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# Channel Dynamics for the Madison River Downstream from Earthquake Lake, Montana

In cooperation with the
Madison River Fisheries
Technical Advisory Committee

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U.S. Department of the Interior
U.S. Geological Survey

# Location


Yellowstone National Park

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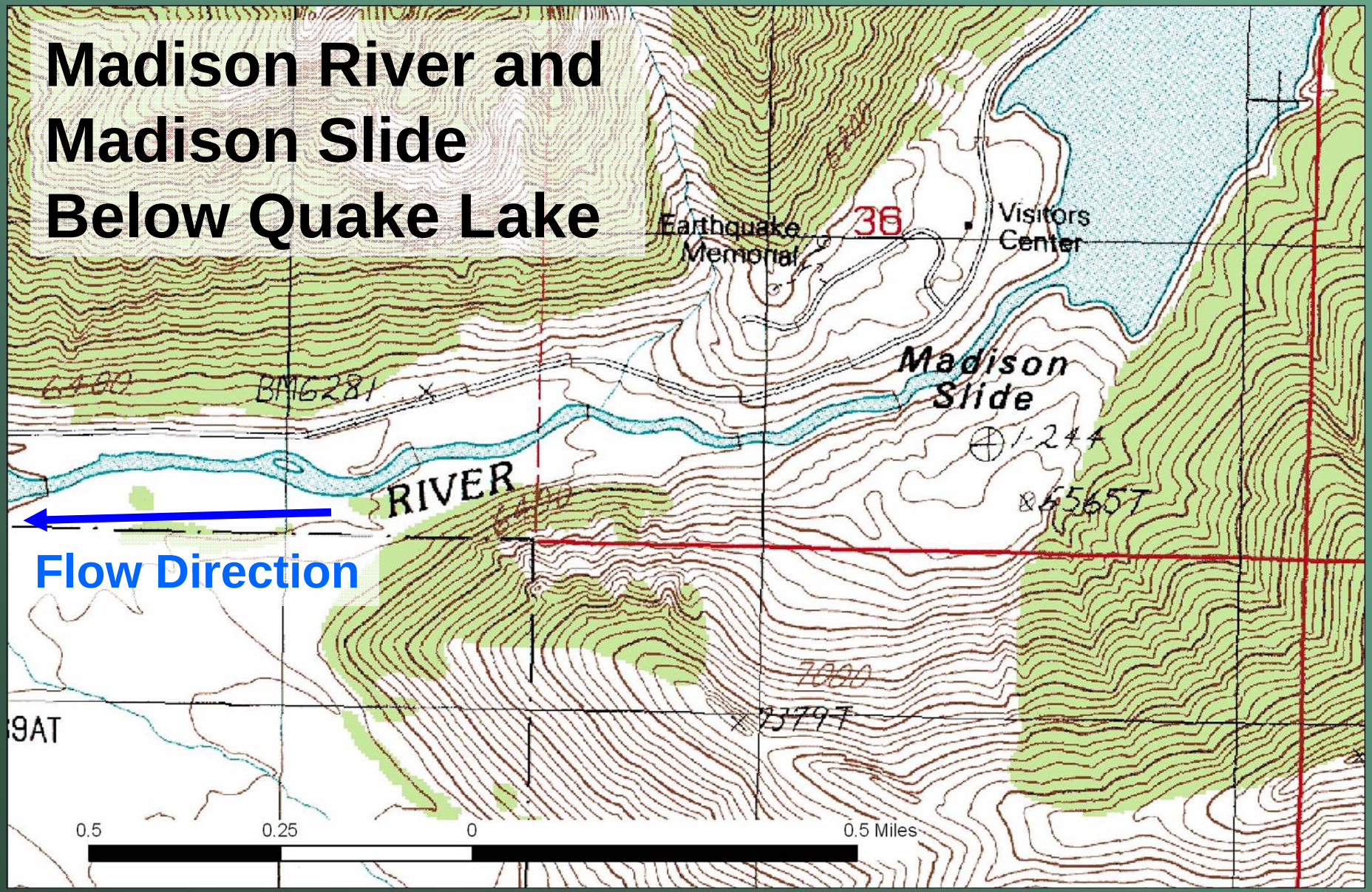
To West Yellowstone

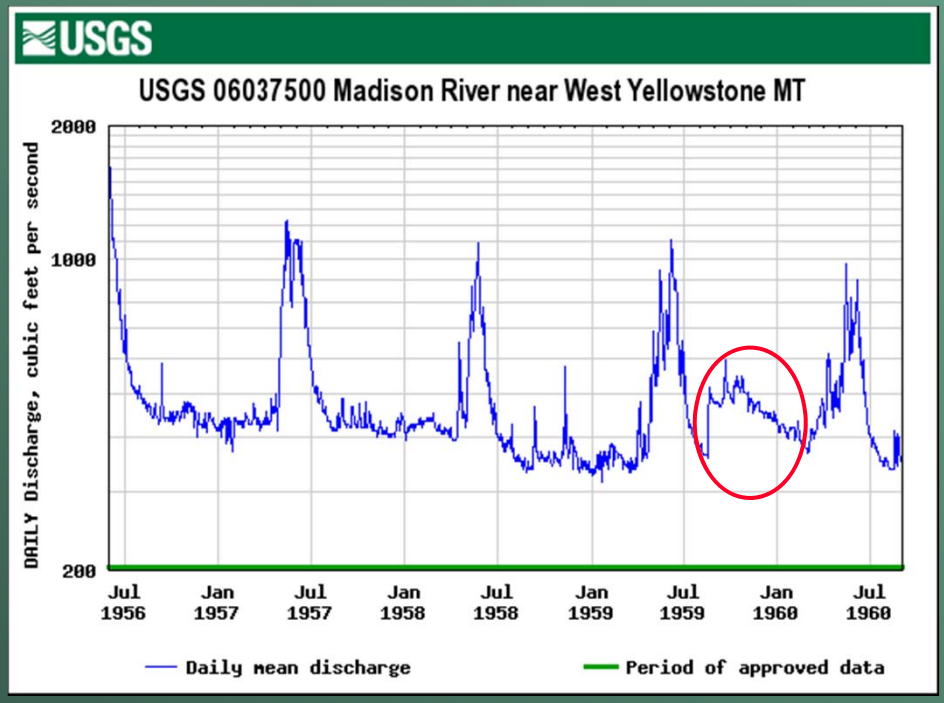

Madison River and
Madison Slide
Below Quake Lake
Earthquake Memorial
36
Visitors Center
Madison Slide
RIVER
Flow Direction
0.5
0.25
0
0.5 Miles

# Hebgen Lake Earthquake

- August 17, 1959
  7.3 Magnitude

- Hebgen Lake tipped - 15-20 foot waves and one shore now higher than other

- Other phenomena

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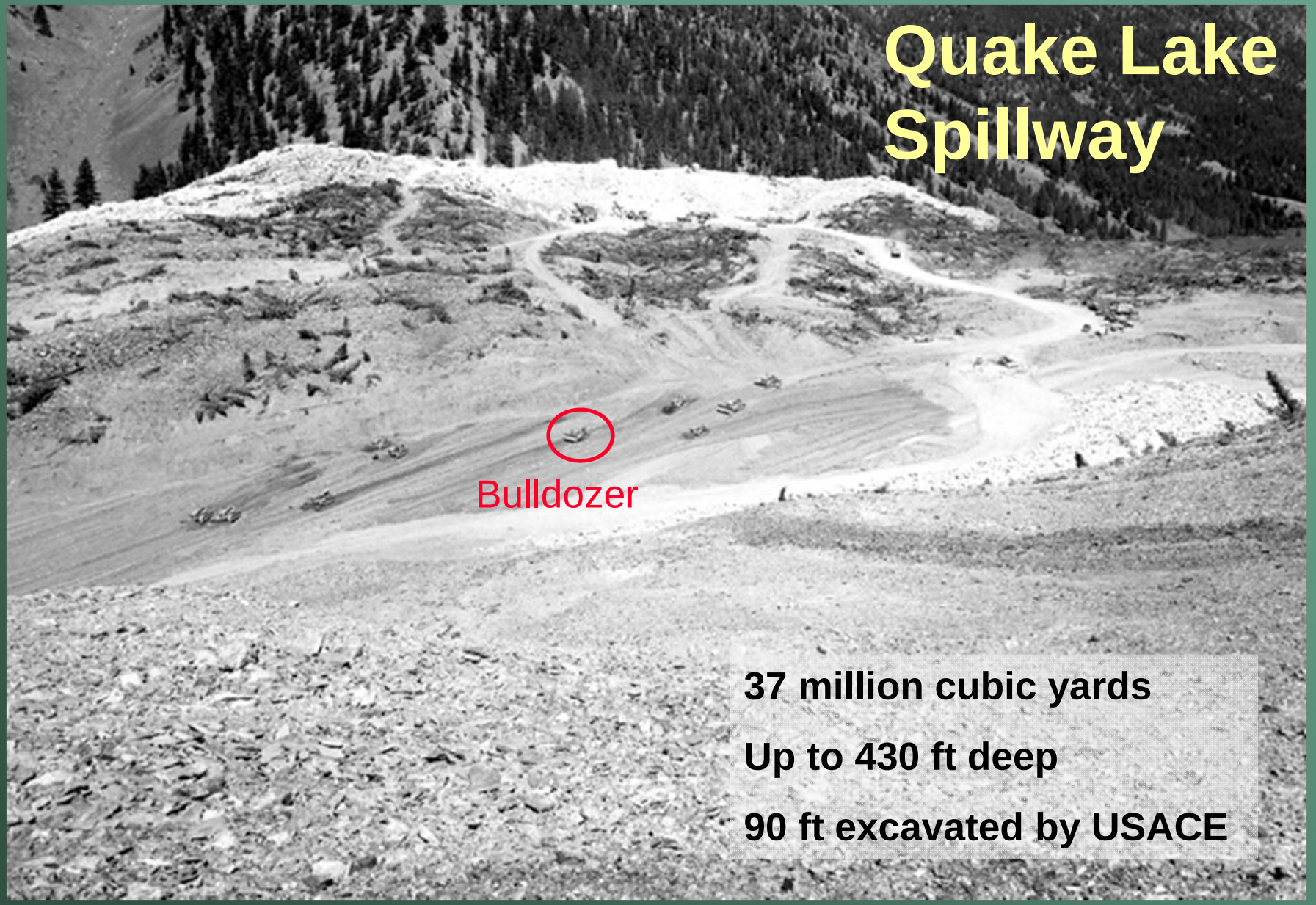
# Quake Lake Spillway




**37 million cubic yards**

**Up to 430 ft deep**

**90 ft excavated by USACE**

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# Madison Slide and Earthquake Lake


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# Madison River Below Quake Lake

- Erosion and property damage 1970, 1971, 1986

- 1972 USACE study recommended Hebgen Lake managed for 3,500 cfs flow threshold

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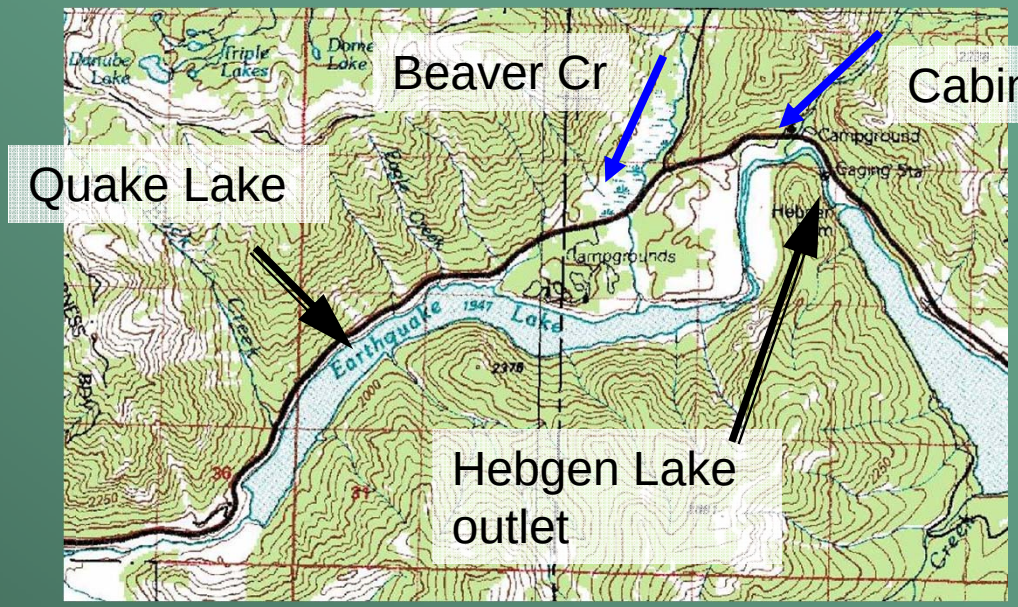
# Question: Can 3,500 cfs threshold be increased?

- Difficult to maintain 3,500 cfs threshold because of 2 large tributaries
- Higher Flows could benefit blue ribbon trout fishery downstream

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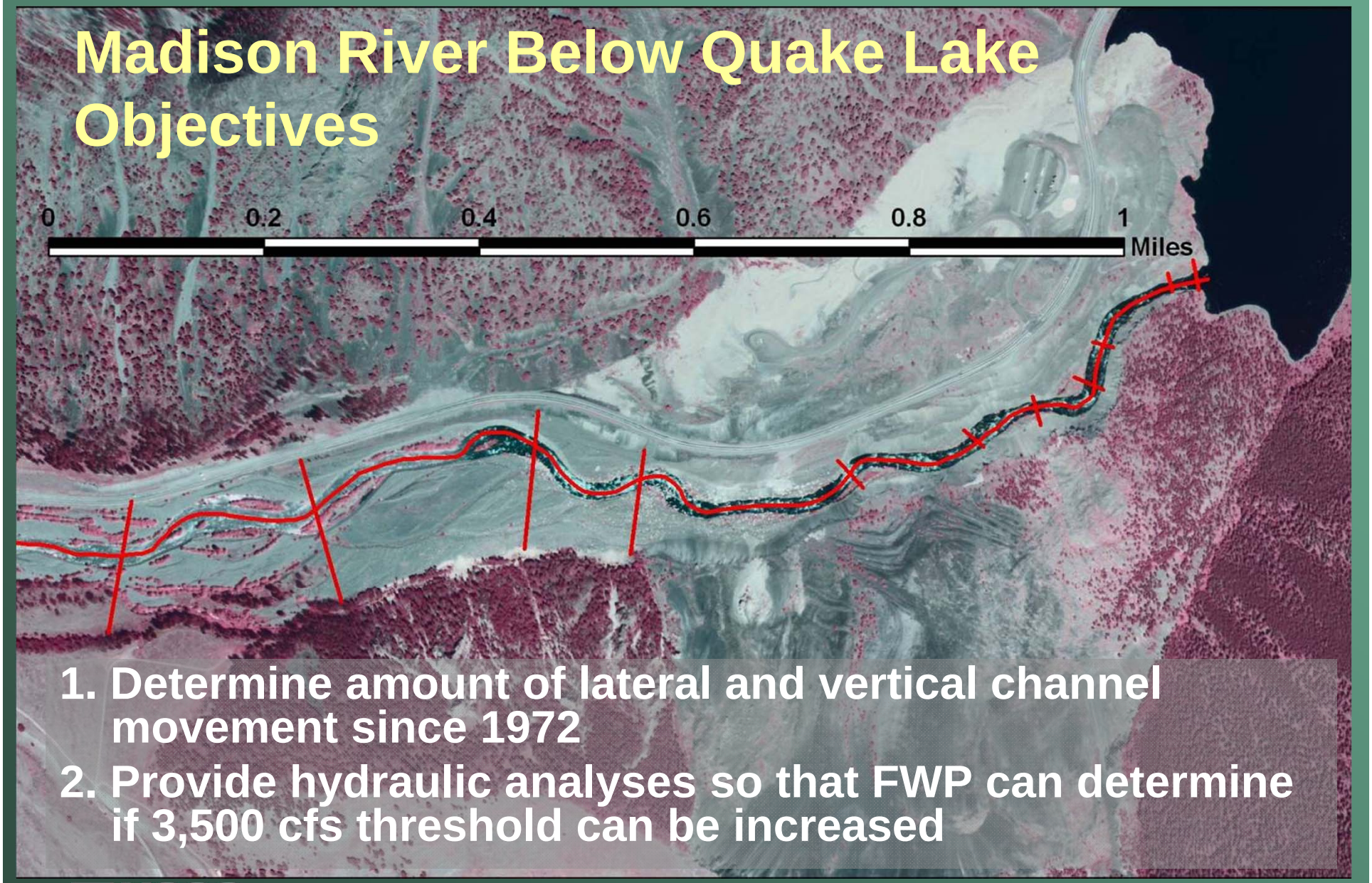
# Madison River Below Quake Lake Objectives




1. Determine amount of lateral and vertical channel movement since 1972
2. Provide hydraulic analyses so that FWP can determine if 3,500 cfs threshold can be increased

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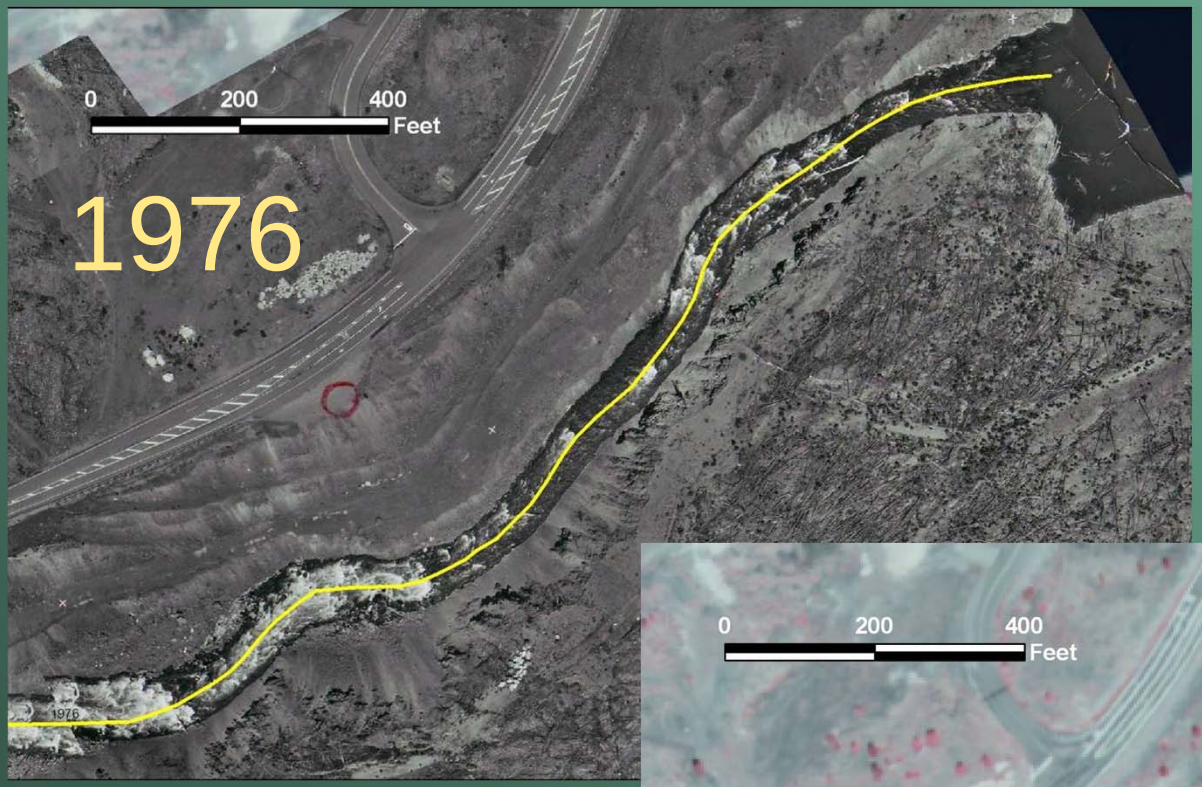
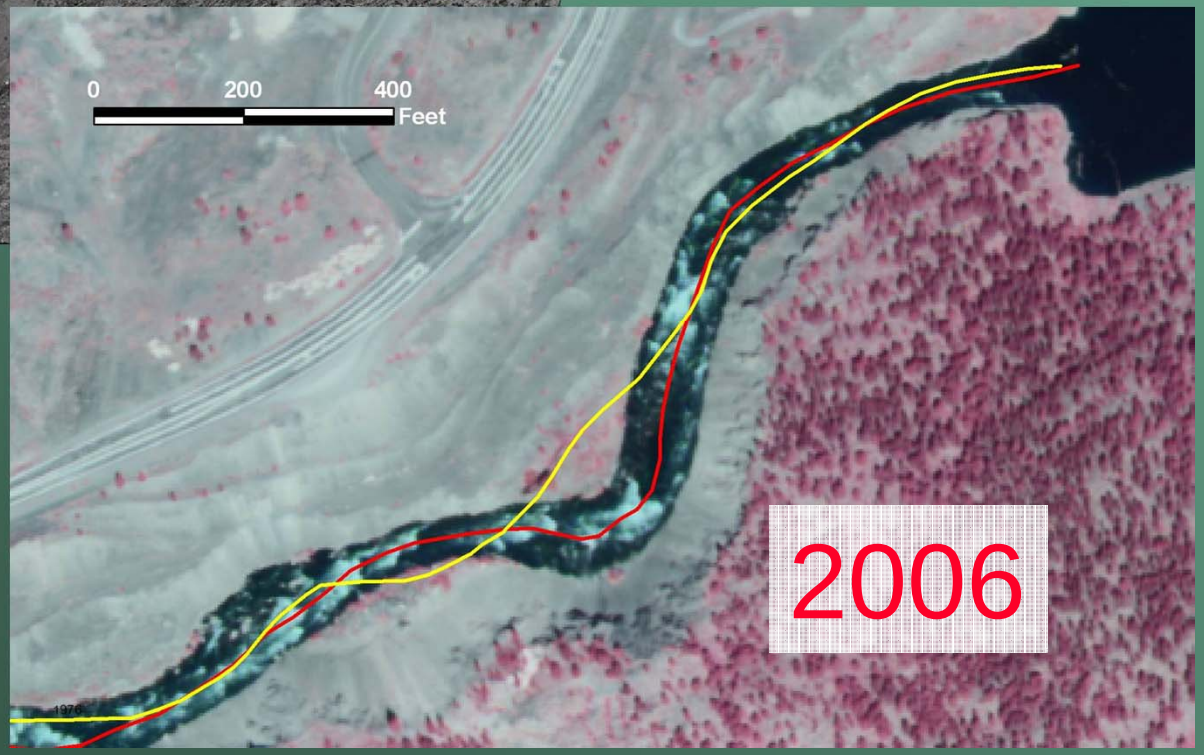
# 1. HISTORICAL CHANNEL MOVEMENT




**Aerial Photography: Upper Study Reach**

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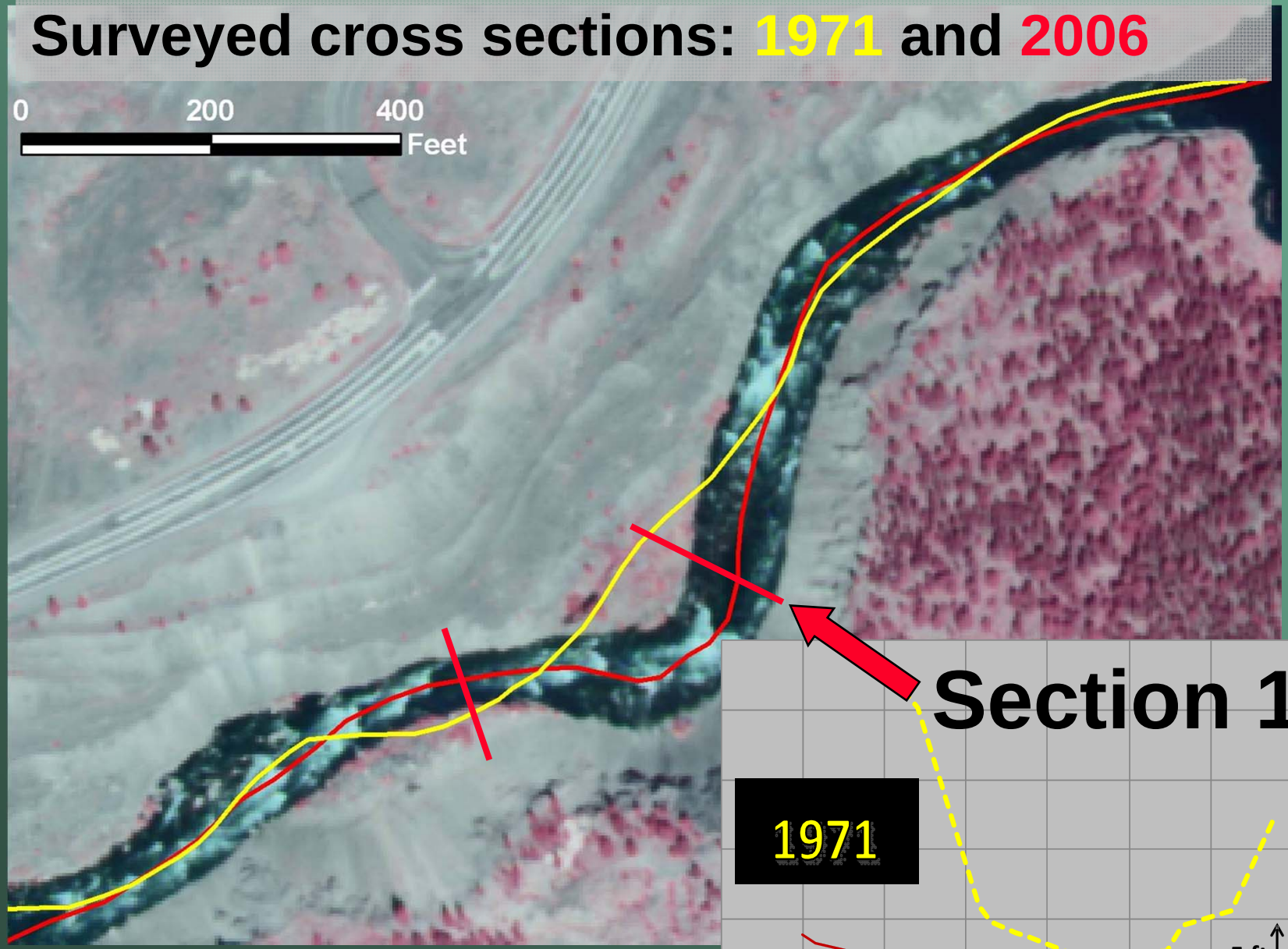
# Surveyed cross sections: 1971 and 2006

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## Section 1100

# Photo comparisons: Section 1100



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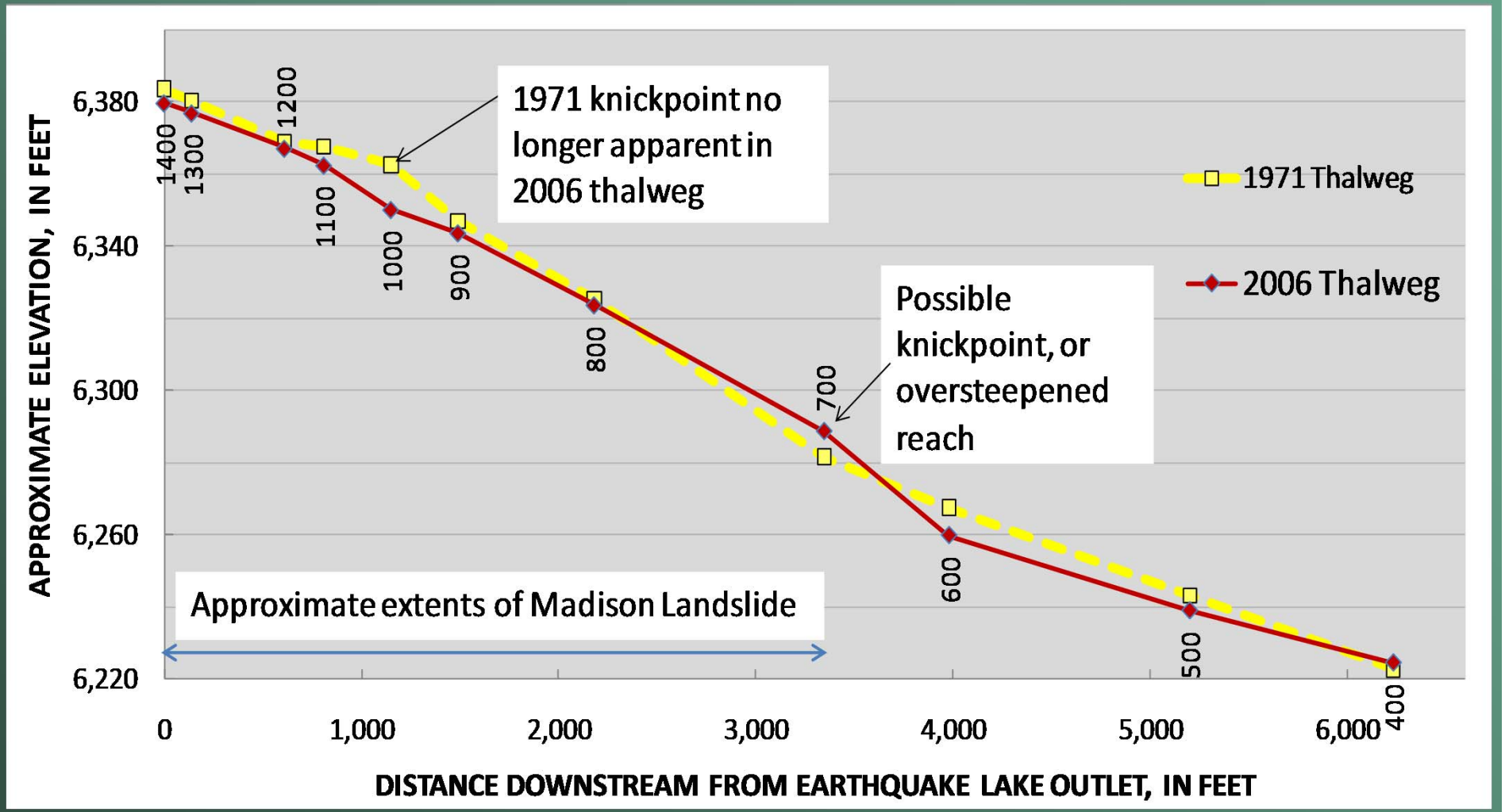
# Madison River Approximate Thalweg Profiles

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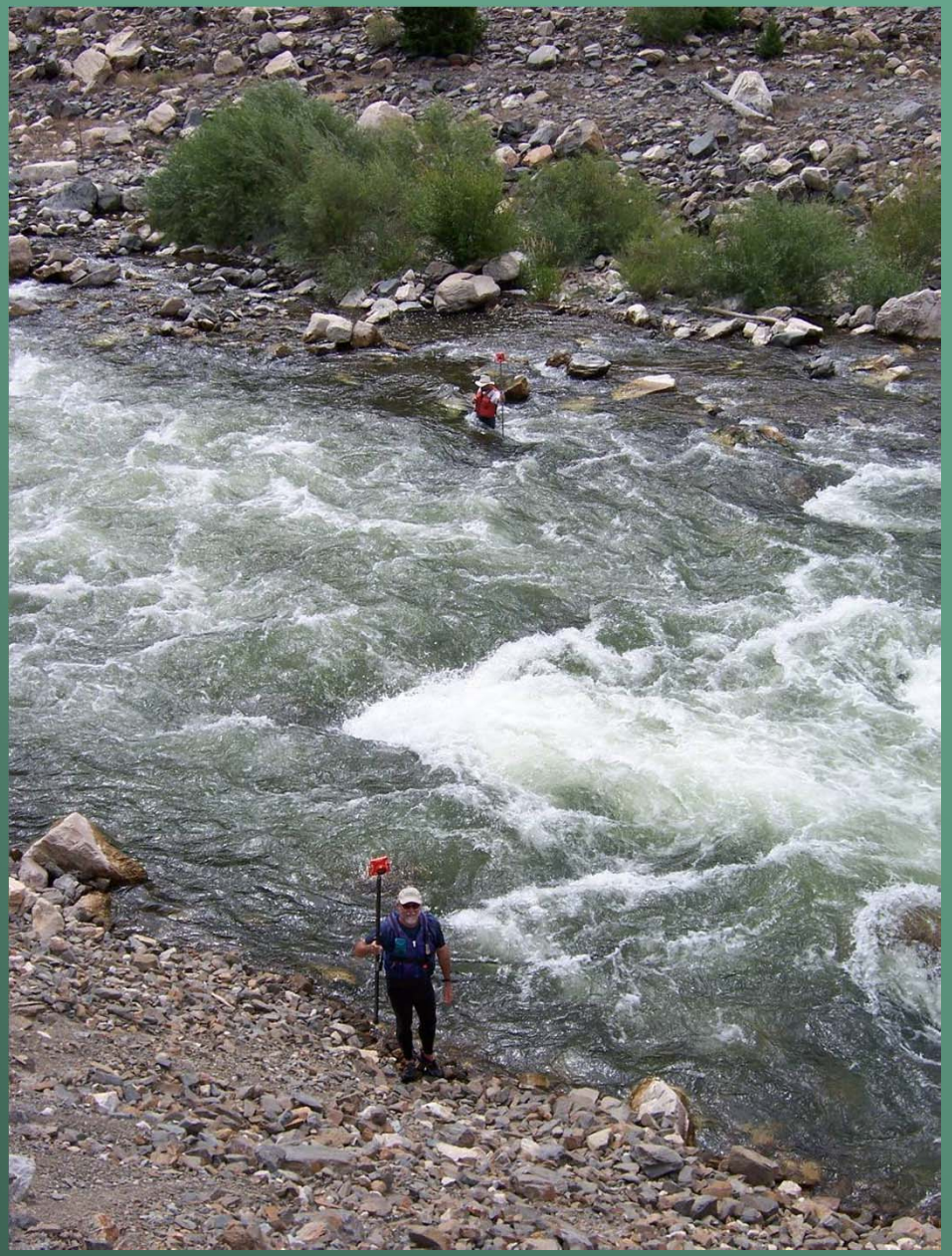
# Why is thalweg approximate?



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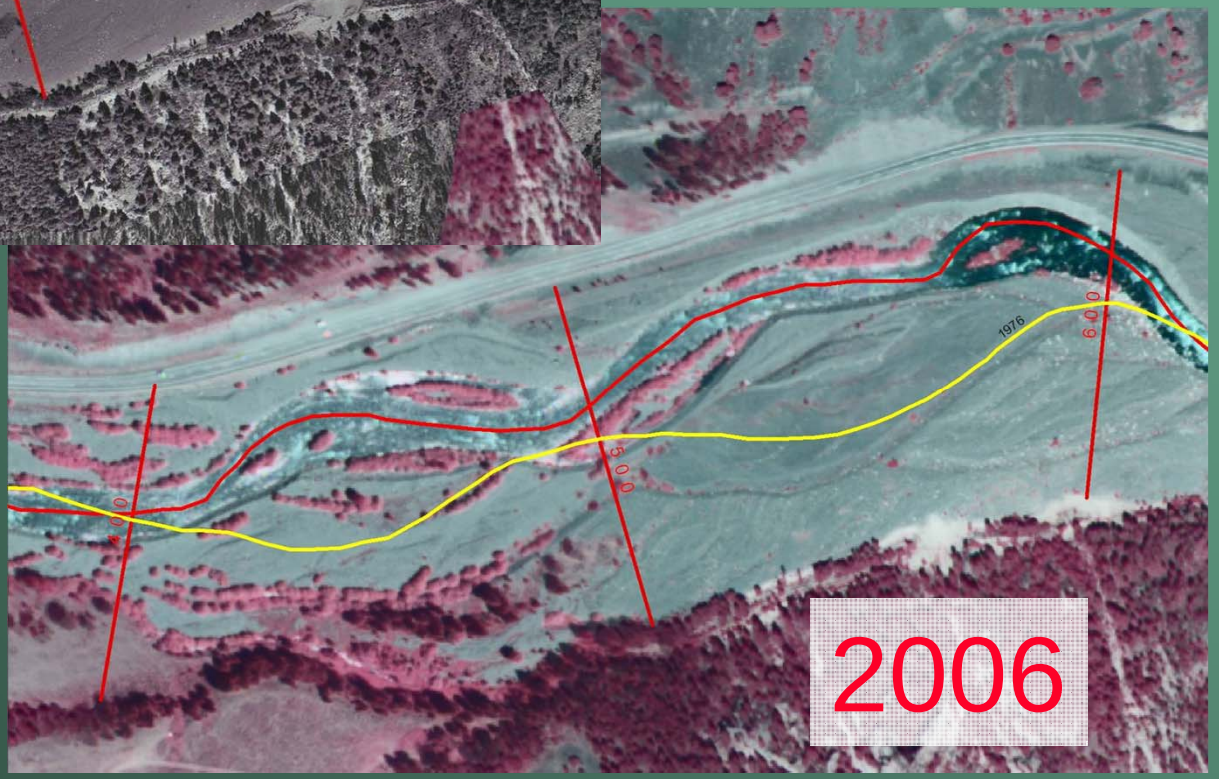
# Aerial Photography: Lower Study Reach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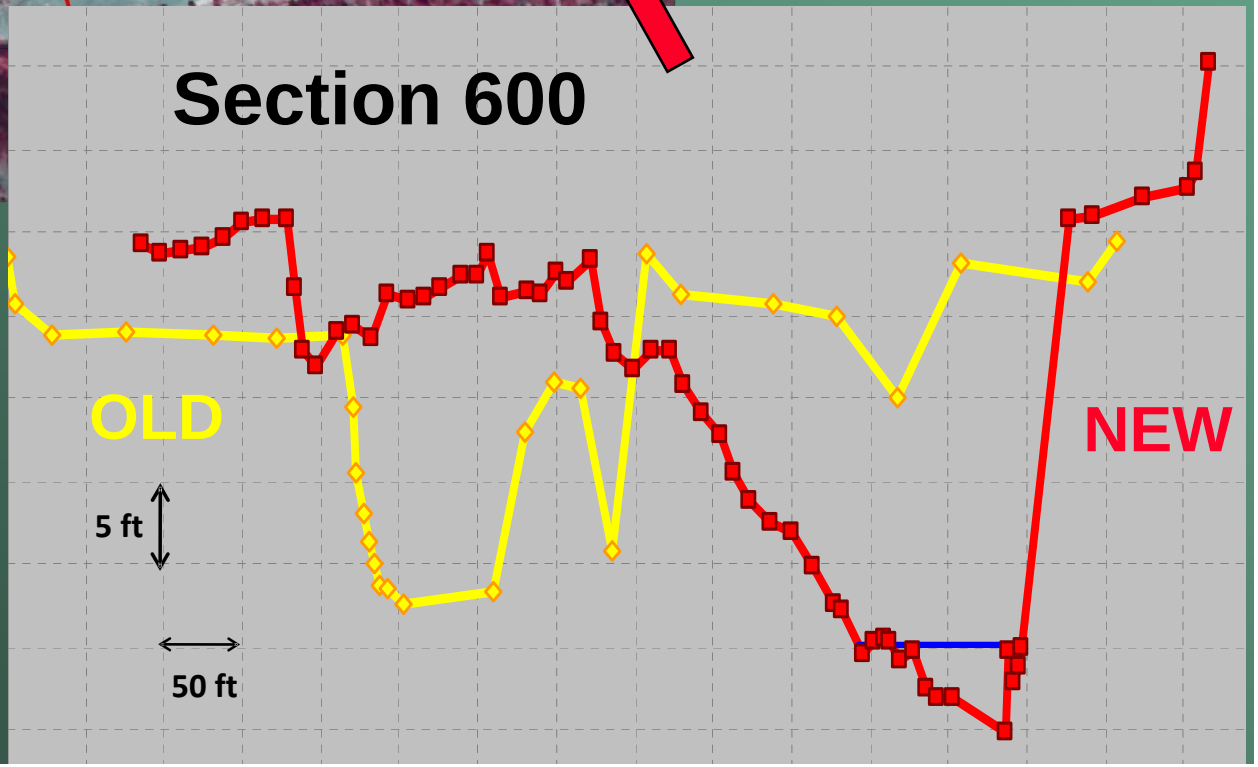
**Surveyed cross sections: 1971 and 2006**

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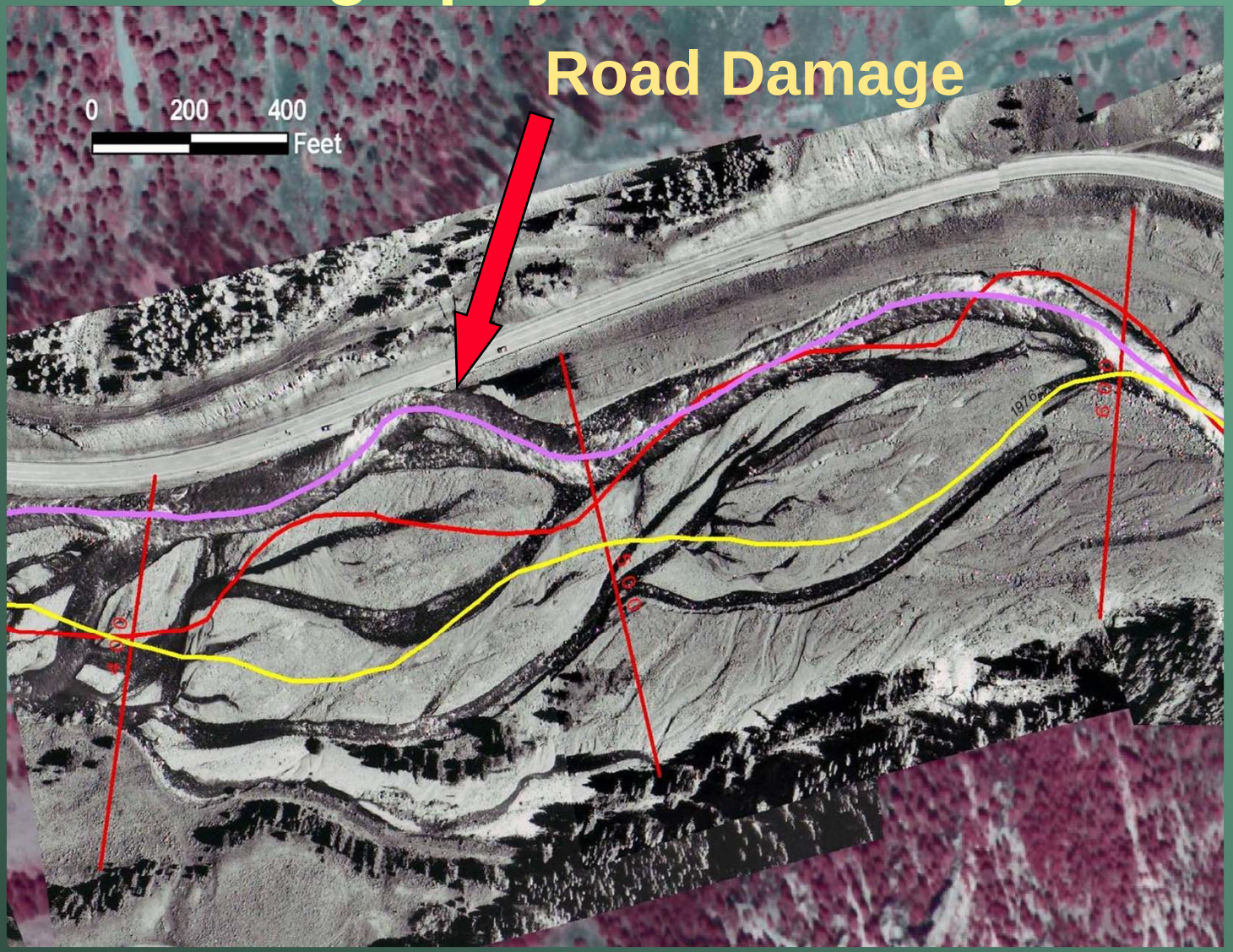
# Aerial Photography: Lower Study Reach

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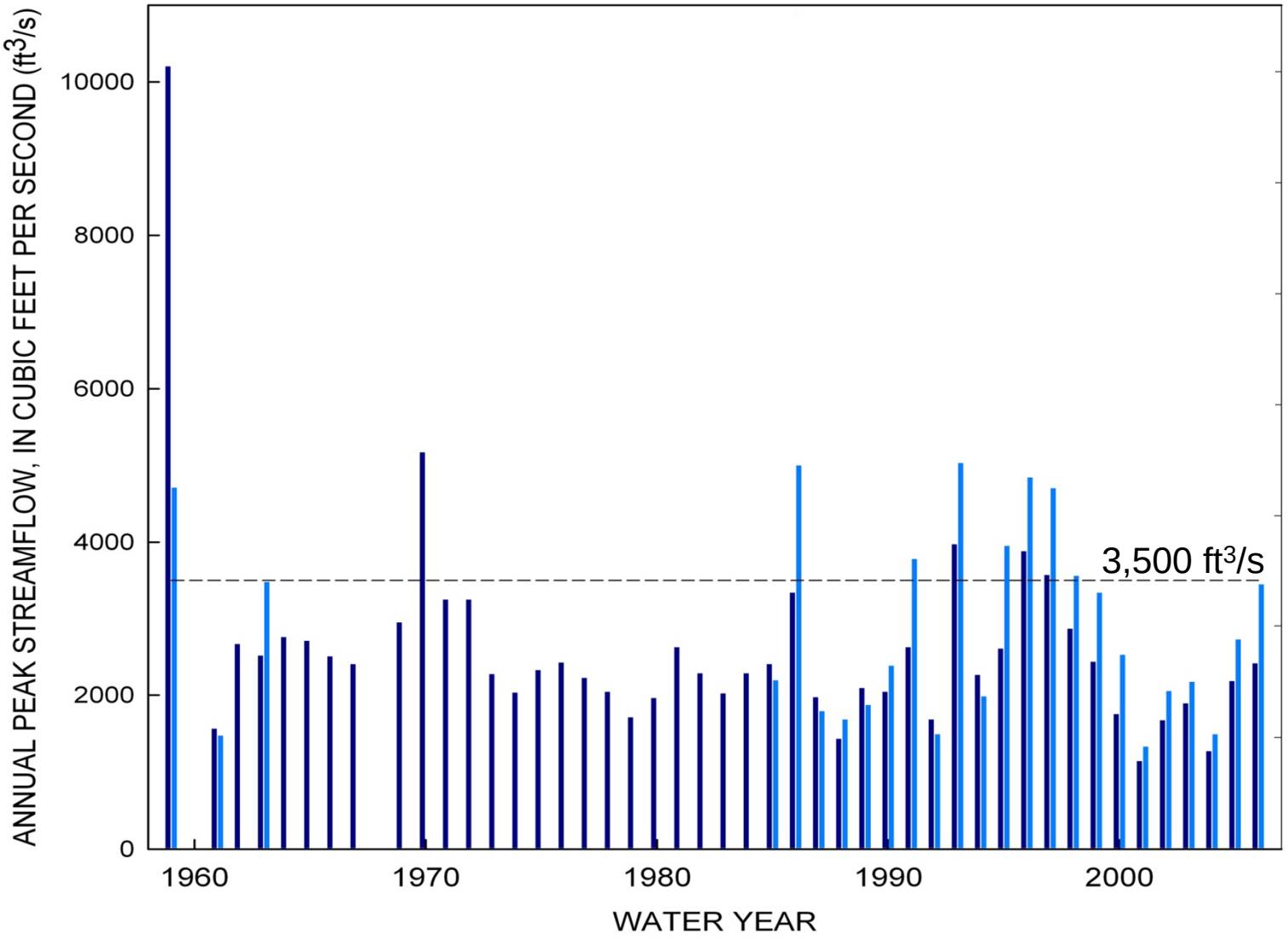
1986

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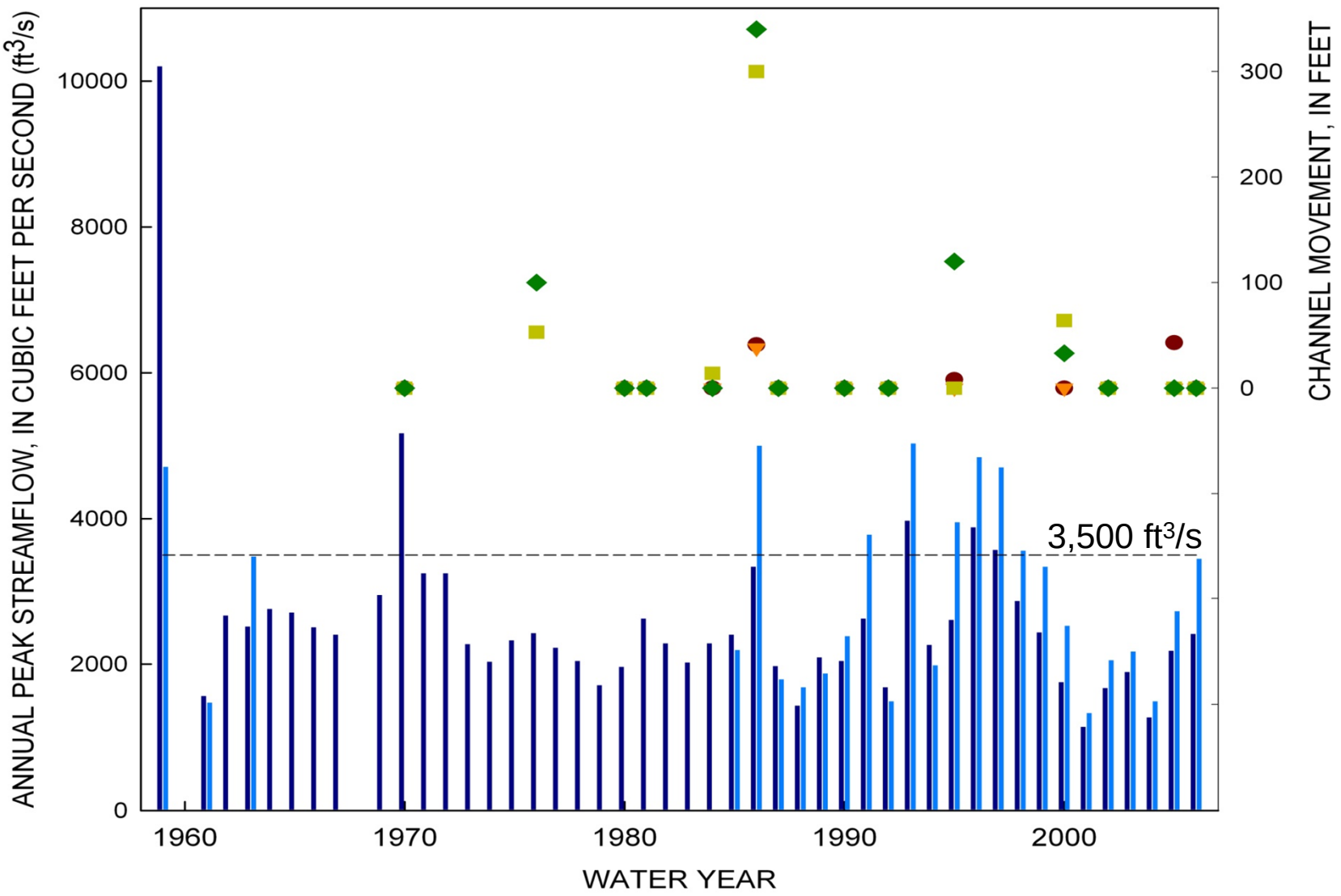
# Peak flows

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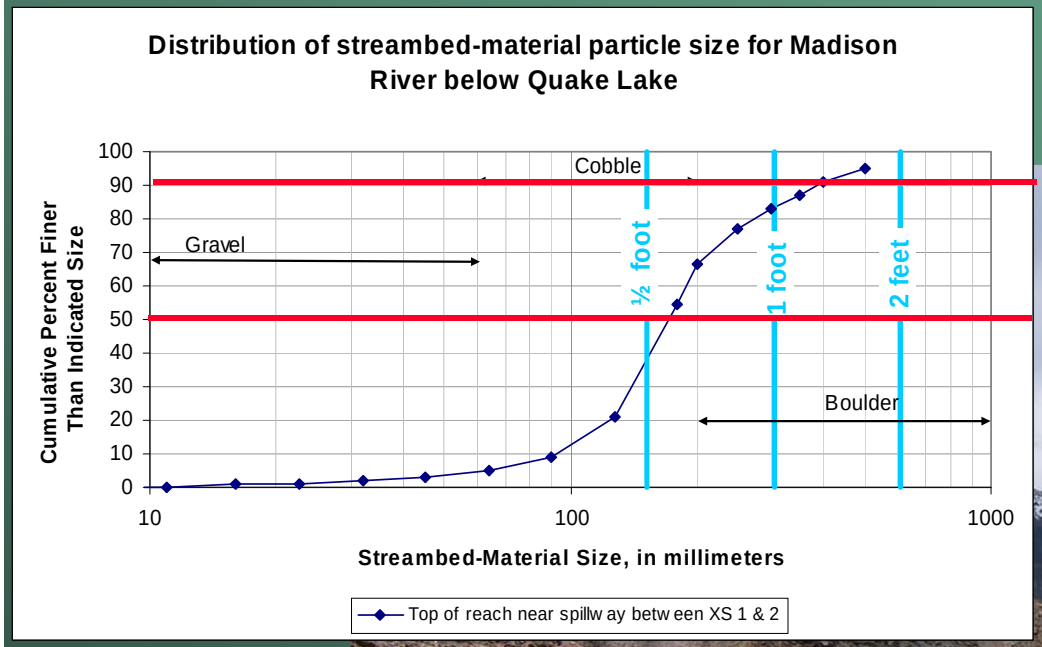
# Peak flows and channel movement

# HYDRAULIC ANALYSIS

Little River Research and Design (LRRD), Missouri Department of Conservation, The US Environmental Protection Agency Region VII, Missouri Department of Natural Resources.

# HYDRAULIC ANALYSIS

## Channel Materials



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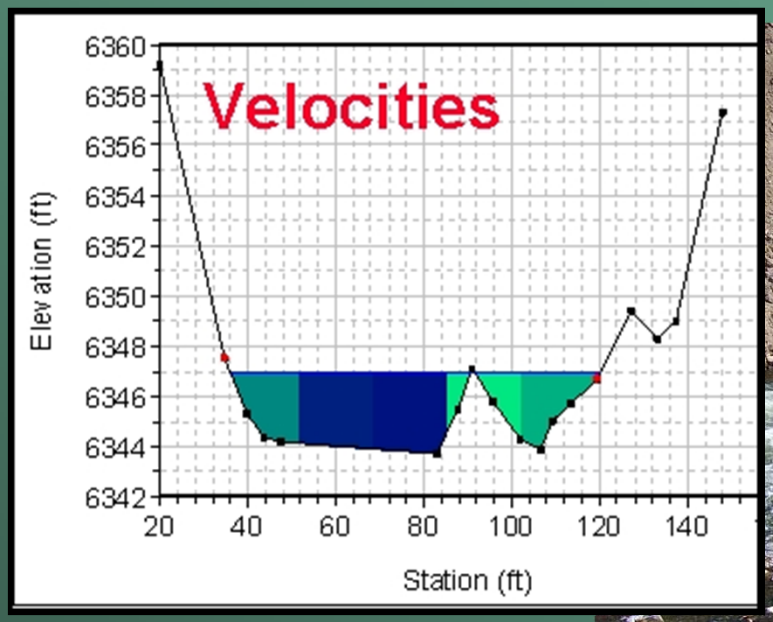
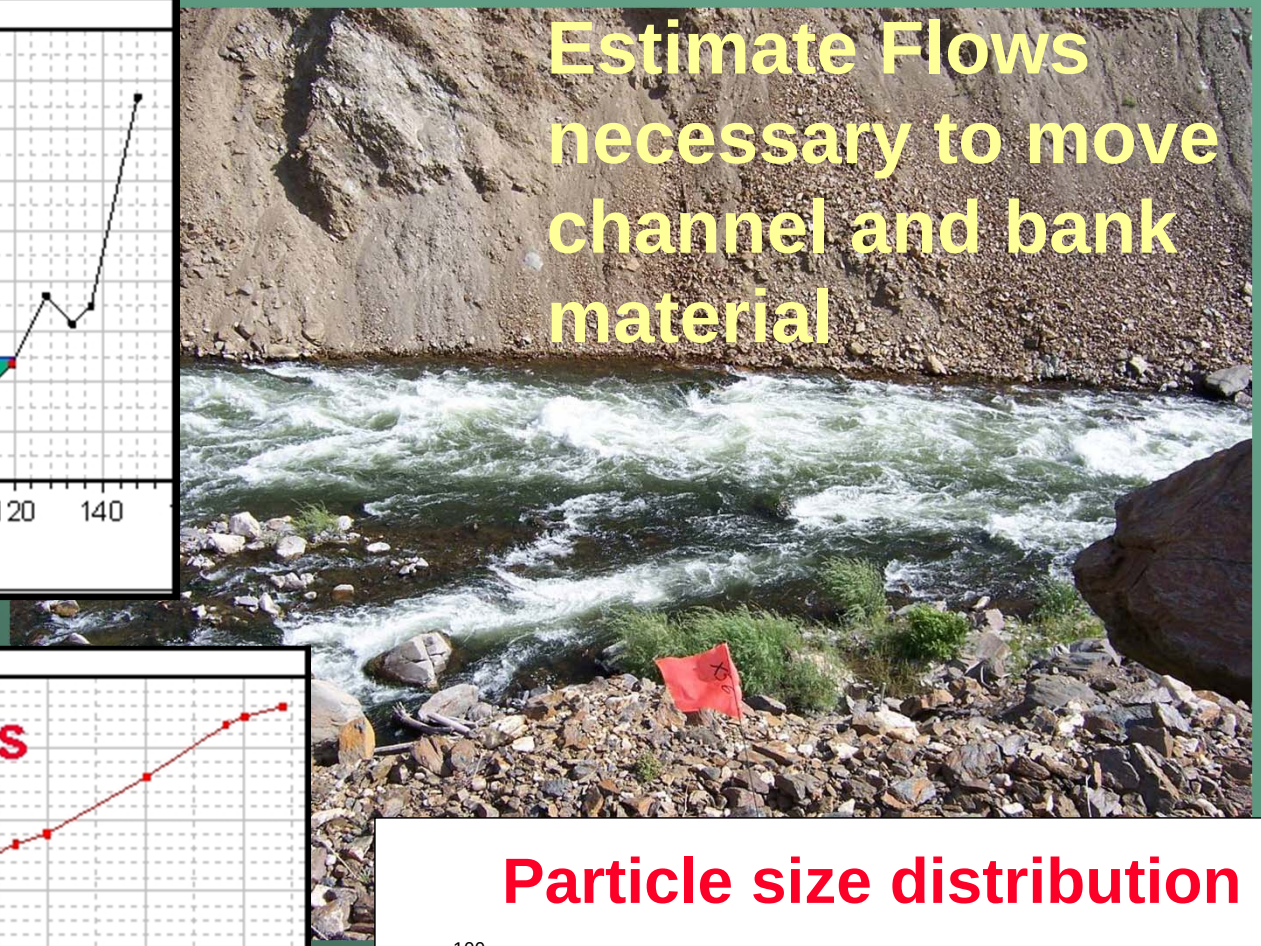
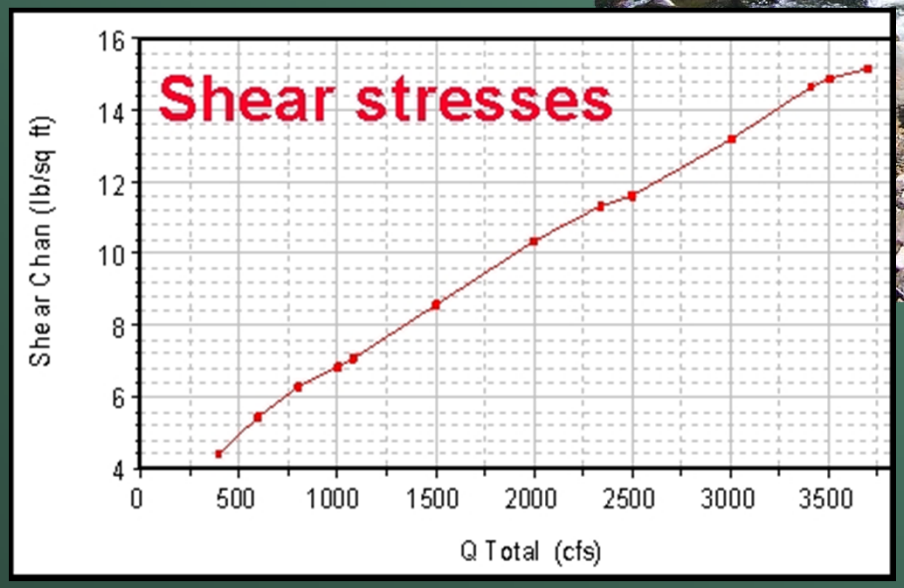
# Flow Forces

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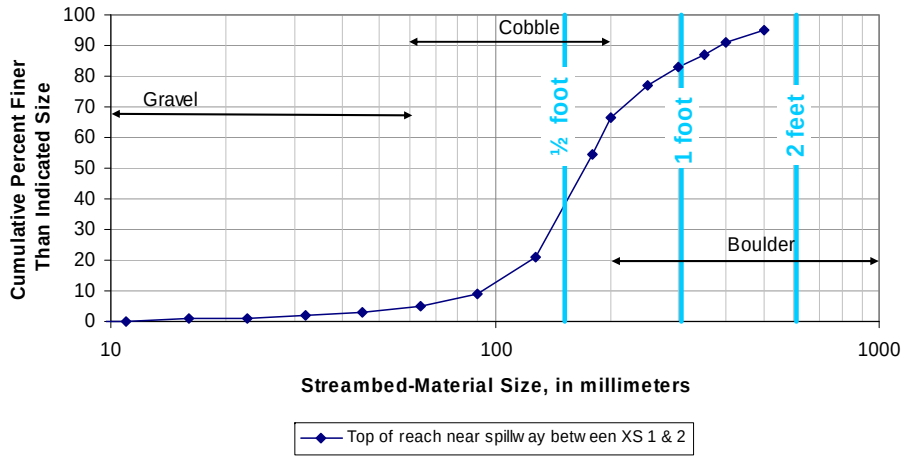
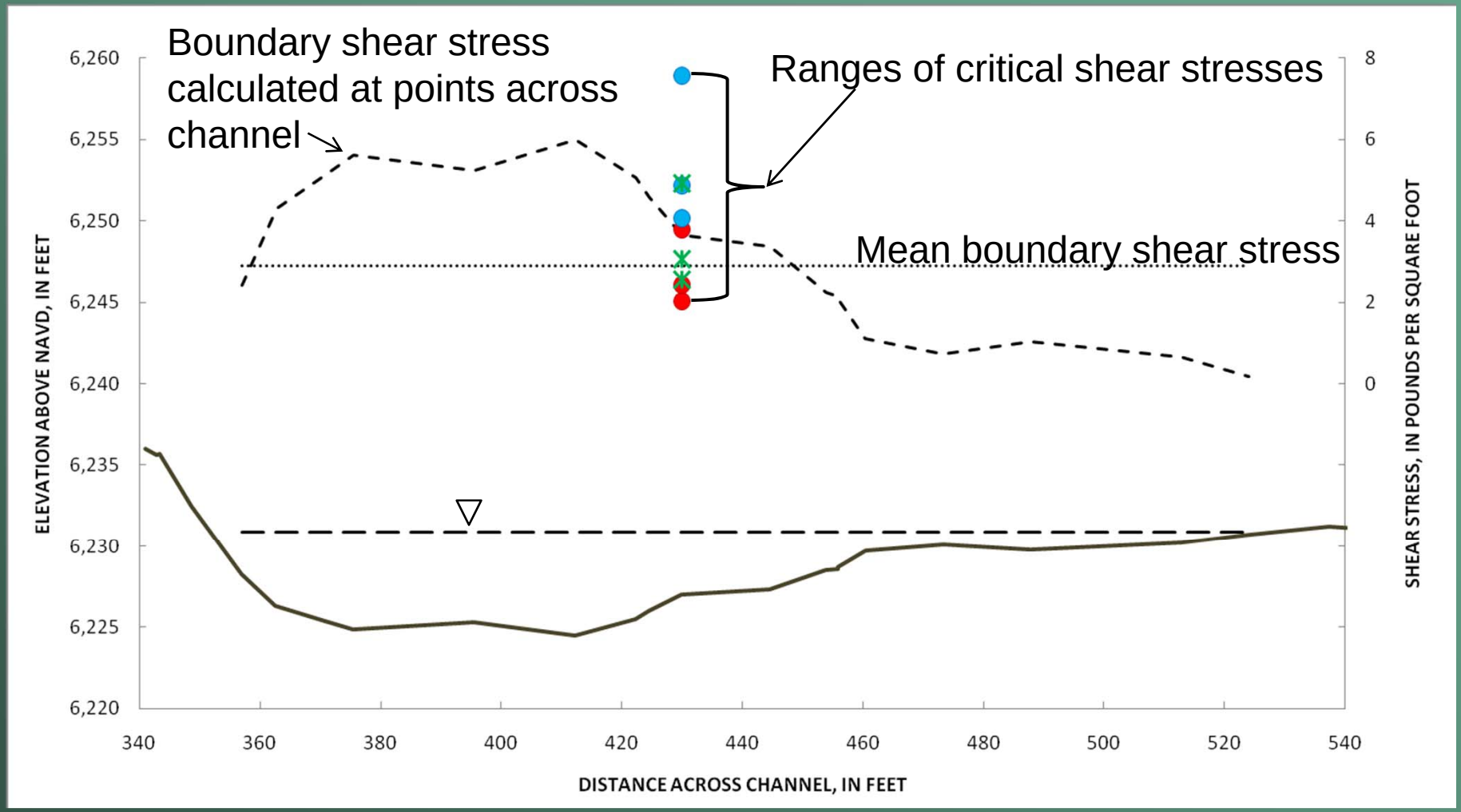
## Particle size distribution






# Boundary shear stresses (3,500 $ft^3/s$) and critical shear stresses

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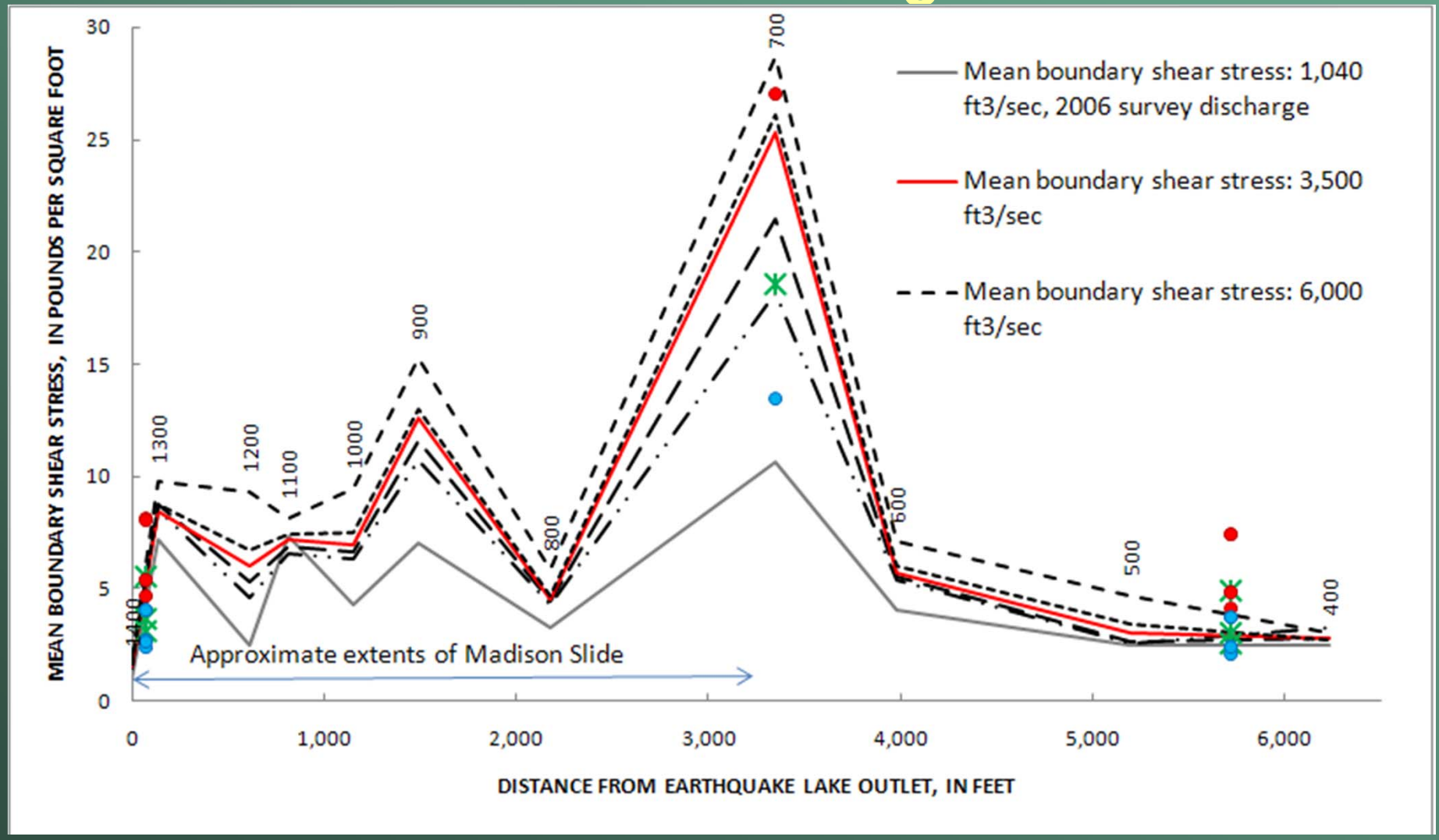
# Average boundary shear stress and critical shear stresses along the channel

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# Additional factor: steep channel side slopes

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# Preliminary Conclusions

- FROM CHANNEL SURVEY
  - Channel degraded up to 10 feet since 1972
- FROM AERIAL PHOTOGRAPHY
  - Channel increased sinuosity (and decreased slope) since 1972
  - Magnitude of channel movement decreased from 1986-2006
  - Channel moved as recently as 2005

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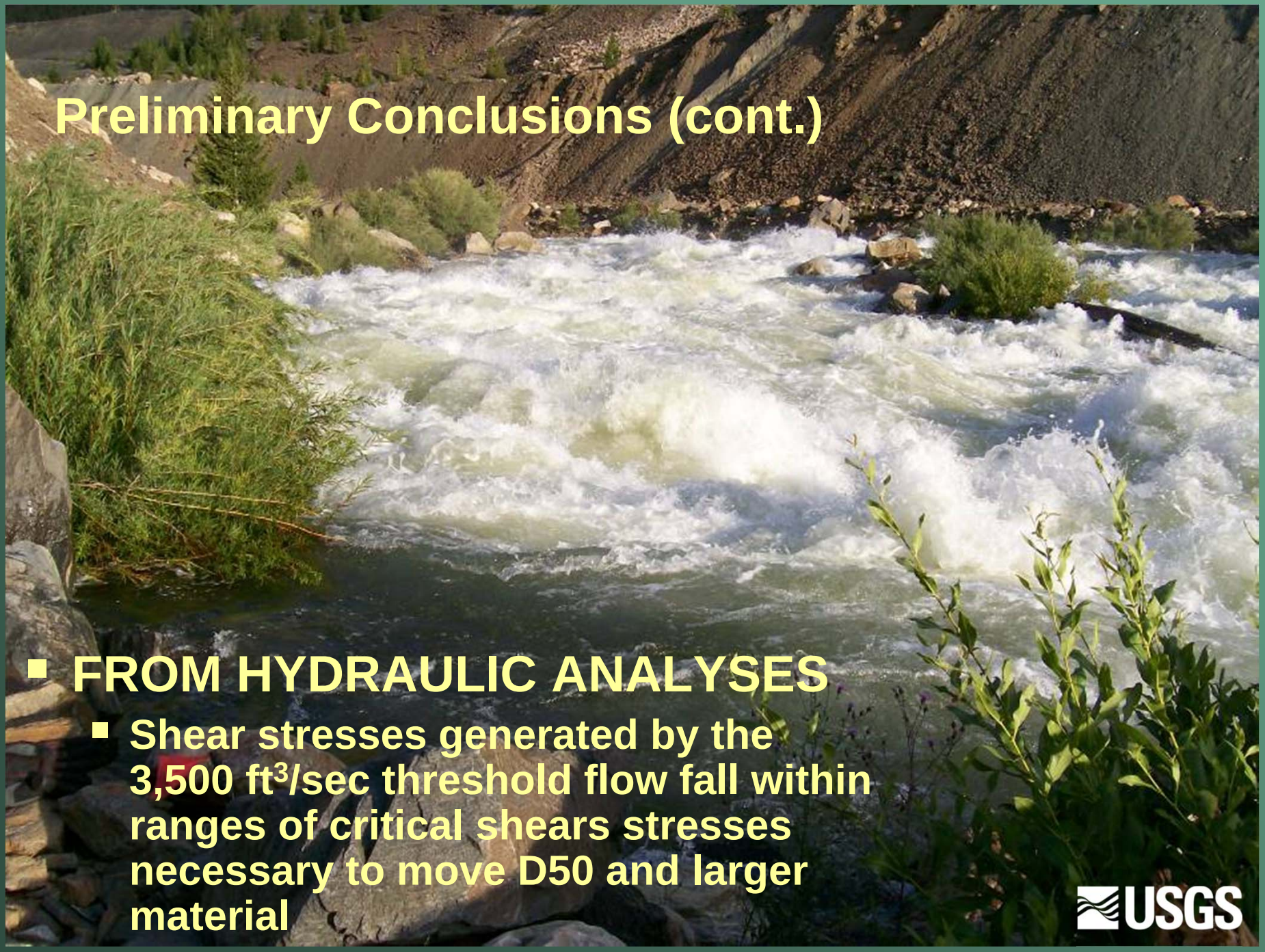

# Preliminary Conclusions (cont.)

- **FROM HYDRAULIC ANALYSES**
  - **Shear stresses generated by the 3,500 $ft^3$/sec threshold flow fall within ranges of critical shears stresses necessary to move D50 and larger material**

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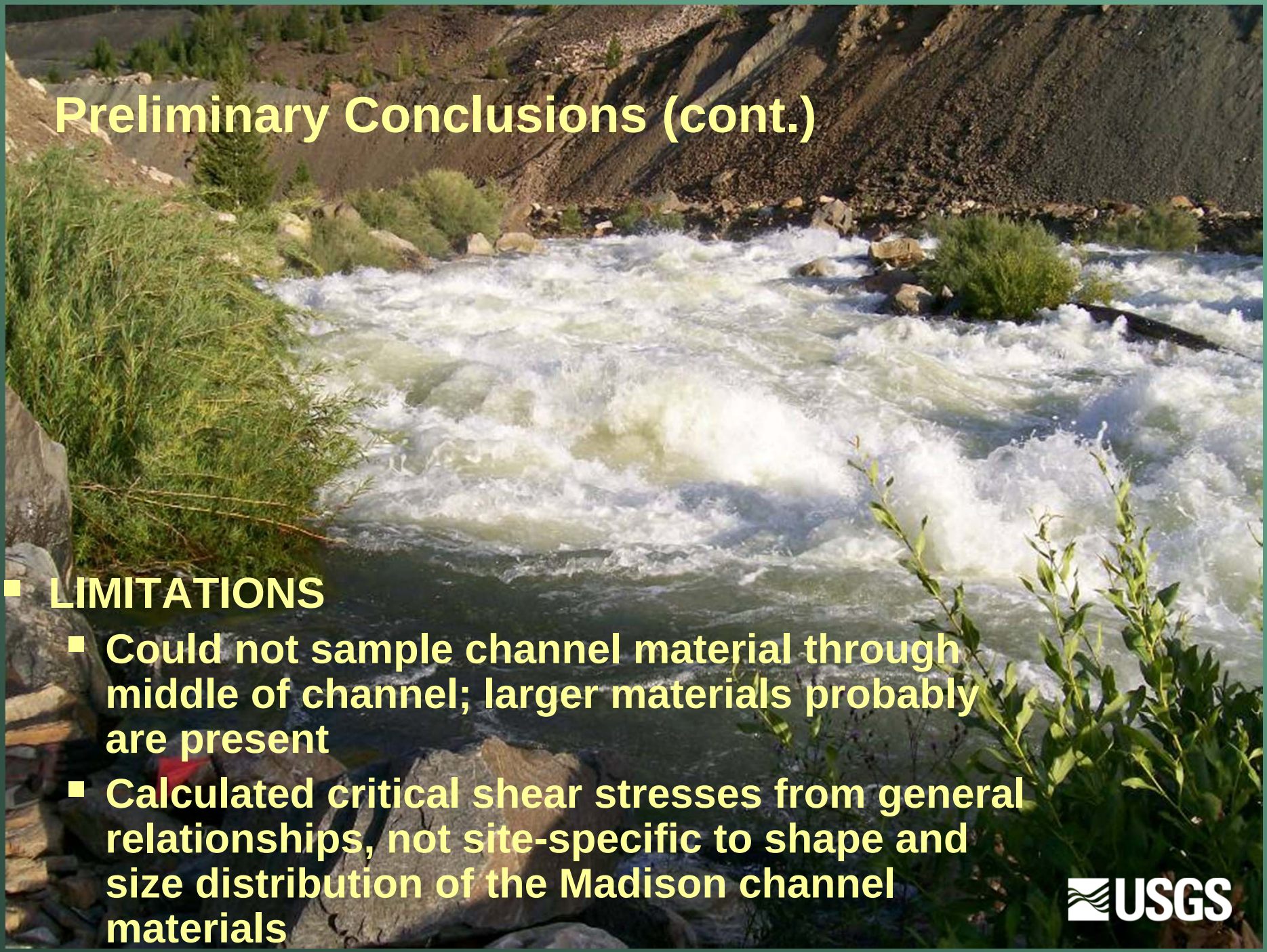
# Preliminary Conclusions (cont.)



- LIMITATIONS
  - Could not sample channel material through middle of channel; larger materials probably are present
  - Calculated critical shear stresses from general relationships, not site-specific to shape and size distribution of the Madison channel materials

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# Madison Slide Info – USGS Photographic Library
# http://libraryphoto.cr.usgs.gov/index.html

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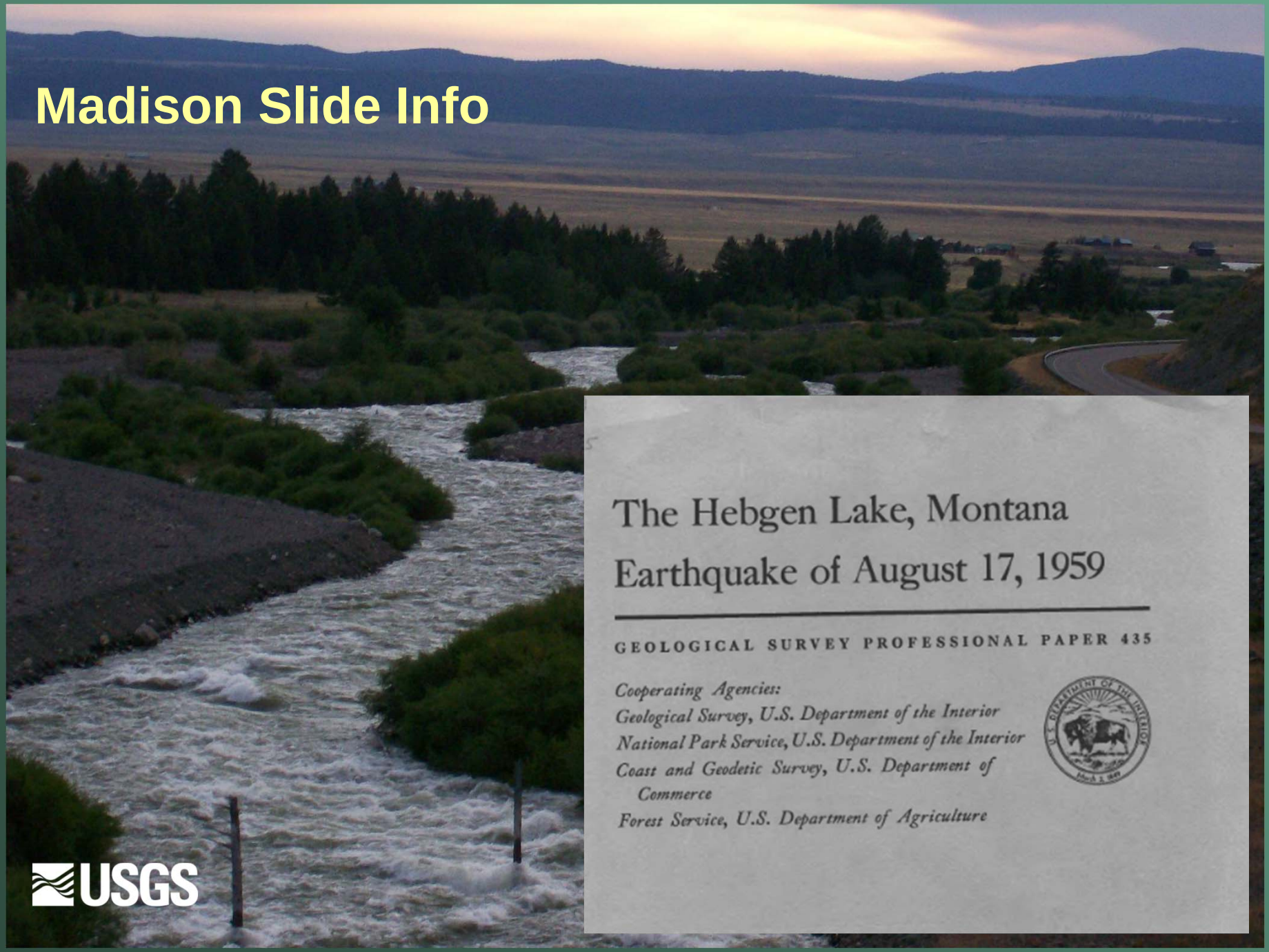
Mount Rainier National Park, Washington. The Nisqually valley below Nisqually Glacier, as seen from station 3. Aggradation on the flood plain, caused by the outburst flood of October 25, 1955, is evidenced by altered topography and dead trees. A new bridge was constructed high above the flood-affected channels. August 31, 1965. Figure 38, U.S. Geological Survey Professional Paper 631.

Local intranet 100%

# Madison Slide Info



The Hebgen Lake, Montana Earthquake of August 17, 1959

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*National Park Service, U.S. Department of the Interior*
*Coast and Geodetic Survey, U.S. Department of Commerce*
*Forest Service, U.S. Department of Agriculture*

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