

FY21 RSM IPR: Iao Sediment Continuity



Stanford Gibson (HEC), Jessica Brunty (POH), Nani Shimabuku (POH),
Travis Dahl (CHL), Jake Helminiak (NAP), Autumn Murray (CHL)

BLUF: Can we reduce debris basin deposition and FRM channel erosion by keeping sediment in the system?

Objective: This examines the feasibility of alternate debris basin designs to restore sediment continuity, reduce maintenance costs in the debris basin and, potentially, reduce scour downstream...without introducing failure modes (more costly or controversial maintenance issues elsewhere).

Approach

1. Debris Basin Design Lit Review
2. Sediment Budget
3. Load-Frequency Relationship
4. Channel Capacity Analysis
 - HEC-RAS 1D,2D
5. Debris Basin Model
 - HEC-RAS 2D Sed





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District/Other USACE PDT Members

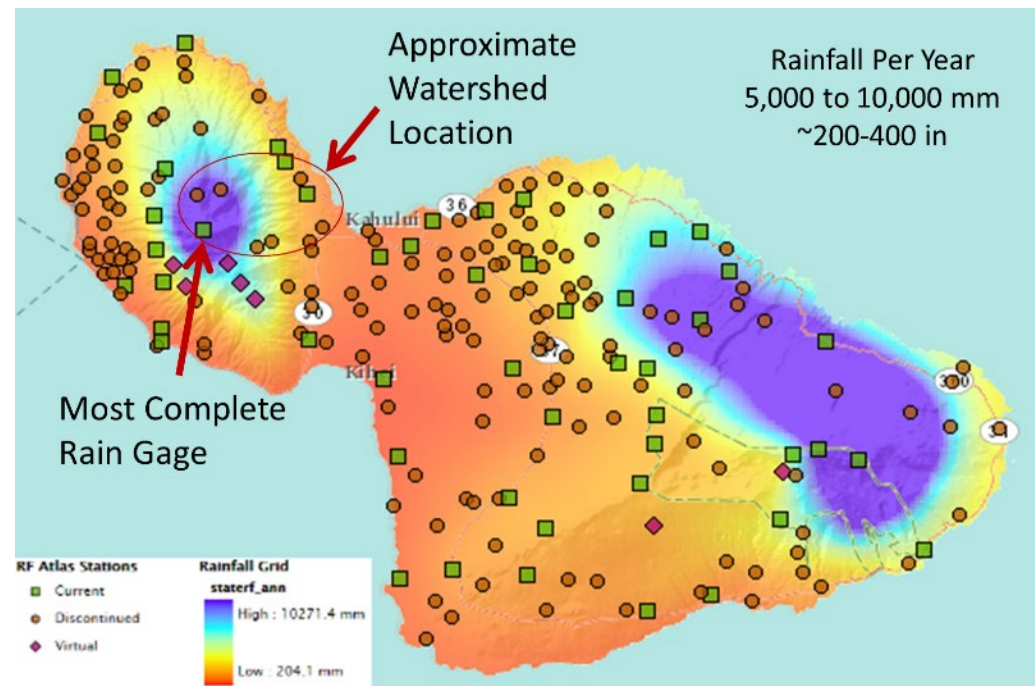
Stanford Gibson (HEC)
Jessica Brunty (POH)
Nani Shimabuku (POH)
Travis Dahl (CHL)
Autumn Murray (CHL)
Jake Helminiak (NAP)

Stakeholders/Partners

Maui County Dep of Public Works
Wailuku Water Company

Leveraging/Collaborative Opportunities

- Alaska District DOTS Request
- RSM Video Work Unit
- 2D HEC-RAS Sediment Dev
- Post Wildfire Debris Yield Modeling



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Debris Basin

High Gradient
Concrete Channel

Alluvial (Eroding, Leveed) Reach

Low Gradient Concrete Channel



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Debris Basin after 2016 Event




Debris Basin after 2021 Event

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1. Debris Basin Design Lit Review

ERDC/CHL TR-XX-DRAFT



US Army Corps of Engineers
Engineer Research and Development Center



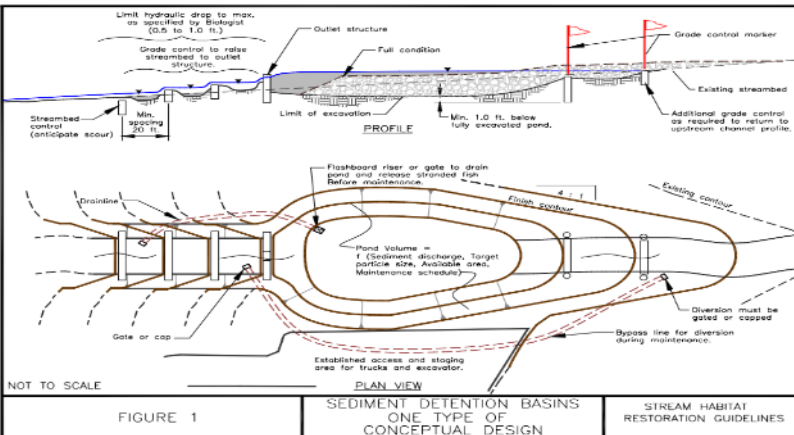
ERDC
INNOVATIVE SOLUTIONS
for a safer, better world

Program Title *[[[if not applicable, delete this entire line]]]*

Current State of Practice for Debris Basin Design: A Literature Review

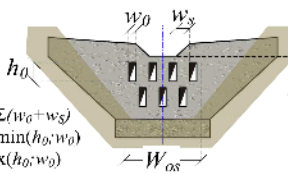
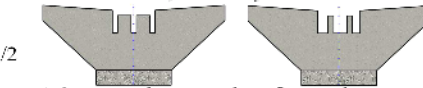
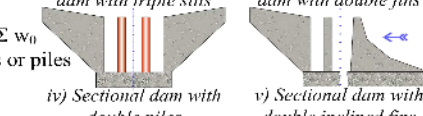
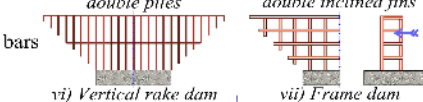
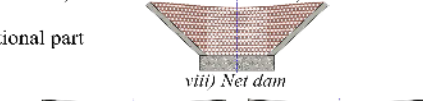

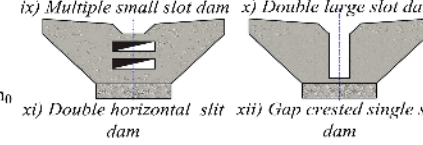
Report Subtitle *[[[if not applicable, delete this entire line]]]*

Autumn S. Murray, Travis A. Dahl, and Stanford A. Gibson
Month Year



- Current draft 64p.
- Informing EM 1601 Update
- Topic of Q2 RSM Webinar

Shape parameters:
 Dam height h_d
 Opening height h_0
 Opening width w_0
 Solid part width w_s
 Open structure total width $W_{os} = \Sigma(w_0 + w_s)$
 Narrow side of the opening $n_0 = \min(h_0, w_0)$
 Long side of the opening $l_0 = \max(h_0, w_0)$

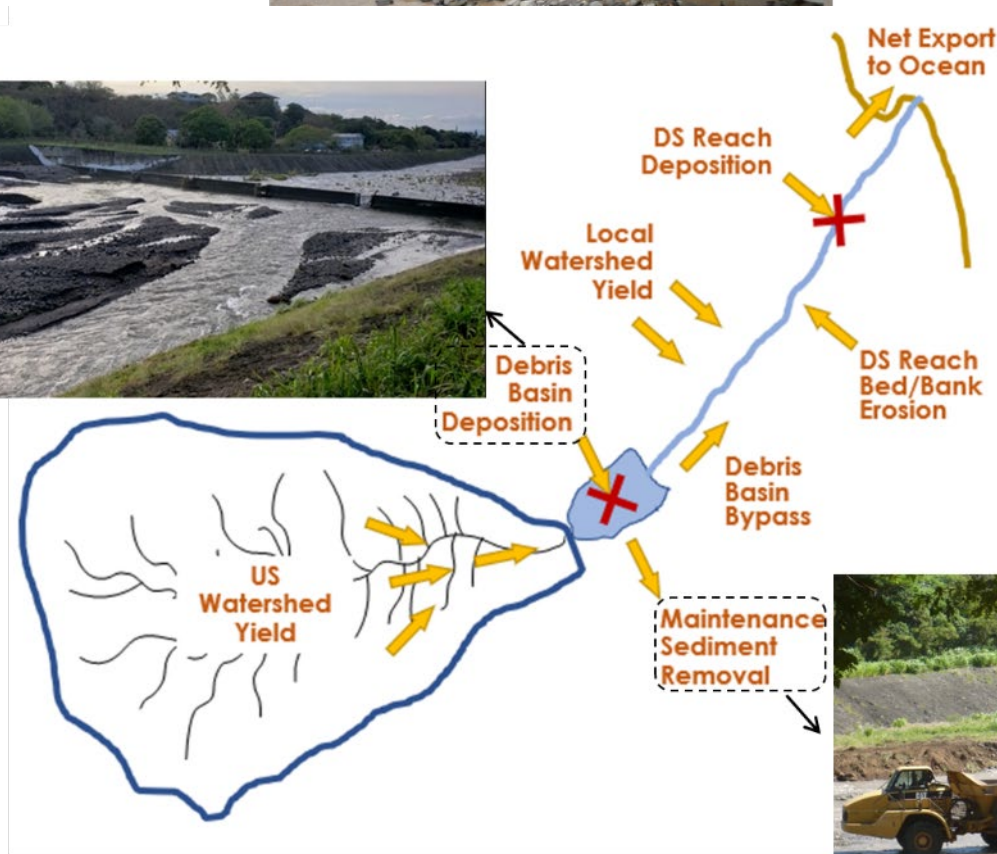
Structure class	Shape criteria	Shape examples	Subclasses (not exhaustive)
(a) Solid body dam	No openings	 i) Solid body dam	Single / Arched / Multiple Solid Body Dams
(b) Compound dams	$h_0 < h_d/2$	 ii) Gap crested compound dam with triple slits iii) Sectional compound dam with double fins	Depend on superior part type
(c) Sectional dams	$\Sigma w_s < \Sigma w_0$ Several fins or piles	 iv) Sectional dam with double piles v) Sectional dam with double inclined fins	Inclined / Vertical – Open / Rake / Beam / Grill Dams with n Fins / Piles
(d) Lattice dams	Built of bars	 vi) Vertical rake dam vii) Frame dam	Inclined / Vertical – Beam / Rake / Grill Dams – Frame Dams
(e) Net Dams	Net is a functional part	 viii) Net dam	
(f) Slot Dams	$l_0 < 2n_0$		Large / Small – Open / Rake / Beam / Grill Slot Dams
(g) Slit Dams	$l_0 \geq 2n_0$	 ix) Multiple small slot dam x) Double large slot dam xi) Double horizontal slit dam xii) Gap crested single slit dam	Gap crested / continuous crest – Single / Multiple – Horizontal / Vertical – Open / Rake / Beam / Grill Slit Dams

Note: If there are several openings in the dam body, the opening with the maximum height (h_0), width (w_0) or long side (l_0) is relevant for selecting the suitable dam classification. Further detail can be found in Wehrmann et al. 2006

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2. Sediment Budget

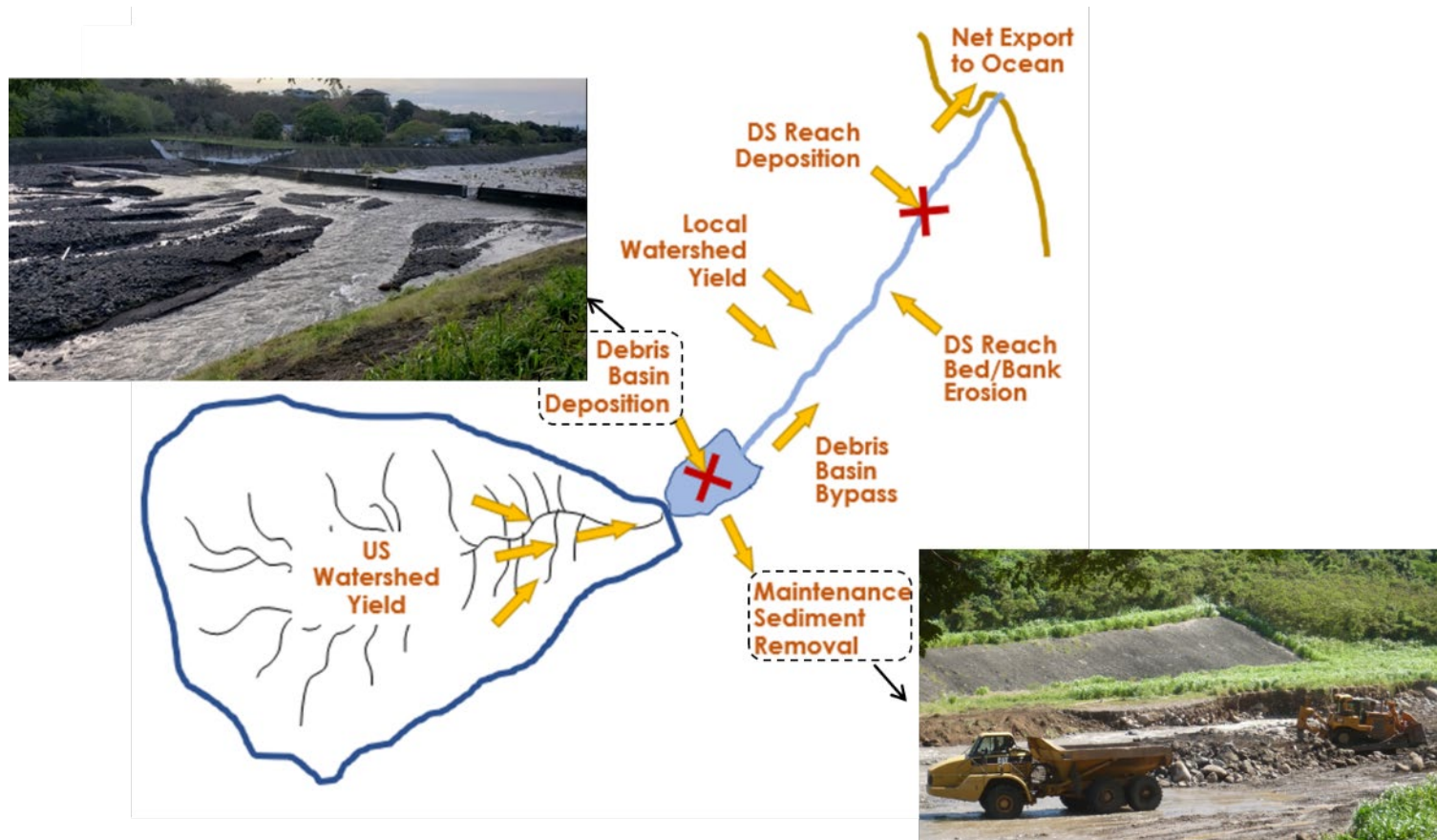


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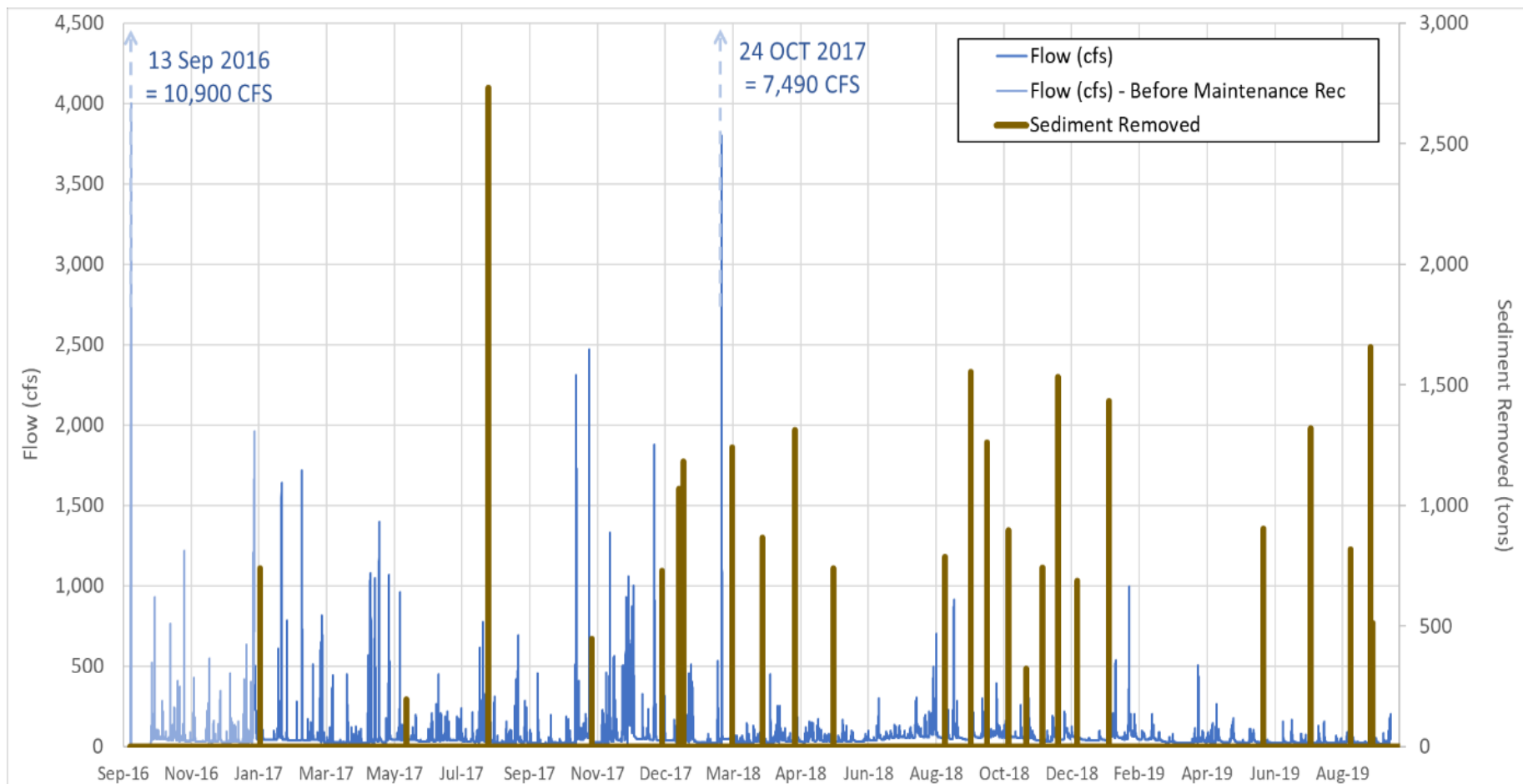


2. Sediment Budget

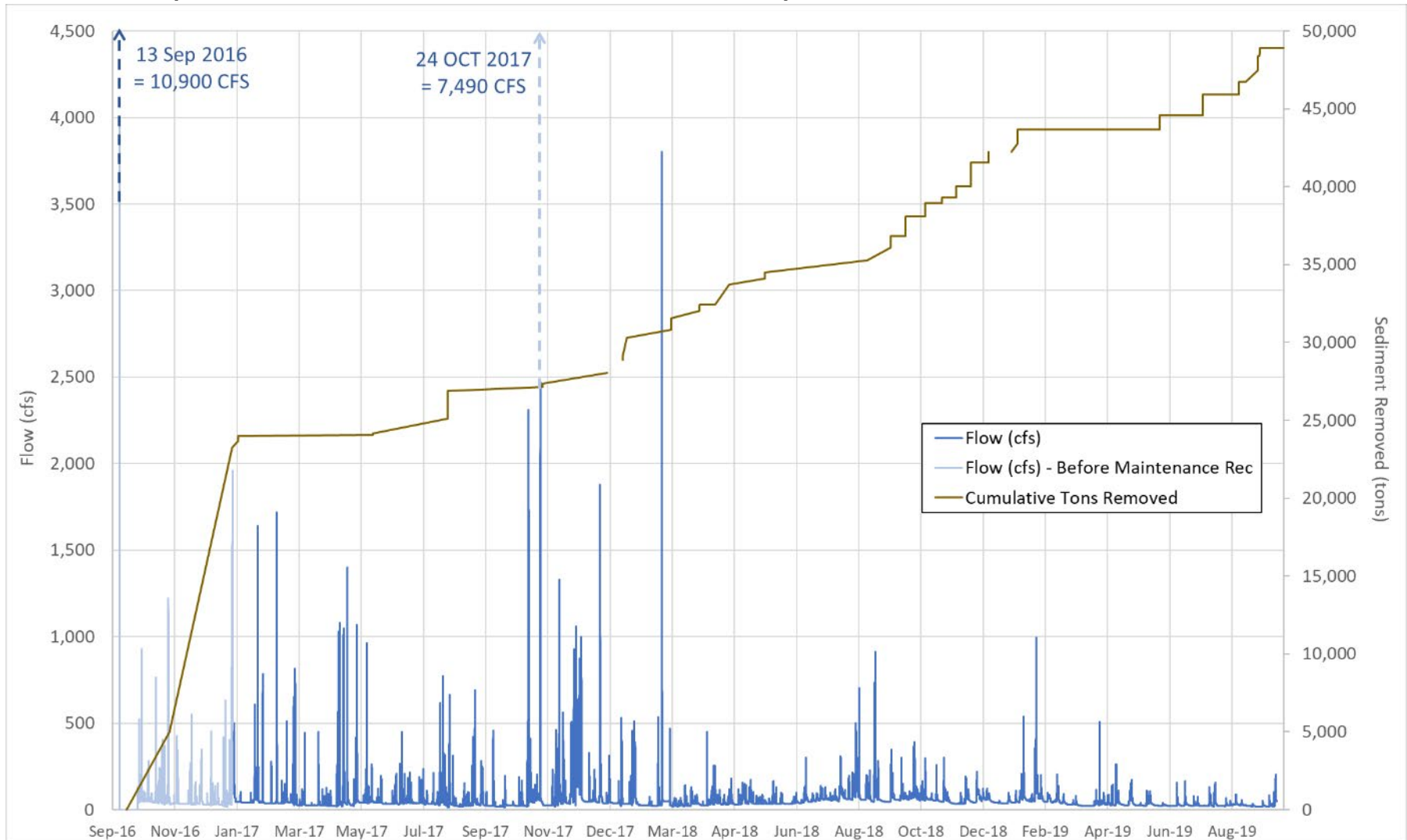
Yield: Mass and Gradation



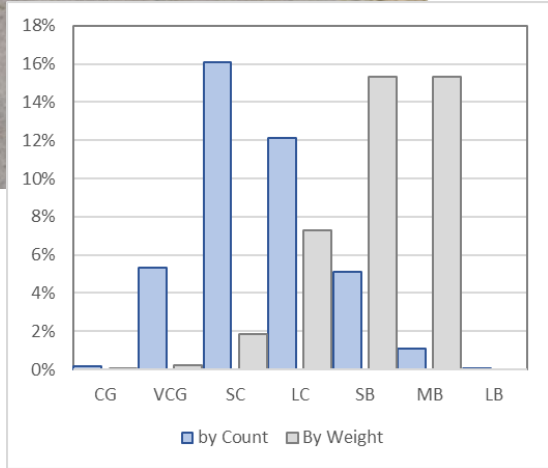
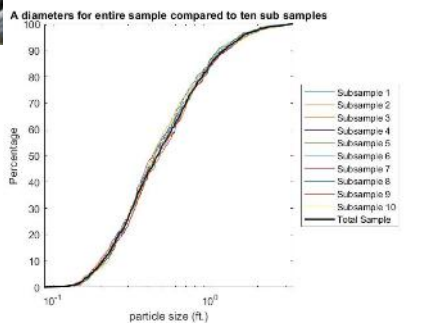
2ai. Yield Mass: Watershed Delivery Analysis (from Maintenance Records)



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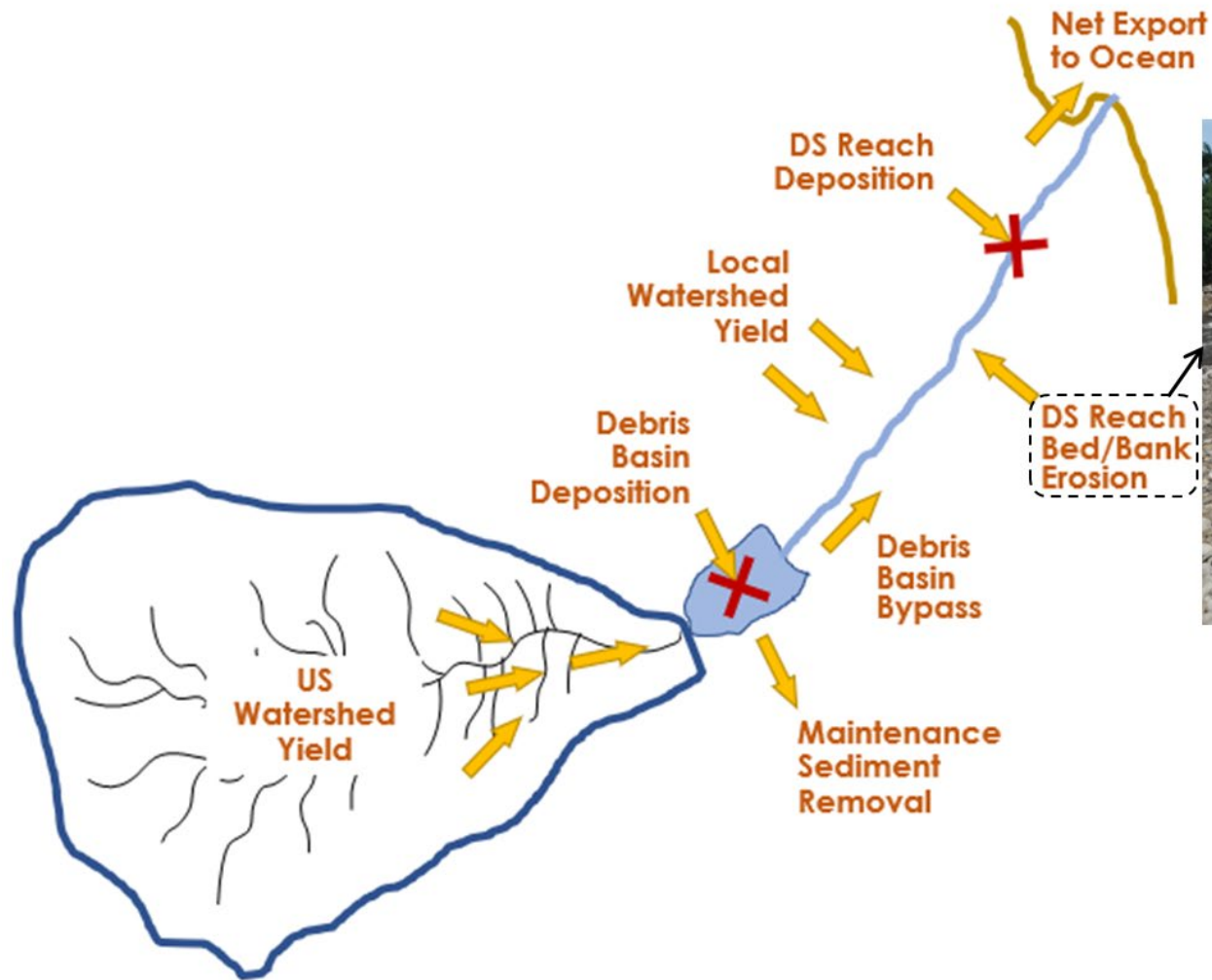
2a. Yield Gradation: Photogrammetry



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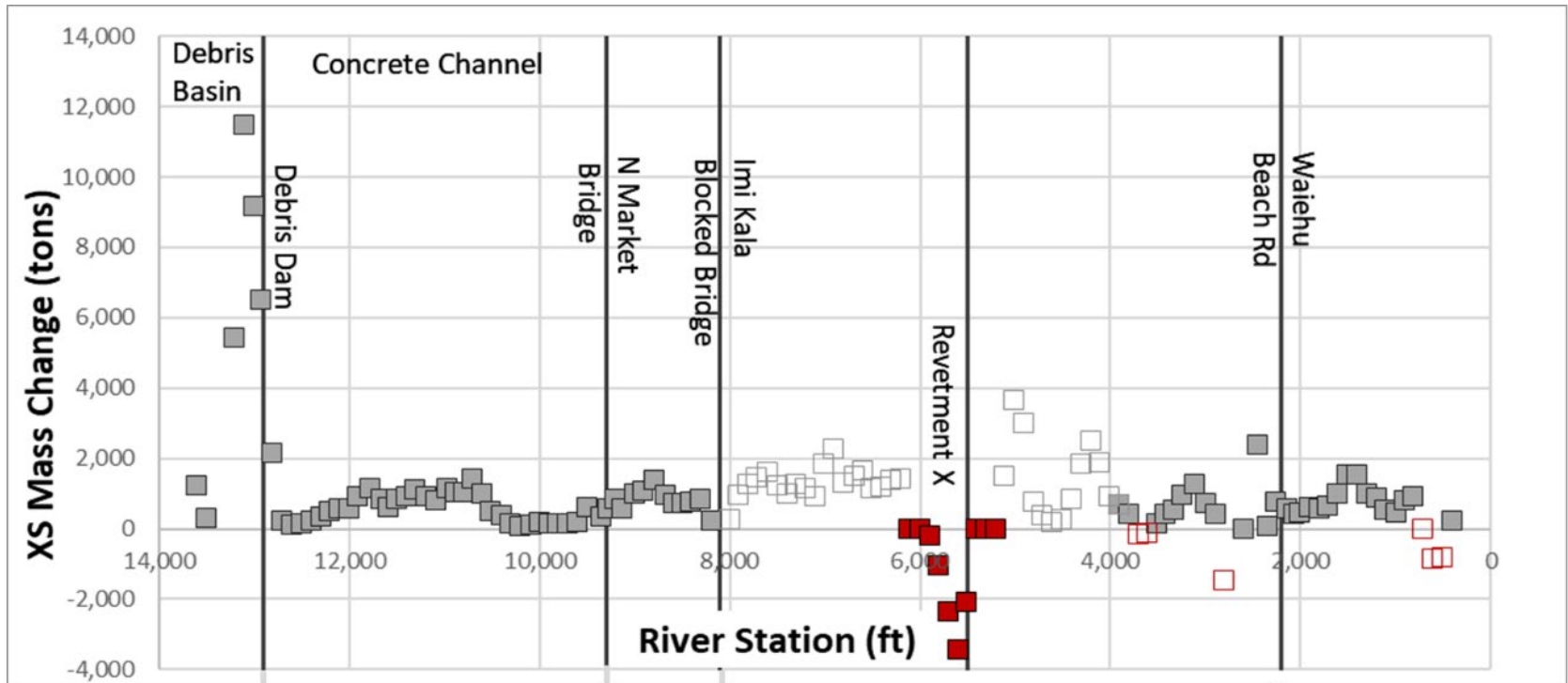
2b. Sediment Budget: Channel Erosion



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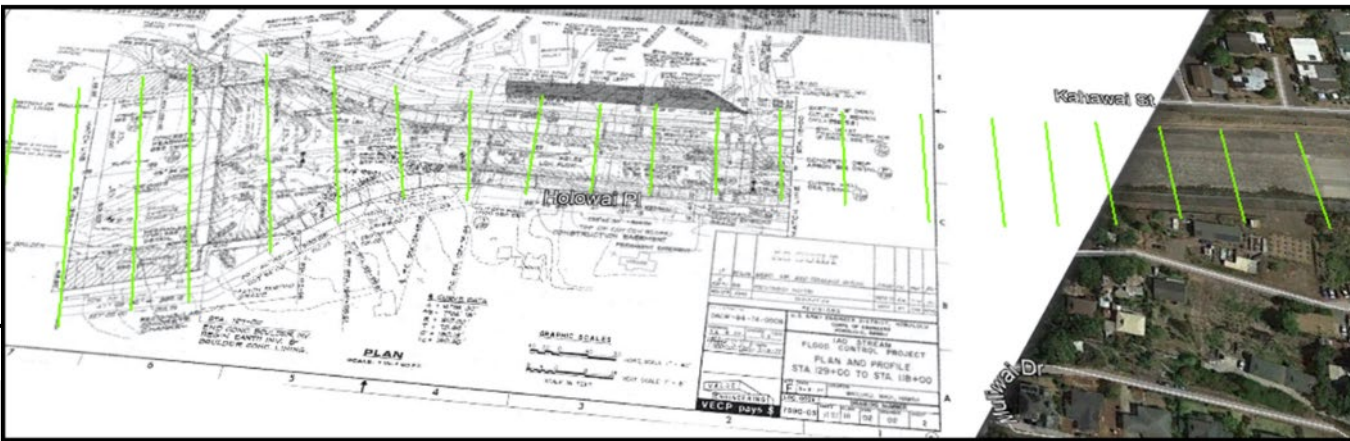
2b. Sediment Budget: Channel Erosion (2011-2013)



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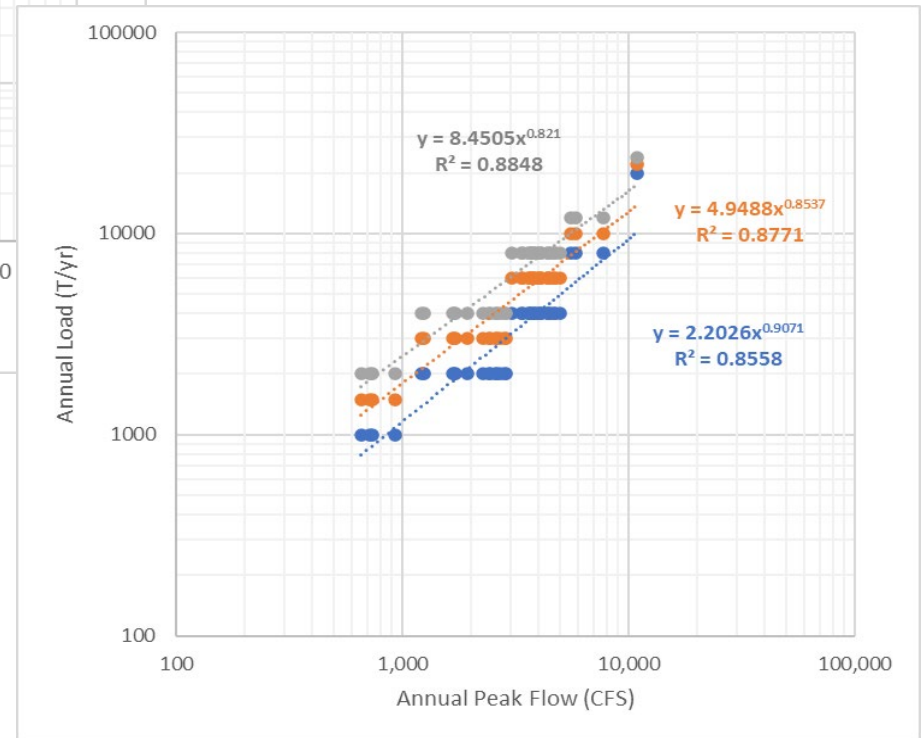
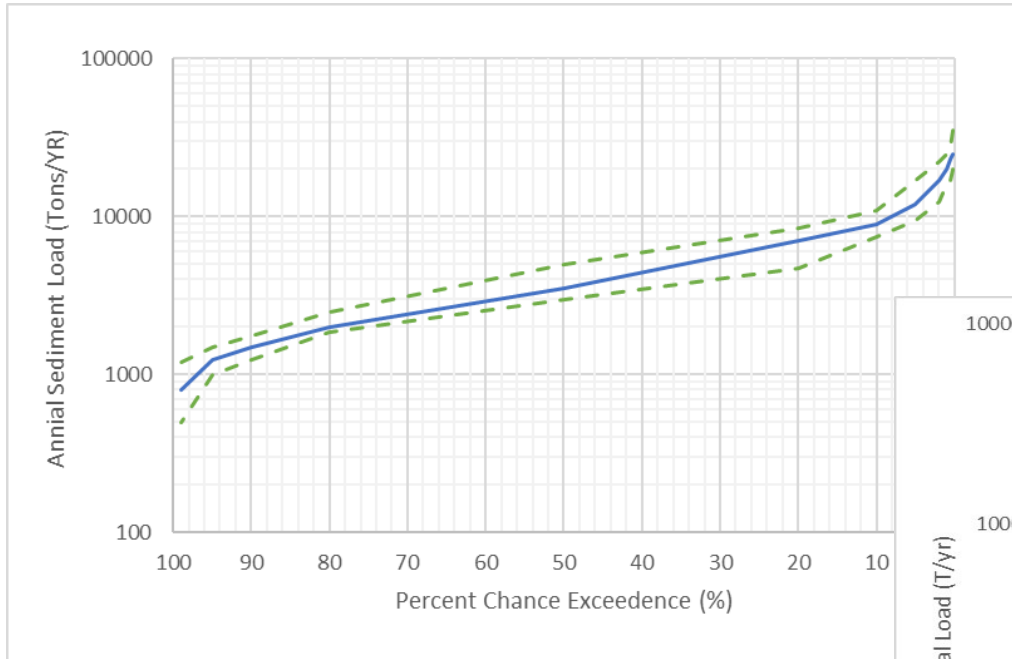


2b. Sediment Budget: Channel Erosion – Digitize 1984 As-Builts





3. Deposition-Frequency Curve



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4. Channel Capacity Analysis

Big Question:

Can the DS Channel Move Material if we Pass it Through the Basin?

- How Much?
- What Size?

Waiehu Beach Road Bridge
Following Sep 14, 2016 Event



Before Sep 14, 2016 Event



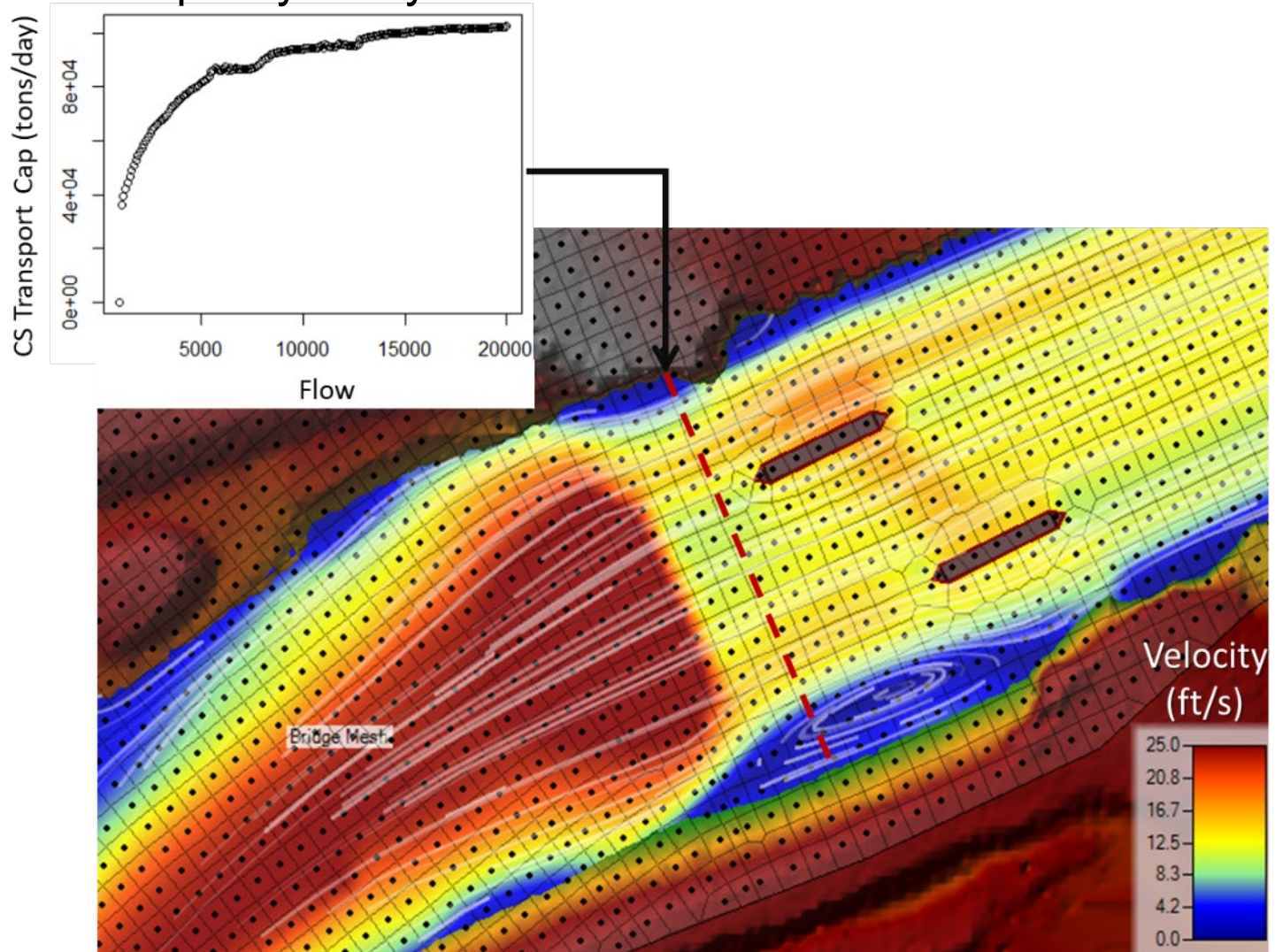
Following Sep 14, 2016 Event



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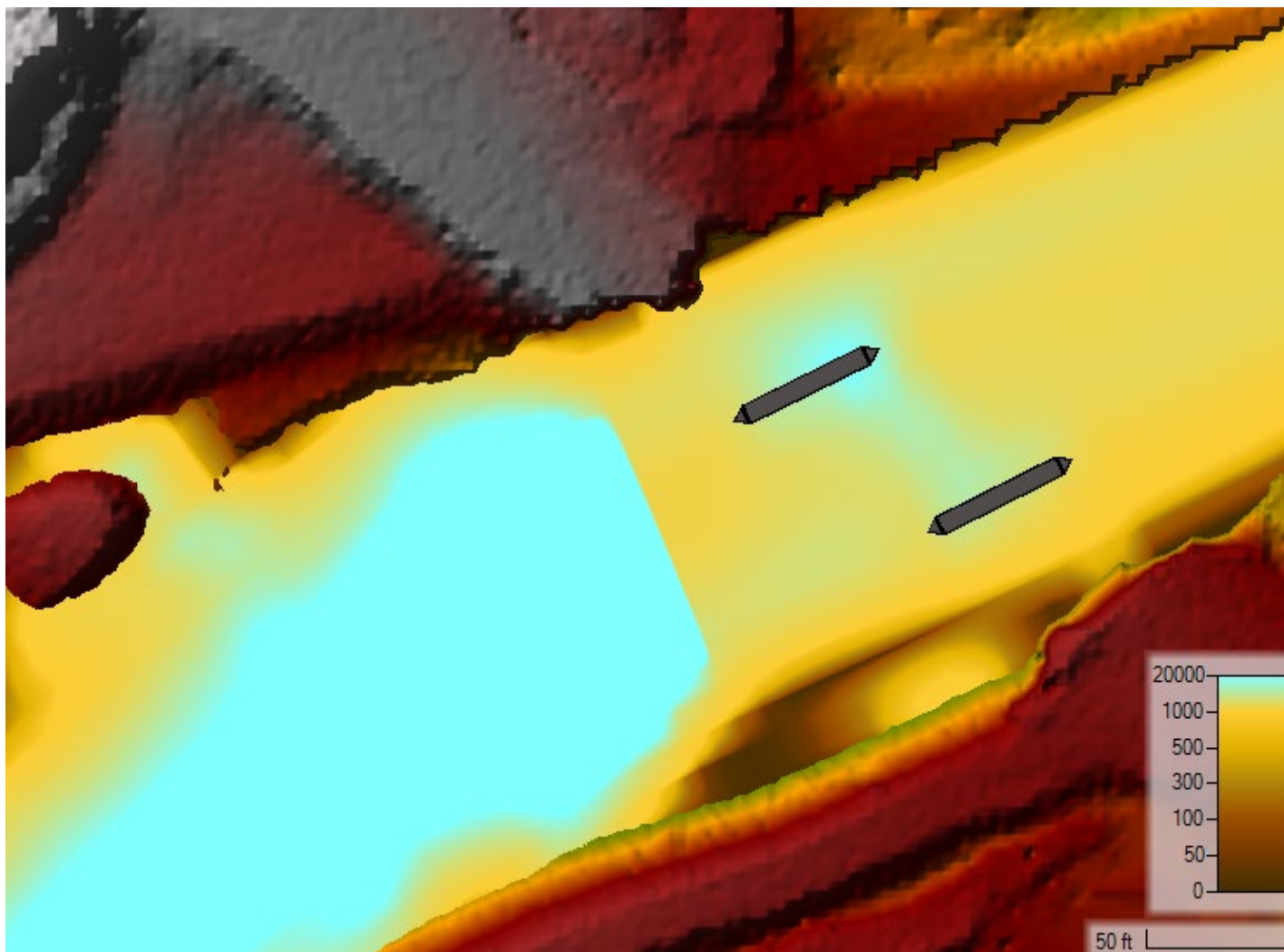
4. Channel Capacity Analysis



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4. Channel Capacity Analysis



4. Channel Capacity Analysis

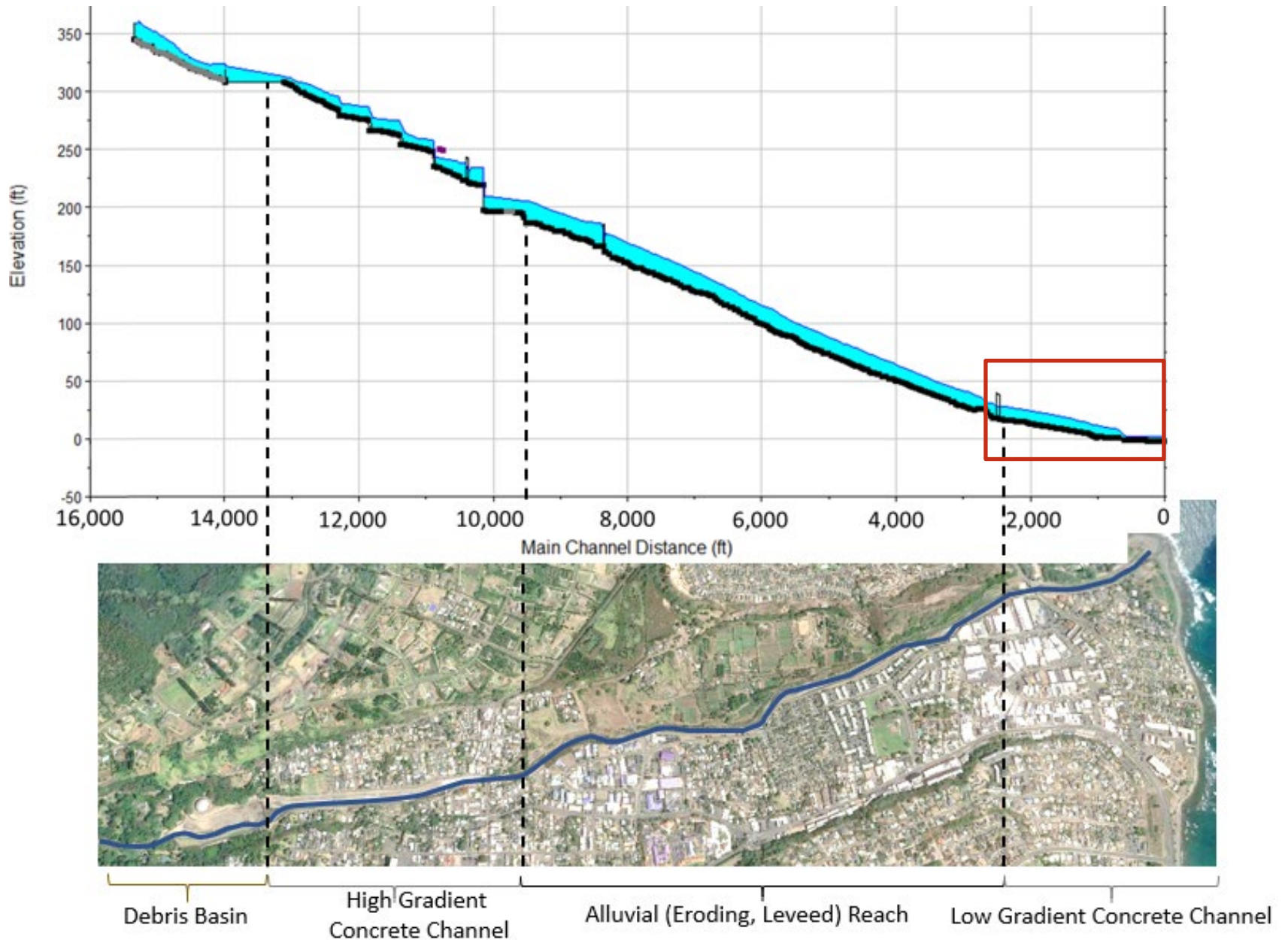


Big Question:

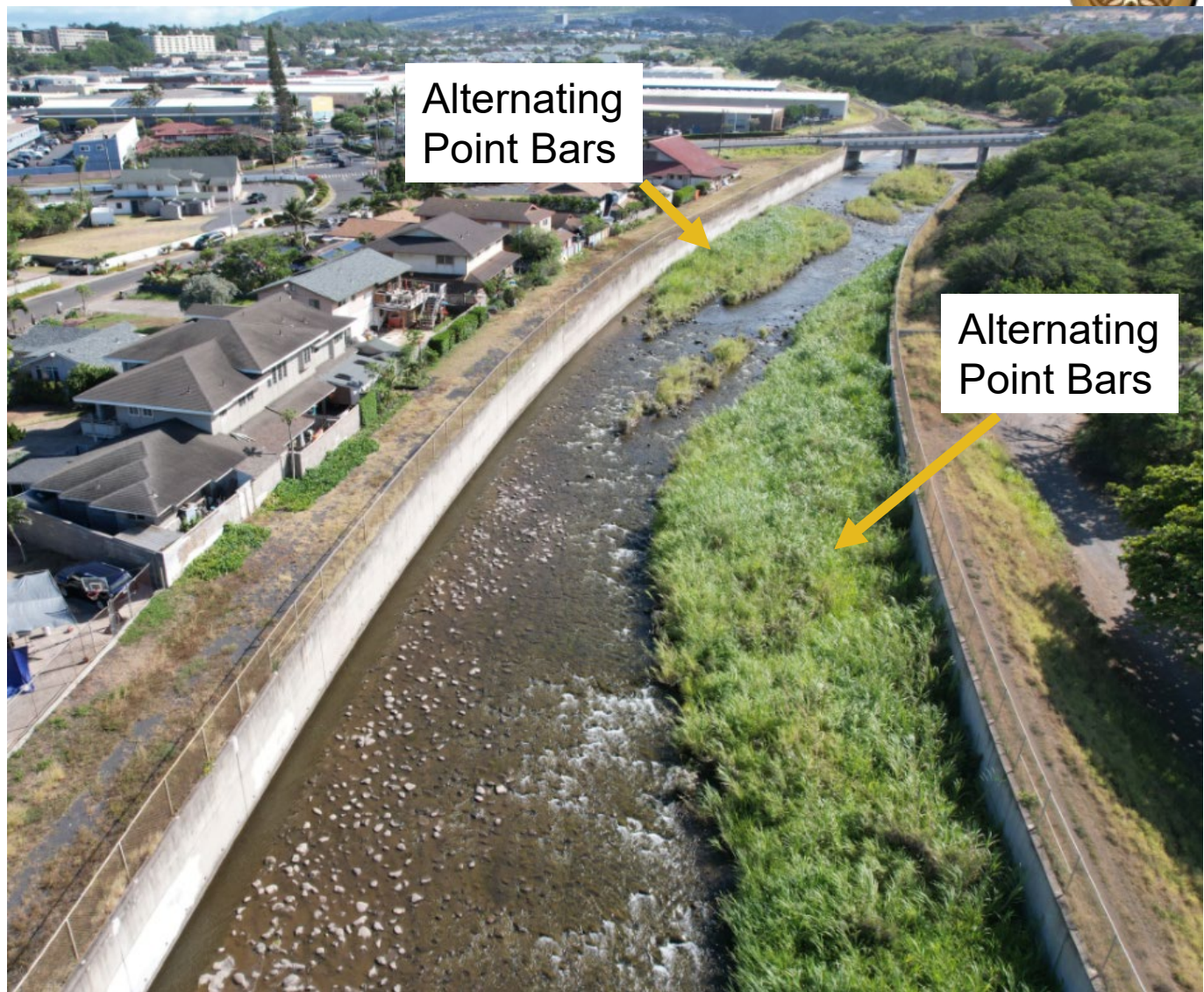
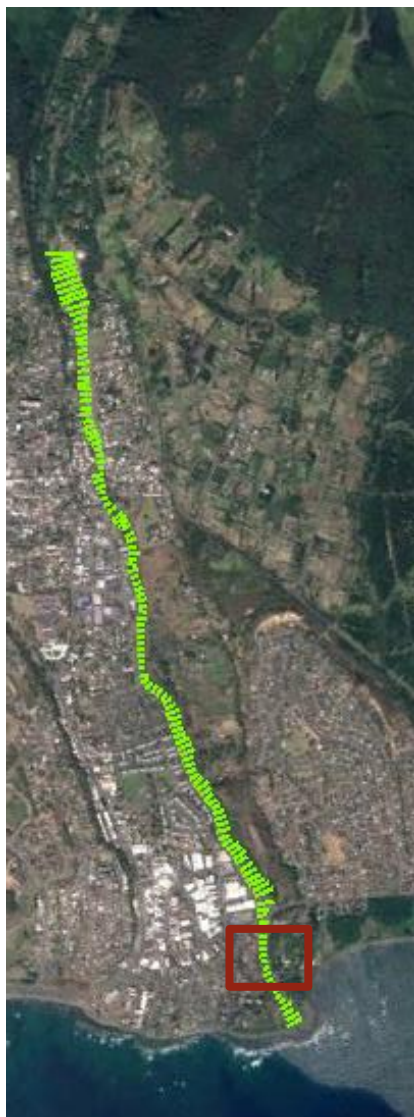
But...after the 2021 event.



4. Channel Capacity Analysis



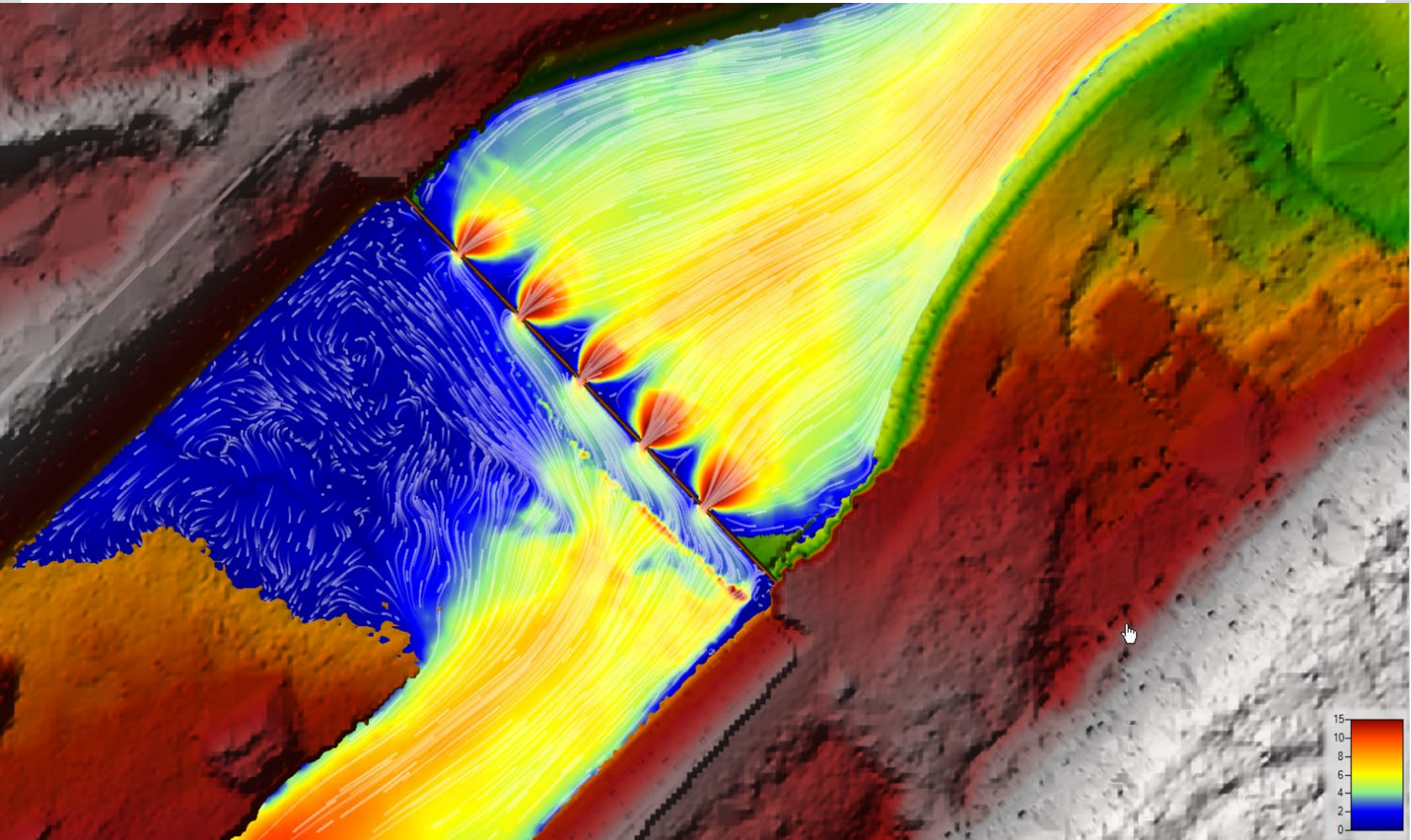
4. Channel Capacity Analysis



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5. 2D Debris Basin Sediment Model





Setbacks

1. Water damage in the County Building destroyed all records more than 5-years old. Those data would have been very valuable.
2. Two of the three largest events were in 2016 and 2017, and it was difficult to parse the maintenance between those two events.
3. Flow/Stage divergence in record upstream and downstream of the basin complicated analysis.
4. COVID Travel restrictions precluded ideal field deployment (following January event).



Lessons Learned

A 5-10 year event in January filled the debris basin. POH has drone capacity and could have flown it to compute the volume and map the gradation. These data would have been incredibly valuable. But the window was short, because the County had to start excavating immediately. We missed the opportunity, but should go into a data-limited project like this with a contingency for opportunistic data collection.



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Maui County Department of Public Works is spending 75% of their transportation budget emptying this debris basin (>\$1 million in 2016).

USACE is doing a project deficiency study of our FRM channel downstream.

A Regional Sediment Management solution could reduce the costs of one or both of these chronic issues.

