

Otter Pond Dam

*Otter Pond Homeowner's Association
September 29, 2022
Montrose, CO*



COLORADO
Division of Water Resources
Department of Natural Resources

Jason Ward, Ph.D., P.E.
Dam Safety Engineer

Meeting Agenda

- Approx. 30-min presentation
- Introduction to Colorado Division of Water Resources
- Dam Safety 101
 - ...as it relates to Otter Pond Dam
- Otter Pond Dam incident
- State Engineer's Office evaluation & actions
- Moving forward (not looking backwards)
- Questions & Discussion (moderated by Kristie)

STATE OF COLORADO

DEPARTMENT OF NATURAL RESOURCES

***DIVISION OF WATER RESOURCES
(OFFICE OF THE STATE ENGINEER)***

Regional Division Offices



Division 1

Division 2

Division 3

Division 4

Division 5

Division 6

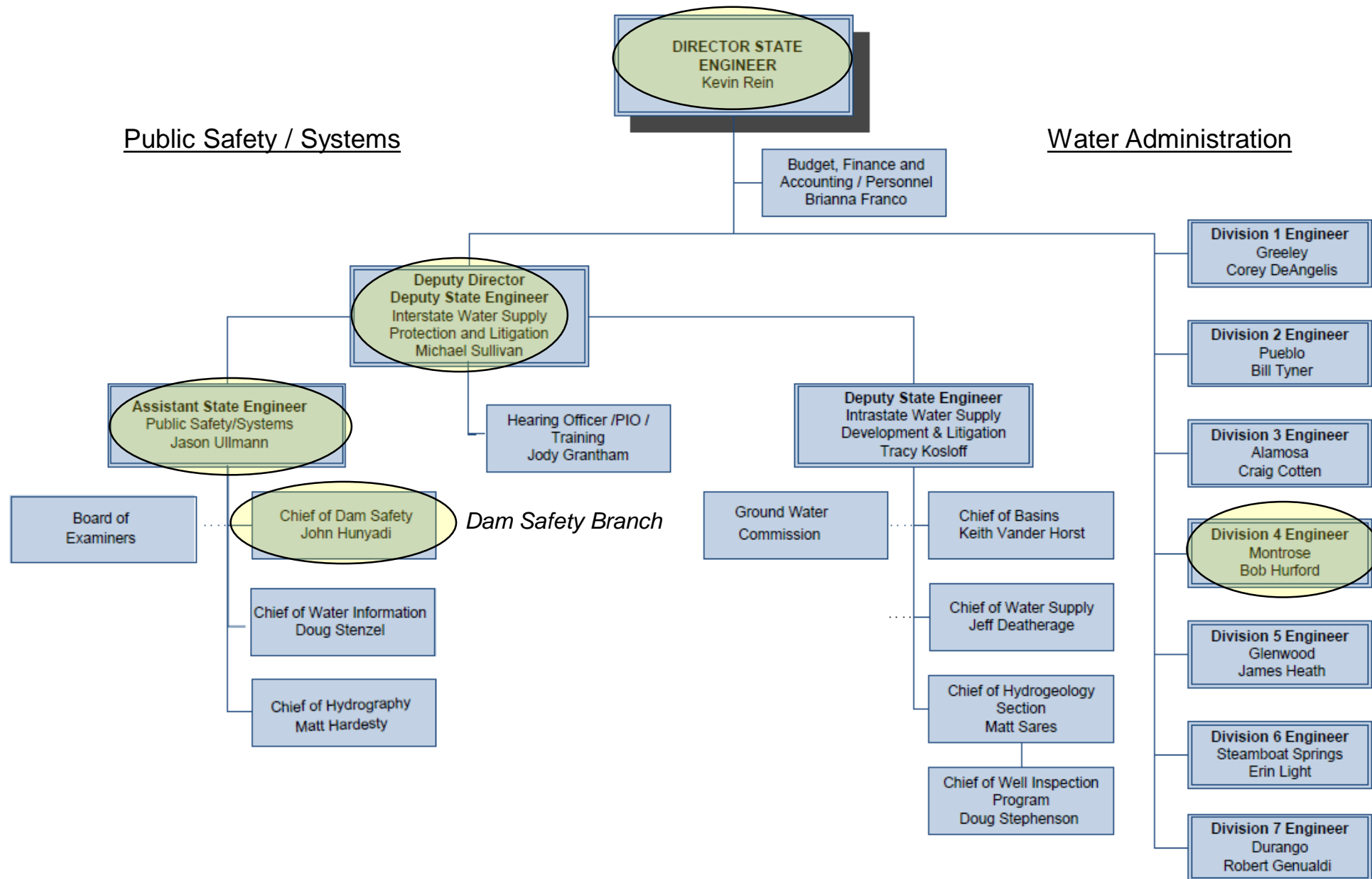
Division 7



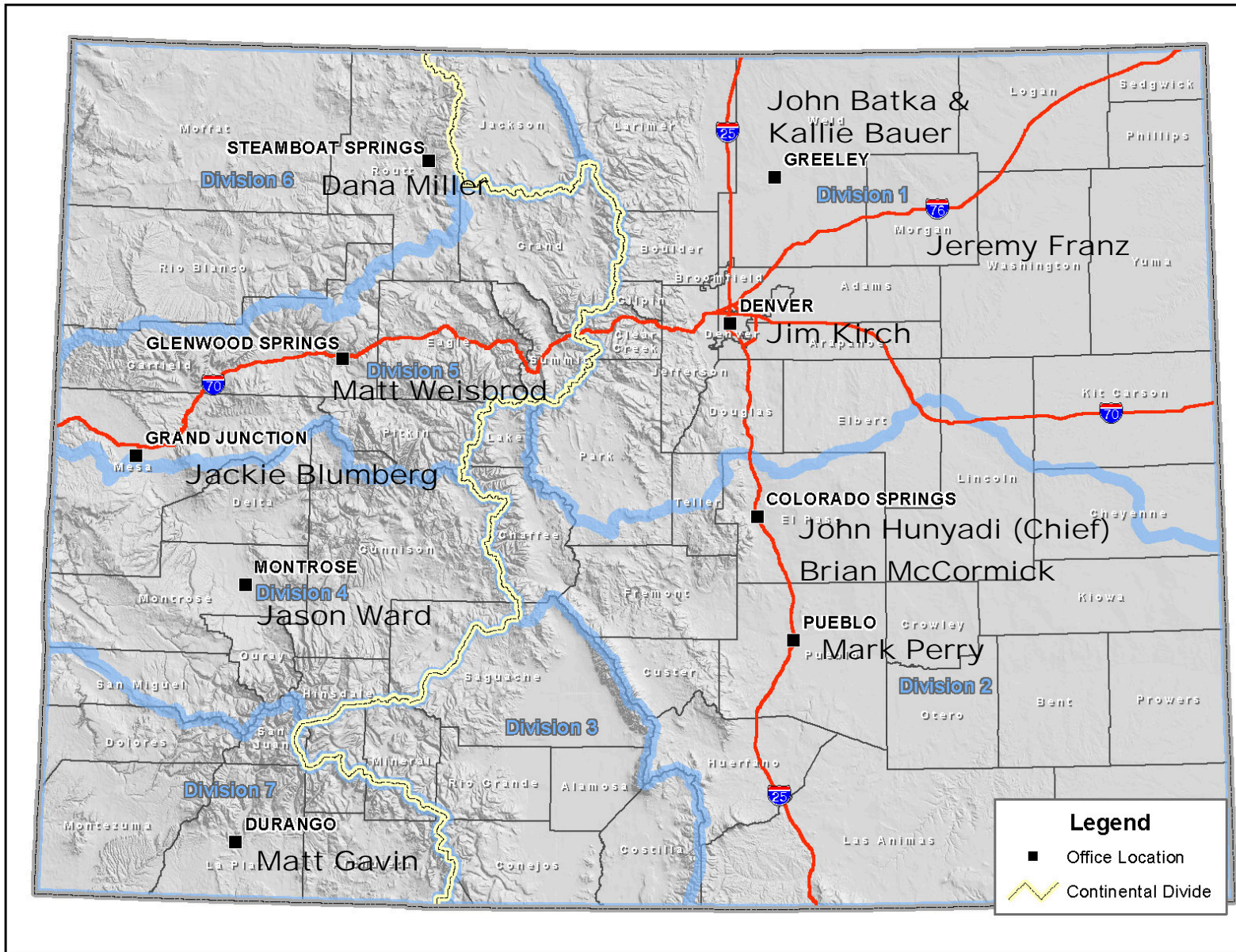
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COLORADO DIVISION OF WATER RESOURCES ORGANIZATIONAL CHART



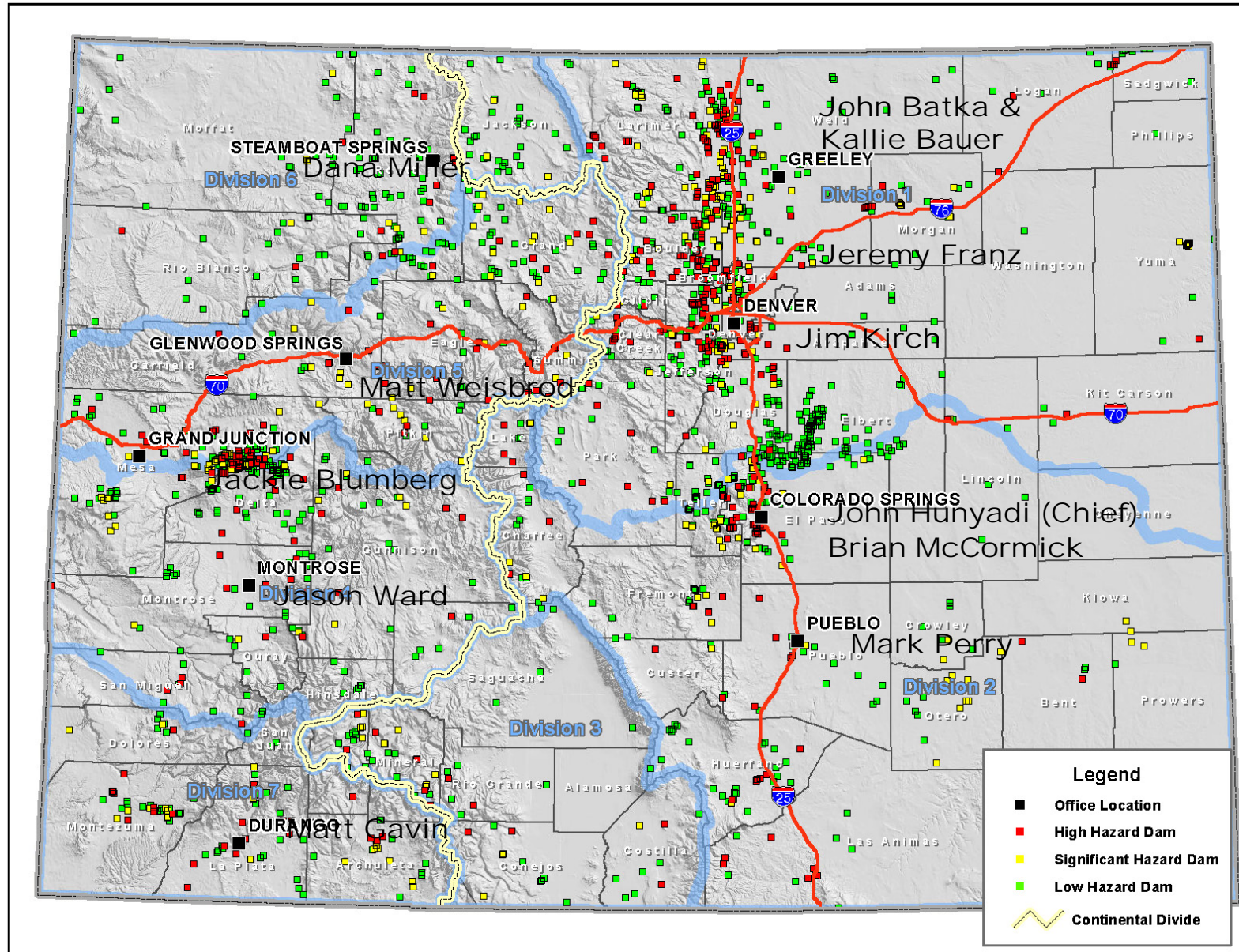
CO Dam Safety Branch Staff



12 Members

- 1 Chief of Dam Safety
- 9 Dam Safety Engineers
- 1 Design Review Engineer (East)
- 1 Dam Safety/Design Review Engineer (West)
- (1 Program Assistant)

Approx. 2,400 Program Dams

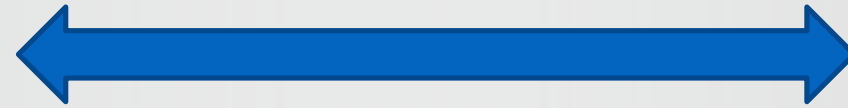


**COLORADO
REVISED STATUTES**



**CONSTITUTIONS
TITLES 1-3**

2022



- Dam Size
- Dam Design Requirements
- Dam Construction Requirements
- Dam Owner Requirements
- Failure Consequence Evaluation
- 'Safe Storage Level' Evaluation

State of Colorado
Department of Natural Resources
Division of Water Resources
Office of the State Engineer
Dam Safety

***RULES AND REGULATIONS
FOR
DAM SAFETY AND DAM CONSTRUCTION***

EFFECTIVE DATE: January 1, 2020

2-CCR 402-1



Jurisdictional Size Dam (37-87-105 CRS, Rule 4.7)

- 'Dam' means a man-made barrier that impounds water above the elevation of the natural surface of the ground for the purpose of impounding water.
- 'Jurisdictional Size Dam'
 - Reservoir capacity more than 100 acre-feet,
 - Reservoir surface area in excess of 20 acres at the high water line,
 - 'Jurisdiction height' exceeds 10 feet

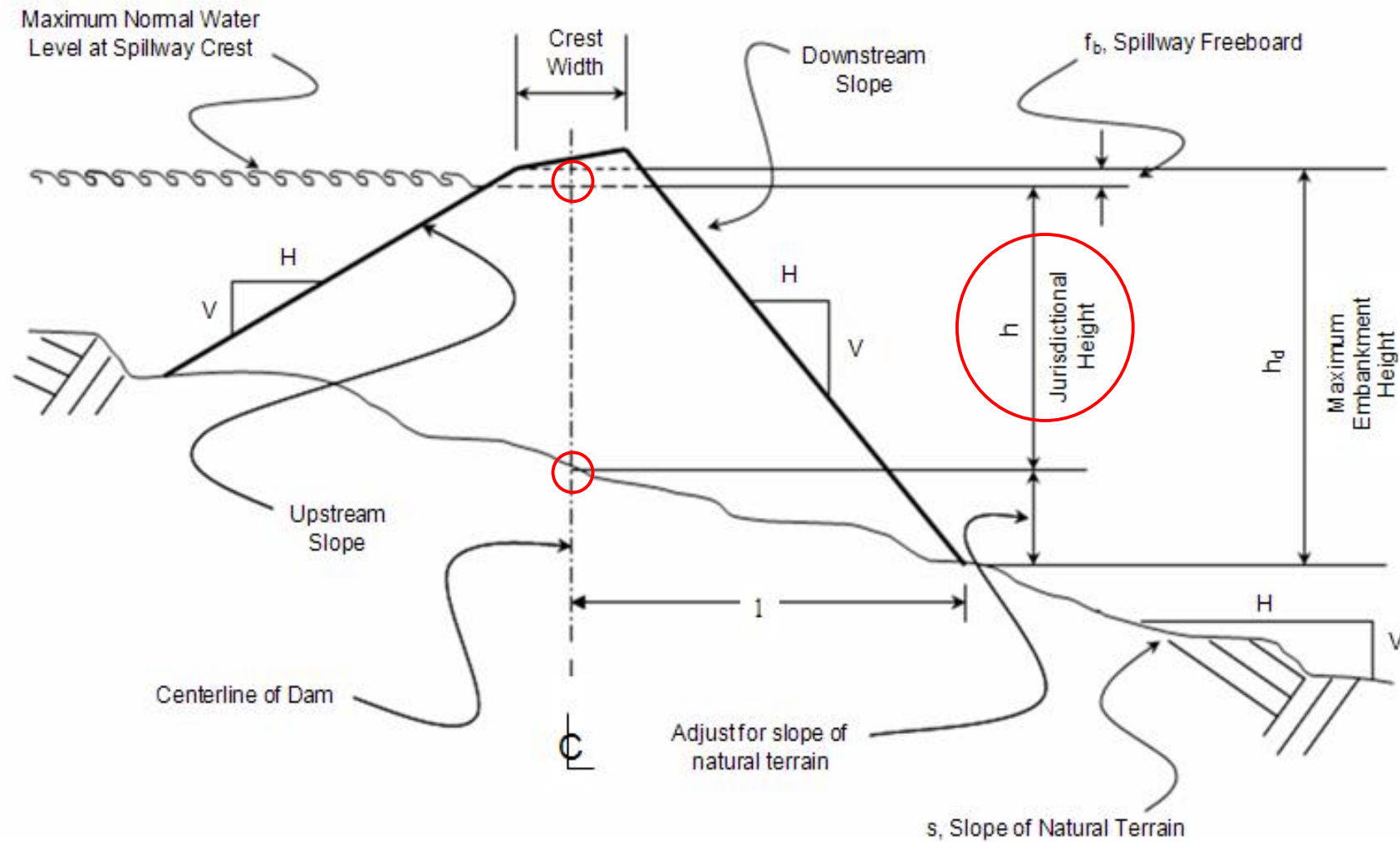
Non-Jurisdictional Size Dam (CRS 37-87-125, Rule 4.6.2)

- Does not meet Jurisdictional size criteria

Safe Storage Level (CRS 37-87-107)

- Storage Restriction Order

'Jurisdictional Height'



Determination of Dam Vertical Height at the Maximum Cross Section

Figure 2

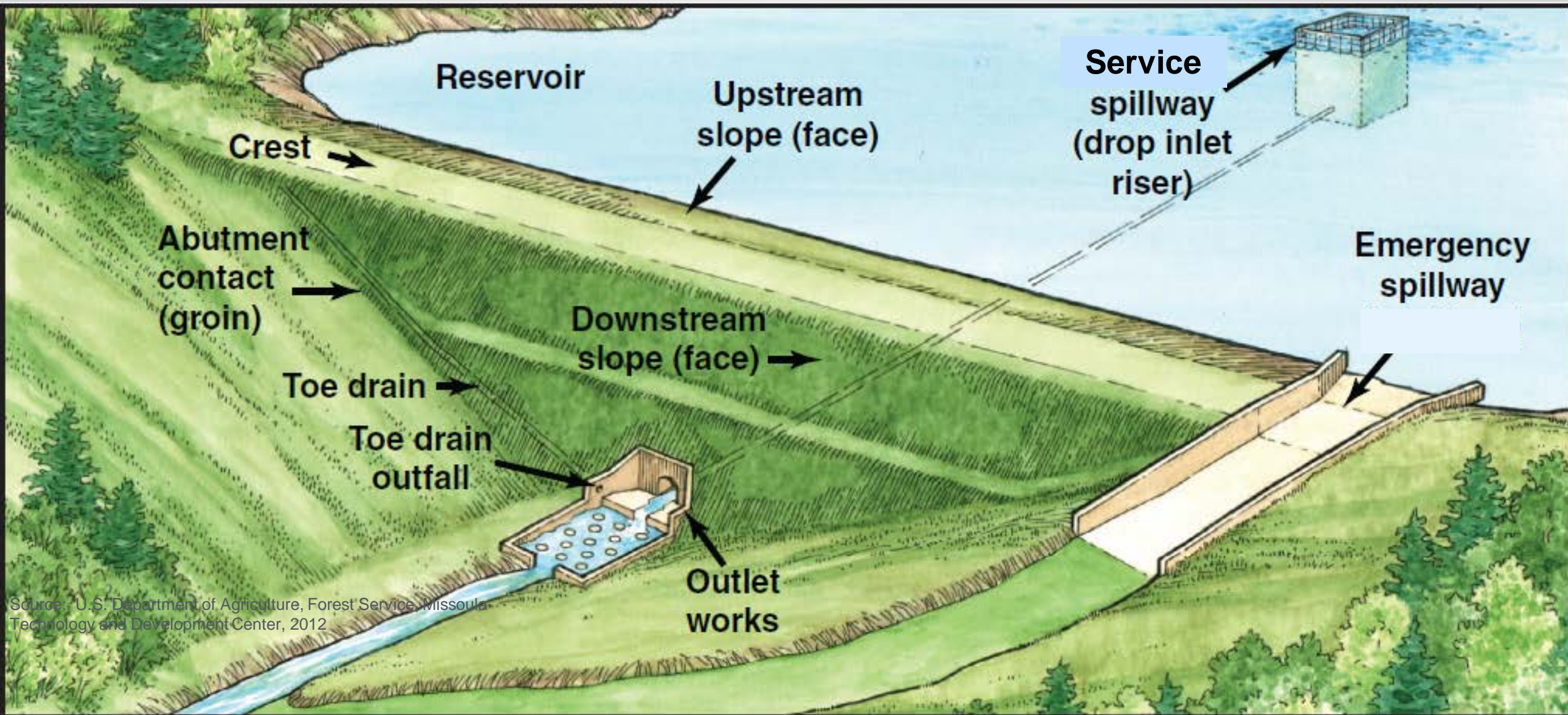
Hazard Classification

Based on an evaluation of consequences of dam failure
absent of flooding conditions

Assumes the reservoir is at the high water line.

Hazard Classification	Description
High	Loss of human life is expected in the event of a failure
Significant	Significant damage is expected, but no loss of human life
Low	No significant damage and no loss of human life
No Public Hazard (NPH)	No loss of human life and damage only to dam owner's property

Typical Dam - Terminology



Source: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center, 2012

Otter Pond Dam

Downstream Slope

Crest

Service Spillway

*Emergency Spillway
Outlet Works*

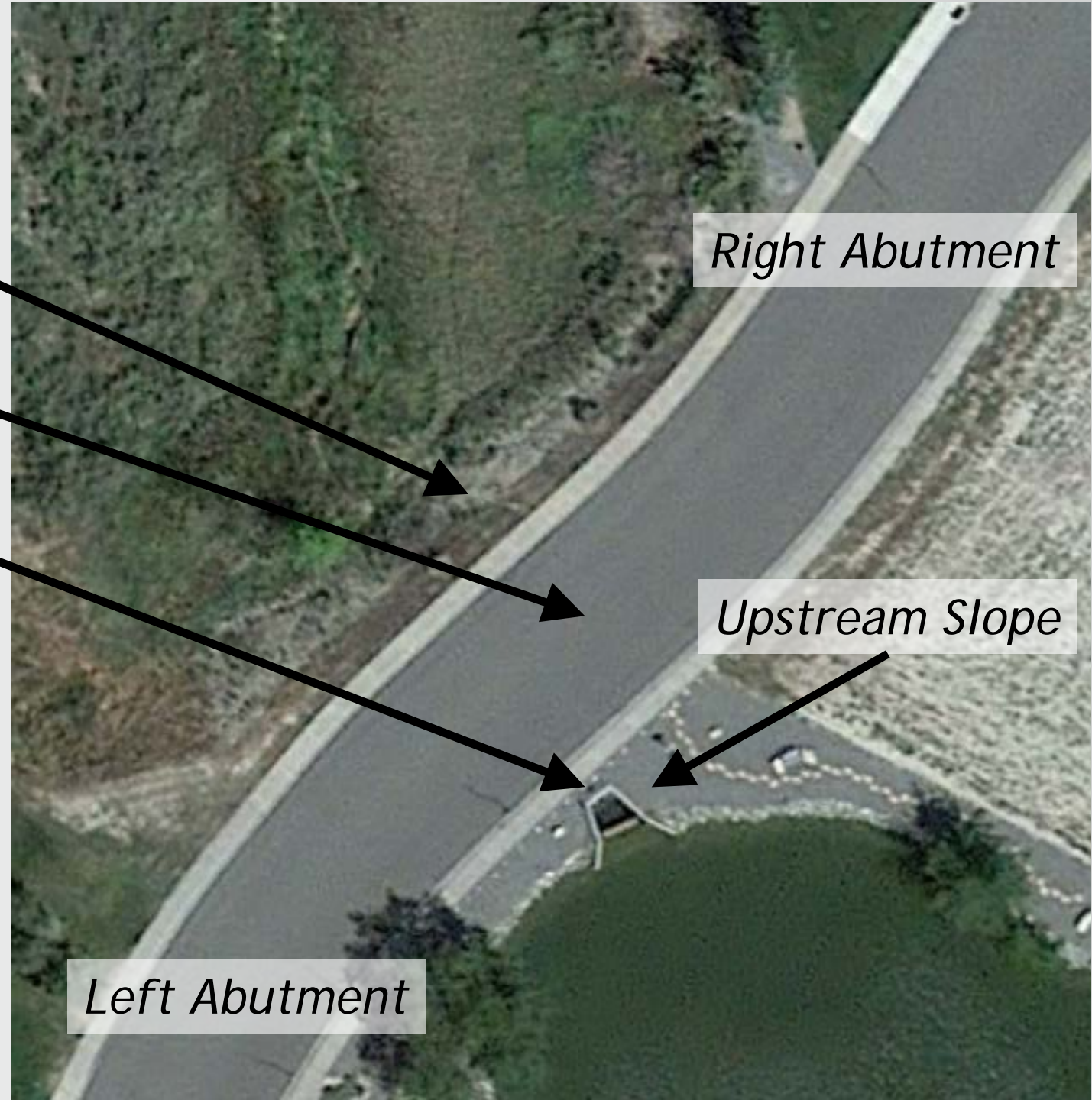
Right Abutment

Upstream Slope

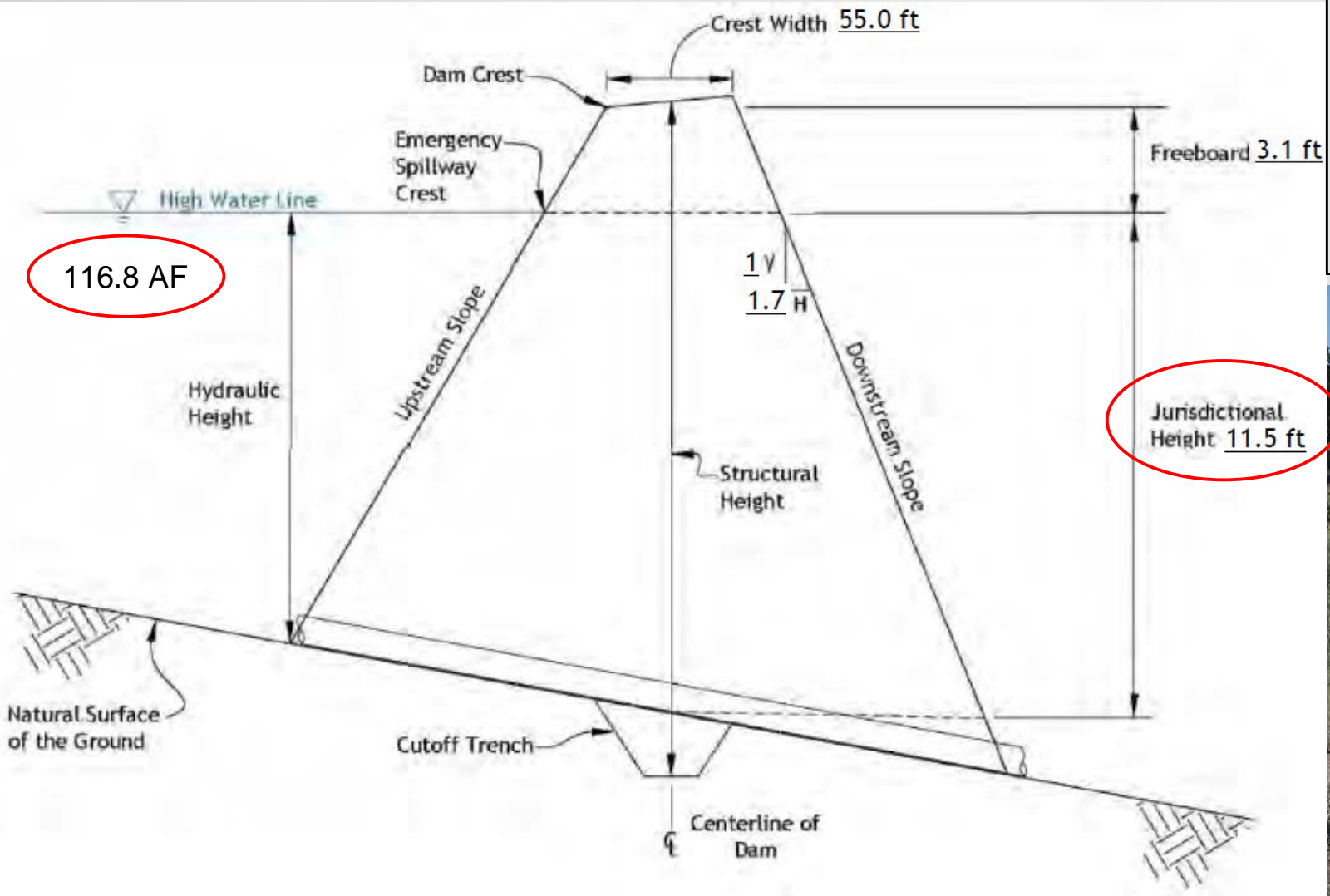
Left Abutment



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Otter Pond Dam - Jurisdictional Size



Jurisdictional Height = 11.5 ft
(> 10-ft)

Reservoir Volume = 116.8 AF
(>100 AF)

'Jurisdictional Size Dam'



How Do Dams Fail?

Overtopping (34%)

Piping/Internal Erosion (20%)

Foundation (30%)

Other Causes (16%)

Source: ASDSO, 2022



St. Francis Dam, CA (failed 1928)

Overtopping

*excess flows
over the dam crest...*



*...leading to
failure of dam*



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Piping/Internal Erosion



Photo Courtesy ASDSO

Internal erosion is the process where water that seeps through the dam carries soil particles away from the embankment, foundation or abutments of the dam.



Fontenelle Dam, 1965

Teton Dam, June 1976



Otter Pond Dam - Hazard Classification

Based on an evaluation of consequences of dam failure absent of hydrologic flooding conditions
("sunny day", internal erosion)

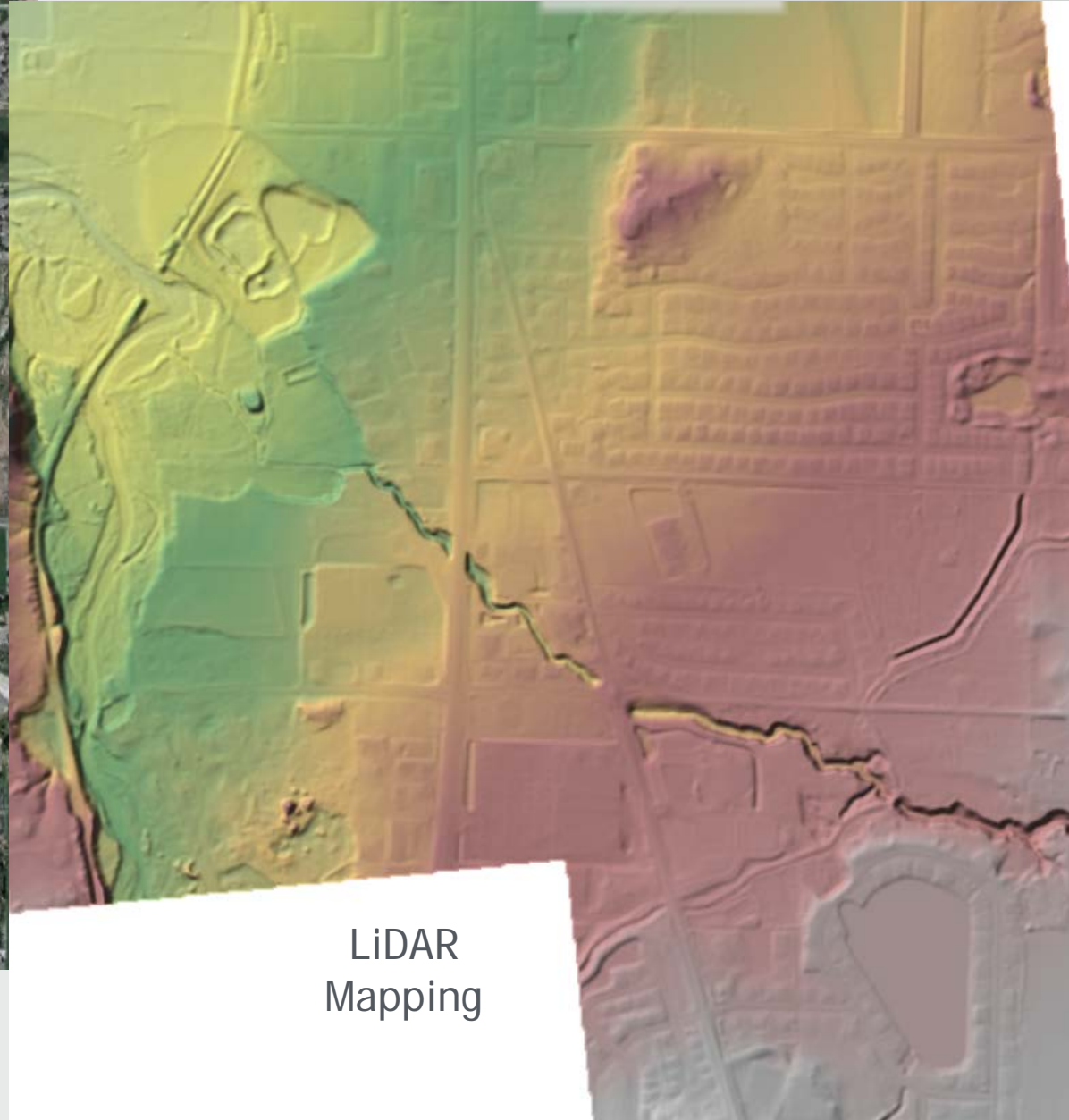
Assumes the reservoir is at the high water line.



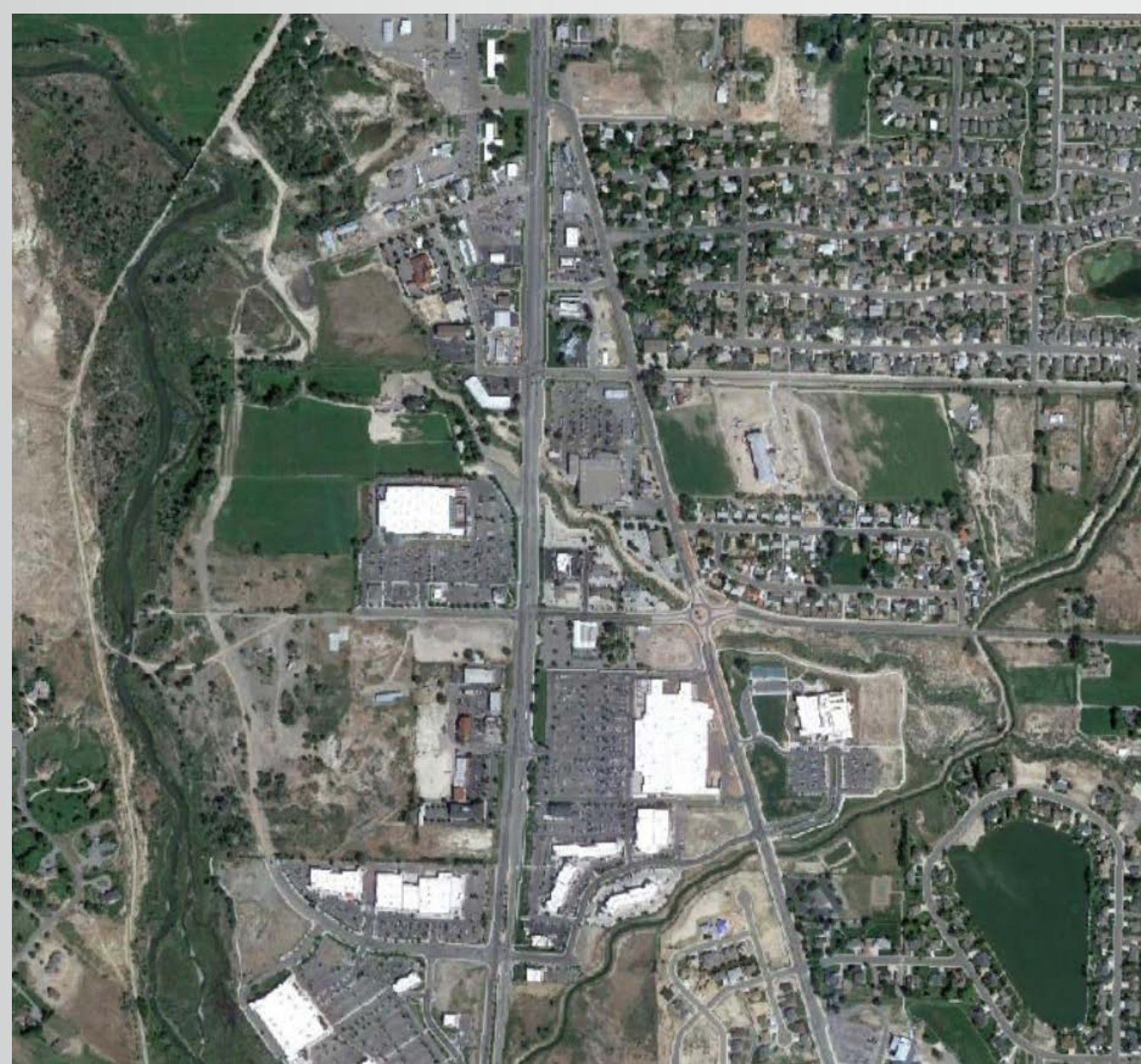
Field
Survey
(8/18/22)



USACE HEC-RAS Computer Model
"Sunny Day" / Internal Erosion



LiDAR
Mapping



Google Earth - aerial imagery

Otter Pond Dam - Hazard Classification

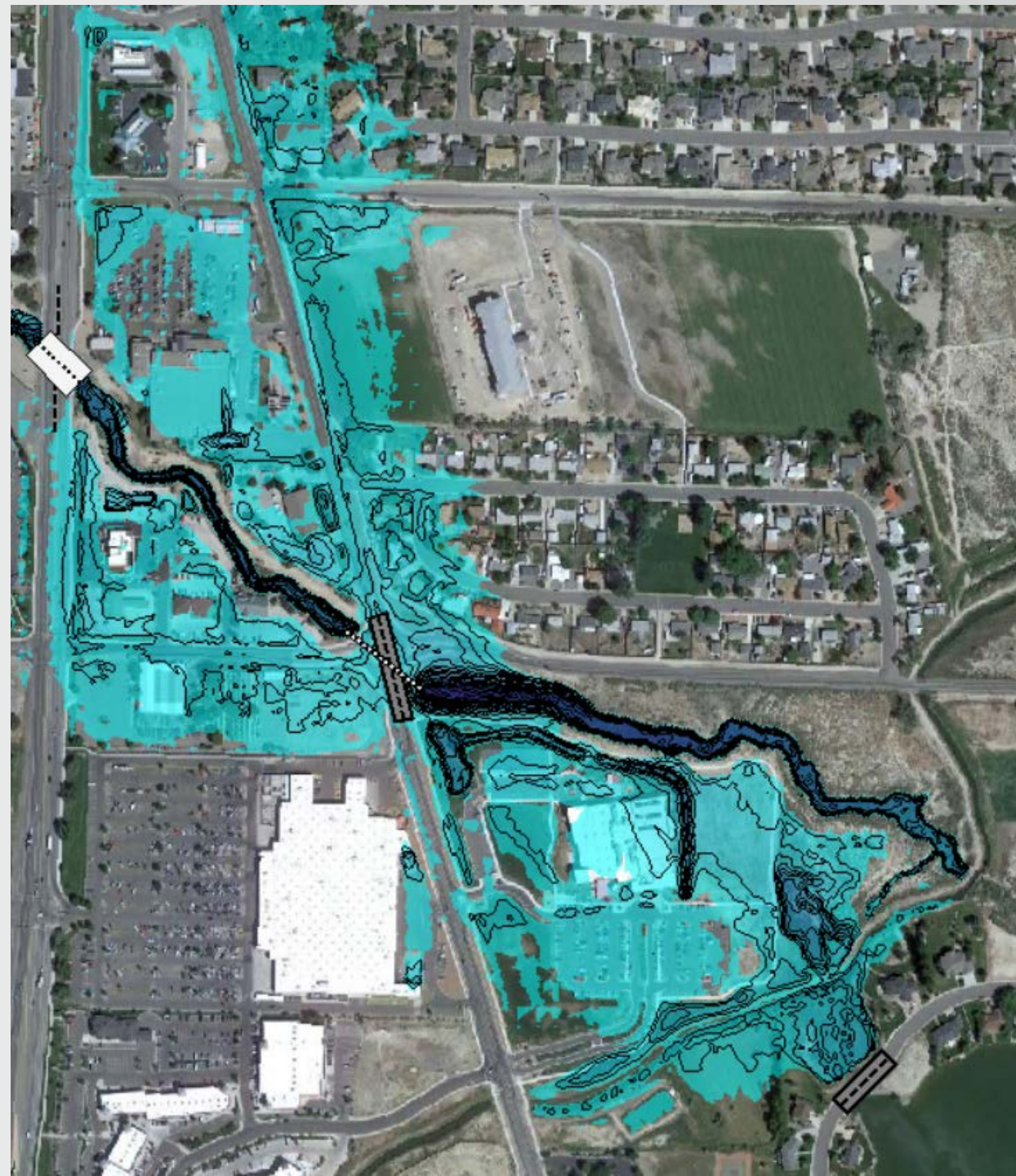
Significant Hazard Dam

"..no life loss is expected in the event of failure of the Otter Pond Dam under a sunny dam failure scenario (i.e., absent hydrologic flooding).

However, the occurrence of widespread flooding in densely populated business and recreation areas of Montrose is sufficient to support a Significant Hazard rating."



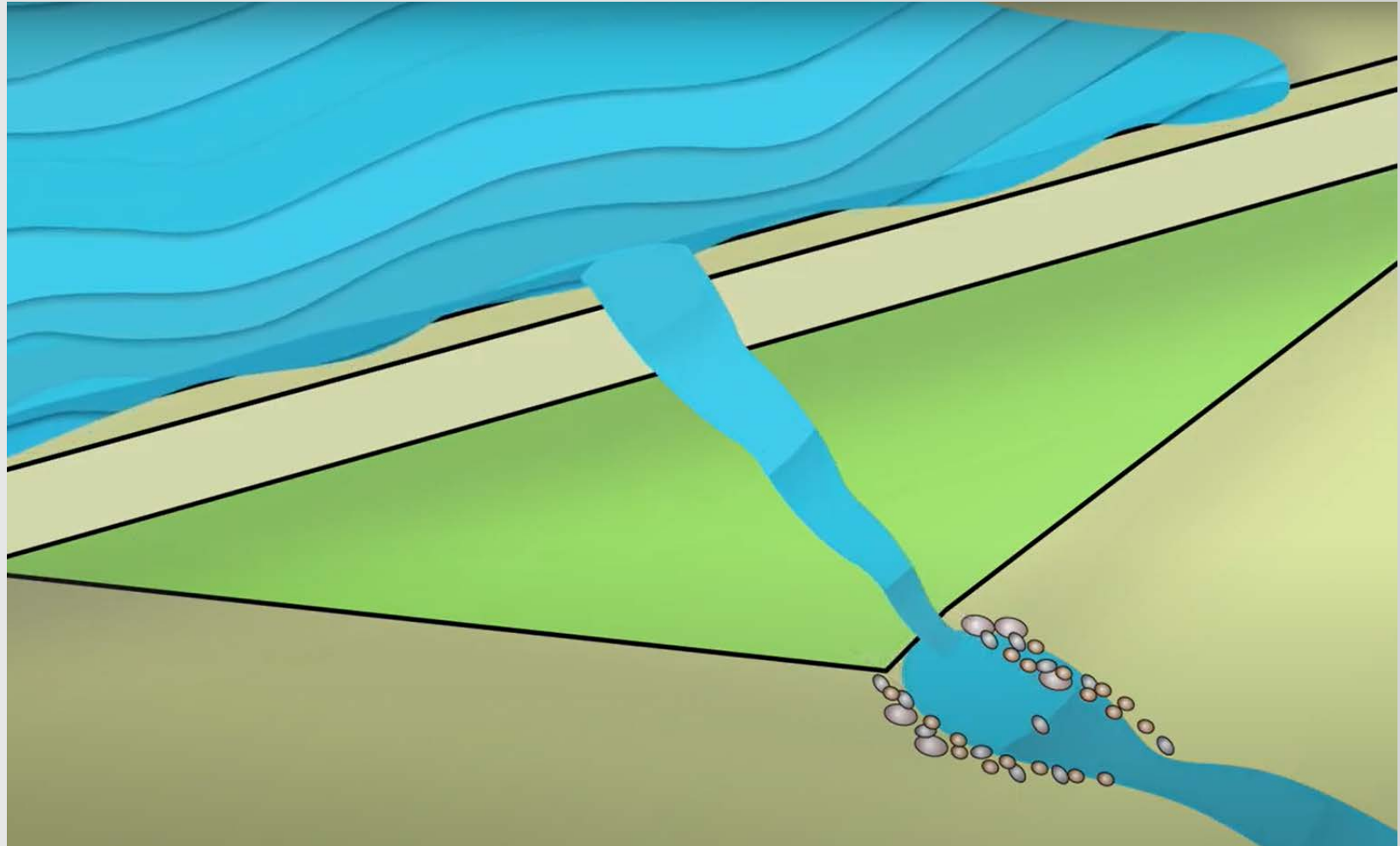
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Otter Pond Dam - Hydrologic Hazard Classification

Based on an evaluation of consequences caused by floodwaters released by overtopping failure of the dam

TBD - required for spillway design



Dam Safety Evaluations & Action

Safety Inspections August 15 and 18, 2022

[LINK TO INCIDENT INSPECTION REPORT](#)

Storage Restriction Order August 23, 2022

[LINK TO RESTRICTION ORDER](#)

Hazard Classification Study August 29, 2022

[LINK TO HAZARD CLASSIFICATION STUDY](#)



Moving forward

1. Maintain restricted storage level until dam is repaired.
2. Additional/refined information?
 - a. Confirm reservoir volume?
 - b. Confirm jurisdictional height?
 - c. Reanalyze hazard classification?
3. Retain a registered Professional Engineer
4. Feasibility/Alternatives studies?
5. Design meetings
6. Engineering plans and specifications
7. Construction
8. Remove storage restriction

Otter Pond Dam - Summary

- Jurisdiction size dam
- Significant Hazard Classification
- TBD Hydrologic Hazard Classification
- Storage Restriction Order of 1-foot below the spillway crest



Questions and discussion

Thank you!

Jason Ward, PhD, PE
Dam Safety Engineer
Dam Safety Branch



M 970.209.1624 (primary) | P 970.249.6622 (alternate)

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jason.ward@state.co.us | <https://dwr.colorado.gov/services/dam-safety>

Additional Resources:

Google:
"Colorado Dam Safety"

YouTube:
"Dam Owner Academy"



9/20/1993