Thermal Refuge Enhancement at the Horsetail/Oneonta Creek – Columbia River Confluence

- Keith Marcoe: Lower Columbia Estuary Partnership
- Matt Cox: Inter-Fluve

HTO – Columbia R. confluence Oct 6, 2022

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Columbia R. mainstem summer thermal regime

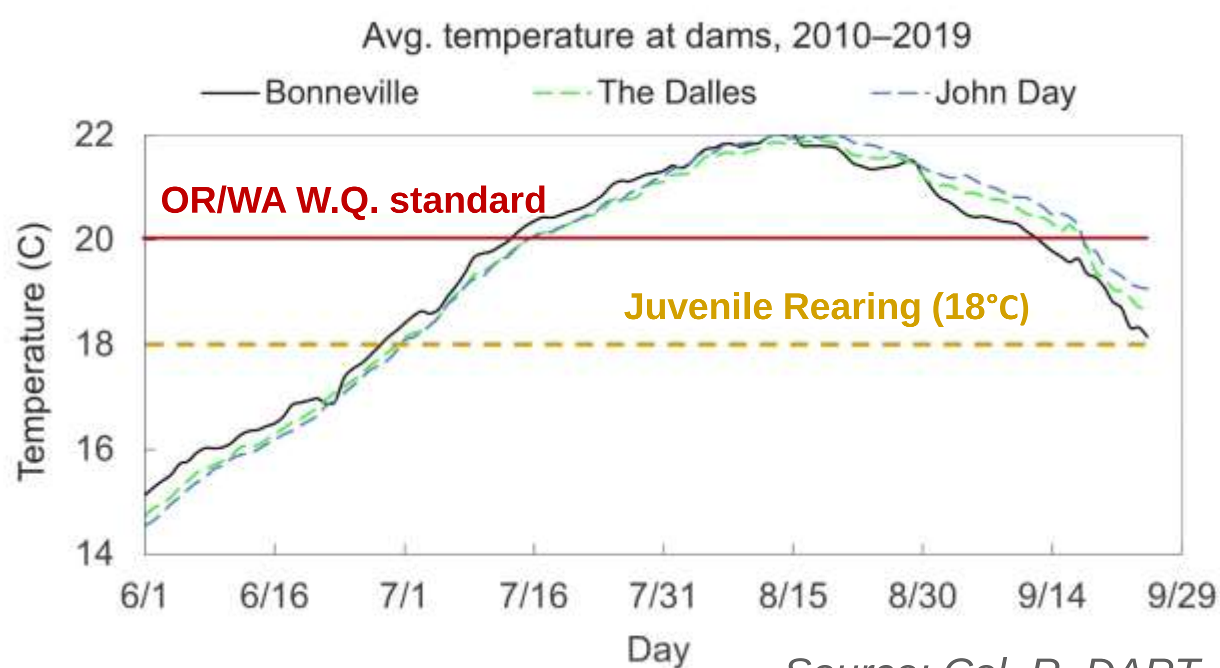
- Temperature exceeds state water quality standards and other salmonid health criteria

- Exceedance concurrent with salmon migration – multiple species, life stages

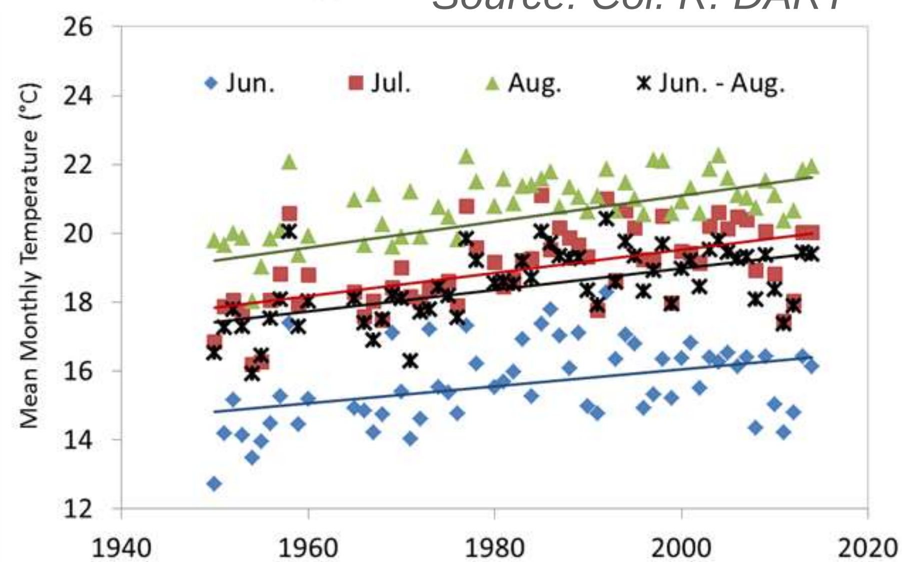
  (Fish Passage Center)

- Temperature will continue to warm - 24°C Aug. daily avg. by 2080

  (NorWesST)



Source: Col. R. DART



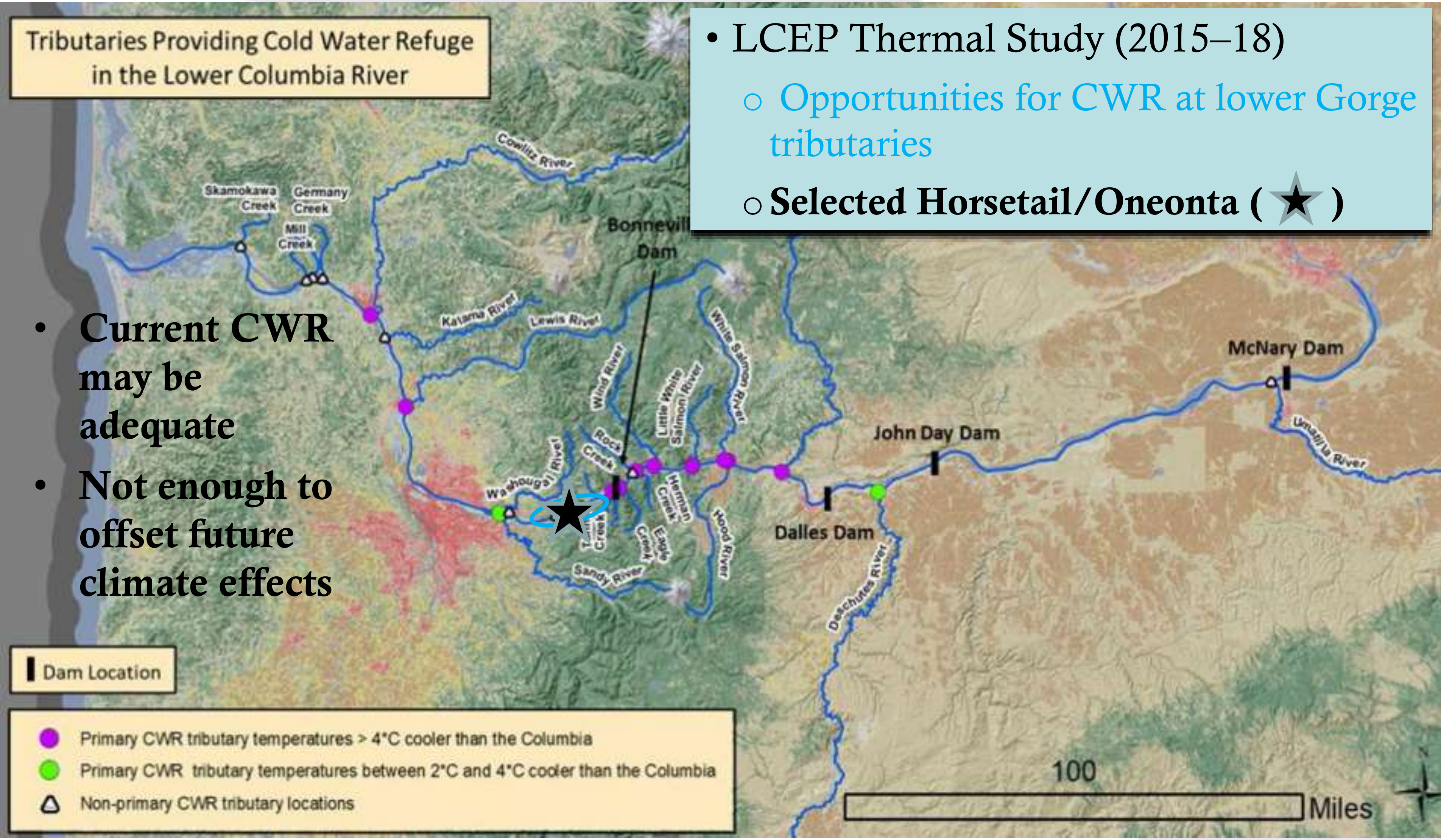
How are salmonids responding to high temperatures?

- Extensive use of cold-water refuge (CWR)
- Documented use of HC, LWS in mid-Columbia by Keefer, Caudill, Goniea, Perry (Univ. of Idaho), and others
- Areas of heaviest use are enhanced by man-made features

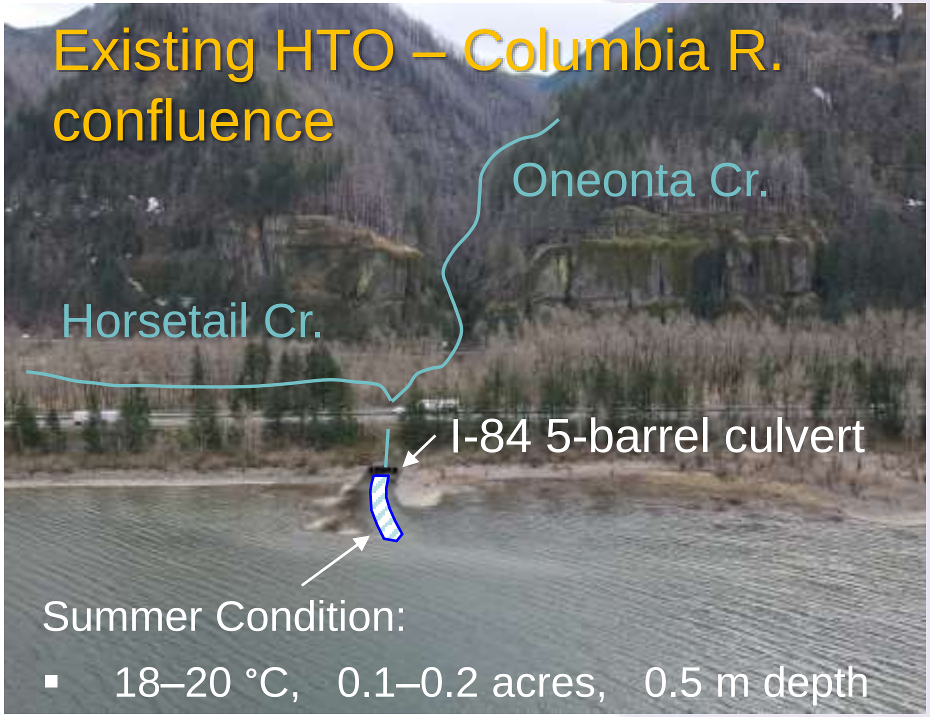
EPA Columbia River Cold Water Refuges Plan (2021)

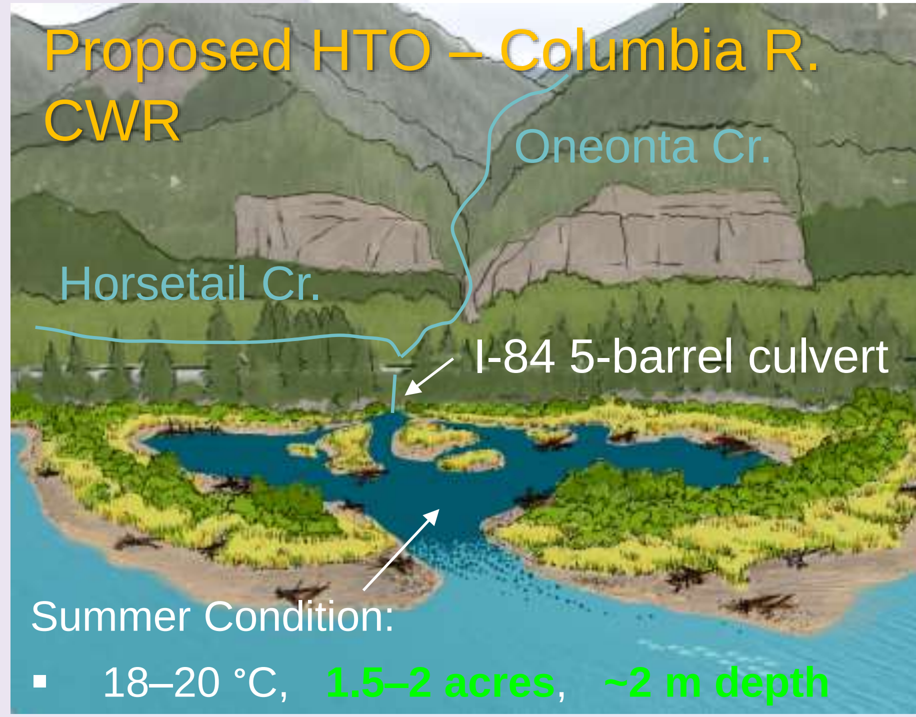
- LCEP Thermal Study (2015–18)
  - Opportunities for CWR at lower Gorge tributaries
  - **Selected Horsetail/Oneonta (★)**

- **Current CWR may be adequate**
- **Not enough to offset future climate effects**



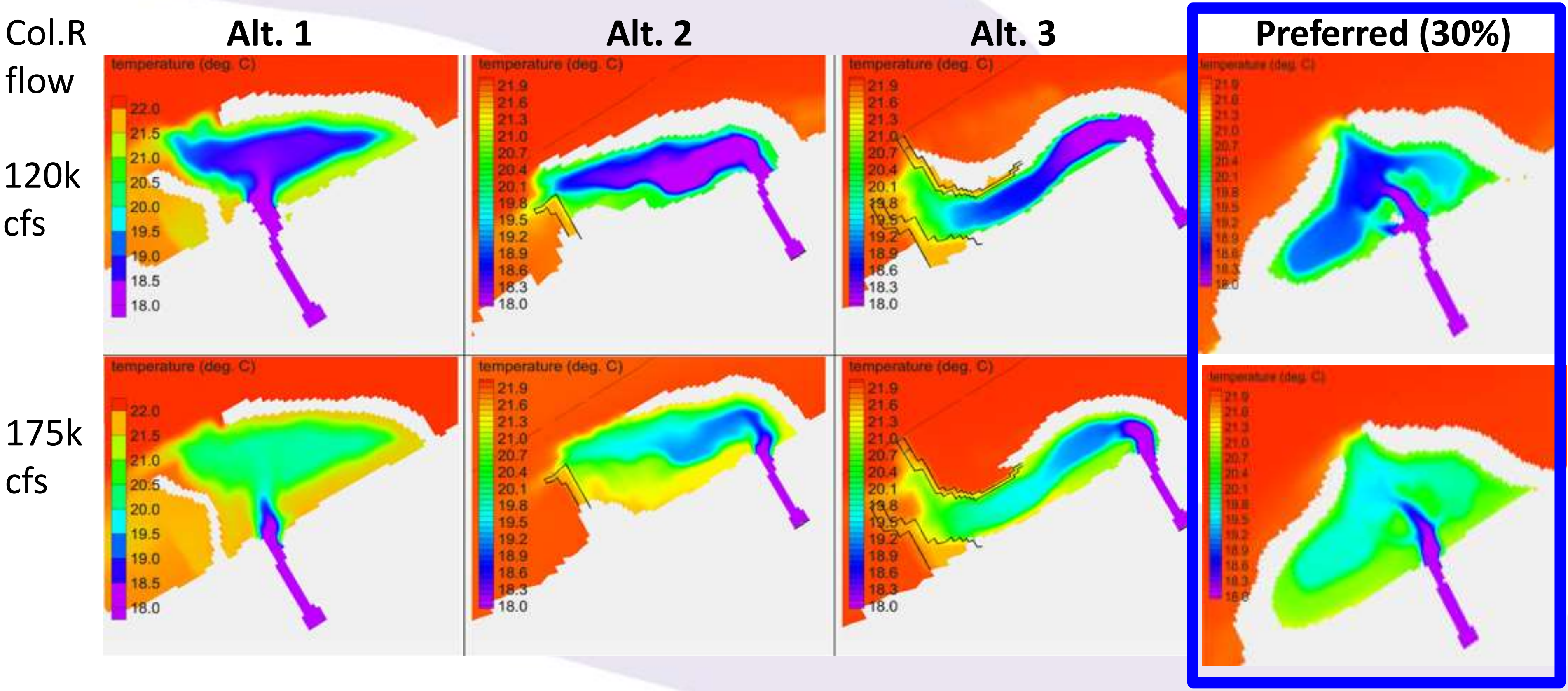
HTO Project Concept





- Challenges
  - Very low tributary flows (4-6 cfs total) >> limited CWR volume
  - Practical limits on structure height >> overtopping and increased sediment
  - Navigation channel impacts >> detectability by migrating salmon

Phase 1 Alternatives Analysis (3D Temperature Modeling)

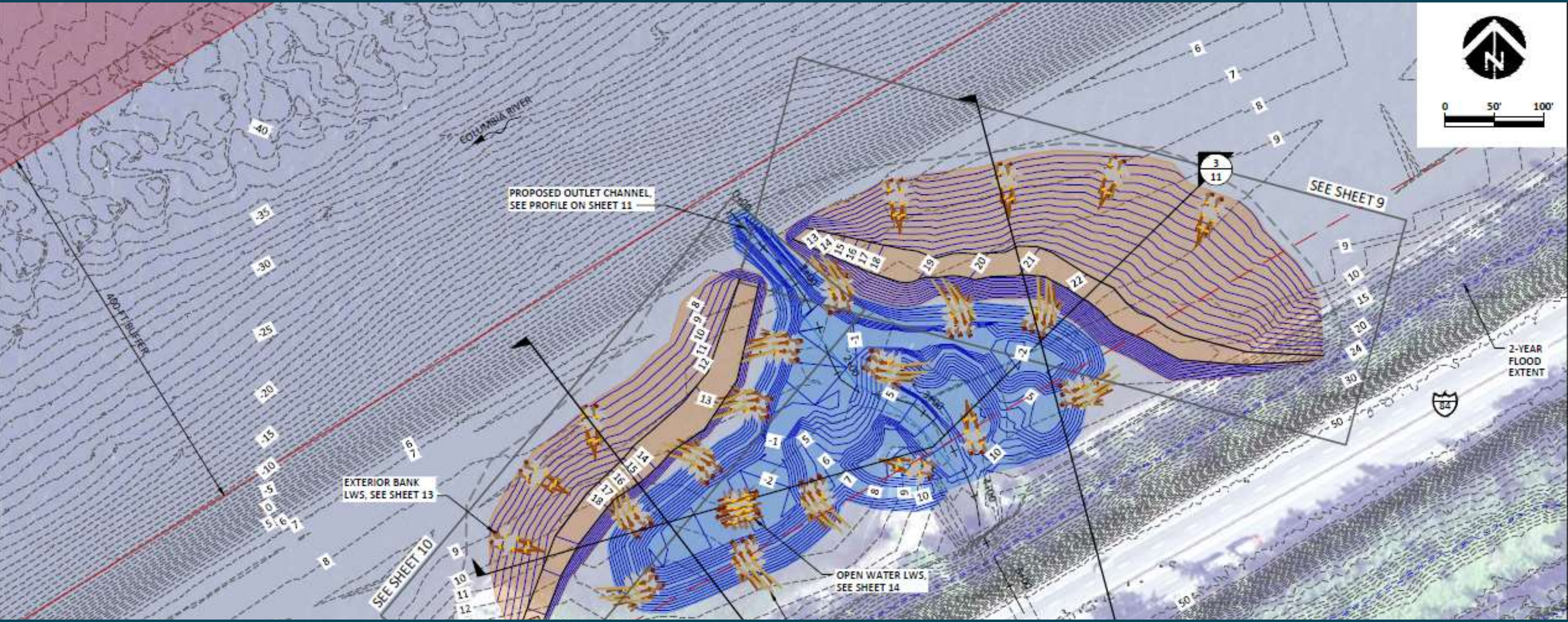


Phase 1 Alternatives Analysis – Final Summary

Design Alternative

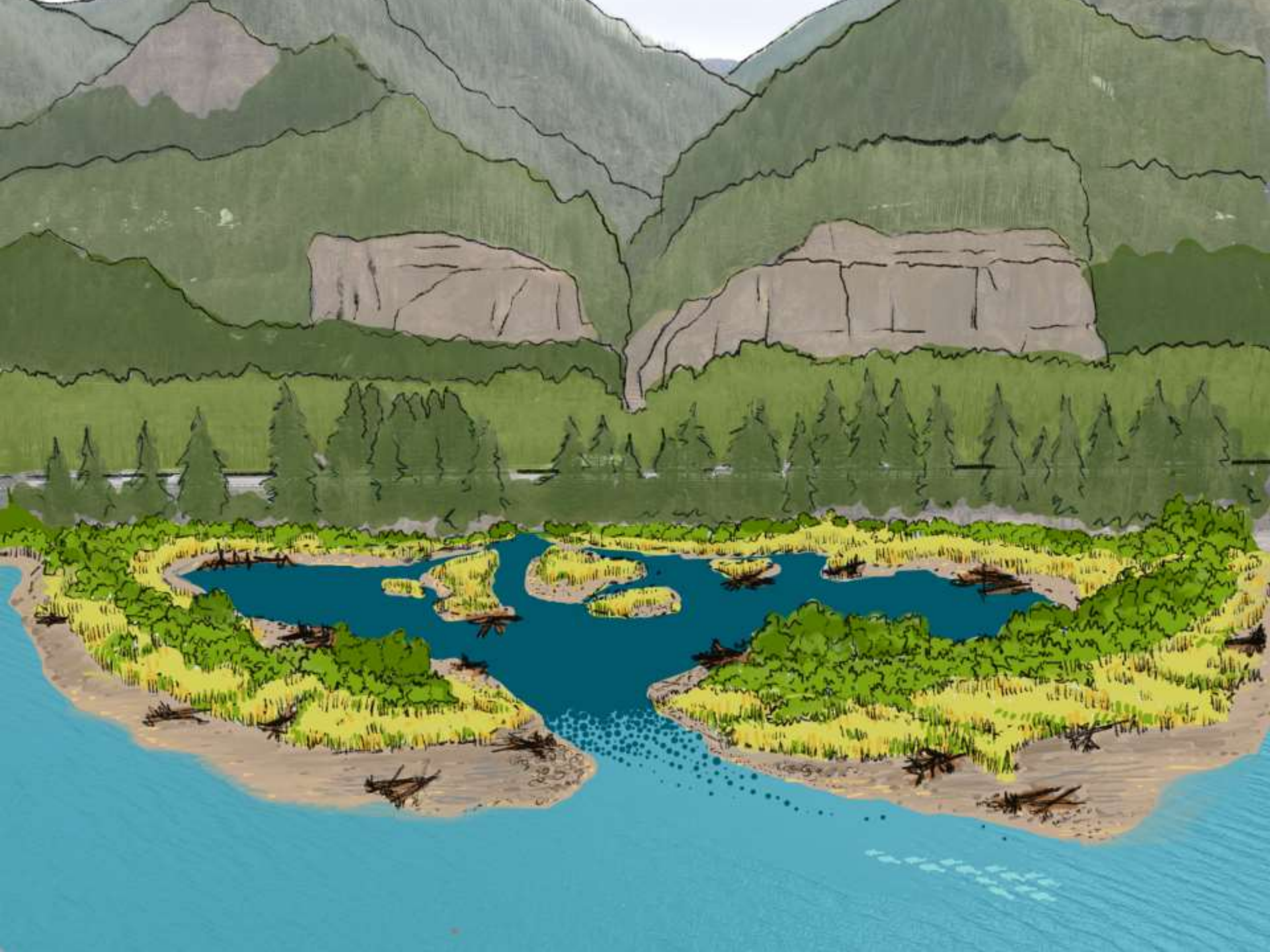
	1	2	3	30%
Goal 1 objectives				
• Core CWR, acres $T_{CWR} \leq T_{Col\,R.} - 2°C$	0.8	1.2	0.8	1.4
• Overall CWR, acres $T_{CWR} \leq T_{Col\,R.} - 1°C$	1.5	1.6	1.0	2.3
• Detectibility (distance to migration zone)	50’	26’	105’	0’
Goal 2 objectives				
• Suitable depths				
• Shoreline length	2200’	2500’	2200’	2800’
Goal 3 objectives				
• Sediment evac. (sand) - Bed shear at mouth	12.0 N/m^2	1.0 N/m^2	20.2 N/m^2	20.2 N/m^2

Preferred Alternative



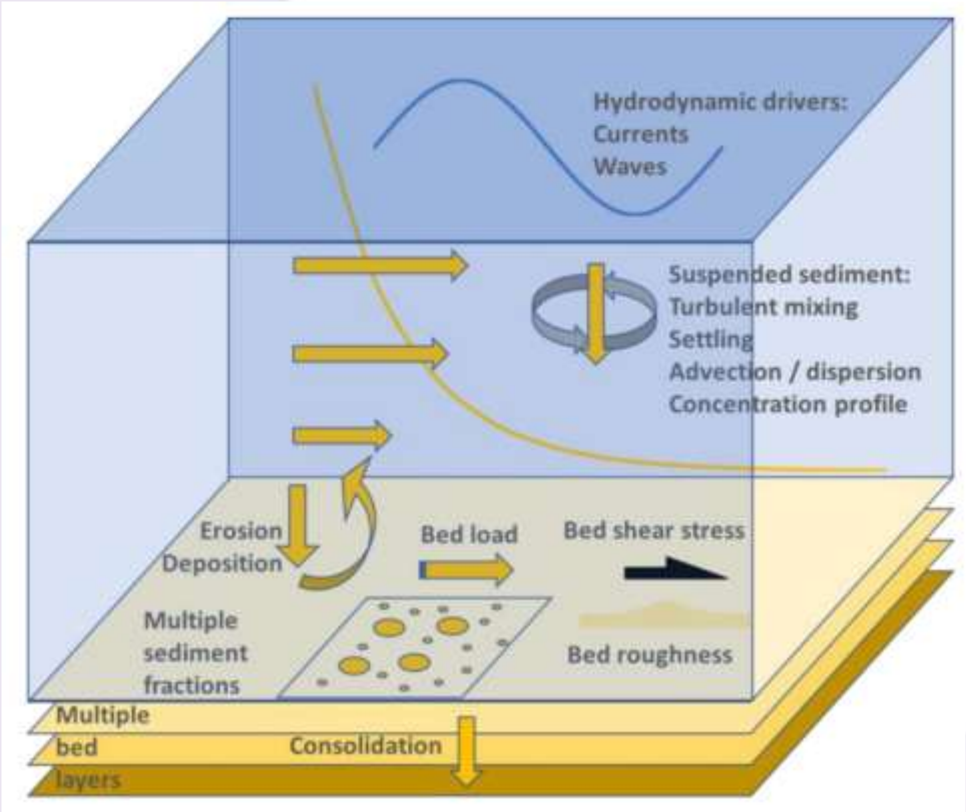
Existing volume of CWR at Oneonta - ~820 m^3 (EPA – 2021 – Cold Water Refuges Plan)

Proposed volume of CWR at Oneonta - ~ **8000 m^3**. A 10 X increase……




Sedimentation?????

Phase 2 Risk Analysis – Sediment Transport Model (STM)

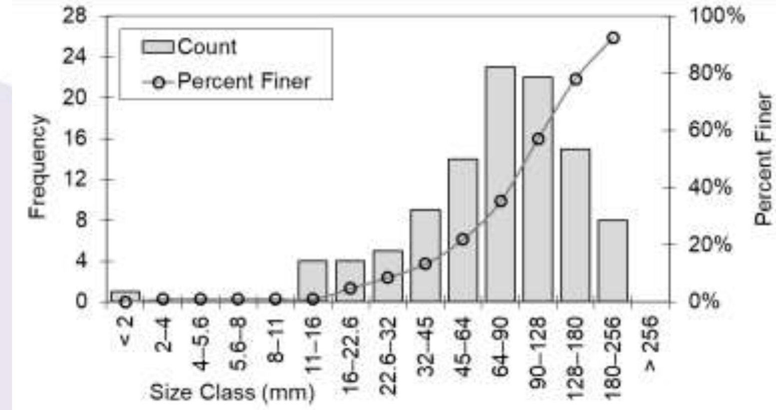


- Sediment model approach:
  - Step 1: Leave setup to the experts
  - single line of evidence – model is just one tool to help assess performance and risk

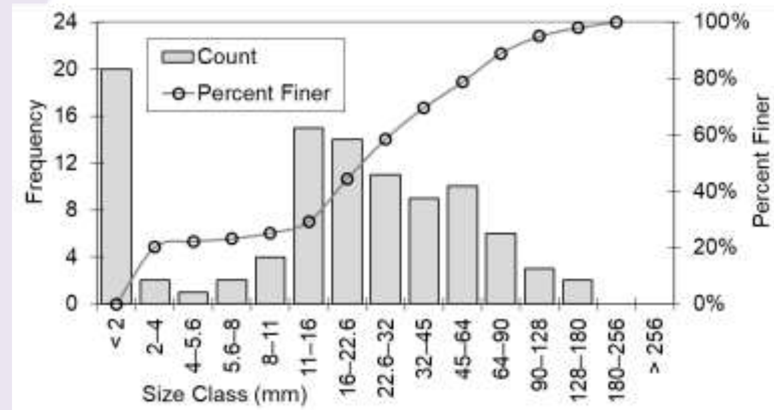
STM Setup

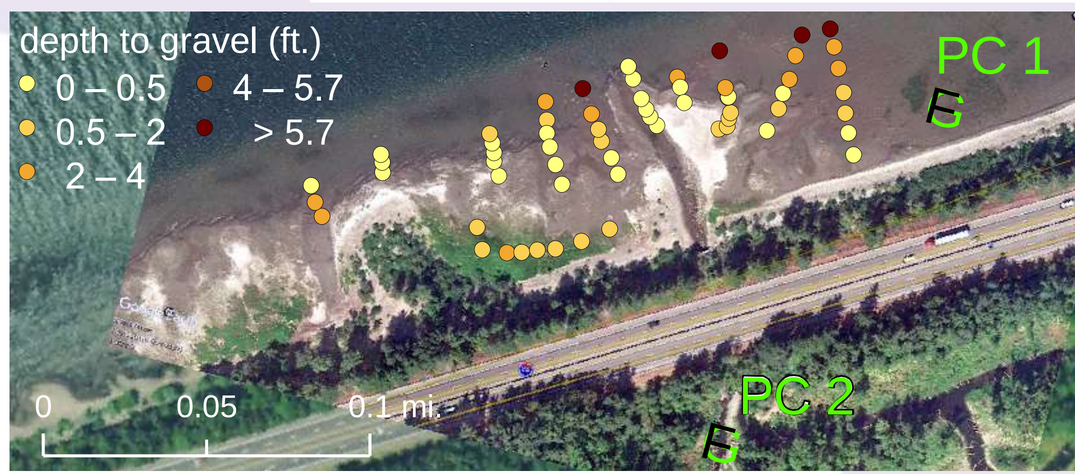
- Sediment composition:
  - fractions based on pebble counts at confluence & tributaries
- Bed layering
  - 2 layers
  - Col R. nearshore based on depth to gravel measurements

Oneonta Cr. (PC2)



Columbia nearshore (PC1)





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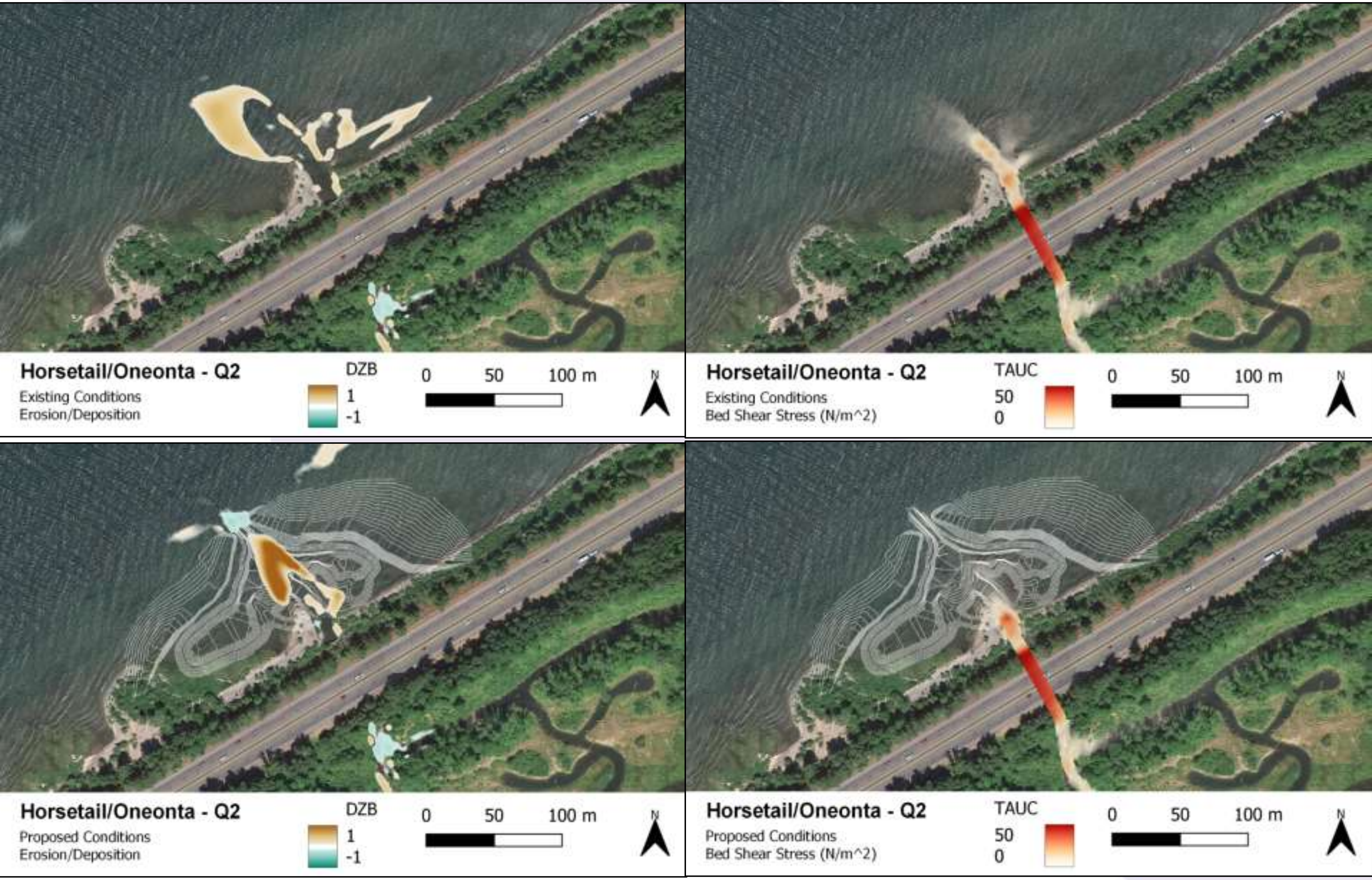
Horsetail/Oneonta - Q2
Existing Conditions
Erosion/Deposition
DZB
1
-1
0 50 100 m
N
Horsetail/Oneonta - Q2
Existing Conditions
Bed Shear Stress (N/m^2)
TAUC
50
0
0 50 100 m
N
Horsetail/Oneonta - Q2
Proposed Conditions
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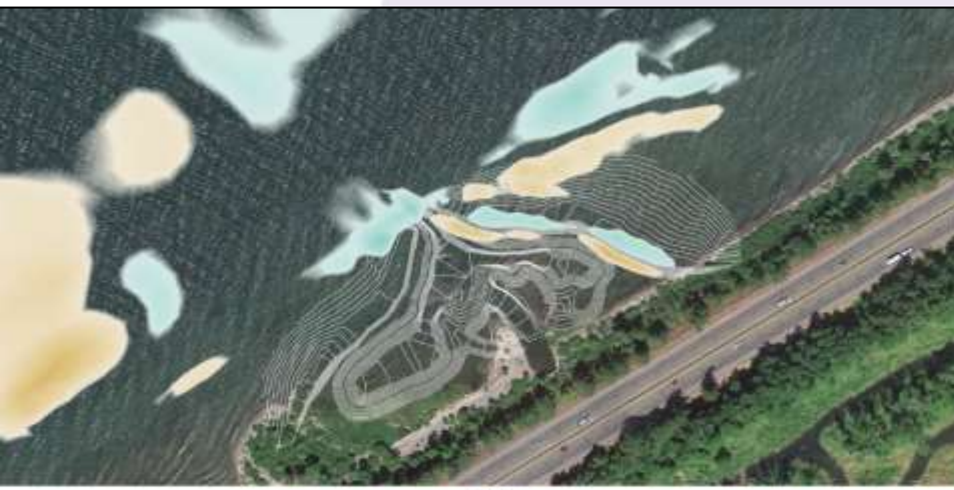
Horsetail/Oneonta - Q2
Existing Conditions
Erosion/Deposition

Horsetail/Oneonta - Q2
Proposed Conditions
Erosion/Deposition

Scenario	Risk Description	Likelihood/Frequency	Impact to Project Function
1	1a - Coarse sediment imported from upstream impact culvert conveyance	Low	High
1	1b - Coarse sediment imported from upstream reduces volume of habitat in embayment	Low	Moderate
1	1c - Fine sediment deposits at the mouth of the embayment	High	Low

Columbia River - Q2
Existing Conditions
Erosion/Deposition

Columbia River - Q100
Existing Conditions
Erosion/Deposition



Columbia River - Q2
Proposed Conditions
Erosion/Deposition

Columbia River - Q100
Proposed Conditions
Erosion/Deposition

Columbia River - (
Existing Conditions
Erosion/Deposition

Columbia River - (
Proposed Conditions
Erosion/Deposition

Scenario	Risk Description	Likelihood/Frequency	Impact to Project Function
2	2a - Fine sediment from the Columbia deposits at the mouth of the embayment	**Moderate**	**Low**
2	2b - Fine sediment from the Columbia deposits with the deeper portions of the embayment	**Low**	**Moderate**
2	2c – Increased velocity along the highway embankment	**Low**	**High**

Closing thoughts

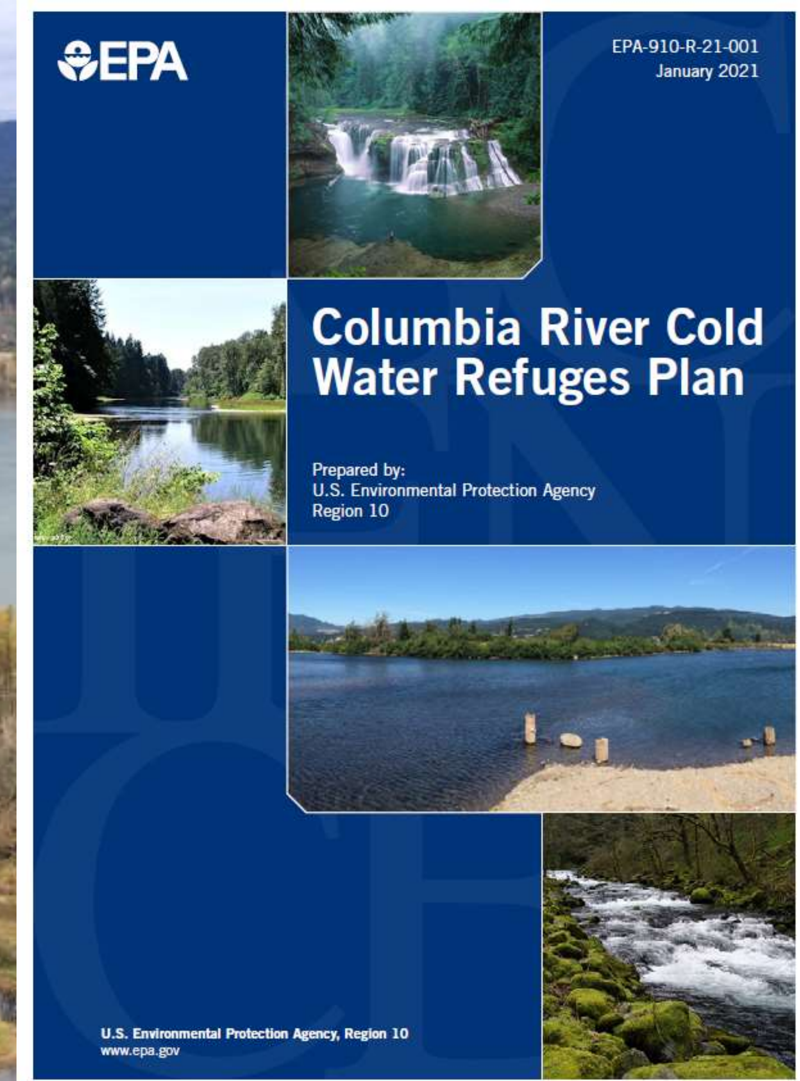
Acknowledgements

Partners:

- InterFluve, Inc.
- U.S. Forest Service
- Matt Keefer, U. of Idaho
- EPA
- Tuflow

Funders:

- EPA
- OWEB
- East Multnomah SWCD



Questions??

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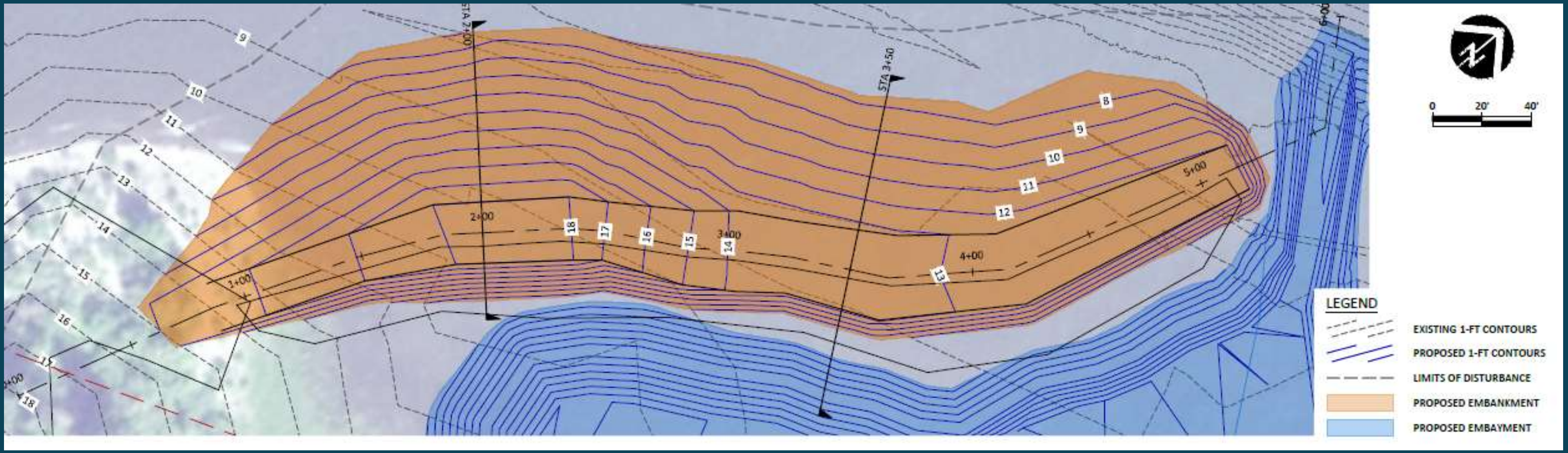
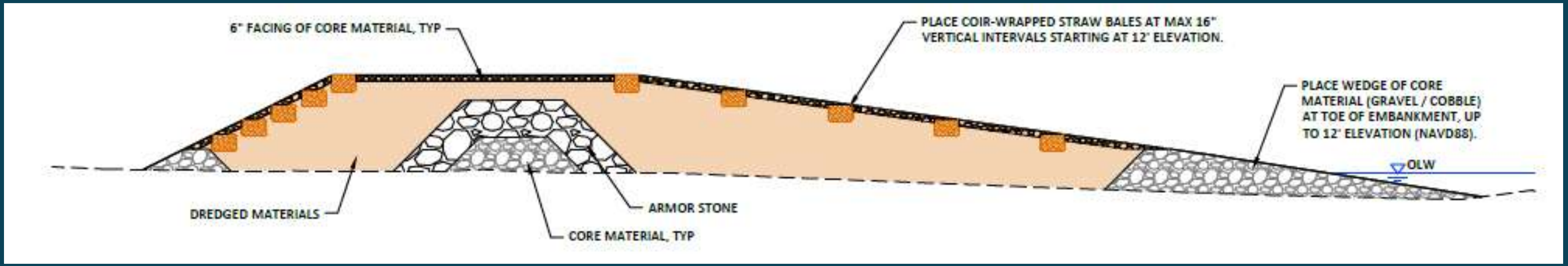
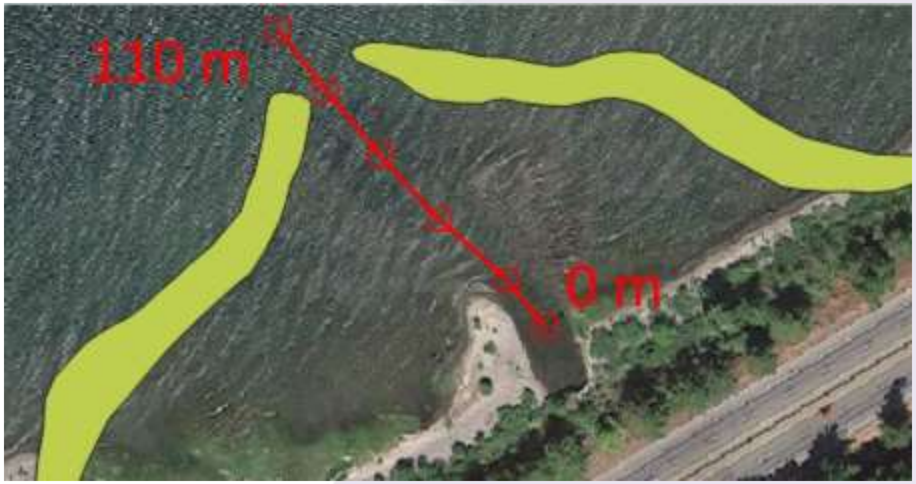
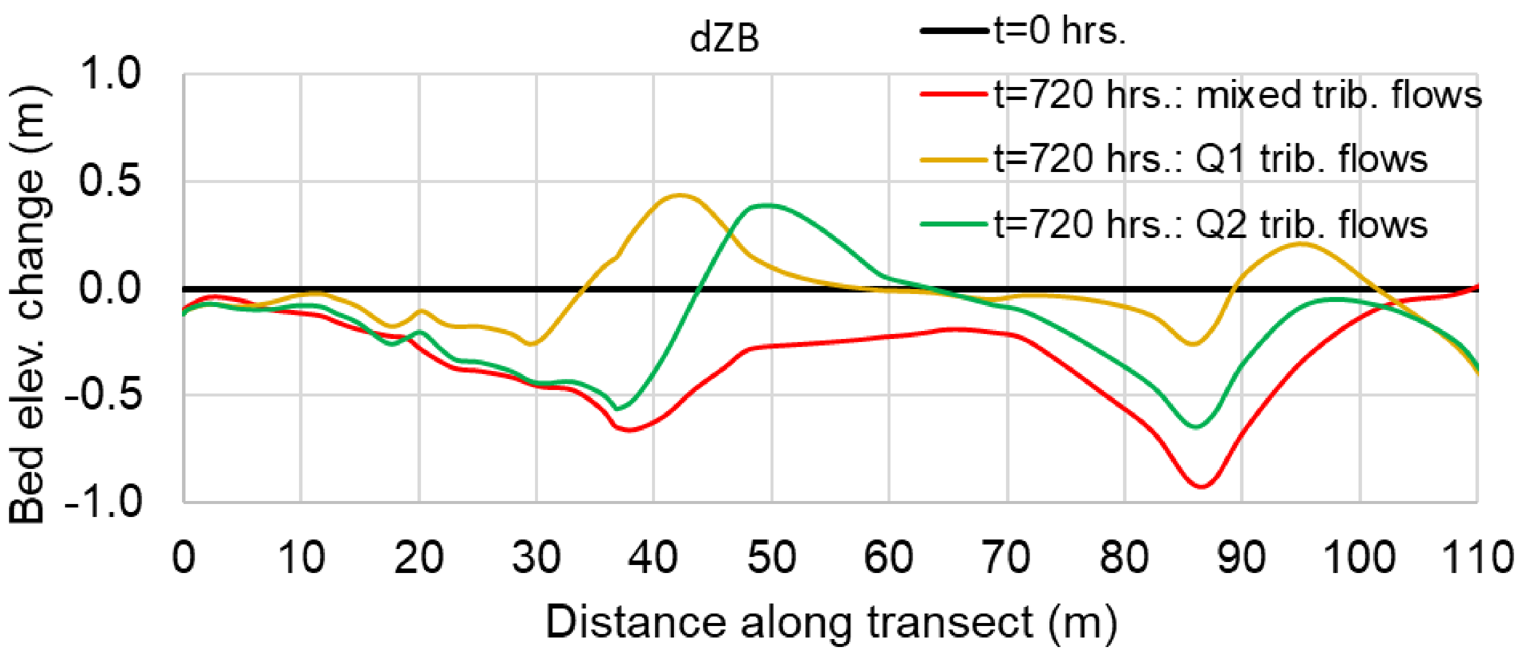
Embankment design





Flushing Results





STM Sediment Transport Simulations

- Conditions modeled:
  - Col R. floods
    Q_1, Q_2, Q_{10}, $Q_{100,}$
    extended freshet (7.mo.)
  - Tributary floods
    Q_1, Q_2, Q_{10}, Q_{100}
  - Combined

- run with defined sediment fractions
- run with unlimited sand in navigation channel and at upstream boundaries
- follow-up flushing simulations (high trib. flows, no sediment)

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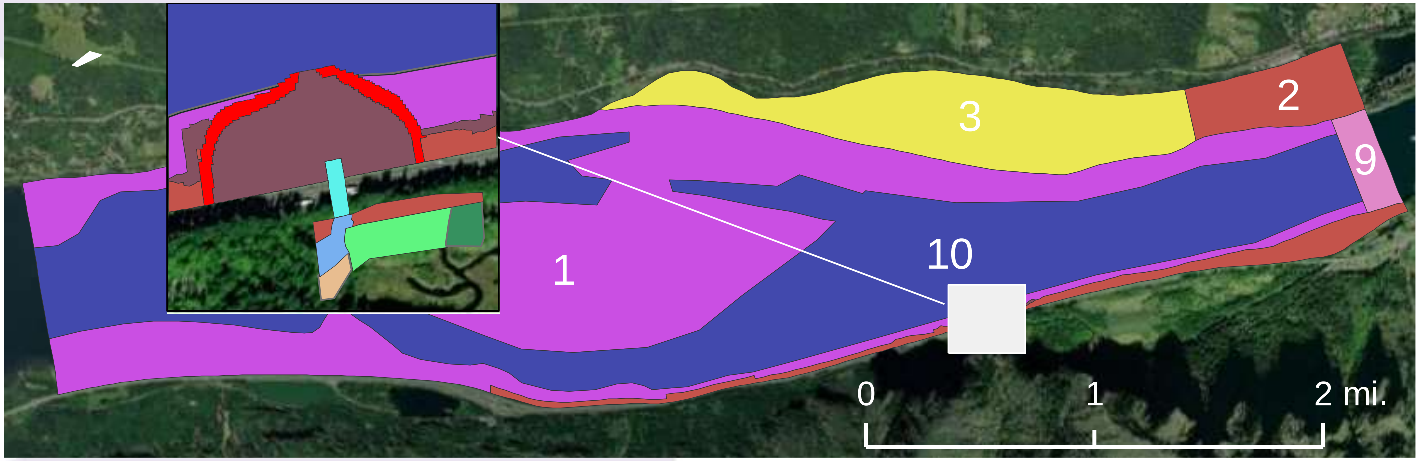
STM Setup

Defined material extents



Material 1 sediment composition by layer

Aggregate of pebble count results

*Sand classes based on range found in literature

Sediment Fraction	D50 (mm)	Layer 1 (surface)	Layer 2
*Sand F	0.2	40%	0%
*Sand C	1	40%	15%
Gravel F-C	10	10%	22%
Gravel VC	40	10%	23%
Cobble	100	0	40%
Rip-rap	600	0	0.0