Briefing to Missouri Flood Recovery Advisory Working Group

20 September 2019
CORPS- “PICK” PLAN
1944 HOUSE DOCUMENT 475

Levees from Sioux City, Iowa to St. Louis, MO
18 Tributary Dams - 11 already authorized
5 New Major Dams on the Missouri River Main Stem
Multi-purpose- emphasis was Flood Control and Navigation support
BUREAU OF RECLAMATION- “SLOAN” PLAN

1944 SENATE DOCUMENT 191

• Approximately 85 new tributary dams

  ▪ 3 New Major Dams on the Missouri River Main Stem

• 5.3 million acres of new irrigated land

• Multipurpose – Emphasis was Irrigation and Water Conservation
MOTIVATION FOR COMPROMISE

Missouri Valley Authority (MVA)
– Comprehensive basin-wide program
– Similar to Tennessee Valley Authority (TVA)
– “New Deal” concept, endorsed by President Roosevelt
– Threatened vested interests of the Bureau and the Corps
Potential source of jobs for returning soldiers
Climate right for full Federal investment in water resource development
COMBINED PICK-SLOAN PLAN

Pick Plan HD 475

Coordinated Plans SD 247

Sloan Plan SD 191

Flood Control Act of 1944, Section 9 “Missouri River Basin Development Program”
General Lewis A. Pick and W. Glenn Sloan
PICK-SLOAN PLAN – BASIC FEATURES

U.S. Army Corps of Engineers
– Flood Control and Navigation
U.S. Bureau of Reclamation
– Irrigation
Both Agencies
– Hydroelectric power production
– Reclamation marketed hydropower
– Transferred to Western Area Power Administration (DOE) in 1977
FLOOD CONTROL ACT OF 1944

Section 4 - authorized recreation development in reservoir areas
Section 5 - authorized hydropower distribution from reservoir projects
Section 6 - authorized surplus water contracts
Section 7 - authorized Secretary of Army to regulate flood control storage at reservoir projects
Section 8 - authorized irrigation works at reservoir projects
Section 9 - Missouri River Basin Development Program—Renamed Pick-Sloan Program in 1971
Constructed Irrigation Units
Power Plants
PUBLIC LAW 84-99

Section 5 of the Flood Control Act of 1941
Authority – 33 USC 701(n) (Law)
Code of Federal Regulations – 33 CFR 203 (Regulation)
Engineering Regulation – ER500-1-1 (Policy)
Engineering Pamphlet – EP500-1-1 (Procedure)

Appropriation – Flood Control and Coastal Emergency (FCCE)

Provides the Corps of Engineers with the authority to prepare for, respond to, and recover from floods and coastal emergencies.
LEVEES: FEDERAL VS NON-FEDERAL
ICW program includes 65 federal levee segments (60 systems) and 8 flood damage reduction channel projects without levees.
2019 Missouri River Flood Event - Request for Assistance

45 Levees have Overtopped and Beachsed in the Kansas City District, while No Levees are currently Overtopping.

106 RFRs (Request for Assistance) have been received.

Note: This map does not show all active levee problems, which are all listed in the USACE PL #19 Continuing Eligibility and Inspection Report.

Map Current as of 20 August 2019.
QUESTIONS FROM PREVIOUS MTG

- People need more information about levee dispute resolution.
- What would it take to convert PL 84-99 to Fed levees?
- Is flood protection fair? Are there differences between the design and engineering of urban and rural levee systems?
- What would it take to convert PL 84-99 to Fed levees?
- Can we change the design of levees to avoid total failure?
- Can we look at Nebraska and Iowa and compare the federal levee system in Missouri?
- Is there a relationship between in-river structures (dike notching) and the location of levee breaches?
QUESTIONS
MISSOURI RIVER BASIN AND TRIBUTARIES WATER MANAGEMENT

ERIC SHUMATE
CHIEF, HYDROLOGIC ENGINEERING
KANSAS CITY DISTRICT

20 SEP 2019
Combined Flood Control Storage of:
Fort Peck, Garrison, Oahe, Big Bend, Ft. Randall
5 Gallon Bucket = 16.2 MAF

Flood Control Storage of Gavins Point:
2/3 Cup Measuring Cup = 0.13 MAF
KANSAS CITY DISTRICT RESERVOIRS
PERCENT OF FLOOD CONTROL POOL OCCUPIED – 30 MAY 2019
MISSOURI RIVER MAINSTEM RESERVOIR SYSTEM

Bank Stabilization and Navigation Project
Sioux City, IA – St. Louis, MO

Jefferson City, MO

Congressionally Authorized Project Purposes
- Flood Control
- Navigation
- Hydropower
- Irrigation
- Recreation
- Water Supply
- Water Quality
- Fish and Wildlife
MISSOURI RIVER MAINSTEM RESERVOIR SYSTEM
MASTER WATER CONTROL MANUAL

- First published in 1960
- Updated in 1975 and 1979
- Master Manual was revised in March 2004 for:
  - Drought Conservation Measures
  - Unbalancing the Upper Three Reservoirs
  - Non-navigation Flows
  - Adaptive Management
- Revised again in March 2006 for Gavins Point Spring Pulse
- Revised in 2018 (MRRP MP EIS), Removed:
  - Unbalancing the Upper Three Reservoirs
  - Spring Pulse Criteria
Eight Authorized Purposes

- Flood Control – Requires Empty Space
- Navigation
- Hydropower
- Water Supply
- Water Quality Control
- Recreation
- Irrigation
- Fish and Wildlife (including T&E*)

Purpose = Priority

Runoff Driven System – The runoff drives system releases, and is managed on an annual basis. We do not carryover water in the flood control zones

Basically operate for flood control or meeting downstream targets (nav)

* - As Hydrologic Conditions Allow
SYSTEM OPERATION TERMINOLOGY

- **System Water Supply forecast**

- **System Storage Check**
  - March 15 – First ½ Navigation Support Service Level
  - July 1 - Second ½ Navigation Support Service Level + Length
  - September 1 – Set winter release rate
  - Evaluated more frequently during flood control actions or above normal water supply

- **Service Level**
  - Full Service – 35,000 cfs
  - Target – Kansas City = Service Level + 6,000 cfs
  - Service Level ≠ Gavins Point Release

- **Full Navigation Flow Support Season**
  - April 1 – December 1 at the mouth
MISSOURI RIVER BASIN – RUNOFF ABOVE SIOUX CITY, IA

Average Annual Runoff ~ 25.3 million acre-feet
Feb Forecasted 2019 Runoff ~ 25.6 million acre-feet

Plains Snowpack + Rainfall
March & April
~ 25% annual runoff

Mountain Snowpack + Rainfall
May – July
~ 50% annual runoff

Rainfall
August – February
~ 25% annual runoff
~ 50% annual runoff
CURRENT SYSTEM STORAGE ZONES AND ALLOCATIONS

Storage Volumes in MAF as of 2013

- Historic max (2011) - 72.8 MAF
- Historic min (2007) - 33.9 MAF
- Permanent Pool: 24%
- Carryover Multiple Use: 53%
- Annual Flood Control & Multiple Use: 16%
- Exclusive Flood Control: 7%

High Runoff Year
Average Yr.
Drought Year
ANNUAL RUNOFF ABOVE SIOUX CITY, IA

Historic Drought Periods

2019 – 58.8 MAF
KANSAS CITY DISTRICT WATER MANAGEMENT

- 18 USACE Reservoirs
- 11 Bureau of Reclamation Reservoirs (not shown)
KANSAS CITY DISTRICT RESERVOIR STORAGE

Our reservoirs have 11.0 MAF of flood control storage spread across 18 lakes in Kansas, Iowa, Missouri, & Nebraska.

On June 2, 2019, 9.0 MAF of the 11.0 MAF of flood control storage, or 82% was occupied.

All of our reservoirs have an authorized purpose for flood control.

MAF = million acre feet

CREATED 18 SEPTEMBER 2019
MAINSTEM PROJECTS - STORAGE

<table>
<thead>
<tr>
<th></th>
<th>Fort Peck</th>
<th>Garrison</th>
<th>Oahe</th>
<th>Big Bend</th>
<th>Fort Randall</th>
<th>Gavins Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exclusive Flood</td>
<td>0.971</td>
<td>1.495</td>
<td>1.107</td>
<td>0.061</td>
<td>0.986</td>
<td>0.054</td>
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<tr>
<td>Annual Flood</td>
<td>2.704</td>
<td>4.211</td>
<td>3.208</td>
<td>0.118</td>
<td>1.306</td>
<td>0.079</td>
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<tr>
<td>Carryover</td>
<td>10.7</td>
<td>12.951</td>
<td>13.353</td>
<td>0.061</td>
<td>0.986</td>
<td>1.532</td>
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<tr>
<td>Permanent</td>
<td>4.088</td>
<td>4.794</td>
<td>5.315</td>
<td>1.631</td>
<td>1.469</td>
<td>0.295</td>
</tr>
<tr>
<td>Gross Storage in MAF</td>
<td>18.463</td>
<td>23.451</td>
<td>22.983</td>
<td>1.81</td>
<td>5.293</td>
<td>0.428</td>
</tr>
<tr>
<td>72.4 MAF System Storage</td>
<td>25%</td>
<td>32%</td>
<td>31%</td>
<td>3%</td>
<td>8%</td>
<td>1%</td>
</tr>
<tr>
<td>Accumulative %</td>
<td>25</td>
<td>57</td>
<td>88</td>
<td>91</td>
<td>99</td>
<td>100</td>
</tr>
</tbody>
</table>
Water Management schedules releases from Flood Control Storage based on current pool elevation and flows/levels at the Downstream Target (control point) gage location. Downstream flow increases as reservoir pool elevation increases.
All flows are in cfs; schematic is not to scale.
OSAGE RIVER BASIN
CONTROL POINT GAGES

Pomona Lake
Ph I  3,200
Ph II 4,000
Ph III 6,000

Hillsdale Lake
Ph I  1,700
Ph II 2,850
Ph III 4,800

Melvern Lake
Ph I  1,900
Ph II 3,100
Ph III 4,500

Stockton Lake
Ph I  3,500
Ph II 5,500
Ph III 6,750

State Line
Ph I  7,000
Ph II 12,000
Ph III 20,000

Pomona
Ph I  4,800
Ph II 8,000
Ph III 9,500

Ottawa
Ph I  4,800
Ph II 8,000
Ph III 9,500

J Bridge
Ph I  3,500
Ph II 5,500
Ph III 6,750

Caplinger Mills
Ph I  5,000
Ph II 8,400
Ph III 12,000

Hermitage
Ph I  2,800
Ph II 3,500
Ph III 6,000

Pomme de Terre Lake
Ph I  2,800
Ph II 3,500
Ph III 6,000

Lake of the Ozarks
Ameren Missouri

Harry S. Truman Lake
Ph I  34,000
Ph II 54,000
Ph III 80,000

Pomona
Ph I  3,600
Ph II 6,000
Ph III 7,000

St. Thomas
Ph I  34,000
Ph II 54,000
Ph III 80,000

Hermann
Rise: 260,000
Fall: 90%

All flows are in cfs; schematic is not to scale.
Flood Recovery Advisory Working Group
Mississippi River Operations

Shawn Sullivan
U.S. Army Corps of Engineers
St. Louis District
Strategic Planning Coordinator

20 September 2019
• Mission Overview
• Levee Authorizations
• Upper Mississippi River Lakes and Levees
• 1993 Lessons Learned
• Preparing for the Next Great Flood
• 1993 vs 2019
• Flood Hazard and Vulnerabilities
• Levee Performance
  – Overtopping
  – “Aged/Aging Infrastructure”
• Flood Recovery
• Addressing Infrastructure Challenges
• Path Forward
NAVIGATION MISSION

How We Keep Commerce Moving:

Locks and Dams
- Routine Operation and Maintenance
- Major Rehabilitation

Water Management
- Monitor River, Reservoir, Tributary Gages
- River Stage Forecast
- Navigation Pool and Reservoir Management
- Communication with Industry/Public

Dredging
- Channel Patrol/Reconnaissance
- Surveys
- Dredge – Government and Contractor Plant

River Engineering
- Improvements to channel and environment
- Model Studies
- Construction
FLOOD RISK MANAGEMENT
MISSISSIPPI RIVER AND TRIBUTARIES FLOOD CONTROL PROJECT OF 1928

Comparing the 1927 & 2011 Floods

<table>
<thead>
<tr>
<th></th>
<th>1927</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Flow:</td>
<td>1,806,000 cfs</td>
<td>2,320,000 cfs</td>
</tr>
<tr>
<td>Acres Flooded:</td>
<td>16,800,000</td>
<td>6,350,000</td>
</tr>
<tr>
<td>Residential Impacts:</td>
<td>162,000</td>
<td>21,000</td>
</tr>
<tr>
<td>Lives Lost:</td>
<td>250</td>
<td>0</td>
</tr>
</tbody>
</table>

Missouri Boothee
Levees
Floodways
Tributary Basin Improvements
UPPER MISSISSIPPI RIVER OVERVIEW

- Levees Federally Constructed, Operated, Maintained (O&M) – 10
- Levees Federally Constructed, turned over to public sponsor for O&M - 119
  - Authorized by Flood Control Act 1936 and various others FCAs
  - Multiple Levee and Drainage District Sponsors
- Levees Locally Constructed, Local O&M in Federal Program – 58
- 1,652 Miles of Levee in USACE Rehabilitation Program
- Reservoirs Federally Constructed and Operated – 8
Union Township Levee, MO - Overtopping at multiple locations

USACE ROCK ISLAND DISTRICT
LEVEE STATUS MAP

Levee Status
- More than 9 ft: Breach is estimated
- Between 6.0 - 9 ft: Breach is likely
- Less than 6.0 ft: Breach is estimated
- Overtopped
- Control operations in progress

Lock & Dam Status
- Open to navigation
- Not gates disabled
- General navigation
- Maintenance closure

Overtopping Risk estimated from National Weather Service and USACE observed conditions as of 1044 AM JUNE 28, 1999, does not take flood fighting efforts into account, and only considers mainstem Mississippi flooding. Leveed areas that are not active in the PL-61-99 program are mapped but not listed.

"These systems have temporary flood fight measures from previous years' flood fight (Levee raise)."
MVS CMT Reservoir Status Map

**Lake Shadyville**
Current Conditions
- Pool Level: 633.10
- Flood Control Pool Utilized: 5.50%
- Flood Control Pool Utilized Date: 
- Forecasted (10 Day QPF):
  - Pool Level: Created
  - Flood Control Pool Utilized Date: 
- Forecasted (2 Day QPF):
  - Pool Level: Created
  - Flood Control Pool Utilized Date: 

- In Flow: 1180
- Out Flow: 1170
- Bank Full: 1400

**Carlisle Lake**
Current Conditions
- Pool Level: 446.11
- Flood Control Pool Utilized: 15.30%
- Flood Control Pool Utilized Date: 
- Forecasted (10 Day QPF):
  - Pool Level: Created
  - Flood Control Pool Utilized Date: 
- Forecasted (2 Day QPF):
  - Pool Level: Created
  - Flood Control Pool Utilized Date: 

- In Flow: 2140
- Out Flow: 2530
- Bank Full: 4000

**Lake Mapesville**
Current Conditions
- Pool Level: 370.35
- Flood Control Pool Utilized: 34.88%
- Flood Control Pool Utilized Date: 
- Forecasted (10 Day QPF):
  - Pool Level: Created
  - Flood Control Pool Utilized Date: 
- Forecasted (2 Day QPF):
  - Pool Level: Created
  - Flood Control Pool Utilized Date: 

- In Flow: 360
- Out Flow: 430
- Bank Full: 4300

**Road Lake**
Current Conditions
- Pool Level: 475.62
- Flood Control Pool Utilized: 87.10%
- Flood Control Pool Utilized Date: 
- Forecasted (10 Day QPF):
  - Pool Level: Created
  - Flood Control Pool Utilized Date: 
- Forecasted (2 Day QPF):
  - Pool Level: Created
  - Flood Control Pool Utilized Date: 

- In Flow: 370
- Out Flow: 180
- Bank Full: 1000

Legend
- Status:
  - 0%-50% Utilized
  - 50%-100% Utilized
  - Surcharge

8/6/2019
11:00 HRS

**Note:** Flood fighting efforts not accounted for in projection.
### MVS Reservoir Benefits

<table>
<thead>
<tr>
<th>Location</th>
<th>Obs Peak Stage</th>
<th>WOP Peak Stage</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chester</td>
<td>46.0</td>
<td>49.7</td>
<td>-3.7 ft</td>
</tr>
<tr>
<td>Cape Girardeau</td>
<td>48.9</td>
<td>51.0</td>
<td>-2.2 ft</td>
</tr>
<tr>
<td>Cairo</td>
<td>56.1</td>
<td>57.5</td>
<td>-1.4 ft</td>
</tr>
</tbody>
</table>

- **Observed**
- **W/O Project**

**Mississippi River at Chester**

- Flood Stage ~ 27.0 ft
- Record River Stage
  - Cape Girardeau, MO
  - January 2016
St. Louis Area Flood Status Map
8 Jun 2019

- 19 levee systems overtopped
- 12 levee segments confirmed breach/7 in Missouri
- 83,000 acres inundated behind Corps portfolio levees
MISSISSIPPI RIVER FLOODS AT ST. LOUIS

1973, 1993, 2019

<table>
<thead>
<tr>
<th>Year</th>
<th>Crest</th>
<th>Consecutive Days</th>
<th>Total Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>43.23</td>
<td>77</td>
<td>81</td>
</tr>
<tr>
<td>1993</td>
<td>49.58</td>
<td>104</td>
<td>147</td>
</tr>
<tr>
<td>2019</td>
<td>46.02</td>
<td>126</td>
<td>126</td>
</tr>
</tbody>
</table>

Graph showing flood stages and total days for different years.
FLOOD OF 1993 LESSONS LEARNED

- The domino effect of levee failure (Columbia, Harrisonville, Fort Chartres).
- Aged drainage and closure structures posed a significant threat to levee integrity.
- Features installed to mitigate underseepage lost efficiency over time without proper maintenance.
- The geology under the levees was more susceptible than anticipated to uncontrolled underseepage.
PREPARING FOR THE NEXT GREAT FLOOD

Reconstruction of Aged Drainage and Levee/Floodwall Structures
- Wood River TPC: $25.8M
- St. Louis TPC: $20.1M
- MESD (East St. Louis) TPC: $60.6M
  - Cape Girardeau Funded to Completion
  - Prairie Du Pont – study required

Remediation of Uncontrolled Underseepage
- Chain of Rocks (East St. Louis)
- St. Louis Flood Protection System
  - Cape Girardeau Funded to Completion
  - MESD (East St. Louis) Funded to Completion
  - Wood River Upper FY20 PBUB to Completion
  - Wood River Lower ongoing
  - Bois Brule Funded to Completion
  - Prairie du Pont and Fish Lake Local Sponsor

Raising or widening levees
- Missouri River L15 / Consolidated North County
- Prairie du Rocher and Edgar Lakes
- Monarch-Chesterfield nearing completion

New USACE Constructed Levees
- Festus/Crystal City
- Ste. Genevieve #3
- Valley Park

Investment = Improved Levee Performance and Reduced Risk
## 1993 VS 2019

<table>
<thead>
<tr>
<th></th>
<th>1993 (inflation adjusted)</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest – St. Louis Gage</td>
<td>49.58'</td>
<td>46.02'</td>
</tr>
<tr>
<td>Days of EOC activation</td>
<td>58</td>
<td>136</td>
</tr>
<tr>
<td>MVS Personnel Engaged</td>
<td>397</td>
<td>85</td>
</tr>
<tr>
<td>FCCE 200 series funding</td>
<td>$16M ($28M)</td>
<td>$5M</td>
</tr>
<tr>
<td>Sandbags</td>
<td>13,751,000</td>
<td>319,200</td>
</tr>
<tr>
<td>Rolls Poly Sheeting</td>
<td>9,044</td>
<td>289</td>
</tr>
<tr>
<td>Pumps</td>
<td>112</td>
<td>14</td>
</tr>
<tr>
<td>Breaches</td>
<td>126</td>
<td>12*</td>
</tr>
<tr>
<td>Protected Acres Inundated</td>
<td>1,407,574</td>
<td>100,953 (MO&amp;IL)</td>
</tr>
<tr>
<td>Estimated Levee Repair Cost</td>
<td>$83M ($147M)**</td>
<td>TBD</td>
</tr>
</tbody>
</table>

* Preliminary number of breaches, evaluation ongoing
** Escalated to current dollars
FLOOD HAZARD AND VULNERABILITIES

Repetitive Impacts From Major and Minor Floods
• 7 major floods in 11 years

Levee System Performance
• Underseepage and through seepage
• Levee slides

Aged and Aging Infrastructure
• Gravity drains and closure gates
• Relief wells and pump stations
• Closure Structures

Financial Structure
• Levee Districts’ structure and income to support operation, maintenance, repair, replacement and rehabilitation is struggling to keep pace with requirements.

Consequence
• Degrading infrastructure resiliency
• Reduced levee system performance
• Increased flood risk to leveed area
• Increased cost of O&M and rehab
• Levee Districts at risk of losing PL84-99 eligibility (Fed $ to repair flood damaged levees)
• Millions spent in State flood response to address problem areas through flood fight.
ELSBERRY OVERTOPPING
ELSBERRY OVERTOPPING

Elsberry Leveed Area 22,189 Acres Inundated
Consolidated North County Levee District, St. Charles County, MO
CONSOLIDATED NORTH COUNTY OVERTOPPING
CONSOLIDATED NORTH COUNTY OVERTOPPING

Community of West Alton, MO
35,000 acres inundated

Highway 367
ST. LOUIS – CARR ST. PUMP STATION
FLOOD RECOVERY – PUBLIC LAW 84-99

• 2015, 2016, and 2017 floods resulted in 34 rehabilitation projects
  • Total costs over $54 Million (IL & MO)
  • 12 levees located in MO
  • 6 projects were still in construction prior to 2019 Flood Event

• New Damages
  • Period to request assistance expired
  • 34 Requests for assistance received
  • 19 damage surveys completed so far
  • Seeking to have all PIRs completed and approved before EOY.
  • Nutwood Initial Repair task order should be issued prior to the end of this month.
HOW ARE WE ADDRESSING INFRASTRUCTURE CHALLENGES WITH OUR PARTNERS

Directly engaging levee sponsors in USACE Levee Safety Program activities (inspections, risk assessment and risk communication)

Emergency preparedness and action planning

Emergency response (flood fight)

Post flood recovery and assistance

Driving modernization of levee ownership through System Wide Improvement Framework (SWIF)
2017 Upper Mississippi River Basin Flood Risk and Sediment Management Summit Issue Areas:

Lack of coordination to achieve a common vision

Management and assumption of risk based on outdated information

Land use and weather changes altering watershed and floodplain dynamics

There is insufficient capacity to store and remove dredged material particularly near accumulation hot spots.

Lack of systemic, agreed-upon approach to management

Lack of investment to improve system infrastructure (structural and nonstructural)
UPPER MISSISSIPPI RIVER: FLOOD, SEDIMENT, AND DROUGHT MANAGEMENT

Planning Assistance to States

Phase I - Listening Sessions - Complete
July 13: Hannibal, Missouri,
July 20: Muscatine, Iowa,
July 27: Dubuque, Iowa,
August 3: Winona, Minnesota,
August 24: Godfrey, Illinois,
September 7: Cape Girardeau, Missouri,

Unable to Attend: You can provide input on the web until 30 SEP 2019
https://www.mvr.usace.army.mil/About/Offices/Programs-and-Project-Management/UMR-F-S-D-Management/

Phase 2 – Generate Report – Initiate September 30th
• Develop problem statements,
• Identify “consent-based” solutions to address those problems,
• Identify more complex issues that need to be more thoroughly explored.
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