AGENDA

• Project Background
• Geotechnical Design Approach
• Failure Mechanisms
• 2019 Flood
• Borrow Areas
• Construction Video
BACKGROUND

PROJECT PURPOSE
- Correct Hydraulic Deficiency
- Provide project that can be FEMA recertified

HISTORY
- Originally built in 1968
- Overtopped in 1993
- FEMA Decertified in 1999
- NWD deemed hydraulically inadequate
- 1999 Feasibility
- 2016 Prelim. Redesign
- 2016 Start Construction
- 2017 Full Federal portion of Funding obtained
LOCATION MAP & CONSTRUCTION

1. Gatewell Complete 2017
2. Gatewell Complete 2018
3. Levee Raise Complete 2020
4. Levee Raise S-36 In Construction Complete ~2022
5. Levee Raise N-36 Construction Start 2022
6. RR Closure Gap Construction Start 2022
**LEVEE RAISE CROSS-SECTION**

- **Side of levee** - Landside
- **Material proposed** – Impervious and Random borrow
- **Top of Levee Raise** – 831.6’ to 817.3’
  - South: .5’ to 3’ (2.5’ average)  
  - North: 0.5’ to 2.5’ (1’ average)
- **Levee Raise distance** – 12.3 miles (65,300 feet)
  - (North: 7+00 – 404+00, 405+00- 416+00,  
    South: 416+00- 629+00, 696+00-728+00)
THROUGH LEVEE SEEPAGE

• Impervious fill material selected for riverside to reduce rate of water entering levee

• Random fill material selected for landside to allow the use of larger variety of material.

• Random fill material in berm can be beneficial to the stability of the levee slope.

(diverts water that would exit on the slope to the toe)
IMPERVIOUS FILL

• Really should be called “much less” pervious fill

• Composed of Clay (low plasticity), or Silt or combination of the two

• Rate of water flow through the material is several orders of magnitude less “Pervious material”, which is typically Sand

• Used to limit how much seepage enters levee
RANDOM FILL

• Will allow water to flow through it more rapidly than Impervious

• It is anticipated that it will be sandy material but can also be clay and silt

• Its placement allows a lot more types of material to be placed and its tendency to move water more rapidly can actually be more beneficial
Design Measures to Prevent Underseepage type Failures

• Option 1. Place Soil (berm) at toe of levee to add weight to soil on landside

• Option 2. Install relief well near landside toe to reduce water pressure.

We have used each of these options where appropriate
Raising Levee – Impact on Seepage Failure Mechanisms

- Raising Levee underseepage pressures on landside of levee can lead to piping failure if not adequately addressed during design.

Sandbag ring around a sandboil
SEEPAGE BERM SECTION

Composed of: RANDOM FILL

UNDERSEEPAGE BERM

NOTE:
1. Contractor shall strip the top 6" of the existing terrace, and stockpile prior to placement of new material. Strip top 6" of the existing levee crest and dispose of opposite.
RESULTS FROM 2019 FLOOD

- Sandboil
- Underseepage
- Berm
- Levee Raise

MO River
RESULTS FROM 2019 FLOOD
## SEEPAGE BERM PARAMETERS

<table>
<thead>
<tr>
<th>Station</th>
<th>Berm Width (ft)</th>
<th>Proposed TOL Elev (ft)</th>
<th>Pre-Raise TOL Elev (ft)</th>
<th>Landslide Ground Elev (ft)</th>
<th>( l_2 )</th>
<th>( l_2 ) addition</th>
<th>Proposed Elev</th>
<th>Min. Tie in Elev (ft)</th>
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<th>Berm Crown Elev. (ft)</th>
<th>Berm Slope (1/S)</th>
<th>Berm toe Slope (1/S)</th>
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**Summary**

- 13.14 miles of berms (69,400 feet)
- 50’ to 400’ in width
- Avg. Width = 220 feet
- 3’ – 5’ thickness
TYPICAL SEEPAGE BERM

Plan View (example): Station 156+00 to 162+00
RELIEF WELLS TO CONTROL UNDERSEEPAGE

• Browning lake and Drainage at station 325+00 necessitated Relief Wells rather than seepage berm

• Needed Relief Wells from Station 292+00 to 325+00

• 27 relief wells

• Spacing 90 to 100-feet

• Will Extend to Bedrock ~90-feet

• Flows to discharge to Browning lake or adjacent ditch
RELIEF WELL - PROPOSED LOCATIONS

BROWNING LAKE

MISSOURI RIVER

RELIEF WELLS
STABILITY – MODE OF FAILURE WE DESIGN TO PREVENT
Stability Berms are designed to add weight and prevent stability failure.
Grout Pipes
712+49, 715+47, 721+47

Reinforce Gatewell
6.5’x4.5’
610+00

Reinforce Gatewell
6’x4’
558+96

Reinforce Gatewell
7.5’x5.4’
498+01

Gatewell Currently Replacement
325+01
BORROW SOUTH OF 36

Borrow Area
BORROW NORTH OF 36

- West Borrow Area
- North Borrow Area
- East Borrow Area
CONSTRUCTION VIDEO FROM MCON

https://www.facebook.com/mconunderground/videos/1735419773329687/