Flood Risks from Spillways
Modeling and Communicating Non-Dam-Failure Flood Impacts to Native American Tribes

USSD 2017 Annual Conference

Rinda Tisdale, MEP, CEM  │  Matt Young, PE, CFM  │  Chris Clopper, PE (contractor)

U.S. Department of the Interior
Bureau of Indian Affairs
Branch of Dam Safety, Security, & Emergency Management
Over 900 dams on 42 Federally-recognized Indian reservations

138 are classified as probable life loss (high-hazard potential)

25% of DOI’s high-hazard potential dam inventory
Flood Risks from Spillways

Coolidge Dam -
San Carlos Reservation

DAM SAFETY, SECURITY, & EMERGENCY MANAGEMENT
Flood Risks from Spillways

Headgate Rock Dam - Colorado River
Flood Risks from Spillways

Red Lake Dam - Navajo Reservation
Flood Risks from Spillways

Elgo Dam – San Carlos Reservation
Flood Risks from Spillways

Water Tank Dam - San Felipe Reservation
Dams are a significant part of the water resources infrastructure and trust assets of many Reservations and Tribes.

**BIA Program Dams - Primary Use**

- **Irrigation**: 33%
- **Flood Control**: 18%
- **Fire Protection/Stock Pond**: 11%
- **Water Supply**: 5%
- **Conservation**: 1%
- **Recreation**: 32%

**Flood Risks from Spillways**
Flood Risks from Spillways

Risk-Informed Decision Making and Prioritization

- Risk Informed Dam Safety Decisions and Rehabilitation Prioritization
- \( f-N \) charts utilized to depict probabilities and consequences associated with dam failures
Flood Risks from Spillways

Risks Associated with Spillway Operation in Accordance with Design Intent
Flood Risks from Spillways

Lack of Floodplain Management ≠ Lack of Flood Risk

- Flooding is the most common and destructive natural disaster in the U.S.
- 37 of 566 Federally Recognized Tribes (7 percent) participate in NFIP
- Most tribal lands remain unmapped
- Tribal communities may be unaware of their flood risk, even in high risk areas
Floodplain management is a responsibility of BIA Division of Water and Power.

It is BIA SOD Program policy to encourage floodplain management below dams and along reservoir shorelines.

Flood Risks from Spillways

BIA Floodplain Policy

- Floodplain management is a responsibility of BIA Division of Water and Power.
- It is BIA SOD Program policy to encourage floodplain management below dams and along reservoir shorelines.
Flood Risks from Spillways

Number of Major Flood Disaster Declarations by County and U.S. Indian Reservation (1980 – 2005)
Flood Risks from Spillways

138 Dams = 58 EAPS

- Planning Meetings
- Exercises

Results:
Improved tools to communicate risks below dams
Flood Risks from Spillways

PMF Dam Failure Inundation Maps

- Each EAP typically has had a PMF Dam Failure Inundation Map
“to reduce the potential loss of human life and property damage caused by dam failure by making BIA dams as safe as practically possible.”

Were our EAPs adequately reflecting our mission? Or putting us at greater liability?
Flood Risks from Spillways

FEMA 64, July 2013
Suggests Response Levels

BIA SOD Handbook, revised 2014

- High flow
- Non-failure
- Potential failure
- Imminent failure

Response Level 1
Response Level 2
Response Level 3
Flood Risks from Spillways

EAP Response Levels → Integrity of the Dam

Normal Flooding ≠ Dam Safety Emergency

BIA has created new tools:

- Rate of Rise Graphs
- Site Plan Maps
- Watershed Maps
- Rainfall Maps
- Spillway Discharge Curves
- Flood Animations
- Non-Dam-Failure Inundation Maps

To provide better information to aid tribes with flood planning efforts.
Flood Risks from Spillways

Rate of Rise Graphs

- Rainfall driven
- Provide advanced warning time
- Other PFMs may exist!

Image credit: damfailures.org http://damfailures.org/lessons-learned
Flood Risks from Spillways

Dam Familiarization – Site Plan Maps

Washakie Dam – Wind River

Tat Momolikot Dam – Tohono O’odham
Flood Risks from Spillways

Watershed Maps

Indian Lake Dam – Umatilla

Wildhorse Dam – Duck Valley

Indian Lake Dam Watershed

Wildhorse Dam Watershed

Wildhorse Reservoir

Sub-Basin A

Sub-Basin B

Sub-Basin C

Sub-Basin D

Sub-Basin E

Sub-Basin F

Sub-Basin G

Sub-Basin H

Sub-Basin I

Sub-Basin J

Sub-Basin K

Sub-Basin L

Sub-Basin M

Sub-Basin N

Sub-Basin O

Sub-Basin P

Sub-Basin Q

Sub-Basin R

Sub-Basin S

Sub-Basin T

Sub-Basin U

Sub-Basin V

Sub-Basin W

Sub-Basin X

Sub-Basin Y

Sub-Basin Z

Sub-Basin AA

Sub-Basin BB

Sub-Basin CC

Sub-Basin DD

Sub-Basin EE

Sub-Basin FF

Sub-Basin GG

Sub-Basin HH

Sub-Basin II

Sub-Basin JJ

Sub-Basin KK

Sub-Basin LL

Sub-Basin MM

Sub-Basin NN

Sub-Basin OO

Sub-Basin PP

Sub-Basin QQ

Sub-Basin RR

Sub-Basin SS

Sub-Basin TT

Sub-Basin UU

Sub-Basin VV

Sub-Basin WW

Sub-Basin XX

Sub-Basin YY

Sub-Basin ZZ
Flood Risks from Spillways

Frequency Storm Rainfall Maps

Ray Lake & Washakie Dams – Wind River

San Francisco & Water Tank Dams – San Felipe

NOAA - Atlas 2 - Volume 2
100-Year 24-Hour Rainfall Map
Precipitation in tenths of an inch
Wind River Reservation
Wyoming

NOAA - Atlas 14 - Volume 1
100-Year 24-Hour Rainfall Map
Pueblo of San Felipe
New Mexico
Flood Risks from Spillways

PMP Rainfall Maps

Eagle Creek No.1, Silver Lake, & Mescalero Dams – Mescalero

Ray Lake & Washakie Dams – Wind River
Flood Risks from Spillways

NOAA Atlas 14 100-Yr 24-Hr

NOAA Atlas 14 1,000-Yr 24-Hr

HMR 55A 24-Hr General Storm PMP

HMR 55A 1-Hr Local Storm PMP
Flood Risks from Spillways

Spillway Discharge Curves

Name of Dam - Spillway Stage-Discharge Curve

- Top of Dam = 2462.0 feet
- Auxiliary Spillway Crest = 2459.0 feet
- Service Spillway Crest = 2454.0 feet
- Threshold Description (eg. Rd 5 Culvert Capacity) = 37 cfs
Many different types of spillways at BIA facilities:

- Uncontrolled (passive) vs Controlled
- Broad-crested, sharp-crested, ogee weirs, and morning-glory inlets
- Culverts, Open Channels
- Discharge curves generated from best available data
Flood Risks from Spillways

Spillway Discharge Curves

Coolidge Dam, AZ
Flood Risks from Spillways

Spillway Discharge Curves

Coolidge Dam - Spillway Stage-Discharge Curve
Spillway Discharge Associated with Response Level Zone at Zero Rate of Rise

Top of Dam = 2536.0 feet
Approximate Low Chord Spillway Deck = 2533.0 feet
Maximum Recorded Reservoir Surface = 2521.7 feet
Approximate Safe Channel Capacity = 2516.4 feet
Spillway Crest = 2511.5 feet

Estimated Combined Spillway Discharge (cubic feet per second) vs. Reservoir Elevation (feet)
Flood Risks from Spillways

Spillway Discharge Curves
Flood Risks from Spillways

Spillway Discharge Curves

Black Rock Dam - Spillway Stage-Discharge Curve
Spillway Discharge Associated with Response Level Zone at Zero Rate of Rise

- Top of Dam = 6447.0 feet
- Auxiliary Spillway Crest = 6441.5 feet
- Approximate Safe Channel Capacity = 700 cfs
- Service Spillway Crest = 6436.6 feet
- Approximate 100-yr Outflow = 13,600 cfs

Estimated Spillway Discharge (cubic feet per second)

Black Rock Dam, NM
Flood Risks from Spillways

Spillway Discharge Curves

McDonald Dam, MT
Flood Risks from Spillways

Spillway Discharge Curves

McDonald Dam - Spillway Stage-Discharge Curve
Spillway Discharge Associated with Level Response Zone at Zero Rate of Rise

Top of Dam = 3604.0 feet
Spillway Gate Crest = 3598.0 feet
Spillway Crest = 3592.5 feet

Estimated Spillway Discharge (cubic feet per second)

McDonald Dam, MT
## Flood Risks from Spillways

<table>
<thead>
<tr>
<th>Flood Event</th>
<th>Peak Flowrate</th>
<th>Total Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-Yr Flood</td>
<td>13,600 cfs</td>
<td>14,400 ac-ft</td>
</tr>
<tr>
<td>Sunny-Day Dam Failure</td>
<td>30,600 cfs</td>
<td>1,730 ac-ft</td>
</tr>
<tr>
<td>Combined Spillway Capacity Flood</td>
<td>58,000 cfs</td>
<td>---</td>
</tr>
<tr>
<td>PMF Dam Failure</td>
<td>225,300 cfs</td>
<td>142,600 ac-ft</td>
</tr>
</tbody>
</table>

### Watershed
- **Watershed**: 690 mi²

![Map of Watershed with Dam and 100-Yr Flood Representation]
### Flood Risks from Spillways

<table>
<thead>
<tr>
<th>Flood Event</th>
<th>Peak Flowrate</th>
<th>Total Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-Yr Flood</td>
<td>13,600 cfs</td>
<td>14,400 ac-ft</td>
</tr>
<tr>
<td>Sunny-Day Dam Failure</td>
<td>30,600 cfs</td>
<td>1,730 ac-ft</td>
</tr>
<tr>
<td>Combined Spillway Capacity Flood</td>
<td>58,000 cfs</td>
<td>---</td>
</tr>
<tr>
<td>PMF Dam Failure</td>
<td>225,300 cfs</td>
<td>142,600 ac-ft</td>
</tr>
</tbody>
</table>
Flood Risks from Spillways

Flooding Risks Associated with Designed Spillway Operation
Flood Risks from Spillways

Flooding Risks Associated with Designed Spillway Operation
Flood Risks from Spillways

Flooding Risks Associated with Designed Spillway Operation
Flood Risks from Spillways

Flooding Risks Associated with Designed Spillway Operation
Flood Risks from Spillways

Evergreen, CO - September 2013
Flood Risks from Spillways

Evergreen, CO - September 2013
Flood Risks from Spillways

Big Thompson Canyon, CO
September 2013
Questions?

Rinda Tisdale, MEP, CEM
Emergency Management Coordinator
Rinda.Tisdale@bia.gov

Matthew Young, PE, CFM
Dam Safety Engineer
Matthew.Young@bia.gov

Chris Clopper, PE
Hydraulic Engineer (contractor)
Christopher.Clopper@bia.gov