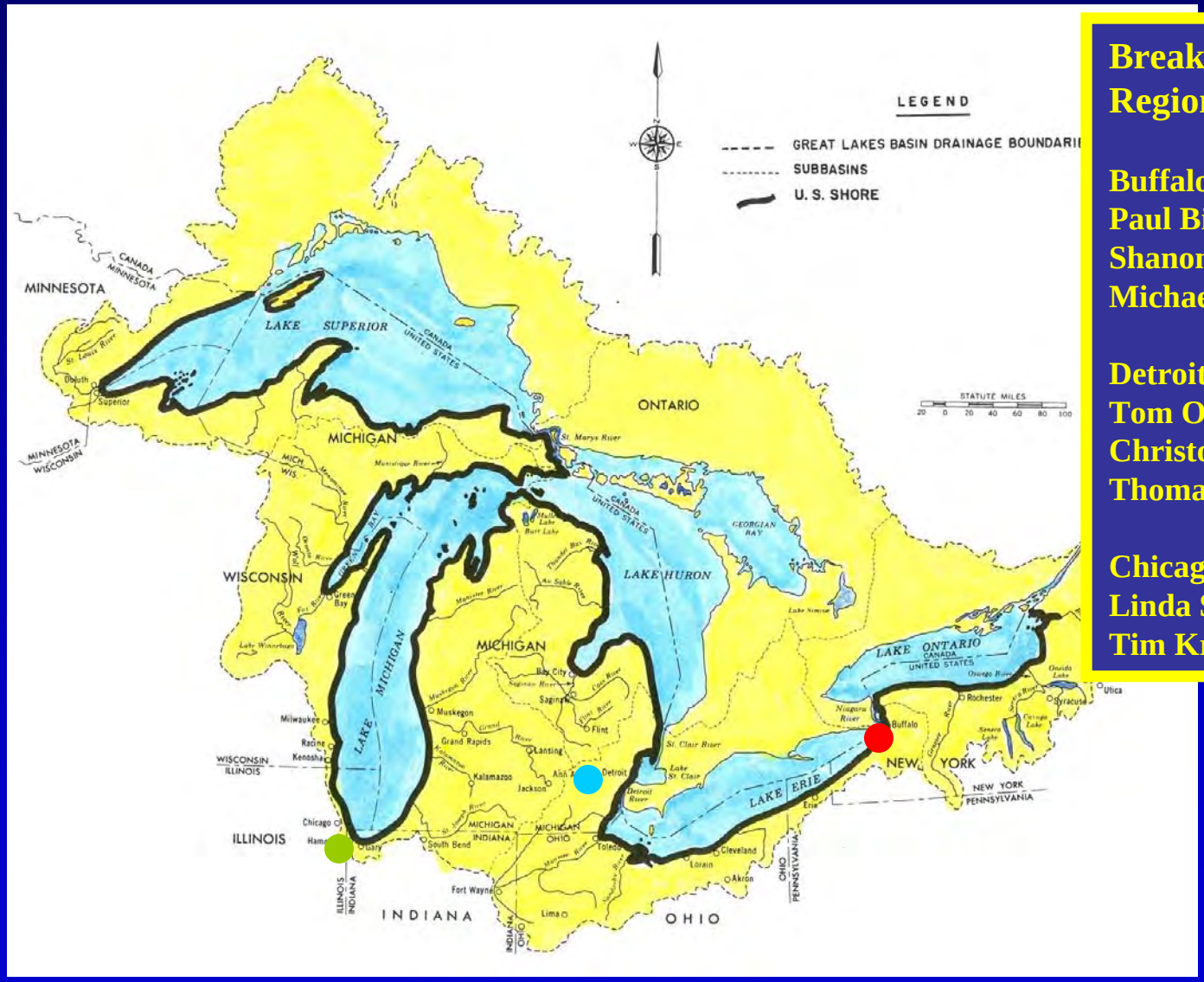
US Army Corps of Engineers
Buffalo District

Meeting of Great Lakes Coastal Zone Managers

24 September 2008
Buffalo, NY



Breakwater Assessment Regional Team Members:

Buffalo District
Paul Bijhouwer
Shanon A. Chader
Michael C. Mohr

Detroit District
Tom O'Bryan
Christopher Lindman
Thomas Johnson

Chicago District
Linda Sorn (Team Leader)
Tim Kroll

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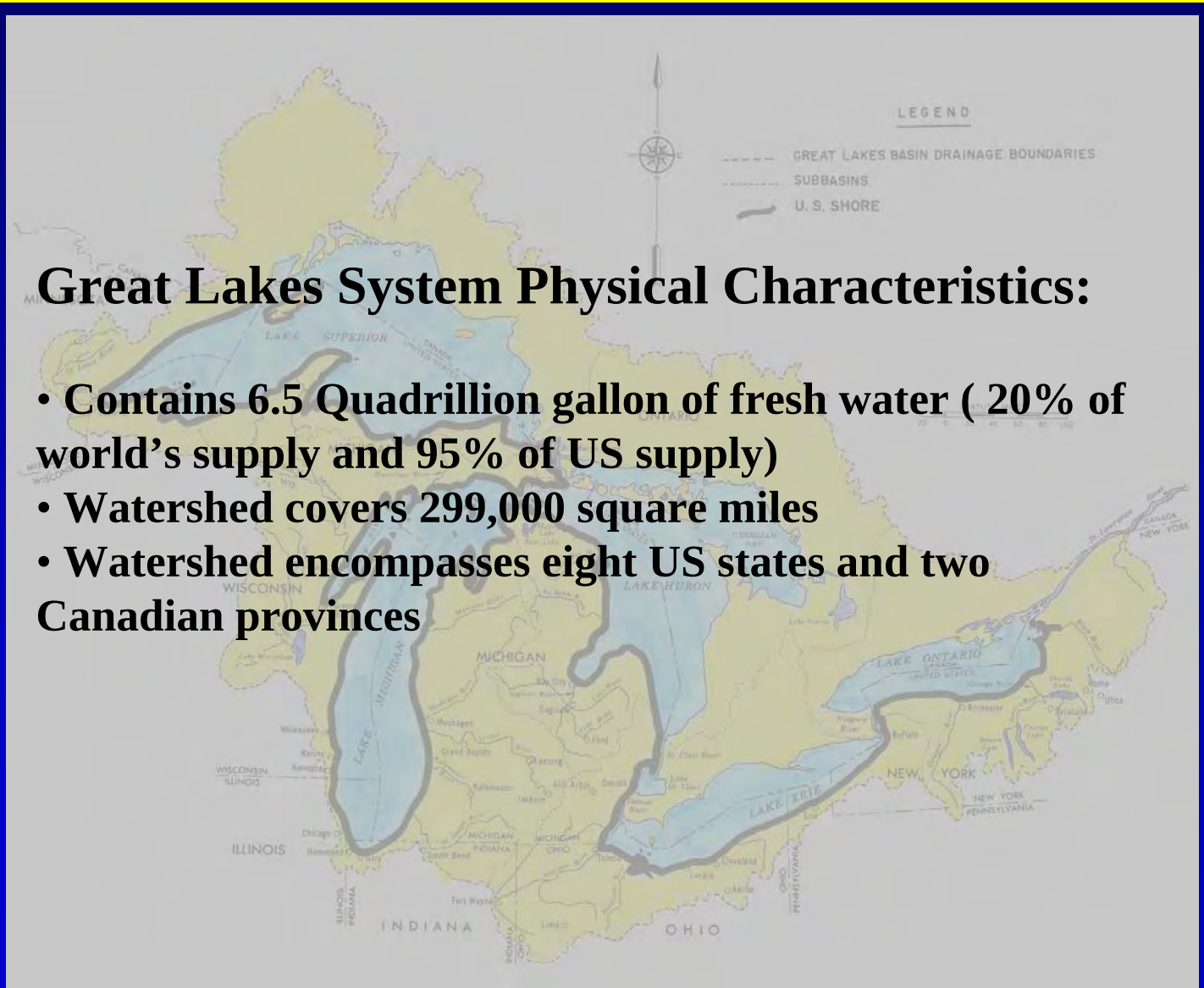

Great Lakes System Physical Characteristics:

- Contains 6.5 Quadrillion gallon of fresh water (20% of world's supply and 95% of US supply)
- Watershed covers 299,000 square miles
- Watershed encompasses eight US states and two Canadian provinces

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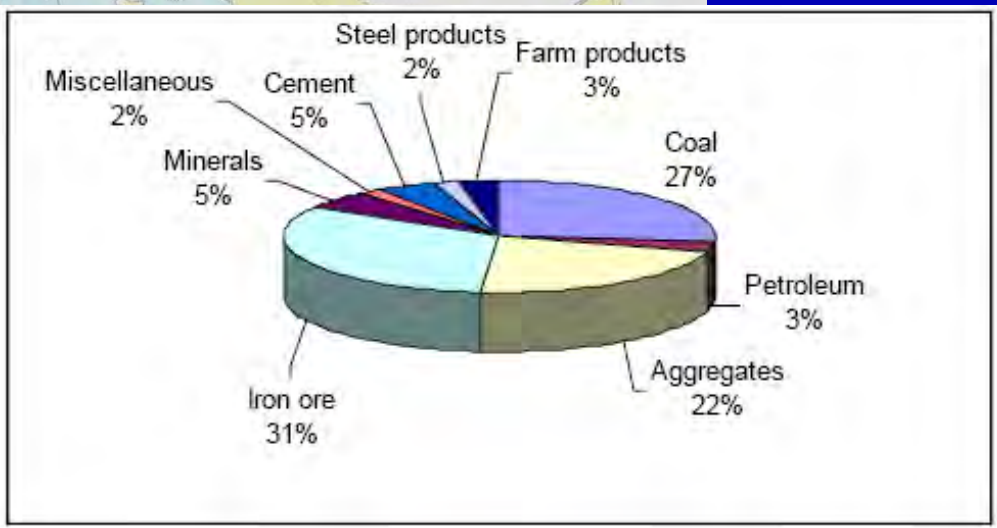
Economic statistics:

- Over 150 million tons of commodities shipped annually
- Two general trade communities: traffic moved on Seaway (import/export) & inter-lake
- Multi-modal system. Major rail and highway hubs – Chicago, Toronto, Detroit & Toledo – are also GLNS ports.



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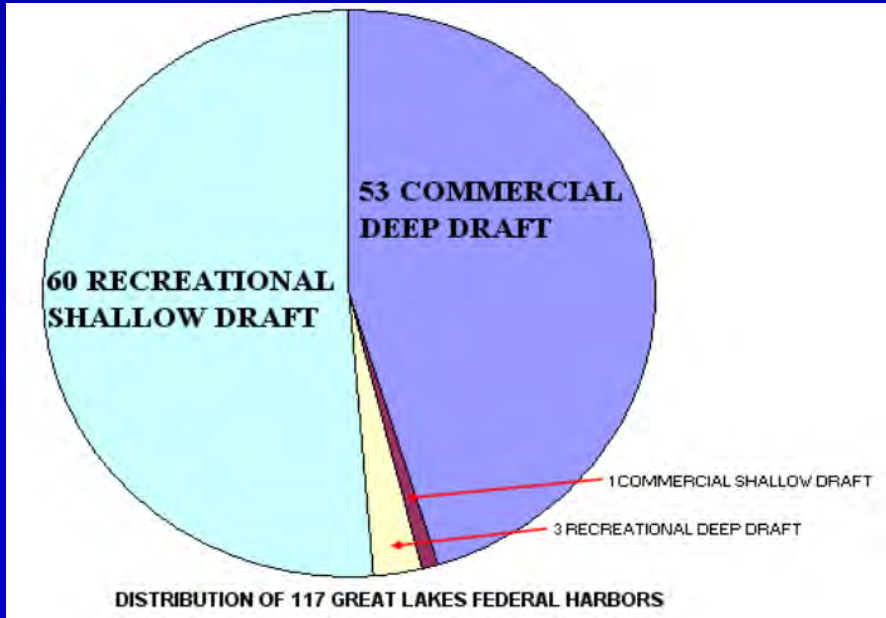
Great Lakes Navigation System:

A continuous 27- foot deep draft waterway from Lake Superior to Gulf of St. Lawrence (2,400 miles)

U.S. portion includes:

- 138 Federal projects
- 117 Federal harbors
- 600 miles of maintained navigation channels
- 104 miles of breakwaters and jetties
- 4 locks



DISTRIBUTION OF 117 GREAT LAKES FEDERAL HARBORS

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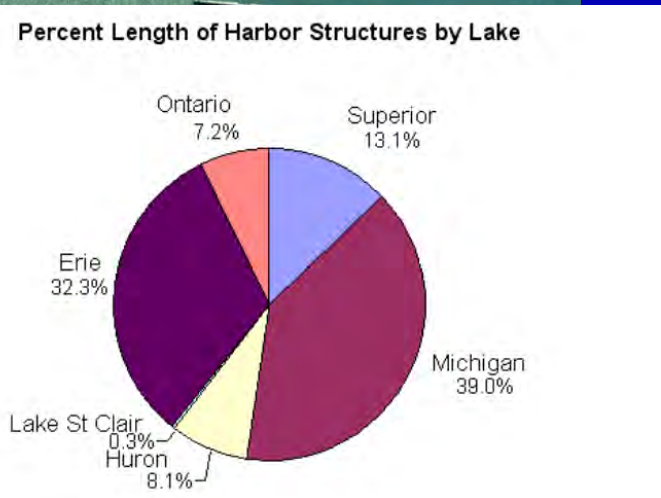
US Great Lakes Harbors with Longest Structures:

Cleveland	32560 feet
Buffalo	24433 feet
Milwaukee	22882 feet
Chicago	20351 feet



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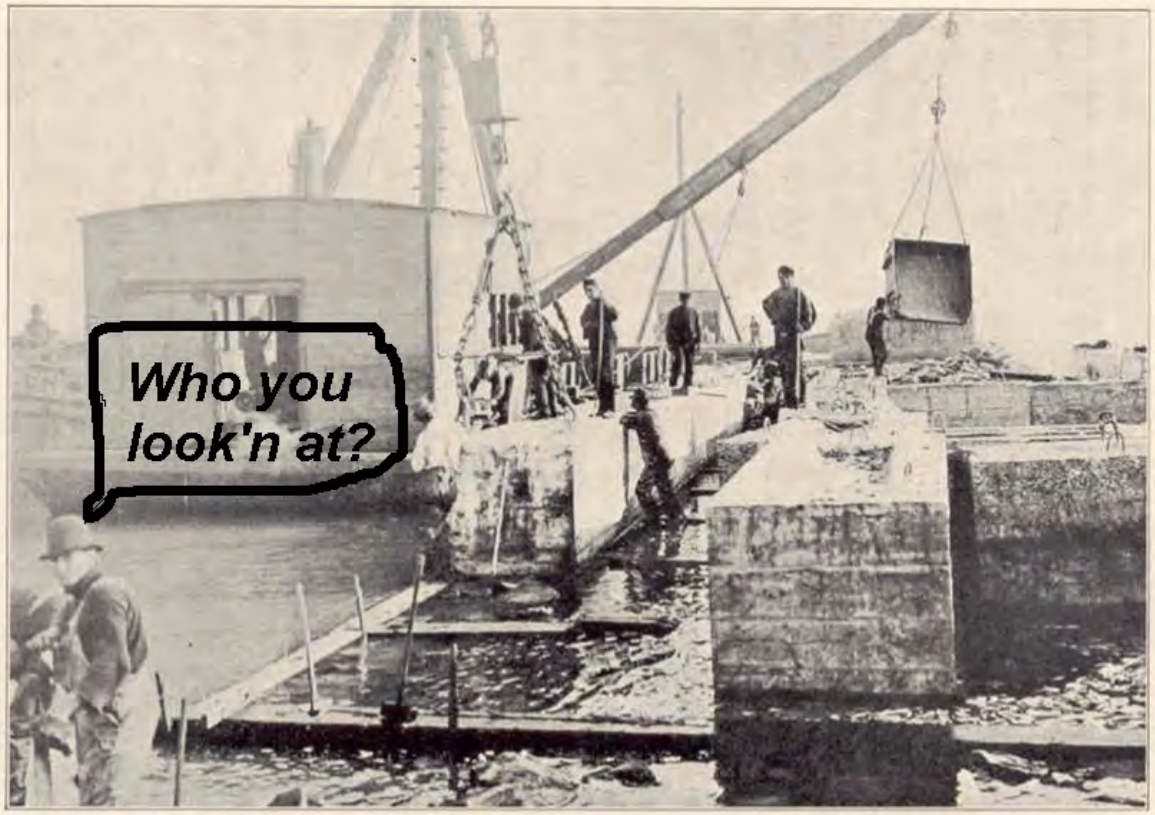
CONSTRUCTION TYPES AND MATERIALS



Buffalo Harbor, NY - Setting Concrete Blocks on Harbor Side 1901

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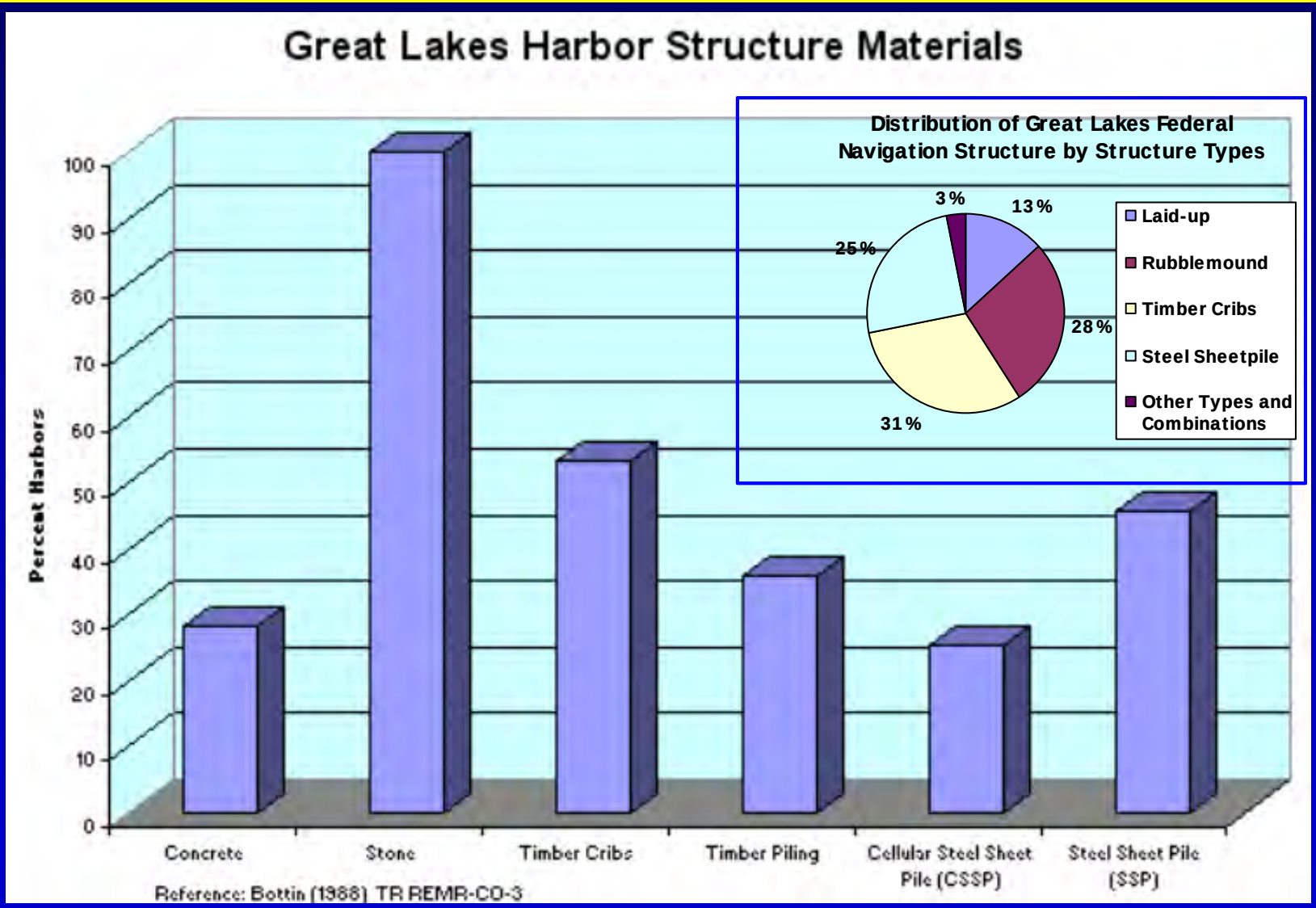

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CONCRETE

Chicago Harbor

Sturgeon Point

Sturgeon Point

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STONE

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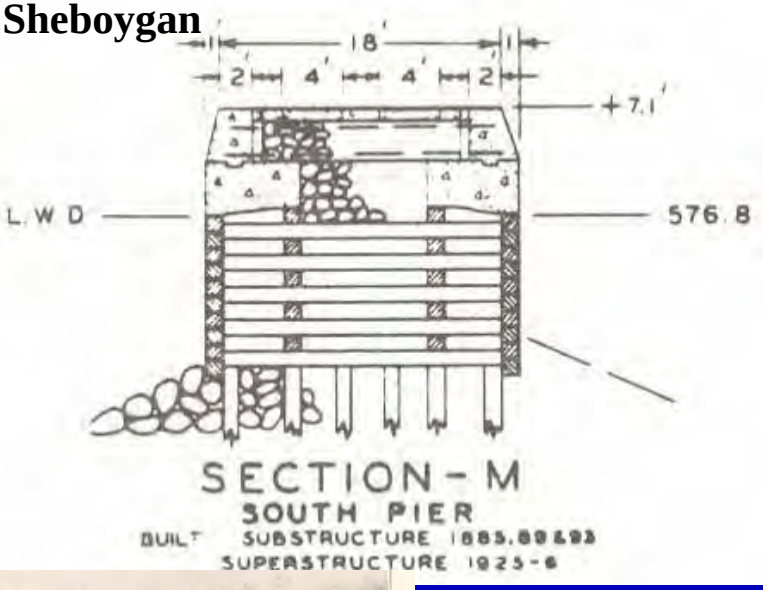
TIMBER

Cleveland E Pier - 1896

Sheboygan



Cleveland 1904

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CELLULAR SHEET PILE

Conneaut East Breakwater

Lorain Outer Breakwater Crest

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STEEL SHEET PILE

Little Sodus East Pier

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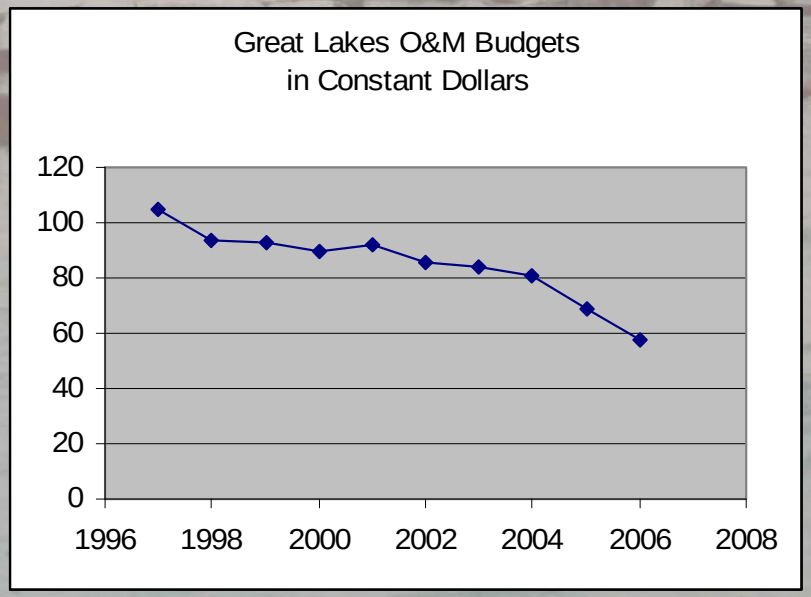
Concrete Armor Units

Ashtabula East Breakwater

HARBOR CONDITION



- **Total O&M Dollars for 2007 are at 57% (real dollars) of the 1997 amount**
- **In order to maintain channels, more structure maintenance is curtailed.**

Chicago Harbor June 2002

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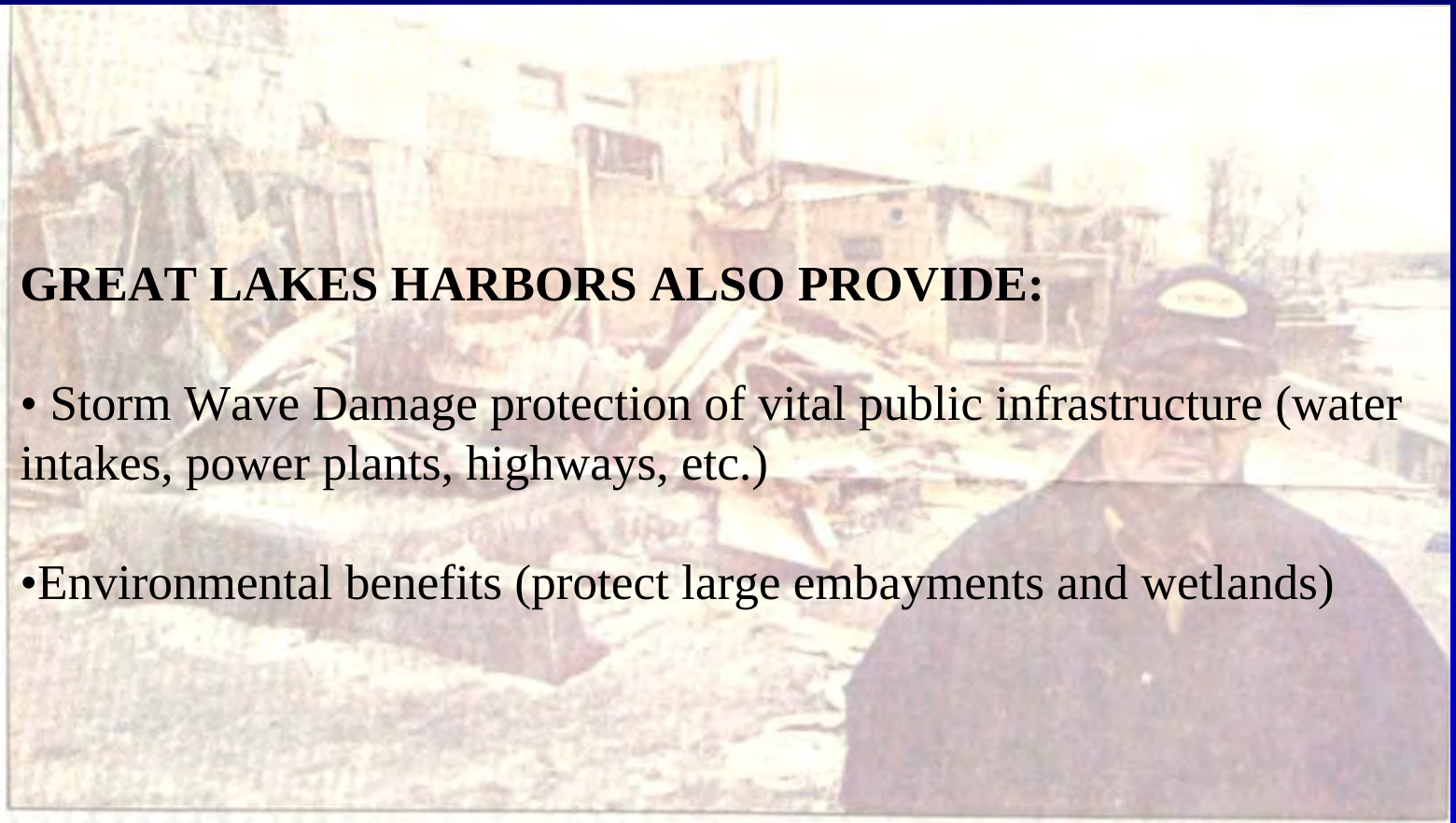
GREAT LAKES HARBORS ALSO PROVIDE:

• Storm Wave Damage protection of vital public infrastructure (water intakes, power plants, highways, etc.)

•Environmental benefits (protect large embayments and wetlands)



All that remains of Vince Caggiano's home at 143 Midshore Drive is a pile of rubble.

RICHARD ROELLER/Buffalo News

Lakeshore Dwellers Pick Up Pieces

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With the majority of Great Lakes Federal coastal structures over 50 years of age, 45% have never undergone a significant rehabilitation effort and in a climate of shrinking budgets ……

How do we prevent coastal structures neglect, and adequately distribute limited funding resources?

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Path Forward

- Assemble a multidistrict Regional team
- Develop a methodology that produces consistent inspection results for harbor structures.
- Determine a rating for the structures of portions of the structures.
- Use the determined rating to assist in planning and budgeting for future maintenance and repair projects.

Great Lakes Navigation System Breakwater Assessment Initiative

Commercial Harbors:

- **Established a team to develop consistent methods to assess harbor infrastructure condition and determine risks associated with the potential structure failure**
- **Use this information to prioritize limited federal funding in a manner that reduces risk to the Great Lakes navigation system**

Great Lakes Navigation System Breakwater Assessment Initiative

Recreational Harbors:

- **Initiate a dialogue with state and local officials regarding current condition of infrastructure and the projected risks posed by deferred maintenance**
- **Provide information regarding condition of navigation structures, as well as estimates for resource requirements for maintenance and repair**

Great Lakes Navigation System Breakwater Assessment Initiative

- **Past Inspection Practices**
  - **Buffalo District**
    - **Who – District Operations Branch/field offices**
    - **What – general inspection**
    - **When – periodic**

Great Lakes Navigation System Breakwater Assessment Initiative

- **Past Inspection Practices**
  - **Chicago District**
    - **Who – District Engineering and O&M staff**
    - **What – 2 levels – annual walk-thru by O&M staff and periodic by district team; periodic surveys on riprap and cross sections**
    - **When – Annual and periodic**

Great Lakes Navigation System Breakwater Assessment Initiative

- **Past Inspection Practices**
  - **Detroit District**
    - **Who – Area Office**
    - **What – Annual riprap and cross-section surveys; limited use of REMR guidance visual inspection with measurements of fill levels and differential settlement.**
    - **When – Annually**

Great Lakes Navigation System Breakwater Assessment Initiative

- **What happens to our projects when funds are tight**
  - Structural repairs are secondary to the dredging program and get sacrificed first.
  - Structural inspections are then reduced concurrently.

REPAIR, EVALUATION, MAINTENANCE AND REHABILITATION (REMR) RESEARCH PROGRAM

ERDC/CERL TR-REMR-OM-26

Construction Engineering Research Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

Condition and Performance Rating Procedures for Nonrubble Breakwaters and Jetties

Doug Pirie, Donald Plotkin, Joseph Kubinski, Stuart Foltz, and David McKay

April 2003

REPAIR, EVALUATION, MAINTENANCE AND REHABILITATION (REMR) RESEARCH PROGRAM

US Army Corps
of Engineers
Construction Engineering
Research Laboratories

Technical Report REMR-OM-24
November 1998

REMR Management Systems—Coastal/Shore Protection Structures

Condition and Performance Rating Procedures for Rubble Breakwaters and Jetties

by *John Oliver*
Consultant

Don Plotkin
U.S. Army Construction Engineering Research Laboratories

John Lesnik
Moffatt and Nichol, Engineers

Doug Pirie
Consultant

Prepared for Headquarters, U.S. Army Corps of Engineers

Great Lakes Navigation System Breakwater Assessment Initiative

- **Present Inspection and Assessment Procedures**
- **Assessment Procedures – Annually visit Great Lakes wide top ten harbor commercial projects**
- **Inspection Procedures**
  - **Buffalo District - Periodic walking inspection**
  - **Chicago District – Annual walkover**
  - **Detroit District – Periodic walking inspection**

Great Lakes Navigation System Breakwater Assessment Initiative

- **Future Inspection and Assessment Procedures**
- **A 2 phased approach**
  - **For FY10 evaluate critical needs for Great Lakes structures on consistent and rational basis.**
  - **In the following phase improve the periodic inspection and assessment strategy and implement across the Great Lakes basin.**

Great Lakes Navigation System Breakwater Assessment Initiative

Future Work

Utilize Flood Risk Management approach for coastal modeling and economic analysis to determine Federal harbor areas at greatest risk, and of greatest value

- **Perform comprehensive inventory of public infrastructure elements protected by all Federal harbors in GLNS**
- **Collect data on value of infrastructural elements and economic impacts of storm damage**

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Inspection Process

- **Methodology**
  - **Photo Documentation of harbor structures.**
  - **Videotaping of harbor structures**
  - **Use of REMR and updated ERDC inspection forms.**
  - **Determine a Regional Rating for harbor structures**

- **Use the determined rating to assist in planning and budgeting for future maintenance and repair projects.**
  - **Contract**
  - **Corps Floating Plant**

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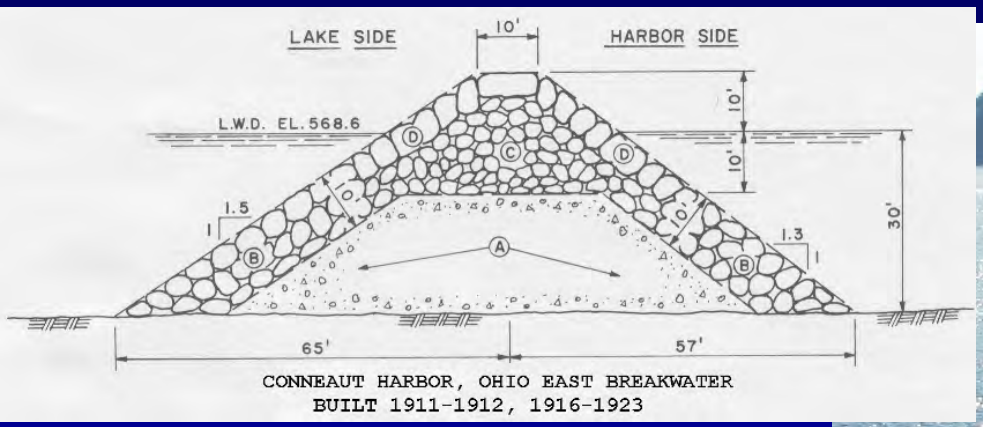
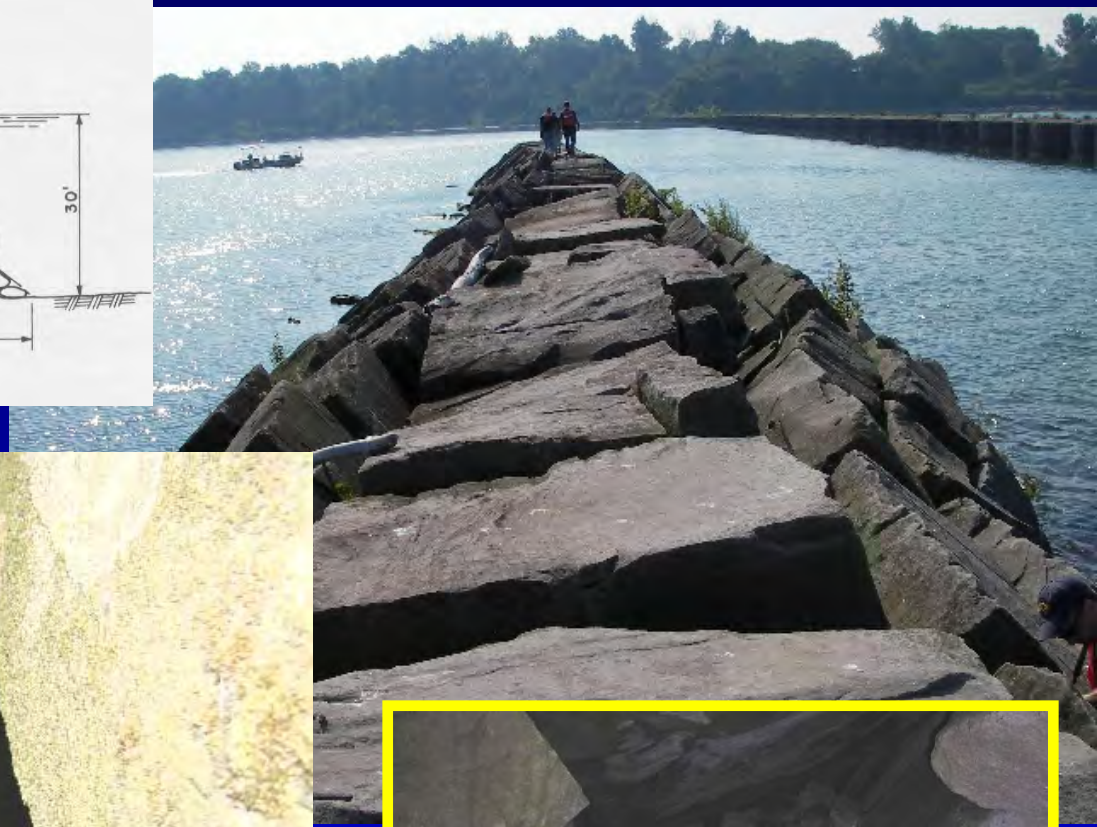
Lorain Harbor Breakwater Assessment

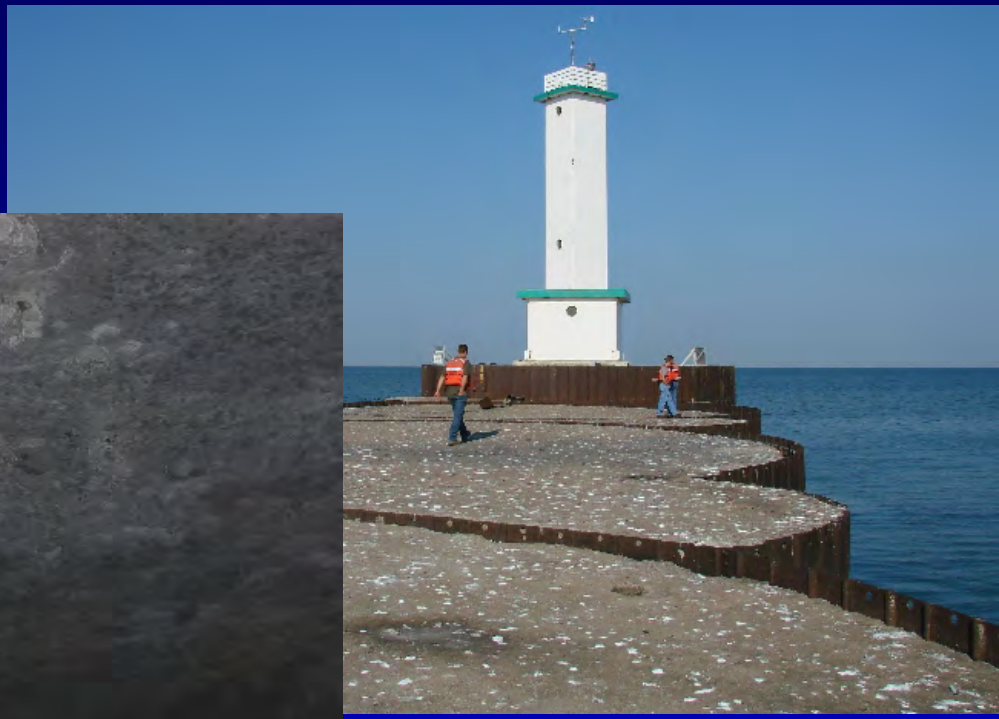
EXAMPLE OF CORE LOSS IN LAID-UP (ASHLAR) STRUCTURE



CONNEAUT HARBOR, OHIO EAST BREAKWATER
BUILT 1911-1912, 1916-1923



EXAMPLE OF CORE LOSS IN CELLULAR STEEL STRUCTURE (LORAIN, OH)



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Loss of section and crest height – Oswego Harbor

Photo by USCG

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24 September 2008
Buffalo, NY

Cleveland East Breakwater – July 2006

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Calumet Crib Breakwater

Harborside

Lakeside

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Chicago Exterior Breakwater

Crest

Crest Interior

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Chicago Exterior Breakwater

Lakeside

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Chicago Shorearm Extension

Crest

Harborside

Lakeside

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Milwaukee N. Breakwater - Detached

Table 6. Rating guidance for loss of armor interlock.

Structural Rating	Description NOTE: Interlock ratings based on Hudson Coefficient of at least 3.5.
	No or Minor Damage
85 to 100	Loss of interlock is minimal.
70 to 84	A few armor units may have lost contact with adjacent units by up to 1/4 of the unit diameter.
	Moderate Damage
55 to 69	Loss of contact or interlock with adjacent units in some places, however separation rarely exceeds ½ of the unit diameter. Bridging of units may occur in isolated locations.
40 to 54	Many adjacent armor units are separated by up to ½ of the unit diameter. Some armor units are completely separated from adjacent units and are acting independently. Many of the loose units show signs of being easily rocked or shifted by normal or light storm waves.
	Major Damage
25 to 39	Many armor units are loosely nested and act alone. Separation between adjacent units commonly exceeds one unit diameter.
10 to 24	Most armor units are loosely nested and are acting alone.
0 to 9	Nearly all visible armor units are loosely nested and are acting alone. At this stage, many of the armor units have also been lost.

REMR-OM-24 presents rating guidance based only on written description:

GOAL: Develop visual reference standard in addition to written guide for ashlar structures.

BENEFIT: Ensures greater uniformity in structural assessment.

Major Damage:

Structural Rating	Description	Photo Example
25 to 39	Many armor stones have either shifted or been displaced by greater than a foot. There may be significant bridging between armor layers along with the loss of individual armor stones within the reach.	

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Summary

- Many Great Lakes harbor structures are over a century old.
- Harbor structures are composed of various materials:
  - timber cribs
  - cut stone
  - steel sheet pile
  - rubble mound
  - concrete
  - concrete units
- Declining maintenance dollars requires regional approach
- Need a consistent condition assessment methodology applied through region
- Work with ERDC and Regional Districts to refine harbor structure assessment procedures
- Focused maintenance program which engages stakeholders and metrics that reflect local, regional and bi-national significance

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Questions????