A summary of the latest sea level rise science, storm surge data, and efforts to address resiliency in municipal adaptation planning

Mid-Coast Regional Planning Commission Annual Meeting

October 24, 2013

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Maine Geological Survey

Work funded by:

Why does sea level change?

Global Sea Levels…

Thermal Expansion (the ocean heats up/expands as atmosphere warms)

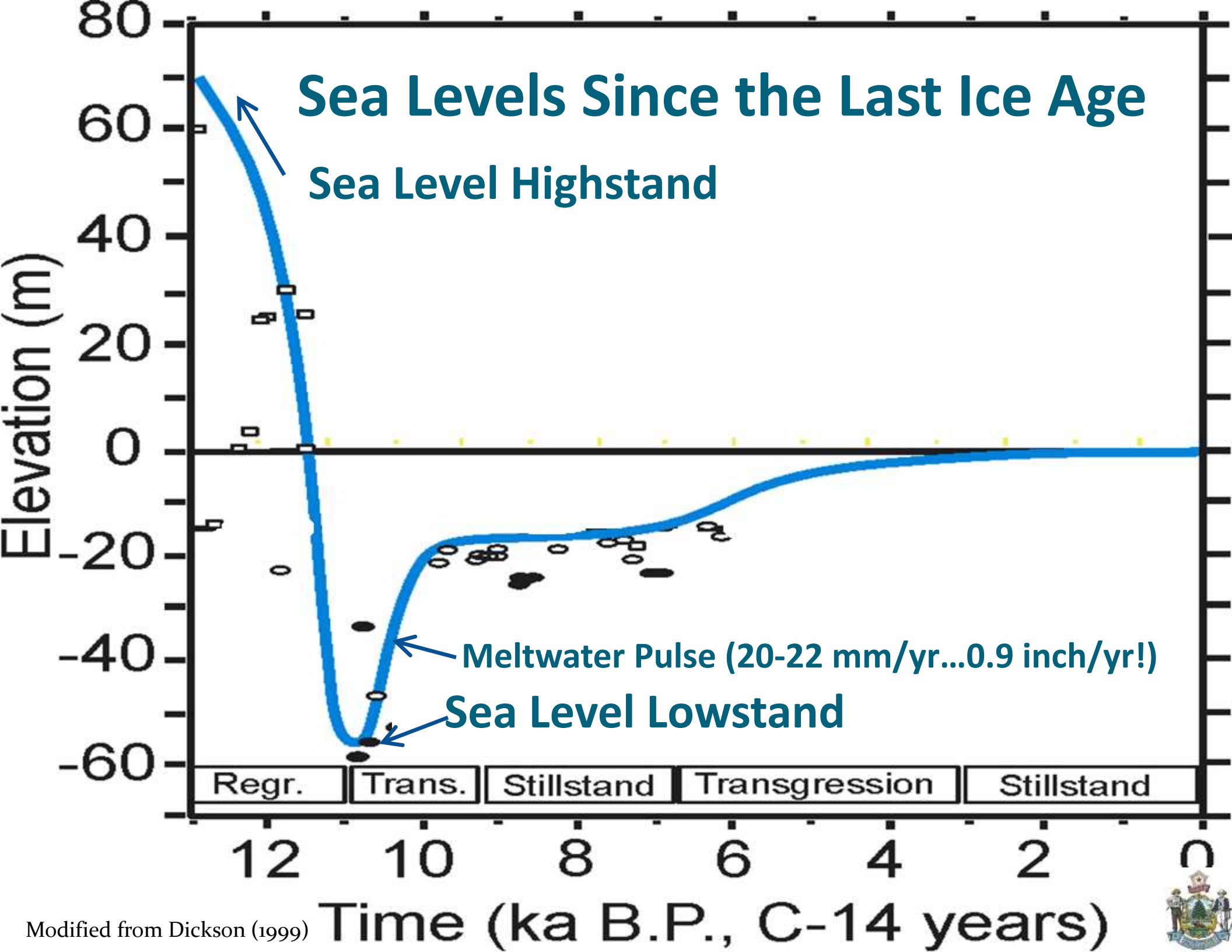
Volumetric Increase (volume increases with water from melting glaciers and land-based ice sheets)

Global climate variation (impacts of ENSO, El Nino/La Niña warming and cooling patterns in the Pacific Ocean)

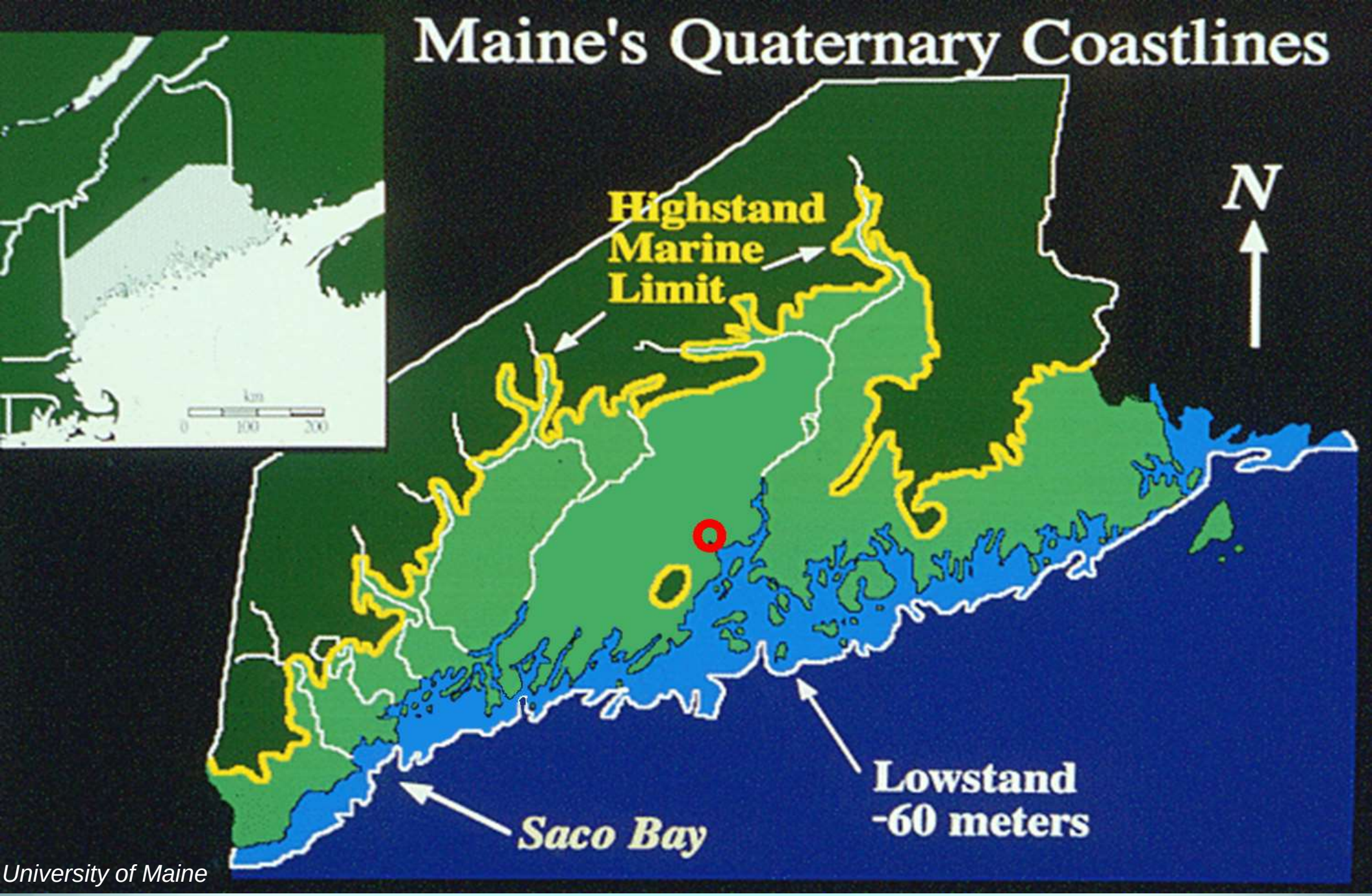
Relative (or "Local") Sea levels…

Isostatic rebound (response of the crust to glaciation)

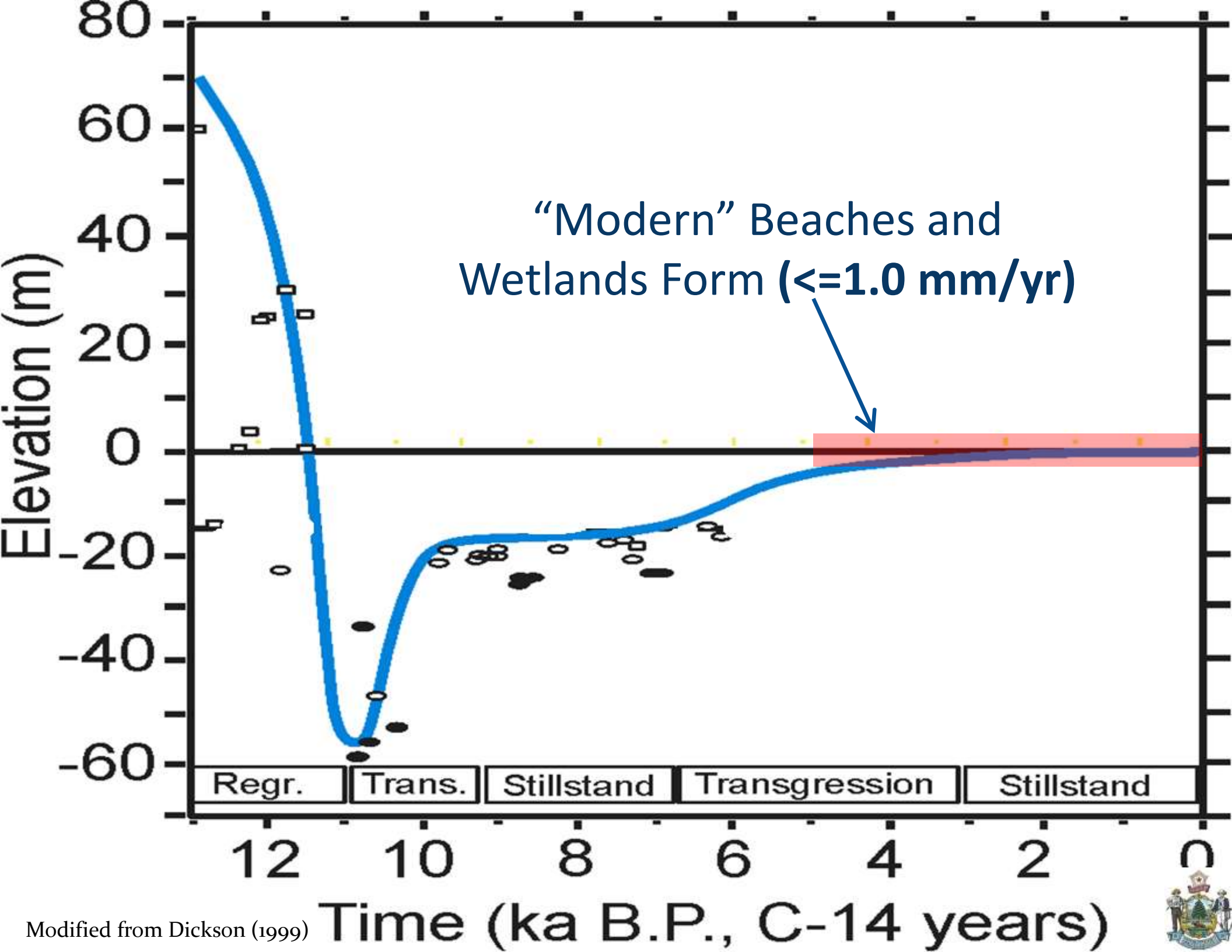
Subsidence (sinking of the land due to other factors than isostasy)



Modified from Dickson (1999)



Massive adjustments in response to glaciation drove much of Maine's sea level changes…



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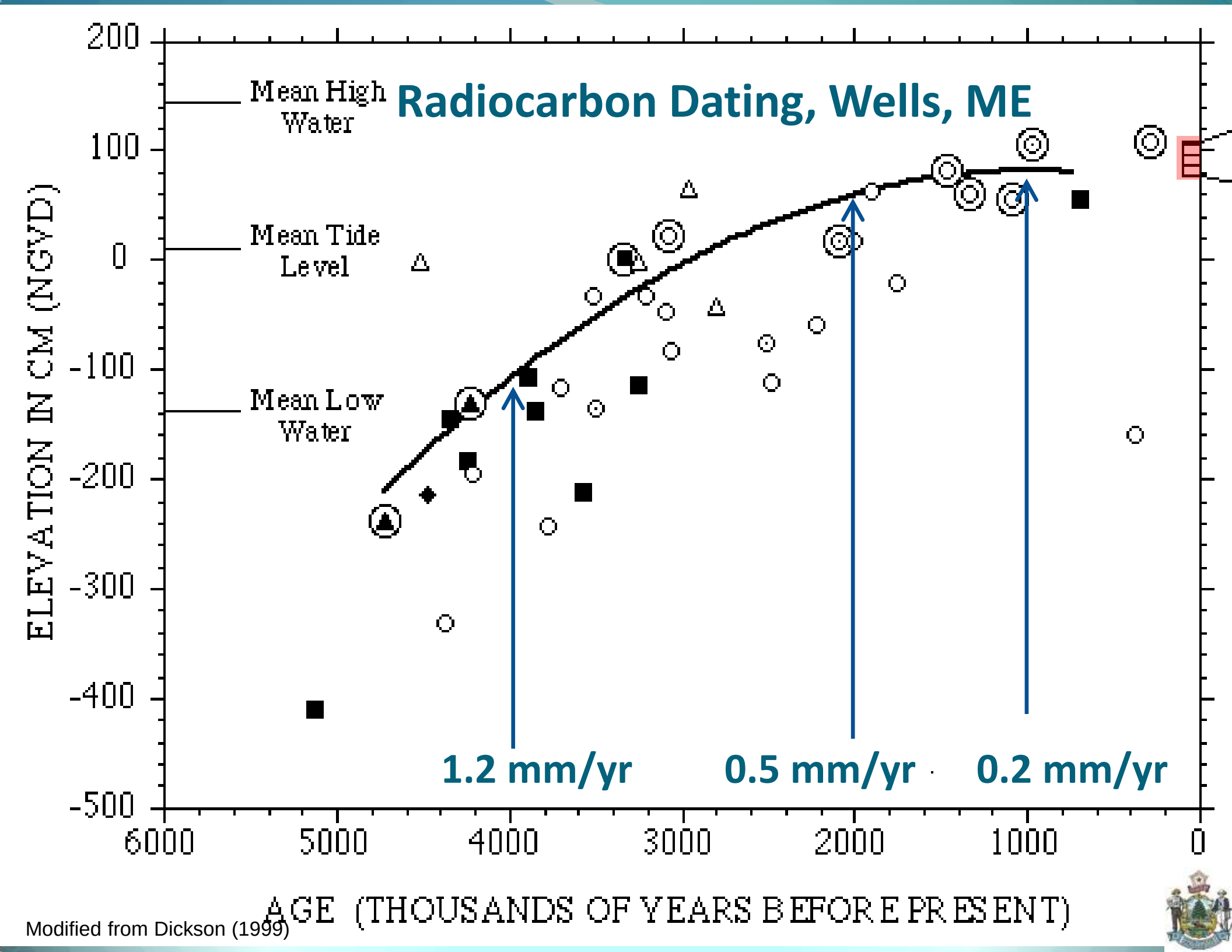
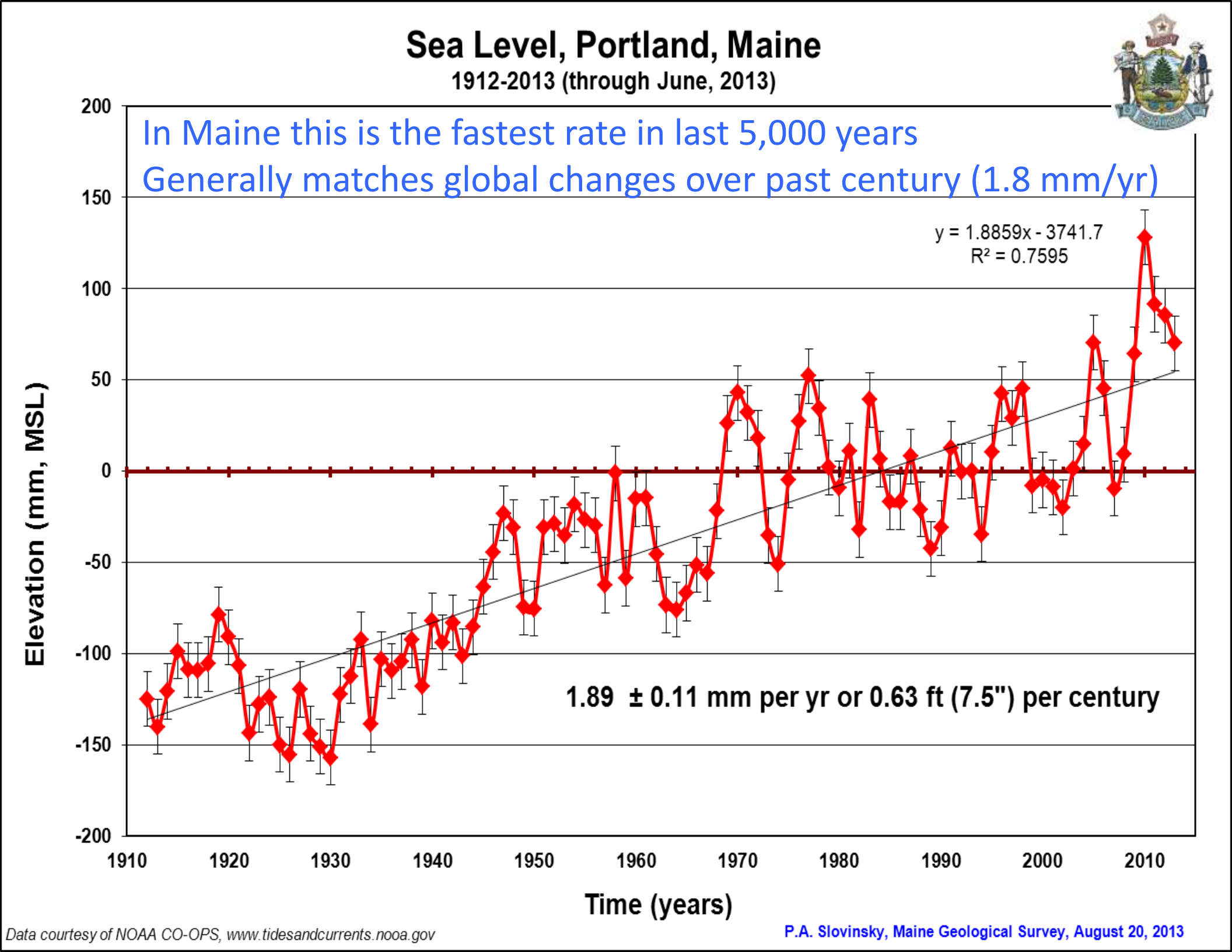


Modified from Dickson (1999)

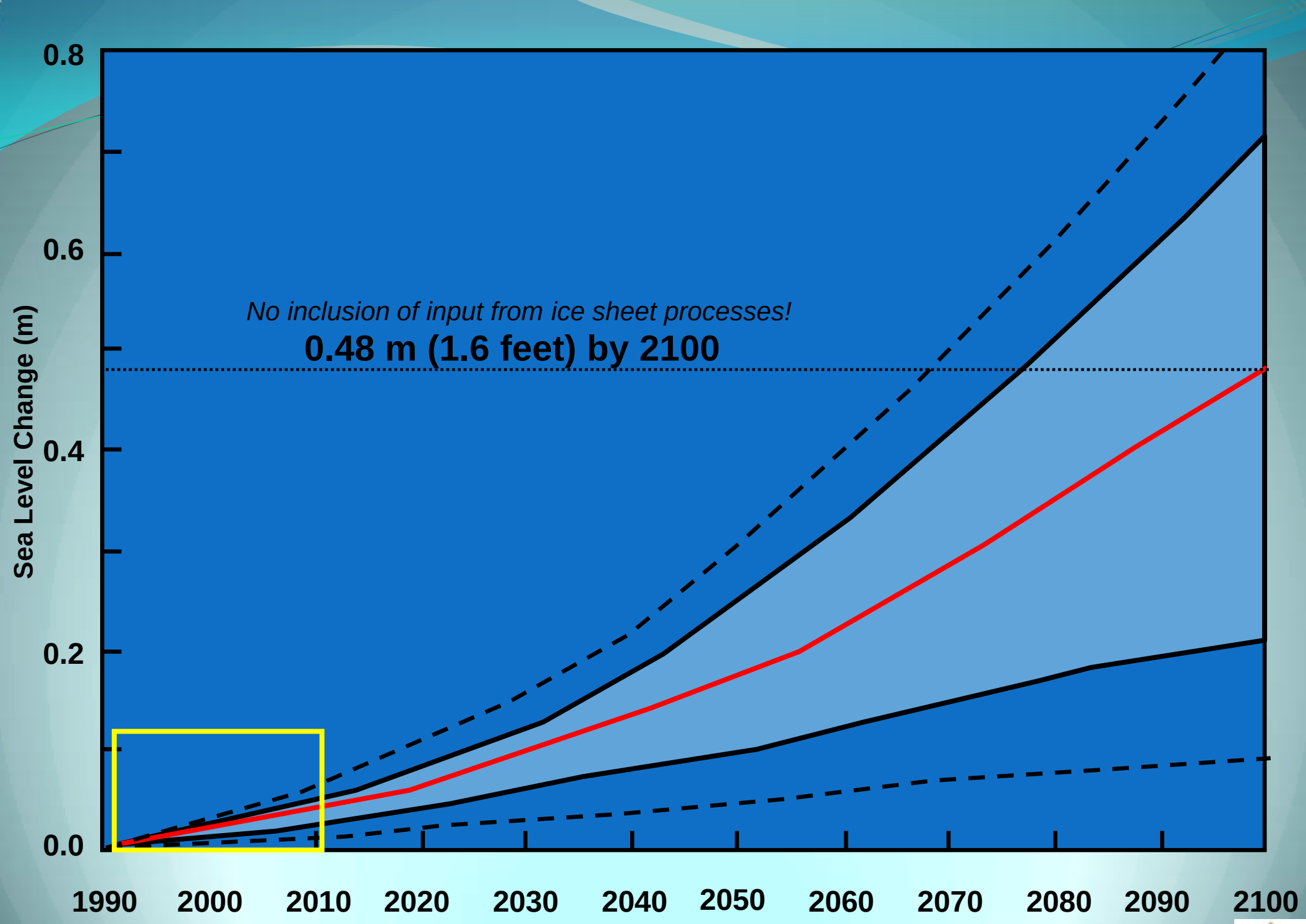
Sea Level, Portland, Maine

1912-2013 (through June, 2013)

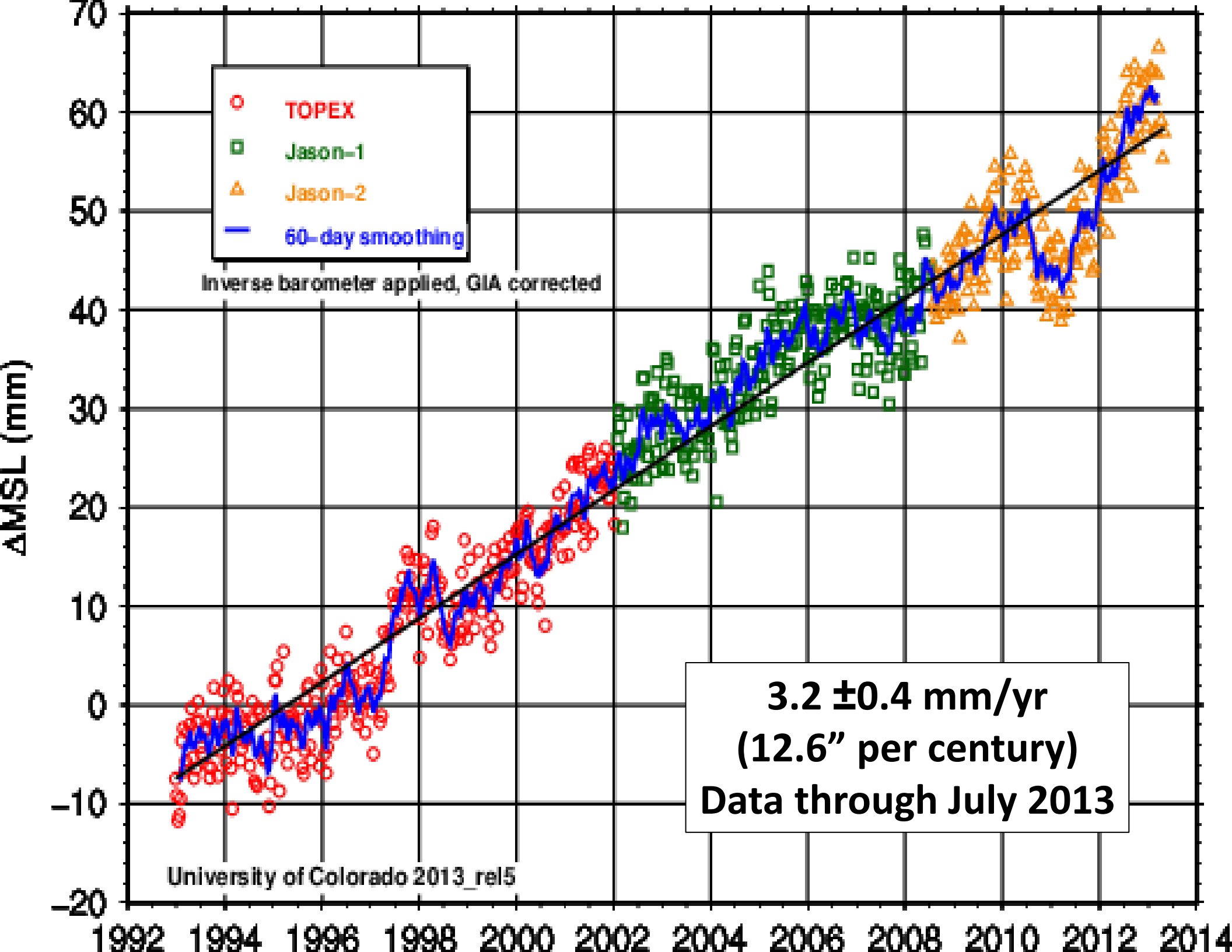


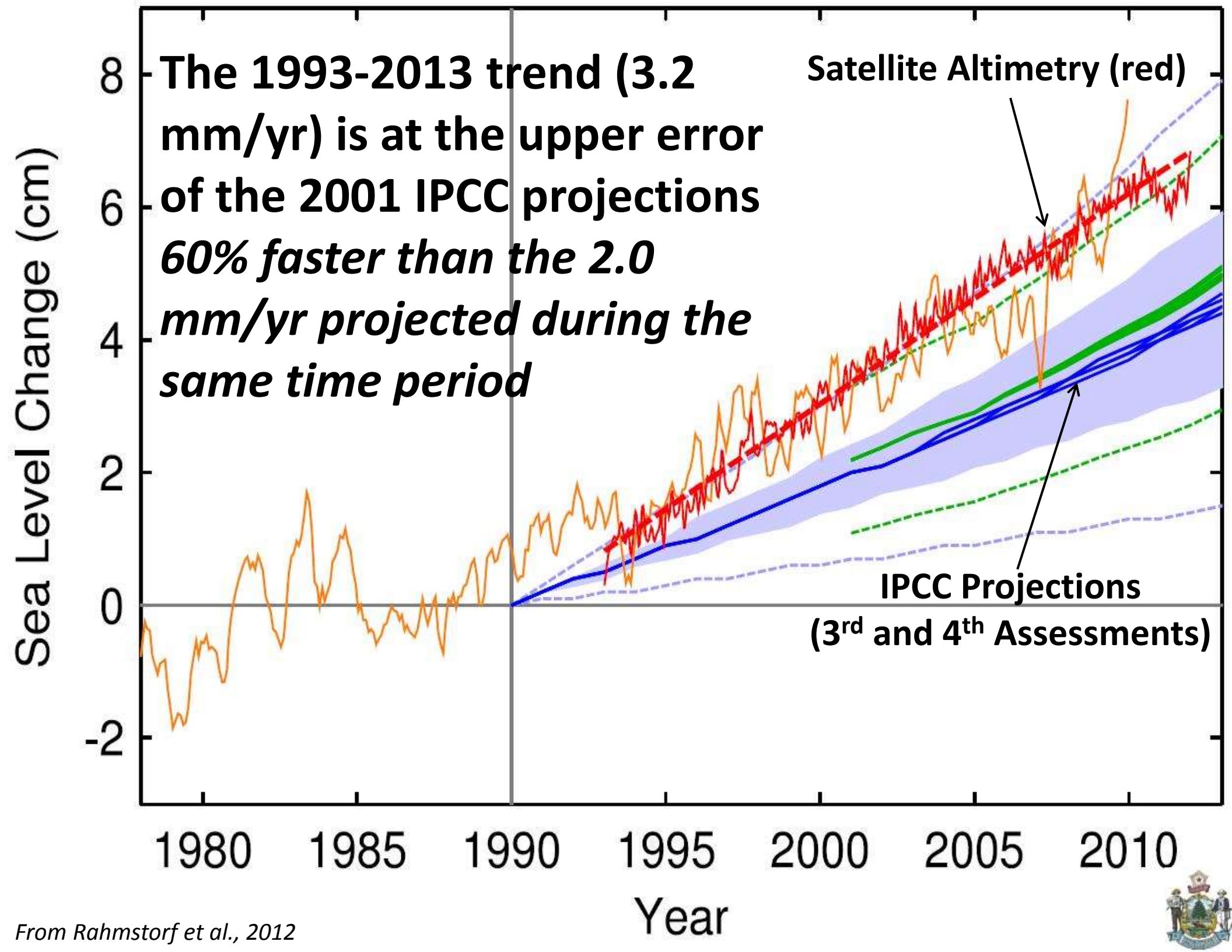
Data courtesy of NOAA CO-OPS, www.tidesandcurrents.nooa.gov

P.A. Slovinsky, Maine Geological Survey, August 20, 2013



Adapted from the IPCC 3rd Assessment (Tech. Summary of Working Group I Report, Fig. 24, p. 74., 2001)

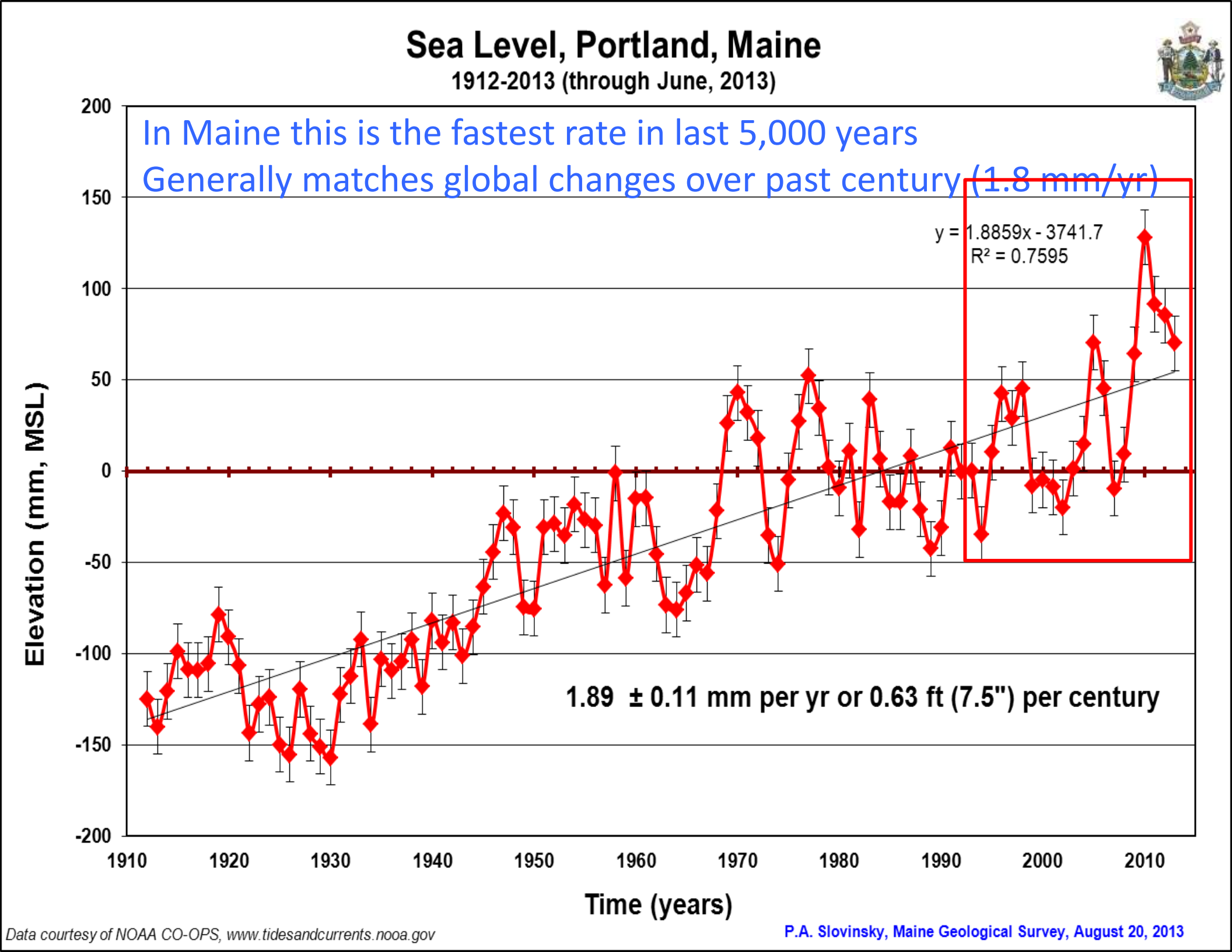

TOPEX
Jason-1
Jason-2
60-day smoothing
Inverse barometer applied, GIA corrected
University of Colorado 2013_rel5
3.2 ±0.4 mm/yr
(12.6” per century)
Data through July 2013
ΔMSL (mm)
70
60
50
40
30
20
10
0
−10
−20
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



From Rahmstorf et al., 2012

Sea Level, Portland, Maine

1912-2013 (through June, 2013)

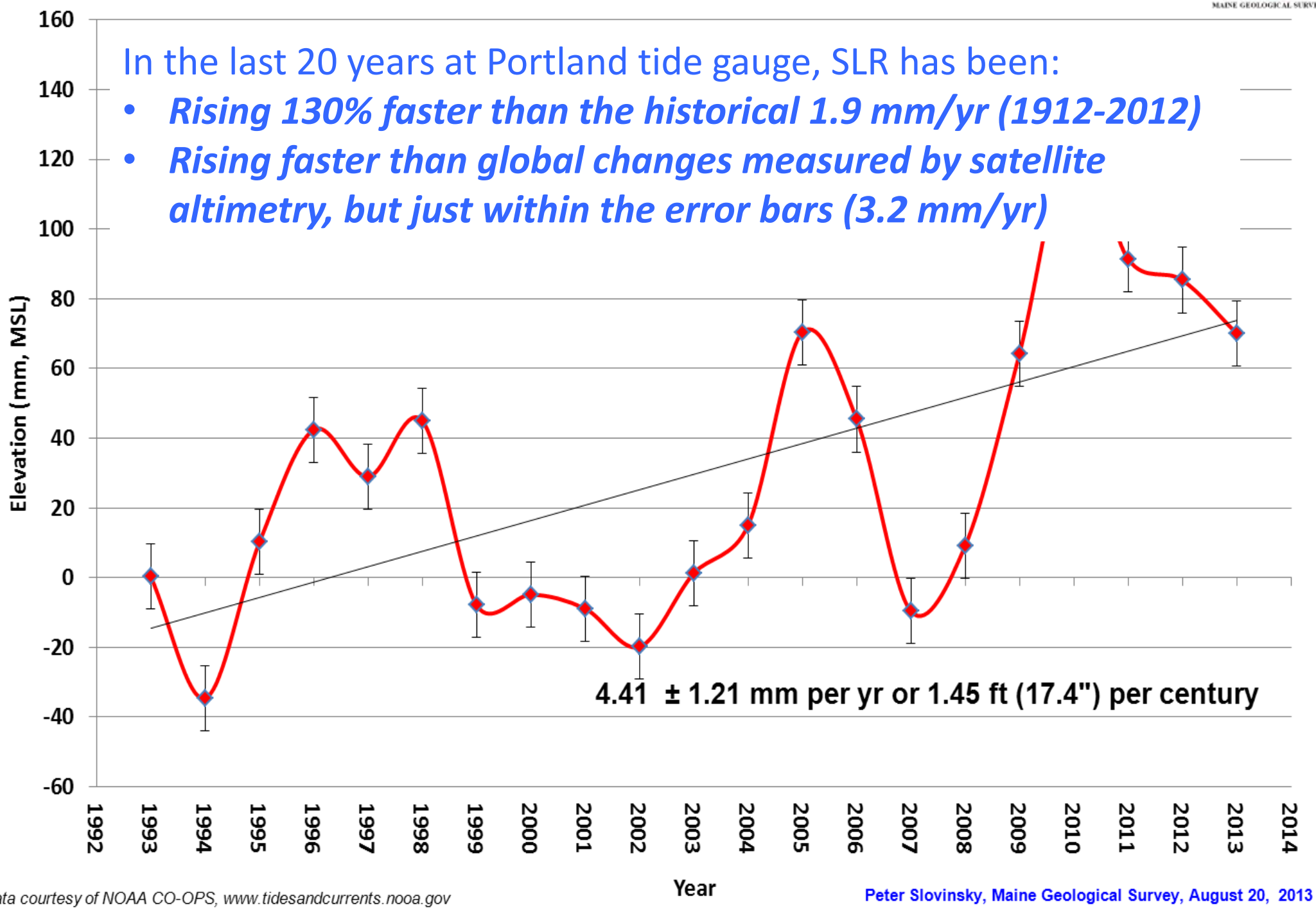


Data courtesy of NOAA CO-OPS, www.tidesandcurrents.nooa.gov

P.A. Slovinsky, Maine Geological Survey, August 20, 2013

Sea Level, Portland, Maine
1993-2013 (through June 2013)

MAINE GEOLOGICAL SURVEY

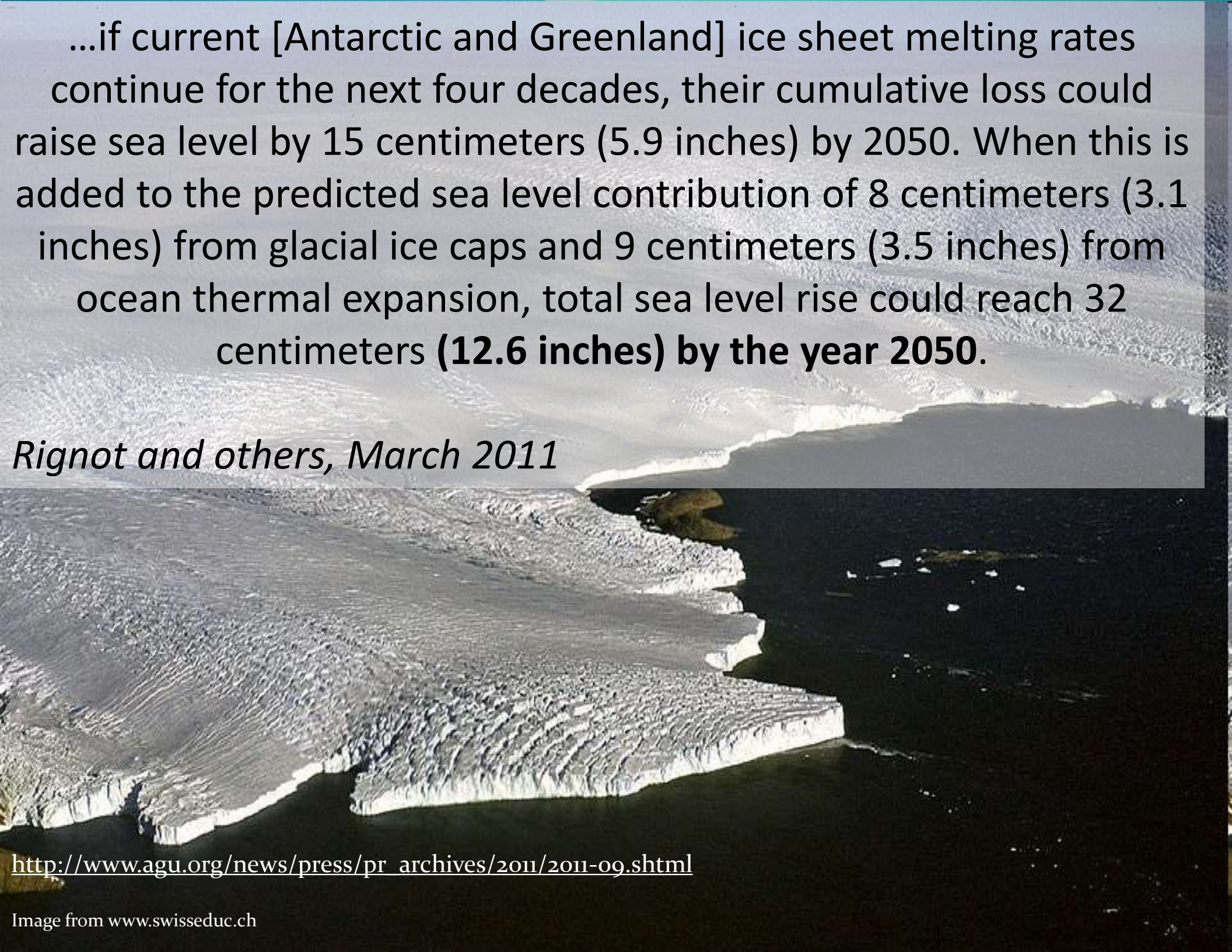


Data courtesy of NOAA CO-OPS, www.tidesandcurrents.nooa.gov

Peter Slovinsky, Maine Geological Survey, August 20, 2013

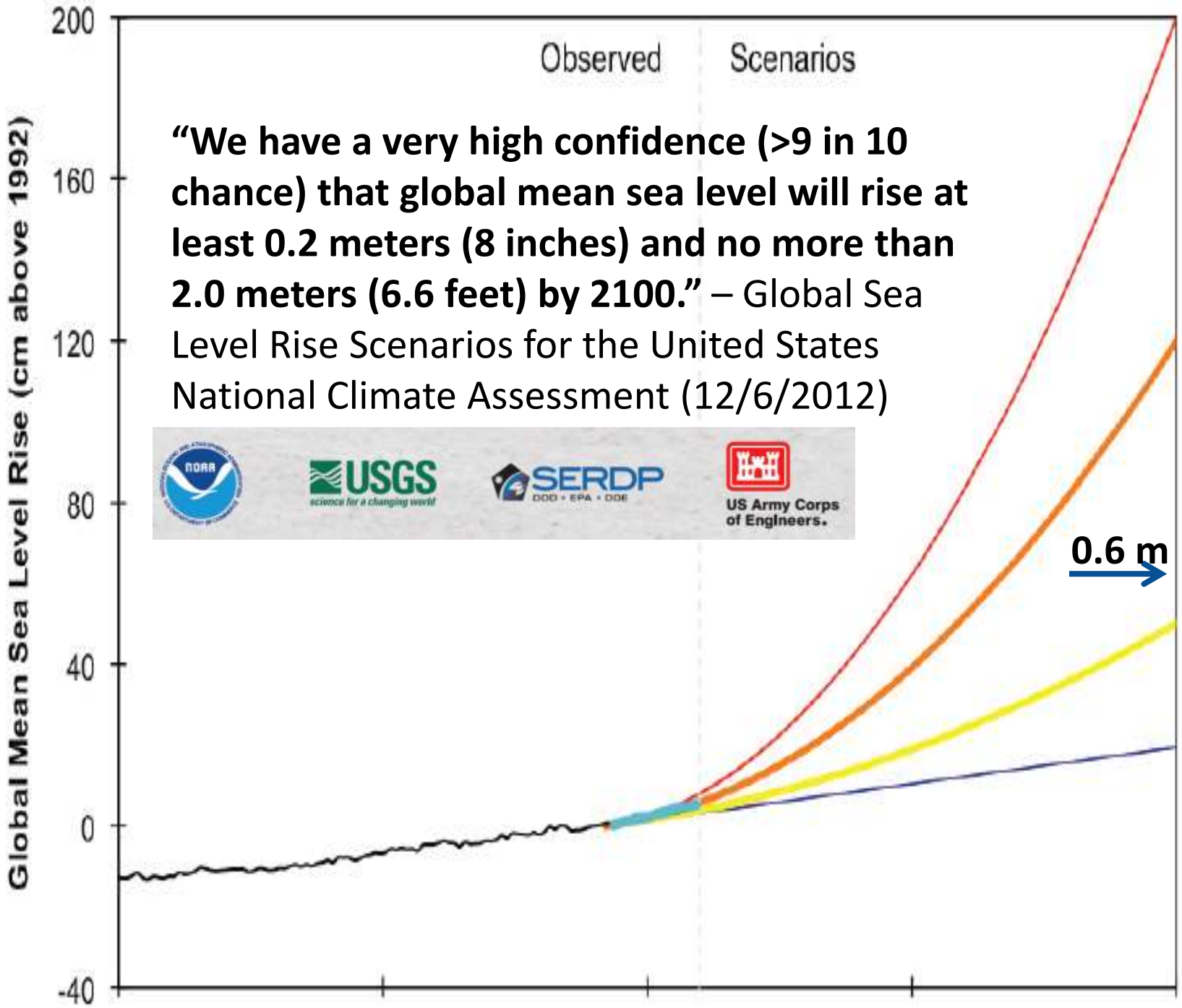
…if current [Antarctic and Greenland] ice sheet melting rates continue for the next four decades, their cumulative loss could raise sea level by 15 centimeters (5.9 inches) by 2050. When this is added to the predicted sea level contribution of 8 centimeters (3.1 inches) from glacial ice caps and 9 centimeters (3.5 inches) from ocean thermal expansion, total sea level rise could reach 32 centimeters **(12.6 inches) by the year 2050**.

Rignot and others, March 2011



http://www.agu.org/news/press/pr_archives/2011/2011-09.shtml

Image from www.swisseduc.ch



"We have a very high confidence (>9 in 10 chance) that global mean sea level will rise at least 0.2 meters (8 inches) and no more than 2.0 meters (6.6 feet) by 2100." – Global Sea Level Rise Scenarios for the United States National Climate Assessment (12/6/2012)

USGS science for a changing world · SERDP DOD • EPA • DOE · US Army Corps of Engineers.

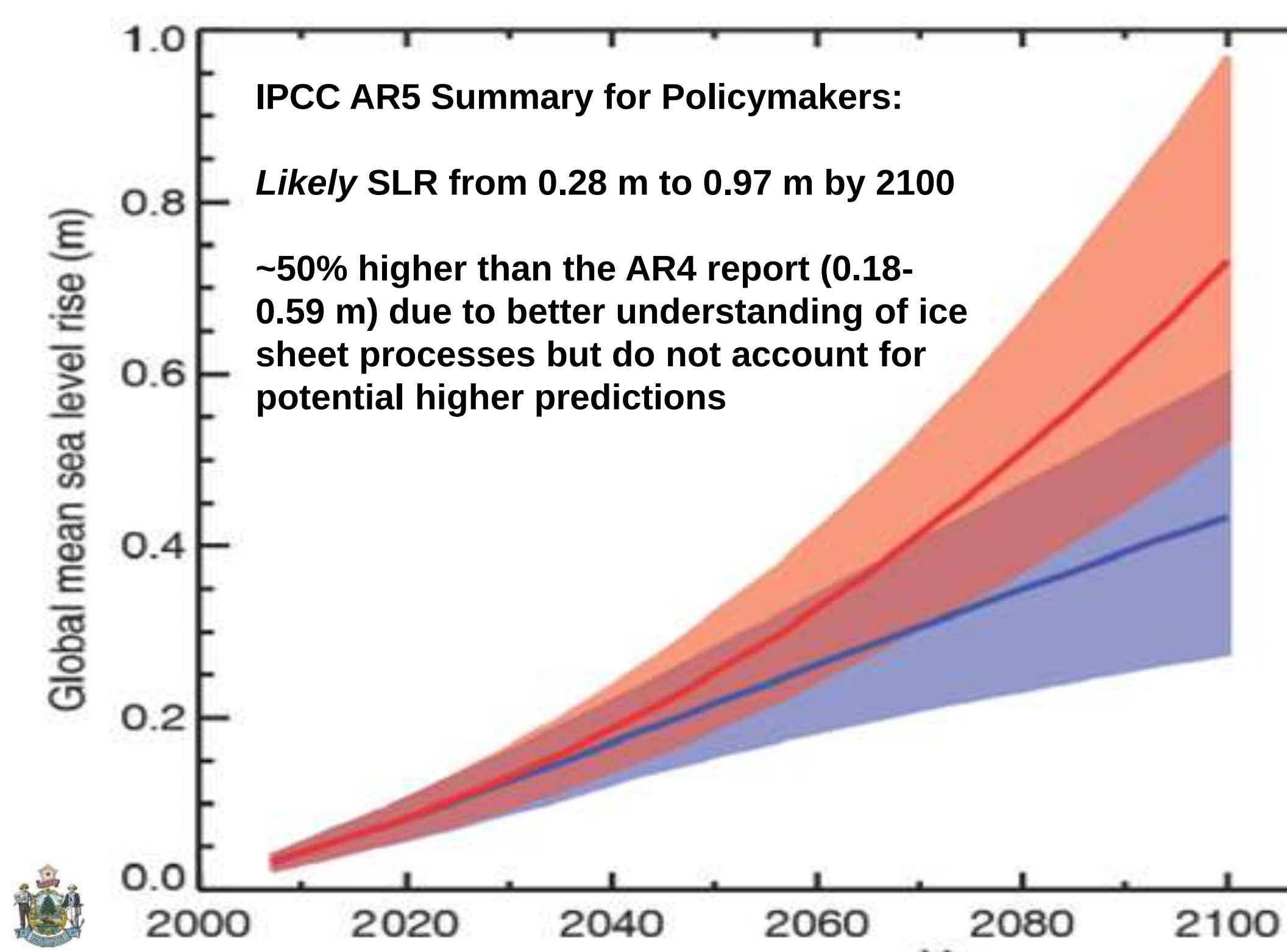
Highest
(2.0 m, 6.6 ft)
***Combines maximum warming, thermal expansion, and possible ice sheet loss from semi-empirical models.**

Intermediate-High
(1.2 m, 3.9 ft)
***Average of high end global predictions, combines recent ice sheet loss and thermal expansion**

Intermediate-Low
(0.5 m, 1.6 ft)
***Includes only thermal expansion from warming from IPCC AR4.**

Lowest
(0.2 m, 0.7 ft)
*** Historical trend continued; no additional thermal expansion from warming**

Recommend using a "Scenario" Based Approach

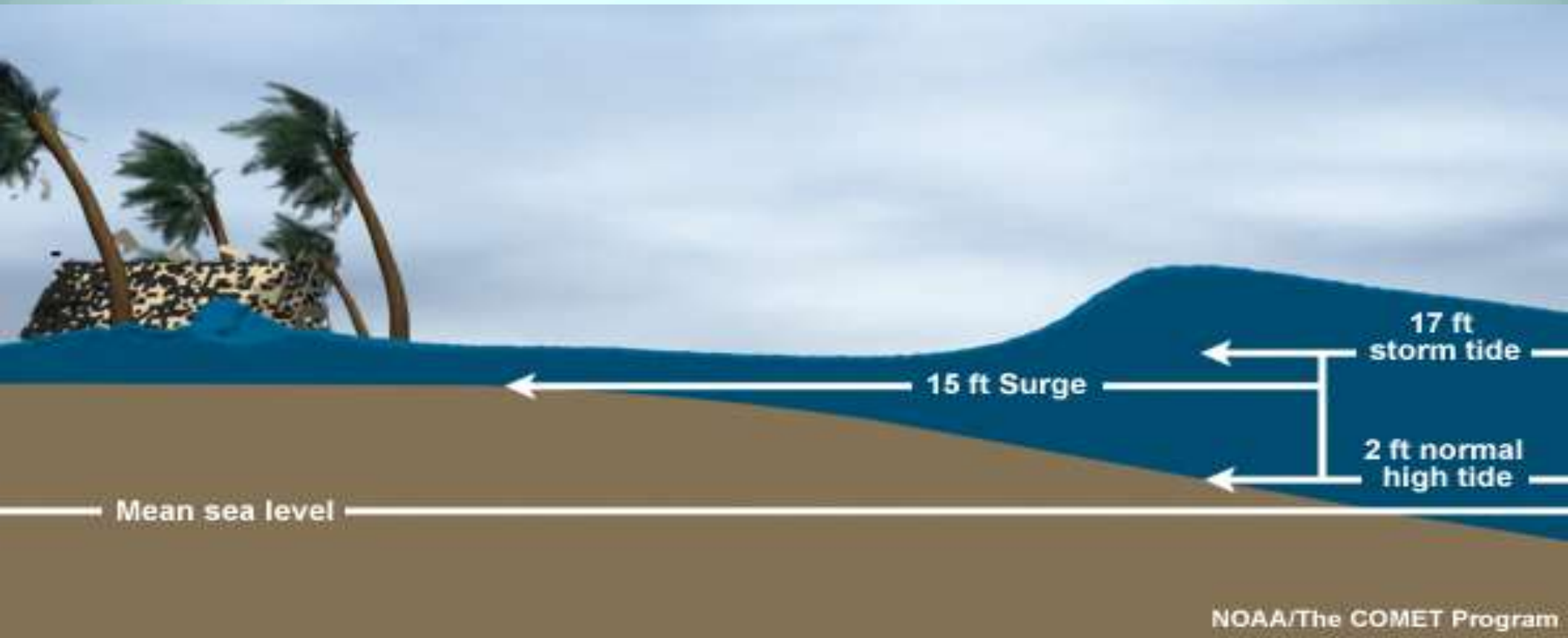


Adapted from IPCC AR5, Summary for Policymakers, 09/27/2013, Figure SPM.9

What about storm tides and storm surges?

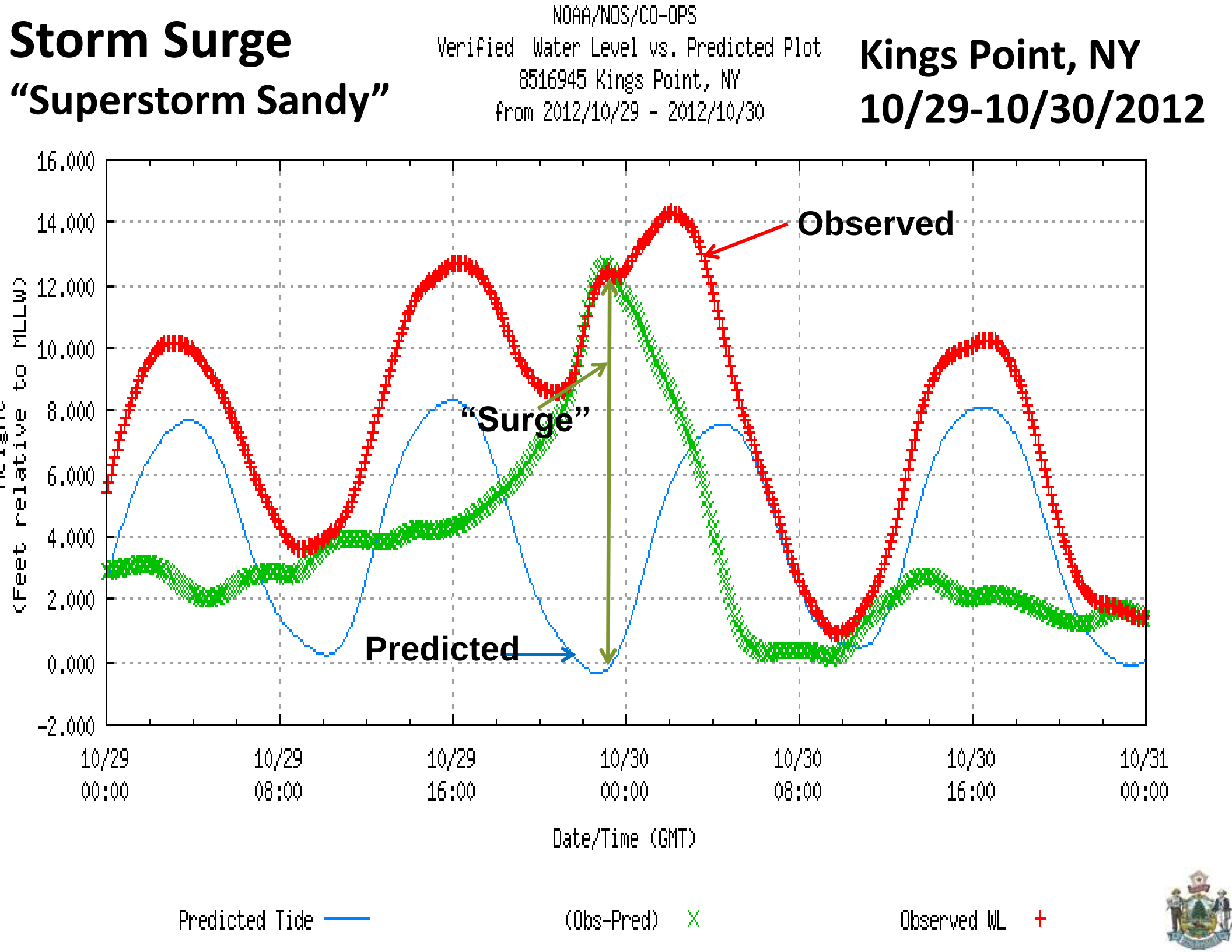
So what is storm surge?

Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. Storm surge should not be confused with storm tide, which is defined as the water level rise due to the combination of storm surge and the astronomical tide (National Hurricane Center)



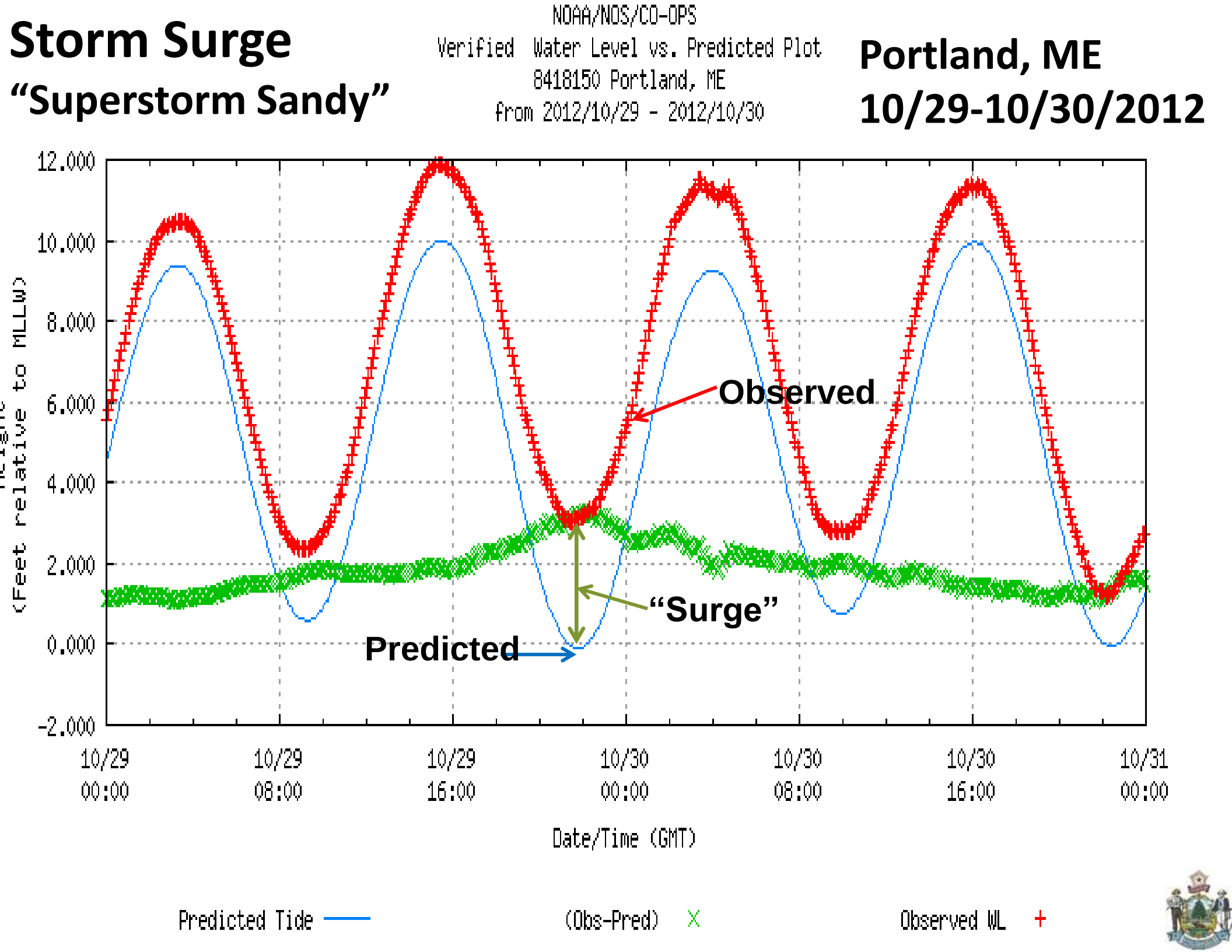
Storm Surge

"Superstorm Sandy"



Storm Surge

"Superstorm Sandy"



Portland Storm Surges (at any tide)

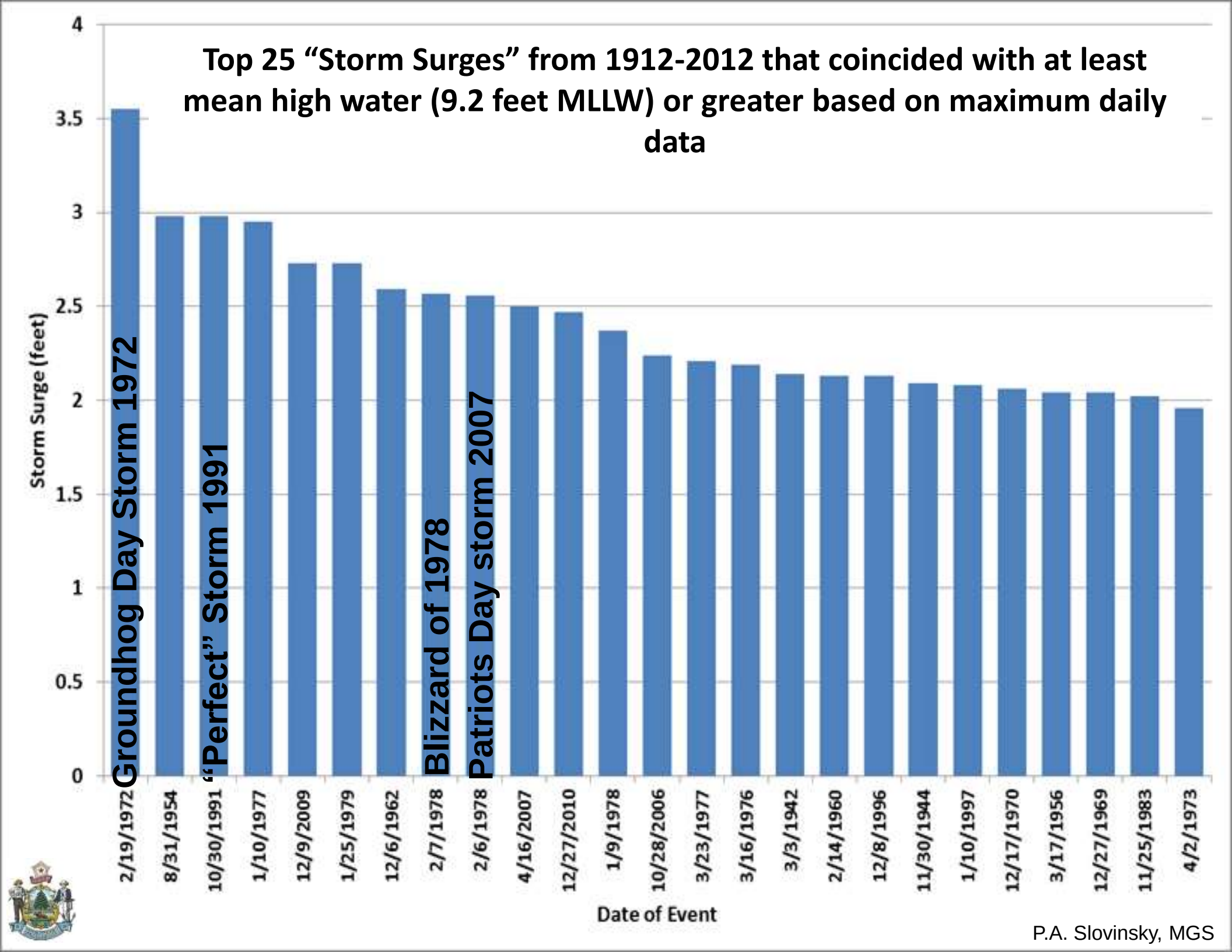
Time Interval (years)	Surge Height (feet)
1 (100 %)	1.8
2 (50%)	2.4
5 (20%)	3.3
10 (10 %)	4.0
20 (5%)	4.7
25 (4 %)	4.9
50 (2 %)	5.6
75 (1.3 %)	6.0
100 (1%)	6.3

P.A. Slovinsky, MGS

Because of Maine's tidal variation, it's *the combination of astronomical tide and "storm surge" that are of concern* (NHC calls this overall water level the **"storm tide"**)

Portland Storm Surges, 1912-2012 (coinciding with mean high water or greater)

Interval (yrs)	Surge at MHW (ft)
1 (100 %)	1.1
5 (20%)	2
10 (10 %)	2.4
25 (4 %)	2.9
50 (2 %)	3.3
100 (1 %)	3.7


Top 25 "Storm Surges" from 1912-2012 that coincided with at least mean high water (9.2 feet MLLW) or greater based on maximum daily data
Storm Surge (feet)
4
3.5
3
2.5
2
1.5
1
0.5
0
Groundhog Day Storm 1972
"Perfect" Storm 1991
Blizzard of 1978
Patriots Day storm 2007
2/19/1972
8/31/1954
10/30/1991
1/10/1977
12/9/2009
1/25/1979
12/6/1962
2/7/1978
2/6/1978
4/16/2007
12/27/2010
1/9/1978
10/28/2006
3/23/1977
3/16/1976
3/3/1942
2/14/1960
12/8/1996
11/30/1944
1/10/1997
12/17/1970
3/17/1956
12/27/1969
11/25/1983
4/2/1973
Date of Event
P.A. Slovinsky, MGS

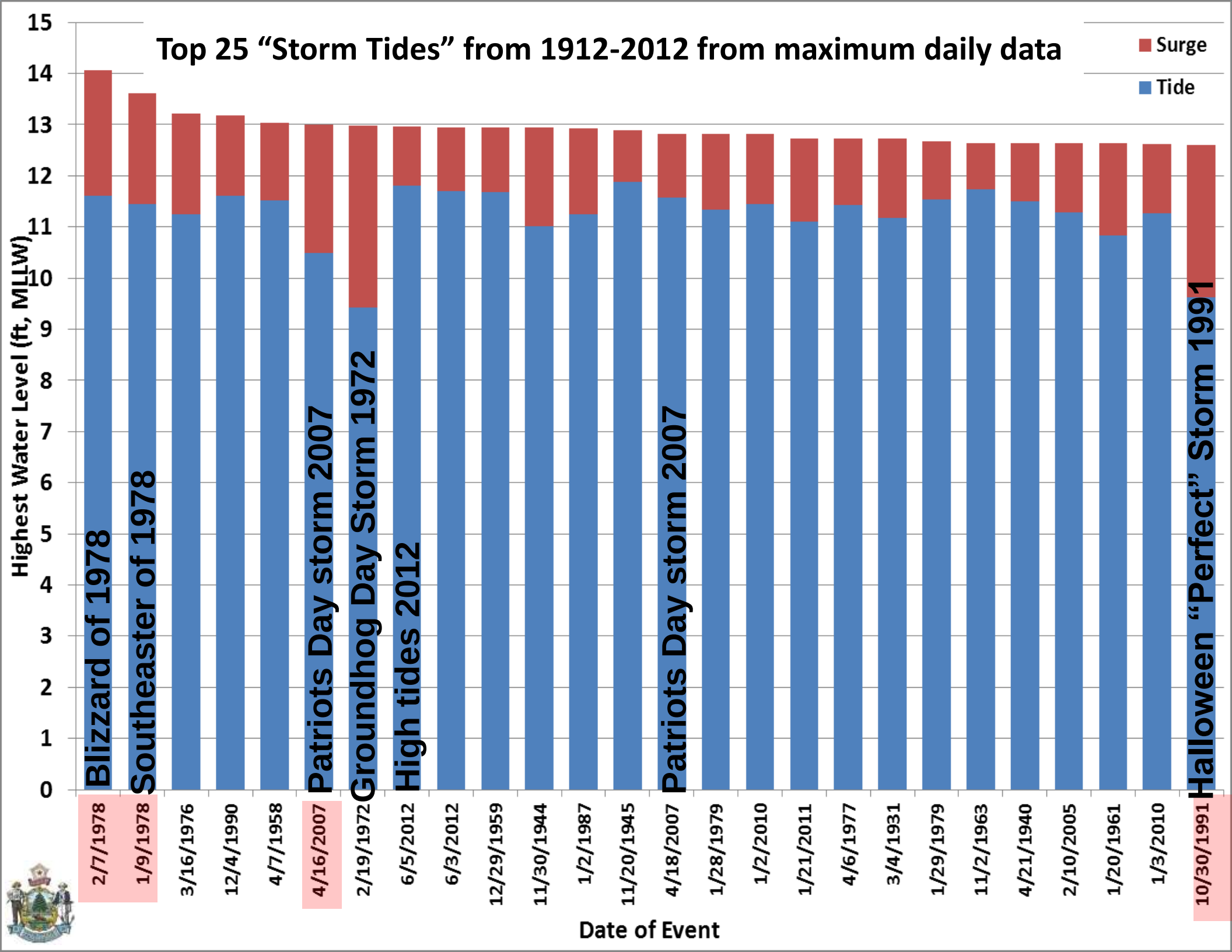
Portland "Storm Tides", 1912-2012

Interval (yrs)	"Storm Tide" Level (ft, MLLW)
1 (100 %)	11.7
5 (20%)	12.6
10 (10 %)	12.9
25 (4 %)	13.4
50 (2 %)	13.7
100 (1 %)	14.1

Portland "Storm Tides", 1912-2012

Interval (yrs)	"Storm Tide" Level (ft, MLLW)
1 (100 %)	11.7
5 (20%)	12.6
10 (10 %)	12.9
25 (4 %)	13.4
50 (2 %)	13.7
100 (1 %)	14.1

1 foot difference!


Top 25 "Storm Tides" from 1912-2012 from maximum daily data
Surge
Tide
Highest Water Level (ft, MLLW)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Blizzard of 1978
Southeaster of 1978
Patriots Day storm 2007
Groundhog Day Storm 1972
High tides 2012
Patriots Day storm 2007
Halloween "Perfect" Storm 1991
2/7/1978
1/9/1978
3/16/1976
12/4/1990
4/7/1958
4/16/2007
2/19/1972
6/5/2012
6/3/2012
12/29/1959
11/30/1944
1/2/1987
11/20/1945
4/18/2007
1/28/1979
1/2/2010
1/21/2011
4/6/1977
3/4/1931
1/29/1979
11/2/1963
4/21/1940
2/10/2005
1/20/1961
1/3/2010
10/30/1991
Date of Event

Sea Level and Storm Surge Summaries

- Latest scientific predictions for SLR: 1 ft 2050, 2-3 ft *but potentially more* by 2100; the **State of Maine has adopted 2 feet as a middle of the road prediction by the year 2100 for areas with regulated Coastal Sand Dunes**.
- There is only about a one foot difference between the "10 year" event and the "100 year" event ; thus, **a one-foot rise in sea level by 2050 would cause the "100 year" event to come about every 10 years because sea level rise significantly lowers the recurrence interval of storms.**
- For vulnerability and adaptation planning, we recommend using a "Scenario Based Approach" using 1 foot, 2 feet, 3.3 feet, and 6 feet on top of the highest annual tide (HAT). **These scenarios also correspond well with evaluating *potential impacts from storm surges that may coincide with higher tides today.***

Sea Level Rise Planning in Maine…

United States Environmental Protection Agency | Policy, Planning, And Evaluation (2122) | EPA-230-R-95-900 September 1995

EPA

Anticipatory Planning For Sea-Level Rise Along The Coast of Maine

This report a joint effort in cooperation with State of Maine's State Planning Office.

On the right track…

in 1995!

But it was never engaged at the local level

So it ended up shelved in the archives.

More reports…and updated sea level regulations

2006 - As the result of a 2 year stakeholder process, Maine adopted 2 feet of sea level rise over the next 100 years, which was a "middle-of-the road" prediction for global sea level rise, into its NRPA.

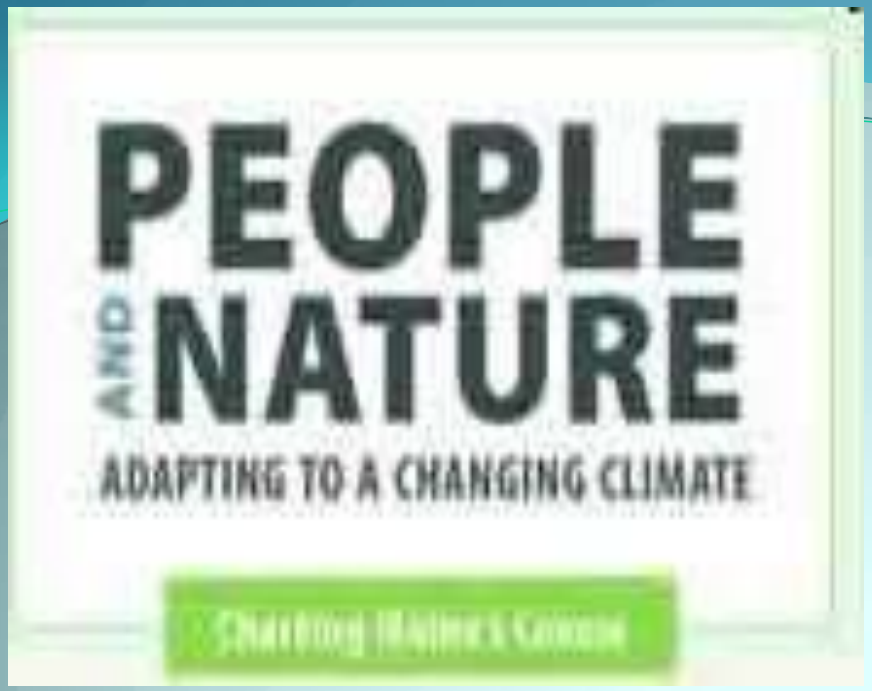
P.A. Slovinsky, MGS

Protecting Maine's Beaches for the Future

A Proposal to Create an Integrated Beach Management Program

A Report of the Beach Stakeholder's Group
to the Joint Standing Committee on Natural Resources
122nd Maine Legislature, 2nd Regular Session

February 2006



Even More recently…

Working Groups:

Built Environment
Coastal Environment
Natural Environment
Social Environment

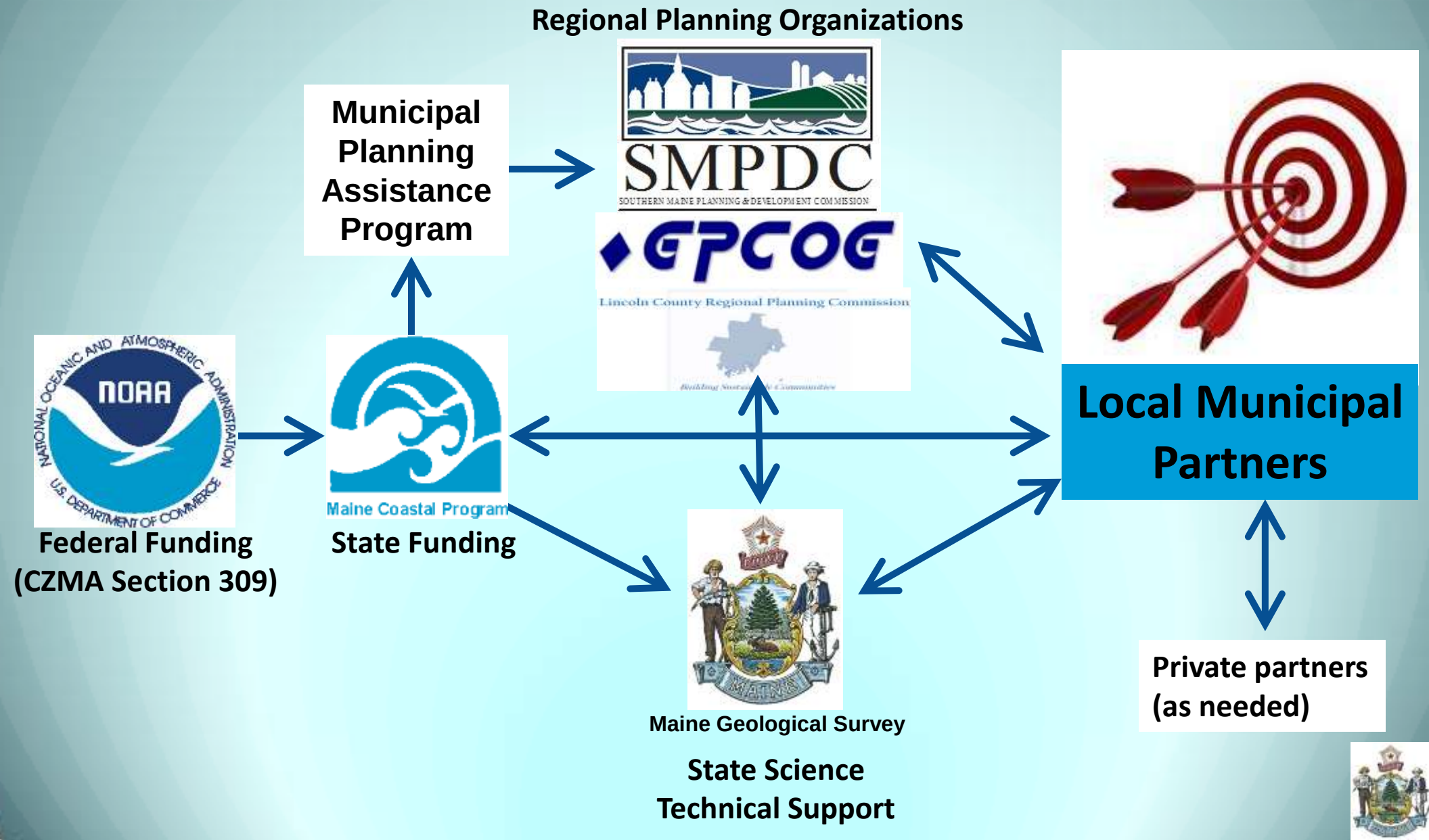
- Year-long Stakeholder Process led to the production of a report in early 2010.
- Major recommendations related to ***bringing tools, models, and technical data to the local decision-making level relating to sea level rise planning.***

Resolves, Chapter 16, LD 460, "Resolve, To Evaluate Climate Change Adaptation Options for the State"

Bringing it down to the local level

Proactive Engagement

Coastal Hazard and Resiliency Tools (CHRT) Project



Some Efforts I will highlight today (there are many!):

Coastal Hazard Resiliency Tools (CHRT) Project)

- Sea Level Adaptation Working Group (SLAWG)
- Lincoln County Regional Study Effort

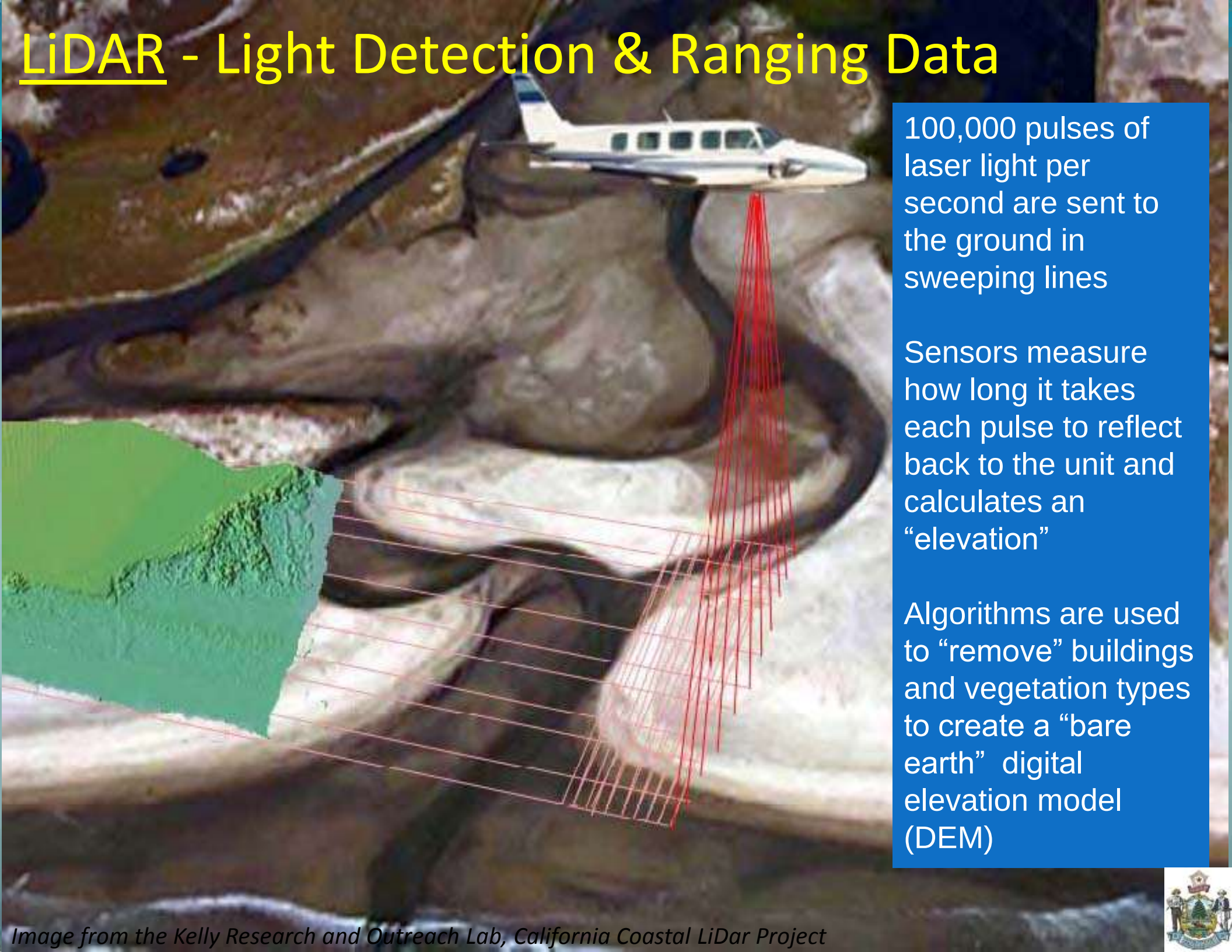
Marsh Migration Studies (EPA and NOAA funded efforts)

Transferable “Low Hanging Fruit” Strategies

Assemble Vulnerability Assessment Data

- Need adequate, *ground-truthed* LiDAR data coverage
- Sea Level Rise Scenarios (we typically have used a "scenario based approach", so 1, 2, 3, 6 feet by 2100)
- Data supporting storm elevations (i.e., effective "100-year" storm Flood Insurance Study data or other data)
- Data supporting natural feature mapping and simulation of SLR impacts (we use NOS tidal stations and VDATUM tool)
- Data supporting "assets at risk" (GIS layers from state, local sources, and others)

LiDAR - Light Detection & Ranging Data

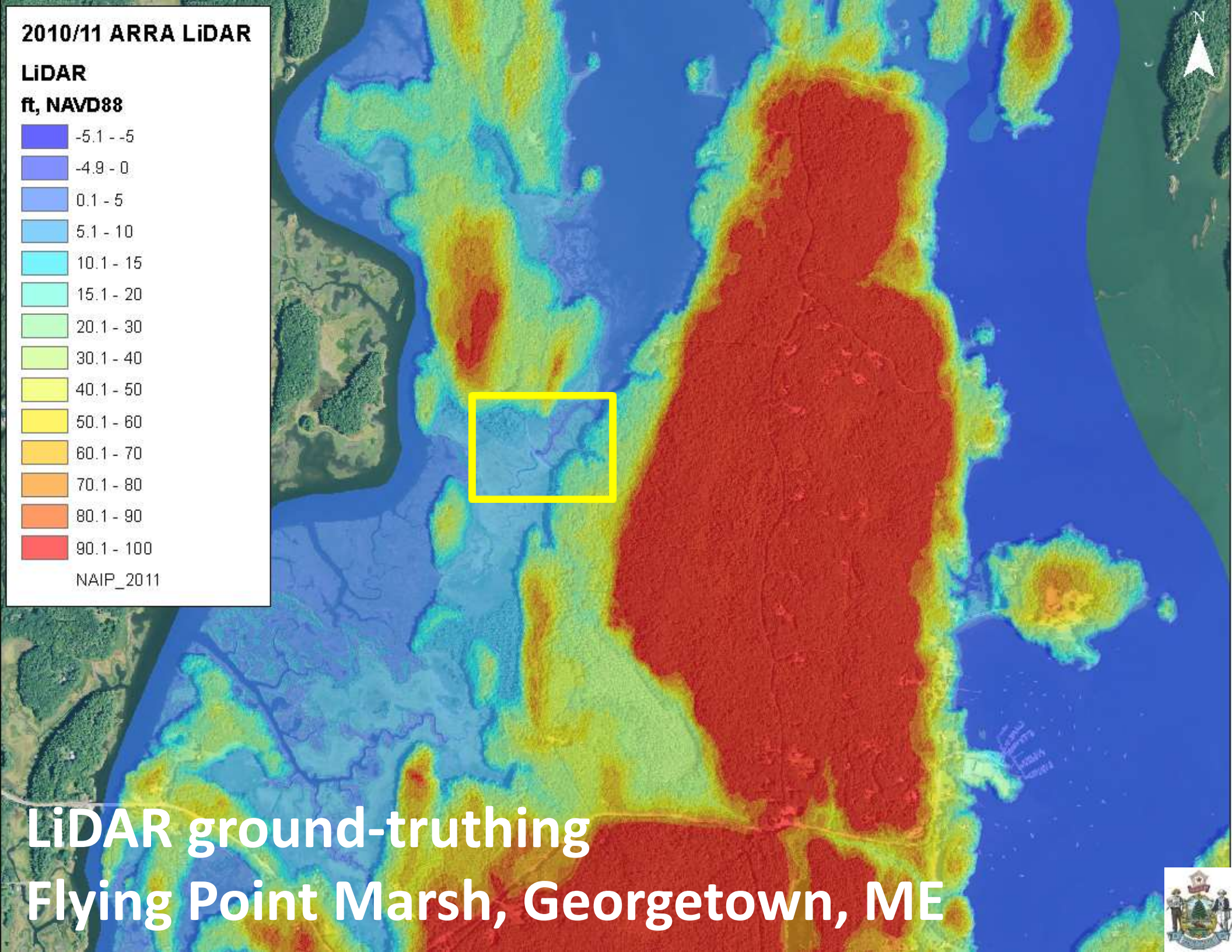


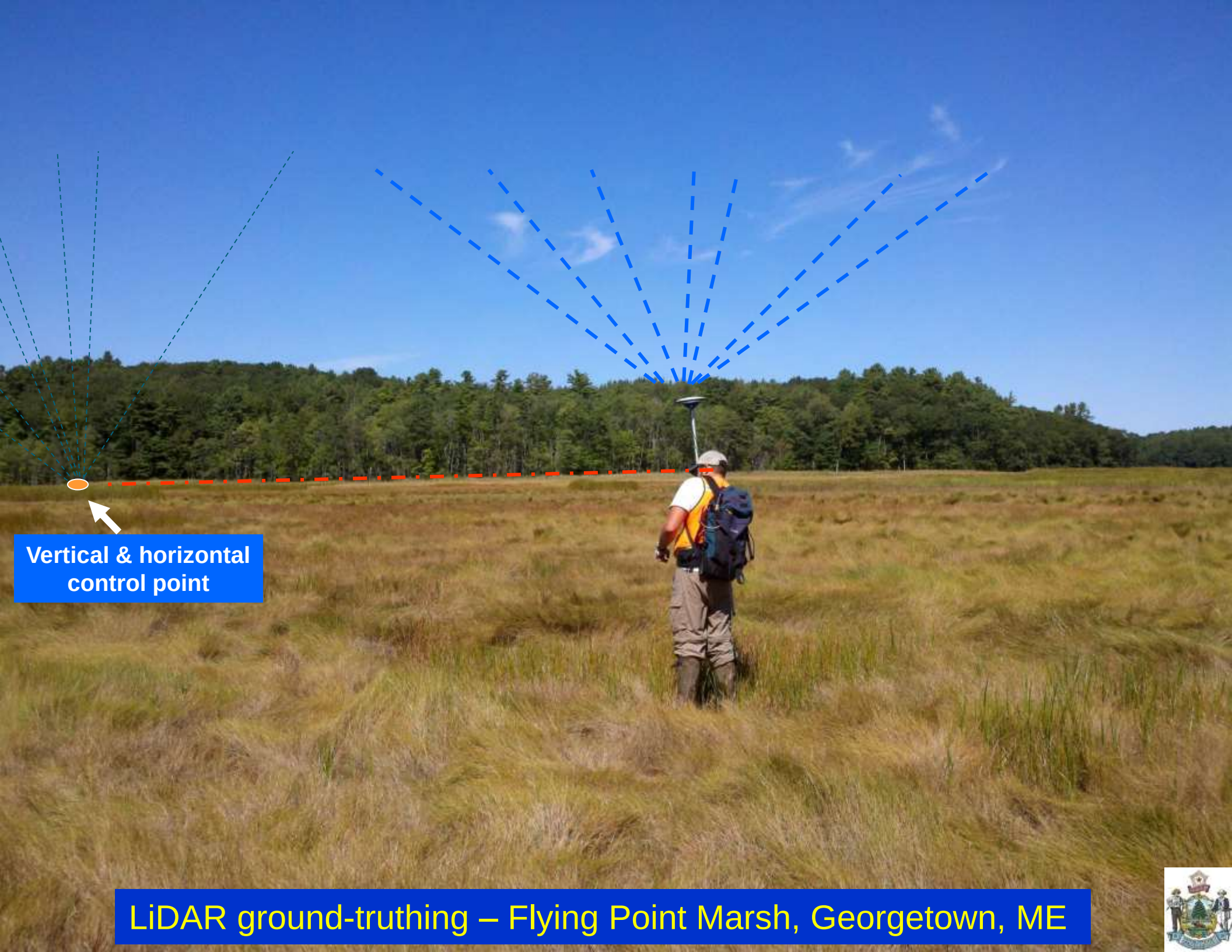
100,000 pulses of laser light per second are sent to the ground in sweeping lines

Sensors measure how long it takes each pulse to reflect back to the unit and calculates an "elevation"

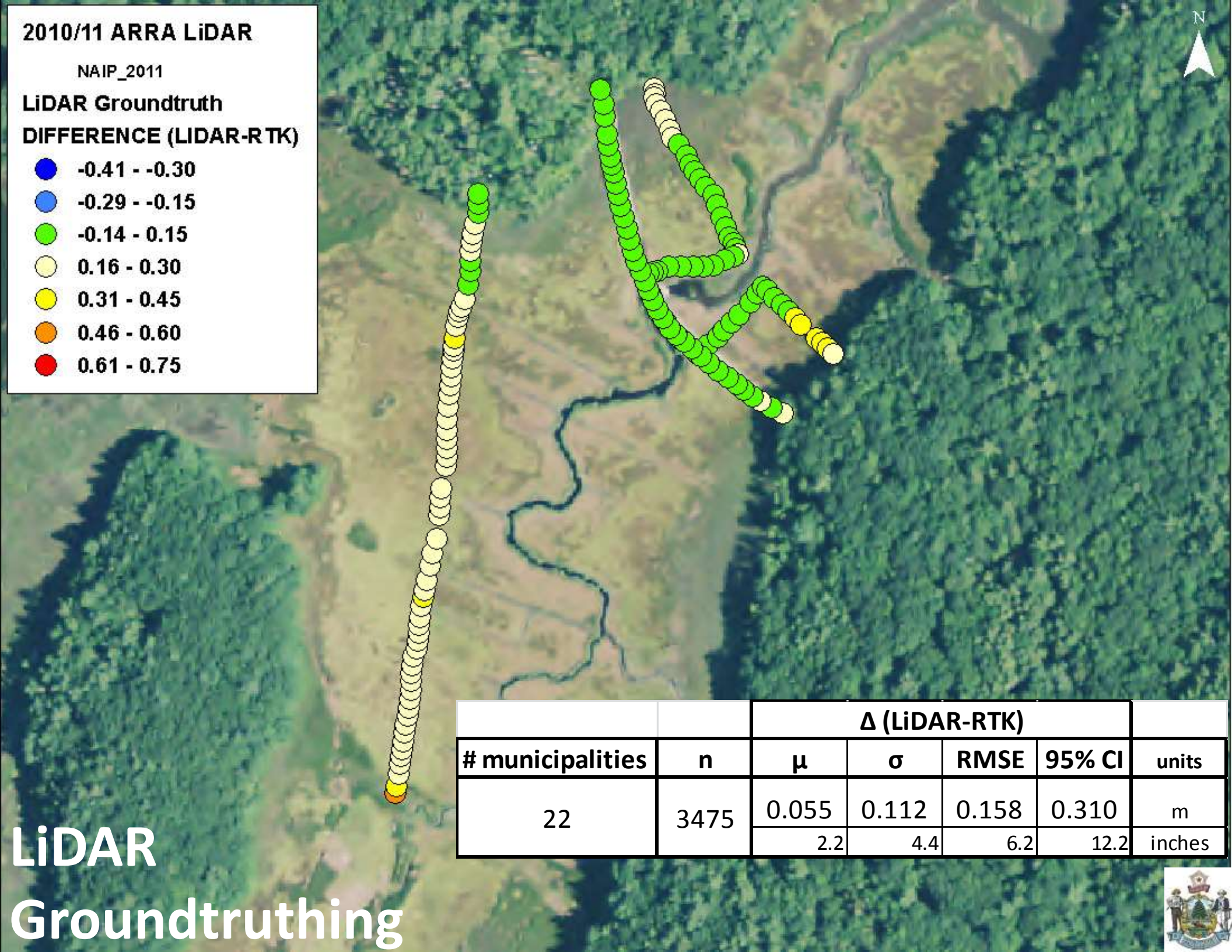
Algorithms are used to "remove" buildings and vegetation types to create a "bare earth" digital elevation model (DEM)

Image from the Kelly Research and Outreach Lab, California Coastal LiDar Project


2010/11 ARRA LiDAR
LiDAR
ft, NAVD88
-5.1 - -5
-4.9 - 0
0.1 - 5
5.1 - 10
10.1 - 15
15.1 - 20
20.1 - 30
30.1 - 40
40.1 - 50
50.1 - 60
60.1 - 70
70.1 - 80
80.1 - 90
90.1 - 100
NAIP_2011
N
LiDAR ground-truthing
Flying Point Marsh, Georgetown, ME



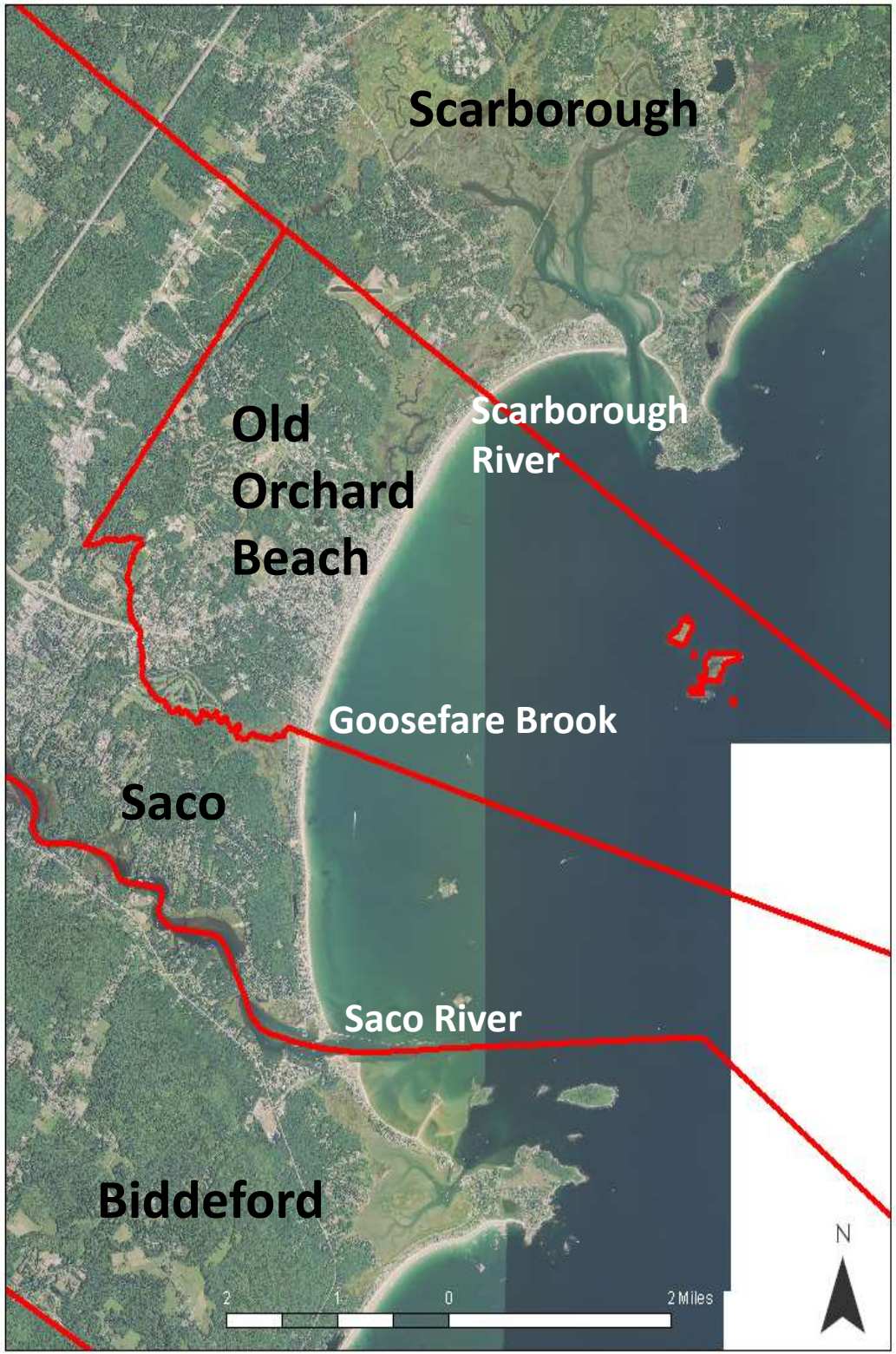
LiDAR ground-truthing – Flying Point Marsh, Georgetown, ME



		Δ (LiDAR-RTK)				
# municipalities	n	μ	σ	RMSE	95% CI	units
22	3475	0.055	0.112	0.158	0.310	m
		2.2	4.4	6.2	12.2	inches

LiDAR Groundtruthing

So now that we know our data is acceptable, how do we simulate potential impacts of SLR and storms to the built environment?



Saco Bay Sea Level Adaptation Working Group

Local Participation:

Planning, Science, Technical Support:

SMPDC
SOUTHERN MAINE PLANNING & DEVELOPMENT COMMISSION

Maine Geological Survey

Additional Support Funding:

Maine Coastal Program

Sea Level Adaptation Working Group

The Process to Legitimacy…

Formation of a Steering Committee (2010)

- Developed an ***Interlocal Agreement*** outlining the creation of a Working Group and its potential duties and action plan.
- Received approval from each municipal council.
- Funded by state Regional Challenge Grant (MCP) and local matches

Working Group (2010-current)

- Comprised of municipal planners and an assigned citizen-at-large member from each community; an SMRPC planner and technical support from MGS.
- Completed a ***Vulnerability Assessment*** and ***Action Plan*** that were submitted to municipal councils for approval.

Sea Level Rise
And Potential Impacts by the Year 2100

A Vulnerability Assessment
for the Saco Bay Communities of
Biddeford, Saco, Old Orchard Beach, and Scarborough

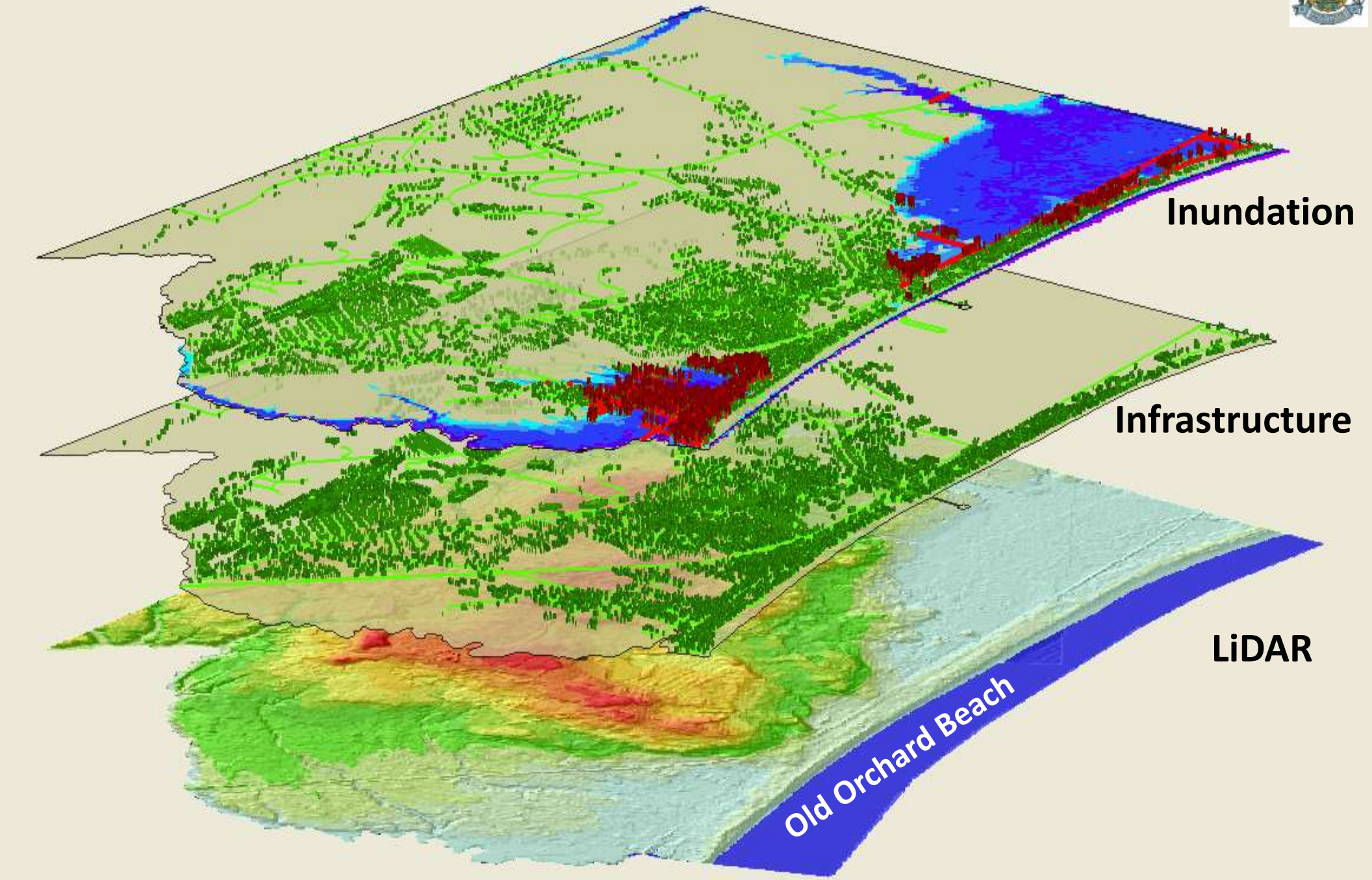
A Report of the Sea Level Adaptation Working Group
Original Report December 31, 2010
Revised May 4, 2011
With the Assistance of the
Maine Department of Conservation – Maine Geological Survey
and the
Southern Maine Regional Planning Commission
With Funding from the Maine State Planning Office & Maine Coastal Program
NOAA Grant Number NA09NOS4190081
and the Participating Partner Communities

The first effort: SLAWG Assessment

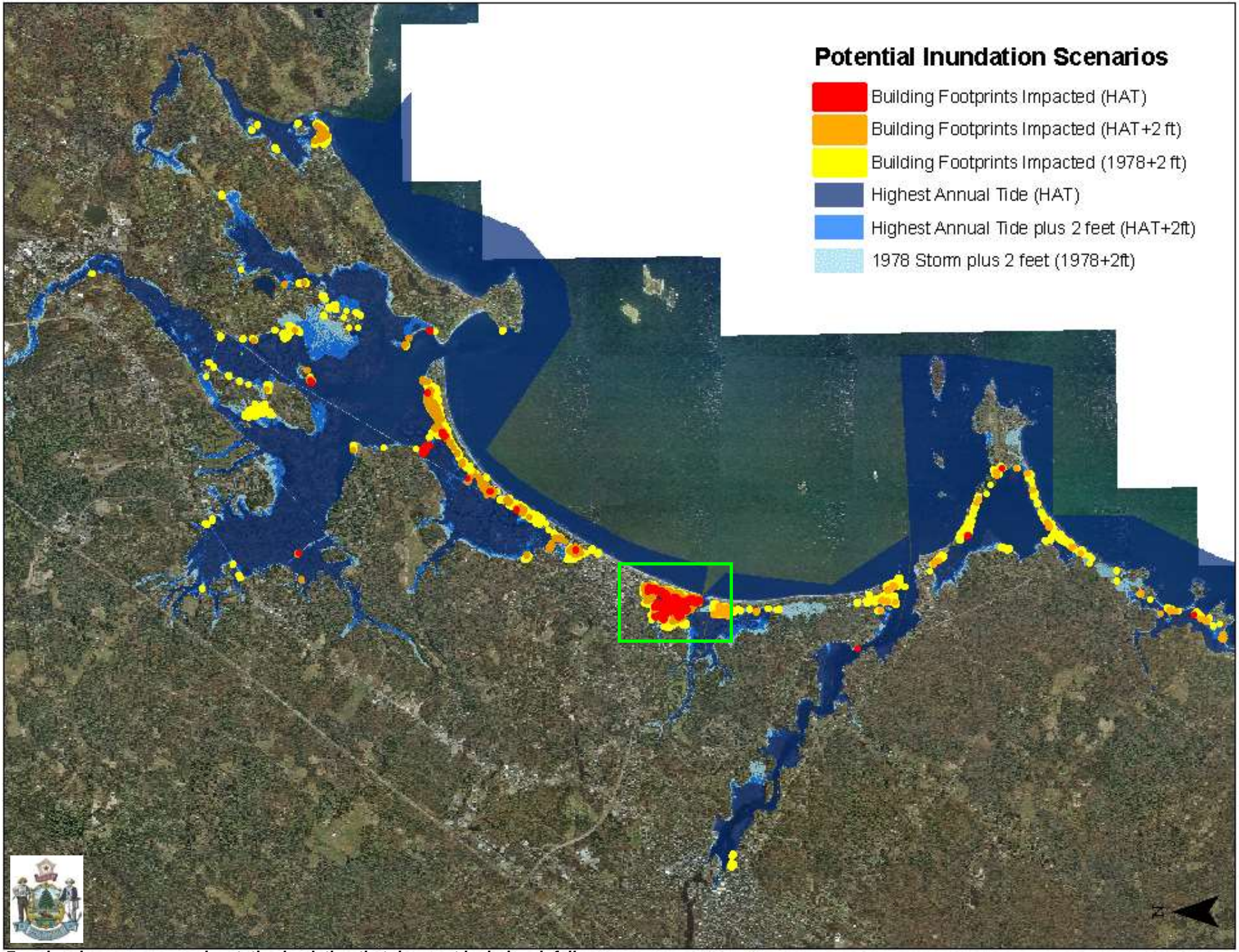
Vulnerability Assessment of the built and natural environments to 2 feet of SLR (agreed upon by the Group) on top of the Highest Annual Tide (HAT) and the historic 1% ("100-year") storm event (February 7, 1978 storm) for each community in Saco Bay.

Identified potentially vulnerable buildings, transportation infrastructure, and wetland migration areas.

Focus: GIS-based visualizations



Data and tools *critical to communicating coastal vulnerability*



For planning purposes only; static simulation that does not include rainfall, waves, or runup.

Visualizing Inundation Depths
HAT+ 2 feet SLR
Almost equal to the Patriots' Day Storm

For preliminary planning purposes only; no dynamic inundation is simulated along the open coast

Updating the original Vulnerability Assessment using a "Scenario Based" Approach

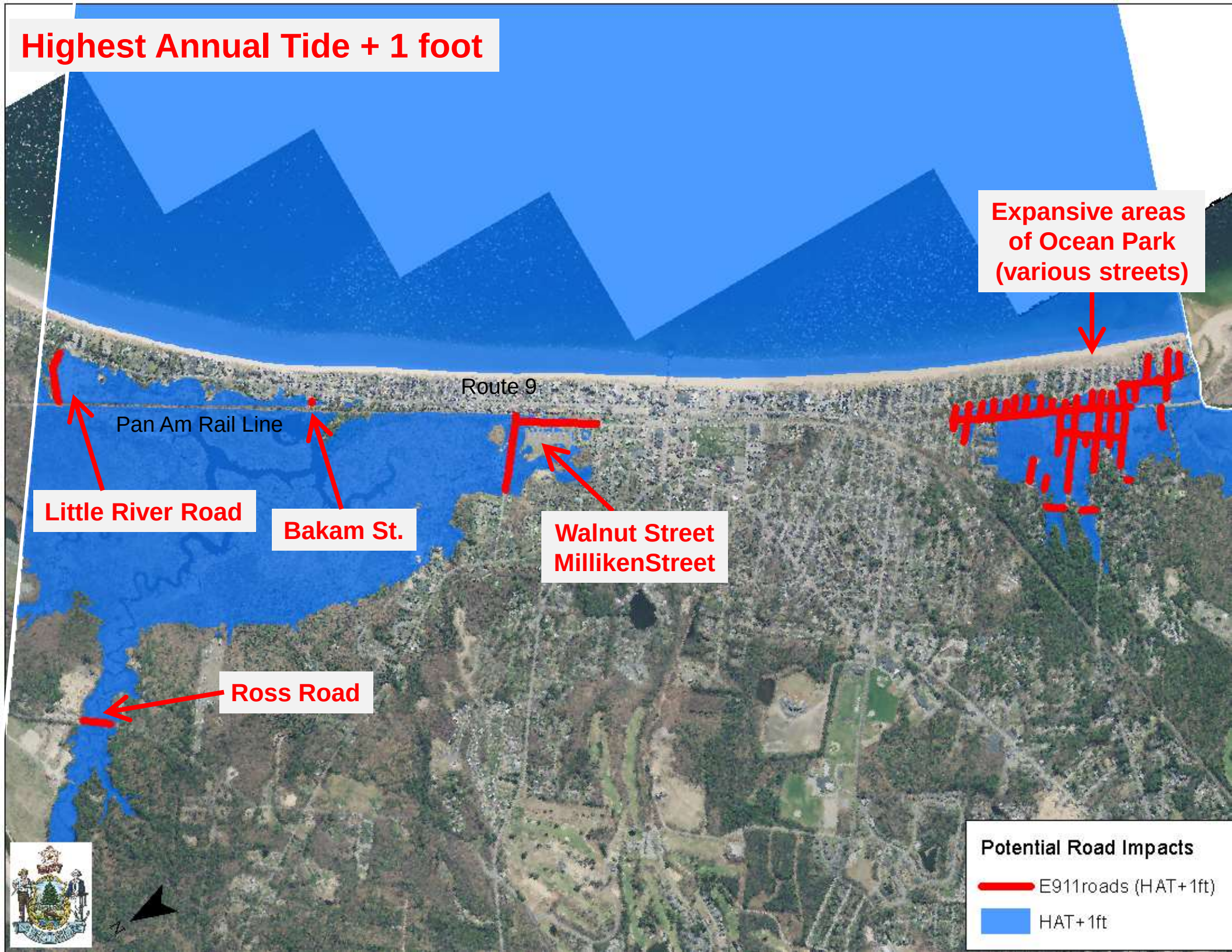
Scenario	Highest Annual	1% storm
Existing	11.5	14.1
0.3 m (1 foot) SLR	12.5	15.1
0.6 m (2 feet) SLR	13.5	16.1
1.0 m (3.3 feet) SLR	14.8	17.4
1.8 m (6.0 feet) SLR	17.5	20.1

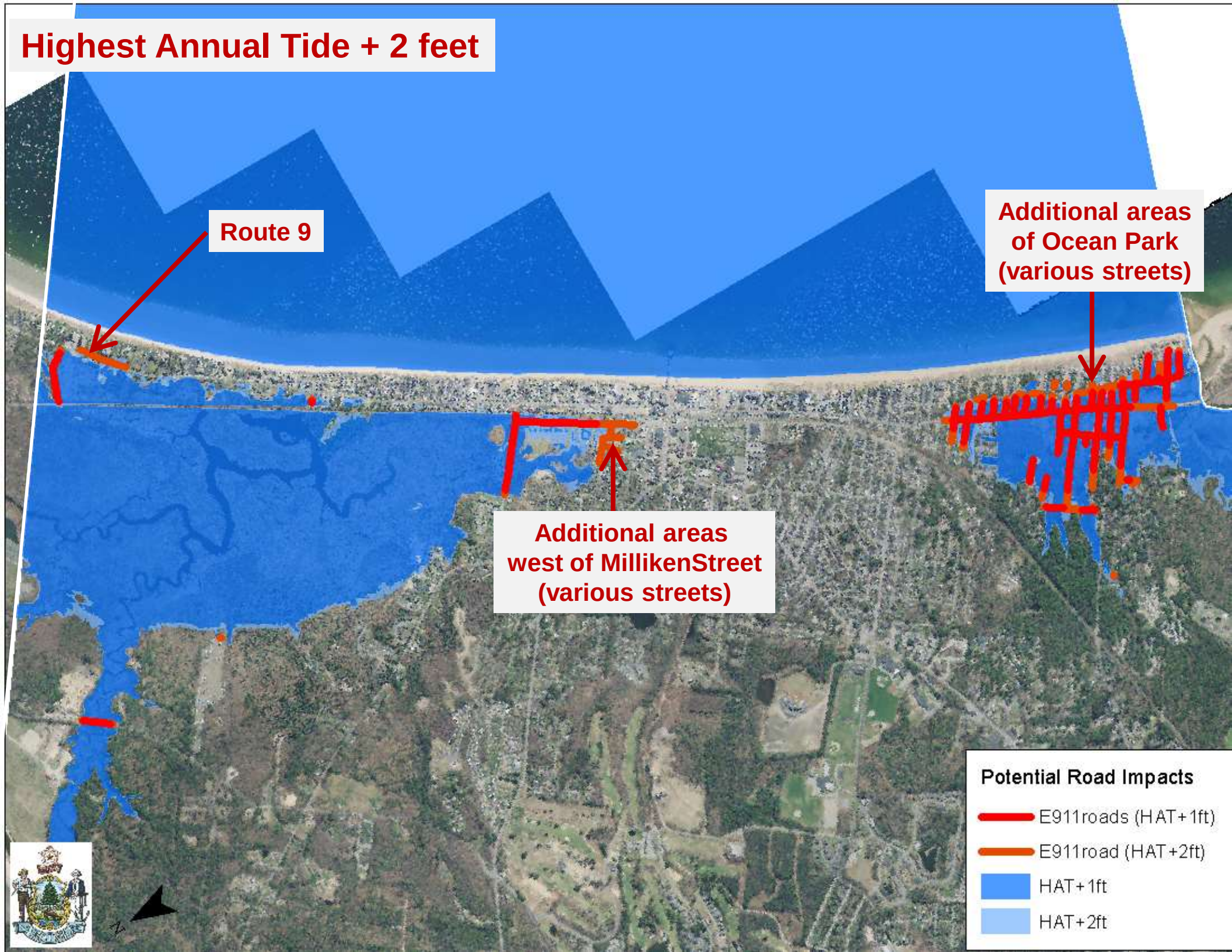
** data in feet, MLLW, mean lower low water*

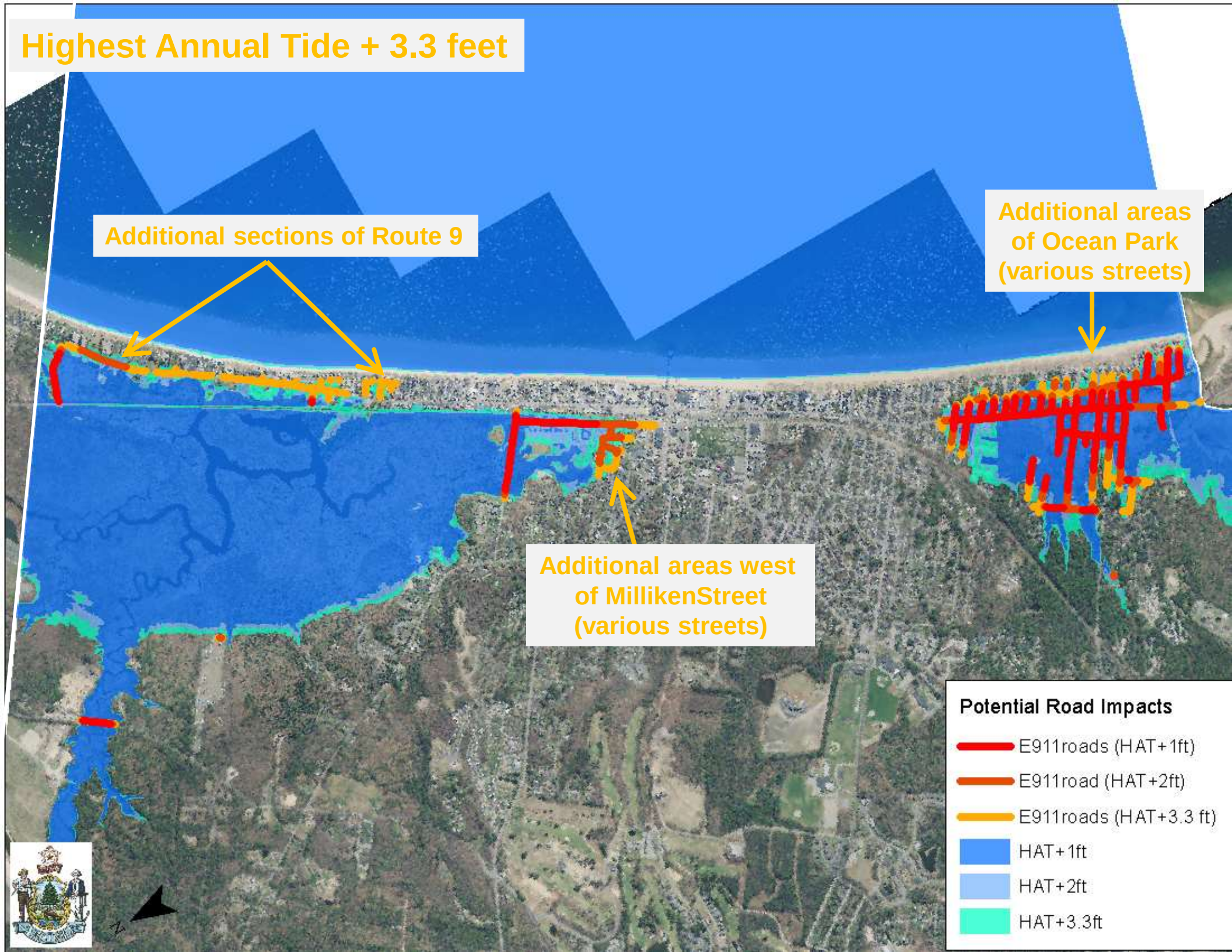
*** data converted from NAVD88-MLLW using NOAA VDATUM tool*

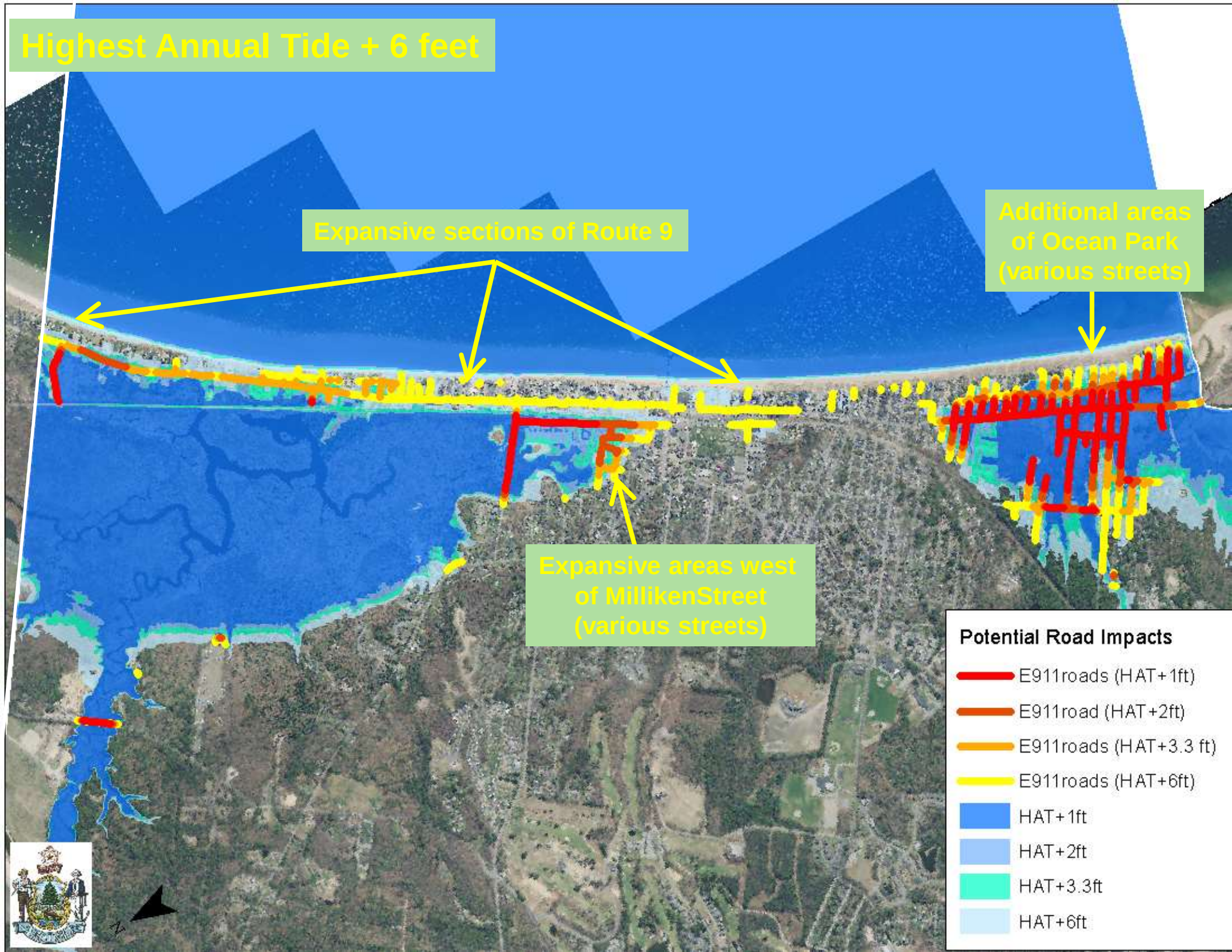
Image courtesy of Bill Edwards

Potential Impacts to Transportation Infrastructure


Highest Annual Tide + 1 foot
Expansive areas of Ocean Park (various streets)
Route 9
Pan Am Rail Line
Little River Road
Bakam St.
Walnut Street
MillikenStreet
Ross Road
Potential Road Impacts
E911roads (HAT+1ft)
HAT+1ft


Highest Annual Tide + 2 feet
Route 9
Additional areas of Ocean Park (various streets)
Additional areas west of MillikenStreet (various streets)
Potential Road Impacts
E911roads (HAT+1ft)
E911road (HAT+2ft)
HAT+1ft
HAT+2ft


Highest Annual Tide + 3.3 feet
Additional sections of Route 9
Additional areas of Ocean Park (various streets)
Additional areas west of MillikenStreet (various streets)
Potential Road Impacts
E911roads (HAT+1ft)
E911road (HAT+2ft)
E911roads (HAT+3.3 ft)
HAT+1ft
HAT+2ft
HAT+3.3ft


Highest Annual Tide + 6 feet
Expansive sections of Route 9
Additional areas of Ocean Park (various streets)
Expansive areas west of MillikenStreet (various streets)
Potential Road Impacts
E911roads (HAT+1ft)
E911road (HAT+2ft)
E911roads (HAT+3.3 ft)
E911roads (HAT+6ft)
HAT+1ft
HAT+2ft
HAT+3.3ft
HAT+6ft

Summary Table – Potential Impacts to Road Infrastructure

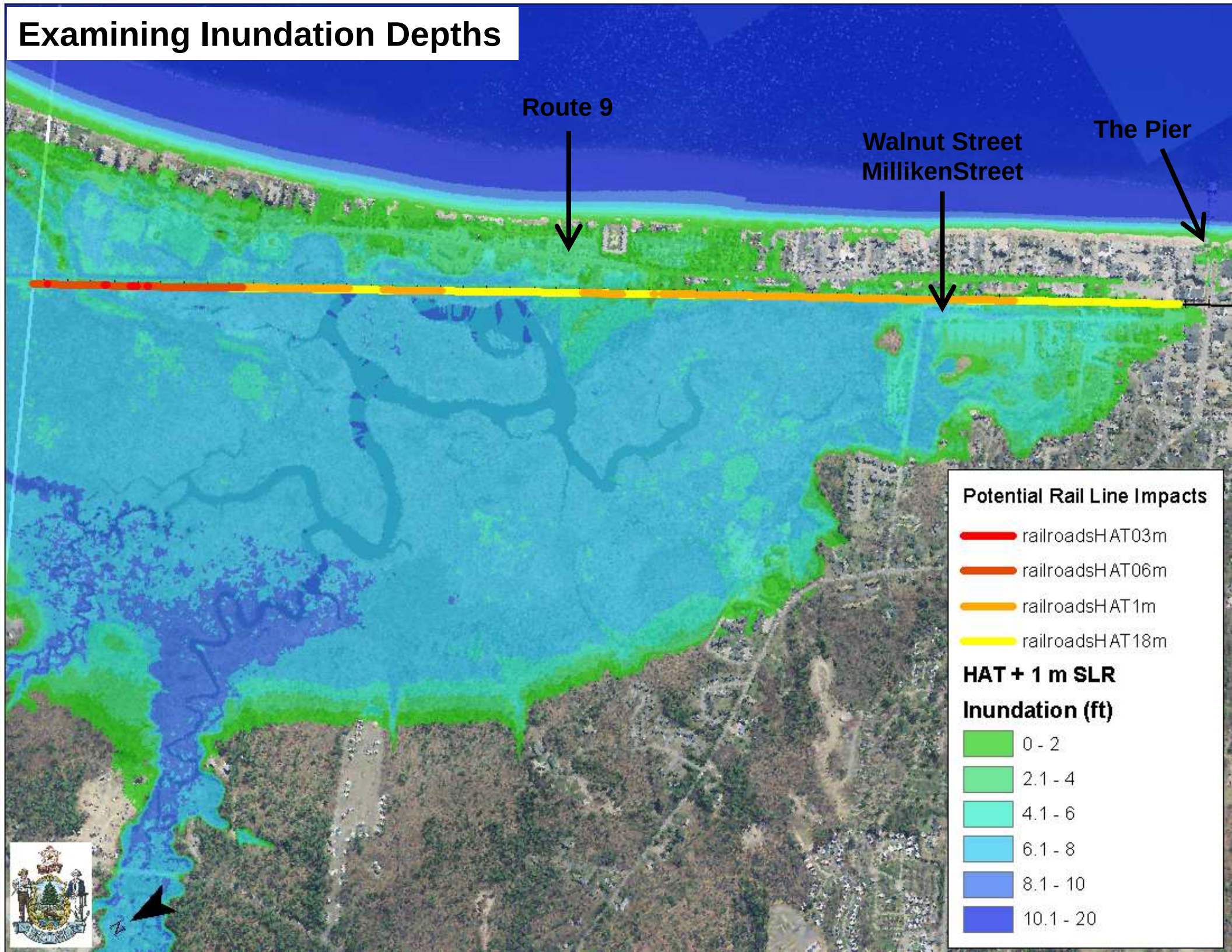
Scenario (HAT)	Infrastructure (miles)	
	Roads (66.8)	% impacted
0.3 m (1 foot) SLR	3.3	4.9%
0.6 m (2 feet) SLR	4.8	7.2%
1.0 m (3.3 feet) SLR	6.9	10.3%
1.8 m (6.0 feet) SLR	11.2	16.8%

Take home point: Some of Old Orchard Beach's major transportation routes including designated evacuation routes are vulnerable under *1-2 ft scenarios* of SLR or storm surge on top of the highest tide.

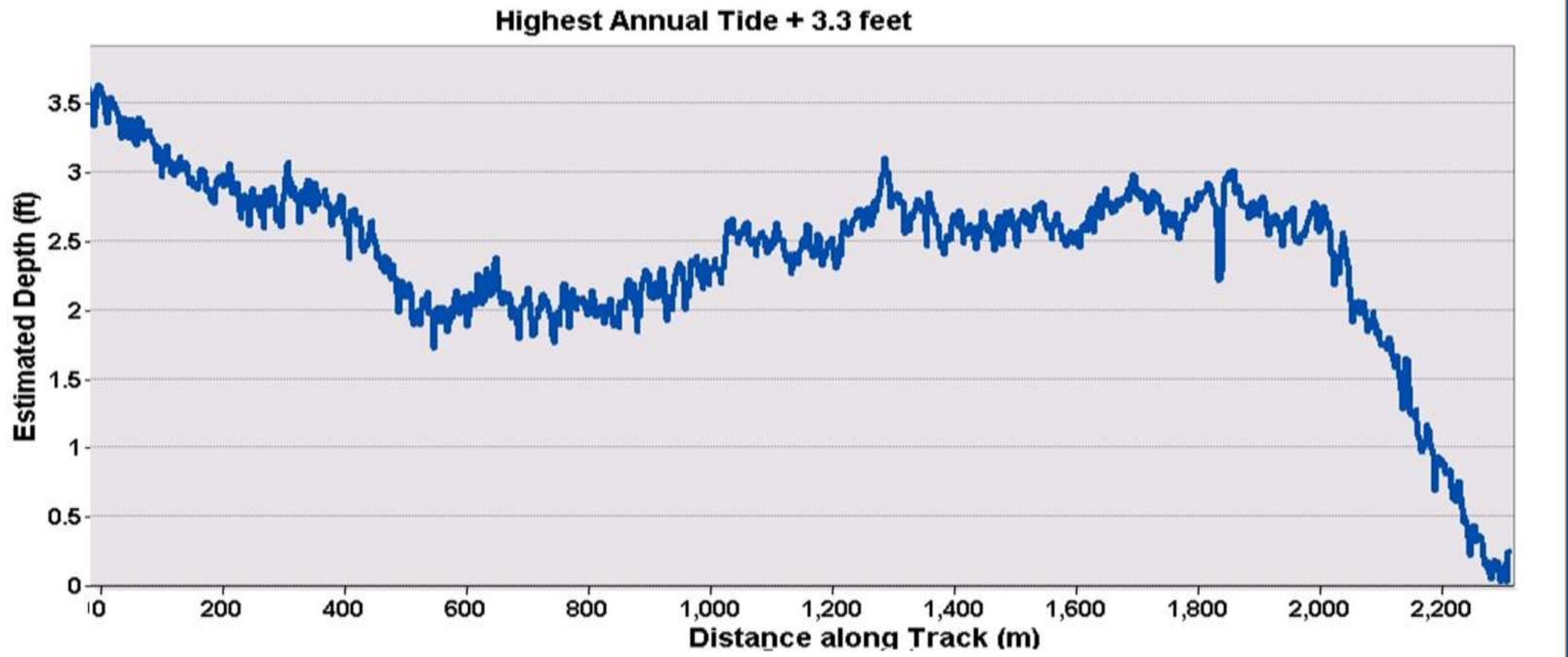
Potential impacts of SLR and storm scenarios to the PanAm Rail Line in Old Orchard Beach

Wikipedia.com

Examining Inundation Depths



Examining Inundation Depths (Highest Tide + 3.3 feet)



Summary Table – Potential Impacts to Rail Infrastructure

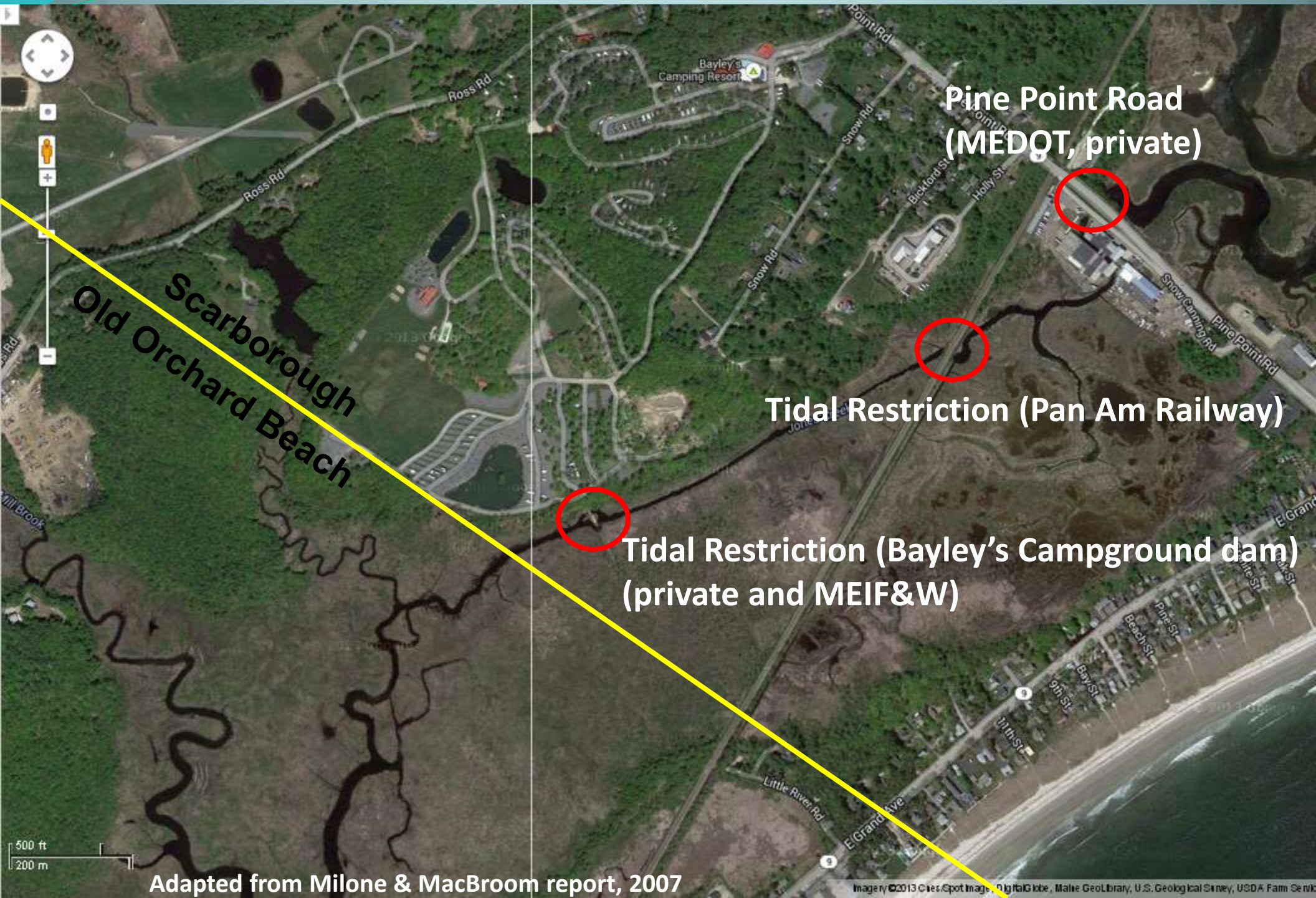
Scenario (HAT)	Infrastructure (miles)	
	Rails (10.5)	% impacted
Existing Conditions	0.0	0%
0.3 m (1 foot) SLR	0.0	0%
0.6 m (2 feet) SLR	0.3	6%
1.0 m (3.3 feet) SLR	1.1	22%
1.8 m (6.0 feet) SLR	1.7	35%

Take home point: The rail line will likely start to see significant potential impacts under 1 meter rise or surge at the time of highest tides in OOB.

So what is SLAWG doing now?

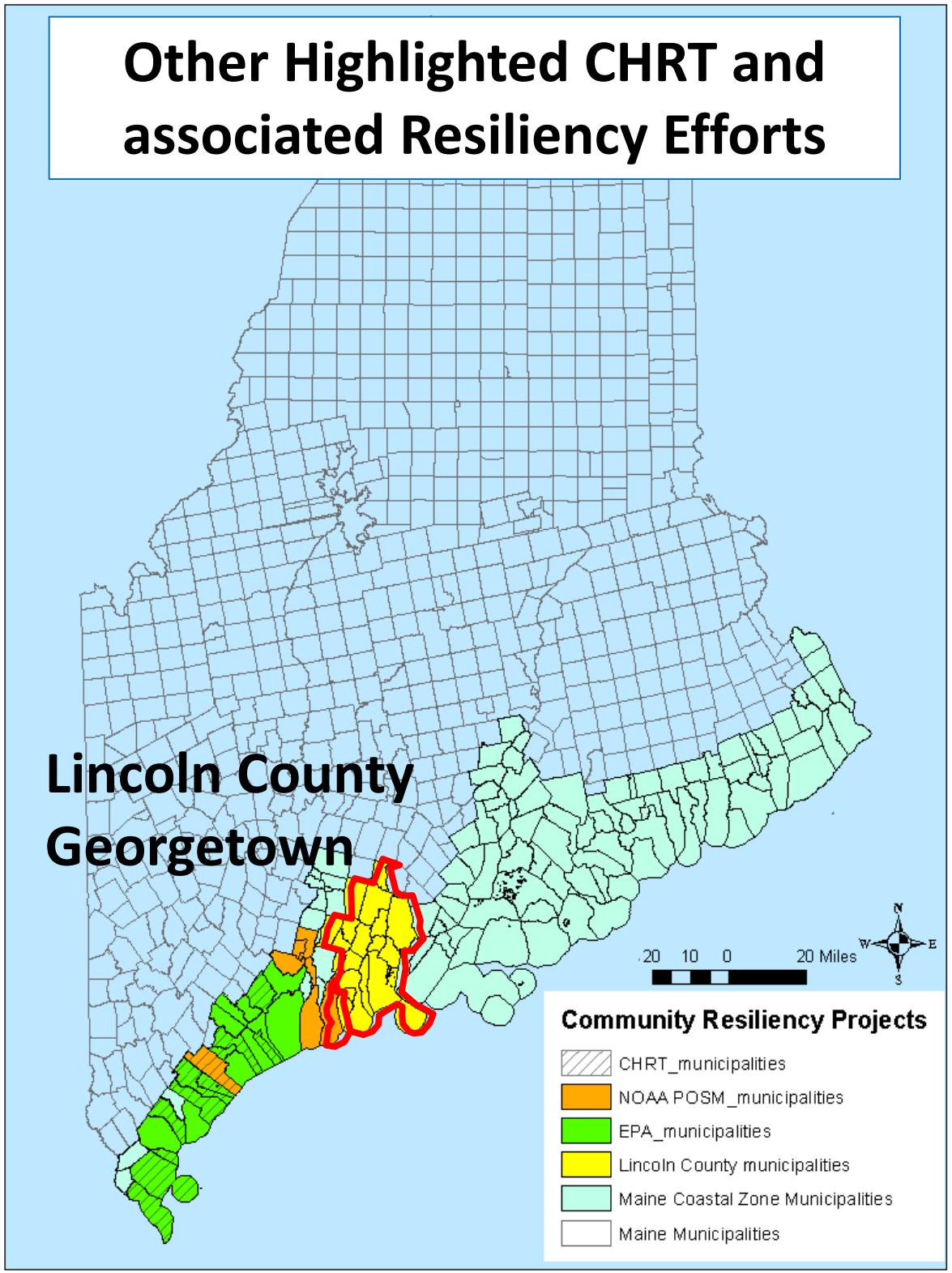
- Using “scenario based approach” Vulnerability Assessment results in conjunction with an **infrastructure criticality matrix to pinpoint critical transportation impacts** in each community
- Engaging with **community DPWs** to get a better handle on viable adaptation strategies for identified critical roads
- Working to start the conversation on how to address **identified regional issues** between Towns and private and state parties (i.e., Scarborough and Old Orchard from the 2007 Milone & MacBroom Report)

A Regional Approach to Tidal Restrictions?



Adapted from Milone & MacBroom report, 2007

Other Highlighted CHRT and associated Resiliency Efforts



Coastal Hazard Resilience

Marsh Migration

Emergency Management

MORE INFORMATION

» Return to Homepage

BUSINESS DIRECTORY

UPCOMING DEADLINES

There are no deadlines at this time.

EVENTS

08.19 | August Full Board Meeting
09.18 | September Executive Committee Meeting

CURRENT PROJECTS

Arts & Culture
GIS Subcommittee

Sea Level Rise Scenarios

LINCOLN COUNTY SEA LEVEL RISE

Lincoln County Sea Level Rise - Coastal Hazard Study

Lincoln County Regional Planning Commission
Lincoln County Commission
Maine Geological Survey
Maine Coastal Program

This presentation was prepared by the LCRPC under award NOAA CZM NA11NOS4190077 and NA11NOS4190188 to the Maine Coastal Program from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the National Oceanic and Atmospheric Administration or the Department of Commerce.

So how was this effort different than other CHRT efforts?

- **County-wide effort** undertaken by LCRPC solely for emergency management, education and outreach. Typical CHRT project engaged only at the local level

- Project designed to require only the affirmative vote of the county and the regional planning commission with the county providing the cash match. **Towns were not required to vote or provide funding** to participate since the project was viewed as a "county service" to its municipalities.

- Building footprint layer was created using LiDAR data

- Not **a single community had GIS capability**, hence the use of **GoogleEarth to disseminate products**

Identified Extremely Vulnerable Areas to 1, 2, 3.3 and 6 ft of SLR

Wiscasset Wastewater Treatment Plant

Downtown Damariscotta

MORE INFORMATION

» Return to Homepage

BUSINESS DIRECTORY

UPCOMING DEADLINES

09.27	Boating infrastructure Grant Program
10.04	MDOT Small Harbor Improvement Program
10.04	RFP for LCRPC Brownfield Assessment Grant
11.01	Maine Coastal Program's Shore and Harbor and Coastal Communities Grants

EVENTS

10.03	Health Insurance Forums
10.08	Forum to Focus on Visual Arts in the Community
10.15	LCRPC October Full Board Meeting

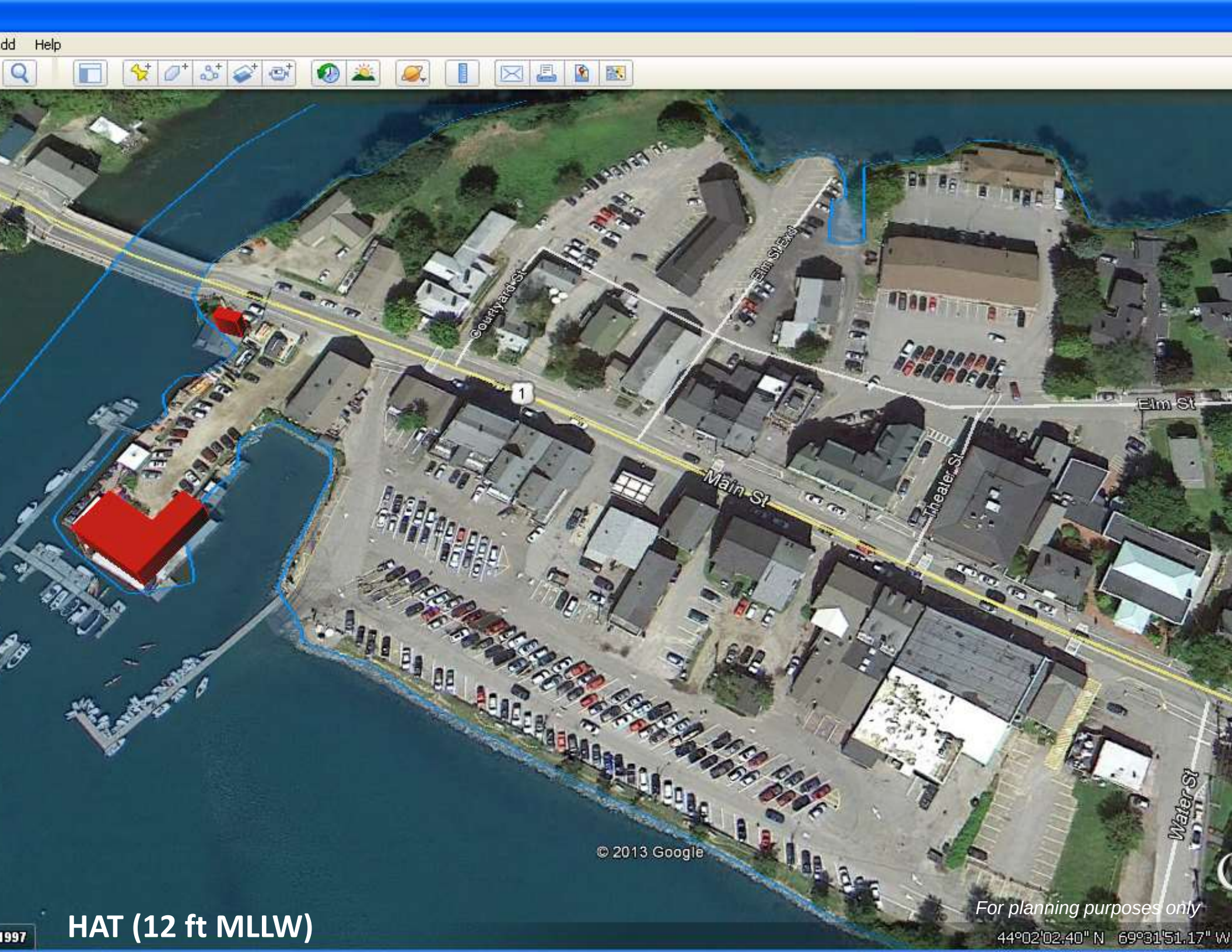
DAMARISCOTTA SEA LEVEL RISE SCENARIOS

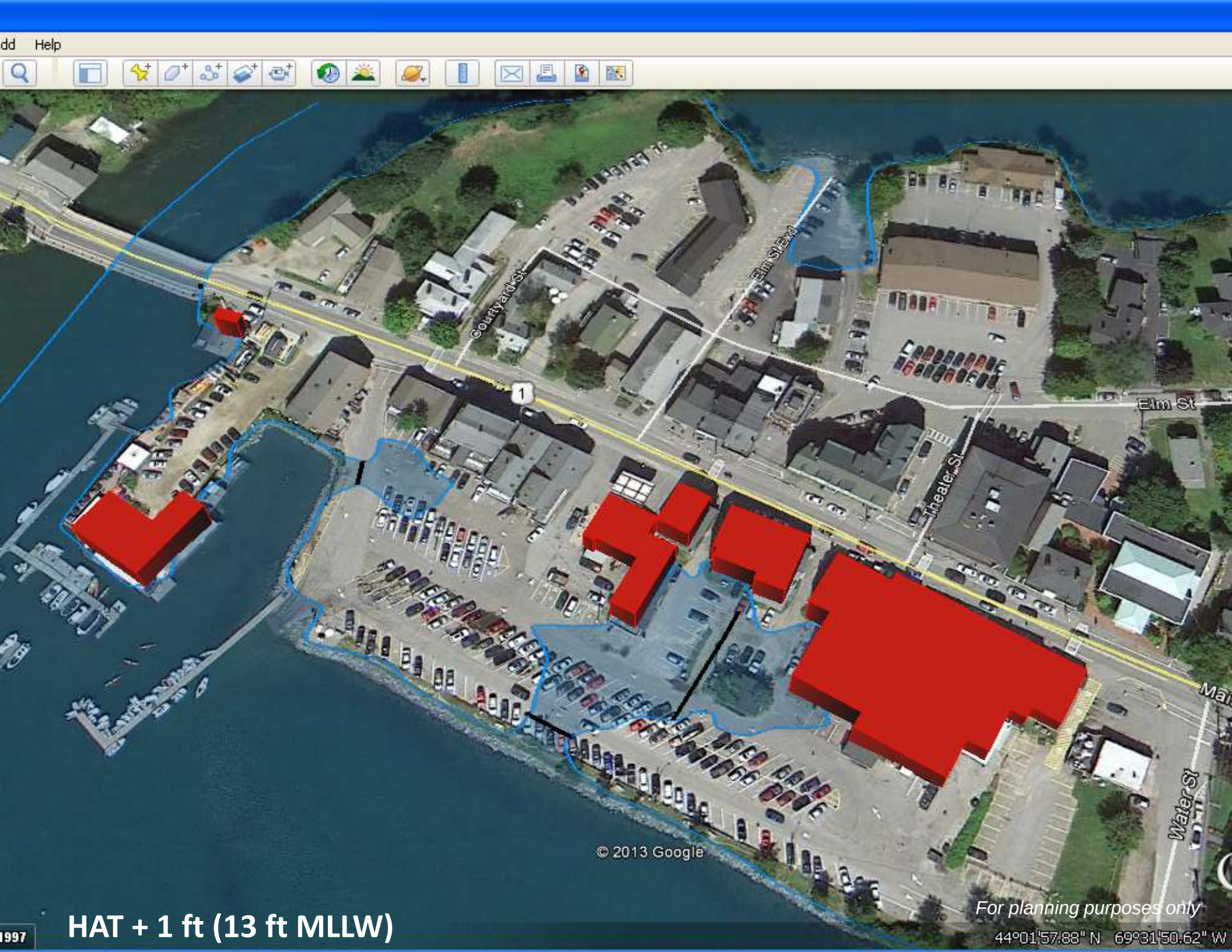
The following scenarios were developed by the Maine Geological Survey in conjunction with the Lincoln County Regional Planning Commission for general planning purposes only. They are based on a "bathtub" simulation model and do not take into account impacts associated with erosion, accretion, or wave action. Though local, regional, and national data indicates that sea level is continuing to rise, scientific authorities cannot predict with certainty the precise increase that will be experienced along Lincoln County's tidal shoreline. Communities are advised to consider the information provided by this project as part of a "scenario-based approach" and create adaption strategies to mitigate impacts on natural systems, public infrastructure and facilities and existing and future development.

Please note the following when viewing the scenarios:

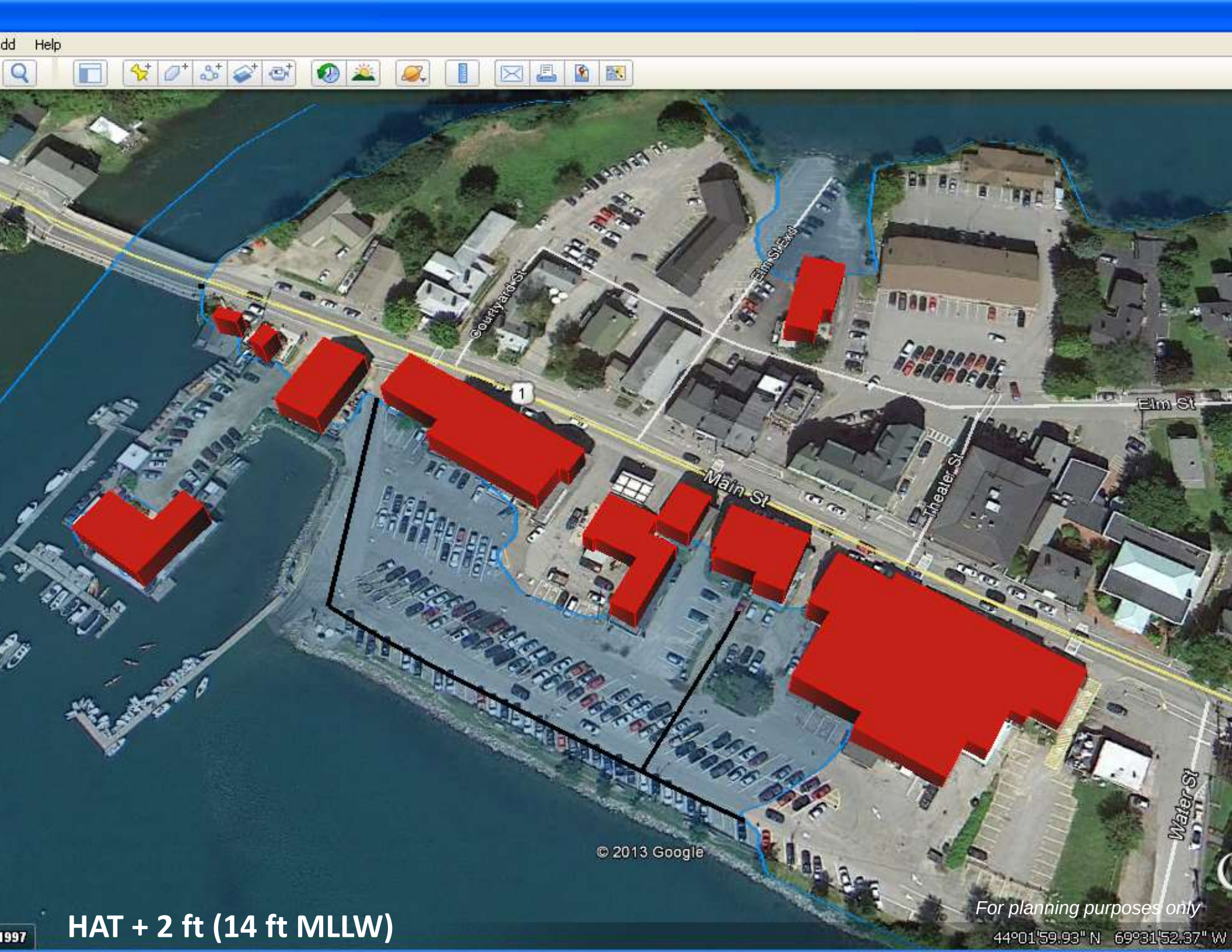
· When a road segment or a rail line is predicted to become inundated it is usually highlighted in black or gray. On occasion the highlighting may be absent so the best indicator of inundation is whether water is shown crossing a road or rail line.

· Buildings are highlighted in red when water is predicted to be present at the building's foundation during a given scenario. The scenarios themselves do not present information on the depth of water, only that some level of water is present at the building's foundation.

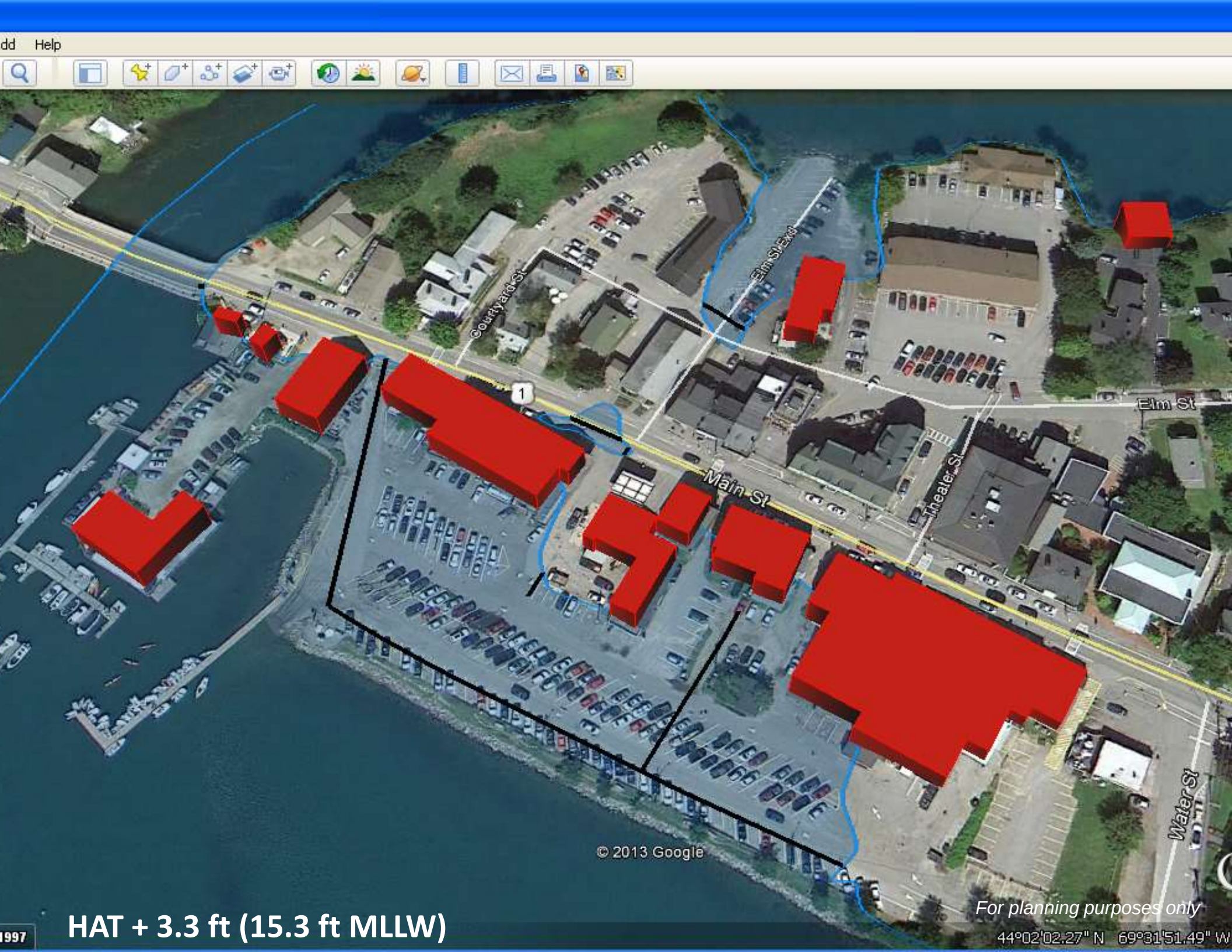

dd Help
Cottage St
Elm St Ext
1
Elm St
Main St
Theater St
Water St
© 2013 Google
For planning purposes only
44°02'02.40" N 69°31'51.17" W
1997
HAT (12 ft MLLW)

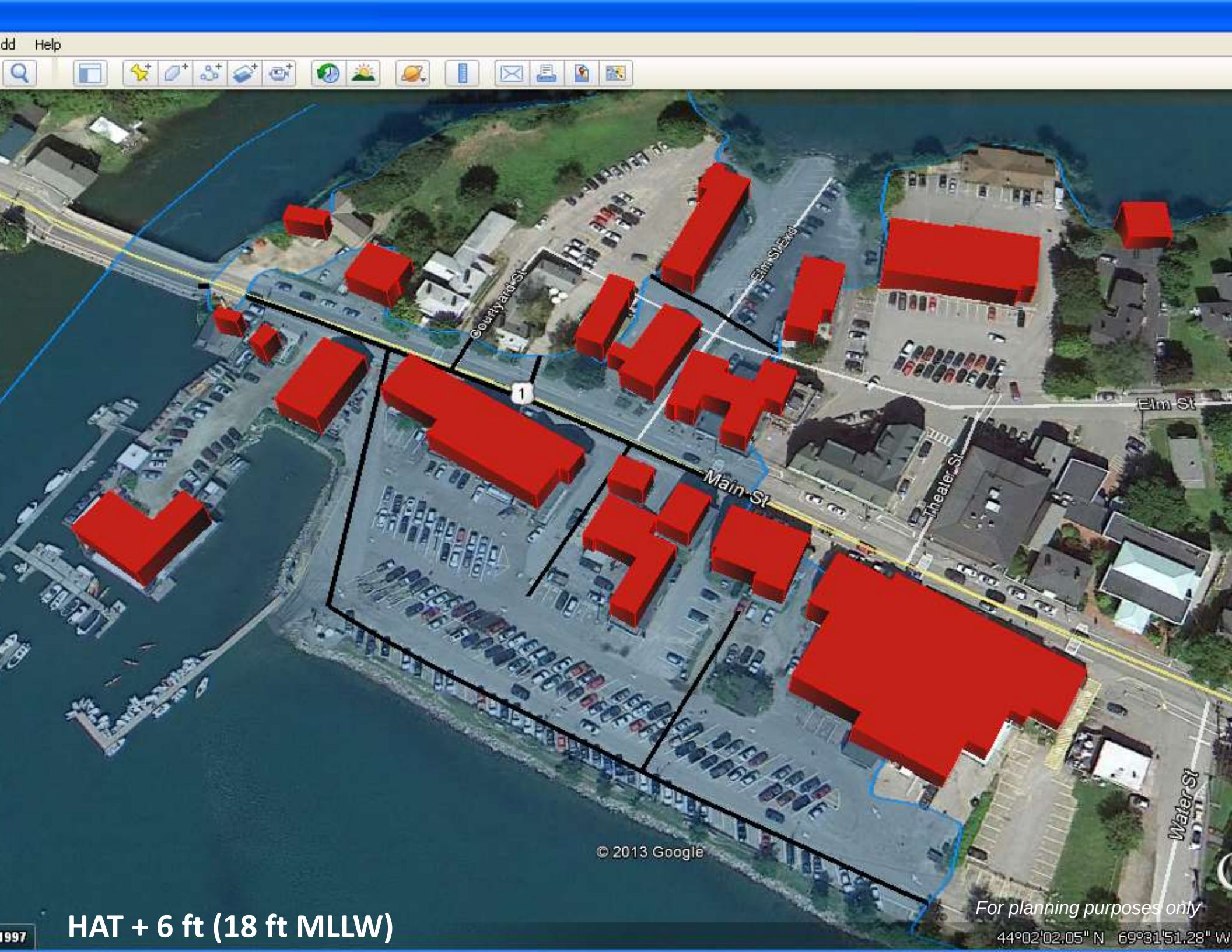


HAT + 1 ft (13 ft MLLW)



HAT + 2 ft (14 ft MLLW)


dd Help
Cottage St
Elm St Ext
Elm St
Theater St
Main St
1
© 2013 Google
Water St
For planning purposes only
HAT + 3.3 ft (15.3 ft MLLW)
1997
44°02'02.27" N 69°31'51.49" W

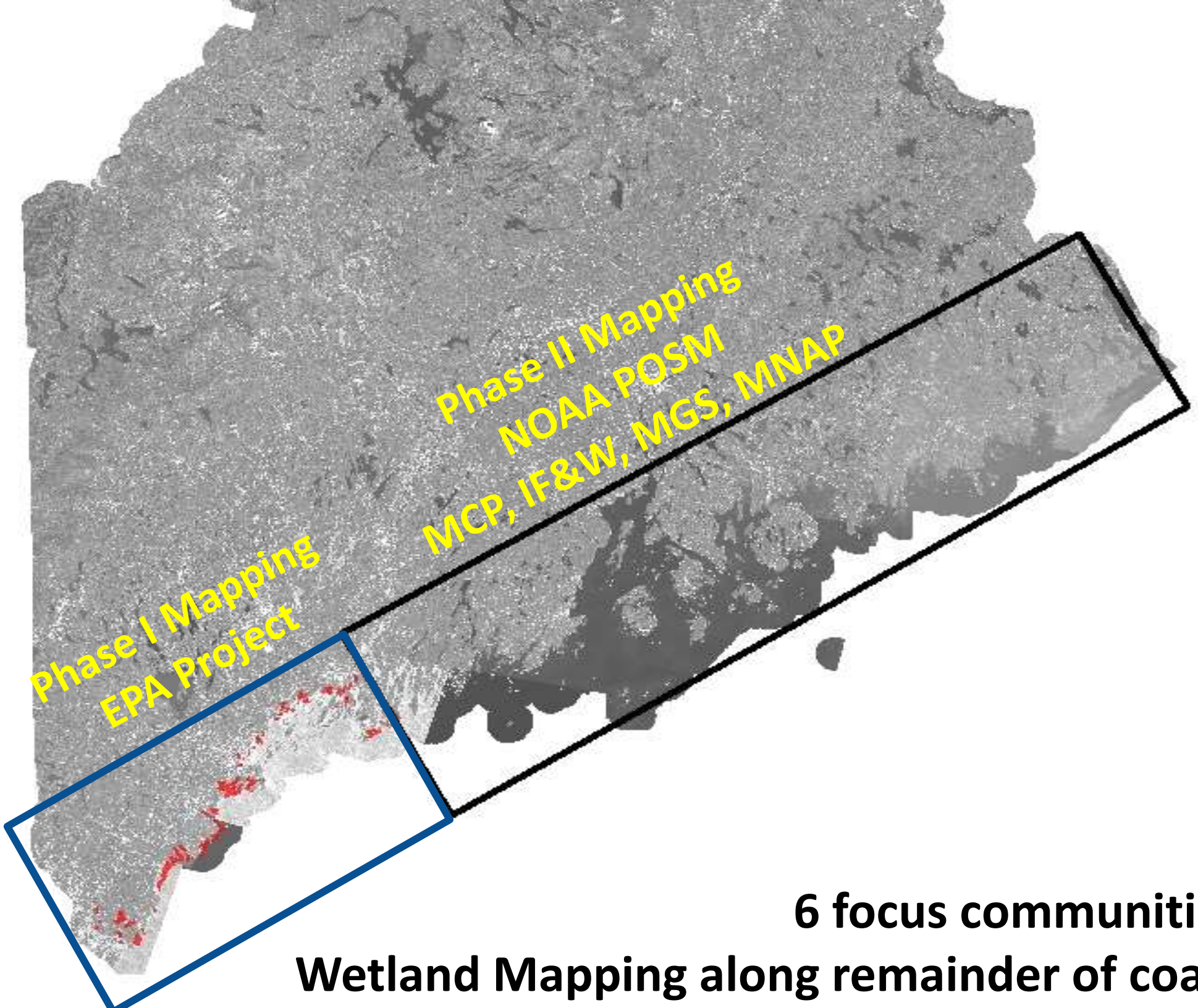

dd Help
Elm St Ext
Elm St
Main St
Theater St
Water St
1
© 2013 Google
For planning purposes only
HAT + 6 ft (18 ft MLLW)
1997
44°02'02.05" N 69°31'51.28" W


What about potential impacts to the natural environment?
NOAA Project of Special Merit

POSM Project Goals

- *Minimal project goal*: increase pubic awareness on SLR and marsh migration
- *Preferred goals:* identify potential marsh migration areas under several different future scenarios of sea level rise (1 ft, 2 ft, 3.3 ft, and 6 ft), develop, and implement **local partner-driven but transferable adaptation strategies for marsh migration**, i.e.:
  - Landowner incentives for increased setbacks
  - Coastal Overlay Zone that establishes performance standards in marsh migration priority areas (setbacks, shoreline hardening, design flexibility, etc.)
  - Bonus Density when subdivisions avoid marsh migration areas
  - Strategic conservation planning in collaboration with LT's

Each project "path" is developed by the partner community!



6 focus communities

Wetland Mapping along remainder of coast

Integrating Science into Policy: Adaptation Strategies for Marsh Migration

- NOAA funded "Project of Special Merit"

- State/NGO Partners:

- Local Partners:

Coastal wetlands

"Coastal wetlands" means all tidal and subtidal lands; all areas with vegetation present that is tolerant of salt water and occurs primarily in salt water or estuarine habitat; and any swamp, marsh, bog, beach, flat or other contiguous lowland that is subject to tidal action during the ***highest tide level for each year*** in which an activity is proposed as identified in tide tables published by the National Ocean Service. Coastal wetlands may include portions of coastal sand dunes.

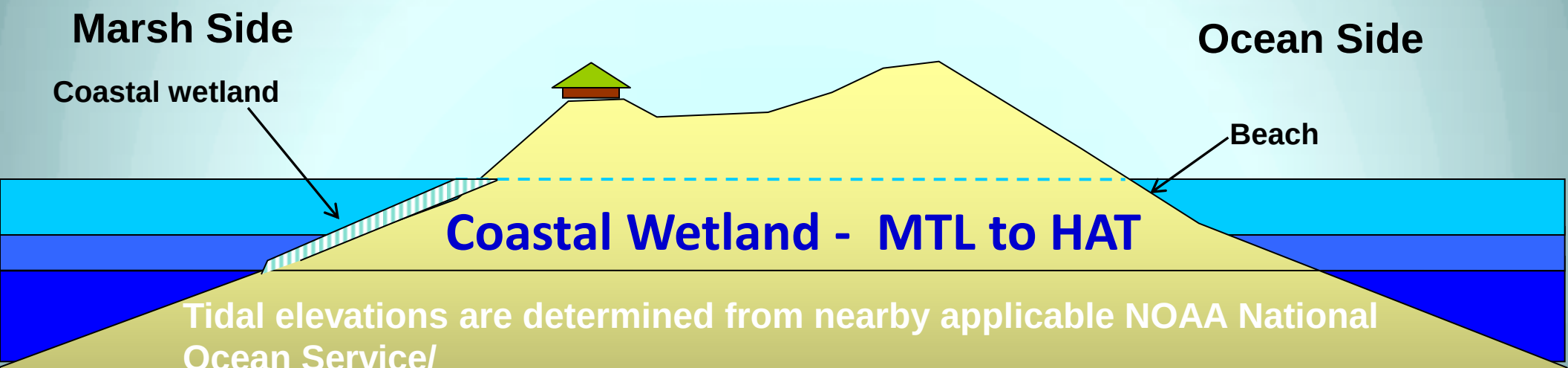
Required in Maine's Municipal Shoreland Zoning

P.A. Slovinsky, MGS

Using Tidal Elevations as Proxies for the Marsh…

Highest Annual Tide (HAT) - "spring" tide, the highest predicted water level for any given year but is reached within several inches numerous tides a year

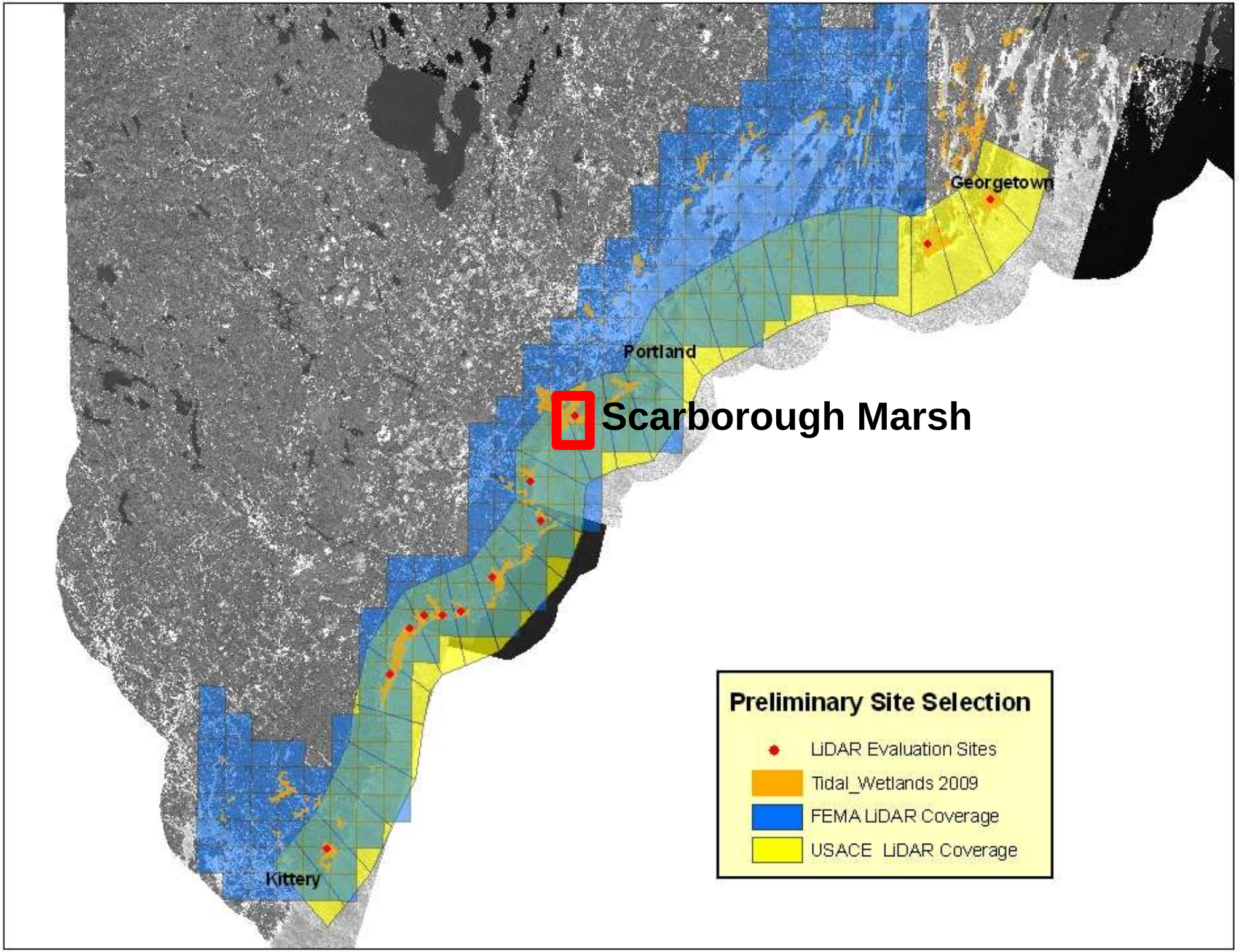
Mean Tide Level (MTL) = average height of the ocean's surface (between mean high and mean low tide).



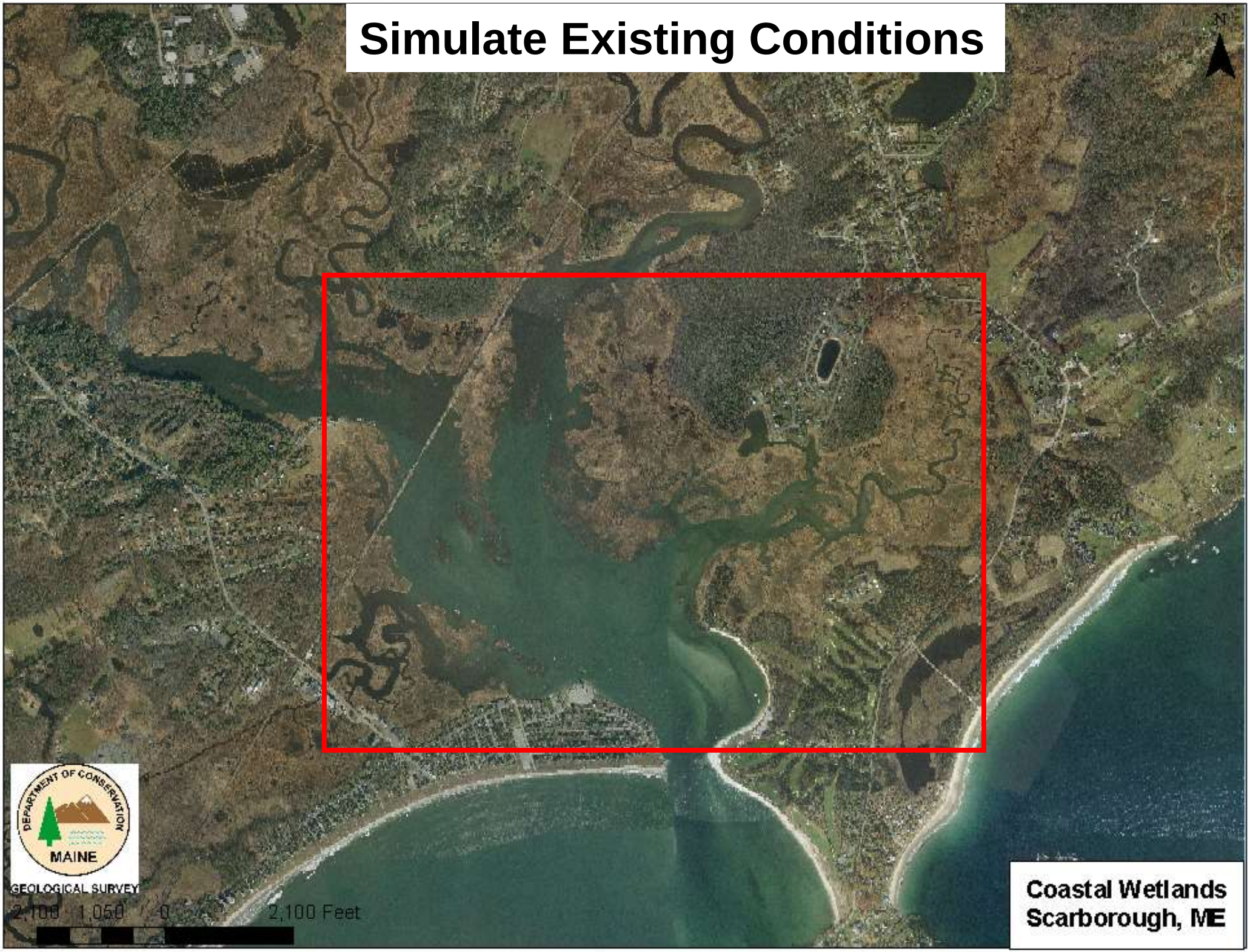
Tidal elevations are determined from nearby applicable NOAA National Ocean Service/
CO-OPs tidal prediction stations
http://tidesandcurrents.noaa.gov

MGS also creates a "HAT" table based on predictions for tidal stations for each year in support of the Shoreland Zoning Program

P.A. Slovinsky, MGS

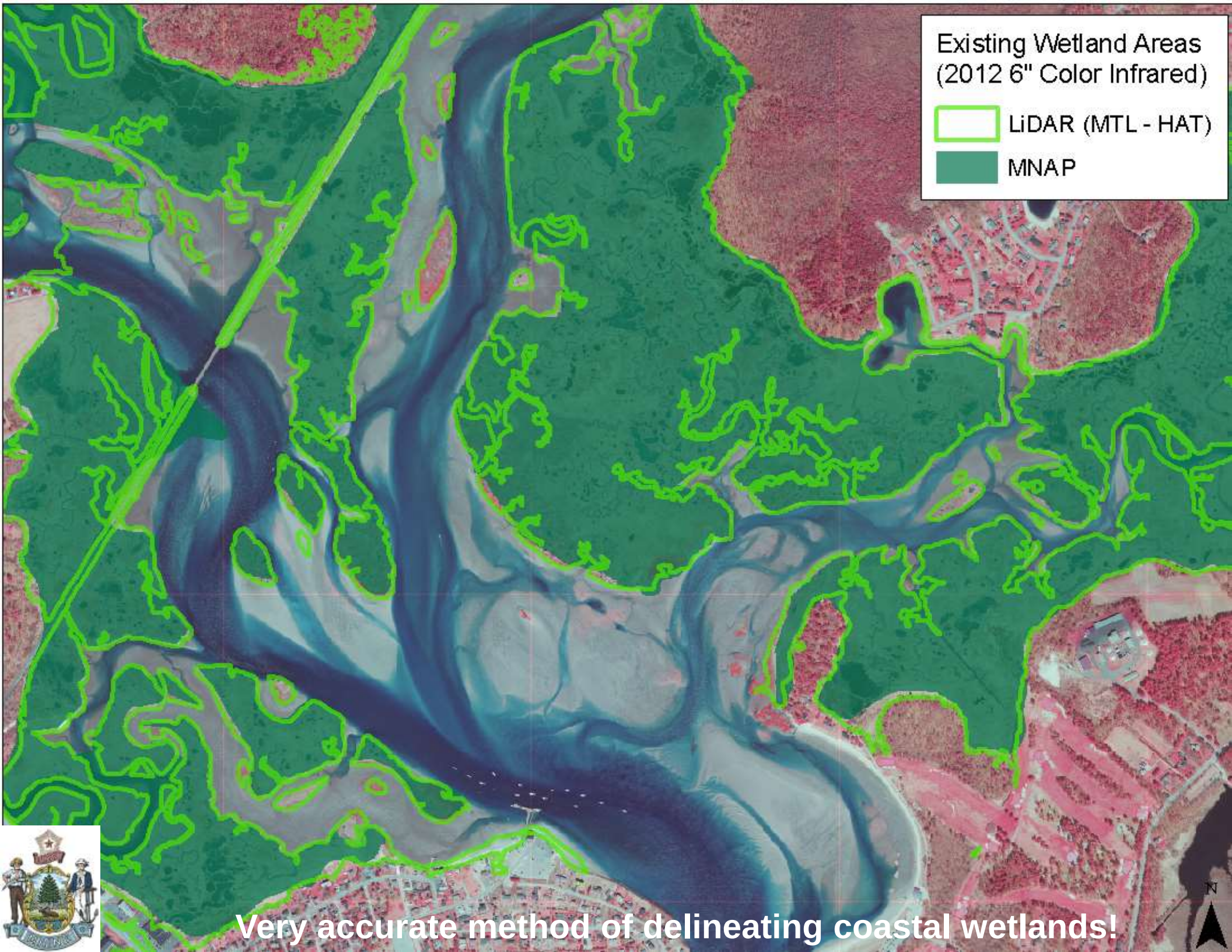

Georgetown
Portland
Scarborough Marsh
Kittery
Preliminary Site Selection
LiDAR Evaluation Sites
Tidal_Wetlands 2009
FEMA LiDAR Coverage
USACE LiDAR Coverage

Simulate Existing Conditions



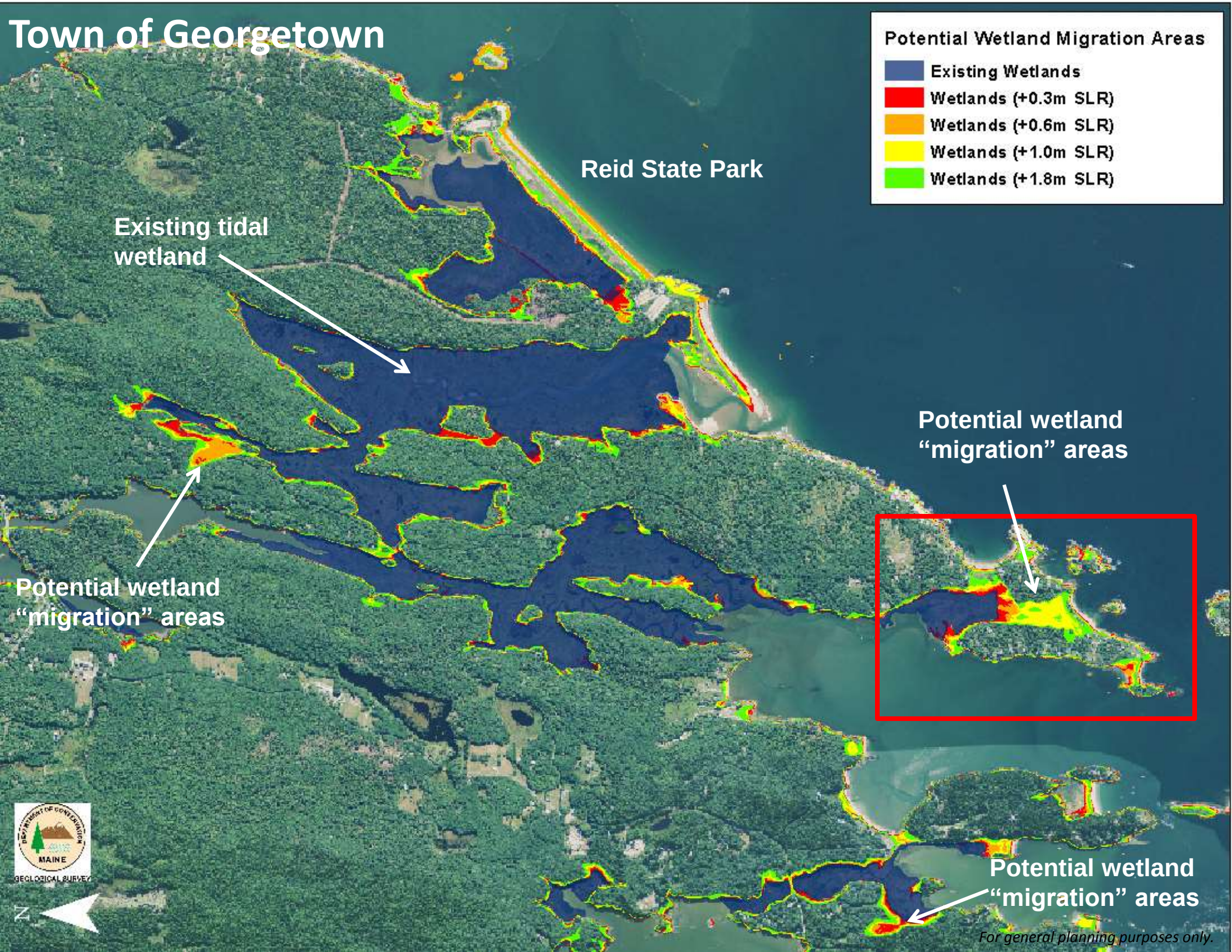

Existing Wetland Areas
(2012 6" Color Infrared)
N

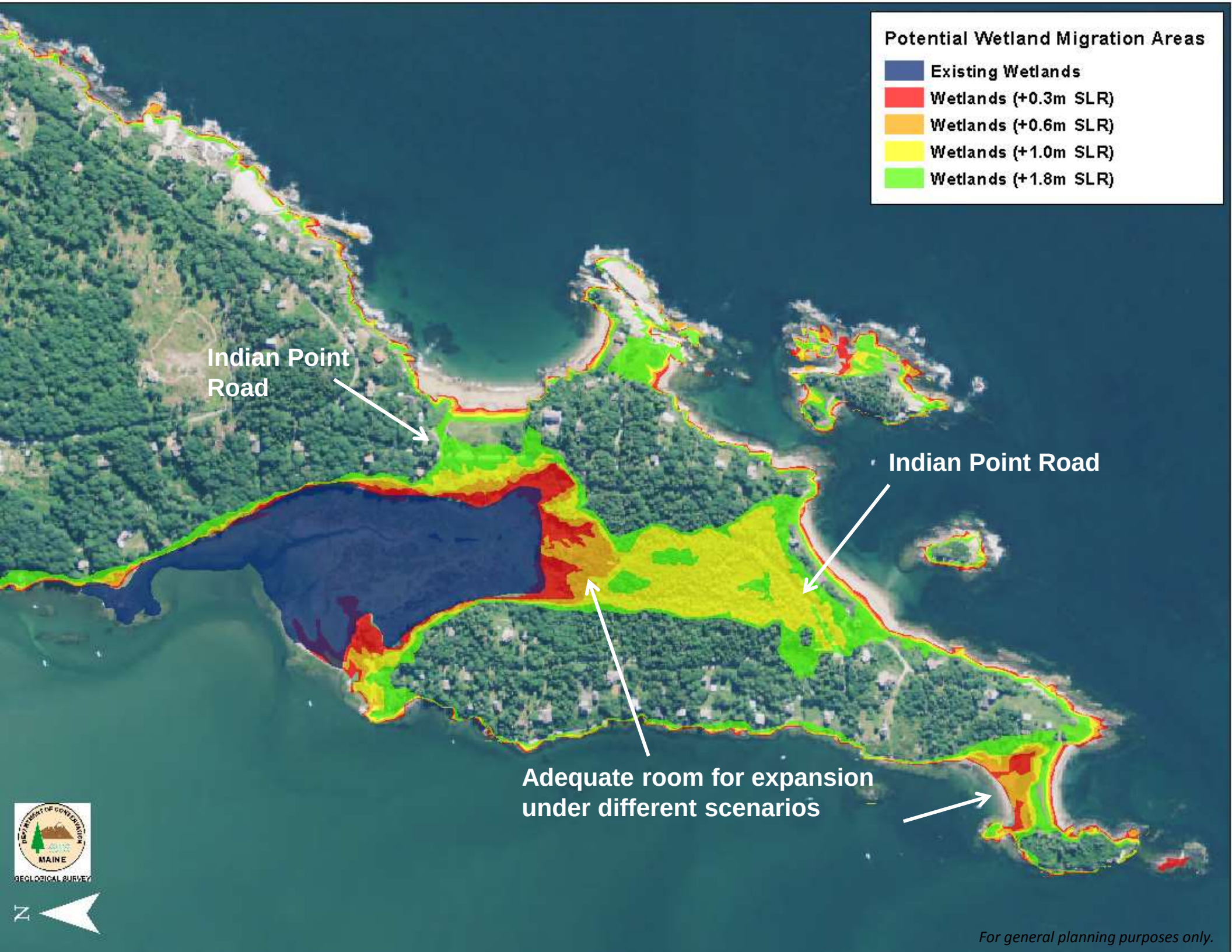

Existing Wetland Areas
(2012 6" Color Infrared)
MNAP
N


Existing Wetland Areas
(2012 6" Color Infrared)
LiDAR (MTL - HAT)
MNAP
N
Very accurate method of delineating coastal wetlands!

Town of Georgetown's Approach to the POSM

- Local efforts spearheaded by the Town's Conservation Commission in conjunction with the Kennebec Estuary Land Trust (KELT)
- With the MM Team, held an initial, large, well attended public workshop in April focusing on education and outreach to the public on project goals, preliminary results, and getting the local take on observations of SLR impacts
- This led to additional GIS work by the MM Team to address the needs of the Town at looking at other potential impacts of SLR – *not just marsh migration!*


Town of Georgetown
Potential Wetland Migration Areas
Existing Wetlands
Wetlands (+0.3m SLR)
Wetlands (+0.6m SLR)
Wetlands (+1.0m SLR)
Wetlands (+1.8m SLR)
Reid State Park
Existing tidal wetland
Potential wetland "migration" areas
Potential wetland "migration" areas
Potential wetland "migration" areas
MAINE
GEOLOGICAL SURVEY
N
For general planning purposes only.


Potential Wetland Migration Areas
Existing Wetlands
Wetlands (+0.3m SLR)
Wetlands (+0.6m SLR)
Wetlands (+1.0m SLR)
Wetlands (+1.8m SLR)
Indian Point Road
Indian Point Road
Adequate room for expansion under different scenarios
MAINE
GEOLOGICAL SURVEY
N
For general planning purposes only.

Town of Georgetown's Approach to Sea level rise and Marsh Migration work

- The Conservation Commission decided to incorporate results from the POSM into a larger context of a "Climate Vulnerability Assessment Report" that would serve as a roadmap for the community and potential impacts on:
  - Fishing economy
  - Roads and infrastructure impacts
  - Emergency preparedness
  - Private property impacts, recreation
  - Marsh ecology

The Cons Comm held several large workshops with KELT, the Georgetown Historical Society, and included MM Team presentation, information on climate change, and first-hand observations by citizens and town leaders

Georgetown Historical Society
Georgetown, Maine

HOME | SHOP | SUPPORT GHS | RESEARCH | LINKS | CONTACT | ABOUT GHS | THE TIDE

Celebration of the ARTS

GHS Events Calendar

Sat, Sept 14 10am-Noon
Fiber Arts Demo
Juliana Cliffe,Hand Quilting

Tue, Sept 17, 7pm Program
Tide Mills: Then and Now, with Bud Warren

Tue, Oct, 6pm Potluck* 7pm Program
OIL SANDS...What Are They and Why Do They Matter to Maine? With Dr. Nancy Kinner

Click HERE For Past Programs.

Library & Museum Hours

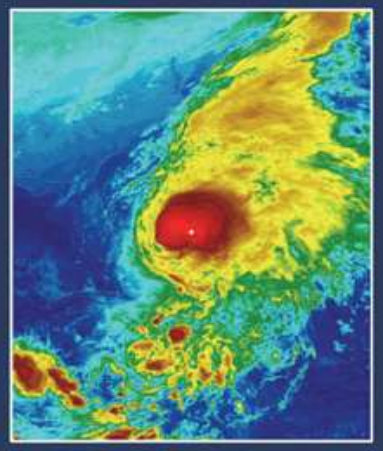
Wed: 10:00AM- 5:00PM
Sat: 10:00 AM- noon
other times by request

Call: 207-371-9200

We Are Open Year Round

Tue. Aug 20
7pm
The Impact of Changing Sea Level & Storms on Georgetown

Georgetown's Future
CLIMATE and WEATHER

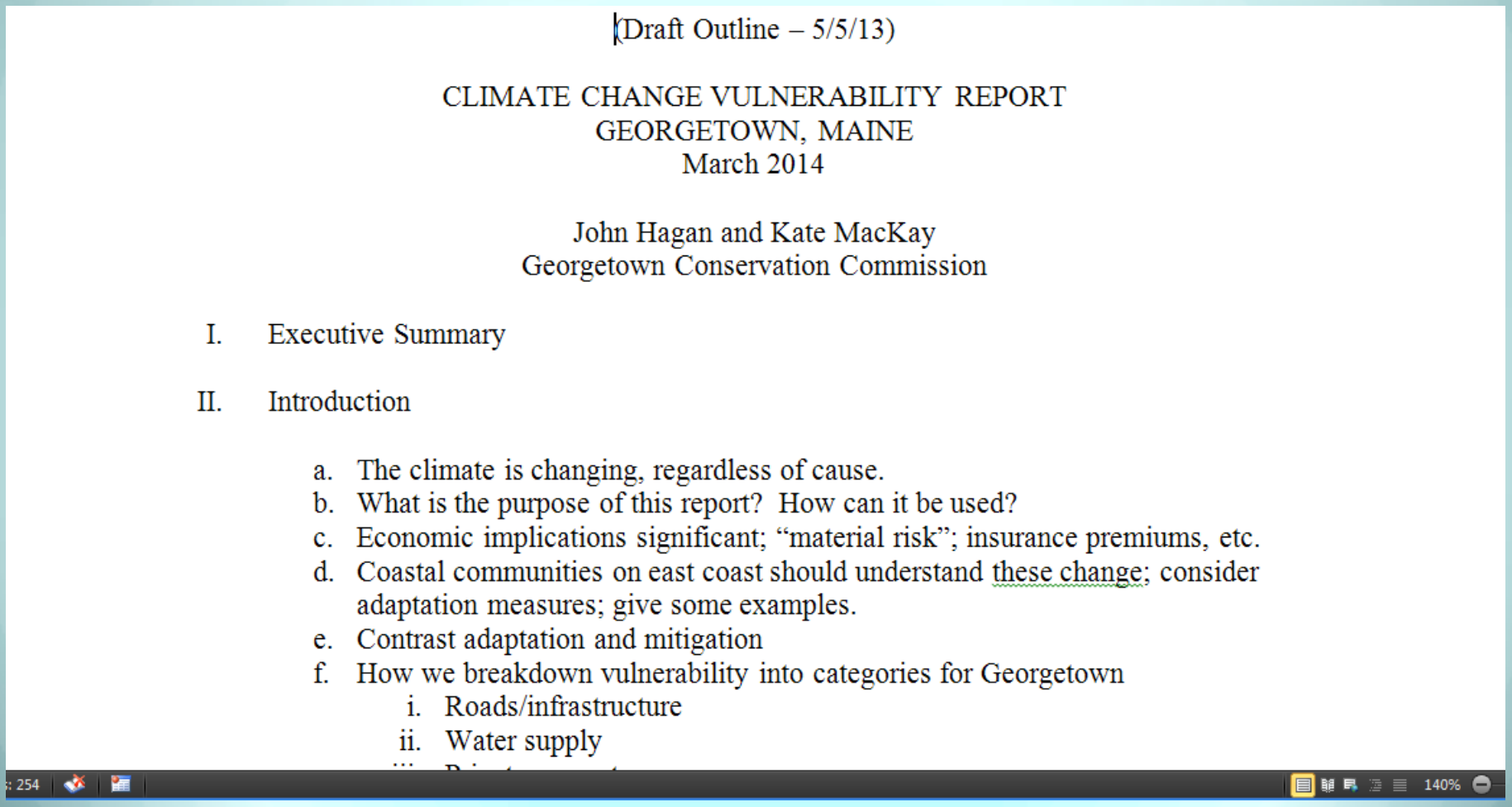


Hosted by
the Georgetown Historical Society

August 20, 2013
7-8:30 PM

Town of Georgetown's Approach

Georgetown's next step: **engage proper and relevant town leaders to help craft the different chapters** of the larger Vulnerability Assessment Report, and develop *potential* mitigation/adaptation solutions in each chapter.



(Draft Outline – 5/5/13)

CLIMATE CHANGE VULNERABILITY REPORT
GEORGETOWN, MAINE
March 2014

John Hagan and Kate MacKay
Georgetown Conservation Commission

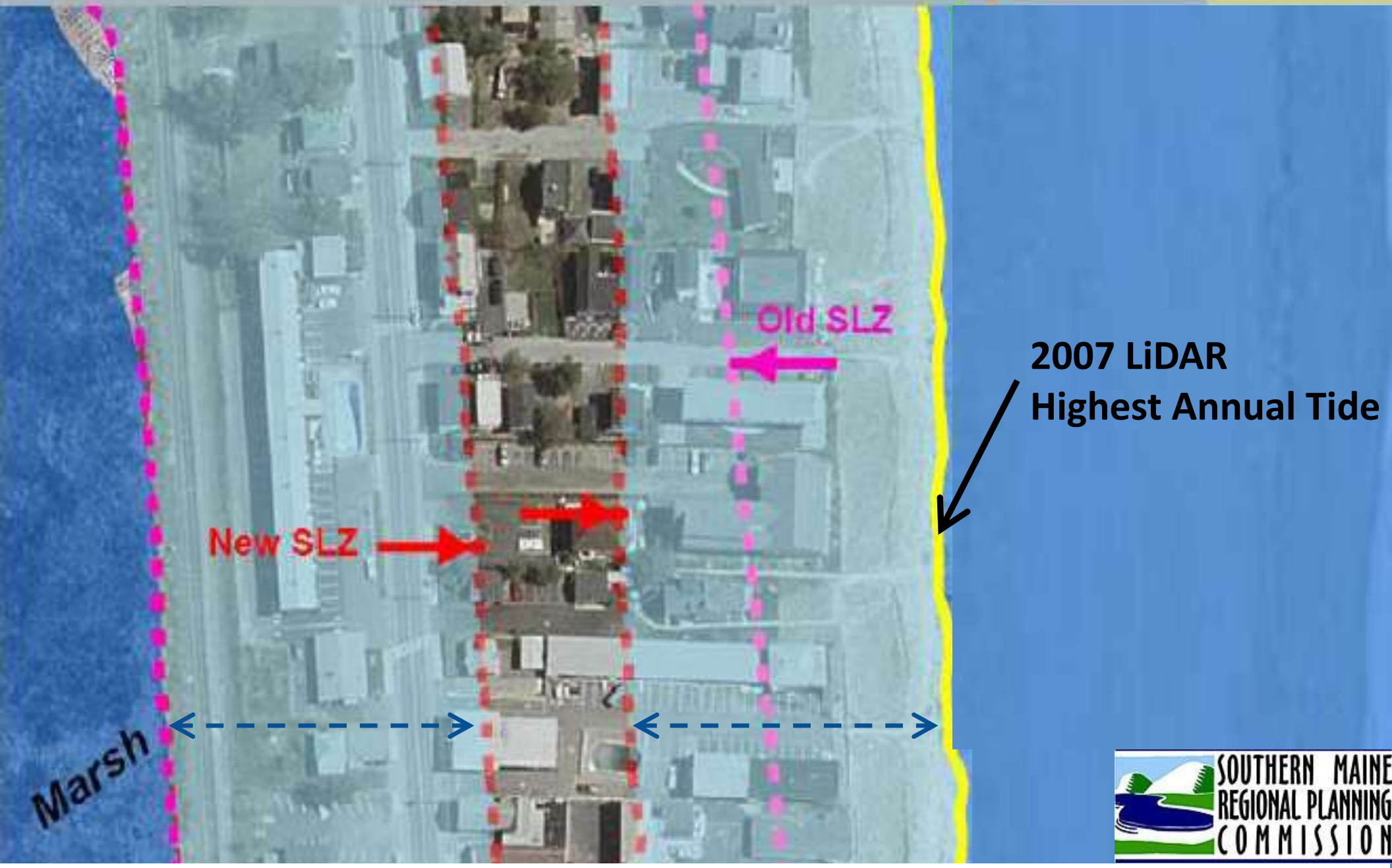
I. Executive Summary

II. Introduction

a. The climate is changing, regardless of cause.
b. What is the purpose of this report? How can it be used?
c. Economic implications significant; "material risk"; insurance premiums, etc.
d. Coastal communities on east coast should understand these change; consider adaptation measures; give some examples.
e. Contrast adaptation and mitigation
f. How we breakdown vulnerability into categories for Georgetown
    i. Roads/infrastructure
    ii. Water supply

Some transferable *low hanging fruit* adaptation and ordinance strategies already being implemented elsewhere as part of resiliency efforts in Maine (there are many, here are only a few)

Old Orchard Beach – East Grand Avenue Area



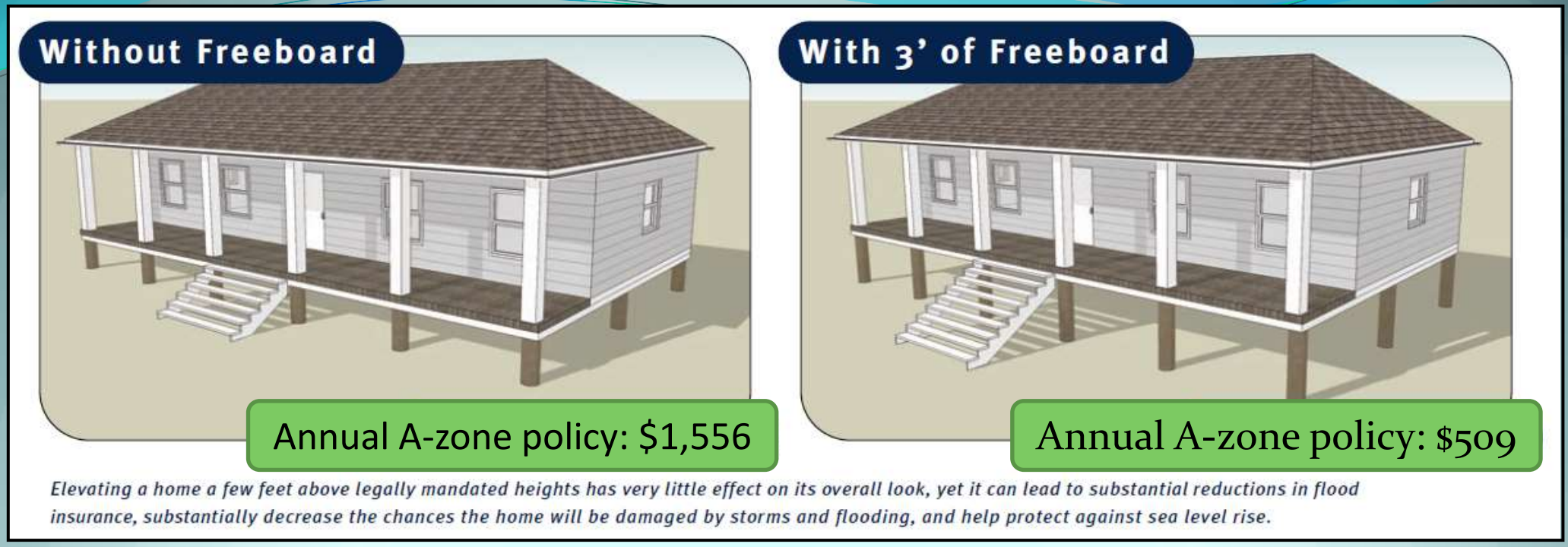
SOUTHERN MAINE REGIONAL PLANNING COMMISSION

Strategy: Use LiDAR to more accurately define the Highest Annual Tide to create better Shoreland Zoning maps (OOB and Saco; Cape Elizabeth *pending*)

Strategy: Incorporating more freeboard into municipal floodplain ordinances to account for SLR or storms

The City of Saco and Town of Berwick made ordinance changes to increase freeboard to <u>three feet</u> above the 100-year Base Flood Elevation (BFE).

“Low Hanging Fruit” : Flood Insurance Premium Benefits



Elevating a home a few feet above legally mandated heights has very little effect on its overall look, yet it can lead to substantial reductions in flood insurance, substantially decrease the chances the home will be damaged by storms and flooding, and help protect against sea level rise.

Scenario	V-zone			A-zone		
	Annual Policy	Savings (%)	30-year savings	Annual Policy	Savings (%)	30-year savings
No Freeboard	$7,747	$0 (0%)	$0	$1,556	$0 (0%)	$0
1 ft freeboard	$5,331	$2,416 (31%)	$72,480	$799	$757 (49%)	$22,710
2 ft freeboard	$3,648	$4,099 (53%)	$122,970	$574	$982(63%)	$29,460
3 ft freeboard	$2,635	$5,112 (66%)	$153,360	$509	$1,047(67%)	$31,410

Based on 2012 rates for a one-floor residential structure, no basement, post-FIRM, $1,000 deductible with $250,000 coverage and $100,000 contents.

Flood policy rating quotes graciously provided to Maine Floodplain Management Program by Chalmers Insurance Group, www.chalmersinsurancegroup.com

Why increase freeboard?

- Is a **simple cost-effective means to protect buildings** from existing ocean storms and surges and accommodate for potential future sea level rise

- Is **only triggered by substantial improvement, new construction, or damage threshold requirements that already exist**

- Will only impact structures that **would need to meet minimum freeboard requirements anyway**

- Will **not substantially increase the costs of elevating a structure** (three feet vs. one foot, 0.25-1.25% of cost!)

Why increase freeboard?

- Will **result in lower Flood Insurance Rate premiums** for property owners
- May result in a **better FEMA Community Rating System (CRS)**, which may further reduce insurance premiums by a certain percentage
- **Conforms with newer FEMA and ASCE guidance** regarding coastal construction in tidal floodplains
- **Sets a model** for other communities to follow

Amendments to the Town of York Comprehensive Plan:

1. To Amend the "Sea Level Rise" and "Beach Erosion" subsections of the existing Coastal Resources Inventory & Analysis section of the Natural Resources Chapter;

2. To Add a new Inventory & Analysis Chapter entitled: "Adaptation to Sea Level Rise;" and

3. To Add new Town Goals and Town Actions Under State Goal 6, to Implement a Variety of Strategies to Adapt to Sea Level Rise.

Adapting to Sea Level Rise in South Portland

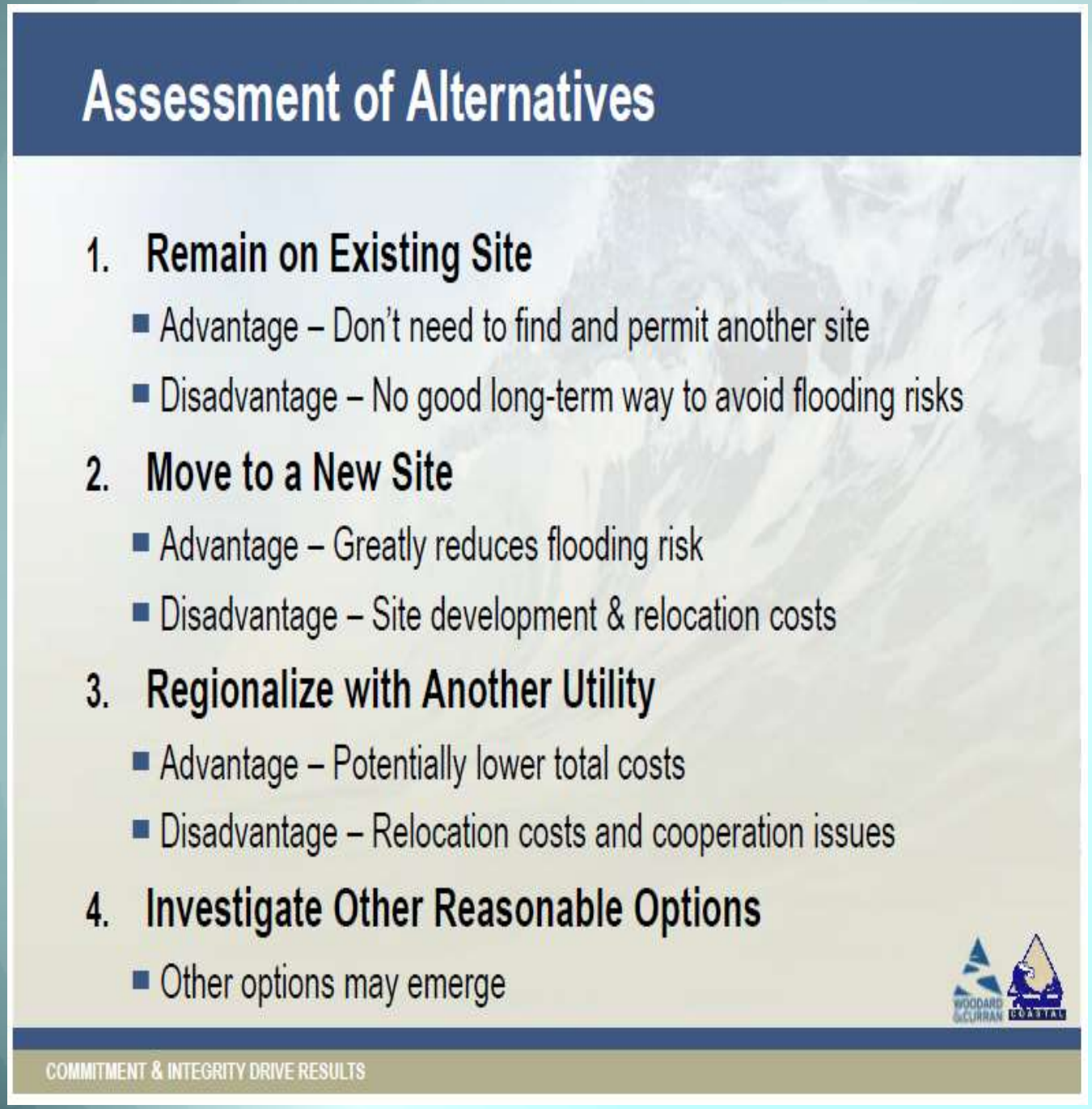
T. Haeuser, Mill Creek, S. Portland.

Prepared by
The Greater Portland Council of Governments in cooperation with the Maine Geological Survey

Strategy: Incorporate analysis of sea level rise and storm impacts and potential adaptation strategies into Comprehensive Plans (York and South Portland)

Strategy: Develop appropriate engineering adaptation options for identified vulnerable critical public infrastructure (Ogunquit Sewer Treatment District; *Wiscasset under way*)

Ogunquit Sewer District



Partnership with quasi-municipal group (Ogunquit Sewer District), **state agency** (MGS), **RPO** (SMRPC), and **private firm** (Woodard & Curran) through a **federal** Gulf of Maine Ocean Council/NROC Grant.

Developed an array (short, long-term) of **SLR adaptation strategies** for the plant (first in Maine!)

Some suggestions for Moving Forward

- Impacts from existing storms and SLR will be felt most at the local level, regardless of what happens at the State or Federal government levels. Preparation needs to start with the **"ground zero" of potential impacts, the municipalities**

- **Establish a sound scientific groundwork for moving forward**; *arguing about "climate change" has no bearing on adaptation strategies to create more resilient communities*.

- Use a "Scenario Based Approach" to build on the concept of "no regrets actions" and **cover a range of scientific predictions and manageable planning horizons**

- Understand and engage **the right municipal players with each partner community**

Some suggestions for Moving Forward

- Consider **working with neighboring communities** to pool resources, create parallel regulations, and leverage funding for capital improvements

- Don't separate **the discussion of natural from built environment impacts** – keep environmentalists, planners, architects, public works staff, and emergency personnel around the same table

- Consider all adaptation actions, but **bring planning time horizons and goals down to realistic levels**…you don't have to tackle it all at once!

- Shoot for the **"low hanging fruit"** in terms of planning or ordinance changes – something that has a definitive benefit in terms of creating resiliency for the "**storms of today and potential tides of tomorrow**"

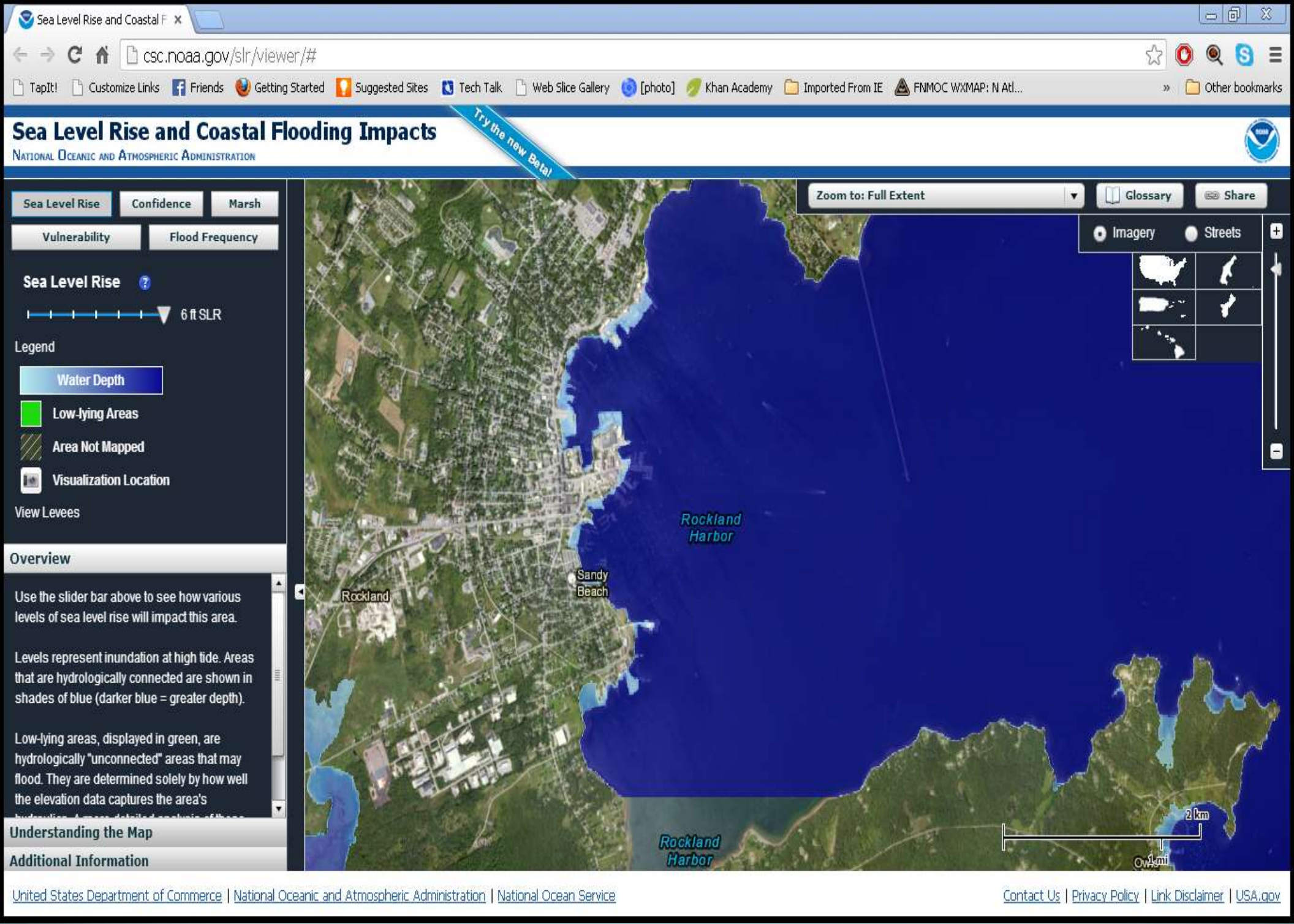
Thank you!

A summary of the latest sea level rise science, storm surge data, and efforts to address resiliency in municipal adaptation planning

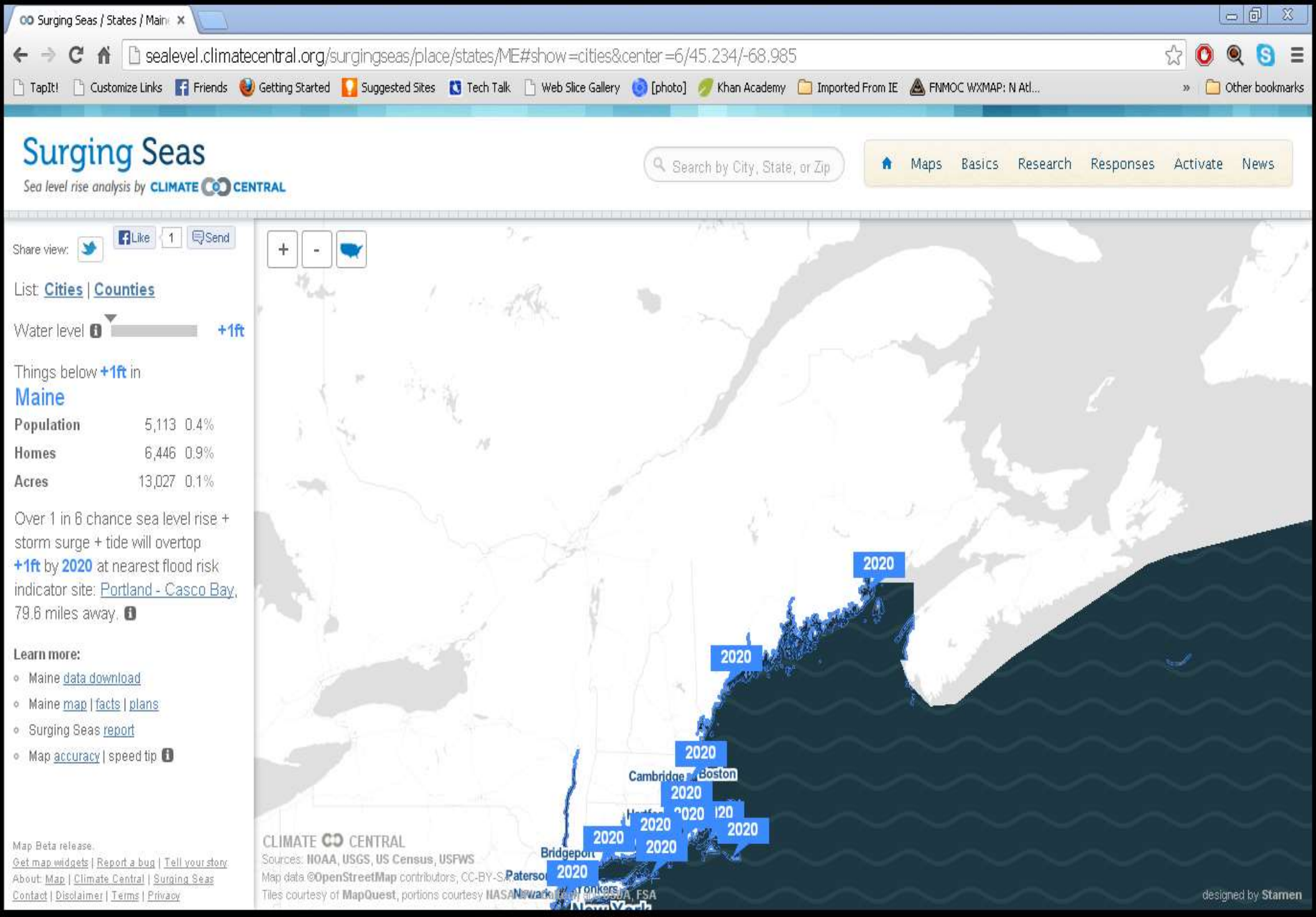
Peter A. Slovinsky, Marine Geologist
Maine Geological Survey
Department of Agriculture, Conservation, and Forestry
peter.a.slovinsky@maine.gov

Some other resources to help start Sea Level Rise Resiliency Planning Efforts

NOAA's Sea Level Rise and Coastal Flooding Viewer
Climate Central's Surging Seas
Sea Lake and Overland Surges from Hurricanes Mapping Tool (MGS)
Highest Annual Tide and Wetland Mapping Tool (MGS)



NOAA's Sea Level Rise and Coastal Flooding Impacts Viewer

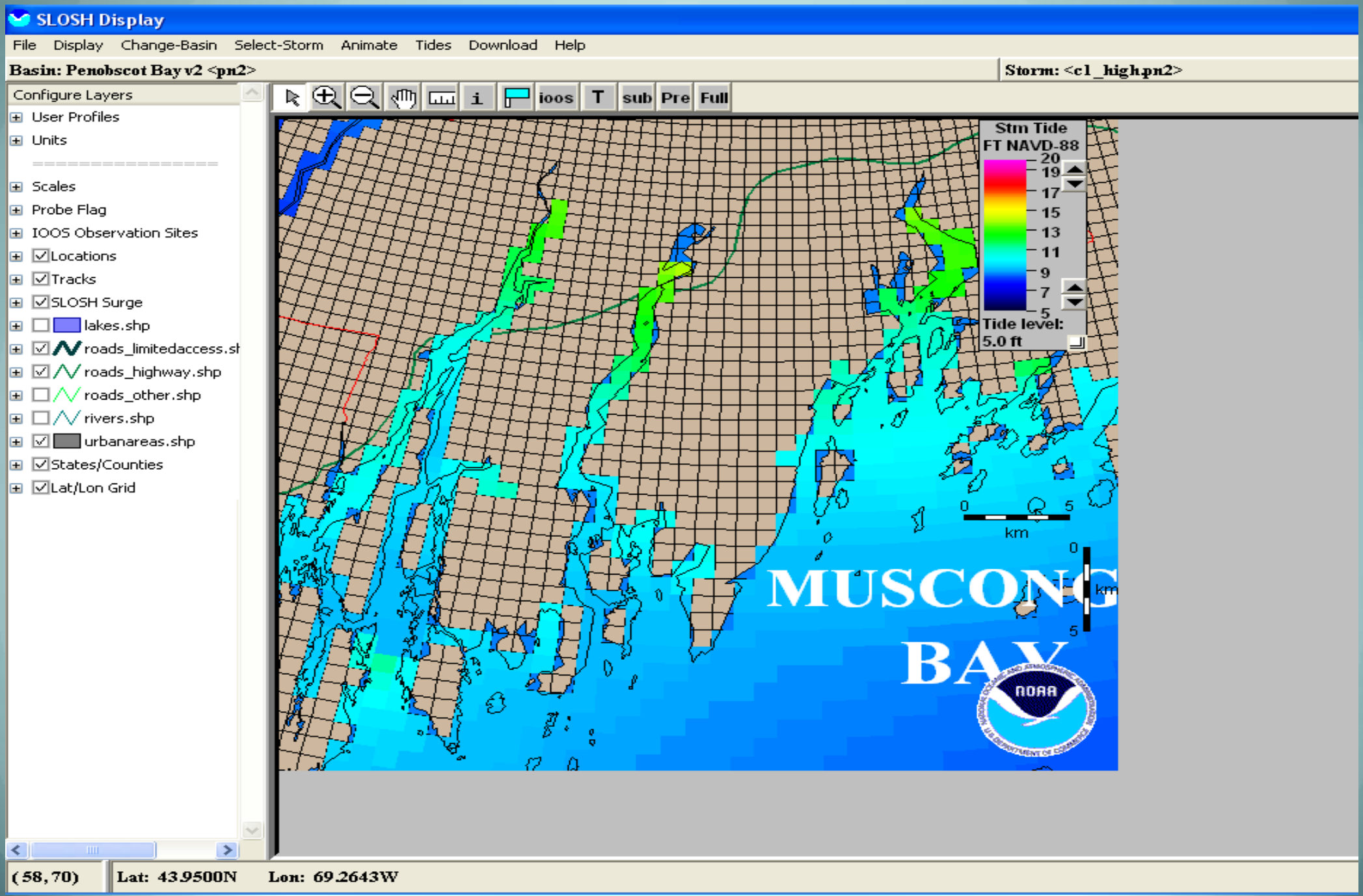


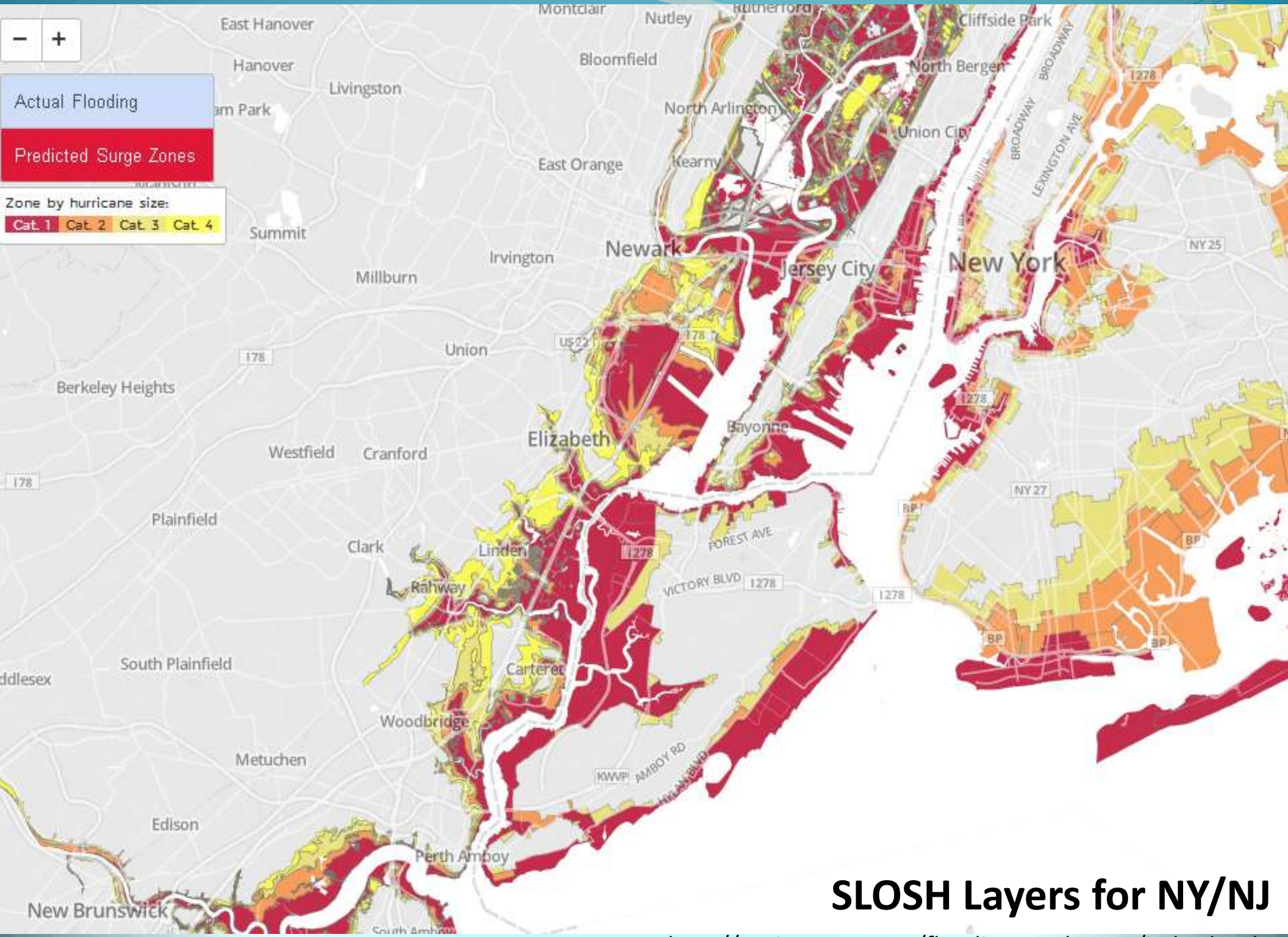
Climate Central's "Surging Seas" website

What about a potential tropical event hitting Maine?

Mantoloking, NJ

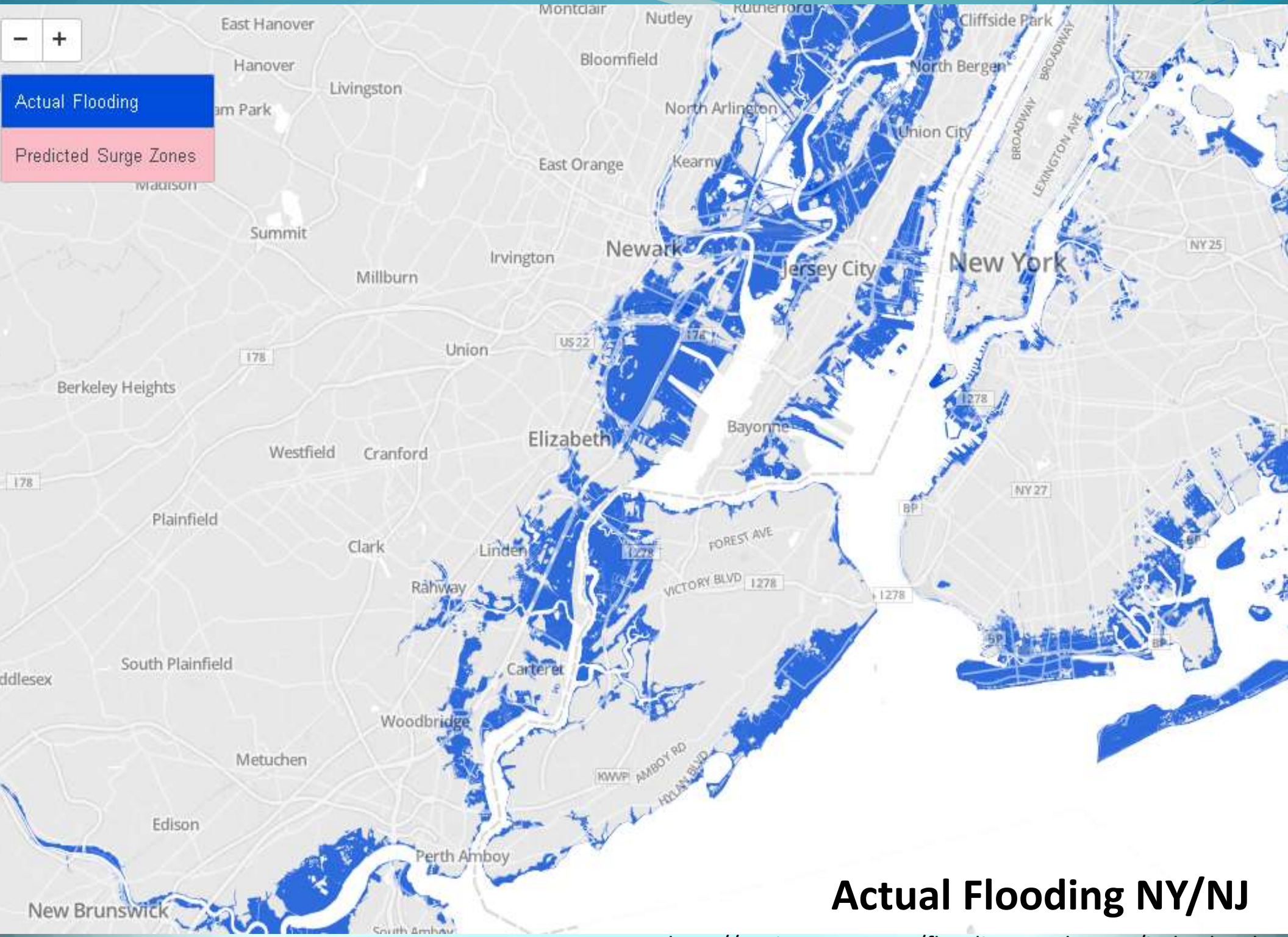
Sea Lake and Overland Surges from Hurricanes (SLOSH)





SLOSH Layers for NY/NJ

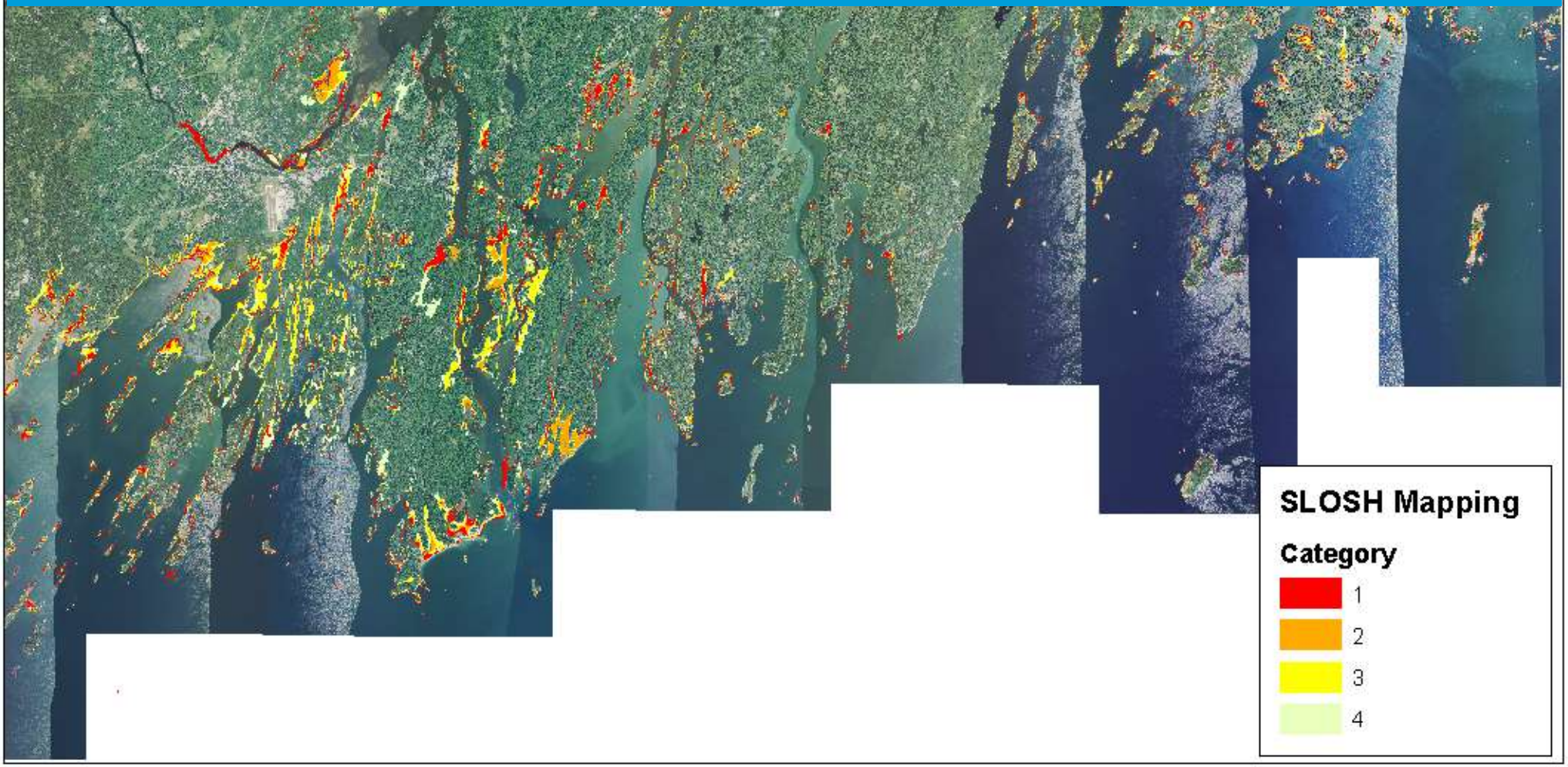
http://project.wnyc.org/flooding-sandy-new/index.html#



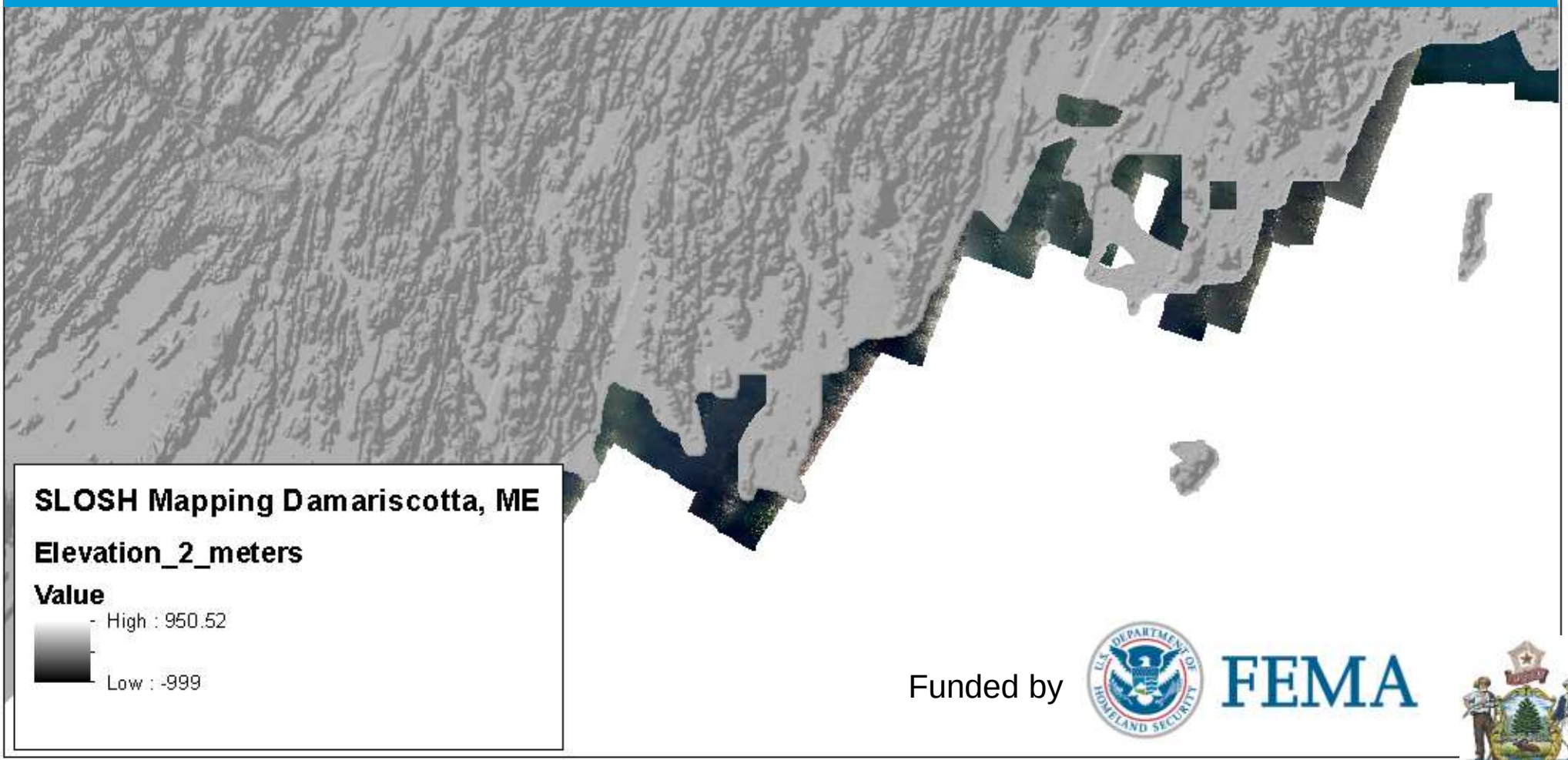
Actual Flooding NY/NJ

http://project.wnyc.org/flooding-sandy-new/index.html#

In Maine, SLOSH model data was taken by the Corps of Engineers and overlain onto the National Elevation Dataset (NED) topographic data. This data is accurate to about <10 meters (~30 feet) horizontally, and 2-3 meters (+- 7 feet) vertically. This was used to create the SLOSH Inundation Layers that Maine currently has from 2006…



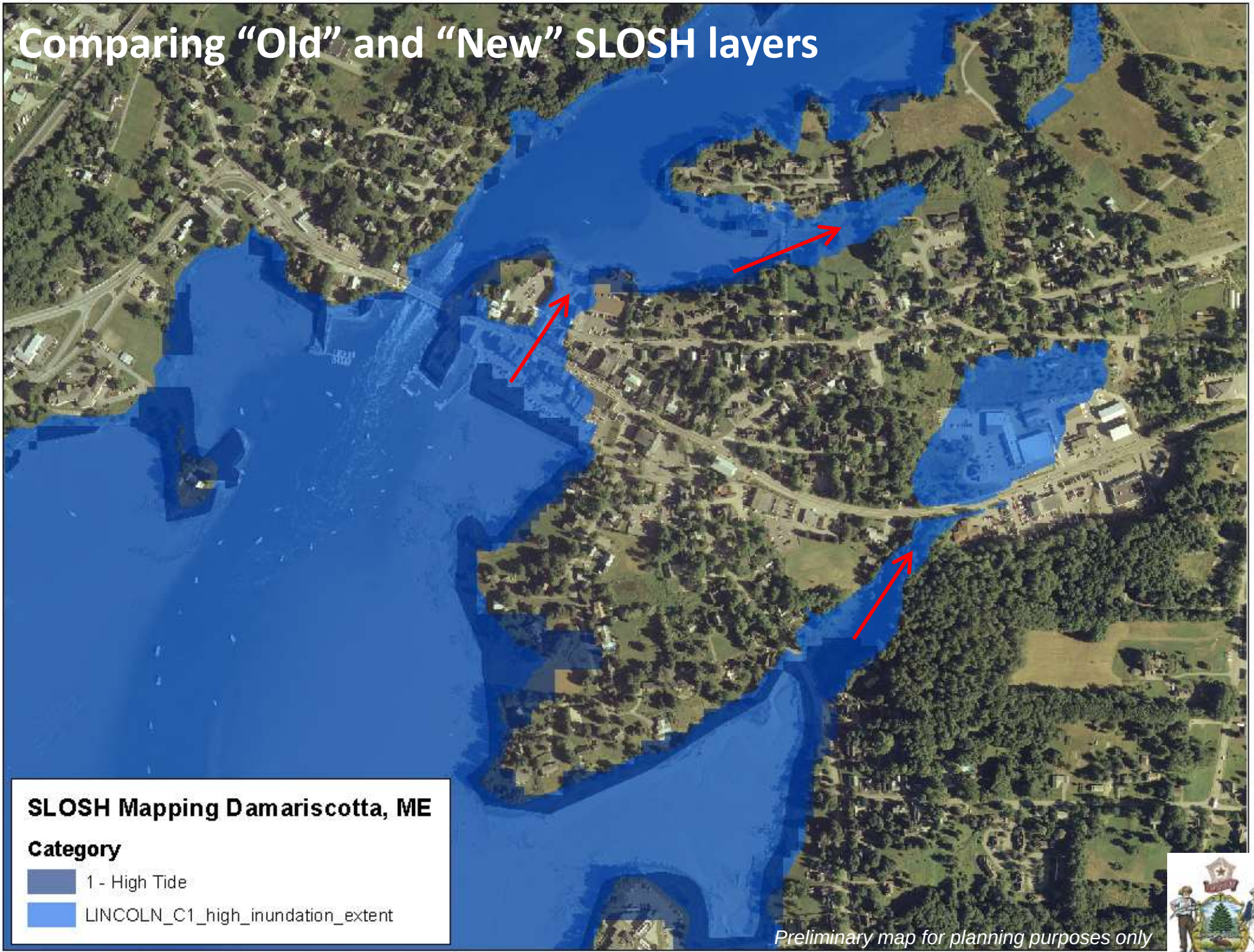
MGS used newer SLOSH data (created using an updated basin model with smaller grid size and better accuracy) and much more accurate Light Detection and Ranging (LiDAR) data (2 m horizontal cell size and +-0.10 m vertical accuracy) to create newer layers depicting potential inundation under a Category 1 and 2 event hitting at mean or high tide.



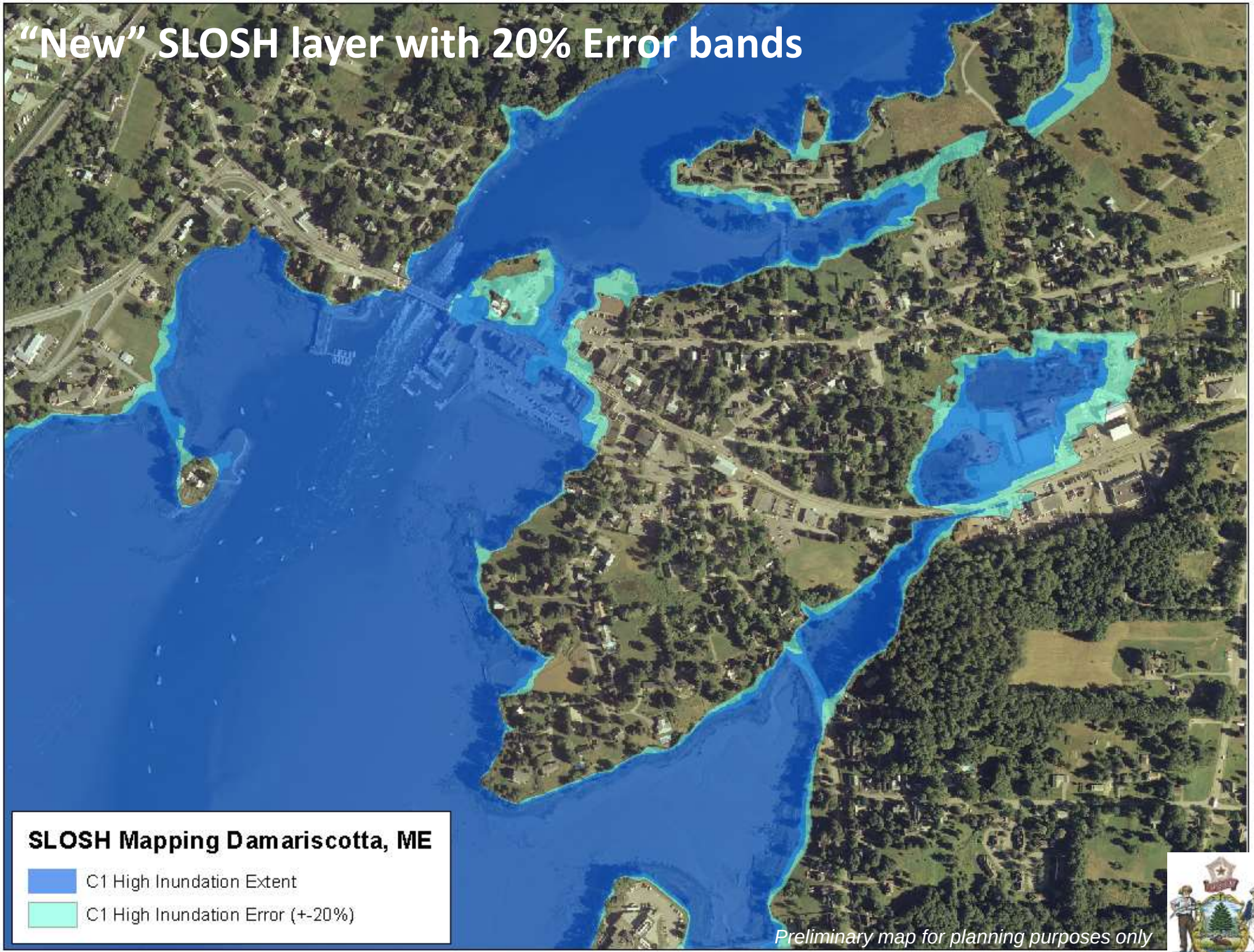
Funded by FEMA

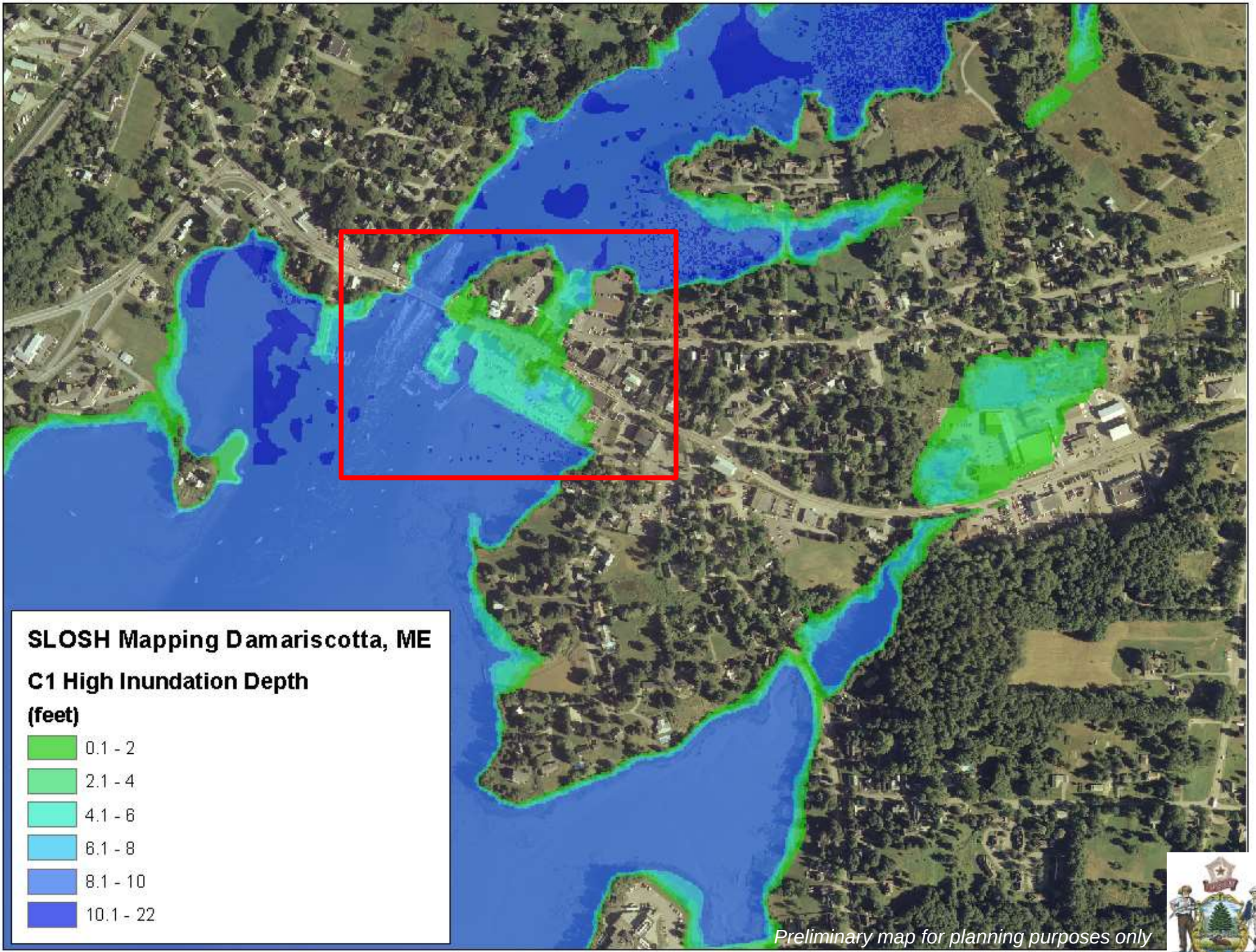
“Old” SLOSH layer

Comparing “Old” and “New” SLOSH layers



“New” SLOSH layer with 20% Error bands




SLOSH Mapping Damariscotta, ME
C1 High Inundation Depth
(feet)
0.1 - 2
2.1 - 4
4.1 - 6
6.1 - 8
8.1 - 10
10.1 - 22
Preliminary map for planning purposes only

“New” SLOSH layer Inundation Depths