WEATHERING CHANGE

AU | ANTIOCH UNIVERSITY NEW ENGLAND
Center for Climate Preparedness and Community Resilience

Strengthen communities to prepare, respond and recover in the face of climate impacts and other disruptions through collaborative, innovative solutions.

communityresilience-center.org

Dr. Christa Daniels
Senior Associate, CCPCR

Climate Change Resilience

… a series of online courses focused on the fundamentals of climate change resilience.

- Engage in each course for 4 weeks
- Enroll for graduate credit or audit the course
- Increase your skill set in climate resilience for better outcomes
- Discover solutions to local issues you face on the job or in your community.
- Register for one course or the whole series.

http://www.communityresilience-center.org/climate-change-resilience-series/

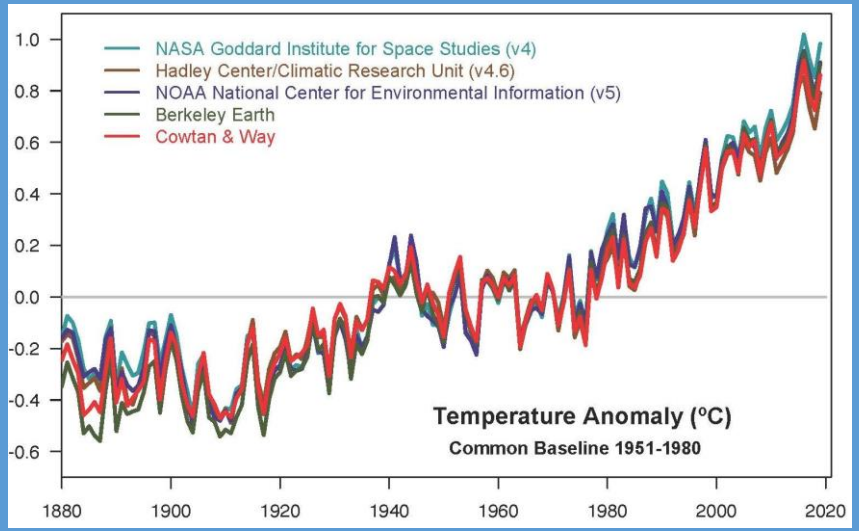
ANTIOCH UNIVERSITY
NEW ENGLAND

Climate Change Resilience Certificate

Climate Change: the Science, Uncertainty, and Risk

Online (1-credit) Course Aug 30, 2020 through Sept 6, 2020

Already communities are being impacted by a changing climate. This module focuses on the science of our changing climate and how to ascertain uncertainty and risk in the models and science. System thinking principles and application in this field will be explored in depth.



For more information or to register for this course:
https://www.communityresilience-center.org/climate-change-science/

ANTIOCH UNIVERSITY NEW ENGLAND

Additional Fall 2020 Climate Change Resilience Professional Certificate Online Courses

Policy Advocacy: Climate

Dates: Sept 10- Nov 19, 2020

Synchronous Online Class:
Thursdays 10:00-11:00 AM ET

http://www.communityresilience-center.org/climate-change-resilience-series/

Climate Impacts: Communication, Facilitation, and Stakeholder Capacity Building

Dates: October 4-31, 2020

Asynchronous Online Class

Climate Impacts: Vulnerability and Adaptation Planning

Dates: November 8 – December 12, 2020

Asynchronous Online Class

U.S. Climate Resilience Toolkit

Meet the challenges of a changing climate by finding information and tools to help you understand and address your climate risks.

toolkit.climate.gov

Dr. Ned Gardiner,
Engagement Manager

Logistics

If you have a question, please write it in the Q&A section (not Chat) and select to All Panelists, so we can see the questions.

If you are having technical difficulty, please use Chat and send to Host, so we can address the issue with you directly.

The presentation will be recorded and posted to the Antioch website within a week www.communityresilience-center.org

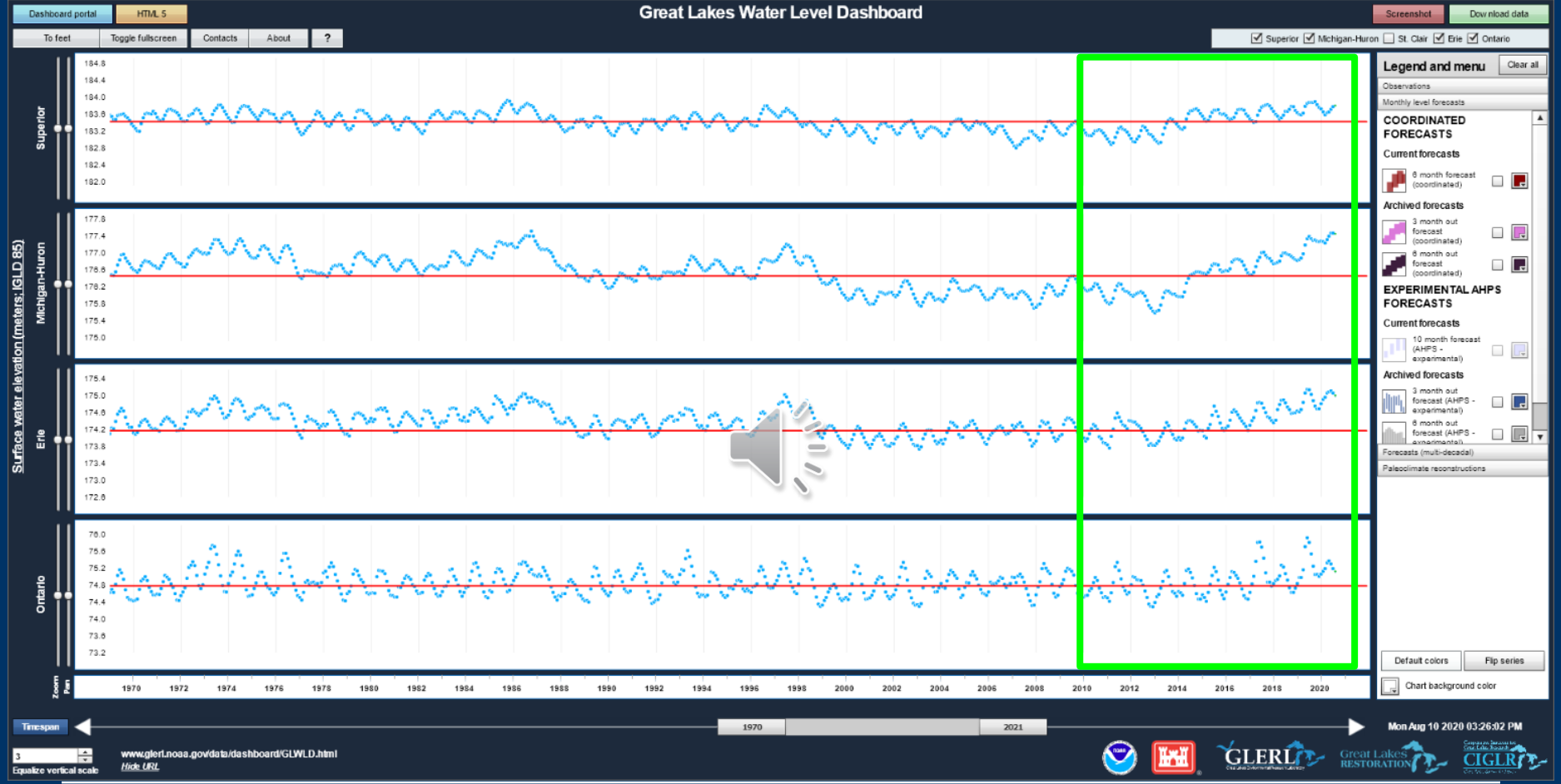
Great Lakes Water Levels and Coastal Impacts

Brandon Krumwiede
Great Lakes Regional Geospatial Coordinator
CSS Inc on contract to NOAA Office for Coastal Management

PRE-RECORDED

Presentation Overview

Water Levels
Water and Wind
Coastal Impacts
Data, Tools, and Resources



Office for Coastal Management

Great Lakes Water Levels: Current

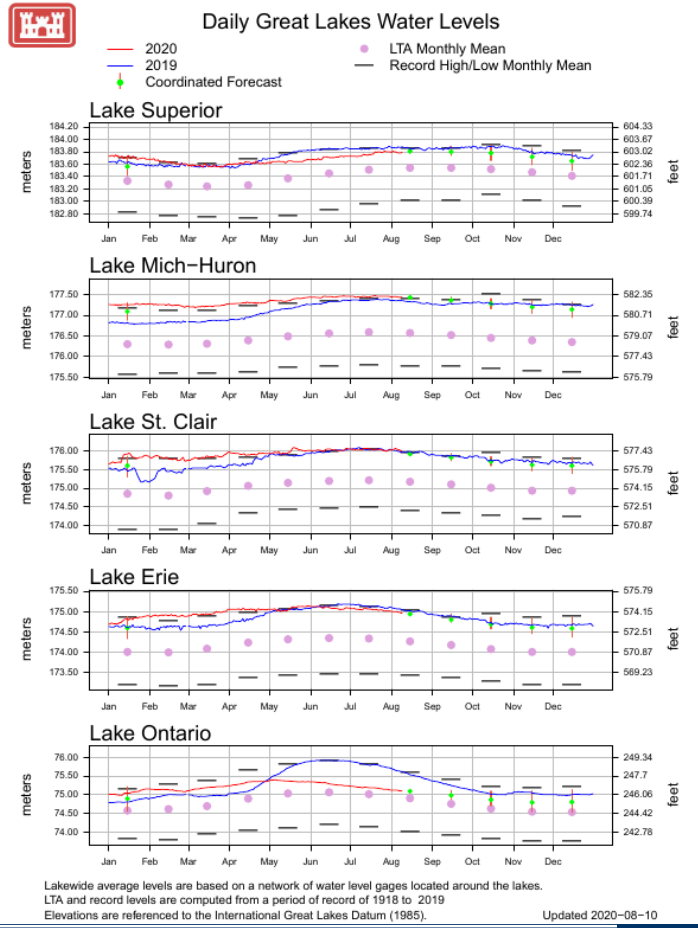
JULY 2020

Precipitation just above average for the Great Lakes basin

Lake Superior rose 2 inches in July

Lake Michigan/Huron remained high and 2 inches above past monthly mean July record

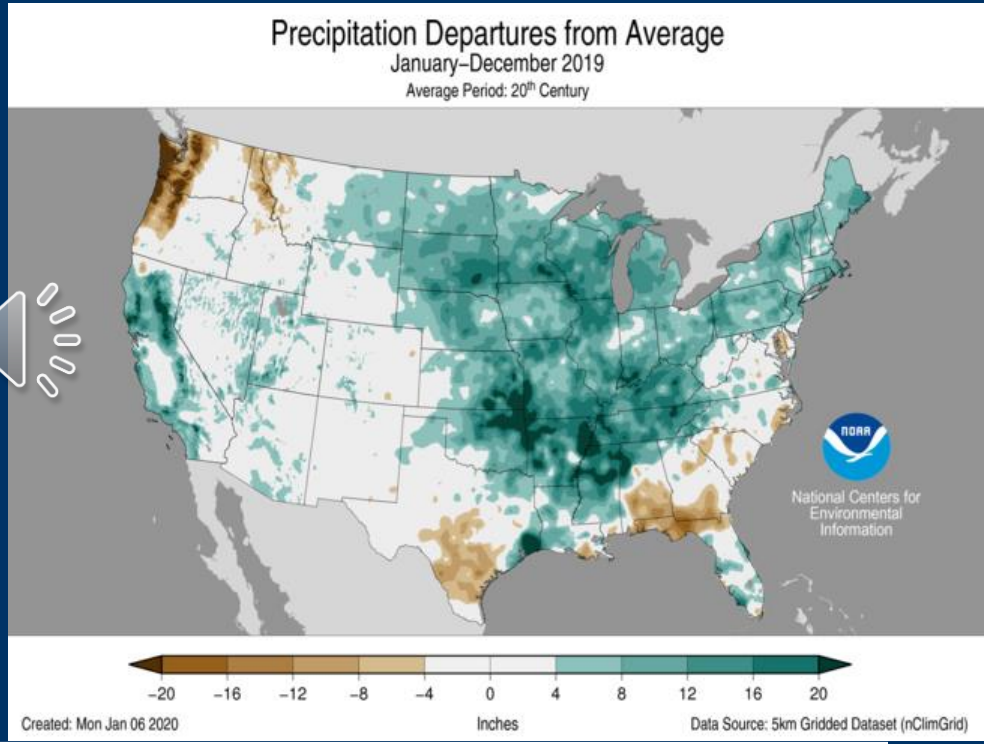
Lake Erie and Lake Ontario declining in water levels



Great Lakes Water Levels: Inputs and Outputs

2019
Wet across much of the Great Lakes basin in 2019

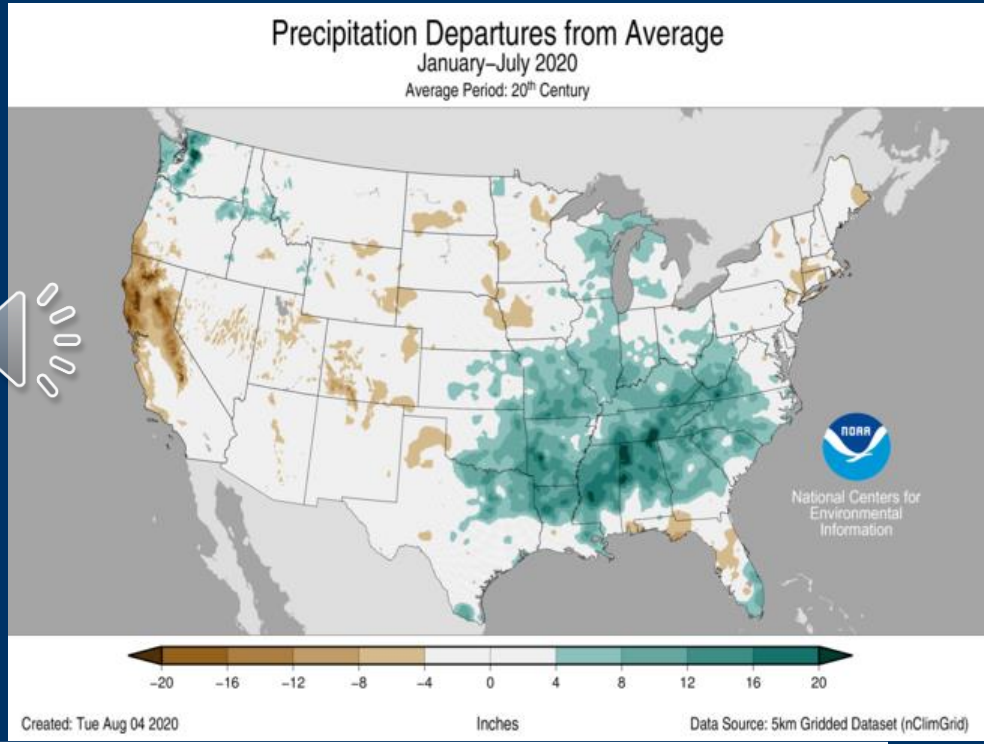
Year to Date Precipitation Departure from Average 2019



Great Lakes Water Levels: Inputs and Outputs

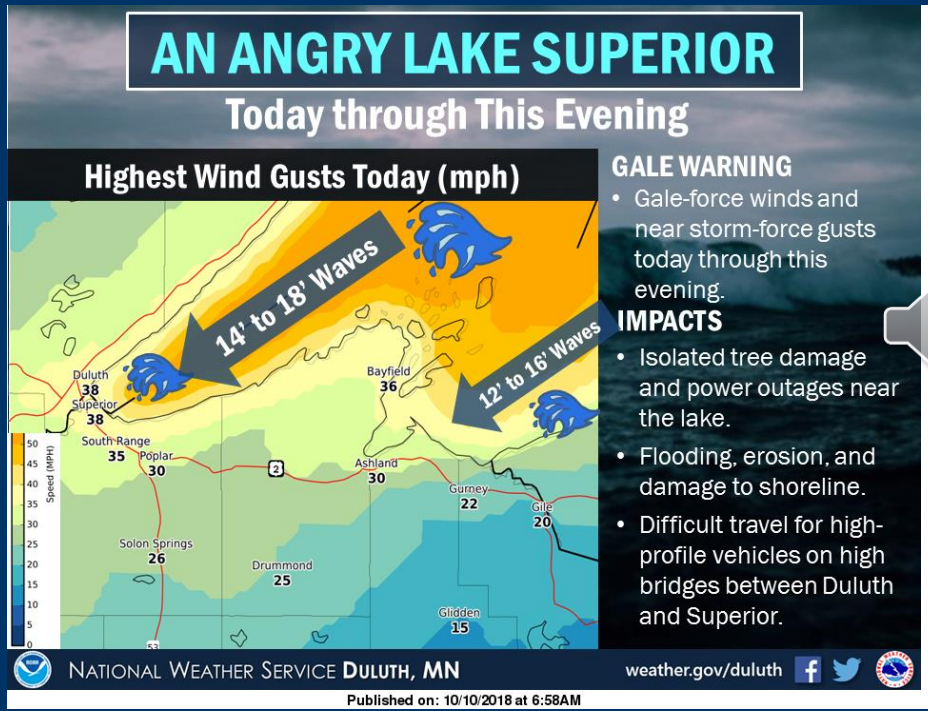
2020
Wet across central part of the Great Lakes basin

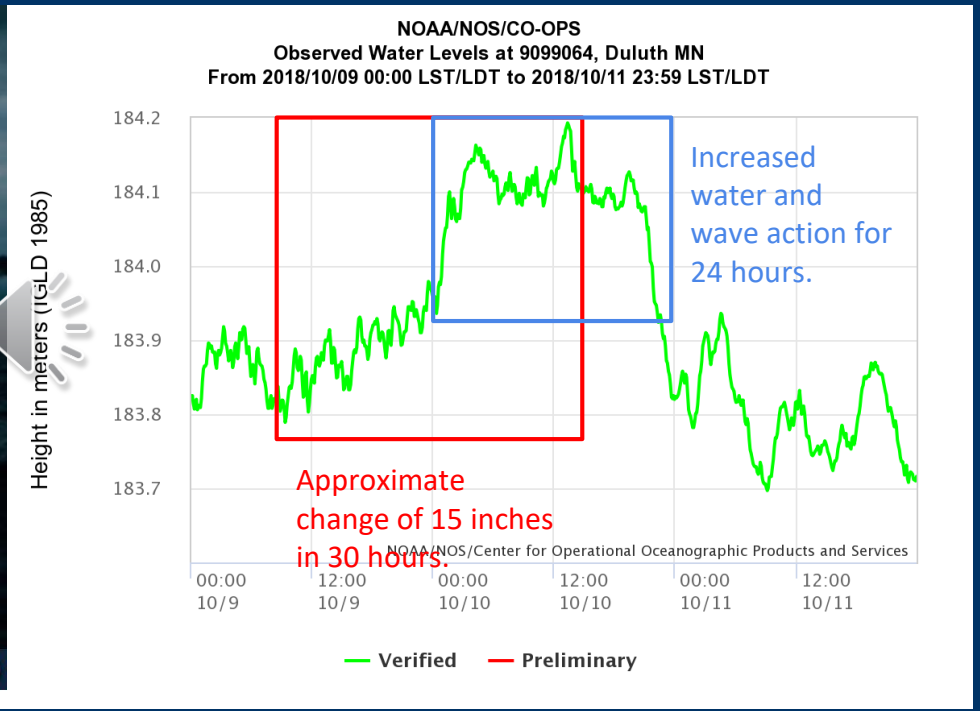
Year to Date Precipitation Departure from Average
Last 6 months



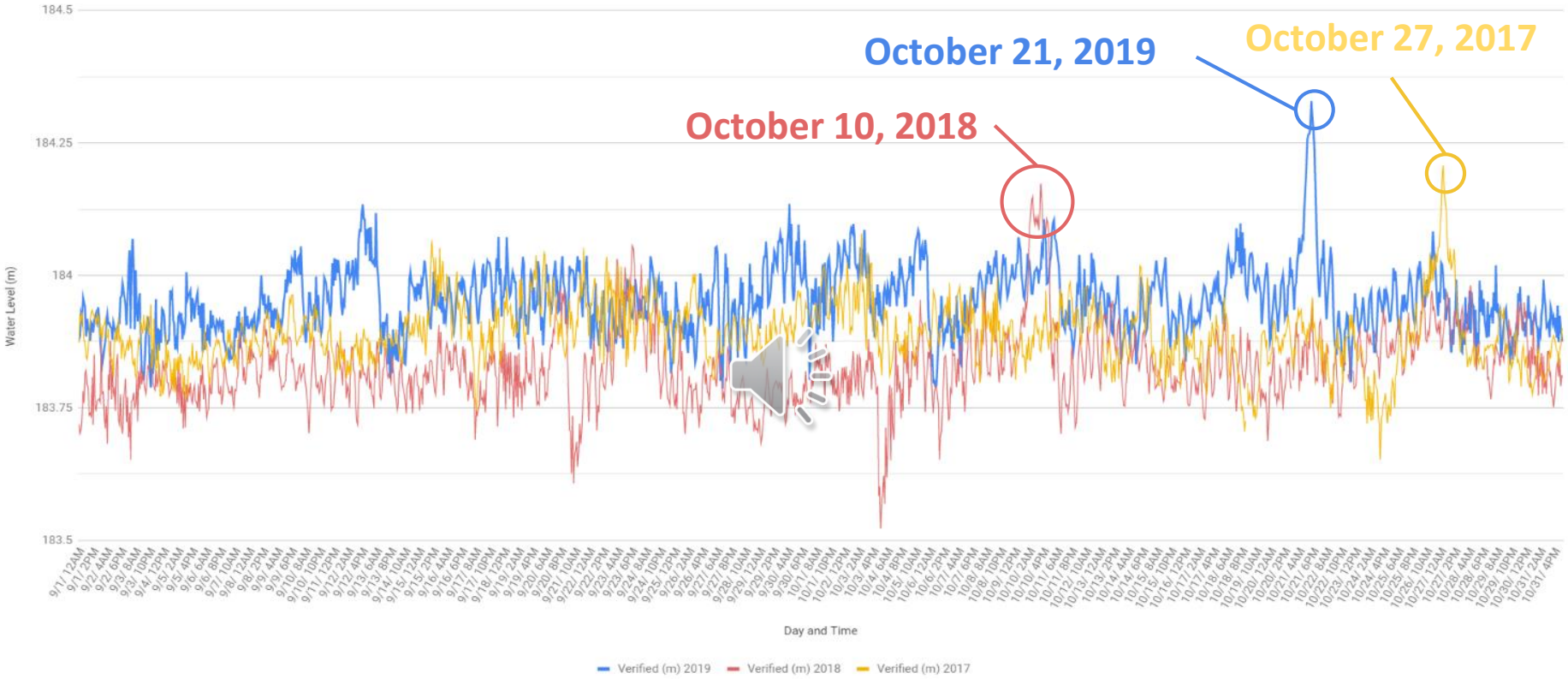
Office for Coastal Management

Lake Superior Water Levels: Storm Impacts



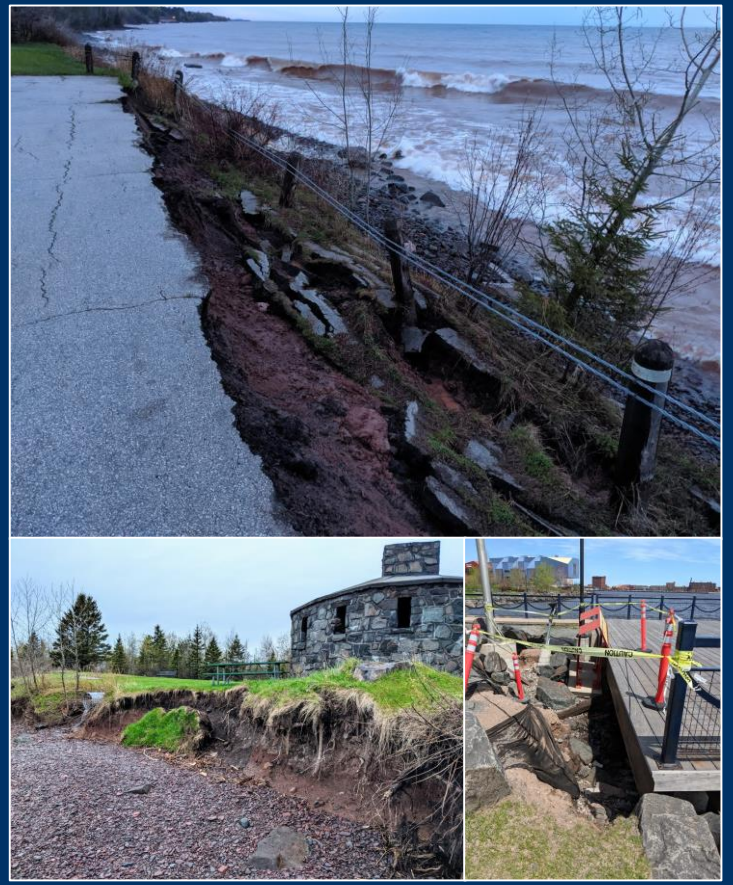


Comparison of Water Levels and Storm Events - Duluth, MN 9099064



Great Lakes Water Levels: Coastal Impacts

- Coastal Erosion
- Increased sediment transport in the littoral zone
- Alterations to stream and river mouths
- Damage to coastal infrastructure
- Flooded marinas and docks
- Hazards to navigation
- Loss of coastal terrestrial and wetland habitat
- Shrinking beaches for recreational use
- Increased impacts when storms move through
- Damage and loss of private property



Brighton Beach, Duluth, MN

Office for Coastal Management

Illinois Beach State Park

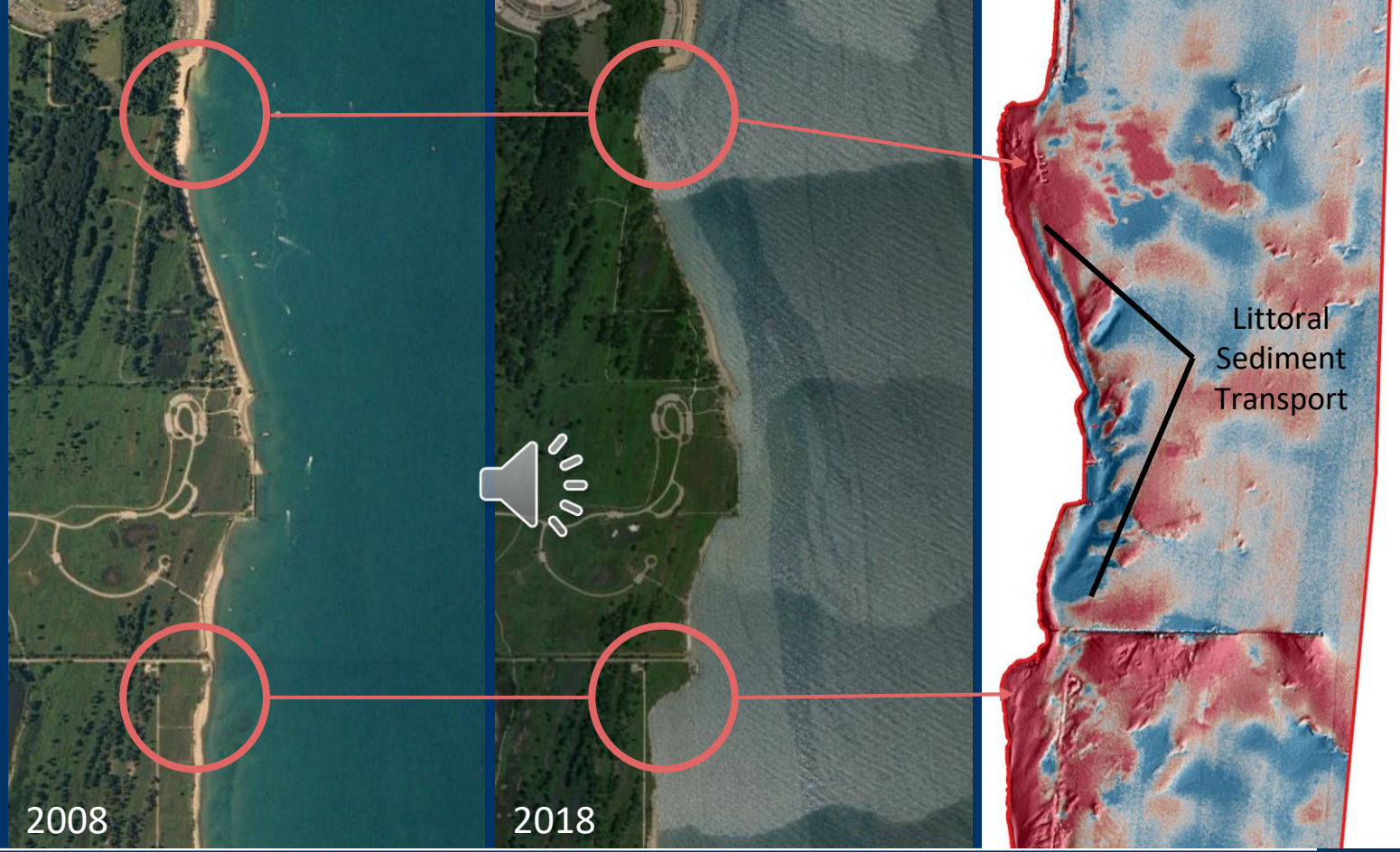
Coastal Erosion

Impact to coastal wetlands

Littoral sediment transport

Red - erosion

Blue - deposition



Coastal Erosion

Lincoln Charter Township, Michigan
AUGUST 2005

Coastal Erosion

Lincoln Charter Township, Michigan
APRIL 2011

Coastal Erosion

Lincoln Charter Township, Michigan
SEPTEMBER 2015

Coastal Erosion

Lincoln Charter Township, Michigan
MARCH 2019

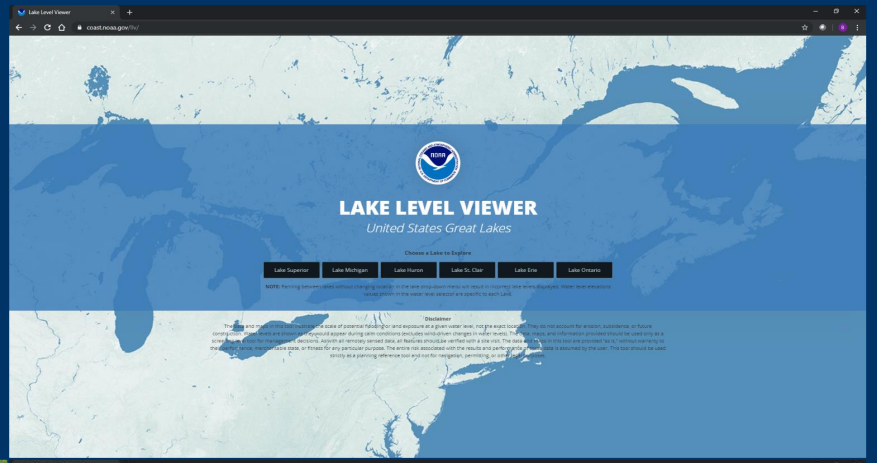
Ontario Beach Park, Rochester, NY

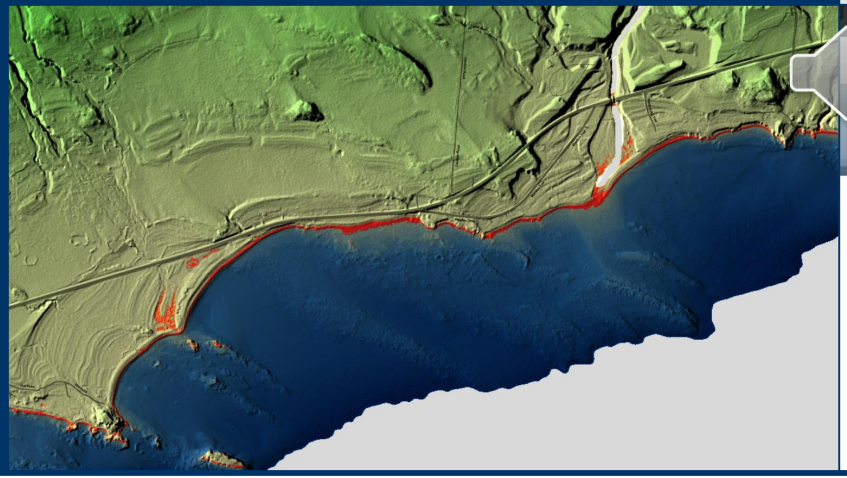
Office for Coastal Management

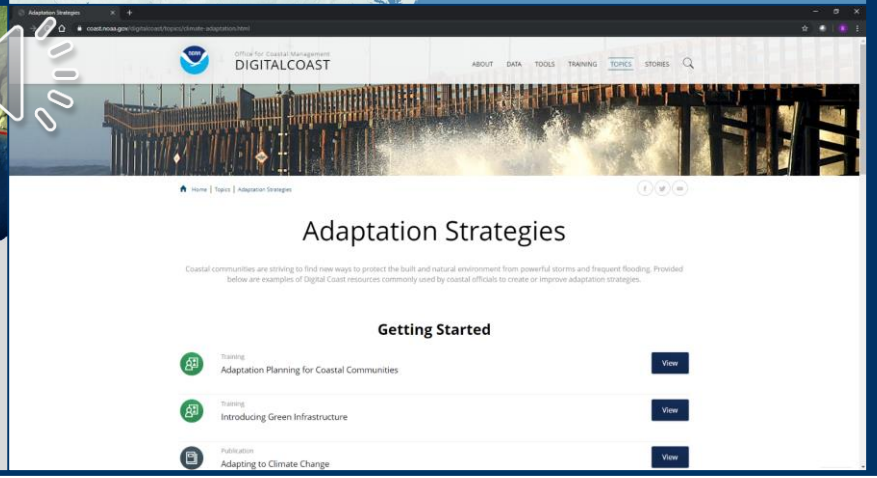
Digital Coast

Data, Tools, Trainings, and Resources

https://coast.noaa.gov/digitalcoast/





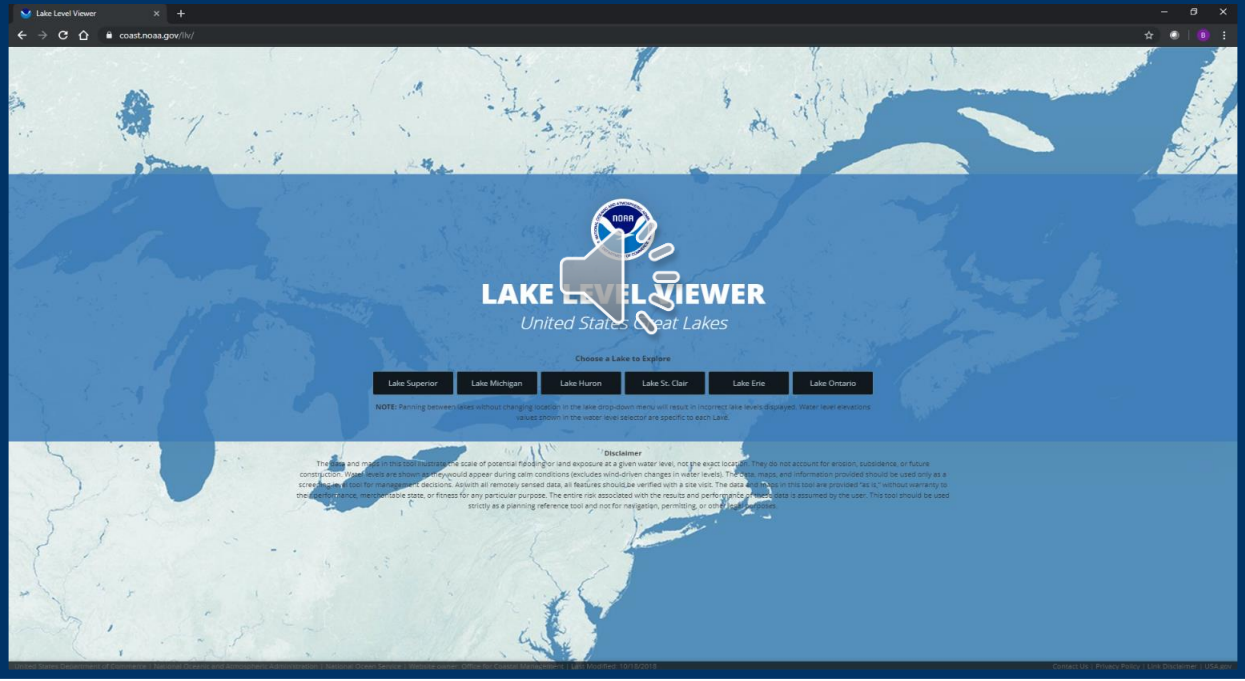


Office for Coastal Management

NOAA's Lake Level Viewer

- Work on the Lake Level Viewer began over 7 years ago
- First official release in November 2014
- Funded by the Great Lakes Restoration Initiative
- Fills a critical information data gap through easy to navigate mapping and visualization
- Digital elevation model data updated in 2016

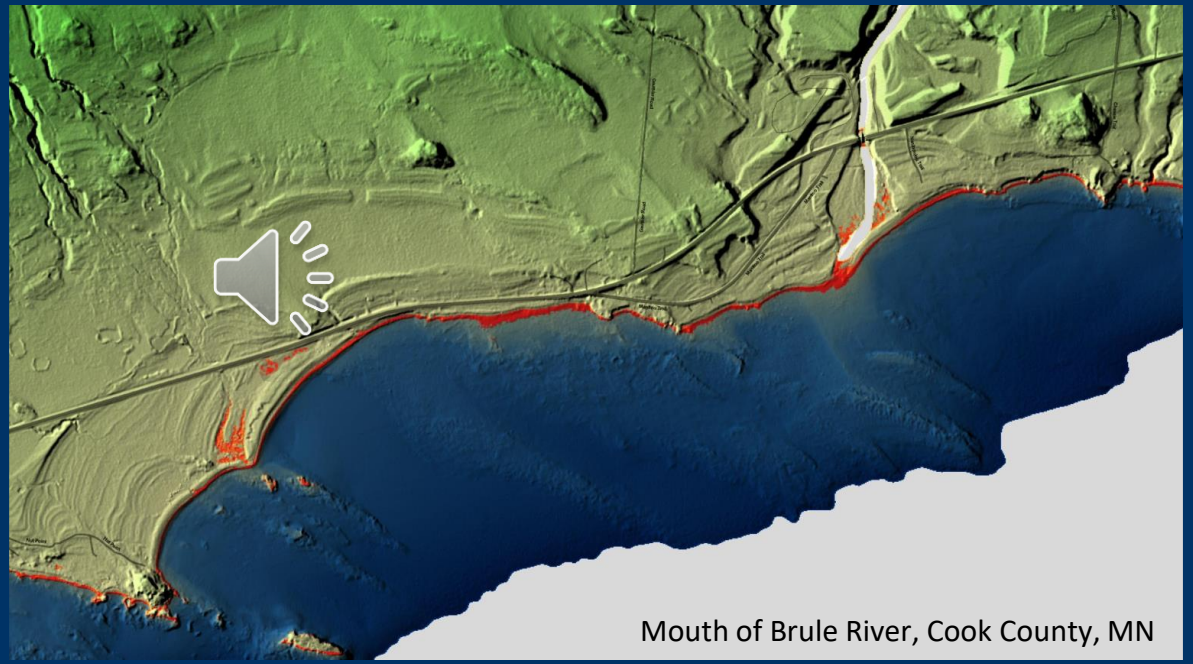
NOAA’s Lake Level Viewer: Tool



NOAA's Lake Level Viewer: Data

Digital Elevation Models (DEMs):

Red area denotes coastal areas that fall between record high and record low water levels for Lake Superior



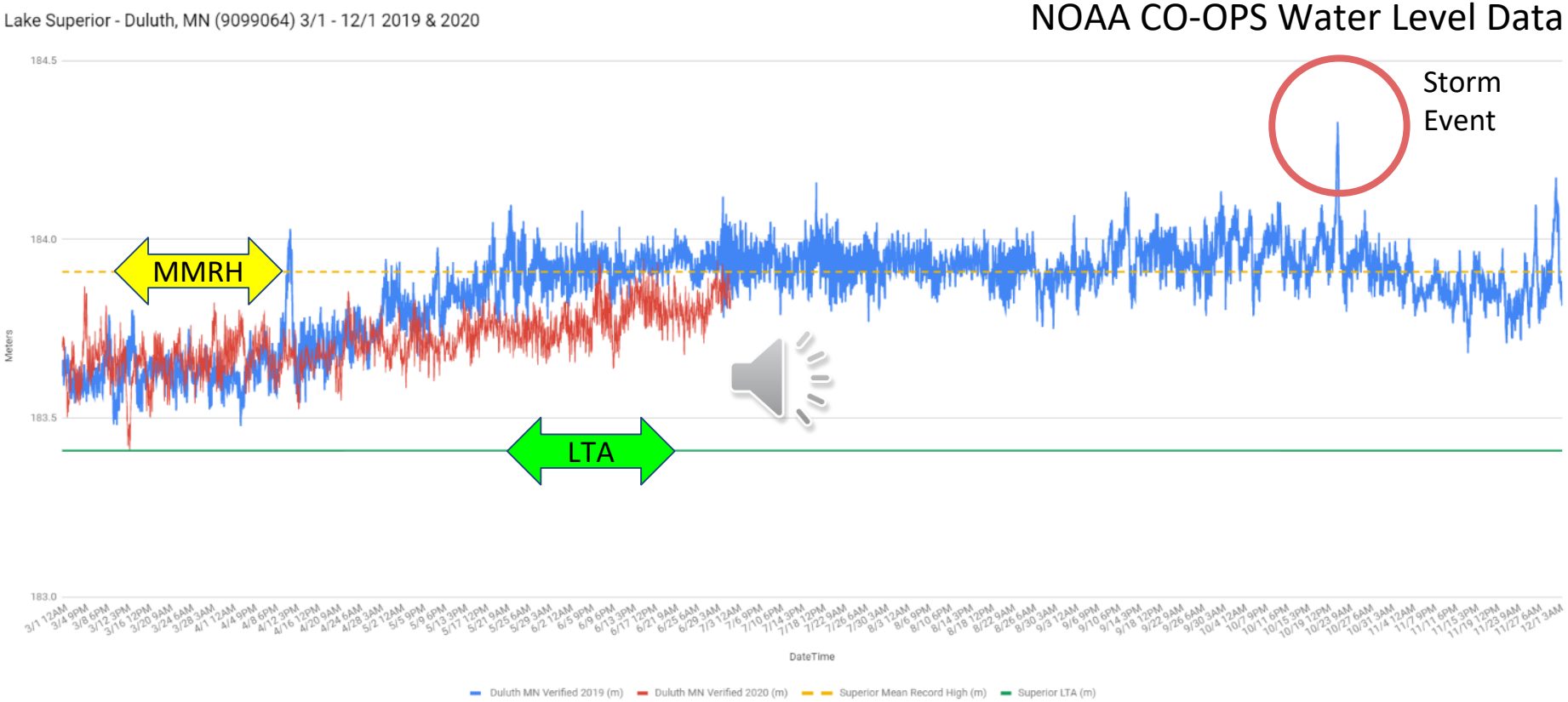
Mouth of Brule River, Cook County, MN

NOAA's Lake Level Viewer

Recent Examples:
Duluth, Minnesota October 21, 2019
Buffalo, New York November, 1, 2019

Large storm event moving west to east across the Great Lakes basin causing lakeshore flooding in multiple locations.

NOAA CO-OPS Water Level Data



IGLD 1985

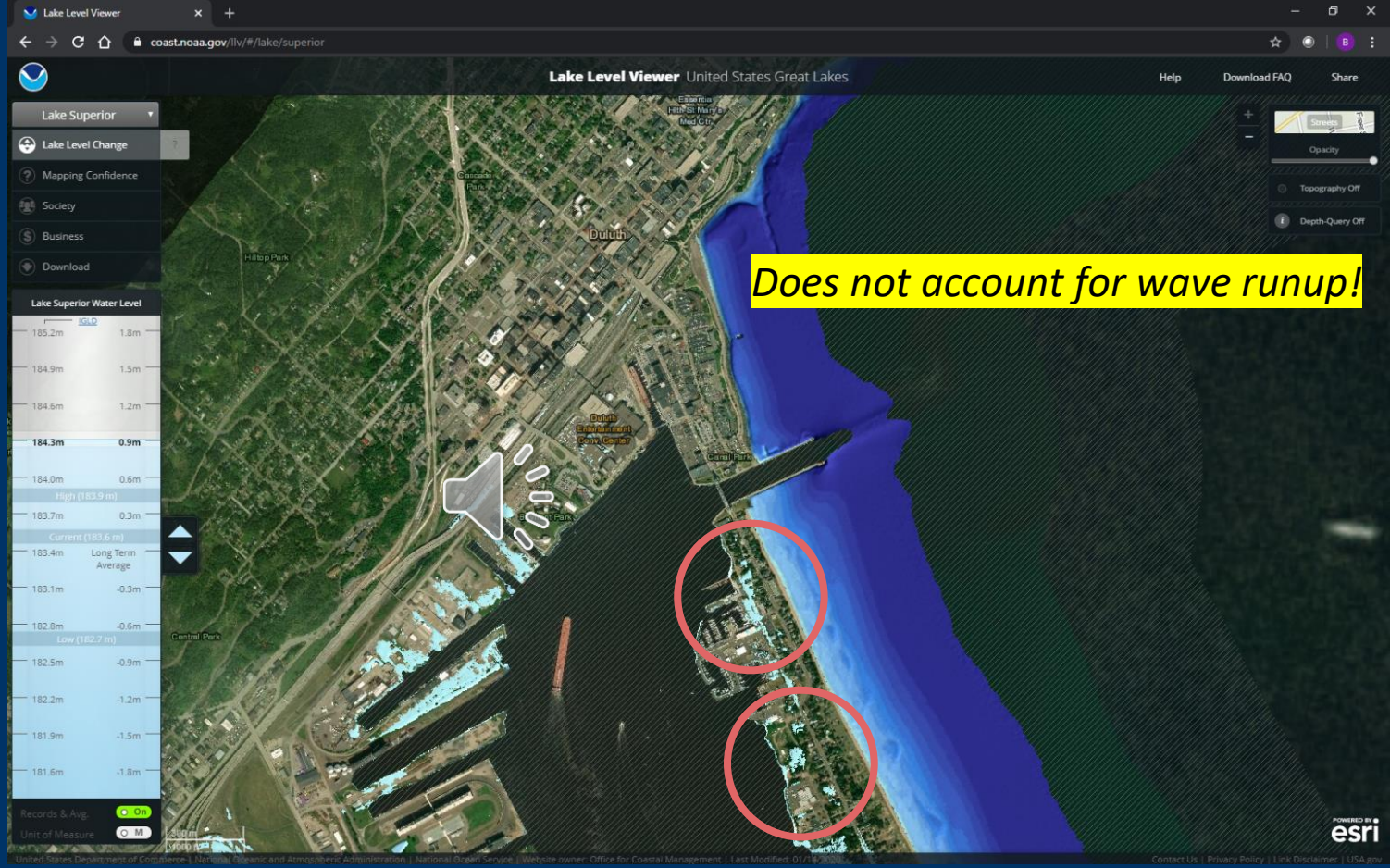
Duluth, MN

10/21/2019 4PM

184.33 meters
604.75 feet

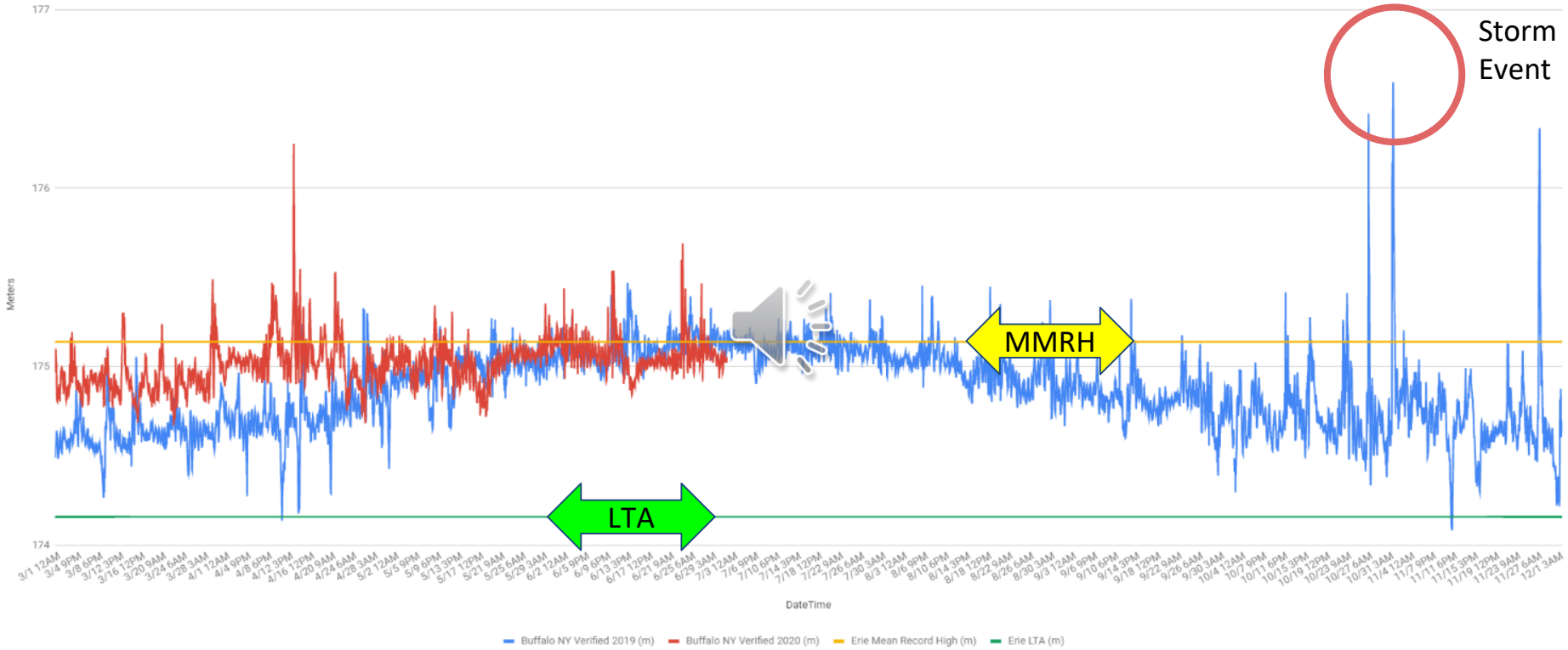
LTA
183.41 m
601.74 ft

Difference
+0.92 m
+3.02 ft



Office for Coastal Management

NOAA CO-OPS Water Level Data



IGLD 1985

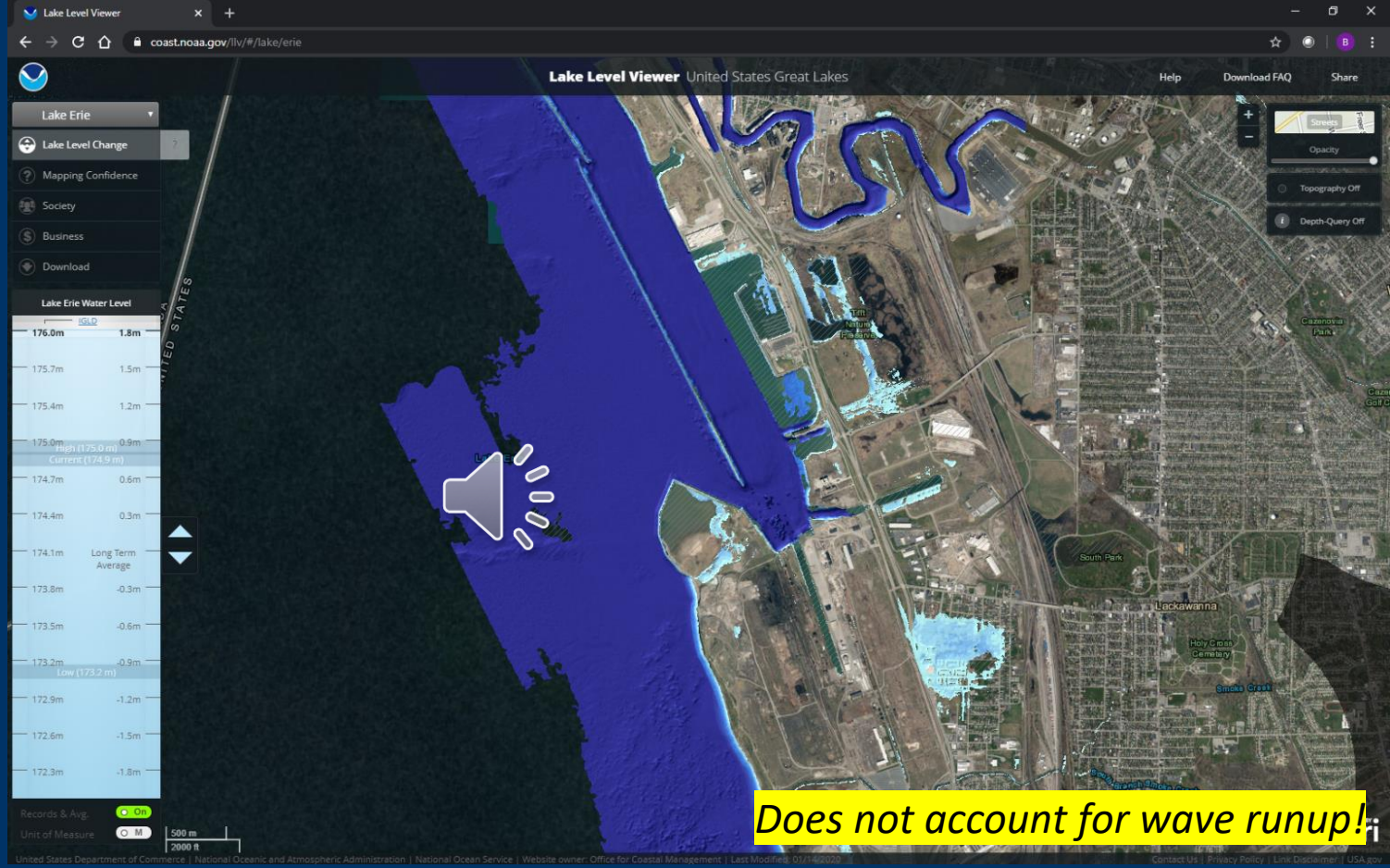
Buffalo, NY

11/1/2019 12AM

176.59 meters
579.36 feet

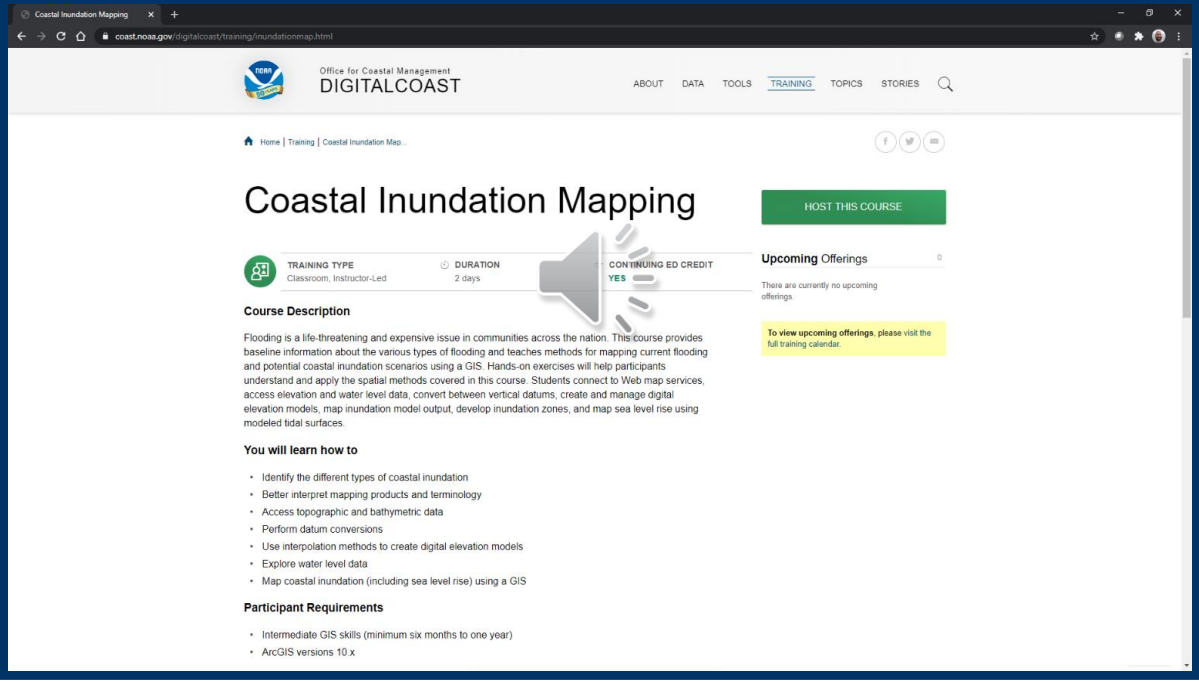
LTA
174.16 m
571.4 ft

Difference
+2.43 m
+7.96 ft



Office for Coastal Management

Coastal Inundation Mapping Training



Great Lakes Coastal Zone Management Programs

Resources

Digital Coast	coast.noaa.gov/digitalcoast/
Lake Level Viewer	coast.noaa.gov/llv/
Water Level Dashboard	www.glerl.noaa.gov/data/dashboard/GLWLD.html
NOAA CO-OPS Water Levels	tidesandcurrents.noaa.gov/stations.html?type=Water+Levels
US Interagency Elevation Inventory	coast.noaa.gov/inventory/
Coastal Inundation Mapping Training	coast.noaa.gov/digitalcoast/training/inundationmap.html
USACE Great Lakes Information	www.lre.usace.army.mil/Missions/Great-Lakes-Information/

Contact Information

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(320) 290-1381

Adam Bechle
Coastal Engineering Outreach Specialist
Wisconsin Sea Grant
bechle@aqua.wisc.edu

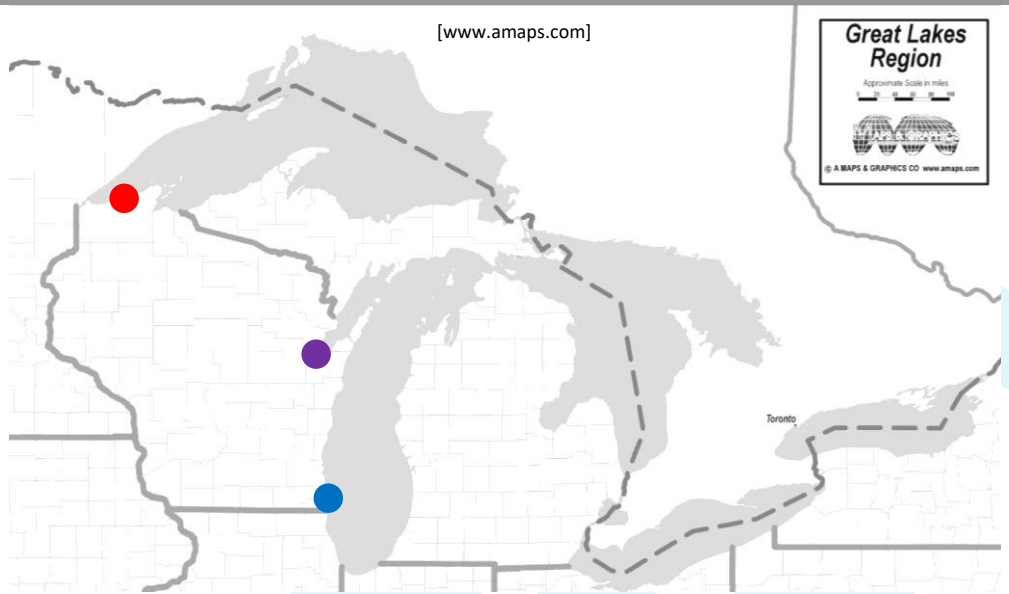
Vulnerability to Heightened Lake Levels on Wisconsin's Great Lakes

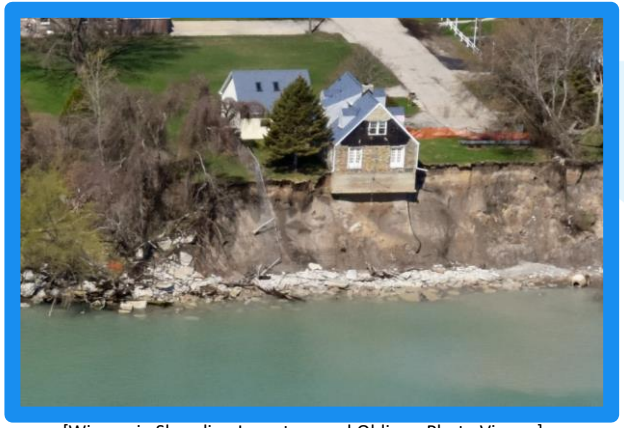
[Wisconsin Shoreline Inventory and Oblique Photo Viewer]

[Julia Noordyk]

[Wisconsin Shoreline Inventory and Oblique Photo Viewer]

[www.amaps.com]



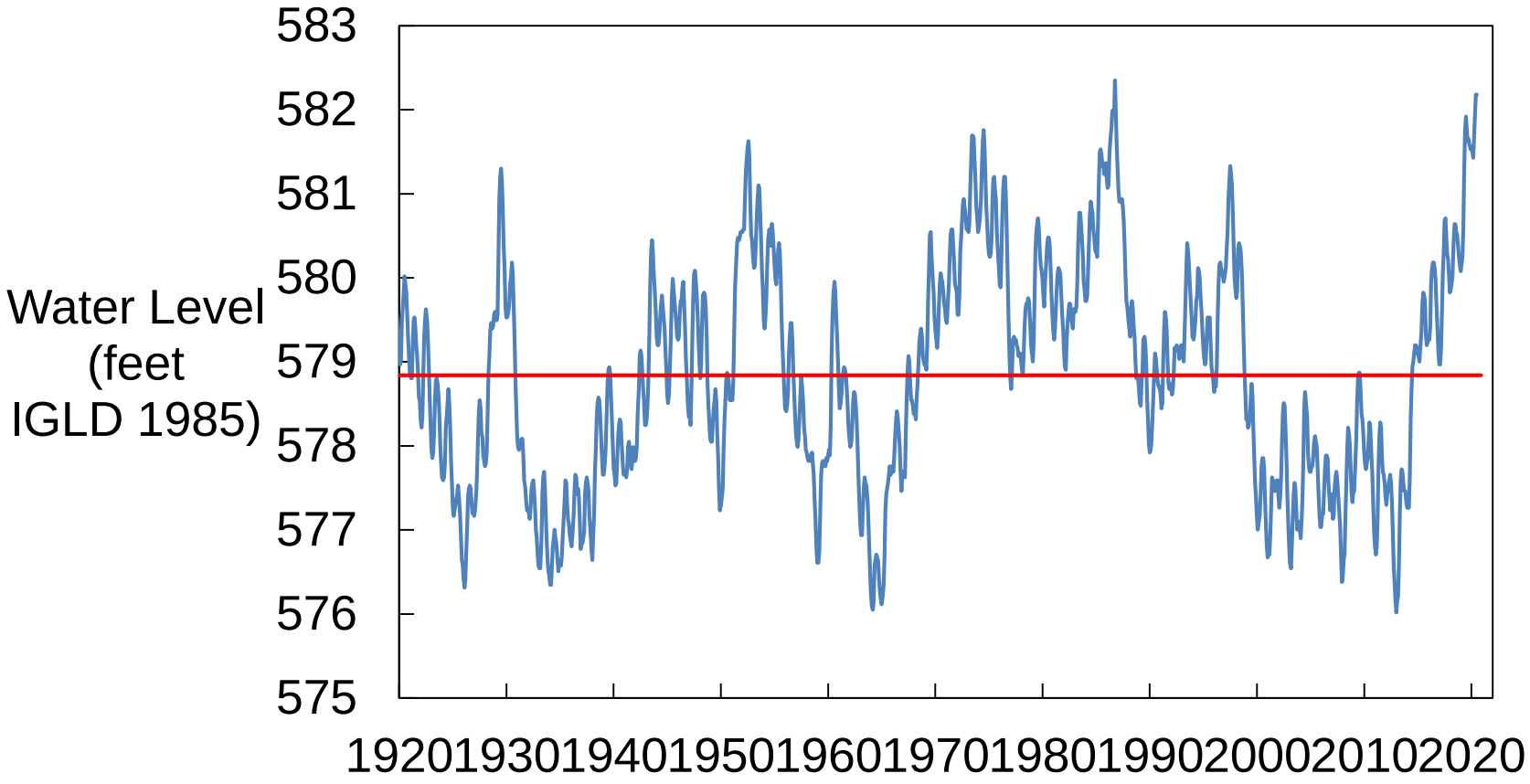


[Wisconsin Shoreline Inventory and Oblique Photo Viewer]

[Julia Noordyk]

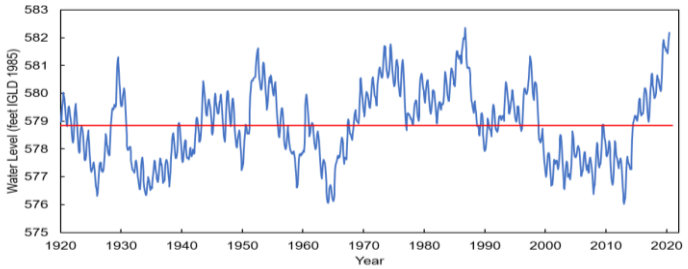
[Wisconsin Shoreline Inventory and Oblique Photo Viewer]

Lake Michigan Water Levels (1918-2020)

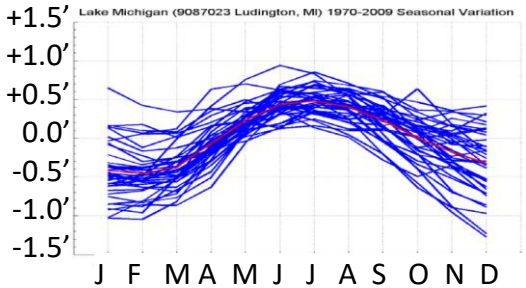


Time Scale of Water Level Changes

- Inter-annual



- Seasonal



[modified from Melby et al., 2012]

- Short-term
  - Seconds – wind waves
  - Minutes/hours – storm surge

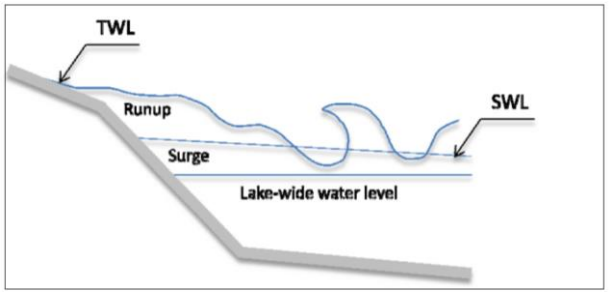


Figure 2. Still water and total water levels sketch.

[Nadal-Carabello et al., 2012]

Green Bay Coastal Flooding 2019-2020

Dec. 1, 2019

[Julia Noordyk]

April 28, 2020

[Jeff DuMez – Brown County]

Historic Green Bay Coastal Flooding

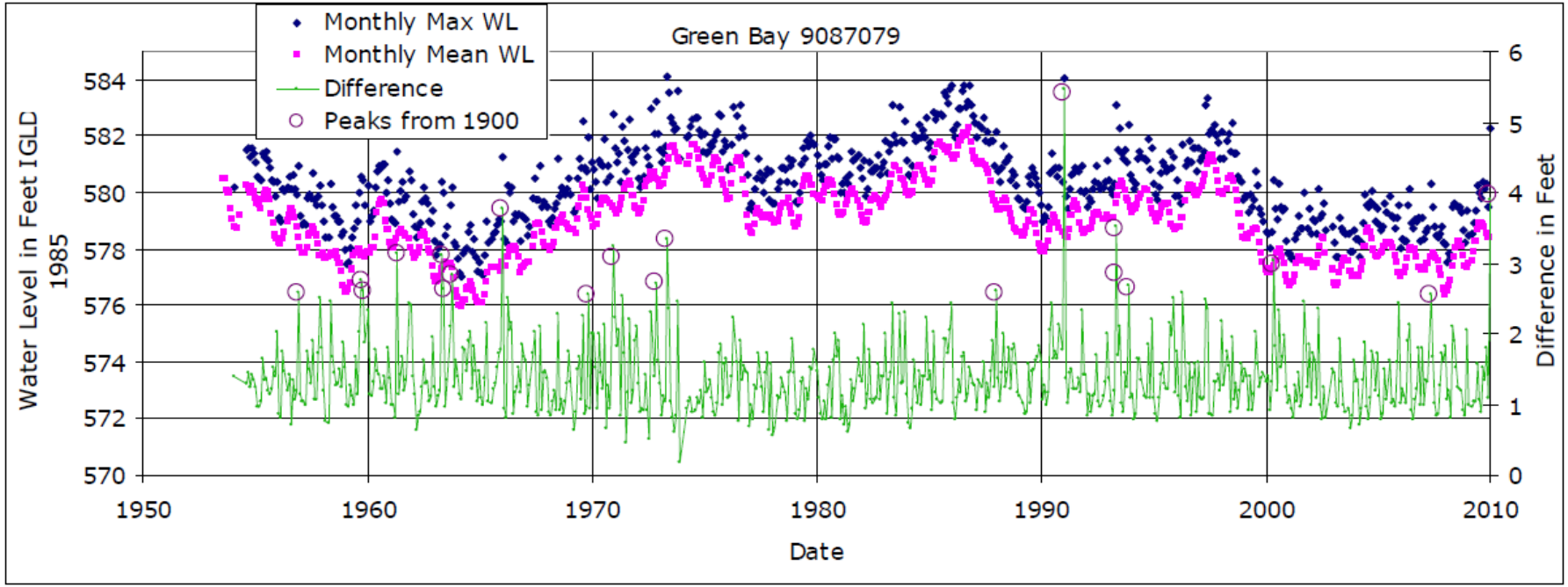


Figure 12. Green Bay 9087078 and 9087079 measured water levels 1954 – 2010.

Melby , J. A., Nadal-Caraballo, N. C., Pagan-Albelo, Y. and Ebersole, B. A. (2012),
"Wave Height and Water Level Variability on Lakes Michigan and St. Clair," U.S. Army Corps of Engineers, TR-12-23

April 8, 1973

GREEN BAY PRESS-GAZETTE

VOLUME LVII, No. 283 48 PAGES GREEN BAY, WISCONSIN, TUESDAY, APRIL 10, 1973 15 CENTS

Floods Force 800 From Homes

Never Been So Bad, Flood Victims Say

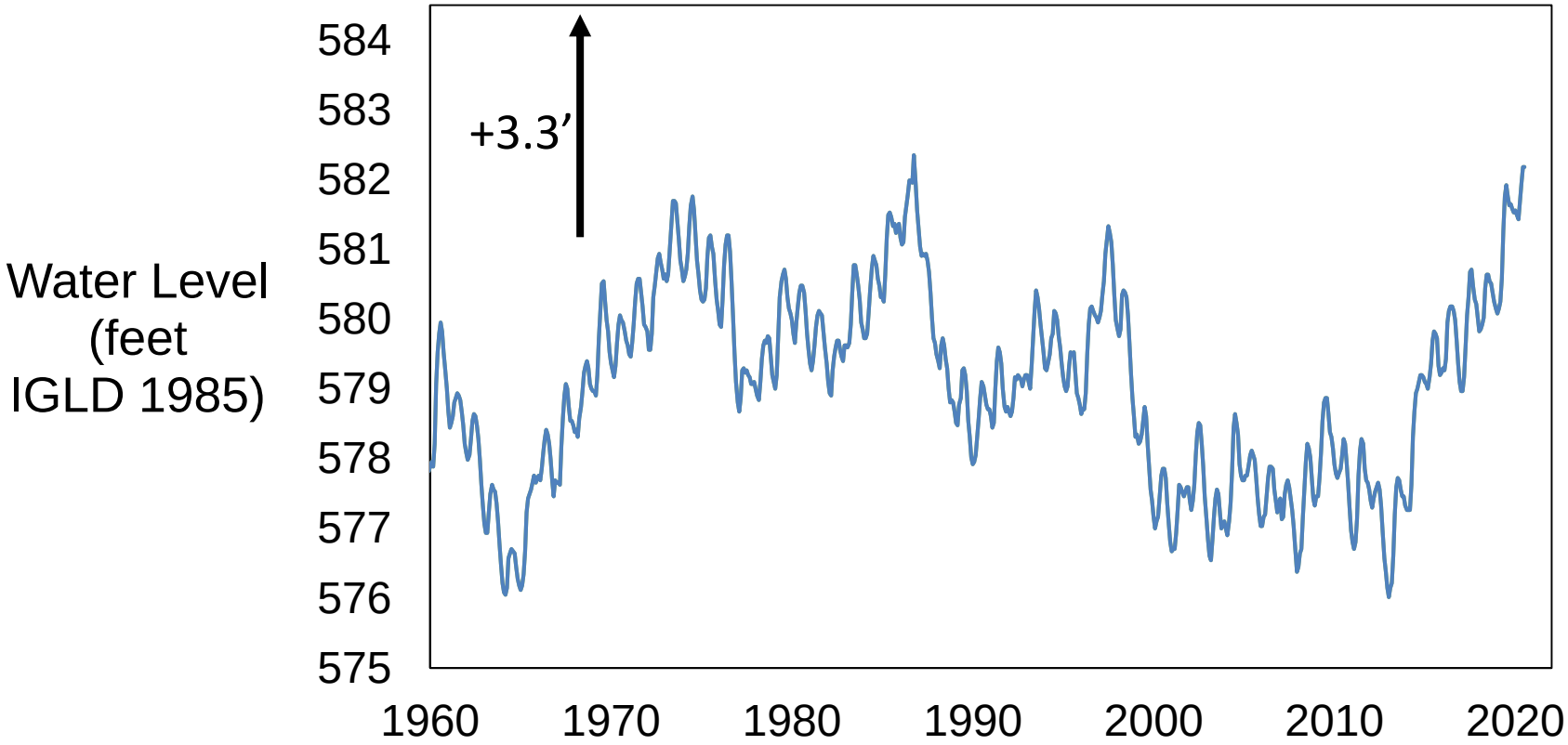
$2 Million Damage at MSD

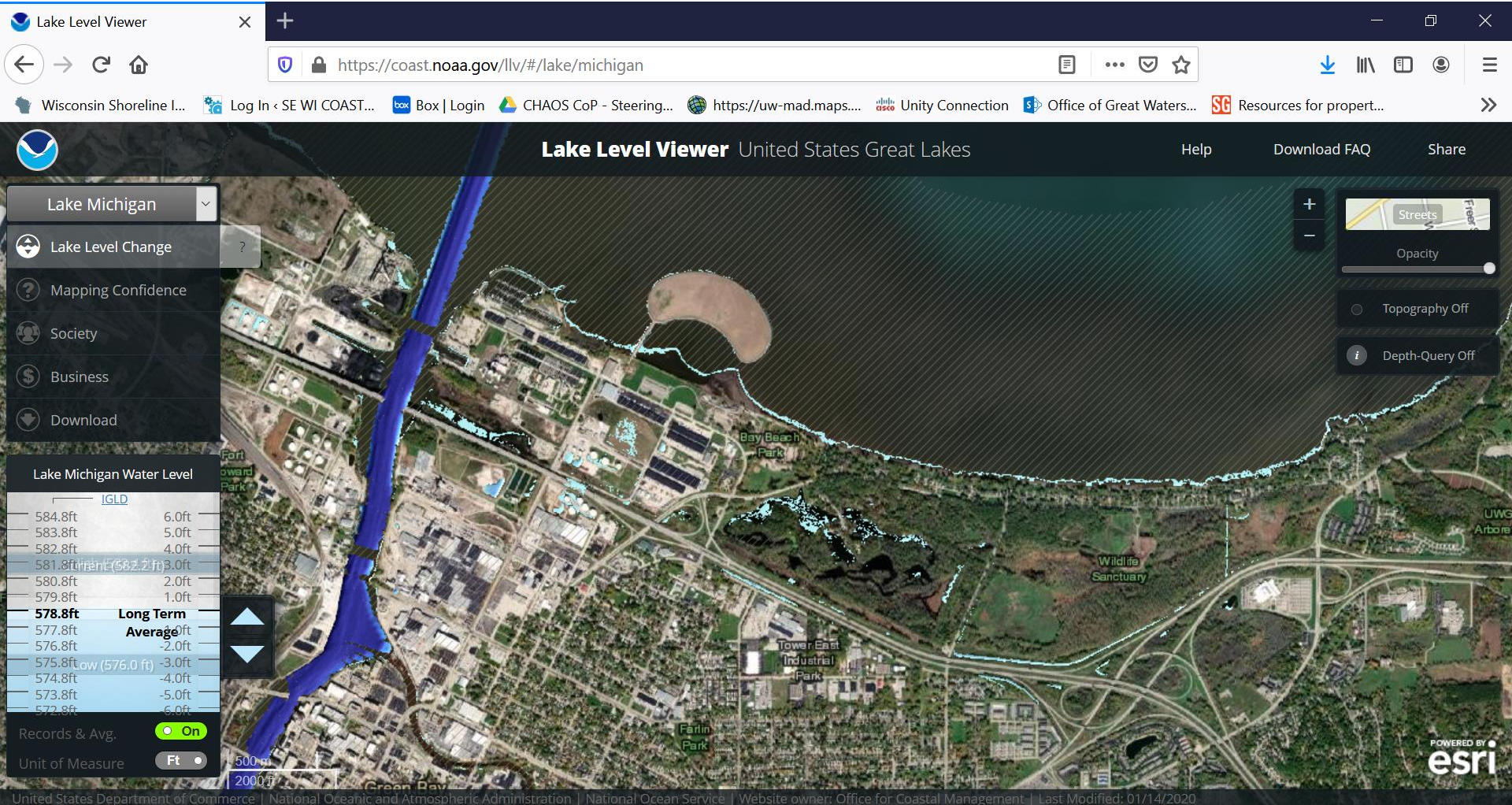
Rescue Crews Resort to Waders

[Green Bay Press-Gazette]

[Green Bay Press-Gazette]

April 8, 1973


Water Level (feet IGLD 1985)
584
583
582
581
580
579
578
577
576
575
+3.3’
1960
1970
1980
1990
2000
2010
2020


Lake Level Viewer
https://coast.noaa.gov/llv/#/lake/michigan
Wisconsin Shoreline I...
Log In ‹ SE WI COAST...
Box | Login
CHAOS CoP - Steering...
https://uw-mad.maps....
Unity Connection
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Lake Level Viewer United States Great Lakes
Help
Download FAQ
Share
Lake Michigan
Lake Level Change
Mapping Confidence
Society
Business
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Lake Michigan Water Level
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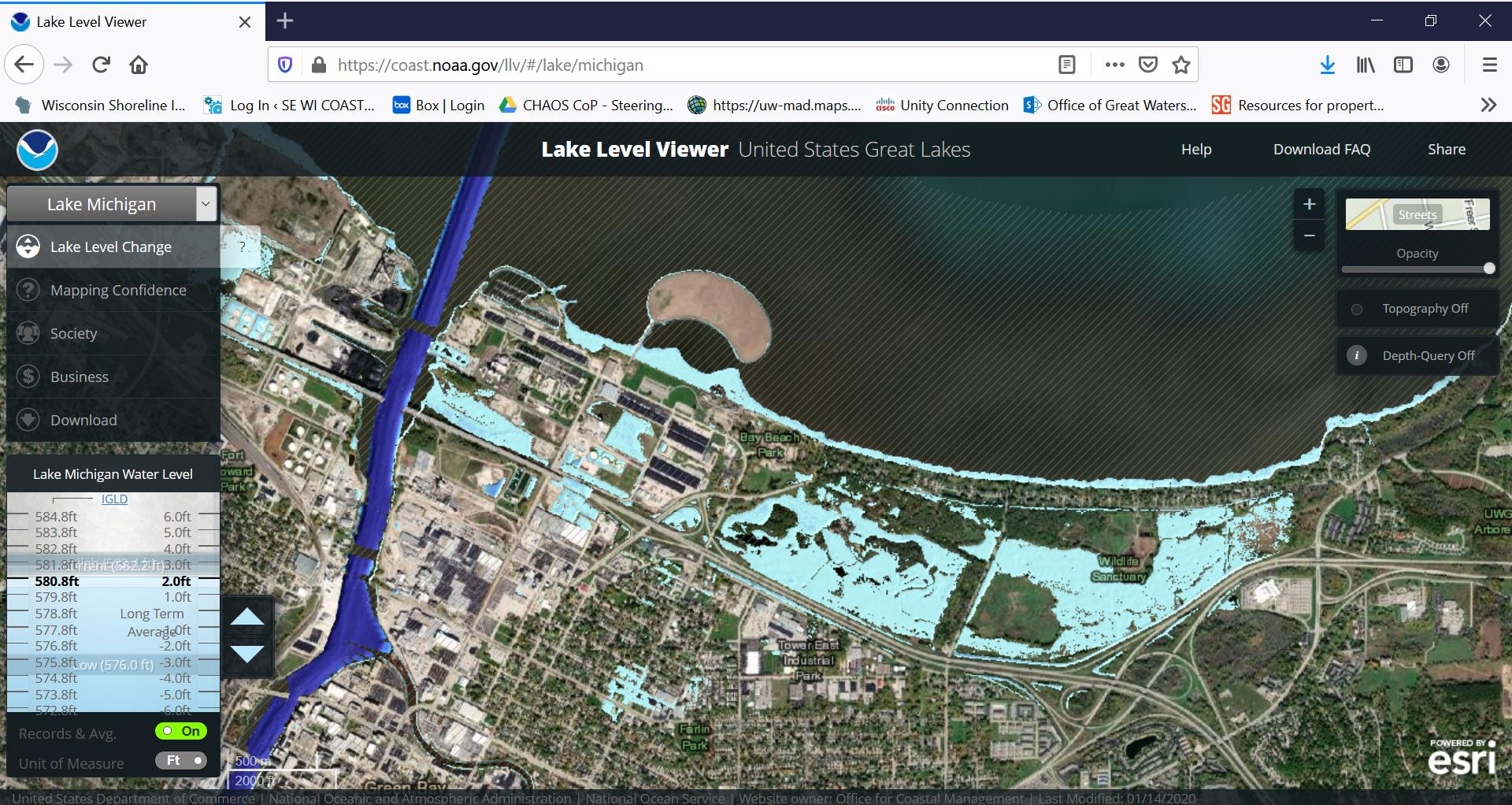
584.8ft 6.0ft
583.8ft 5.0ft
582.8ft 4.0ft
581.8ft 3.0ft
580.8ft 2.0ft
579.8ft 1.0ft
578.8ft Long Term Average
577.8ft 0.0ft
576.8ft -2.0ft
575.8ft -3.0ft
574.8ft -4.0ft
573.8ft -5.0ft
572.8ft -6.0ft
Current (582.2 ft)
Low (576.0 ft)
Records & Avg. On
Unit of Measure Ft
Streets
Opacity
Topography Off
Depth-Query Off
Bay Beach Park
Wildlife Sanctuary
Tower East Industrial Park
Farlin Park
500 ft
2000 ft
Green Bay
POWERED BY esri
United States Department of Commerce | National Oceanic and Atmospheric Administration | National Ocean Service | Website owner: Office for Coastal Management | Last Modified: 01/14/2020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580.8ft 2.0ft
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578.8ft Long Term
577.8ft Average 0ft
576.8ft -2.0ft
575.8ft -3.0ft
Low (576.0 ft)
574.8ft -4.0ft
573.8ft -5.0ft
572.8ft -6.0ft
Records & Avg.
On
Unit of Measure
Ft
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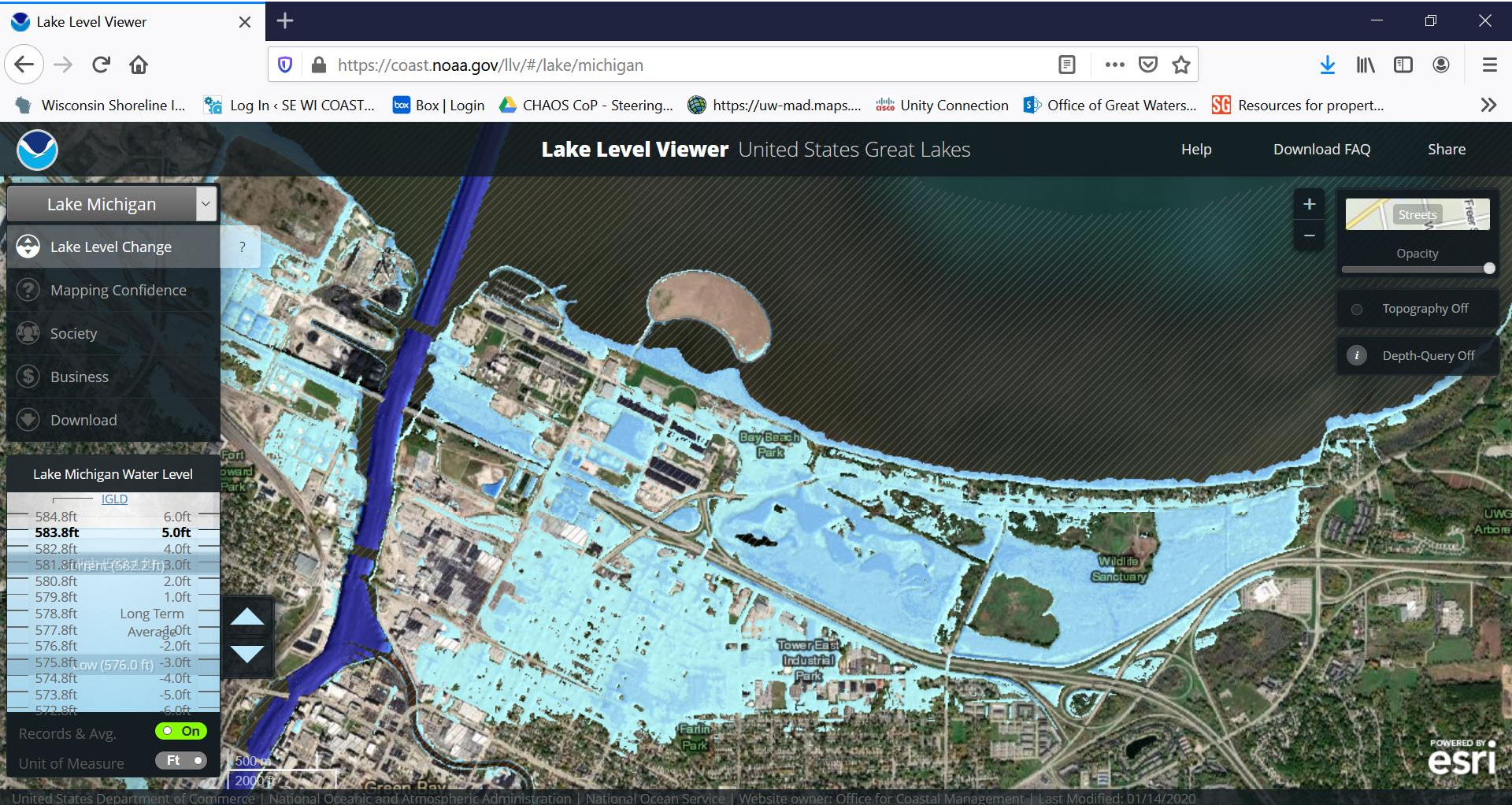
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572.8ft -6.0ft
Records & Avg.
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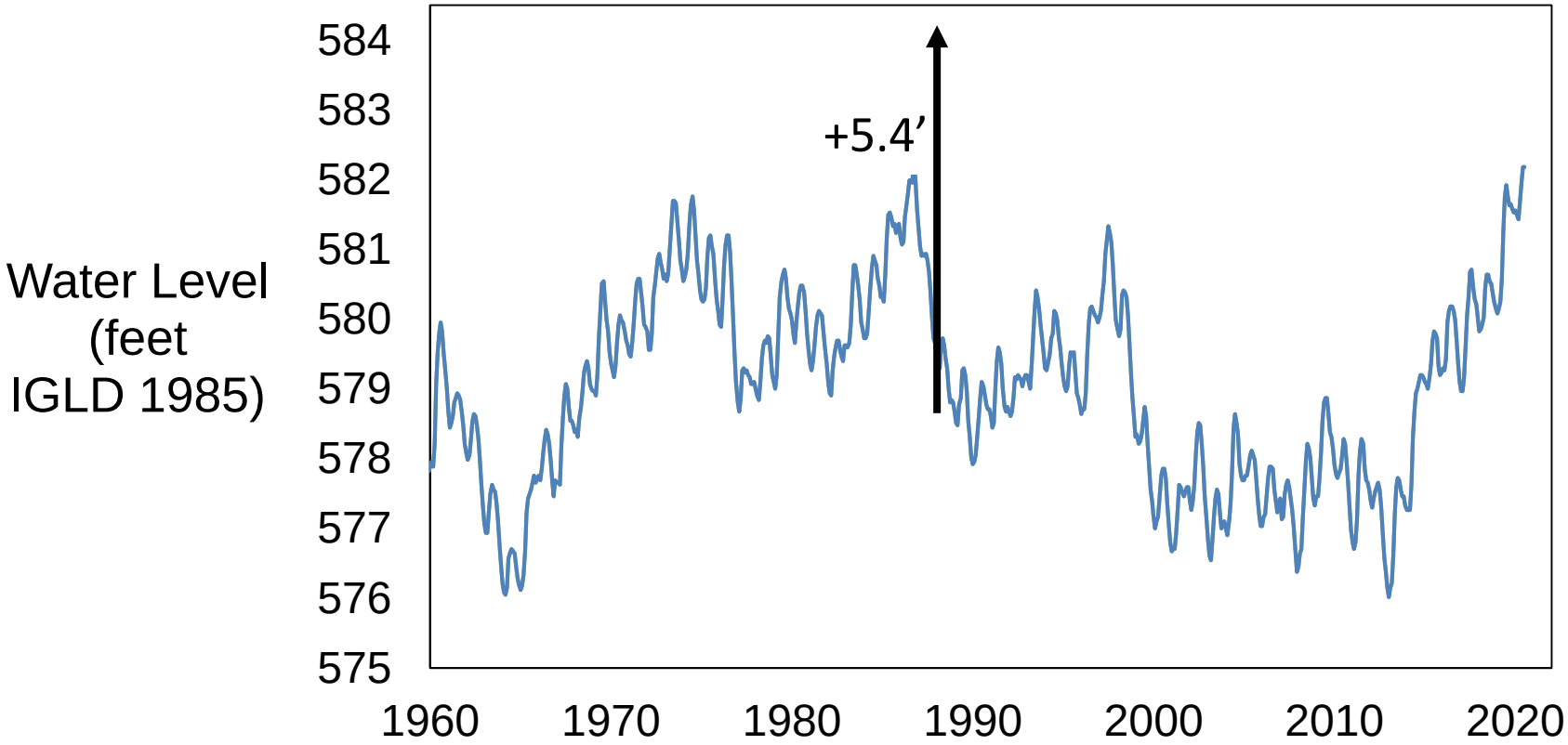
Farlin Park
500 ft
2000 ft
POWERED BY esri
United States Department of Commerce | National Oceanic and Atmospheric Administration | National Ocean Service | Website owner: Office for Coastal Management | Last Modified: 01/14/2020

May 12, 1973

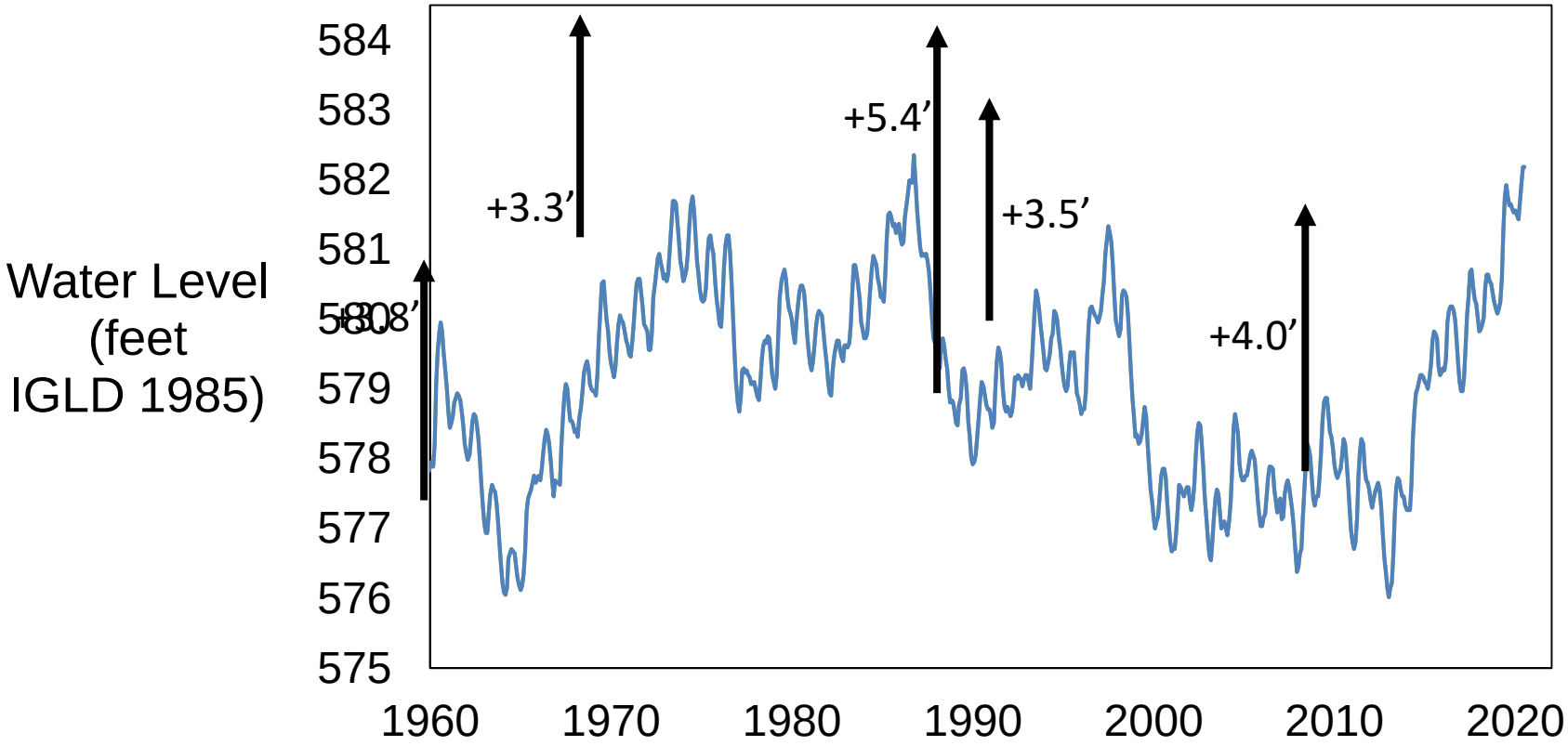
Dike Work Started — Heavy equipment was brought in this week to move sand and clay for the state of the $1 million east shore dike. The Boulanger Construction Co. of Casco is building the dike which will run from near the mouth of the Fox River to Mahon Avenue. It is hoped the dike will prevent flooding, such as that which occurred last month which caused widespread damage to homes and businesses on the Northeast Side.
(Press-Gazette Photo)

[Green Bay Press-Gazette]

December 3, 1990



Timing of Water Levels + Storm Surge



December 1, 2019

+2.4 foot storm surge

(~average annual storm surge height)

[Julia Noordyk]

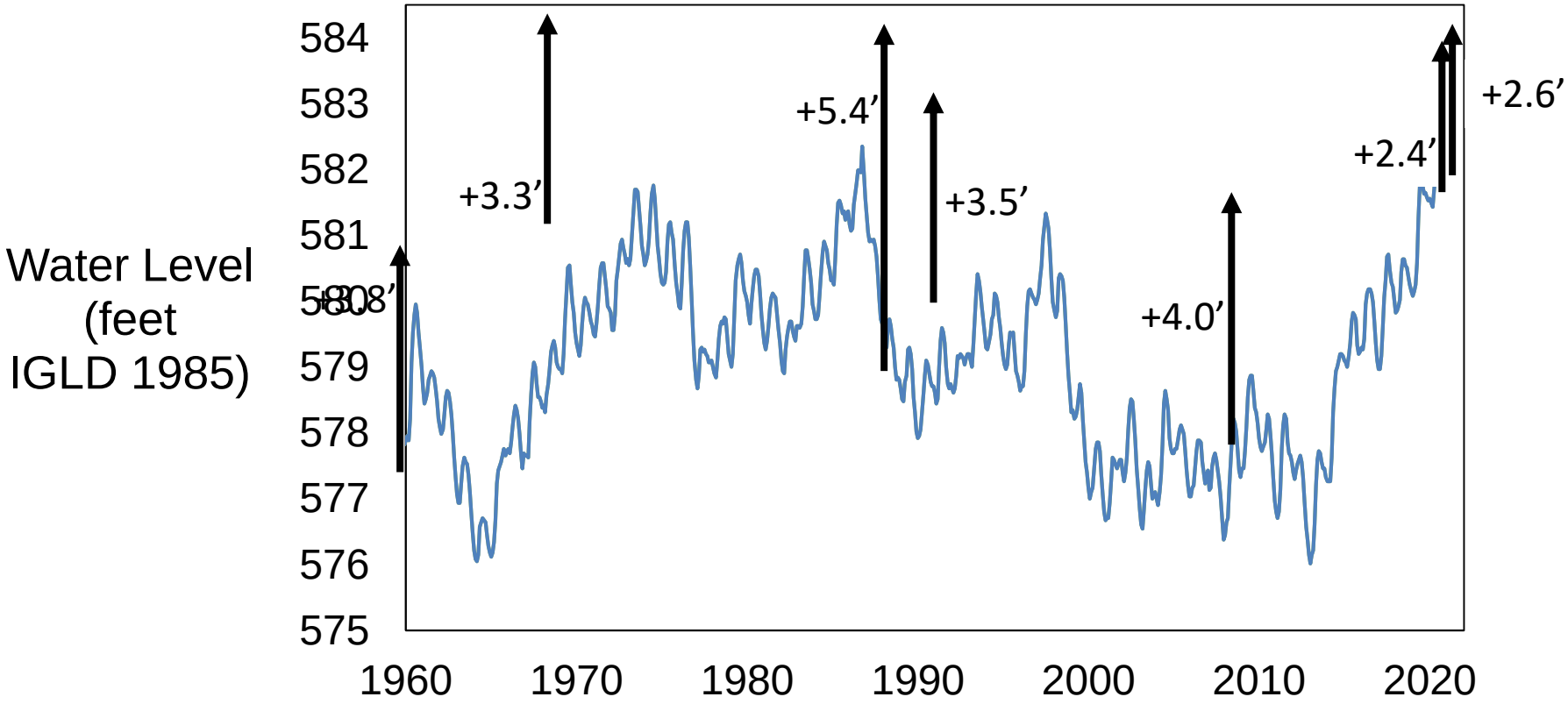
April 28, 2020

+2.6 foot storm surge

(~2 to 3 year return interval storm surge height)

[Jeff DuMez, Brown County]

Timing of Water Levels + Storm Surge



January 11th 2020 Southeastern Wisconsin Coastal Storm

[Michael Sears – Milwaukee Journal Sentinel]

[Stephanie Jones – Racine Journal Times]

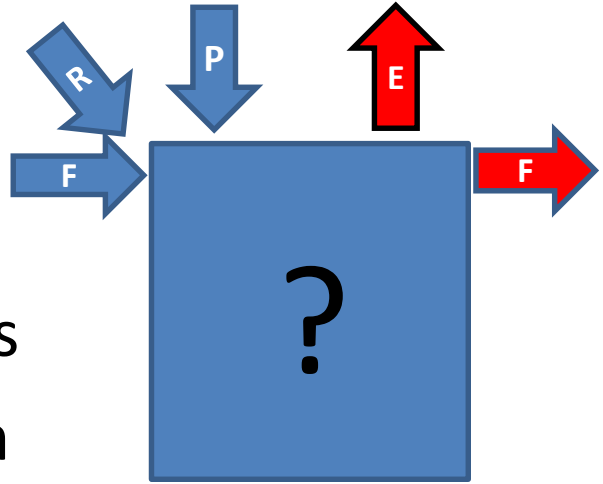
[Mike De Stisi – Milwaukee Journal Sentinel]

Summary

- Multiple Time Scales of Coastal Risk in the Great Lakes
  - Inter-annual - Lake Levels
  - Seasonal - Lake Levels
  - Short-Term - Storm Surge and Waves

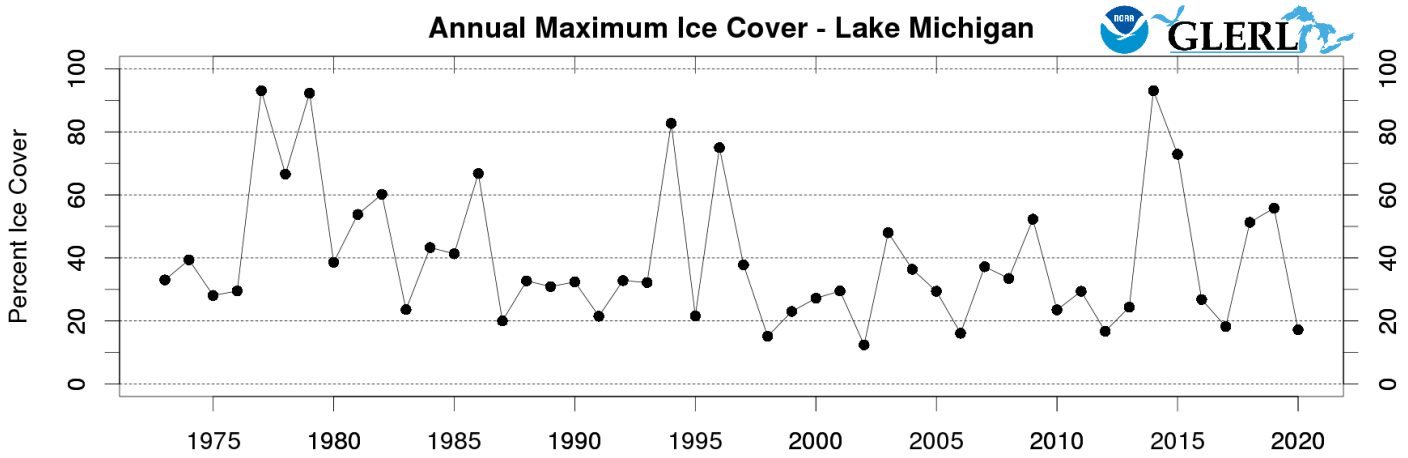
Climate Change Impact on Great Lakes Water Levels

- **Precipitation** onto a lake surface
- **Runoff** into a lake
- **Evaporation** from lake surface
- **Flow** through connecting channels
- **Diversions** into/out of lake system



Climate Change Impacts on Ice Cover

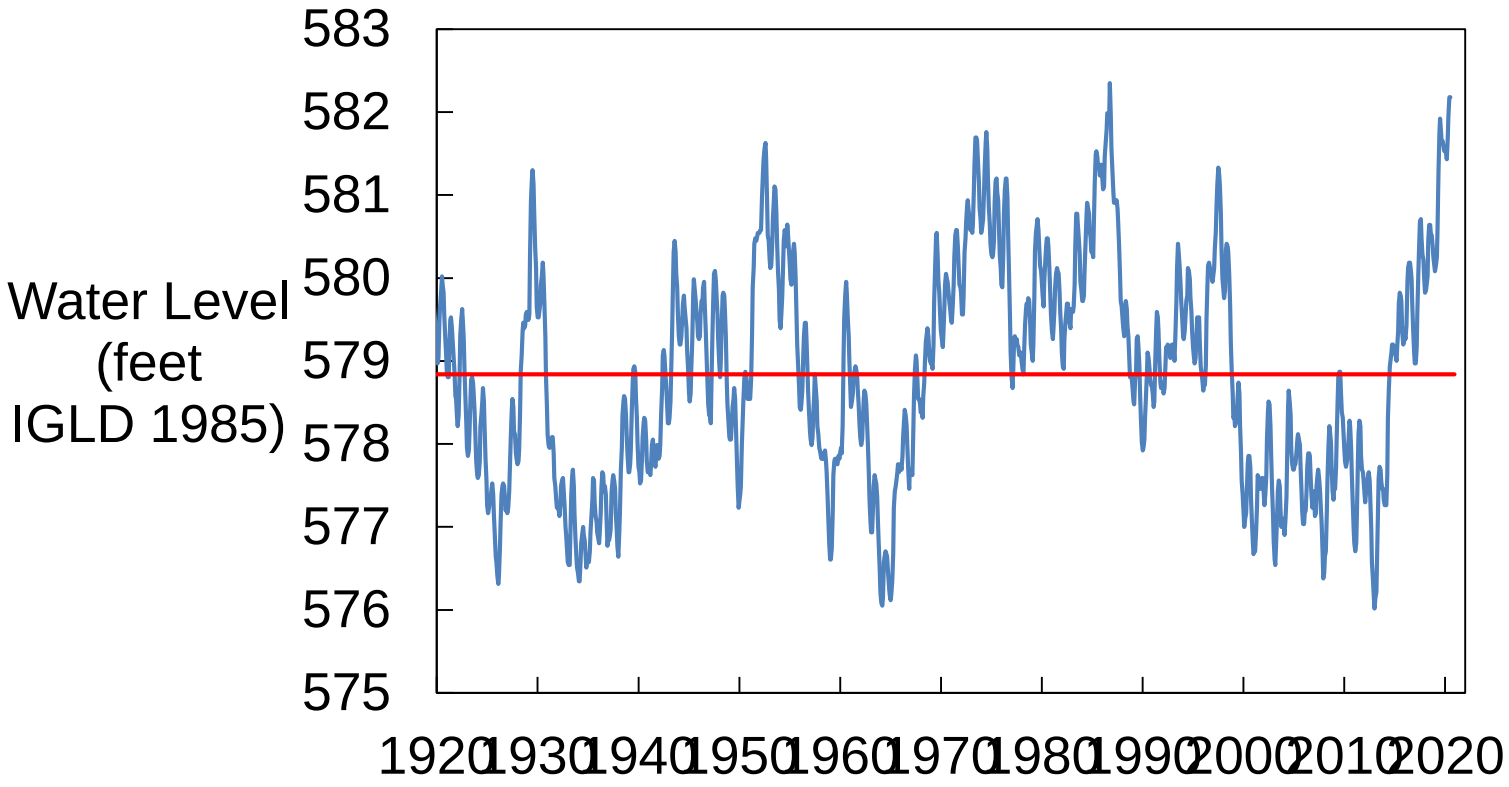
[MODIS Satellite Image]



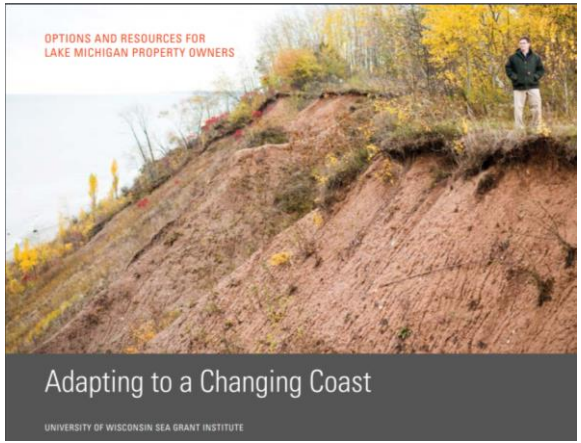
Summary

- Multiple Time Scales of Coastal Risk in the Great Lakes
  - Inter-annual - Lake levels
  - Seasonal - Lake Levels
  - Short-Term - Storm Surge and Waves
  - Climate Change - Lake Levels, Ice, and Storms

Awareness of Coastal Hazard Risks ∝ Great Lakes Water Levels?



Coastal Resilience Outreach



Coastal Resilience Self-Assessment

Part 1: Identifying Coastal Hazard Risks

COASTAL HAZARD ISSUE	PROBABILITY	IMPACT			PREPAREDNESS	RISK SCORE
	Likelihood this issue will occur	***HUMAN*** *Possibility of death or injury*	***PROPERTY*** *Physical losses and damages*	***BUSINESS/ AGENCY*** *Interruption of services*	*Level of planning done for this issue*	*Relative threat* *calculated by Coastal Resilience team
Shoreline Recession & Bluff Failure	High	Low	High	Moderate	Low	75
Coastal Flooding						0
Shore Protection Damage						0
Beach Loss						0
Beach Impairment						0
Port, Harbor, & Marina Damage						0
Port, Harbor, & Marina Navigation Impairment						0

Coastal Resilience Self-Assessment

Part 2: Resilient Practices Questionnaire

- Understanding Coastal Hazard Impacts
- Hazard Mitigation Planning
- Community Planning
- Local Ordinances
- Public Education and Engagement
- Shore Protection
- Managing Water on Coastal Lands
- Beaches
- Ports Harbors and Marinas

64

Coastal Resilience Self-Assessment

RACINE ON THE LAKE
CITY OF RACINE, WISCONSIN

	Yes	No	?
2) Do updated maps or spatial data exist that identify areas at risk to coastal hazards?	○	◉	○
19) Are ordinances pertaining to coastal hazards consistent with those of surrounding jurisdictions in both policy and language?	○	○	◉
35) Do beach management plans exist that detail strategies for addressing beach loss due to erosion or high lake level conditions?	○	◉	○

65

Coastal Resilience Self-Assessment

PORT Milwaukee
CONNECTING TO THE WORLD

	Ports, Harbors and Marinas (if applicable)	Yes	No	?
37)	Does your facility conduct a regular assessment of critical infrastructure to identify maintenance issues requiring corrective action?	○	◉	○
38)	Does your facility have an assessment of costs to maintain, repair and replace its assets?	○	◉	○

Summary

- Multiple Time Scales of Coastal Risk in the Great Lakes
  - Inter-annual - Lake Levels
  - Seasonal - Lake Levels
  - Short-Term - Storm Surge and Waves
  - Climate Change - Lake Levels, Ice, Storms

- Coastal Resilience Outreach
  - Build and maintain institutional knowledge
  - Self-Assessment to start conversation about holistic approaches to resilience

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Coastal Engineering Outreach Specialist

Wisconsin Sea Grant

bechle@aqua.wisc.edu

https://www.seagrant.wisc.edu

https://sewicoastalresilience.org/

Funding provided by the Wisconsin Coastal Management Program and the National Oceanic and Atmospheric Administration, Office for Coastal Management, Grant # NA17NOS4730144

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Images

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- Wisconsin Shoreline Inventory and Oblique Photo Viewer - http://floodatlas.org/asfpm/oblique_viewer/
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Water Level Data

NOAA GLERL - https://www.glerl.noaa.gov/data/dashboard/data/

Ice Data

NOAA GLERL - https://www.glerl.noaa.gov/data/ice/#historical

Surge Data

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Nadal-Caraballo, N. C., Melby, J.A. and Ebersole, B.A. (2012), "Lake Michigan: Statistical

AECOM Imagine it. Delivered.

2D Modeling Applications for Watershed Modeling Studies in Toledo, OH and Duluth, MN

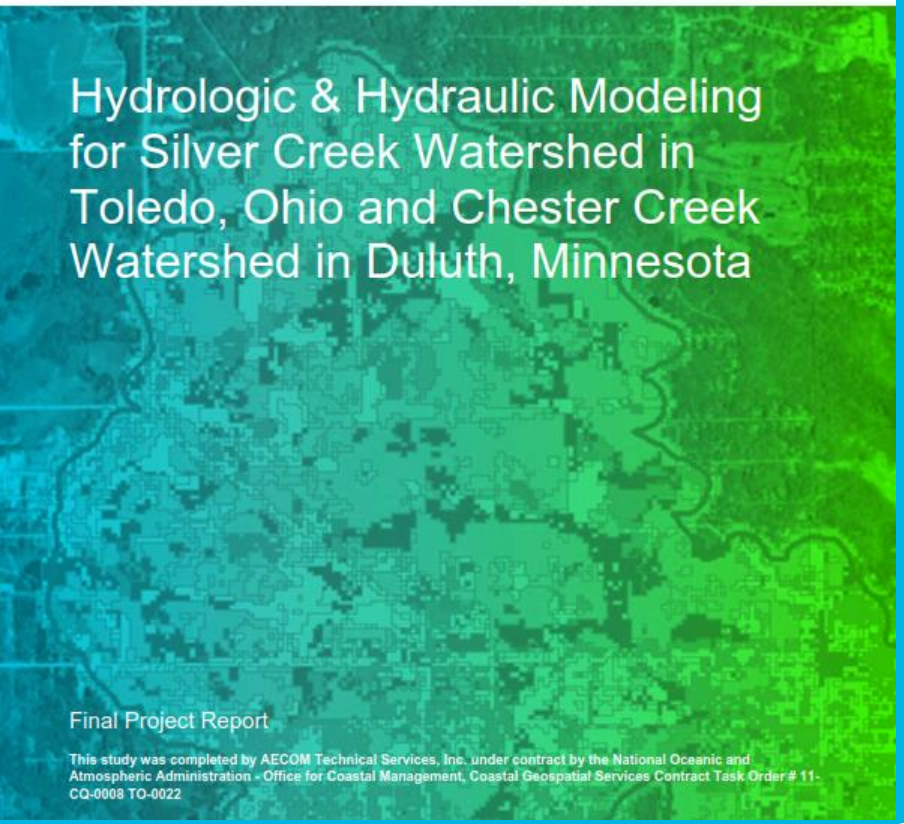
Joe Chapman, PE
Vice President

August 13, 2020

AECOM

Submitted to
NOAA Office for Coastal Management
2234 South Hobson Avenue
Charleston, SC 29405

Submitted by
AECOM
4016 Salt Pointe Pkwy Suite 200
North Charleston, SC 29405
April 22, 2016



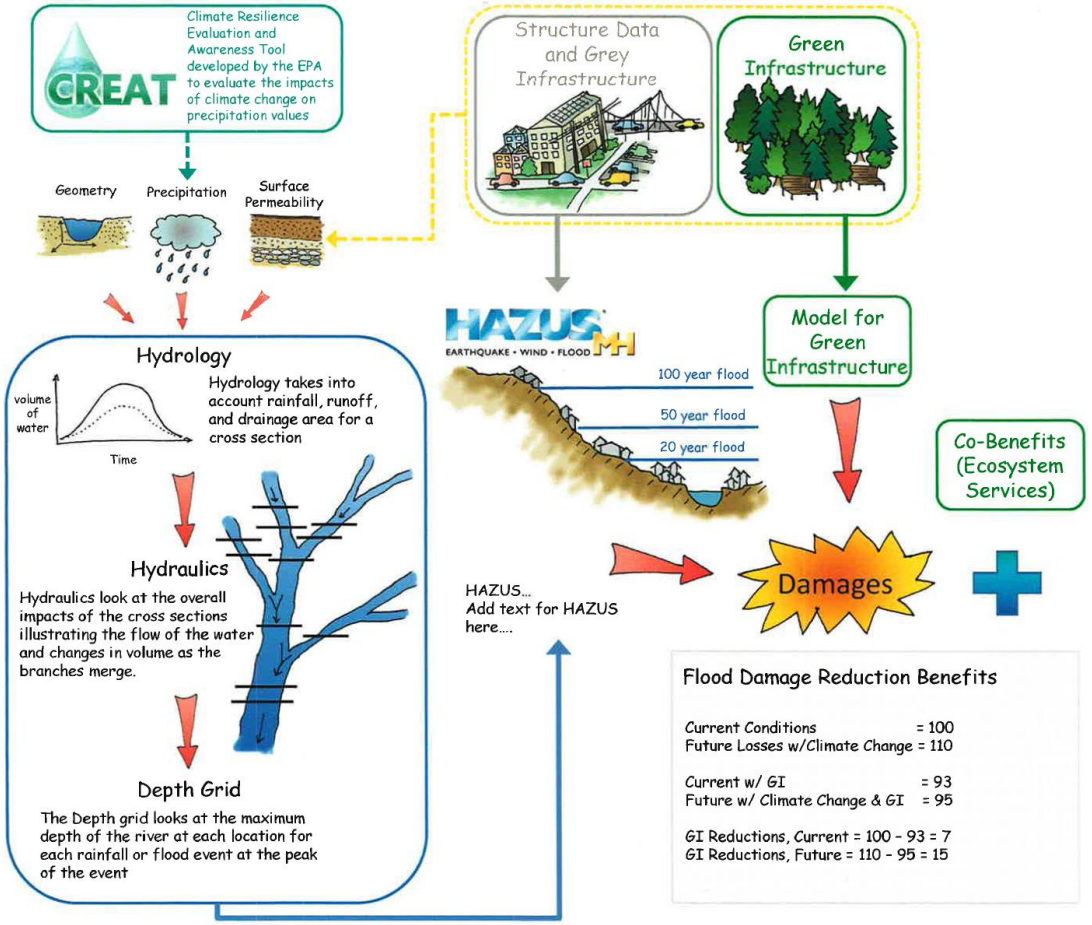
Hydrologic & Hydraulic Modeling for Silver Creek Watershed in Toledo, Ohio and Chester Creek Watershed in Duluth, Minnesota

Final Project Report

This study was completed by AECOM Technical Services, Inc. under contract by the National Oceanic and Atmospheric Administration - Office for Coastal Management, Coastal Geospatial Services Contract Task Order # 11-CQ-0008 TO-0022

Study Overview

Framework for Original Pilot



Old Pilot vs New Pilot

Final Report

Economic Assessment of Green Infrastructure Strategies for Climate Change Adaptation: Pilot Studies in The Great Lakes Region

May 2014

Eastern Research Group, Inc.

Written under contract for the
National Oceanic and Atmospheric Administration
Coastal Services Center

NOAA Coastal Services Center
(843) 740-1200
www.csc.noaa.gov

NOAA Coastal Services Center
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY

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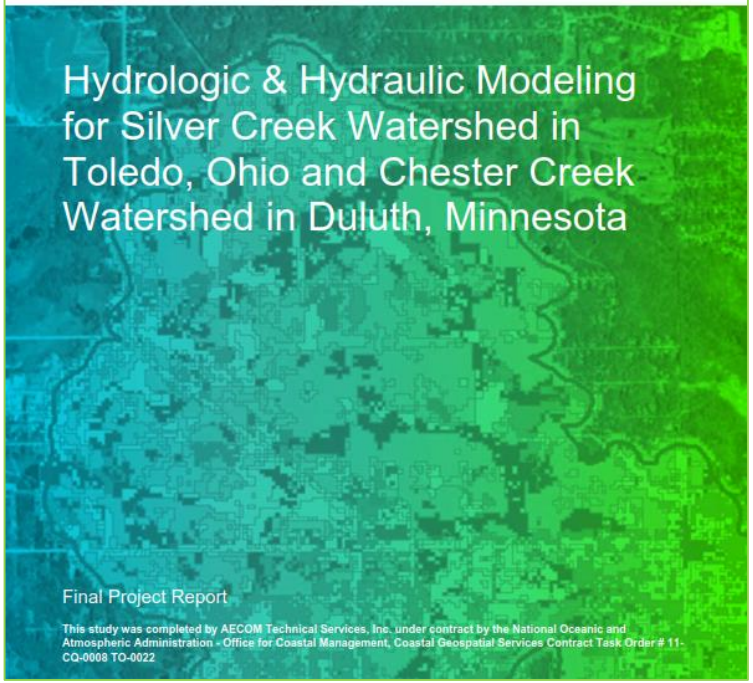

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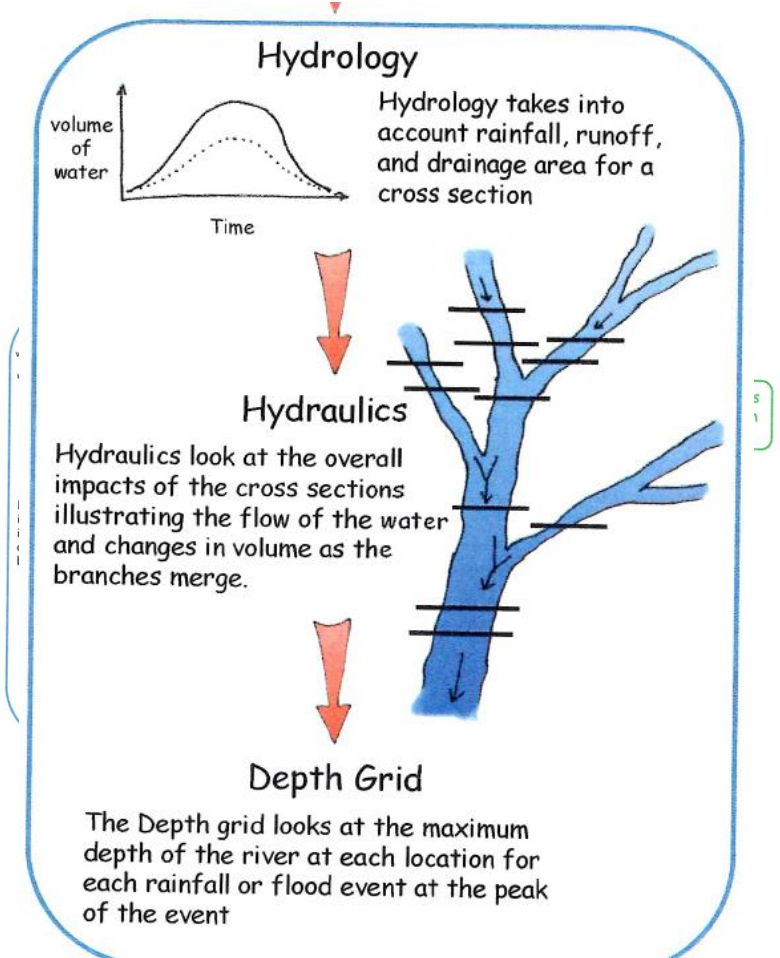
New Project Objectives



- Evaluate application of 2D modeling approach to previous pilot study areas
- Assess existing and future (with and w/out GI) scenarios
- Prepare summary findings and recommendations

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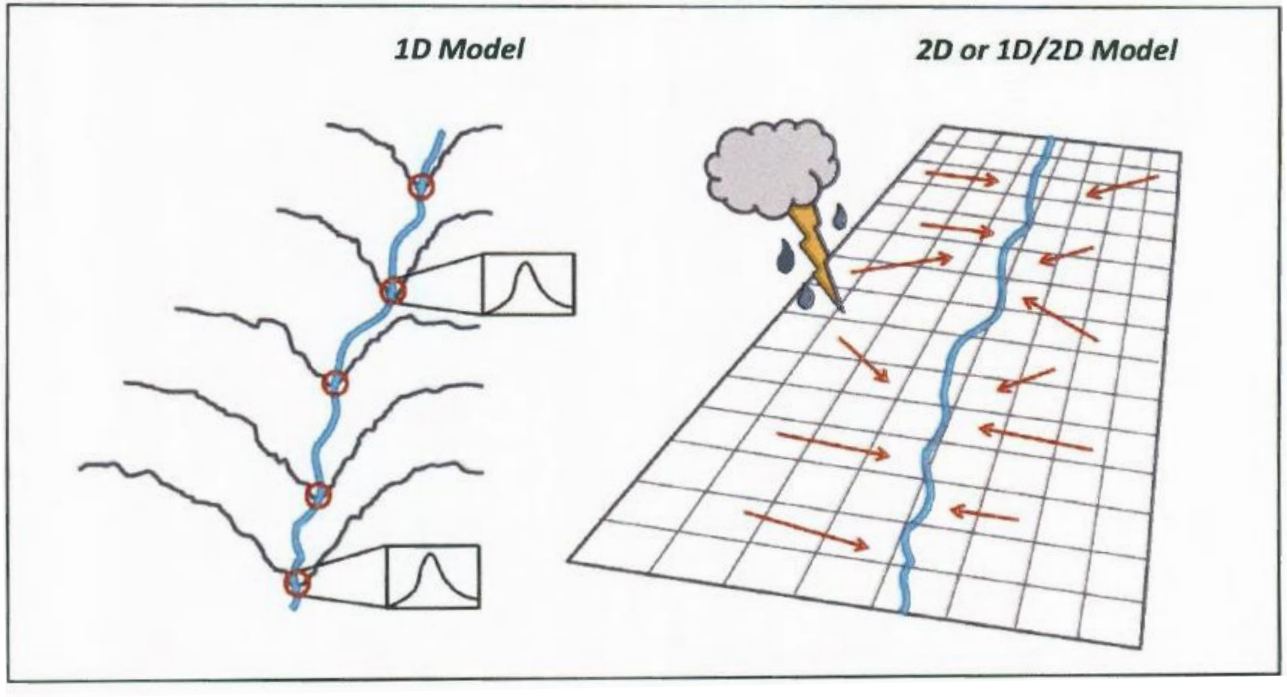
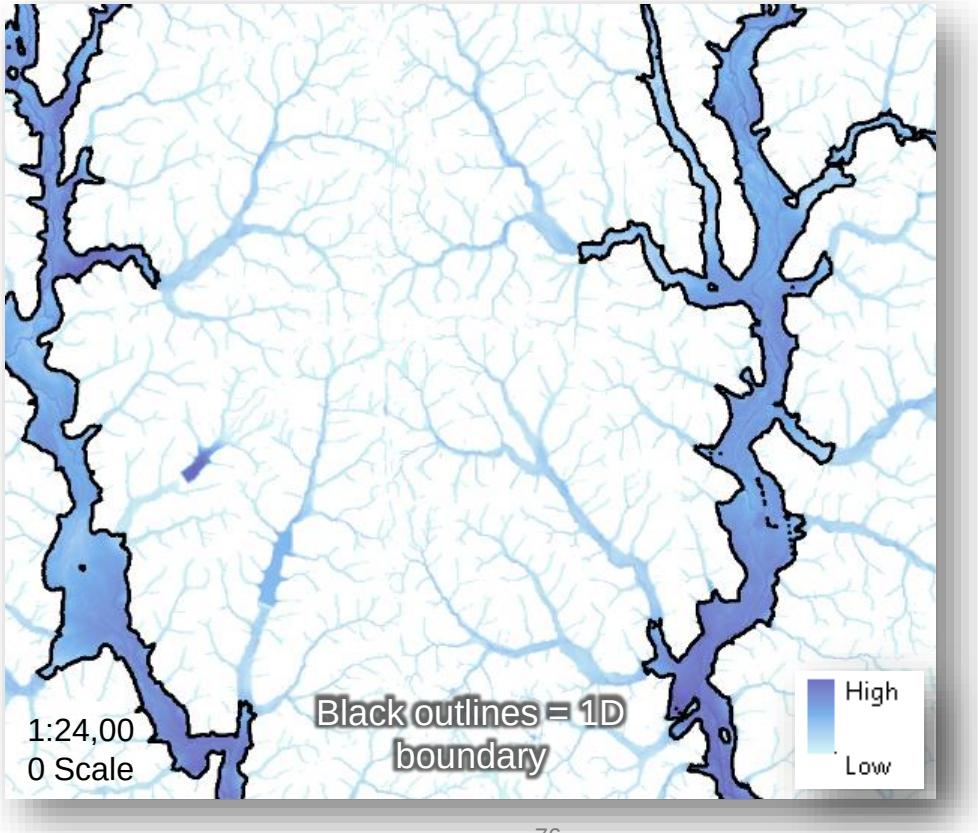
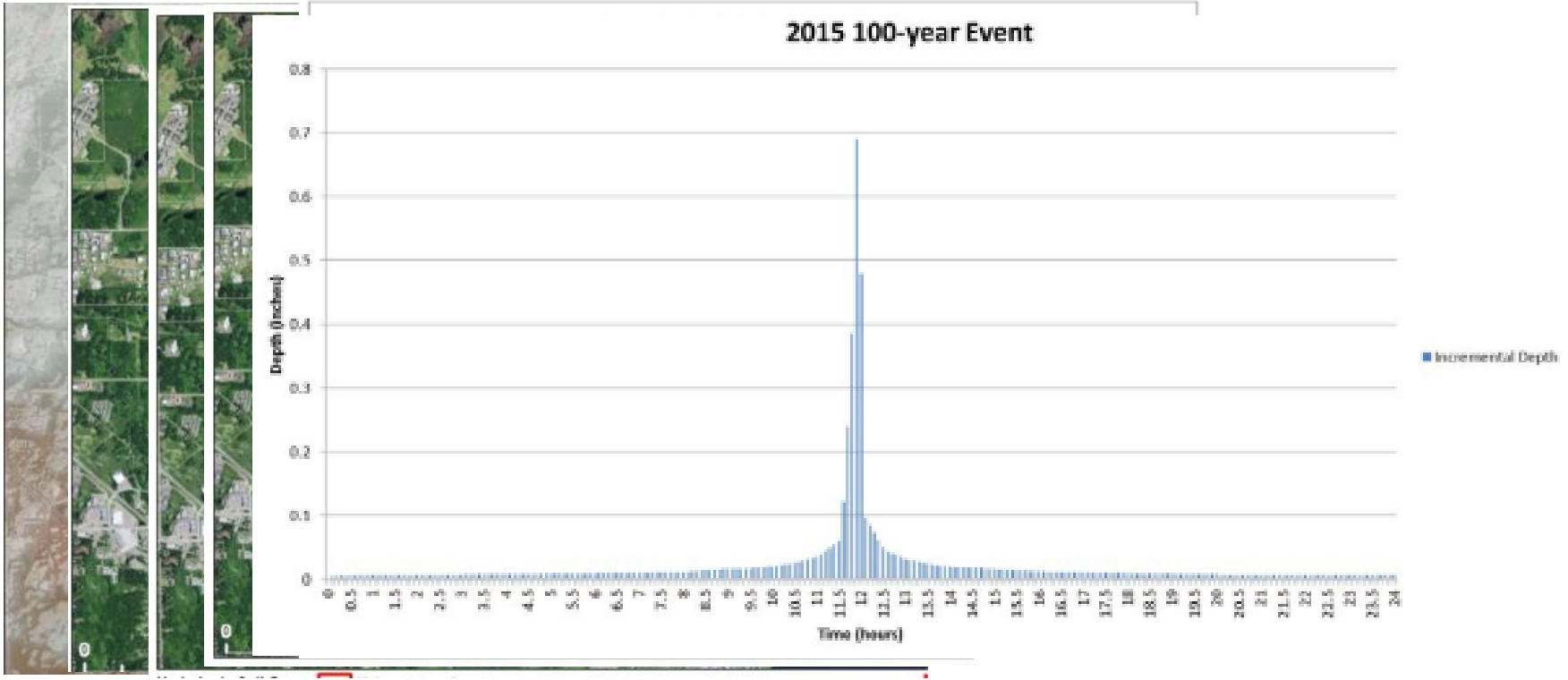
1-D Modeling vs 2-D Modeling



1-D Modeling vs 2-D Direct Rainfall Modeling

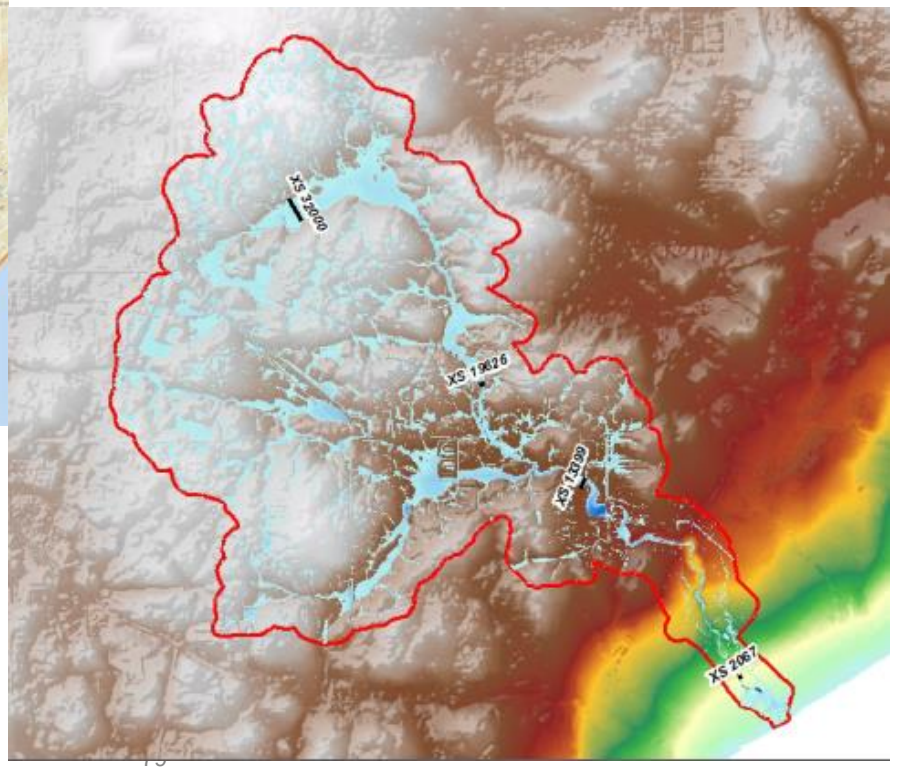


Modeling Input Parameters



1-D Modeling vs 2-D Modeling – Silver Creek

1-D Modeling vs 2-D Modeling – Chester Creek



Modeling Scenarios

- TUFLOW GPU
- 2015 – rainfall, landuse, landcover
  - Without Green Infrastructure
  - With Green Infrastructure
- 2035 – projected rainfall, landuse, landcover
  - Without Green Infrastructure
  - With Green Infrastructure

Simulating Impacts of Green Infrastructure

- Green Infrastructure impacts modeled through changes to surface roughness and percent impervious
  - Estimate of percentage of area to be impacted by GI
  - Modify surface roughness and percent impervious for impacted area of watershed

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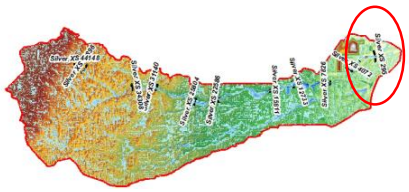
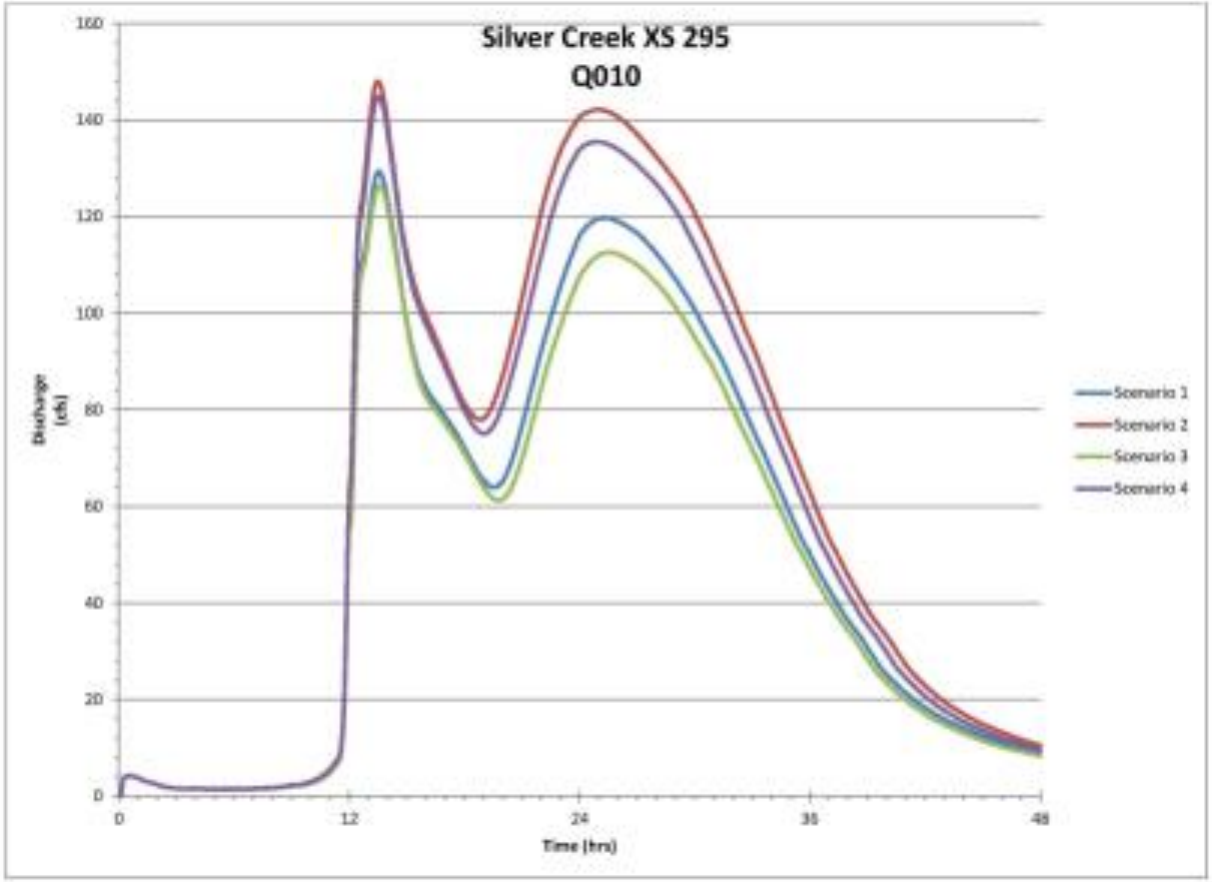
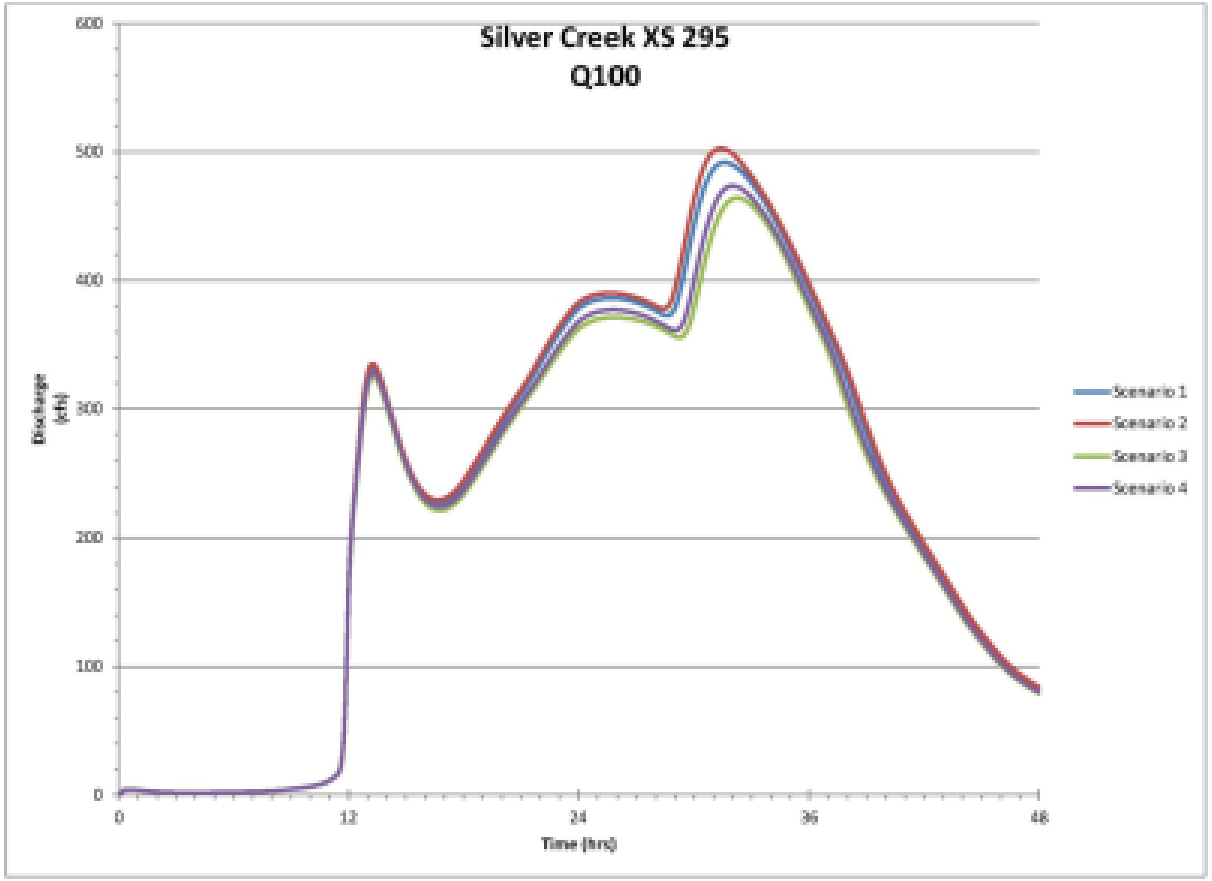
Modeling Results





Modeling Results



Modeling Results – Average Peak Discharge Reductions

Average Chester Creek Peak Discharge Reductions						
	Q2	Q5	Q10	Q25	Q50	Q100
Existing Conditions	0.5%	0.4%	0.4%	0.3%	0.3%	0.3%
Future Conditions	2.7%	1.9%	1.9%	1.6%	1.6%	1.7%
Average Silver Creek Peak Discharge Reductions						
	Q2	Q5	Q10	Q25	Q50	Q100
Existing Conditions	4.7%	5.0%	6.0%	5.3%	4.0%	4.4%
Future Conditions	5.1%	4.5%	4.9%	4.5%	3.9%	4.3%

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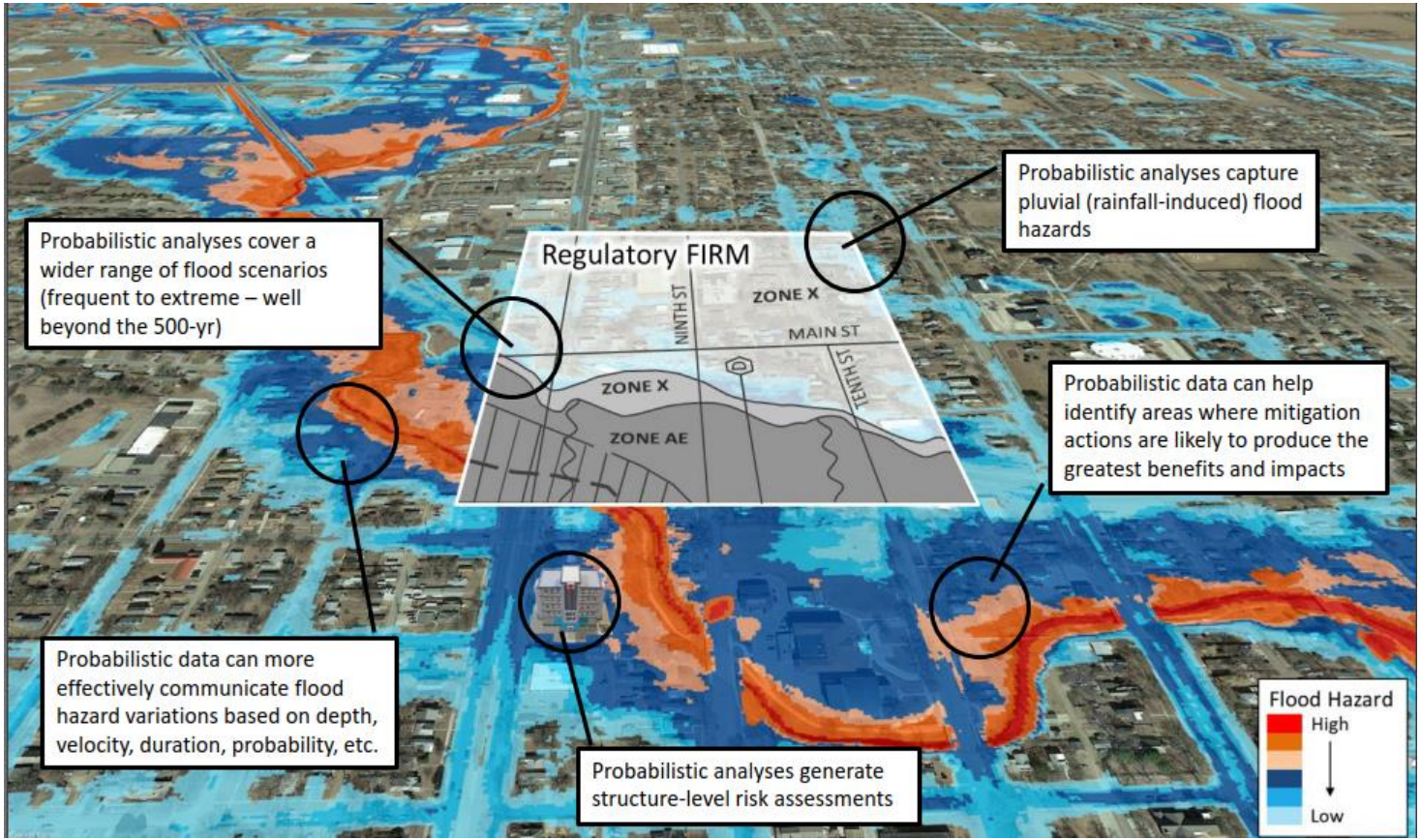
Modeling Results – Average Inundation Area Reduction

	Average Chester Creek Inundation Area Reductions (% | acres)					
	Q2	Q5	Q10	Q25	Q50	Q100
Existing Conditions	-0.1% | -0.56	-0.1% | -0.98	-0.1% | -1.09	-0.2% | -1.48	-0.2% | -1.65	-0.2% | -1.86
Future Conditions	-0.5% | -3.08	-0.7% | -5.55	-0.8% | -7.04	-0.8% | -7.84	-0.8% | -8.65	-0.9% | -9.55
	Average Silver Creek Inundation Area Reductions (% | acres)					
	Q2	Q5	Q10	Q25	Q50	Q100
Existing Conditions	1.7% | 22.65	1.1% | 20.37	0.9% | 20.52	0.7% | 18.30	0.5% | 15.72	0.4% | 13.58
Future Conditions	1.5% | 22.18	1.1% | 21.85	0.8% | 19.30	0.6% | 16.94	0.5% | 14.65	0.4% | 13.45

Takeaways

- GI can be a cost effective tool for reducing impacts of more frequent flood events
- GI measures can reduce impact of climate induced rainfall increases and extend design life of stormwater infrastructure
- Results vary depending size and shape of watershed, topography, urbanization, etc.
- 2D modeling provides a cost effective method to quickly perform comprehensive watershed wide assessments
- The future of 2D modeling continues to evolve rapidly

2D Modeling – Probabilistic Flood Risk Assessment



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Thank You

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