Dam and Seismicity, what should we do?
Dam Safety Facts

• 69% dams are privately owned and dam owners are responsible for maintenance and upgrades
• Oklahoma has the second highest number of jurisdictional dams in the nation
• Average age of dams in the U.S. is more than 53 years old
• Many people are unaware of living in dam failure inundation zones
• Dam failure flood is not equal to 100-year flood

Oklahoma has 55,646 miles of shoreline along lakes and ponds
Oklahoma Dam Inventory
(Jurisdictional Dams by Agency and Hazard Classification)
### Hazard-Potential Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>No probable loss of human life and low economic losses</td>
</tr>
<tr>
<td>Significant</td>
<td>No probable loss of human life but can cause economic loss or disruption of lifeline facilities</td>
</tr>
<tr>
<td>High</td>
<td>Probable loss of human life</td>
</tr>
</tbody>
</table>

**What is jurisdictional size?**

*Any sized dam determined to be of high hazard-potential.*
Oklahoma’s 2013 ASCE Report Card

- Age – Average age is 46 years

- Condition – Most low hazard potential dams condition are unknown

- Funding
  - Lack of funding for the program
  - Lack of funding from the dam owners to perform major repairs

- Hazard-potential reclassification of dams
Seismicity in Oklahoma

- 36 M3+ earthquakes in 2012
- 109 M3+ earthquakes in 2013
- 585 M3+ earthquakes in 2014
- 907 M3+ earthquakes in 2015
- ± 600 M3+ earthquakes in 2016


Note: Only Earthquakes with a magnitude of 3.0 and higher are displayed.
Rules Amendment in 2013
Pawnee Earthquake September 2016

Added a language for unscheduled inspections after earthquakes within 50 miles of a dam that measure 5.0 or greater
Water for 2060 Act

• 2012 update of Ok. Comprehensive Water Plan set priority recommendation for water conservation, reuse, efficiency

• Act set goal - Consume no more fresh water in 2060 than was consumed in 2012, while continuing to grow Oklahoma’s population and economy

• Achieved by – Using fresh water supplies more efficiently AND expanding use of alternatives such as treated wastewater, brackish water, and other supplies

• Established Advisory Council to make recommendations – Ag, M&I, Energy
Water for 2060
Produced Water Working Group

• 2014 Governor Fallin establishes Coordinating Council on Seismic Activity

• 2015 WF 2060 Advisory Council recommends expanded use of MQW for energy and industry

• 2016 Gov. Fallin approved $1.4m from emergency fund to bolster efforts of earthquake regulators (OCC) and researchers (OGS)

• 2016 Gov. Fallin establishes fact-finding work group to ID regulatory, technical, and economic barriers to PW use

• Idea – Could potentially reduce quantities of PW injected, thus reducing seismic activity, AND help conserve fresh water
Dam Safety Program Priorities/Updates

- Public awareness
- Emergency Action Planning
- Hazard-potential reclassification of dams
- Rehabilitation of structurally deficient dams
Public Awareness in 2016 - 2018

- Dam Safety for Real Estate Agents
- Free low hazard dam inspections
- Dam safety quarterly newsletter
- Website

Past workshops

- Earthquakes and Infrastructure (Winter 2016)
- HEC-RAS 2D workshop (Spring 2017)
- Dam Safety Workshop (April 25, 2018)

New language on dams in the Oklahoma Real Estate Commission’s Appendix A. Residential Property Condition Disclosure Statement.
Oklahoma Dam Safety Program EAP Performance

- Based solely on the downstream risk in the event of failure
- **NOT** based on the physical condition of the structure
- Emergency Action Plans
  - 345 High Hazard Dams out of 359 (96%)
  - Dam Breach Inundation Maps (99%)
  - Breach map 2010 and newer (90%)
Hazard Creep

April 2003

August 2003
Hazard Creep

May 2008

March 2014
Hazard Reclassification


2. Field visit

3. Simplified steady state analysis

4. Detailed study

5. Refer to OWRB hazard reclassification guidelines and ACER Technical Memorandum No. 11 by Bureau of Reclamation
Hazard Reclassification Rule of Thumb Model

High (H1) Dams with Residential and Commercial Structures (not in backwater and not in fringe)

Dam Classification Summary

- High High (1144) 48%
- Low (844) 35%
- Significant (144) 6%
- High Low (20) 1%
- High Medium (75) 3%
- Review (150) 6%
- Drained (24) 1%

30 or Greater Structures per Dam
- (32) 6.1%
- (13) 2.5%

20-29 Structures per Dam
- (23) 4.4%
- (60) 11.5%

10-19 Structures per Dam
- (23) 4.4%

5-9 Structures per Dam
- (60) 11.5%

1 Structure per Dam
- (232) 44.7%

2-4 Structures per Dam
- (161) 30.8%
# Design Flood

<table>
<thead>
<tr>
<th>Size</th>
<th>Hazard- Potential</th>
<th>Design Flood (% PMF)</th>
<th>Minimum Freeboard (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>Low</td>
<td>25%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Significant</td>
<td>40%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>50%</td>
<td>1</td>
</tr>
<tr>
<td>Inter</td>
<td>Low</td>
<td>25%</td>
<td>1</td>
</tr>
<tr>
<td>mediate</td>
<td>Significant</td>
<td>50%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>75%</td>
<td>3</td>
</tr>
<tr>
<td>Large</td>
<td>Low</td>
<td>50%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Significant</td>
<td>75%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>100%</td>
<td>3</td>
</tr>
</tbody>
</table>
Probable Maximum Precipitation (PMP)

Source: NOAA – Hydrometeorological Report No. 51
24 hours 10 mi²

Harvey
31.25” for 24 hour 10 mi²
Why do we need to update the PMP?

- HMR 51 was published in **1978**
- Many major storms happened in the last 40 years
- The importance of extending the duration of the storm
- Partnership with Arkansas, Louisiana, Mississippi, and Oklahoma Conservation Commission/NRCS
Technical Assistance to Dam Owner

Hominy Dam

Knight Lake Dam

Carlton and Clayton Lake
Oklahoma Dam Safety Program in 2017

Overall Weighted Percentage

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Oklahoma</td>
<td>83%</td>
<td>85%</td>
<td>82%</td>
<td>88%</td>
</tr>
<tr>
<td>National Average</td>
<td>59%</td>
<td>66%</td>
<td>77%</td>
<td>79%</td>
</tr>
</tbody>
</table>

State-Regulated Dams per FTE (blue) and National Average (red)

2016 State Weighted Percentage

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legislation (5)</td>
<td>97%</td>
</tr>
<tr>
<td>Inspection (4)</td>
<td>93%</td>
</tr>
<tr>
<td>Enforcement (4)</td>
<td>100%</td>
</tr>
<tr>
<td>EAP &amp; Response (4)</td>
<td>78%</td>
</tr>
<tr>
<td>Permitting (3)</td>
<td>73%</td>
</tr>
<tr>
<td>Education &amp; Training (3)</td>
<td>89%</td>
</tr>
<tr>
<td>Public Relations (1)</td>
<td>58%</td>
</tr>
<tr>
<td>Weighted Percentage</td>
<td>88%</td>
</tr>
</tbody>
</table>
Oklahoma Dam Safety Program in 2017

Strengths

• Staff and executive leadership
• Work environment
• Commitment to training
• Outreach
• Information technology
• Legal support
• Dialogue with finance

Areas to Improve

• Fees are not consistent
• Funding availability
• Limited technical references
• Number of personnel
• Construction
Questions