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FEMA Region V
Great Lakes Coastal Flood Study

Brown County Pilot Study

Neville Public Museum
Green Bay, Wisconsin

February 27, 2014

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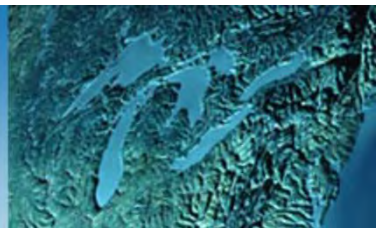
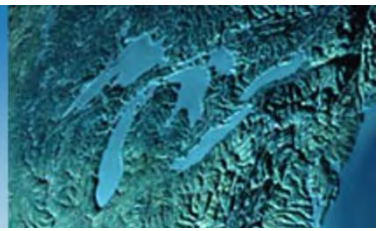


Brown County Pilot Study
Agenda

- Great Lakes Coastal Flood Study Background
- Pilot Study Background
  - Study objective
  - Project site determination and background
- Modeling Approach
  - Regional study approach
  - Local modeling activities
- Results and Conclusions
  - Pilot study outcomes
  - Developed model approach
  - Mapping considerations



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Great Lakes Coastal Flood Study

Background

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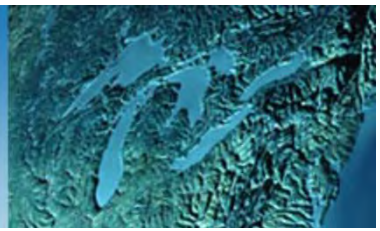
Brown County Schedule

- Technical Workshop: May 10, 2012
- Discovery Kick-off: June 15, 2012
- Discovery Report: February 2013
- Demonstration Project: November 2012 – February 2014
- Bathymetry Data Collection: February 2014
- Workmap Meetings: April 2015
- Preliminary Maps: September 2015



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Pilot Study

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Study Objective

- Evaluate the revised guidelines for coastal flooding analyses and mapping in the Great Lakes (Appendix D.3 of the G&S) for the following:
  - Response-based vs. event-based approach
  - Storm-induced erosion
  - Lake level variation
  - Wave runup
- Test CSHORE model
- Develop methodologies to produce wave propagation and wave runup results for future coastal PMRs

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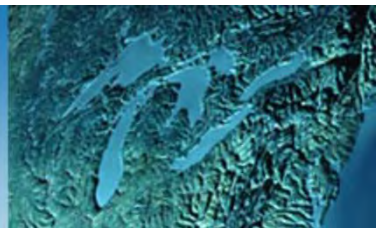
Revised Guidelines

- **Response-based vs. event-based approach**
  - Model large suite of individual historical storms rather than a single ‘representative’ event
  - Use statistical analysis of storm suite results to generate BFEs
- **Storm-induced erosion**
  - Utilize advanced numerical models for profile evolution vs. ‘rule of thumb’ eroded profiles
  - Consider erosion for each individual event and how it affects wave transformation/runup

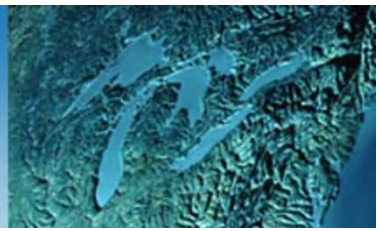


Revised Guidelines

- Lake level variation
  - Incorporate long-term varying lake levels specific to each storm event
  - Storm suite encompasses events during both high and low lake levels
- Wave runup
  - Numerical surf zone dynamics models
  - Other FEMA-approved methods

Project Site Determination

- Appropriateness of site for pilot study
- Availability of data
- Status of on-going flood studies
- Ability to test D.3 guidance on shoreline features that will be found throughout Great Lakes (for future flood studies)
- Variability in storm surge / wave exposures



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- Coastal hazard analysis recently completed in 2009
- Allows for comparison of CSHORE numerical model results to effective BFEs and empirical equations
- Different shoreline types to develop and test erosion, wave propagation and wave runup methodologies
- Shallow and sheltered waters that present unique wave actions
- 150 storm events from ERDC ADCIRC and STWAVE modeling (1960-2009)

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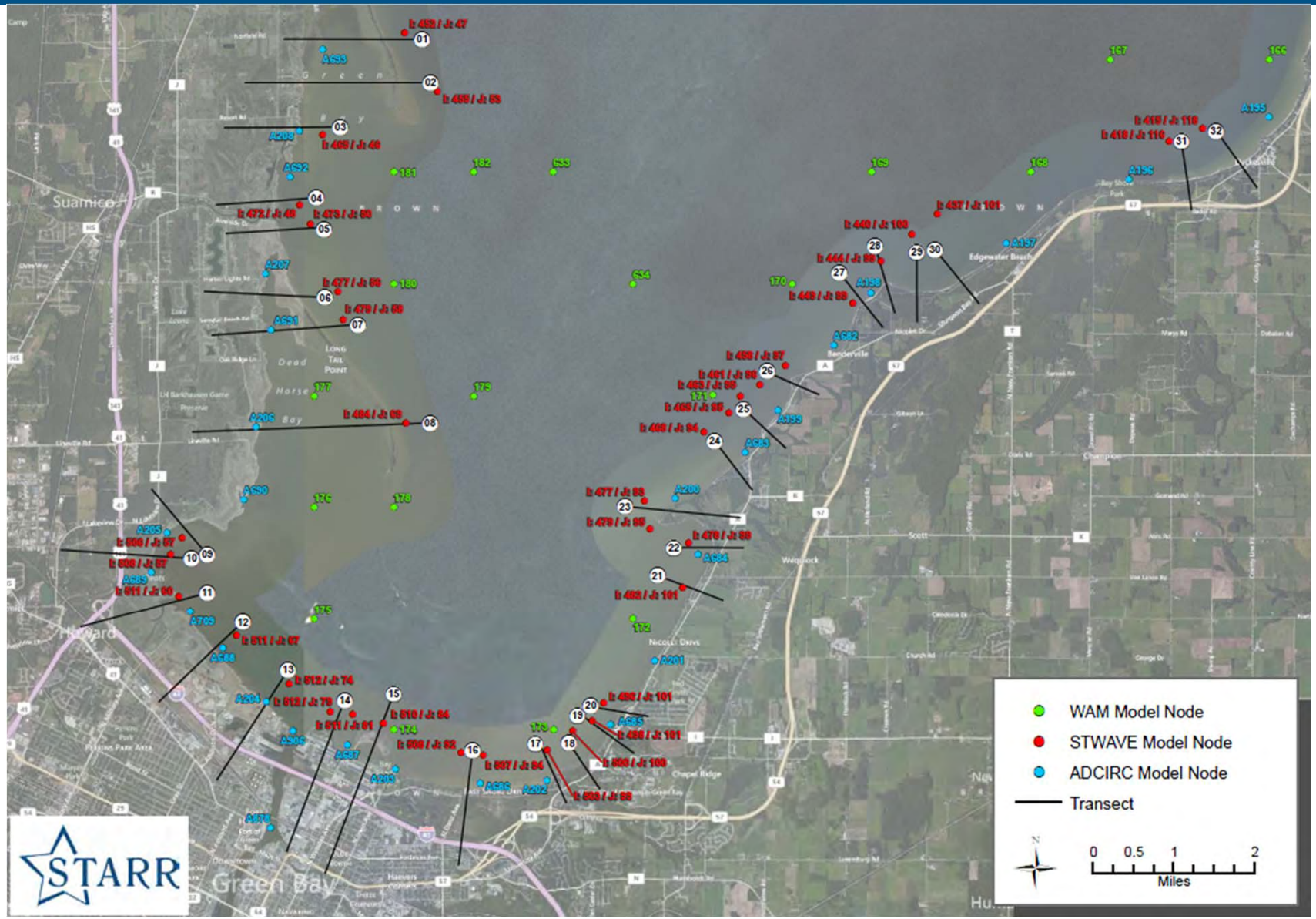

Site Background

- Multiple shoreline types
  - Low-lying areas
  - Steep beaches / bluffs
  - Revetments and seawalls
  - Commercial, residential, and open land uses
  - Urban and rural areas
- Multiple exposures to surge and wave action
- Impacted by winds in all directions

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Modeling Approach

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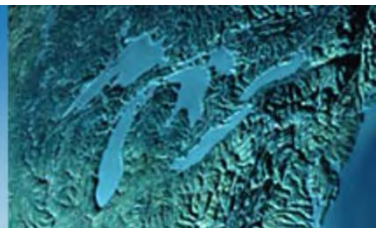
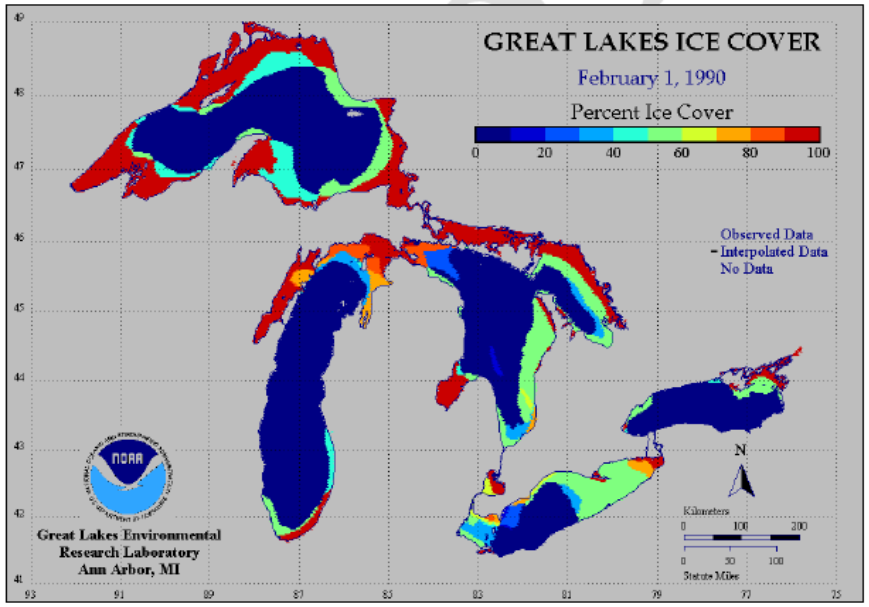


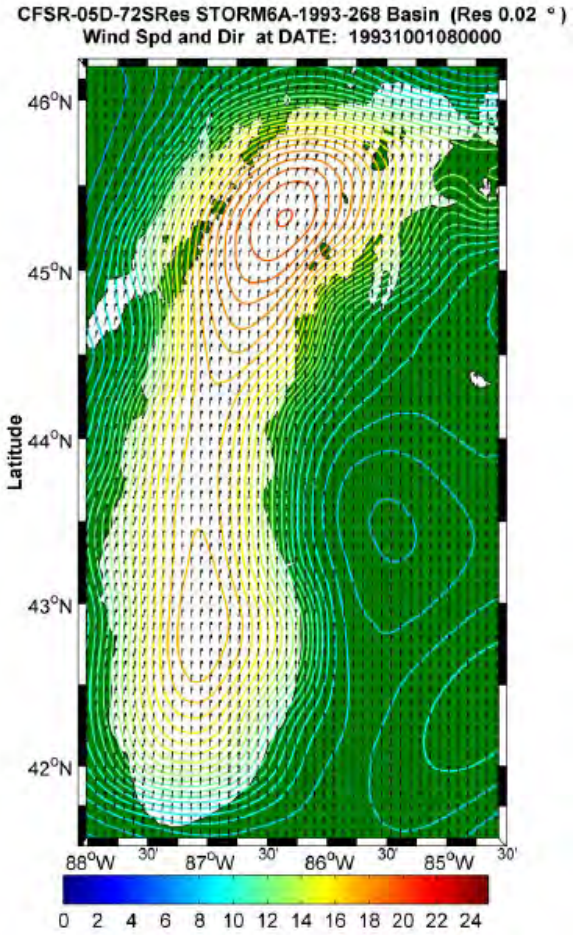
Study Approach

- Regional Study Approach
  - Water level and wave analysis
  - Improvement over community-county
  - Reduces number of boundary conditions
  - Greater consistency in assumptions
- Local/County Level Activities
  - Mapping level tasks performed at county level
  - Nearshore wave transformations
  - Wave runup
  - Overland wave propagation

Lake-Wide Modeling Results

- 150 storm events from ERDC ADCIRC and STWAVE modeling (1960-2009)
- Water levels and wave parameters at hundreds of output points along the lake shore
- Wind, ice cover, long-term lake level accounted for





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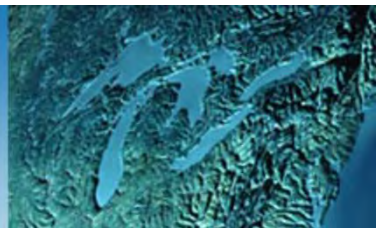
Surf Zone Modeling Approach

- Demonstration project allowed modeling approaches to be developed for:
  - Erosion
  - Wave Propagation
  - Wave Runup
- Followed revised guidance in Appendix D.3
- Modeling approaches investigated:
  - 1-D Models, including CSHORE
  - WHAFIS
  - Other approved methods



Coastal Erosion

- Episodic, flood-related erosion due to coastal storm events
- Does not consider long-term erosion hazard areas
- Evaluated prior to wave runup and overland wave propagation

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Overland Wave Propagation

- WHAFIS
  - Based on 1977 NAS report
  - Version 4.0
- Simulates wave interactions with landforms
  - Elevation
  - Obstructions
- Develops wave envelope; compares to ground elevations to determine BFE and zone extents

Wave Runup

- Uprush of water from wave action on beach or shore barrier
- National Flood Insurance Program (NFIP) definition of wave runup elevation is the value exceed by 2-percent probability of exceedance – $R_{2\%}$
- Methodologies reviewed in Melby (2012)

CSHORE

- Developed by U.S. Army Corps of Engineers' Engineer Research and Development Center (ERDC)
- Dynamic one-dimensional model of wave runup and profile morphology (Johnson et al., 2011)
- Utilizes time-series of waves and water levels from ADCIRC and STWAVE modeling effort
- Physical processes accounted for within model:
  - Wave-current interaction
  - Sediment transport (suspended and bedload)
  - Porous flow and energy dissipation
  - Irregular wave runup and overtopping
- Tested, calibrated, and verified using small-scale physical modeling

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Results and Conclusions

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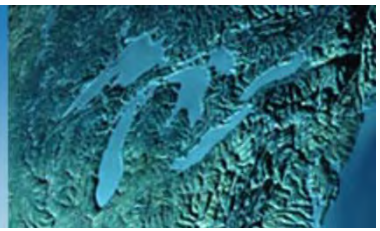
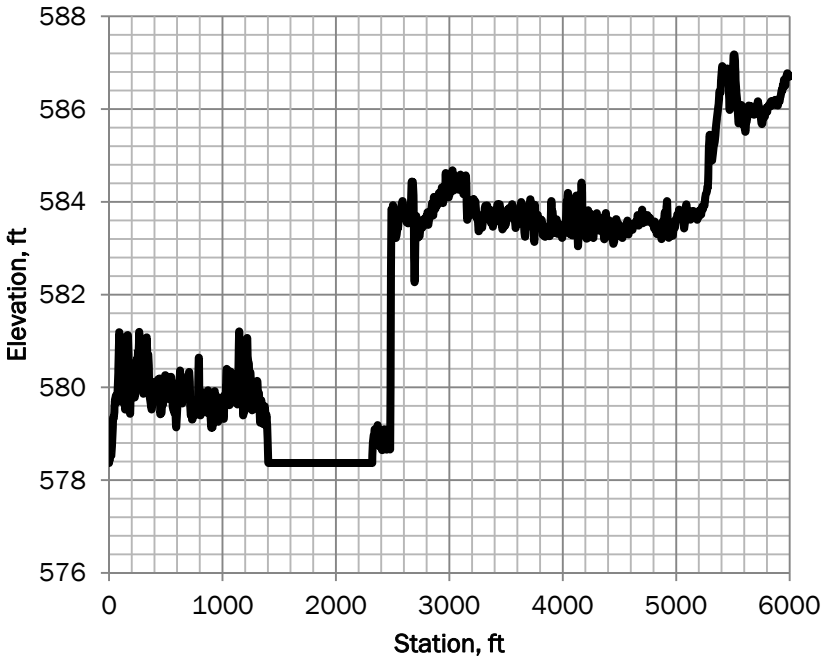


Wave Propagation

- Considered transects susceptible to wave propagation
- Eroded applicable transects
- Example: BR-06



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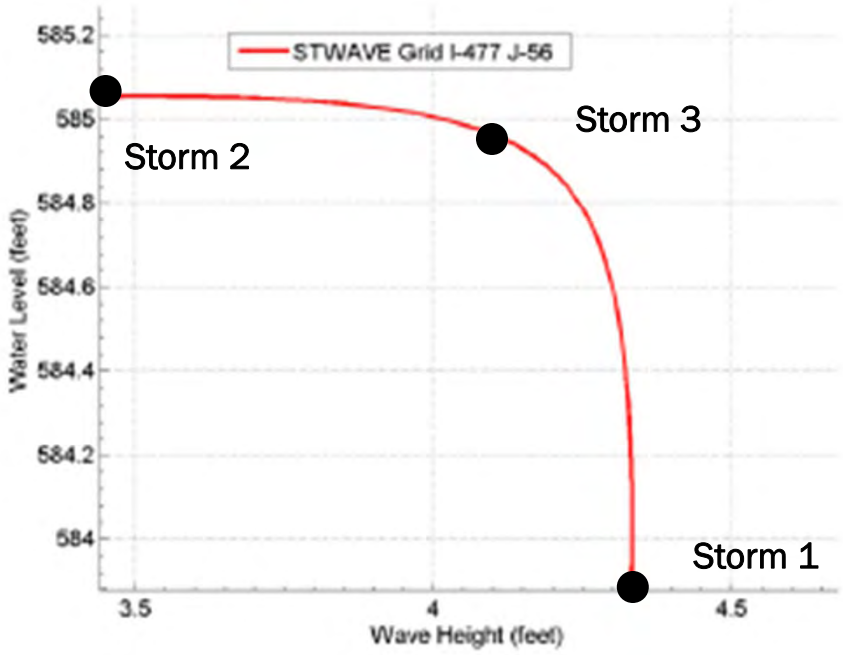
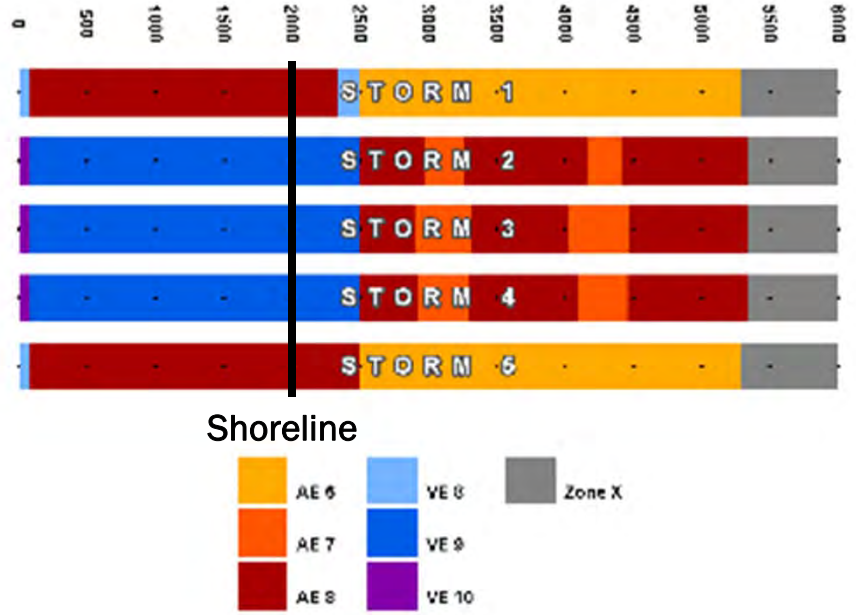
Wave Propagation

- Developed hybrid response-based / event-based approach
- Compared setup values developed from CSHORE and from empirical equations; used as inputs to WHAFIS





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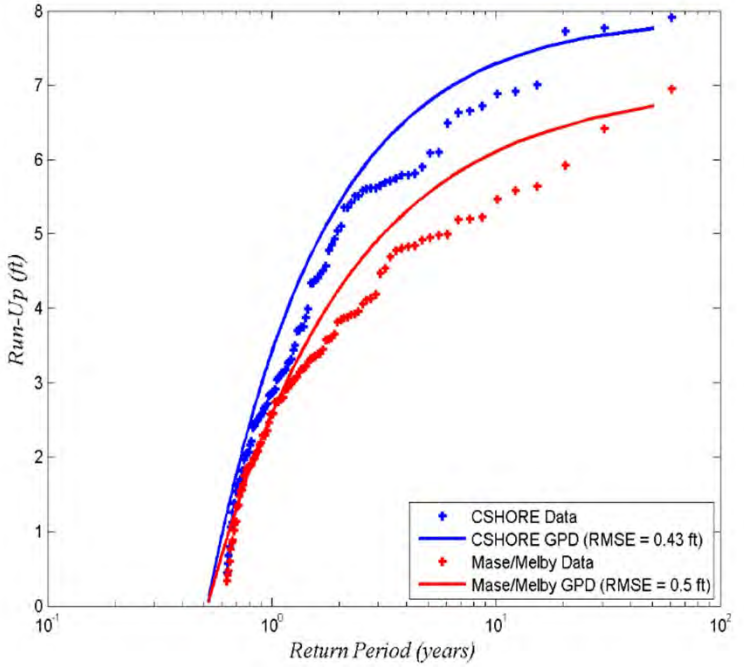
Wave Runup

- Response-based approach
- Eroded applicable transects
- Compared runup values developed from CSHORE and from empirical equations
- Example BR-23



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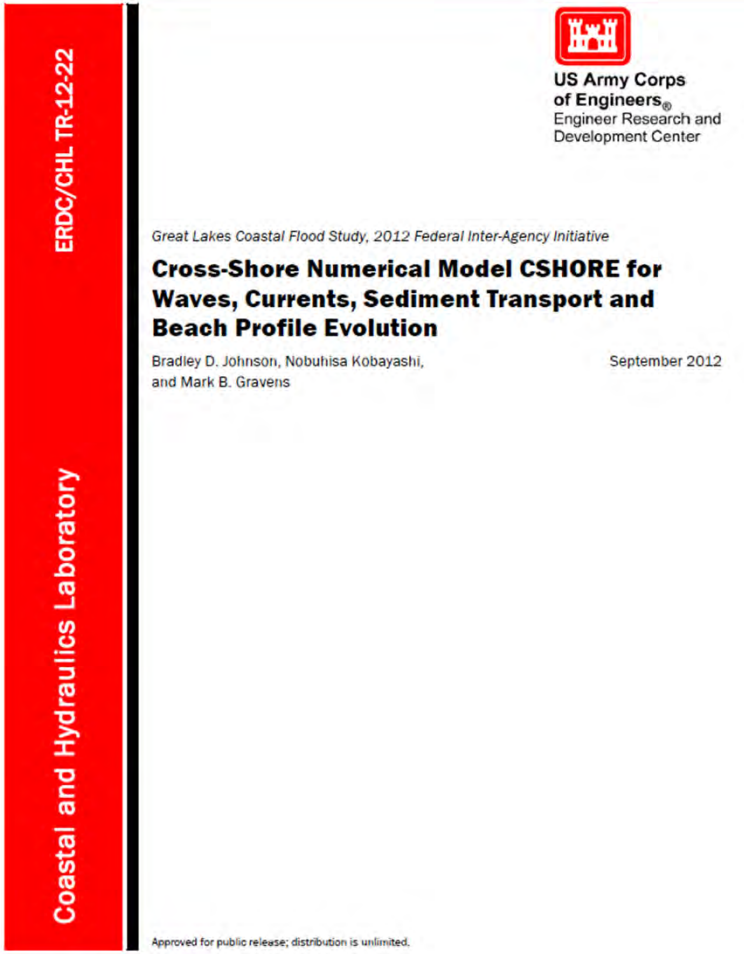
CSHORE Model Progression

- Initial CSHORE code provided by ERDC (late 2012)
- Applied model to develop wave runup results (Jan 2013)
- Provided results to ERDC for consideration (Feb 2013)
- ERDC provided revised model code and updated guidance (March 2013)
- Transects reanalyzed using revised code (Jan 2014)



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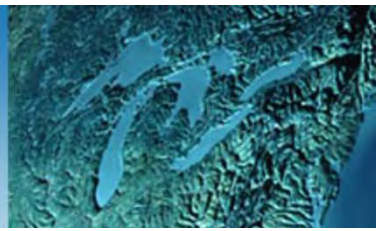
CSHORE Model Revisions

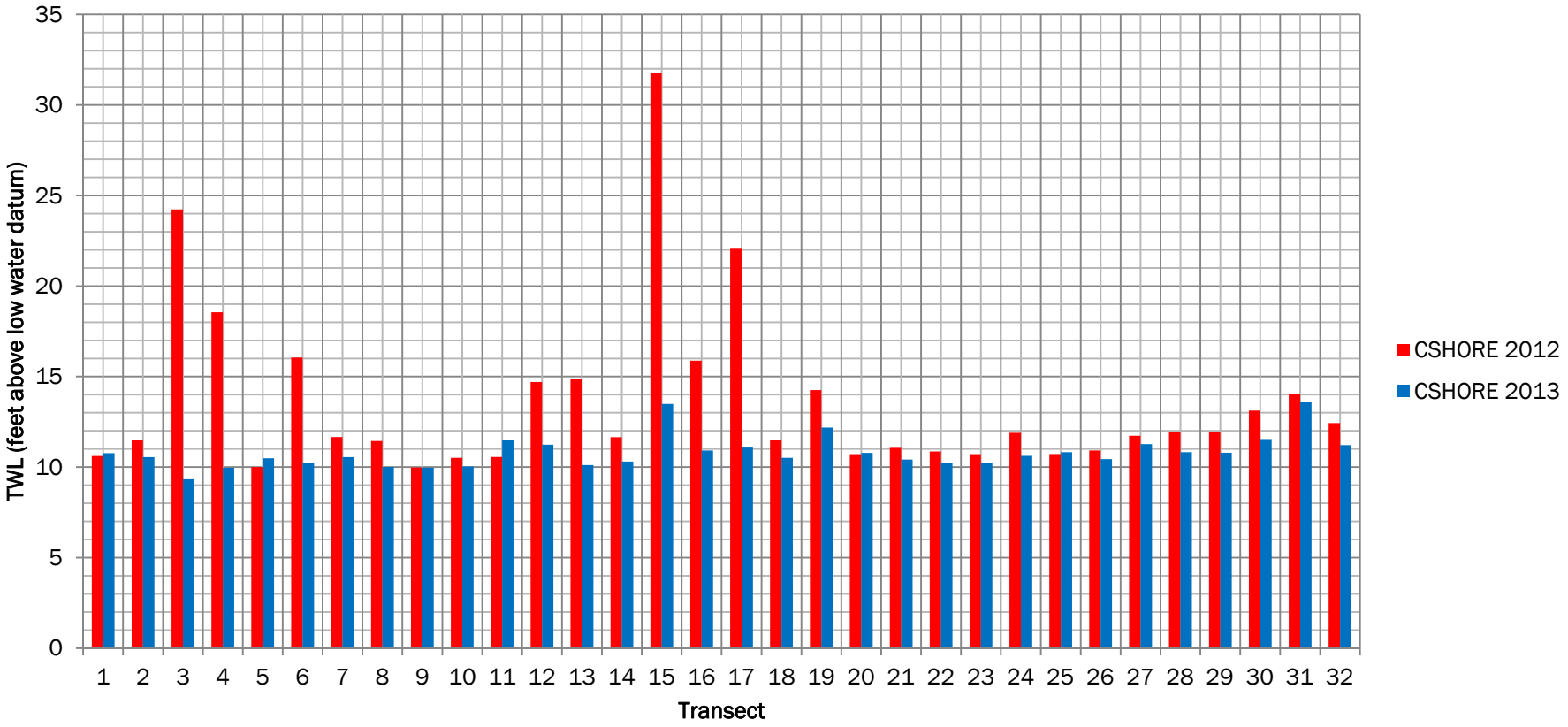
Based on the results of the pilot study, CSHORE code and inputs were modified as follow:

- Model code was revised in how runup calculations were performed on transects that have a dramatic break in slope near the stillwater elevation
- Runup wire height input parameter changed
- Model run simulations were reduced from six days to one day



Wave Runup

- Comparison of initial CSHORE runs to revised CSHORE runs



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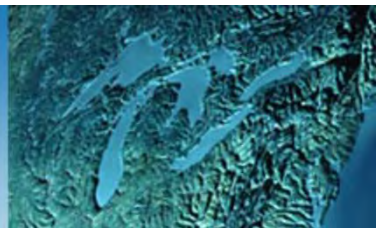
Developed Model Approach

- Based on the results of the pilot study, ERDC recommendations, and the guidance in Appendix D.3:
  - CSHORE will be used to determine coastal erosion
  - CSHORE will be used to determine wave heights, water levels, and wave setup values to be used as inputs to WHAFIS
  - WHAFIS will be used to determine coastal BFEs and mapping extents based on wave propagation
  - CSHORE will be used to develop coastal BFEs and mapping extents based on wave runup



Mapping Considerations

- VE Zones
- LiMWA

Coastal Flood Hazard Zones

FEMA developed a memorandum regarding the mapping of VE Zones along the Great Lakes (September 30, 2013):

- VE Zones
  - Currently mapped based on wave height / runup depth
  - This procedure was developed for the Atlantic, Pacific, and Gulf Coasts
  - FEMA recognizes it may not be appropriate for Great Lakes
- An independent study will be performed to determine the appropriateness of mapping VE Zones in Great Lakes
- In the interim:
  - VE Zones will be identified on work maps
  - VE Zones will not be mapped on regulatory products
  - LiMWA will be identified on both work maps and regulatory products

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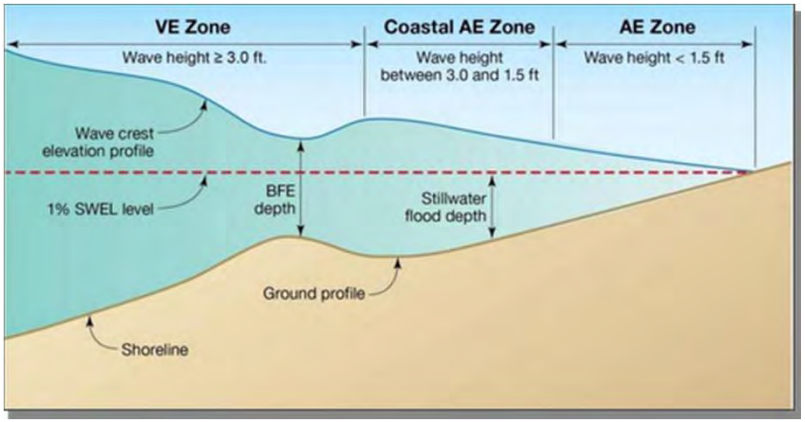
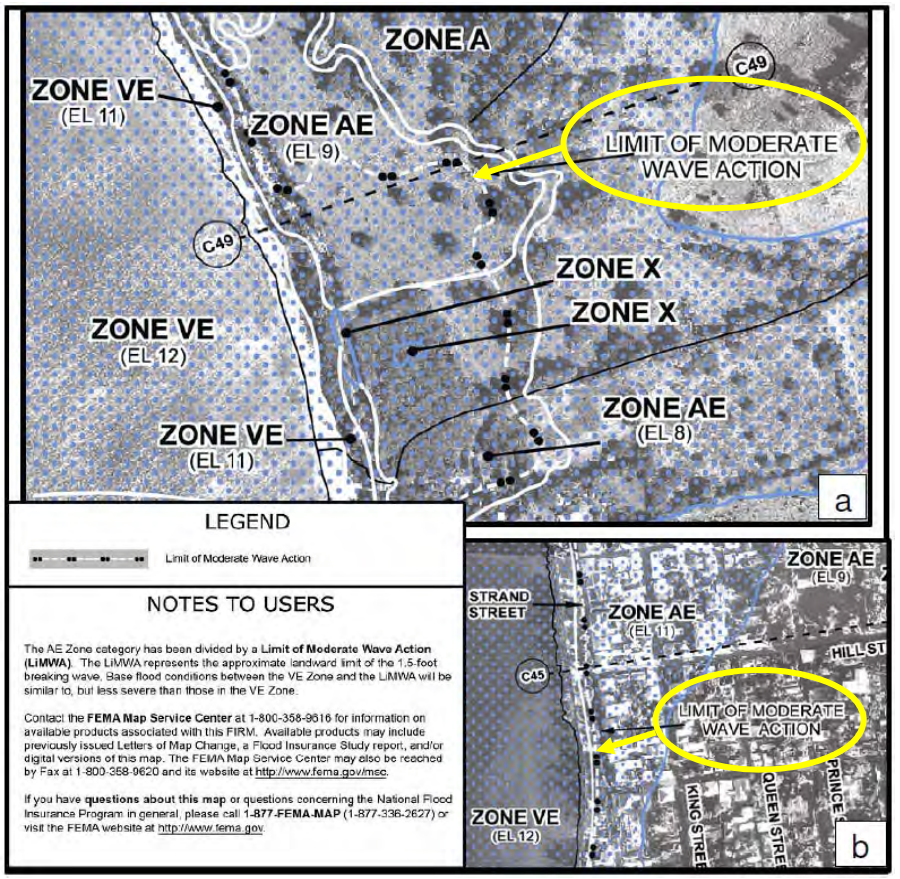
Limit of Moderate Wave Action (LiMWA)

FEMA Procedure Memorandum No. 50, 2008

- Not a regulatory requirement
- No Federal Insurance requirements tied to LiMWA





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Who to Contact

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