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science for a changing world

Using Mobile Networks to Monitor Hurricane Sandy Storm-Tide

Interagency Hurricane Conference
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U.S. Geological Survey

U.S. Department of the Interior
U.S. Geological Survey

USGS Hurricane Sandy Activities

- Basics of Storm-Tide monitoring
- Field Methods
- Example data analyses
- Storm-Tide Monitoring
  - Deployed/recovered storm-tide sensors
  - Flagged and surveyed HWMs
  - Developed a web-based map viewer portal for data delivery
- OFCM DIAP: Wind and Water

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History of USGS STS Program

Began by USGS La WSC after Hurricane Katrina (2005)

- Rita (2005)
- Wilma (2005)
- Ernesto (2006)
- Gustav (2008)
- Ike (2008)
- Earl (2010)
- Irene (2011)
- Isaac (2012)
- Sandy (2012)

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USGS Storm-Tide Deployment

- Use new sensor technology
- Mobile networks
- Rapid, opportunistic deployments
- Post-storm recovery and processing

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Post-storm GPS RTN Surveying Permits Rapid Tie-In to Common Datum

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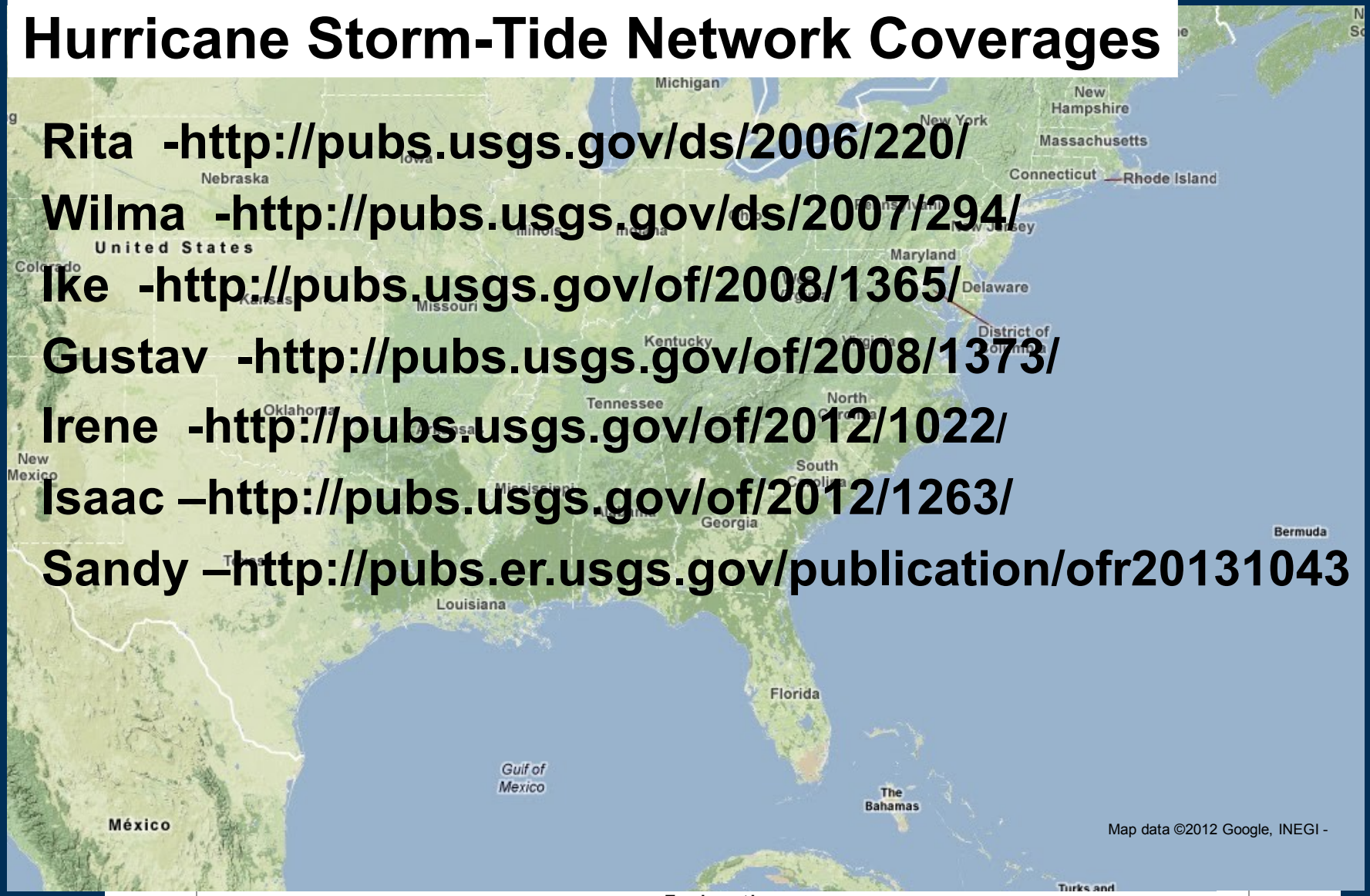
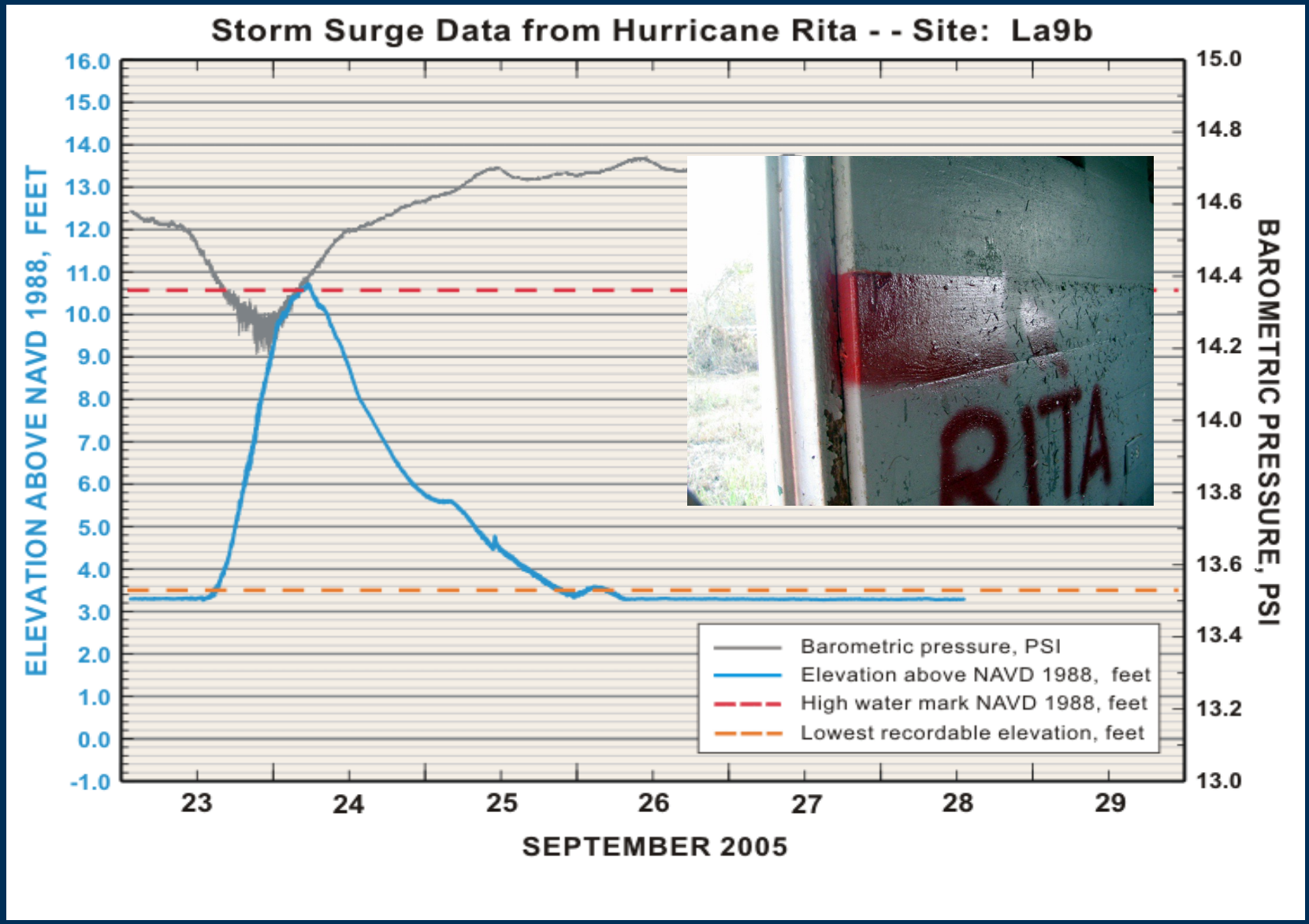
Hurricane Storm-Tide Network Coverages



Explanation							
Rita(2005)	Wilma(2005)	Ernesto(2006)	Gustav(2008)	Hanna(2008)	Ike(2008)	Earl(2010)	Irene(2011)
-- Temporary storm tide sensor, -- USGS real-time streamgage							



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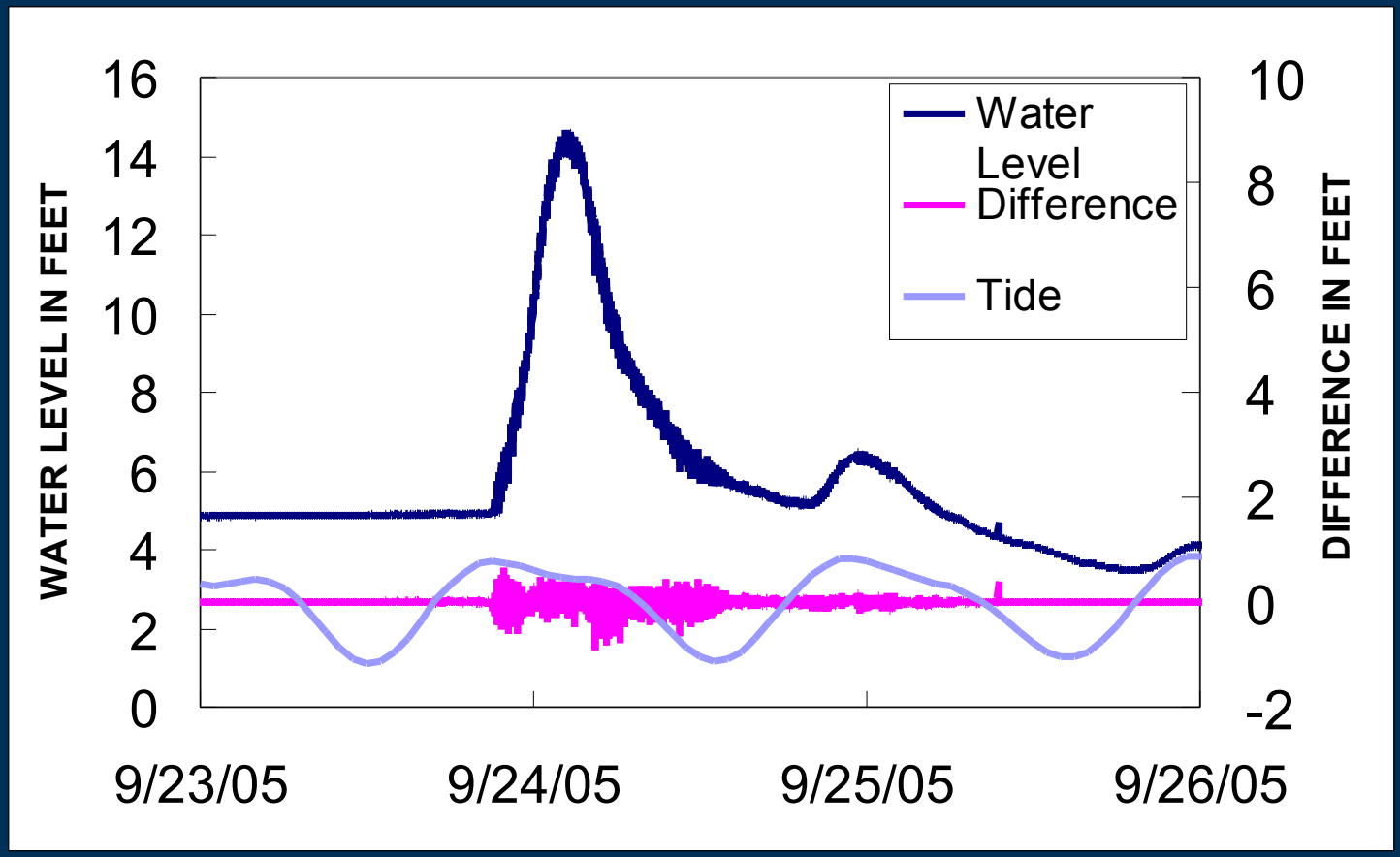
http://pubs.water.usgs.gov/ds220/.

Importance of Data-Rita
Wave Heights 1000 Feet From Beach



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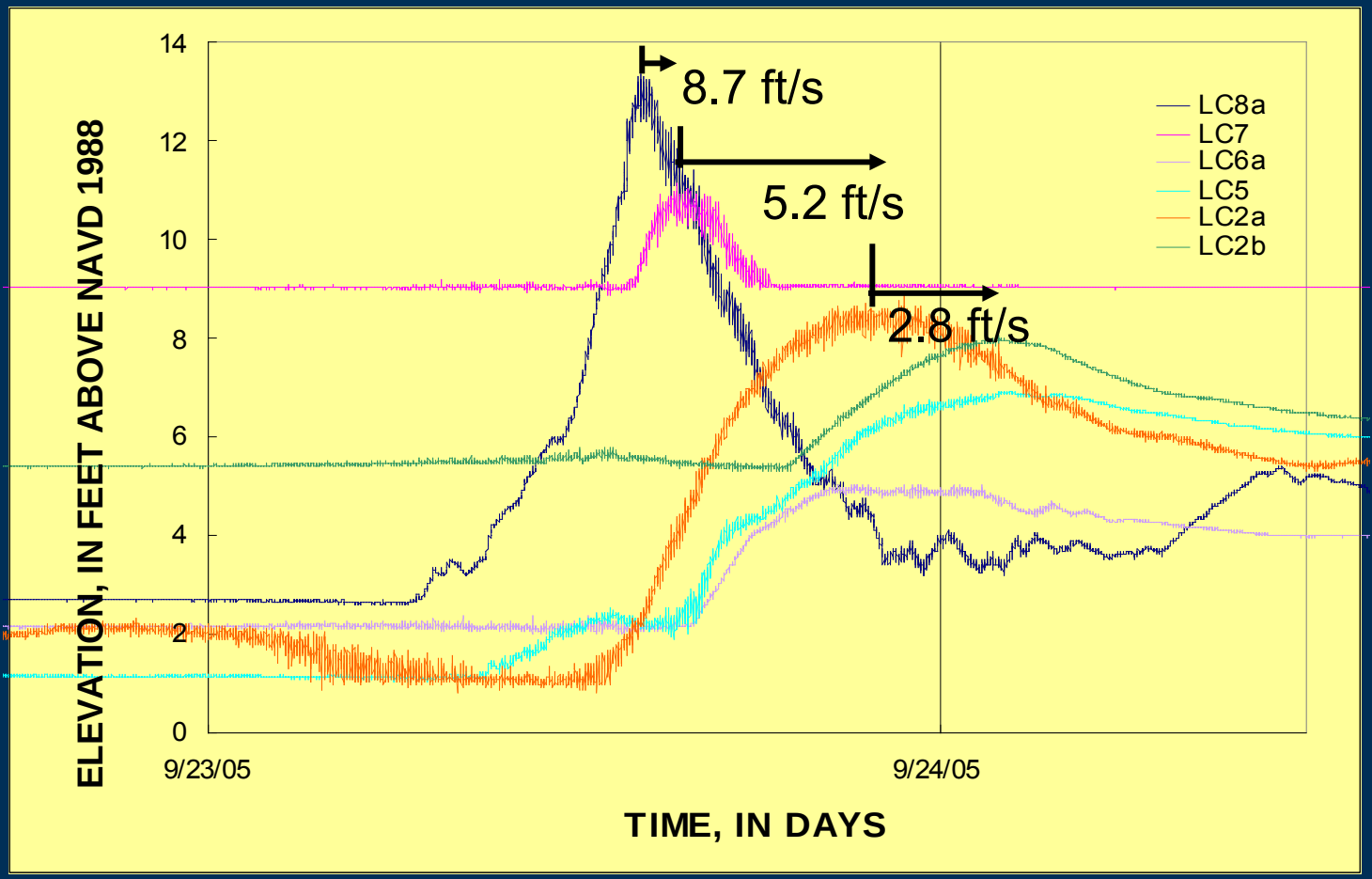
Storm Surge Hydrographs for Calcasieu River, LA



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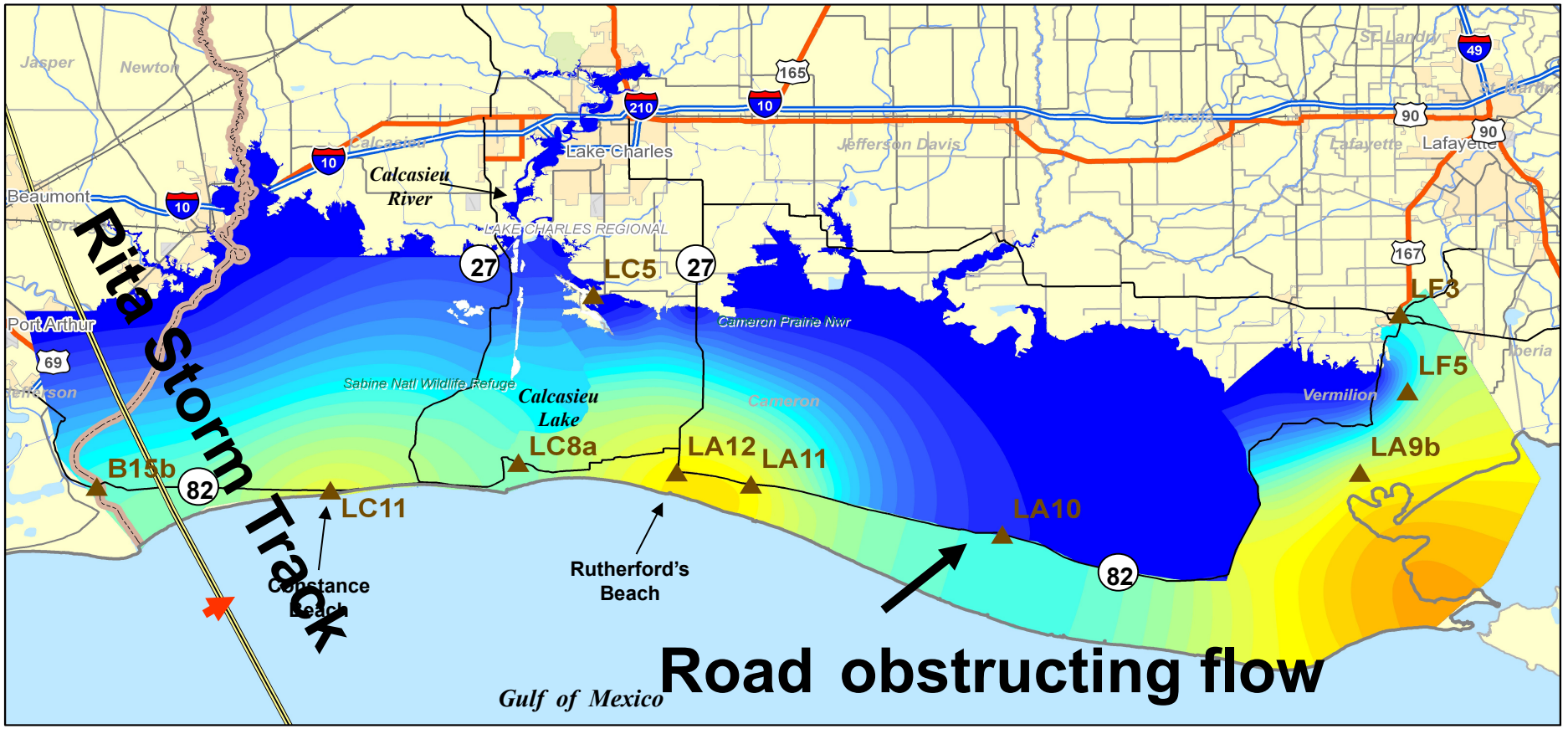
Hurricane Rita
Storm Tide at 12:00 am (midnight)



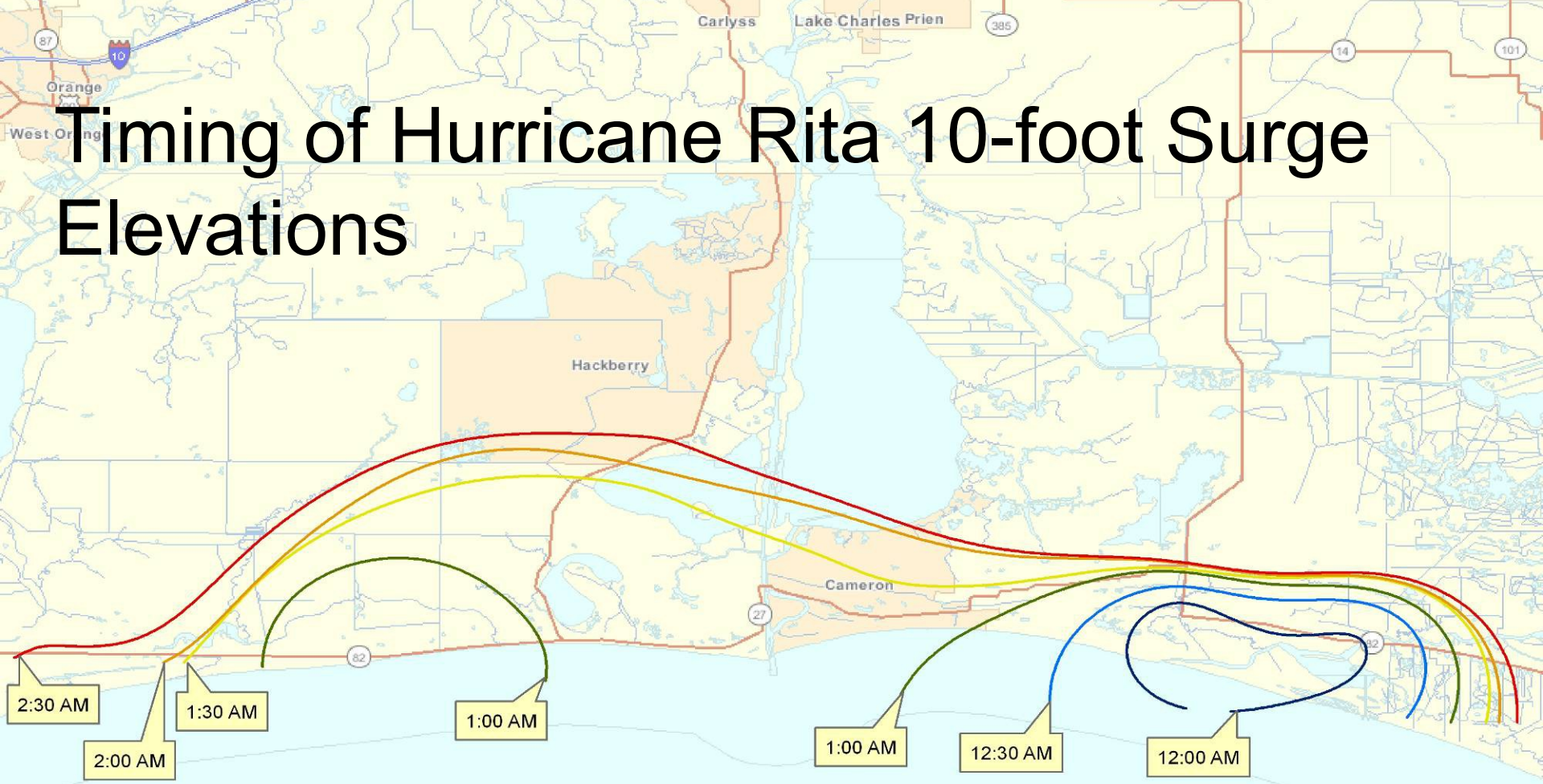
Explanation

▲ LC11 — USGS Storm surge sensor

Storm-tide elevation, in feet above NAVD88

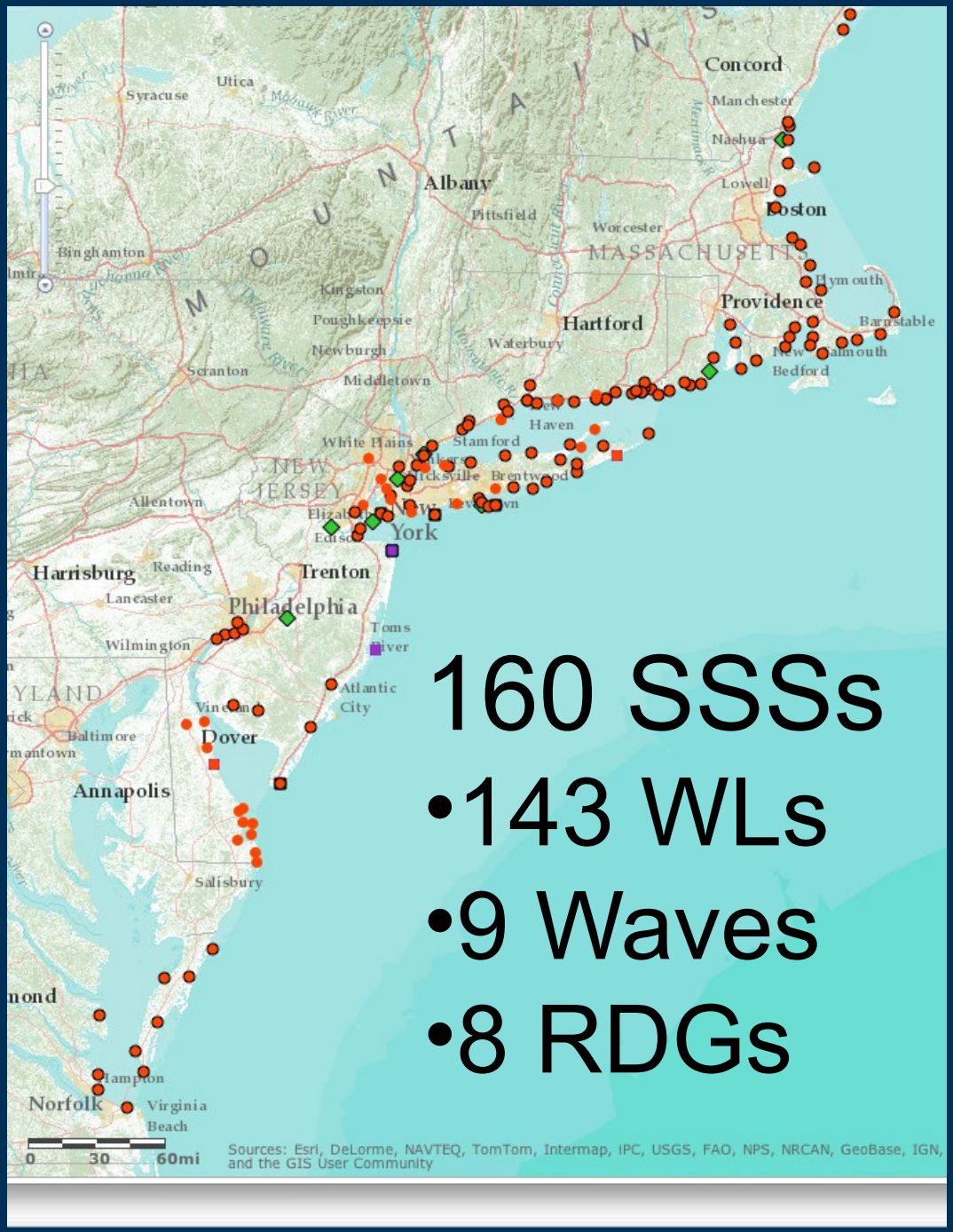
0 - 2	6 - 8	12 - 14
2 - 4	8 - 10	14 - 16
4 - 6	10 - 12	

Timing of Hurricane Rita 10-foot Surge Elevations



Water elevation (10 foot contour)

http://pubs.usgs.gov/fs/2006/3136/



160 SSSs

- 143 WLs
- 9 Waves
- 8 RDGs

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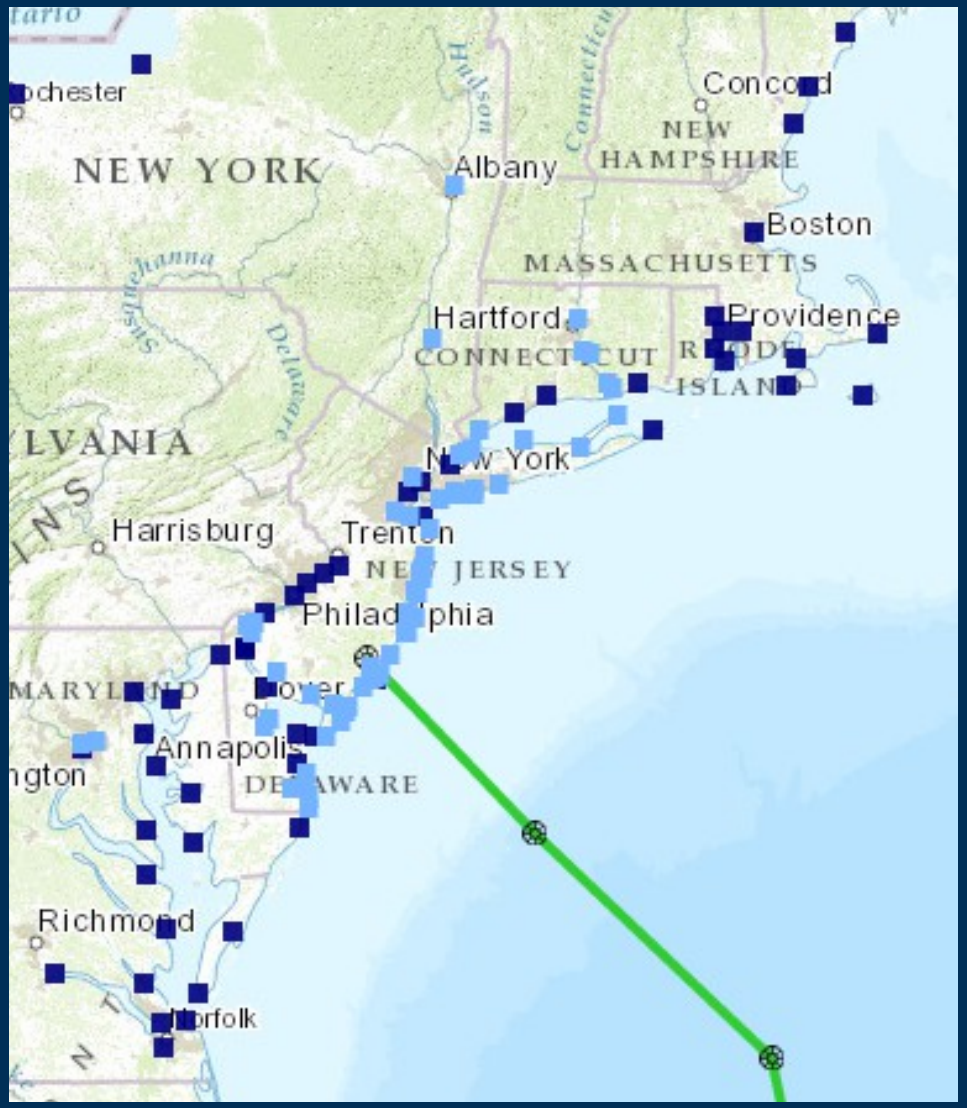
Sandy—Timeline

Wednesday, October 24th

- Contact NOS and NHC
- Discussions with FEMA begin

Thursday, October 25th

- USGS mobilizes people and equipment for possible deployment



EXISTING USGS & NOAA TIDE GAGES

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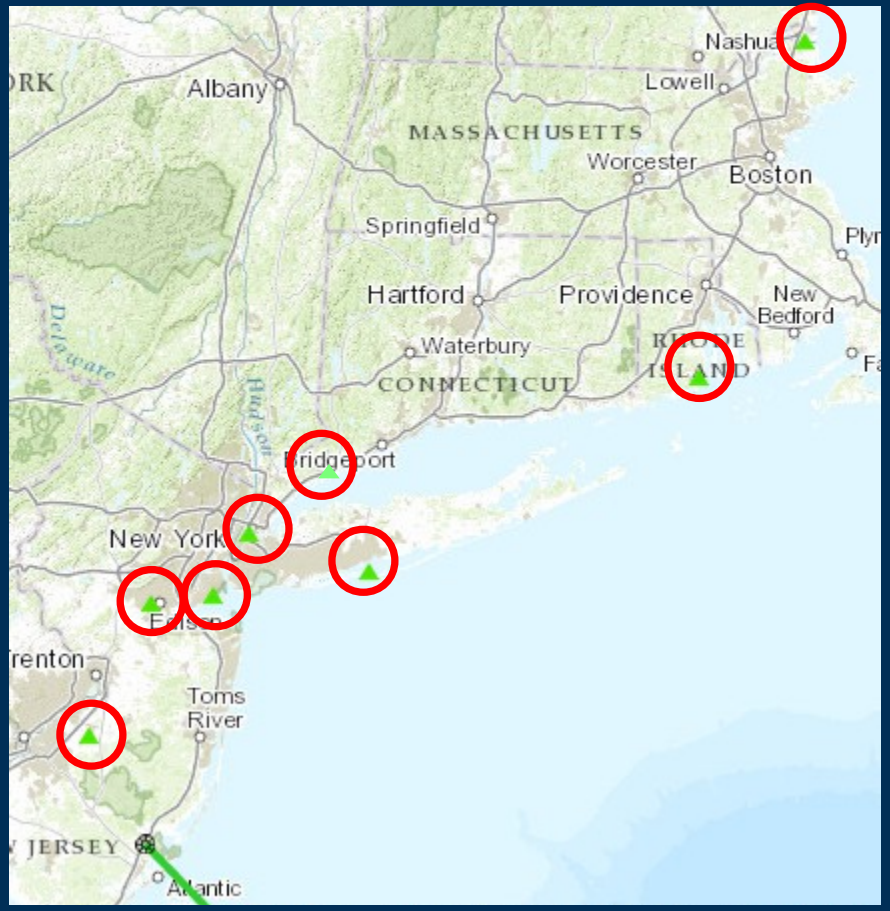
Sandy—Timeline

Friday, October 26th

- Teams from GA WSC arrive with equipment
- NY, NY, and GA WSC start RDG deployments
  - NY Harbor and Long Island -2 RDGs -
  - New Jersey -2 RDGs
  - Rhode Island/Massachusetts -3 RDGs
- Started new “Storm-Tide Mapper” for Hurricane Sandy



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Sandy—Timeline

Saturday, October 27th

- Deployment well underway

Sunday, October 28th

- Deployment continues

Monday, October 29th

- Deployment is complete
- Teams fall back to safe locations
- 2 RDGs lost to storms

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Sandy—Timeline

Tuesday, October 30th

- Additional teams (NC, SC, OH) assist with HWMs and sensor recovery

Wednesday, October 31st

- Crews remain in fallback locations

Thursday, November 1st

- Rush HWMs collections (new storm)
- Target 1992 HWM locations in NY & NJ
- Sensor recovery begins
- Gas shortage complications

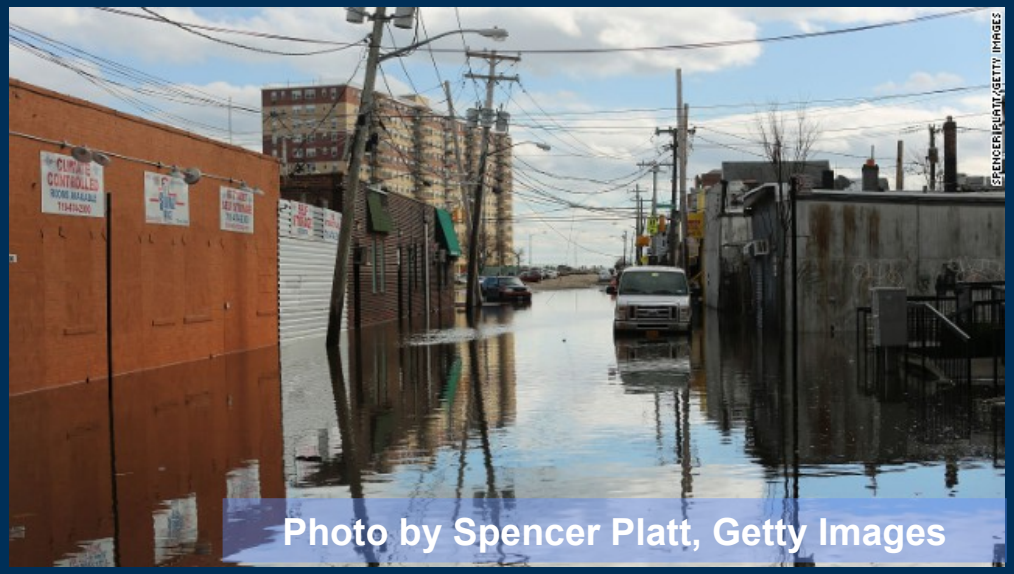

Photo by Spencer Platt, Getty Images

Photo by Michael Boomier, Getty Images

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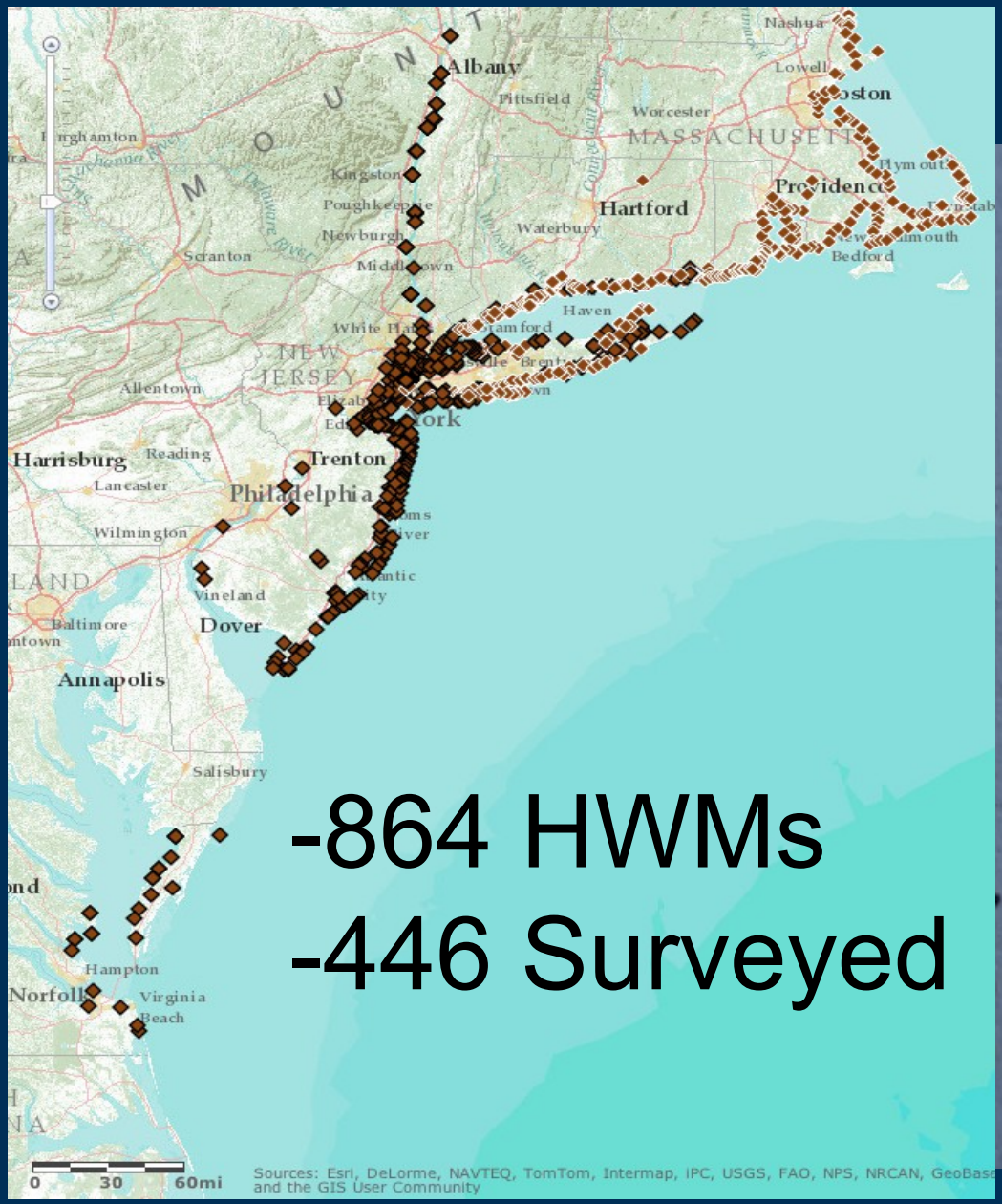
Highwater Mark Flagging and Surveying



Data by State

As of 12/03/2012 09:30 EST

	WL	WV	BP	RDG	Sensor Total	Ind HWM
Massachusetts	22		6	1	29	144
Rhode Island	10		3	1	14	78
Connecticutt	28		8		36	165
New York	40	4	13	4	61	330
New Jersey	11	4	7	2	24	169
Delaware	12	1	12		25	
Maryland	4		2		6	
Virginia	10		10		20	26
Pennsylvania	6		3		9	
New Hampshire	2		1		3	
Maine	3		1		4	
Total	148	9	66	8	231	912

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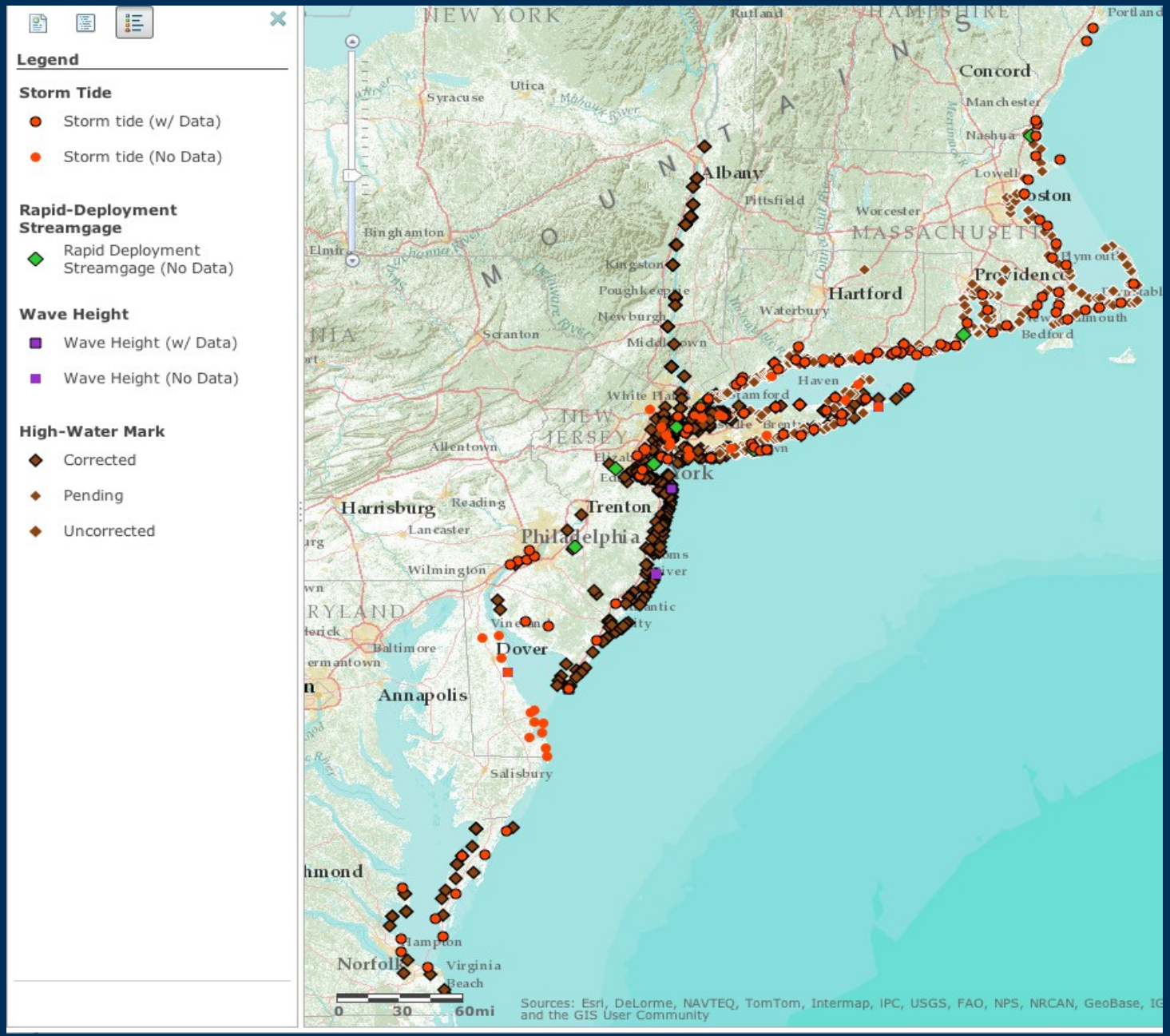
USGS storm-tide map viewer and data portal



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http://water.usgs.gov/floods/events/2012/sandy/

Storm-Tide Monitoring Sites

Connecticut
Storm-tide sites
High-water marks

Delaware
Storm-surge sites

Massachusettes
Storm-surge sites
High-water marks

Maryland
Storm-surge sites

Maine
Storm-surge sites

Hew Hampshire
Storm-surge sites

New Jersey
Storm-surge sites
High-water marks

New York
Storm-surge sites
High-water marks

Pennsylvania
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Rhode Island
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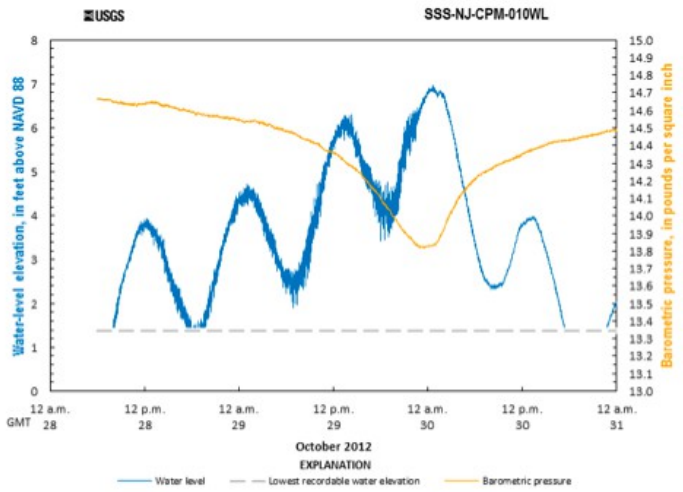
Virginia
Storm-surge sites
High-water marks

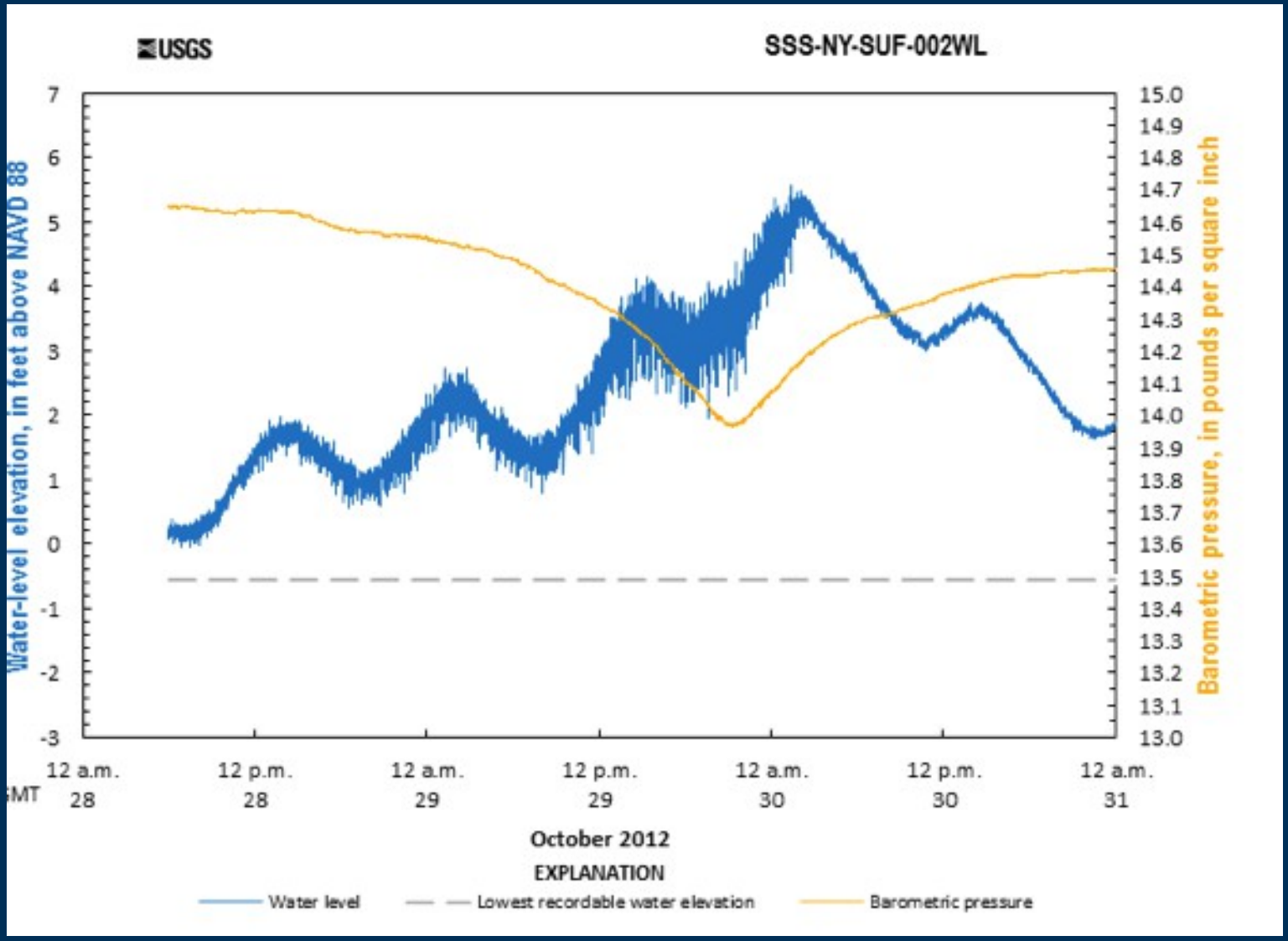
SSS-NJ-CPM-010WL
Great Egg Harbor Bay at Beesleys Point, NJ
Storm-Tide Sensor

Download the data file for this site.



Deployment

Storm-Tide and Barometric Data



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Storm-Tide Timeseries Data

Date/Time	Surge	BP
08-27-2011 22:59:30		14.5532
08-27-2011 23:00:00	0.52	14.5532
08-27-2011 23:00:30	0.54	14.5532
08-27-2011 23:01:00	0.56	14.5532
08-27-2011 23:01:30	0.57	14.5512
08-27-2011 23:02:00	0.58	14.5532
08-27-2011 23:02:30	0.59	14.5532
08-27-2011 23:03:00	0.61	14.5512
08-27-2011 23:03:30	0.63	14.5512
08-27-2011 23:04:00	0.64	14.5512
08-27-2011 23:04:30	0.64	14.5532
08-27-2011 23:05:00	0.63	14.5512
08-27-2011 23:05:30	0.69	14.5512
08-27-2011 23:06:00	0.71	14.5490
08-27-2011 23:06:30	0.71	14.5512
08-27-2011 23:07:00	0.71	14.5512
08-27-2011 23:07:30	0.73	14.5490
08-27-2011 23:08:00	0.75	14.5490
08-27-2011 23:08:30	0.74	14.5490

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Field Note Header

HWM id number: HWM-VA-ACC-001 Date: 11/2/12

County: Accomack Field party: RRL/SMW

Nearest Town: Chincoteague Nearest road: Deep Hole Rd.

Latitude: N 37.93594 GPS unit: Garmin etrex (make, model)

Longitude: W 075.34949 (Horizontal datum is NAD83)

Accuracy: 27 ft GPS serial #: 21511448

Directions to site

(Include such details as address, distance from intersection, physical description, etc.)

- From Chincoteague Town Office:
- Travel North on Deep Hole Road through sharp bend to the right
- Continue straight at sharp left bend & continue on Fir to landing and HWM on fence in right corner of lot

* HWM NOT wave-affected *

HWM identified with (colored flagging, marker, stake, disc, spray paint, other_____)

Type of mark (debris line, mud line, seed line, wash line, other_____)

Inside or outside mark: Outside Approx. height above ground (ft): 1.5

Quality of mark: Excellent (+/- 0.05 ft) Good (+/- 0.10 ft) Fair (+/- 0.25 ft) Poor (>0.25 ft)

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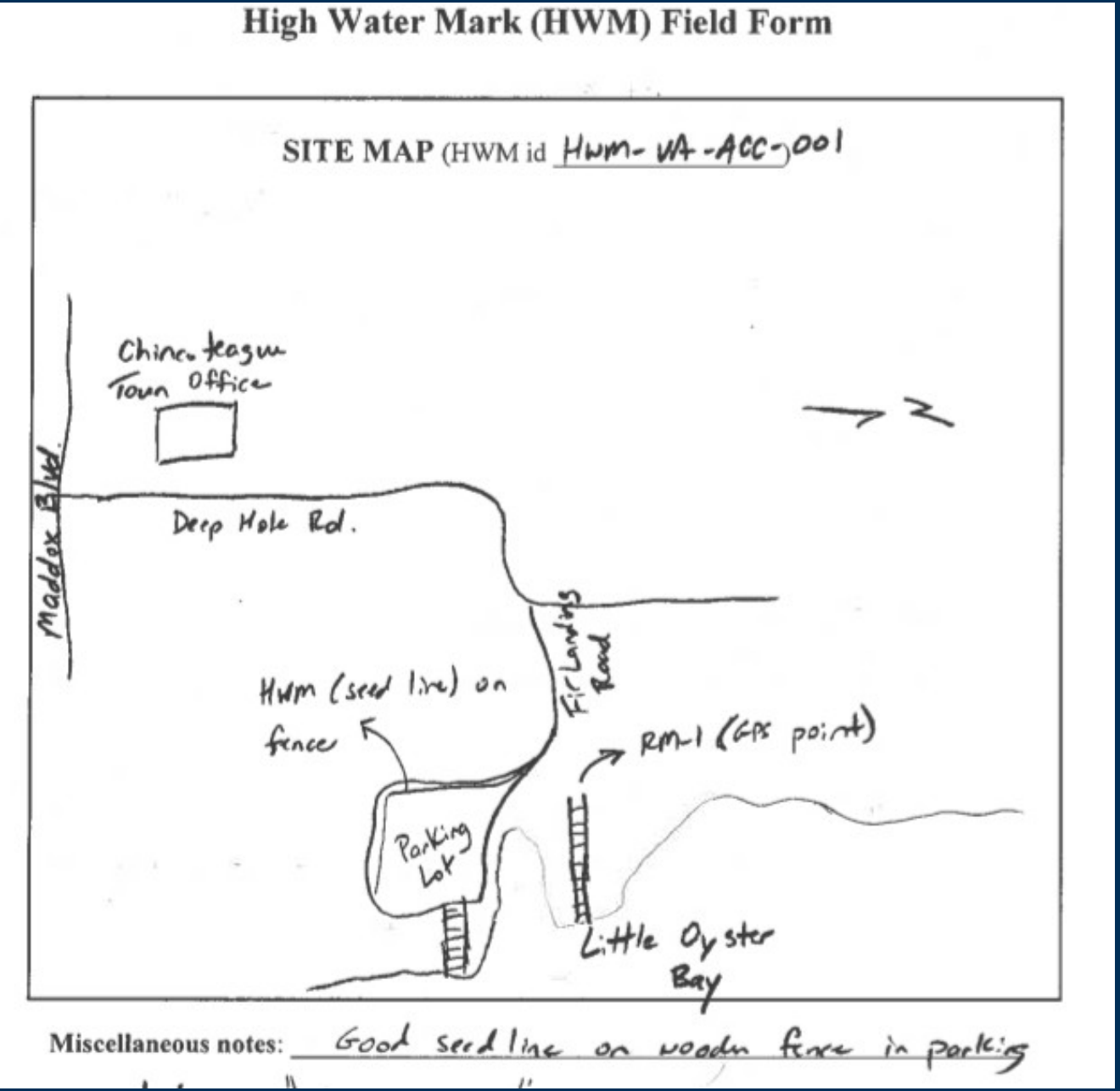
Site Sketch



High Water Mark (HWM) Field Form

SITE MAP (HWM id HWM-VA-ACC-001

Chincoteague Town Office

N

Maddox Blvd.

Deep Hole Rd.

Fir Landing Road

HWM (seed line) on fence

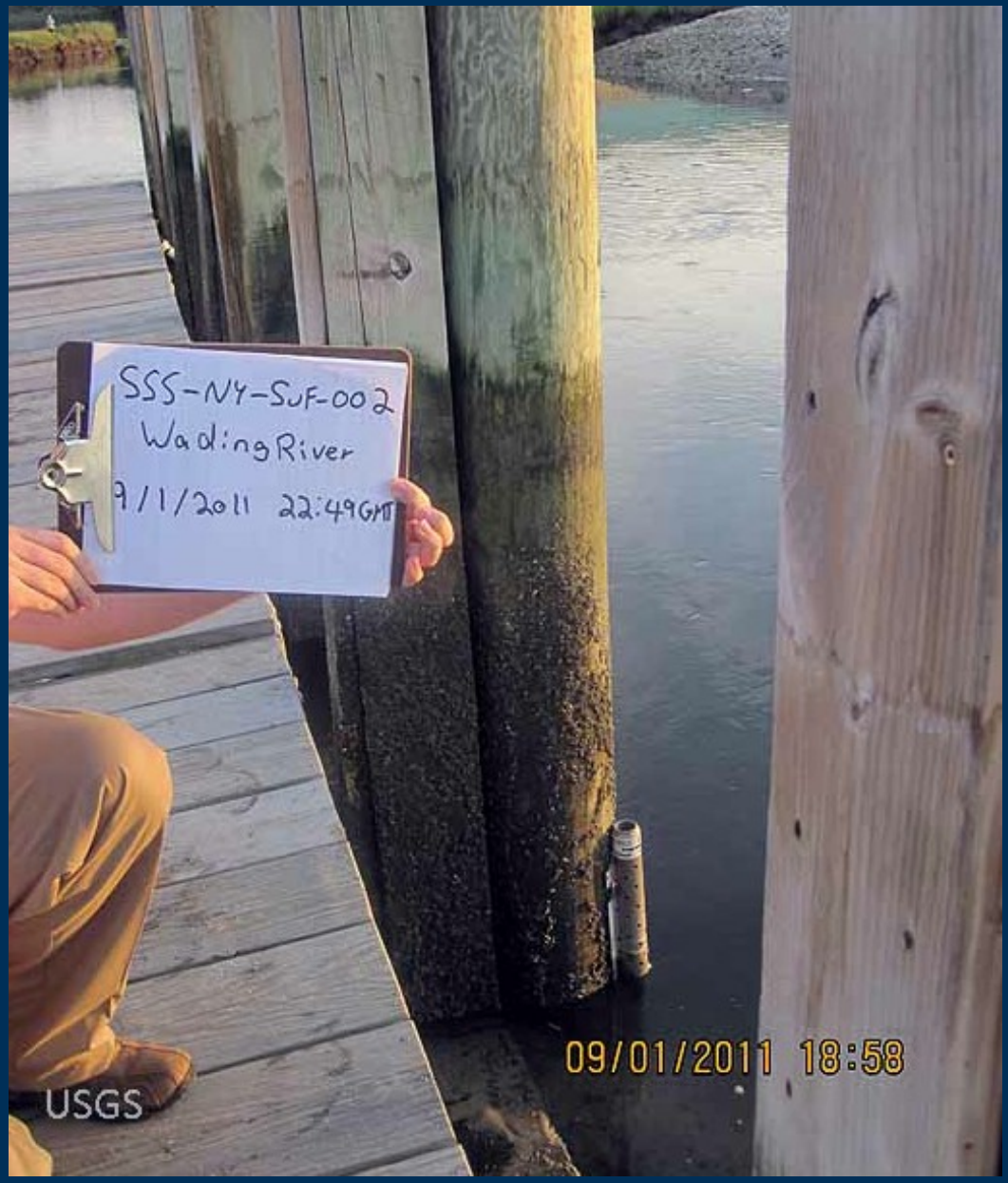
RM-1 (GPS point)

Parking Lot

Little Oyster Bay

Miscellaneous notes: Good seed line on wooden fence in parking

Site Photos



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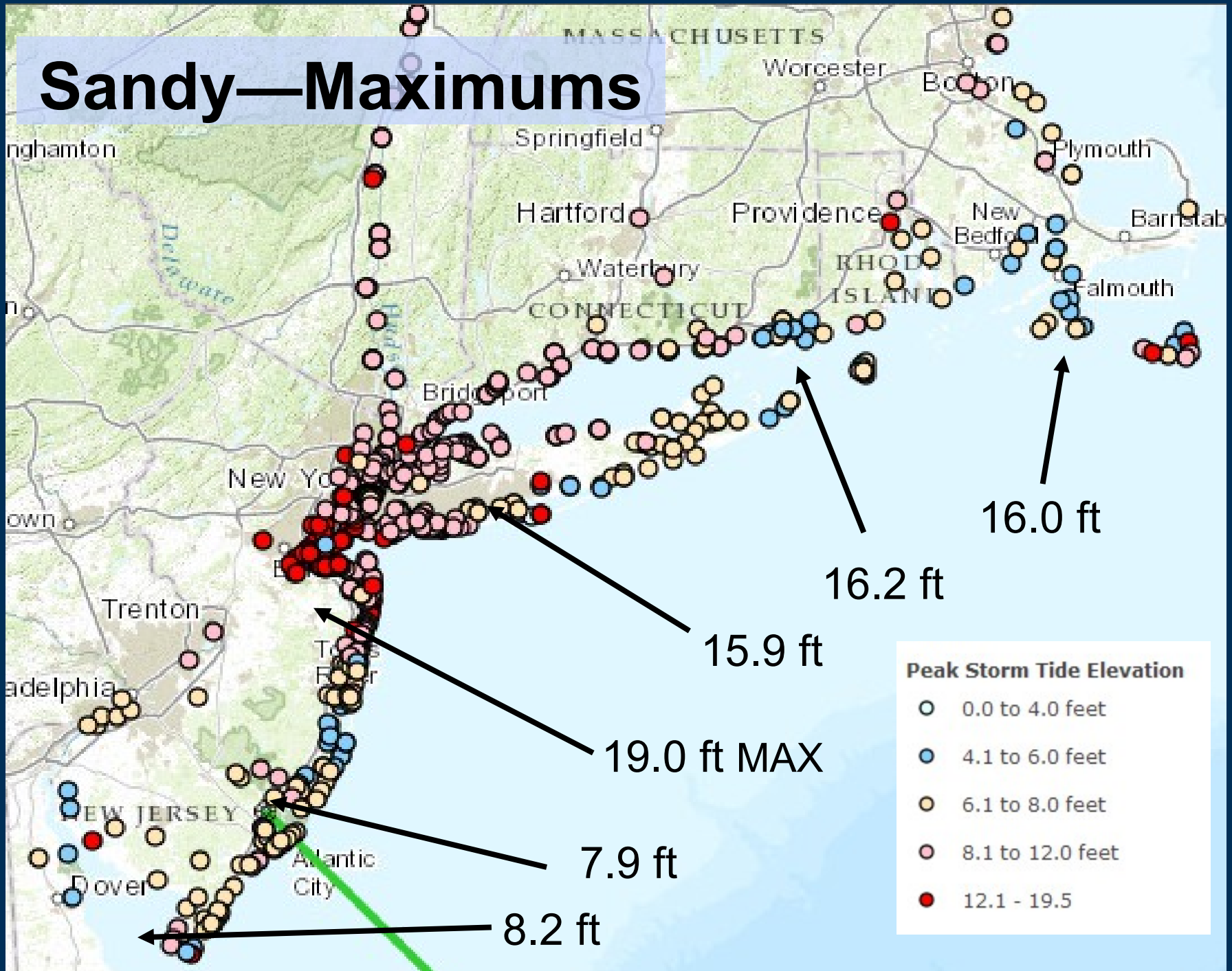
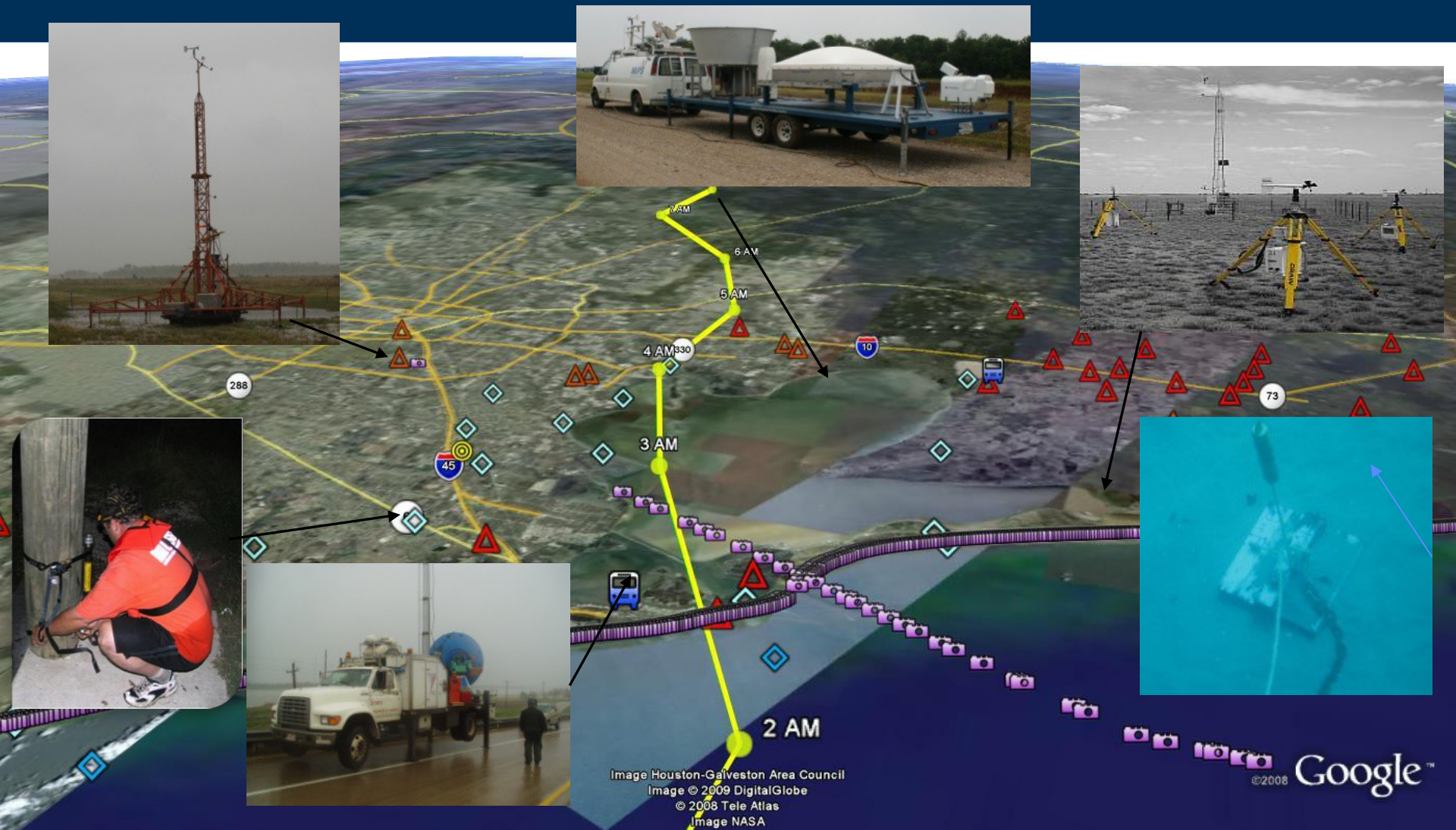

Sandy—Maximums
MASSACHUSETTS
Worcester
Springfield
Hartford
Providence
Plymouth
Waterbury
CONNECTICUT
Trenton
Atlantic City
Dover
16.0 ft
16.2 ft
15.9 ft
19.0 ft MAX
7.9 ft
8.2 ft
Peak Storm Tide Elevation
0.0 to 4.0 feet
4.1 to 6.0 feet
6.1 to 8.0 feet
8.1 to 12.0 feet
12.1 - 19.5

OFCM Disaster Impact Assessments and Plans: Wind and Water

Successful instrument deployments…
…but not optimally placed or coordinated



What's next…?

- Coastal Act –Timing just as important as levels
  - Expand use of web viewer to show time and depths
- Enhance and extend real-time capability
- Better integrate water level with wind data
- Seek opportunities for observations of near-field water and winds effects on veg, terrain, and built structures
- Seek opportunities to use SSSs as base line for remotely sensed data

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