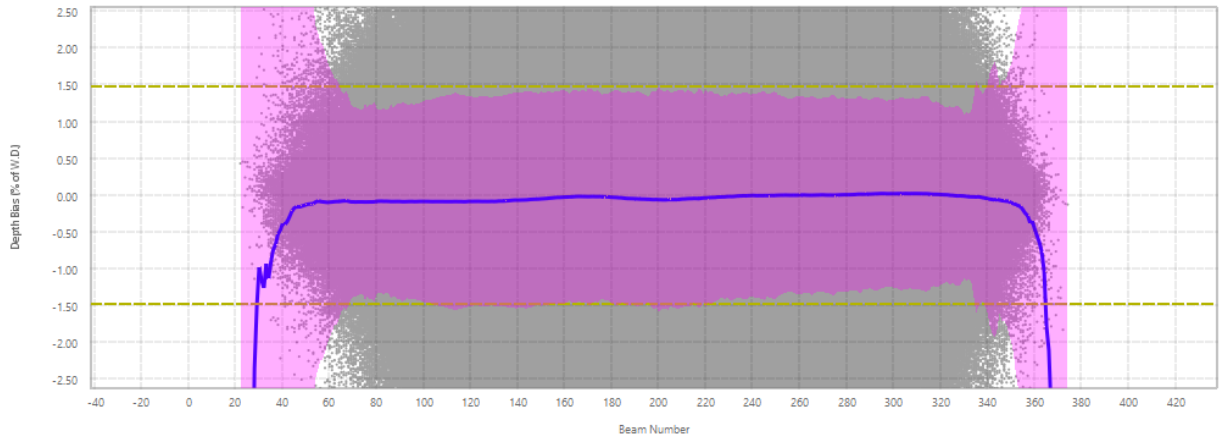
Scatter: Depth Bias (% Water Depth) vs Beam Angle (Degrees from Nadir)



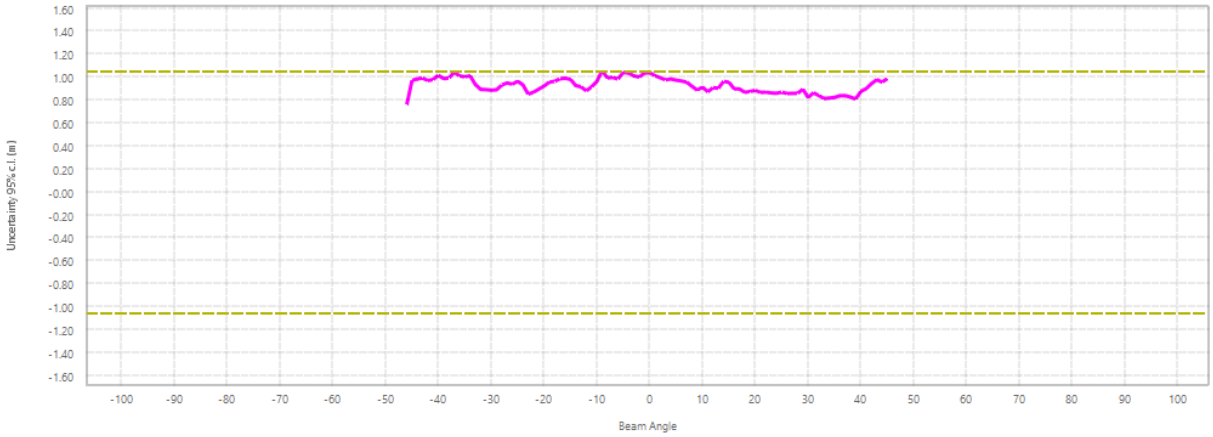
Scatter: Depth Bias (m) vs Beam Number



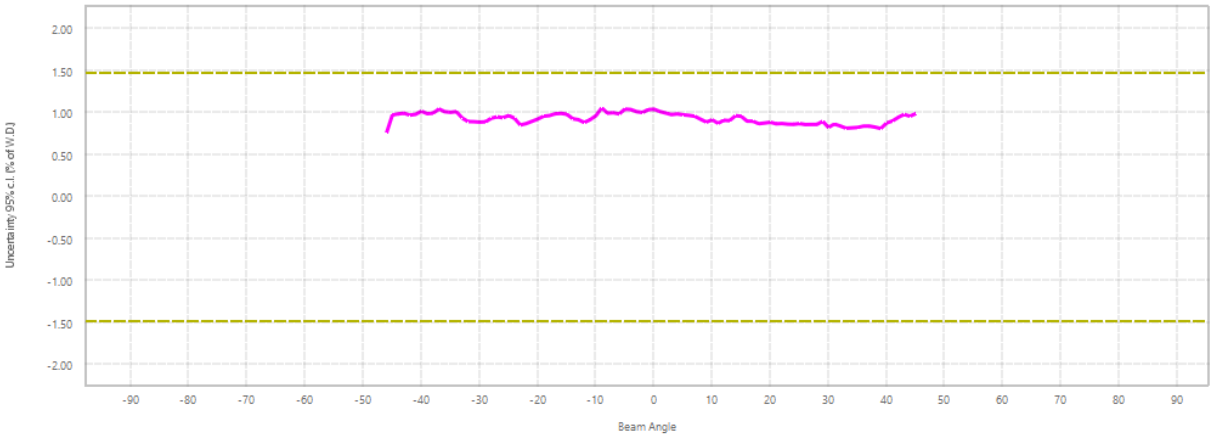
Scatter: Depth Bias (% Water Depth) vs Beam Number



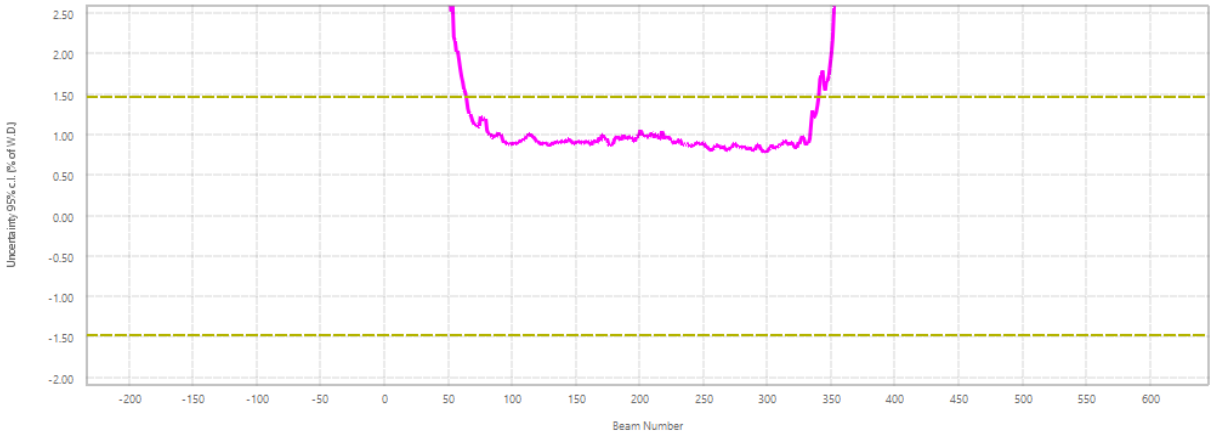
Uncertainty: Depth Bias (m) vs Beam Angle (Degrees from Nadir)



Uncertainty: Depth Bias (% Water Depth) vs Beam Angle (Degrees from Nadir)



Uncertainty: Depth Bias (% Water Depth) vs Beam Number



Uncertainty: Depth Bias (m) vs Beam Number