



*Federal Energy Regulatory Commission*

# **Federal Energy Regulatory Commission Condition Assessment for Dams**

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**Federal Energy Regulatory Commission**

**Division of Dam Safety and Inspections**

**San Francisco Regional Office**

**DOE Condition Assessment**

**Las Vegas, NV October 25, 2023**

# Outline

- FERC – Who are we and what do we do?
  - D2SI (Division of Dam Safety and Inspections)
  - Relationship with DOE
- Role as a Regulatory agency
- Dam safety inspection process
- D2SI Condition Assessment program
- Dam failures and incidents
- Q & A



# FERC – Who are we?



# Federal Energy Regulatory Commission

- The Federal Energy Regulatory Commission, or FERC, is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil. FERC also reviews proposals to build liquefied natural gas (LNG) terminals and interstate natural gas pipelines as well as licensing hydropower projects.
- This presentation focuses on hydropower only and more specifically dams





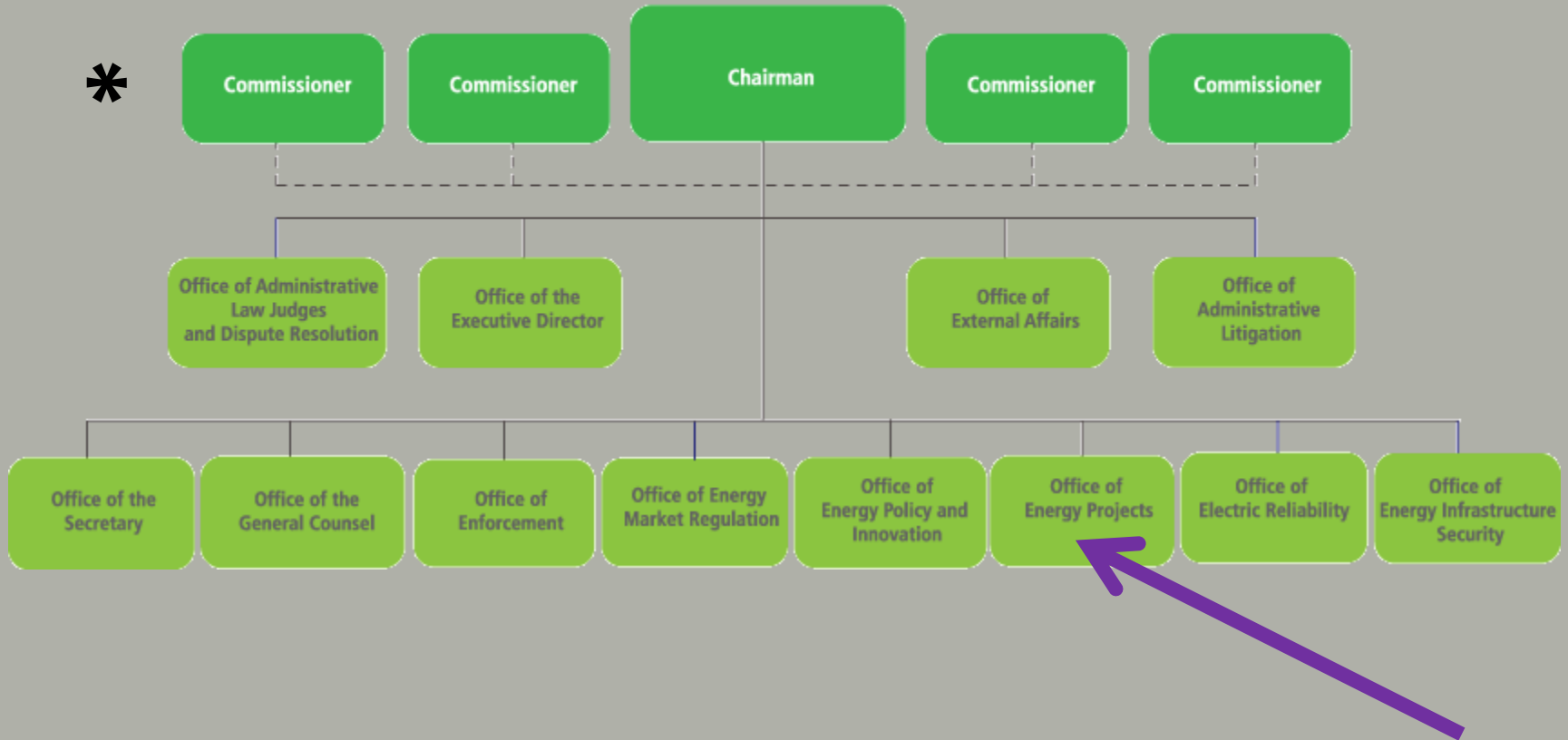
# FERC - Hydropower

- The Licensing of hydropower projects allow for the construction of a hydroelectric project that falls under the jurisdiction of the Division of Dam Safety and Inspections once it is licensed for construction.



# FERC General Organization Chart

## Federal Energy Regulatory Commission

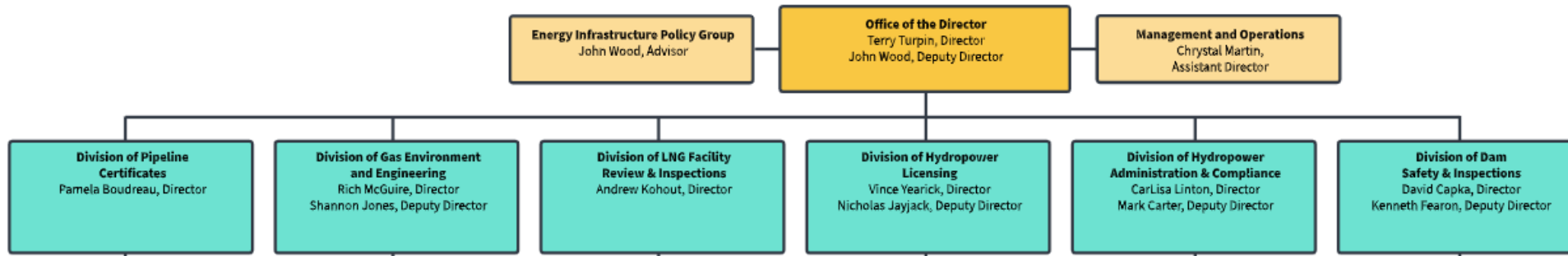


\* All commissioners appointed by the President of USA



# Office of Energy Projects

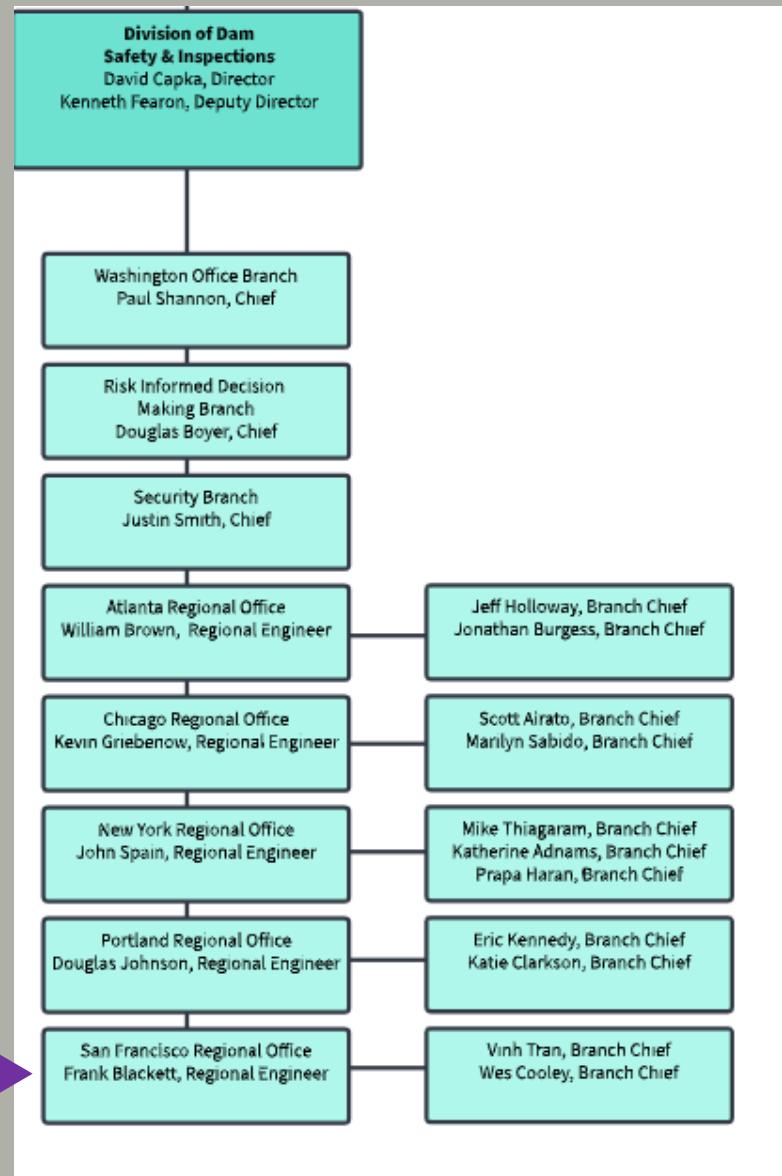
## Office of Energy Projects (OEP)



## Division of Dam Safety & Inspections (D2SI)



# Division of Dam Safety and Inspections



# DOE – FERC Relationship

- The relationship between DOE and the FERC can best be described as “it’s complicated!”
- Some of the highly generic items include:
  - Mostly related to the hydropower generation commonality
  - Coordinated out of Oakridge National Laboratory
  - FERC is an Independent Agency under DOE
  - DOE has grant funding for hydropower incentives
  - DOE worked with D2SI in early 2023 when developing grant funding
    - Added condition assessment rating of dams as one of the screening criteria for providing grant money



# DOE – FERC Relationship

- Grant Funding
  - EPLA 2005 – Section 247: Application Guidance for the Maintaining and Enhancing Hydroelectricity Incentives
  - Links NID **Condition assessment**/classification to selection process
- <https://www.energy.gov/sites/default/files/2023-05/Section-247-Guidance-for-2023.pdf>



# DOE – FERC Relationship

- DOE recently released “Mapping a path toward a modern vision for hydropower”
- <https://hydropowervision.pnnl.gov/>
  - The release of the [Hydropower Vision](#) report in 2016 lays out a path to grow hydropower and storage capacity from 101 gigawatts today to 150 gigawatts by 2050.
  - The Department of Energy made a commitment to the hydropower community to make the Vision report a living document. To uphold that commitment, we recently reimagined the Hydropower Vision Roadmap with the support of the hydropower community.



# Division of Dam Safety and Inspections





# D2SI Mission

- **Inspections** are the backbone of the **dam safety** program and are an effective tool for **detecting and preventing potential catastrophic structural failures**. In the event of a dam failure, there are both loss of life and economic (property damage, environmental impacts and costs associated with loss of use of the resource) consequences.
- Through inspections the Commission is able to **verify that the dams meet current Commission dam safety criteria**, identify necessary investigations, remedial modifications or required maintenance, and ensure compliance with license requirements.

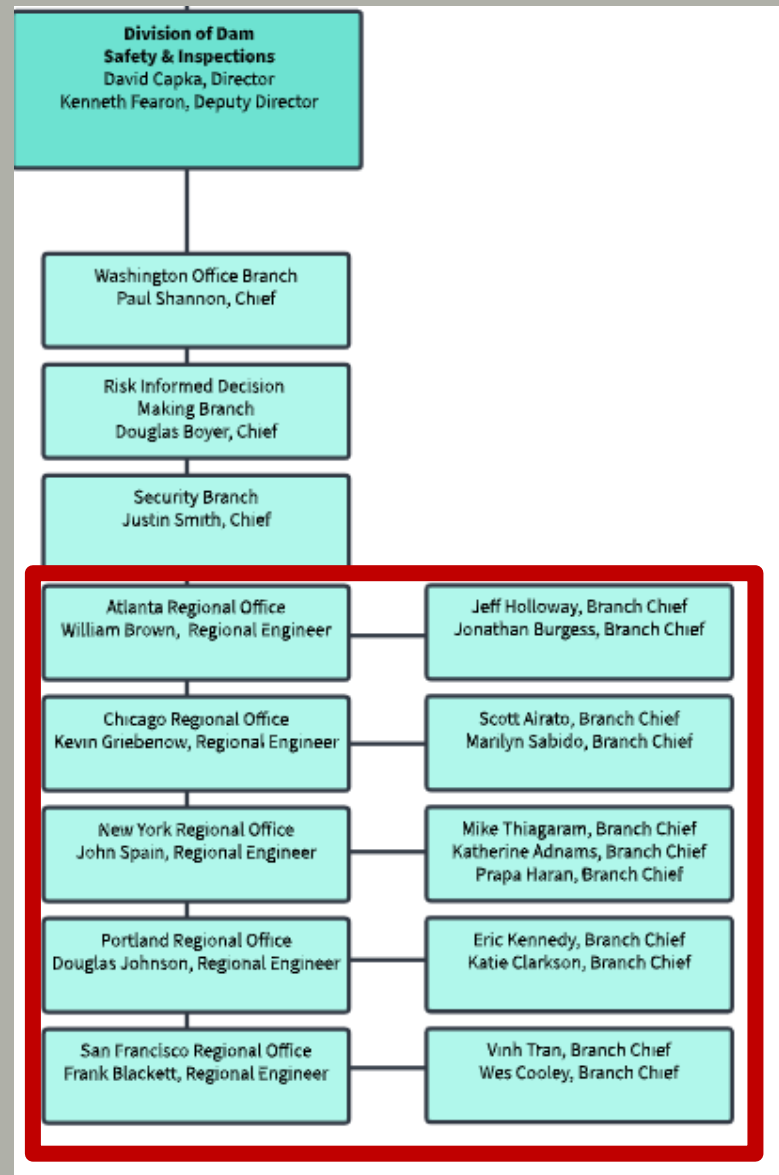


# D2SI Mission

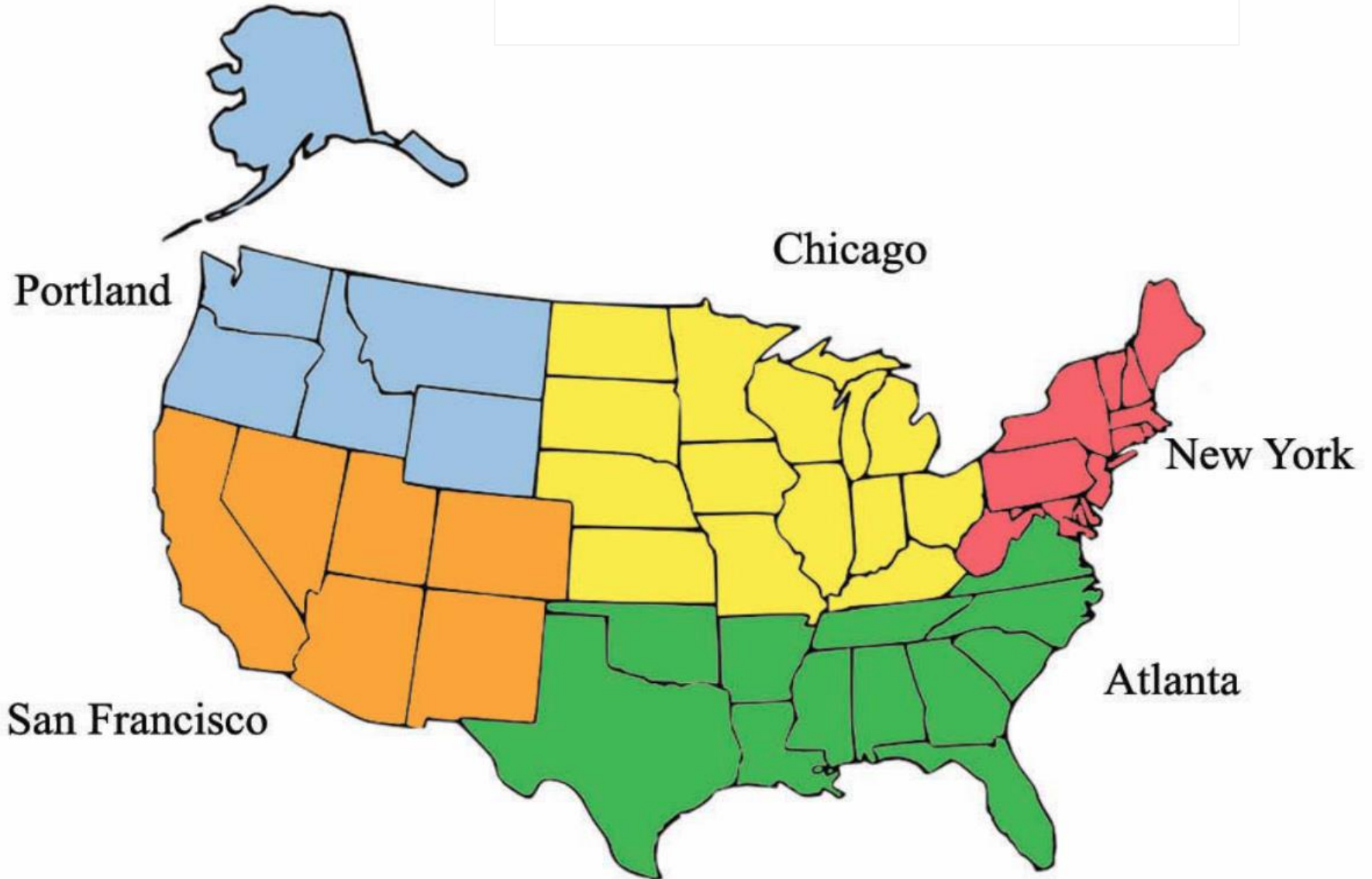
- The Division of Dam Safety and Inspections (D2SI) is responsible for **ensuring the safety of the Commission's hydroelectric projects and implementing the Commission's dam safety, public safety, and security**. The safety programs apply advances in technology to address the technical challenges presented by the aging national water resources infrastructure. D2SI's safety related programs have a direct bearing on life, property and the environment.



# Division of Dam Safety and Inspections

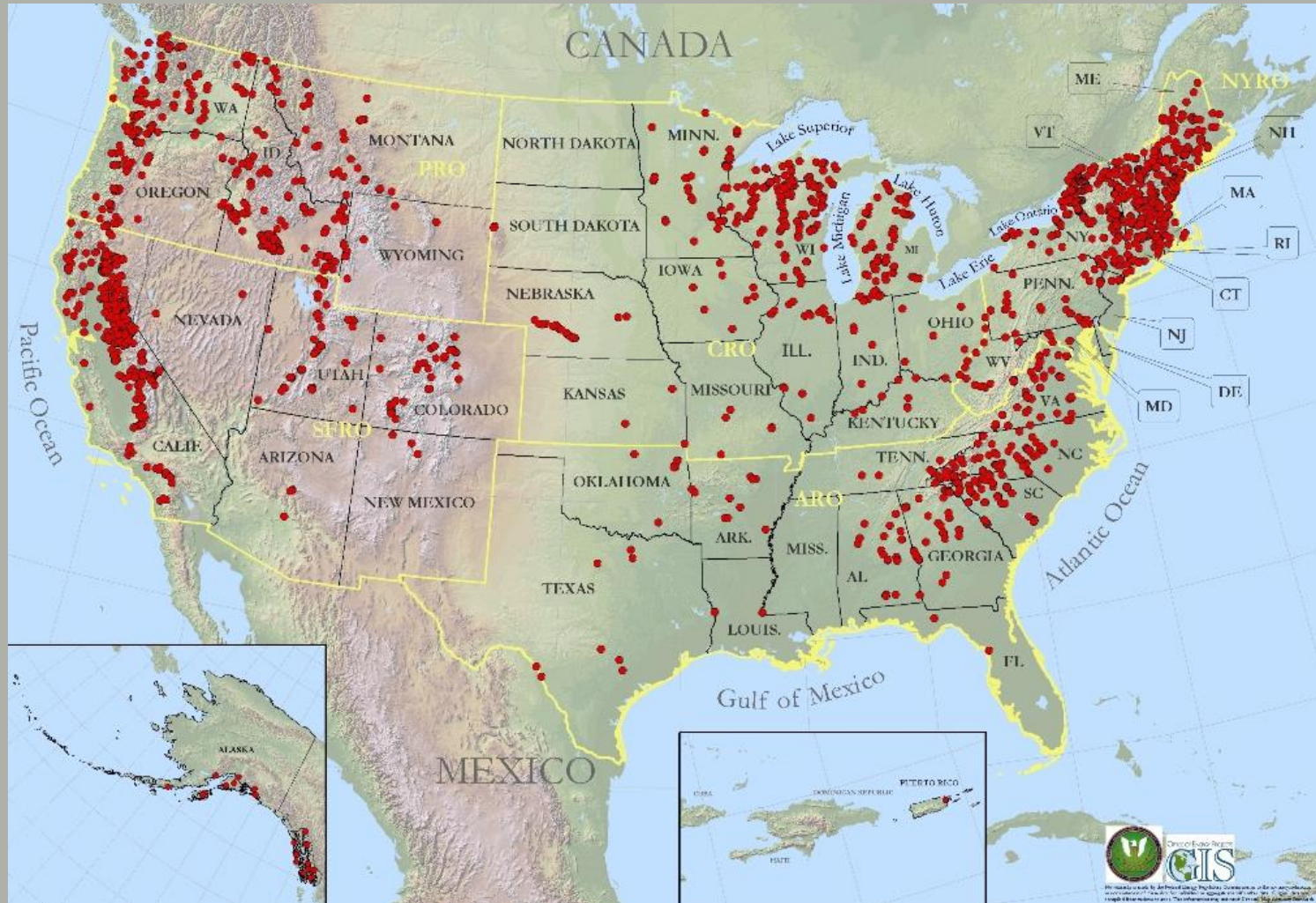


# D2SI Regional Offices





# Dams under FERC Jurisdiction



Hydro needs elevation difference - mountains



# Division of Dam Safety & Inspections

- Unlike other Federal Agencies (Reclamation, Army Corps of Engineers, Tennessee Valley Authority, Bonneville Power) we do not own and operate dams
- *Side note – most states have a similar regulatory role of varying involvement. Some dual regulation*
- Qualification for FERC Jurisdiction
  - Located on Federal Property
  - Located on a navigable waterway
  - Introduces electricity into the interstate grid



# D2SI Mission

- The Federal Power Act (1920) is the original source of our regulatory oversight authority
- 18 CFR Part 12 is current regulations
  - Revised in April 2022
  - Significant changes to Part 12D – Review, Inspection, and Assessment by Independent Consultant
    - Implemented risk-informed decision-making into our dam safety program, every 10 years
- Engineering Guidelines – licensees obligated to follow these guidelines



# FERC Engineering Guidelines

## Hydropower

Overview

Licensing

Administration and Compliance

### Dam Safety and Inspections

Regulations, Guidelines,  
Manuals

Meetings, Workshop,  
Panels

Initiatives

### Risk-Informed Decision Making (RIDM)

Security Program

Case Histories

[HOME](#) > [INDUSTRIES DATA](#) > [HYDROPOWER](#) > [DAM SAFETY AND INSPECTIONS](#) > [ENGINEERING GUIDELINES FOR THE EVALUATION OF HYDROPOWER PROJECTS](#)

## Engineering Guidelines for the Evaluation of Hydropower Projects



- [Preface](#)
- [Drilling](#) - About Drilling at Embankment Dams [Read More](#)
- [Chapter 1](#) - General Requirements [Read More](#)
- [Chapter 2](#) - Selecting and Accommodating Inflow Design Floods for Dams [Read More](#)
- [Chapter 3](#) - Gravity Dams [Read More](#) →
- [Chapter 4](#) - Embankment Dams [Read More](#) →
- [Chapter 5](#) - Geotechnical Investigations and Studies
- [Chapter 6](#) - Emergency Action Plans [Read More](#) →
- [Chapter 7](#) - Construction Quality Control Inspection Program
- [Chapter 8](#) - Determination of the Probable Maximum Flood
- [Chapter 9](#) - Instrumentation and Monitoring
- [Chapter 10](#) - Other Dams
- [Chapter 11](#) - Arch Dams
- [Chapter 12](#) - Water Conveyance
- [Chapter 13](#) - Evaluation of Earthquake Ground Motions [Read More](#)
- [Chapter 14](#) - Dam Safety Performance Monitoring Program
- [Chapter 15](#) - Supporting Technical Information Document
- [Chapter 16](#) - Part 12D Program
- [Chapter 17](#) - Potential Failure Modes Analysis
- [Chapter 18](#) - Level 2 Risk Analysis

### Quick Links

- [Annual Spillway Gate Operation Certificate DOC](#)
- [Annual Spillway Gate Operation Certificate PDF](#)
- [Testing and Reporting on Spillway Gate Operations](#)
- [Revised Dam Safety Surveillance Monitoring Plan and Report \(DSSMP/DSSMR\) - Appendices J and K](#)
- [Status of Proposed New Chapters and Proposed Revisions](#)



- <http://www.ferc.gov/industries/hydropower/safety.asp>
- These guidelines are used internationally





# FERC Dam Inventory

Region	Hazard Potential Rating			Total
	High	Significant	Low	
Atlanta	187	15	115	317
Chicago	175	28	226	429
New York	187	123	503	813
Portland	121	15	260	396
San Francisco	163	25	402	590
<b>Total</b>	<b>833</b>	<b>206</b>	<b>1506</b>	<b>2545</b>

Dam heights range from 770 feet (Oroville) to several less than four feet high.

Dam owners range from large utilities (approx. 145 dams) to individuals with only one dam.



# Hazard Classification

<b>Hazard Potential Classification</b>	<b>Loss of Human Life</b>	<b>Economic, Environmental, Lifeline Losses</b>
Low	None expected	Low and generally limited to owner
Significant	None expected	Yes
High	Probable. One or more expected	Yes (but not necessary for this classification)



# Regulatory Role in Dam Safety

## D2SI Staff Duties



# Inspections!

## And a whole lot more!

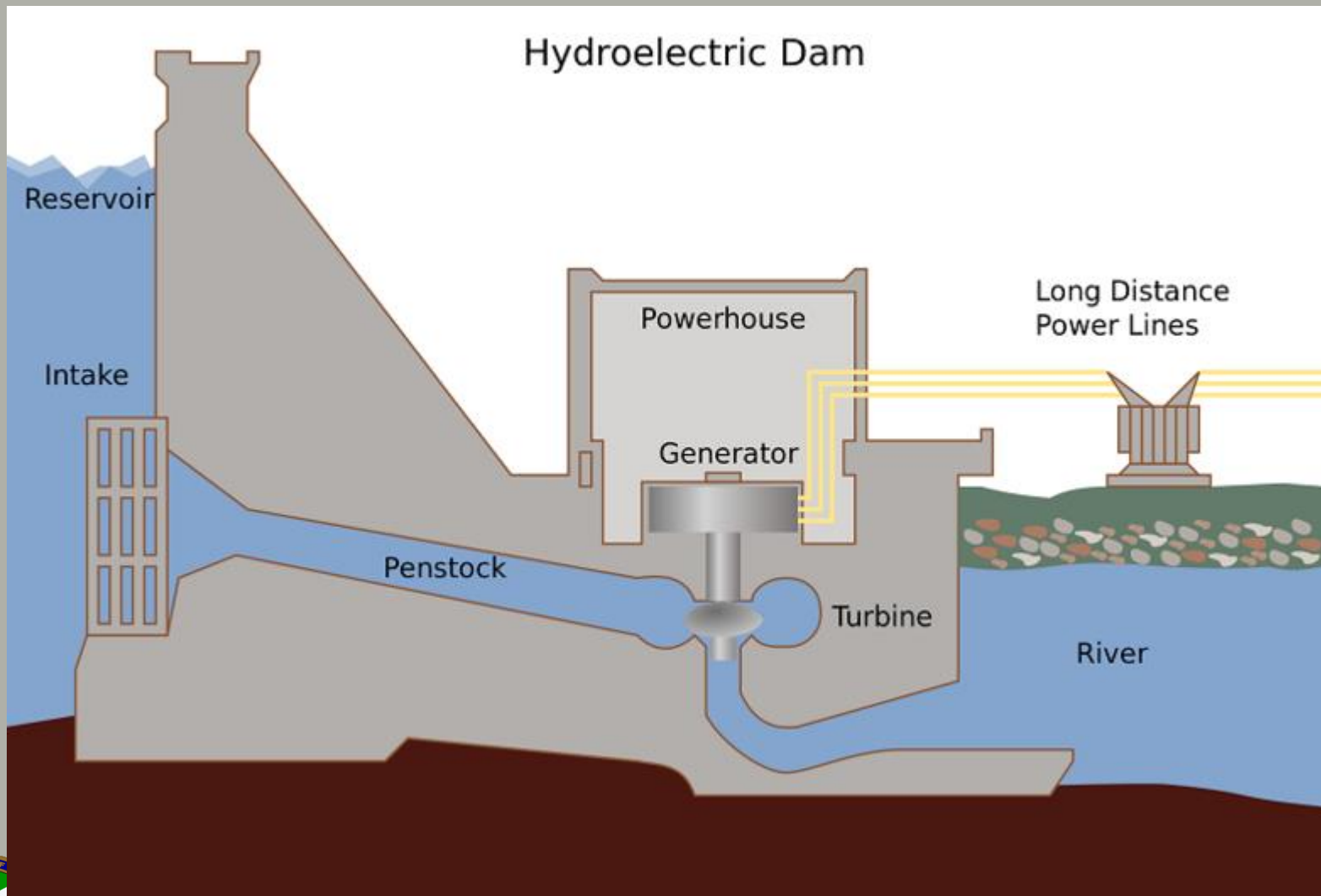


# Inspection Features Inspected

- Various types of concrete dams
- Various types of earth fill embankment dams
- Other dam types such as timber crib dams and various combinations of construction
- Penstocks, 10's of feet to 10's of miles of conveyance features
- Underground powerhouse
- Outlet works tunnels
- Construction inspections and oversight
- Spillways
- Etc...



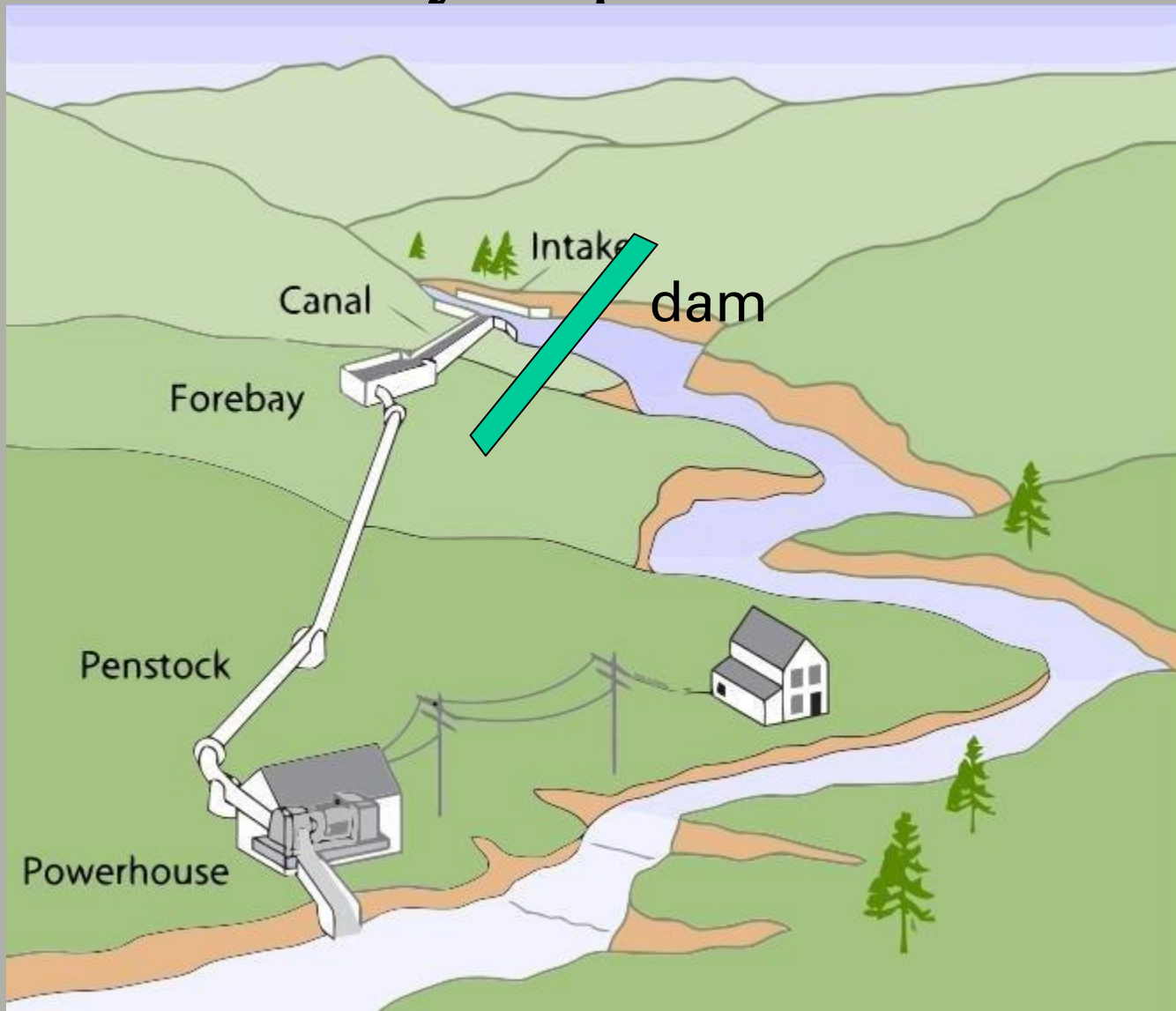
# General Hydropower Schematic



Typical layout when powerhouse is at the toe of the dam



# General Hydropower Schematic



When powerhouse is not at dam



# Inspection Process

- Each staff engineer has a list of projects assigned to them. They are accountable for all aspects of the project.
- They perform a desktop review of past inspections, outstanding dam safety items and documentation
- Pre-briefing with their immediate supervisor
- Travel to and inspect the project. Inspect all parts of the project within the FERC project boundary that are associated with impounding or conveying water from one end of the project to the other.





# Inspection Process

- Staff expected to be a “jack-of-all trades”
  - Inspect multiple dams of various types, penstocks, canals, spillways, outlet works, instrumentation, mechanical and electrical equipment, geology, etc...
- De-brief with the licensee (owner)
- Post-inspection briefing with immediate supervisor
- Inspection follow-up letter, 2 weeks after the inspection
- Provides owner with any follow-up items they need to address



# Other Staff Responsibilities

- Non-inspection season activities
  - Write inspection report
  - Review engineering analyses / required submittals
    - Slope stability
    - Structural stability
    - Flood studies
    - Seismic studies
    - Instrumentation reports
    - Inundation maps
    - Emergency Action Plans
    - Numerous other required submittals



# Examples of FERC Projects



# Concrete Multiple Arch Dams





# Concrete Dams



635 feet tall

350 feet tall





# Smaller Concrete Dams



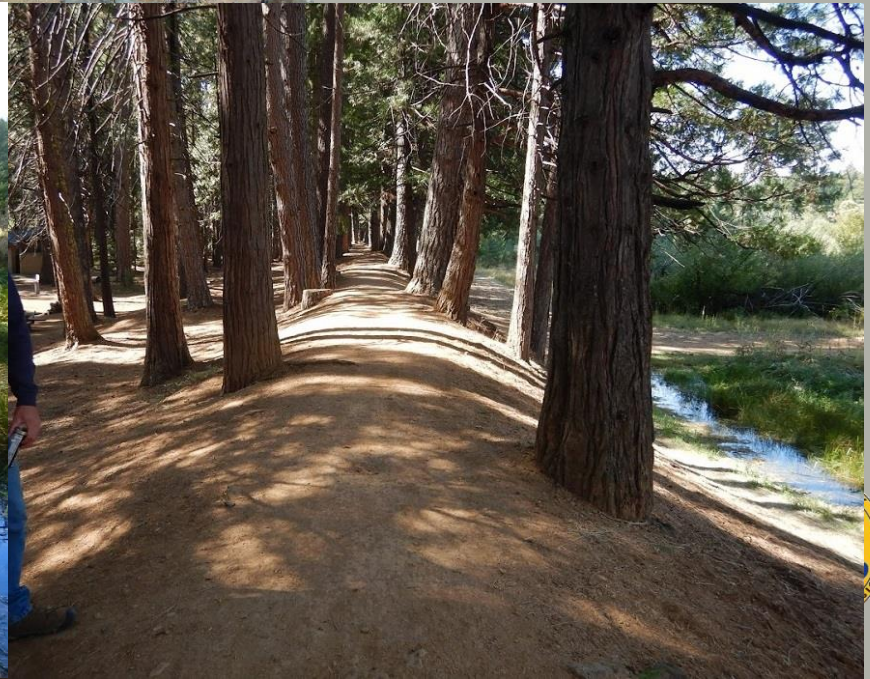


# Embankment / Earthfill Dam





# Embankment / Earthfill Dam





# Composite Dams



Embankment

Integral Power house

Gated Spillway

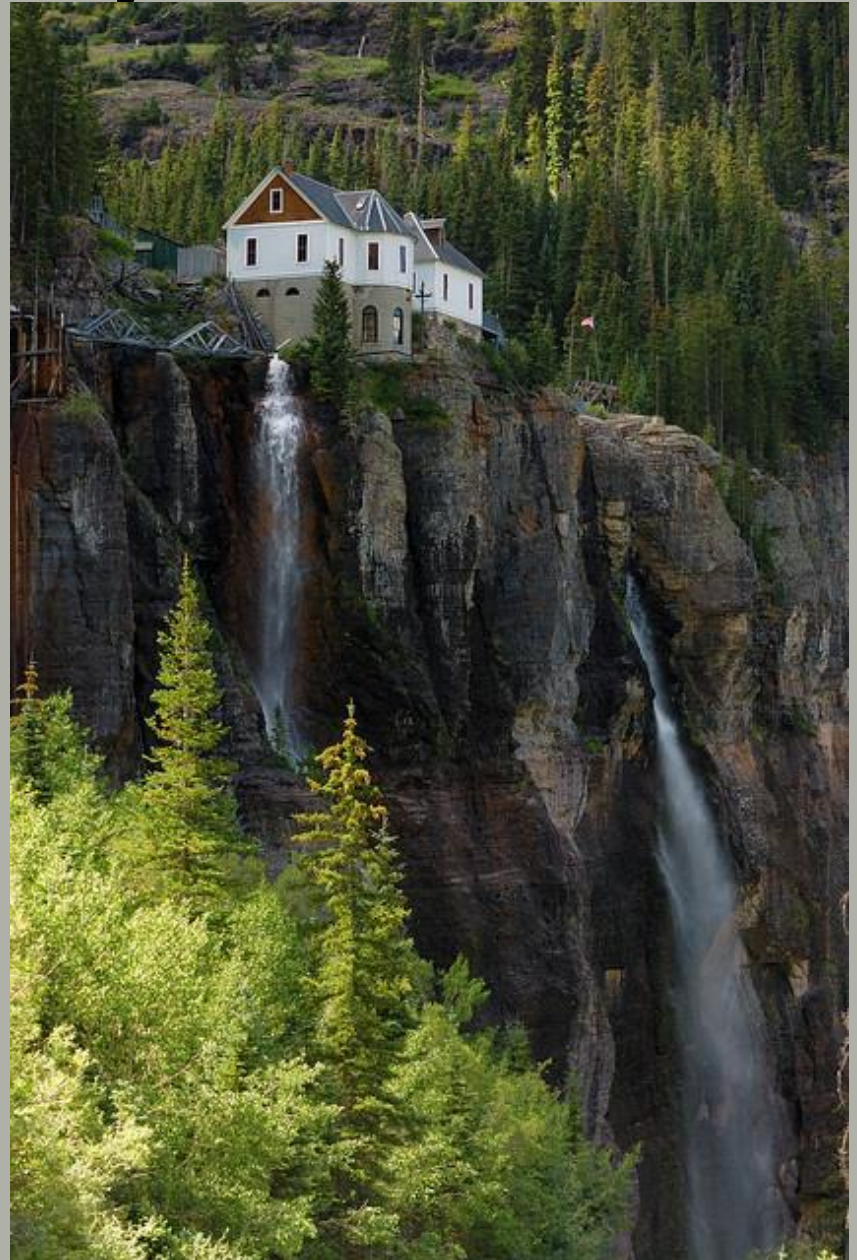
Embankment

8,320 feet long





# Scenic Projects





# Scenic Projects





# Wide Variety of Small Hydro Projects



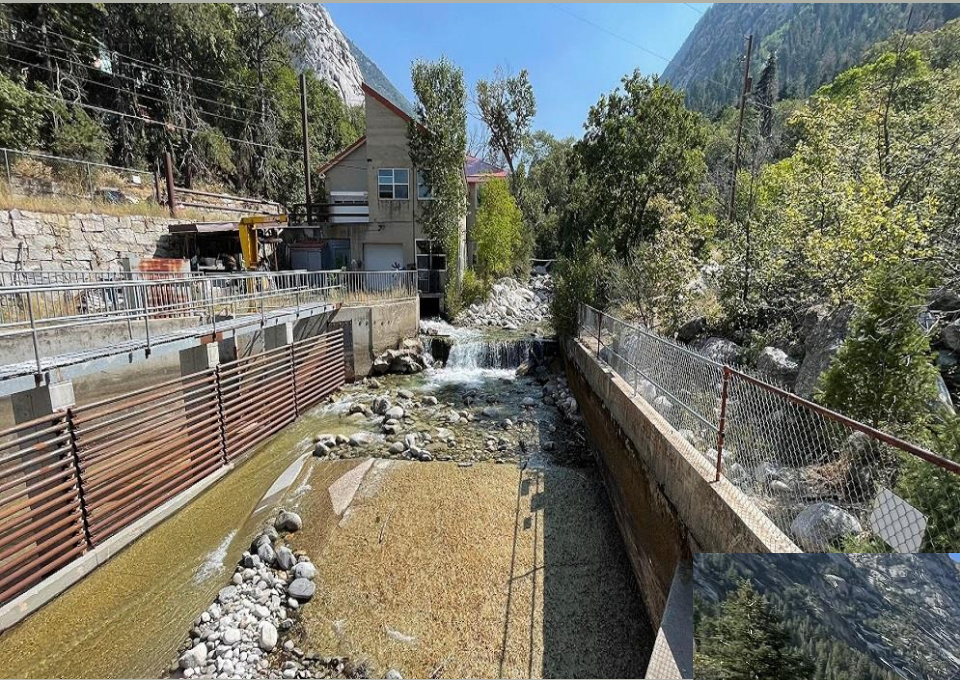


# Wide Variety of Small Hydro Projects





# Wide Variety of Small Hydro Project

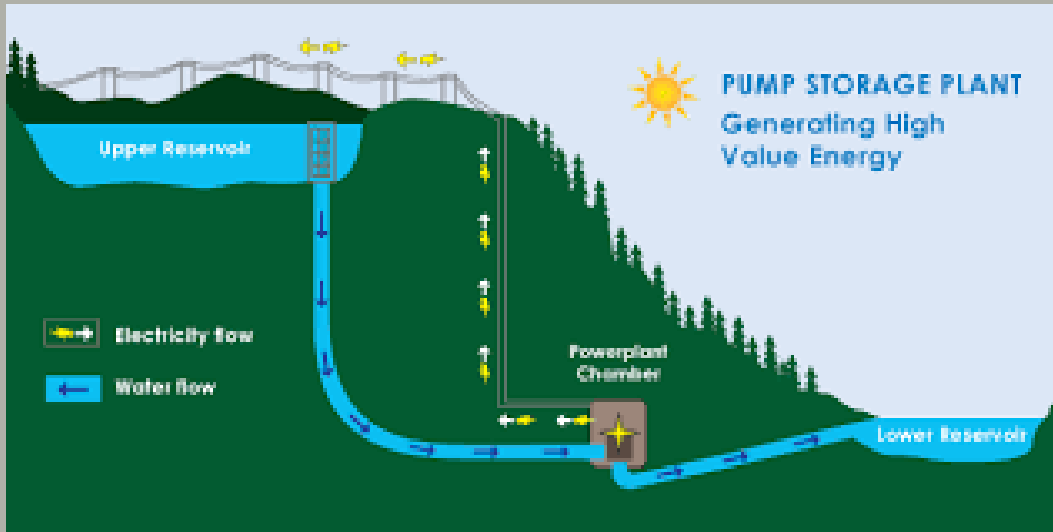




# Wide Variety of Small Hydro Project



# Pumped Storage Projects





# Spillways





# Spillways





# Outlet Works





# Penstocks



© 2015  
© 2015



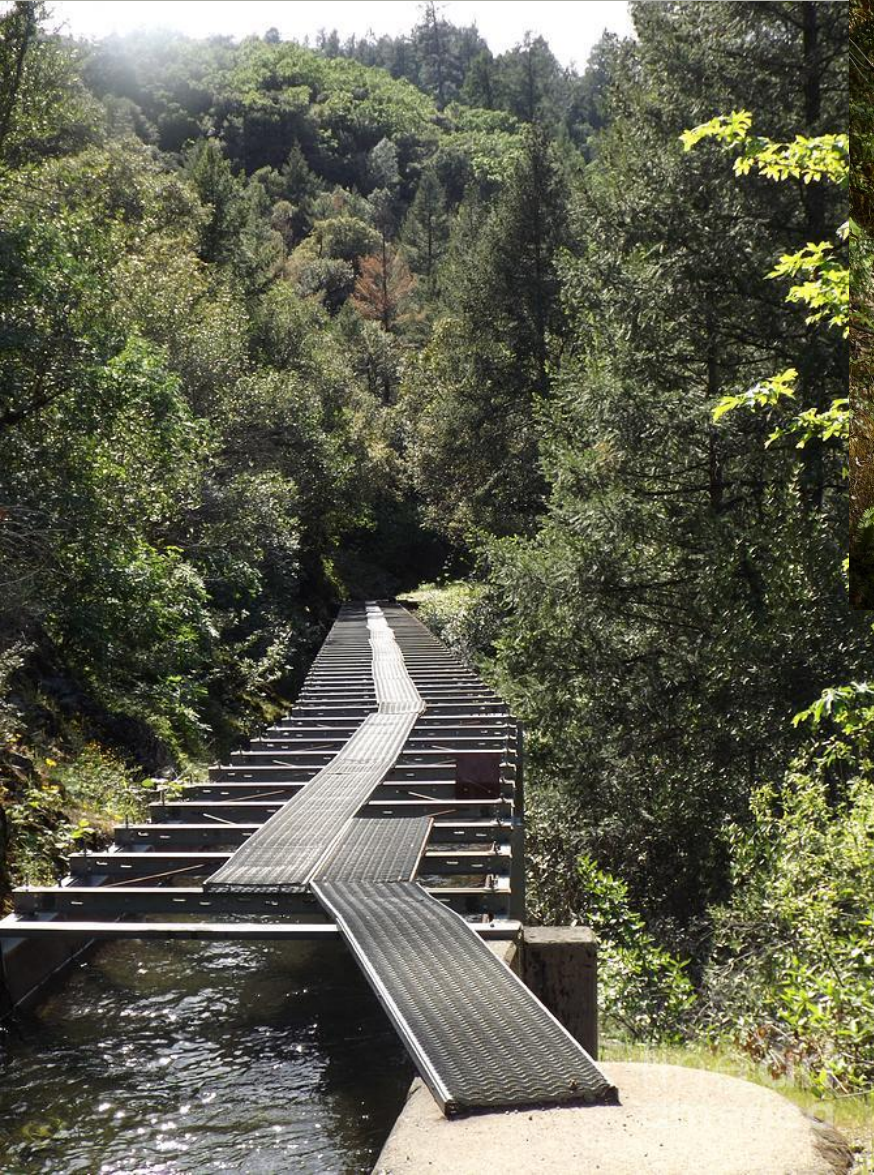


# Penstocks





# Other Conveyance Features



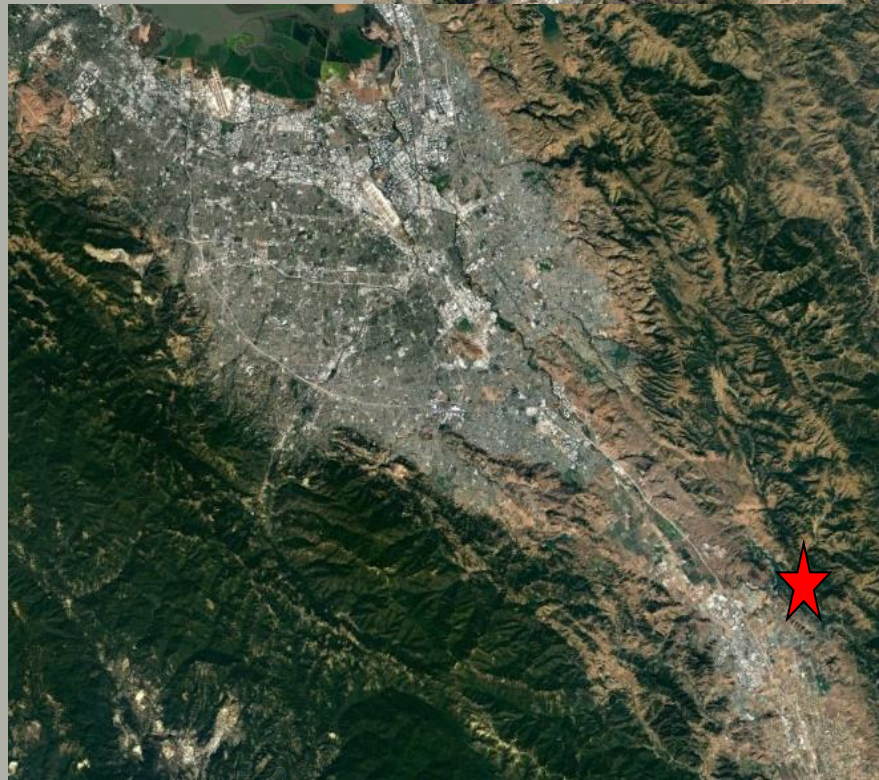


# Other Conveyance Features





# High Consequence Dams





# Construction





# Construction





# Construction





# Construction





# Construction





# Condition Assessment National Inventory of Dams (NID)



# NID

- FERC has not historically released the condition assessment of FERC dams to the public.
- USACE (Army Corps) recently decided to make the condition assessment of dams public information on the NID website.
- We are using NID definitions for CA, although we have some slight differences with how we track information. Based on interim risk reduction measures and loading conditions
- Based upon our inspections, the Part 12D inspections, review of engineering analyses.





# NID Definitions

Condition Assessment	Definition
Satisfactory	No existing or potential dam safety deficiencies are recognized. <b>Acceptable performance</b> is expected under all loading conditions (static, hydrologic, seismic) in accordance with the minimum applicable state or federal regulatory criteria or tolerable risk guidelines.
Fair	No existing dam safety deficiencies are recognized for normal operating conditions. <b>Rare or extreme hydrologic and/or seismic events</b> may result in a dam safety deficiency. Risk may be in the range to take further action. Note: Rare or extreme event is defined by the regulatory agency based on their minimum applicable state or federal criteria.
Poor	A dam safety <b>deficiency is recognized for normal operating</b> conditions which may realistically occur. Remedial action is necessary. <b>POOR</b> may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Investigations and studies are necessary.
Unsatisfactory	A dam safety deficiency is recognized that <b>requires immediate or emergency</b> remedial action for problem resolution.
Not Rated	The dam <b>has not been inspected</b> , is not under state jurisdiction, or has been inspected but, for whatever reason, has not been rated.



# NID

- D2SI uses other internal processes, not just condition assessment, to manage our program
- Newly revised Part 12D process plays a major role in our dam safety program
  - Complete Independent Consultant major review every 10 years
- The addition of risk-informed decision-making (RIDM) and our Level 2 Risk Analysis (L2RA) also play a major role





# Should There be Regulatory Oversight of Dam Safety?

**Show and tell!**



# Dam Safety

- Unfortunately, not everyone does the right thing.
  - Funding challenges
  - Complacency
  - Arrogance
  - Ignorance
- Multiple world-wide dam failures / incidents ranging from no fatalities to thousands of fatalities
  - Some most recent dam failures / incidents
    - » Libya – possible more than 10,000 lives lost
    - » Edenville, MI
    - » Oroville, CA (Spillway Incident)



# Dam Safety

- Teton Dam (Idaho) failure in 1976 paved the way for current day dam safety programs
- Full workshops on case histories of dam failures
  - Learn from our mistakes
- A few other dam failures/incidents are briefly mentioned here





# Teton Dam

- 305 feet high
- Completed 1976
- Failed June 5, 1976
- 288,250 ac-ft capacity





## Teton Dam near Rexburg, ID Changed Face of Dam Safety







Teton Dam, 1976  
Bureau of Reclamation  
Dam







Teton Dam, 1976







Teton Dam, 1976







Teton Dam, 1976







Teton Dam, 1976







Teton Dam, 1976











Teton Dam, 1976





Some of the flooding resulting from Teton Dam, 1976 - 11 deaths









# Teton Dam

Right abutment  
Dam failed at this point

Left abutment  
This portion of the dam  
removed by engineers to  
study embankment material



Teton Dam, today

More information at [www.usbr.gov](http://www.usbr.gov)







- Swift Dam No. 2
- Washington
- No deaths
- Piping into lava tubes in the foundation







## Vajont Dam Italy

- 1963
- 860 feet high
- Landslide failure into reservoir displaced entire reservoir
- 2000 deaths







# Bayless Dam Austin, PA





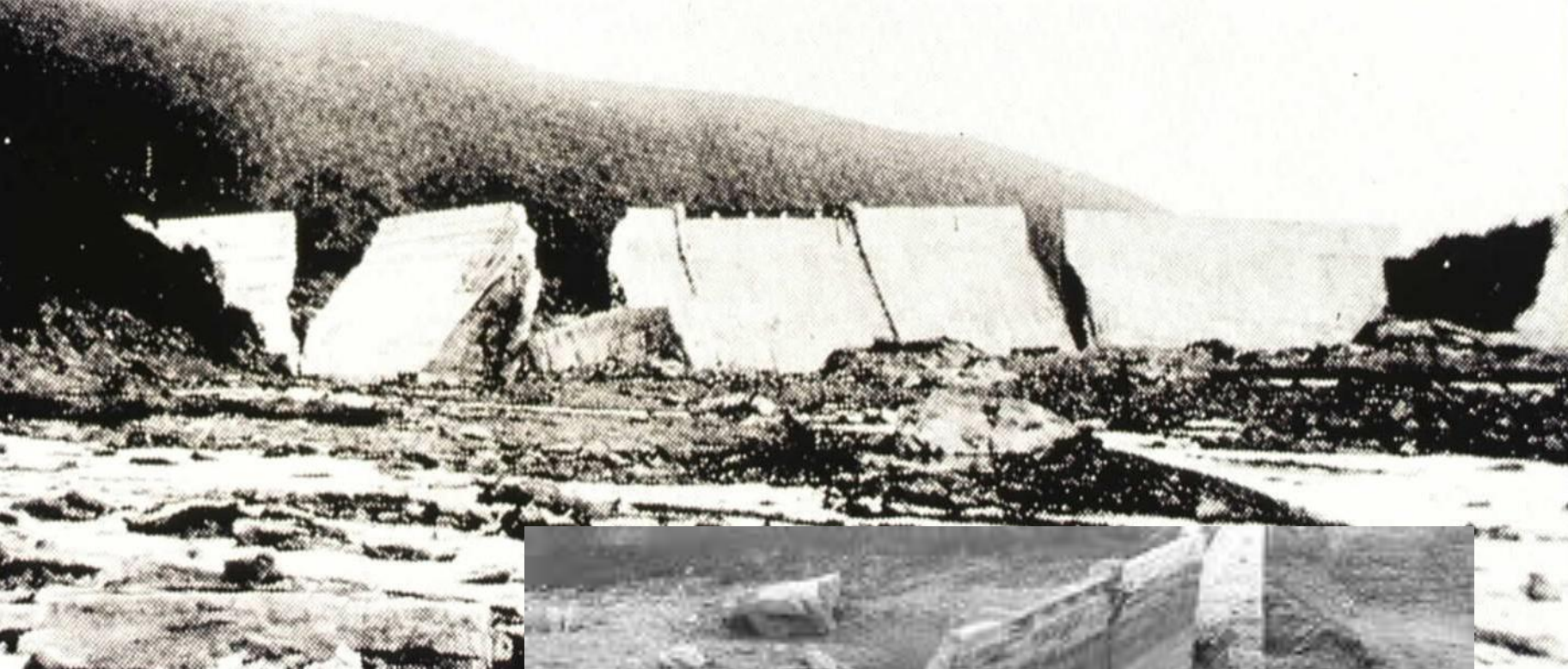
- Bayless Dam, PA 1911  
Paper Mill Dam failure
- Killed 78 people





- Bayless Dam, PA
- 1911 Paper Mill Dam failure
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- Bayless Dam, PA
- 1911 Paper Mill Dam failure
- Killed 78 people







- St. Francis Dam
- Near Los Angeles
- Failed 1928
- Killed over 400
- **Attributed to arrogant design engineer**



Photo courtesy of the Santa Clarita Valley Historical Society



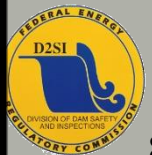
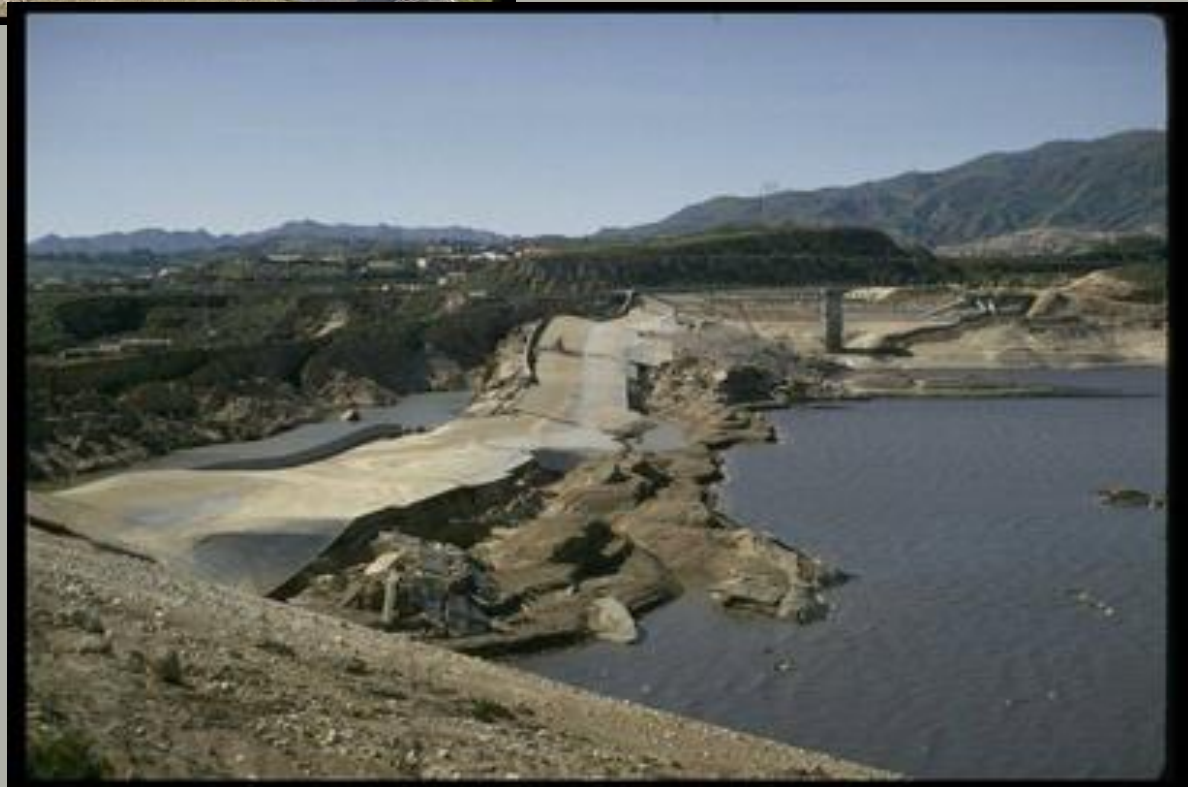


- San Fernando Dam
- California
- No deaths





- San Fernando Dam
- Los Angeles
- 1971 Earthquake
- Liquefaction



# Oroville Dam, CA





# Oroville Dam

- Spillway Incident in 2017
- 770-foot high, 6,920-foot-long embankment dam
- 3,000 by 200-foot-wide spillway chute
- 3.5-million-acre-foot reservoir at elevation 901
- Incident resulted in the evacuation of 188,000 people
- No deaths



# Oroville Dam





# Oroville Dam

- By February 7, 2017 precipitation already at 145% of normal
- Not one specific storm event
  - Unprecedented number of atmospheric rivers one after another

## RIVERS OF RAIN

In a typical year, California receives between 10 and 15 “atmospheric river” storms. Since Oct. 1, there have been 30. Here are some of the major storms:



Source: Center for Western Weather and Water Extremes

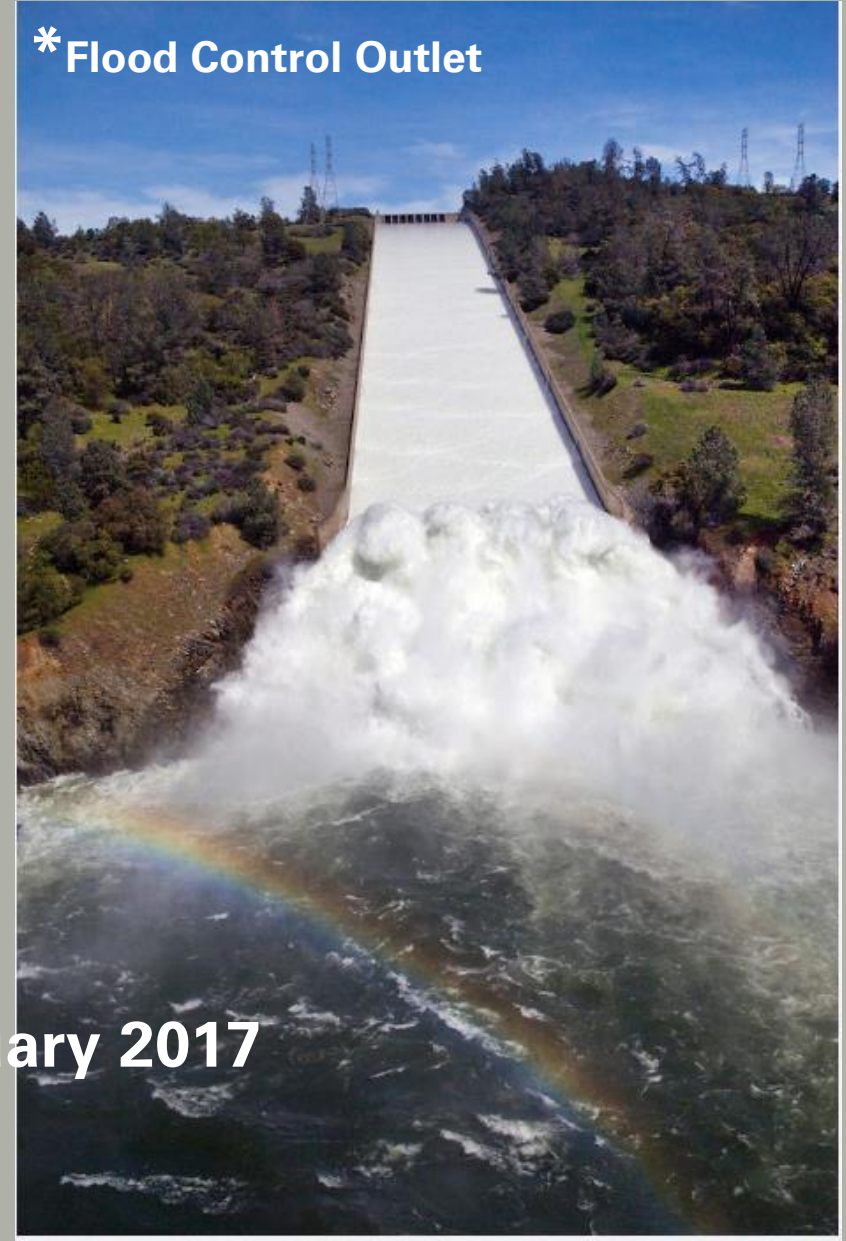
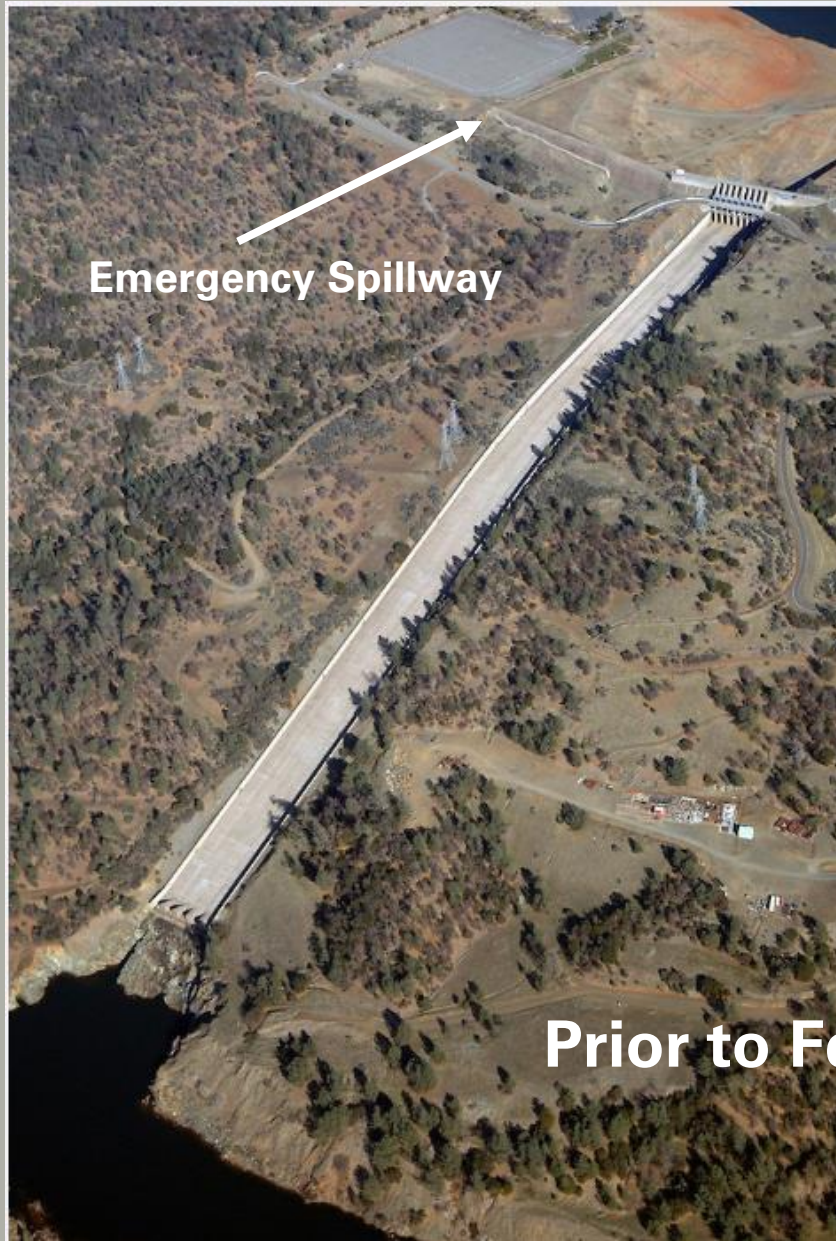
BAY AREA NEWS GROUP



Mercury News  
February 24, 2017



# Oroville FCO\* Spillway



\* Flood Control Outlet

Prior to February 2017







February 7, 2017



Note Person



02/





Note People







# Oroville FCO Spillway Chute



# Oroville Emergency Spillway



Morning of February 12, 2017  
Approximately 12,600 cfs





# Oroville Emergency Spillway



# Oroville Emergency Spillway



Late afternoon of February 12, 2017





100,000 cfs











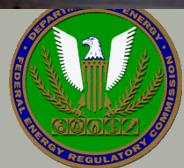




Nearly 1.8 million cy of material eroded and deposited into the Feather River







Emergency spillway erosion as the result of 12,600 cfs discharge



# Emergency Spillway Grouted Riprap









# FCO Spillway Progress





# Oroville Dam 2023





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## Questions?

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