

Gardiner WIN #018964.00 Rolling Dam 2 Bridge 6023
Tidal Analysis

02/22/2017

Performed by: Kendra Nash

Tidal Analysis: BDG 2.3.6

Reference Station: Portland, ME Station ID 8418150

NOAA Chart#: 13292

Epoch: 1983-2001

Tidal Datum Analysis Periods: 01/01/1983 - 12/31/2001

<http://tidesandcurrents.noaa.gov/datums.html?id=8418150>

Highest Observed Water Level: 02/07/1978 10:30 $HOWL := 22.68 \text{ ft}$

Mean Higher-High Water: $MHHW := 18.46 \text{ ft}$

Mean High Water: $MHW := 18.02 \text{ ft}$

NAVD88: $NAVD := 13.81 \text{ ft}$

Mean Sea Level: $MSL := 13.49 \text{ ft}$

Mean Tide Level: $MTL := 13.46 \text{ ft}$

Mean Low Water: $MLW := 8.90 \text{ ft}$

Mean Diurnal Tide Level: $MDTL := 13.51 \text{ ft}$

Mean Lower-Low Water: $MLLW := 8.55 \text{ ft}$

Lowest Observed Water Level: 11/30/1955 17:18 $LOWL := 5.10 \text{ ft}$

Highest Astronomical Tide: 05/17/1999 04:42 $HAT := 20.50 \text{ ft}$

Lowest Astronomical Tide: 01/21/1996 22:36 $LAT := 6.43 \text{ ft}$

Convert tidal datum information to the NAVD

$$MHHW_{REF} := MHHW - NAVD = 4.65 \text{ ft}$$

$$MHW_{REF} := MHW - NAVD = 4.21 \text{ ft}$$

$$MTL_{REF} := MTL - NAVD = -0.35 \text{ ft}$$

$$MSL_{REF} := MSL - NAVD = -0.32 \text{ ft}$$

$$MDTL_{REF} := MDTL - NAVD = -0.3 \text{ ft}$$

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$$MLW_{REF} := MLW - NAVD = -4.91 \text{ ft}$$

$$MLLW_{REF} := MLLW - NAVD = -5.26 \text{ ft}$$

$$HOWL_{REF} := HOWL - NAVD = 8.87 \text{ ft}$$

$$LOWL_{REF} := LOWL - NAVD = -8.71 \text{ ft}$$

$$HAT_{REF} := HAT - NAVD = 6.69 \text{ ft}$$

$$LAT_{REF} := LAT - NAVD = -7.38 \text{ ft}$$

Highest Predicted Tide: <<http://tidesandcurrents.noaa.gov/waterlevels.html?id=8418150&units=standard&bdate=20150712&edate=20160711&timezone=GMT&datum=MLLW&interval=hl&action=data>>

The largest predicted height is on 6/25/2017 $HT_{max} := 11.91 \text{ ft}$

2017 Predicted High Tide: $HT_{REF} := MLLW_{REF} + HT_{max} = 6.65 \text{ ft}$

Subordinate Station: <https://tidesandcurrents.noaa.gov/datums.html?id=8417134>
Gardiner Station ID 8417134

Mean Higher-High Water: $MHHW_{Gar} := 28.24 \text{ ft}$

Mean High Water: $MHW_{Gar} := 27.89 \text{ ft}$

Mean Sea Level: $MSL_{Gar} := 25.08 \text{ ft}$

Mean Tide Level: $MTL_{Gar} := 24.91 \text{ ft}$

Mean Low Water: $MLW_{Gar} := 21.93 \text{ ft}$

Mean Lower-Low Water: $MLLW_{Gar} := 21.72 \text{ ft}$

Mean Diurnal Tide Level: $MDTL_{Gar} := 24.98 \text{ ft}$

Mean Range of Tide: $MN_{Gar} := 5.96 \text{ ft}$

Spring Range: $GT_{Gar} := 6.53 \text{ ft}$

There are not any elevation benchmarks at this station, so use the Augusta MCRR Bridge (8417144) station and Richmond (8417208) station to get an elevation and interpolate to estimate the elevation at the Gardiner station.

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Subordinate Station: <https://tidesandcurrents.noaa.gov/datums.html?id=8417144>
Augusta, MCRR Bridge Station ID 8417144
Use the Mean High Water elevation:

Mean High Water: $MHW_{Aug} := 33.53 \text{ ft}$

NAVD 88: $NAVD_{Aug} := 28.51 \text{ ft}$

$$MHW_{Aug.sub} := MHW_{Aug} - NAVD_{Aug} = 5.02 \text{ ft}$$

Distance from Augusta Station to Gardiner Station: $D_{Aug.Gar} := 48473 \text{ ft}$

Subordinate Station: <https://tidesandcurrents.noaa.gov/datums.html?id=8417208>
Richmond Station ID 8417208

Use Benchmark 31 to get elevation of the MHW

Height of Benchmark above MHW: $H_{B31} := 8.119 \text{ m} = 26.64 \text{ ft}$

NAVD 88 Benchmark 31: $NAVD_{B31} := 30.23 \text{ ft}$

$$MHW_{Ric.sub} := NAVD_{B31} - H_{B31} = 3.59 \text{ ft}$$

Distance from Gardiner Station to Richmond Station: $D_{Gar.Ric} := 45497 \text{ ft}$

Distance from Augusta Station to Richmond Station: $D_{Aug.Ric} := D_{Gar.Ric} + D_{Aug.Gar} = 93970 \text{ ft}$

Mean High Water Reference for Gardiner:

$$MHW_{sub} := MHW_{Aug.sub} + D_{Aug.Gar} \cdot \frac{MHW_{Ric.sub} - MHW_{Aug.sub}}{D_{Aug.Ric}} = 4.28 \text{ ft}$$

NAVD 88: $NAVD_{sub} := MHW_{Gar} - MHW_{sub} = 23.61 \text{ ft}$

Convert tidal datum information to the NAVD

$$MHHW_{sub} := MHHW_{Gar} - NAVD_{sub} = 4.63 \text{ ft}$$

$$MHW_{sub} = 4.28 \text{ ft}$$

$$MTL_{sub} := MTL_{Gar} - NAVD_{sub} = 1.3 \text{ ft}$$

$$MSL_{sub} := MSL_{Gar} - NAVD_{sub} = 1.47 \text{ ft}$$

$$MDTL_{sub} := MDTL_{Gar} - NAVD_{sub} = 1.37 \text{ ft}$$

$$MLW_{sub} := MLW_{Gar} - NAVD_{sub} = -1.68 \text{ ft}$$

$$MLLW_{sub} := MLLW_{Gar} - NAVD_{sub} = -1.89 \text{ ft}$$

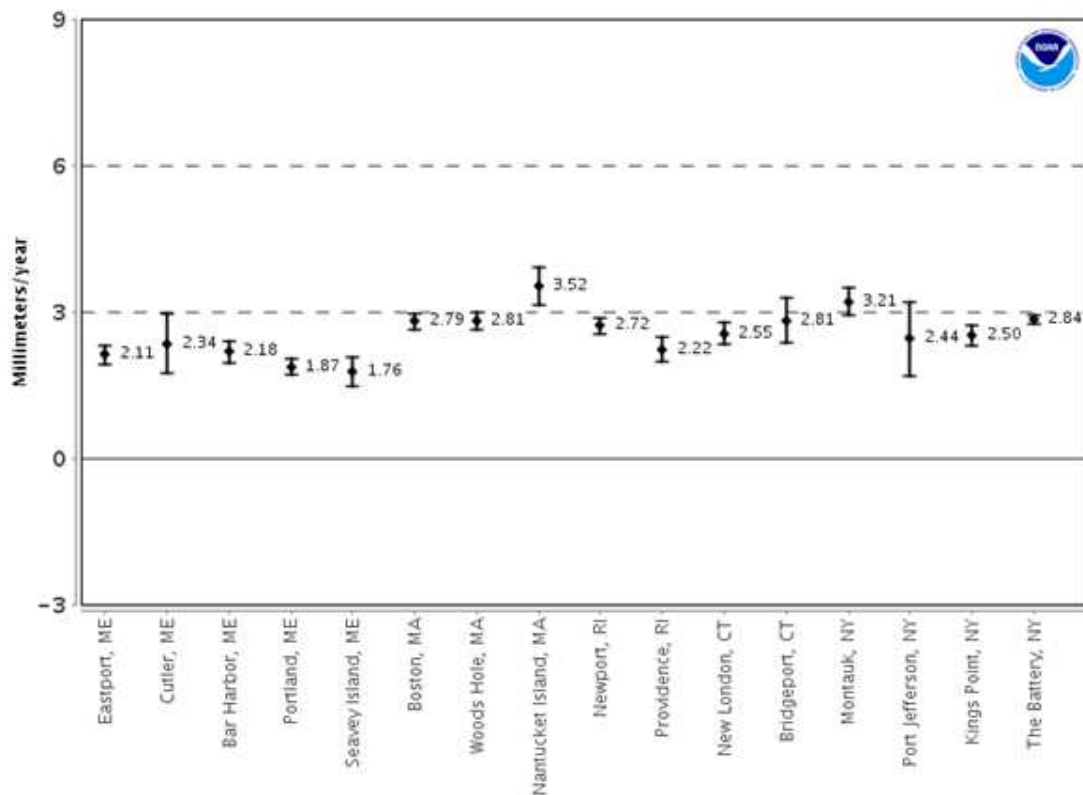
Highest predicted tide at Gardiner

$$\text{Ratio of height difference at high water: } Ratio := \frac{MHHW_{sub} - MTL_{sub}}{MHHW_{REF} - MTL_{REF}} = 0.67$$

$$\text{Predicted High Tide: } HT_{sub} := MLLW_{sub} + Ratio \cdot HT_{max} = 6.05 \text{ ft}$$

Sea Level Rise: multiply yearly sea level rise by 100, to get 100 years using the following link: <http://www.co-ops.nos.noaa.gov/sltrends/northeastatlantictrends.htm>

Take sea level rise average at Bar Harbor, ME and Portland, ME since the project location is between these points.



$$rise_1 := 2.18 \frac{mm}{yr} \cdot 100 \text{ yr} = 0.72 \text{ ft} \quad \text{sea level rise at Bar Harbor, ME}$$

$$rise_2 := 1.87 \frac{mm}{yr} \cdot 100 \text{ yr} = 0.61 \text{ ft} \quad \text{sea level rise at Portland, ME}$$

$$rise := \frac{rise_1 + rise_2}{2} = 0.66 \text{ ft} \quad \text{Average sea level rise}$$

Future Tide Datum Elevations:

$$MHHW_{future} := MHHW_{sub} + rise = 5.3 \text{ ft}$$

$$MHW_{future} := MHW_{sub} + rise = 4.95 \text{ ft}$$

$$MLW_{future} := MLW_{sub} + rise = -1.01 \text{ ft}$$

$$MLLW_{future} := MLLW_{sub} + rise = -1.22 \text{ ft}$$

$$HT_{future} := HT_{sub} + rise = 6.71 \text{ ft}$$