Understanding the Tides in South Bethany's Canals

Probably more than you wanted to know

Topics

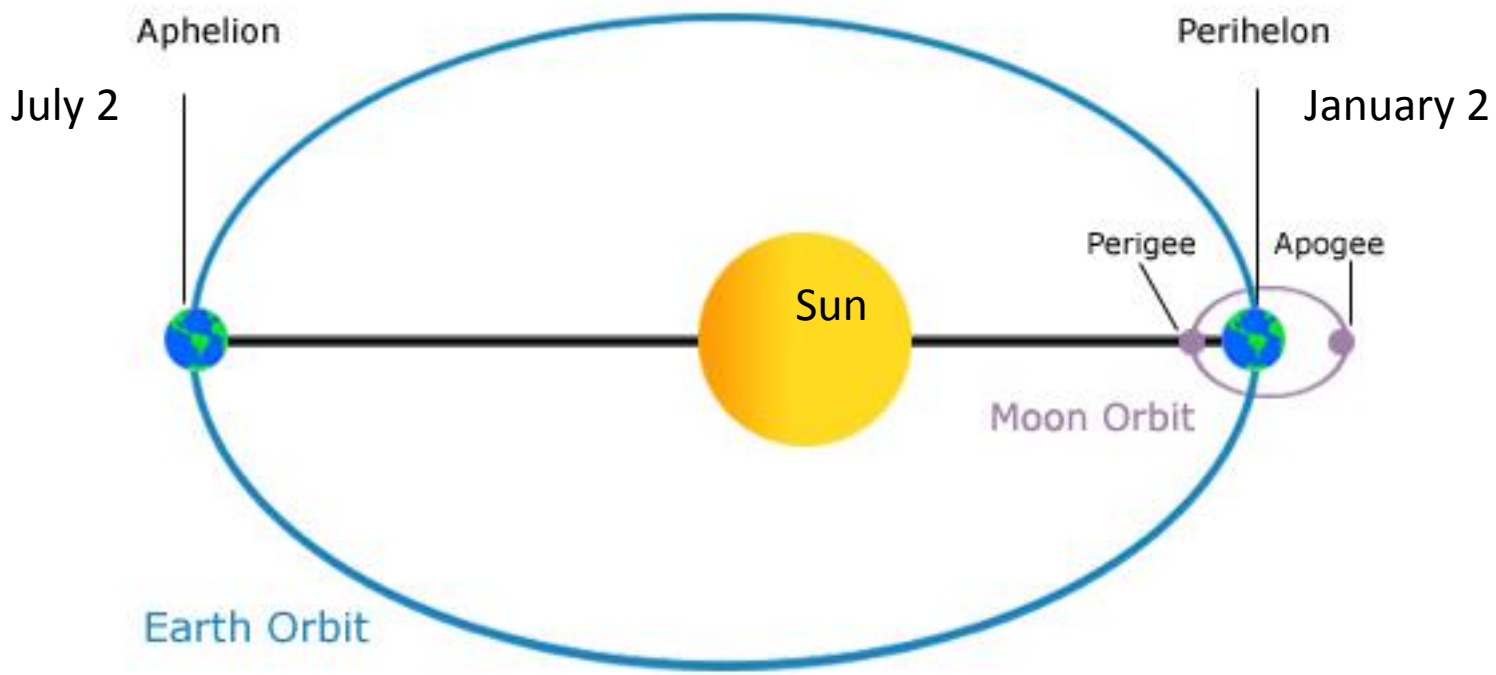
- South Bethany canal tides are the result of many factors.
- 5 years of recorded South Bethany Canal tide data.
- Predicting South Bethany canal tides, based on predicted Ocean City Inlet tides.
- An Understanding of datums is needed to understand tide data available on web sites.

South Bethany Canal Tides Are The Result Of Many Factors

- Gravity effects due to astronomical masses, and their orbits, rotations and positions. The most significant of the astronomical masses are the moon, the sun and the earth. The effects of these factors are easily predicted.
- Topography on the ocean floor, shoreline, bays and inlets. The effects of these factors are predictable. Comparison of predicted tides at Lewes, and Ocean City, due to topology. The tides at these locations are not the same.
- Meteorological contributions know as "storm surges", caused by a continuous strong flow of winds. This is the largest “unknown” relative to tide height prediction and is of the most concern to South Bethany.
- Specific to South Bethany is the geography of the Inland Bays between the Ocean City Inlet and the South Bethany Canals. This affords South Bethany a six hour warning as to what is coming.

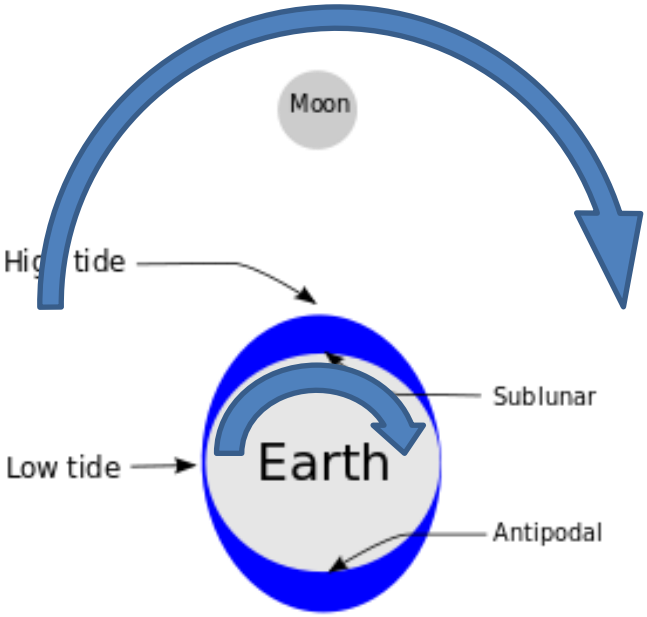
An Understanding Of Astronomy Is Needed To Understand Tides

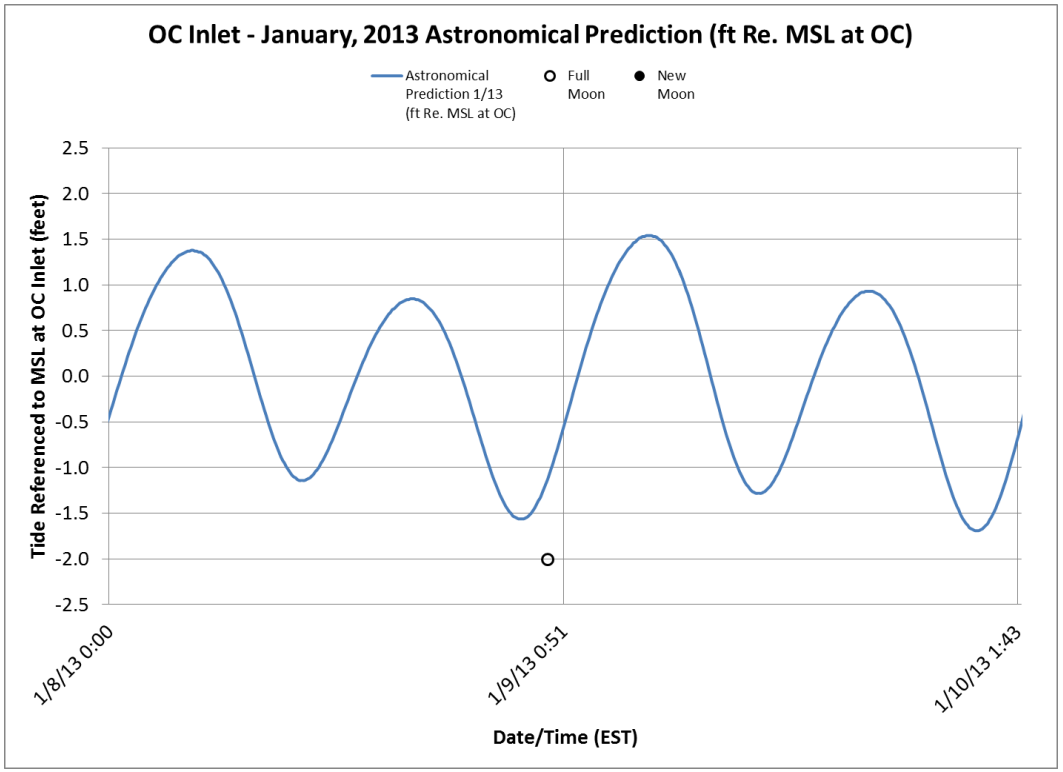
- The gravitational pull of the moon and the sun creates tides on the earth.
- The rotation of the earth and the orbits of the moon and earth cause cyclic periods of about 24.87 hours, 29.5 days and 365.256 days.



The Moon Is The Primary Tidal Force – About 56%

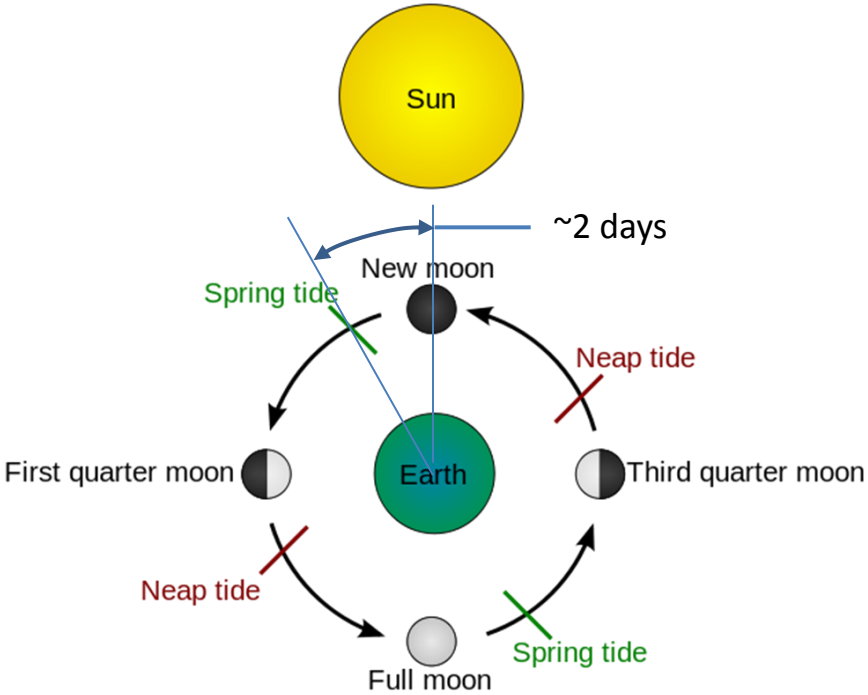
- Due to the cyclic rotation of the earth and moon, the tidal cycle is 24 hours and 52 minutes (~1.036 days) long. During this time, any point on the earth's surface experiences two high tides and two low tides
- On the <u>opposite side of the earth simultaneously there is a high tide</u> due to the inertia of the ocean water and because the earth is being pulled toward the moon by its gravitational field yet the ocean water remains left behind. This creates a high tide on the side of the earth opposite the high tide caused by the direct pull of the moon.

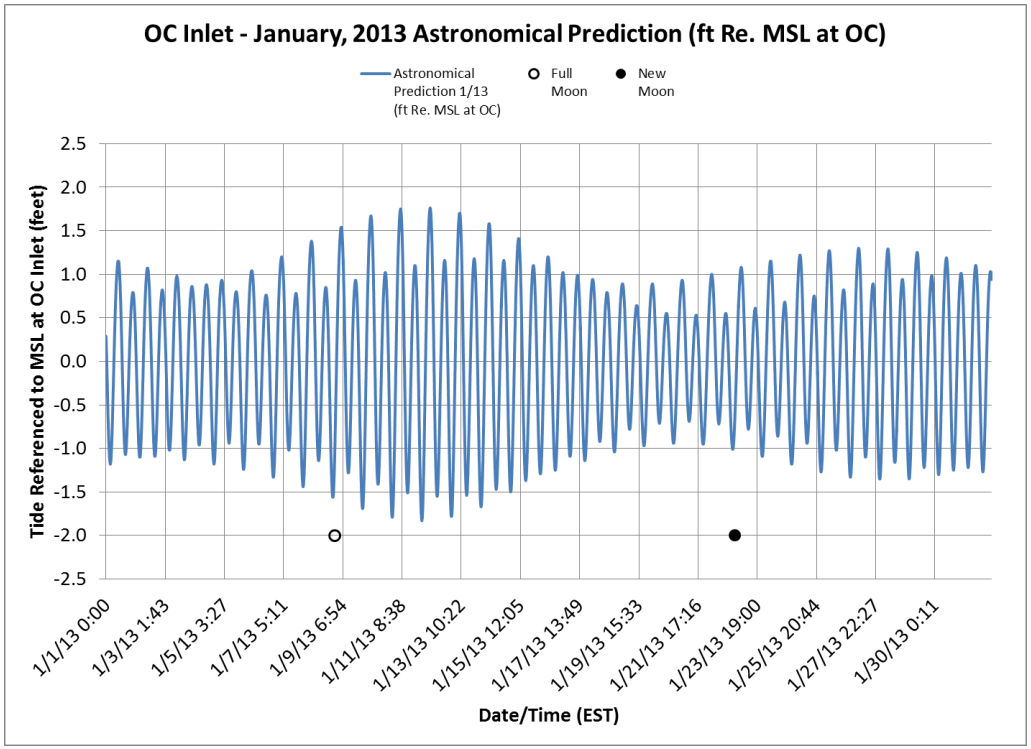


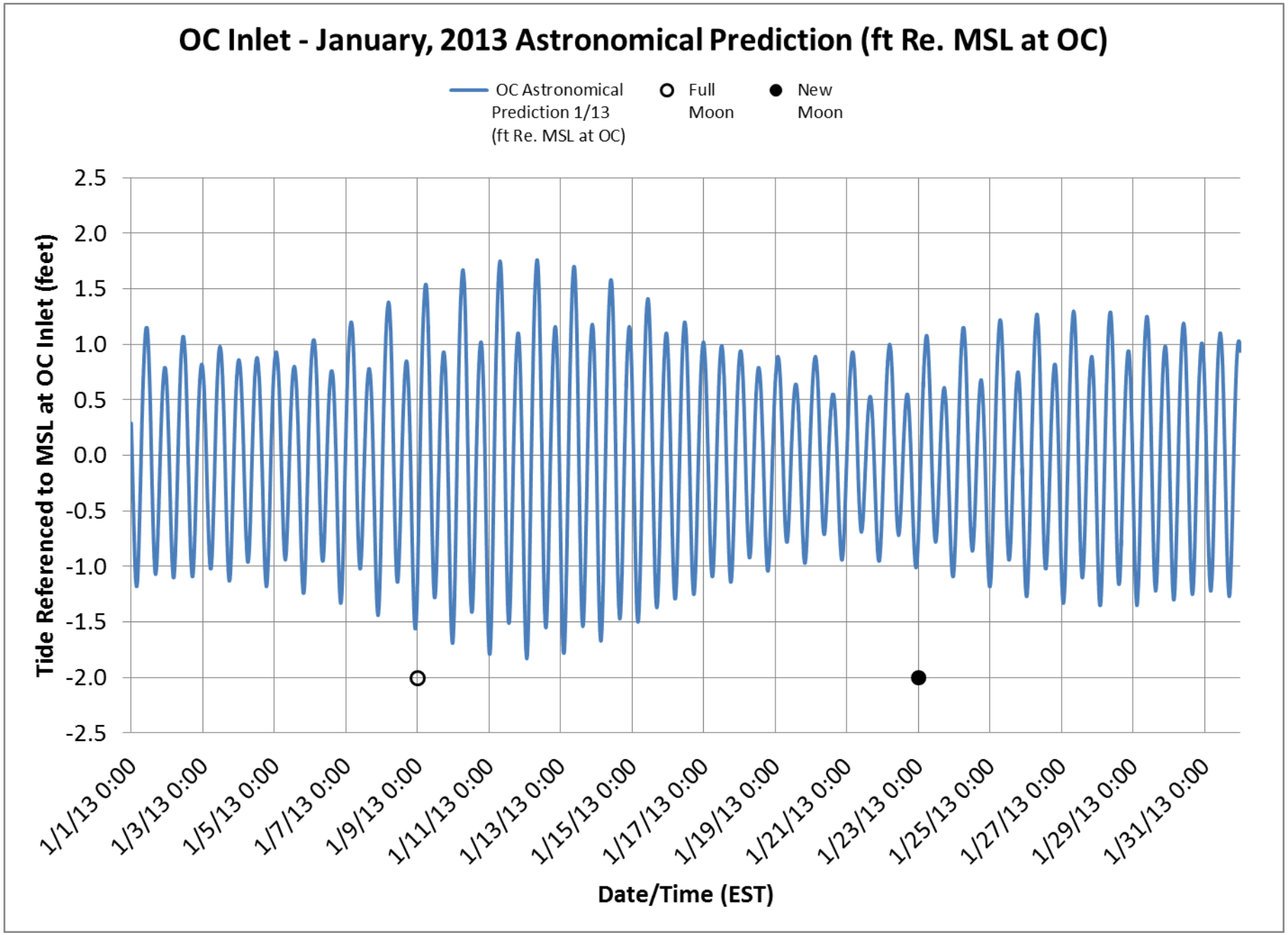


The Sun Is The Secondary Inertial Force – About 44%

- When the sun, moon, and the earth are lined up, the sun and moon are exerting their strongest force together and tidal ranges are at their maximum. This is known as spring tide (spring tides are not named from the season but from "spring forward") This occurs twice each month, when the moon is full and new. The period is about 29.5 days.

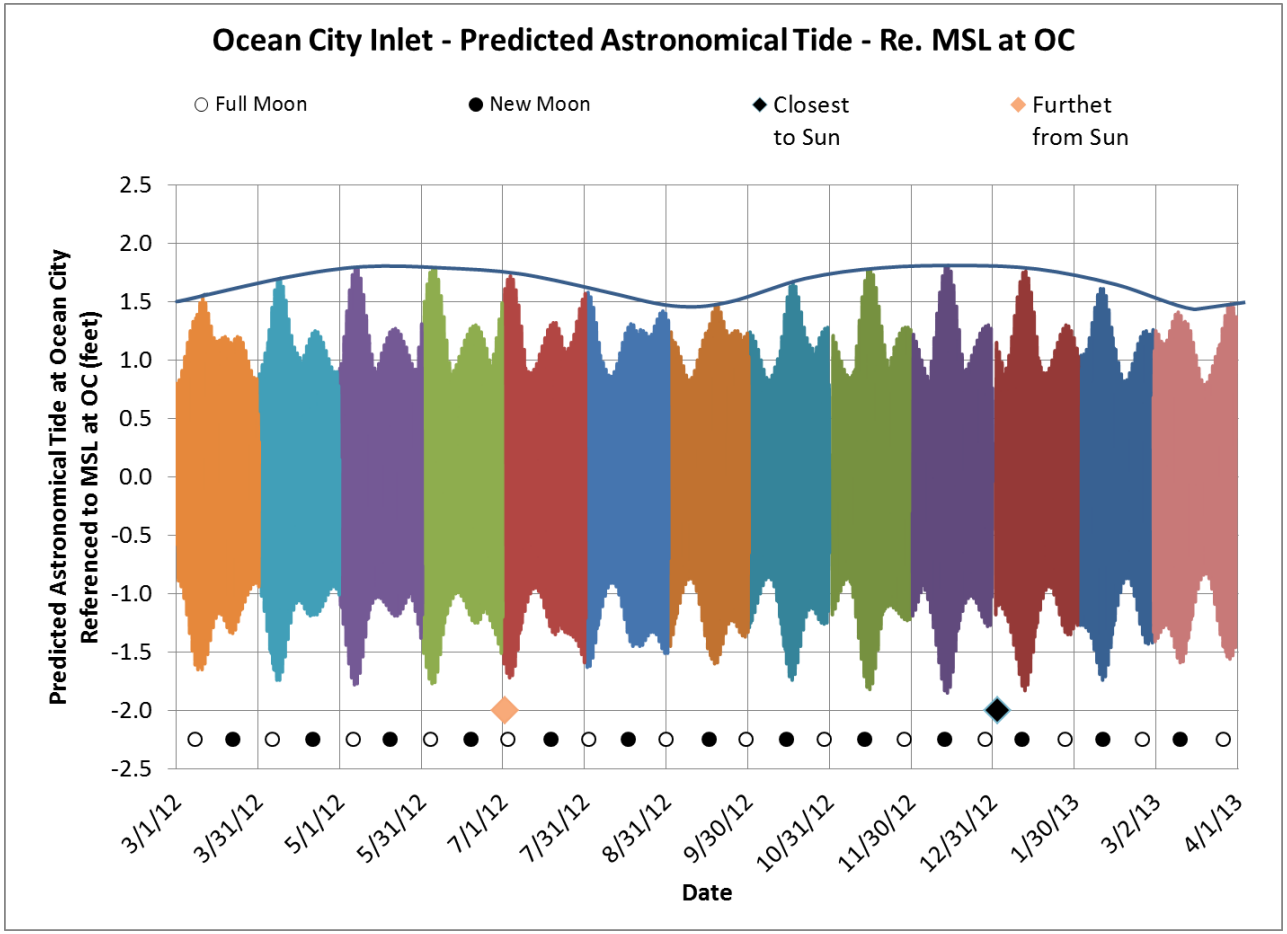




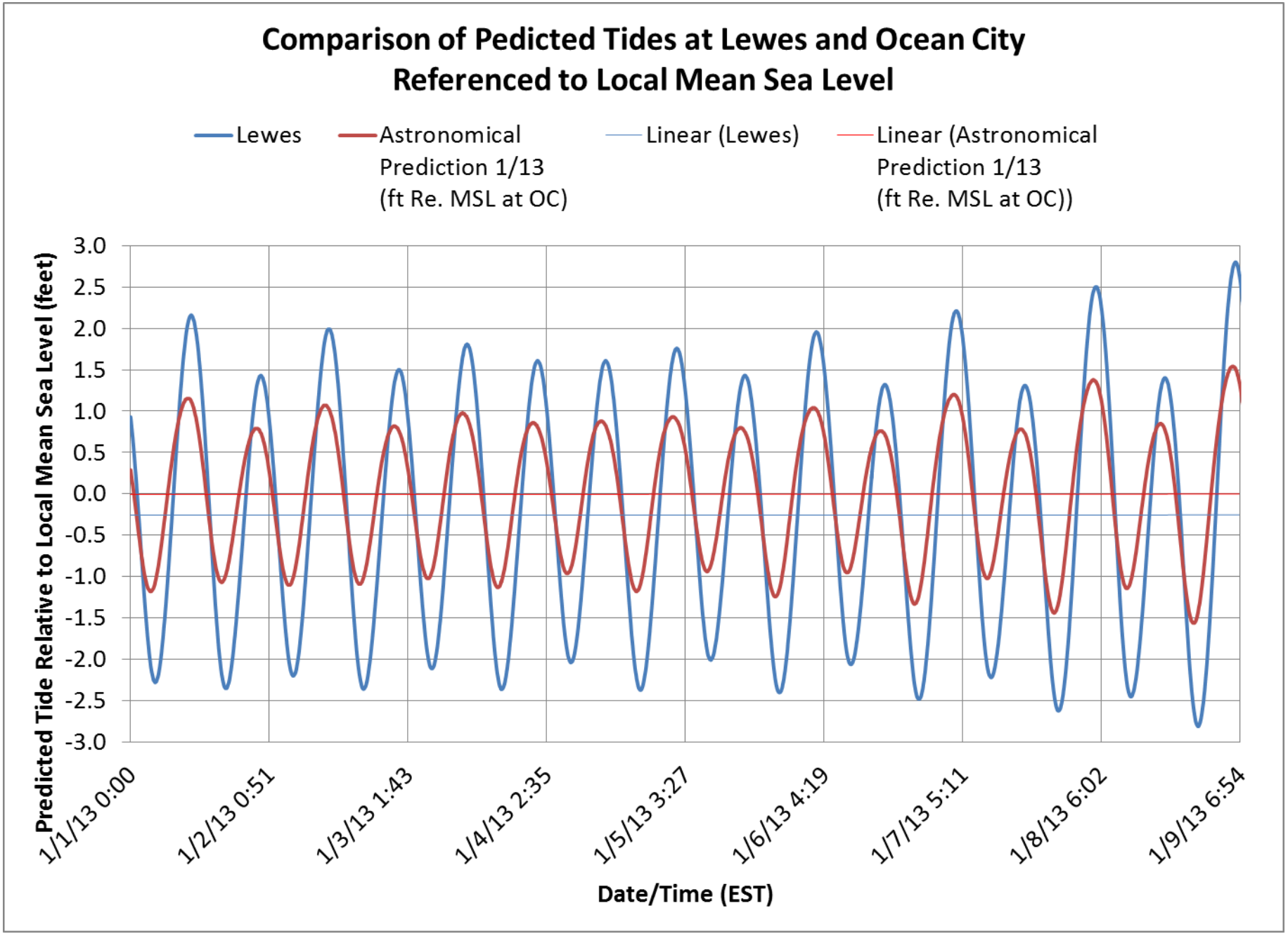

OC Inlet - January, 2013 Astronomical Prediction (ft Re. MSL at OC)
OC Astronomical Prediction 1/13 (ft Re. MSL at OC)
Full Moon
New Moon
Tide Referenced to MSL at OC Inlet (feet)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
1/1/13 0:00
1/3/13 0:00
1/5/13 0:00
1/7/13 0:00
1/9/13 0:00
1/11/13 0:00
1/13/13 0:00
1/15/13 0:00
1/17/13 0:00
1/19/13 0:00
1/21/13 0:00
1/23/13 0:00
1/25/13 0:00
1/27/13 0:00
1/29/13 0:00
1/31/13 0:00
Date/Time (EST)

Something Other Than The Earth's Orbit About The Sun Is Affecting The Predicted Astronomical Tides At Ocean City

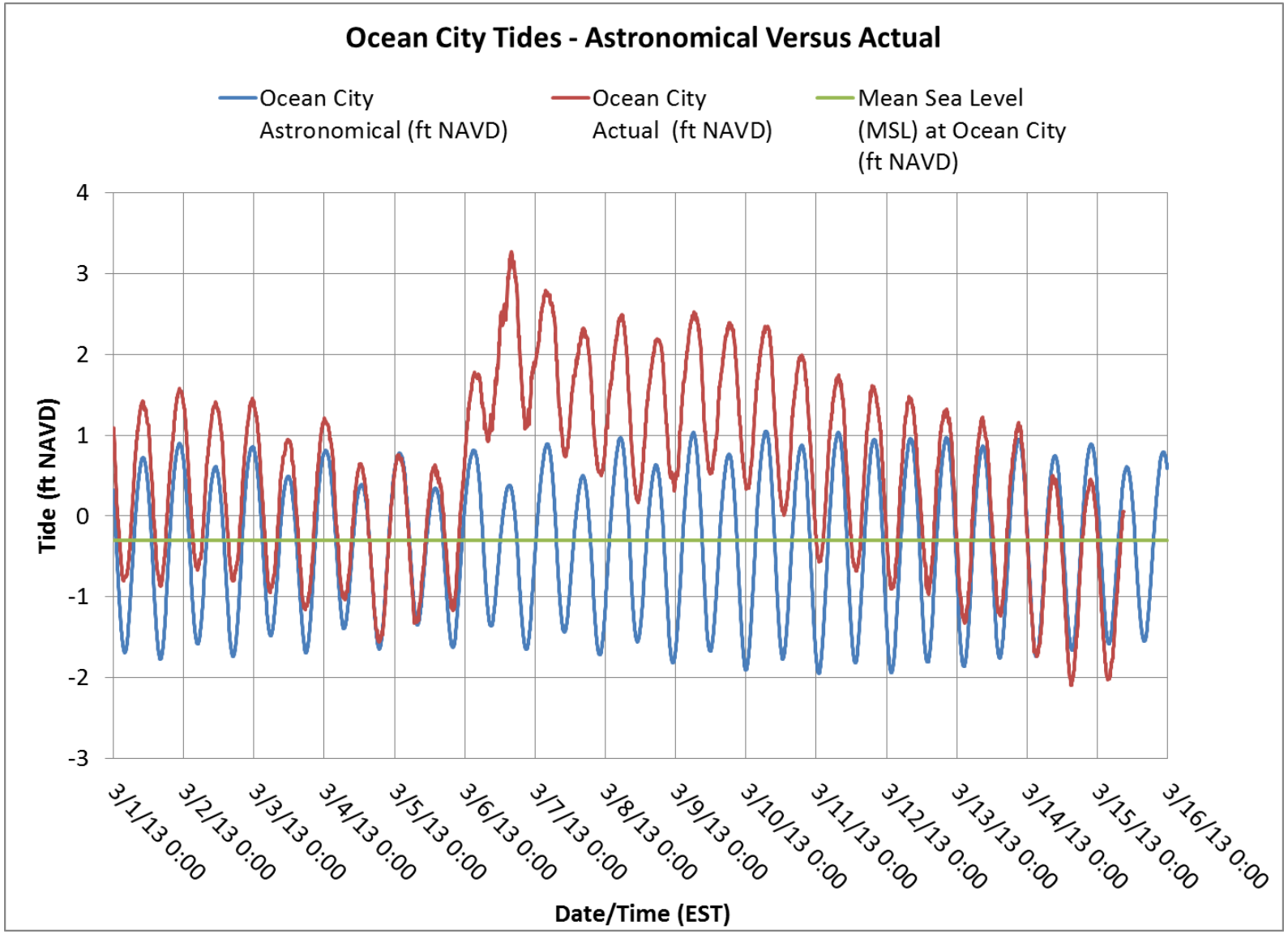
- "When the Earth is closest to the sun (perihelion), around January 2 of the calendar year, tidal ranges are enhanced. At aphelion, when the Earth is furthest from the sun, around July 2, tidal ranges are reduced." This is not consistent with OC predictions.



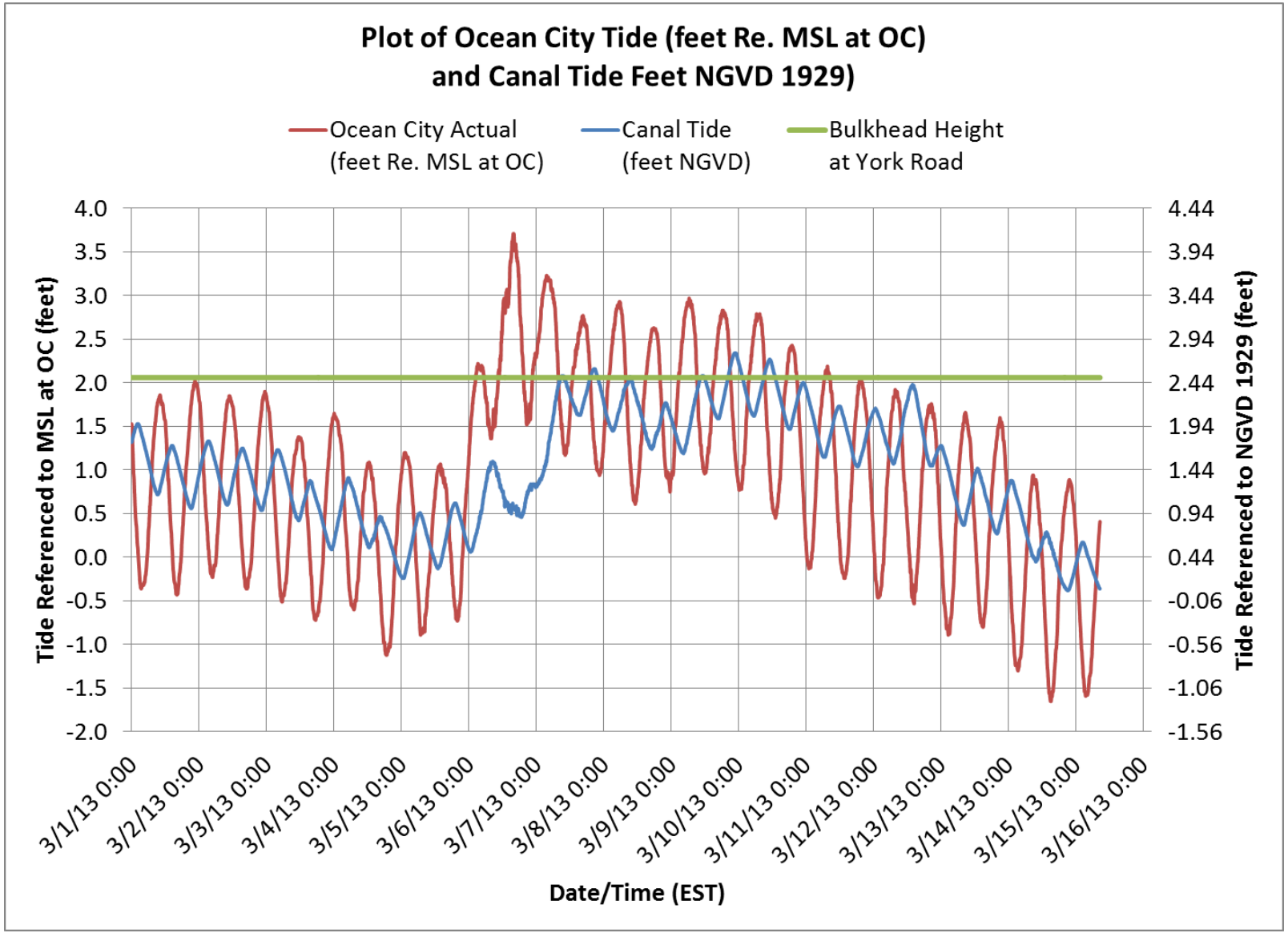
Topography Causes Variations In Tidal Predictions

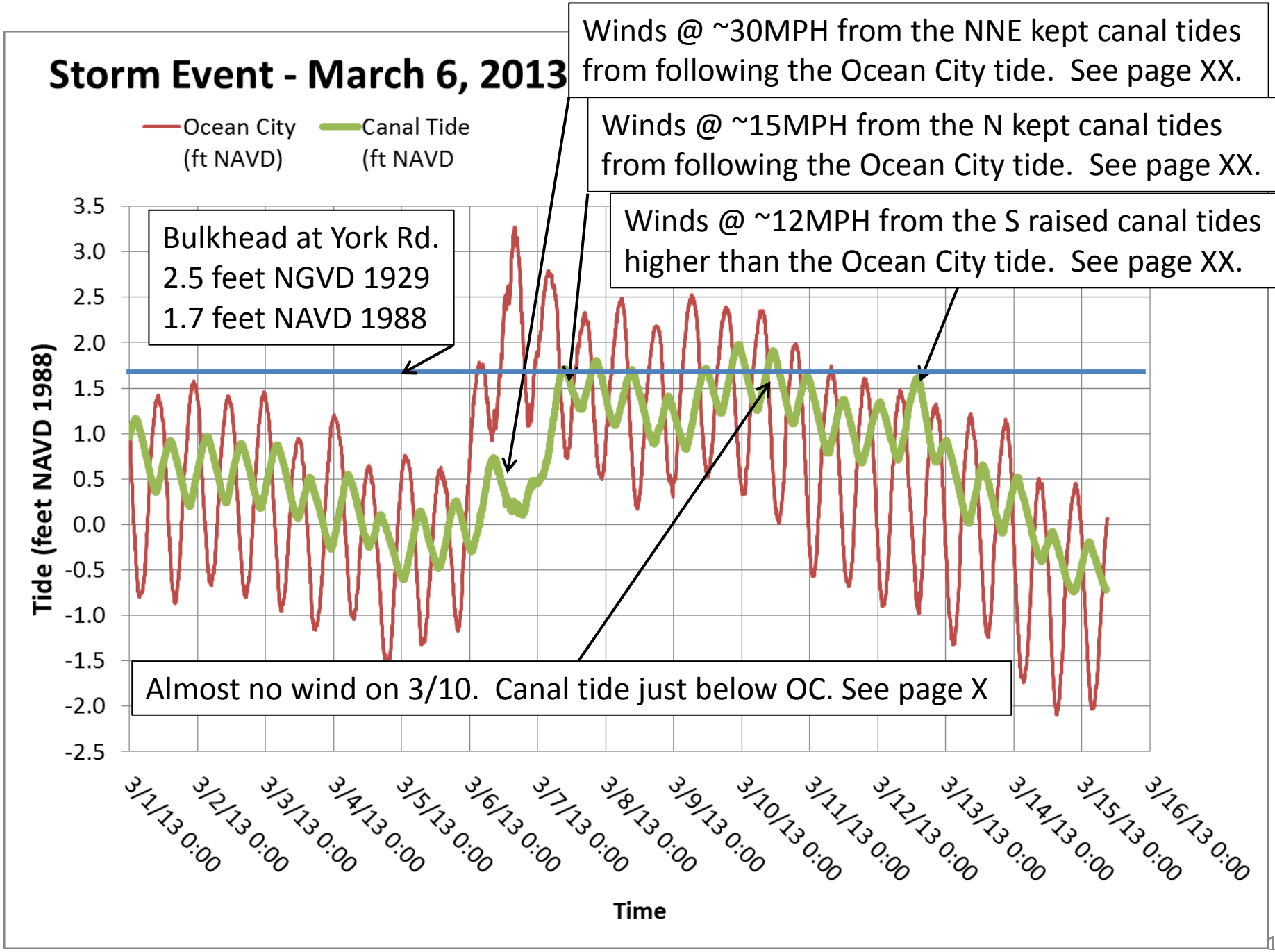


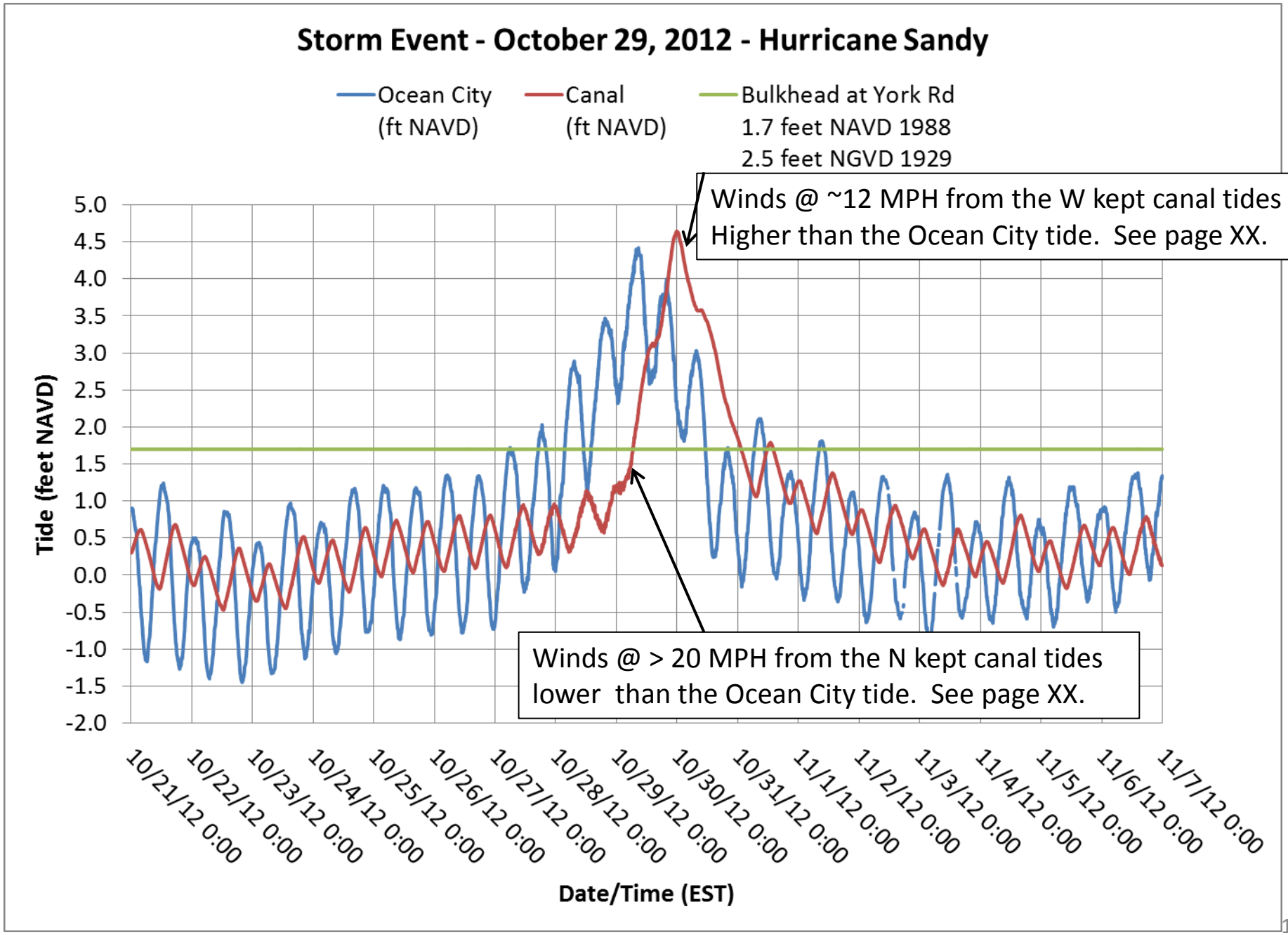
High Winds (Storms) Have A Significant Influence On Ocean City Tides

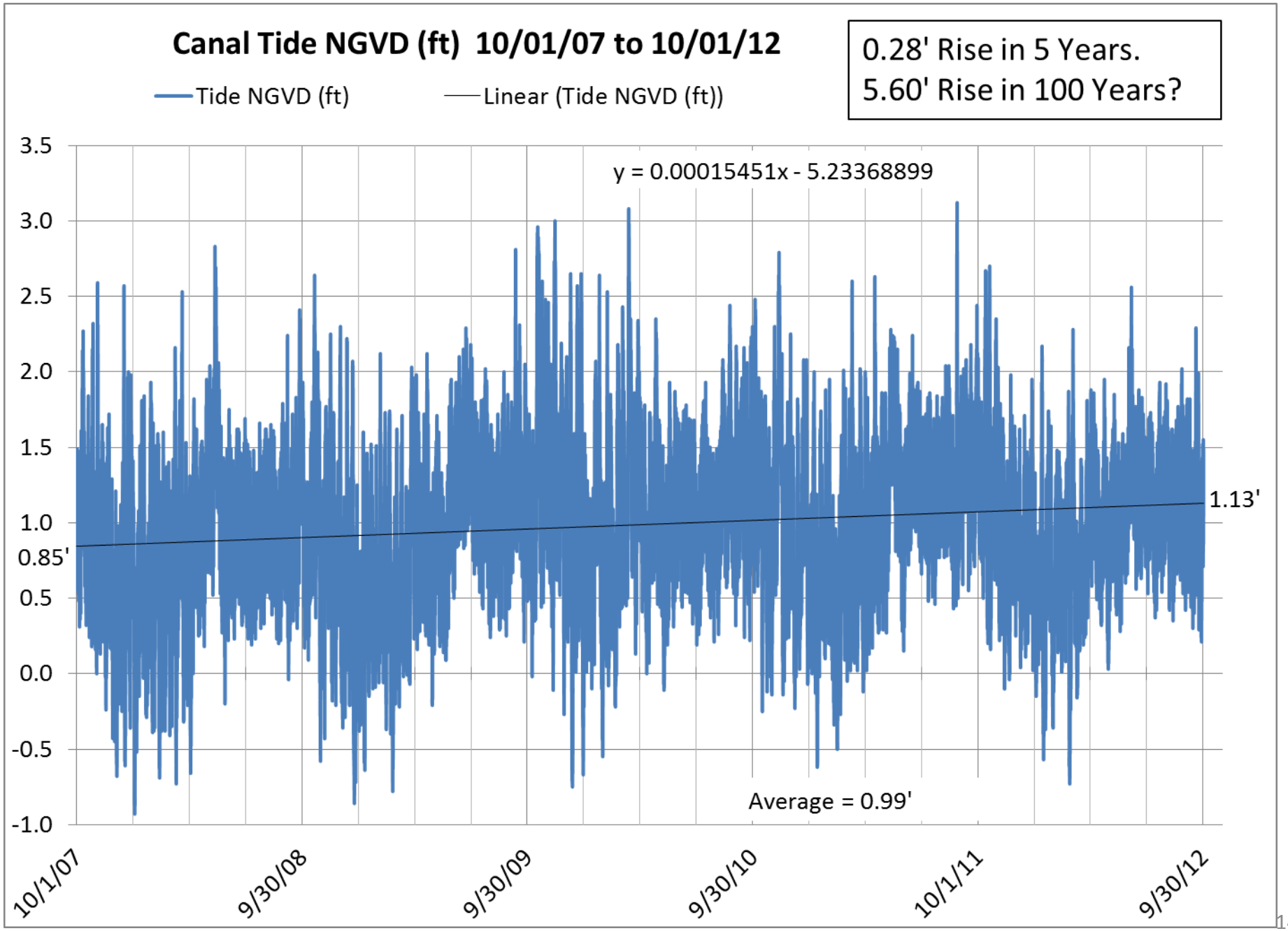


South Bethany Canal Tides Are Driven by the Ocean Tides At Ocean City and Very Significantly by the Local Wind. Canal Tides Occur About Six Hours After the Ocean City Tide.

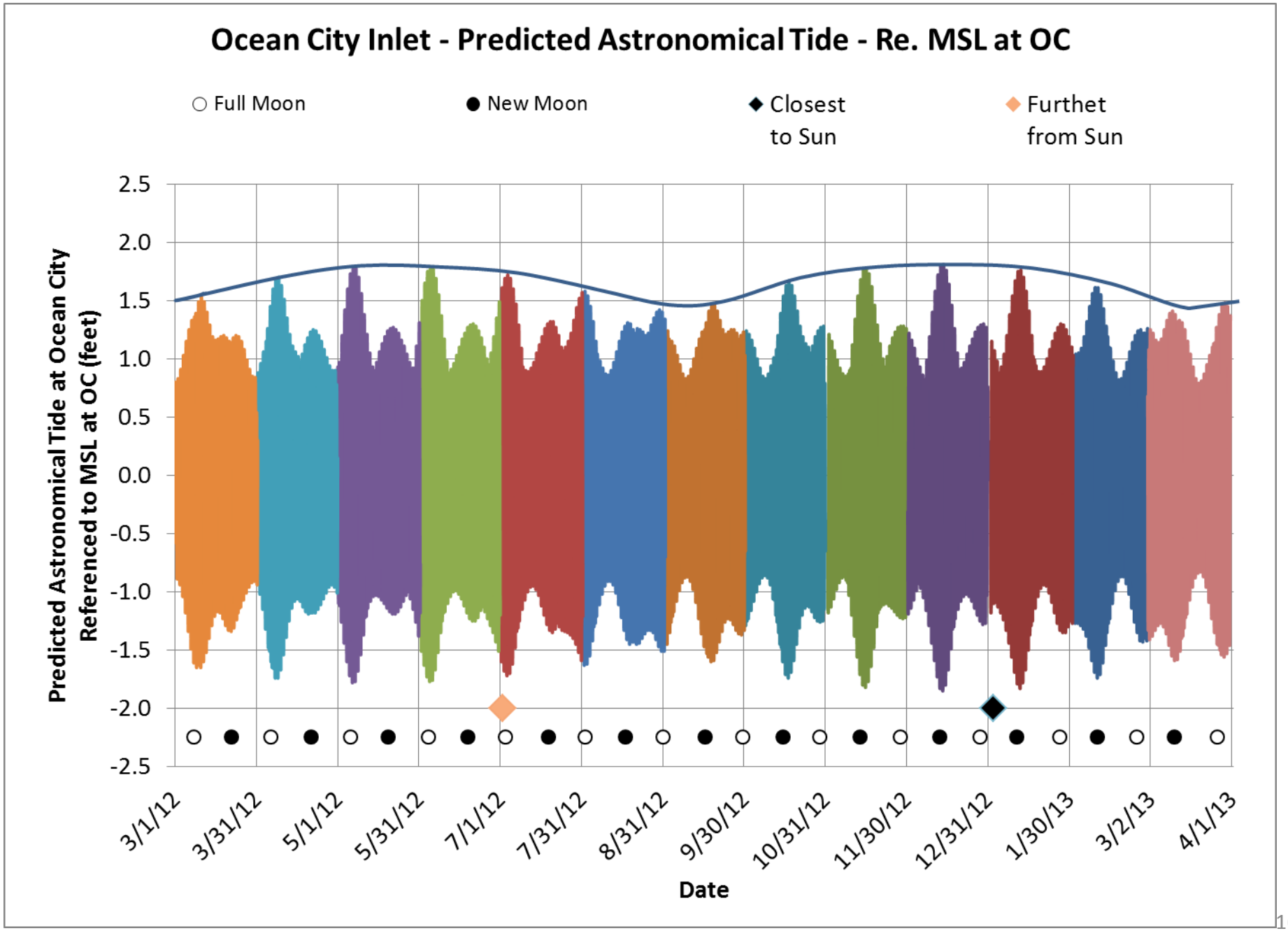


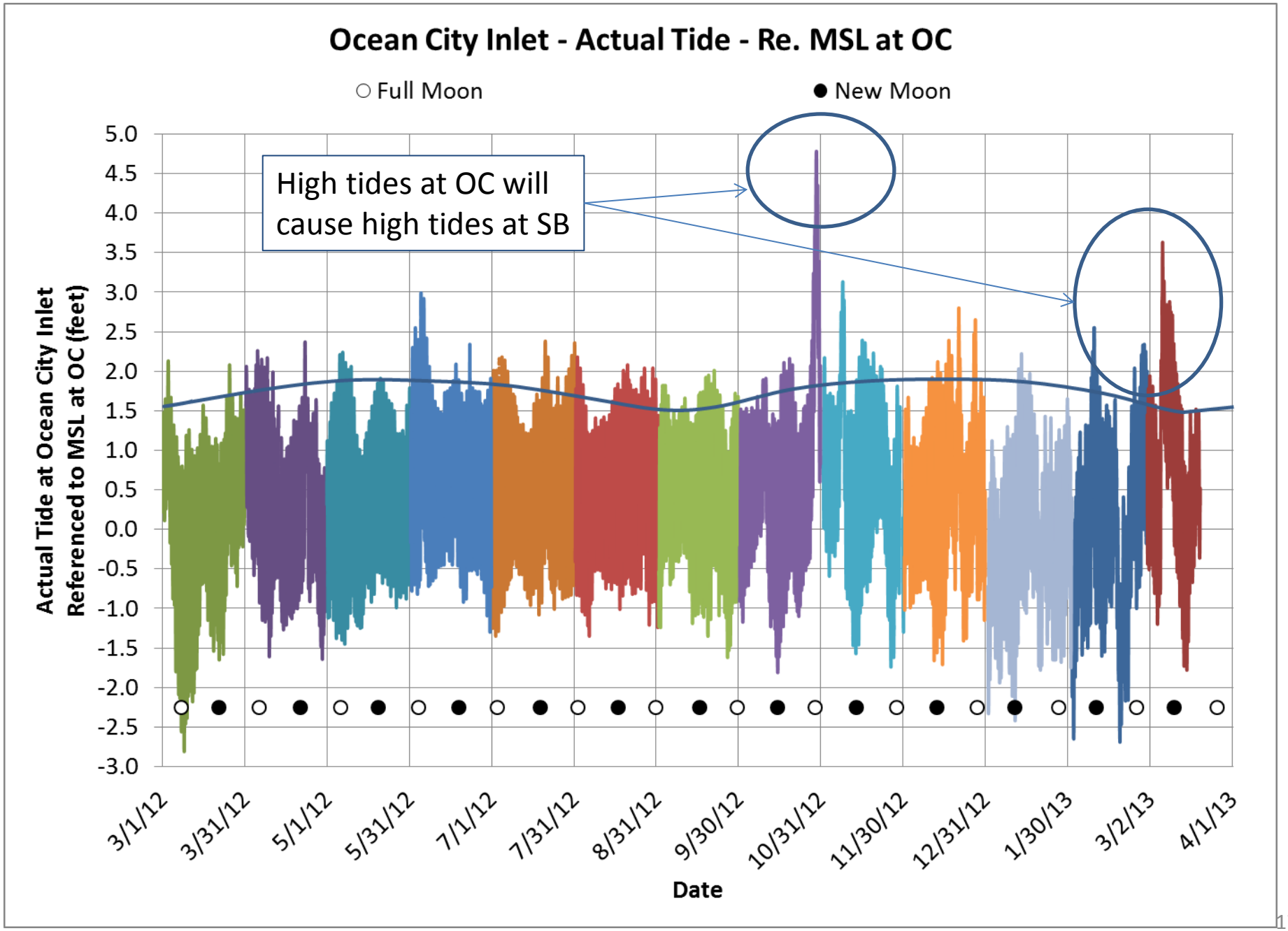

Storm Event - March 6, 2013
Ocean City (ft NAVD)
Canal Tide (ft NAVD
Winds @ ~30MPH from the NNE kept canal tides from following the Ocean City tide. See page XX.
Winds @ ~15MPH from the N kept canal tides from following the Ocean City tide. See page XX.
Winds @ ~12MPH from the S raised canal tides higher than the Ocean City tide. See page XX.
Bulkhead at York Rd.
2.5 feet NGVD 1929
1.7 feet NAVD 1988
Almost no wind on 3/10. Canal tide just below OC. See page X
Tide (feet NAVD 1988)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
3/1/13 0:00
3/2/13 0:00
3/3/13 0:00
3/4/13 0:00
3/5/13 0:00
3/6/13 0:00
3/7/13 0:00
3/8/13 0:00
3/9/13 0:00
3/10/13 0:00
3/11/13 0:00
3/12/13 0:00
3/13/13 0:00
3/14/13 0:00
3/15/13 0:00
3/16/13 0:00
Time


Storm Event - October 29, 2012 - Hurricane Sandy
Ocean City (ft NAVD)
Canal (ft NAVD)
Bulkhead at York Rd
1.7 feet NAVD 1988
2.5 feet NGVD 1929
Winds @ ~12 MPH from the W kept canal tides Higher than the Ocean City tide. See page XX.
Winds @ > 20 MPH from the N kept canal tides lower than the Ocean City tide. See page XX.
Tide (feet NAVD)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
10/21/12 0:00
10/22/12 0:00
10/23/12 0:00
10/24/12 0:00
10/25/12 0:00
10/26/12 0:00
10/27/12 0:00
10/28/12 0:00
10/29/12 0:00
10/30/12 0:00
10/31/12 0:00
11/1/12 0:00
11/2/12 0:00
11/3/12 0:00
11/4/12 0:00
11/5/12 0:00
11/6/12 0:00
11/7/12 0:00
Date/Time (EST)

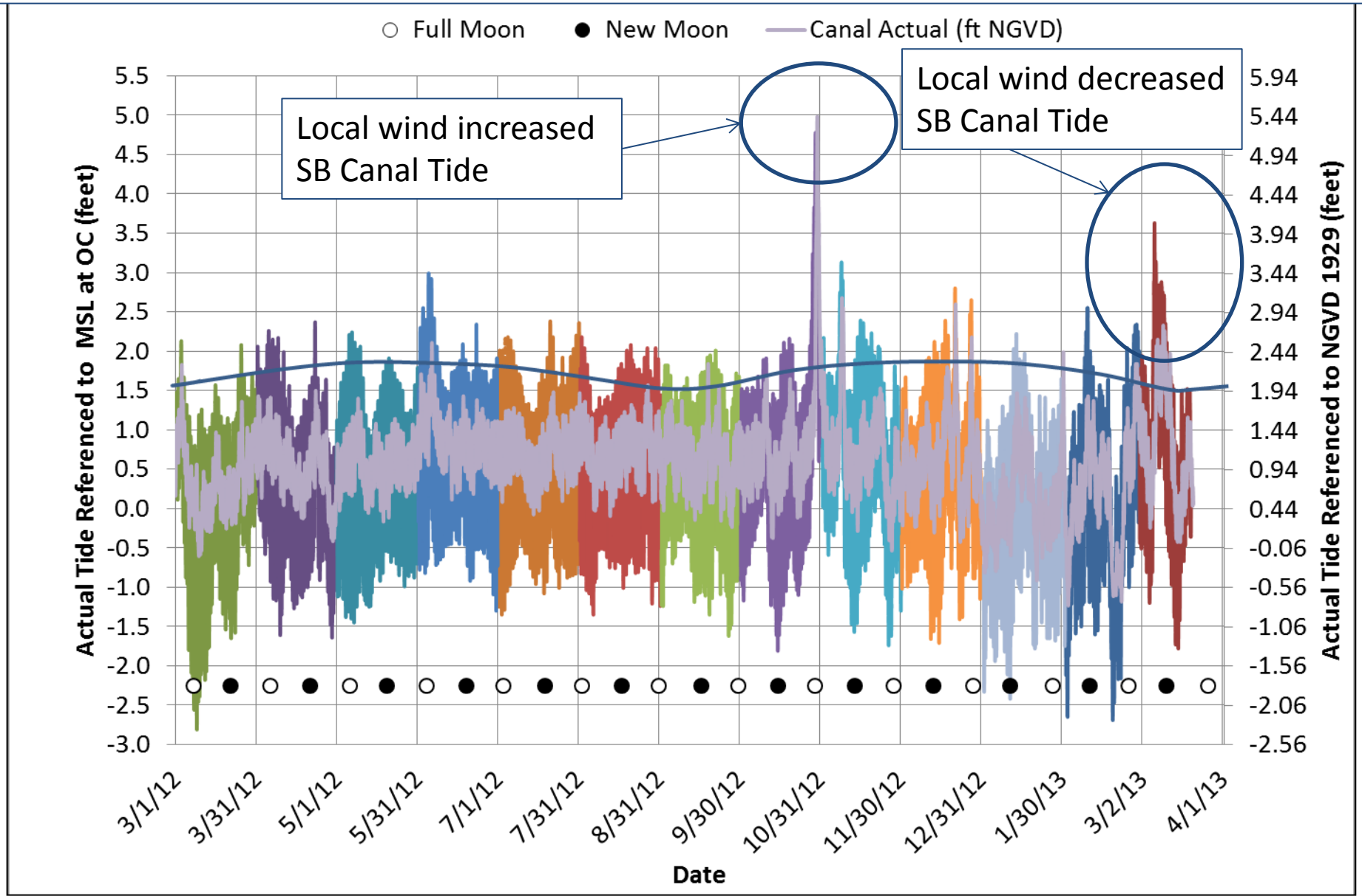

Canal Tide NGVD (ft) 10/01/07 to 10/01/12
0.28' Rise in 5 Years.
5.60' Rise in 100 Years?
Tide NGVD (ft)
Linear (Tide NGVD (ft))
y = 0.00015451x - 5.23368899
3.5
3.0
2.5
2.0
1.5
1.0
0.85'
0.5
0.0
-0.5
-1.0
1.13'
Average = 0.99'
10/1/07
9/30/08
9/30/09
9/30/10
10/1/11
9/30/12

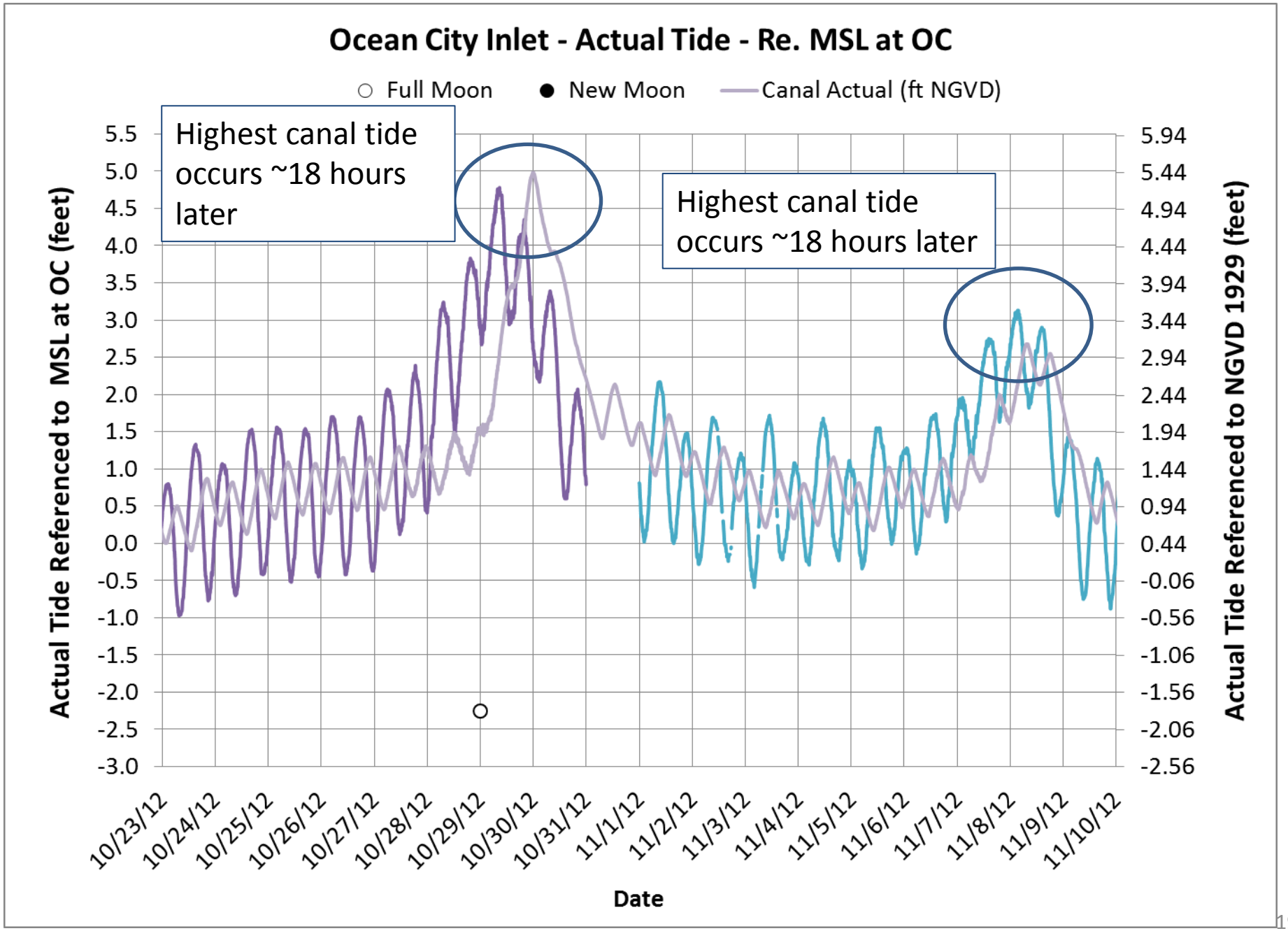
Predicting
South Bethany Canal Tides

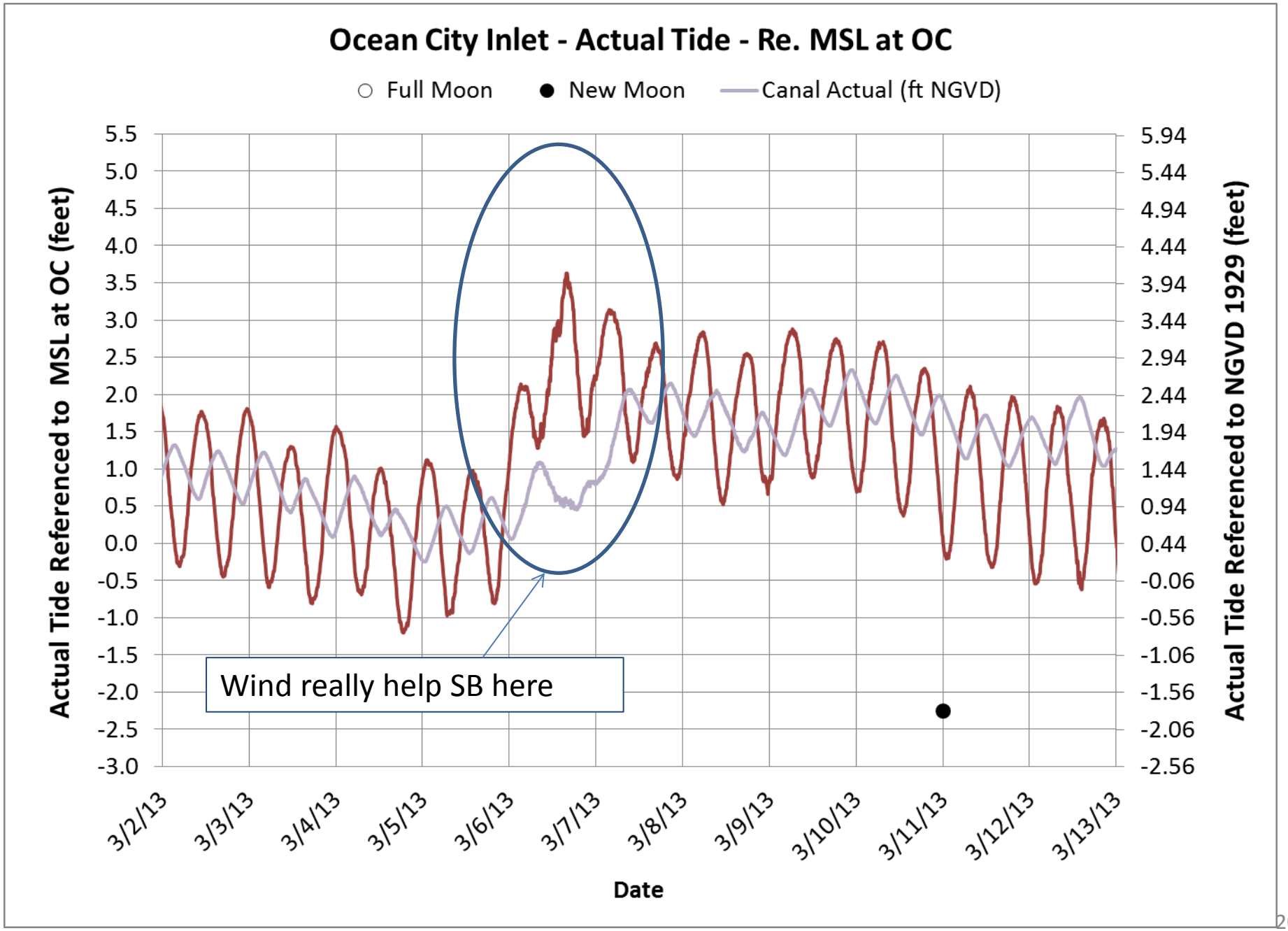

Ocean City Inlet - Predicted Astronomical Tide - Re. MSL at OC
Full Moon
New Moon
Closest to Sun
Furthet from Sun
Predicted Astronomical Tide at Ocean City Referenced to MSL at OC (feet)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
3/1/12
3/31/12
5/1/12
5/31/12
7/1/12
7/31/12
8/31/12
9/30/12
10/31/12
11/30/12
12/31/12
1/30/13
3/2/13
4/1/13
Date

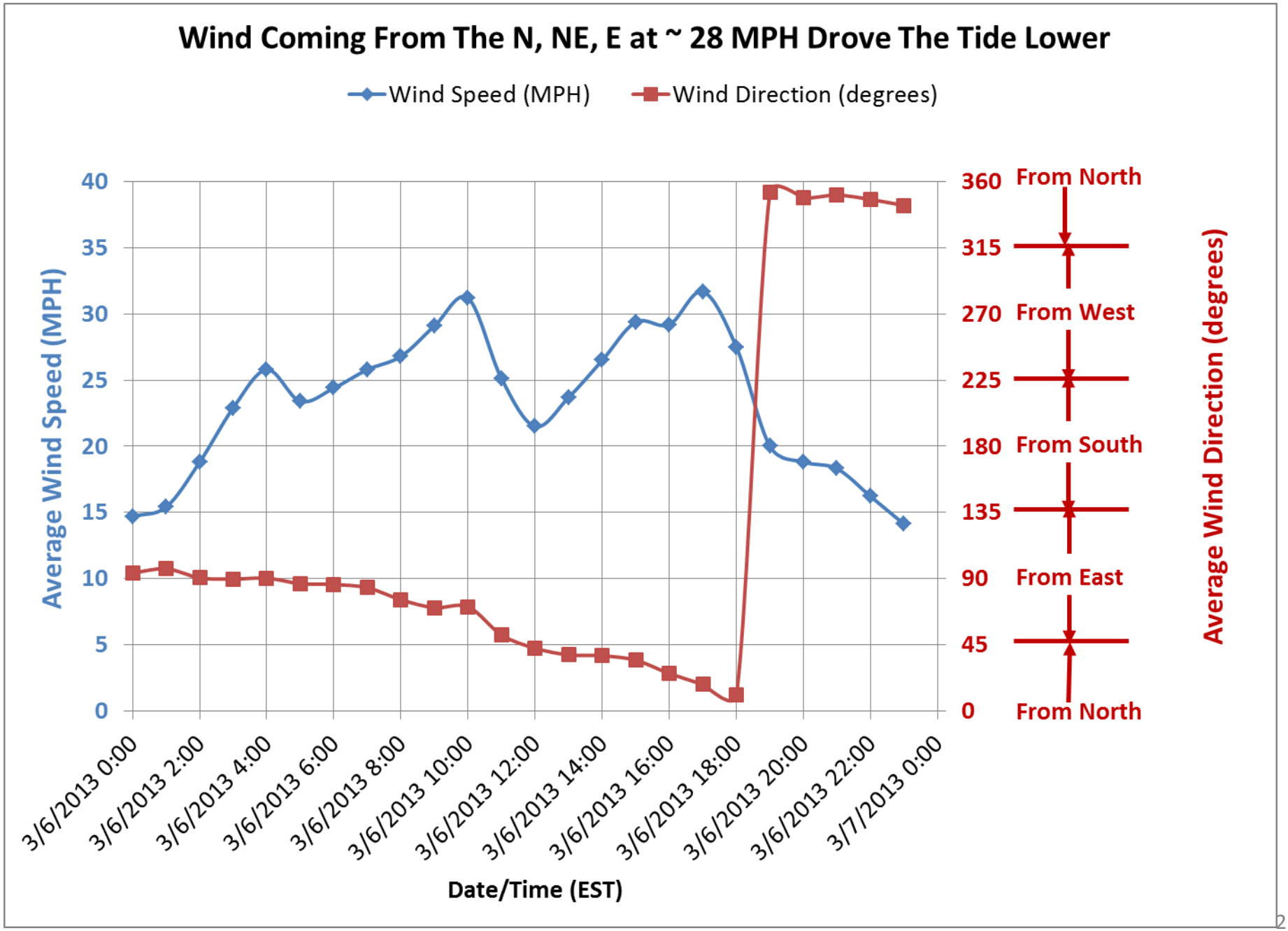

Ocean City Inlet - Actual Tide - Re. MSL at OC
Full Moon
New Moon
High tides at OC will cause high tides at SB
Actual Tide at Ocean City Inlet Referenced to MSL at OC (feet)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
3/1/12
3/31/12
5/1/12
5/31/12
7/1/12
7/31/12
8/31/12
9/30/12
10/31/12
11/30/12
12/31/12
1/30/13
3/2/13
4/1/13
Date

The Actual Canal Tide Is Almost Never Higher Than The Actual Ocean City Tide. Two Times Last Year It was Higher By About 0.25 Feet. Most Times It Was Lower By About 0.50 Feet, Depending On The Wind.




Ocean City Inlet - Actual Tide - Re. MSL at OC
Full Moon
New Moon
Canal Actual (ft NGVD)
Highest canal tide occurs ~18 hours later
Highest canal tide occurs ~18 hours later
Actual Tide Referenced to MSL at OC (feet)
Actual Tide Referenced to NGVD 1929 (feet)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
5.94
5.44
4.94
4.44
3.94
3.44
2.94
2.44
1.94
1.44
0.94
0.44
-0.06
-0.56
-1.06
-1.56
-2.06
-2.56
10/23/12
10/24/12
10/25/12
10/26/12
10/27/12
10/28/12
10/29/12
10/30/12
10/31/12
11/1/12
11/2/12
11/3/12
11/4/12
11/5/12
11/6/12
11/7/12
11/8/12
11/9/12
11/10/12
Date


Ocean City Inlet - Actual Tide - Re. MSL at OC
Full Moon
New Moon
Canal Actual (ft NGVD)
Actual Tide Referenced to MSL at OC (feet)
Actual Tide Referenced to NGVD 1929 (feet)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
5.94
5.44
4.94
4.44
3.94
3.44
2.94
2.44
1.94
1.44
0.94
0.44
-0.06
-0.56
-1.06
-1.56
-2.06
-2.56
3/2/13
3/3/13
3/4/13
3/5/13
3/6/13
3/7/13
3/8/13
3/9/13
3/10/13
3/11/13
3/12/13
3/13/13
Date
Wind really help SB here

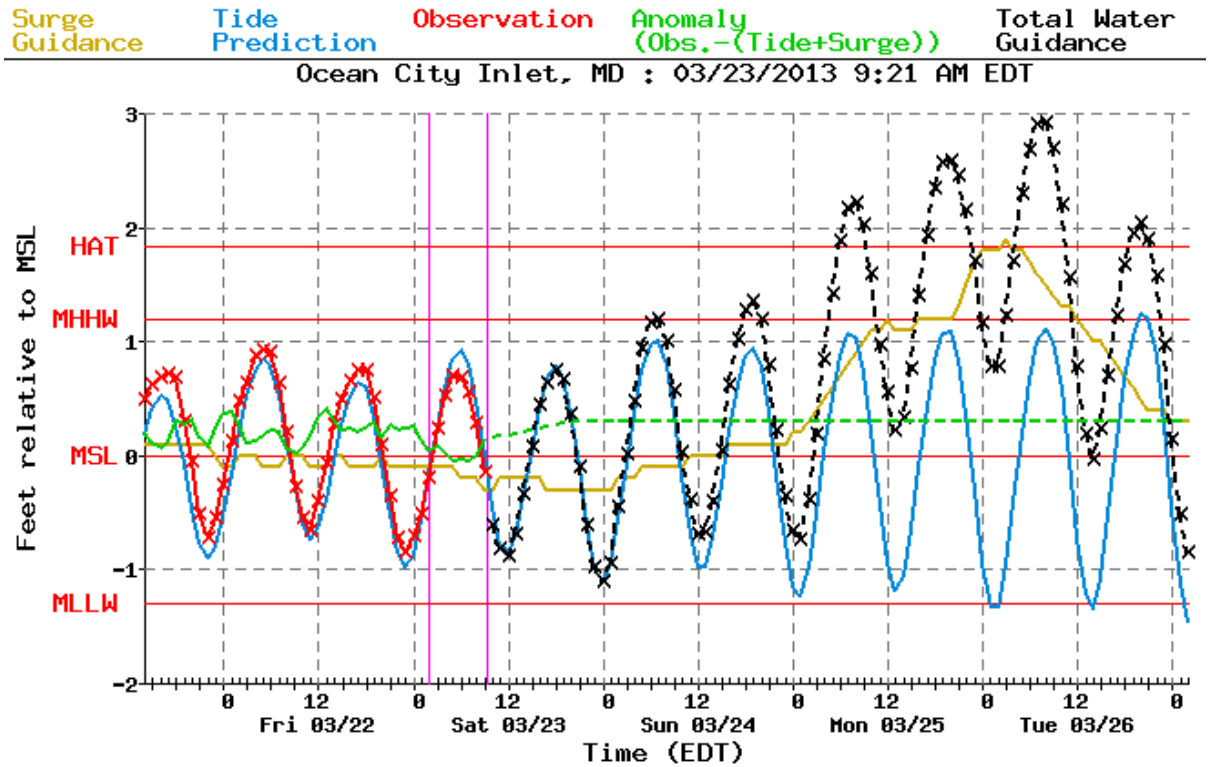

Wind Coming From The N, NE, E at ~ 28 MPH Drove The Tide Lower
Wind Speed (MPH)
Wind Direction (degrees)
Average Wind Speed (MPH)
40
35
30
25
20
15
10
5
0
360 From North
315
270 From West
225
180 From South
135
90 From East
45
0 From North
Average Wind Direction (degrees)
3/6/2013 0:00
3/6/2013 2:00
3/6/2013 4:00
3/6/2013 6:00
3/6/2013 8:00
3/6/2013 10:00
3/6/2013 12:00
3/6/2013 14:00
3/6/2013 16:00
3/6/2013 18:00
3/6/2013 20:00
3/6/2013 22:00
3/7/2013 0:00
Date/Time (EST)

My Guess at Predicting High Canal Tides. -

Look for the highest predicted tide (MAX TIDE MSL) for Ocean City at http://www.nws.noaa.gov/mdl/etsurge/index.php?page=stn&region=ne&type=both&stn=delews .

My prediction for the canals is that about 6 hours after the predicted OC MAX TIDE

- If the wind is strong from the south and/or west, that the canals will see a tide of about (MAX TIDE MSL) to (MAX TIDE MSL + 0.5) feet NGVD.
- If there is not much wind, the canals will see (MAX TIDE MSL – 0.5) to (MAX TIDE MSL) feet NGVD.
- If the wind is strong and from the north and/or east, the canals will see (MAX TIDE MSL – 1.0) to (MAX TIDE MSL – 0.5) feet NGVD.



An Understanding Of Datums Is Needed To Understand Tide Data Available On Web Sites

- Need to understand different datums (Slide 24)
- Need to understand different web sites
  - Jefferson creek Tides (slide 25) http://waterdata.usgs.gov/nwis/uv?01484696
  - Ocean City Tides – Astronomical and Actual (slide 26) http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=8570283+Ocean City Inlet, MD&bdate=20130317&edate=20130318&ssid=a1:1&datum=6&unit=1&shift=&type=Tide Data&format=View+Plot&plot_backup=Predicted Ocean City
  - Tides due to Storms (slide 27) http://www.nws.noaa.gov/mdl/etsurge/index.php?page=stn&region=me&datum=msl&list=&map=0-48&type=both&stn=mdoce

Mar 18 2013 22:12 GMT ELEVATIONS ON STATION DATUM
National Ocean Service (NOAA)

Station: 8570283 T.M.: 75 W
Name: Ocean City Inlet, MD Units: Feet
Status: Accepted (Dec 7 2012) Epoch: 1983-2001
Datum: STND

Datum	Value	Description
MHHW	10.50	Mean Higher-High Water
MHW	10.30	Mean High Water
NAVD88	9.67	North American Vertical Datum of 1988
MSL	9.31	Mean Sea Level
DTL	9.27	Mean Diurnal Tide Level
MTL	9.25	Mean Tide Level
MLW	8.20	Mean Low Water
MLLW	8.03	Mean Lower-Low Water
STND	0.00	Station Datum
GT	2.46	Great Diurnal Range
MN	2.10	Mean Range of Tide
DHQ	0.20	Mean Diurnal High Water Inequality
DLQ	0.16	Mean Diurnal Low Water Inequality
HWI	0.38	Greenwich High Water Interval (in Hours)
LWI	6.41	Greenwich Low Water Interval (in Hours)
Maximum	14.11	Highest Observed Water Level
Max Date	19980205	Highest Observed Water Level Date
Max Time	08:18	Highest Observed Water Level Time
Minimum	5.63	Lowest Observed Water Level
Min Date	20070217	Lowest Observed Water Level Date
Min Time	05:54	Lowest Observed Water Level Time
HAT	11.15	Highest Astronomical Tide
HAT Date	19991223	Highest Astronomical Tide Date
HAT Time	13:12	Highest Astronomical Tide Time
LAT	7.44	Lowest Astronomical Tide
LAT Date	19960121	Lowest Astronomical Tide Date
LAT Time	06:36	Lowest Astronomical Tide Time

Tidal Datum Analysis Period: 08/01/2002 - 07/31/2008
04/01/2009 - 03/31/2012

Click HERE for further station information including New Epoch products.

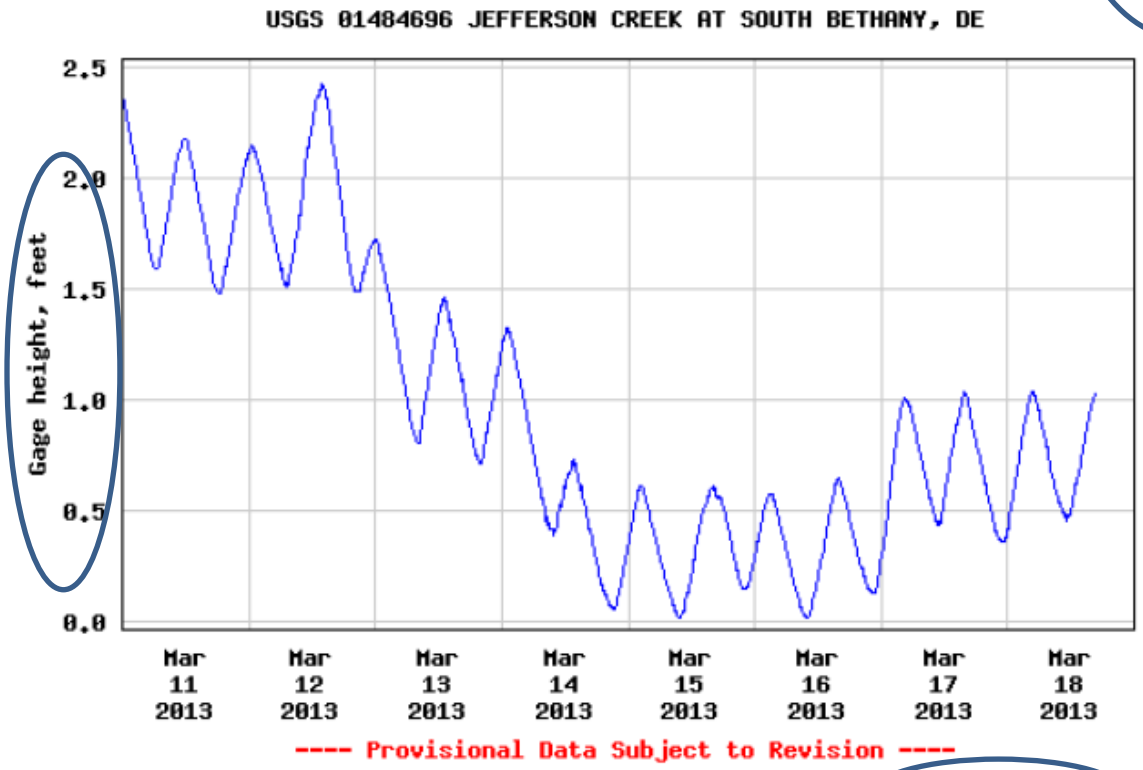
Datums

- Datums can be very confusing.
- There are many different datums for OC.
- You must pay attention to what datum is being used in order to make comparisons.
- Datums for Ocean City are shown to the left.
- MSL at OC is at -0.3 feet NAVD 1988.
- MSL is at about +0.5 feet NGVD 1929.
- MSL is not moving. The zero point for the datum is moving.
- Different web sites reference to different datums.

At South Bethany 0.0 feet NAVD 1988 = 0.80 feet NGVD

Web site available for Jefferson Creek

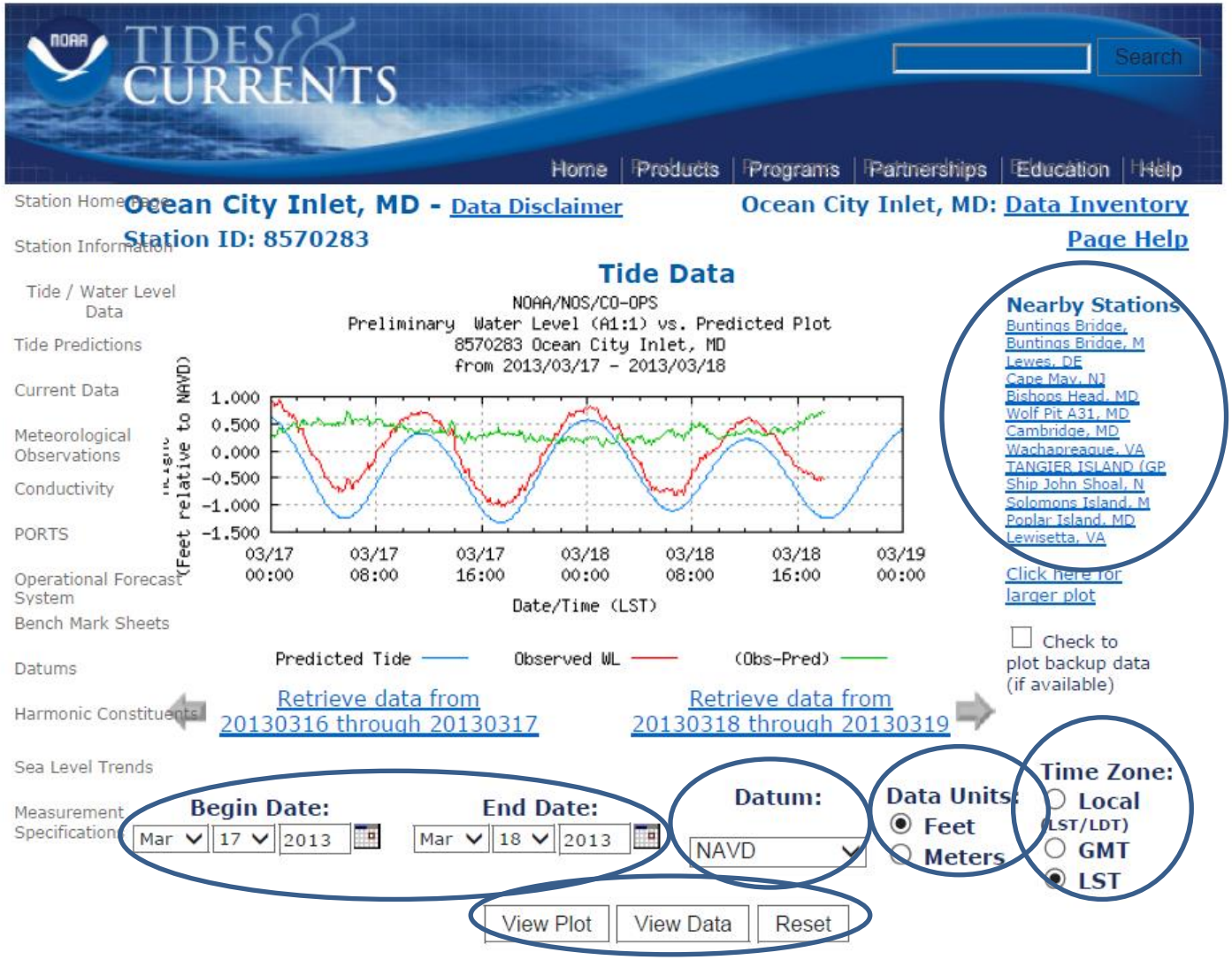
Available Parameters	Available Period	Output format	Days (7)
☐ All 1 Available Parameters for this site		◉ Graph	
☑ 00065 Gage height	2007-10-01 2013-03-18	○ Graph w/ stats	-- or --
		○ Graph w/o stats	Begin date 2013-03-11
		○ Table	End date 2013-03-18
		○ Tab-separated	GO



Create presentation-quality / stand-alone graph. Subscribe to WaterAlert

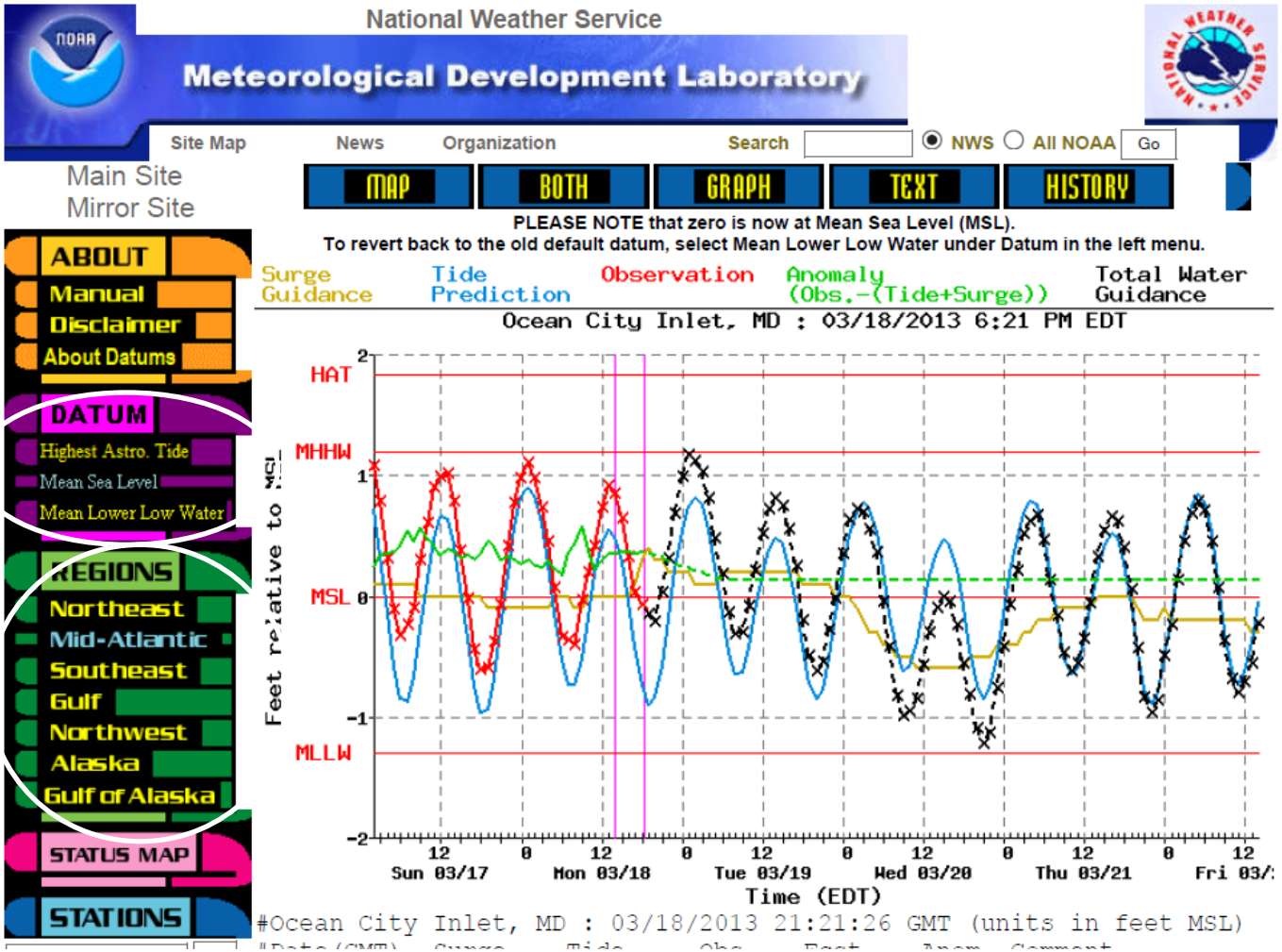
- Select Output Format.
- Select # of days or dates.
- Gage height is feet NGVD.
- Date/time is EST.
- You can sign up for "WaterAlert" and they will e-mail you when the gage reaches your selected value. My selected value is 2.5 feet, when York Rd. begins to flood.

http://waterdata.usgs.gov/nwis/uv?01484696



- Select Dates
- Select Data
- Select Units
- Select Time Zone
- Select Plot or Data
- You can select a different station
- You get
  - Predicted tide
  - Actual tide
  - Difference between the predicted and actual

http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=8570283+Ocean City Inlet, MD&bdate=20130317&edate=20130318&ssid=a1:1&datum=6&unit=1&shift=&type=Tide Data&format=View+Plot&plot_backup=Predicted Ocean City



- This chart only looks forward ~4 days.
- Select datum.
- You can select another region.
- Tide prediction (in blue) is the astronomical prediction.
- The actual observed tide is red.
- The black x-x-x-x is the prediction with wind/storm effects.
- Time is local time (EDT or EST as appropriate.)

Note: HAT (Highest Astronomical Tide), MHHW (Mean Higher High Water), Mean Sea Level (MSL) and MLLW (Mean Lower Low Water) as shown on the chart above.

http://www.nws.noaa.gov/mdl/etsurge/index.php?page=stn&region=me&datum=msl&list=&map=0-48&type=both&stn=mdoce