Arenac and Iosco County, MI Coastal Hazard Analysis Flood Risk Review Meeting

April 26, 2018

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Agenda

- Introductions
- Coastal Flood Risk Study and Mapping Program
- Current Status
- Technical Overview of Study and Mapping
- Floodplain Management
- Next Steps
- Q&A
- Workmap Review

Arenac and Iosco County, MI

COASTAL FLOOD RISK STUDY AND MAPPING PROGRAM

Great Lakes Flood Study

- Comprehensive study of the Coastal Great Lakes flood hazards
- Latest technology, data, and models – including response based modelling concepts

Partners involved:

FEMA

US Army Corps of Engineers ® Detroit District

ERDC (U.S. Army Engineer Research and Development Center)

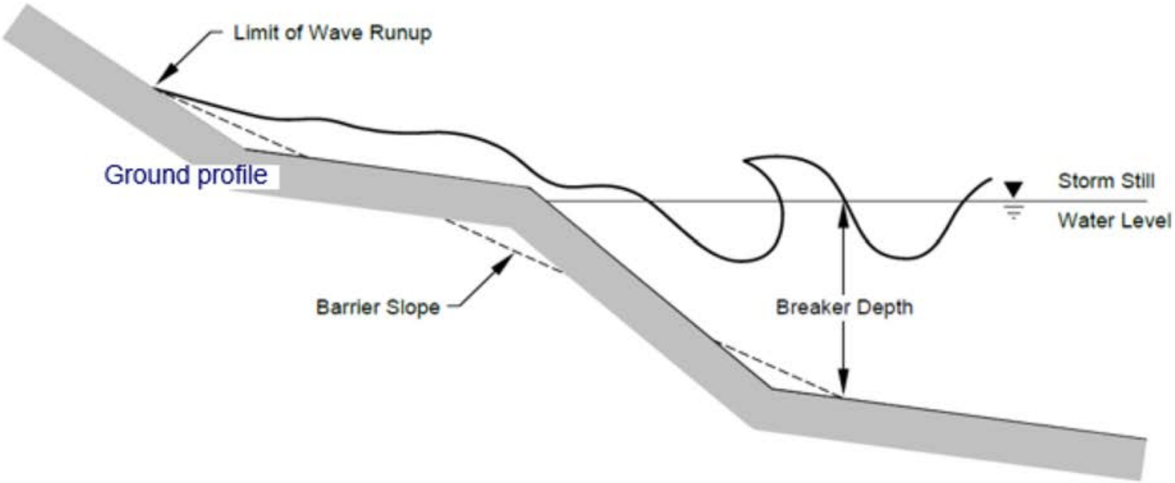
Association of State Floodplain Managers (ASFPM)

RAMPP

STARR Strategic Alliance for Risk Reduction

Response-Based Wave Runup

- Wave runup is the uprush of water from wave action on a beach, steep bluff or coastal structure.
- Calculated at each transect using appropriate hydrodynamic equations that simulate events for every time step captured for selected storms using lake-wide gridded record (ADCIRC-SWAN)
- Statistical analysis is performed on the maximum runup results at each transect to obtain the 1-percent-annual-chance runup elevation.



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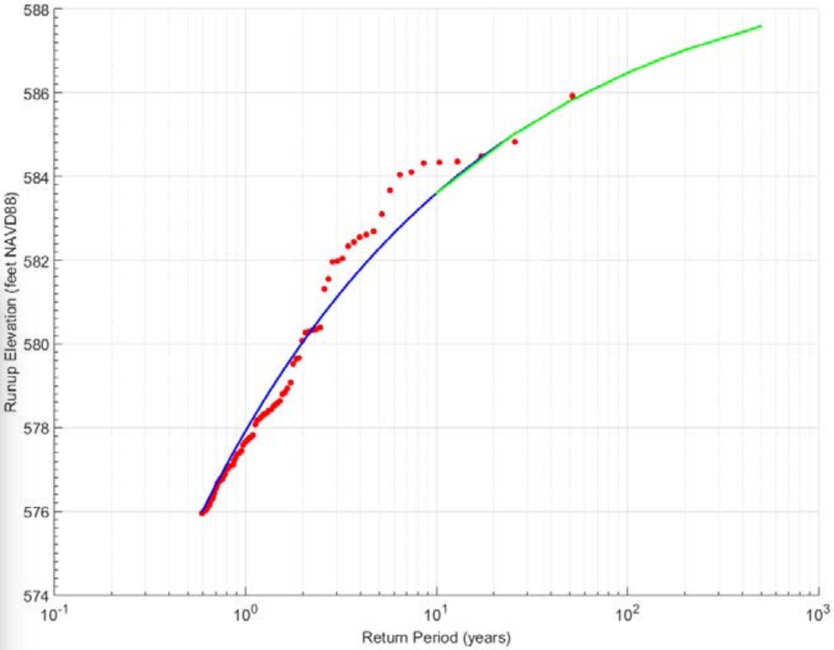
Response-Based Wave Runup



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FEMA's Risk MAP Program

Risk Mapping, Assessment, and Planning …

- Will deliver quality data to increase public awareness and lead to action that reduces risk to life and property
- New non-regulatory products and datasets

Mitigation Actions: A Shared Responsibility

STRUCTURE AND INFRASTRUCTURE PROJECTS

- Acquisition
- Elevation
- Revetments and Seawalls
- Breakwater

LOCAL PLAN AND REGULATIONS

- Zoning
- Building Codes
- Open Space Plan
- Lake Front Development Master Plan

CITIZEN AND BUSINESS ENGAGEMENT

- Firewise
- StormReady
- NFIP and CRS

NATURAL SYSTEM PROTECTION

- Vegetation management
- Wetland restoration
- Erosion control

Arenac and Iosco Counties

CURRENT STATUS REVIEW

Analyses/Mapping: Grouping

Blue: Phase 1

- Huron
- Arenac
- Iosco
- Sanilac
- St Clair

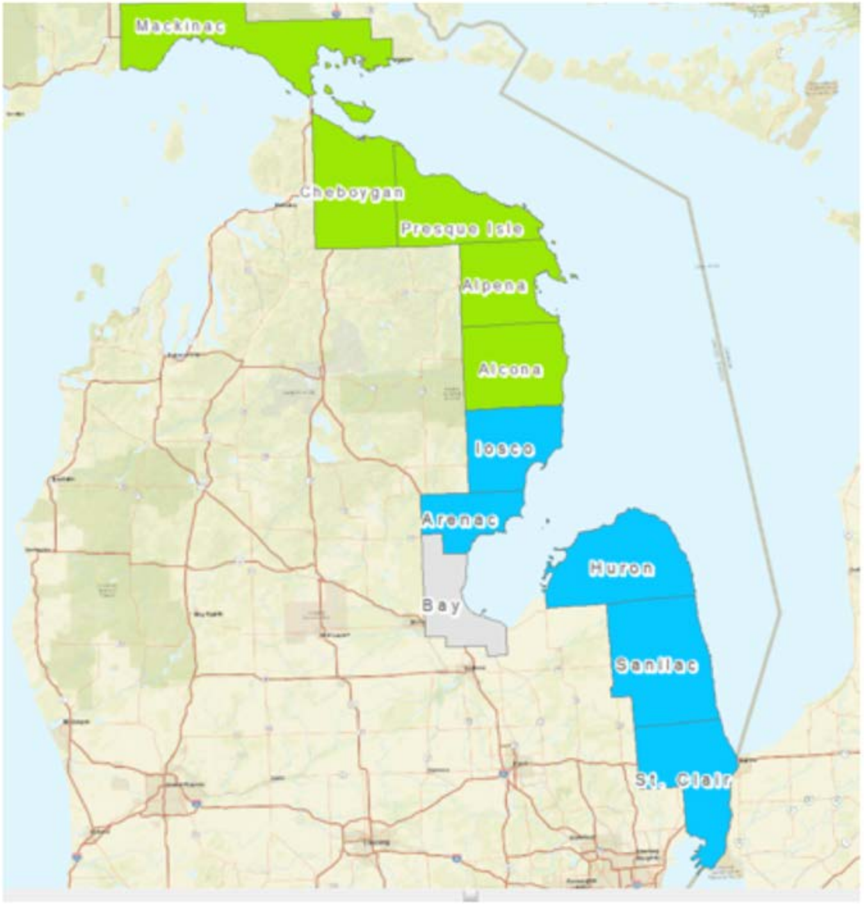
Grey: Standalone

- Bay

Green: Phase 2

- Alcona
- Alpena
- Presque Isle
- Cheboygan
- Mackinac

- Remaining Counties on this map are being finalized and FRR meetings will be in June
- FRR Meetings fall at the end of a multi-year study including sophisticated modeling
- Next, the maps and data will be put into the official regulatory format



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Current Study Status

Lake-Wide Storm Surge and Waves Study

↓

County Based Wave Runup, Overtopping, and Overland Analyses

↓

Workmap Production

↓

You are here →

Comment Period

↓

FIRM Production

↓

Preliminary FIRM

↓

Community Coordination Meeting

↓

Comment and Appeal Periods

↓

Letter of Final Determination

↓

Effective FIRM

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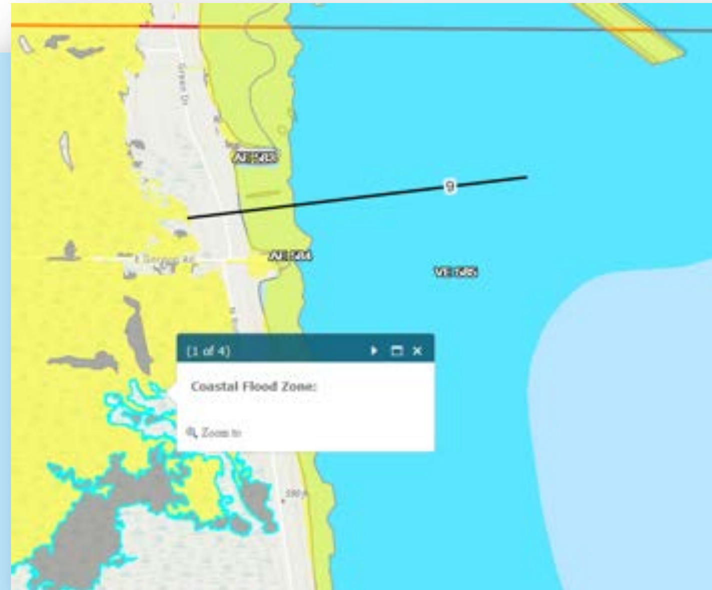
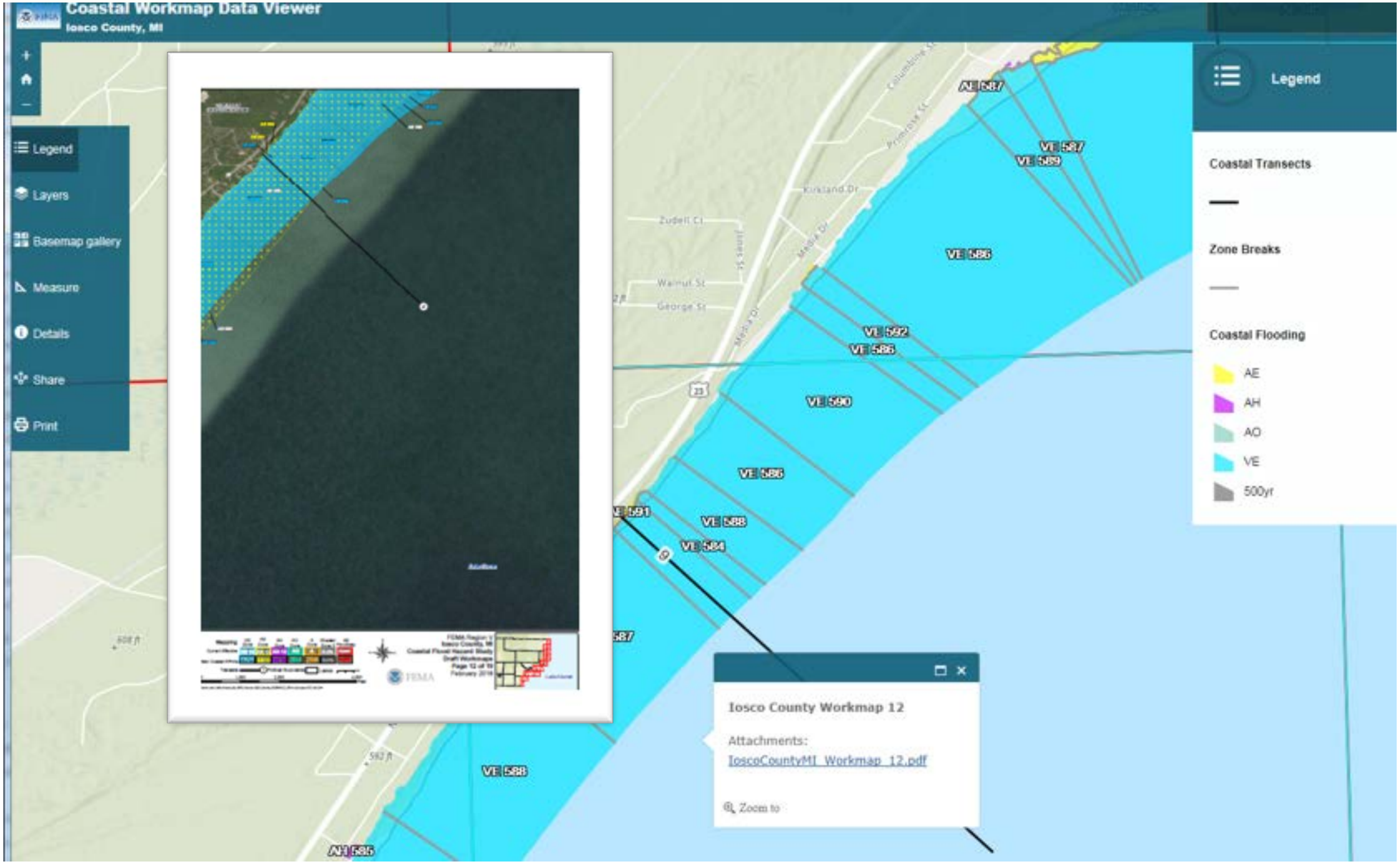
Work Map Data Viewer



Link to the Arenac County Work Map Data Viewer: https://goo.gl/wDRBMT
Link to the Iosco County Work Map Data Viewer: https://goo.gl/wpJS33

Work Map Data Viewer



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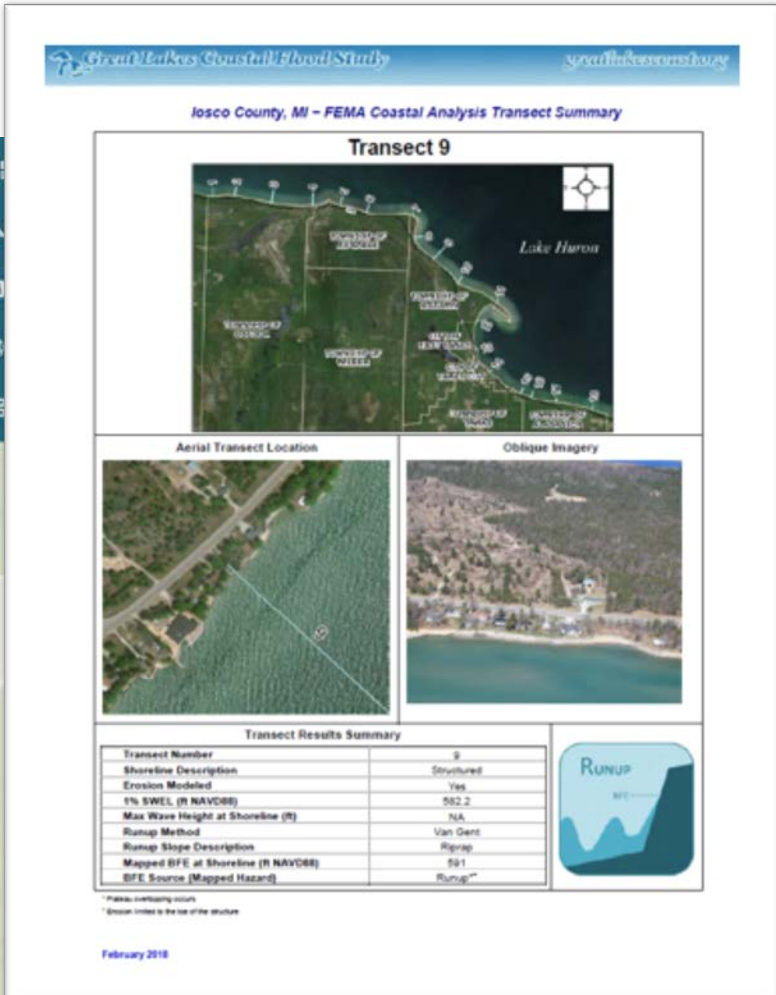
Work Map Data Viewer



Great Lakes Coastal Flood Study — greatlakescoast.org

Iosco County, MI – FEMA Coastal Analysis Transect Summary

Transect 9

Aerial Transect Location

Oblique Imagery

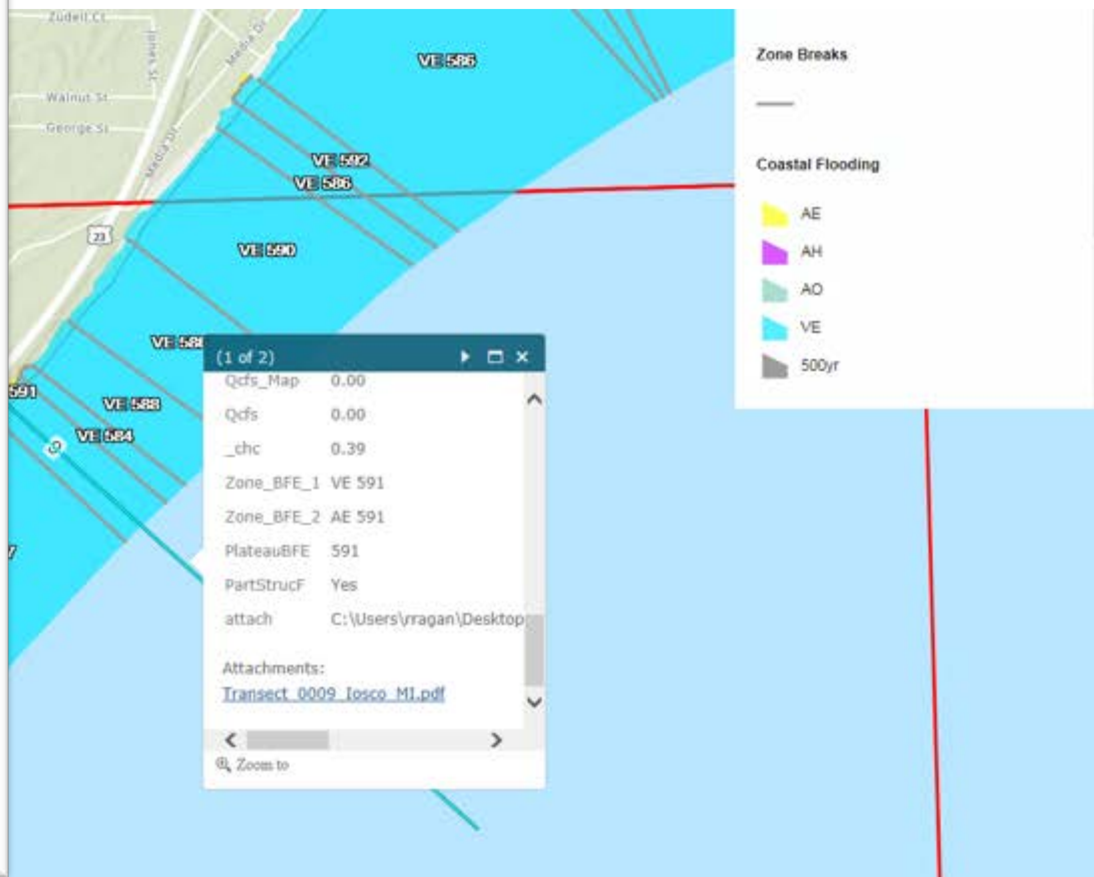
Transect Results Summary

Transect Number	9
Shoreline Description	Structured
Erosion Modeled	Yes
1% SWEL (ft NAVD88)	582.2
Max Wave Height at Shoreline (ft)	NA
Runup Method	Van Gent
Runup Slope Description	Riprap
Mapped BFE at Shoreline (ft NAVD88)	591
BFE Source (Mapped Hazard)	Runup**

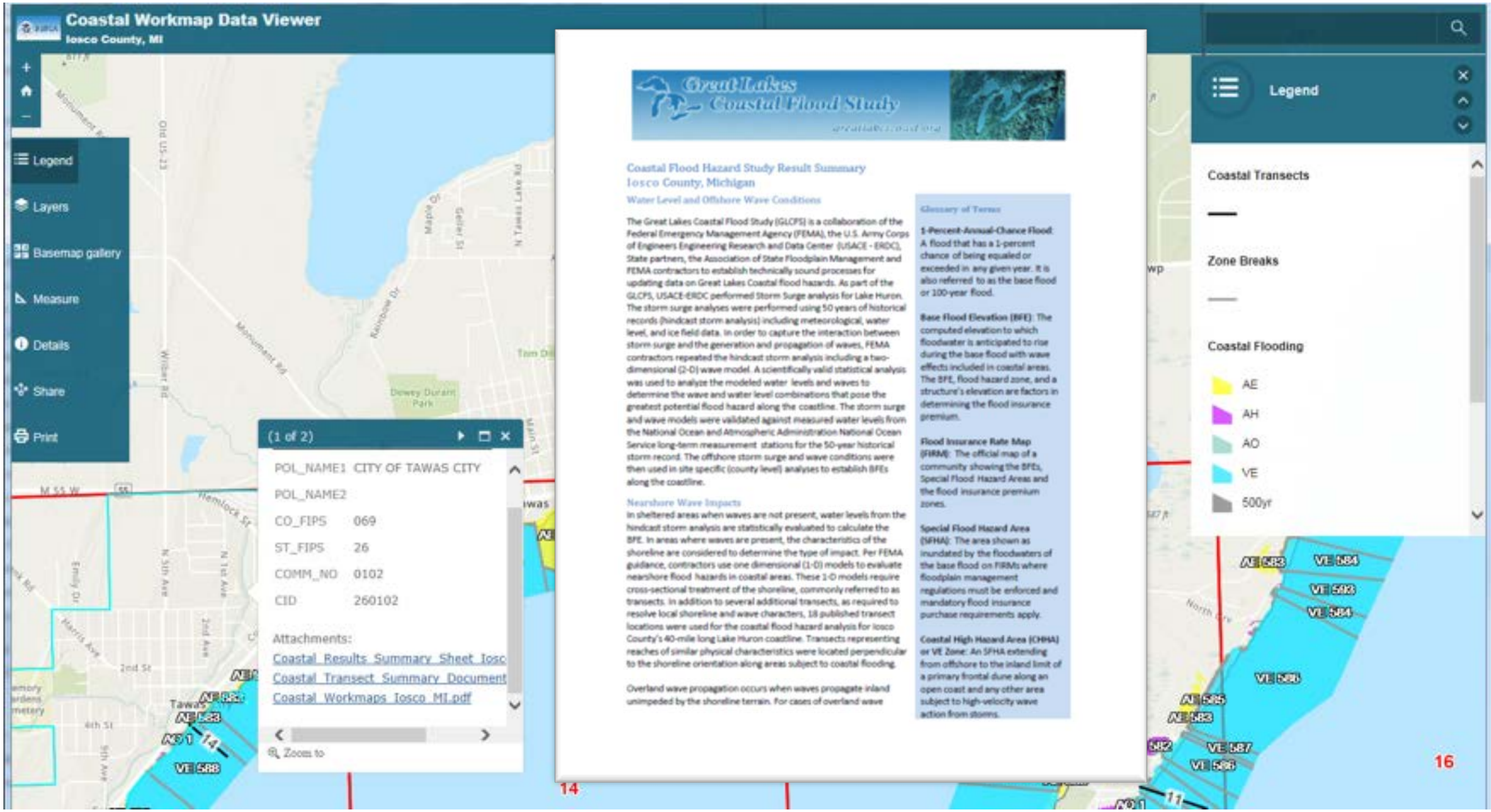
* Plateau overtopping occurs

* Erosion limited to the toe of the structure

February 2018



Work Map Data Viewer



Arenac and Iosco Counties

TECHNICAL OVERVIEW OF STUDY AND MAPPING

Coastal Flood Hazard Modeling Overview

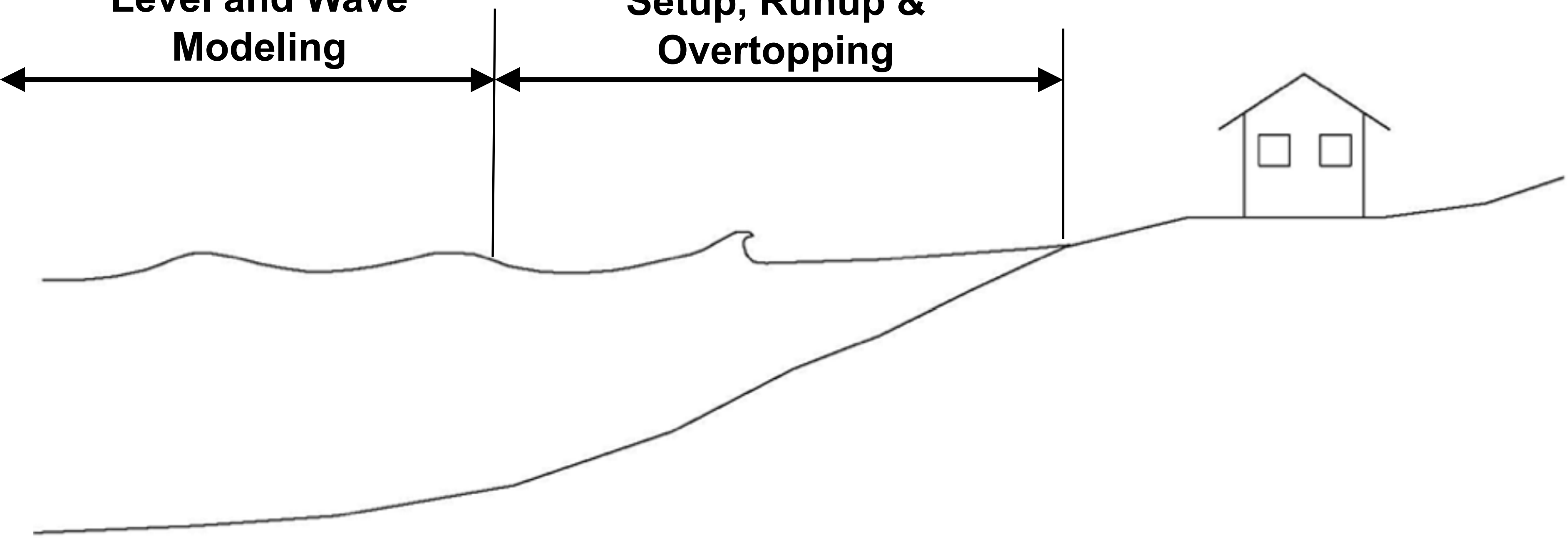
Lake-Wide Variation

Local Variation

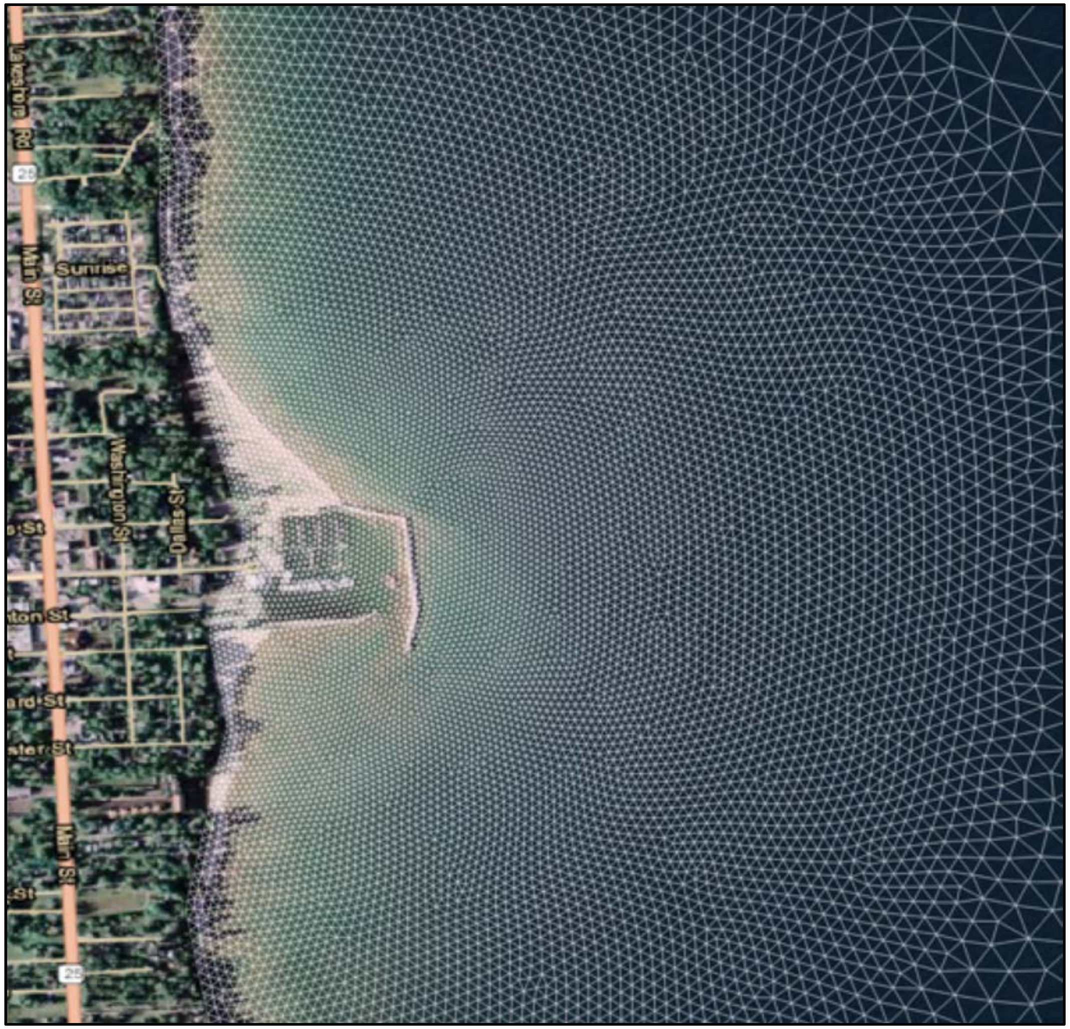
Step 1: Offshore Water Level and Wave Modeling

Step 2: Nearshore Wave Setup, Runup & Overtopping

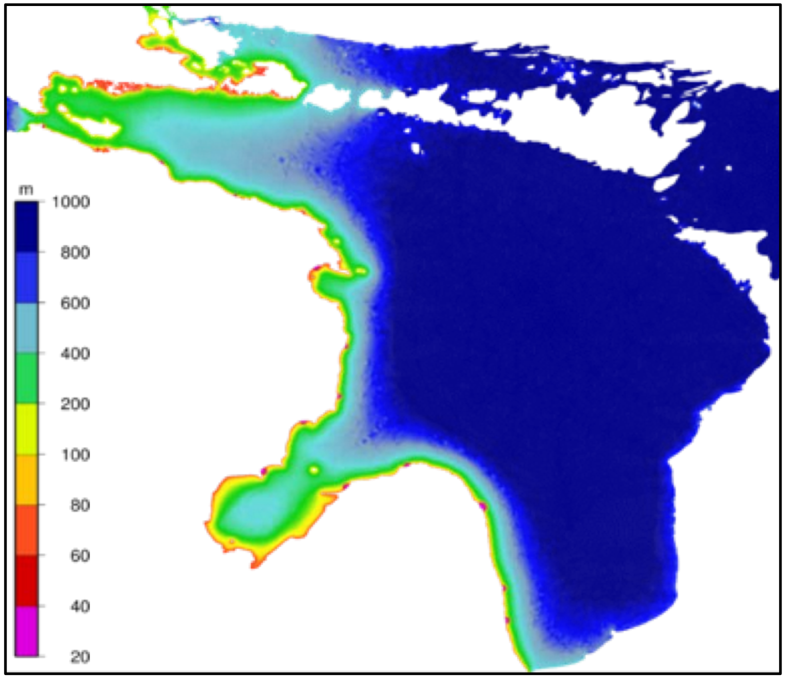
Step 3: Floodplain Mapping



Step 1: ADCIRC+SWAN Mesh



- Resolution as fine as 10 m along complex shoreline features including:
  - Jetties
  - Breakwaters
  - Inlets
  - Natural Shoals



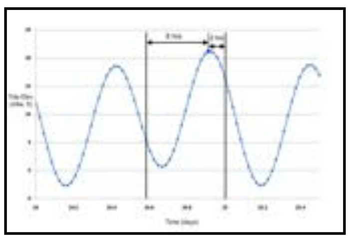
Step 1: Run the Models

Baseline

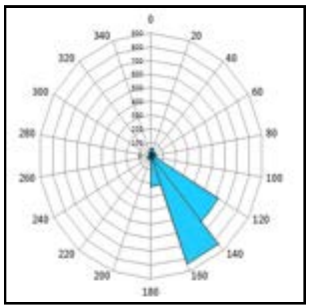
Meteorological Forcing

Physical Setting

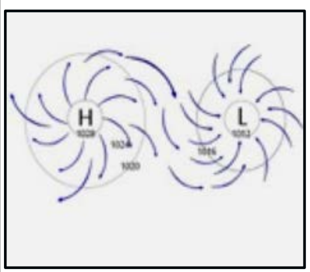
Water Level



Wind

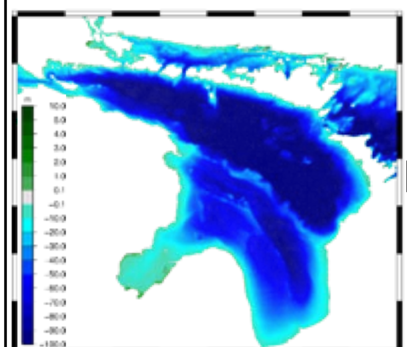


Pressure



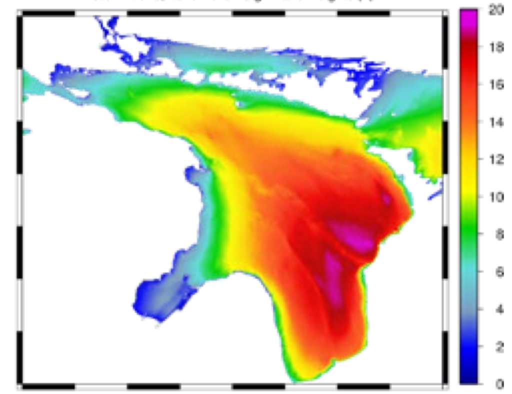
Ice

Bathymetry



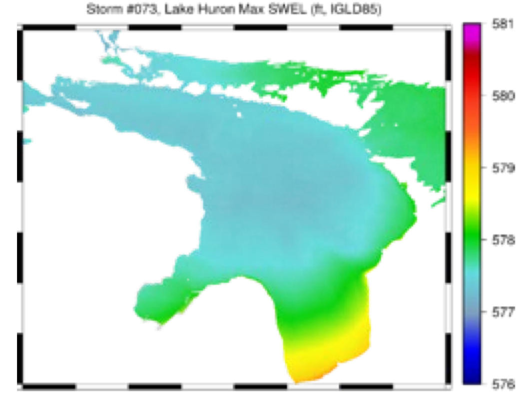
Waves

Storm #073, Lake Huron Sig. Wave Heights (ft)



Still Water Elevations

Storm #073, Lake Huron Max SWEL (ft, IGLD85)



Total of 151 events between 1960-2009

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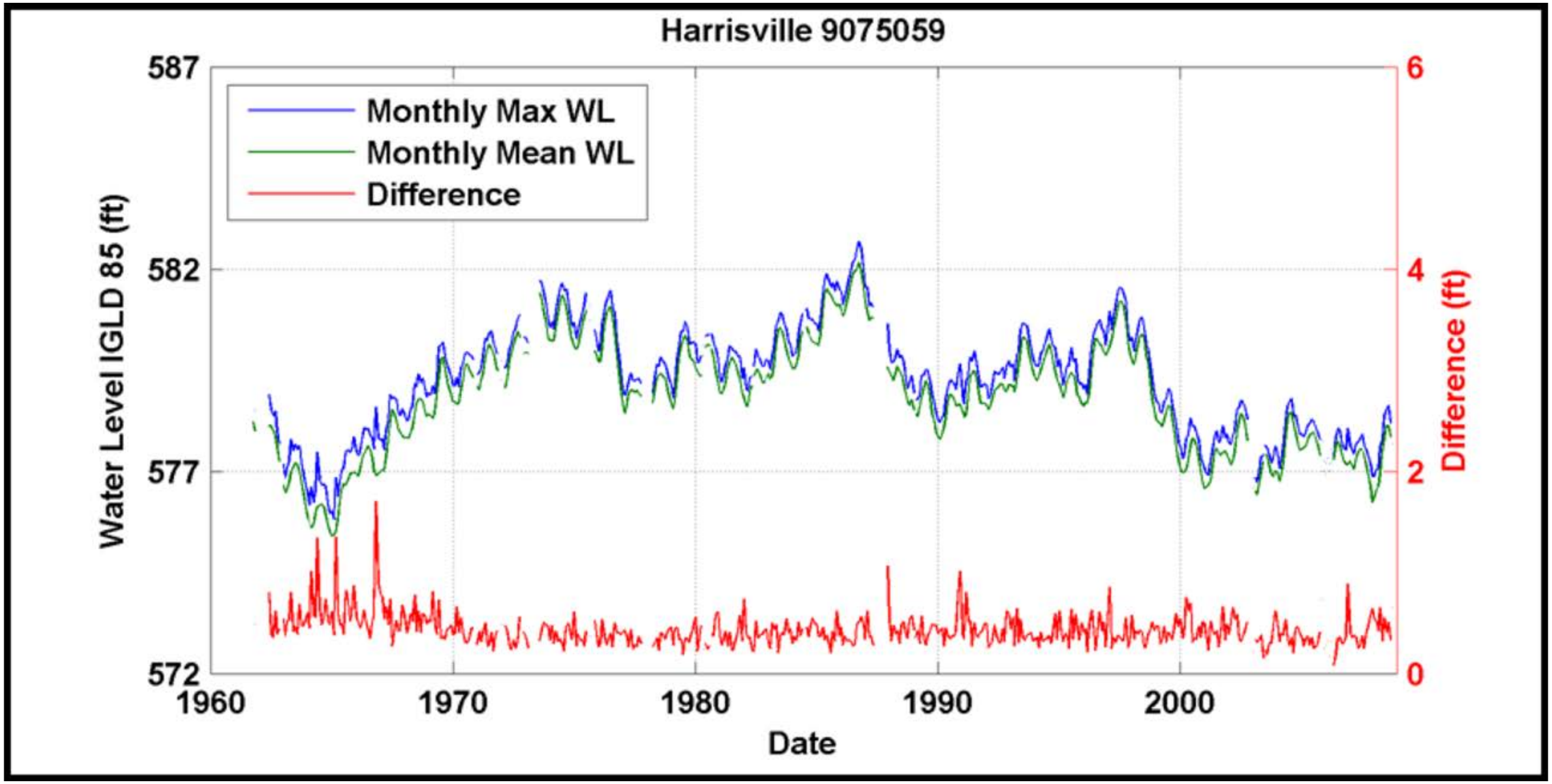
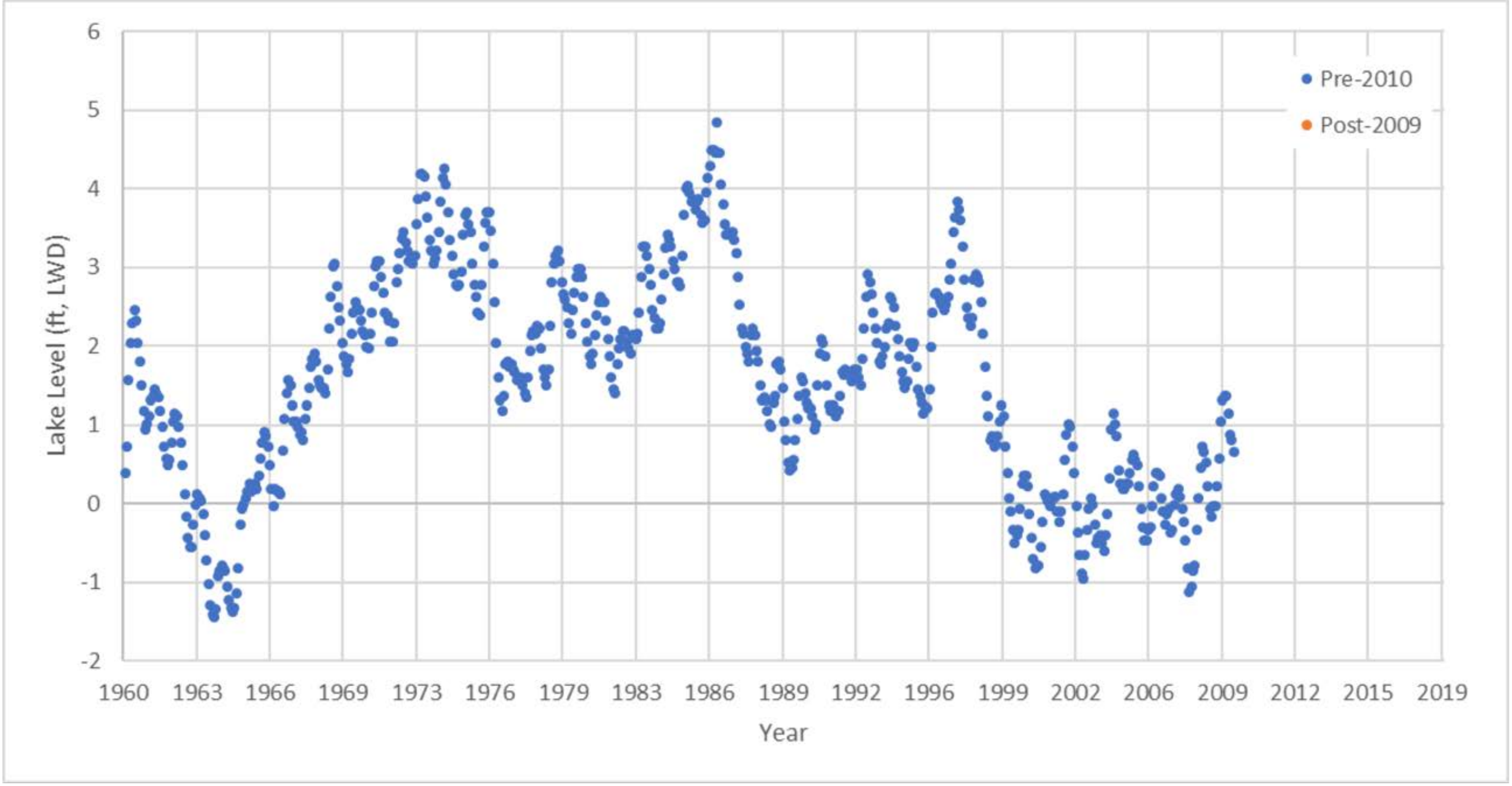
Step 1: Lake Levels



Step 1: Lake Levels



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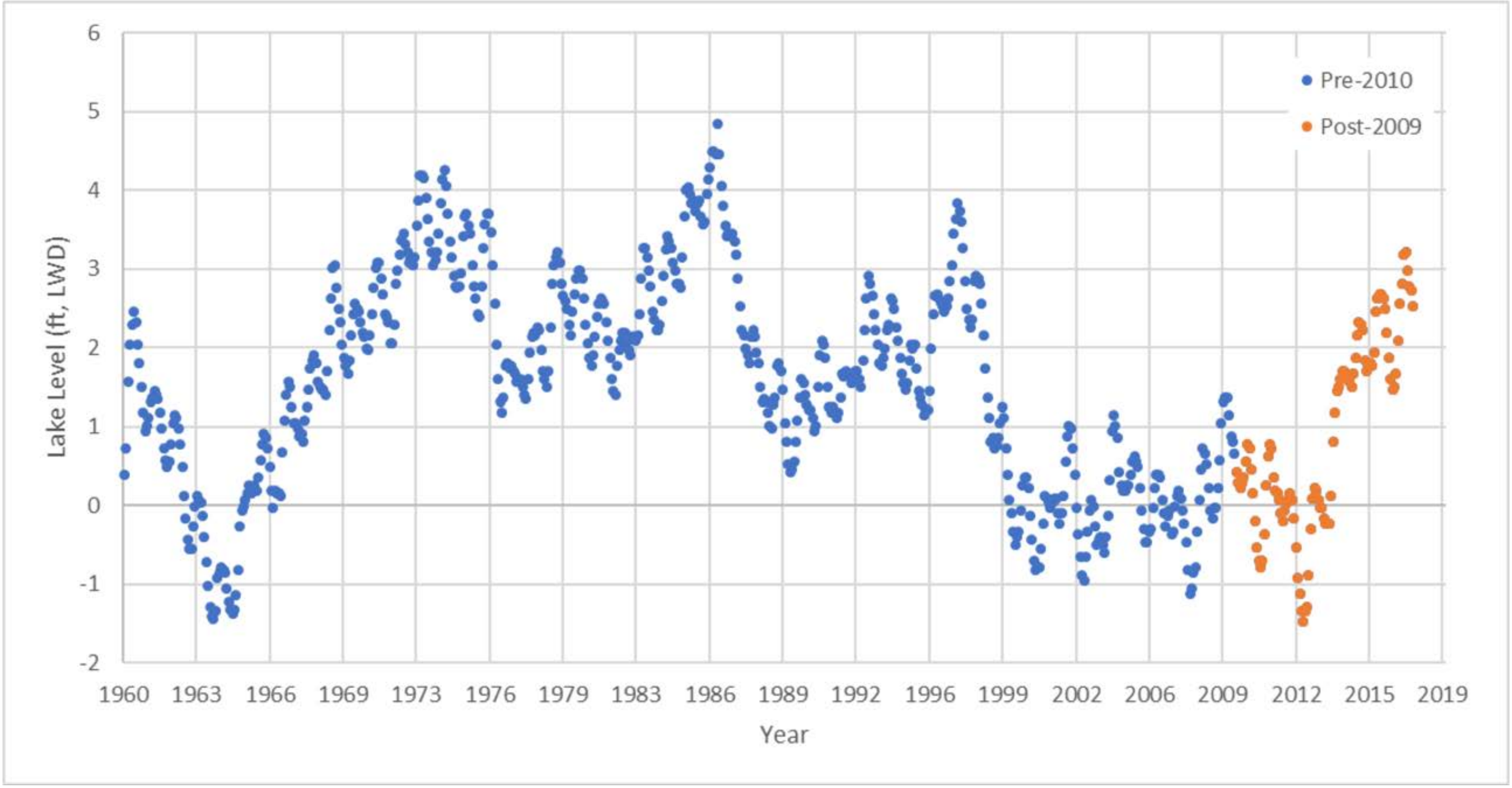
Step 1: Lake Levels



Step 1: Model Accuracy Assessment

Water Level Gauge Station		RMS error (m)	Bias (m)
9075014	Harbor Beach	0.054	0.018
9075080	Mackinaw City	0.061	0.011
9075099	De Tour Village	0.051	0.026
9014098	Fort Gratiot	0.106	0.069
9075002	Lakeport	0.072	0.011
9075035	Essexville	0.103	-0.003
9075059	Harrisville	0.054	0.027
Average		0.071	0.023

Wave Buoy Station		RMS error (m)	Bias (m)
45003	North Lake Huron	0.317	-0.024
45008	South Lake Huron	0.310	0.051
Average		0.313	0.014

Step 2: Nearshore Wave-Induced Flood Hazards

Nearshore Wave-Induced Flood Hazards Analysis includes:

- Shoreline classification
- 2-D Wave and Surge Model data extraction
- Wave setup
- Erosion
- Evaluation of coastal structures
- Wave runup
- Wave overtopping
- Overland wave propagation
- Statistical analysis

Along 1-D Transects

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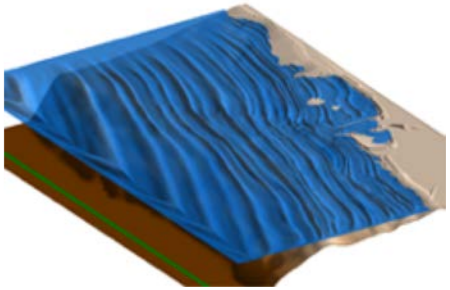
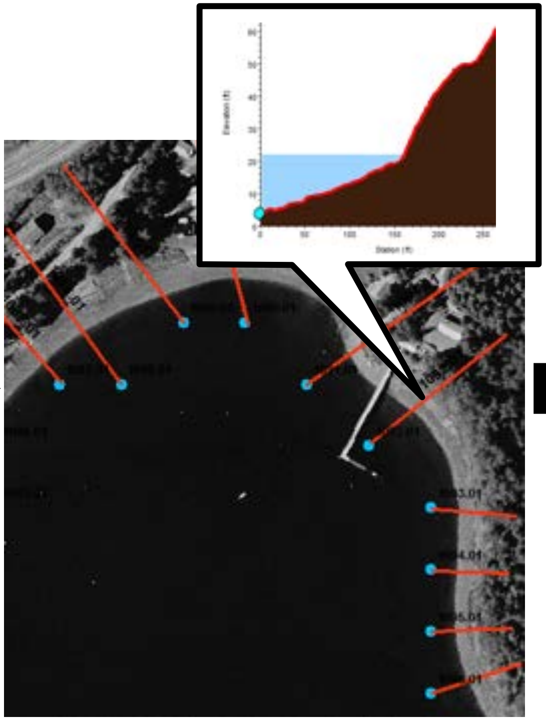
Step 2: Transect Analysis Overview

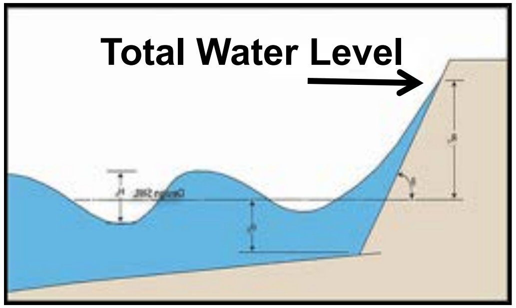
Water Level & Offshore Waves



Transect Analysis



Total Water Level



Total Water Level

- Water Level (Surge)
- Waves
- Setup, Runup and Overtopping

Step 2: Transect Layout

- Arenac County:
  - 18 Published Transects
  - 102 Analytical Transects
  - 52 Shoreline Miles
- Transects placed at representative shoreline reaches based on:
  - Topography
  - Exposure
  - Shoreline Material
  - Upland Development

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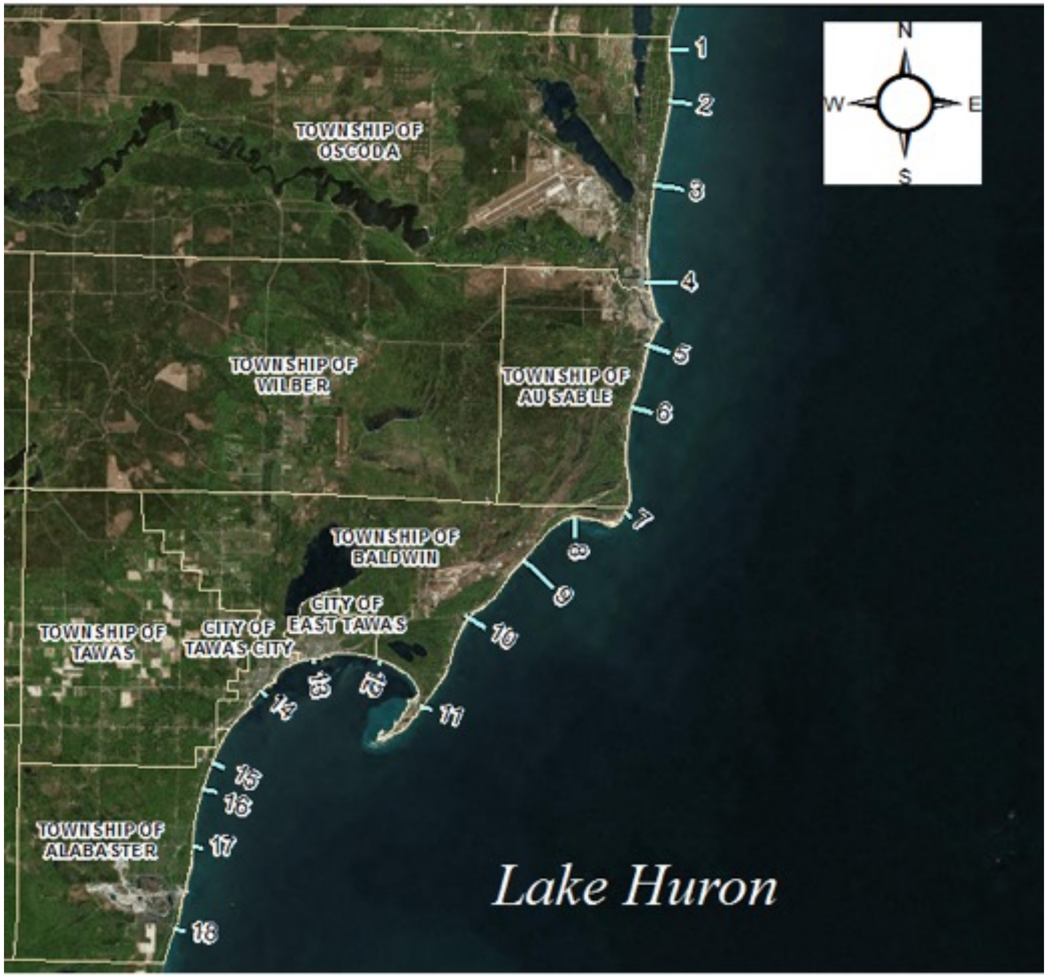
Step 2: Transect Layout

- Iosco County:
  - 18 Published Transects
  - 146 Analysis Transects
  - 40 Shoreline Miles
- Transects placed at representative shoreline reaches based on:
  - Topography
  - Exposure
  - Shoreline Material
  - Upland Development



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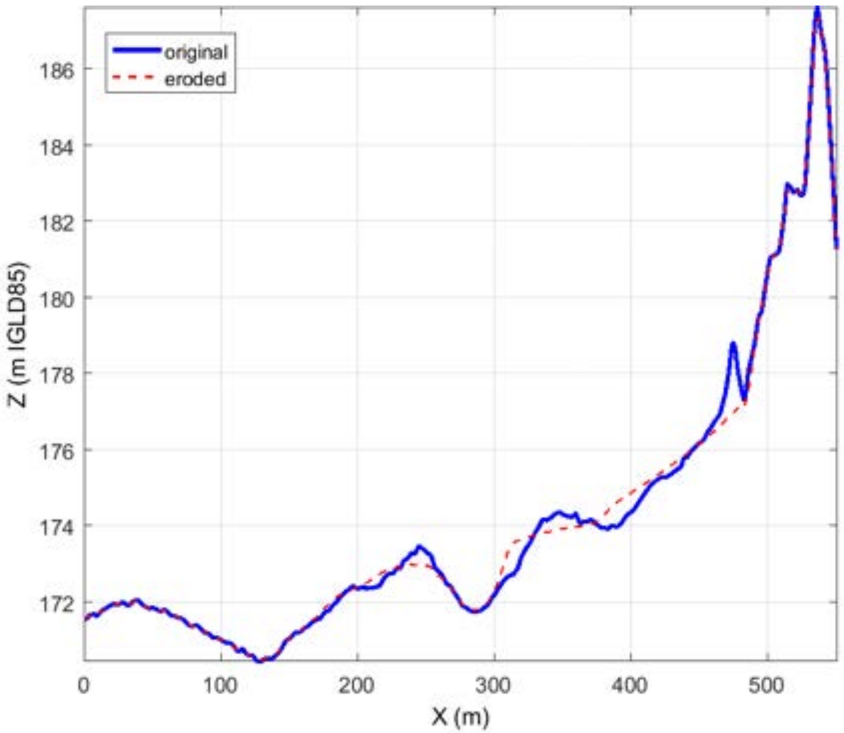
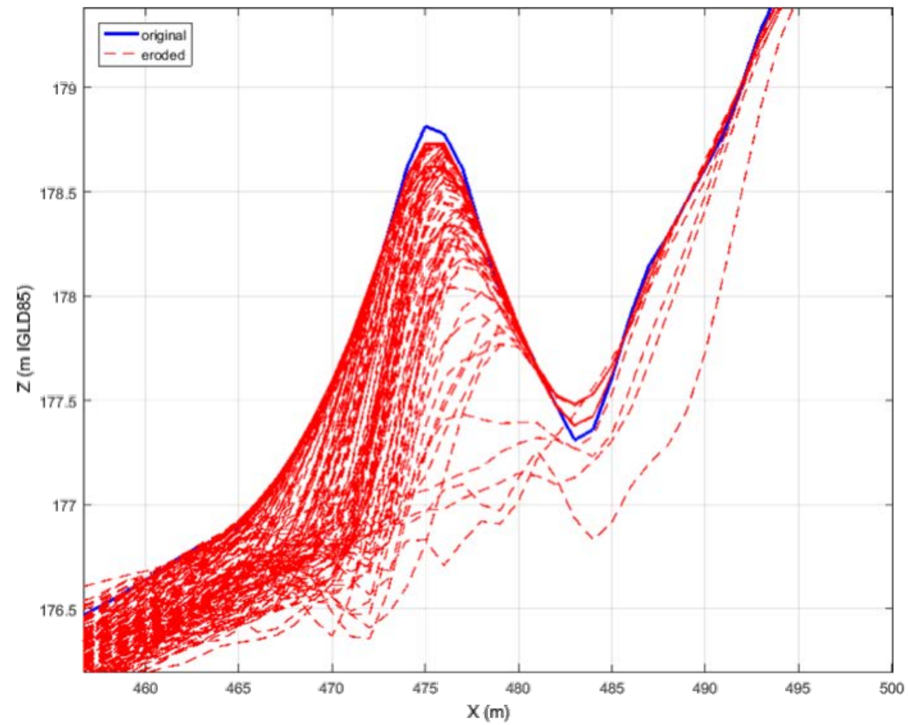
Step 2: Eroded Transect Profiles

- Erosion analysis applied for sandy beach transects with gradual slopes.
- Eroded profiles are calculated using the USACE CSHORE model for each storm event.
- Influences wave setup, runup, and overtopping by affecting profile slope.





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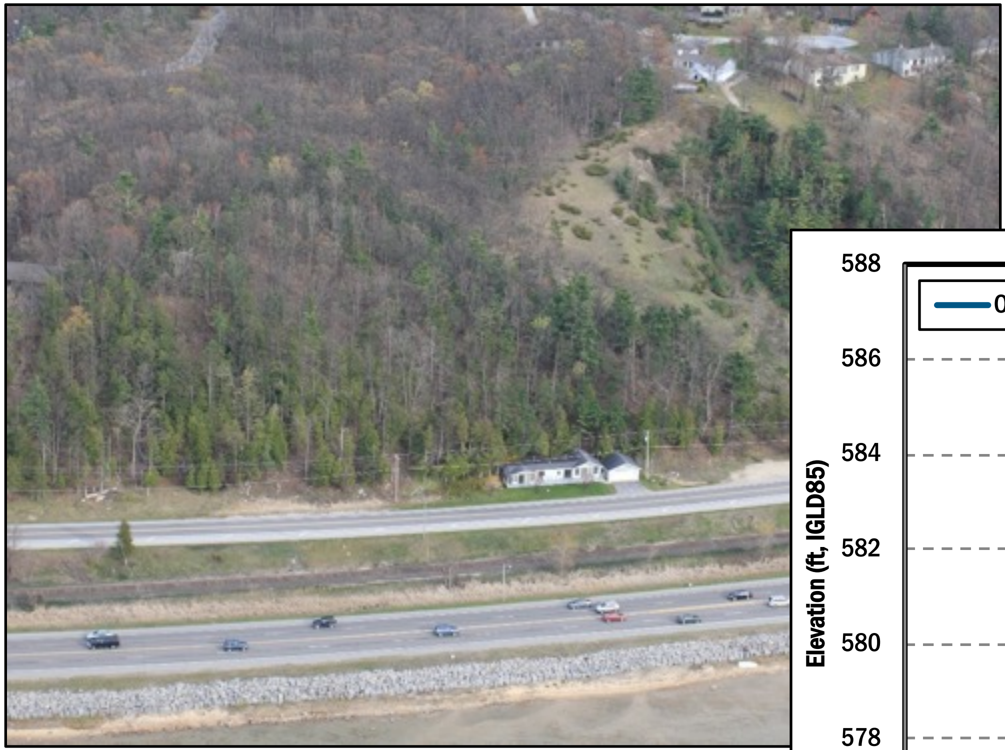
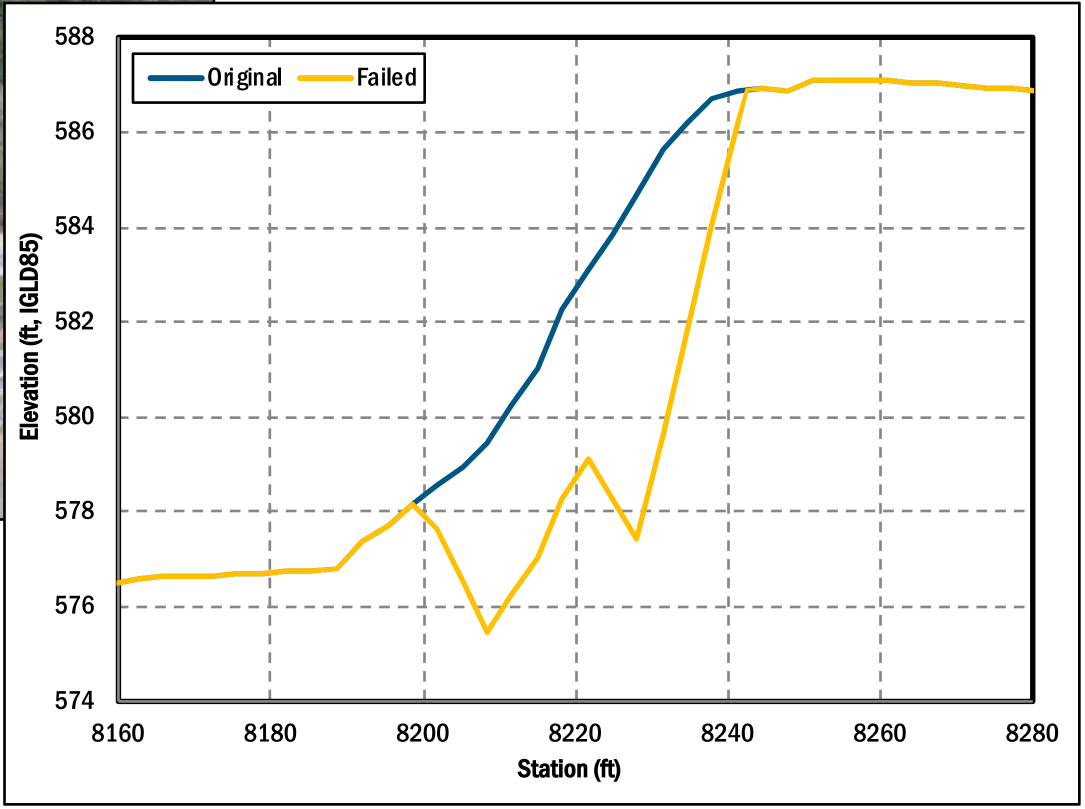
Step 2: Failed Structure Profiles





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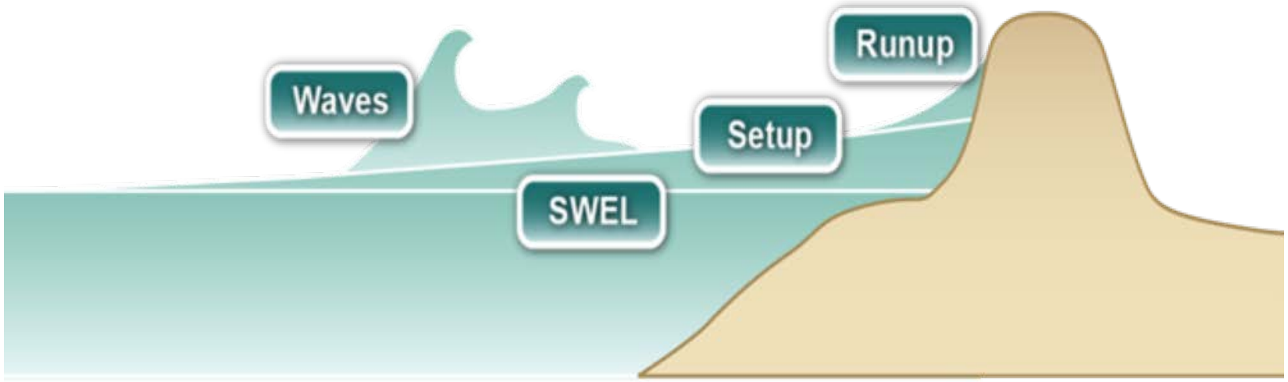
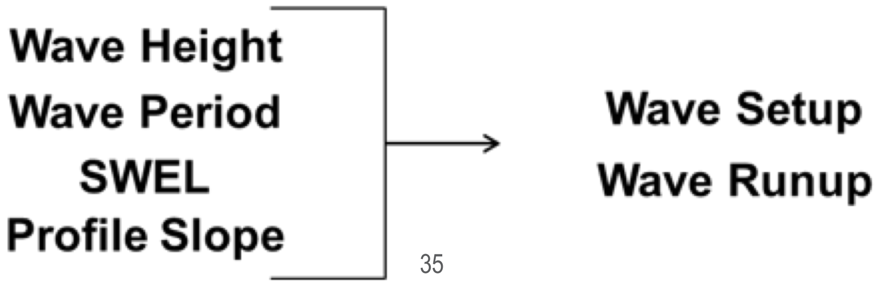
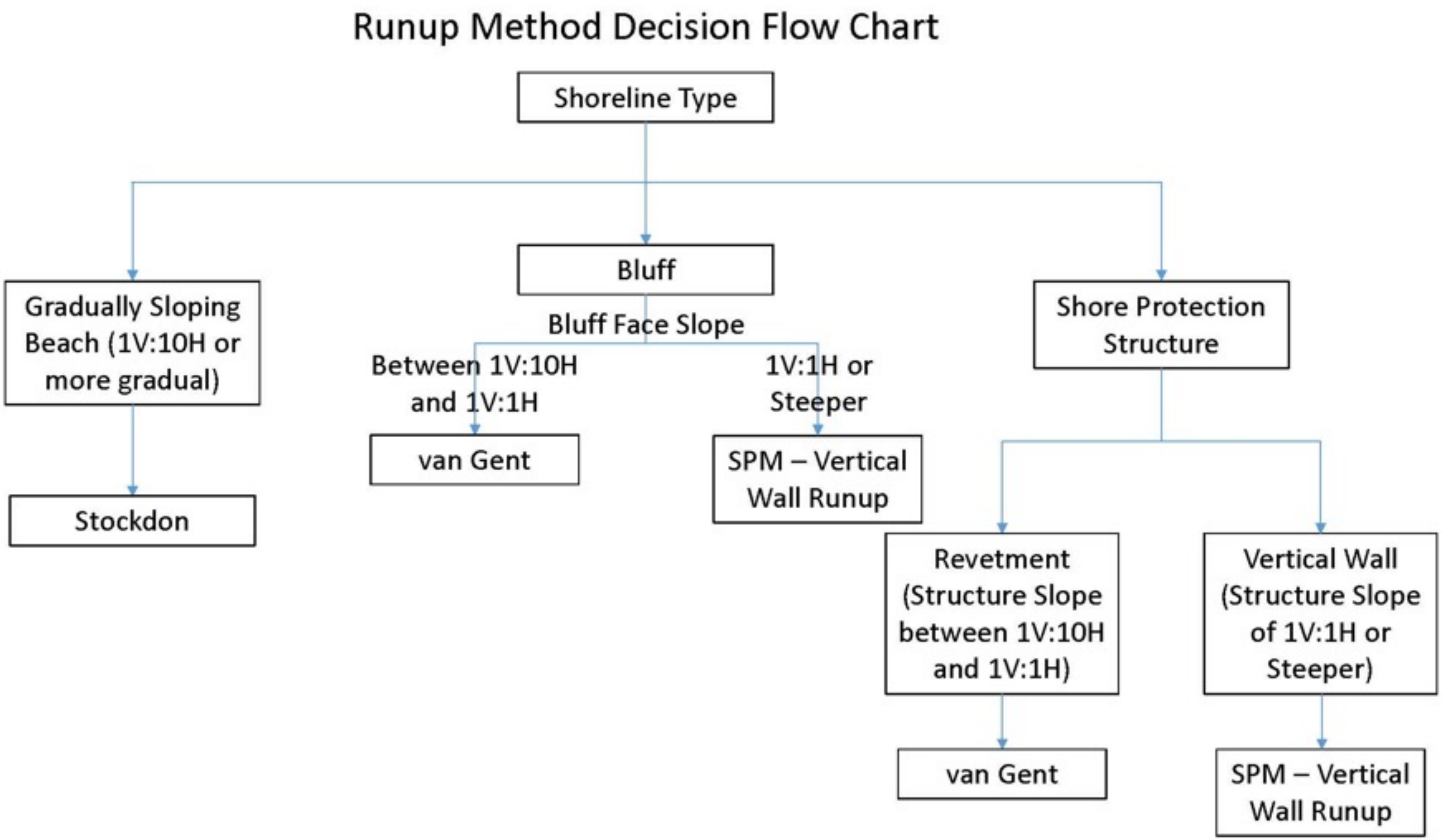
Step 2: Transect Analysis: Wave Setup and Runup

- Wave runup is the uprush of water from wave action on a beach or shore barrier such as a steep dune, bluff or coastal structure.
- Runup was calculated for every time step of each of the 151 storm events at each transect for the response-based approach.
- A statistical analysis was performed on the maximum runup results at each transect to obtain the 1-percent-annual-chance runup elevation.





Response-Based Wave Runup



Step 2: Runup

http://www.mlive.com/expo/erry-2018/04/33c5eb88b72690/heres_a_look_at_how_michigan_r.html
http://machicon-akihabara.info/2017eimage-estuarine-floods.awp

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Step 2: Transect Analysis: Wave Overtopping

- If wave runup exceeds the barrier crest elevation, overtopping occurs.
- Overtopping rates are calculated using methods described in the EurOTop Manual
- Overtopping rates determine VE splash zones and AO Zone (sheet flow) depths

Step 2: Wave Overtopping

https://www.youtube.com/watch?v=2N6SYWuP9p0

https://www.youtube.com/watch?v=iLmbBJLBDBs

Step 2: Wave Overtopping – Plateau Method

- When overtopping occurs, the zone behind the barrier is designated as:
  - AE if landward slope is positive
  - AO if landward slope is negative
  - AH if landward slope is negative and flow is trapped
- Inland extent of overtopping mapping generally follows the 1-percent-annual-chance BFE contour
- Plateau method allows for an inland limit of runup to be calculated as the AE zone extent for gradually sloping upland areas behind a steep barrier

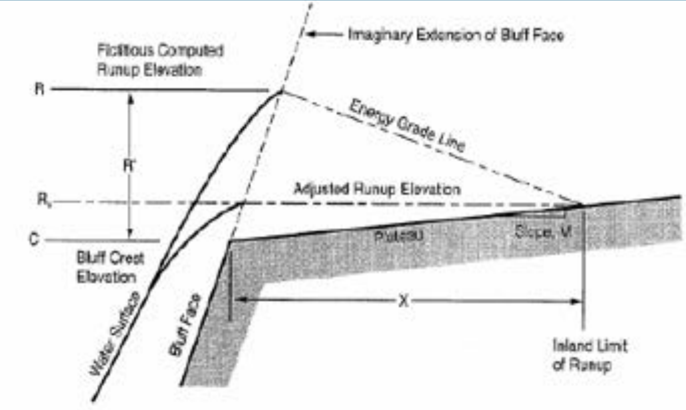

Figure D.3.5-3: Treatment of Runup onto Plateau above Low Bluff

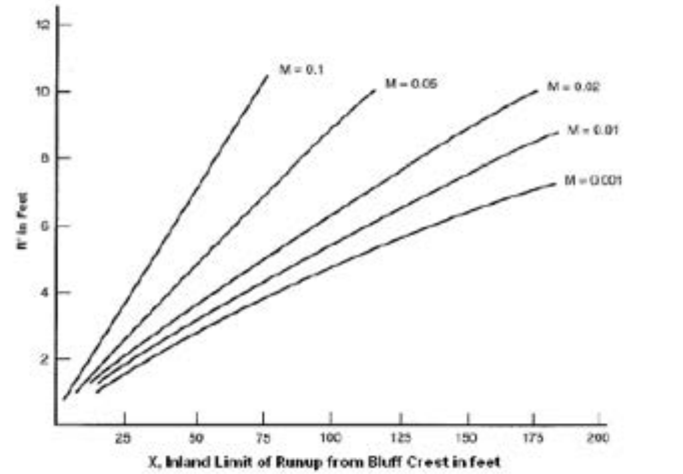

Figure D.3.5-4: Curves for Computation of Runup Inland of Low Bluffs

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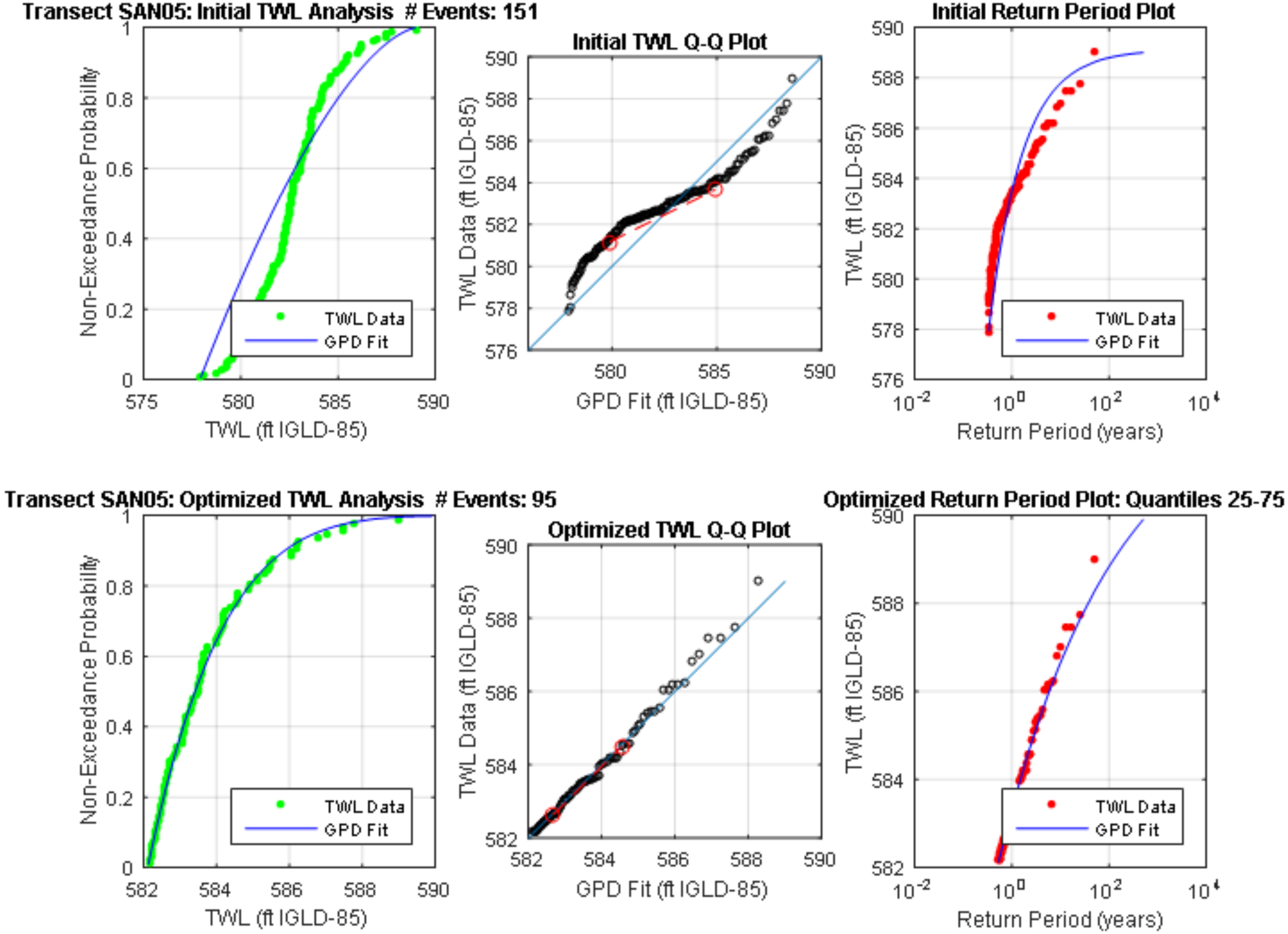
Step 2: Compute Setup, Runup, and Overtopping

- 151 storms with hourly waves and water levels yields hourly wave setup, runup and overtopping rates
- Hourly Still Water Levels (SWELs)
- Hourly Water Levels + Setup + Runup = Hourly Total Water Levels (TWLs)
- Extract the Peak SWEL and TWL from each storm
- Perform Return Period Analysis on SWEL and TWL
- 1-percent-annual-chance TWEL is used to define the Base Flood Elevation (BFE)

Step 2: Return Period Analysis



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Step 2: Overland Wave Propagation

- Waves will propagate overland at areas where 1-percent still water level inundates far inland
- Overland wave propagation was modeled using event-based approach with synthetical storms determined by JPM analysis
- WHAFIS simulates inland wave propagation, dissipation due to obstructions, and wave regeneration

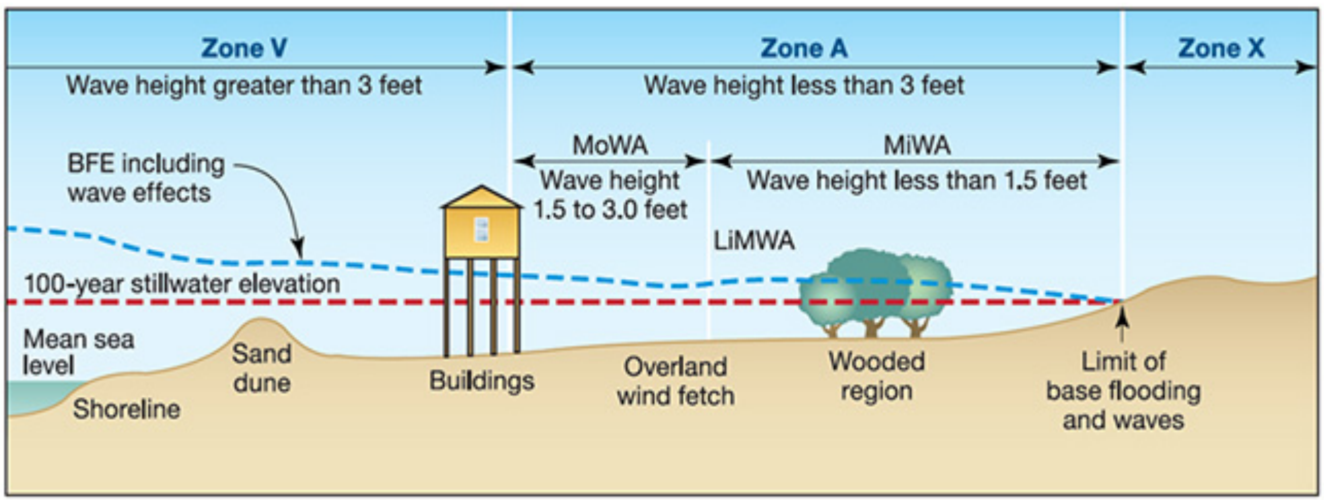
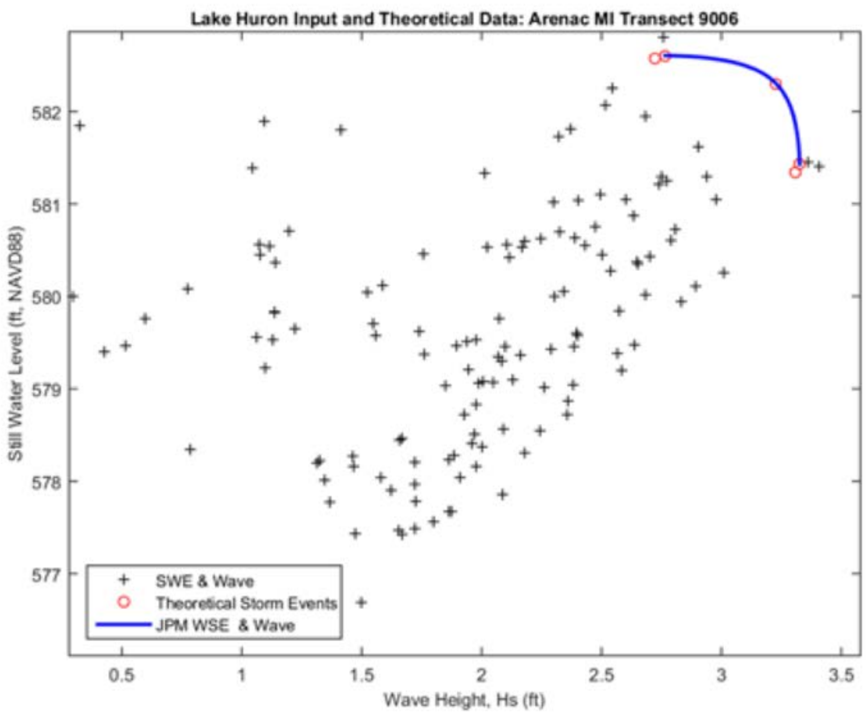


Figure 2-4. Wave height transect showing LiMWA, MoWA, and MiWA

Step 2: JPM Analysis

- Joint Probability Method looks at the joint probability between peak wave height and water level of all historical storm events
- Five 1-percent events were determined corresponding to:
  - ❖ Max Hs and expected SWEL
  - ❖ Max SWEL and expected Hs
  - ❖ Intermediate SWEL and Hs
  - ❖ 1% SWEL and conditional Hs
  - ❖ 1% Hs and conditional SWEL



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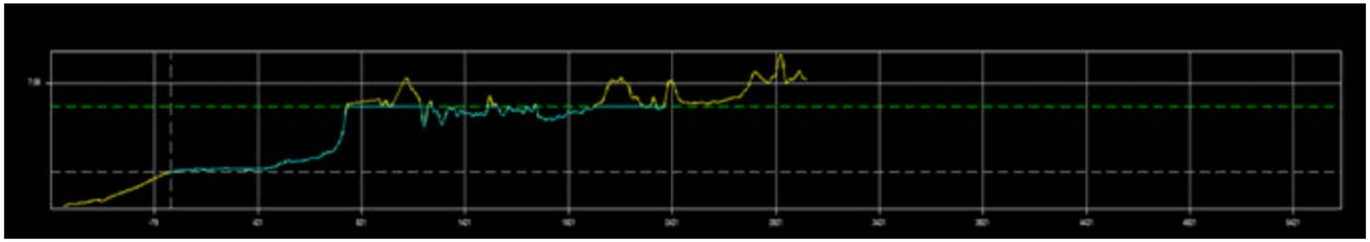
Step 2: WHAFIS Modeling

- Physical Setup: Transect profile with WHAFIS Carding

Card	Description
OF, IF	Overwater Fetch, Inland Fetch with 40 mi/hr wind associated with 1% event for wave generation
VH, VE	Marsh Grass, Rigid Tree line for wave dissipation
DU, BU	Obstruction due to Barriers, Building for wave dissipation

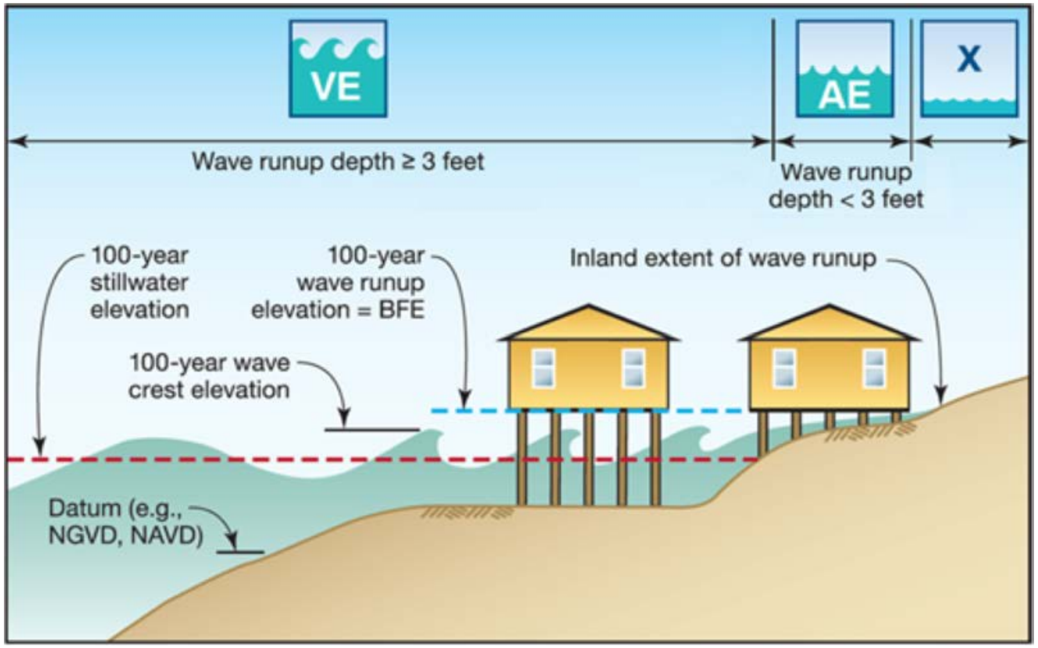
- Forcing Condition: Apply the maximum TSWL (SWEL + Wave Setup) and Hs from the 5 JPM storm events
- Model Output: Cross-shore wave height profile



Step 3: Mapping

Coastal Flood Hazard Zones

- **Zone VE:**
  - Represents coastal high hazard areas
  - Wave heights ≥ 3ft
  - Wave runup ≥ 3ft above ground elevation
  - BFEs are assigned
- **Zone AE:**
  - Inundation areas
  - Wave heights < 3ft
  - Wave runup < 3ft above ground elevation
  - BFEs are assigned
- **Zone AH:**
  - Ponding areas with 1-3 ft depths
  - BFEs are assigned
- **Zone AO:**
  - Applied in areas of sheet-flow shallow flooding
  - Designated with depths of 1-, 2-, or 3-ft
- **Zone Shaded-X:**
  - Areas impacted by the 0.2-percent-annual-chance event



Step 3: Zone Breaks

- Zone breaks are placed along the coast where the characteristics of the shoreline transition from one shore type to another
- Define the extents of each representative shoreline reach

Step 3: Runup VE Zones

- Intact transects
  - VE zone mapped to elevation associated with TWL or structure crest elevation
- Failed transects (coastal structures)
  - VE zone mapped to station along the profile associated with TWL
  - Elevation may not match topography since mapping extent is associated with failed structure elevation
- Eroded profiles
  - VE zone mapped to station along the profile associated with TWL
  - Elevation may not match topography since mapping extent is associated with the eroded profile elevation

Step 3: Overtopping Zones

AO Zones

- Applied in areas of shallow flooding, usually sheet flow on sloping terrain
- Flood depth determined based on overtopping rate

AH Zones

- Applied in areas of ponding

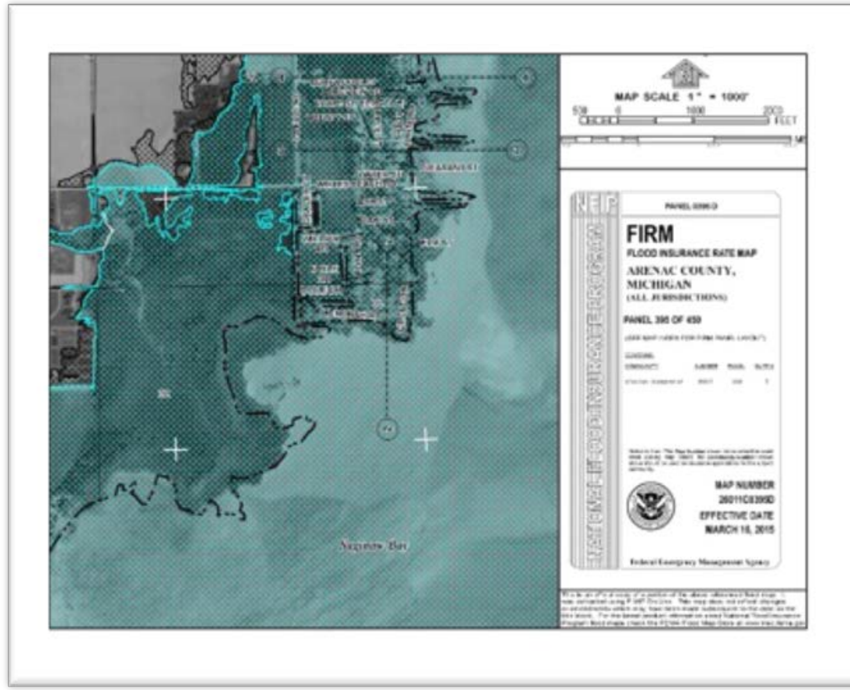
Step 3: SWEL Inundation

Step 3: Overland Wave Propagation

Draft Work Map vs FIS/FIRM

Arenac County, MI Workmap

Arenac County, MI Effective FIRM
(shown as FIRMette from FEMA Map Service Center)



Arenac and Iosco Counties

FEMA FLOODPLAIN MANAGEMENT

V-zone Floodplain management : 44 CFR 60.3(e)

The community must require that all new construction and substantial improvements have the lowest horizontal structural member of the lowest floor elevated to or above the base flood level,

> ... with the space below the lowest floor either free of obstruction or constructed with non-supporting breakaway walls ...

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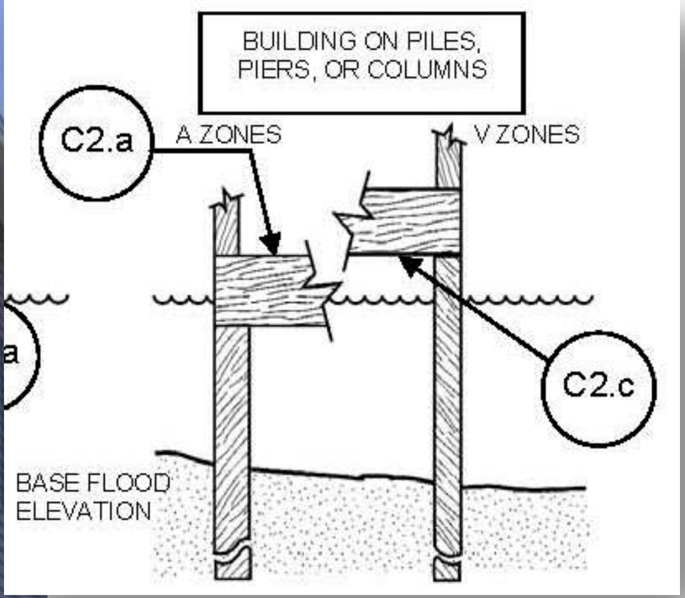
Lowest horizontal structural member

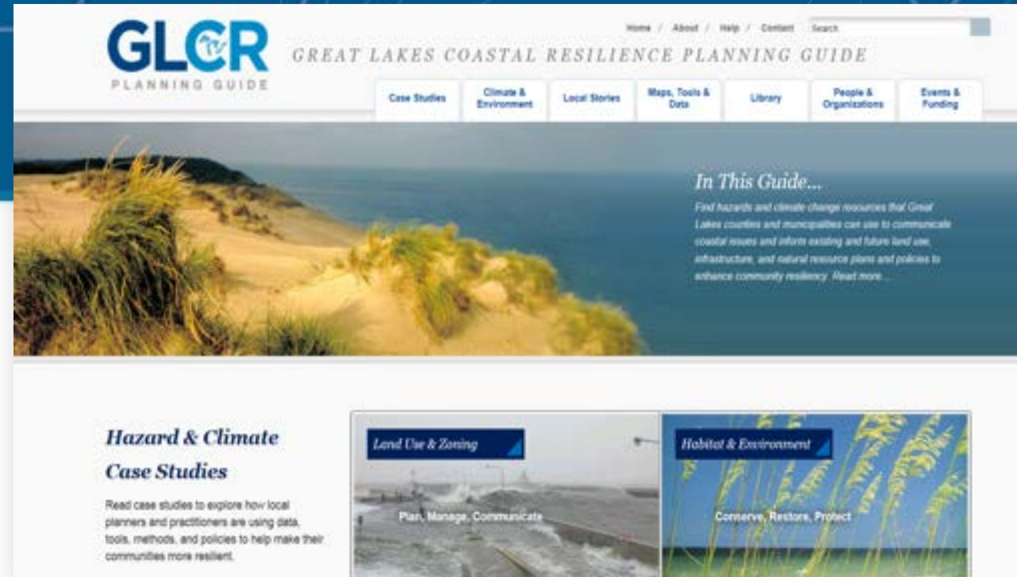


Other key points in Zone VE:

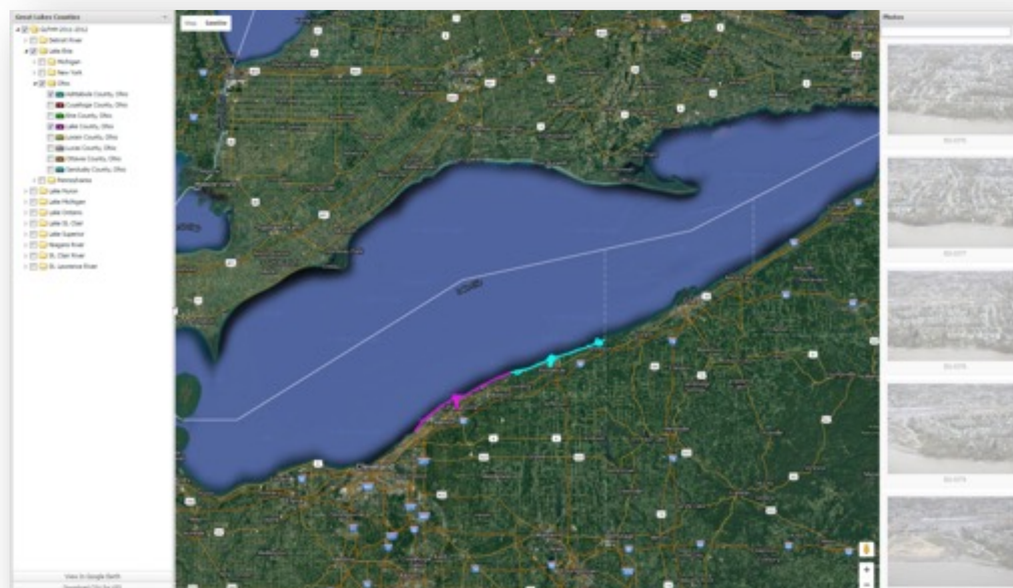
- NO USE OF FILL as structural support
- Elevated portion of the building and piling/column foundation must be designed to withstand water and wind loads acting simultaneously under base flood conditions

Online Resources

Great Lakes Coastal Resilience Planning:
http://www.greatlakesresilience.org/



High resolution oblique aerial images
http://greatlakes.erdc.dren.mil/



FEMA

RiskMAP
Increasing Resilience Together

Arenac and Iosco Counties

NEXT STEPS

Next Steps

60 day review and comment period ends May 27, 2018.

FEMA's next steps:

1. Inventory all comments received
2. Evaluate and incorporate comments and data as appropriate
3. Move studies into the NFIP regulatory process (developing FIRMs)

Comments

Send comments via email to
matt.bauer@stantec.com
or mail to:

Great Lakes Coastal Flood Study
Comment Repository
c/o Stantec
Attn: Matt Bauer
6110 Frost Place
Laurel, MD 20707

Include county, community, map panel number, description of area (screenshots or drawings are very helpful), detailed comment, and contact information

- You will receive acknowledgement of receipt of your comment within 3 business days
- Within 3 weeks, FEMA's response will indicate if enough technical justification was provided to necessitate a map change
- If you are not satisfied with a comment response on technical grounds, consider using the appeal process during Preliminary FIRM rollout

FEMA Contacts

KEN HINTERLONG

Senior Engineer, Risk Analysis

FEMA Region 5

312-408-5529

ken.hinterlong@fema.dhs.gov

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Questions?

Thank you for your participation!