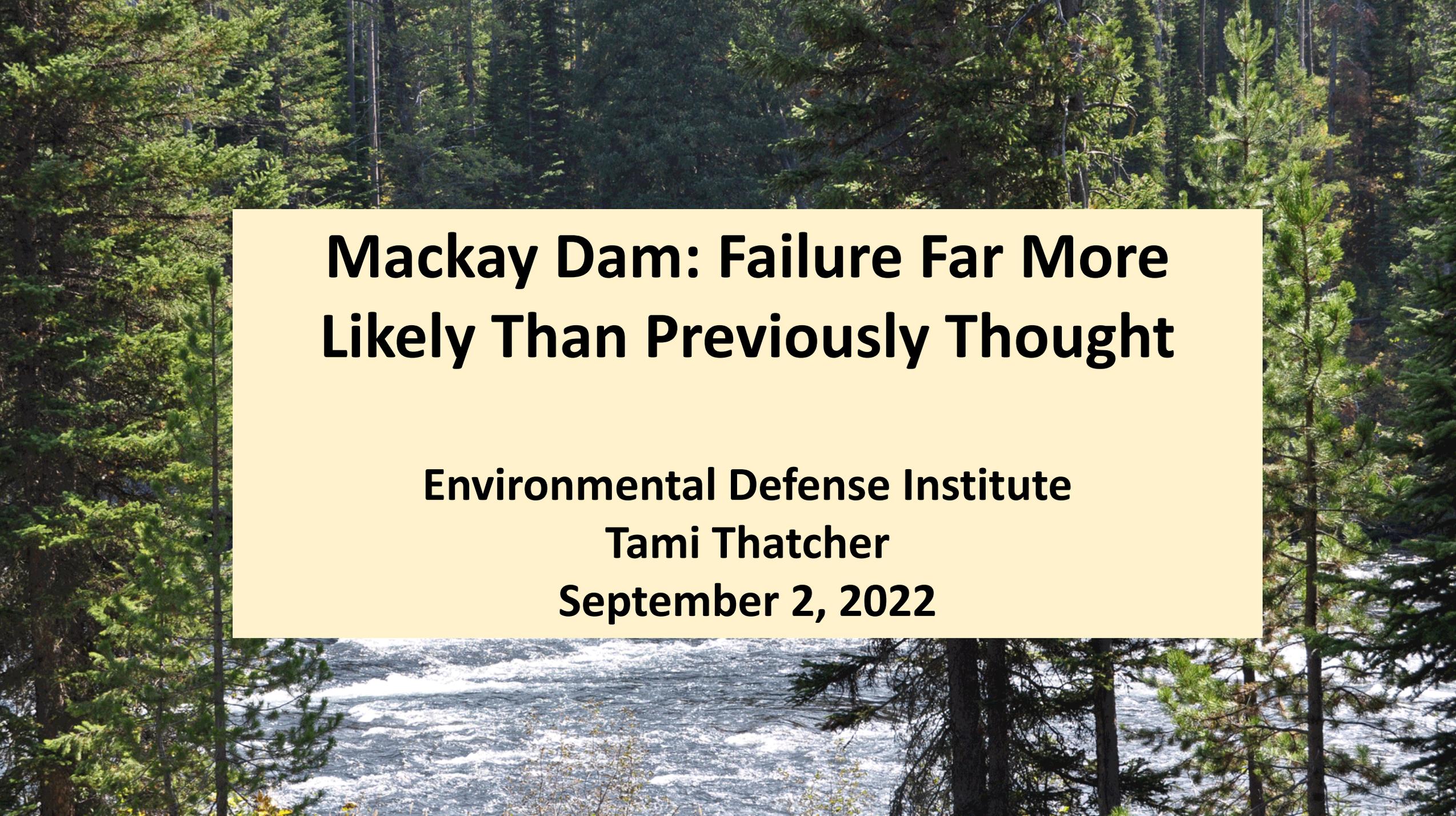




ENVIRONMENTAL DEFENSE INSTITUTE

**A non-profit focusing on radiation health effects and
radiological contamination from the Idaho National
Laboratory since 1990.**

WWW.ENVIRONMENTAL-DEFENSE-INSTITUTE.ORG



Mackay Dam: Failure Far More Likely Than Previously Thought

Environmental Defense Institute

Tami Thatcher

September 2, 2022

Mackay Dam, Custer County Idaho

**Poses a threat to the town of
Mackay and
to the Idaho National Laboratory**

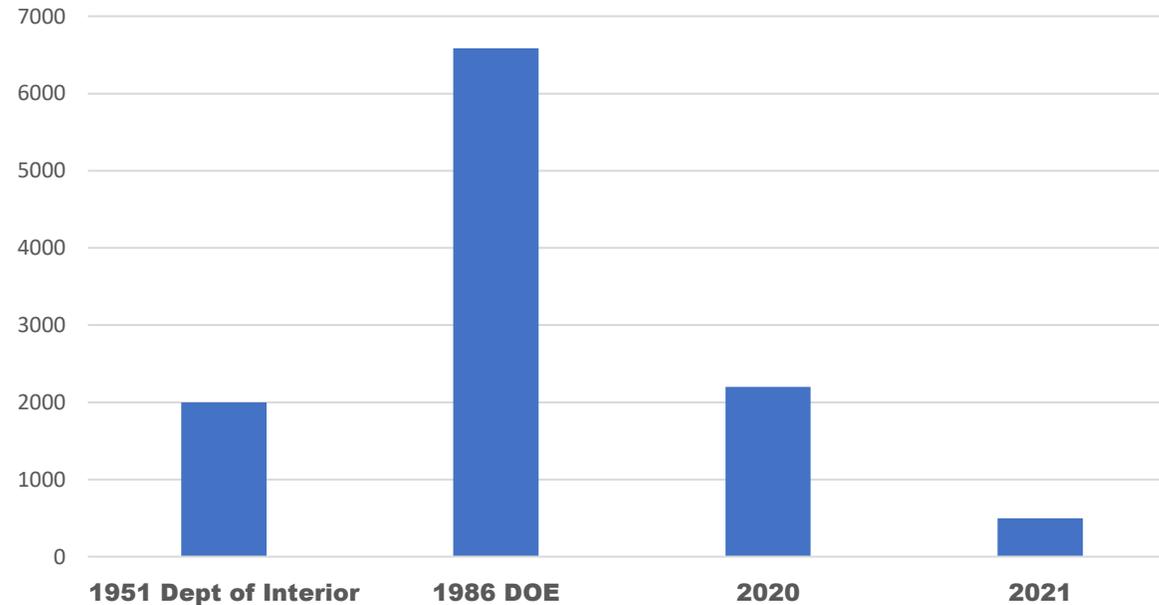
1986 Department of Energy funded study estimated that the Mackay Dam could withstand 1000-year flooding

2020 McMillen Jacobs study estimated Mackay Dam could withstand 500-year flooding

2021 McMillen Jacobs study found that the Mackay Dam would not withstand sustained 50-year flooding (only 25-yr flooding, 95% confidence)

Mackay Dam Spillway Capacity Estimates

Mackay Dam
Evolving estimates of Spillway Capacity,
Cubic Feet Per Second



Mackay Dam spillway estimates

- 1951 Bureau of Reclamation estimated 2000 cfs
- 1986 Department of Energy funded study by Koslow and Van Haaften state that the Mackay Dam spillway capacity was 6,588 cfs (by assuming the entrance width rather than the narrower width and by ignoring that this estimate overtopped the spillway walls)
- 2020 McMillen Jacob estimate spillway capacity of 2,200 cfs (using 24-ft spillway width rather than 75-ft entrance width)
- 2021 McMillen Jacob study concluded that the degraded condition of the spillway walls would cause failure of the spillway and then the dam if spillway flows sustained at 500 cfs (or 50-year flood)

Spillway concrete deterioration

- The spillway was never of adequate width.
- The spillway crosses over the embankment
- The spillway crosses over the outlet tunnel.
- The spillway experiences rockfall.
- The spillway walls are cracked and buckling.



Mackay Dam vulnerabilities

- Undersized and deteriorating spillway
- Rockfall from the limestone cliff compromises spillway and can partially block lower outlet gates
- Deteriorating outlet control tower and unreliable outlet gate control
- Deteriorating outlet tunnel and apron at outlet
- Embankment is not earthen, but is a sandy gravel
 - Steps to seal the upstream side of dam with “clayey” material never taken
 - Sandy gravel not compacted
 - Dam is subject to earthquake induced liquefaction
- Foundation of dam never to bedrock or solid base

The Outlet Tower is vulnerable to rock fall

Backhoe has Removed Rock and Debris from Gate. Gate on Right has a Bent Stem:



MACKAY DAM
34-2225
October 29, 1985

The outlet tunnel apron is deteriorating



Photo 3b (3/27/2013) – Similar view of the tunnel outfall at low flow conditions.

The outlet tunnel is deteriorating



The concrete core wall is of partial height and inadequate design and construction. The sandy gravel fill was not compacted.

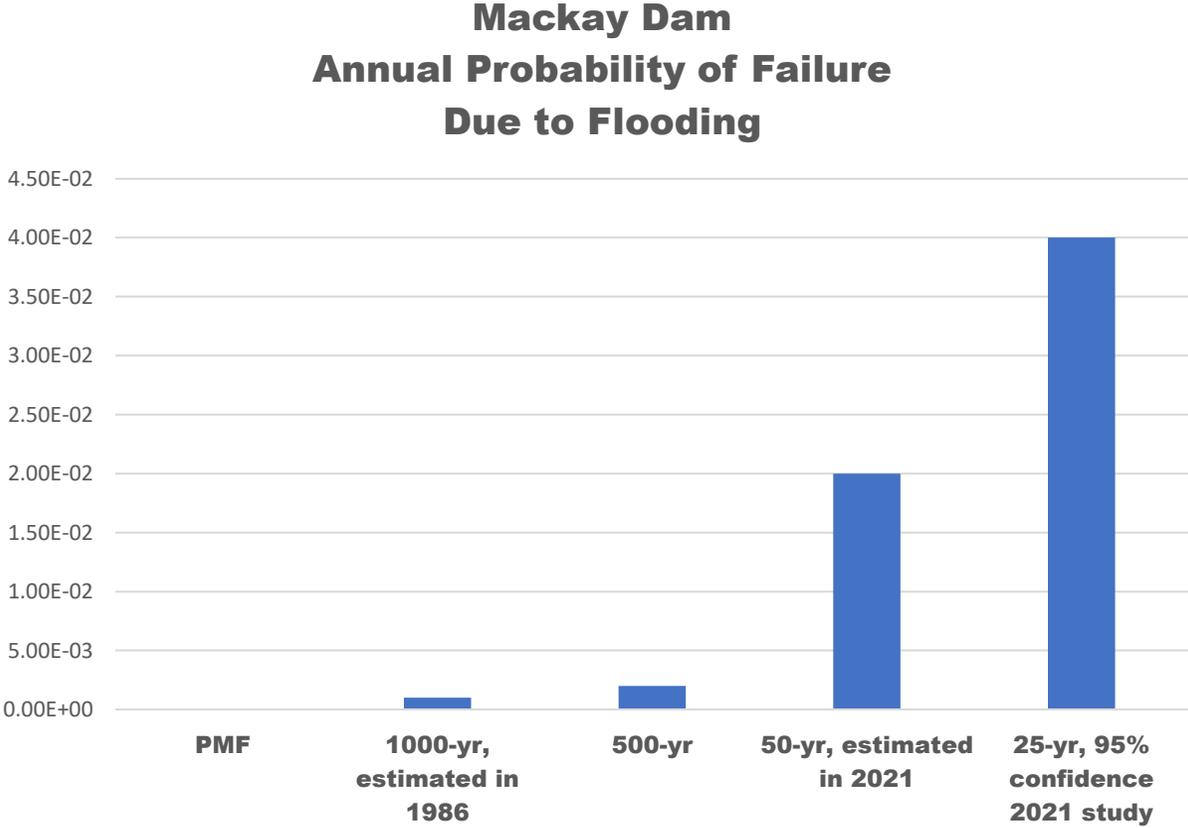
No. 2 shows the foundation course for the core wall being placed,



Mackay Dam Flood Vulnerabilities

- Large drainage area
- Probable Maximum Flood estimates that high hazard dams are normally designed to be able to release is 82,100 cfs
- At best, Outlet Works capability maximum at 3010 cfs plus spillway (2,200 cfs) would only be 5,210 cfs
- More realistically, Outlet Works capability will be about 2000 cfs and spillway fails at 500 cfs.
- High flow inflows (to Howell gage above inlet to the reservoir) set record in 2017. Had precipitation not been spread over three peaks, the dam could have failed.

Mackay Dam, Likely to Fail at 25-yr to 50-yr Flooding



Perception of Mackay Dam Safety

1951 – Bureau of Reclamation considers the Mackay Dam **an unsafe structure**, and estimates spillway capacity of 2000 cfs

1986 – Department of Energy funded study by Koslow and Van Haaften states that Mackay Dam can withstand 1000-yr flooding event, and estimates spillway capacity of 6588 cfs. They estimate an annual failure probability due to flooding at less than $1.0E-3/yr$

2020 – McMillen Jacobs study estimates spillway capacity of 2200 cfs. This corresponds to failure at 500-yr flooding, an annual failure probability due to flooding at $2.0E-3/yr$

2021 – McMillen Jacobs study then determines that due to spillway condition, it is likely to fail during sustained 500 cfs flow. This corresponds to failure at 50-yr flooding, an annual failure probability due to flooding at $2.0E-2/yr$. But this relies on several favorable assumptions. The 95 percent confidence failure is only at 25-yr flooding or $4.0E-2/yr$

Dam Crest Elevation Increases	Comment
Current dam crest, 6075.2 ft	<p>1956, addition of the 15-ft wide gravel parapet, surveys not accurate and often stated at 6076 ft.</p> <p>1956, addition of 5-ft ogee weir at spillway entrance, reduces safety</p>
Dam crest of 1932, 6070 ft	1932, addition of limestone from the spillway construction, spillway too small
Original dam crest, 6065 ft	1910, original height of the dam crest. Also note that the elevation of the entrance to the original spillway was 6055 ft.

History of “don’t ask – don’t tell” approach to Mackay Dam

- Early problems during construction were recognized.
- State Engineer identifies issues but design criteria not enforced
- 1932 spillway was too small and never adequately evaluated
 - Also may have cut into the upper core wall that had been required
- State Engineer opposes 5-ft ogee weir in 1956 that increases elevation of the reservoir but court rules for Big Lost River Irrigation District. Conditions of the decree not enforced such as maintaining reliable outlet gates and access to the tower.
- Inspections every 5 years or so, are relatively superficial.
- No analyses of hydraulic capability or seismic adequacy requested by Idaho Department of Water Resources

Failure of Mackay Dam would devastate the town of Mackay and loss of life is expected

- It has long been recognized that the flooding due to failure of the dam at high water would cause loss of life
- Floodwaters would exceed an 8 ft wall of water that arrives within 30 minutes of failure of the dam
- It has long been recognized that there is no time to evacuate citizens
- Without a dam, high flood waters can still occur, but rise over hours and days, allowing the ability to evacuate
- Incremental impacts studies that evaluate only the flood height to damage structures but not also the ability to evacuate may make an inadequate assessment

Failure of Mackay Dam can cause 4 to 5 ft flood depths at some INL facilities

- The 1986 study by Koslow and Van Haaften estimated flood depths are various Idaho National Laboratory nuclear facilities. Other more recent studies have excluded the Mackay Dam failure from consideration.
- The former nuclear fuel reprocessing facility at INTEC stores spent nuclear fuel in numerous facilities. Peach Bottom underground vaults, Three Mile Island fuel storage, casks and other facilities
- INTEC stores high level waste (HLW) such as the powdery calcine in partially underground vaults and the underground tanks of liquid sodium-bearing waste.
- The Advanced Test Reactor area and Naval Reactors Facilities are in the flood plain of the Big Lost River and also flood.

Failure of Mackay Dam can cause 4 to 5 ft flood depths at some INL facilities

- Moisture can compromise Peach Bottom spent nuclear fuel
- Stainless steels when exposed to chloride in ground water (or flood water) can cause chloride induced stress corrosion cracking. Calcine bins are stainless steel as are HLW liquid waste tanks.
- Even if radiological release is avoided, the costs of repairs and of complications due to flood waters would be high.
- Facilities built since 1986 have generally addressed the flood water potential. Facilities built prior to 1986 generally did not and could be flood vulnerable.
- Department of Energy not disclosing safety status.

Mackay Dam – No funding for improvements has been found

- The Big Lost River Irrigation District struggles to pay for routine repairs
- The McMillen Jacobs study initially sought more reasonable outlet and spillway release capability of 20,000 cfs. But then focused on more modest release capability and aims low and relies on old structures
- Accepting less than 1000-yr flooding capacity should not be considered acceptable
- Overall risk of the dam failing due to seismic events and other failures add to likelihood of failure due to flooding.

Mackay Dam – Certificate to Impound Water

- Termination of the Certificate issued by the Idaho Department of Water Resources must be accompanied with dismantling the structure
- IDWR needs to be transparent and accountable.
 - Idaho Statute (Idaho Title 42-1717) forbids legal action against the State and the IDWR for damages due to failure of the dam, even if IDWR's regulations and enforcement are inadequate.
 - Despite the mandated lack of accountability to citizens of Idaho, the IDWR must not recertify the Mackay Dam and must assure that it is put into a safe configuration ASAP.

If no funding is found to fix Mackay Dam, IDWR must not recertify the dam

- Funding will be needed to dismantle the dam
- Costs of damage will be far higher than the cost to dismantle the dam
- Funding, if found, for Mackay Dam “rehabilitation” must be to high standards, not simply aimed at least cost options



Thank you

WWW.ENVIRONMENTAL-DEFENSE-INSTITUTE.ORG

References

- See Environmental Defense Institute website at [environmental-defense-institute.org](https://www.environmental-defense-institute.org), many references in the September 2022 newsletter