What we do and don't know about Alabama's dams and why it matters!

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Safety Moment - Oroville Dam

Background

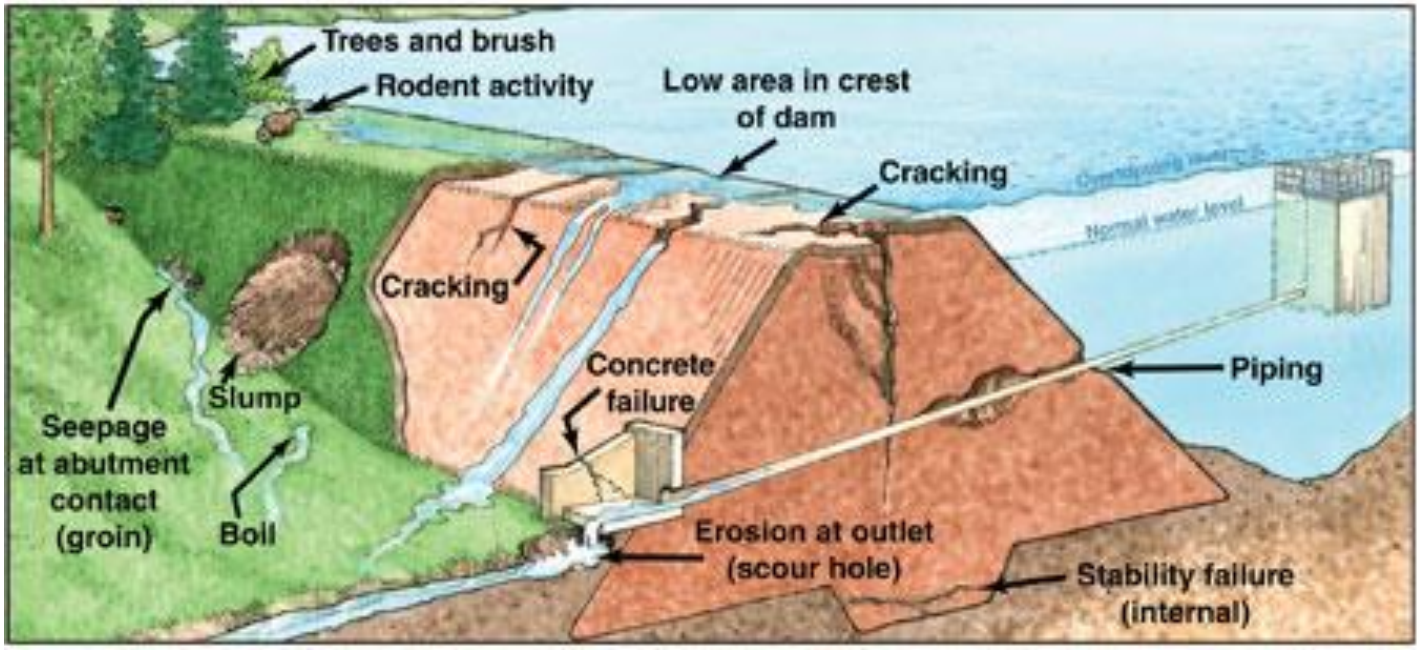
- Earthen embankment
- 770 feet tall
- Tallest dam in U.S.
- Used for:
  - Water supply
  - Hydroelectricity
  - Flood control
- Storage = 3.5 million acre-feet
- Completed in 1968

Issue

- Crater formed in main spillway
- Emergency spillway activated and eroded
- 188,000 residents evacuated

Problem statement

- "Of the large dams 85 percent would have exceeded their design lifespan by 2020 or soon thereafter" (Federal Emergency Management 2001).
- More than 600 dams need to be upgraded to ensure the safety of those downstream (NRCS-small watershed projects)



Hazard classification criteria

Based on the National Engineering Manual (NEM)

- High Hazard – Class C – This is a dam where failure may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways, or railroads.

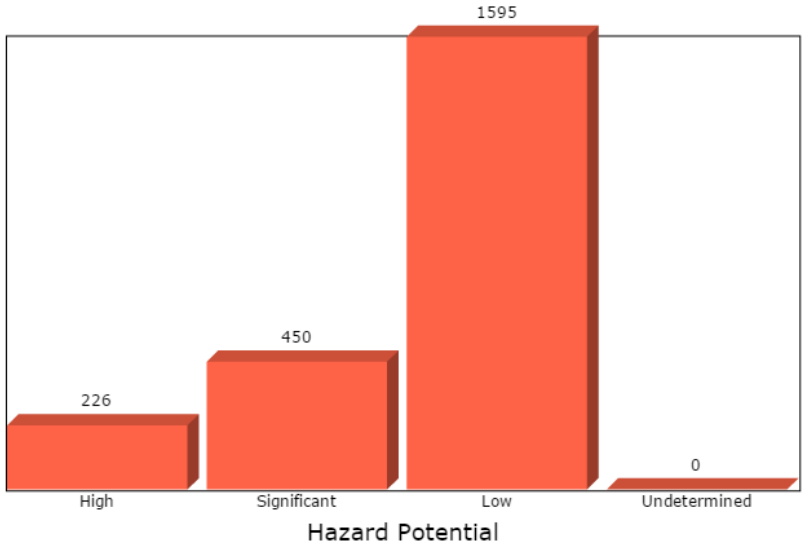
- Significant Hazard – Class B – This is a dam in a predominantly rural or agricultural area where failure may damage isolated homes, main highways, or minor railroads or interrupt service of relatively important public utilities.

- Low Hazard – Class A – This is a dam that is located in rural or agricultural areas where failure may damage farm buildings, agricultural land, or township and country roads.

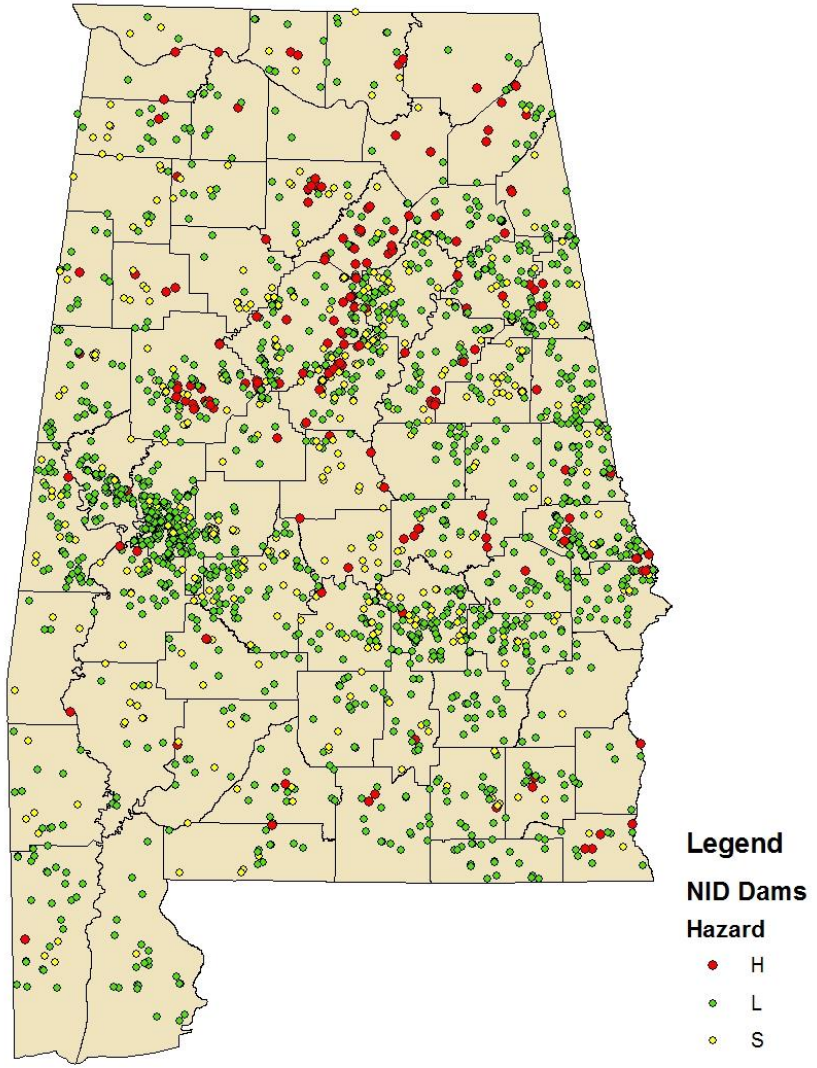
Alabama dams

National Inventory of Dams

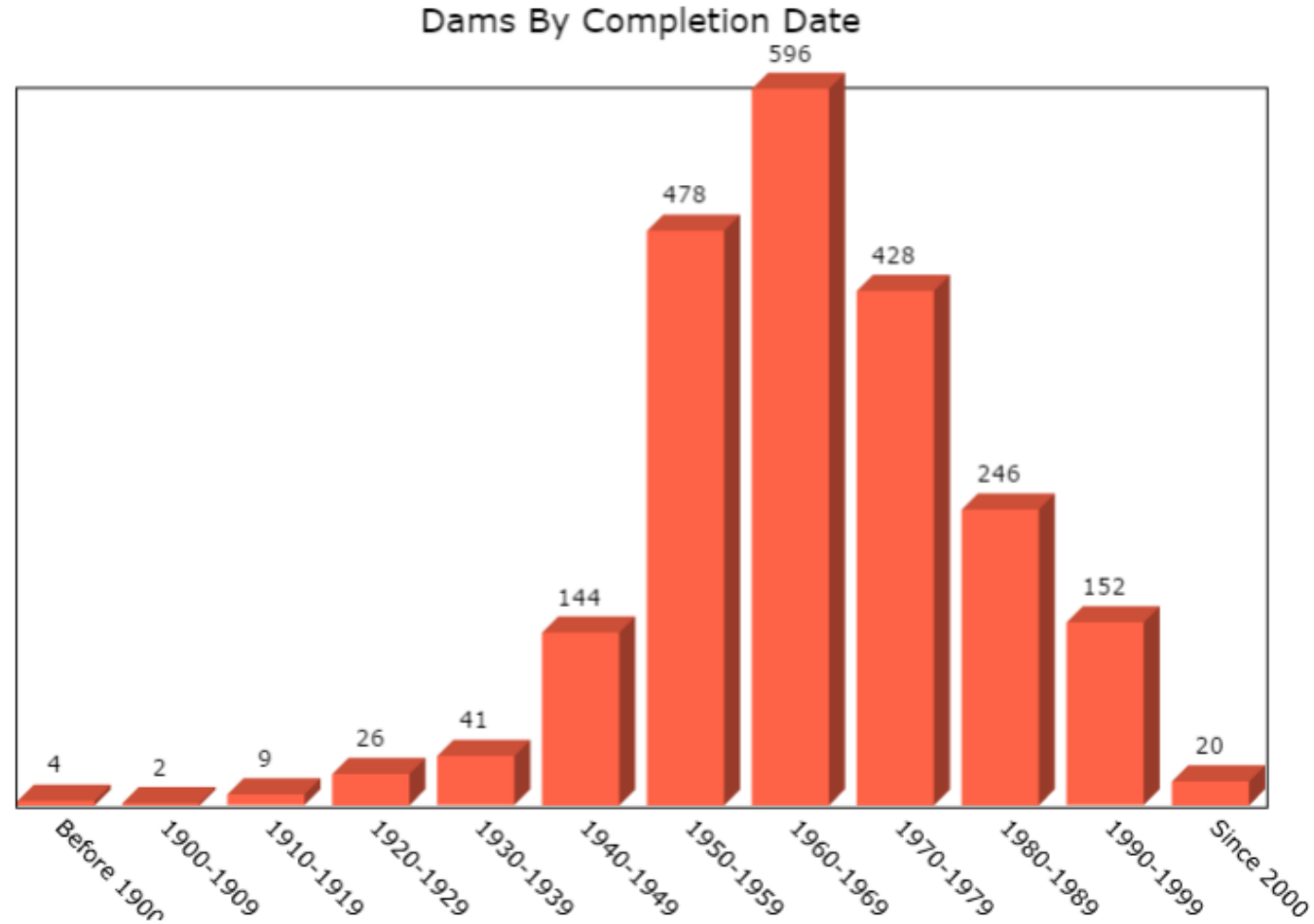
- 2,271 dams in Alabama



- # is growing with inventory being put together by the State of Alabama Office of Water Resources

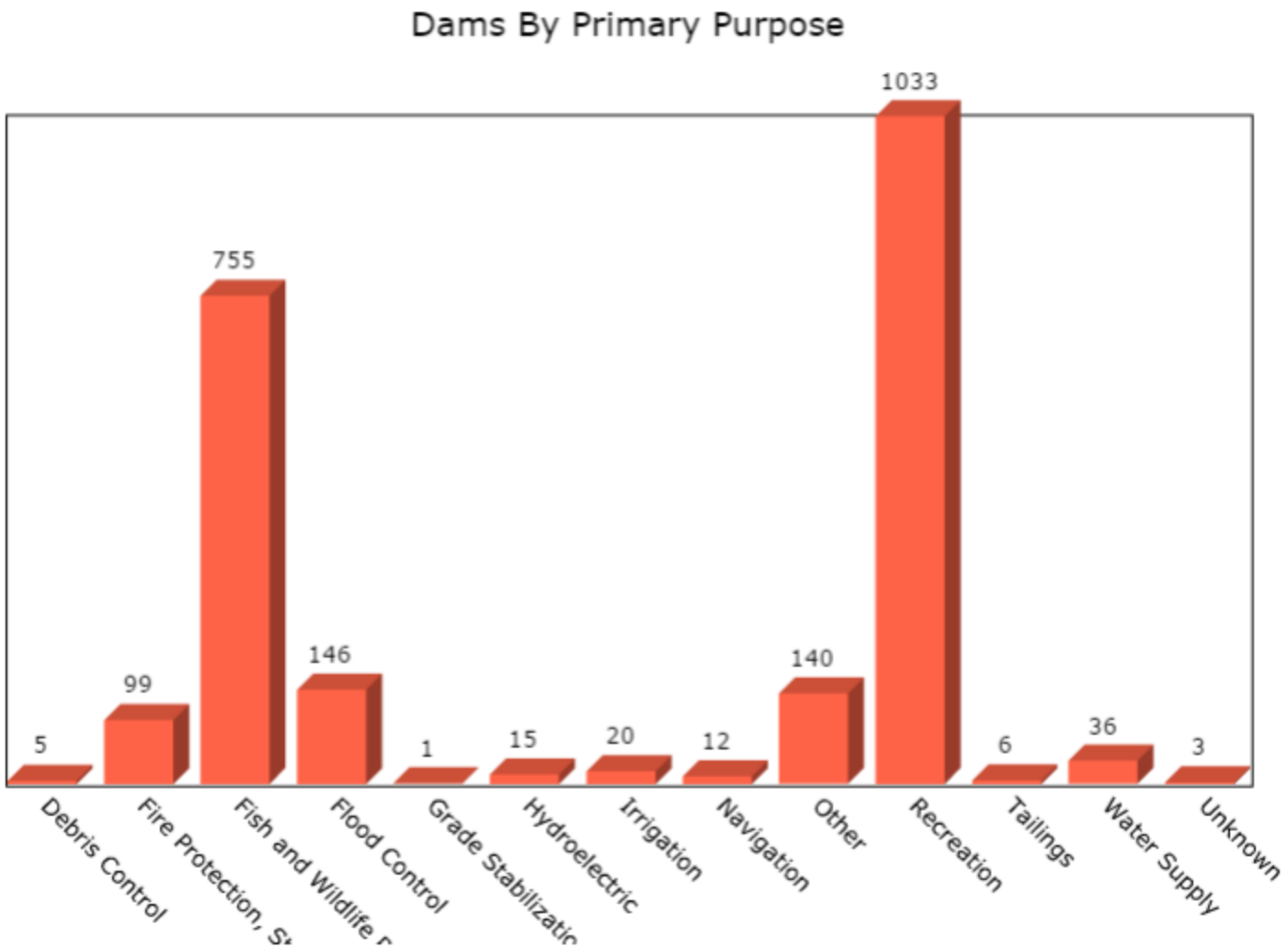


Alabama dams

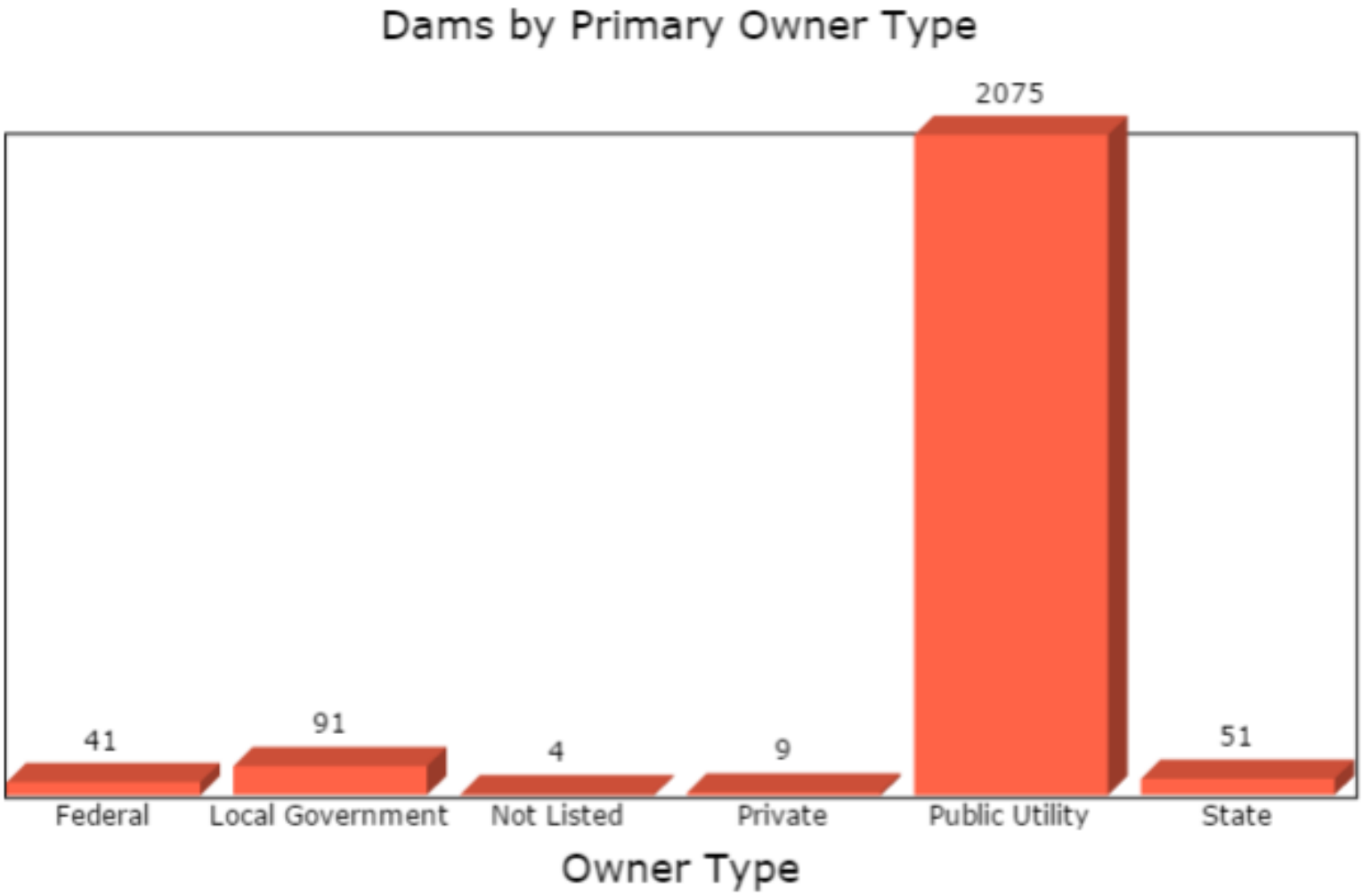


Pre-1965 = over 50 years old

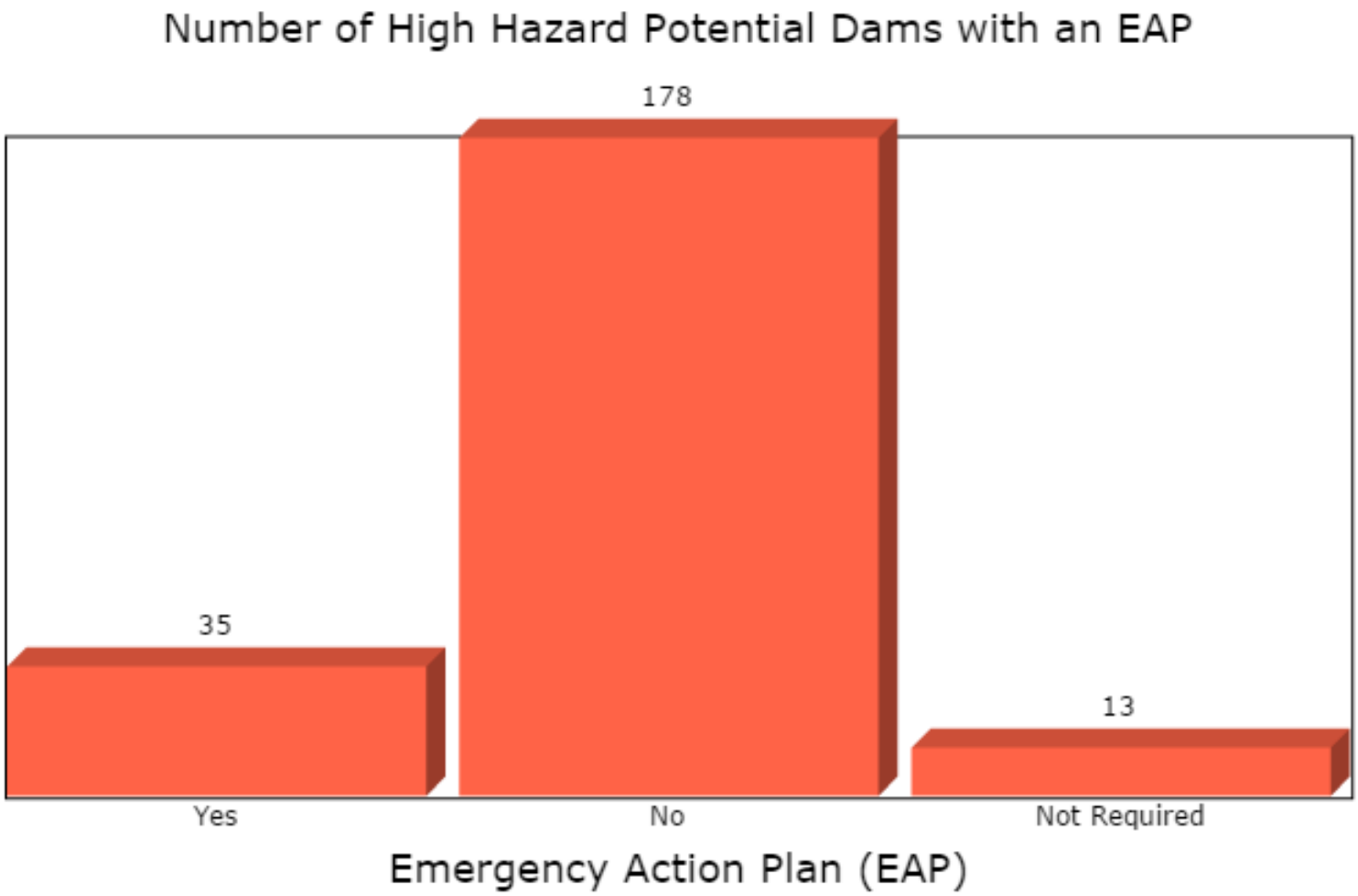
Alabama dams



Alabama dams



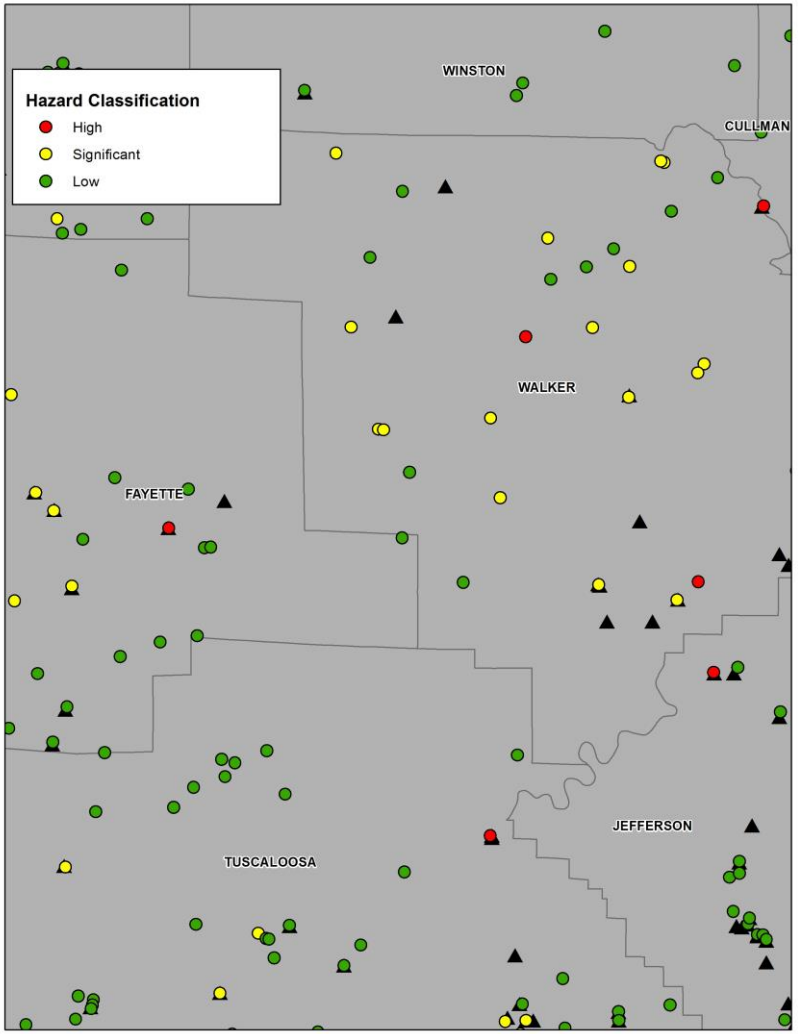
Alabama dams



AL OWR dam inventory update

Draft results:

- 5,209 total dams
  - 209 high hazard
  - 1,127 significant hazard
  - 3,873 low hazard
- Only 1,510 of the NID points accurately represent an actual dam. Roughly 1/3 of the NID dams can't be spatially referenced to a dam.
- Recommends adding ~3,700 new points to the NID.



Recent Dam Failures

Why do dams fail? (from our friends at FEMA)

amec foster wheeler

Main causes of dam failure:

- Overtopping caused by floods that exceed the capacity of the dam
- Deliberate acts of sabotage
- Structural failure of materials used in dam construction
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate maintenance and upkeep

Most common deficiency

Spillways not properly sized

- Age of dam/designed 50 years ago or not designed at all
- Newer software
- Hazard class has changed due to development

Recommendations

- Raise/widen auxiliary spillway
- Raise top of dam
- Add overtopping section
- Land acquisition

Camp Sumatanga Lake

Sumatanga Lake - piping failure

Big Bay Lake Dam—near Purvis, MS

- Woody material stripped from stream valley for 2,300 feet immediately below the dam.
- 104 structures damaged or destroyed, no lives lost

March 12, 2004

- Piping Failure 12 years after construction
  - Growth in pre-existing seep
  - Full formation of the breach occurred in 55 minutes

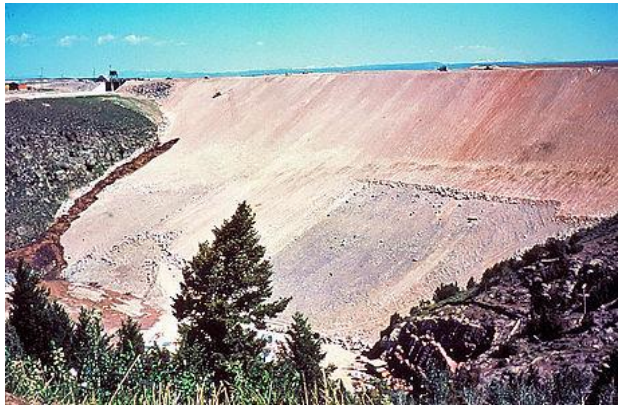
Lake Delhi Dam--Iowa

June 24, 2010

- Overtopping Failure
  - 10 inches of rain in 12 hrs.
  - “Internal erosion in the embankment coupled with overtopping”
  - 8,000 people evacuated

Famous Dam Failures

- Banqiao Reservoir Dam-China (1975)—overtopping (2000 yr rain)
  - 170,000 killed; 11 million homes destroyed
- Austin Dam—Potter County, PA (1911)—structural failure of concrete
  - 78 killed
- Teton Dam—Teton River, ID (1976)—Geological conditions, design flaws led to piping failure.
  - 11 killed, 1 billion in damages



Famous Dam Failures

- South Fork Dam—Johnstown, PA (1889)—Structural Failure
  - 2,209 killed
- Kelly Barnes Dam—Toccoa Falls, GA (1976)—Unknown Cause
  - 39 killed
- Buffalo Creek—West Virginia (1972)—Structural Failure
  - 125 killed
- 1972 Black Hills Flood—South Dakota—Heavy Rain, Debris, overtopping
  - 238 killed; 1300 homes destroyed

Dam Inspections

What to look for during inspection

Dam inspection items

- Embankment
- Front slope protection
- Inlet structure and gates
- Principle spillway conduit
- Principle spillway release channel
- Auxiliary spillway
- Reservoir area

H & H items

Principle spillway

- Debris blocking outlet
- Concrete pipe deterioration
- Metal pipe corrosion

Auxiliary spillway

- Adequate vegetative cover
- Is flow area blocked?
- Erosion
- Under-cutting of the dam

Embankment

Embankment damage

Embankment damage

Embankment slide

Growth on dam

Trees on dam

Holes in dam

Principle spillway riser (inlet)

Principle spillway blockage

Principle spillway outlet

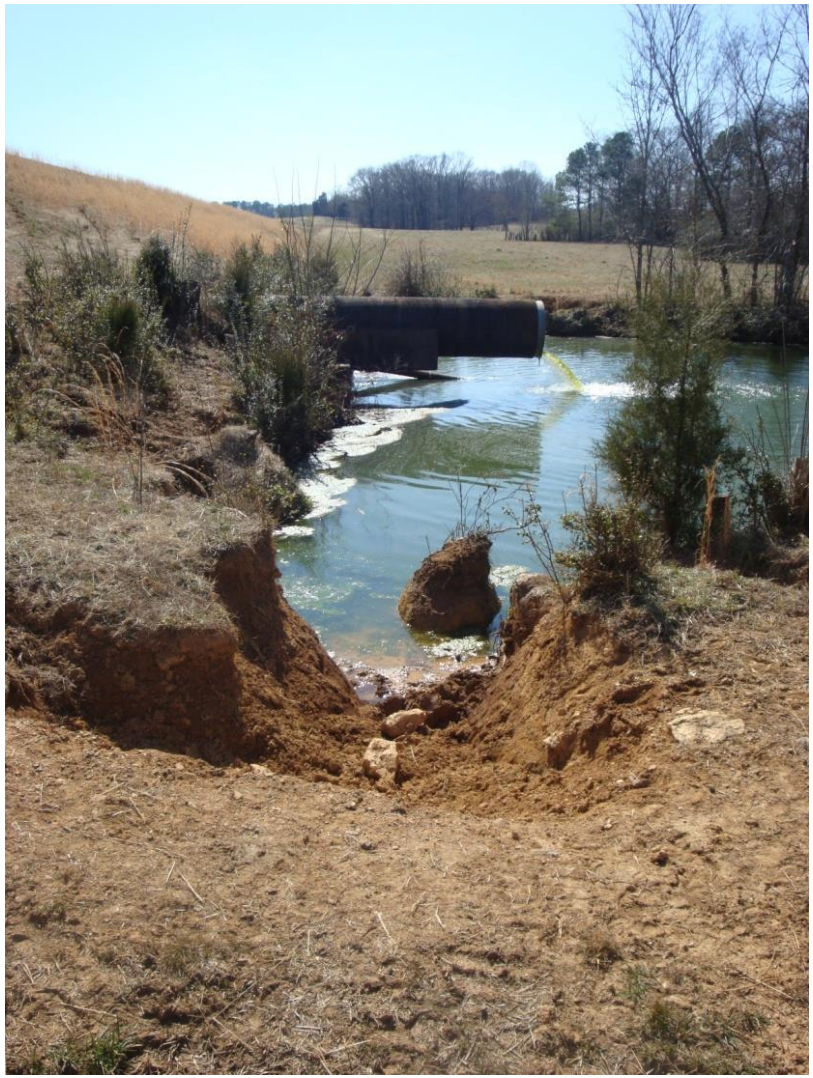
Plunge pool erosion protection

Auxiliary spillway – good condition

Auxiliary spillway – needs improvement

Auxiliary spillway – repair

Livestock damage



Structures below the top of the dam

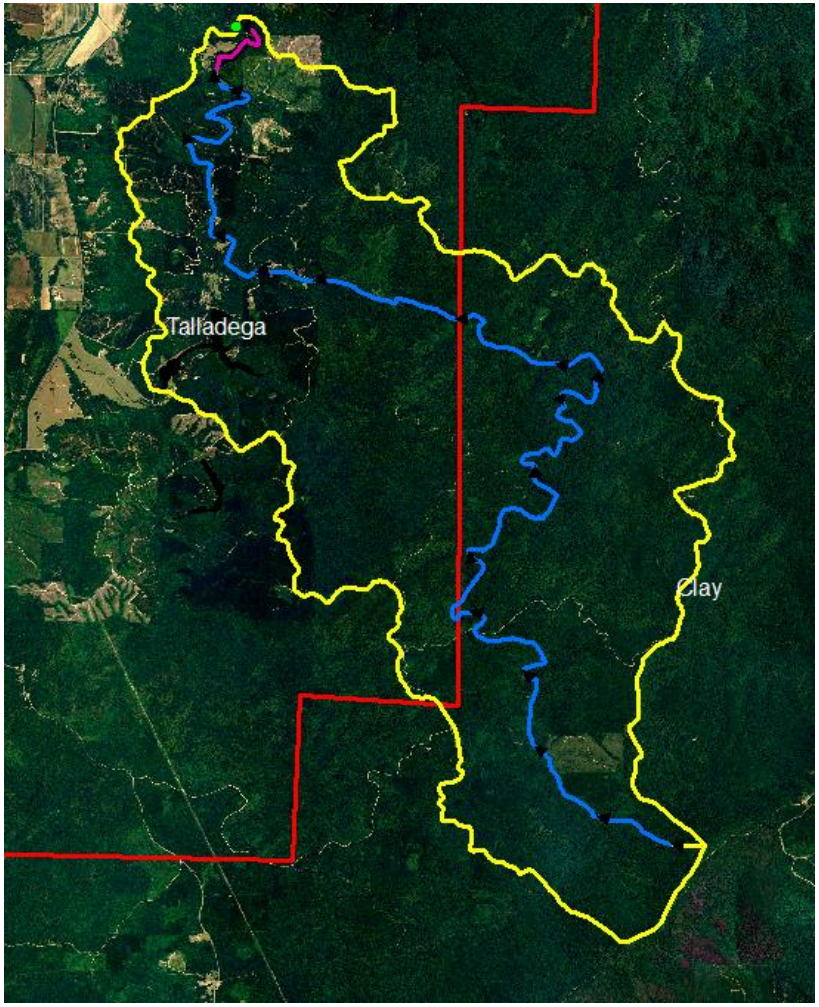
Hydrologic analysis

Hydrology

- Time of Concentration
- Drainage Area
- Curve Number
  - NRCS Soils Data
  - USGS Land-use Data

USDA SITES Program

- Route design storm thru structure
  - Adequacy of structure
  - Alternative configurations to comply with current hydrologic criteria

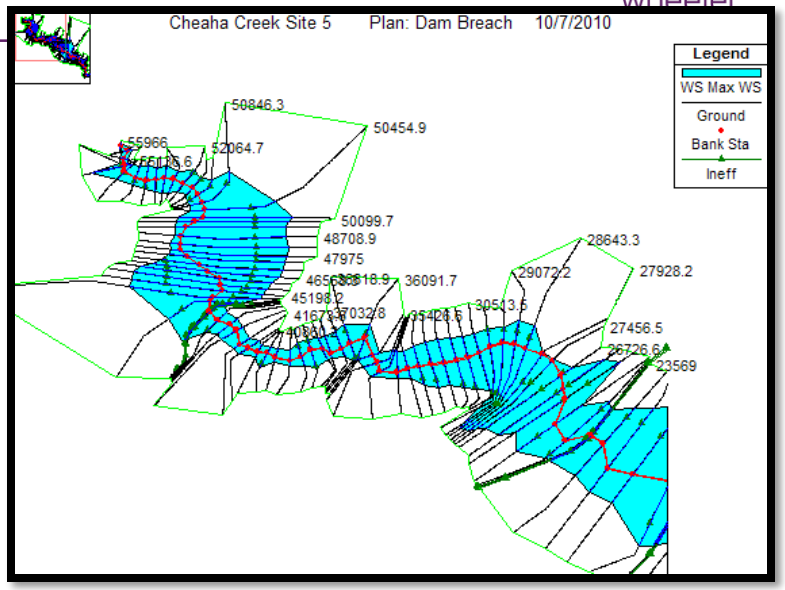


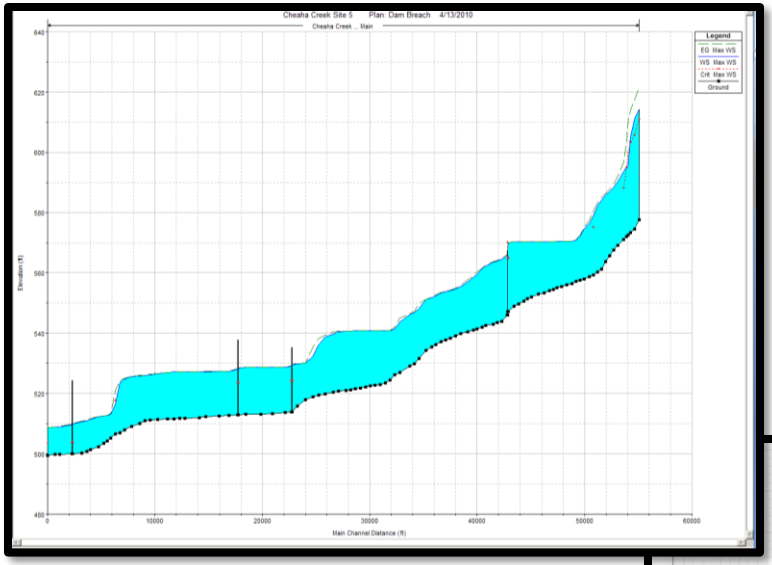
Dam breach analysis

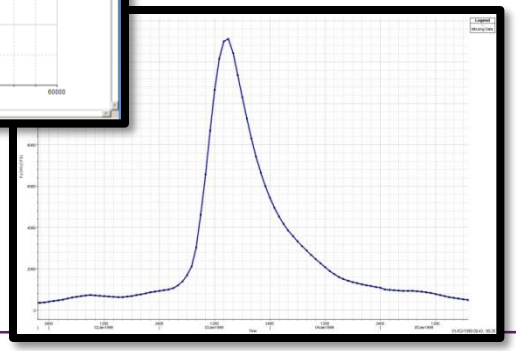
Dam Breach Hydrograph

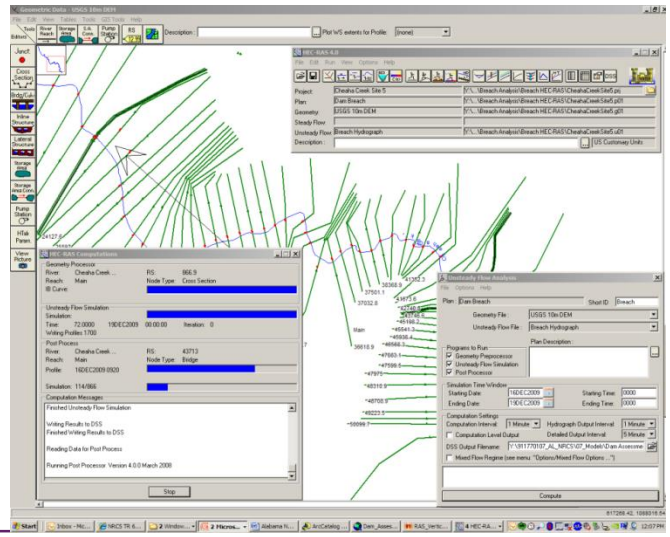
- NRCS TR-60/TR-66

HEC-RAS Unsteady Flow Model

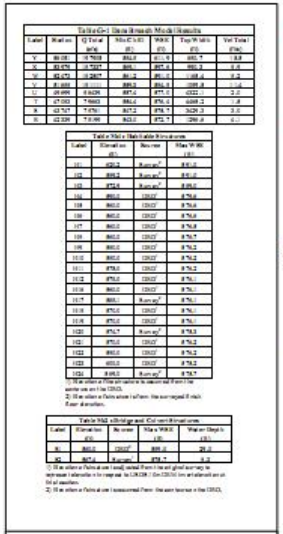


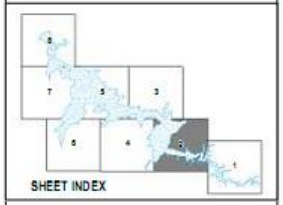


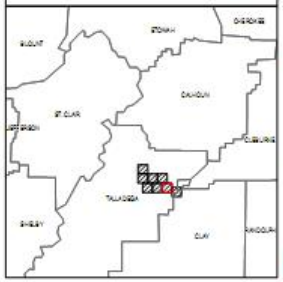


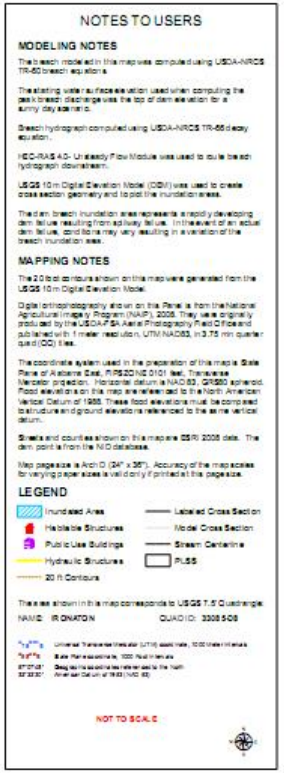


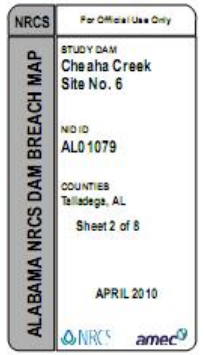
Dam breach inundation mapping



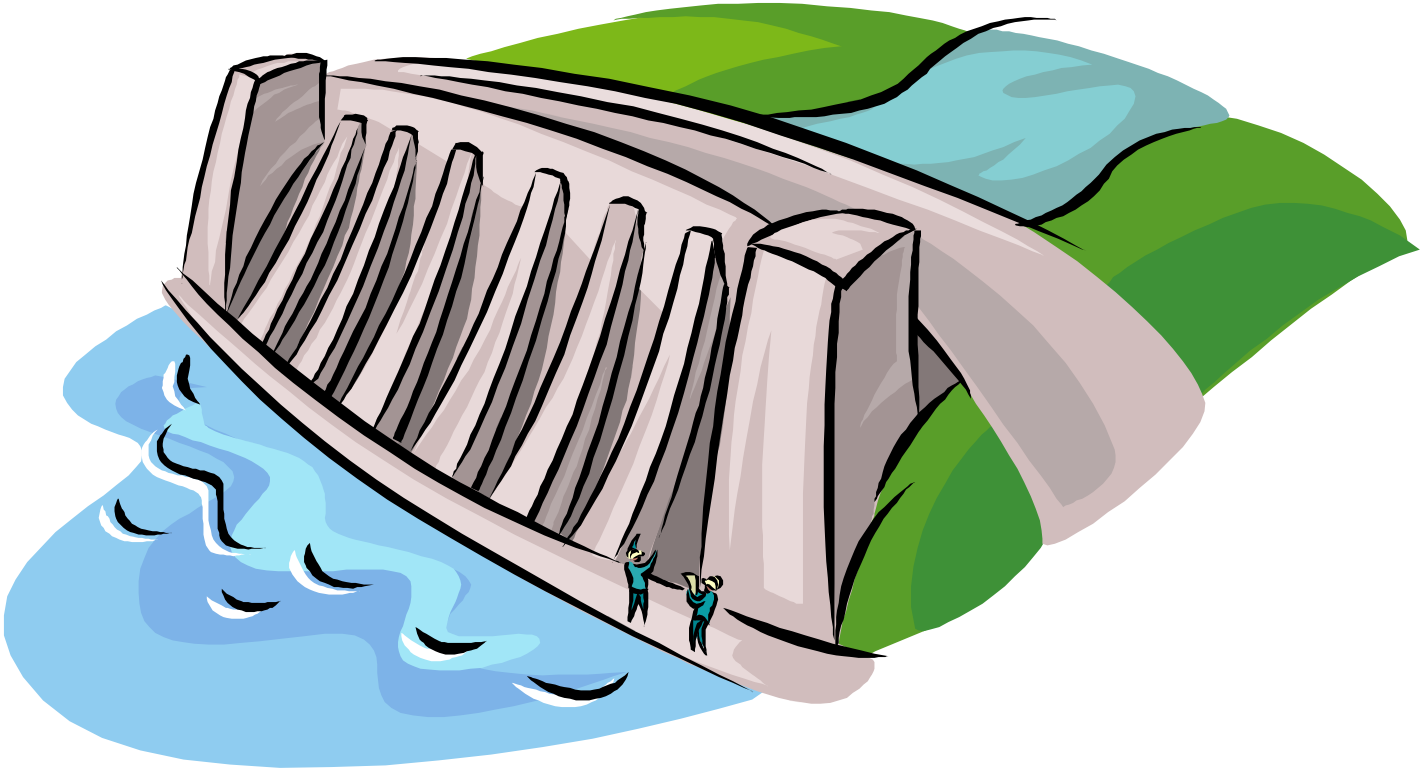








Downstream hazards do exist in Alabama!



Downstream hazard

Downstream hazards

Questions?

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