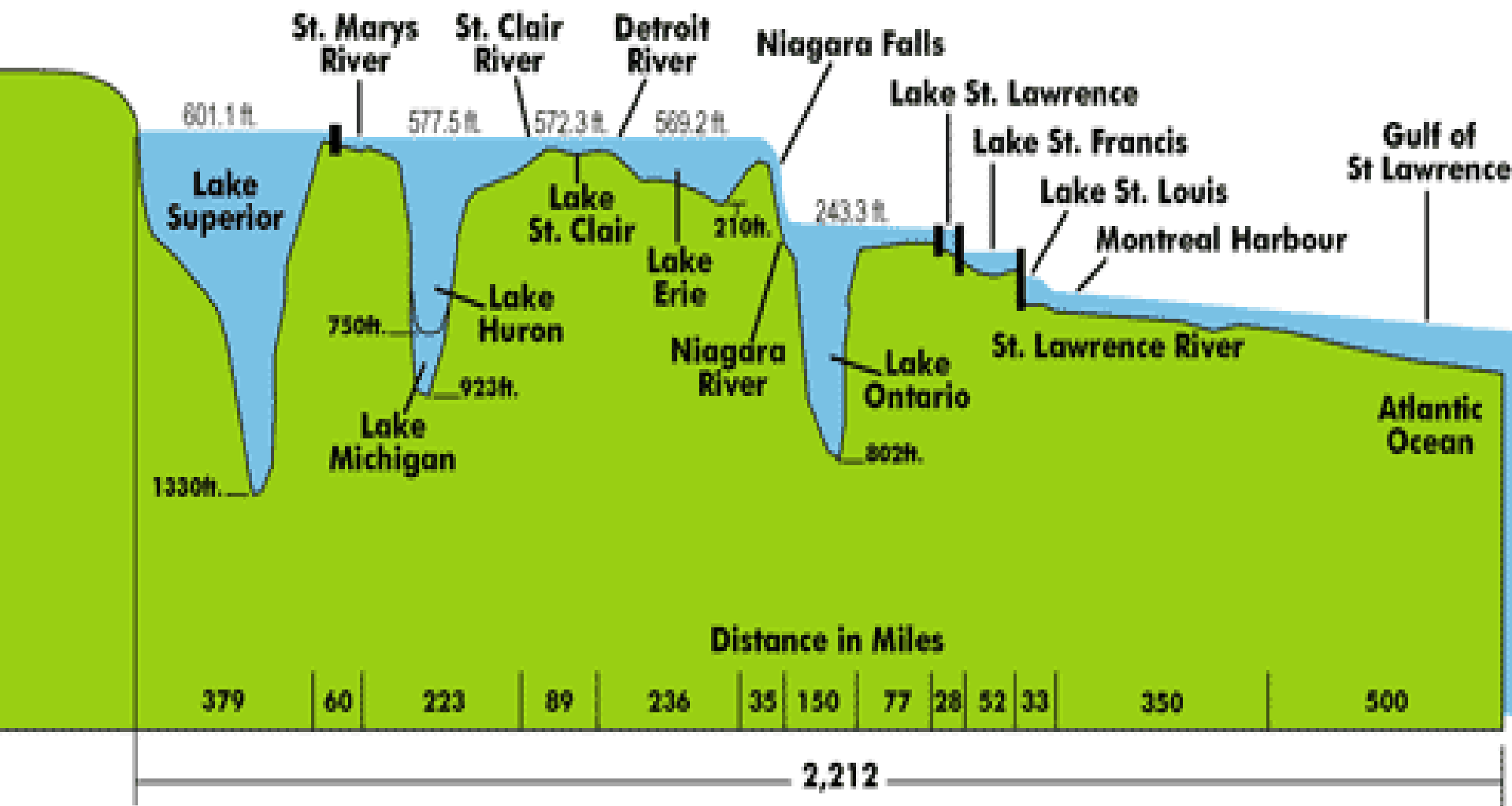


# **Strategies & Actions for Responsible Floodplain Management**

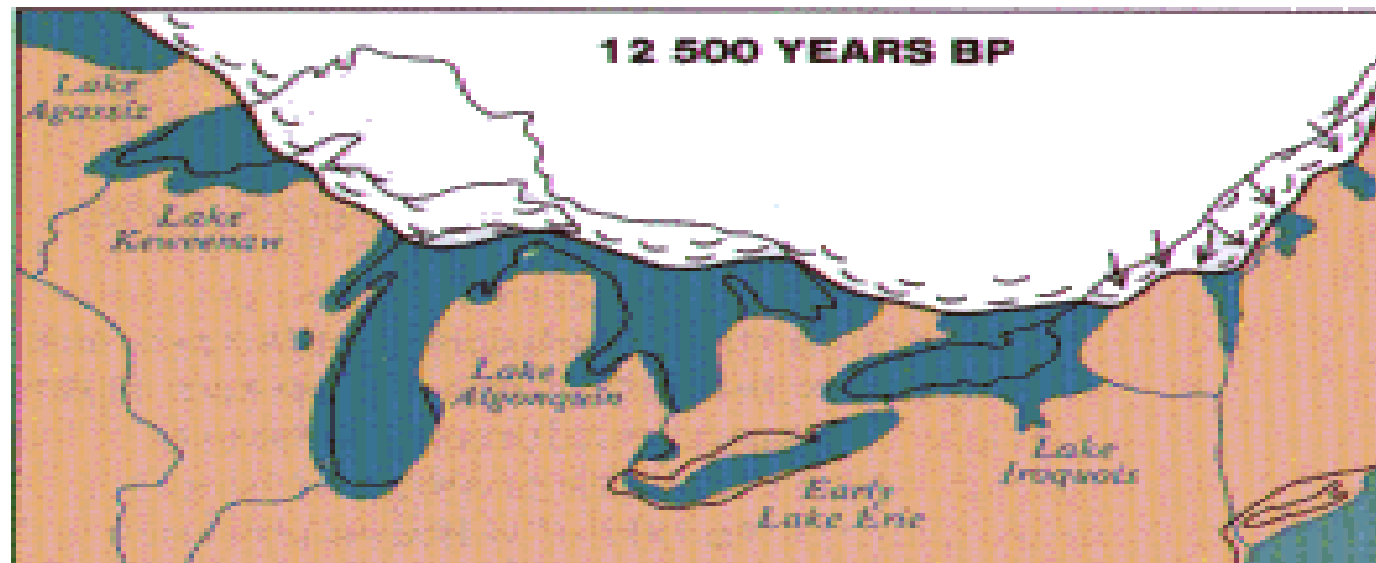
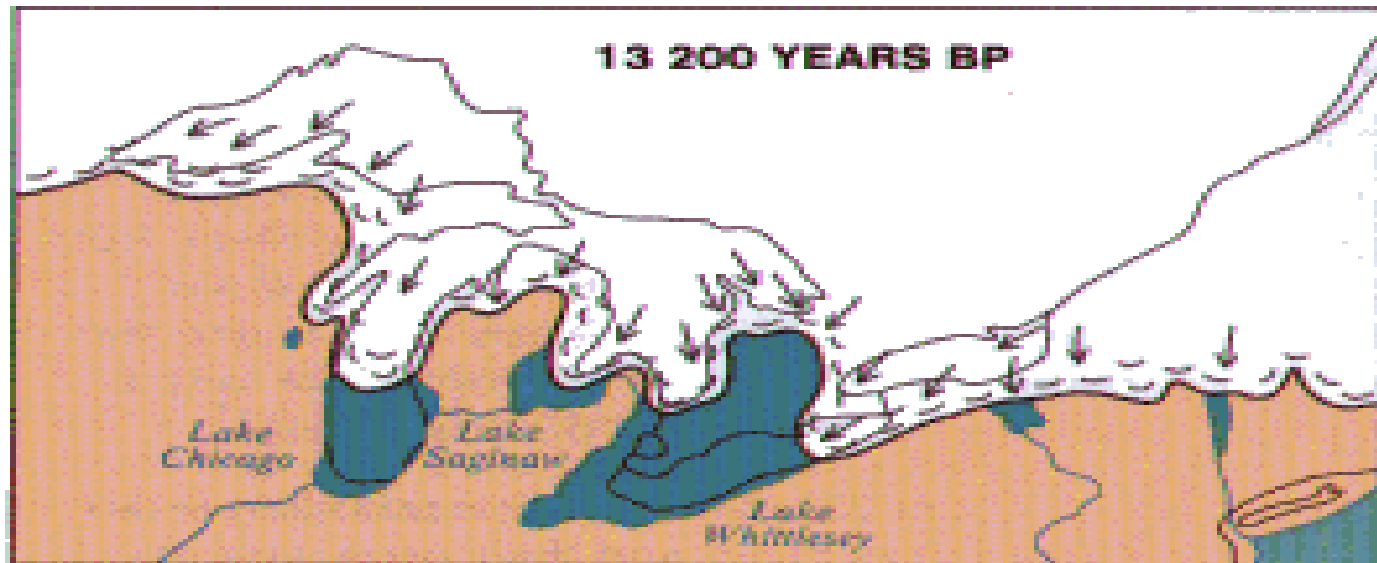
## **No Adverse Impacts Strategies**

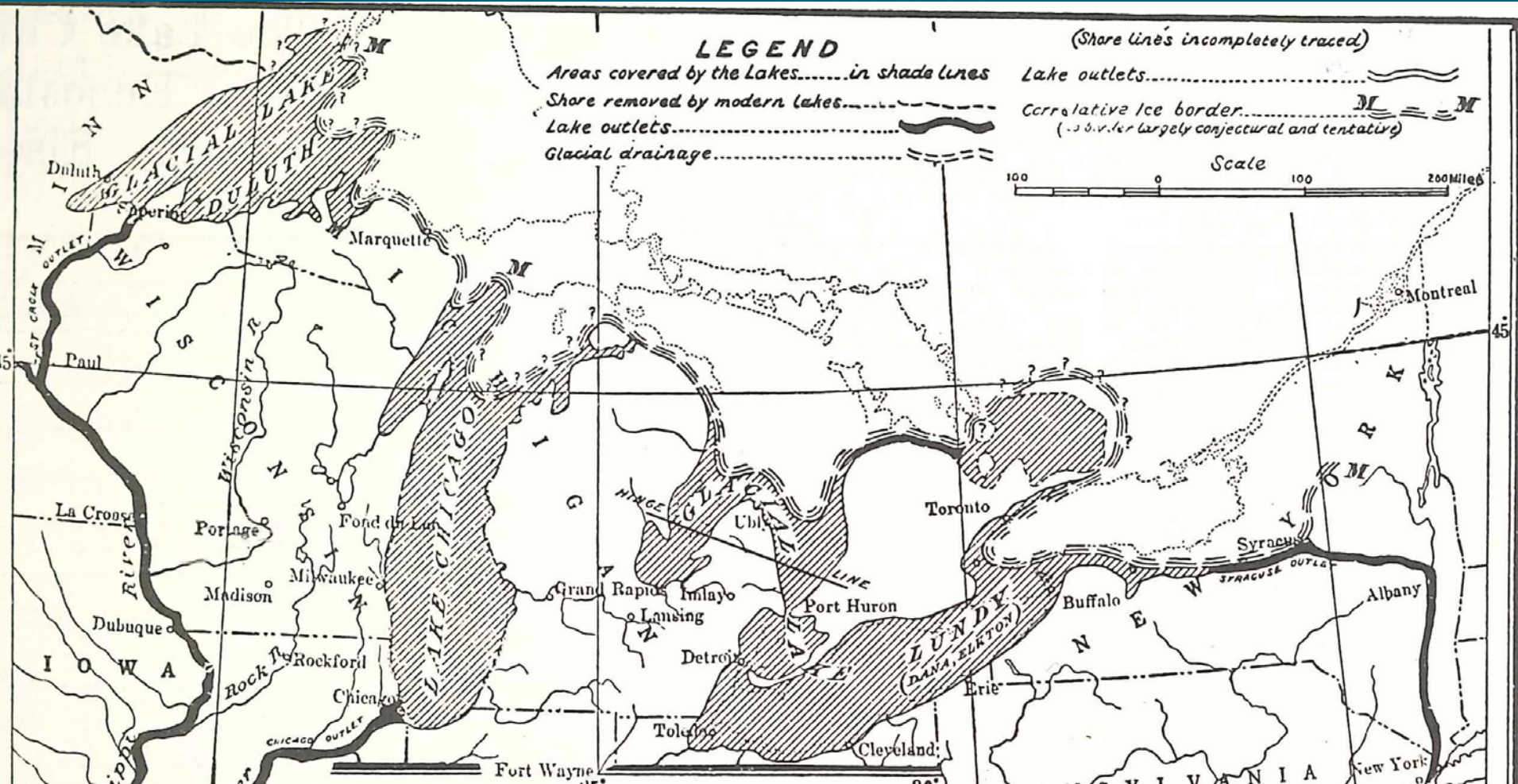


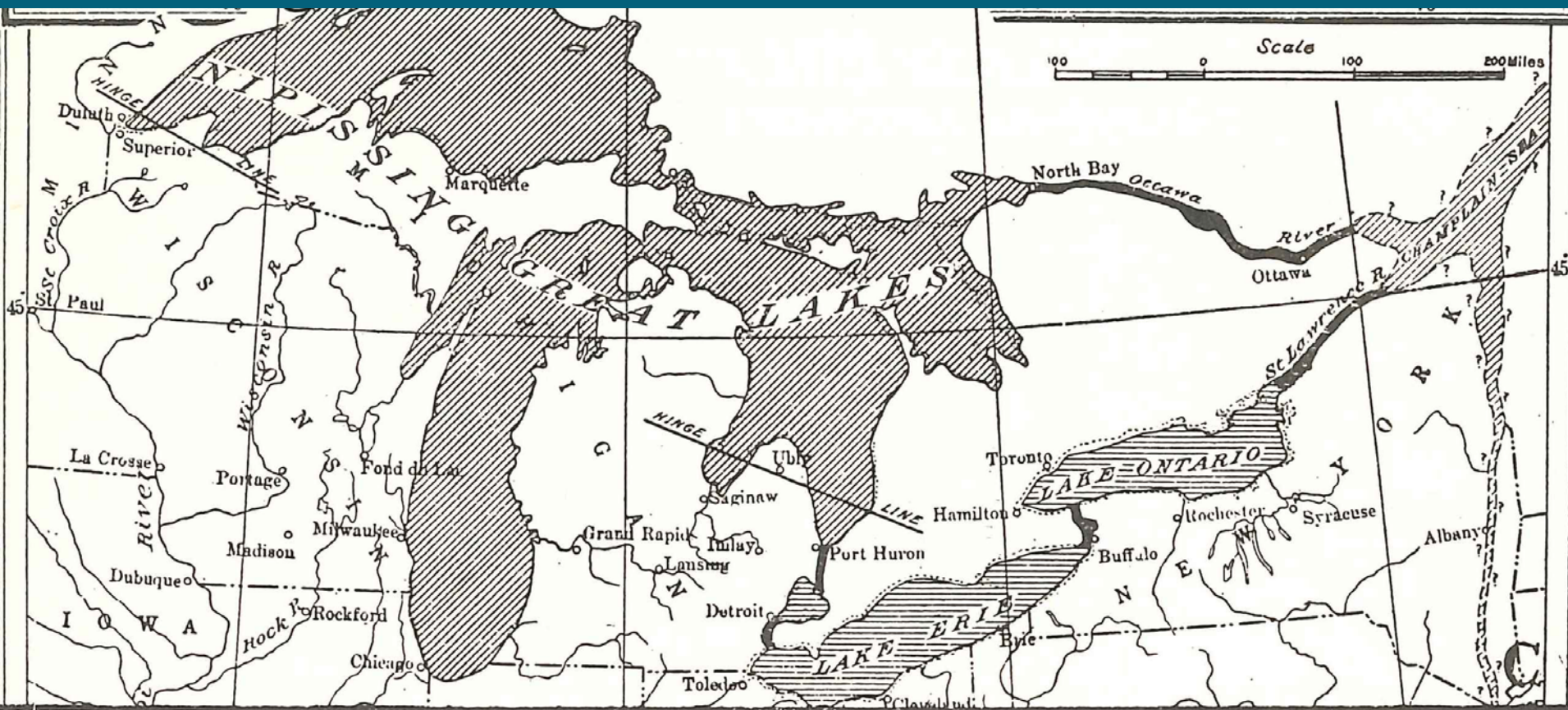


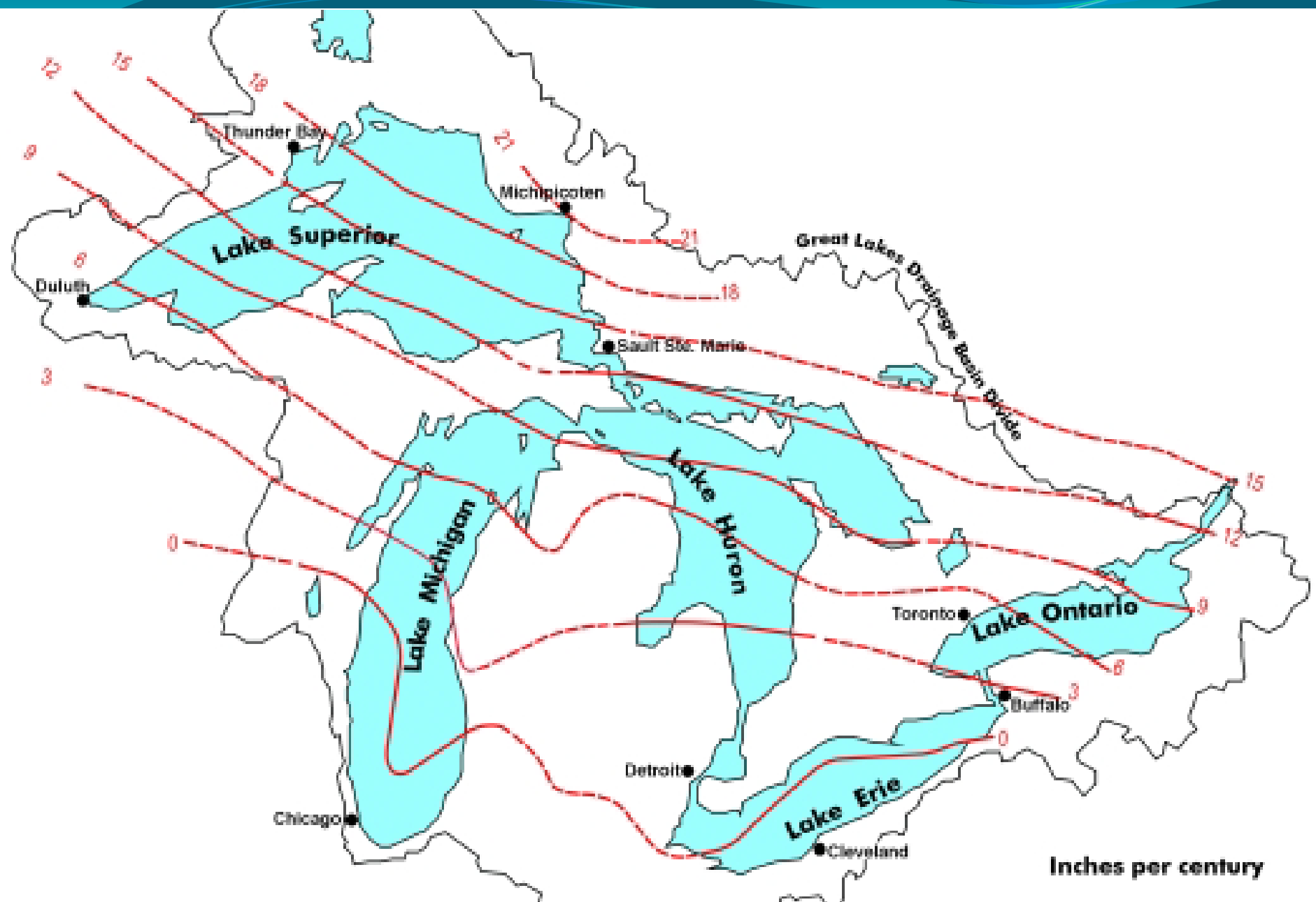
# STAGES IN THE EVOLUTION OF THE GREAT LAKES

SCALE 1: 20 000 000

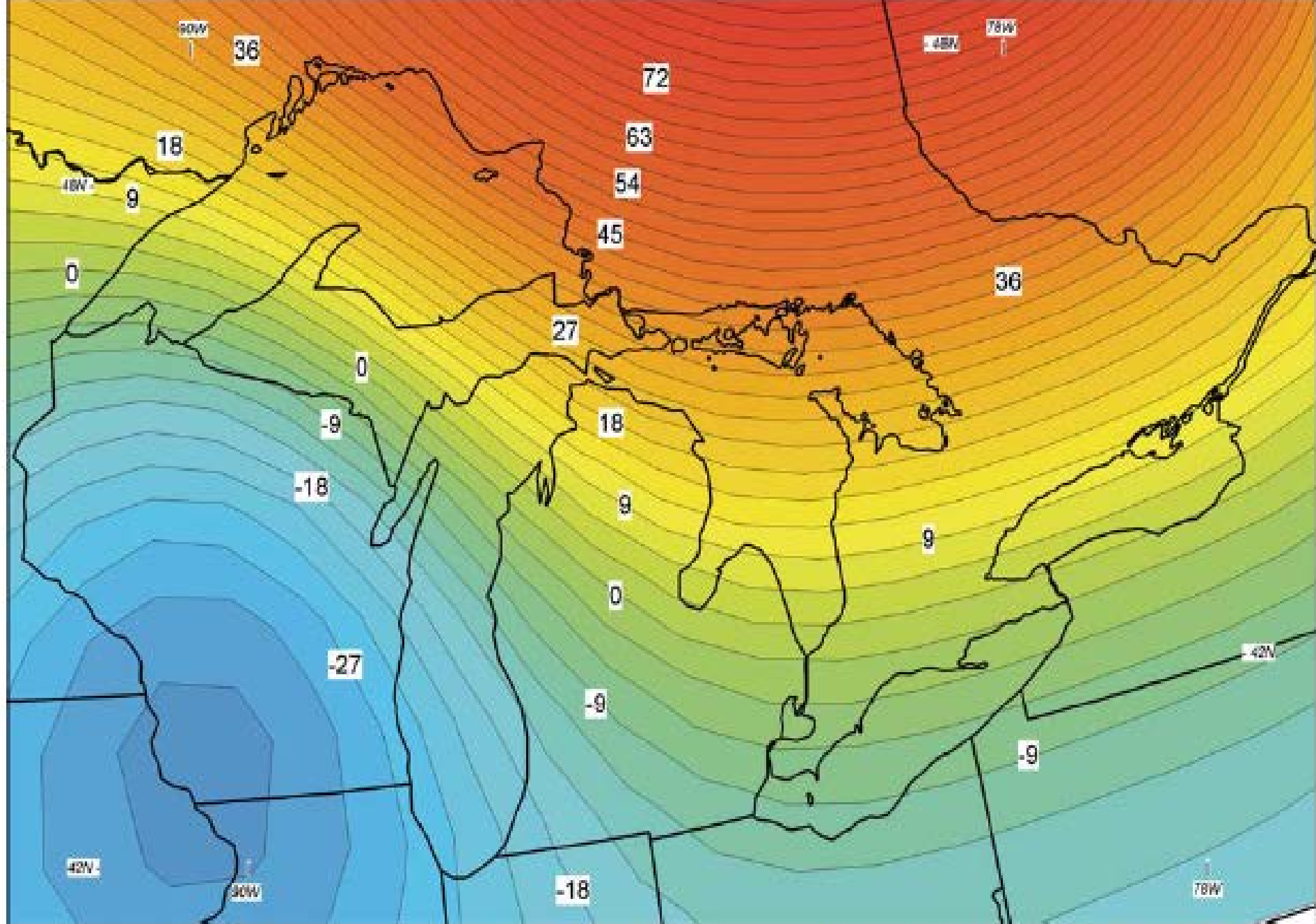






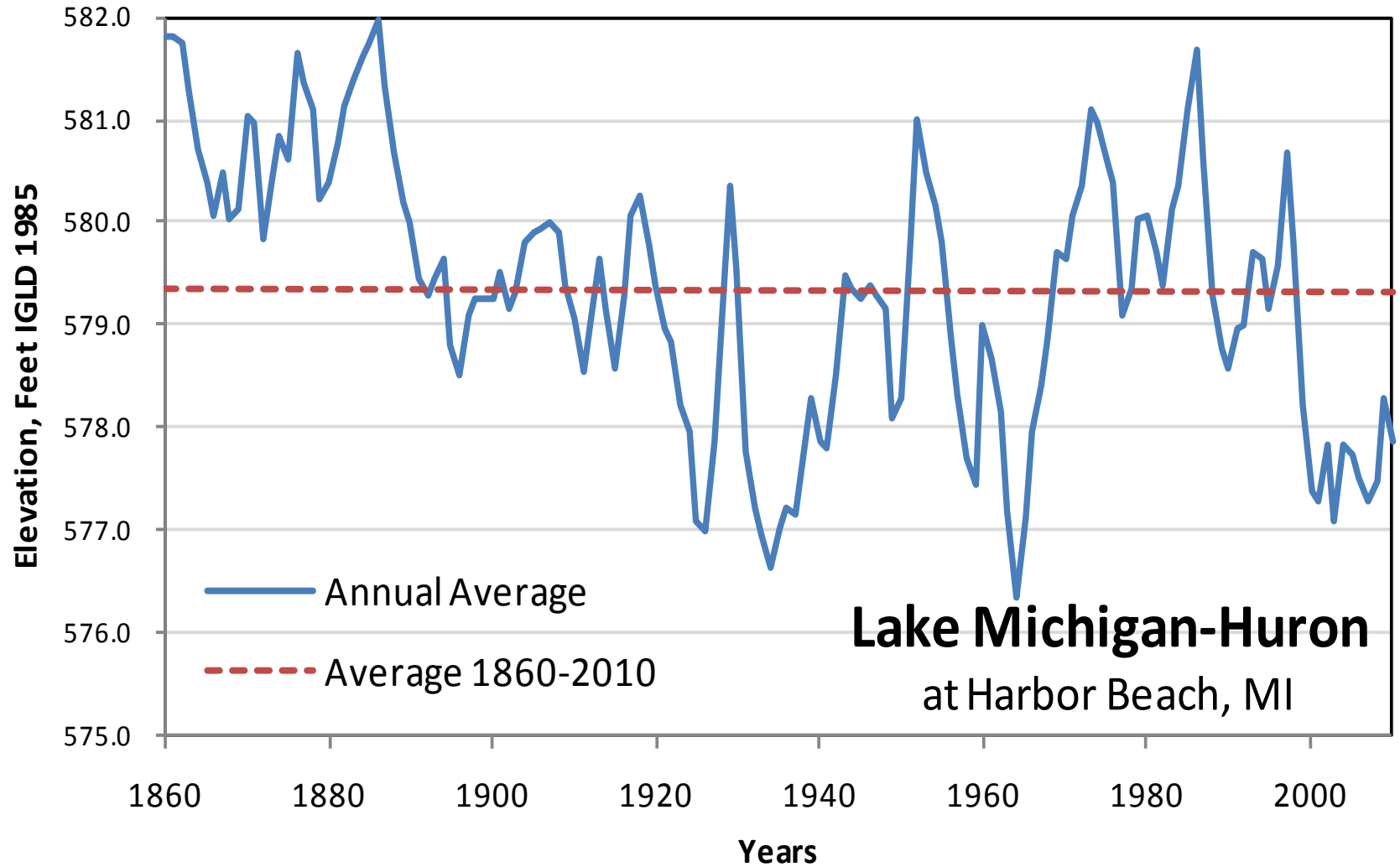


Inches per century

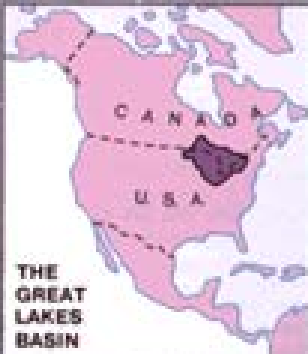
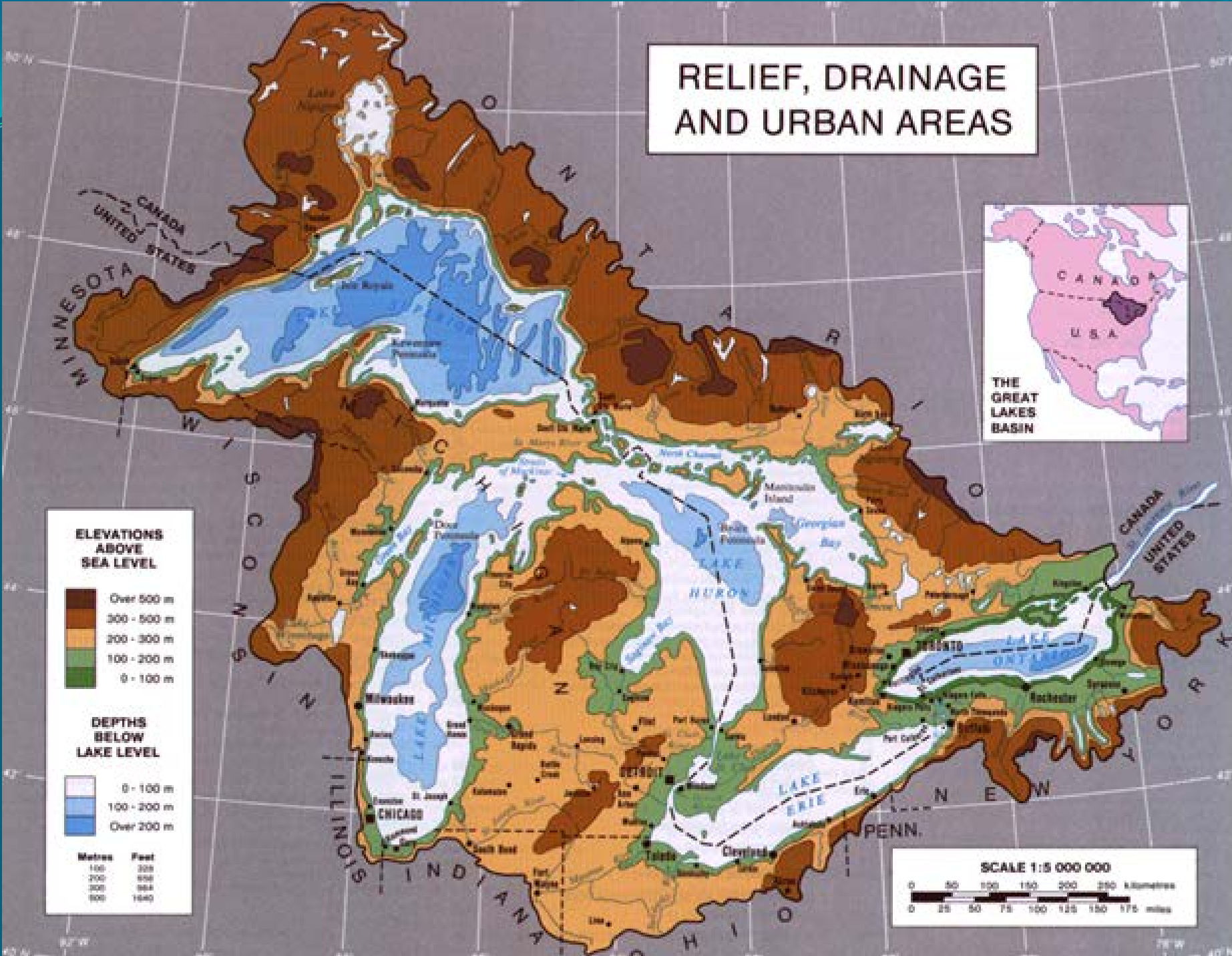


6. Contour map of ICE-3G global postglacial rebound-derived velocities in the Great Lakes area. Contour interval—3 cm





# RELIEF, DRAINAGE AND URBAN AREAS



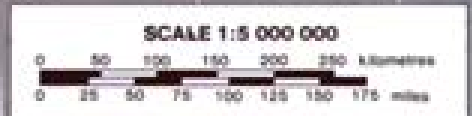
**ELEVATIONS ABOVE SEA LEVEL**

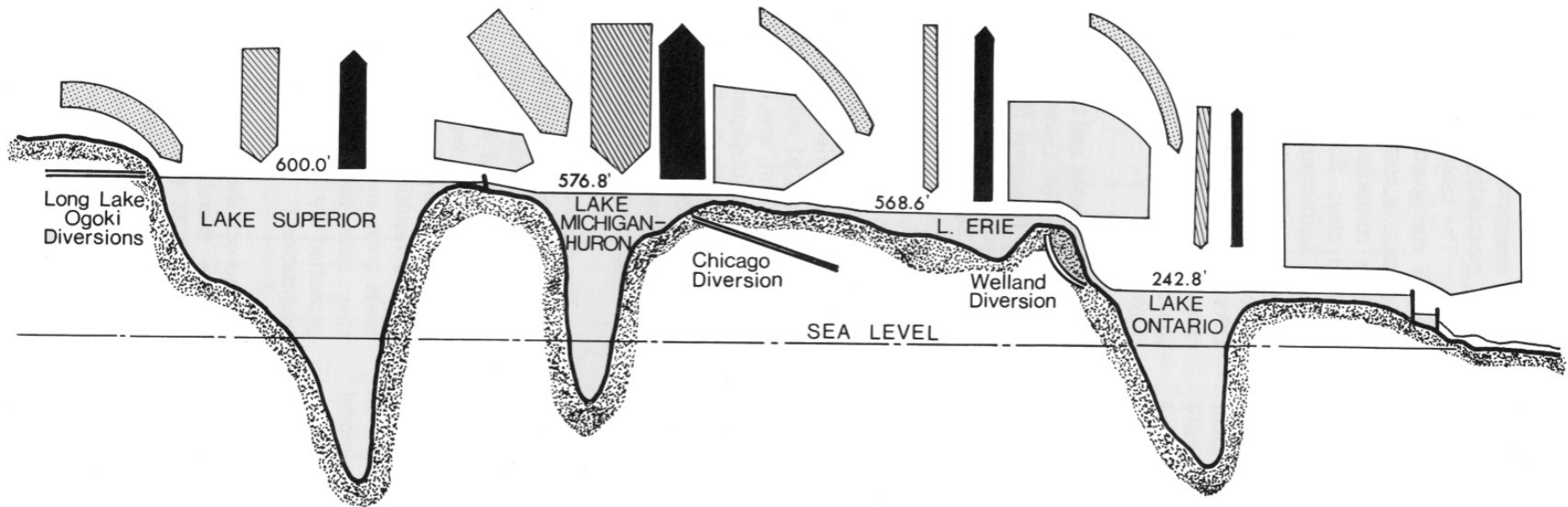
- Over 500 m
- 300 - 500 m
- 200 - 300 m
- 100 - 200 m
- 0 - 100 m

**DEPTHS BELOW LAKE LEVEL**

- 0 - 100 m
- 100 - 200 m
- Over 200 m

Metres	Feet
100	328
200	656
300	984
500	1640





Outflow

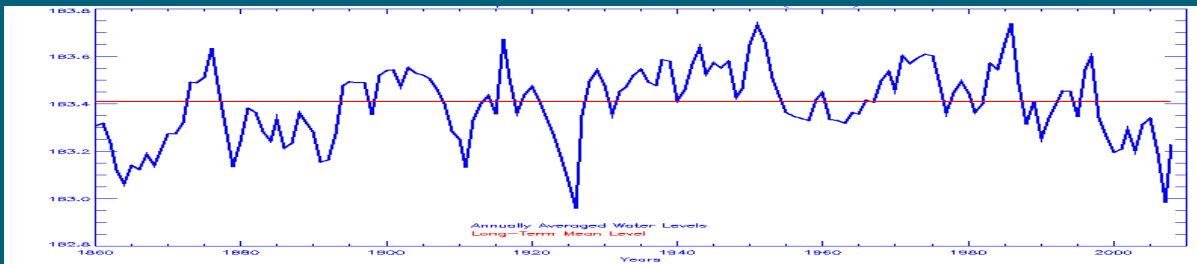
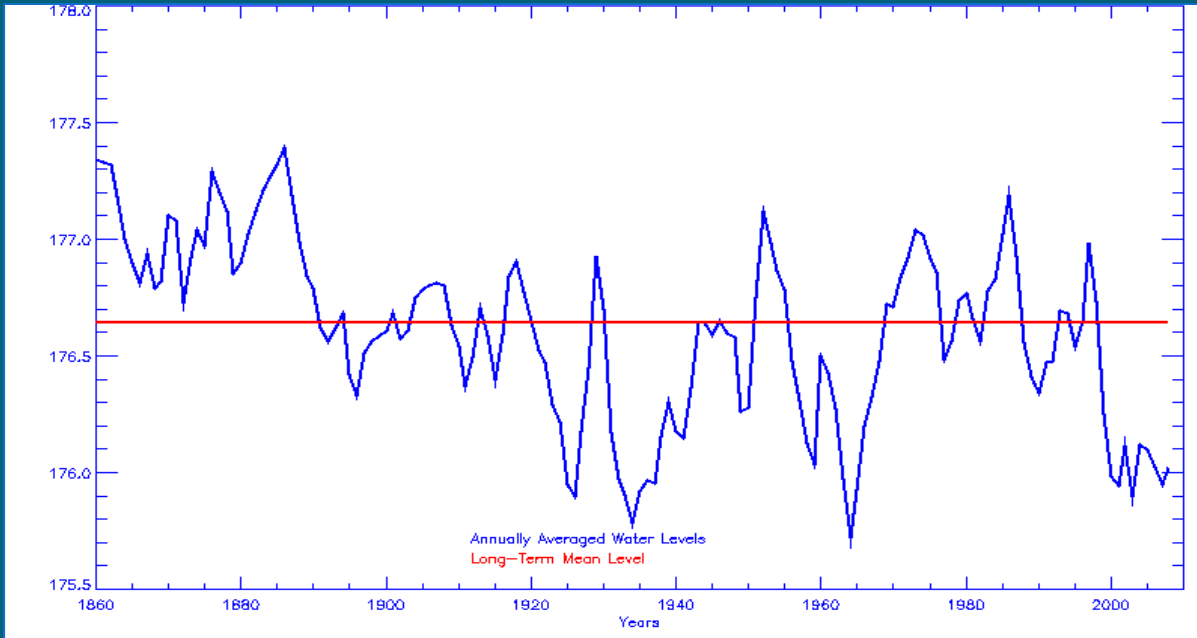
Precipitation

Runoff

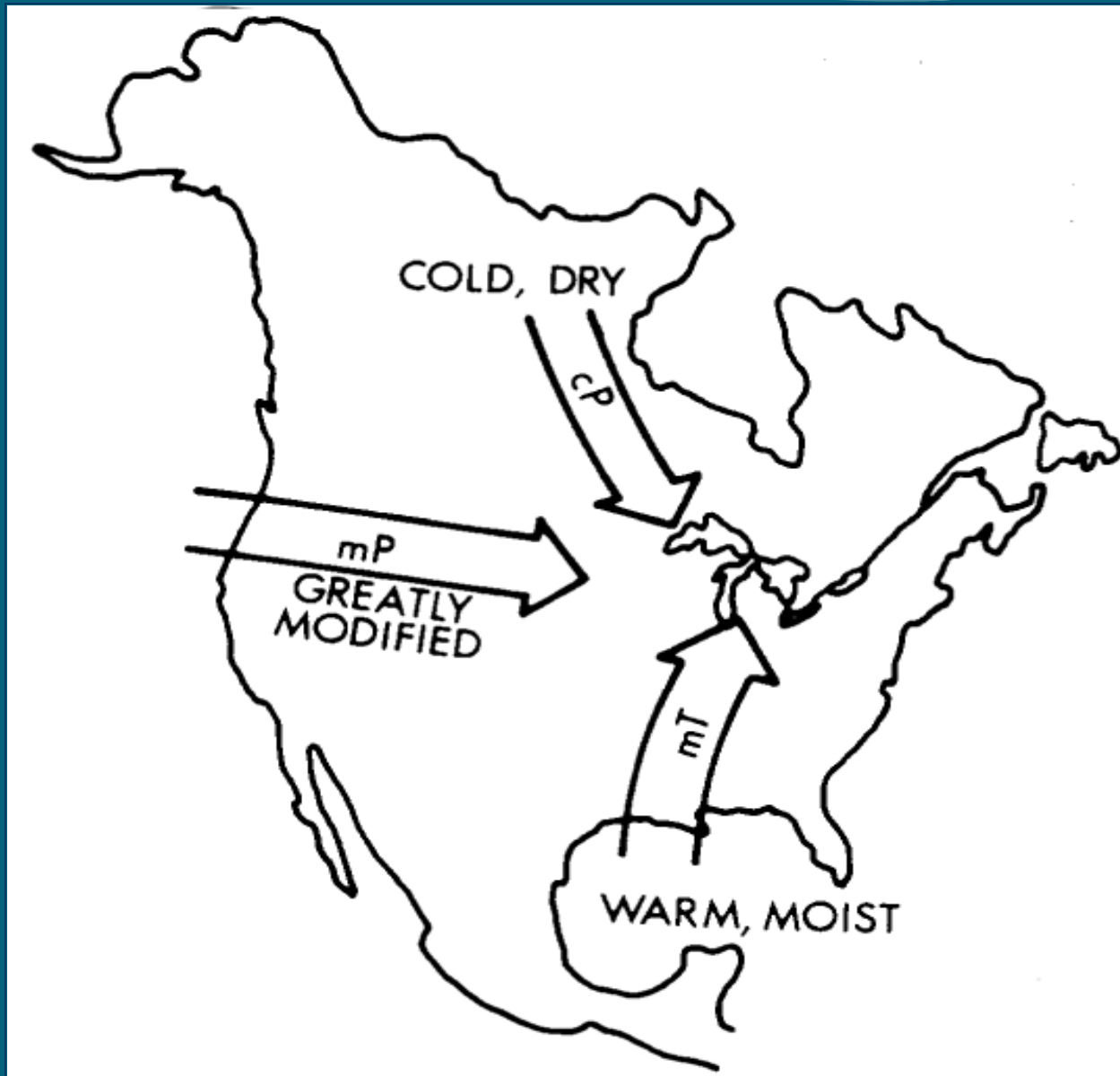
Evaporation

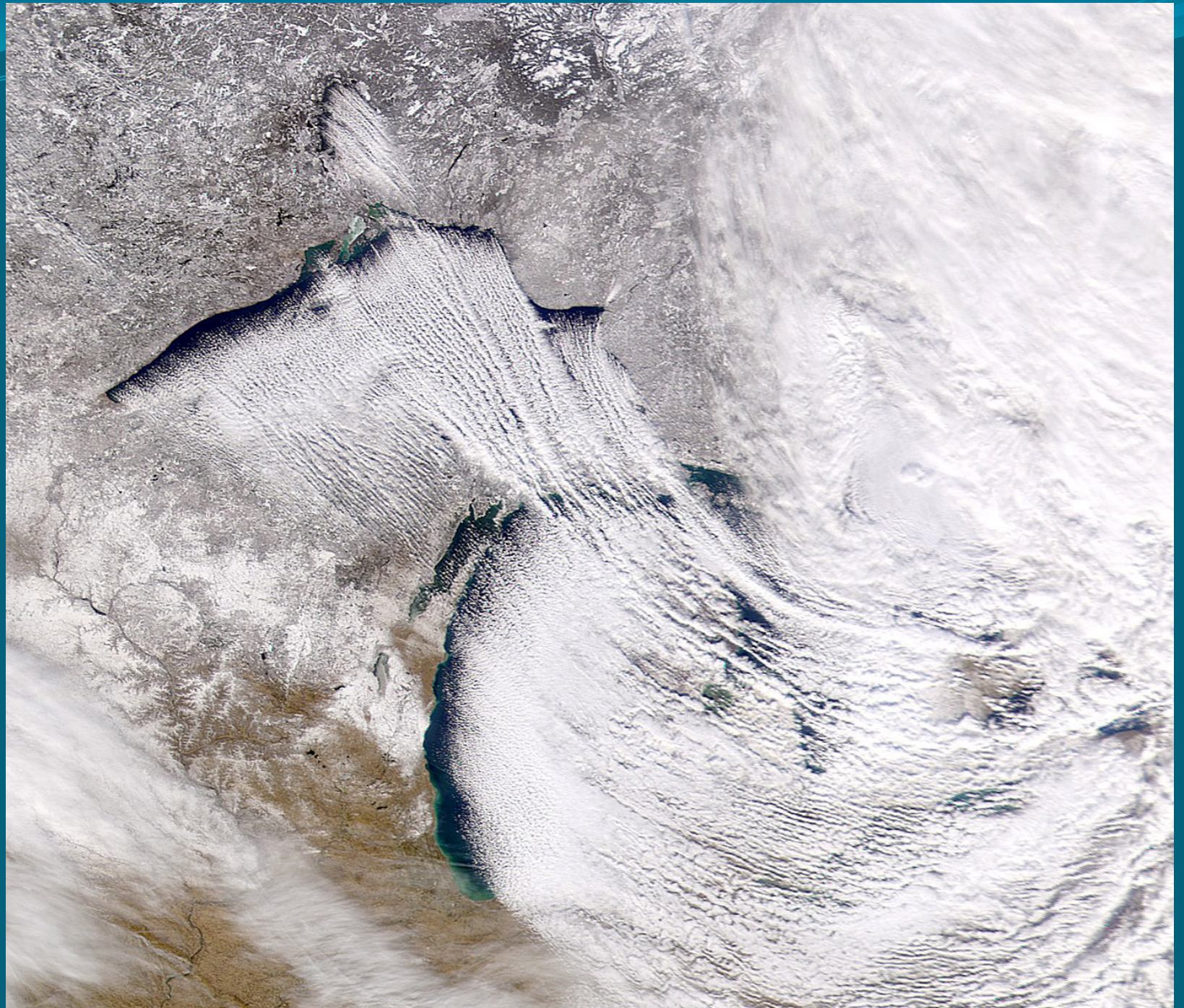
Width of arrows represents relative magnitudes of various factors



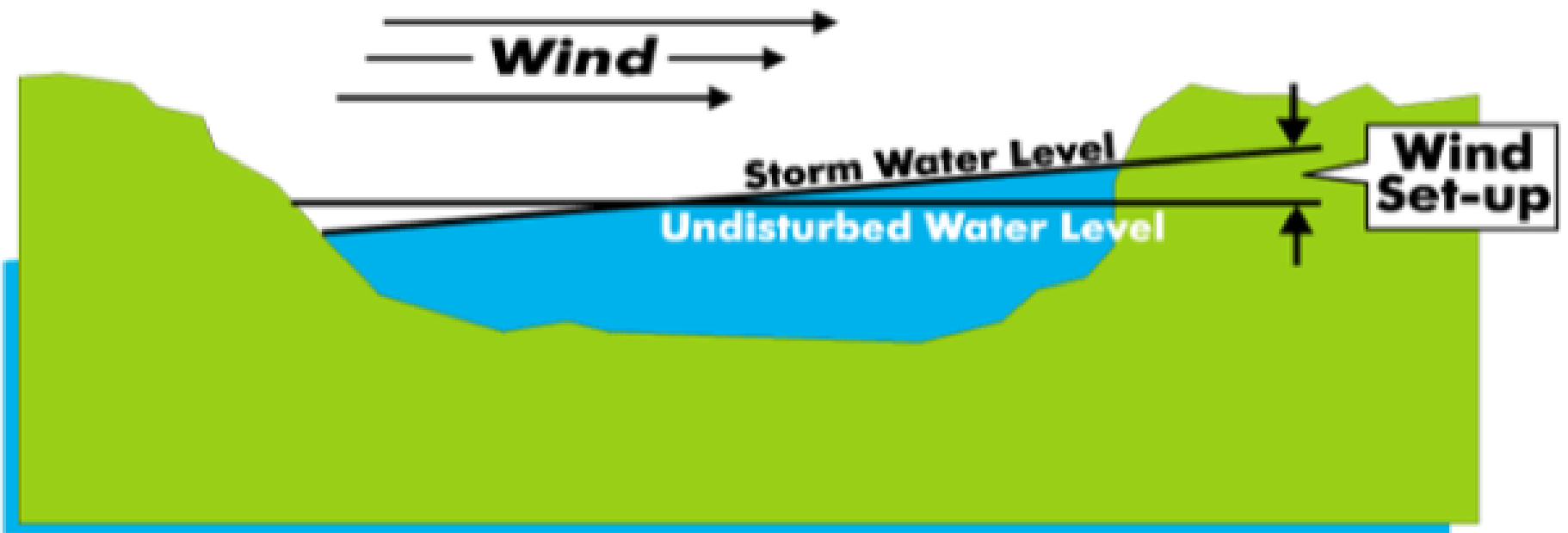


<b>Total Change (feet)</b>	<b>Time Span</b>	<b>Annual Rate of Change (ft./yr.)</b>	<b>Period of Change</b>
<b>Lakes Michigan- Huron</b>			
<b>+1.5</b>	8 months	+2.4	Feb. 2013 – Aug 2013
<b>+ 3.5</b>	17 months	+2.5	Feb. 1928 - July 1929
<b>+3.1</b>	18 months	+2.1	Feb. 1951 - Aug. 1952
<b>+3.2</b>	18 months	+2.1	Feb. 1959 - Aug. 1960
<b>+5.6</b>	8.5 years	+0.7	Jan. 1965 – July 1973
<b>-4.8</b>	3.5 years	-1.4	July 1929 – Jan. 1933
<b>-4.0</b>	2.3 years	-1.7	Oct. 1986 – Feb. 1989
<b>-4.7</b>	3.5 years	-1.3	Aug. 1997 – Dec. 2000
<b>Lake Superior</b>			





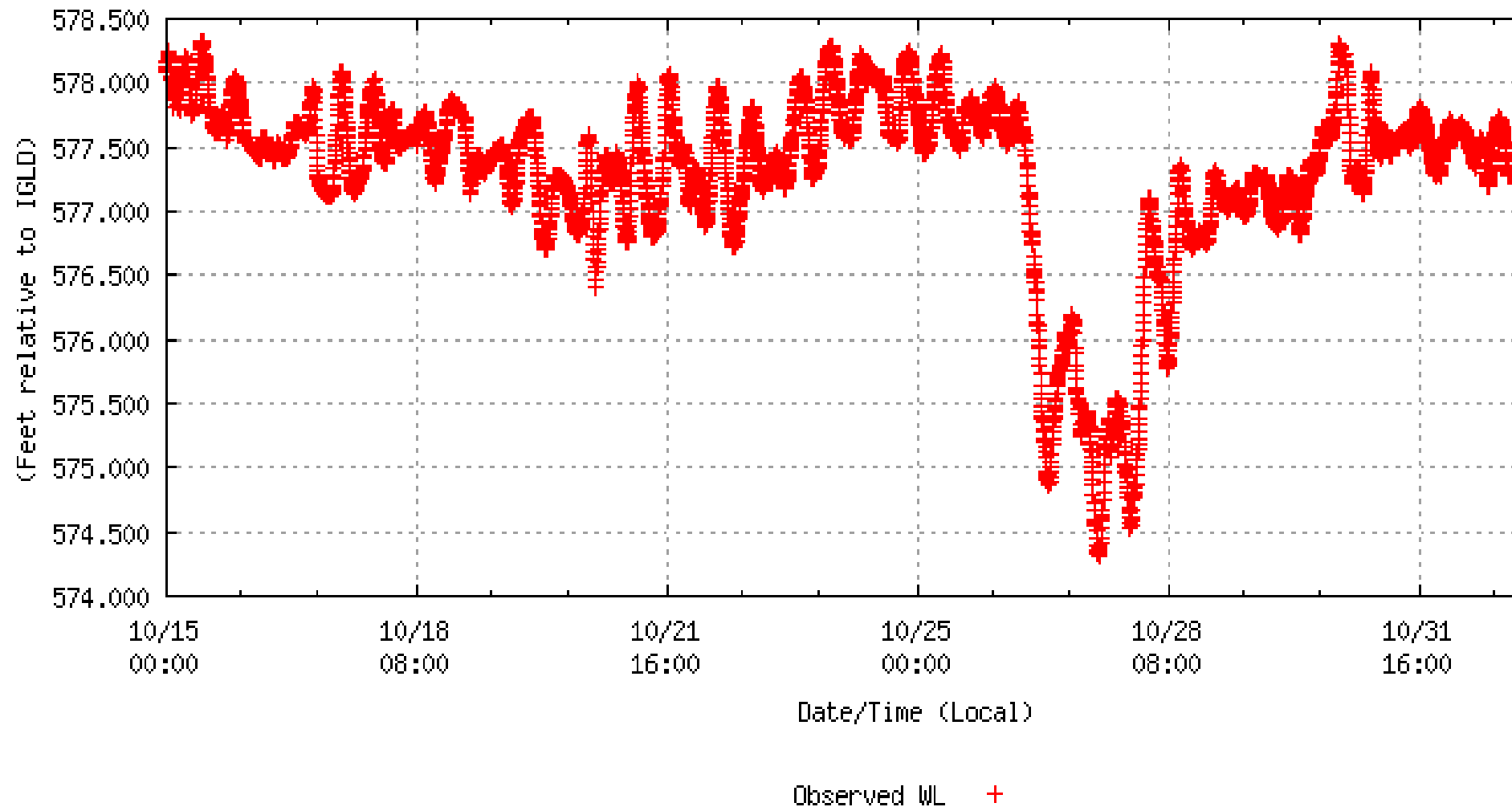




## Lake profile showing wind set-up

Courtesy *Living with the Lakes*, copyright 2000  
USACE-Detroit District and Great Lakes Commission

NOAA/NDS/CO-OPS  
Verified Water Level Plot  
9087079 Green Bay, WI  
from 2010/10/15 - 2010/11/03









# NAI Strategies



- Hazard Identification
- Planning
- Regulations and Standards
- Mitigation Actions
- Infrastructure
- Emergency Services
- Education and Outreach



# Hazard Identification

## BASIC

## *The Flood Insurance Rate Map*



NATIONAL FLOOD INSURANCE PROGRAM

**FIRM**  
FLOOD INSURANCE RATE MAP  
HORRY COUNTY,  
SOUTH CAROLINA  
AND INCORPORATED AREAS

PANEL 703 OF 753


SEE MAP INDEX FOR PANELS NOT PRINTED

CONTAINS:

CONTAINS:	NUMBER	PANEL	SHEET
HORRY COUNTY	45051	0703	11
UNINCORPORATED AREAS	45051	0703	11

MAP NUMBER  
45051C0703 H

MAP REVISED:  
AUGUST 23, 1999



Federal Emergency Management Agency







# Great Lakes Flood Hazard Mapping (GLFHM)

## Collaborative Project Between:

FEMA Region 5 (Lead)

FEMA Region 2

FEMA Region 3

Detroit District USACE





## Welcome to GreatLakesCoast.org

Great Lakes Coastal  
Analysis & Mapping

Wind Surge Study

Coastal Hazard  
Analysis & Mapping

Great Lakes Flood  
Zones Overview

Technical Resources

Outreach

Fact Sheets

Newsletters

Presentations

Events

Discovery Reports

Additional Resources

Contact Information

Site Map

Search for:

Search

Home > Great Lakes Coastal Analysis & Mapping > **Technical Resources**

## Technical Resources

### Project Data Centers

- **C-STORM** [cstormdb.erdc.dren.mil] – Basin wave and storm surge database platform, for access to wind, waves, pressure, ice, and water level data at near-shore "Save Points"  
*Note: This site will start with Lake Michigan data, followed by Lake St. Clair and Lake Erie data.*
- **U.S. Army Corps of Engineers Great Lakes Oblique Photo Viewer** [greatlakes.usace.army.mil]
- **LIDAR** [csc.noaa.gov] – High-resolution bathymetric and topographic data housed at NOAA's Coastal Service Center
- **Great Lakes Shoreline Geodatabase (.gdb)** [2.4 MB .zip]
- **CSHORE** [sites.google.com] – CSHORE is a one-dimensional time-averaged nearshore profile model for predictions of wave height, water level, wave-induced steady currents, and profile evolution.

### Great Lakes Coastal Flood Study, 2012 Federal Inter-Agency Initiative: Guidance Documents and Reports

- **Statistical Analysis and Storm Sampling for Lakes Michigan and St. Clair** [3.68 MB .pdf],  
*Norberto C. Nadal-Caraballo, Jeffrey A. Melby, and Bruce A. Ebersole, U.S. Army Corps of Engineers*  
(Final Published Report, September 2012)

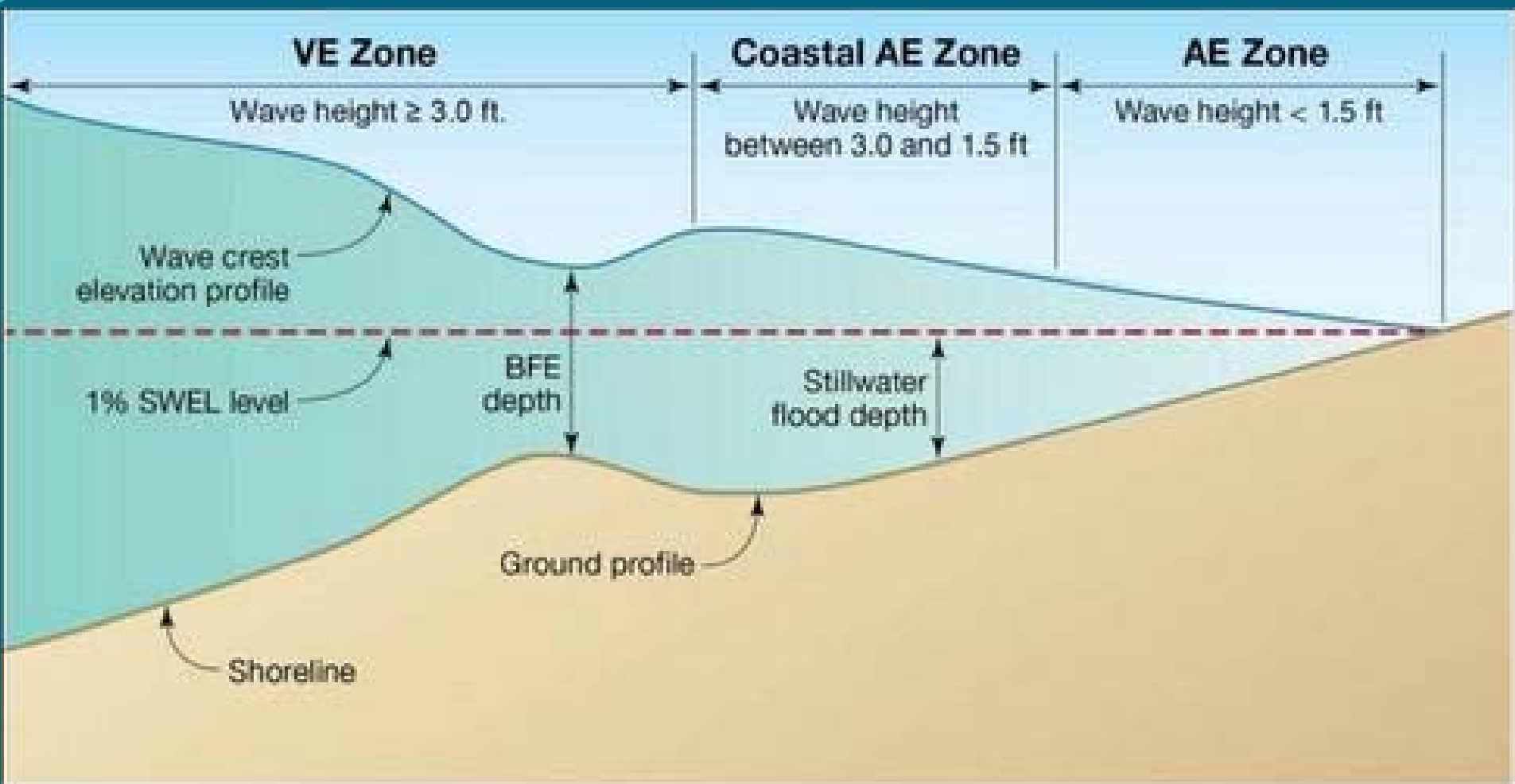


### RSS Feed

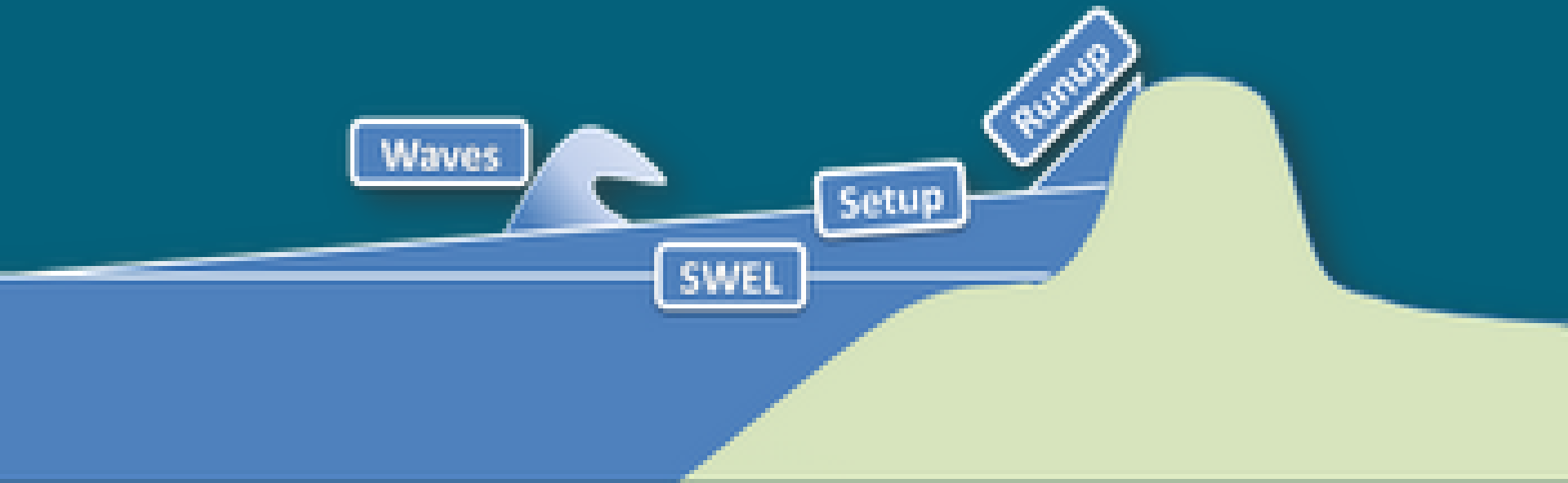
- [Great Lakes Coast RSS](#)

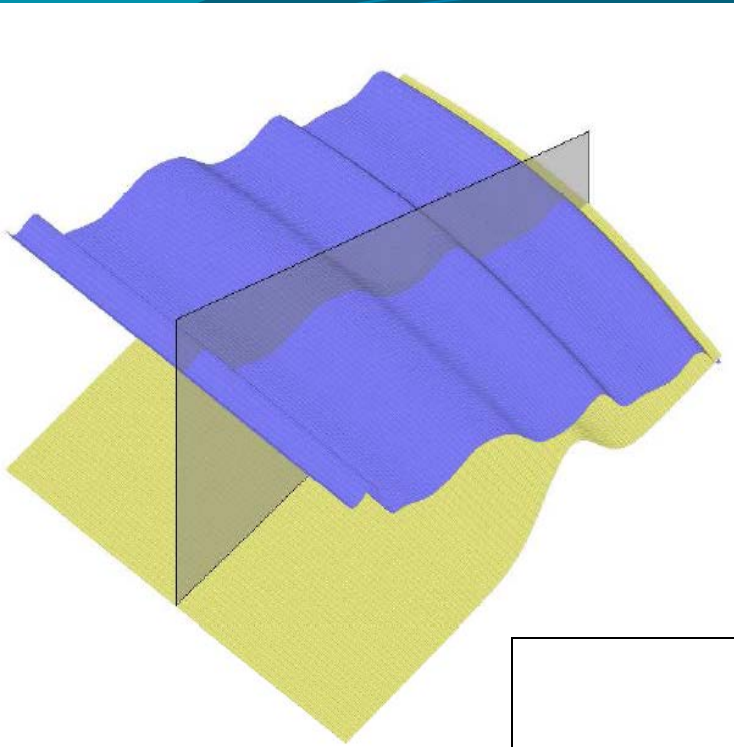
### Archives

- [October 2012](#) (1)
- [August 2012](#) (1)
- [July 2012](#) (1)
- [June 2012](#) (1)
- [May 2012](#) (2)
- [April 2012](#) (3)

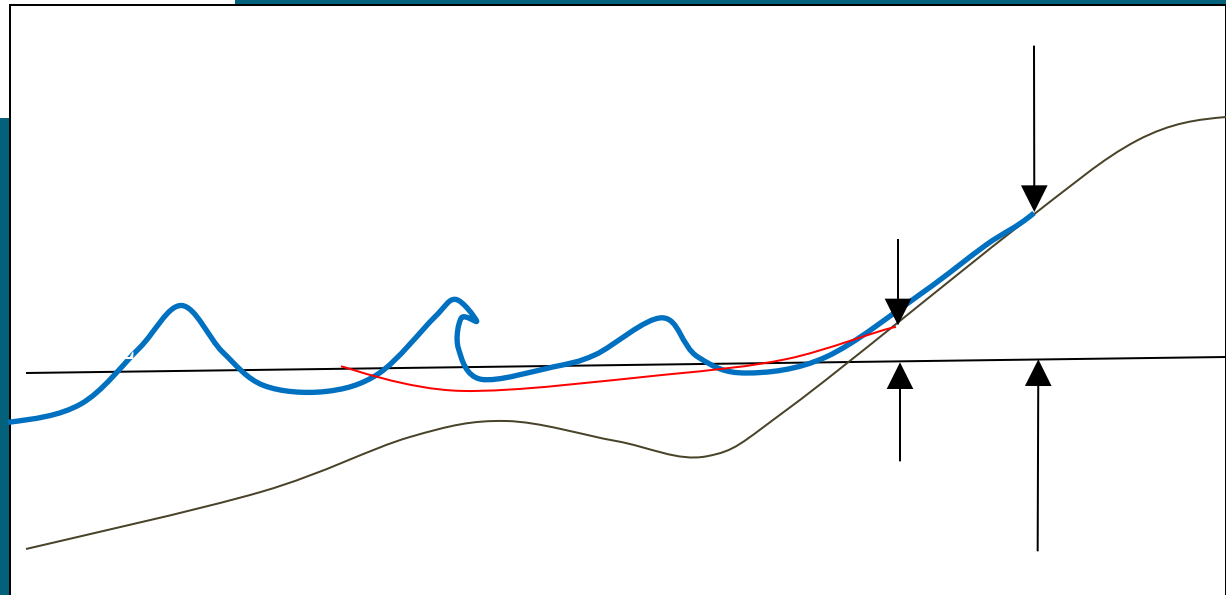


# Generalized Coastal Zone Schematic

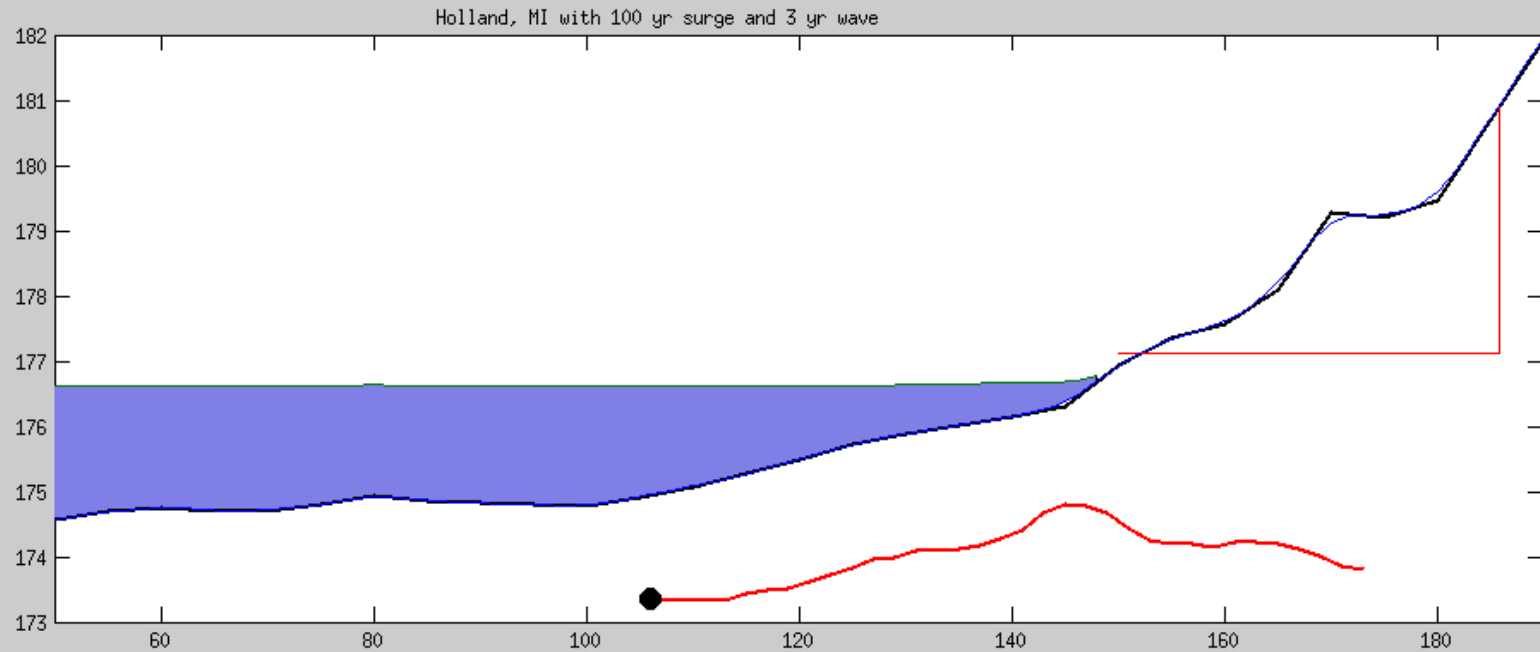




# Nearshore Dynamics and Wave Run-up Modeling with CSHORE



# Beach Erosion Simulations



Holland, MI morphology change using CSHORE



**ZONE VE**  
(EL 588)

**ZONE AE**  
(EL 584)

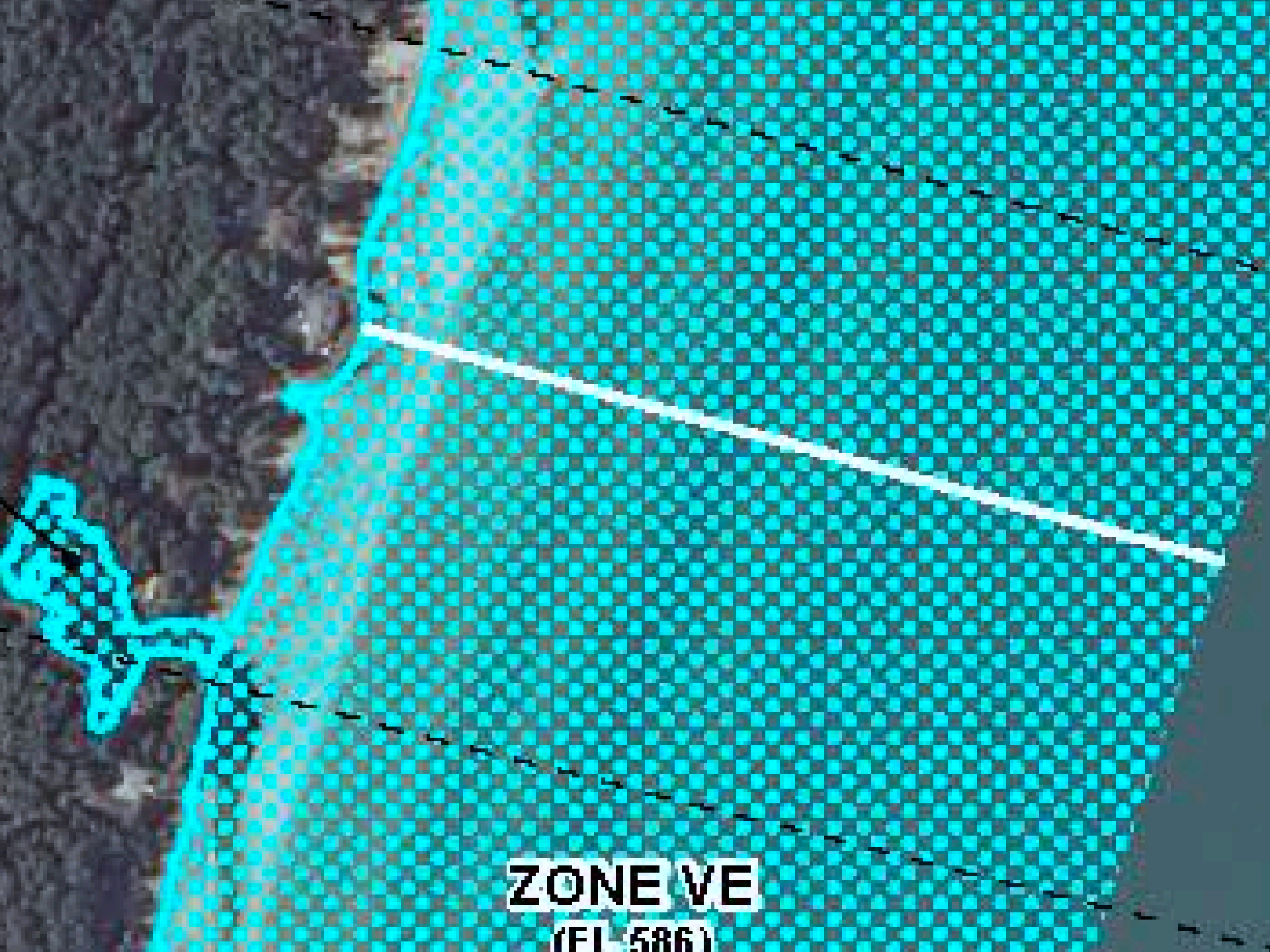
**ZONE VE**  
(EL 586)

1218

1217C

1217B





**ZONE VE**

(EL. 586)

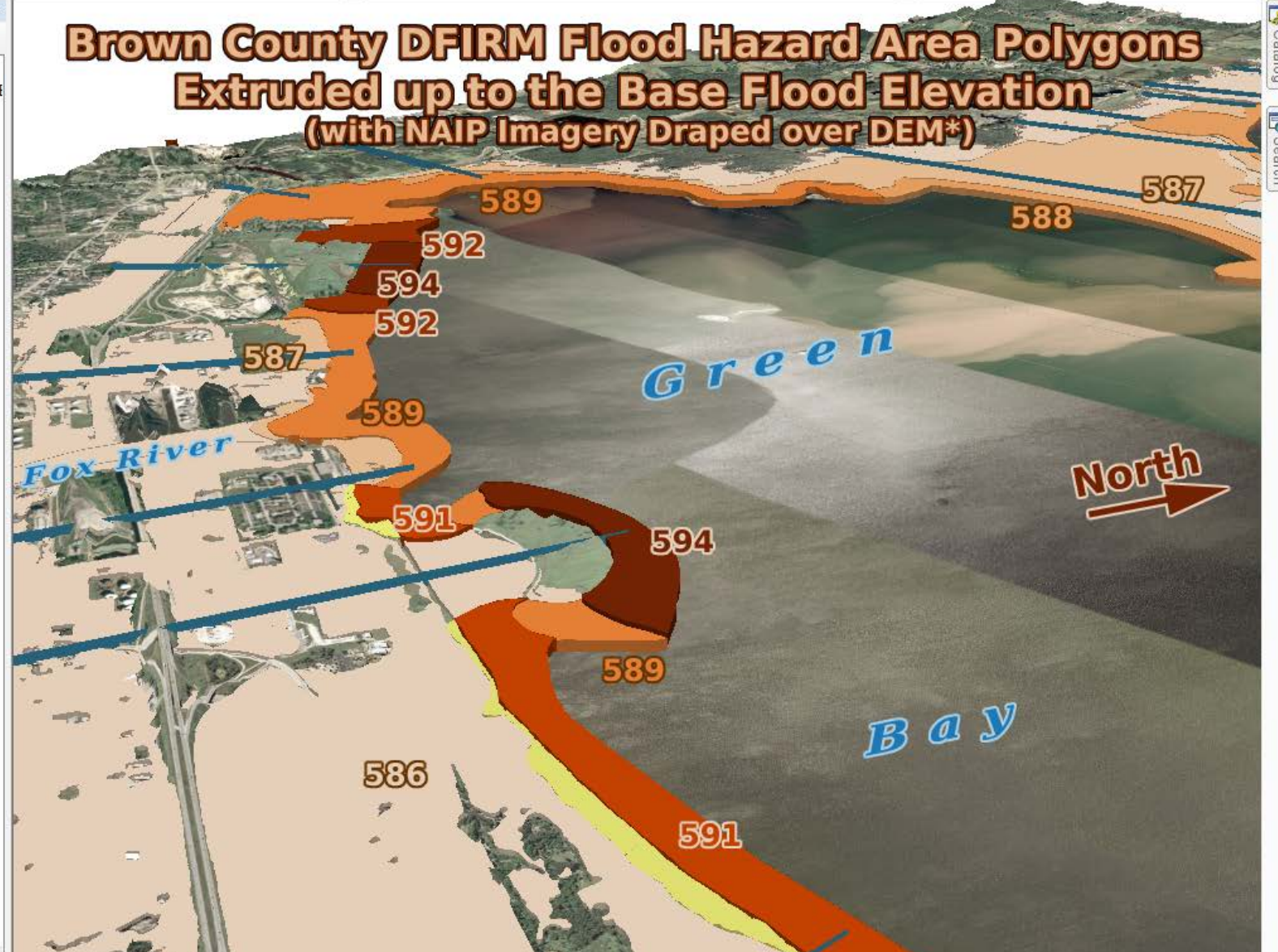


586

588

- Scene layers
  - C:\TEMP\Brown\_co\DFIRM\F
  - Coastal Transects
  - AO Zone
    - DEPTH
    - 2
  - AE Zone
    - STATIC\_BFE
    - 586
    - 587
    - 588
    - 589
    - 590
    - 591
    - 592
    - 594
  - C:\TEMP\Brown\_co\
    - NED 1/9 ArcSecond
      - Value
      - High : 264.916
      - Low : 166.749
    - NAIP 2010 Imagery
      - Res: 1 : 1.000
      - RGB
      - Red: Band\_1
      - Green: Band\_2
      - Blue: Band\_3

# Brown County DFIRM Flood Hazard Area Polygons Extruded up to the Base Flood Elevation (with NAIP Imagery Draped over DEM\*)



\* 10x Vertical Exaggeration in ArcScene

# Hazard Identification

**BETTER**

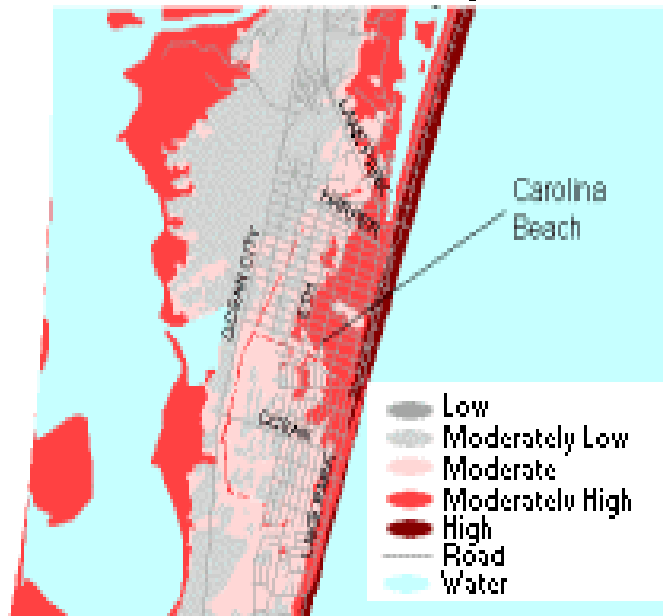
*Fill in the Gaps*

- Overlay other jurisdictional lines, wetlands and other protected areas over the FIRM
- Map other flood-related hazards (coastal erosion hazard area, areas with local flood history; stream erosion; dam failure inundation; mudflow hazard)
- Document High Water Marks from significant storms to aid in FIS/FIRM updates

# Hazard Identification

## NAI Strategies

Natural Hazard Summary Risk Areas



- Higher Mapping Standards
- Natural & Beneficial Functions
- Information Sharing

# Hazard Identification

NAI

*Higher Mapping Standards*

- Use future conditions hydrology (flood discharges based on build-out scenarios for current zoning)
- Map hazards not shown on FIRM (unstable bluffs and coastal recession)



# Hazard Identification

## Identify Sensitive Resources - NAI

**Natural & Beneficial Functions**

**Environmentally Sensitive Areas**

- **Wetlands**
- **Beaches**
- **Critical Habitat for Threatened & Endangered Species**



# Hazard Identification

## Information Sharing

- Make Community Data Available
- Limit Fee and/or Licensing Requirements
- Host Website for Downloading Data
- Develop Disaster Contingency for Data Access

# Hazard Identification

Think big and small,  
current & future...

Explore hazards  
history & impacts...

Find stories  
(examples, anecdotes  
and photos) to  
supplement other data  
sources...



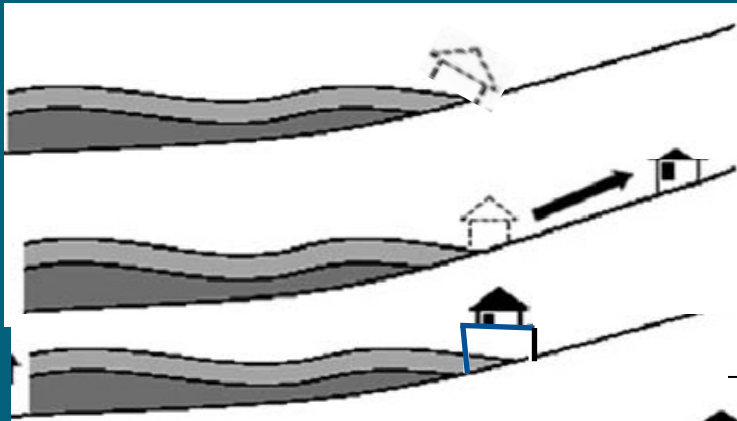
# NAI Strategies



- Hazard Identification
- **Planning**
- Regulations and Standards
- Mitigation Actions
- Infrastructure
- Emergency Services
- Education and Outreach



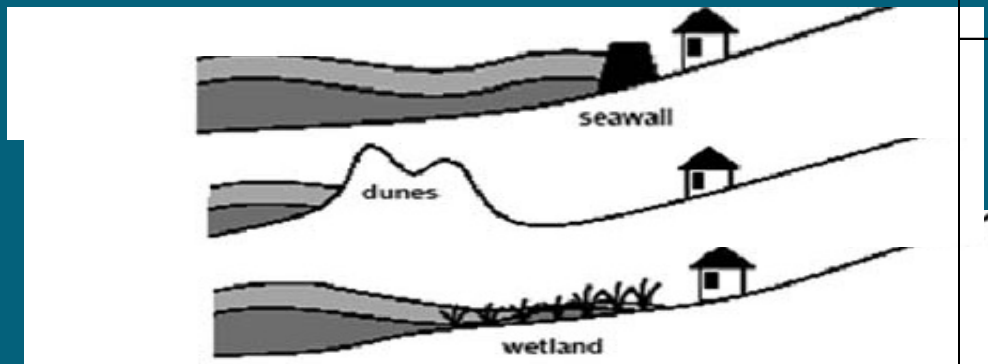
# Adaptation Strategies



Do nothing

Retreat

Accommodate



Protect

# Planning

## BASIC

### *Planning & Implementation*

- Prepare comprehensive land use plans
  - Identify hazard areas
  - Identify appropriate land uses
- Develop special subject plans to supplement comprehensive plans
  - Economic development plans
  - Habitat protection plans
  - Watershed management plans
- Adopt zoning or other ordinances to enforce plans

# Planning

**BETTER**

## *Risk Analysis and Strategy*

- Identify flood-risk areas on plans and restrict development
- Adopt low-density zoning in floodplains
- Use specialized tools (ex: GIS, HAZUS, etc.)
- Prepare FPM, storm water management plans to supplement comprehensive plans
- Prepare multi-hazard mitigation plans

# Planning

NAI

## *Sustainability*

Include watershed, MOM and sustainable development principles in land use planning

- Consider current and future development
- Coordinate floodplain planning with other planning activities (economic development, housing, recreation, ecosystem restoration, water quality, etc.)
- Identify long-term implications of alternative land uses
- Promote “sustainable” development

# Planning

Some great  
planning tools:





# Digital Coast

## More than just data...

The Digital Coast also provides the tools, training, and information needed to turn these data into the information most needed by coastal resource management professionals. [Read more...](#)

Welcome to the Digital Coast. If you have questions or comments, please [contact us](#).

### Data

Learn more about the kinds of data available and download data.

### Tools

Use these tools to turn data into the useful information your organization needs.

### Training

Update your skills by participating in one of these training programs.

### In Action

See how data and tools are used to address coastal management issues.

### Approaches

#### Coastal Inundation Toolkit

Understand the basics and get the tools that will help make your community more resilient.

#### Social Coast

Social science data can help address coastal issues. Find highlights of economic and demographic data, and also tools and methods, that can be applied to solve real issues.

#### Conserving Coastal Wetlands for Sea Level Rise Adaptation

Learn spatial techniques and get resources to prioritize wetland conservation.

### Featured Resources

#### "Marshes on the Move"

Provides a basic understanding of parameters, uncertainties, and appropriate uses of model results depicting potential future impacts of sea level rise on coastal wetlands

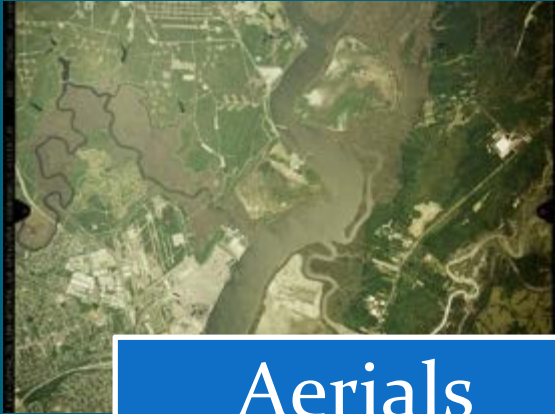
#### "Incorporating Sea Level Change Scenarios at the Local Level"

Outlines eight steps to help communities calculate sea level change scenarios and communicate impacts

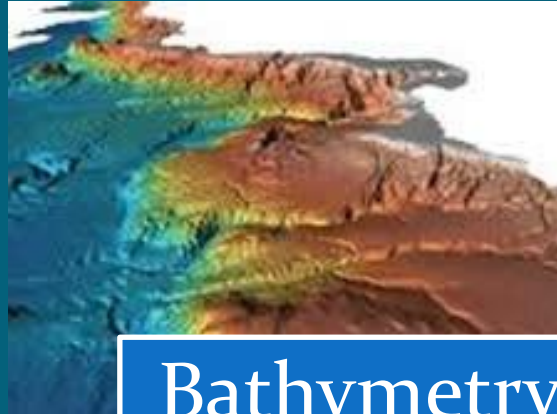
#### Sea Level Rise and Coastal Flooding Impacts Viewer

Creates maps of potential impacts of sea level rise along the coast and provides related information and data for community officials

# Digital Coast Data



Aerials



Bathymetry



LiDAR



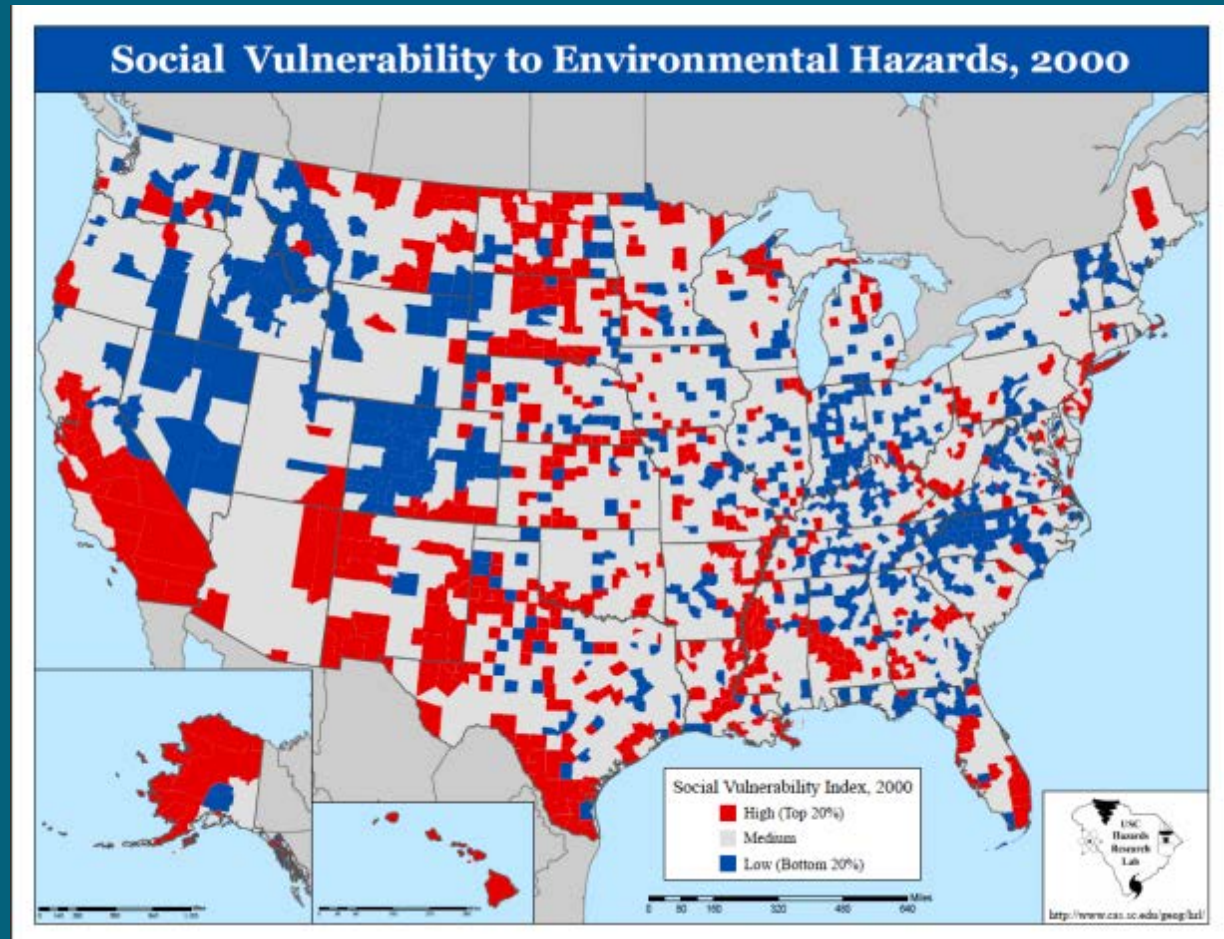
LandCover

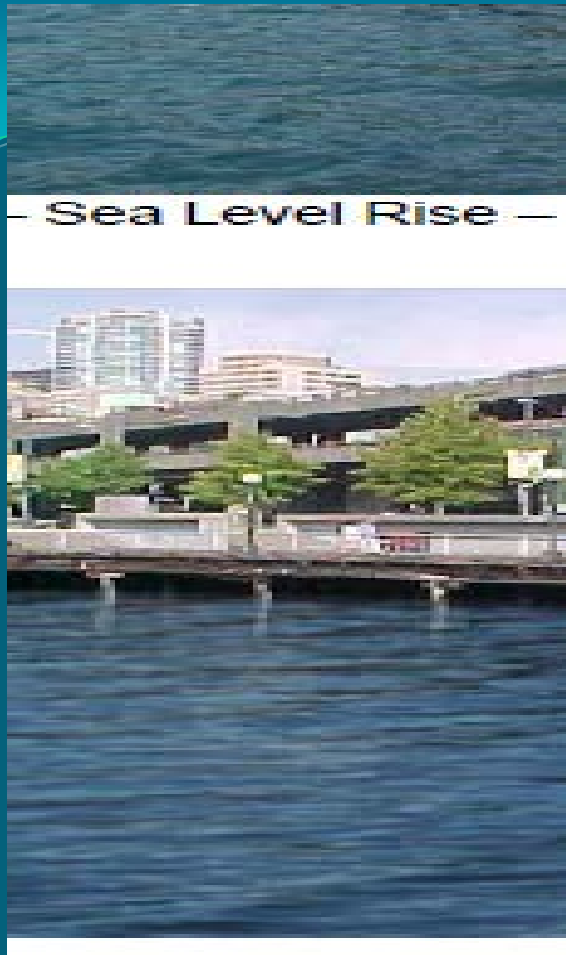
# Social Vulnerability Index (SoVI)

42 socioeconomic and built environment variables

## Examples

- Socioeconomic status
- Gender
- Race and ethnicity
- Age
- Commercial development
- Employment loss
- Rural/urban
- Infrastructure
- Renters
- Occupation
- Family structure
- Education





# CanVis Tool



Visualization

Alternatives



Charleston Customs House – 1.5m SLR - Before



Charleston Customs House – 1.5m SLR - After

Communication



# Coastal Resilience Guidebook

[Home](#) | [Hazard Management](#) | [Coastal Erosion](#) | [Infrastructure Planning](#) | [Habitat Conservation](#)

## Who are you?

Coastal Manager  
Floodplain Manager  
**Planner**  
Emergency Manager

## Where are you?

Lake: **Michigan**  
State: **Wisconsin**  
County: **Ozaukee**  
Municipality: **None**  
Address: **None**

Find Location (Map)



U.S. Great Lakes System

## Great Lakes Coastal Resilience Guidebook

This guidebook allows state and local officials engaged in coastal management, planning, mitigation and development issues to explore the primary coastal and shoreline hazards facing Great Lakes communities by allowing them to:

- examine how recent and ongoing trends in short-term and long-term climate conditions affect hazards and their impacts on land, water and resources
- investigate how different hazards management alternatives respond to and affect changing conditions

### 1. Hazards Management and Planning



### 2. Coastal Erosion & Bluff Recession



### 3. Coastal Infrastructure Planning



### 4. Habitat Conservation & Restoration



## Learn:

**Great Lakes**  
[Lake Levels](#)  
[Climate Change](#)  
[Geology](#)  
[History](#)

# NAI Strategies



- Hazard Identification
- Planning
- **Regulations and Standards**
- Mitigation Actions
- Infrastructure
- Emergency Services
- Education and Outreach



# Regulation & Development Standards

## BASIC

### *Core Regulations*

Adopt floodplain management ordinance recognizing:

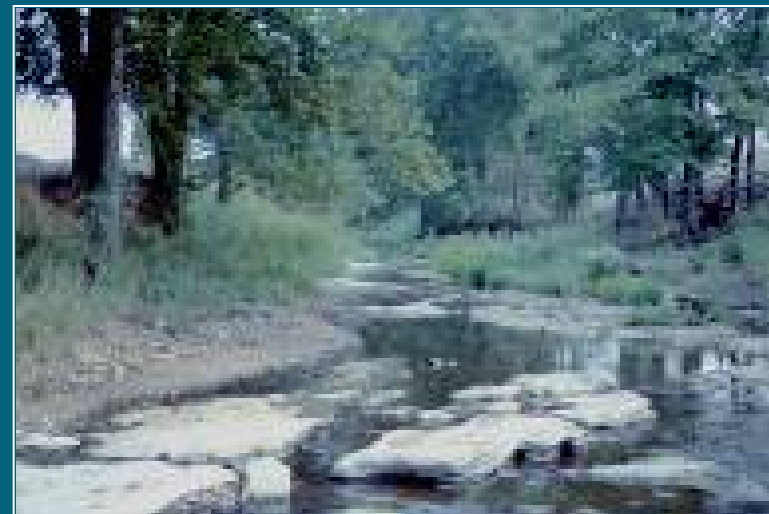
- Flood damage can still occur with minimum standards
- BFEs subject to change, particularly as development occurs in watershed

# Regulation & Development Standards

**BETTER**

*Higher Regulations*

- Prevent a loss of storage and/or an increase in velocity
- Restrict development in Coastal High Hazard Areas
- Adopt higher health/safety regs
- Utilize “green infrastructure”
- Adopt storm water regulations





# Regulation & Development Standards

NAI

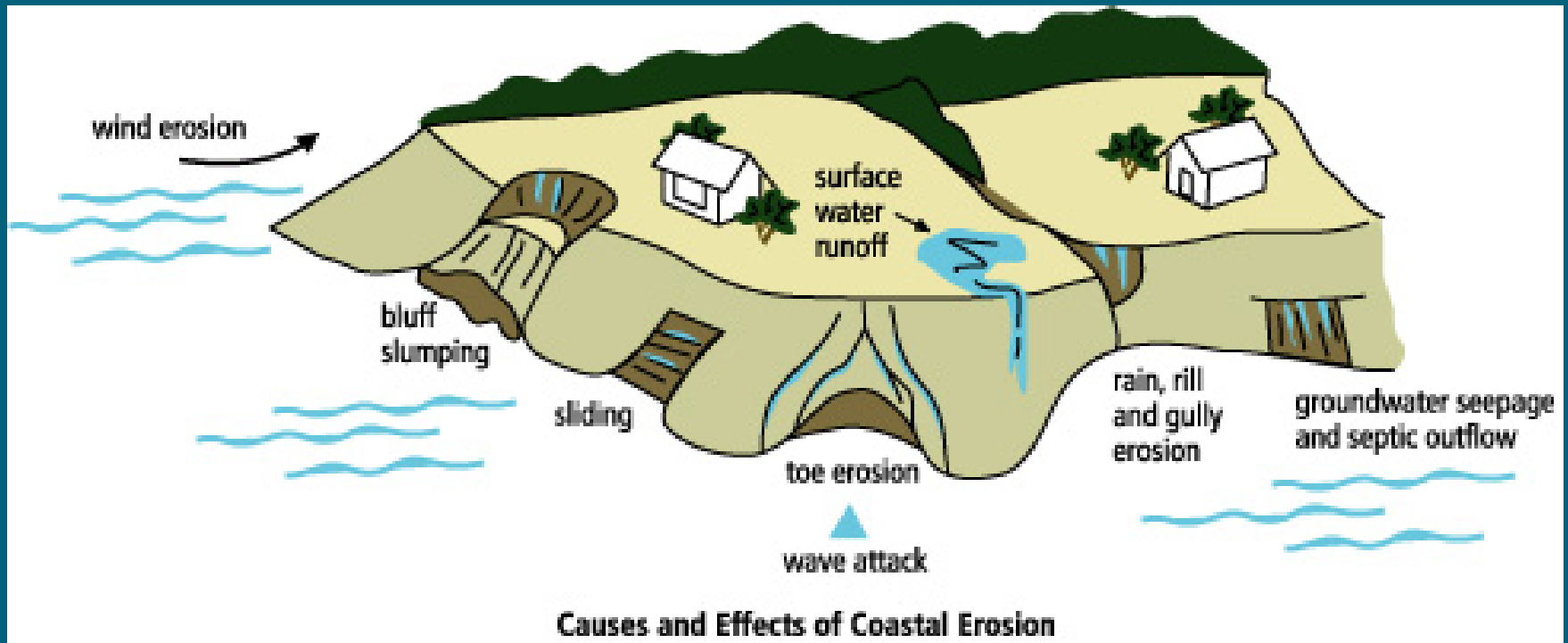
*Ensure Neighbors are not adversely impacted*

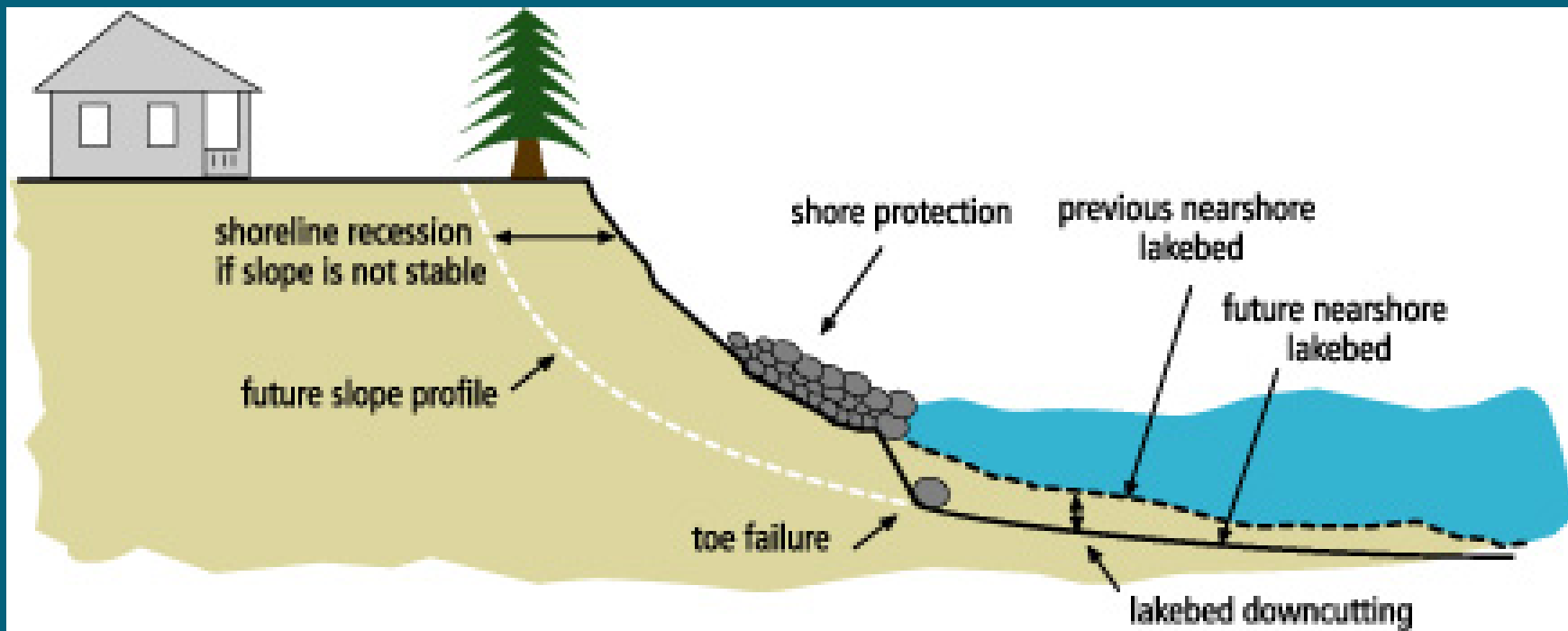
Require community permits for shore protection structures:

- Include a requirement that structures do not adversely impact neighboring property

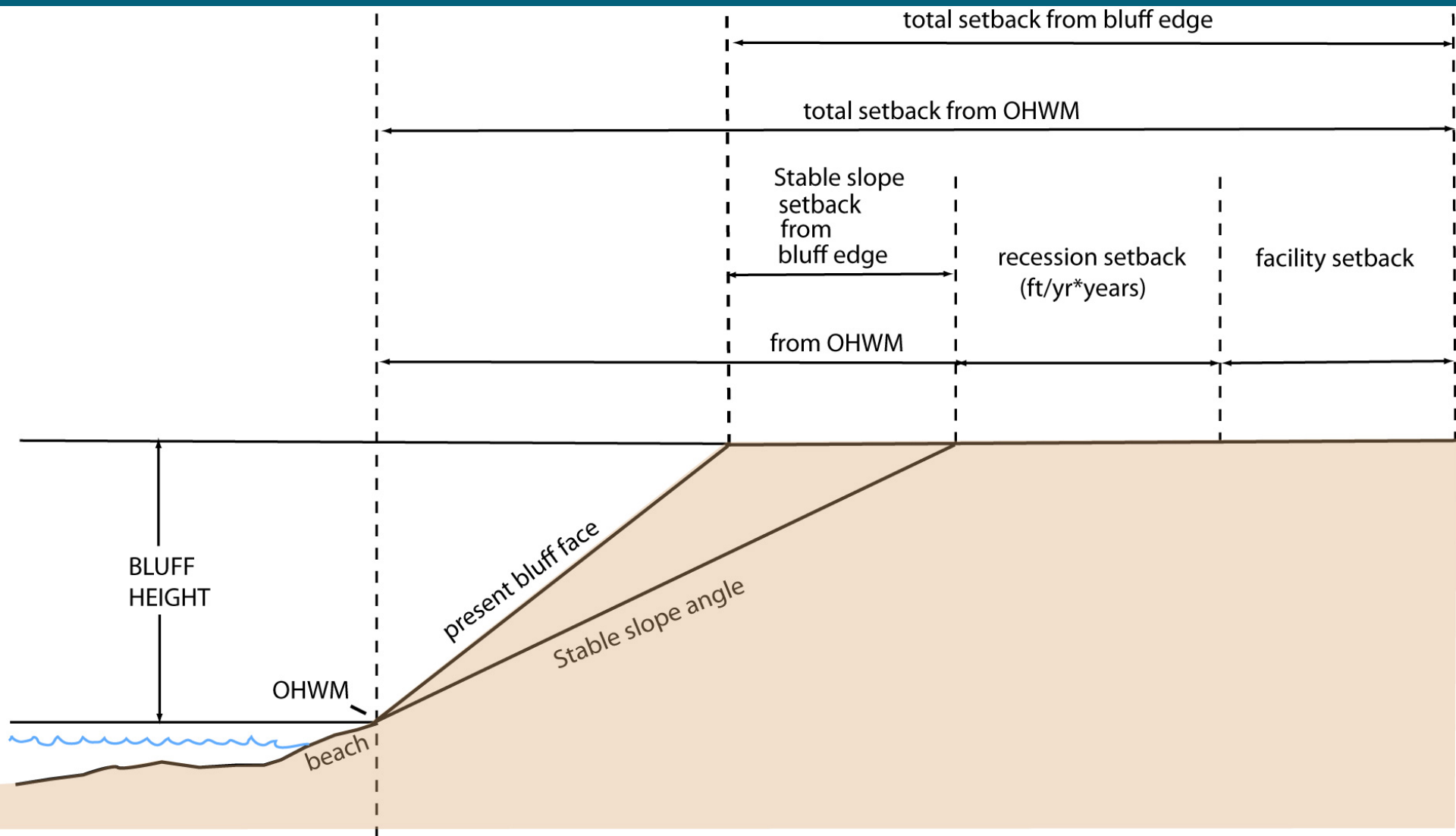
Adopt setback regulations in areas with unstable bluffs

# CAUSES OF COASTAL EROSION





**Lakebed Erosion with Slope Recession and Failure of Shore Protection Structure**



# GL States with Coastal Setbacks

- Michigan
- Pennsylvania
- Ohio
- New York
- Wisconsin (some counties)

## Movement of Location of "Ordinary High Watermark" (OHW)



Location of OHW  
with **EROSION**

**ORIGINAL** location  
of OHW

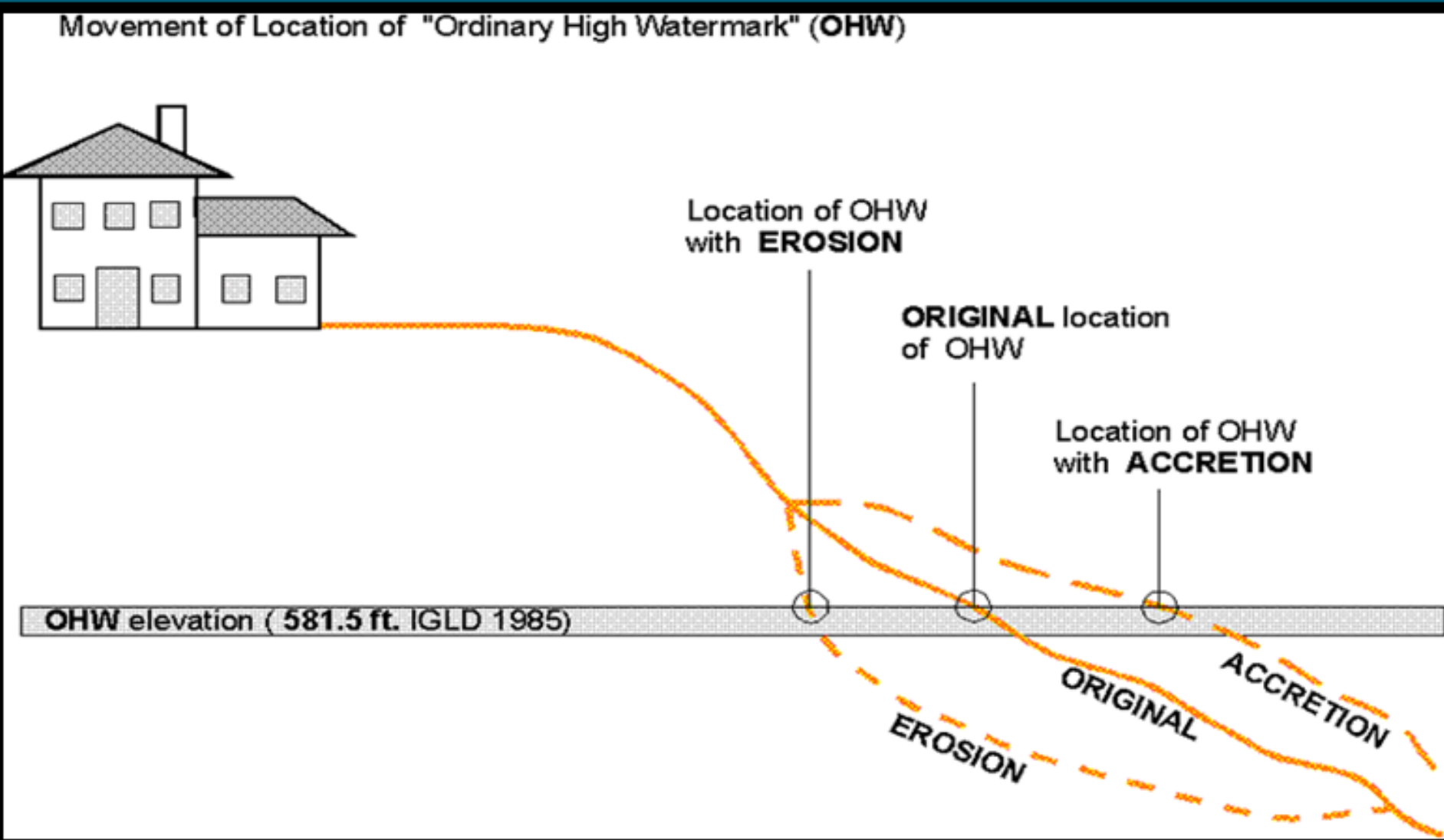
Location of OHW  
with **ACCRETION**

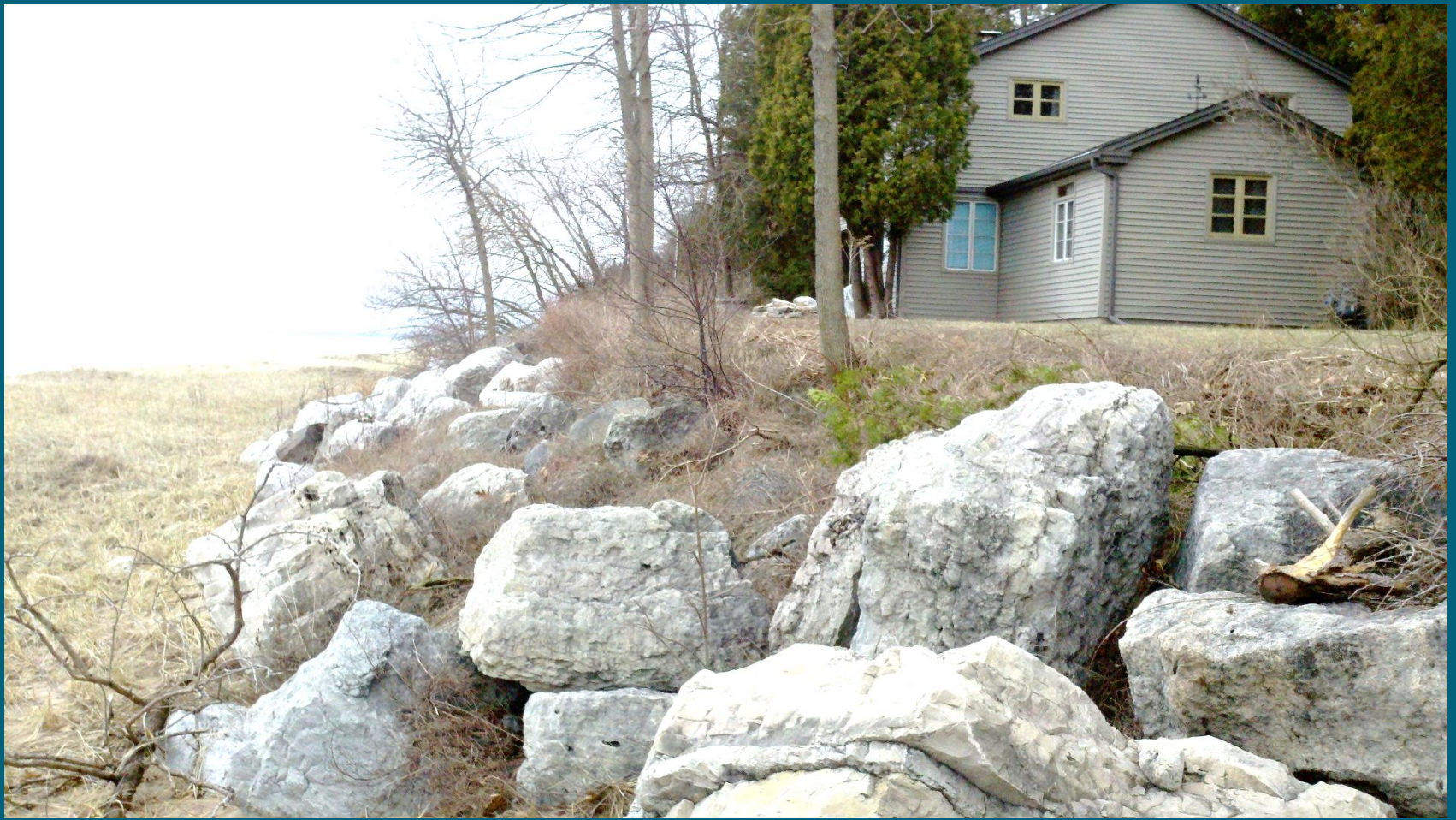
OHW elevation ( 581.5 ft. IGLD 1985)

**EROSION**

**ORIGINAL**

**ACCRETION**













# Regulation & Development Standards

NAI

## *Natural Floodplain Functions*

Preserve beneficial natural floodplain functions

- Adopt setback standards to establish minimum distances from river channels or shorelines
- Adopt buffer zone requirements between sensitive and developed areas
- Implement stream restoration programs

# NAI Strategies



- Hazard Identification
- Planning
- Regulations and Standards
- **Mitigation Actions**
- Infrastructure
- Emergency Services
- Education and Outreach



# Mitigation

## BASIC

### *Structural Controls, Insurance*

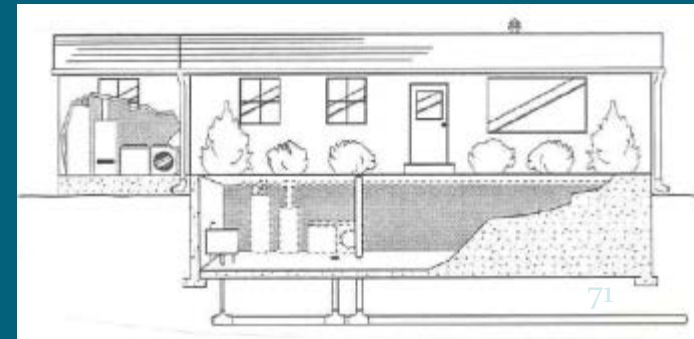
- Structures used to control flooding
  - Levees, floodwalls, seawalls
  - Groins
  - Channel modification
  - Dredging
- Flood Insurance

# Mitigation

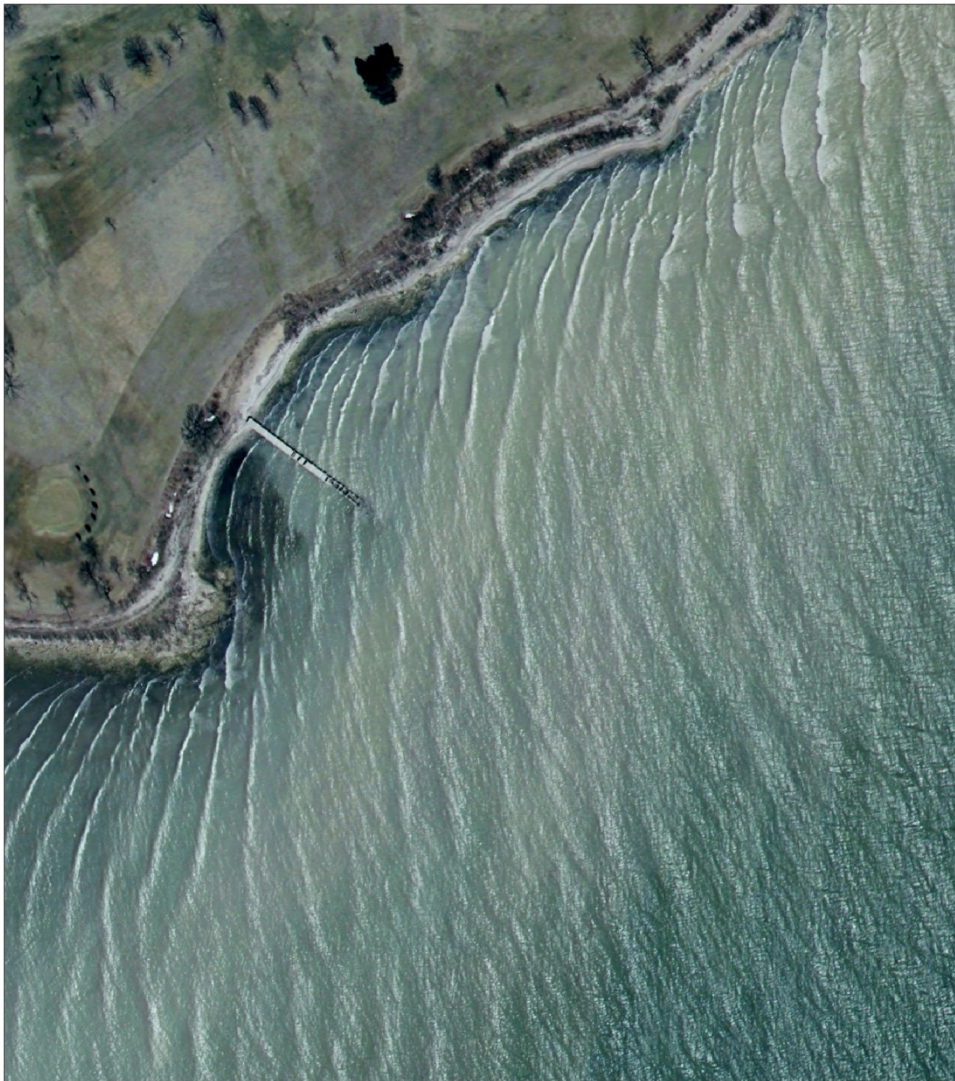
**BETTER**

*Human Adjustment to Flooding*

- Enforcing the rules you \*do\* have
- Elevating structures
- Building barriers around a structure
- Wet and dry floodproofing



- Non-structural vs.  
Structural

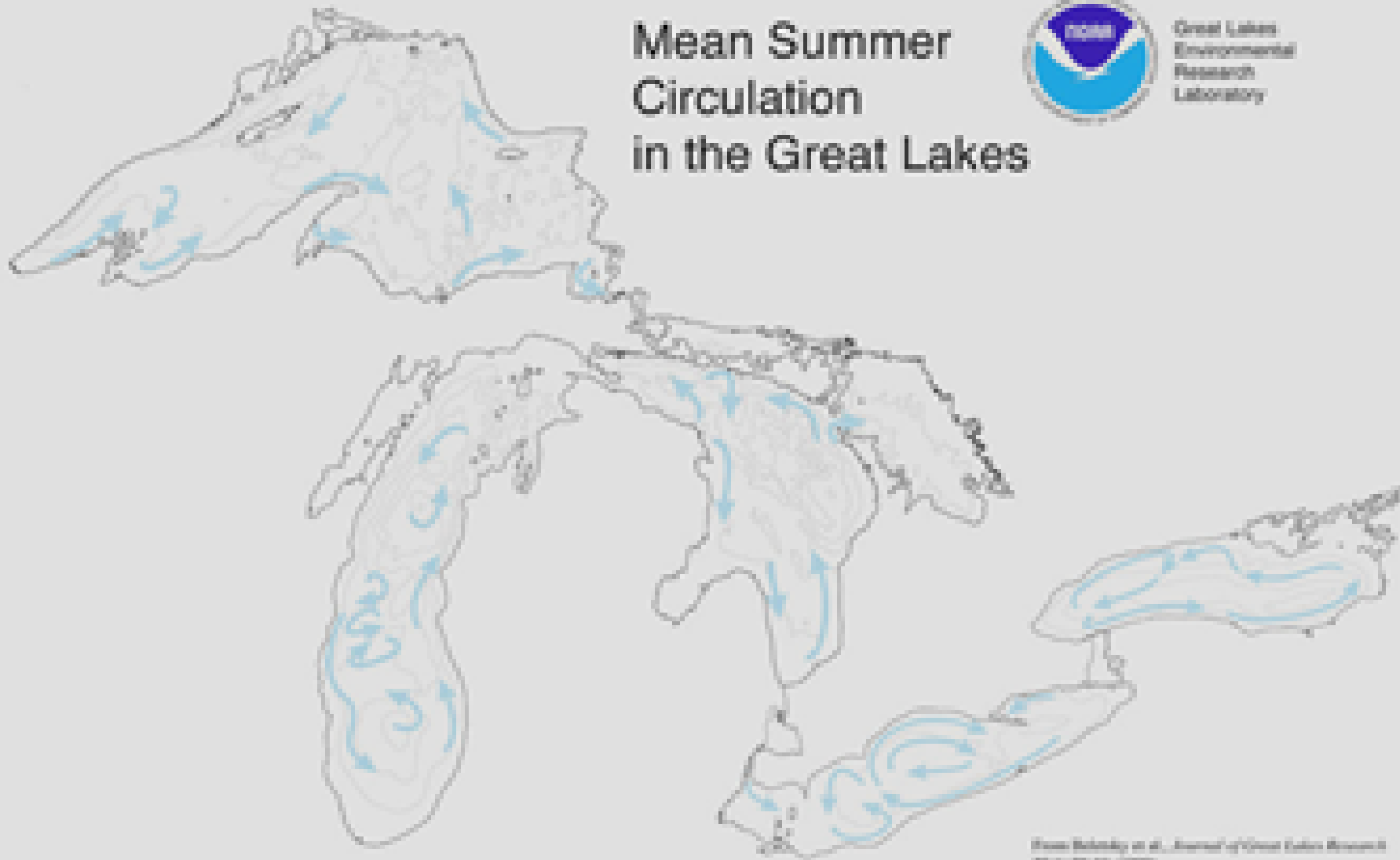




# Mean Summer Circulation in the Great Lakes



Great Lakes  
Environmental  
Research  
Laboratory



From Schwab et al., *Journal of Great Lakes Research*  
24 (2008) 100-108

**Figure 1 – Circulation Patterns in the Great Lakes**

**Lake Superior dm**



**N 46° 47.655' W 091° 23.096'**

**952 ft**

**04/18/2007 9:43:56 AM**





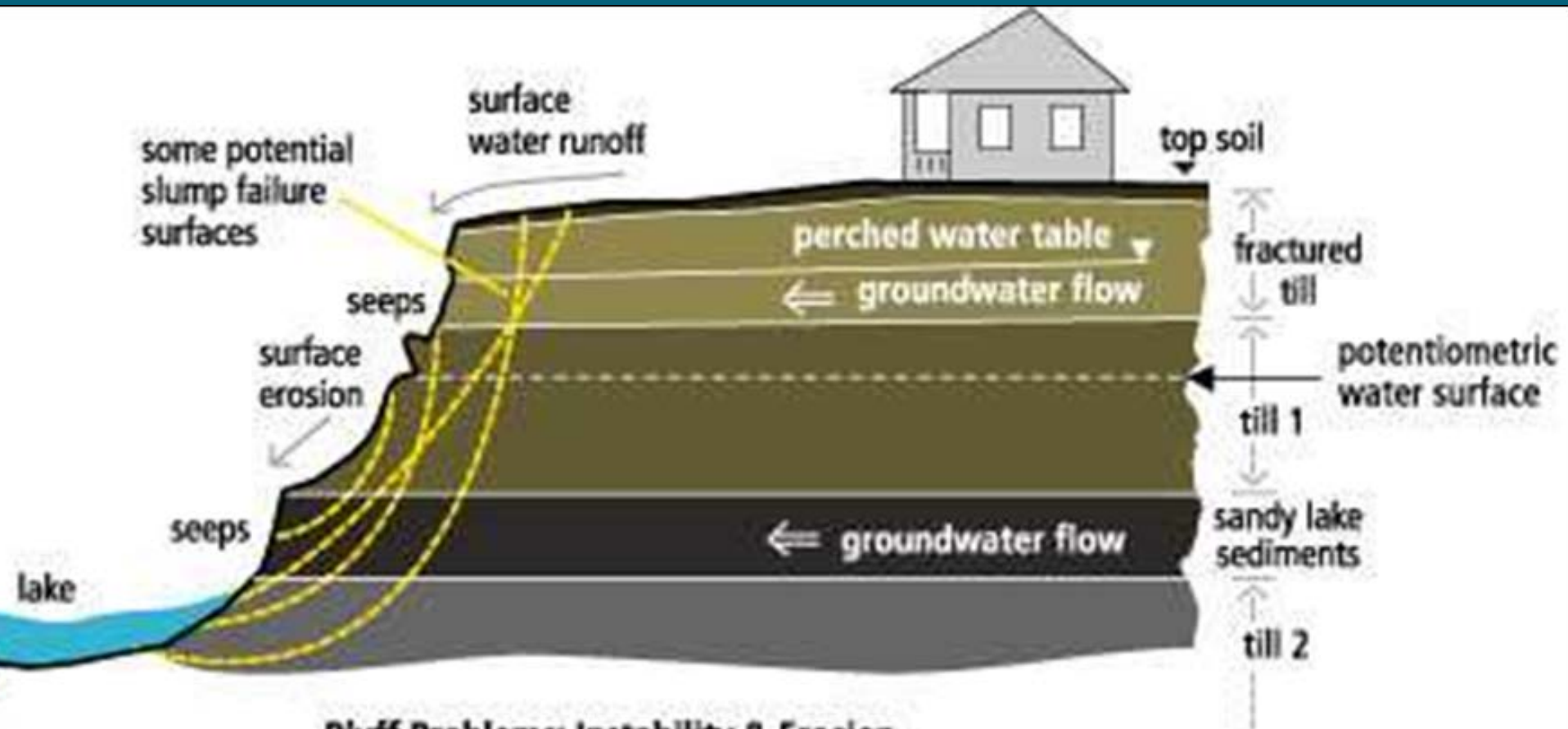
*"No, sweetie, we don't go to the beach. We're from  
New Jersey—we go to the shore."*

# Mitigation

NAI

## *Human Adjustment to Flooding*

- Include Ecosystem Services in BCA
- Relocate structures out of the floodplain
- Acquire properties in the floodplain



**Bluff Problems: Instability & Erosion**  
**Surface Water Runoff Groundwater Seepage**

# Case Study



# Case Study



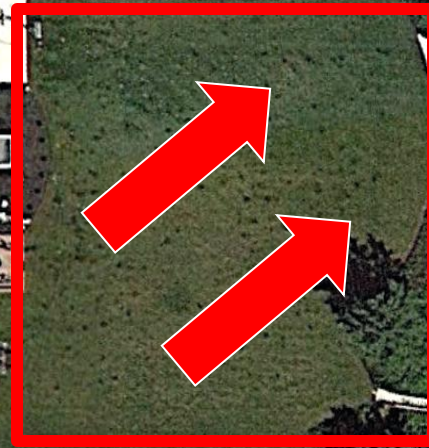


# Case Study



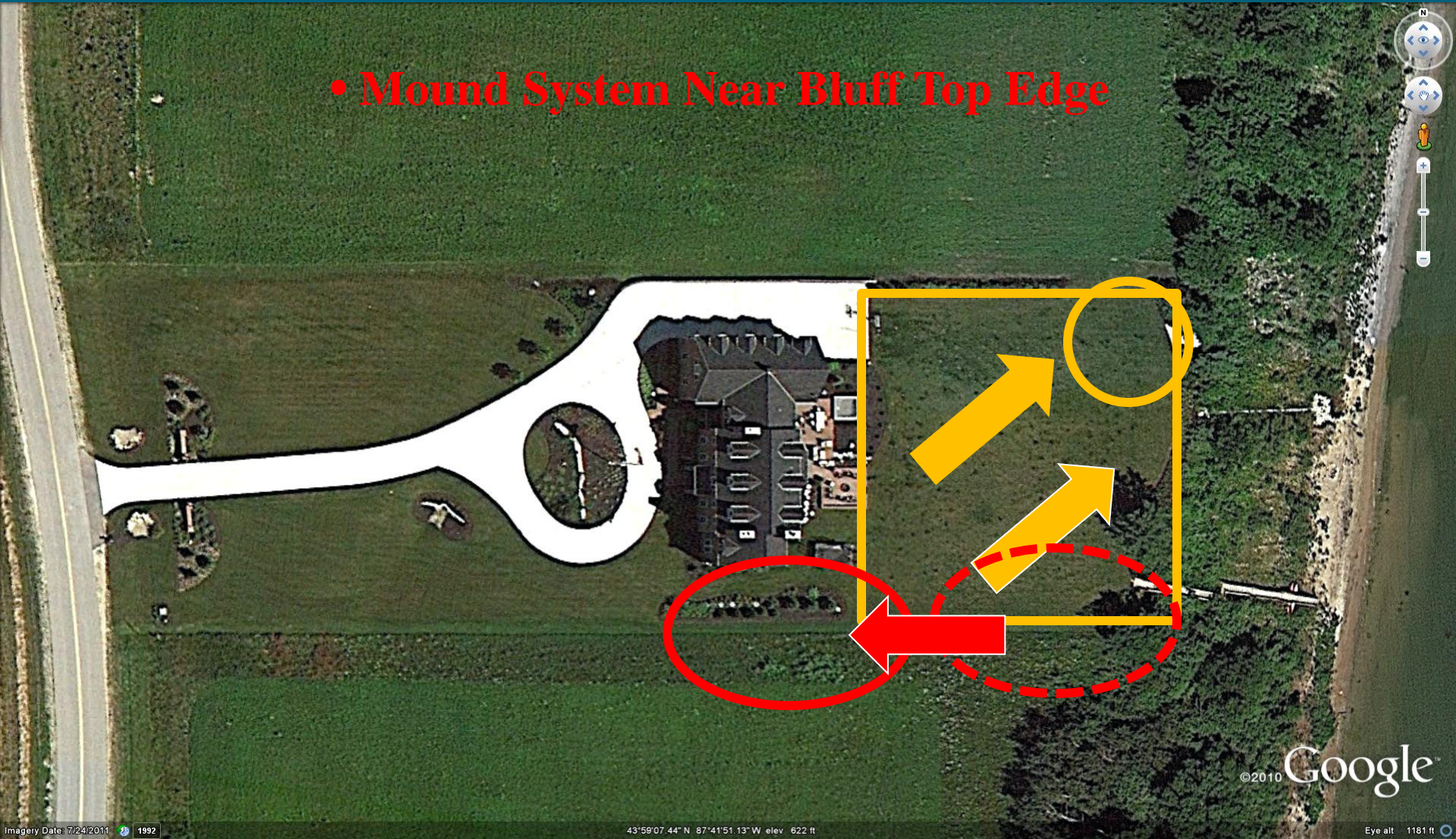
# Case Study

- **Removed Natural Vegetation**
- **Graded (Compacted) Front Yard**
- **Sloped Yard Towards Lake**



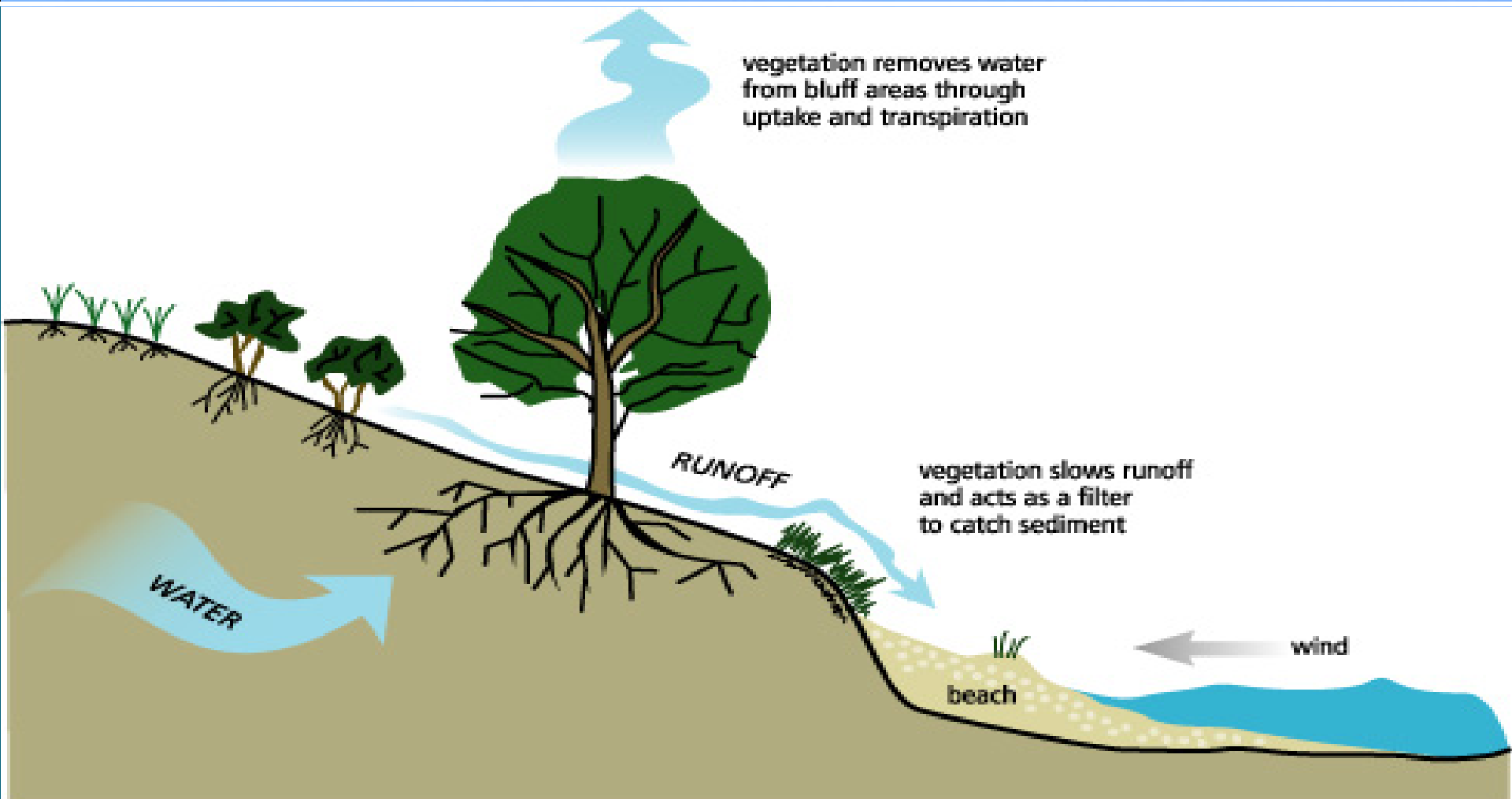
# Case Study

• Mound System Near Bluff Top Edge



# BLUFF STABILITY BMPs

## Vegetation Restoration



Revegetated Coastal Slope

- Bluff Stability BMPs
- Courtesy of Gene Clark – WI SeaGrant

# BLUFF STABILITY BMPs

## Vegetation Restoration – Cold Storage



# BLUFF STABILITY BMPs

## Vegetation Restoration – Simple Planting



# BLUFF STABILITY BMPs

## Vegetation Restoration – 3 Month Growth





# BLUFF STABILITY BMPs

## Slope Vegetation Restoration

- Use Native Vegetation!
  - Not **Black Locust, Crown vetch,**  
**or Bird's-foot trefoil**
  - Contact Local Conservation Agencies,  
University Extension, SeaGrant for  
Assistance



# BLUFF STABILITY BMPs

## Surface Water Management: Rain Barrels



Source: [greenculture.com](http://greenculture.com)

# BLUFF STABILITY BMPs

## Surface Water Management: Rain Gardens



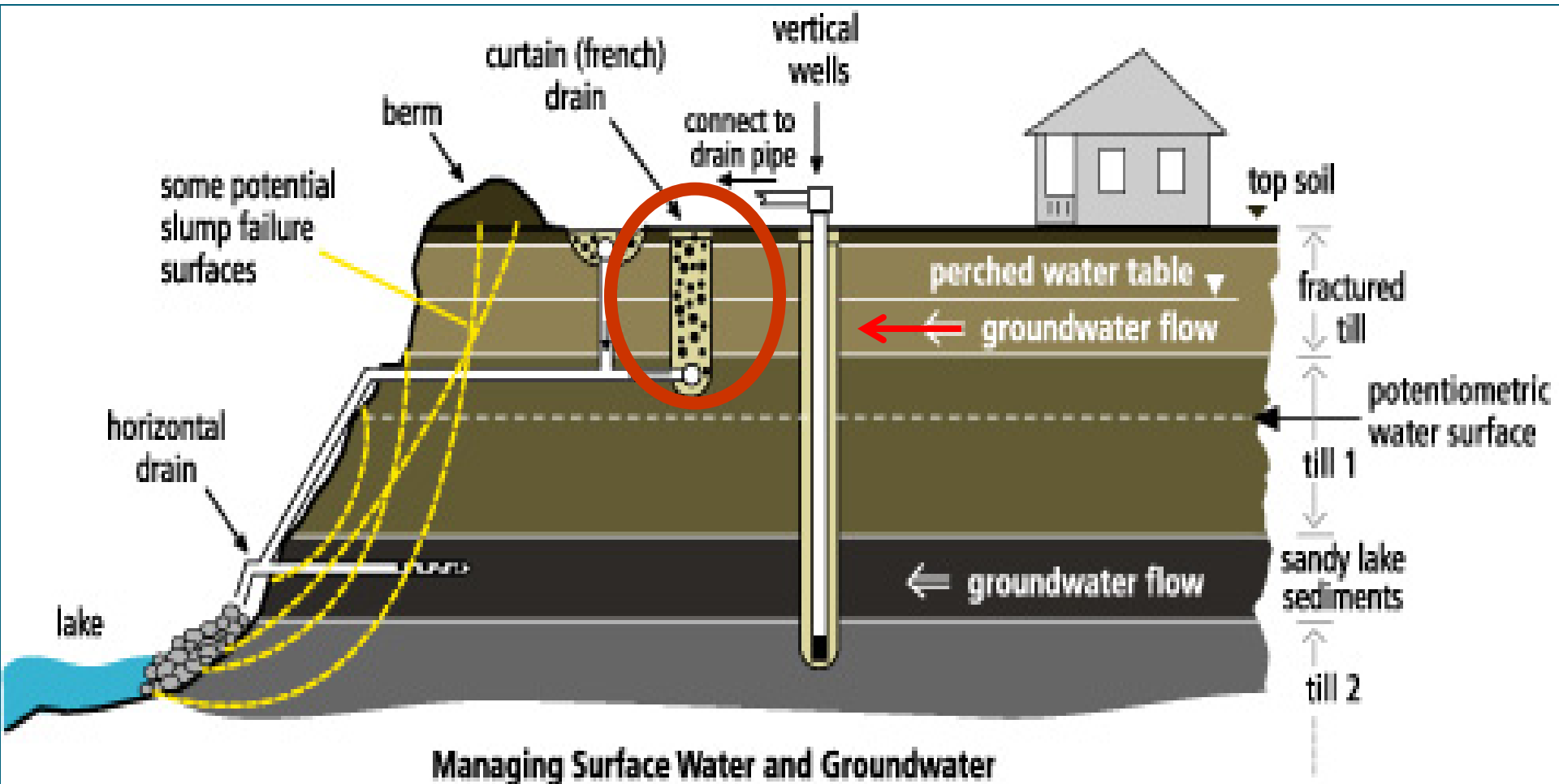
# BLUFF STABILITY BMPs

## Surface Water Management: Retention



# BLUFF STABILITY BMPs

## Ground Water Management: French Drains



Managing Surface Water and Groundwater

# BLUFF STABILITY BMPs

## Ground Water Management: French Drains



# BLUFF STABILITY BMPs

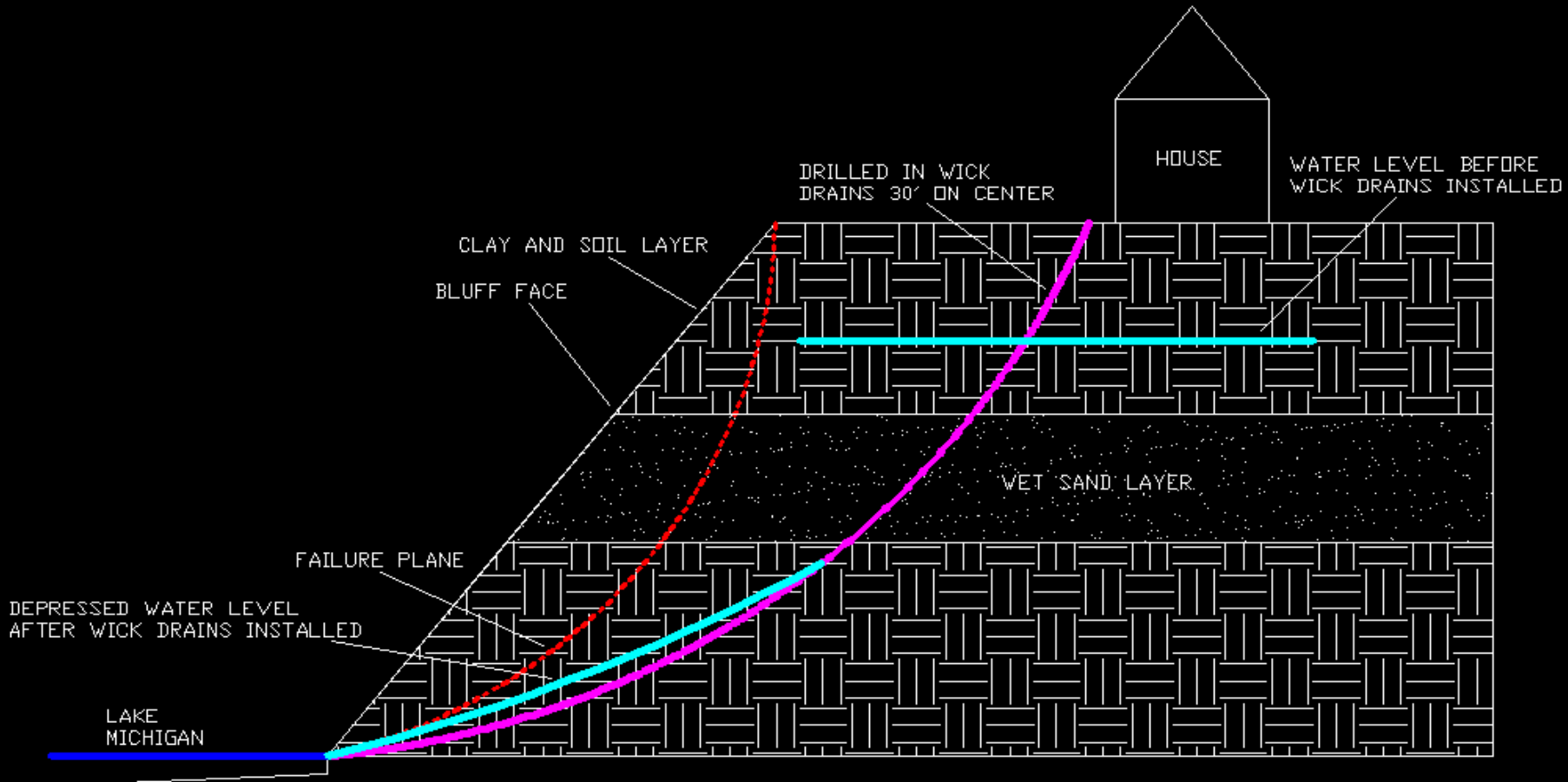
## Ground Water Management: French Drains



# BLUFF STABILITY BMPs

## Ground Water Management: Wick Drains

Source: Edward E. Gillen Co.





# BLUFF STABILITY BMPs

## Ground Water Management: Wick Drains

Source: Edward E. Gillen Co.



# BLUFF STABILITY BMPs

## Ground Water Management: Wick Drains

Source: Edward E. Gillen Co.



# Mitigation

NAI

## *Master Planning and Monitoring*

- Take a “master plan” approach to flood protection

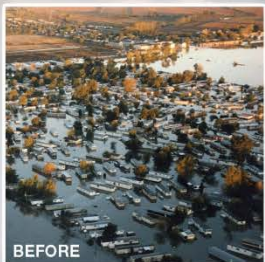
### *Involve all levels of services...*

- Utilities (water, sewer, power)
- Stormwater
- Streets
- Building services
- Planning
- Parks
- Budget/Finance

### *Involve the public...*

- “Town Hall” meetings
- Workshops with Planning Commission
- Owners of properties affected
- Other interested parties

# MITIGATION



## How-To Guide for No Adverse Impact



July 2013



# Relocation



# NAI Strategies



- Hazard Identification
- Planning
- Regulations and Standards
- Mitigation Actions
- **Infrastructure**
- Emergency Services
- Education and Outreach



# Infrastructure

## BASIC

### *Response and Replacement*

- Doing the minimum to maintain the infrastructure and repair it after a flood or other disaster
- Includes roads, bridges, utilities, parks, drainage systems



## Infrastructure

**BETTER**

*Protection Measures, Procedures*

- Routine inspections of bridges, culverts, etc. after a flood event, with resulting corrective measures
- Do a “flood audit” of all public buildings in relation to the floodplain
- Participate in the development of emergency action plans



# Infrastructure

NAI

## *Plans and Alternatives*

- Use a capital improvement plan (CIP) to acquire land for public uses – parks in the floodplain, channels and drainage structures, etc.
- Restrict road development through flood-prone areas (wetlands, marshes, floodplains, etc)
- Create a master greenway plan to link open spaces
- Stream restoration
- Regulate critical facilities out of flood zones

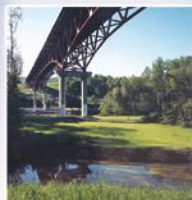
# Case Study – County LS



# INFRASTRUCTURE



## How-To Guide for No Adverse Impact



July 2013

## How-To Guide for No Adverse Impact

# INFRASTRUCTURE

July 2013



URS

# NAI Strategies



- Hazard Identification
- Planning
- Regulations and Standards
- Mitigation Actions
- Infrastructure
- **Emergency Services**
- Education and Outreach



# Emergency Services

## BASIC

### *Generic Response Plan*

- Treats all disasters alike
- No specific actions for different types of hazards

## Emergency Response

**BETTER**

### *Flood Preparedness Plan*

- Implement a flood threat recognition system
- Work with the NWS for a flood warning program (both internal – for staff – and external – for the public)
- Map out the predicted flood stages

# Emergency Response

NAI

*Pre- and Post-Disaster Preparedness*

- Pre-Disaster:
  - Pre-plan your emergency response for flood events
  - Educate the public about mitigation options
  - Apply for grants to pro-actively deal with repetitive losses
- Post-Disaster
  - Use the Residential Substantial Damage Estimator (RSDE) to determine level of structural damage
  - Regulate post-disaster construction to newer regulations

# NAI Strategies



- Hazard Identification
- Planning
- Regulations and Standards
- Mitigation Actions
- Infrastructure
- Emergency Services
- Education and Outreach





## Education/Outreach

**BASIC**

*Answer Questions*



- Am I in the floodplain?
- What regulations apply to my floodplain property?
- Make public documents available for review

## Education/Outreach

**BETTER**

### *Outreach Projects*

- Provide map information to the public via non-traditional routes (web sites, using FIRMettes, etc)
- Send out floodplain information brochures to all residents in their utility bills or tax bills
- Post signs in the floodplain showing historical flood heights or required elevations
- Create a flood section in your local library
- Offer flood protection advice to the public

## Education/Outreach

NAI

### *Education and Outreach*

- Train staff to CFM level
- Host or participate in workshops, conferences, etc. where you can speak about NAI and distribute related materials
- Help educate children about environmental issues and flood/hurricane/tsunami safety education



*Thank you for your time!*

*Questions???*

# Great Lakes Coastal Flood Mapping Program

[greatlakescoast.org](http://greatlakescoast.org)



Visit [greatlakescoast.org](http://greatlakescoast.org)  
for more information on the  
Great Lakes Coastal Flood  
Study



FEMA

**RiskMAP**  
Increasing Resilience Together