Superstorm Sandy

A Look at Coastal Flooding in Greenwich

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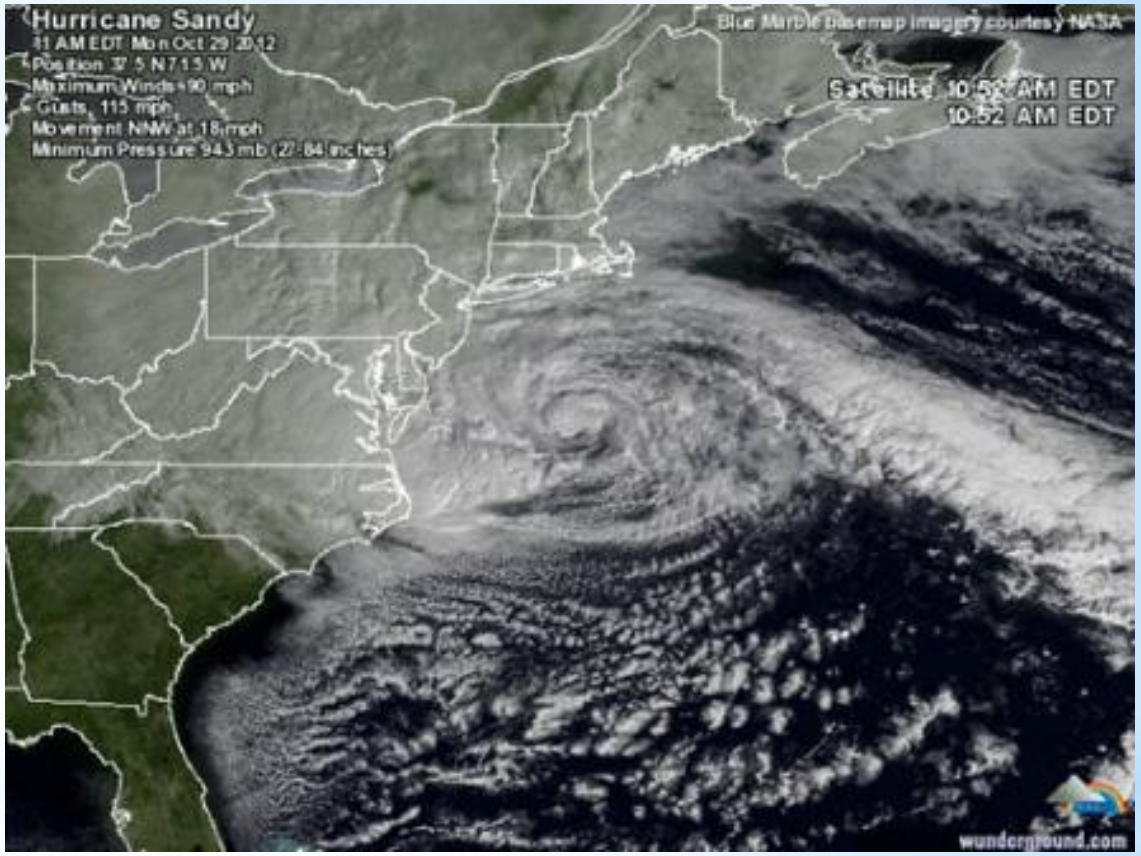


Understanding Storm Events

Although we often refer to storm events in terms like the 100 year storm, this causes confusion. It does not mean that the storm will happen only once in 100 years. It refers to the percent chance that a storm will happen in a given year.

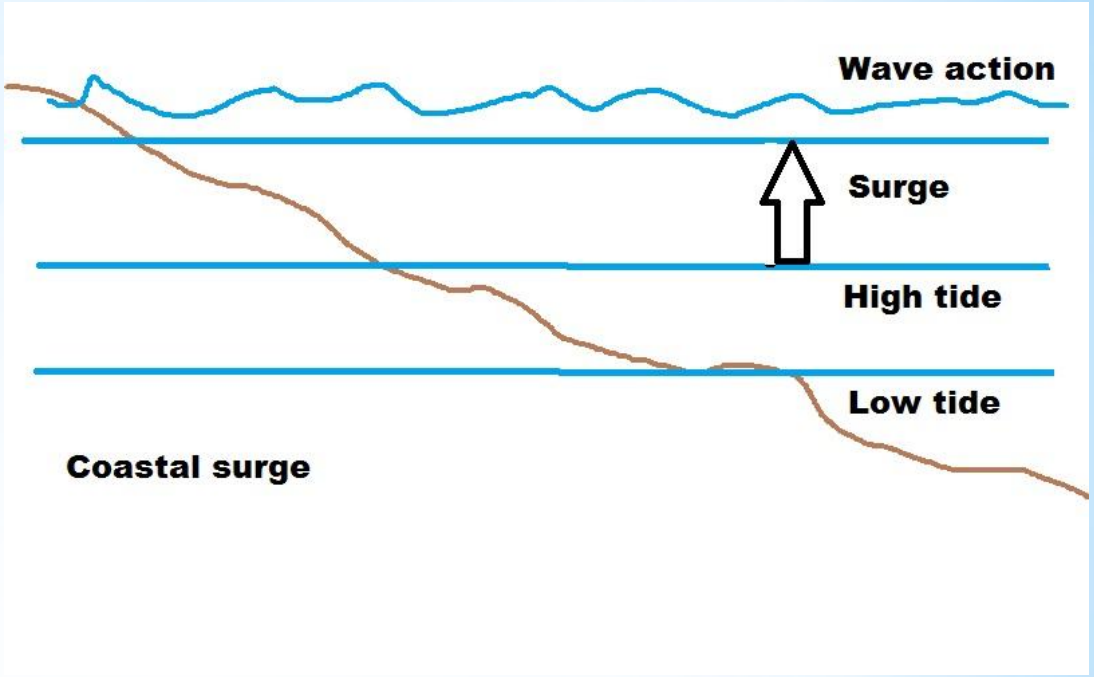
100 year storm = 1/100 = 1% chance each year
50 year storm = 1/50 = 2% chance each year (Sandy in CT)
24 year storm = 1/25 = 4% chance each year
10 year storm = 1/10 = 10% chance each year
5 year storm = 1/5 = 20% chance each year
2 year storm = 1/2 = 50% chance each year
1 year storm = 1/1 = 100% chance each year

Understanding Storm Surge

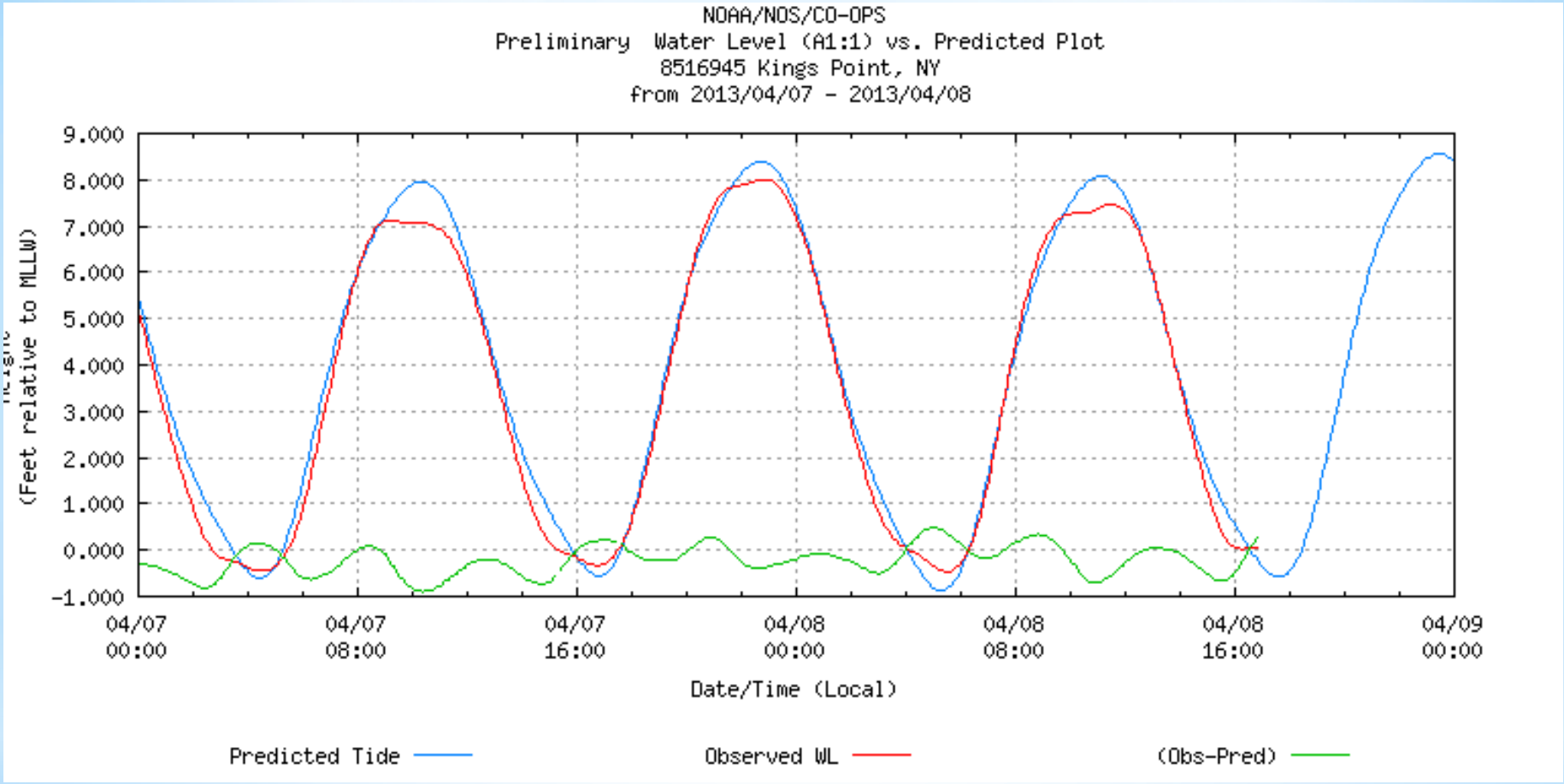
- The storm surge is the difference between the actual recorded water elevation and the predicted water elevation (predicted tide).

- Surge heights are measured at still water and do not take wave action (surf) into account.

- A storm surge is NOT a big wave or tsunami-type event.



- During a storm event, the highest water elevation recorded does not necessarily occur when the surge is the highest. It depends on the timing of the surge in relationship to the tidal cycle.



Observed water level minus predicted tide = surge

As seen here, at 8 a.m. on 4/7 the observed water level was at 6 ft.. and the predicted tide was at 6 ft. so the surge was 0 (6-6= 0)

Post Tropical Cyclone Sandy – By the Numbers

- Sandy made landfall at 8 p.m. EDT near Atlantic City, NJ with sustained winds of 80 mph

- In CT, the highest rainfall total was only 1.43” compared to 15” rain in MD and 34” of snow in TN

- In CT, Madison recorded the highest wind gusts at 85 mph

- The Top Storm Surges:
  - Kings Point, N.Y.: ~12.5 feet above normal
  - Bridgeport, CT: ~9.83 feet above normal

  (note storm surge is NOT water level)

In Connecticut, this was primarily a coastal event.

NOAA Records on Sandy Surges

The highest storm surges for Sandy were recorded in Long Island Sound.

Note that at King's Point, Bridgeport, and New Haven, the maximum water level (not surge) exceeded historical levels even though the surge came in near low tide. At the Stamford Hurricane Barrier, the previous highest recorded levels were during the Hurricane of 1938.

Table 3a: Maximum recorded storm surge/residual levels ranked by amplitude for Hurricane Sandy, October 2012. Storm Surge/Residual represents the observed water level (storm tide) minus predicted astronomical tide levels.

Station Name	Station ID	Date & Time GMT	Residual	
			in Meters	in Feet
[3] Kings Point, NY	8516945	10/29/2012 23:00	3.855	12.65
[3] Bridgeport, CT	8467150	10/30/2012 00:18	2.997	9.83
[3] Bergen Point West Reach, NY	8519483	10/30/2012 01:48	2.913	9.56
[3] The Battery, NY	8518750	10/30/2012 01:24	2.866	9.40
[3] New Haven, CT	8465705	10/30/2012 00:06	2.786	9.14
[2,3] Sandy Hook, NJ	8531680	10/29/2012 23:36	2.611	8.57
New London, CT	8461490	10/29/2012 22:54	1.982	6.50
Newbold, PA	8548989	10/30/2012 10:42	1.956	6.42
Burlington, Delaware River, NJ	8539094	10/30/2012 10:24	1.917	6.29
[3] Marcus Hook, PA	8540433	10/30/2012 08:00	1.907	6.26
Providence, RI	8454000	10/29/2012 22:12	1.888	6.20
Tacony-Palmyra Bridge, NJ	8538886	10/30/2012 09:48	1.861	6.11
[3] Delaware City, DE	8551762	10/30/2012 06:54	1.826	5.99
[3] Conimicut Light, RI	8452944	10/29/2012 22:12	1.795	5.89
Montauk, NY	8510560	10/29/2012 22:12	1.794	5.89
[3] Philadelphia, PA	8545240	10/30/2012 09:18	1.777	5.83
Atlantic City, NJ	8534720	10/29/2012 20:42	1.773	5.82
Reedy Point, DE	8551910	10/30/2012 07:06	1.769	5.80
[3] Fall River, MA	8447386	10/29/2012 22:30	1.677	5.50
Lewes, DE	8557380	10/29/2012 17:30	1.627	5.34
Newport, RI	8452660	10/29/2012 22:18	1.627	5.34
[3] Ship John Shoal, NJ	8537121	10/30/2012 05:42	1.615	5.30
[3] Cape May, NJ	8536110	10/29/2012 18:00	1.574	5.16
[1] Quonset Point, RI	8454049	10/29/2012 20:48	1.572	5.16
Woods Hole, MA	8447930	10/29/2012 22:06	1.545	5.07
Wachapreague, VA	8631044	10/29/2012 05:54	1.508	4.95
Chesapeake City, MD	8573927	10/30/2012 10:18	1.486	4.88
Money Point, VA	8639348	10/29/2012 07:54	1.460	4.79
Sewells Point, VA	8638610	10/29/2012 07:24	1.394	4.57
Boston, MA	8443970	10/29/2012 21:00	1.394	4.57
Chesapeake Bay Bridge Tunnel, VA	8638863	10/29/2012 06:54	1.330	4.36
Ocean City Inlet, MD	8570283	10/29/2012 16:48	1.321	4.33

[1] Sensor reached physical limit on measurements and did not record a maximum value.
[2] Sensor was damaged or destroyed and likely did not record a maximum water level.
[3] Maximum recorded water level value exceeded historical maximum value.

At the Emergency Operation Center (EOC)in Greenwich, we monitor multiple stations during a storm event.

The three key stations we watch most closely are:

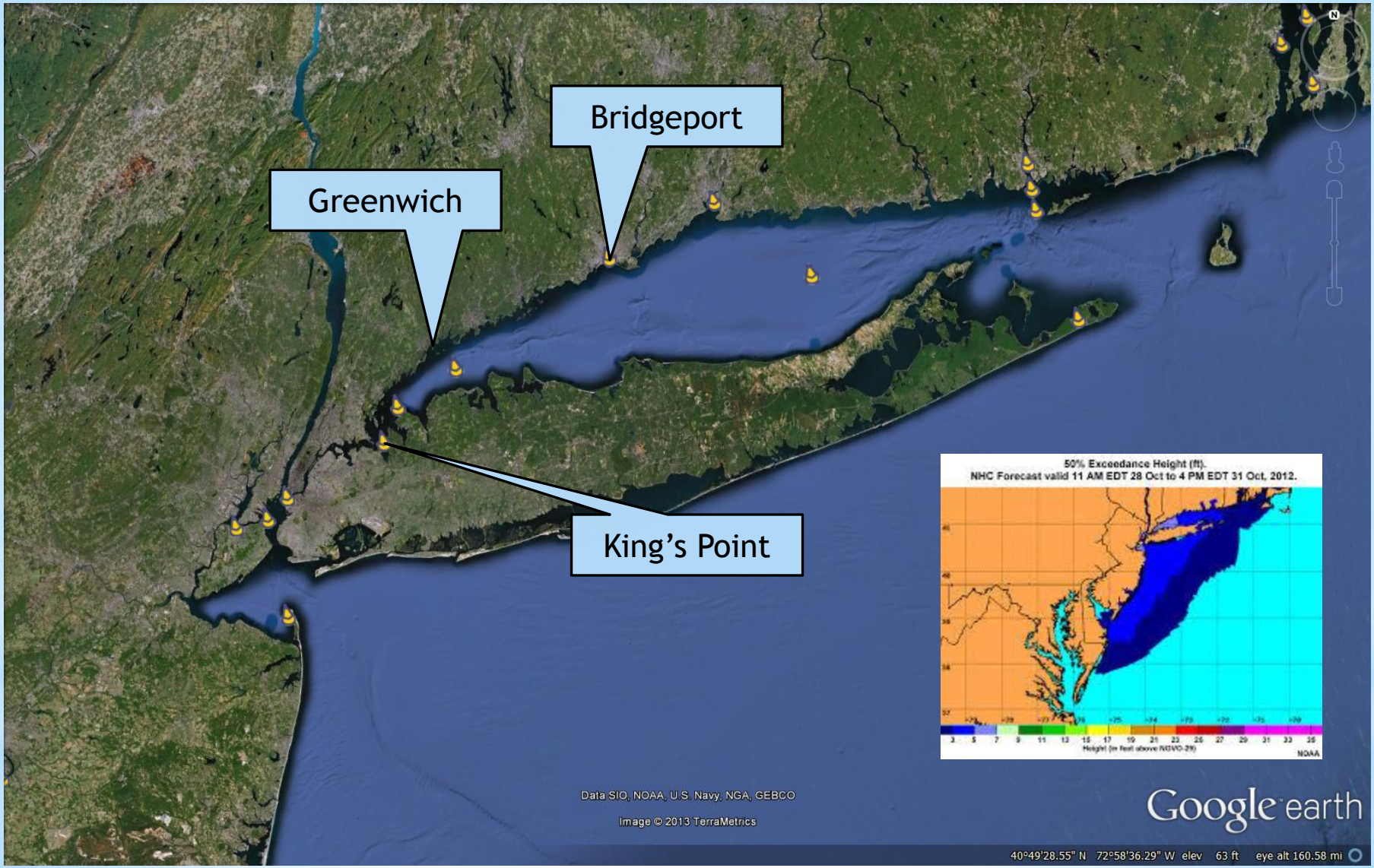
NOAA sites – King's Point, NY and Bridgeport, CT

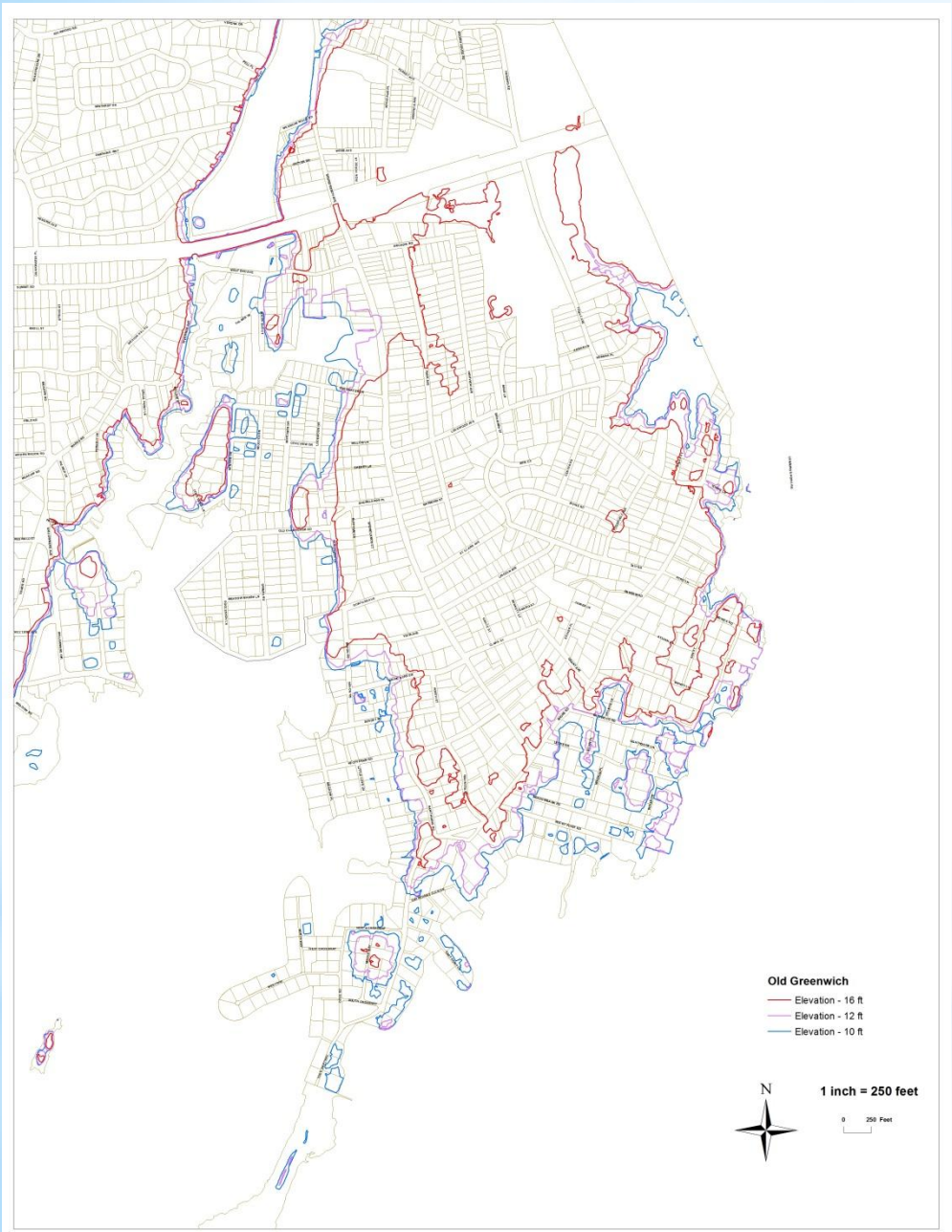
ACOE site – Stamford Hurricane Barrier

We also use the NOAA weather site for predicted surge reports for our area (north shore of western LIS) and for wave action (surf).

We also received information directly from the State and Federal agencies at the EOC.

We translate all information into NAVD 88 which is the elevations used on our GIS and on the FEMA flood maps.


Bridgeport
Greenwich
King's Point
50% Exceedance Height (ft).
NHC Forecast valid 11 AM EDT 28 Oct to 4 PM EDT 31 Oct, 2012.
NOAA
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2013 TerraMetrics
Google earth
40°49'28.55" N 72°58'36.29" W elev 63 ft eye alt 160.58 mi

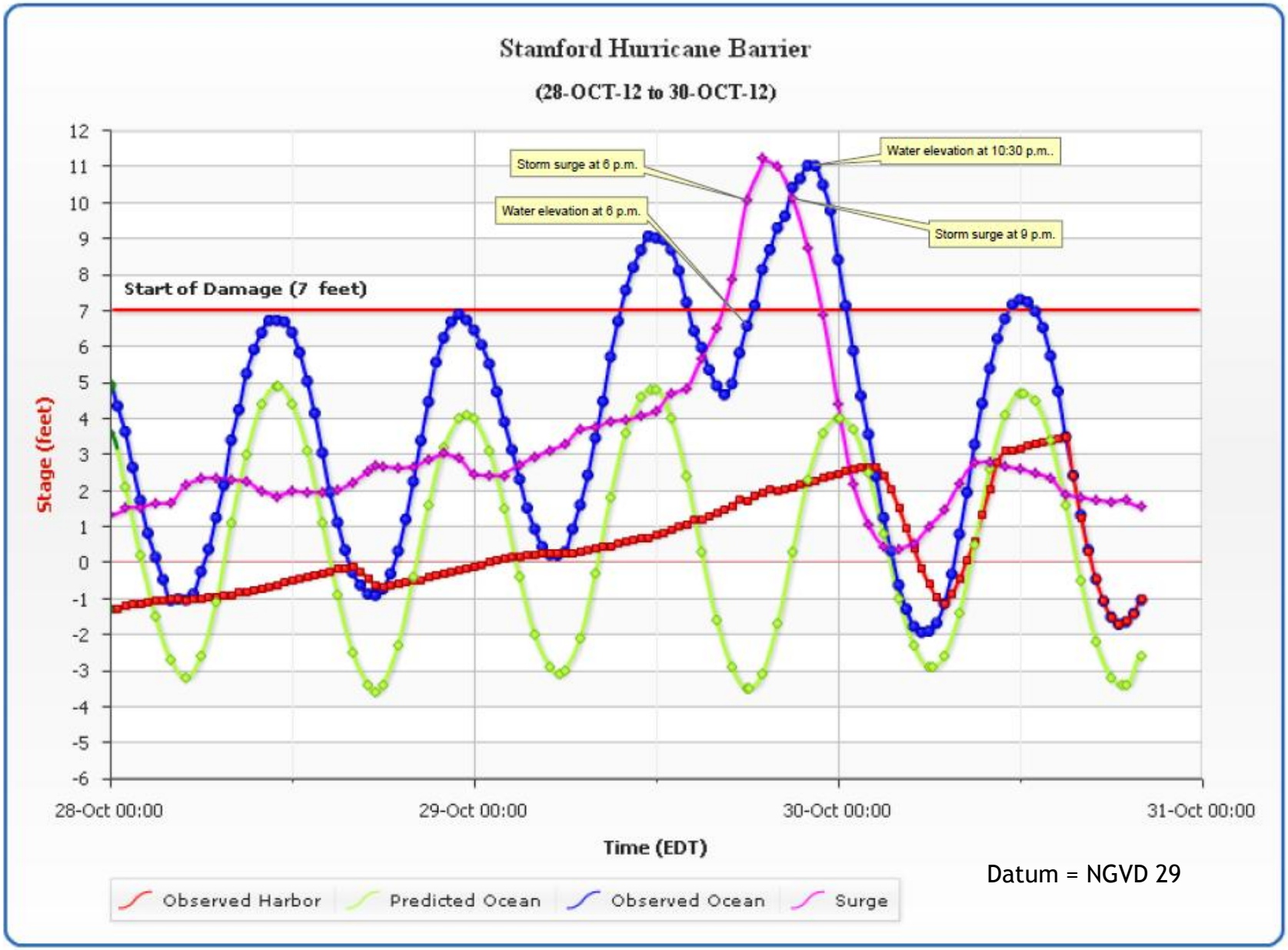


In Greenwich, the high water elevation was measured after the storm at about 10.2 ft. NAVD 88. Areas in VE zones experienced an additional 2-3' of wave action.

Just like we measure temperatures on different scales, water elevations use different datum.

All Greenwich GIS and FIRM are at NAVD 88. Residents need to know what elevation their property is at when determining flood risk.

The Stamford Hurricane barrier is NGVD. The difference between NGVD and NAVD in the Greenwich area is about 1.1 ft. (NGVD – NAVD = 1.1 ft.)



Datum = NGVD 29

On October 29, 2012

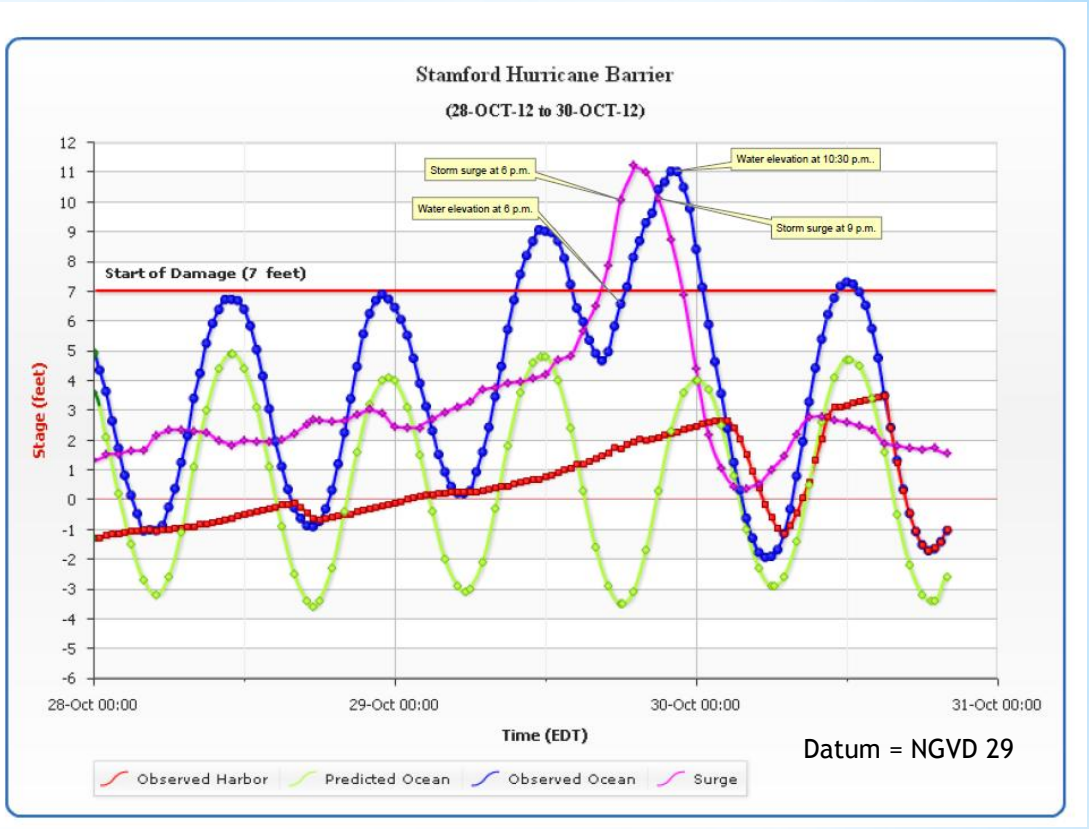
6 p.m. – low tide
Observed level 6.57’
Predicted level (3.5’)
Surge 10.7’

7 p.m. – highest surge
Observed level 8.14’
Predicted level (3.10’)
Surge 11.24’

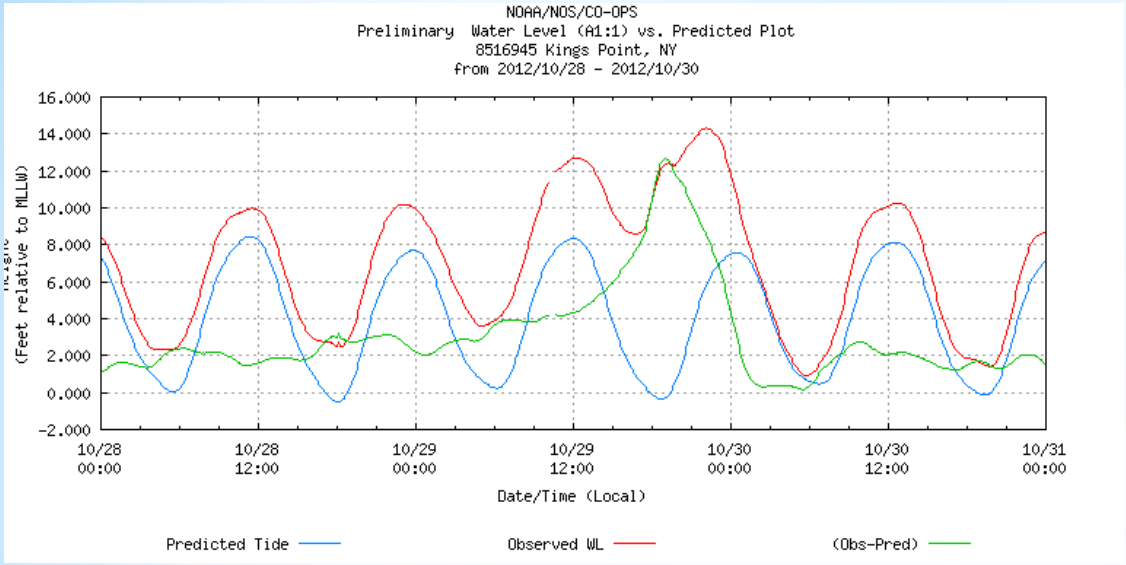
10 p.m. – highest water
Observed level 11.03’
Predicted level 2.30’
Surge 8.73’

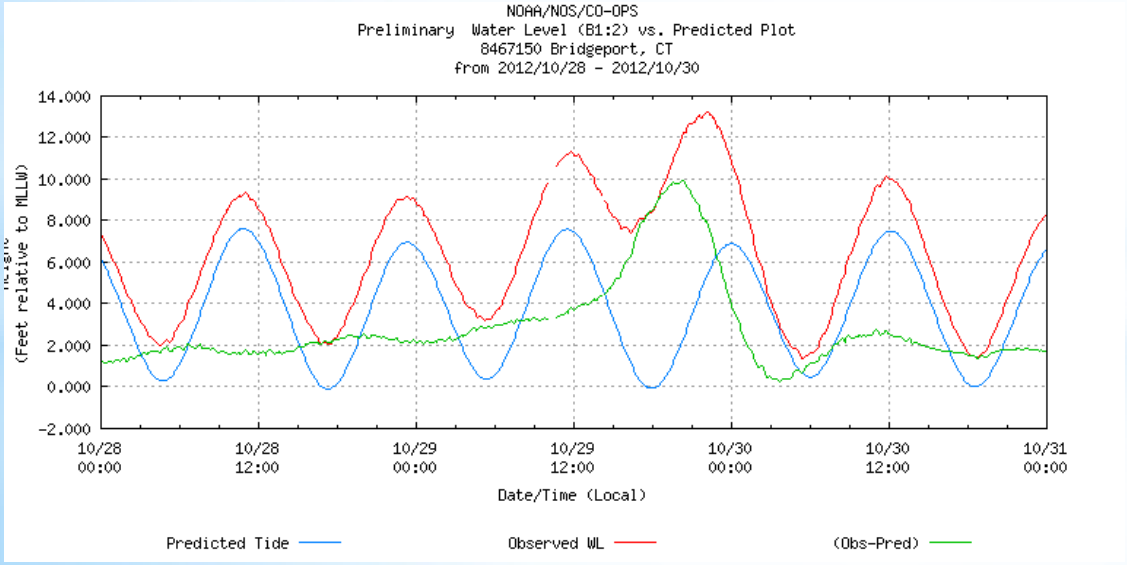
Midnight – high tide
Observed level 8.40’
Predicted level 4.00’
Surge 4.40’

Datum = NGVD 29



Between 5 p.m. and 7 p.m. the surge accelerated from 7.87’ to 11.24’ = 3.37 ft. Not taking into account additional acceleration, at the 7 p.m. surge levels, the still water elevation at high tide would have reached 14.14 ft. NAVD in Greenwich.





The NOAA stations we also watch were showing and recorded the same data.

The surge in western Long Island Sound came in just after low tide. If the storm had delayed just 5 hours we would have experienced catastrophic flooding.

Again the surge is not a tidal wave, it is about still water elevations rising caused by wind pushing water into Long Island Sound.

Planning for Community Stability and Coastal Resiliency

- Over the past 100 years Sea level has risen about .8 feet in Long Island Sound
- Currently sea level is rising about 1 inch per decade
- With increasing global temperatures, sea level rise is accelerating due to melting of polar caps and warmer water temperature (water expands when it is warm).
- We could experience a 1-2 ft. (or more) rise in sea level by 2050.
- The frequency of severe storm events is increasing. What was once considered a 1% (1/100) storm is now a 1.4 or 2% storm (1/70 or 1/50).

Planning for Community Stability and Coastal Resiliency

The Town has a Natural Hazard Mitigation Plan that has been accepted by FEMA.

The Town's Plan of Conservation and Development calls for planning for Climate Change Adaptation. Conservation Commission and Planning and Zoning are working on this with other departments.

- Inventory and evaluate Town infrastructure
- Develop long term plan to address concerns
- Work with State on transportation concerns
- P&Z Regulations

Individual residents also need to do long term planning.

- Know the elevation of your home and surrounding area.
- Know the Base Flood Elevation for your area.
- Mitigate your home for the long term
  - Elevate
  - Flood proof
  - Hurricane proof windows

On LIS - Elevated structure on left survived Sandy as opposed to the structure on the right that had significant damage

Home elevation does not have to be done on pilings. It can be done to match aesthetics of neighborhood and on historic homes such as this home in Mandeville, LA.

Things to know:

Planning and Zoning is responsible for implementing flood regulations in Greenwich that comply with FEMA.

The Flood Insurance Rate Maps (FIRM) have been updated and will be adopted by July 8, 2013. P&Z held an information session on March 26, 2013 on the new maps and implications for Greenwich residents. Detailed information, including the PowerPoint presentation, is on the P&Z website at

http://www.greenwichct.org/Government/Departments/Planning_and_Zoning/fema_flood_panels/

For more information on the FRIM maps and
Katie DeLuca, Deputy Director of Planning and Zoning – katie.deluca@greenwichct.org
Jodi Couture, Zoning Enforcement Officer – jodi.couture@greenwichct.org

Funding Assistance – Office of the First Selectman and Conservation Commission coordinating on this

HMGP – Hazard Mitigation Grant Program

- Town must be applicant – no deadline (as of May 9, 2013)
- Can be used for elevating individual homes and utility rooms
- Not for storm damage repairs
- Must be primary residence
- 75% federal- 25% resident cost share
- All properties have separate grants

Historic Structures – different rules and opportunities not only with FEMA but also National Park Service grants

With all federal funding looking at applying locality adjustment factors such as RS Means as the industry standard.

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