Enloe Dam Removal: Case study in Connectivity

Upper Columbia Science Summit
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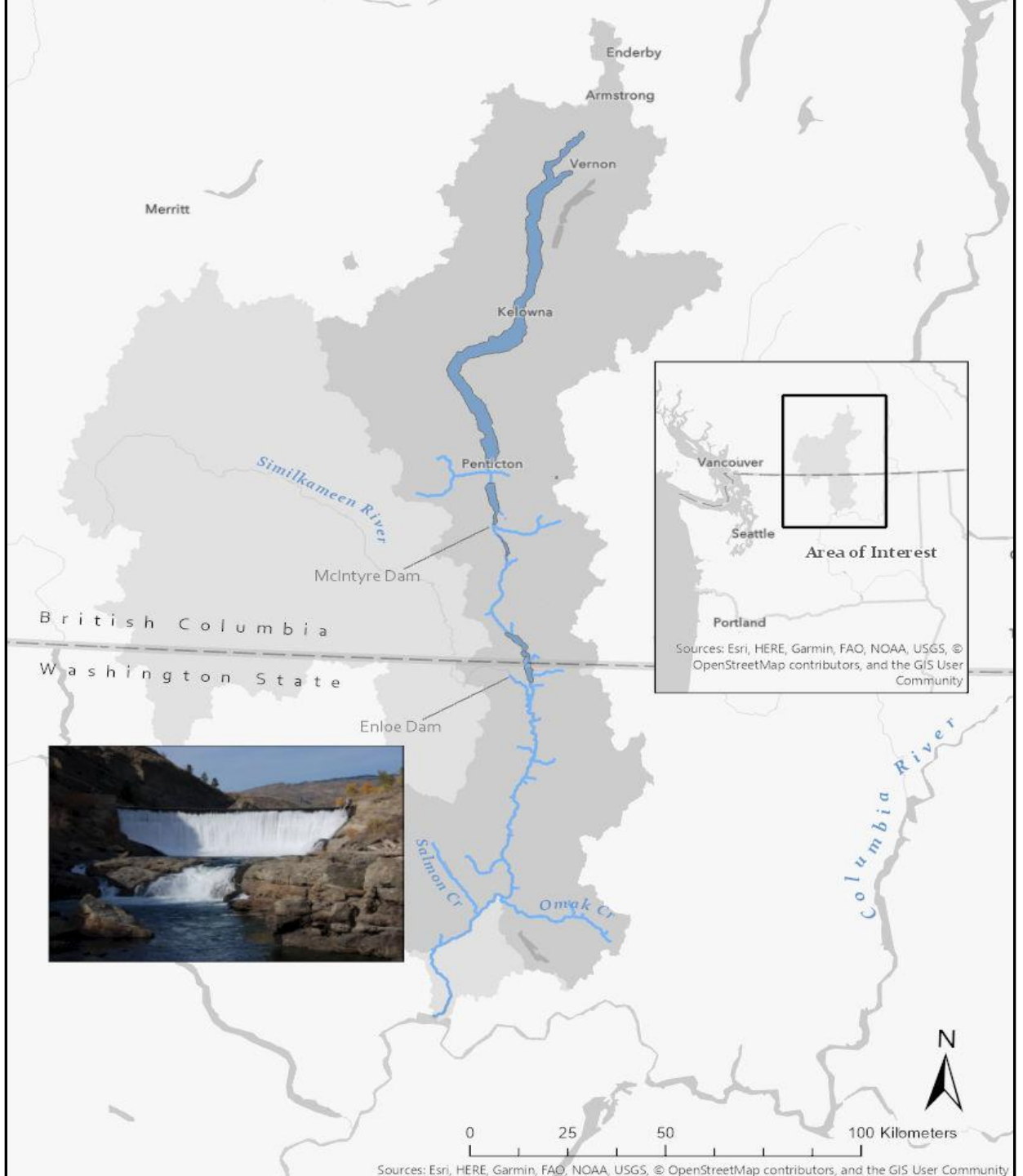
Presented *by* Christopher J. Fisher –
Confederated Tribes of the Colville Reservation

Overview

1. Location and Dam Characteristics
2. History
3. Sediment Evaluation
4. Project Alternatives and Selection
5. Elutriate Test Results
6. Fisheries Benefits
7. Next Steps

Enloe Dam - Location

- North Central Washington
- Similkameen River - Rkm 14
- 70% of flow Okanogan River
- Similkameen Basin 7,500 km^2
- ~ 80% in British Columbia



Enloe Dam – Characteristics and Comparison

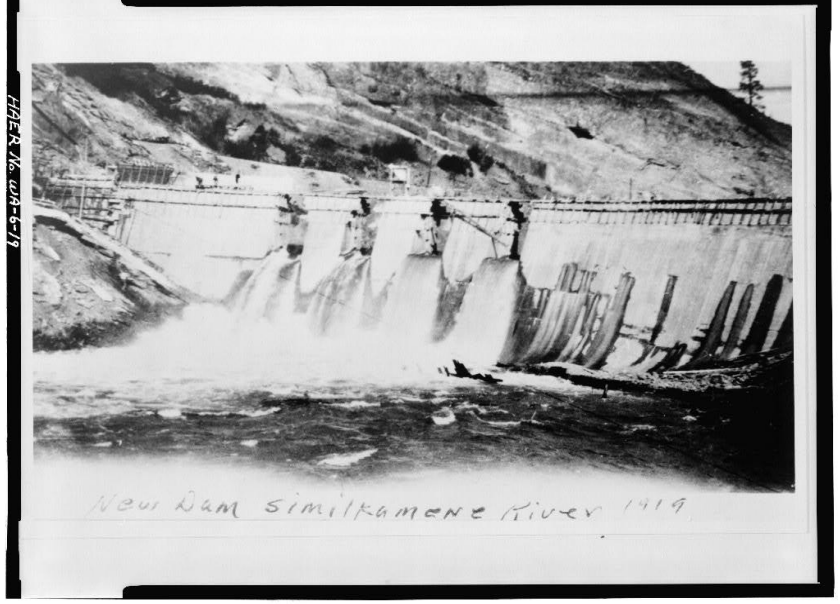
- 54 feet tall, 276 feet wide
- Thickness: 40 feet bottom, 6 feet top

Size Comparison

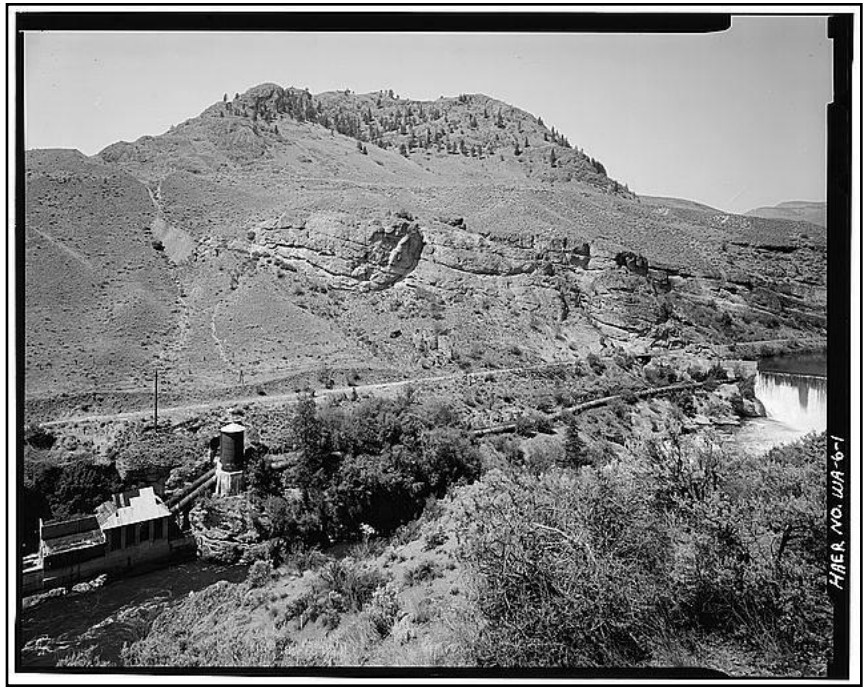
- ½ size Elwha Dam
- 1/3 size of Iron Gate Dam

Enloe Dam - History

- Gold discovered 1859
- Mining camps established
- Power production at Enloe 3.2 MW
- Operated until 1958; Columbia River Dams - less expensive electricity



1919



1940

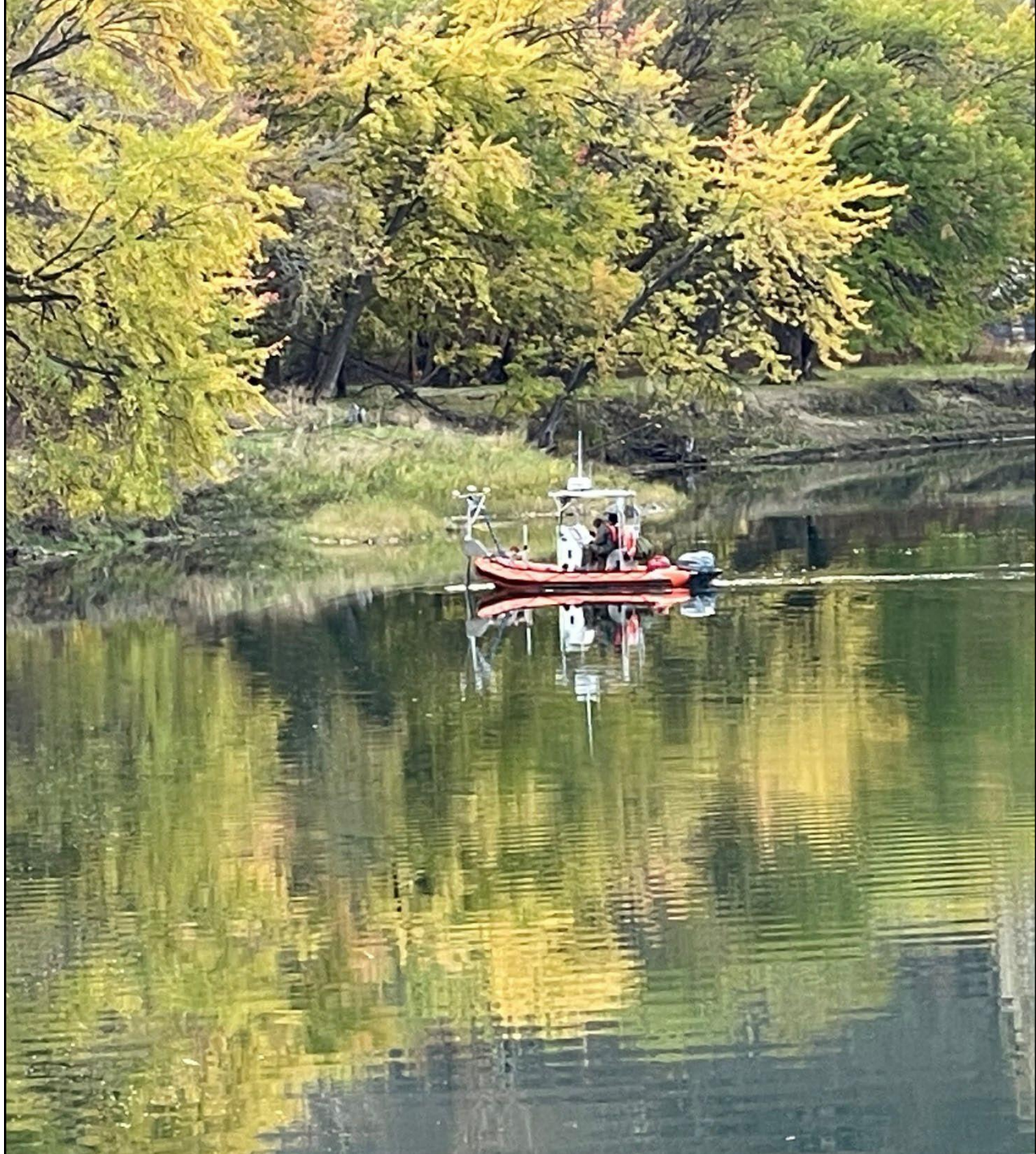
1923

Major Milestones

2019 – OPUD ceases power production at Enloe Dam – cost prohibitive

2022 - OPUD Commissioners passed resolution #1775 "supporting a process to evaluate potential Enloe Dam Removal"

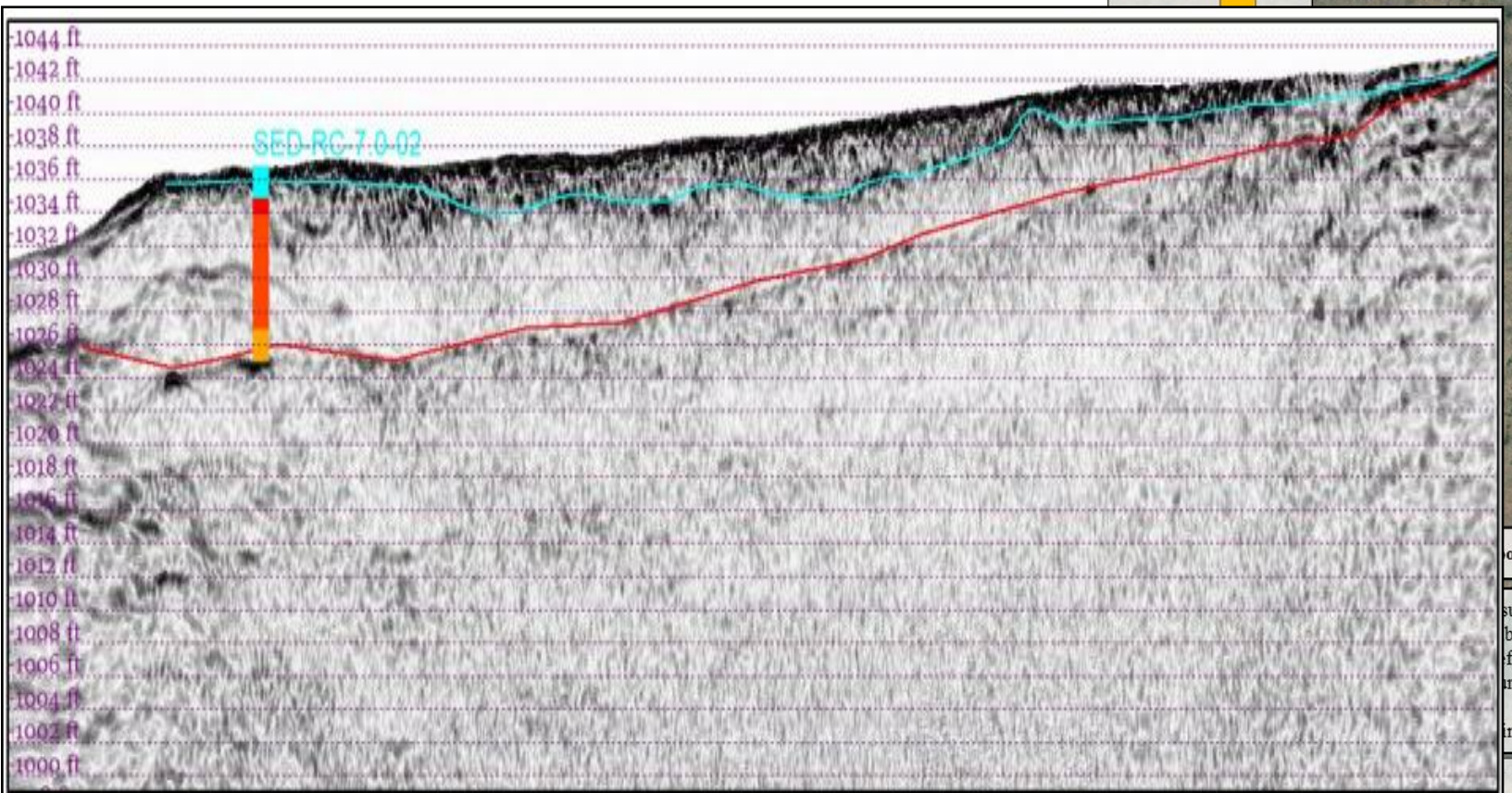
2023 - NOAA Barrier Removal Fish Program – award to fund a feasibility study

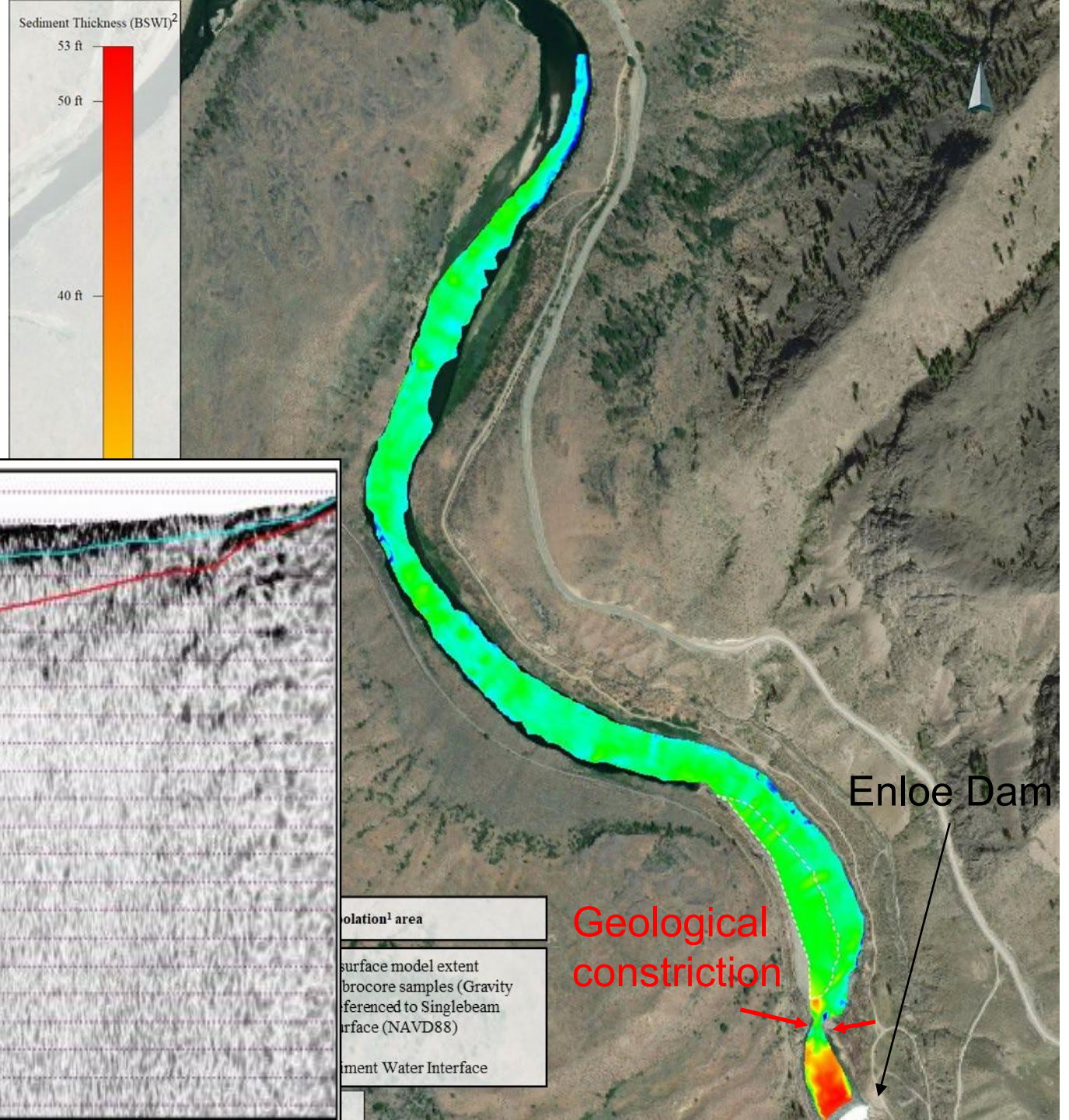


Sediment Evaluation - Volume

Bedrock: 2.9 million yds^3

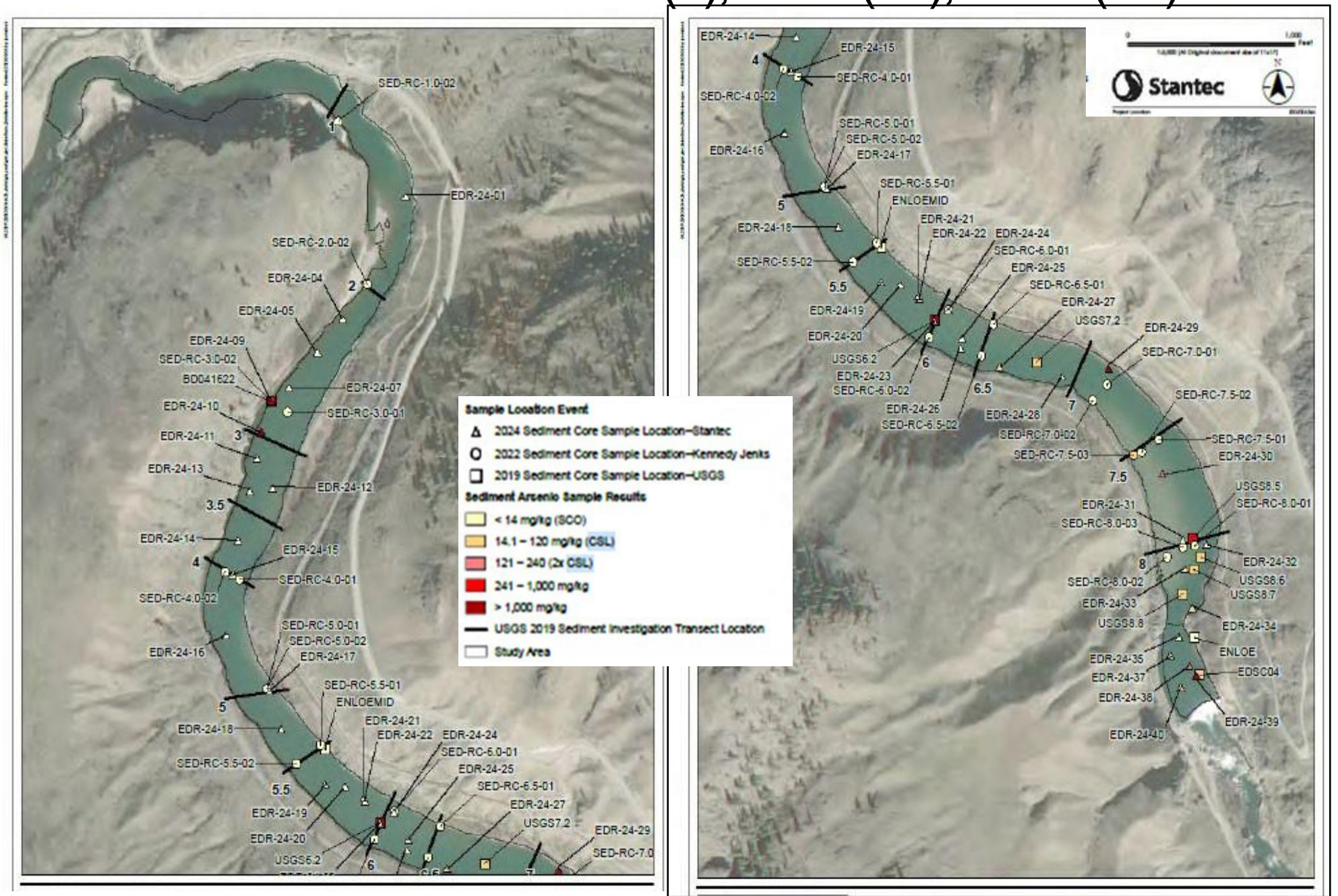
Bedload lens: 560,000 yards^3





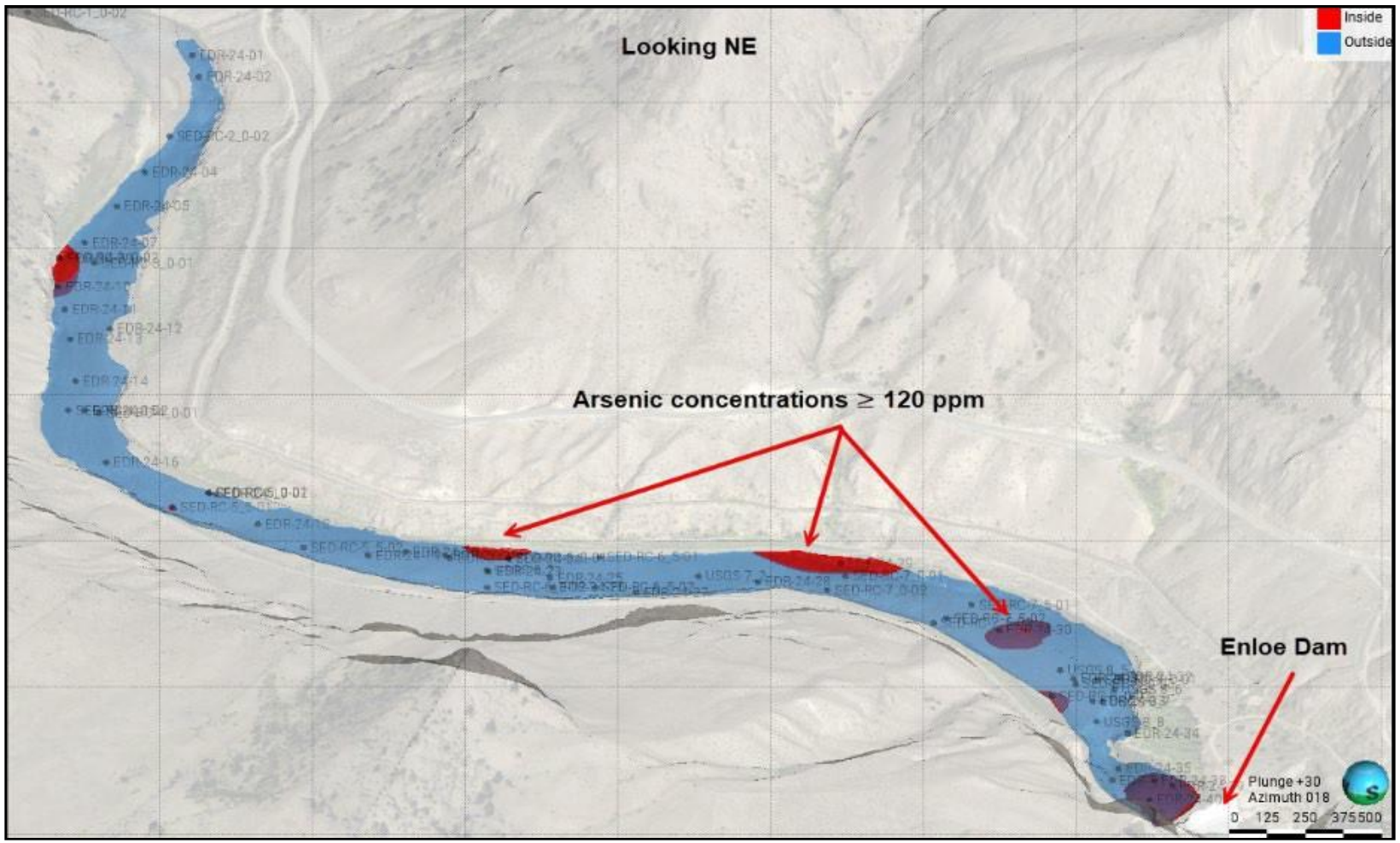
Sediment Core Locations 2019 (6), 2022 (22), 2024 (34)

Arsenic contaminant of interest



Impounded Sediments and Arsenic

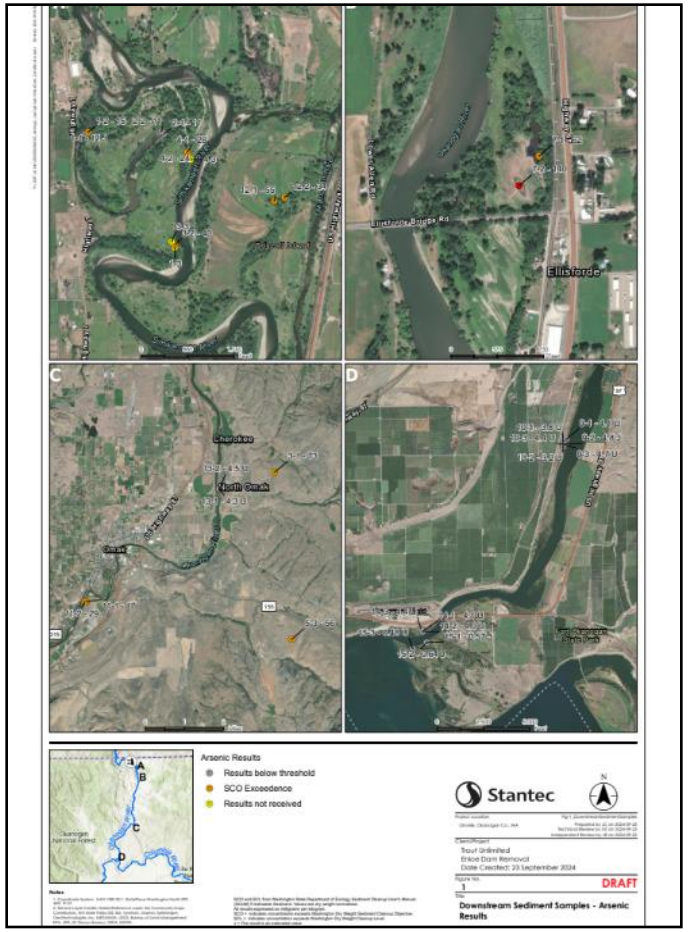
- Arsenic is adhered to silt
- concentrated in the reservoir
- common in river and floodplain downstream
- less in the reservoir than previously believed

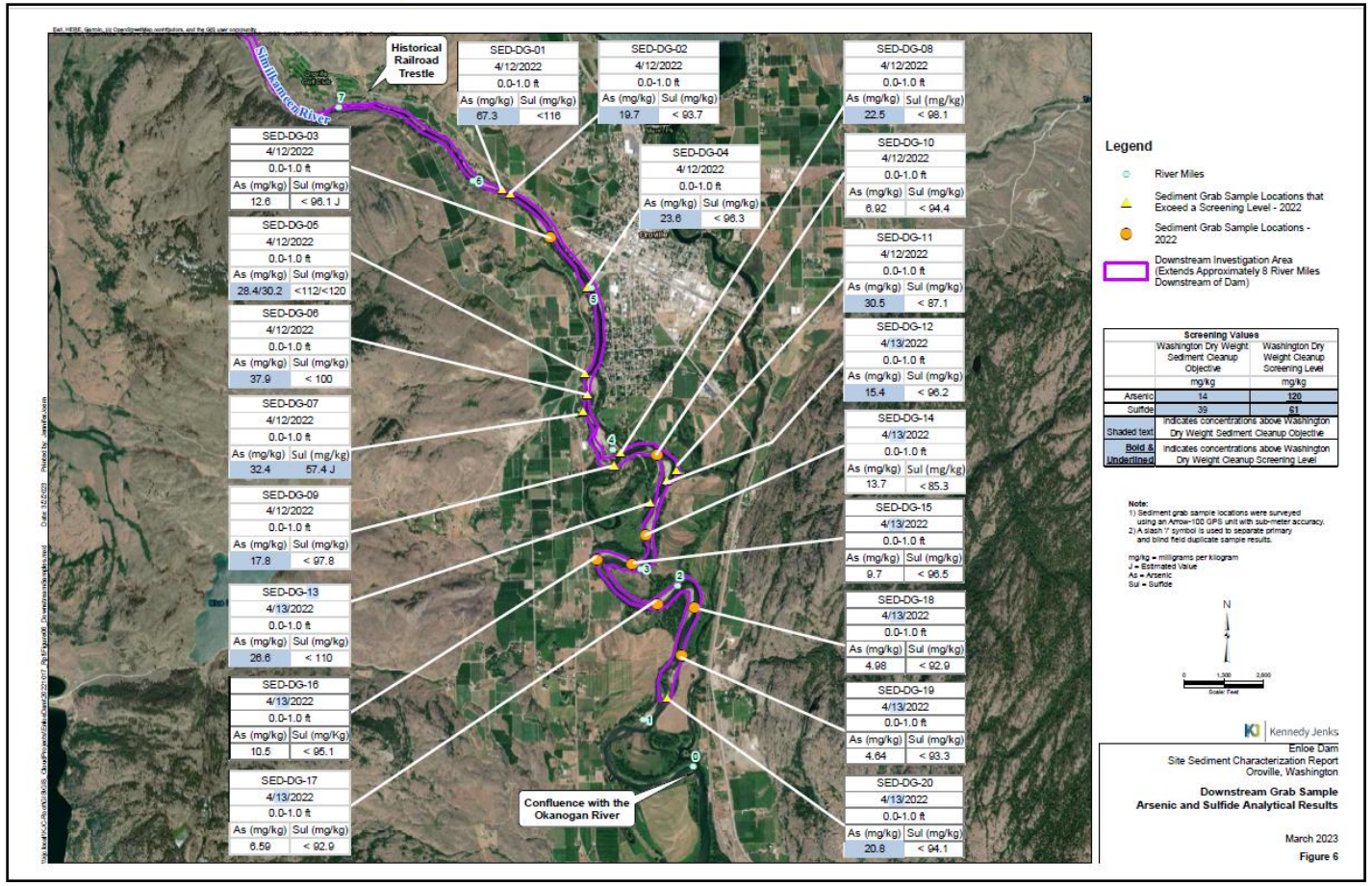


Summary Statistics – Total Arsenic (mg/kg)

	N	Minimum	Maximum	Arithmetic Mean	Geometric Mean	95% UCL
Reservoir – Bulk Sediment	108	2.4	4,030	185	22	275
Downstream – Surficial Sediment[1]	59	0.24	140	25	12	32.4

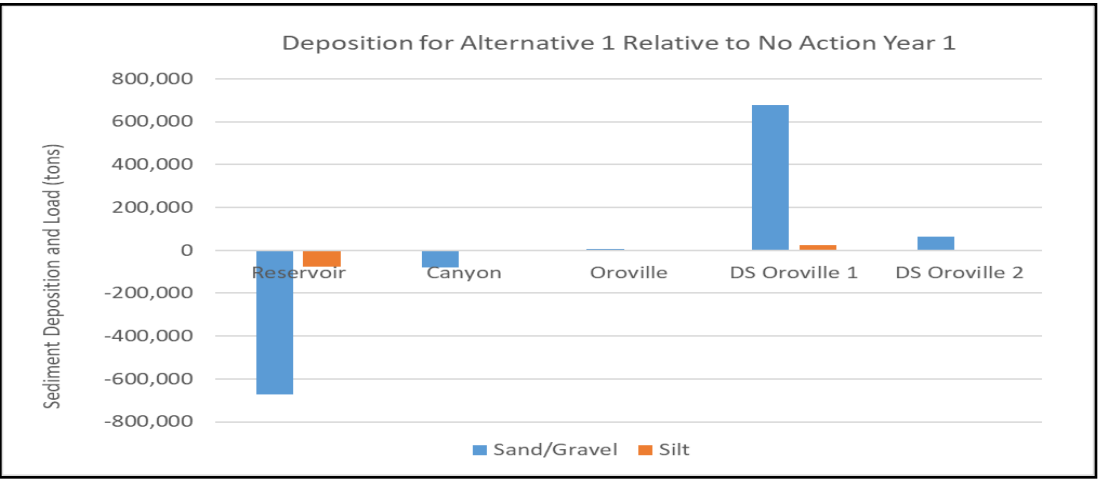
1. Collected by Colville Tribes' staff (2024) and Kennedy Jenks (2023)





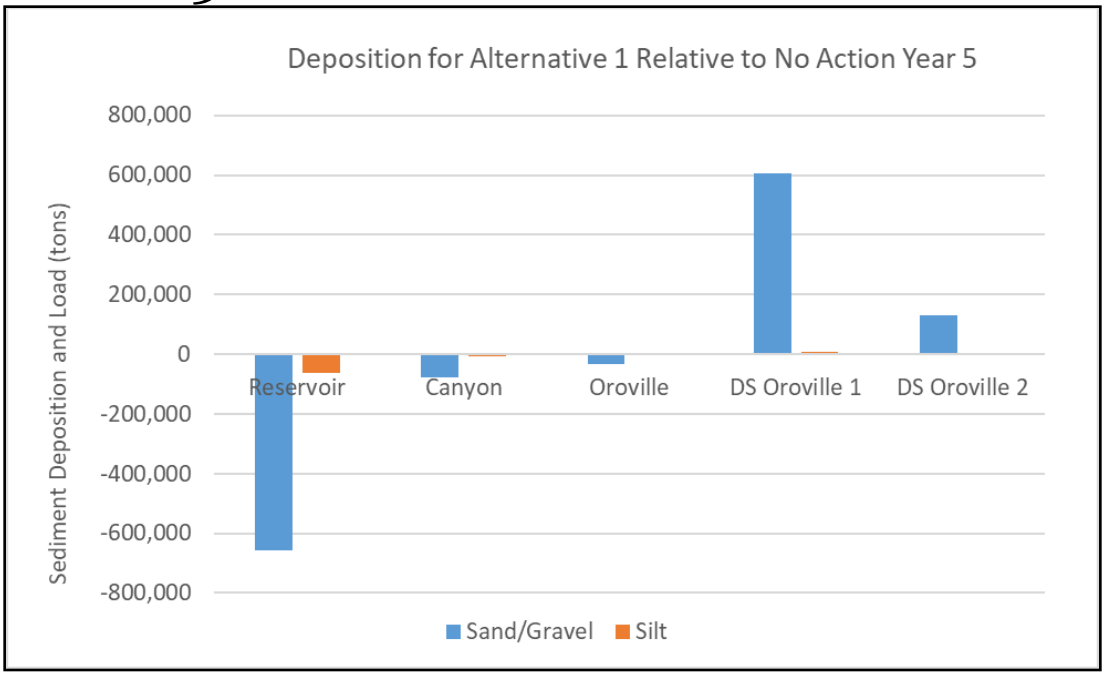
SEDIMENT TRANSPORT-DEPOSITION - -

Year 1

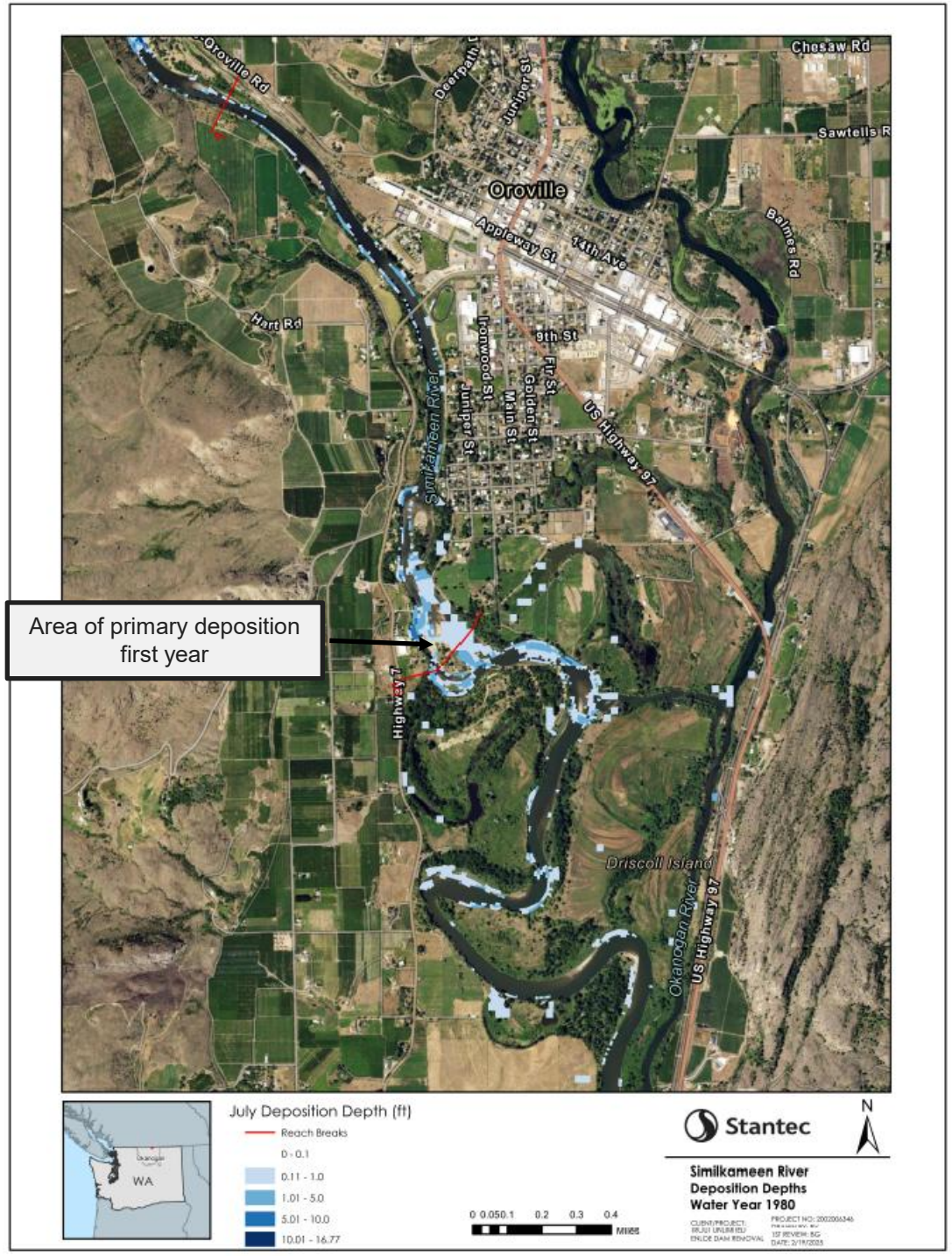


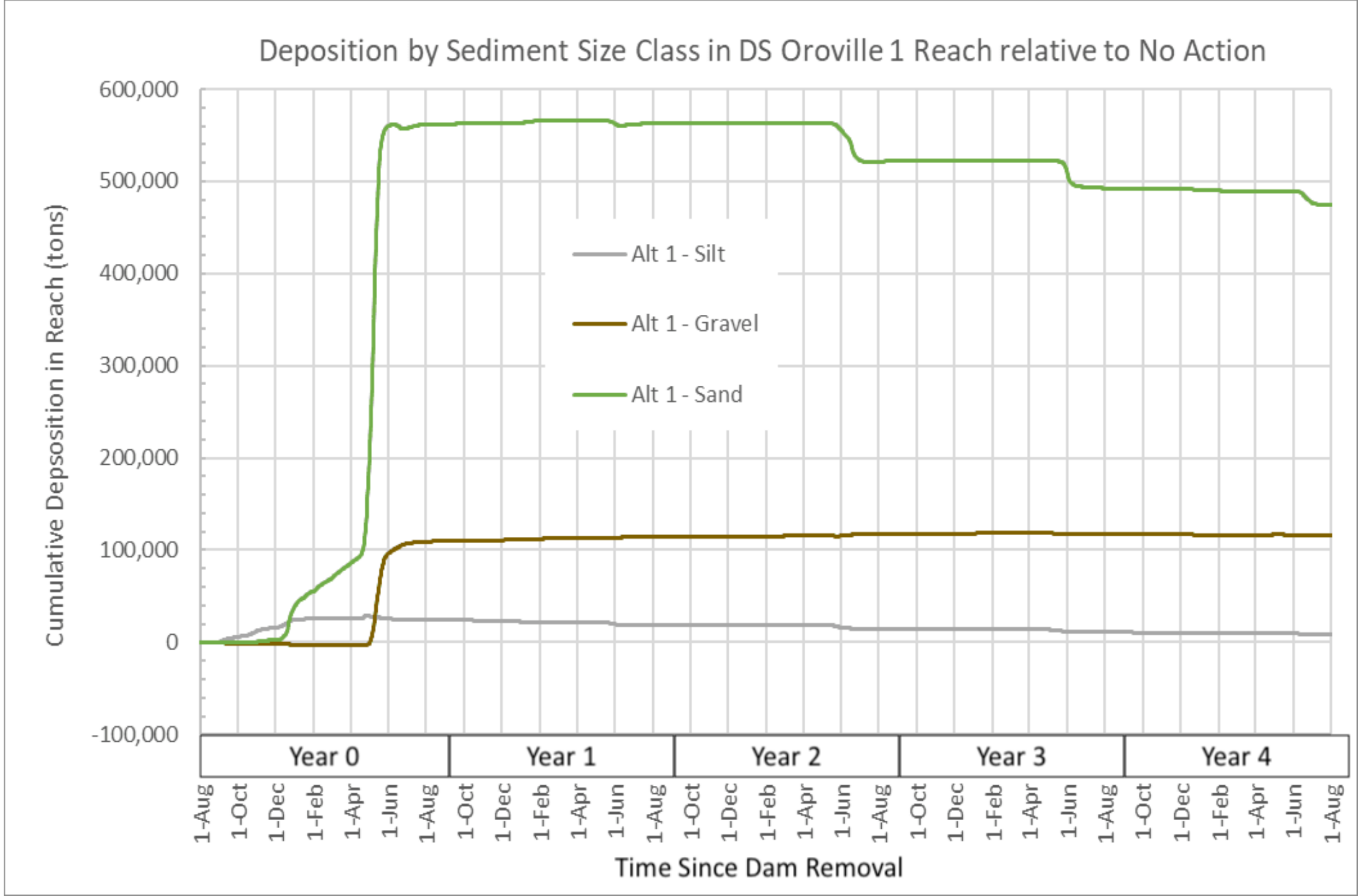
Approx. 70% silt transported to Columbia River

Year 5

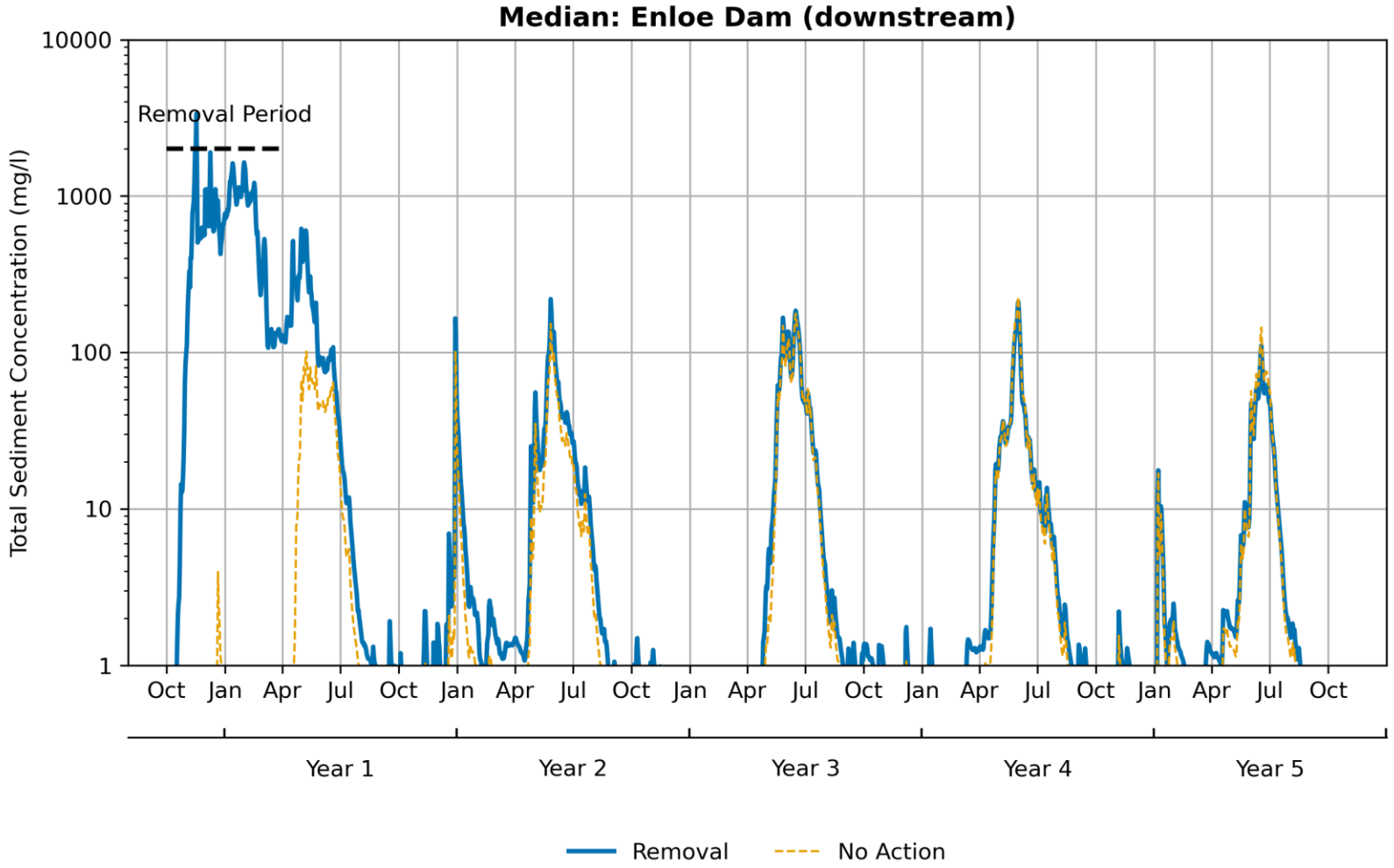


Approx. 90% silt transported to Columbia River




Deposition by Sediment Size Class in DS Oroville 1 Reach relative to No Action
Cumulative Depsosition in Reach (tons)
600,000
500,000
400,000
300,000
200,000
100,000
0
-100,000
Alt 1 - Silt
Alt 1 - Gravel
Alt 1 - Sand
Year 0
Year 1
Year 2
Year 3
Year 4
1-Aug
1-Oct
1-Dec
1-Feb
1-Apr
1-Jun
1-Aug
Time Since Dam Removal

Sediment Concentrations Downstream of Dam



- Simulations qualitatively consistent with Feasibility estimates, with slight shift due to change in dam removal timing
- Elevated concentrations staring Oct continuing until end of spring snowmelt of first year

Enloe Dam – Feasibility Study Alternative Ranking Categories

Technical: Can the dam be removed (benefits and negative impacts)
Permit-ability: Time would take to obtain permits for removal
Risk: Is there insurance to cover Okanogan PUD and other stakeholders
Affordability: How much would the various alternatives cost

Feasibility Study Action Alternatives

Alternative	Description	Score
A0	No Action	1.4
A1	Dam Removal with minimal sediment removal.	3.7
A2	Dam Removal with majority of sediment removed by dredging.	3.5
A3	Dam Removal with selected sediment removal	3.7

Elutriate Testing

- Site water collection
- Composite sampling from highest concentration archived samples
- Generation of control samples
- Dilution series elutriate preparation
- 96-hour elutriate bioassay testing using daphnid and rainbow trout
- Evaluation of acute toxicity to assess compliance with water quality standards

Elutriate Testing – Elutriate Water Results

Sample ID	Total Arsenic Concentration (microgram per liter (µg/L])	Dissolved Arsenic Concentration (µg/L)	Total Organic Carbon Concentration (milligram per liter [mg/L]) (mg/L)	Notes
Site Water	0.875 J	0.707 J	3.97	Water collected from Similkameen River
EDR-Comp1-Elutriate-W	1,940	104	4.63	Elutriate water generated from Comp-1 Sample
EDR-Comp2-Elutriate-W	163	10.5	4.27	Elutriate water generated from Comp-2 Sample
EDR-24-10-Elutriate	8.09	1.18	3.77	Elutriate water generated from control sample
Control- rainbow trout (Oncorhynchus mykiss)	2.15	1.97	0.347 J	Lab Control Sample
Control- water flea (Ceriodaphnia dubia)	1.00 U	1.00 U	0.500 U	Lab Control Sample

WAC 173-201A-24 (March 2025) for dissolved fraction:
Freshwater acute toxicity = 300 µg/L and
Chronic toxicity = 130 µg/L

Elutriate Testing – Rainbow Trout Survival

Table 3-1. Survival Summary for the Water-Column Test with *Oncorhynchus mykiss*.

Sample ID	Conc. (%)	Mean Survival (%)	Standard Deviation	Statistically Less Than Control?	LC_{50}
Control		100	0.0		
Similkameen River Site Water		100	0.0	No	
EDR24-10	10	98	4.5	--	>100
	25	100	0.0	--	
	50	100	0.0	--	
	100	100	0.0	No	
EDR24-COMP1	10	100	0.0	--	>100
	25	100	0.0	--	
	50	100	0.0	--	
	100	100	0.0	No	
EDR24-COMP2	10	100	0.0	--	>100
	25	100	0.0	--	
	50	98	4.5	--	
	100	98	4.5	No	

Elutriate Testing – Water Flea Survival

Table 3-7. Survival Summary for the Water-Column Test with *Ceriodaphnia dubia*.

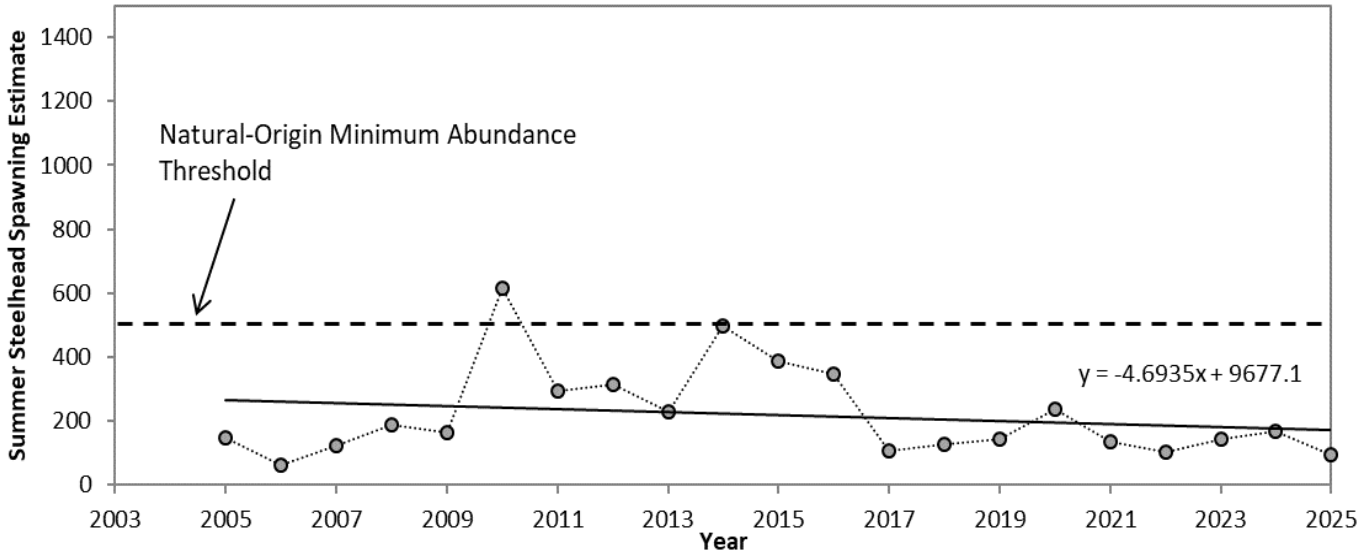
Sample ID	Conc. (%)	Mean Survival (%)	Standard Deviation	Statistically Less Than Control?	LC_{50}
Control		96	8.9		
Similkameen River Site Water		100	0.0	No	
EDR24-10	10	92	11.0	--	>100
	25	96	8.9	--	
	50	96	8.9	--	
	100	100	0.0	No	
EDR24-COMP1	10	60	37.4	--	>100
	25	84	16.7	--	
	50	96	8.9	--	
	100	100	0.0	No	
EDR24-COMP2	10	92	11.0	--	>100
	25	100	0.0	--	
	50	100	0.0	--	
	100	96	8.9	No	

Enloe Dam – Potential Salmonid Production*

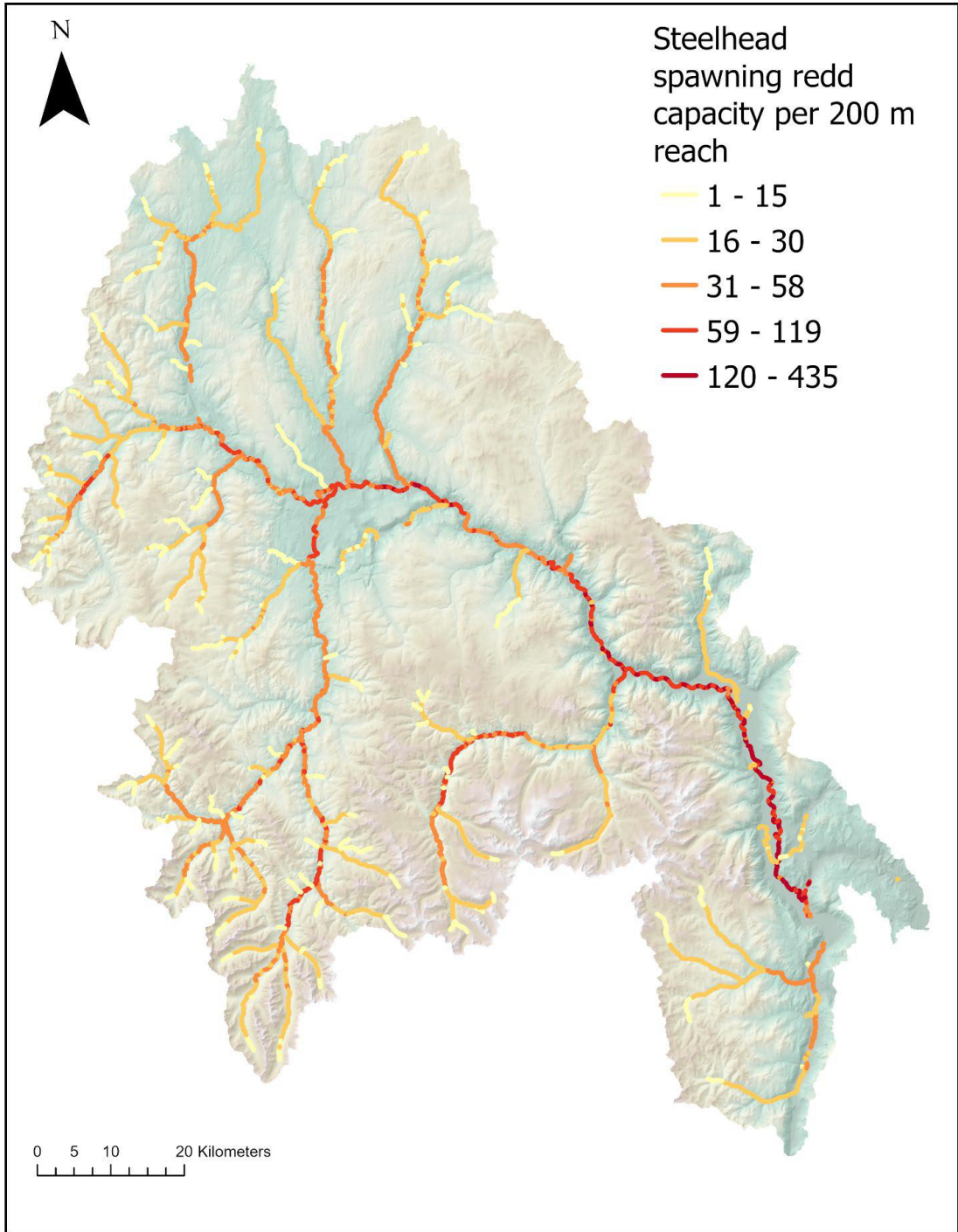
- Redds: Chinook: 77,863
  Steelhead: 203,310

- Adult: Chinook: 7,800 to 47,000
  Steelhead: 29,000 to 118,000

*Bond, M. H., T. J. Beechie, and G. R. Pess. 2023. Habitat Capacity for Chinook Salmon and Steelhead Spawning and Rearing in the Similkameen River Basin. U.S. Department of Commerce, NOAA Contract Report NMFS-NWFSC-CR-2023-01. https://doi.org/10.25923/xf8y-x065



OBMEP — CCT Fish & Wildlife

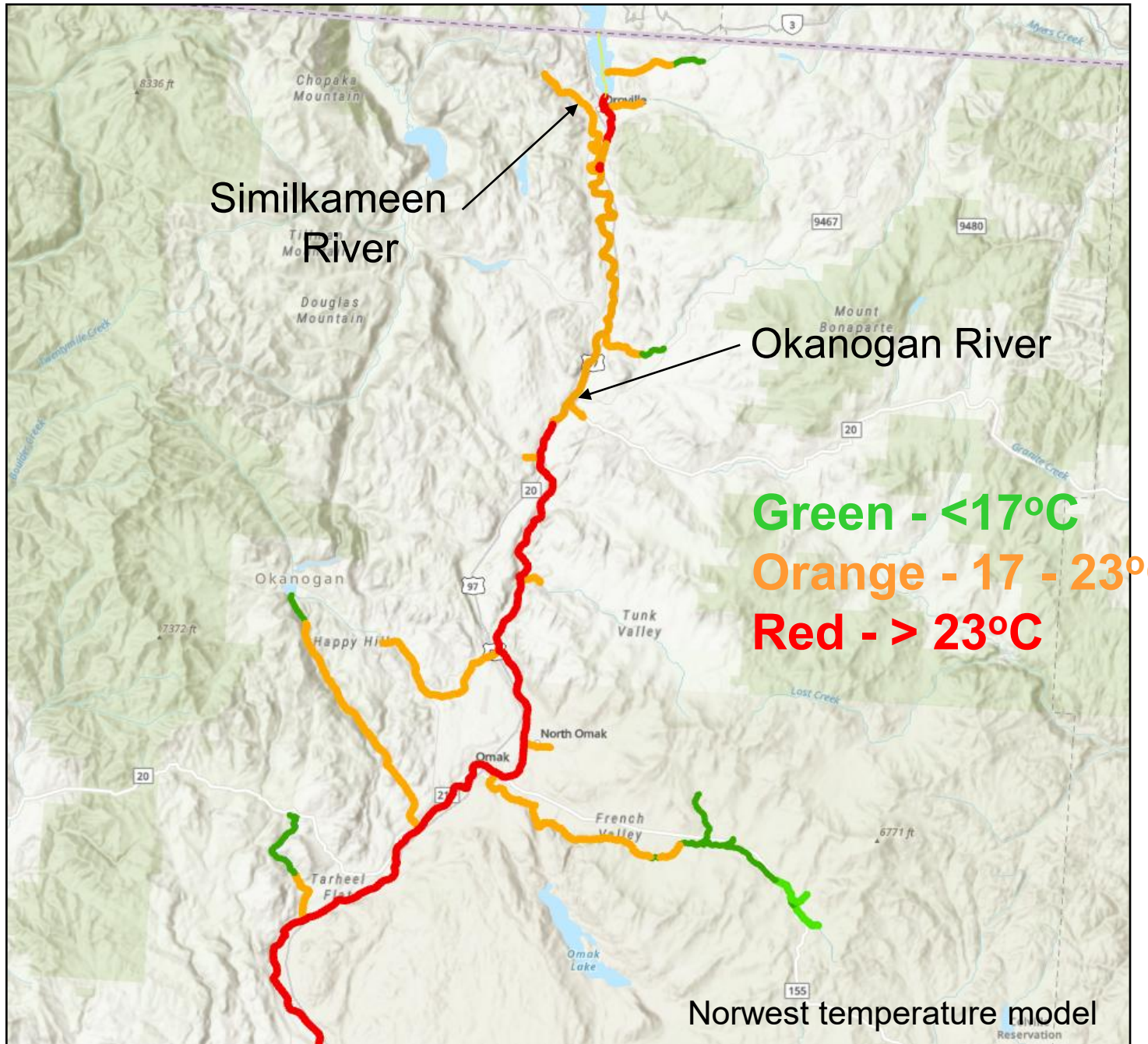


Okanogan Basin – 2040 – Mean Monthly Water Temperatures

Thermally suitable

2020: 90 km

2040: 40 km

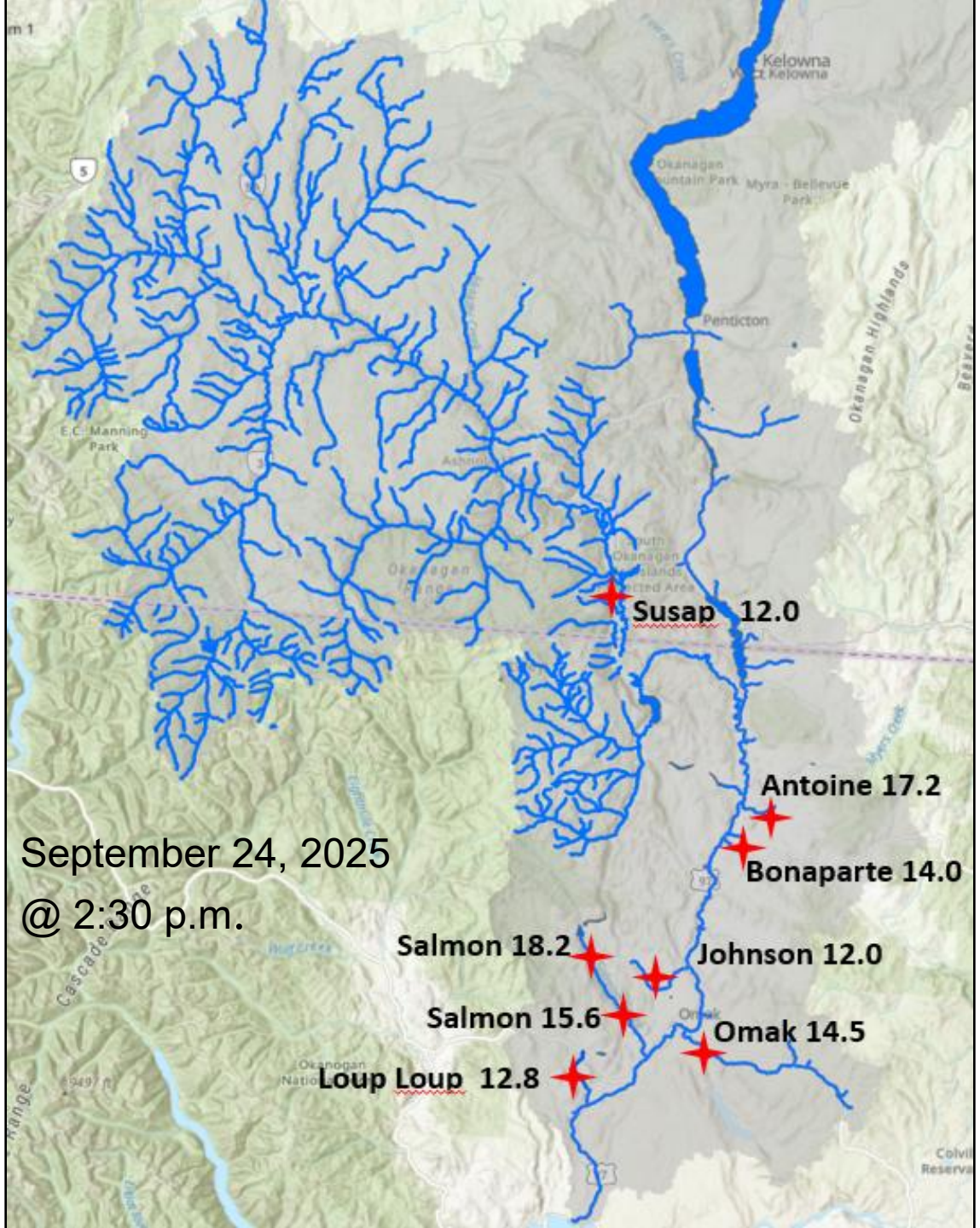


Estimated 2,446 km (1,520 miles) of habitat

Approximately 1,606 km (998 miles) > 3,000 ft.

Increase 1,000 ft. elevation, air temp decrease 3.3°C

Tulameen River



Enloe Dam – Summary

- Enloe Dam inoperable since 1958, comparatively small to other dam removal
- Sediment deposition increase water elevation ~ 0.2 ft., increase gravel recruitment
- Arsenic associated with fine sediment, 90% mobilized at 5 years
- Elutriate tests – meets water quality standards, bioassay LC50 non-issue
- Substantial amount of habitat for Chinook salmon and steelhead (2,446 Km)
- Steelhead returns low, climate forecast reduced habitat, max. benefit - expedite removal

Enloe Dam – Next Steps

- Select action alternative – collaboration with OPUD and agencies
- Public outreach to local entities to summarize the feasibility study
- 30% design, basis of design report, planning cost estimate (May 2026)
- Initiate permitting process (meet with regulatory agencies, develop applications, NEPA/SEPA etc.)

Questions - Comments

Christopher J. Fisher
Habitat subdivision manager
Chris.Fisher@Colvilletribes.com
O: (509) 422-7427
C: (509) 631-0773

Michael Ward / Project Manager - Enloe Dam
Michael.Ward@TU.org
(509) 883-8451

U.S. FISH & WILDLIFE SERVICE

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

Habitat Conservation Plan
Wells, Rocky Reach, Rock Island Tributary Committees

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