Cover Sheet (NOAA Form 76-35A)

NOAA FORM 76-35A

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

Horizontal and Vertical Control Report

Type of Survey HYDROGRAPHIC

Field No OPR-A366-KR-17

Registry No. H13011, H13012, H13013 & H13014

LOCALITY

State Maine

General Locality East Penobscot Bay

Sublocality Covers the regions of Isle Au Haut Bay, Deer Island Thorofare, Vicinity of Swans Island, and Eggemoggin Reach.

2017

CHIEF OF PARTY

Dean Moyles

LIBRARY & ARCHIVES

DATE

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Title Sheet (NOAA Form 77-28)

NOAA FORM 77-28 (11-72) U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION **HYDROGRAPHIC TITLE SHEET**	REGISTER NO. H13011, H13012, H13013 & H13014
INSTRUCTIONS – The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office	FIELD NO.

State Maine

General Locality East Penobscot Bay

Locality Covers the regions of Isle Au Haut Bay, Deer Island Thorofare, Vicinity of Swans Island, and Eggemoggin Reach.

Scale 1:10,000 Date of Survey LiDAR 06/26/2017 – 07/04/2017
MBES 07/03/2017 – 10/07/2017
Instructions dated May, 2017 Project No. OPR-A366-KR-17

Vessel R/V Theory (1217549), R/V Westerly (1231991), De Havilland DC-6 Twin Otter (N94AR)

Chief of party Dean Moyles

Surveyed by Moyles, Cox, Blackbourn, Reynolds, Rokyta, Mount, Farley, Klein, Lopez et al.

Soundings taken by echo sounder, hand lead, pole Dual Head Reson 7125 (R/V Theory, Over the Stern Mount), Dual Head Reson 7125 (R/V Westerly, Over the Stern Mount), SHOALS-1000T Airborne LiDAR Bathymetry (DC-6 Twin Otter)

Graphic record scaled by Fugro Personnel

Graphic record checked by Fugro Personnel

Protracted by N/A Automated plot by N/A

Verification by

Soundings in METERS at MLLW

REMARKS: The purpose of this survey is to update existing NOS nautical charts in a high commercial traffic area.

ALL TIMES ARE RECORDED IN UTC.

FUGRO PELAGOS INC.
6100 HILLCROFT STREET
HOUSTON, TX 77081

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A – Vertical Control

Multibeam vertical control for OPR-A366-KR-17 was provided by way of a Tidal Constituent And Residual Interpolation (TCARI) grid, based on verified tide data from Portland (8418150), and Bar Harbor (8413320), ME (refer to Figure 1).

During field operations, the Theory and Westerly sounding data were initially reduced to MLLW using a combination of preliminary and verified tidal data from gauges 8413320 (Bar Harbor, ME) and 8418150 (Portland, ME) using the TCARI GUI (version 16.8) and merged in CARIS HIPS. These stations are owned and operated by NOAA's National Ocean Service (NOS) through the Center for Operational Oceanographic Products and Services (CO-OPS). Preliminary and verified tidal data was assembled by CO-OPS and accessed through NOAA's Tides&Currents website (***http://tidesandcurrents.noaa.gov/***). These unverified tides were used in the field for preliminary processing only.

On October 26, 2017, notification that the preliminary TCARI grid was accepted as the final grid for survey project OPR-A366-KR-2017, was acquired from CO-OPS and applied to all sounding data using the TCARI GUI (version 16.8) and merged in CARIS HIPS. Verified tidal data were used for all final CUBE Surfaces, soundings, and S-57 Feature files.

During the OPR-A366-KR-17 survey, there were no unusual conditions regarding tidal information to note other than a few bust that were noted in the XMLDR's.

For additional information, refer to **Appendix I -Tides and Water Levels**.

Table 1 Tide Gauges

Gauge	Gauge Type	Location	Latitude	Longitude
8418150	Acoustic	Portland, ME	43-39.4 N	70-14.8 W
8413320	Acoustic	Bar Harbor, ME	44-23.5 N	68-12.2 W

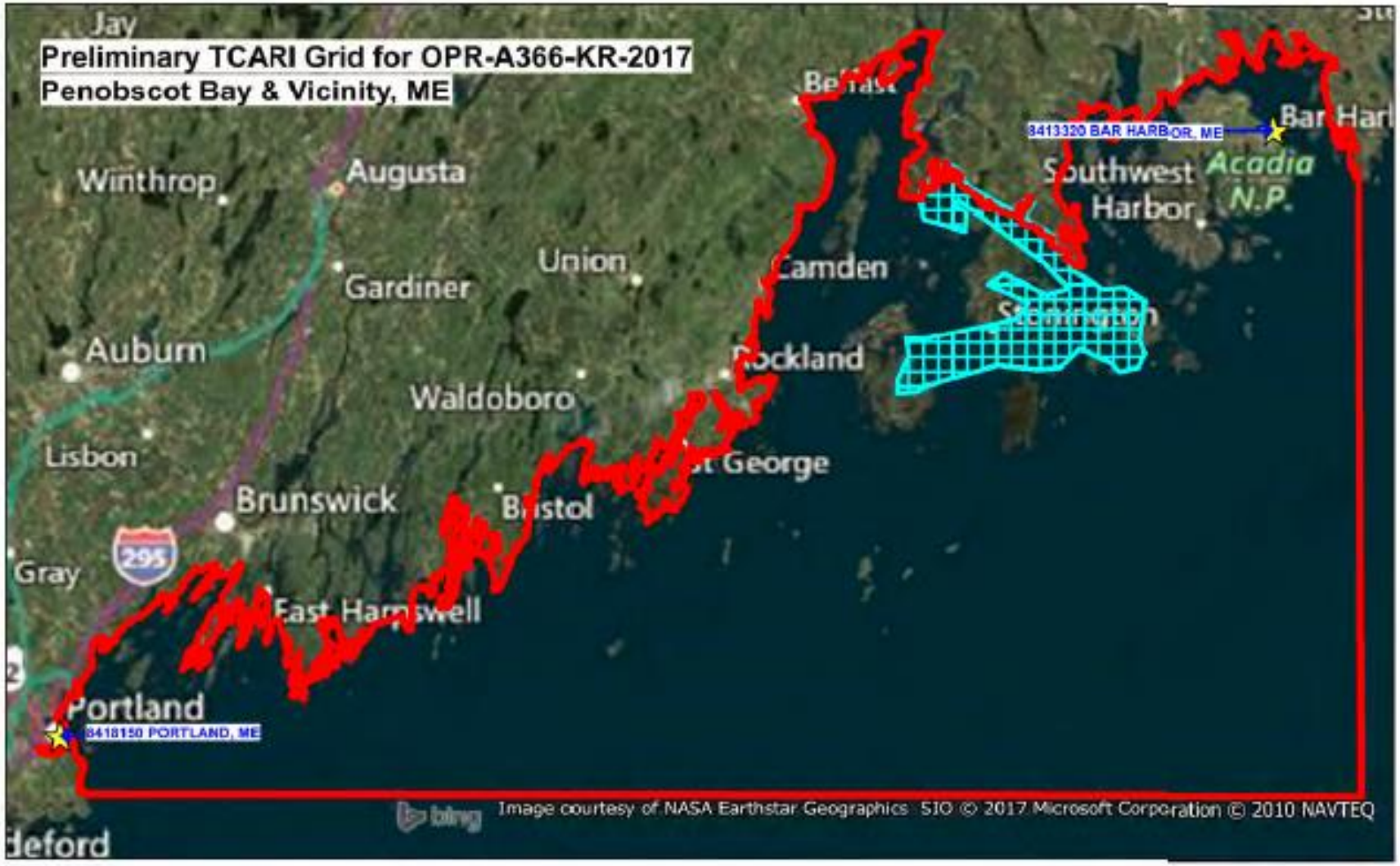


Figure 1 TCARI Grid

LiDAR vertical control for OPR-A366-KR-17 was GPS-derived. POS files logged during data acquisition on each flight were post-processed using Applanix POSPac SmartBase routine to create an SBET file. Following creation, the SmartBase SBETs were then applied to the data in SHOALS GCS, replacing the real-time GPS navigation position with a post-processed GPS position. The separation model was created with NOAA's VDatum v3.6. This model also allowed for topographic data to be referenced to MLLW through the use of DTM-derived interpolation (refer to **Figure 2**).

Data was referenced to the WGS84 (ITRF00) datum with the KGPS trajectory solution processed with POSPac SmartBase (ASB) routine using a network of CORS stations, with station ID MEOW, as primary control. The LiDAR data was maintained on the ellipsoid during processing.

LiDAR elevations on the ellipsoid were eventually reduced to soundings on MLLW in CARIS using a separation model grid created in VDatum v3.6. Topographic heights detected by LiDAR were also related to MLLW through the same method. The model was applied to the data, using the compute GPS tides utility, and then merged.

There were no unusual tidal conditions to note during the OPR-A366-KR-17 survey.

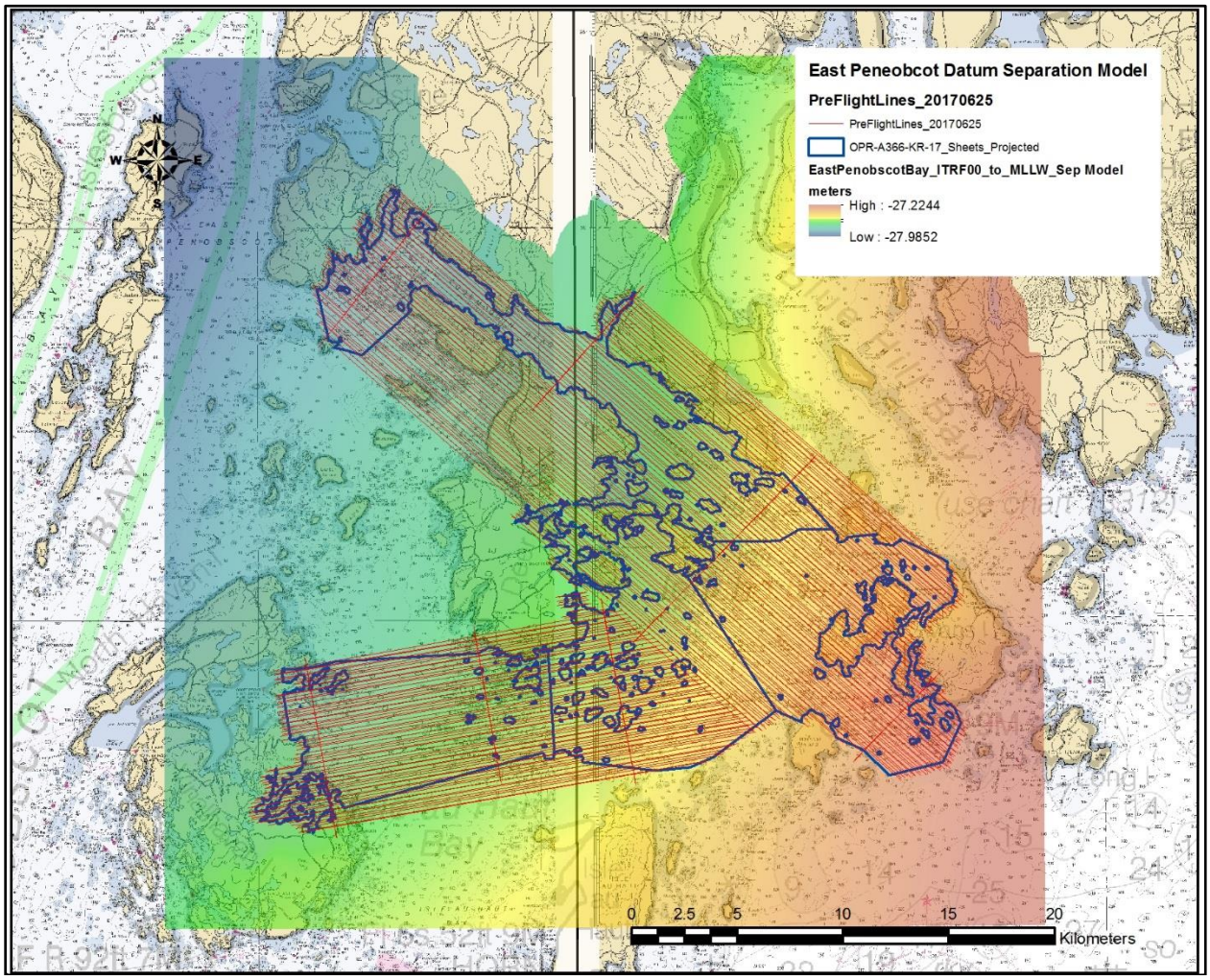


Figure 2 VDatum ITRF00 to MLLW

B – Horizontal Control

The horizontal control datum for this survey is ITRF00 (WGS84: G1150). The deviation from the Section 2.1 of the HSSD 2017 was approved on 21 June 2017. Refer to the Project Correspondence file "OPR-A366-KR-17_Kathryn_Pridgen_Correspondence" for additional details.

Real-time corrections for both the vessels and aircraft, the POS/MV and POS/AV were configured to accept Fugro's Marinestar G2 corrections. Marinestar G2 service is a real-time GPS and GLONASS Precise Point Positioning (PPP) service providing refined satellite 'clock and orbit' data to any GNSS receiver with a valid subscription. Signals on the L-band with corrections are broadcasted by geo-stationary satellites and are received by the integrated GNSS/L-band antenna. The unit outputs corrected positions at 1 Hz to the POS units where they are integrated with inertial data. A position for the top-center of the IMU is generated, providing a horizontal accuracy of 10 cm and a vertical accuracy of 15 cm.

This position was logged concurrently with the bathymetry from WinFrog and the POS file using Fugro Pelagos PosMvLogger for the R/V Theory and R/V Westerly. For multibeam data, the real-time solution was used for the final positioning and no post processing was required.

Processed LiDAR point positions for the SHOALS system were derived relative to the ITRF00 datum using a Post Processed Kinematic (PPK) solution where primary control coordinates observed the said datum. LiDAR POS files and IMU inertial data, along with concurrently logged onshore dual-frequency base station (CORS stations) data, were post-processed to create a KGPS SBET file.

A SmartBase network of NGS CORS stations was established and processed with Applanix POSPac MMS software (refer to **Figure 3**). The primary and control station used for the network was MEOW. Network stations as well as the primary and control were held for the duration of ALB acquisition. Primary station coordinates were transformed from NAD83 (2011) to ITRF2000 using the NGS' Horizontal Time-Dependent Positioning (HTDP) utility. This network configuration was also used during the MBES portion of the survey to ensure overlapping data would closely align.

To ensure solution accuracy, each SBET was reviewed for quality before being applied to the data. Ideally, solutions had a separation difference under ten centimeters and were in a fixed solution for the period of acquisition. Additionally, PDOP values were confirmed to be under 3.0 and the number of satellites tracked more than five. If a solution was found to fail one or more checks, the processing project would undergo greater scrutiny and additional reprocessing until it was of sufficient quality to be applied to the data. Refer to the Data Acquisition and Processing Report for additional information on system calibrations and checks.

Descriptions for the SmartBase network and Fugro base stations are in **Appendix II – Horizontal Control** .

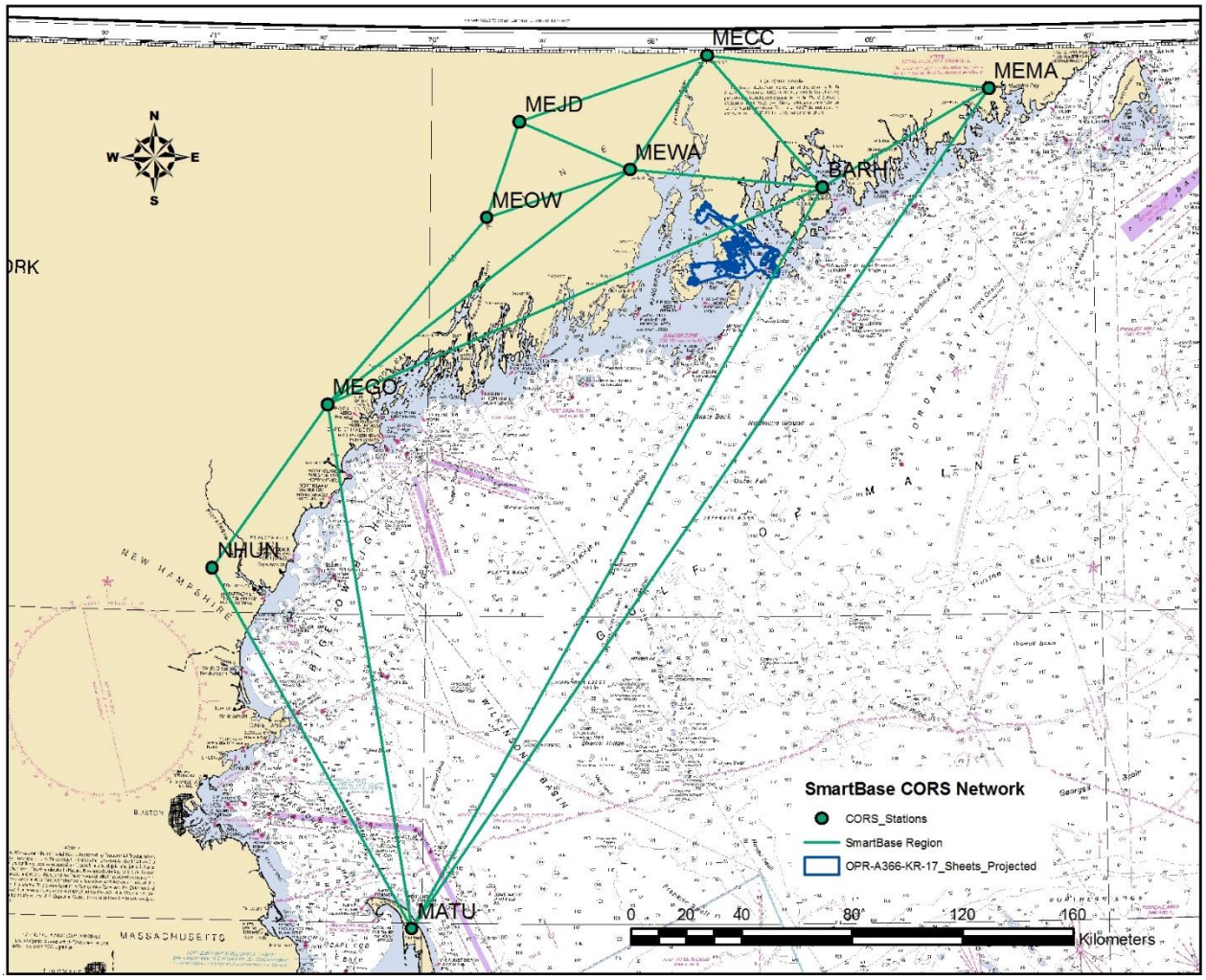


Figure 3 SmartBase CORS Network

C – Approval Sheet

Approval Sheet

For

H13011, H13012, H13013, & H13014

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

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

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

Approved and forwarded,

Dean Moyles, (ACSM Cert. No. 226)
Senior Hydrographer
Fugro Pelagos, Inc.
February 22, 2018

x Moyles, Dean

Digitally signed by Moyles, Dean
DN: dc=com, dc=fugro, l=america, ou=fpi, ou=people_fpi, 0.9.2342.19200300.100.1.1=moyles, cn=Moyles, Dean, email=dmoyles@fugro.com
Date: 2018.02.22 16:29:52 -03'30'

Dean Moyles (ACSM Cert. No. 226)
Senior Hydrographer

Appendix I -Tides and Water Levels

Tide Station: 8418150 Portland, ME

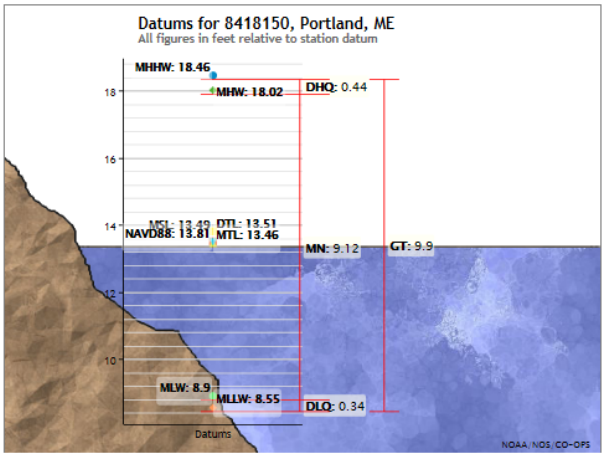
Datums for 8418150, Portland ME

Elevations on Station Datum

Station: 8418150, Portland, ME
Status: Accepted (Apr 17 2003)
Units: Feet
T.M.: 75
Epoch: 1983-2001
Datum: STND

Datum	Value	Description
MHHW	18.46	Mean Higher-High Water
MHW	18.02	Mean High Water
MTL	13.46	Mean Tide Level
MSL	13.49	Mean Sea Level
DTL	13.51	Mean Diurnal Tide Level
MLW	8.90	Mean Low Water
MLLW	8.55	Mean Lower-Low Water
NAVD88	13.81	North American Vertical Datum of 1988
STND	0.00	Station Datum
GT	9.90	Great Diurnal Range
MN	9.12	Mean Range of Tide
DHQ	0.44	Mean Diurnal High Water Inequality
DLQ	0.34	Mean Diurnal Low Water Inequality
HWI	3.59	Greenwich High Water Interval (in hours)
LWI	9.75	Greenwich Low Water Interval (in hours)
Maximum	22.68	Highest Observed Water Level
Max Date & Time	02/07/1978 10:30	Highest Observed Water Level Date and Time
Minimum	5.10	Lowest Observed Water Level
Min Date & Time	11/30/1955 17:18	Lowest Observed Water Level Date and Time
HAT	20.50	Highest Astronomical Tide
HAT Date & Time	05/17/1999 04:42	HAT Date and Time
LAT	6.43	Lowest Astronomical Tide
LAT Date & Time	01/21/1996 22:36	LAT Date and Time

Tidal Datum Analysis Periods



Showing datums for
8418150 Portland, ME

Data Units ○ Feet
● Meters

Epoch ● Present (1983-2001)
○ Superseded (1960-1978)

Submit

Tide Station: 8413320, Bar Harbor, ME

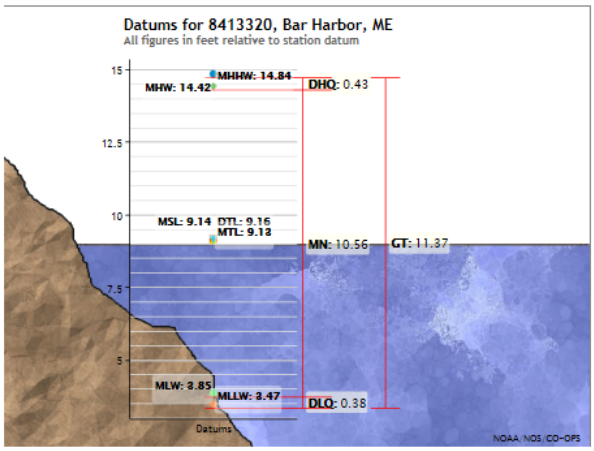
Datums for 8413320, Bar Harbor ME

Elevations on Station Datum

Station: 8413320, Bar Harbor, ME
Status: Accepted (Nov 2 2012)
Units: Feet
T.M.: 75
Epoch: 1983-2001
Datum: STND

Datum	Value	Description
MHHW	14.84	Mean Higher-High Water
MHW	14.42	Mean High Water
MTL	9.13	Mean Tide Level
MSL	9.14	Mean Sea Level
DTL	9.16	Mean Diurnal Tide Level
MLW	3.85	Mean Low Water
MLLW	3.47	Mean Lower-Low Water
NAVD88		
STND	0.00	Station Datum
GT	11.37	Great Diurnal Range
MN	10.56	Mean Range of Tide
DHQ	0.43	Mean Diurnal High Water Inequality
DLQ	0.38	Mean Diurnal Low Water Inequality
HWI	3.29	Greenwich High Water Interval (in hours)
LWI	9.51	Greenwich Low Water Interval (in hours)
Maximum	19.68	Highest Observed Water Level
Max Date & Time	02/07/1978 05:00	Highest Observed Water Level Date and Time
Minimum	0.56	Lowest Observed Water Level
Min Date & Time	03/21/2007 11:06	Lowest Observed Water Level Date and Time
HAT	17.16	Highest Astronomical Tide
HAT Date & Time	12/23/1999 15:36	HAT Date and Time
LAT	1.19	Lowest Astronomical Tide
LAT Date & Time	11/05/1998 22:18	LAT Date and Time

Tidal Datum Analysis Periods



Showing datums for
8413320 Bar Harbor, ME

Data Units ○ Feet
◉ Meters

Epoch ◉ Present (1983-2001)
○ Superseded (1960-1978)

Submit

Appendix II – Horizontal Control

ASB network Control: MEOW (Augusta, ME)

```
L1 Phase Center of the current GPS antenna: AUGUSTA CORS L1 PC C
-----------------------------------------------------------------
The Zephyr GNSS Geodetic Model 2 antenna
(Antenna Code = TRM55971.00     NONE) was installed on 07Dec2007.
       The L2 phase center is 0.009 m below the L1 phase center.
                             PID = DN9941


IGS08 POSITION (EPOCH 2005.0)
Computed in Aug 2012 using 9 days of data.
    X =   1582991.526 m     latitude     =  44 17 45.97139 N
    Y =  -4289834.449 m     longitude    = 069 44 43.57763 W
    Z =   4431725.135 m     ellipsoid height =   36.223   m

The IGS08 VELOCITY of the L1 PC is the same as that for the ARP.


NAD_83 (2011) POSITION (EPOCH 2010.0)
Transformed from IGS08 (epoch 2005.0) position in Aug 2012.
    X =   1582992.233 m     latitude     =  44 17 45.93628 N
    Y =  -4289835.877 m     longitude    = 069 44 43.57002 W
    Z =   4431725.167 m     ellipsoid height =   37.380   m

The NAD_83 (2011) VELOCITY of the L1 PC is the same as that for the ARP.
```

NAD83 to ITRF00 Conversion:

HTDP Output

```
*****************************************
HTDP (VERSION v3.2.5    ) OUTPUT

TRANSFORMING POSITIONS FROM NAD_83(2011/CORS96/2007) (EPOCH = 08-01-2012 (2012.5820))
                        TO ITRF2000 or IGS00/IGb00  (EPOCH = 07-15-2016 (2016.5355))

MEOW
 LATITUDE     44 17 45.93628 N     44 17 45.97280 N       -1.83 mm/yr  north
 LONGITUDE    69 44 43.57002 W     69 44 43.58587 W        2.07 mm/yr  east
 ELLIP. HT.             37.380              36.214 m      -1.01 mm/yr  up
 X                1582992.233         1582991.342 m       2.14 mm/yr
 Y               -4289835.877        -4289834.478 m       0.19 mm/yr
 Z                4431725.167         4431725.160 m      -2.01 mm/yr
```

NGS HOME PAGE