DEMOPOLIS LOCK
UPPER MITER SILL FAILURE

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U.S. ARMY

US Army Corps of Engineers®

DEMOPOLIS LOCK

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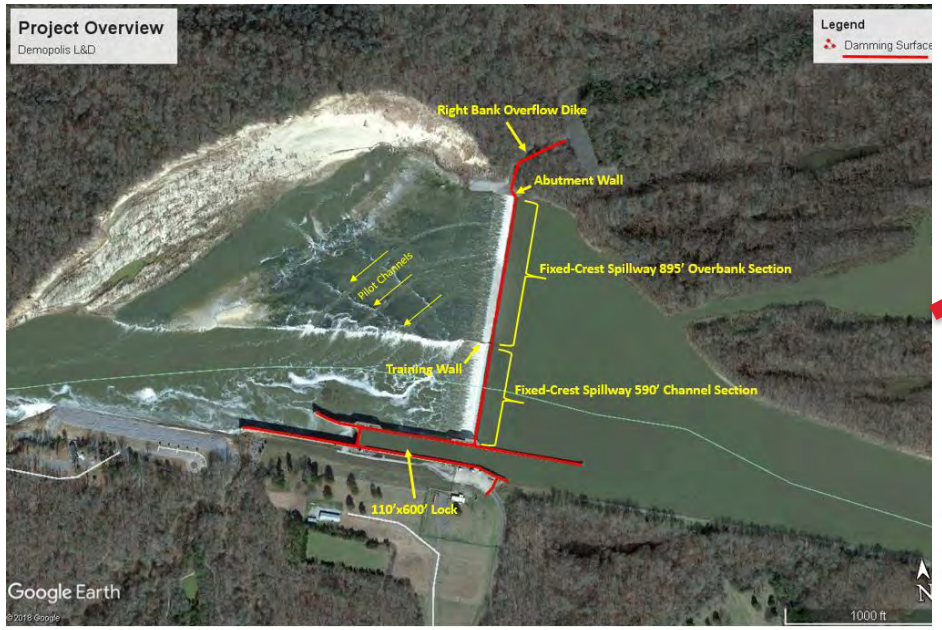
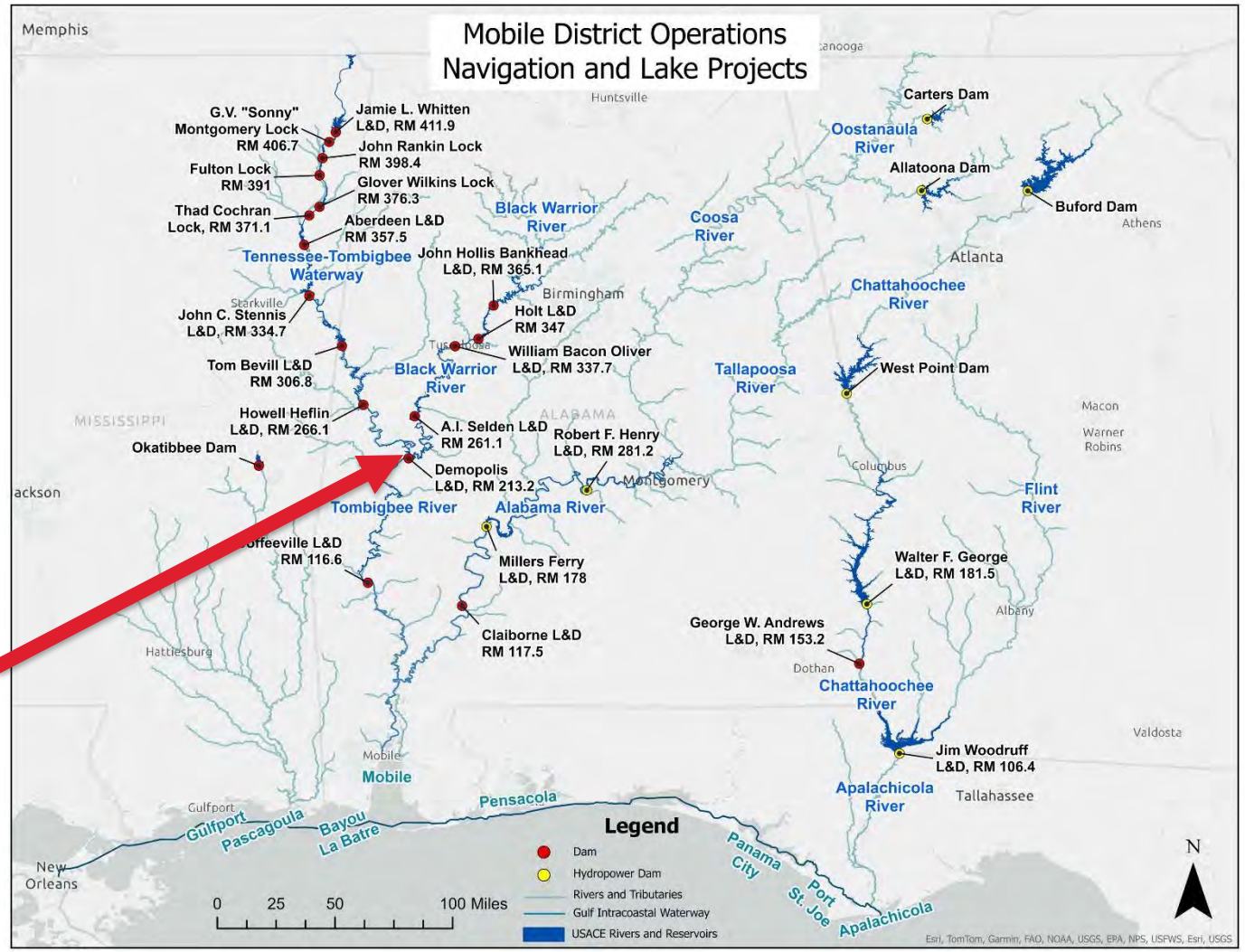
- Open to Navigation in 1954
- Busiest & Oldest Lock on the System

- Single Chamber: 110’ x 600’, 40’ lift
- Fixed Crest Spillway: 1450’ long

- 3-Year Averages
  - Tonnage: 10,542,054
  - Commercial Lockages: 1,855
  - Recreational Lockages: 446





FAILURE & EMERGENCY RESPONSE

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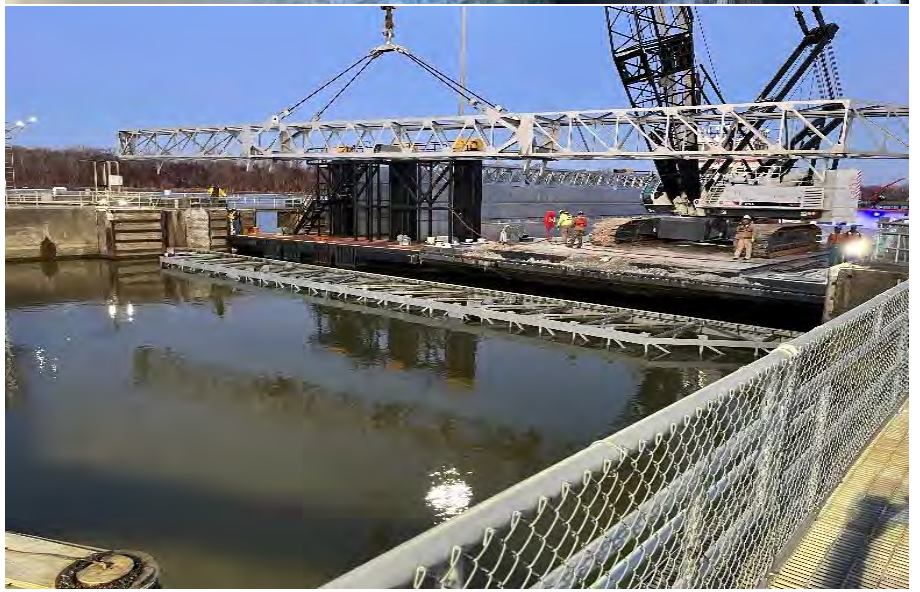
- January 16, 2024
  - Concrete sill under upper miter gate failed
  - Lower gate open and chamber at lower pool
- January 19
  - Lower miter gates closed under flow (assistance from Parker Towing)
- January 20
  - Placed stoplogs (assistance from TVA)

Breach Through Failed Sill



Placing Stoplogs

Lower Miter Gate Closure

REPAIR EFFORTS

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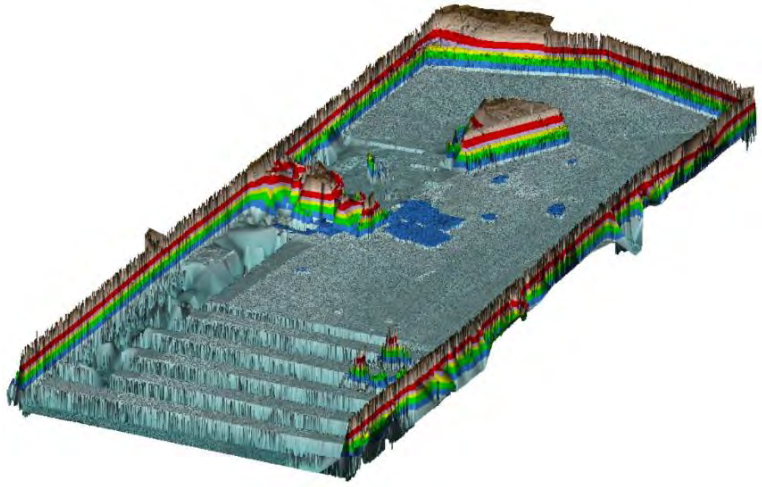
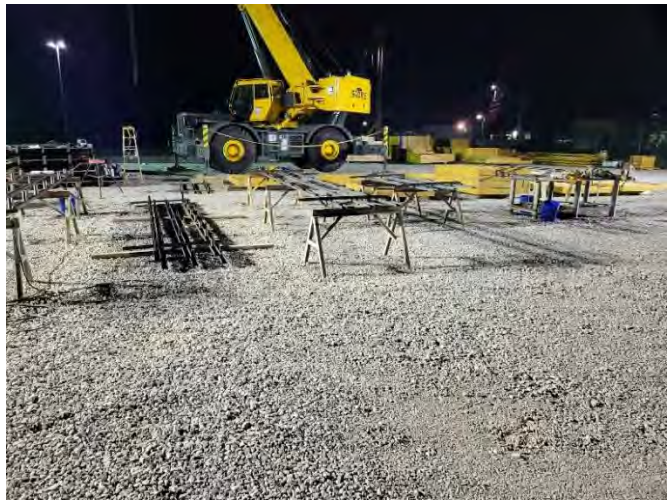
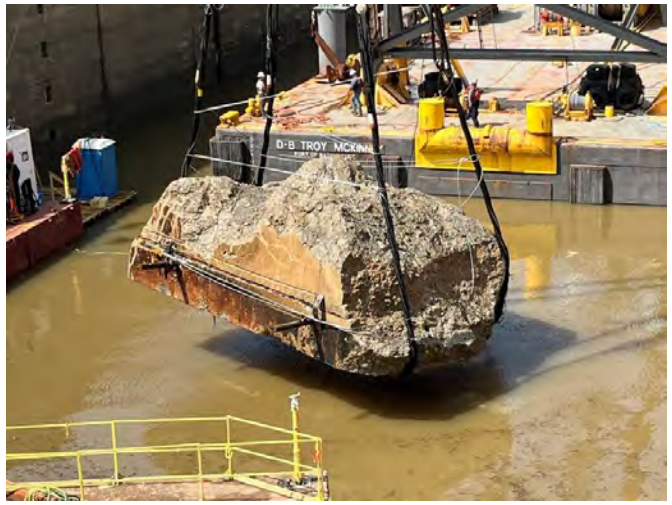
- District Crisis Response Team
  - Subject Matter Experts throughout USACE and Industry
- Debris Removal (assistance from McKinney Salvage)
  - Approximately 1,000 tons total
  - Largest piece - 400 tons
- Mass Concrete
  - Wet and dry placements
  - Innovative formwork designs
  - Rebar and reinforcement
  - Steel beam and seal plate



Survey of Damage



Initial Formwork Assembly



Debris Removal

Reinforcement & Embedded Steel

SCHEDULE

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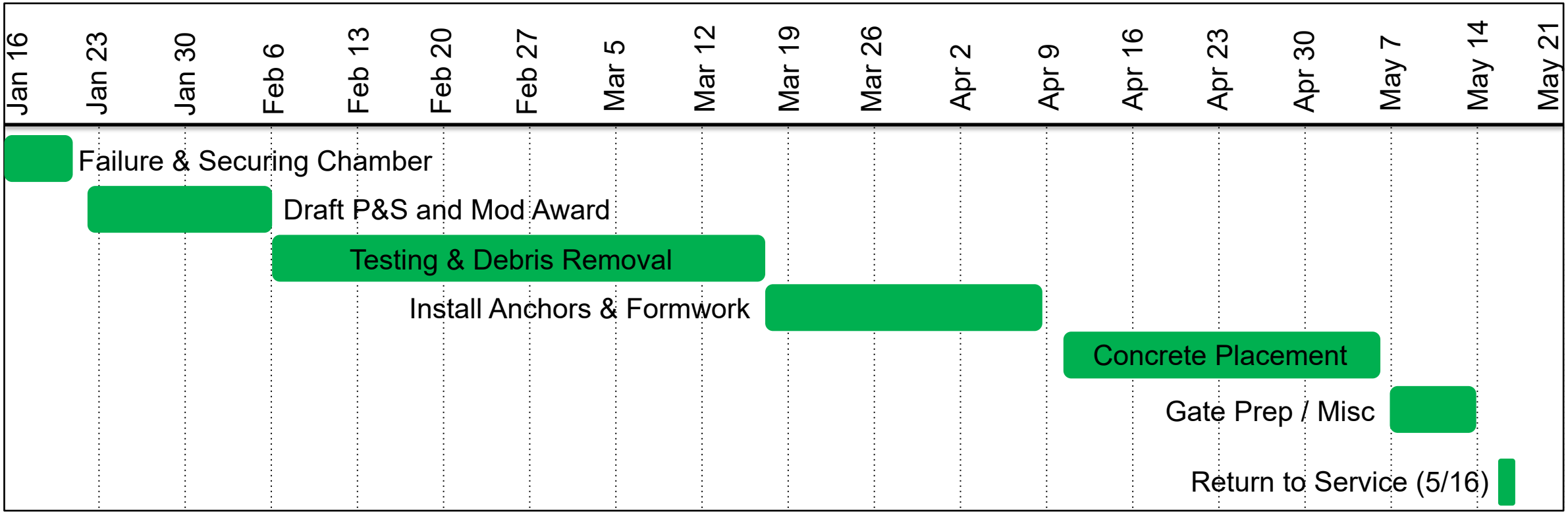
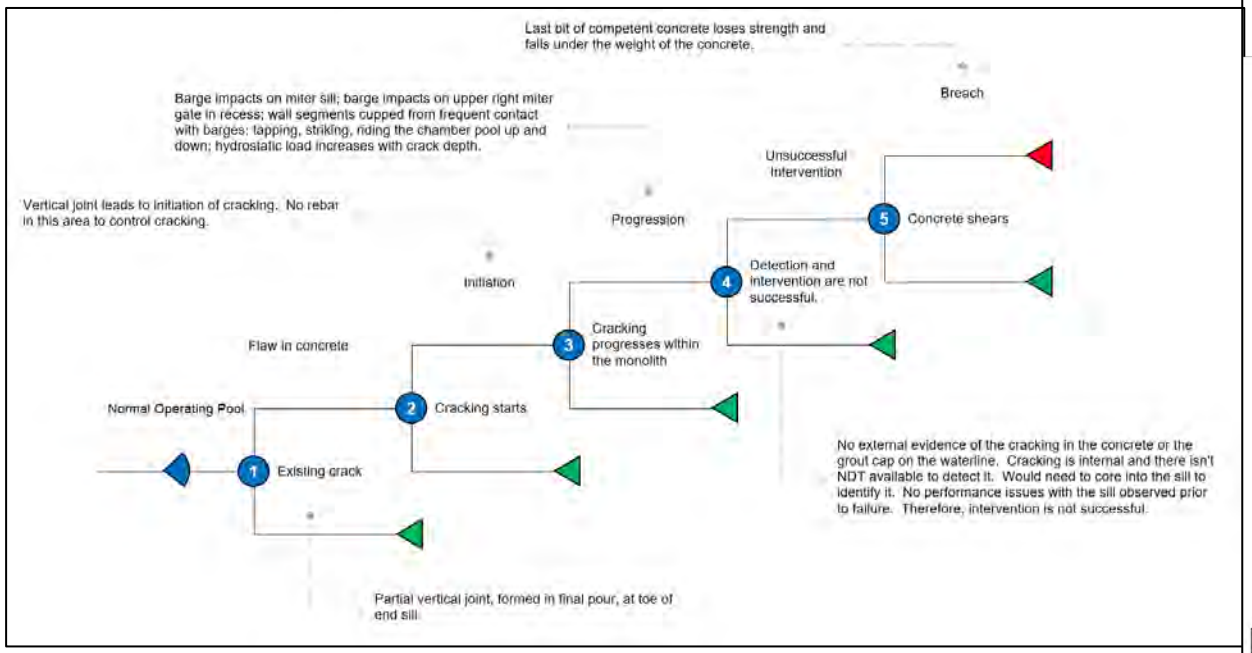
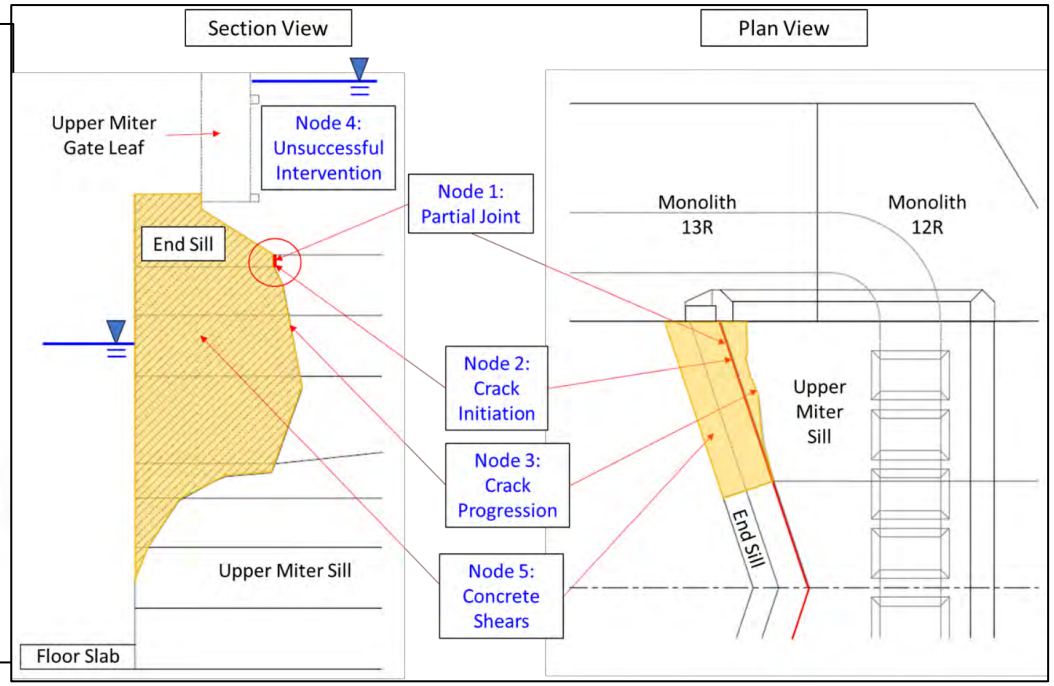


Lock was returned to service on 4-month anniversary of failure

INCIDENT TEAM

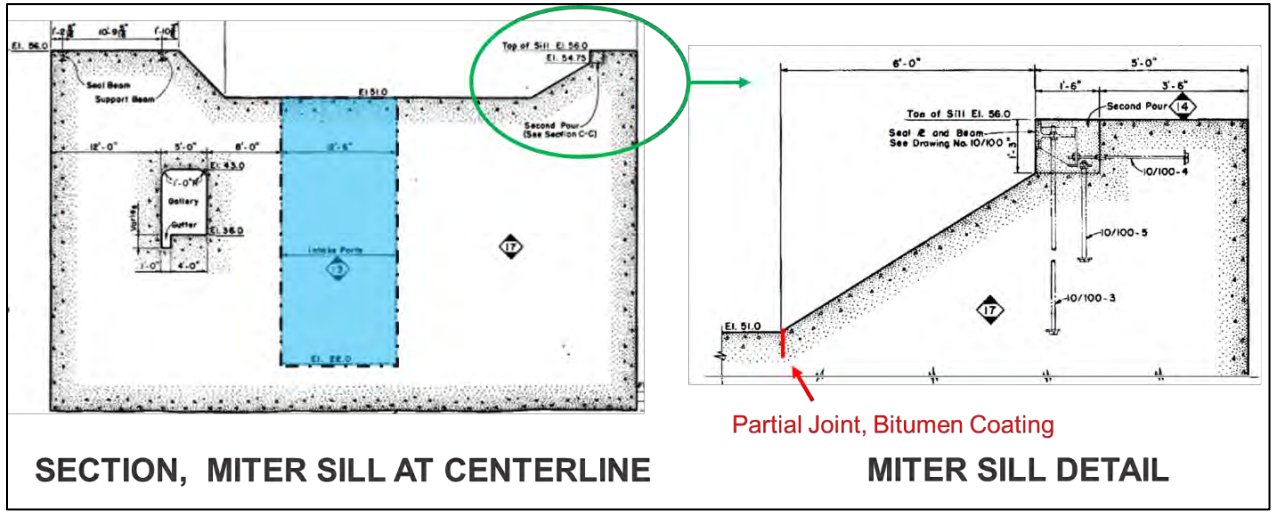
- PDT: SAM EN & OPs, ERDC, and LRP
- Reviewed background information (barge strikes, whirlpool from intake design, etc.)
- Brainstormed failure causes and discussed failure extensively
- Outlined potential failure mode and created event tree to explain and clarify breach





NODE 1 – PARTIAL VERTICAL JOINT

- No issues had been found with the concrete matrix or aggregate
- Partial vertical construction joint at toe located in a high stress area w/o reinforcement



NODE 2 – CRACK INITIATION

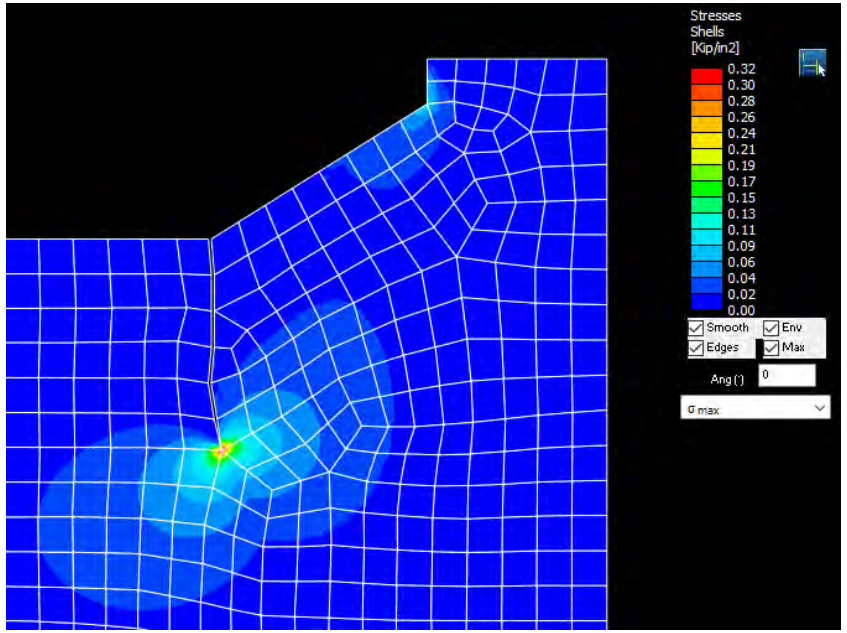
- Loads from the vertically framed upper miter gates during each lockage
- Barge Impacts
  - Top of sill when chamber lowered
  - Upper miter gate impacts
  - Adjacent monoliths transfer energy
- Temperature fluctuations
  - Expansion/contraction when chamber at lower pool

Monolith movement upstream of sill


Gate & Sill Strikes

NODE 3 – CRACK PROGRESSION

- Cracking starts at the partial vertical construction joint
- Continuous loading contribute to the propagation
- Tensile stress increased as the crack propagated
  - Eventually surpassed the capacity of the concrete



NODE 4 – UNSUCCESSFUL INTERVENTION

- No signs of cracking
- Crack location is submerged except during lock dewatering
  - No inspection had been emphasized during dewatering

NODE 5 – CONCRETE SHEARS

- Stress exceeded capacity, resulting in miter sill failure

VISUAL INSPECTION

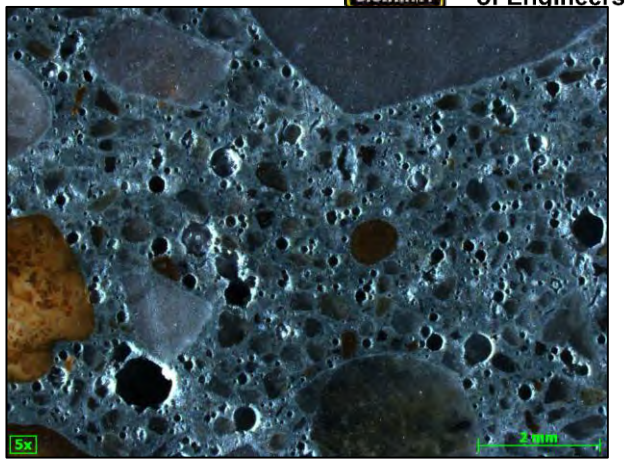
- Only gate damage was seal material
- Section of the concrete was a different color with a defined separation area
- The center monolith interface appeared to be very smooth, indicating that there was little adhesion between both the monoliths and the lock wall

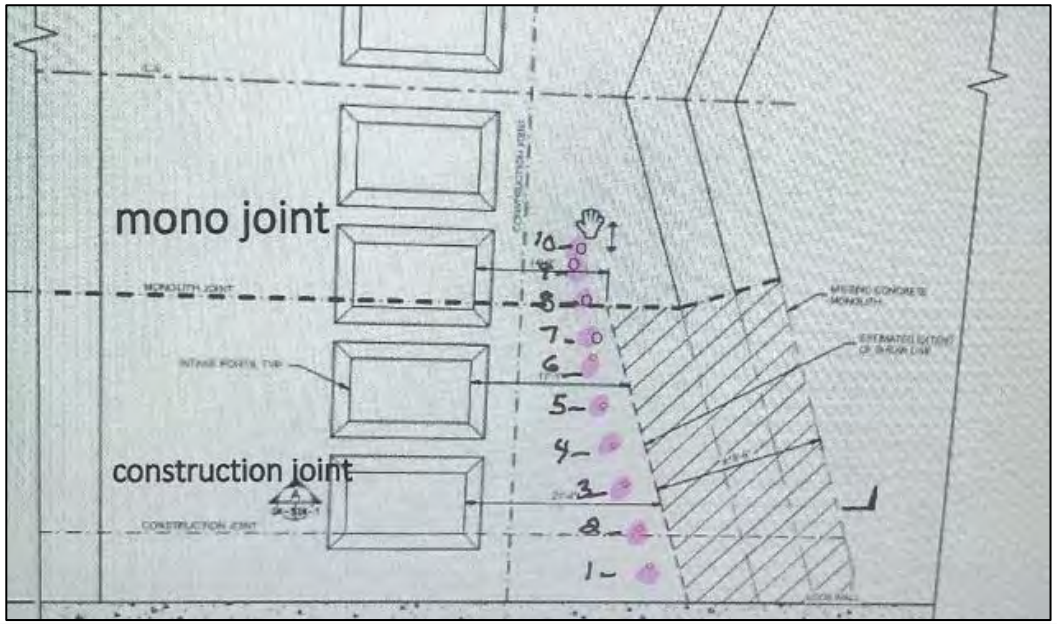
CONCRETE SAMPLING

- 10 core samples were obtained for testing
  - Tested by O&M contractor and ERDC
  - Tested per ASTM C39 and ASTM 42

- Removed debris pieces indicated uniform concrete throughout with no obvious signs of internal deterioration

- Lab testing showed no issues with the matrix or aggregate and no signs of alkali-aggregate reaction (AAR).



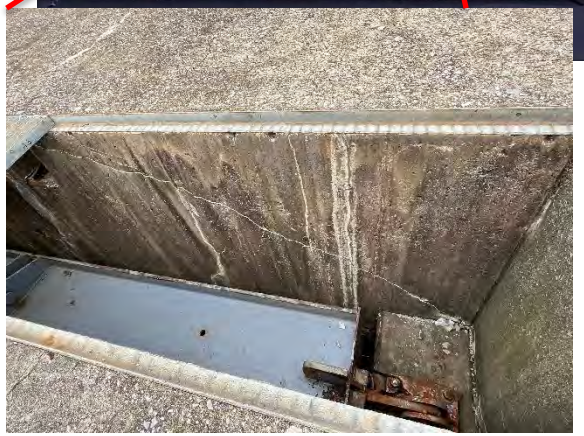


FUTURE RECOMMENDATIONS

- USACE needs to identify methods to explore mass concrete for the presence of deep structural cracks
- Evaluate other projects with vertically framed miter gates.
  - Selden Lock (BWT)
  - Jim Woodruff Lock (ACF)
- Keep lower gates in mitered position as much as possible
- During extreme temperatures, keep chamber at upper pool as much as possible.
- Install operational cameras to monitor vessel movements and clearances and improve communications

HOLT LOCK – MONOLITH 14R CRACKING

- BWT PMO notified MDO of changes in observed cracks in river wall Monolith 14R
  - Increased water flows through machinery room cracks
  - New cracks and spalling in bulkhead slot
  - Failure of gallery sump pumps



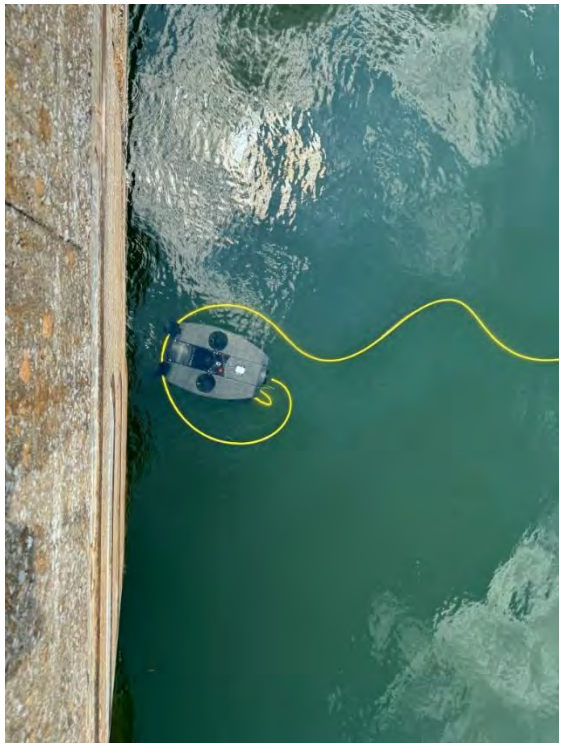
New Crack in Upstream Bulkhead Slot

Crack in Machinery Room Floor

HOLT LOCK – MONOLITH 14R CRACKING

- Emergency Response Team
  - Site visit to map and analyze cracking
    - Initial assessment – extends length of monolith 14R from culvert up to machinery room floor
  - Comprehensive instrumentation & monitoring program
  - Dye Test to further determine crack locations
- Stability analysis – Safety Factor < 1
- Lock closed to navigation on 22 June 2024
- ROV inspection w/ ERDC 3 July 2024

Instrumentation at Monolith Joint



ROV in Chamber

Dye Observed from Leaks in Lift Lines Along 14R

THANK YOU

QUESTIONS?

NAVIGATION IMPACT & SYSTEM INVESTIGATIONS

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- Navigation redirected: GIWW > MS River > TN River
  - Additional ~ 1200 miles
- No indications of severe cracking/issues
  - Dam Safety Inspections, 5-year intervals
  - OCA's, 5-year intervals, "Good" rating
- Aging Infrastructure
  - Demopolis (70),Selden (67), Coffeeville (64)
- No auxiliary chambers at any project
  - Failure can shut down entire system
- Similar Projects
  - Selden – no reinforcement in sill, different intake structure
  - Jim Woodruff – reinforcement in sill, similar intake structure

Key	Lock Name
1	John Hollis Bankhead
2	Holt
3	William Bacon Oliver Lock & Dam
4	Armisted I. Seldon
5	Demopolis Lock & Dam
6	Howell Heflin Lock & Dam
7	Tom Bevill Lock & Dam
8	John C. Stennis Lock & Dam
9	Aberdeen Lock & Dam
10	Thad Cochran Lock
11	Glover Wilkins Lock
12	Fulton Lock
13	John Rankin Lock
14	G.V. "Sonny" Montgomery Lock
15	Jamie Whitten Lock & Dam
16	Pickwick Landing Lock
17	Kentucky Lock
18	Olmsted Locks & Dam
19	Inner Harbor Nav Canal
20	Coffeeville Lock

MITER SILL DESIGN

- Poured in monoliths consisting of 5ft lifts
- Bearing sill consisted of a steel beam with embedded vertical and horizontal anchors
- Vertical construction joint at the base of the slope at the end sill
- No reinforcement
- Designed to support the water load transmitted by the bottom girder of the vertically framed miter gates.