GFT

The Montana Department of Natural Resources & Conservation

Hazard Classification
Technical Guidance Update

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October 7, 2026

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AGENDA

- Hazard classification overview
- Regulatory requirements for performing a hazard classification
- Guidance available through DNRC
- Using DST to perform a hazard classification
- Advanced breach analyses
- Questions?

Hazard Classification Overview

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Hazard Classifications

A Hazard Classification involves an evaluation of the area downstream from the dam that would be flooded if the dam fails under clear weather conditions with the pool at maximum normal operating elevation. If the flooding caused by the dam failure is likely to cause a loss of life, the dam or reservoir is classified as a High-Hazard structure (Montana ARM 36.14.206).

Hazard Classification is based on consequences of dam failure, not the condition, probability, or risk of failure.



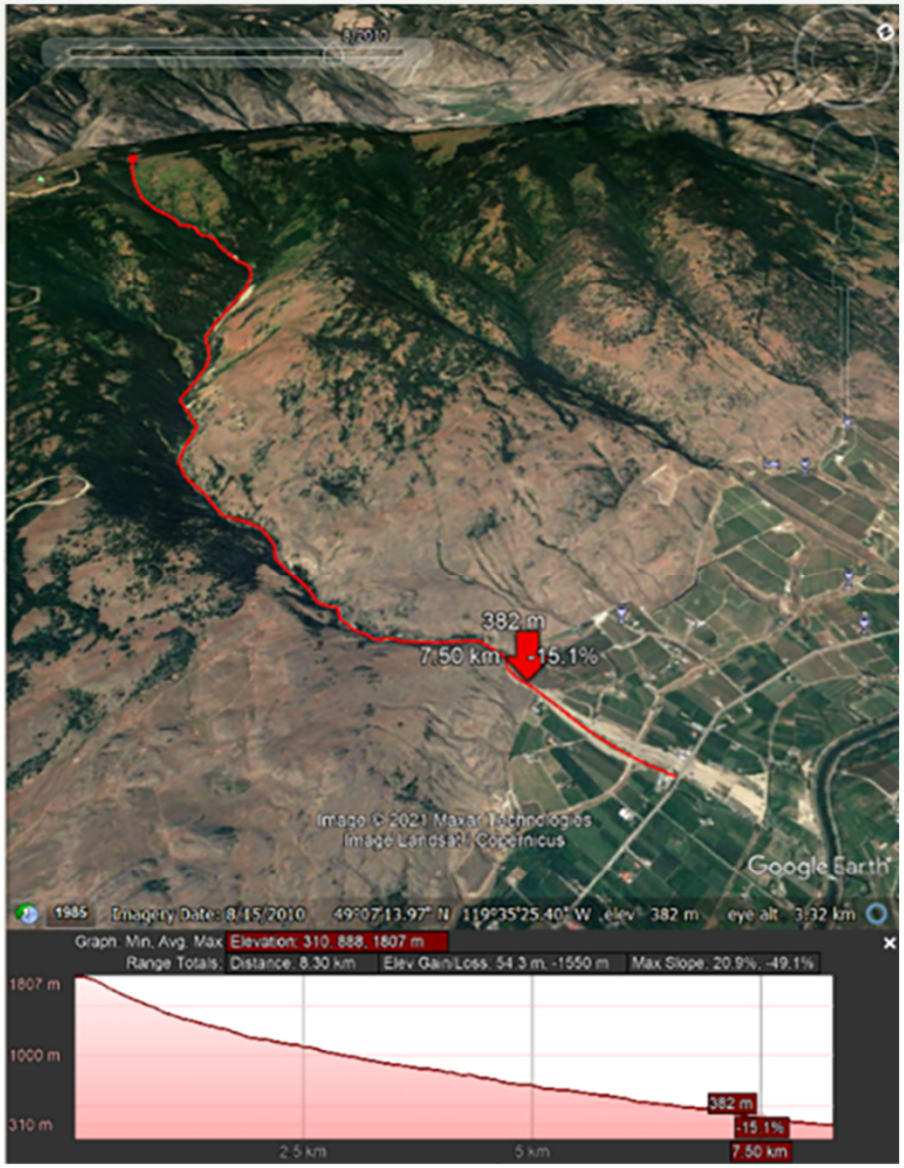
Spillway Erosion Incident at Sage Creek Dam, Petroleum County

Hazard Classifications

Dams with Under 50 Acre-Feet of Storage	Not High Hazard	High Hazard
Hazard classification is not required Dam owners still have responsibility More information can be found on DNRC Dam Safety *Small Dam Hazard Assessment Inventory*	Capacity is greater than 50 acre-feet A loss of human life is not likely to occur as a result of dam failure	Capacity is greater than 50 acre-feet A loss of human life is likely to occur within the breach flooded area as a result of dam failure



- Testalinden Dam in B.C. impounded 29 acre-feet at top-of-dam
  - Dam was 2.5 m (8.2 ft) high
- Dam was approximately 4,921 feet above the Okanagan River Valley
- Higher than average snowpack in 2010 led to the dam overtopping both the dam and a downstream road before breaching two days later
- Dam was later found to have known deficits that were never addressed
- Damaged or destroyed 5 houses and caused over $20M CAD in losses



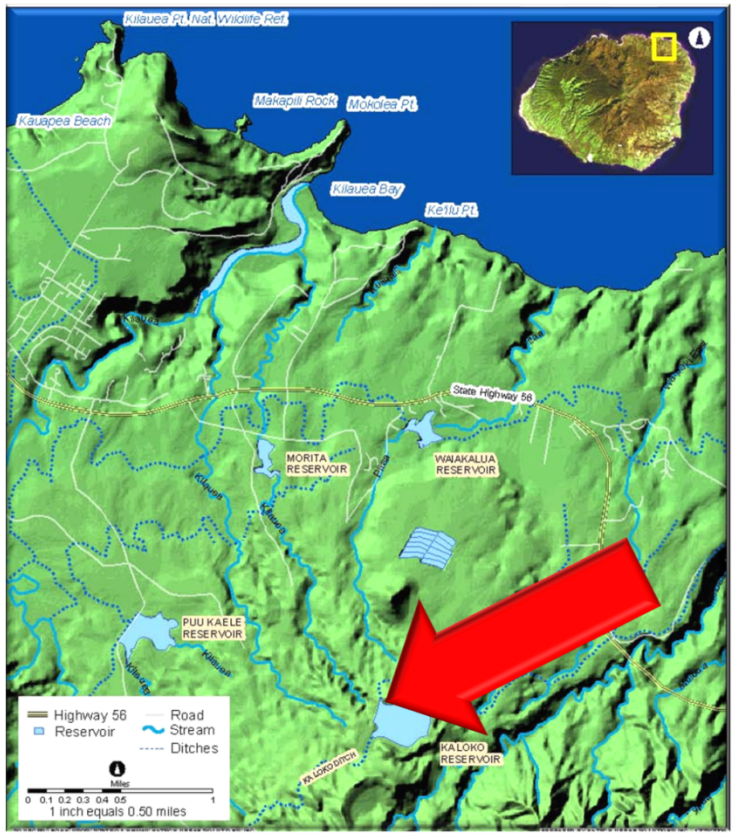
Hazard Classifications

The purpose of a Hazard Classification is to determine if additional dam safety permits are required.

Construction and Operating Permits	Design Criteria	Five-Year Dam Evaluations	Annual O&M Inspections
An Operation Permit is required for High Hazard dams A Construction Permit is required for major construction activity on High Hazard dams	Must pass or safely store the Inflow Design Flood Spillway sizing in accordance with Montana ARM 36.14.502	Comprehensive Five-Year Dam Evaluation in compliance with DNRC Guidelines for High Hazard dams	Annual walk over the dam and document condition of the dam Instruction manual for O&M is required

Case Study: Ka Loko Dam (Hawai‘i)

- Island of Kauai
- Constructed in 1890





Ka Loko Dam Failure



- Capacity of 1,200 acre-feet
- Classified as “Low Hazard”

Ka Loko Dam Failure

- March 14, 2006 flood
- Dam overtopped and failed
- 8 people killed






Before


After

Ka Loko Dam Failure




Ka Loko Dam Failure

Ka Loko Dam Failure

Engineering firms sued in Kaloko dam failure

By **Diana Leone**
Advertiser Kaua'i Bureau

LIHU'E, Kaua'i — Two O'ahu engineering firms are being sued in connection with the March 14, 2006, failure of the Kaloko dam on Kaua'i.

Belt Collins, which has an office in Honolulu as well as in other U.S. and foreign cities, and Hirata & Associates Inc., which is based in 'Aiea, are named as defendants in civil suits filed in Kaua'i's 5th District Court on Tuesday.

The lawsuits say that the consulting firms, which were employed by Jimmy Pflueger for work on his Kaua'i property that includes Kaloko dam, "failed to take appropriate actions to correct a 1997 grading violation — including removal of material that covered the spillway, and/or notifying the county of the precise area filled in 1997, including the spillway."

No O&M Manual
No Formal Inspections …
Little Maintenance …
Unintended Modification ..
No enforcement …

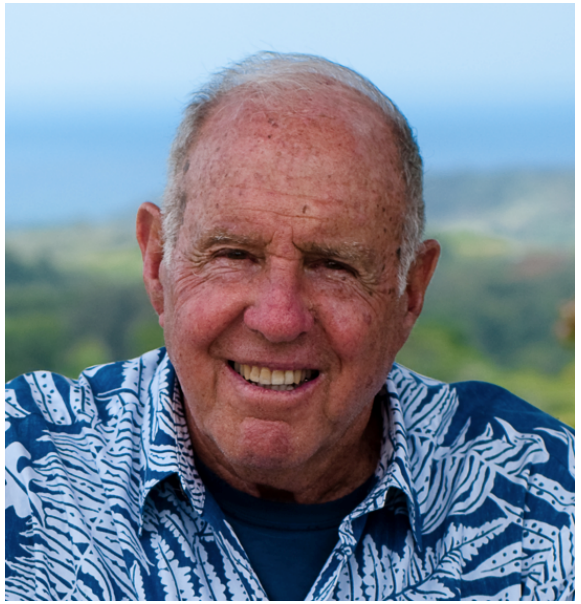
Helicopter Search for Survivors

Posted on: Sunday, November 8, 2009

$25M agreement settles lawsuits over Kauai dam tragedy

Manslaughter charges stand in Pflueger appeal

BY **Rick Daysog**
Advertiser Staff Writer



In one of the largest legal settlements in Hawaii in recent years, the families of seven people killed in the Kaloko Dam tragedy and several Kauai property owners will receive $25 million in an out-of court settlement, The Advertiser has learned.

The global settlement of multiple Kaloko Dam lawsuits was announced Oct. 29 in circuit court in Líhu'e, but details of the settlement, including how much the injured parties would receive, were not released.

The money will be paid by retired car dealer Jimmy Pflueger, the state of Hawaii, Kauai County, current and former owners of the land under the dam and their insurers, several people familiar with the deal said.

Case Study: Ka Loko Dam (Hawai‘i) – Key Takeaways

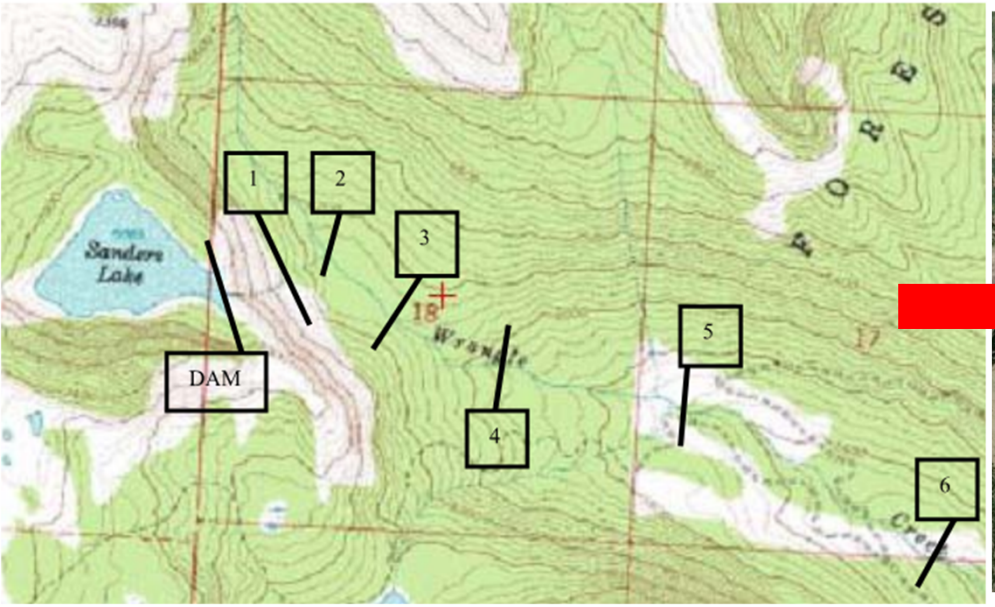
- Proper hazard classification of dams is needed to guide an appropriate level of regulatory oversight and inspection.
- The hazard classification of a dam can change over time due to downstream development.
- Failure of dams (even small ones), can cause fatalities and extensive downstream damage.
- Dam owners and engineers are liable for negligence leading to dam failure.

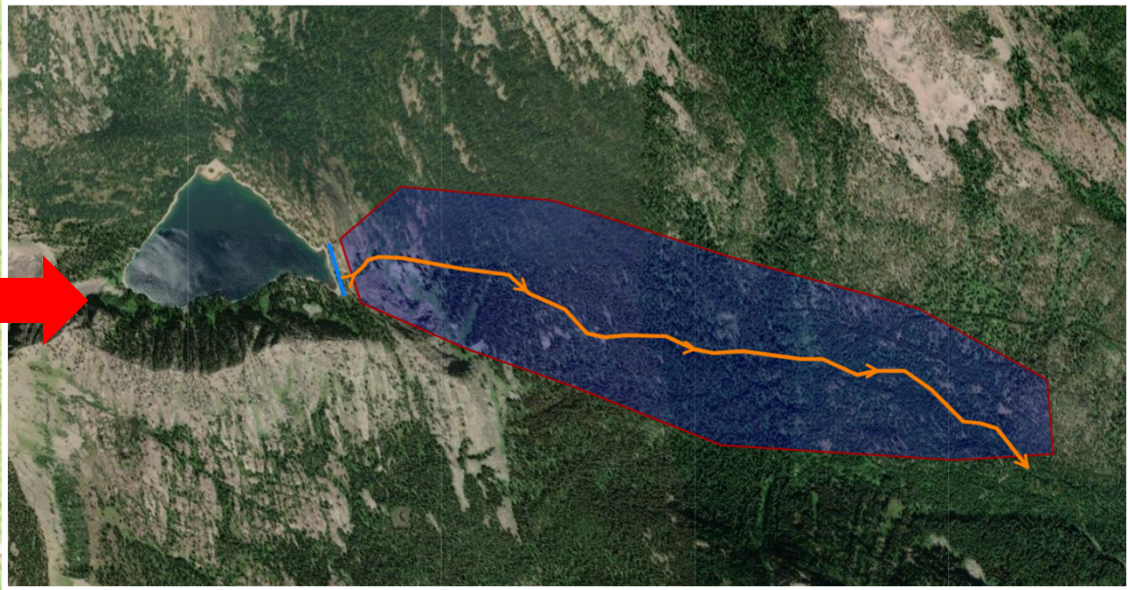


Regulatory Requirements

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What's Changing?





Currently Technical Note 6 outlines steps for performing a breach analysis using HEC-HMS (1-Dimensional)

Guidance is being updated for performing a breach analysis using 2-dimensional modeling software, including the USACE Dam Screening Tool (DST)

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36.14.206 CRITERIA FOR DETERMINATION

(1) The department's hazard determination shall be based on the consequences of dam failure, not the condition, probability, or risk of failure.

(2) A dam must be classified high-hazard if the impoundment capacity is 50 acre-feet or larger measured at the maximum normal operating pool, and it is determined that a loss of human life is likely to occur within the breach flooded area as a result of failure of the dam.

(a) Loss of life is assumed likely to occur if the following structures are present or planned for as a matter of public record or notice in the breach flooded area:

(i) occupied houses and farm buildings;

(ii) stores;

(iii) gas stations;

(iv) parks;

(v) golf courses;

(vi) stadiums;

(vii) ball parks; and

(viii) interstate, principal, and other paved highways, including railroads, highway rest areas, RV areas, and developed campgrounds. Excluded from this list are unpaved county roads and all private roads.

Hazard Classifications - Montana ARM 36.14.206 Continued

(3) For purposes of the hazard determination classification in this rule, the following apply:

(a) The breach flooded area is the flooded area caused by a breach of the dam with the reservoir full to the maximum normal operating pool.

(b) The evaluation of the effects of flood inundation will continue downstream until the flood stage is equal to that of the 100-year floodplain.

(c) The breach flow hydrograph and downstream routing of the breach flows may be estimated by the department either by visual determination or dam breach modeling techniques.

Hazard Classifications

If a repair or removal of a dam is planned, or there is obvious new downstream development, a new Hazard Classification Application is required, even if the dam was classified previously.

Exceptions:

- *If the dam is already classified as High Hazard, and there is no reason to believe this is changed, a new Classification is not required.*

- *If capacity and height of the dam is not being increased, there is no additional downstream development, and the original analysis is available for review, please contact your local dam safety Regional Engineer to discuss. Recent Red Tape Reduction Rule Changes gave DNRC the authority to waive the hazard classification requirement if it is clear the impact downstream is unchanged.*


Creston
BLACKFEET INDIAN RESERVATION
Cut Bank
Scobey
Plentywood
Kootenai National Forest
Shelby
Havre
Chinook
FORT PECK INDIAN RESERVATION
Columbia Falls
Malta
Sandpoint
Kalispell
Conrad
Big Sandy
FORT BELKNAP RESERVATION
Glasgow
Culbertson
Idaho Panhandle National Forests
Flathead National Forest
Wolf Point
Fort Peck
Choteau
Fort Benton
Upper Missouri River Breaks National...
Polson
Sidney
FLATHEAD RESERVATION
Great Falls
Circle
Jordan
Lolo National Forest
Seeley Lake
Lewistown
Glendive
Wibaux
Helena-Lewis & Clark National Forest
MONTANA
Missoula
Lolo
Helena
Roundup
Miles City
Baker
Deer Lodge
Townsend
Nez Perce-Clearwater National Forest
Hamilton
Forsyth
Anaconda
Butte
Grangeville
Three Forks
Colstrip
Big Timber
Billings
Belgrade
Hardin
Bozeman
Laurel
NORTHERN CHEYENNE INDIAN RESERVATION
Beaverhead-Deerlodge National Forest
CROW RESERVATION
Custer Gallatin National Forest
Big Sky
Dillon
Red Lodge
Salmon
Payette National Forest
Gardiner
Salmon-Challis National Forest
Lovell
Sheridan
Powell
West Yellowstone
Yellowstone National Park
Cody
Greybull
Bighorn National Forest
Spearfish
Deadwood
Challis
Buffalo

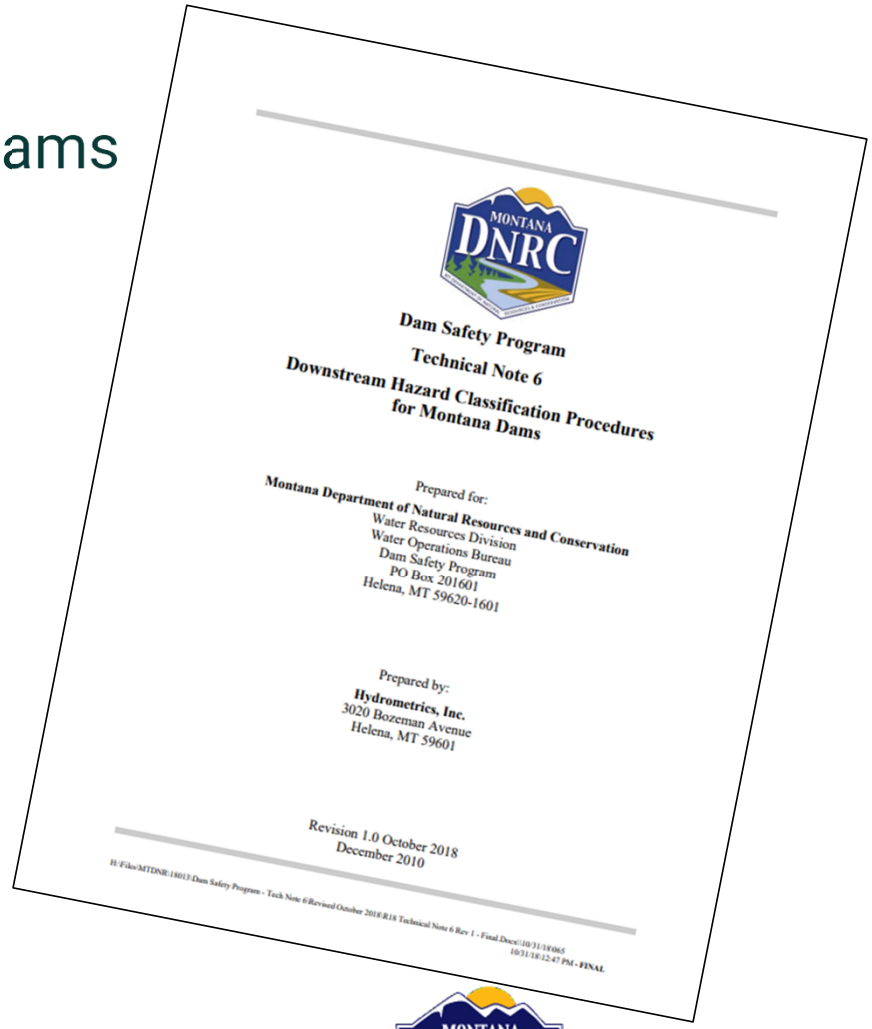
Guidance Available Through DNRC

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Technical Note 6 – Downstream Hazard Classification Procedures for Montana Dams

- Hazard Classification Basics
- Guidelines for Conducting a Hazard Classification
  - Breach Analysis Options
  - Breach Parameters for 2D Models
  - Using USACE's Dam Screening Tool Software
- Hazards
- Advanced Modeling Scenarios

- Updated document will be available in 2026



Froehlich Breach Parameter Spreadsheet

- Available as part of Technical Note 3 – Guidelines for Emergency Action Plans and Inundation Maps
  - References and Additional Information
- Developed by the Colorado Dam Safety Branch
  - For small dams (under 10 feet) consider other methods

ESTIMATION OF DAM BREACH PARAMETERS
USING THE FROEHLICH 2008 METHOD

PROJECT: ENTER DAM NAME

BREACH INPUT PARAMETERS:

Select Failure Mode From Drop-Down Menu:	PIPING	
Height of water over base elevation of breach (H_w) =	32.8	Feet
Volume of water in the reservoir at the time of failure (V_w) =	428.0	Acre-Feet
Reservoir Surface Area at Hw (A_s) =	21.4	Acres
Height of breach (H_b) =	40.8	Feet
Failure Mode Factor (K_o) =	1	
Breach Side-Slope Ratio (Z_b) =	0.7	Z(H):1(V)
Dam Size Class:	Small	Assumes Full Reservoir At Time of Breach.

CALCULATED BREACH CHARACTERISTICS:

Average Breach Width (B_{avg}) =	66.4	Feet
Bottom Width of Breach (B_b) =	37.9	Feet
Breach Formation Time (T_f) =	0.33	Hours
Storage Intensity (SI) =	13.0	Acre Feet/Foot
Predicted Peak Flow (Q_p) =	19866	Cubic Feet per Second

RESULTS CHECK:

Average Breach Width Divided by Height of Breach (B_{avg}/H_b) =	1.63	If (B_{avg}/H_b) > 0.6, Full Breach Devlopment is Anticipated
Erosion Rate (ER), Calculated as (B_{avg}/T_f) =	202.9	
Erosion Rate Divided by Height of Water Over Base of Breach (ER/H_w) =	6.2	If 1.6 < (ER/H_w) < 21, Erosion Rate is Assumed Reasonable

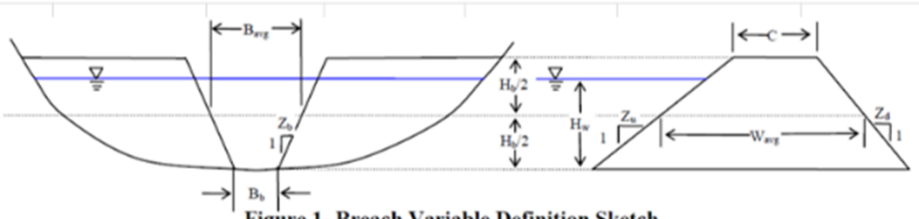


Figure 1- Breach Variable Definition Sketch

Using U.S. Army Corps of Engineers Dam Screening Tool (DST) to perform a Hazard Classification Assessment

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Breach Analysis Options

Screening Level Breach Analysis

Appropriate when it seems readily apparent that no hazard exists downstream, and thus the dam hazard level is determined to be not-high hazard

An acceptable Screening Level Breach Analysis requires a sufficiently detailed justification of the hazard classification. If justification is not found, then a Standard Breach Analysis should be done

Standard Breach Analysis

Recommend using USACE DST, a free web application (requires registration for login credentials)

Basic hydraulic modeling knowledge is required. Allows users to add terrain data, refine computational mesh, and simulate a wide range of dam breach scenarios

The 2026 National Structure Inventory (NSI) is integrated in the software

Advanced Breach Analysis

Recommend an experienced engineer or hydraulic modeler use USACE HEC-RAS (or other similar 2D modeling software)

Can model complex scenarios, including dams in series, ring impoundments, highly variable flow patterns, skewed bridges/roadways

Breach Analysis Options

Screening Level Breach Analysis

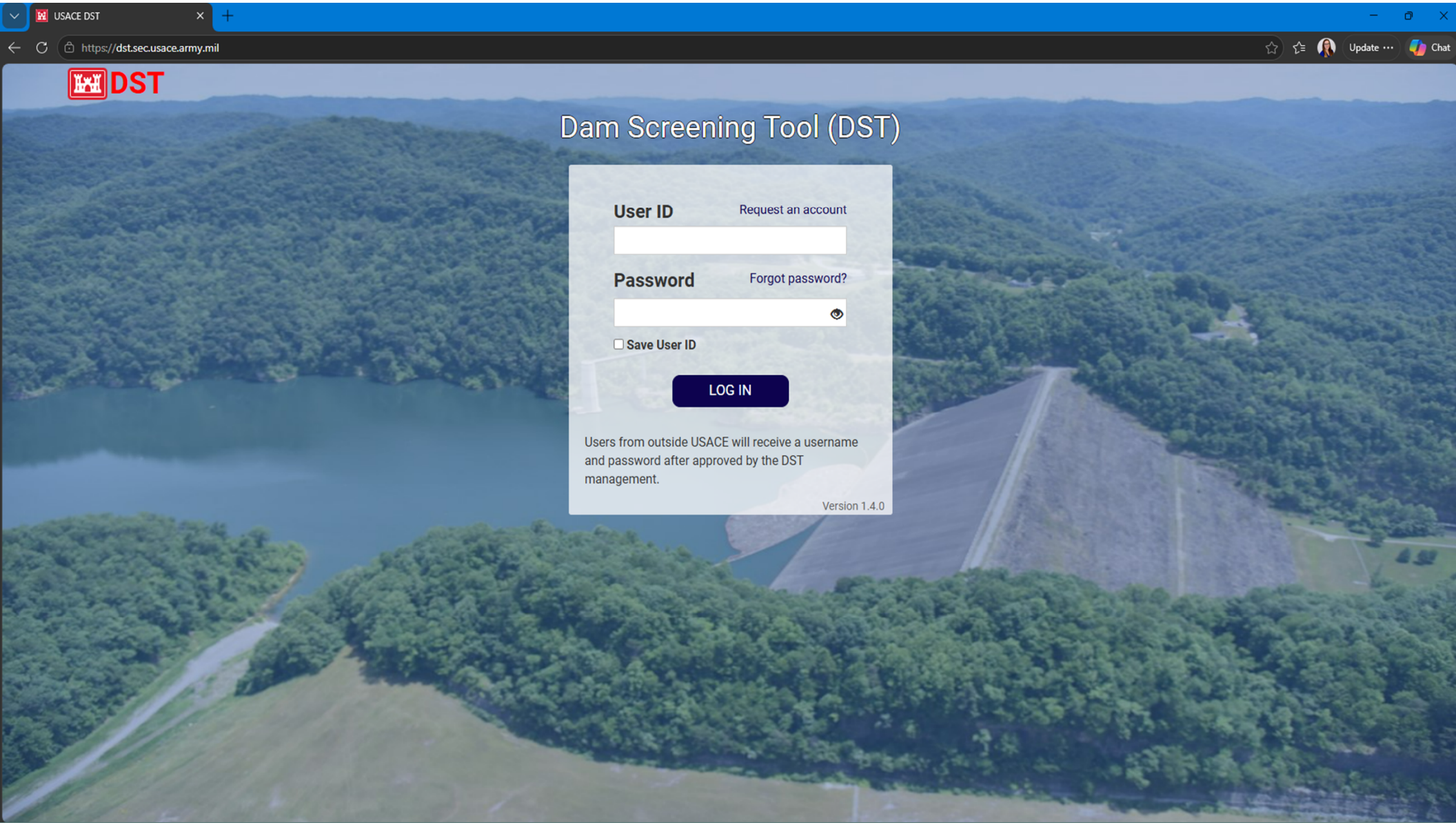
- Very steep channels where attenuation of the peak flood flow would be unlikely due to the momentum of the flood and lack of storage capacity in the floodplain
- Only downstream hazards are located at elevations well above the maximum possible stage of the breach flood

Standard Breach Analysis

- General breach model that does not have complex structures or terrain downstream of floodplain
- Breach parameters are simple and model controls fall within the capabilities of DST

Advanced Breach Analysis

- Complex terrain or structures in the floodplain
- Complex failure modes, including failures in series or ring dikes
- If the results from DST seem unreasonable.

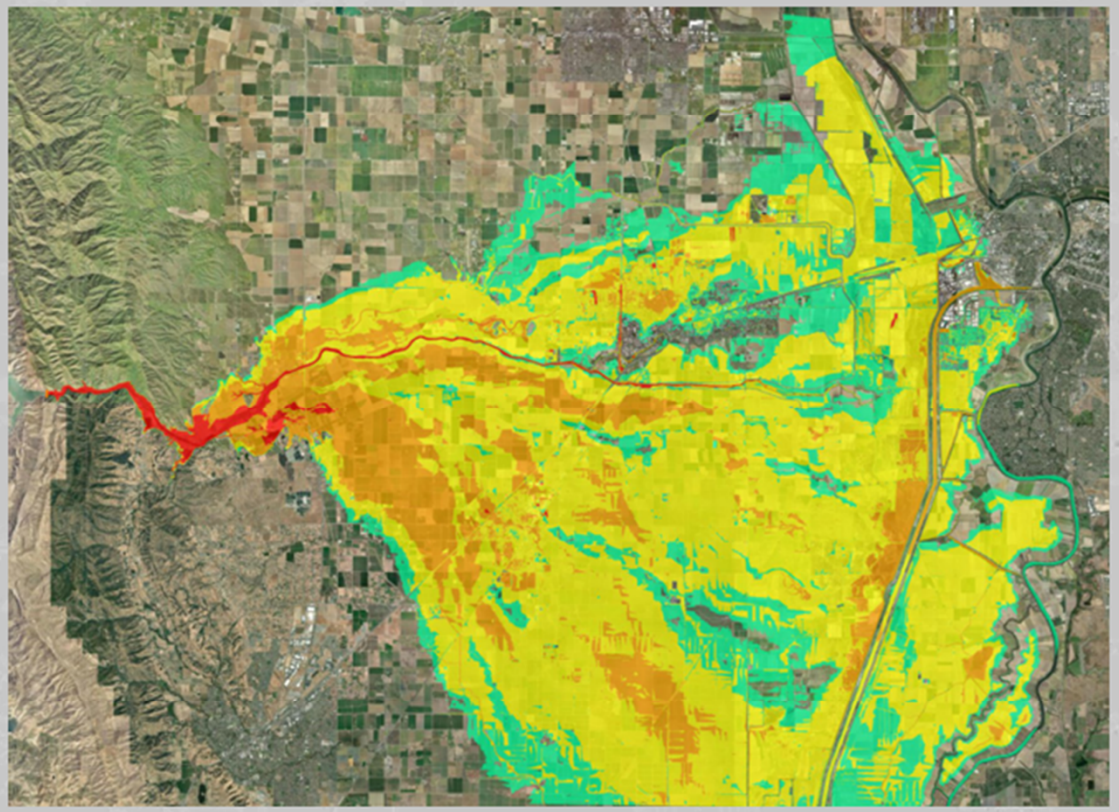

USACE DST
https://dst.sec.usace.army.mil
Update
Chat
DST
Dam Screening Tool (DST)
User ID
Request an account
Password
Forgot password?
Save User ID
LOG IN
Users from outside USACE will receive a username and password after approved by the DST management.
Version 1.4.0

DST Help Documentation

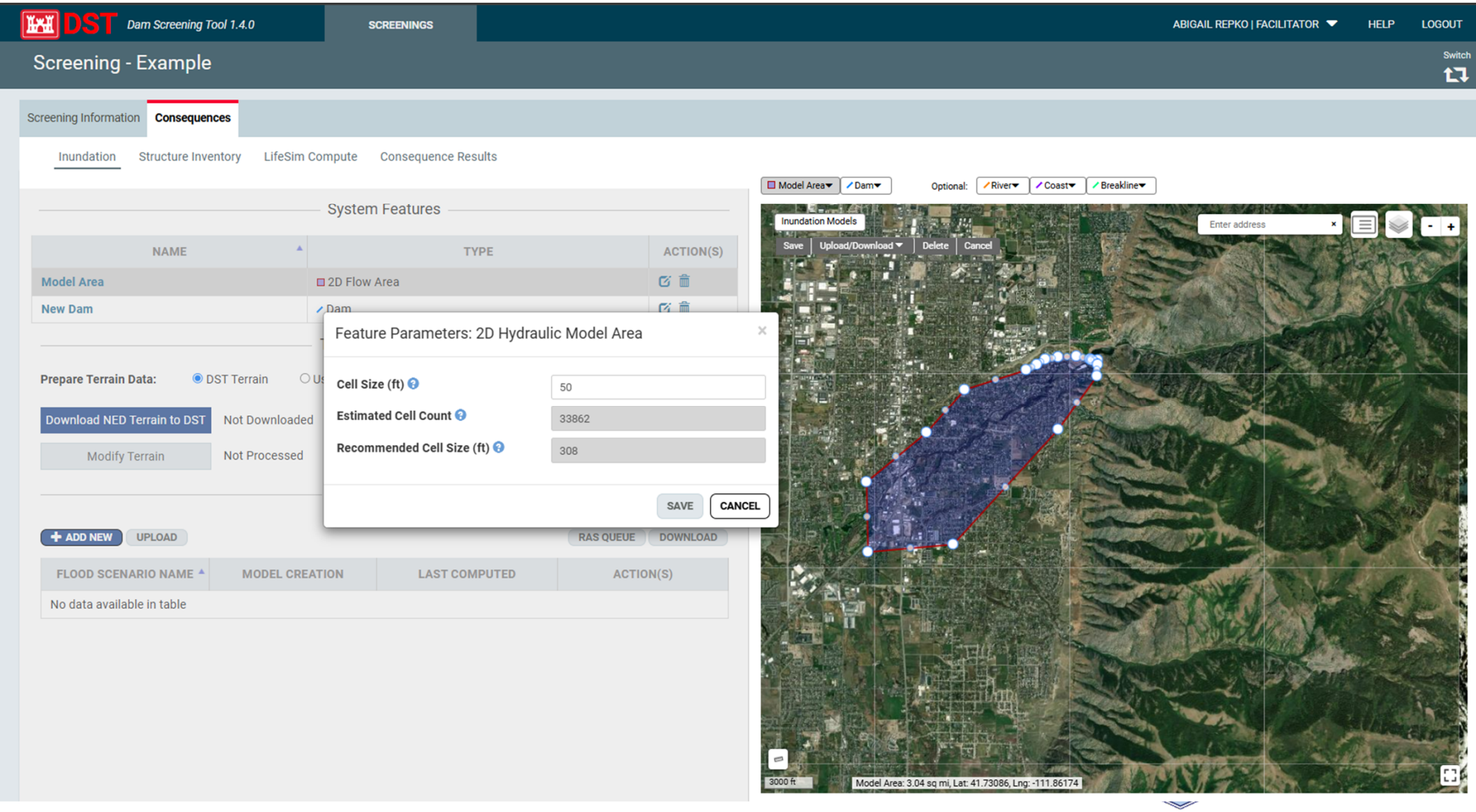
DAM SCREENING TOOL (DST) CONSEQUENCES MODULE TRAINING

Version 1.3.2

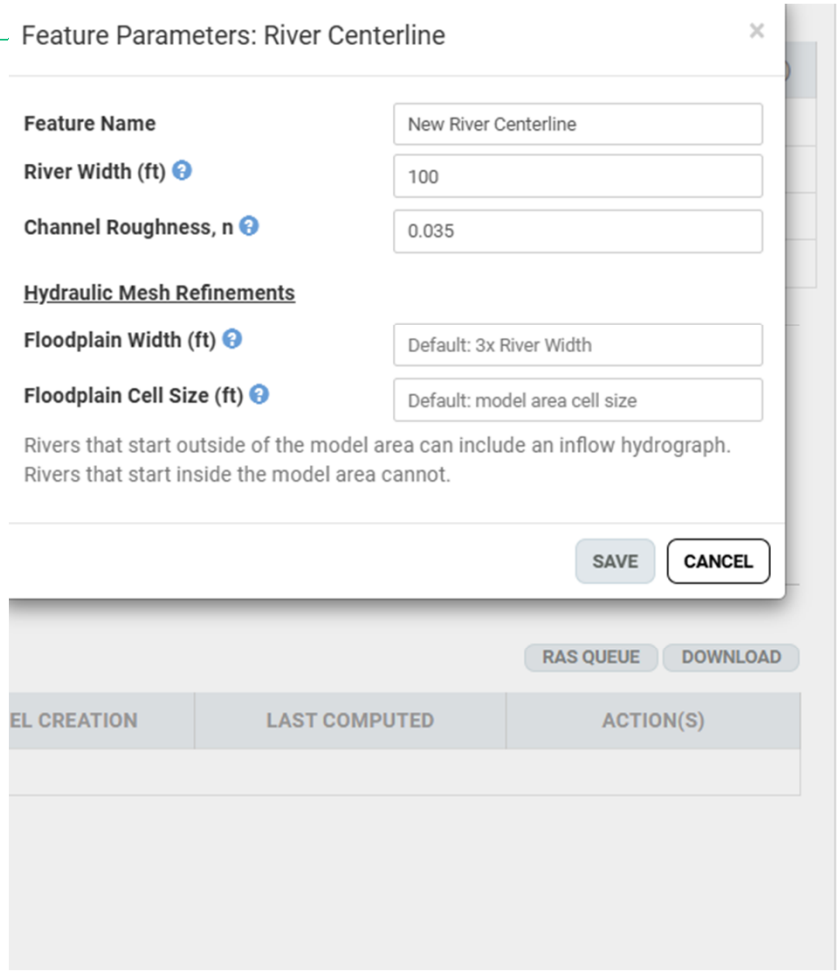
Updated August 2024

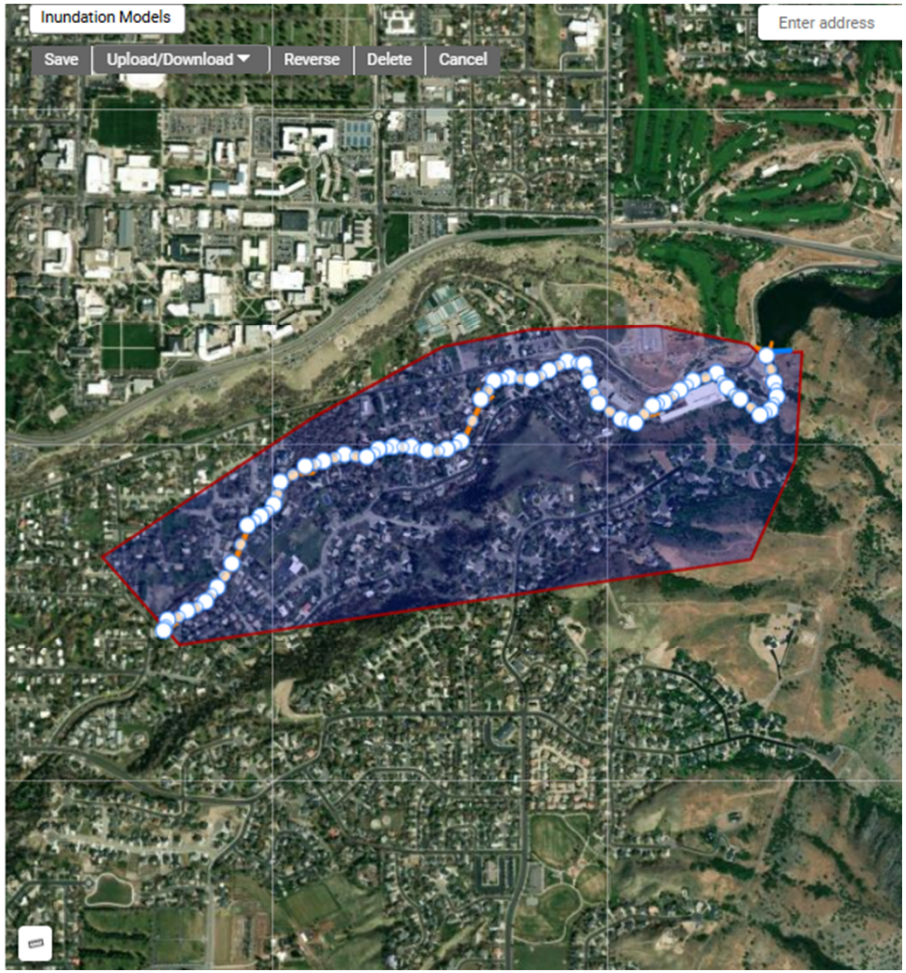


US Army Corps of Engineers®

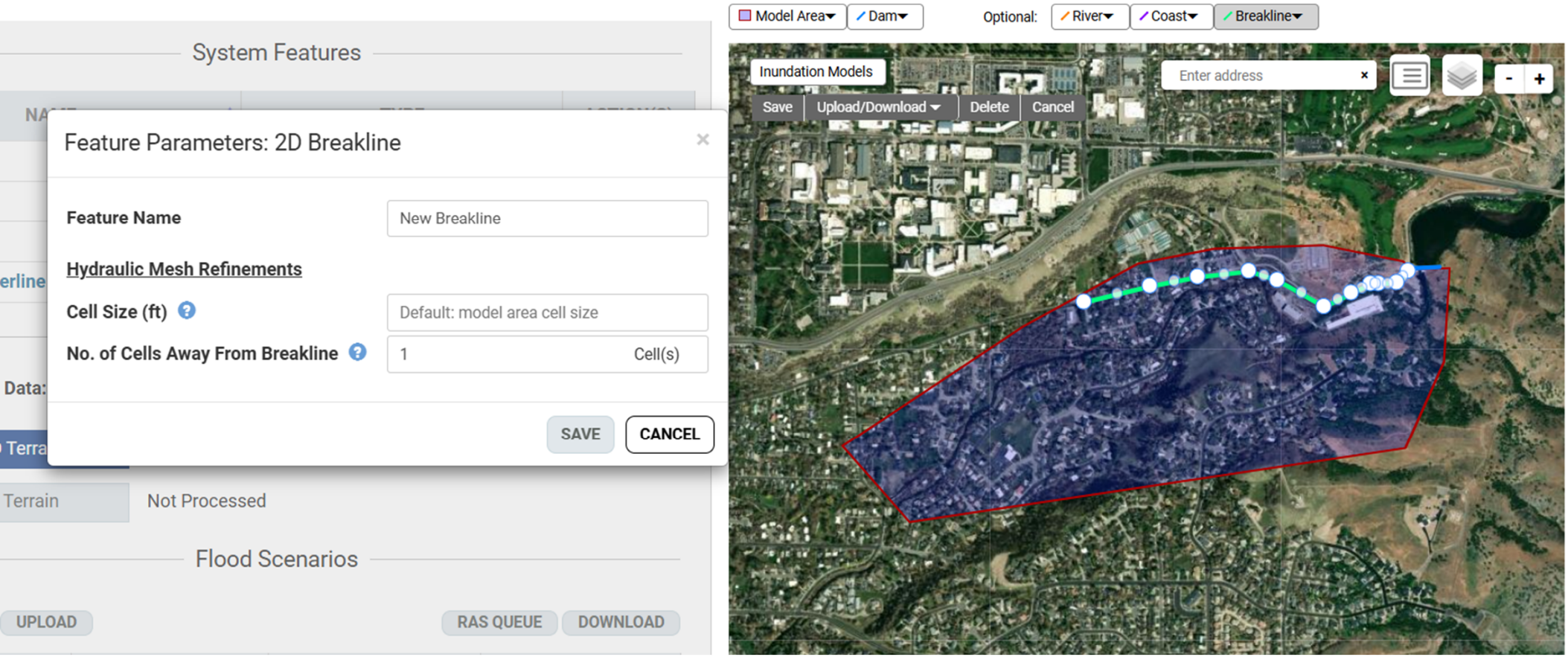

DST
Dam Screening Tool 1.4.0
SCREENINGS
ABIGAIL REPKO | FACILITATOR
HELP
LOGOUT
Screening - Example
Switch
Screening Information
Consequences
Inundation
Structure Inventory
LifeSim Compute
Consequence Results
System Features
NAME
TYPE
ACTION(S)
Model Area
2D Flow Area
New Dam
Dam
Feature Parameters: 2D Hydraulic Model Area
Cell Size (ft)
50
Estimated Cell Count
33862
Recommended Cell Size (ft)
308
SAVE
CANCEL
Prepare Terrain Data:
DST Terrain
Download NED Terrain to DST
Not Downloaded
Modify Terrain
Not Processed
ADD NEW
UPLOAD
RAS QUEUE
DOWNLOAD
FLOOD SCENARIO NAME
MODEL CREATION
LAST COMPUTED
ACTION(S)
No data available in table
Model Area
Dam
Optional:
River
Coast
Breakline
Inundation Models
Save
Upload/Download
Delete
Cancel
Enter address
3000 ft
Model Area: 3.04 sq mi, Lat: 41.73086, Lng: -111.86174

DST Flood Scenario Editor





DST Flood Scenario Editor



Montana Lidar Inventory EB

experience.arcgis.com/experience/59eb1cfca29445a0ae04655379c314e9

MONTANA STATE LIBRARY

Montana Lidar Inventory

Disclaimer

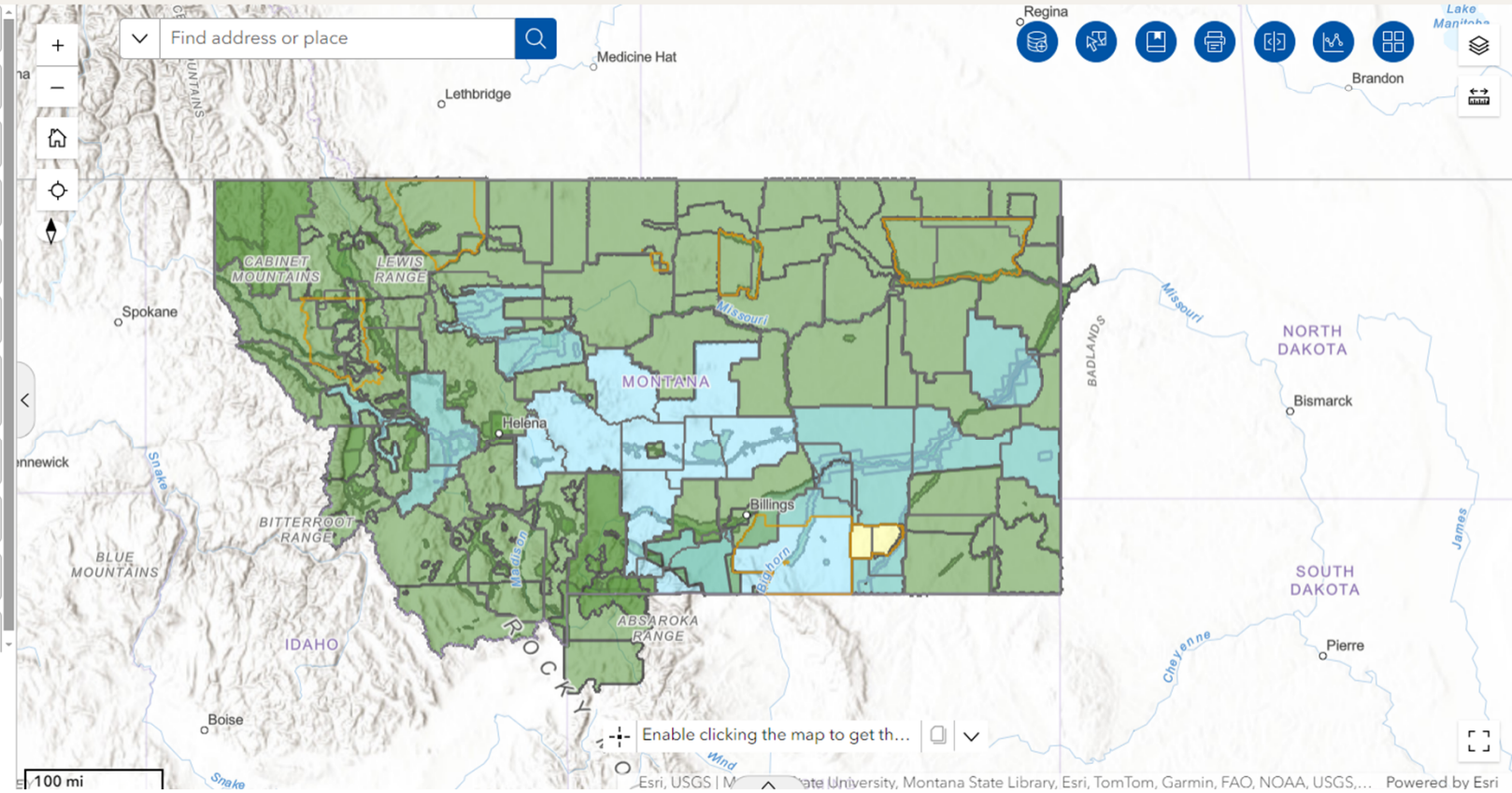
Introduction | Status Dashboard | View, Download, and Request | Collaborate | Data Use Survey | Lidar 101 & Images | User Guide

- Viewable Lidar Projects (in this application)
- Downloadable lidar projects (MSL or USGS)
- Lidar projects not yet at the State Library
- Completed lidar acquisitions
- In-progress lidar acquisitions
- Planned lidar acquisitions
- Completed lidar projects that are less than 5 years old
- Lidar projects that have contours
- Lidar projects that have building footprints
- Quality Level 1 lidar (~8 points per square meter)
- Quality Level 2 lidar (~2 points per square meter)

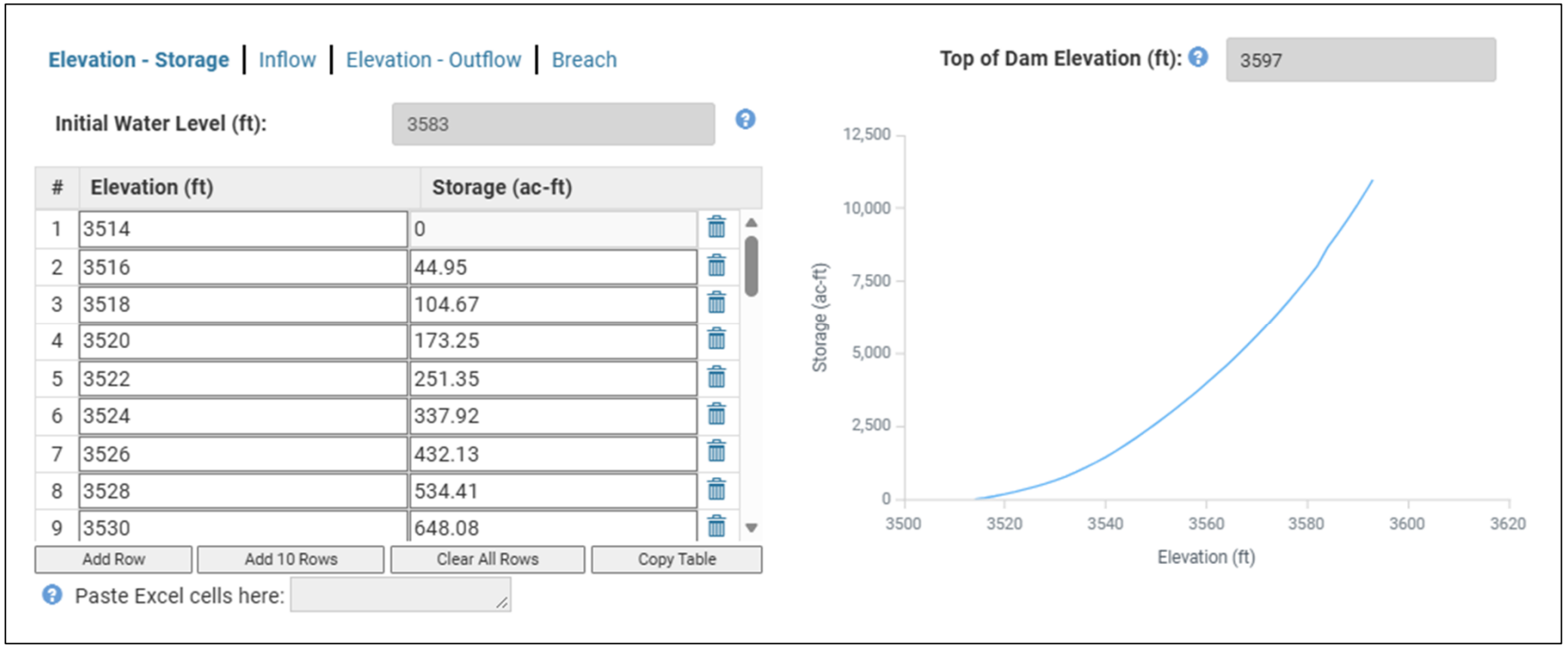
| Request lidar data not available by download |

| View lidar projects as a list |

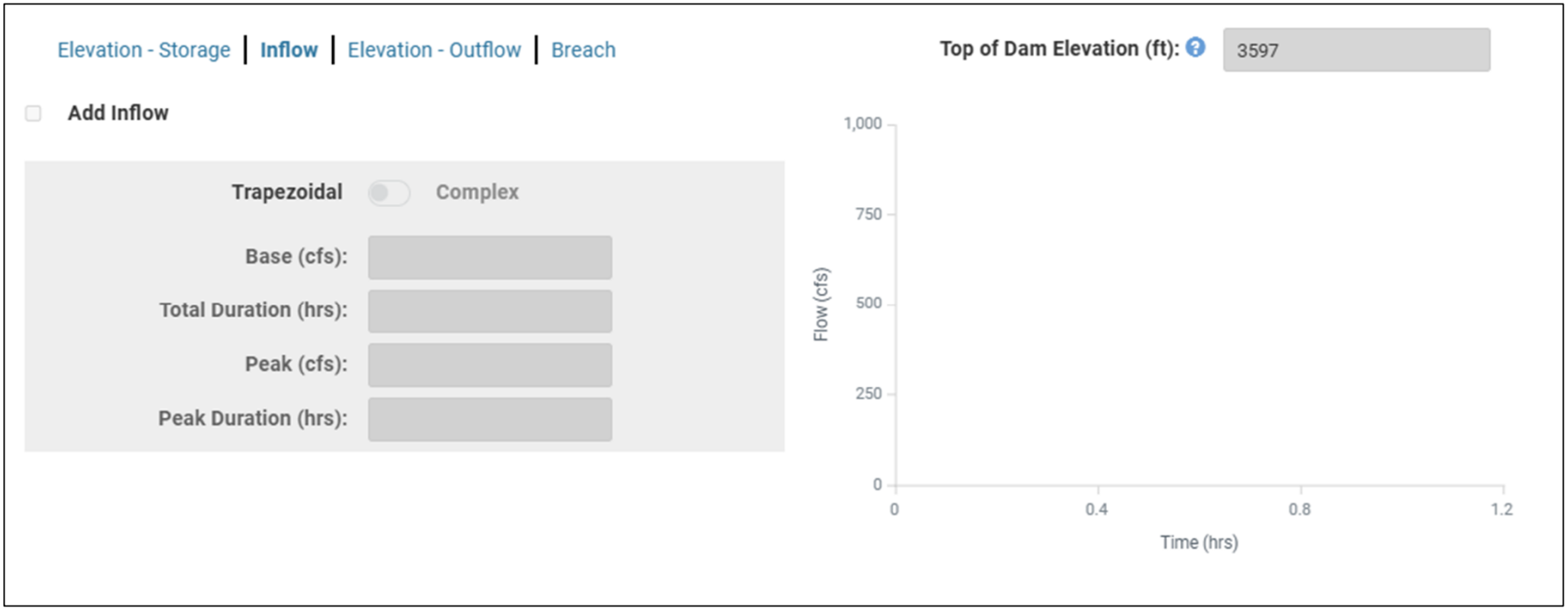
| Let us know how you are using the data |



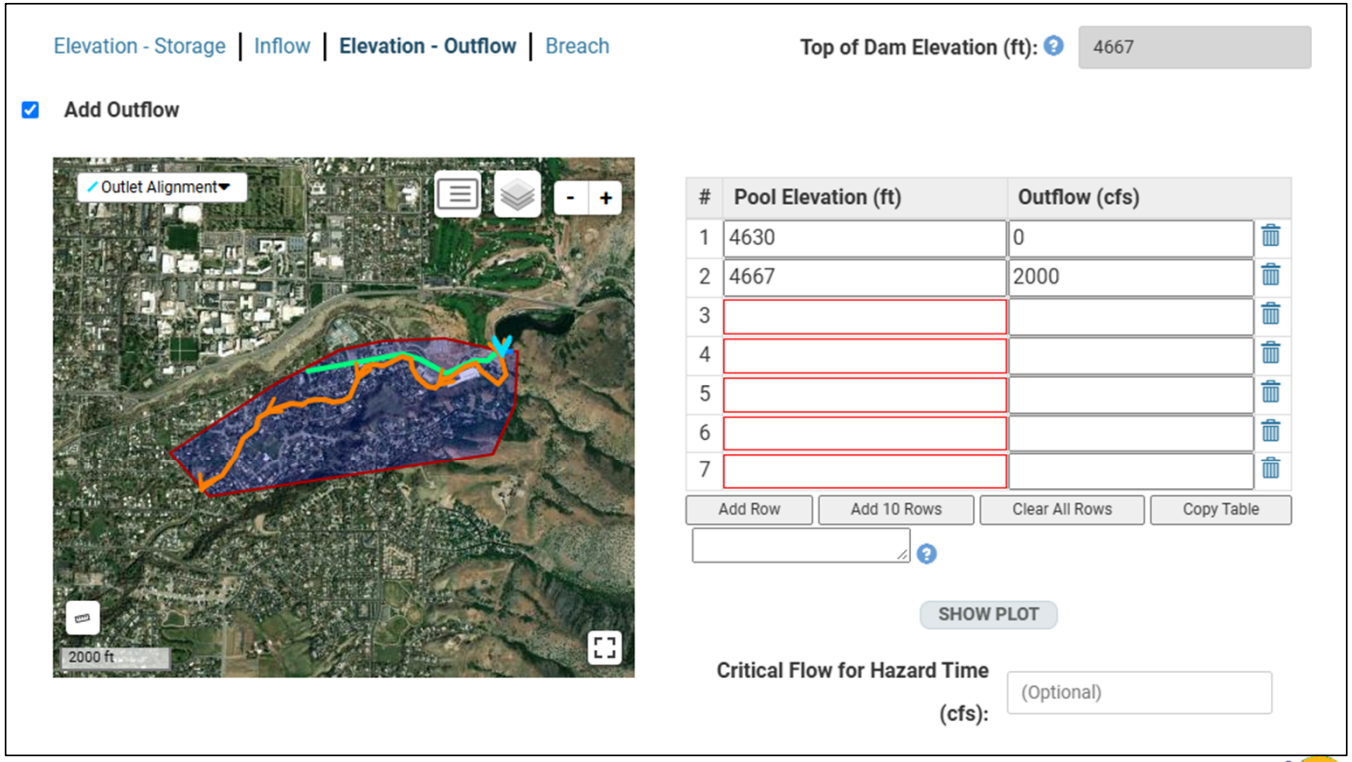
DST Flood Scenario Editor



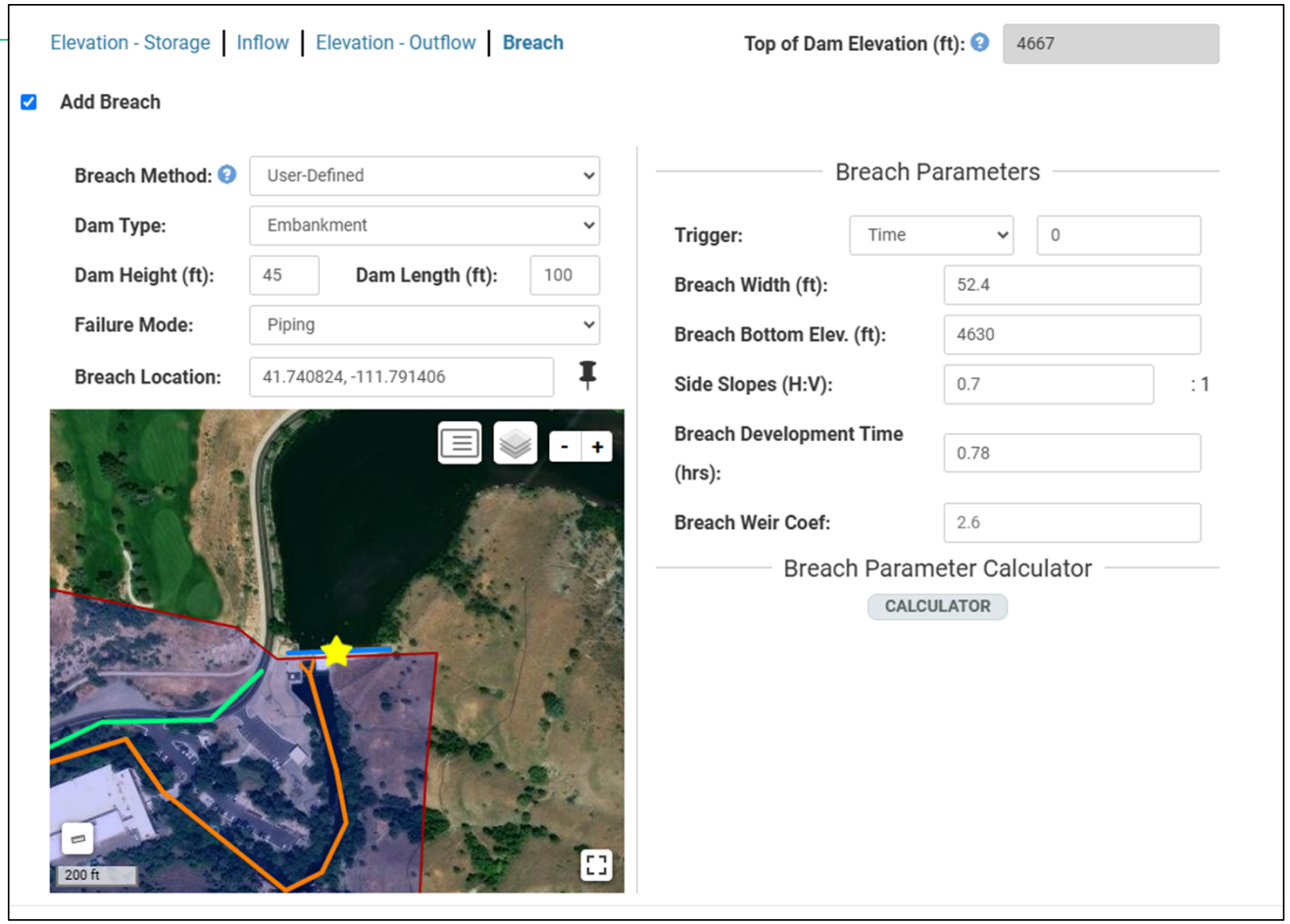
DST Flood Scenario Editor



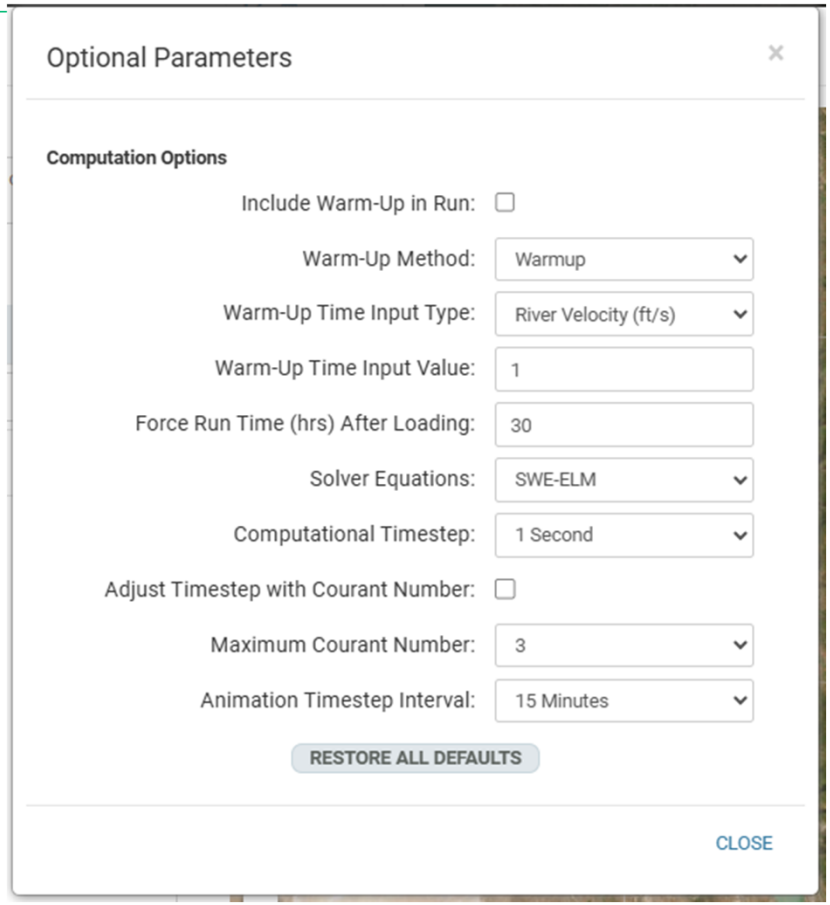
DST Flood Scenario Editor

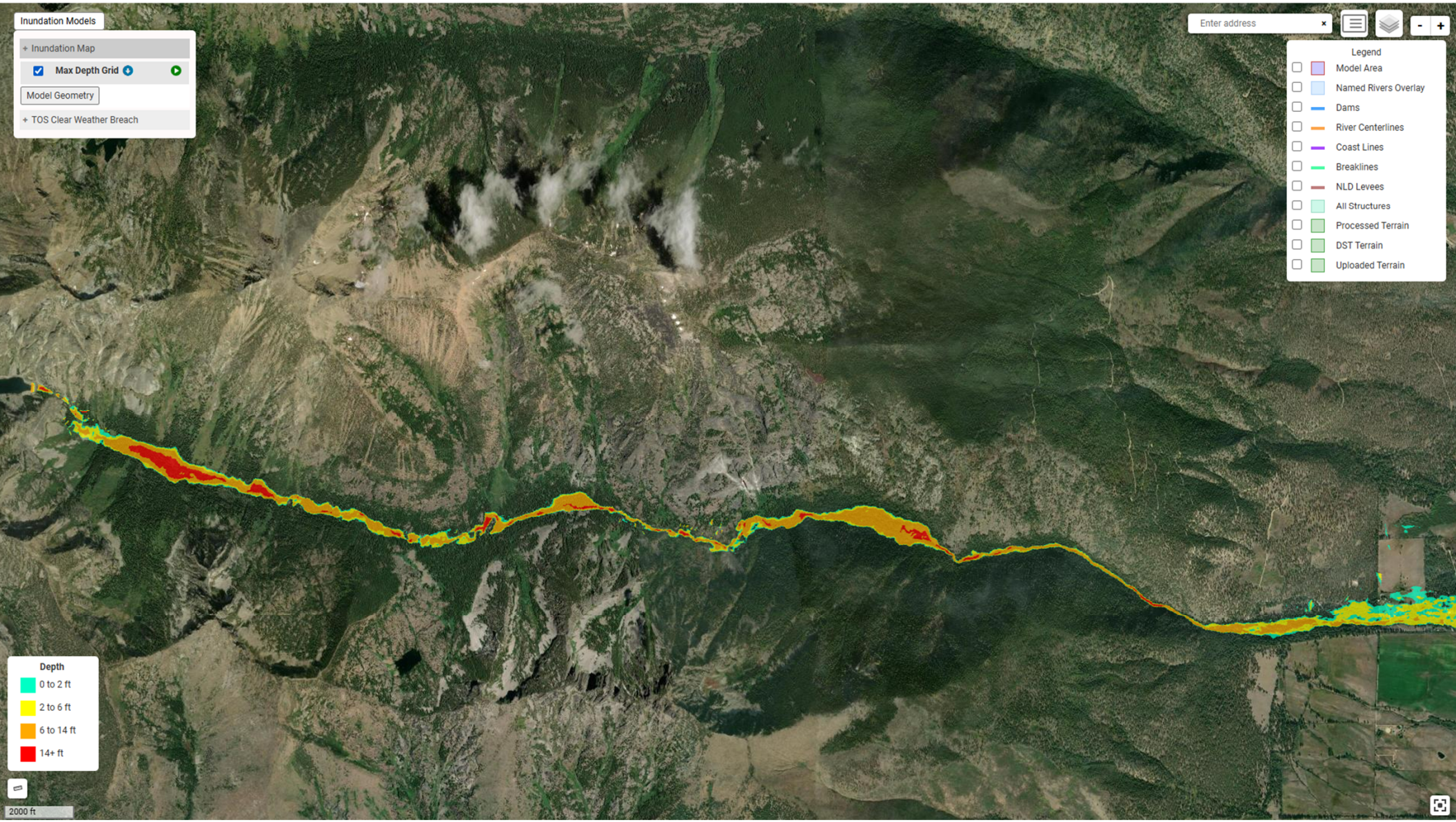


DST Flood Scenario Editor



DST Flood Scenario Editor



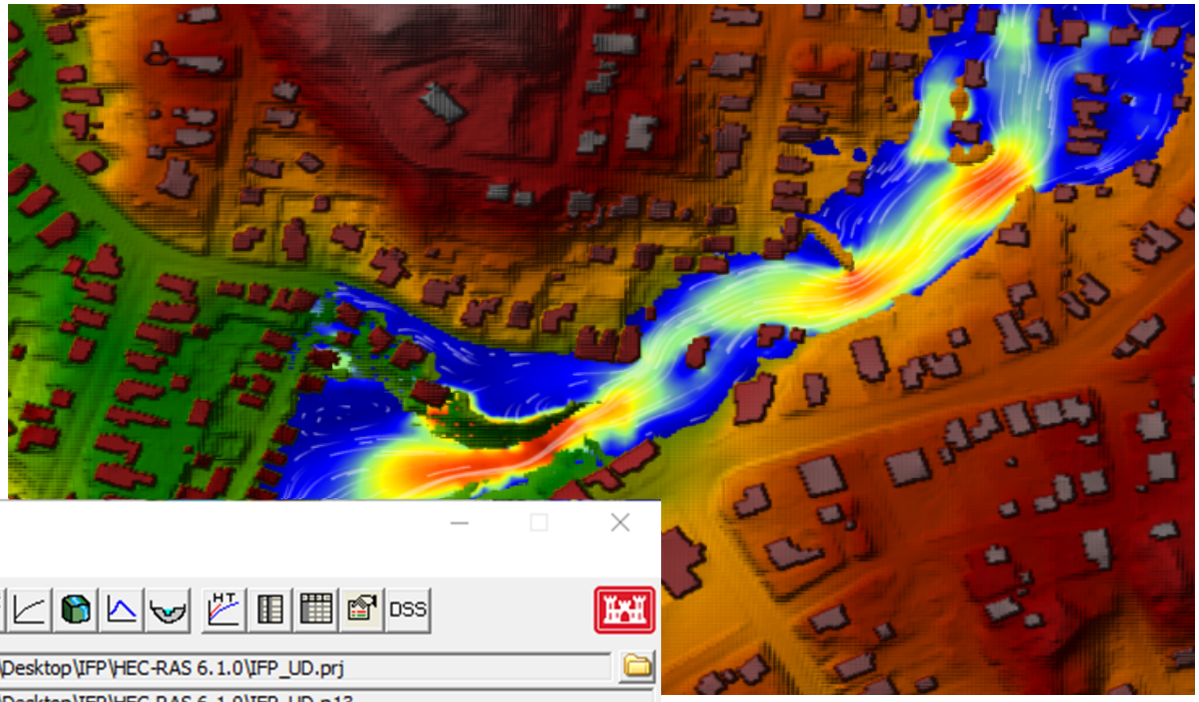

Inundation Models
+ Inundation Map
Max Depth Grid
Model Geometry
+ TOS Clear Weather Breach
Enter address
Legend
Model Area
Named Rivers Overlay
Dams
River Centerlines
Coast Lines
Breaklines
NLD Levees
All Structures
Processed Terrain
DST Terrain
Uploaded Terrain
Depth
0 to 2 ft
2 to 6 ft
6 to 14 ft
14+ ft
2000 ft

Advanced Breach Analyses

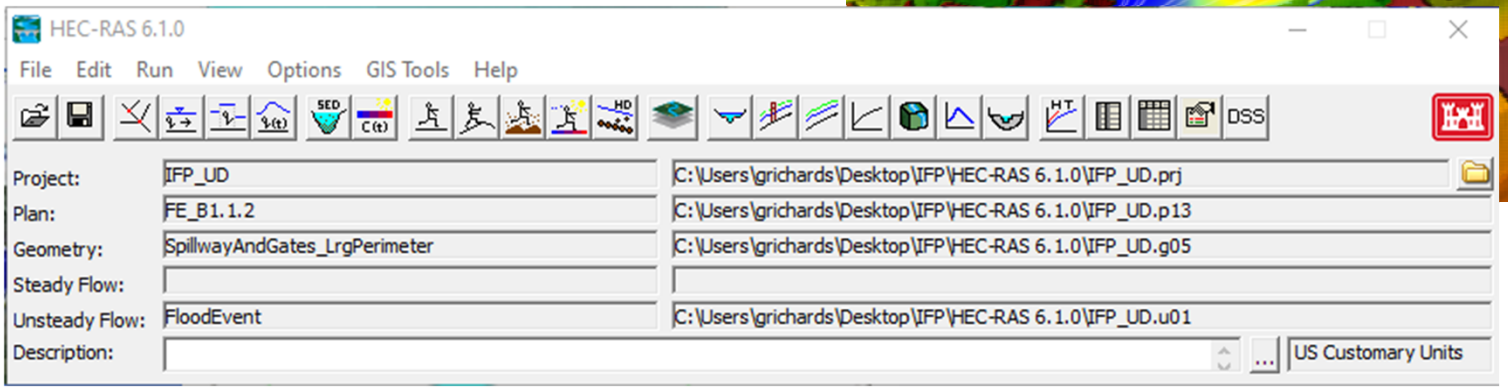
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Advanced Breach Analysis

- HEC-RAS (Two-Dimensional Flow)
- Current Version 7.0.1 (June 2026)

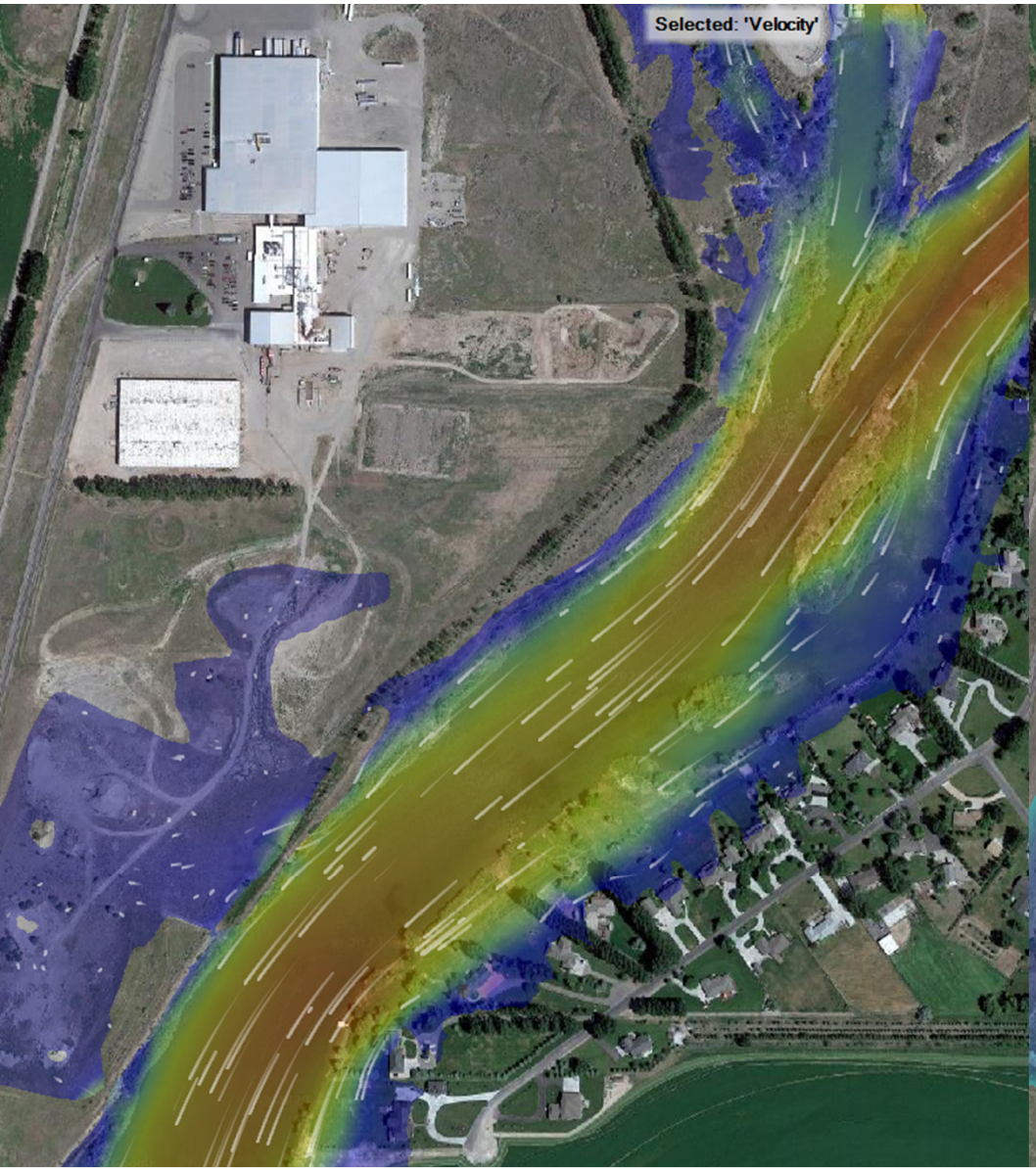


US Army Corps of Engineers®

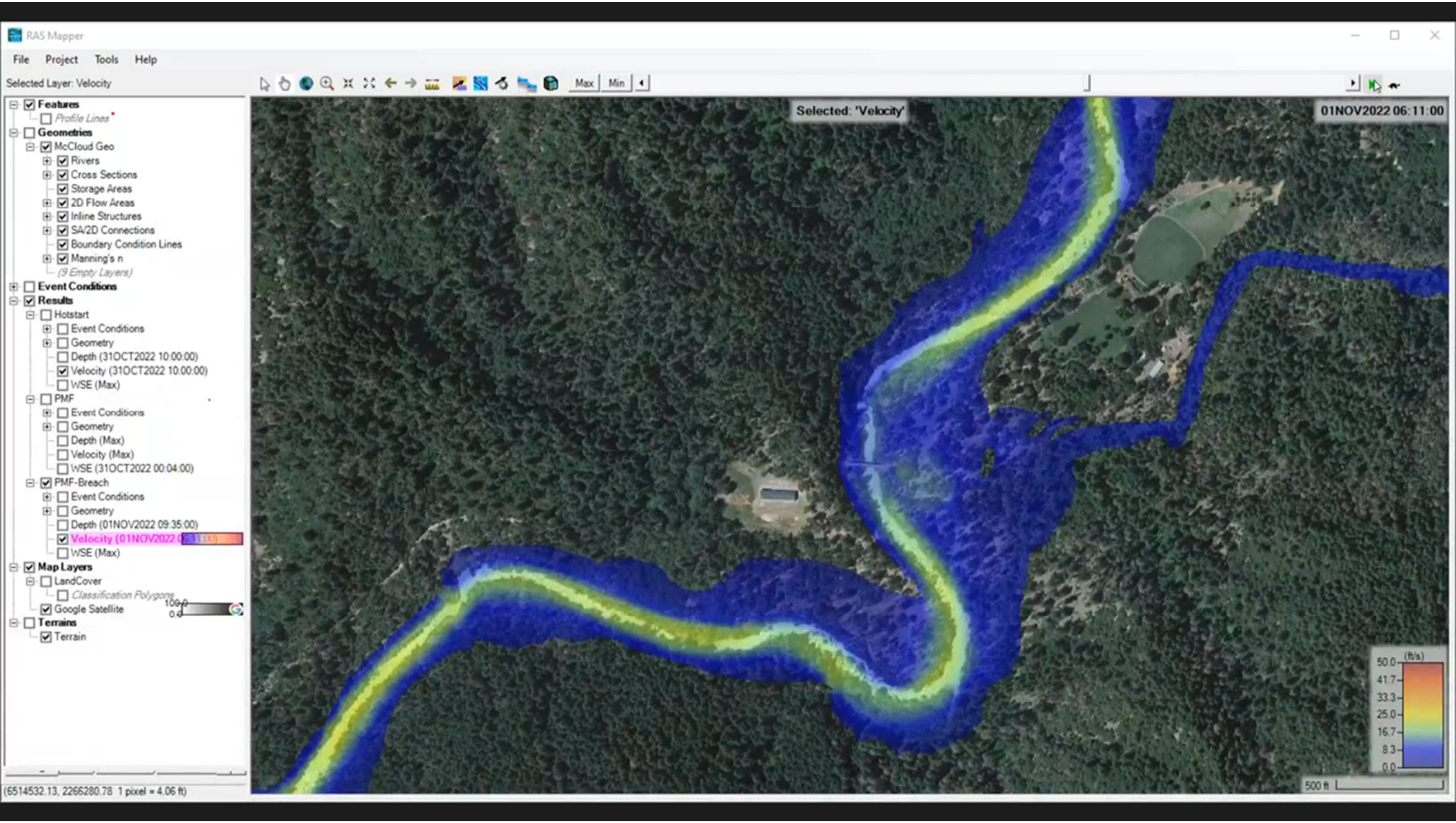


MONTANA DNRC

GFT


Selected: 'Velocity'


Selected: 'Depth'


RAS Mapper
File
Project
Tools
Help
Selected Layer: Velocity
Max
Min
Features
Profile Lines
Geometries
McCloud Geo
Rivers
Cross Sections
Storage Areas
2D Flow Areas
Inline Structures
SA/2D Connections
Boundary Condition Lines
Manning's n
(9 Empty Layers)
Event Conditions
Results
Hotstart
Event Conditions
Geometry
Depth (31OCT2022 10:00:00)
Velocity (31OCT2022 10:00:00)
WSE (Max)
PMF
Event Conditions
Geometry
Depth (Max)
Velocity (Max)
WSE (31OCT2022 00:04:00)
PMF-Breach
Event Conditions
Geometry
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Velocity (01NOV2022
WSE (Max)
Map Layers
LandCover
Classification Polygons
Google Satellite
100.0
0.0
Terrains
Terrain
(6514532.13, 2266280.78 1 pixel = 4.06 ft)
Selected: 'Velocity'
01NOV2022 06:11:00
(ft/s)
50.0
41.7
33.3
25.0
16.7
8.3
0.0
500 ft



36.14.208 DAMS IN SERIES

(1) The worst case scenario shall govern for determining the hazard classification of dams in series where more than one mode of failure is possible among the dams. Classification shall be based on potential for failure under combined and, if applicable, individual dam breach scenarios.

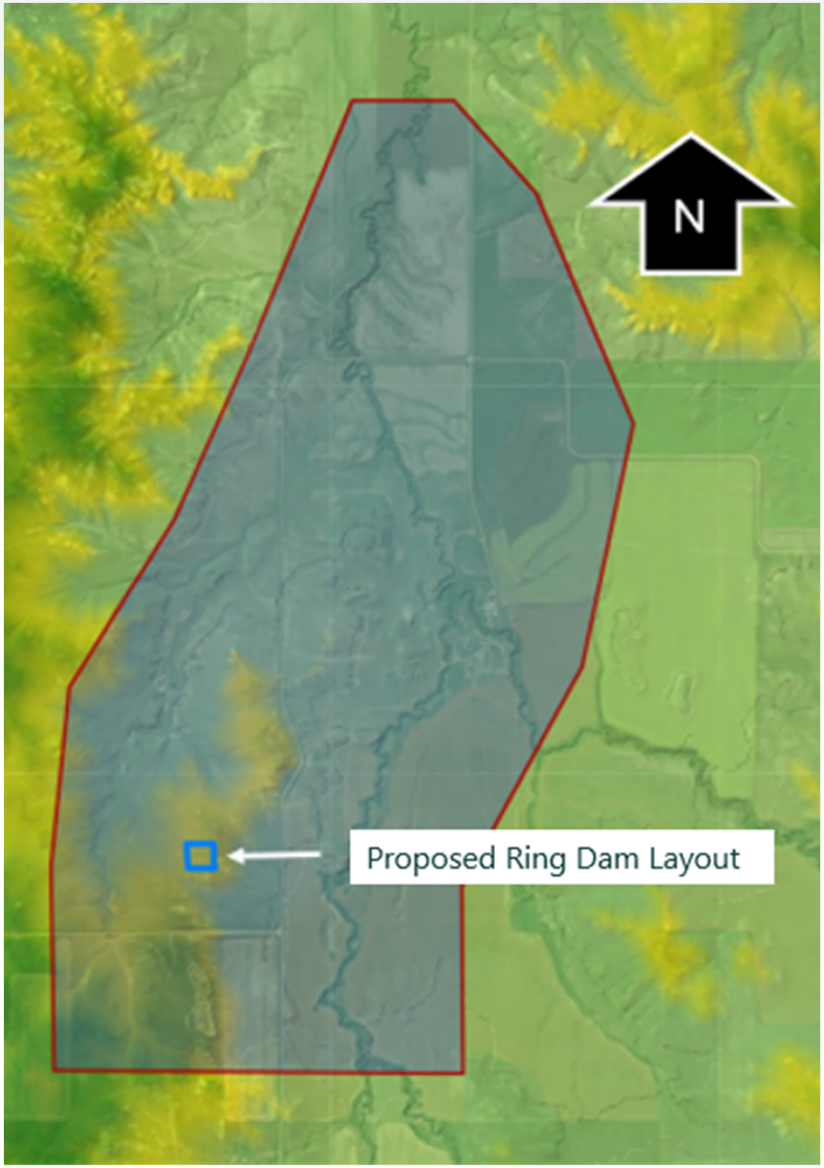
(2) The upstream dam must be classified as a high-hazard dam if:

(a) an upstream dam has the capability to create failure in a downstream high-hazard dam because of its failure flood wave; or

(b) the failure flood wave of the upstream dam will likely cause a loss of life, with or without failure of the downstream dam.

(3) Wastewater ponds that are separated by internal berms are not considered to be dams in series.

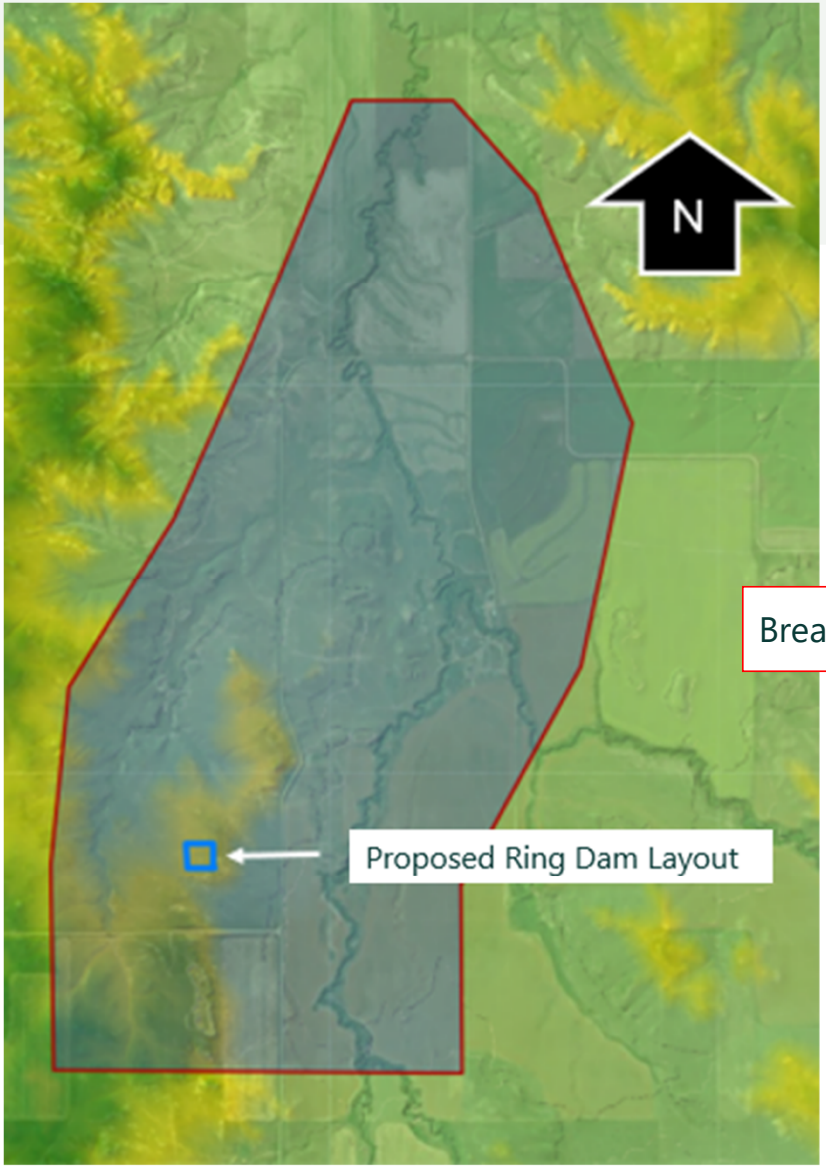




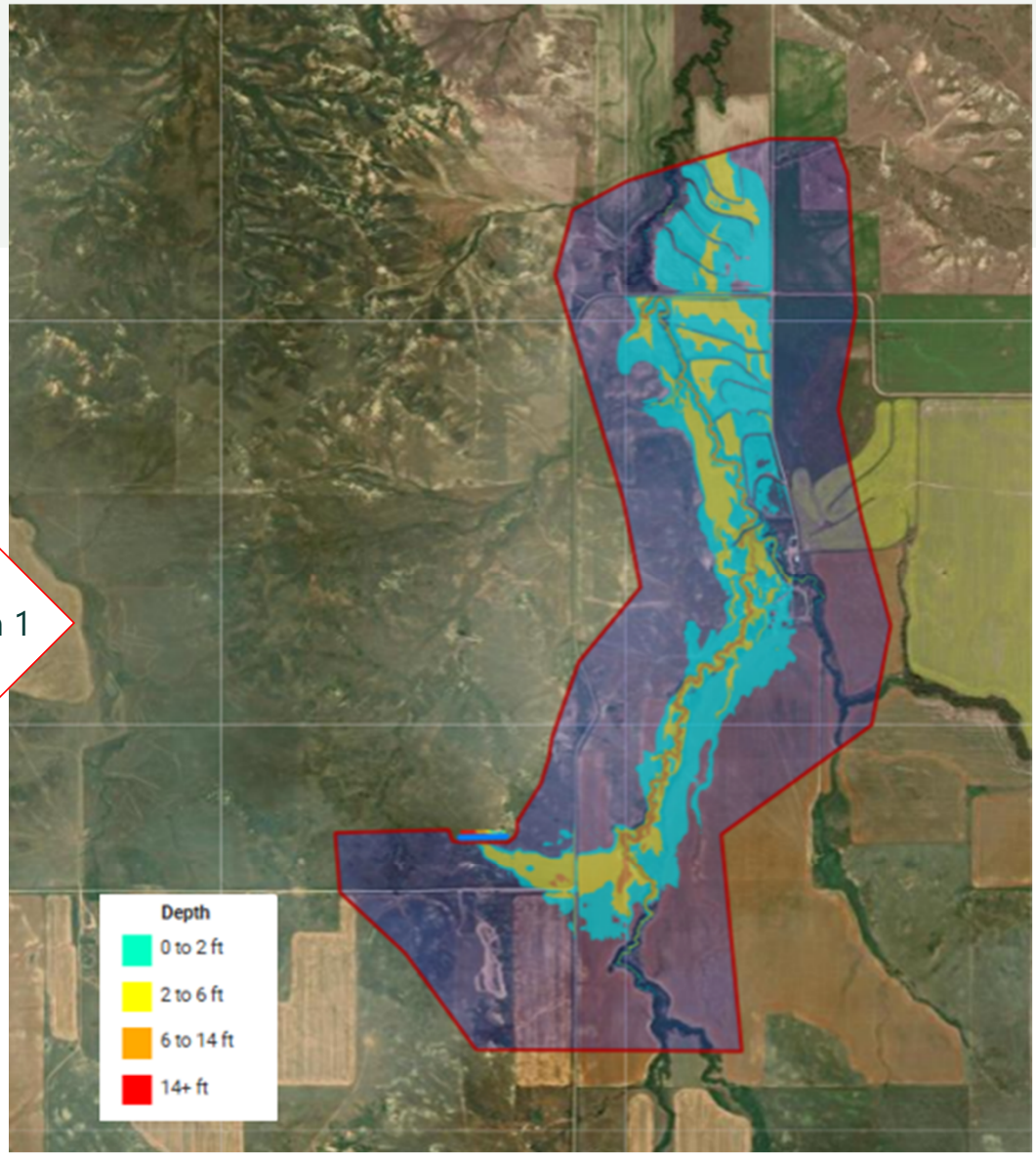


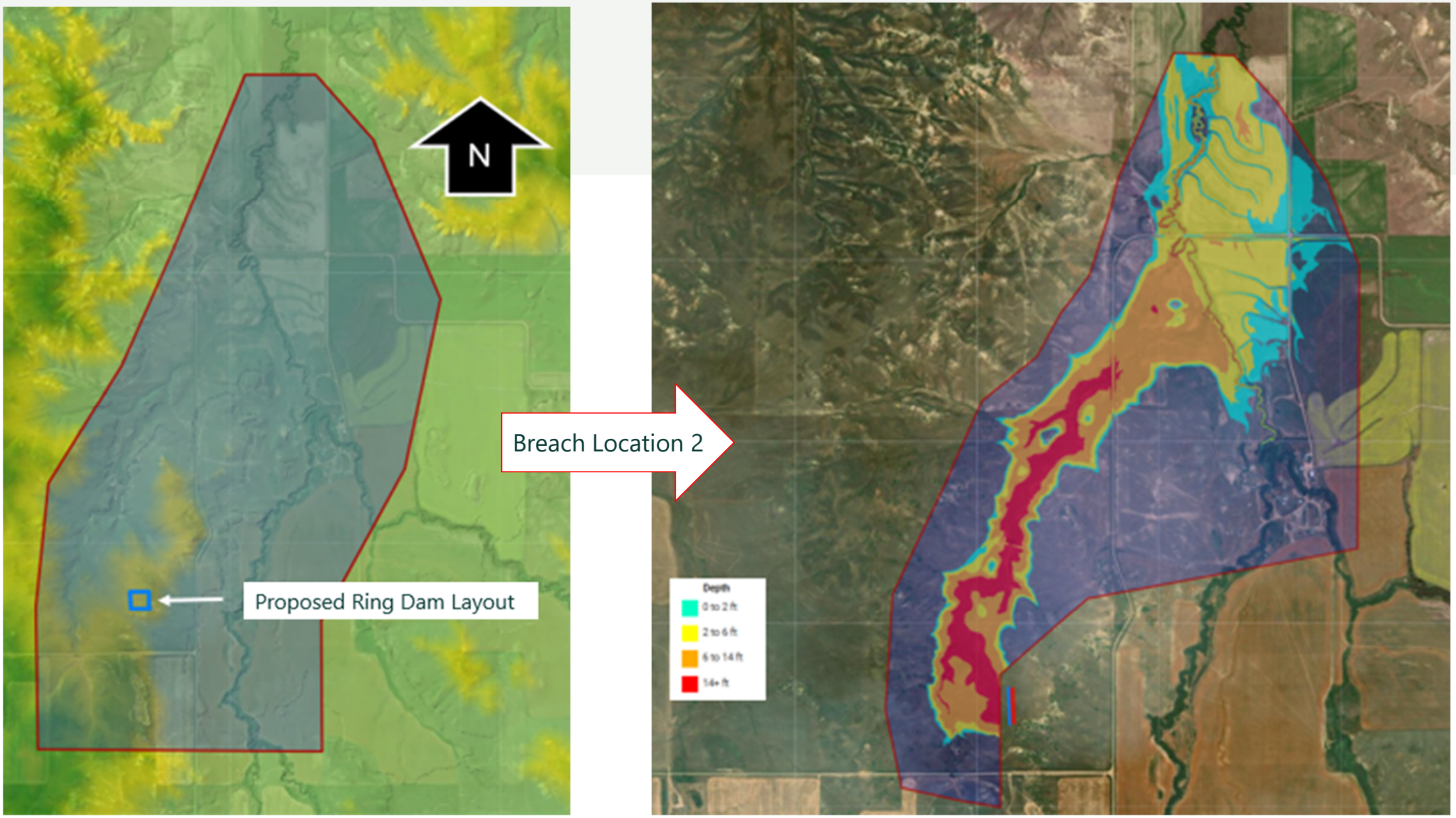
MONTANA DNRC

GFT



Breach Location 1




N
Proposed Ring Dam Layout
Breach Location 2
Depth
0 to 2 ft
2 to 6 ft
6 to 14 ft
14+ ft

Questions?

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