Monitoring Completed Navigation Projects (MCNP) Program

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Funding Source
O&M

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Purpose of the MCNP Program

The Advancement of Coastal and Hydraulic Engineering Technology

To determine how well Coastal and Inland Navigation projects are accomplishing their purposes (how well they are resisting attacks by the physical environment)

(a) Create more accurate and economical engineering solutions
(b) Strengthen design criteria and methodology
(c) Improve construction practices and cost effectiveness
(d) Enhance Operation and Maintenance techniques

MCNP program identifies where current technology is inadequate. (Determines where additional research is required.)

Engineer Regulation ER 1110-2-8151

Engineering and Design

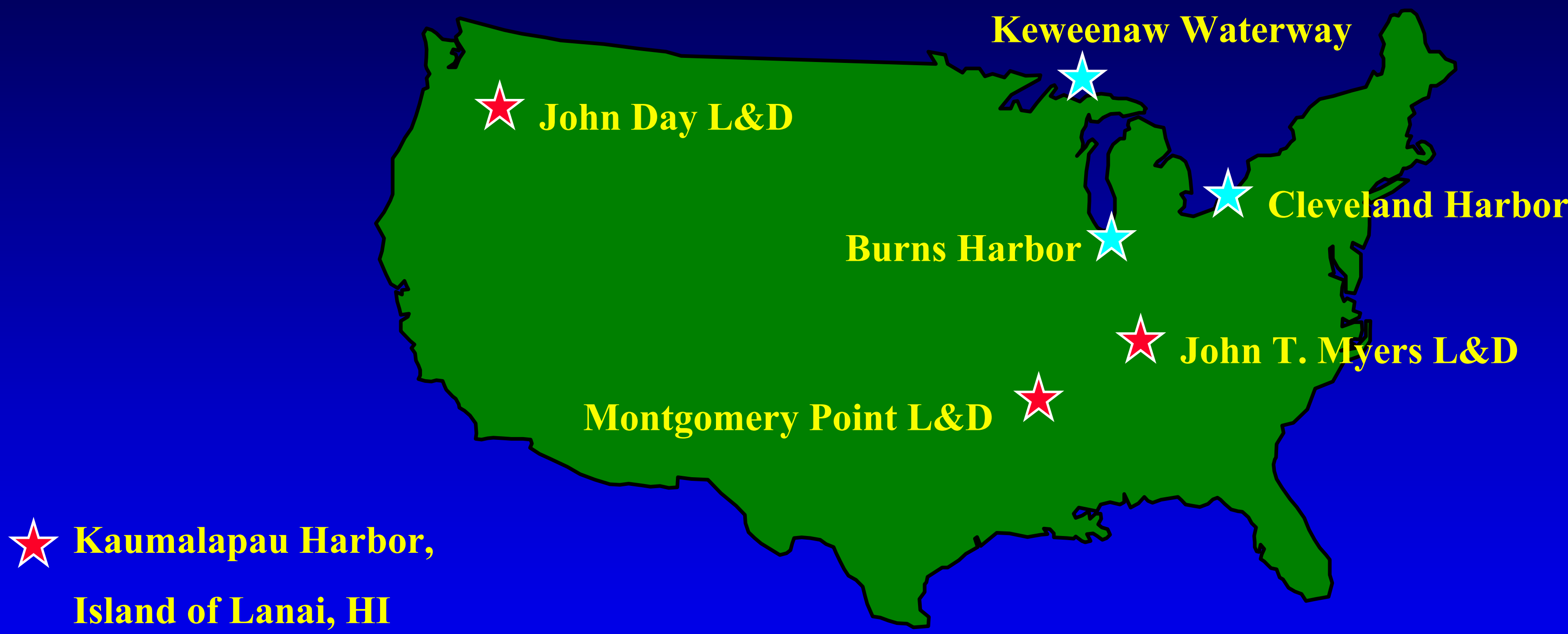
MONITORING COMPLETED NAVIGATION PROJECTS

31 July 1997

- Deep- and Shallow-draft Navigation Projects located in the Coastal Zone, Estuaries, Rivers, Lakes, and Reservoirs
- Completed Navigation Projects Operated and Maintained by the Corps of Engineers

- MCNP Program is Field Driven, addressing real-world problems.
- Nominations for New Monitoring Projects are solicited from Divisions and Districts by HQ as funding becomes available, per ER 1110-2-8151.
- Nominations are Evaluated and Prioritized by CECW (Chief, Navigation Branch, et al.) according to criteria of ER 1110-2-8151.
- Structures with Unique Features and/or distinct unforseen problem area.
- Site-specific monitoring is intended to produce Generic results and conclusions applicable on a regional basis.
- Program functions at the pleasure of Chief, Navigation Branch, CECW.

MNCP Monitoring and Periodic Inspections FY07



FY07 MCNP Program

1. Periodic Inspections; Burns, Cleveland, and Keweenaw Waterway
2. Kaumalapau Harbor; CORE-Loc Breakwater Armor Units, Island of Lanai, Hawaii
3. Great Lakes Breakwater Armor; Stone Testing Protocols, Burns, Cleveland, Keweenaw
4. John T. Myers Locks and Dam; Lock Wall Armor Deterioration, Ohio River
5. John Day Lock and Dam; Hazardous Current Conditions, Columbia River
6. Montgomery Point Lock and Dam; Hazardous Current Conditions during Low Flow, White River

Periodic Inspections

Product Delivery Team

Jeff Melby (PI), CHL, ERDC
District Team Members in every district where periodic inspections are performed.

Problem

- Lack of long-term structure performance data
- Lack of documented long-term experience

Benefits

- Better performance knowledge translates to better designs

Periodic Inspections

Coastal Structures

Work closely with Districts

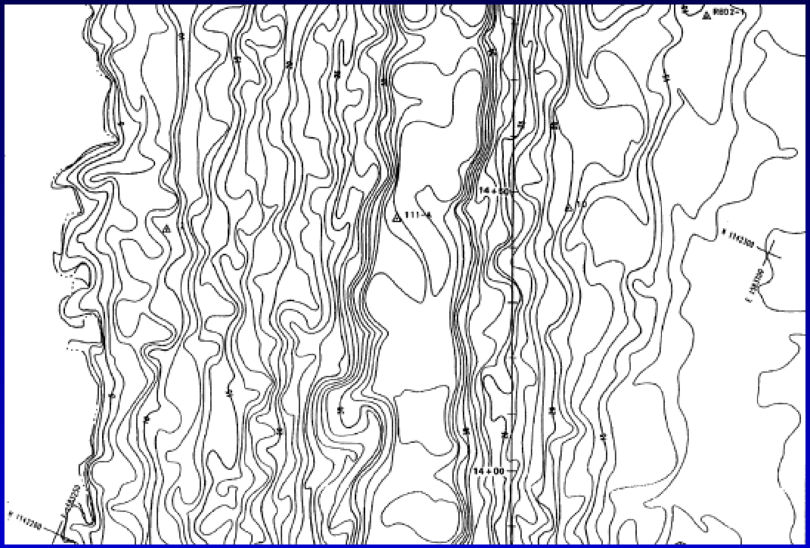
Detailed but relatively low-cost monitoring (lidar, photogrammetry, walking surveys, concrete cores, photographs)

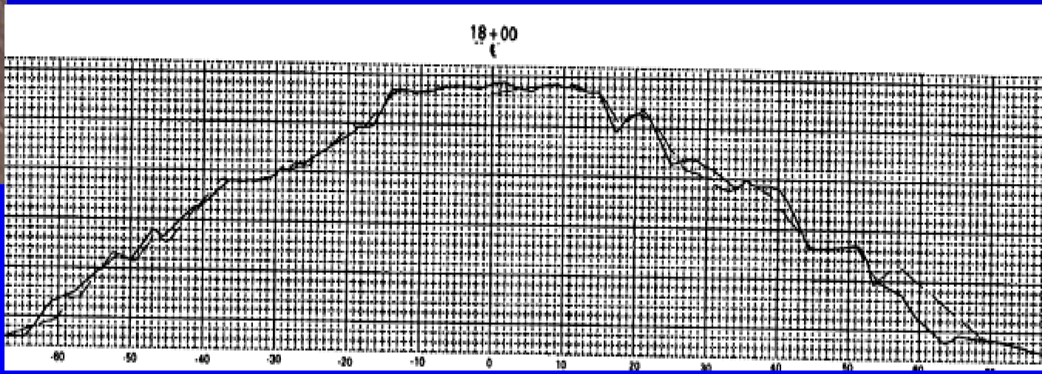
Measure stone and concrete armor movement, breakage, subsidence, etc.

Correlate performance with forcing

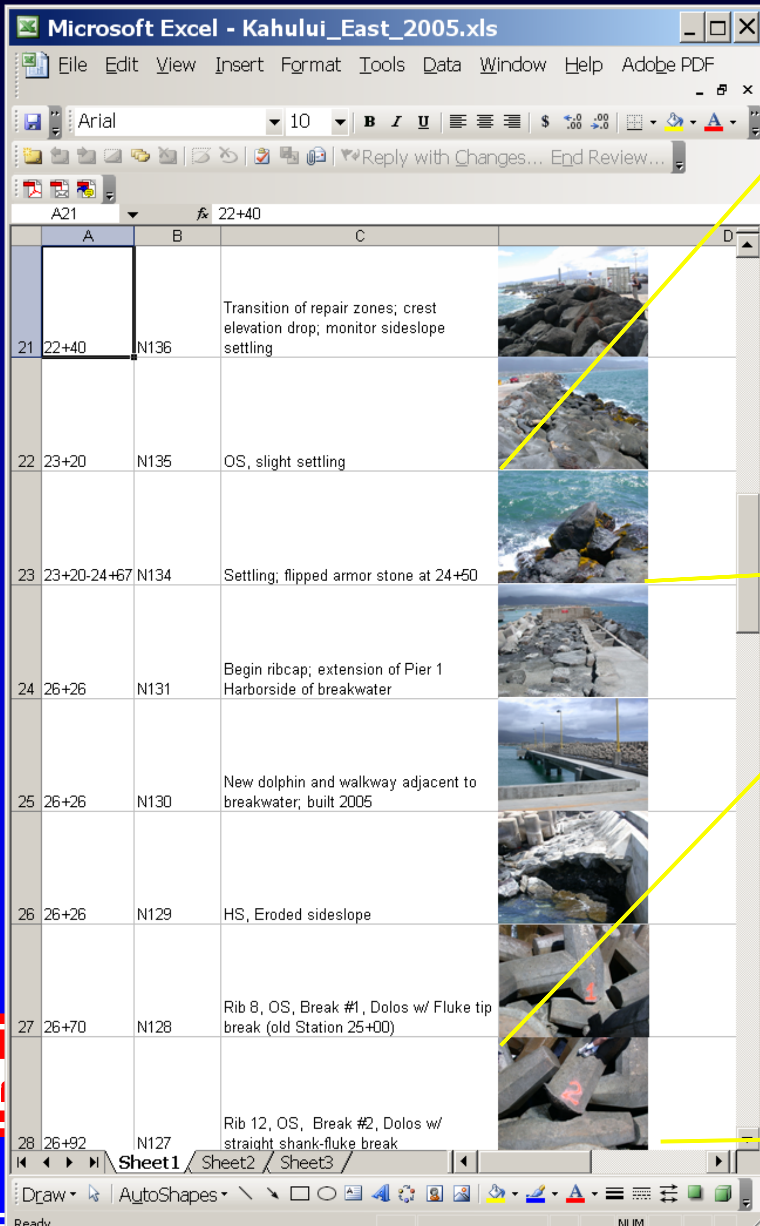
Place data into eCoastal GIS

Periodic Inspections





Improved Survey Records



	A	B	C
21	22+40	N136	Transition of repair zones; crest elevation drop; monitor sideslope settling
22	23+20	N135	OS, slight settling
23	23+20-24+67	N134	Settling; flipped armor stone at 24+50
24	26+26	N131	Begin ribcap; extension of Pier 1 Harborside of breakwater
25	26+26	N130	New dolphin and walkway adjacent to breakwater; built 2005
26	26+26	N129	HS, Eroded sideslope
27	26+70	N128	Rib 8, OS, Break #1, Dolos w/ Fluke tip break (old Station 25+00)
28	26+92	N127	Rib 12, OS, Break #2, Dolos w/ straight shank-fluke break

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eCoastal GIS for Coastal Structures

JALBTCX, Mobile District

1. Coastal functional performance data collected for 20 years by MCCP.
2. Data continues to be acquired both by MCNP and other Corps research programs at exceedingly rapid rate.
3. Data from these disparate efforts not stored in common database or format.
4. Common database and interface will facilitate long-term Corp-wide easy access to these data.

- Estimated over 50 % of Corps personnel will retire in next 10 years. Corporate knowledge should be preserved.

6. Data available for structure Condition Index and Asset Management.

Periodic Inspections FY07

1. Keweenaw Waterway west breakwater, MI
2. Burns Harbor breakwater, IN

   Previous monitoring 1985-1992

   Previous periodic inspections, 1995 and 1999

3. Cleveland Harbor east breakwater, OH

   Previous monitoring, 1980-1985

   Previous periodic inspection, 1995

Kaumalapau Harbor Breakwater

Island of Lanai, Hawaii

Product Delivery Team

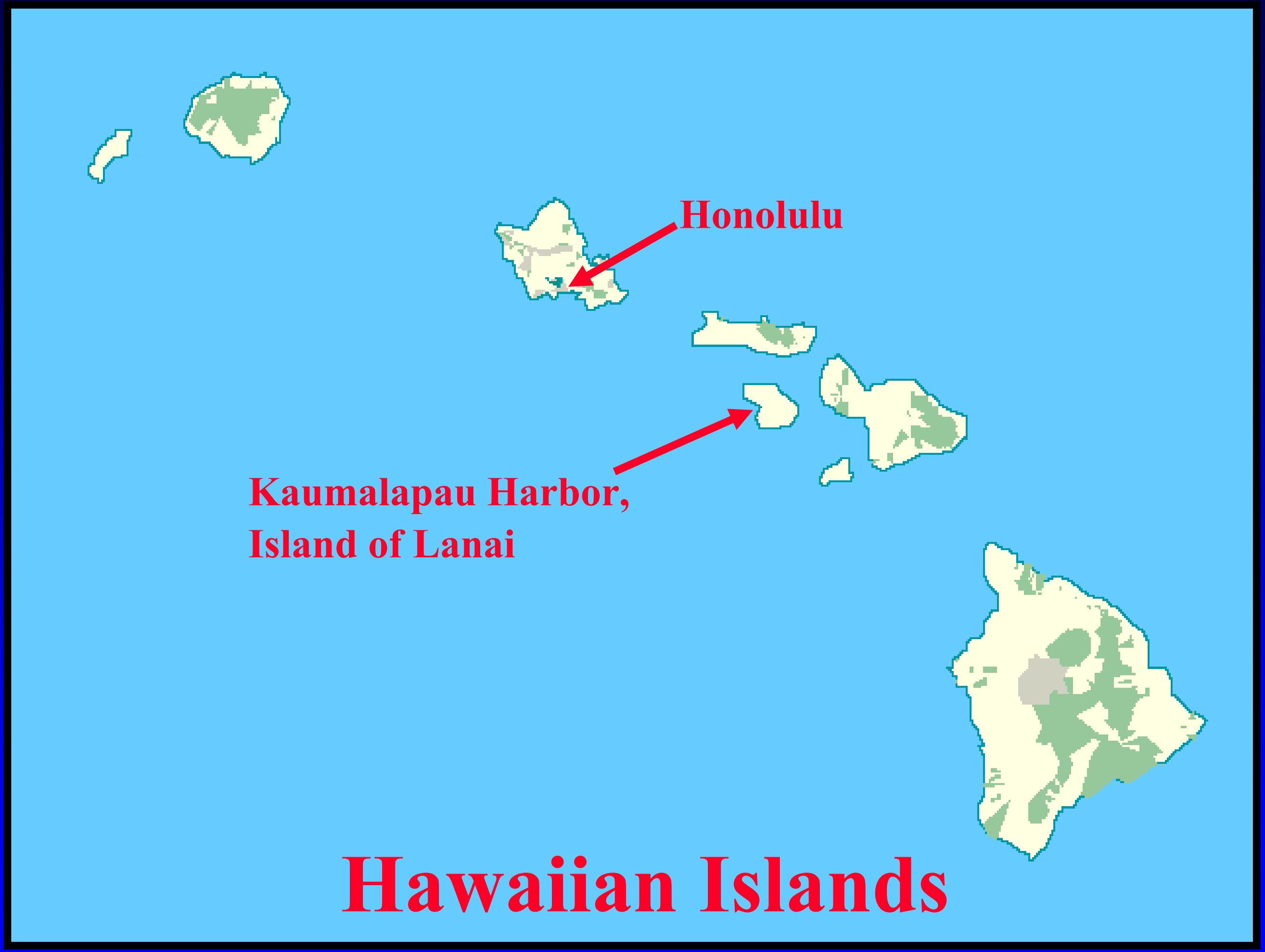
Steve Hughes (PI) and Jeff Melby, CHL, ERDC; Ed O'Neil, GSL, ERDC;
Hawaii District Team Members: Tom Smith and Jessica Hays

Problem

Harbor constructed in 1922; Only deepwater port on the island; Services hotel, tourist, and farming industry, and import of food and commercial goods; Breakwater has severely deteriorated over the years.

Non-availability of large quarry stone; Necessary to use manufactured armor units (water depths 70 ft; wave heights 30 ft); 35-ton CORE-Loc armor units (largest ever manufactured) being installed (790 units); Placed over existing broken dolos armor units; Significantly important to understand design, stability, construction, and performance of these CORE-Loc units.

Location Map, Kaumalapau Harbor, HI



Kaumalapau Harbor Breakwater

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Kaumalapau Harbor Offloading Area

Old Shape 35-Ton CORE-Loc, Azores

35-Ton CORE-Loc for Rehabilitating Kaumalapau Harbor Breakwater

790 CORE-Loc units were cast

35-Ton CORE-Loc in Casting Yard

35-Ton CORE-Loc in Storage Area

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35-Ton CORE-Loc Test Unit

35-Ton CORE-Loc Test Unit Core

Contractor’s Model of Kaumalapau Harbor Breakwater

Kaumalapau Harbor Breakwater

Kaumalapau Harbor Breakwater

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Kaumalapau Harbor Breakwater

Study Approach

Breakwater repair provides unique opportunity to monitor project that incorporates largest CORE-Loc armor units ever utilized by USACE.

Objectives include detailed documentation and assessment of breakwater repair activities (underlayer preparation, armor unit fabrication, placement, etc.) for base-line data, and subsequent monitoring and evaluation of project performance.

Monitoring and quality control of underlayer shaping essential to overall success of the CORE-Loc placement.

Specific CORE-Loc units being marked, photographed, and location surveyed by GPS. Weathering and weak zone within units being tracked. Program will leverage resources with District's Project Inspection Program. Sub-aerial precision armor unit monitoring being conducted annually, and following significant storm events.

Construction Delays

1. Contractor fabricated 10 forms based on previous Azores configuration.
2. Storm damage in Azores resulted in a few cracks in some CORE-Locs.
3. CORE-Loc redesign was recommended.
4. New CORE-Loc test forms were fabricated.
5. Difficulty with concrete mix design not meeting both temperature and temperature differential specifications.
6. Prototype units formed in 2006 instead of 2005.

Monitoring Program

1. In-Situ Wave Measurements
2. Wave Hindcast and Transformation
3. Breakwater Settlement Measurements
4. Armor Unit Movement Measurements
5. Toe Stability Monitoring
6. CORE-Loc Concrete Strength
7. Breakwater Inspections
8. eCoastal GIS for Coastal Structures Condition Index
9. Reporting

Great Lakes Breakwater Armor, Stone Testing Protocols

Product Delivery Team

Danny Harrelson (PI), GSL, ERDC

District Team Members: Joe Kissane, LRC; Michael Allis, LRE; Mike Mohr, LRB

Ron Erickson, Consultant (formerly LRE District Geologist)

Problem

Specifications for armor stone for breakwaters and jetties include objective criteria from laboratory tests, and subjective criteria based on quarries and stockpiles. Issues relate to stone durability. Variability of quality between and within quarries exceedingly problematic.

ASTM tests presently used were designed for small concrete aggregate and stone many orders of magnitude smaller than stone on breakwaters. These small-scale tests are not appropriate for stone weighing tens of tons.

Present Lab Test Criteria

• Specific Gravity	ASTM C 127
• Absorption	ASTM C 127
• Los Angeles Abrasion	ASTM C 535
• Freeze/Thaw	ASTM D 5312
• Wetting/Drying	ASTM D 5313
• Petrographic Examination	ASTM C 295
• Field Examination	ASTM D 4992

Keweenaw Waterway, MI

West Jetty

East Jetty

Burns Harbor, IN

Cut Limestone

Blasted Dolomite

Cleveland Harbor, OH

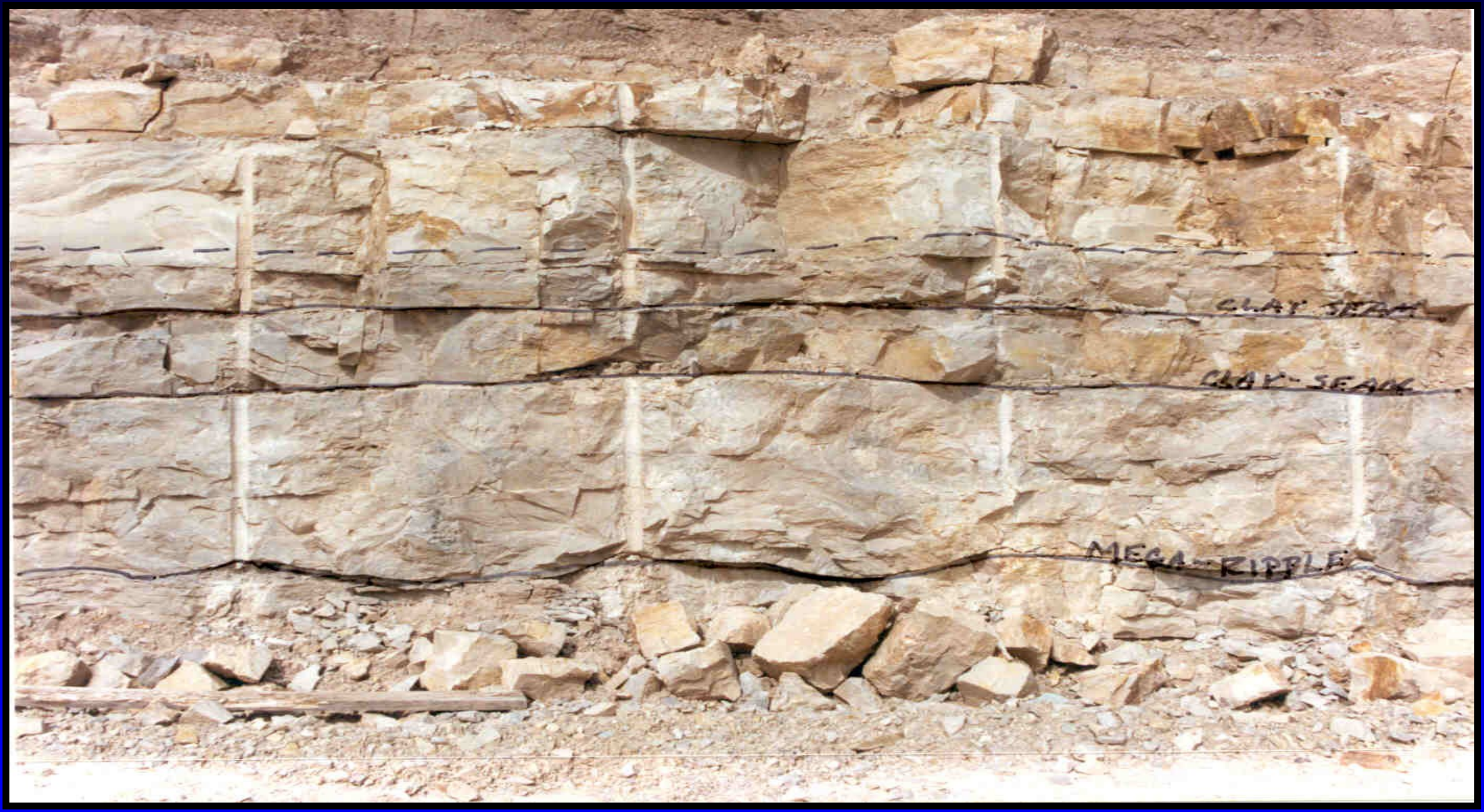
Cut Sandstone

Blasted Limestone

Wire-Saw Cut Quarry Operation

Reed Quarry, Bloomington, IN

Drilled and Blasted Quarry Operation
Valders Quarry, Valders, WI



High-Energy Blasted Dolomite
McCook Quarry, McCook, IL

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Study Approach

Objectives are to investigate and evaluate effects of scaling on lab test results using samples of various rock types used in Great Lakes coastal projects. Several different sizes of each different stone type from different quarries being cut to the same relative dimensions. Some samples being tested prior to any weathering exposure using existing protocols. Scaling effects being ascertained.

Various size samples being placed on prototype structures to experience weathering effects of wet/dry and freeze/thaw, and large wave attack. Results will be compared to lab tests.

Results will be used to develop guidance and new protocols for armor stone selection with respect to ranking of stone types, excavation methods, and geologic characteristics of material available in a region.

Test stone include dolomite, limestone, granite, sandstone, and quartzite.

Index Stones for Keweenaw Waterway

Corps LRD Work Barge Placing Index Stones, Keweenaw Waterway

Index Stone on Keweenaw Waterway Structure

FY07 Research Efforts

Prototype Stones to be Placed at Burns and Cleveland Harbor

1. Complete quarry supply arrangement for Index Stones, and place on structures.
2. 6-ton Index Stones representative of materials used in the projects (3 ft x 4 ft x 6 ft)
3. Samples obtained by means consistent with project histories (cut or blasted). Blasted stones cut to shape after blasting, to retain impacts of excavation method.
4. 3 scales (sizes) of stones per quarry being evaluated in lab: (a) Conventional test size (500 gm); (b) Larger-scale test size (5,000 gm; and (c) Largest-scale test size (50,000 gm).

FY07 Research Efforts

Laboratory Tests

1. 3 sizes of slab sawed laboratory samples per quarry.
2. 12 quarries x 3 sizes per quarry x 5 repetitions = 180 lab samples.
3. Laboratory test results will be correlated with field observations corresponding to that particular stone type.
4. Guidance documents should be up-dated for construction representatives and geotechnical engineers who prepare design specifications.
5. Enhanced ASTM test criteria protocols for armor stone will be deduced. Guidance documents will be prepared for armor stone use around the Great Lakes. Present documents are evolving, and need to be standardized. Update quarry ETL for mapping and geological observations.

Wall Armor System
John T. Myers Locks and Dam, Ohio River

Product Delivery Team

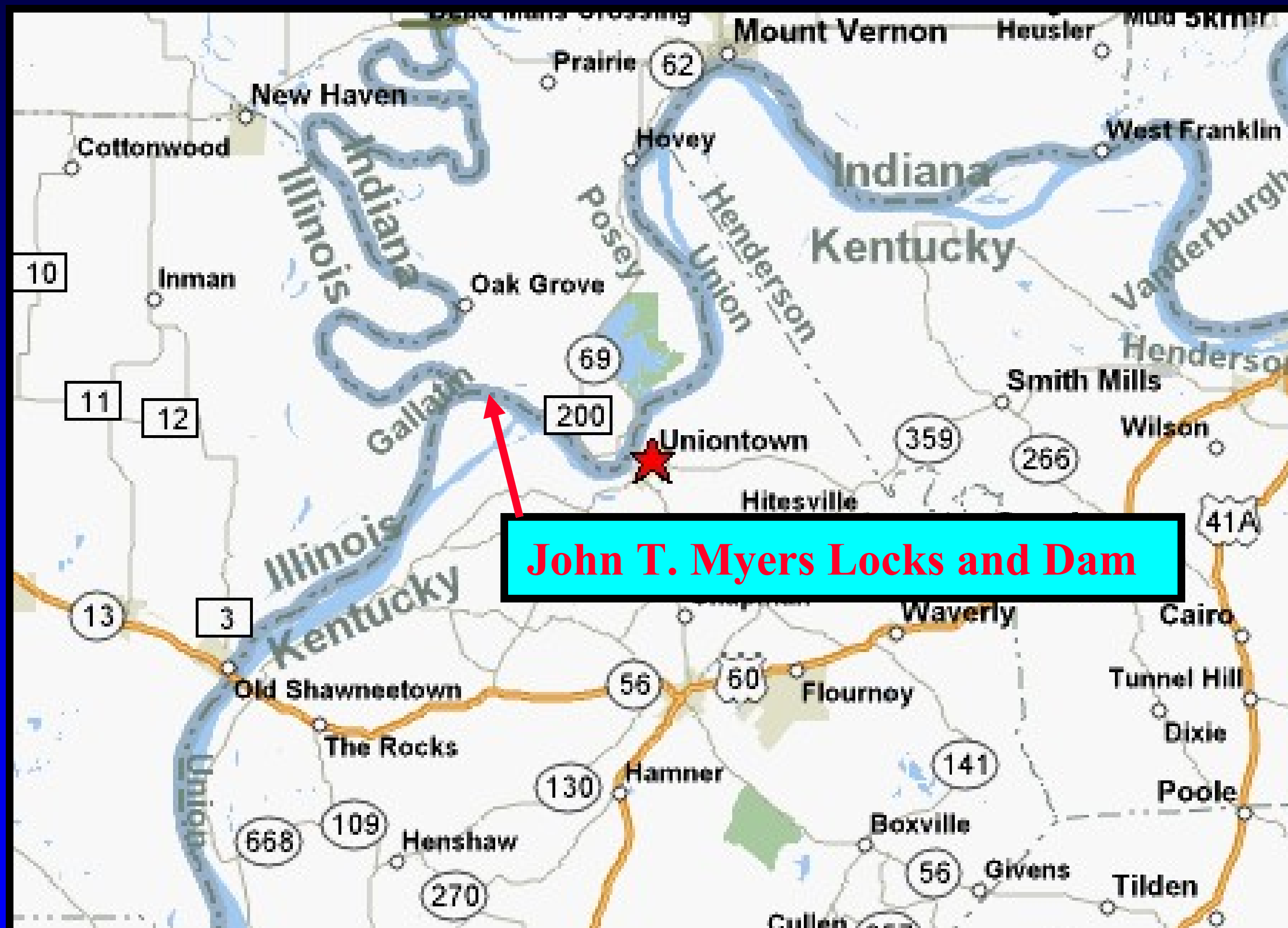
Stan Woodson (PI), GSL, ERDC
District Team Members: Rick Lewis, LRL; Jeff Stamper, MVS; Mike Tarpey, MVR

Problem

Lock wall armor systems experiencing large amount of damage due to large number of vessels passing through locks. Majority of damage includes gouges and spalls in concrete adjacent to armor strips. Many gouges are next to vertical joints. Several locations includes broken armor.

Majority of damage occurs in 1,200-ft lock, due to impact and abrasion by commercial barge traffic that typically use this lock. Broken wall armor is vulnerable to "catching" protruding metal on barges (a special concern for barges that have protection themselves). When armor is worn flat, it is no longer effecting in protecting the surrounding concrete.

Location Map, John T. Myers Locks and Dam



John T. Myers Locks and Dam, Ohio River

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Wall Armor System Deterioration

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Wall Armor System Deterioration

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Wall Armor System Deterioration

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Study Approach

Design parameters for lock were insufficient, resulting in extensive wear of lock walls. Design did not provide for wall armor protection at concrete joints, with considerable damage to concrete and armor. Performance prediction technology not fully utilized.

Ability of this lock to remain fully functional significant to insure continued efficient operation of system, a major artery for commercial navigation in the U.S. Innovative repair techniques being applied to not disrupt navigation traffic through locks and on Ohio River.

Continuous monitoring being undertaken to provide prediction indicators of rate and extent of projected deterioration of wall armor system. Will indicate time available for development of non-disruptive repair methodology at other locks.

Wall Armor System

1. Problem is extensive along Upper Mississippi locks, as well as Ohio River.
2. St. Louis and Rock Island Districts have provided exceedingly helpful discussion about Locks 18, 19, 20, 21, 22, 24 and 25, as well as at Lagrange on the Illinois River.
3. These lock wall designs have not previously provided for vertical concrete joint protection (design parameters were insufficient).
4. Extensive repairs are necessary at John T. Myers, as well as other locks.
5. Innovative repair techniques that will not disrupt navigation traffic are presently being researched.
6. Baseline conditions for John T. Myers have been established. Extensive survey and documentation of existing visual damages have been made.

Wall Armor Test Repair 2006

Wall Armor Test Repair 2006

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Wall Armor System FY07

1. Conduct thorough evaluation of Damage Survey Data for John T. Myers and Markland Locks.
2. Inspection of isolated damage zones at additional locks to document range and extent of wall armor damage.
3. Perform annual damage survey of John T. Myers to monitor changes from baseline conditions.
4. Assess use of state-of-the-art nondestructive test techniques to evaluate extent of concrete damage and concrete quality at damaged sections.
5. Apply innovative concrete repair techniques to selected damaged concrete sections for future monitoring.
6. Repairs must be performed with little or no effect on continued operation of the locks.

John Day Lock and Dam

Product Delivery Team

Donald Wilson (PI) and Thad Pratt, CHL, ERDC

Portland District Team Members: Kyle McCune and Sean Askelson

Problem

Addition of (a) Spillway Flow Deflectors, and (b) Spill Pattern Generators, and Changed Operations to improve fish passage through the tailrace environment and water quality, adversely impacted Dam's ability to safely meet navigation mission under certain river conditions.

System modifications being investigated to eliminate unsafe navigation situation existing here and at 7 other similar dams located on the Lower Columbia and Lower Snake Rivers.

Location Map, John Day Lock and Dam

John Day Lock and Dam, Columbia River

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Study Approach

1. Physical model predicts significant flow moving from the spillway toward the powerhouse, opposite in direction from that measured by limited 2003 ADCP survey.
2. Comprehensive data set under various flow conditions being acquired to understand impact of flow deflectors and spillway operations on trailrace environment adjacent to navigation lock.
3. Changed river bottom topography being acquired to determine impacts on currents.
4. Monitoring will establish impact of fish passage changes, and create a data set for improvements to both physical and numerical modeling.

John Day Lock and Dam

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John Day Lock and Dam

John Day Lock and Dam

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John Day Lock and Dam

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John Day Lock and Dam

1. 2-D ADCP side-looking meters installed (a) on face of powerhouse, (b) along the length of the skeleton bays, (c) near downstream end of guard wall, and (d) along north bank approximately 1,000 ft downstream of end of guard wall.

2. Positions monitor entrained flow from powerhouse tailrace into spillway, high velocity flow along end of guard wall, and velocities on barge tows along north bank where industry reports problems.

3. Video monitoring records navigation approach, and time-synchronizing all recording devices to determine when hazardous conditions occur.

4. Discharges determined by multiple transits over specific cross sections using 3-D ADCP probe mounted on survey boat.

5. Special operations of the dam arranged to examine how dam operation impacts conditions in the lower lock approach.

Montgomery PointLock and Dam

Product Delivery Team

Howard Park (PI) and Michael Winkler, CHL, ERDC
District Team Member Glen Raible, SWL

Problem

Declining water levels on the Mississippi River mean elevations less than that used for establishing lower sill elevations at Lock, resulting in navigation restrictions being imposed (reduced drafts, lengths, and widths; daylight navigation only; escort service). Dredges can not work fast enough to maintain navigation depths.

Monitoring Plan being developed to address critical concerns.