Glen Canyon Slough: Proposed Habitat Improvements

Glen Canyon Dam

The rate and pattern of bed incision and bank adjustment on the Colorado River in Glen Canyon downstream from Glen Canyon Dam, 1956–2000

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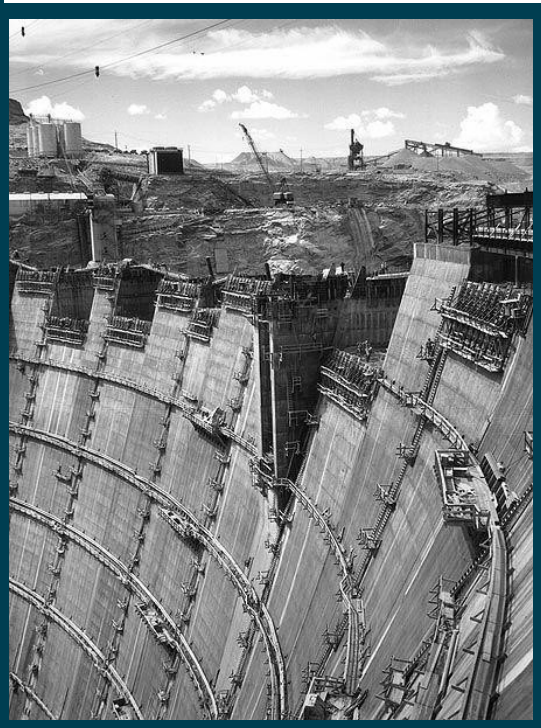
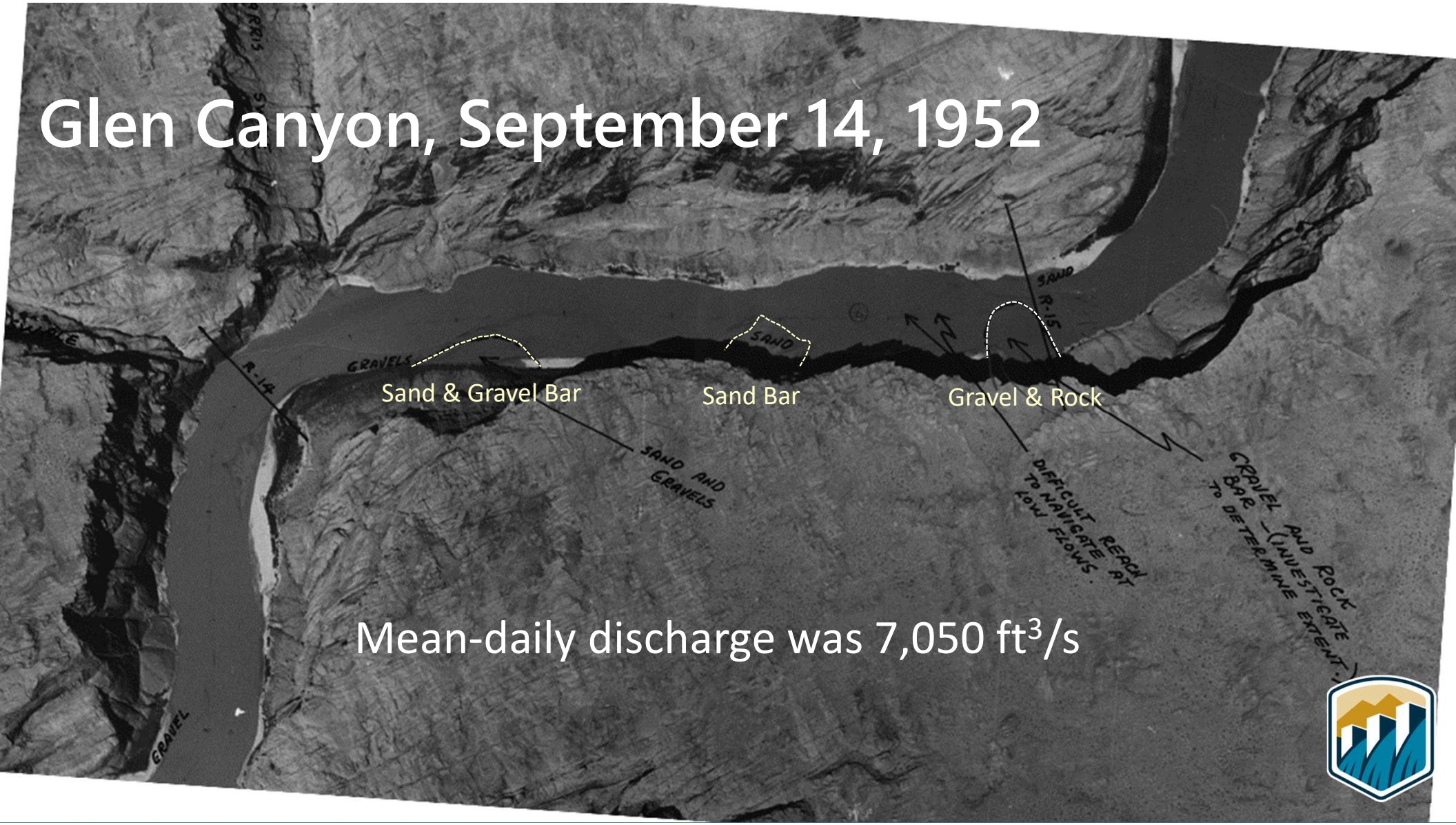


Changes in the timing and magnitudes of flow and reductions in sediment delivery have caused the channel to incise, armor, and narrow

Glen Canyon, September 14, 1952



Sand & Gravel Bar

Sand Bar

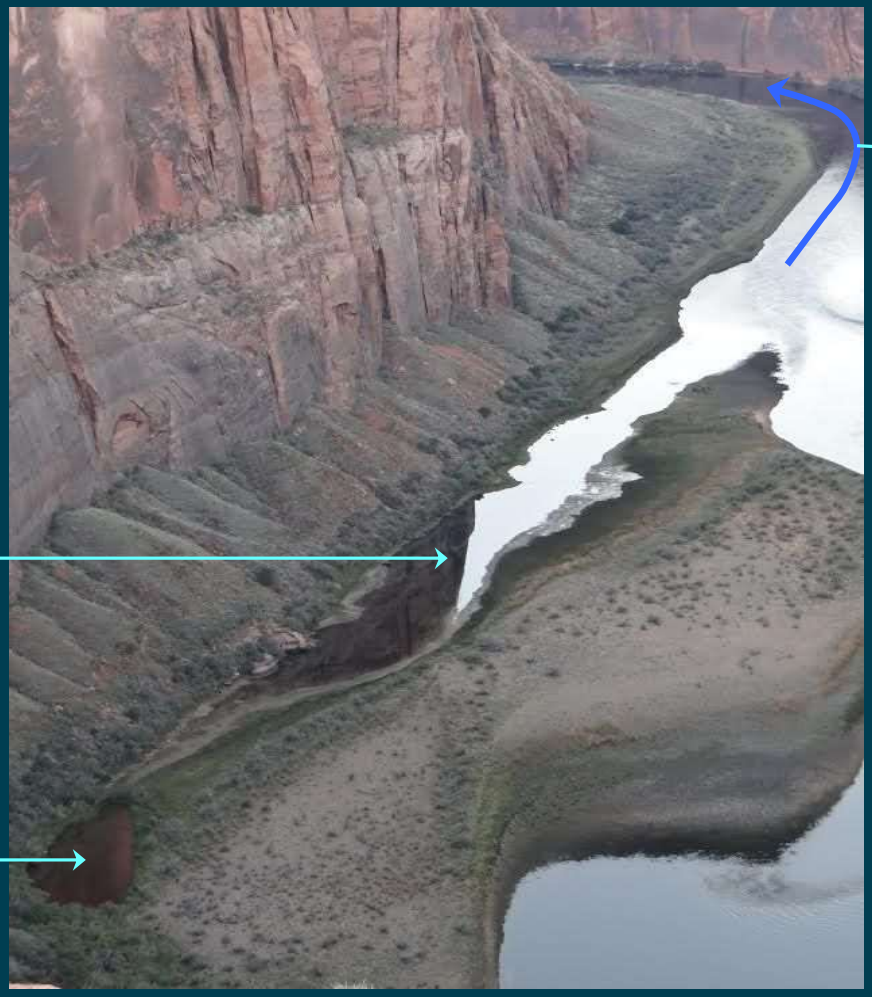
Gravel & Rock

Mean-daily discharge was 7,050 ft^3/s

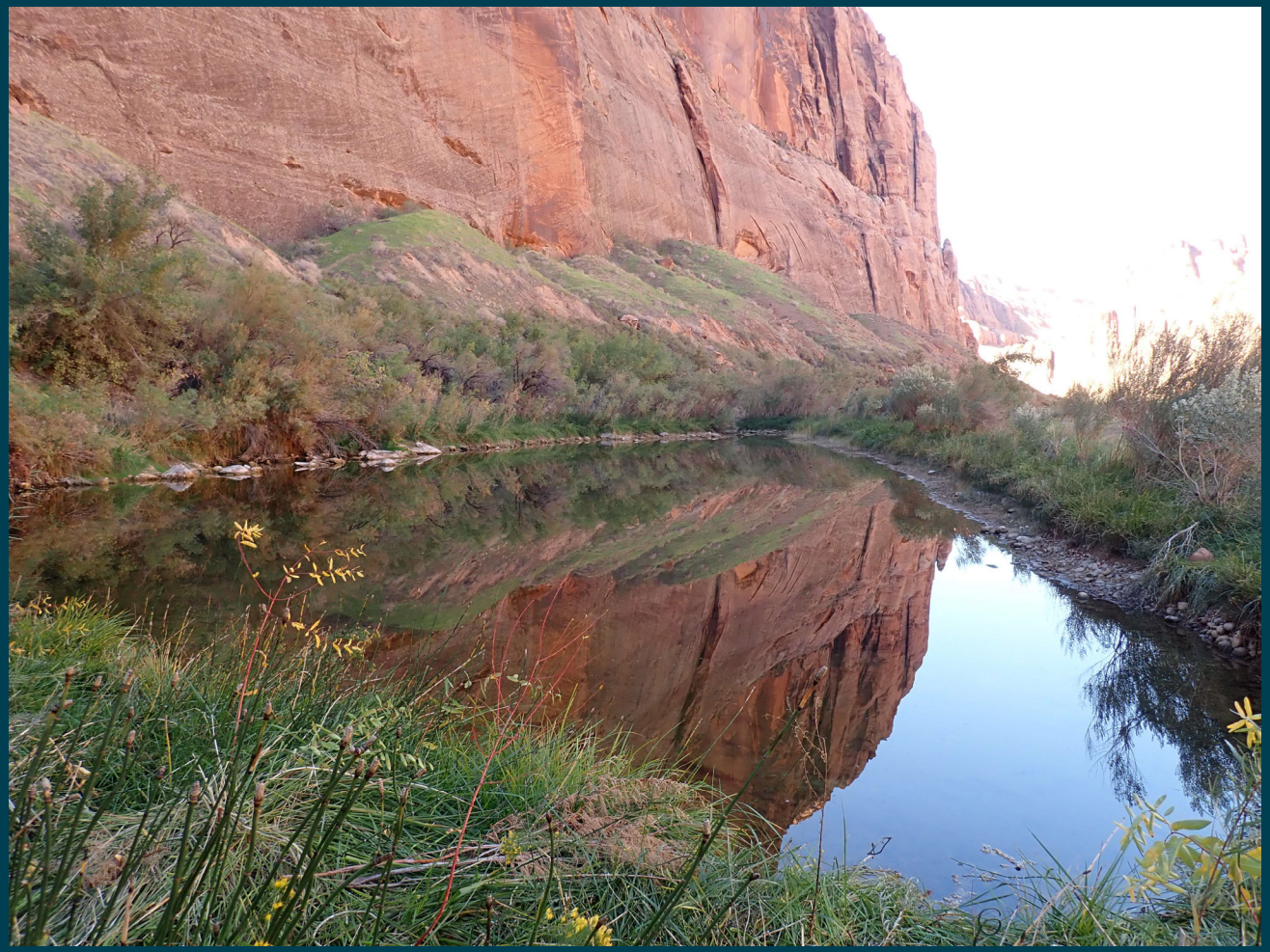
Glen Canyon, August 2, 2015

Discharge at 7:30 AM was 9,160 ft^3/s

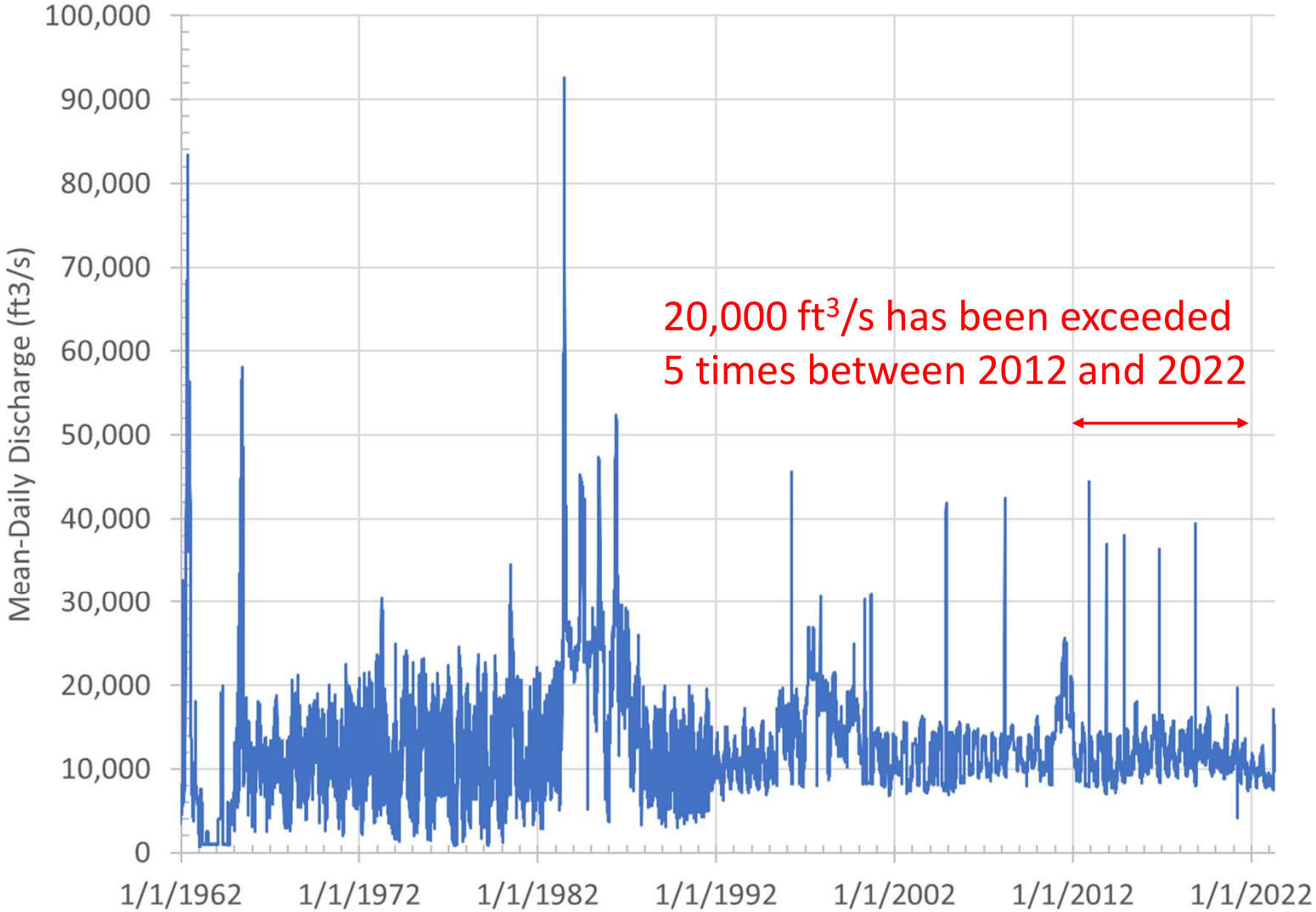
Glen Canyon Sloughs (looking downstream)



Glen Canyon Upper Slough

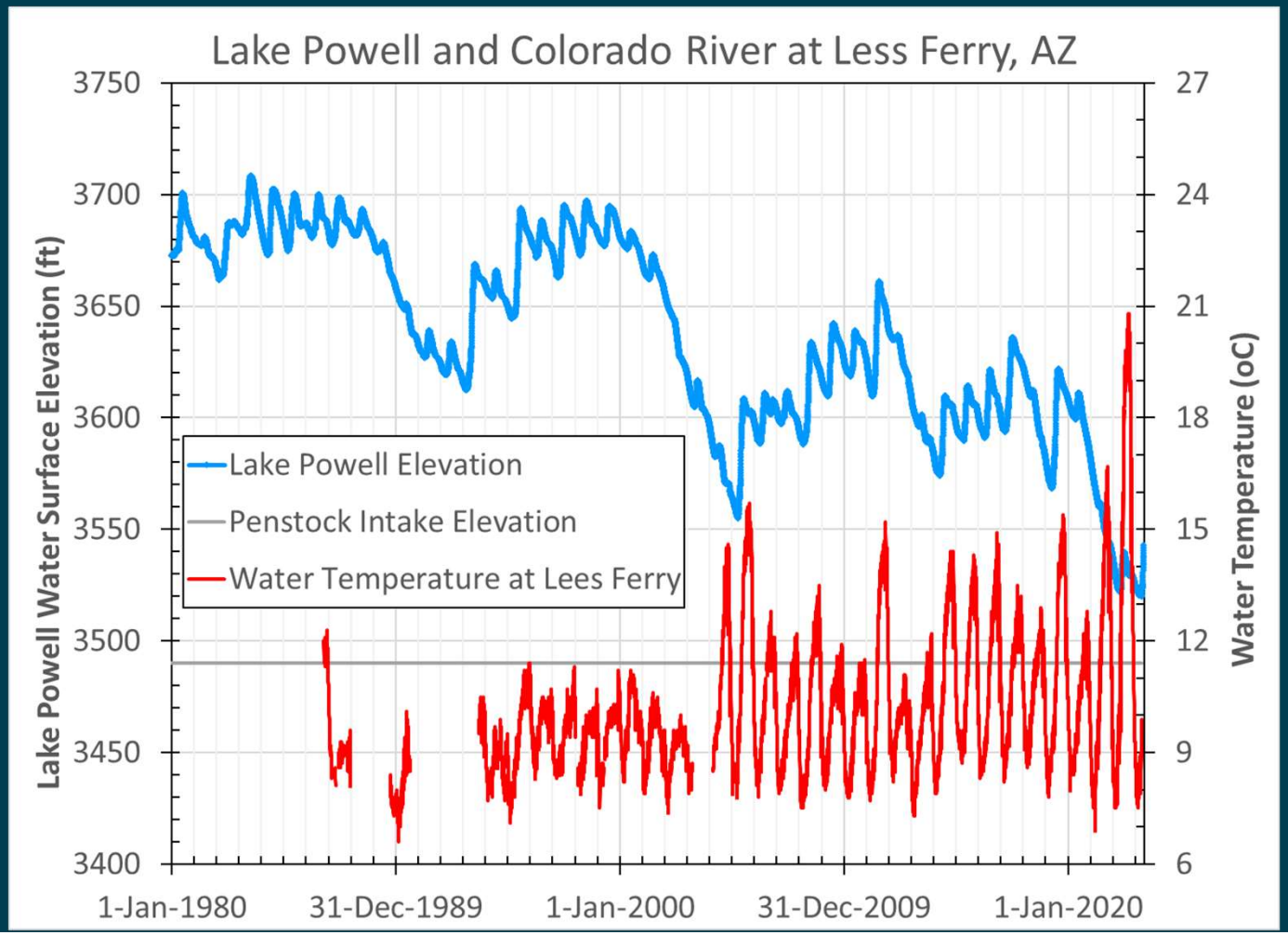


Glen Canyon Lower Slough


Colorado River Discharge at Lees Ferry, AZ
Mean-Daily Discharge (ft3/s)
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1/1/1962
1/1/1972
1/1/1982
1/1/1992
1/1/2002
1/1/2012
1/1/2022
20,000 ft³/s has been exceeded
5 times between 2012 and 2022

Glen Canyon Slough Armoring

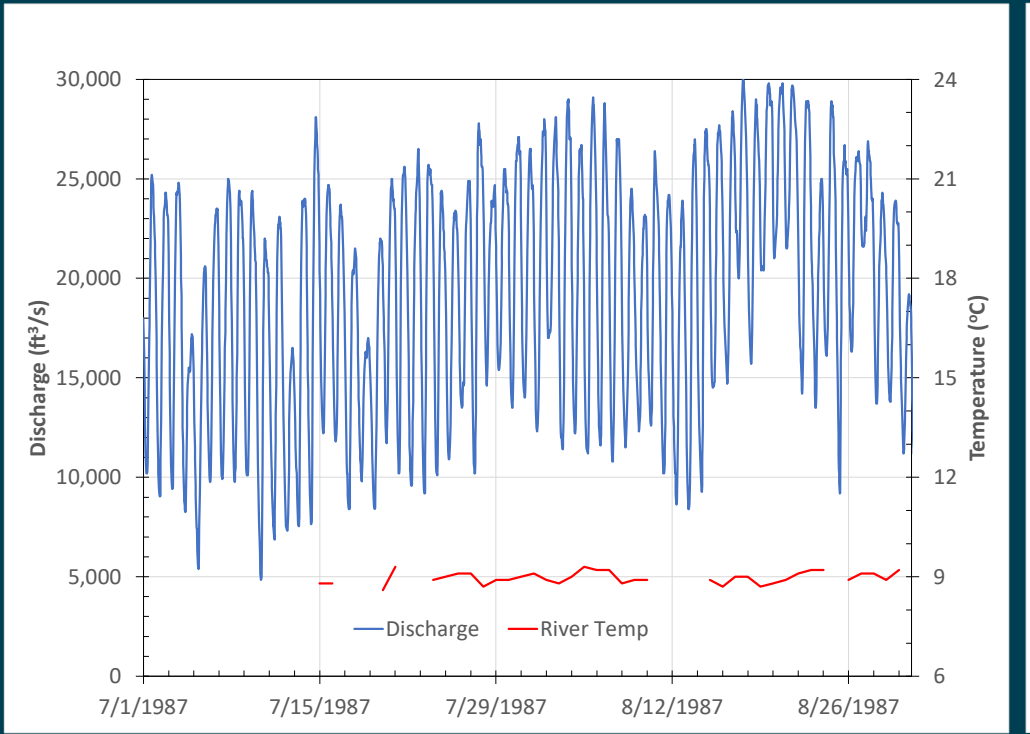
Historic Lake Powell levels and river temperatures



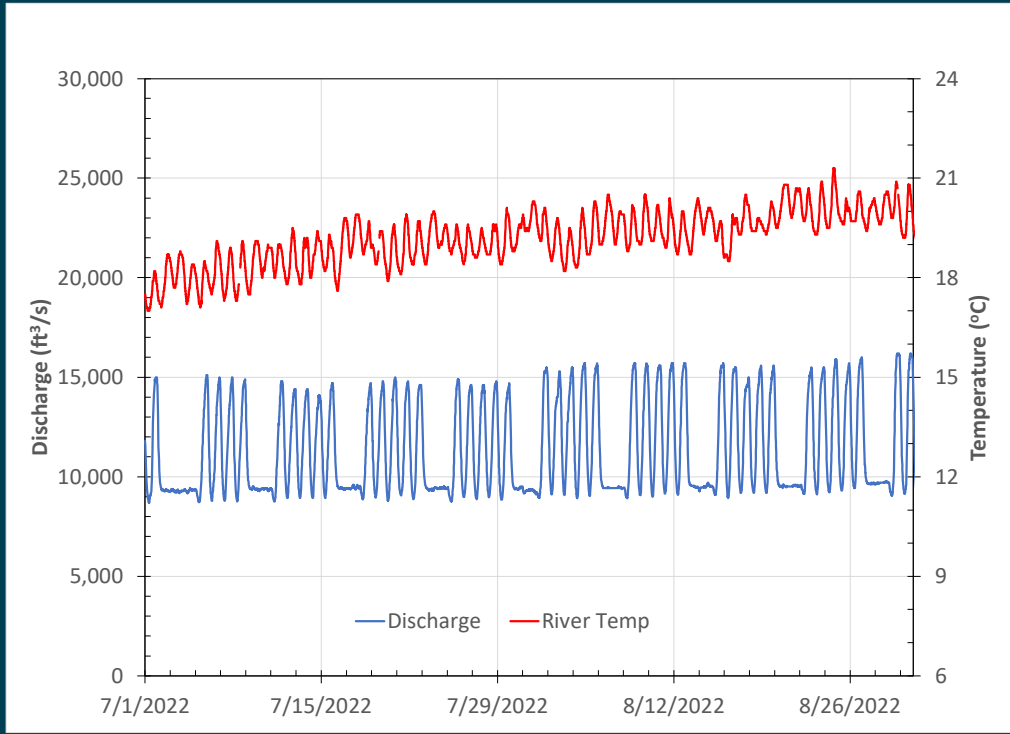
Water depths to the dam outlet decreased as reservoir elevations declined and the temperature of water discharge increased

Comparison of summer discharge and river water temperature variations for 1987 & 2023

July & August 1987

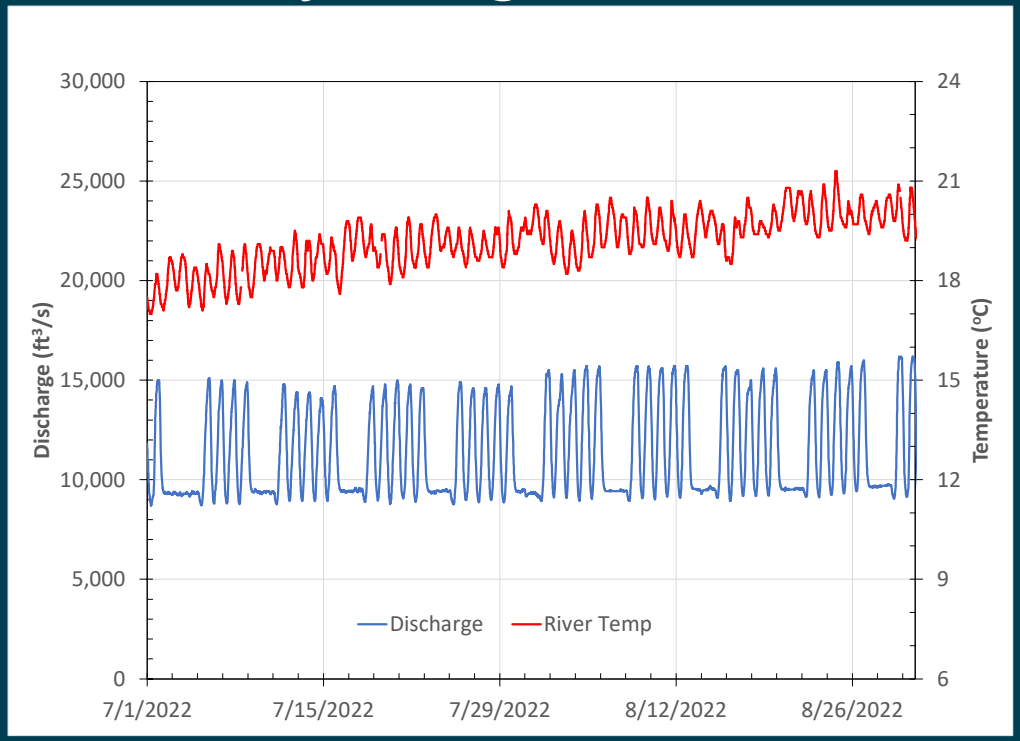


July & August 2022

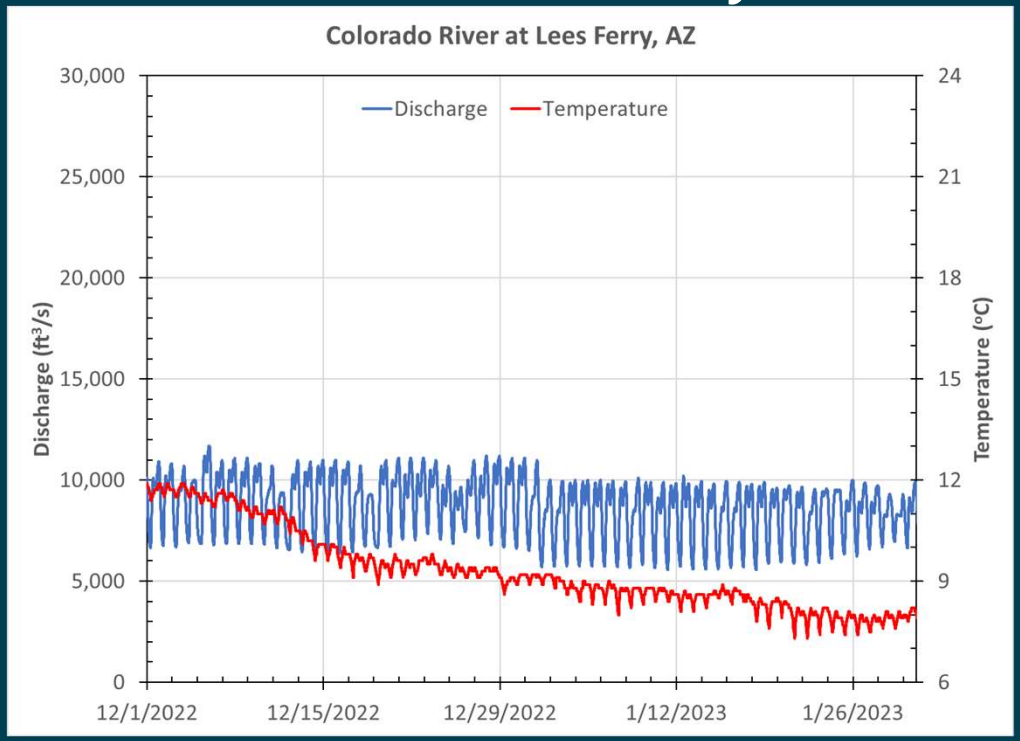


Comparison of discharge & river water temperature variations for summer 2022 & winter 2023

July & August 2022

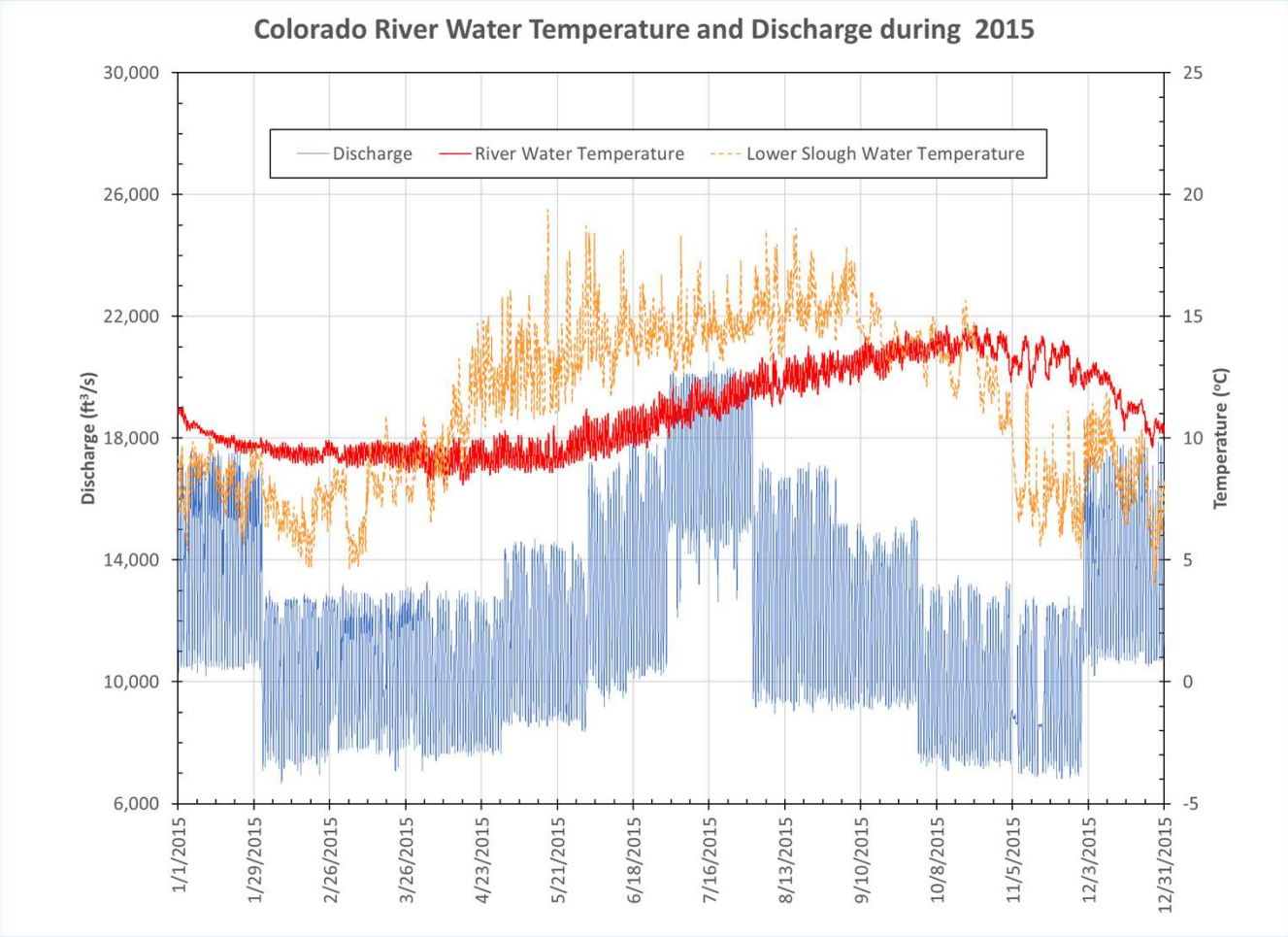


December 2022 & January 2023



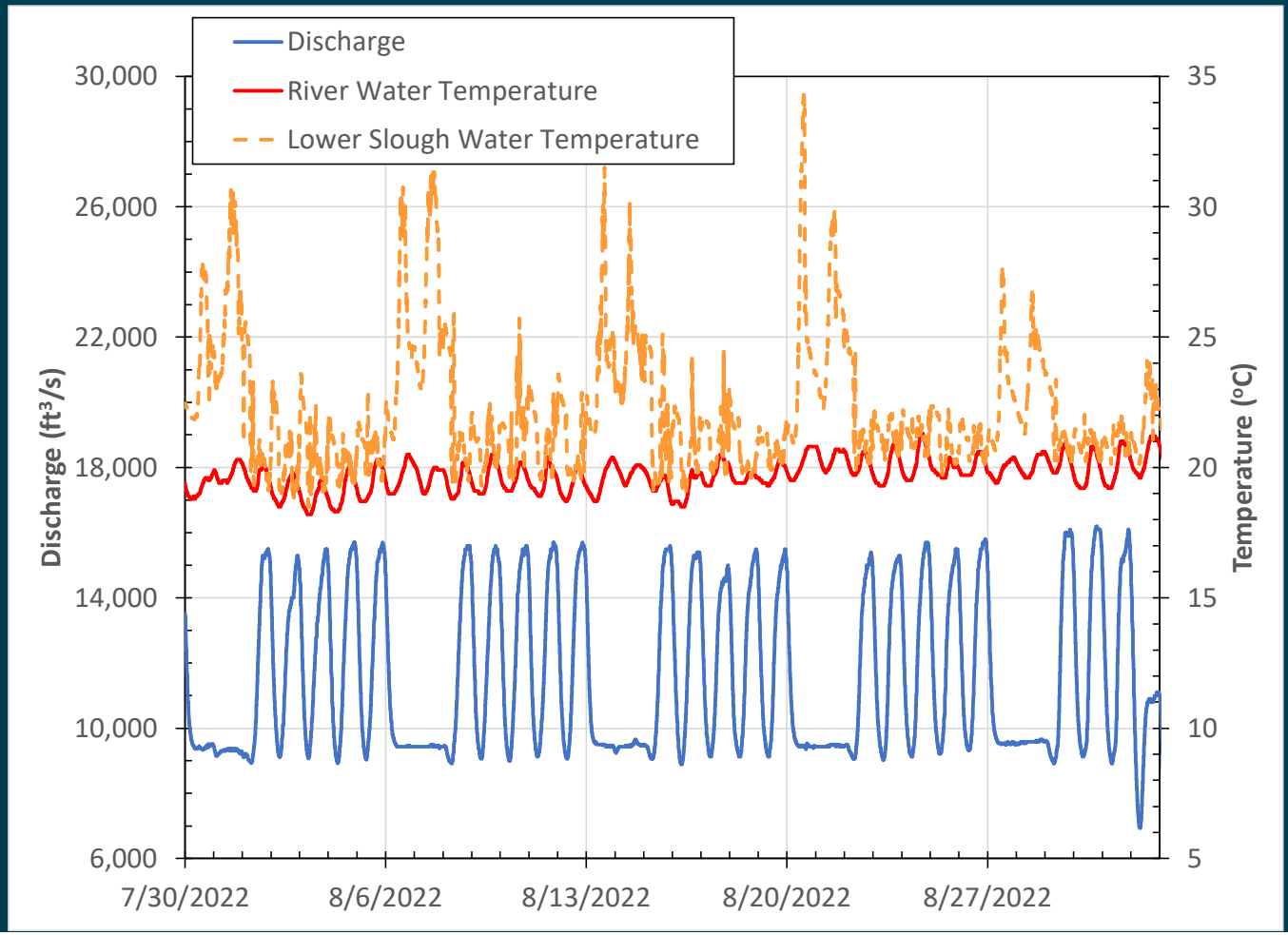
2015 discharge and water temperature Variations

Seasonal and daily discharge and water temperature variations of the Colorado River and Glen Canyon sloughs



Summer 2022 discharge and water temperature variations

Substantial diurnal fluctuation in slough temperatures

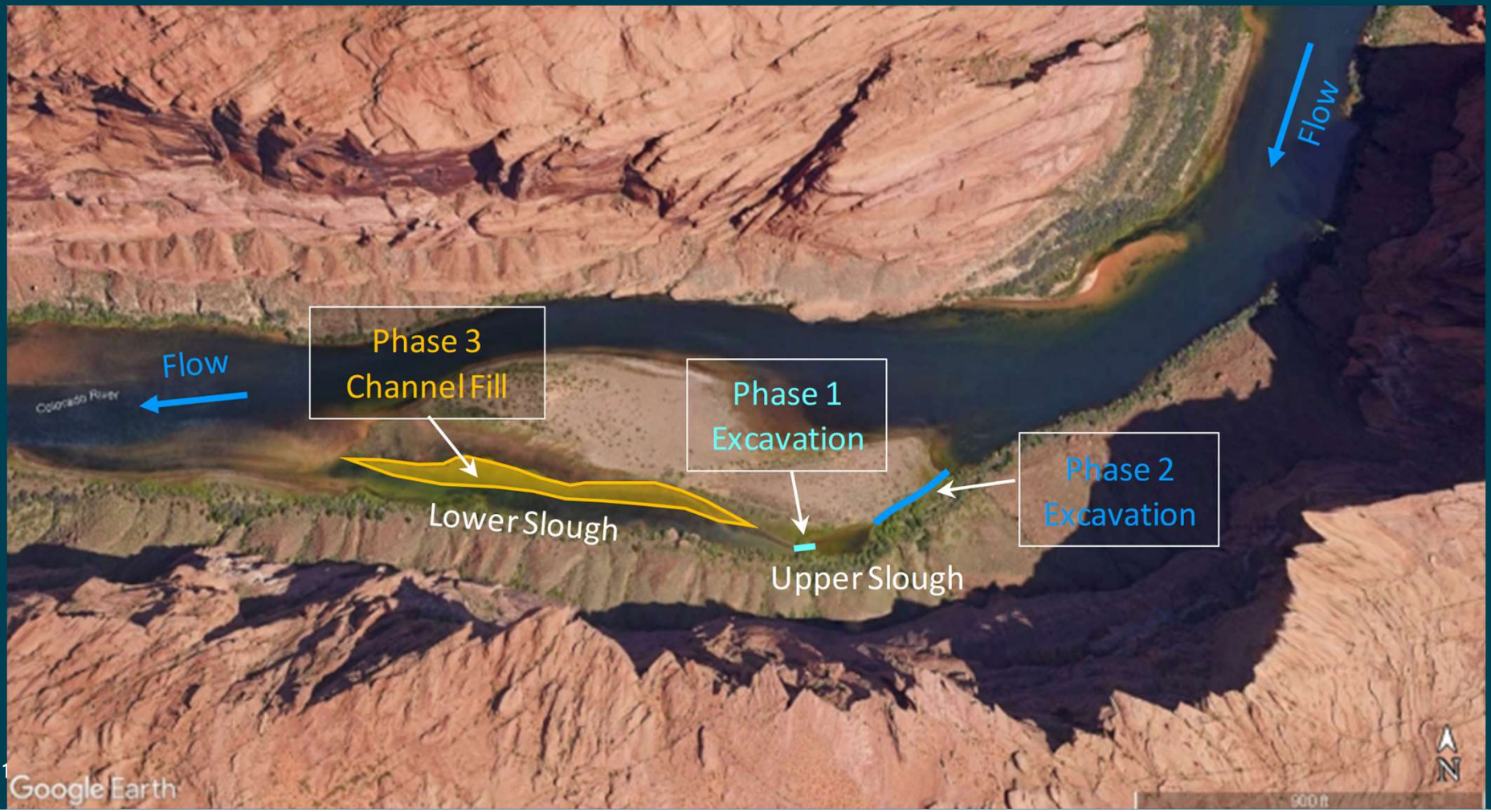


Slough Alternatives from Greimann and Sixta (2018)

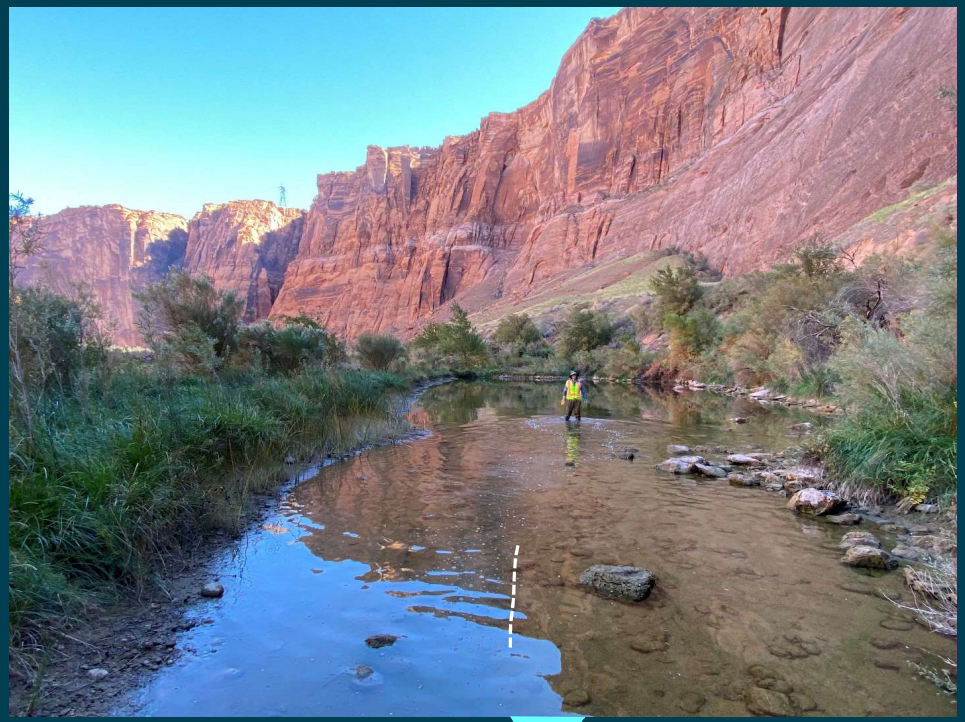
Focused on eliminating the warm-water habitats favorable to the non-natives

Alternative	Description
1.1	Deep channel excavation from the main channel to the Upper Slough, without filling Upper Slough
1.2	Shallow channel excavation from the main stem to the Upper Slough, with filling the Upper Slough
2	Install pipe or culvert to connect flow from river to Upper Slough
3	Continually pump cold river water into Upper Slough
4	Periodically pump warm water out of Upper Slough
5	Install permanent fish barrier between Upper and Lower Sloughs
6.1	Excavate channel between Upper and Lower Sloughs
6.2	Excavate channel between Upper and Lower Sloughs with water control weir
7	Fill-in Upper Slough

New Slough Alternative [2023]



Phase 1: Partially drain upper slough

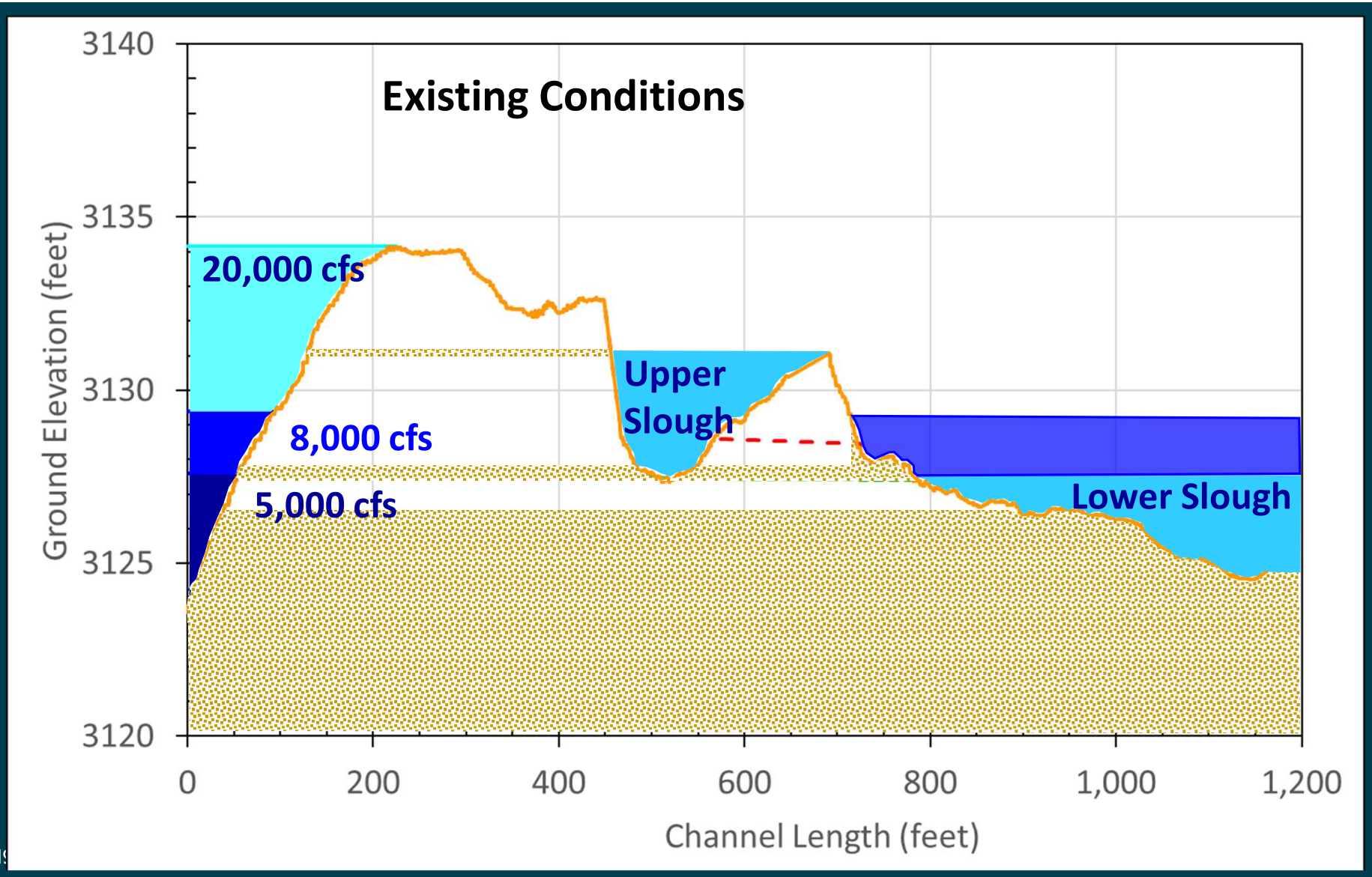


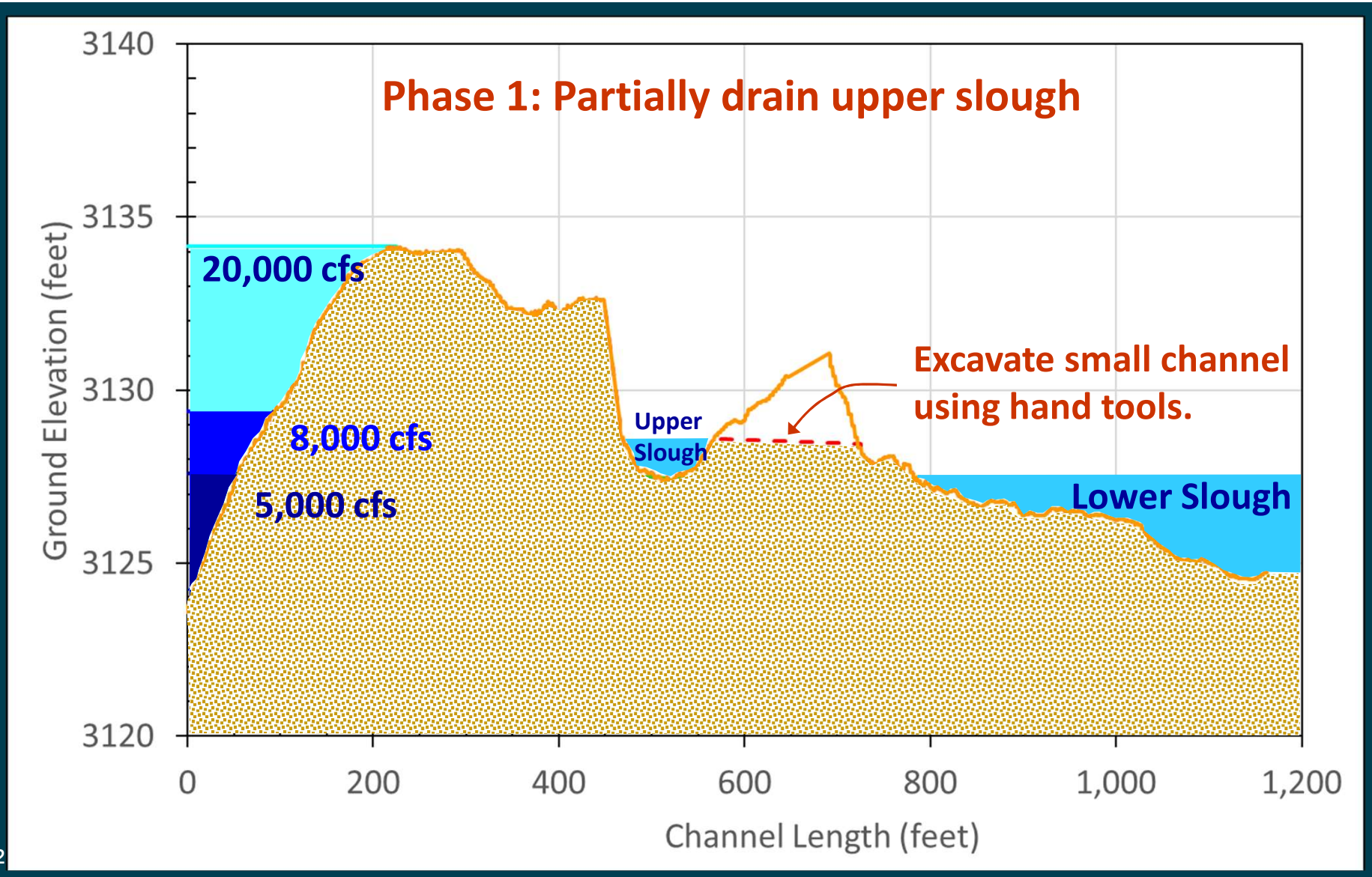
- Excavation of 2-foot-wide channel by manual labor using picks, shovels, and pry bars
- 160-foot-long channel

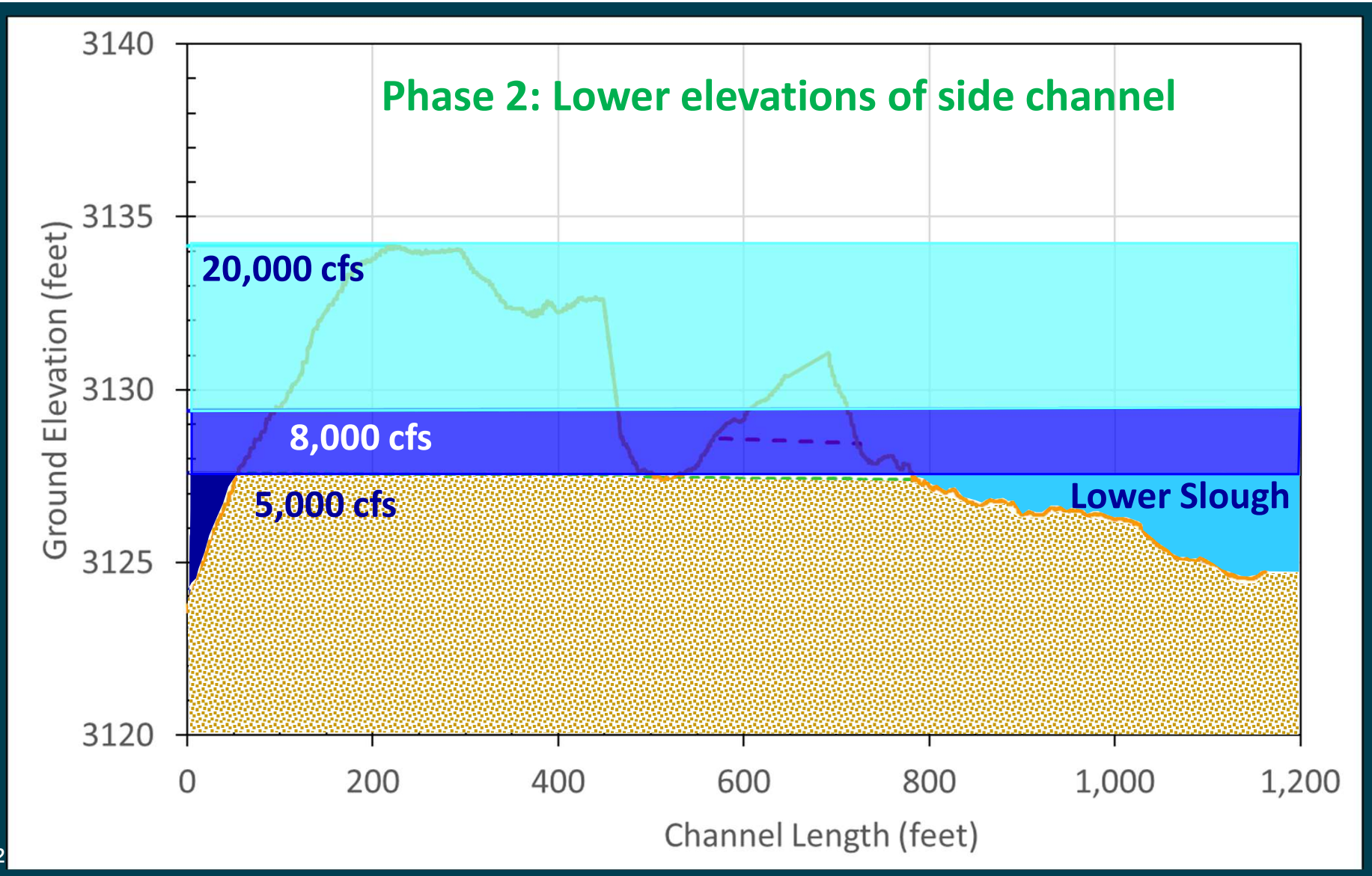
- Excavation depths: 0.1 to 2.5 ft
- Excavation volume: 65 yd^3

Phase 2: Lower elevations of side channel

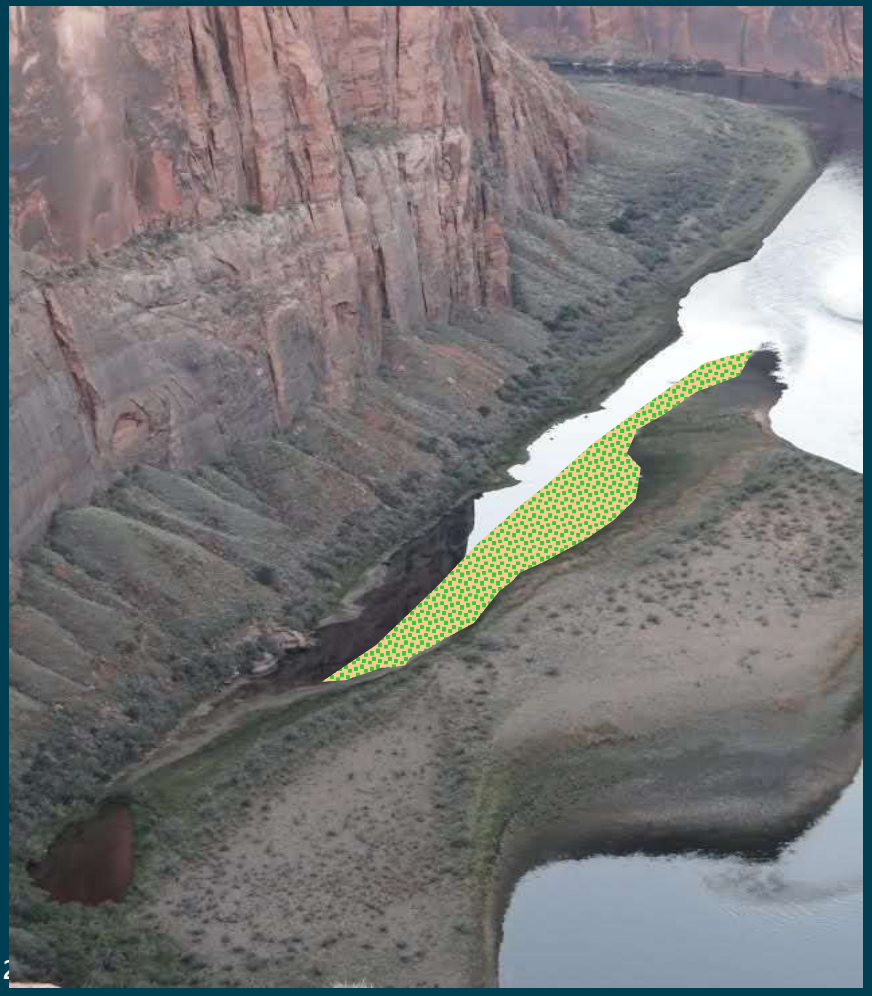
- Using small mechanized equipment, excavate a lower side channel 730-feet long, at depths of 0.1 to 6.5 feet, top widths of 2 to 28 feet
- Excavate 1,300 yd^3 of sand, gravel, cobble and place in upper slough


Existing Conditions
20,000 cfs
8,000 cfs
5,000 cfs
Upper Slough
Lower Slough
Ground Elevation (feet)
3140
3135
3130
3125
3120
0
200
400
600
800
1,000
1,200
Channel Length (feet)

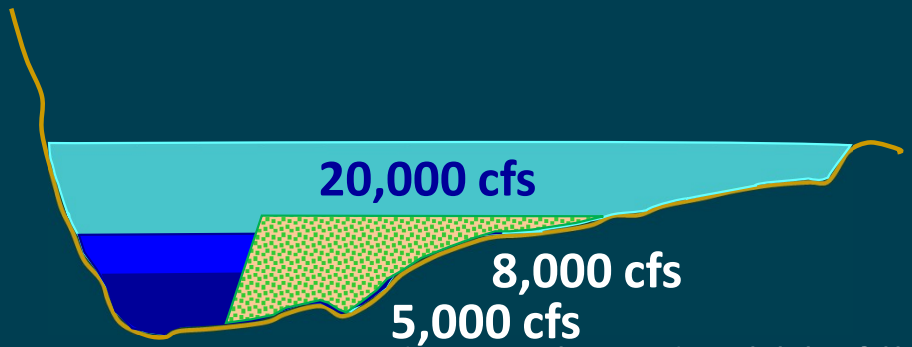

Phase 1: Partially drain upper slough
20,000 cfs
8,000 cfs
5,000 cfs
Upper Slough
Excavate small channel using hand tools.
Lower Slough
Ground Elevation (feet)
3140
3135
3130
3125
3120
0
200
400
600
800
1,000
1,200
Channel Length (feet)


Phase 2: Lower elevations of side channel
20,000 cfs
8,000 cfs
5,000 cfs
Lower Slough
Ground Elevation (feet)
3140
3135
3130
3125
3120
0
200
400
600
800
1,000
1,200
Channel Length (feet)

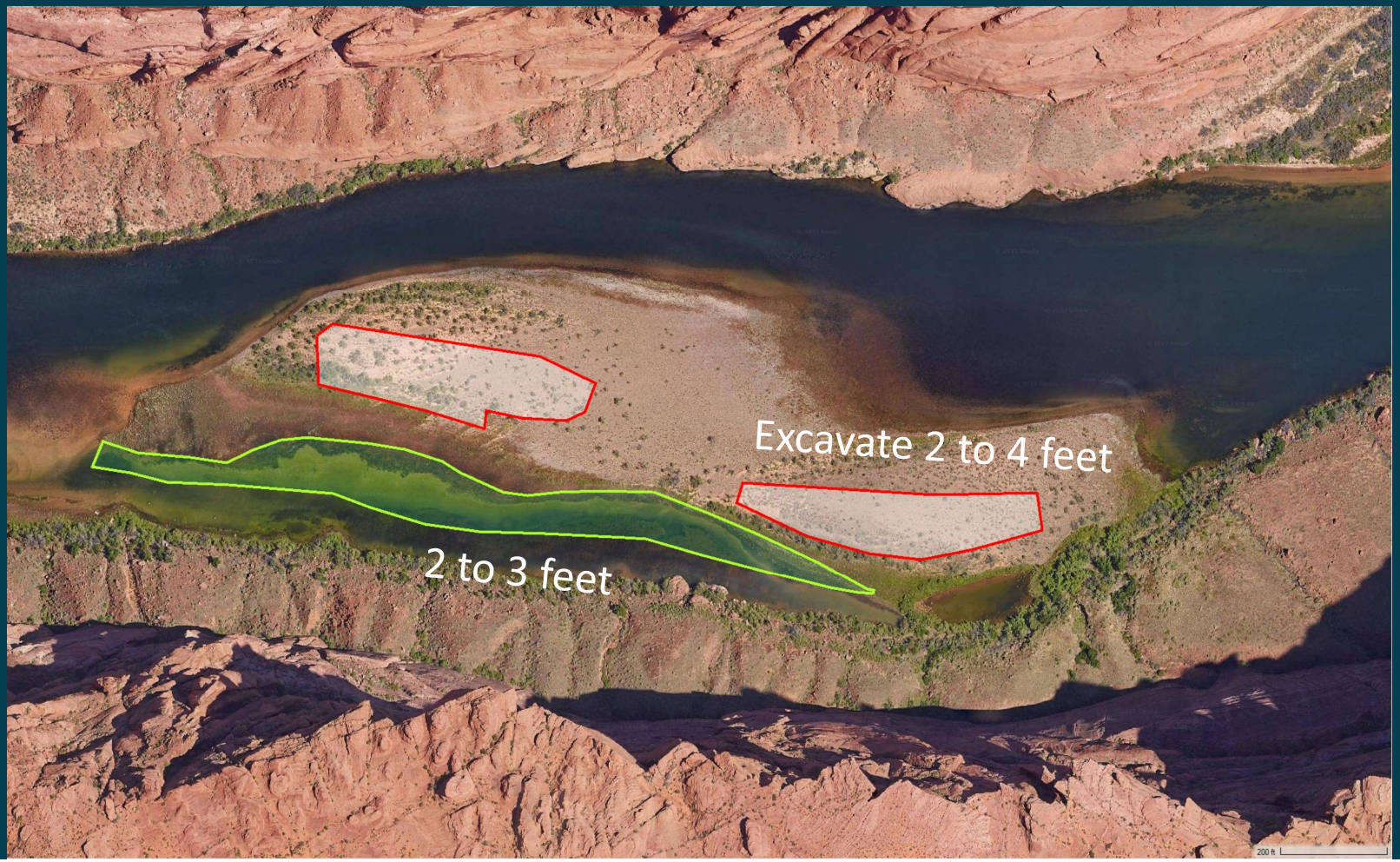
Phase 3: Narrow width of lower slough



- Narrow slough to width of 80 feet
- Place sand, gravel, and cobble along right bank of slough using small mechanized equipment
- Fill volume of 8,500 yd^3 with depths of 2 to 3 ft



Excavation and fill areas



Phases 2 & 3 Small Mechanized Equipment

Compact mini excavator

16.7 ft long, 6.1 ft wide,
8.3 ft high, 4.9 tons

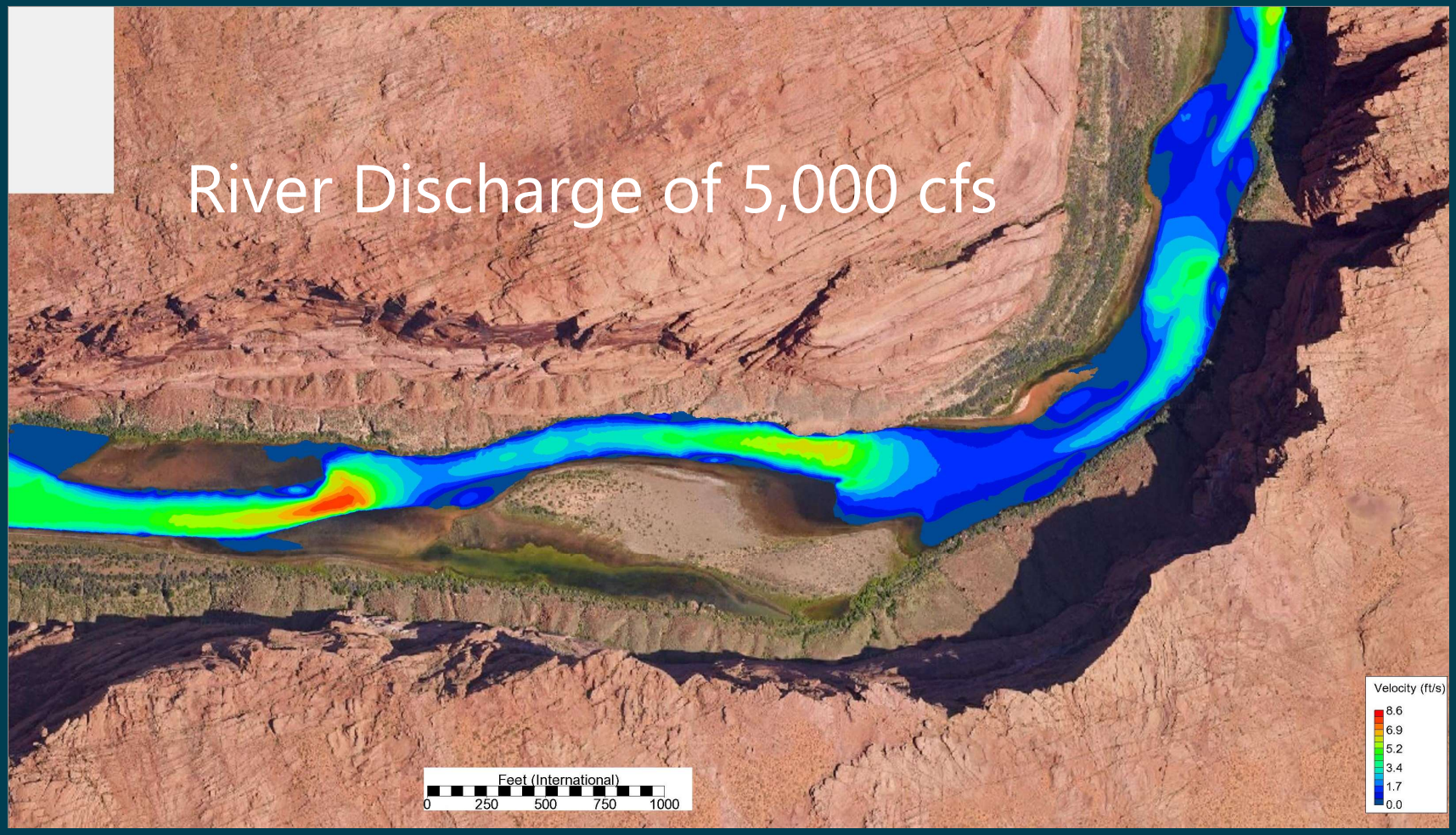
Compact Track Loader

11.8 ft long, 6.5 ft wide,
6.8 ft high, 5.3 tons

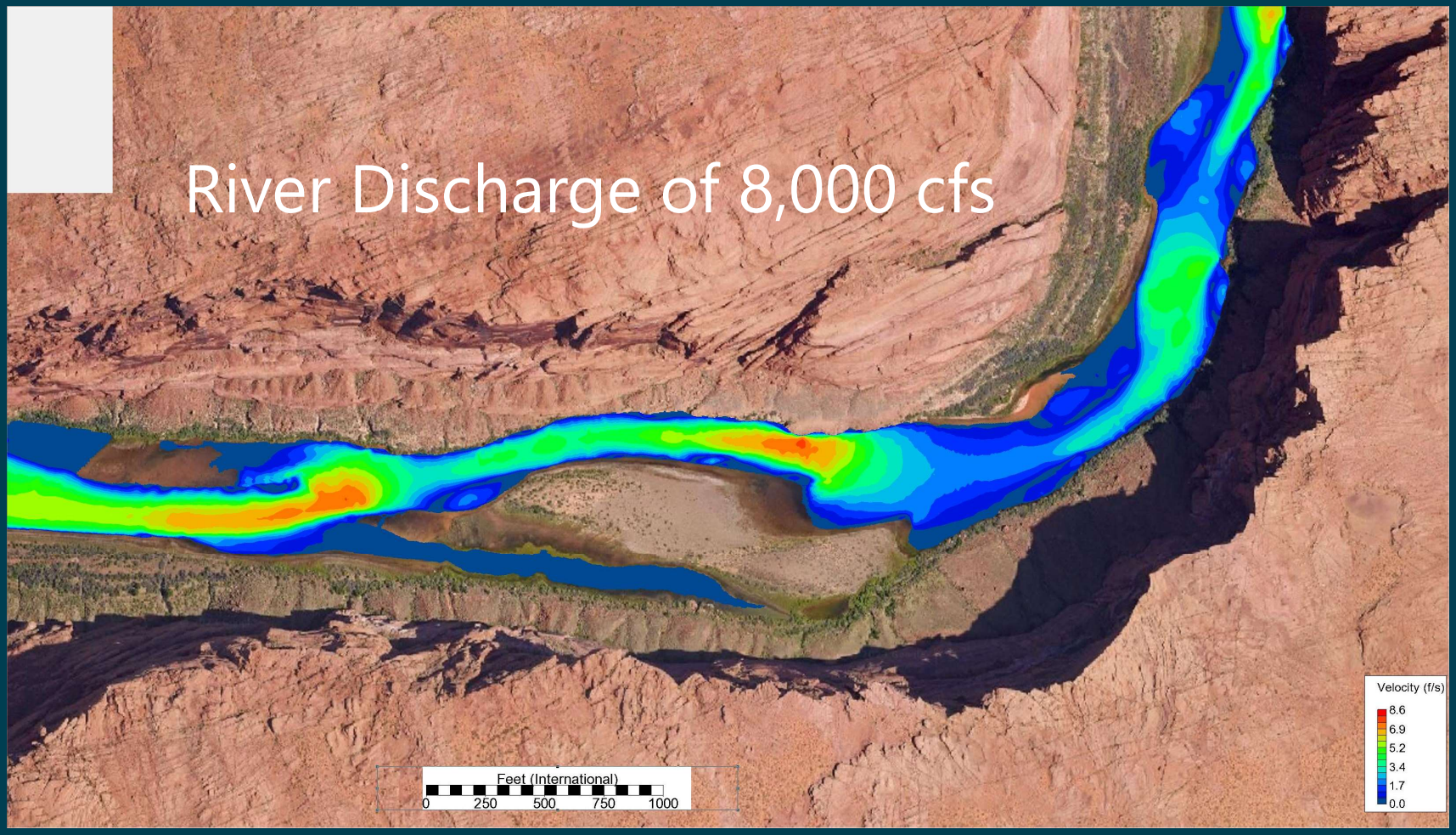
Project Implementation (draft estimates)

Phase	Activity	Crew Size	Duration (days)	Cost
1	Channel excavation, using hand tools	6	5	$
	Optional planting of floodplain vegetation	6	5	$
2	Mobilization of equipment		4	$$
	Excavation using small mechanical equipment	4	7	$$
	Planting of floodplain vegetation	6	10	$$
3	Placement of sand, gravel, & cobbles to narrow the slower slough using small mechanical equipment	4	32	$$
	Planting of floodplain vegetation	6	30	$$
	Demobilization of equipment		4	$$

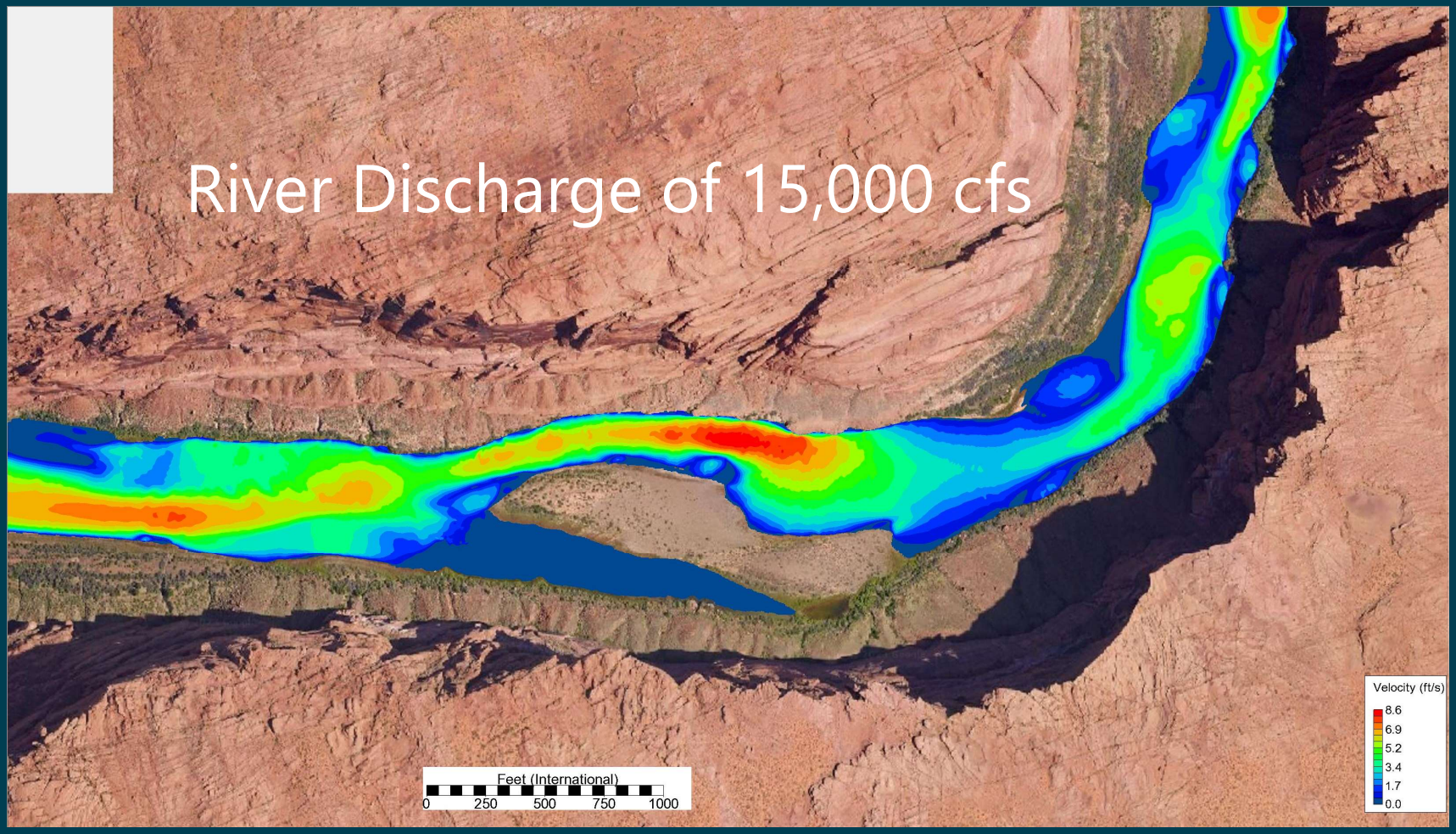
Velocity Results: Existing Conditions



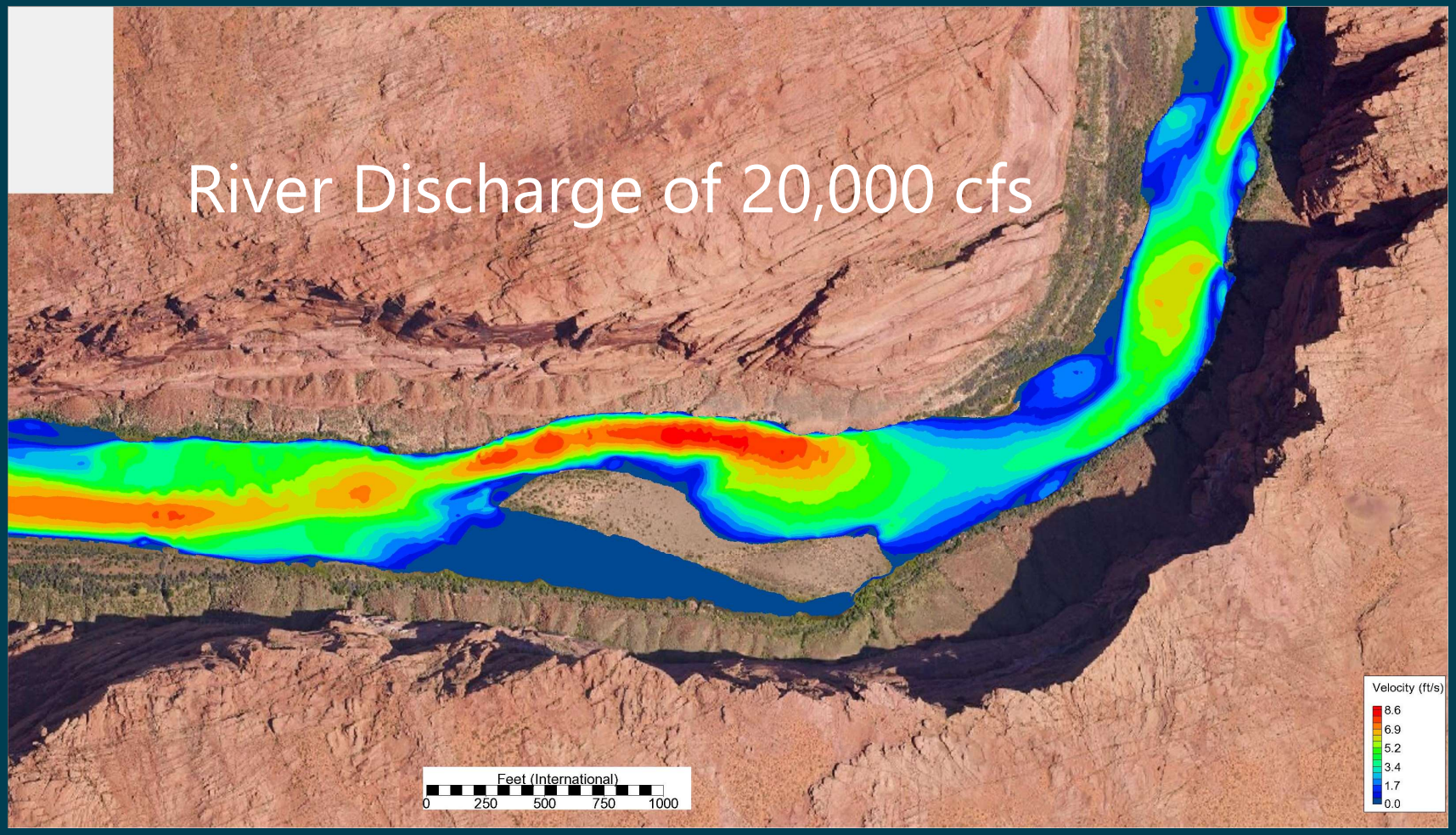
Velocity Results: Existing Conditions



Velocity Results: Existing Conditions



Velocity Results: Existing Conditions

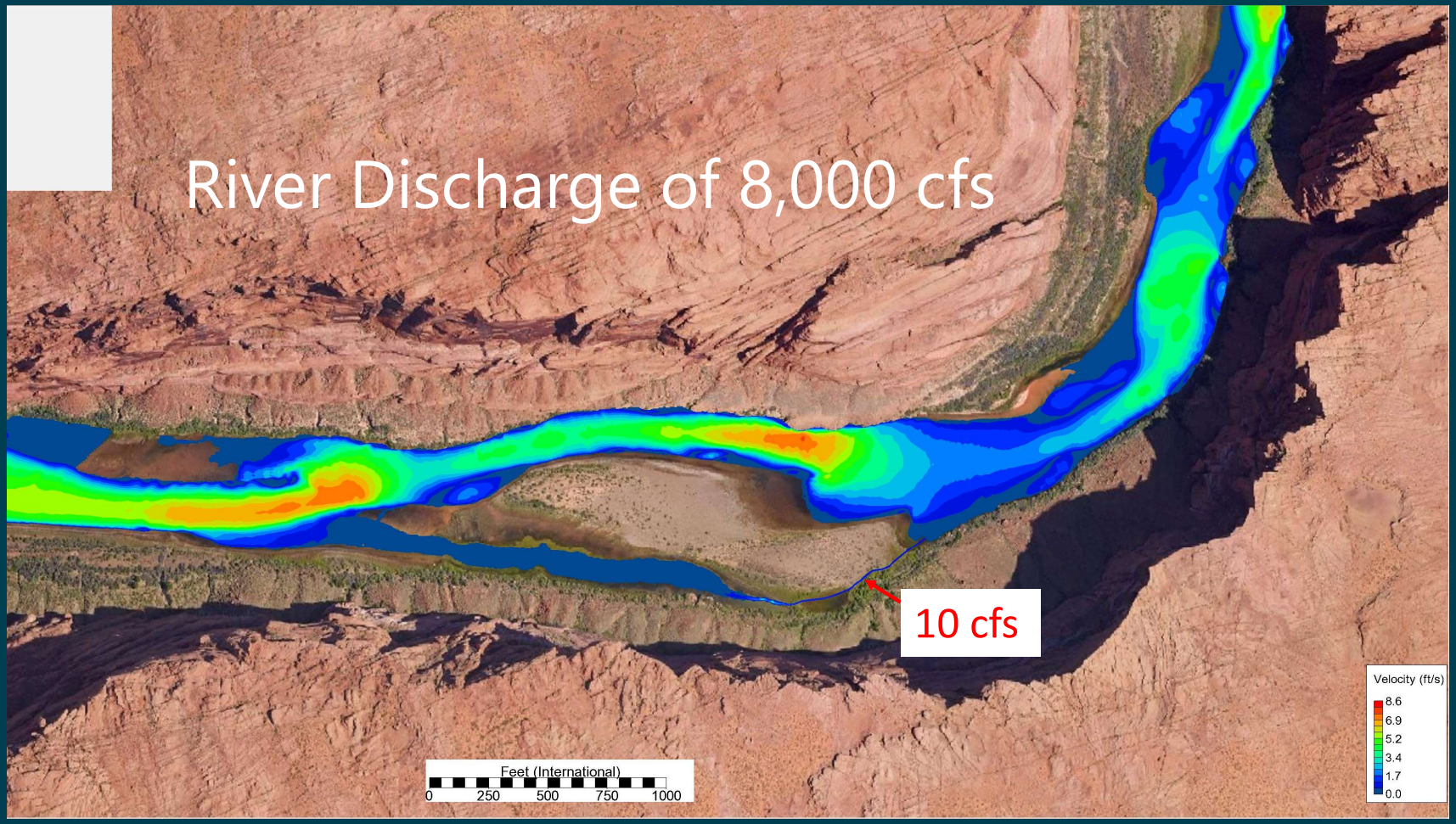


Proposed Phase 1 conditions with a partially drained upper slough

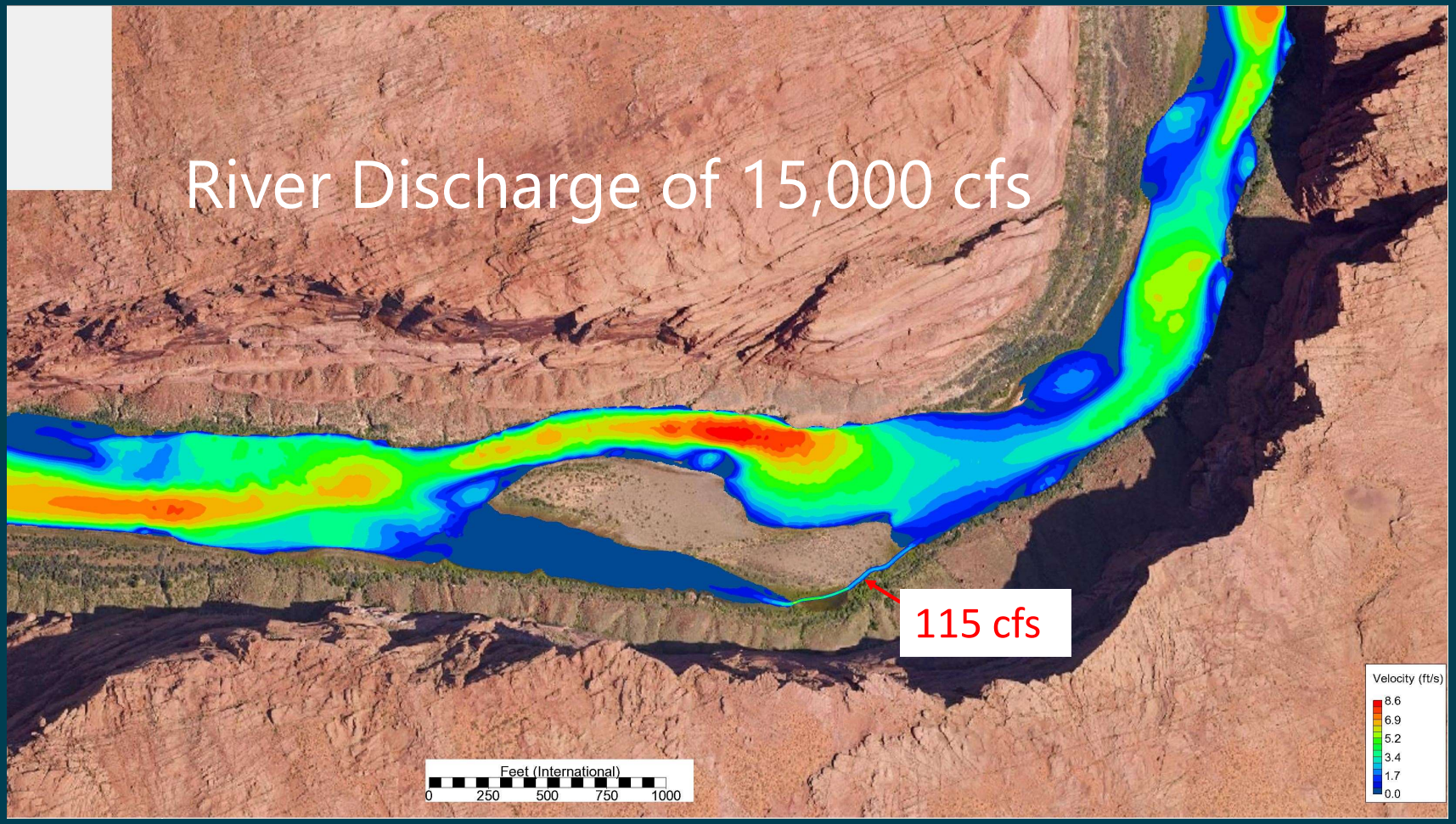
Wetted surface areas:

- Existing conditions 0.3 acres
- Phase 1 conditions 0.1 acres

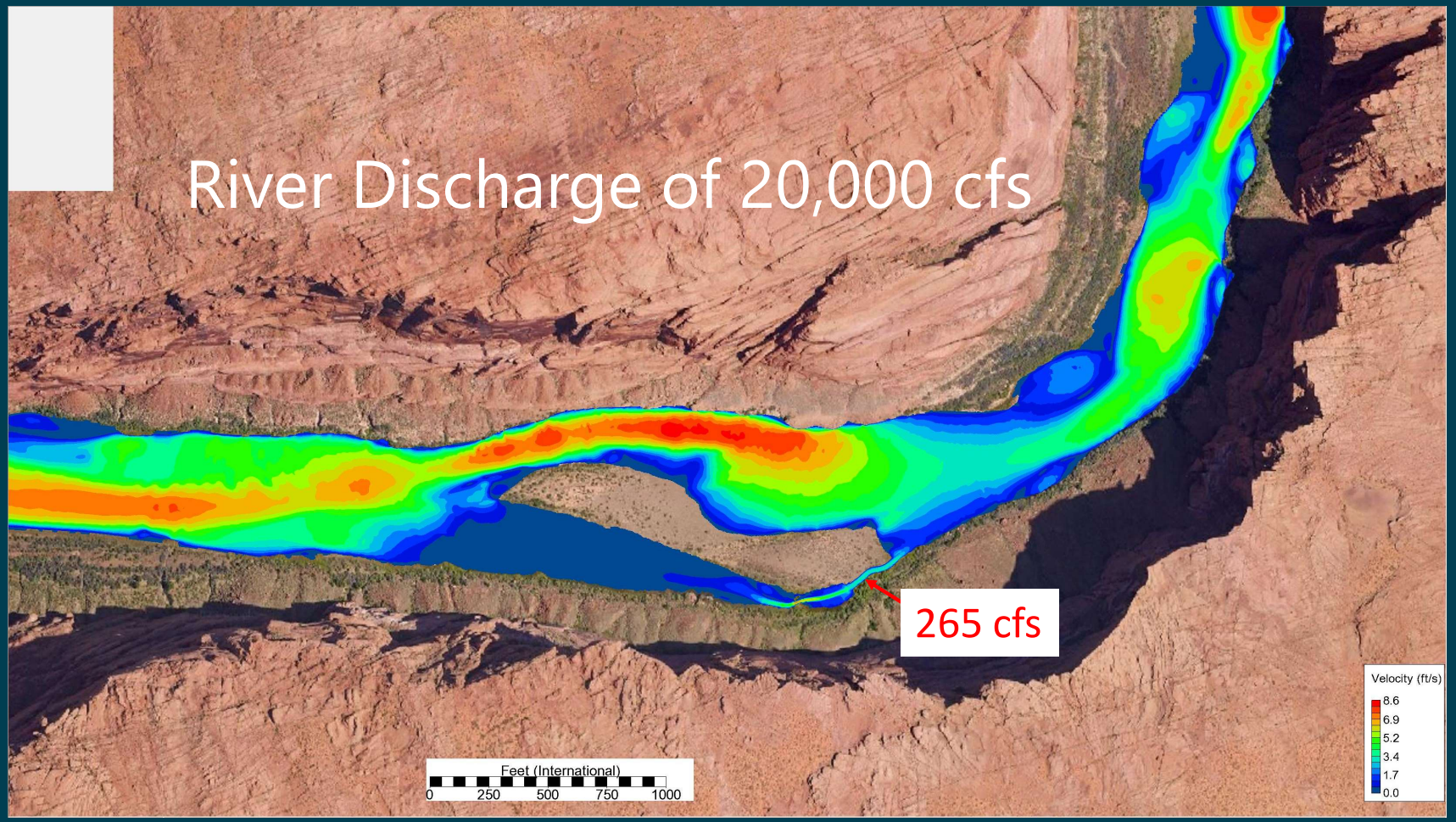
Velocity Results: Proposed Conditions Phase 2



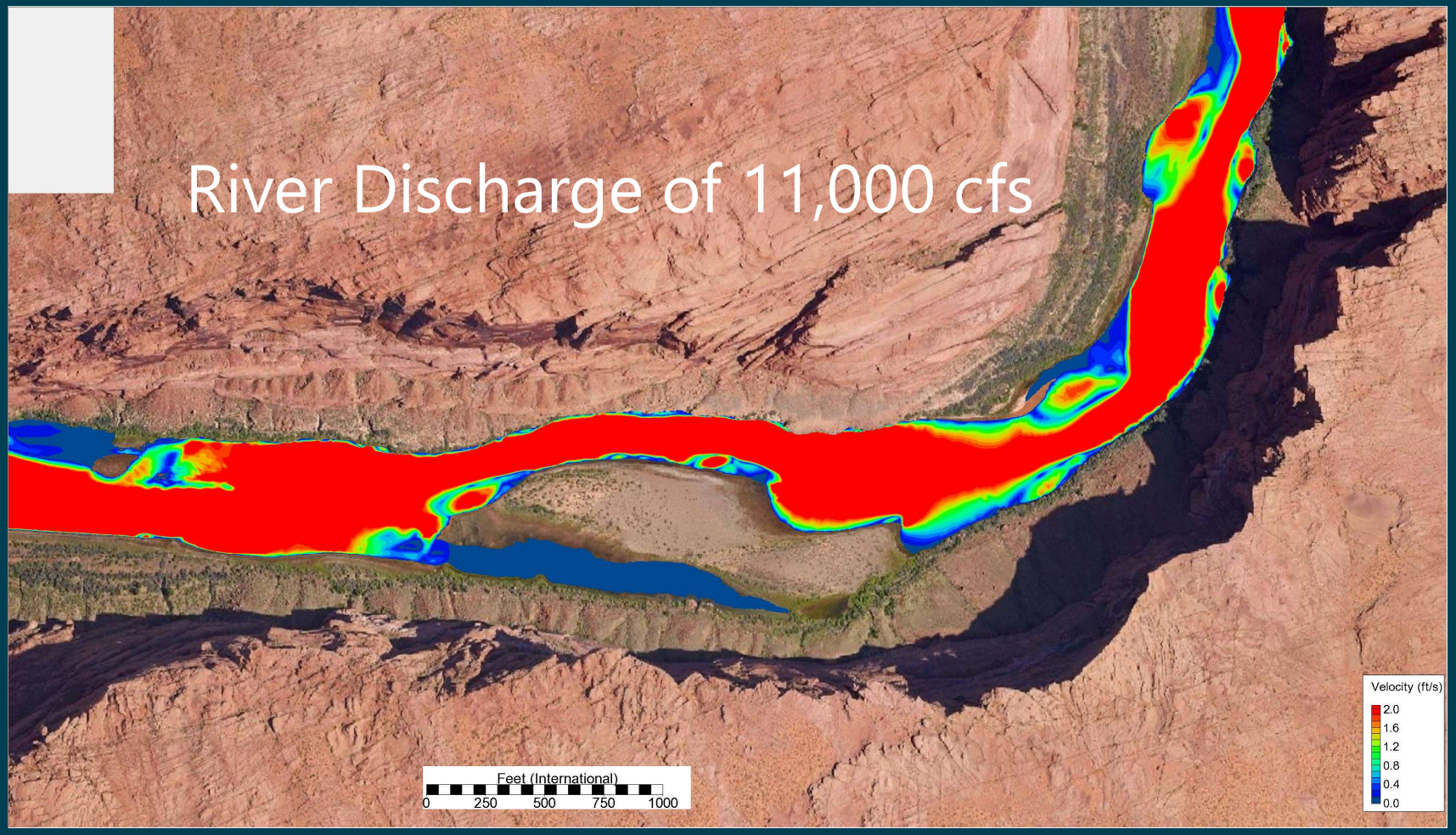
Velocity Results: Proposed Conditions Phase 2



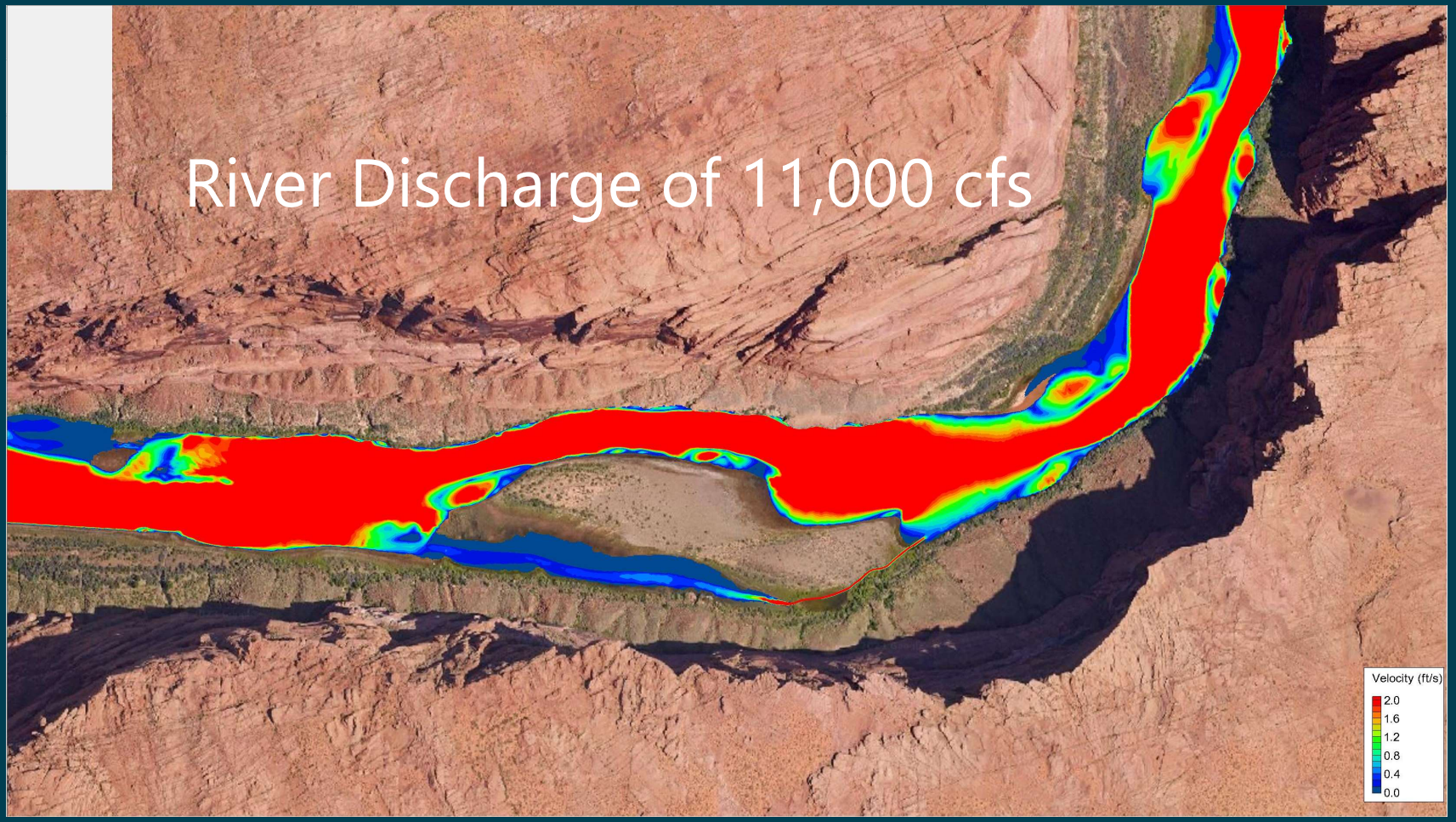
Velocity Results: Proposed Conditions Phase 2



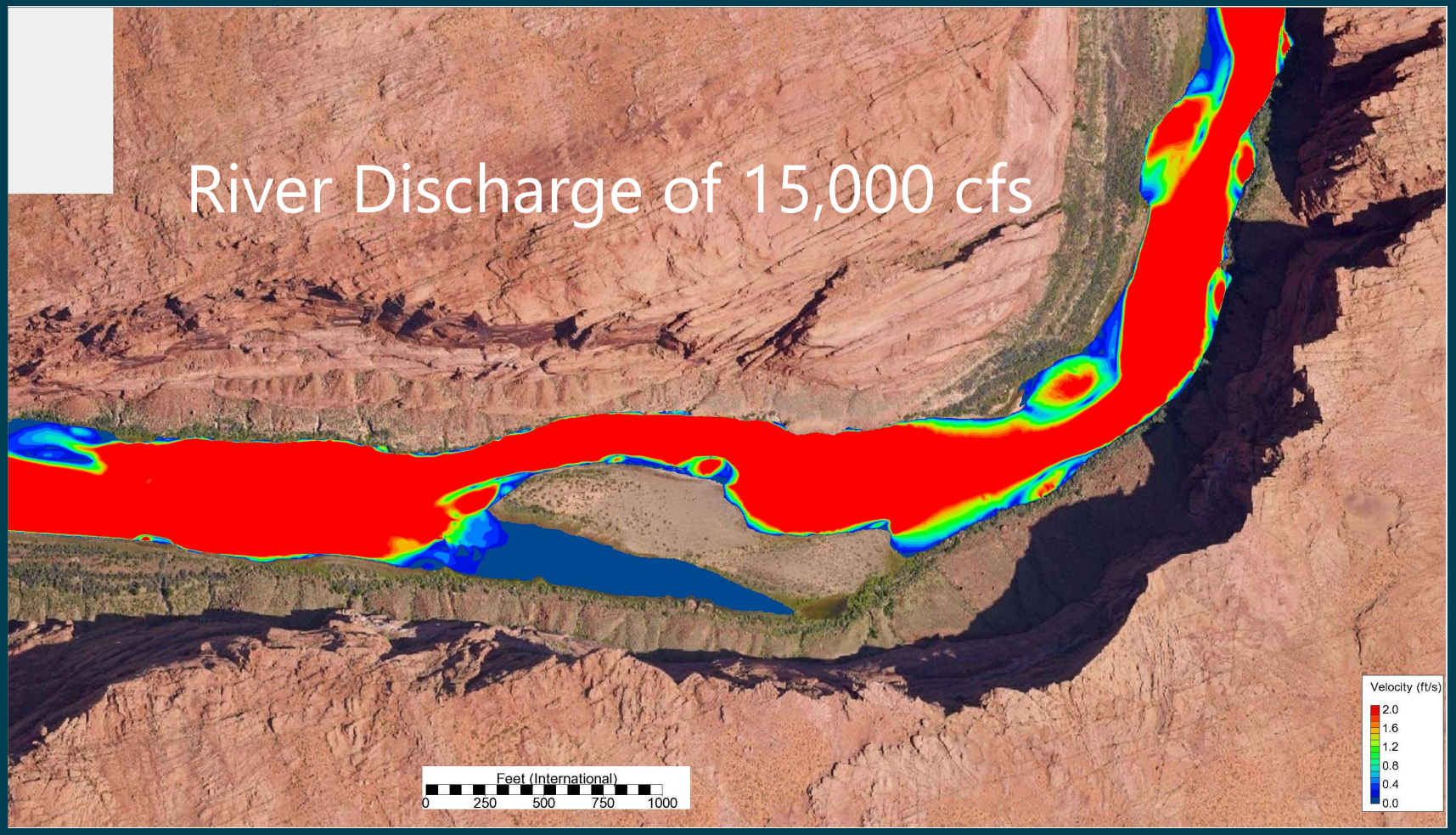
Velocity Results: Existing Conditions



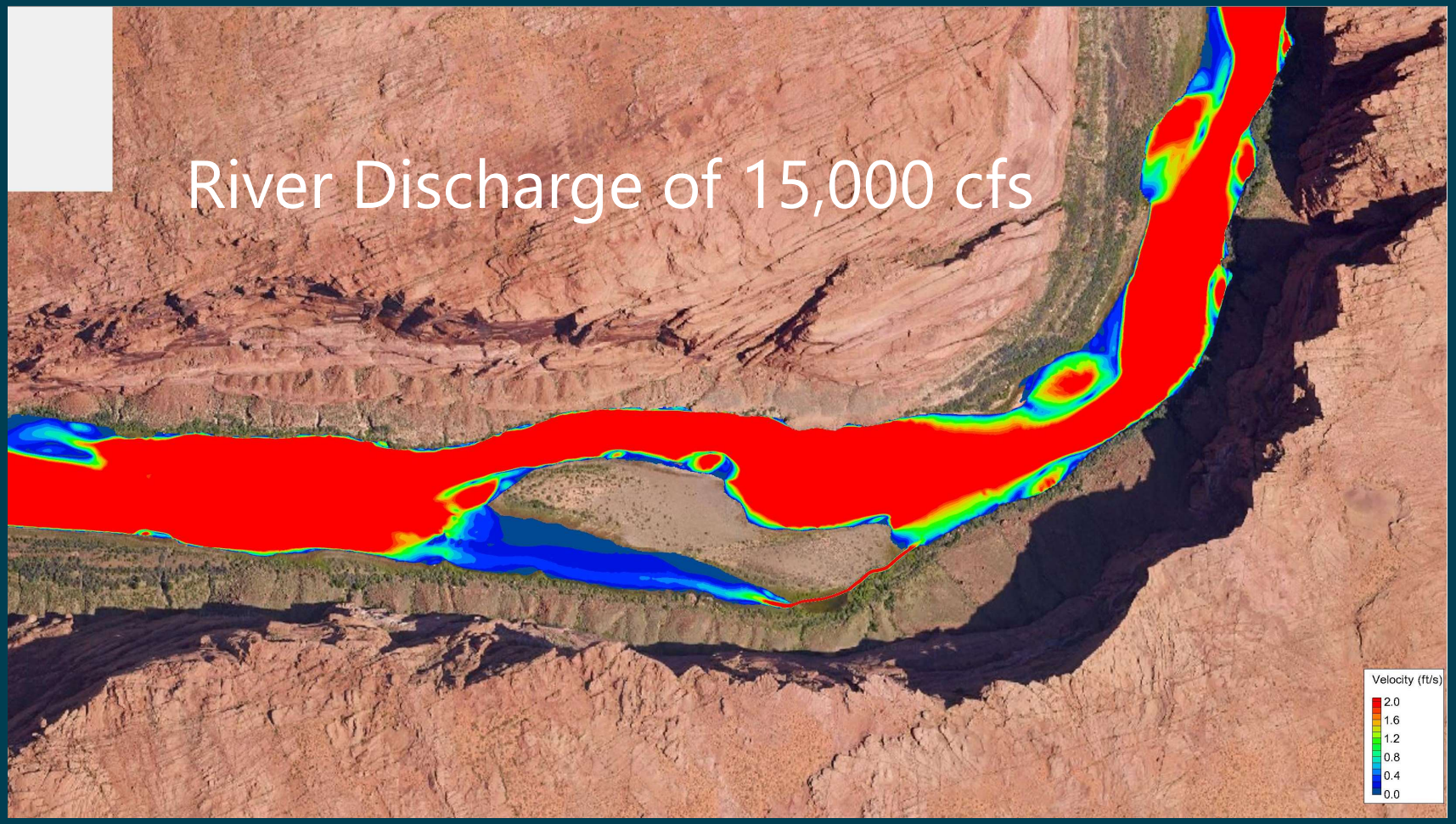
Velocity Results: Proposed Conditions Phase 3



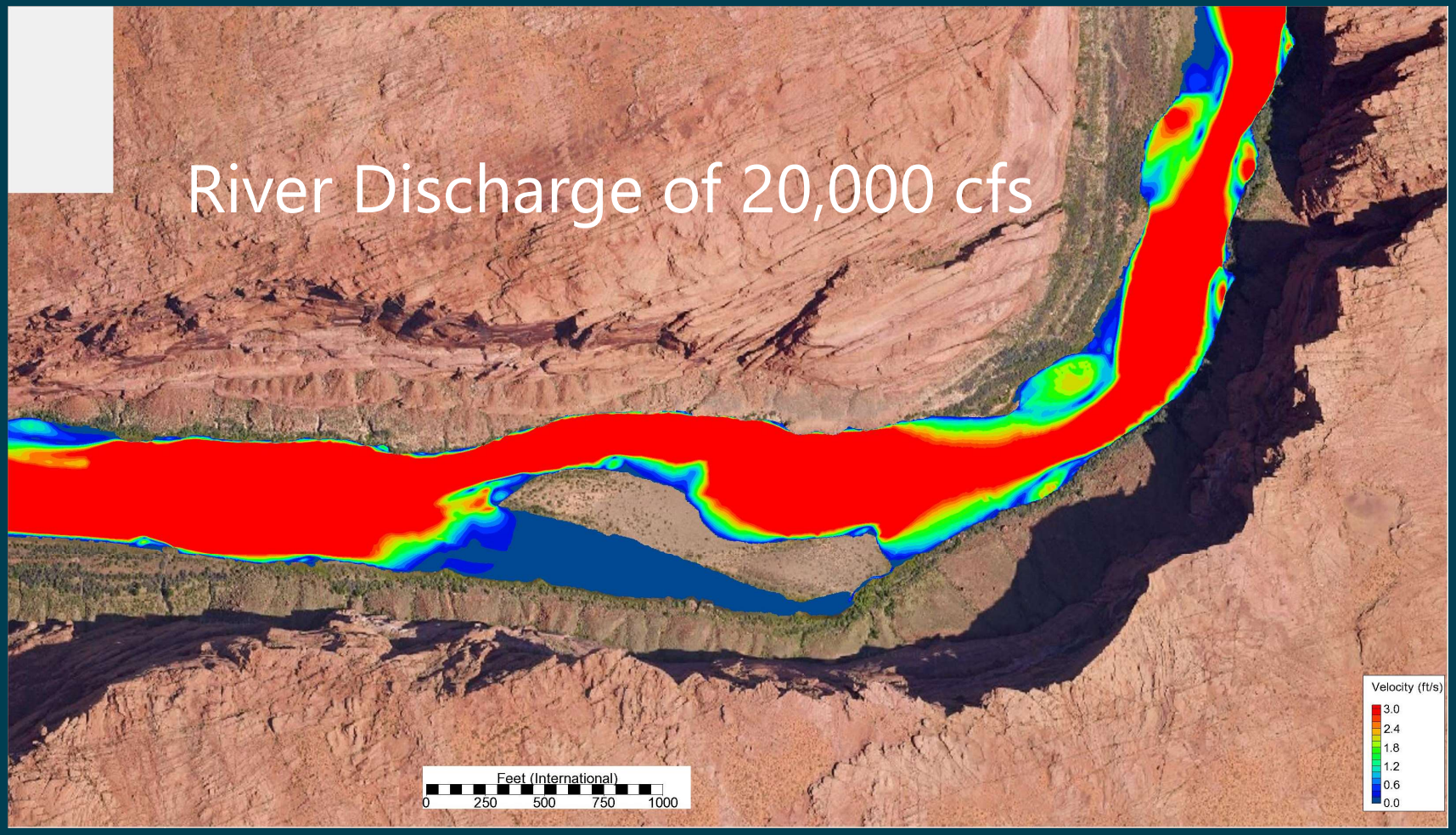
Velocity Results: Existing Conditions



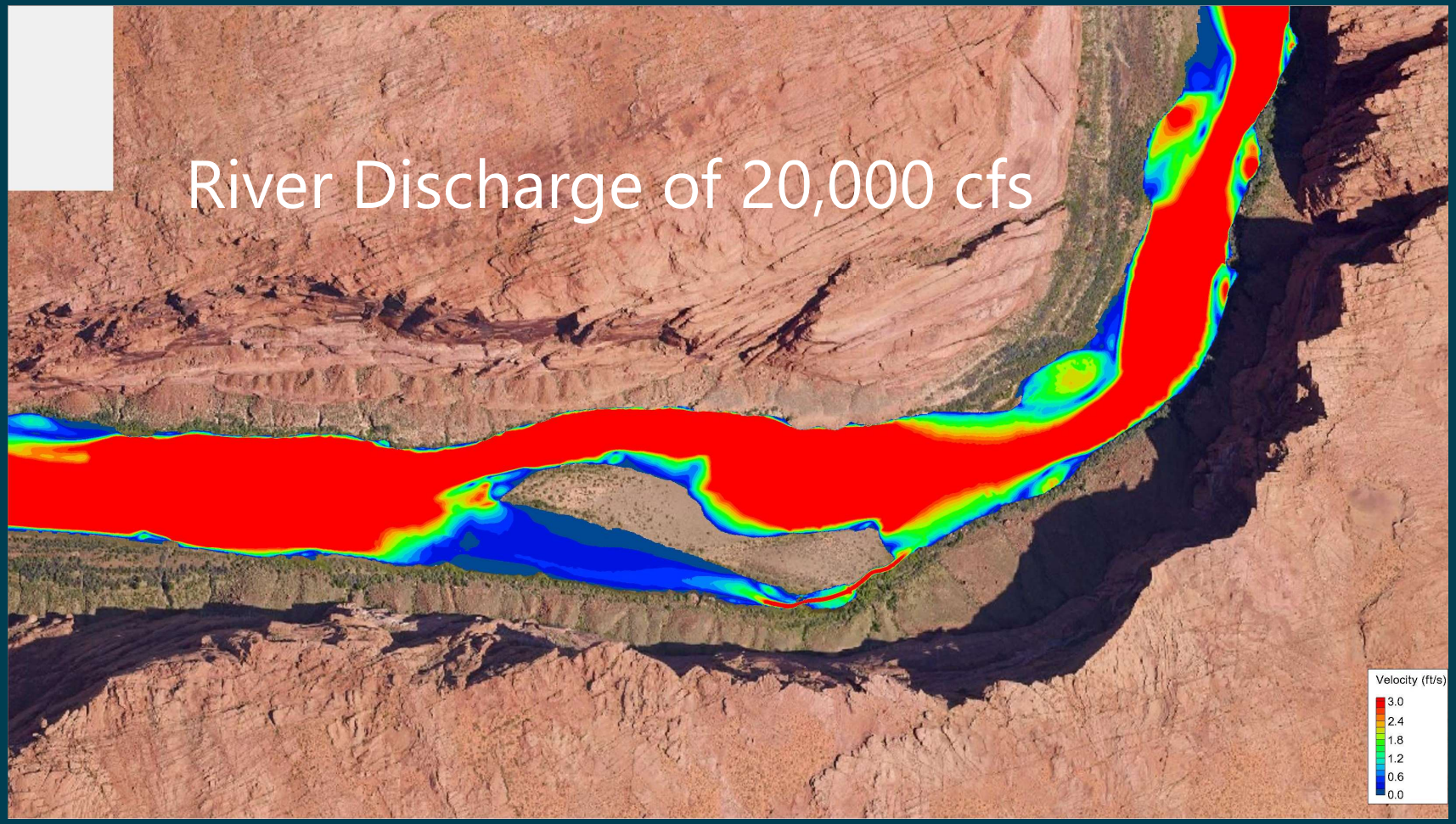
Velocity Results: Proposed Conditions Phase 3



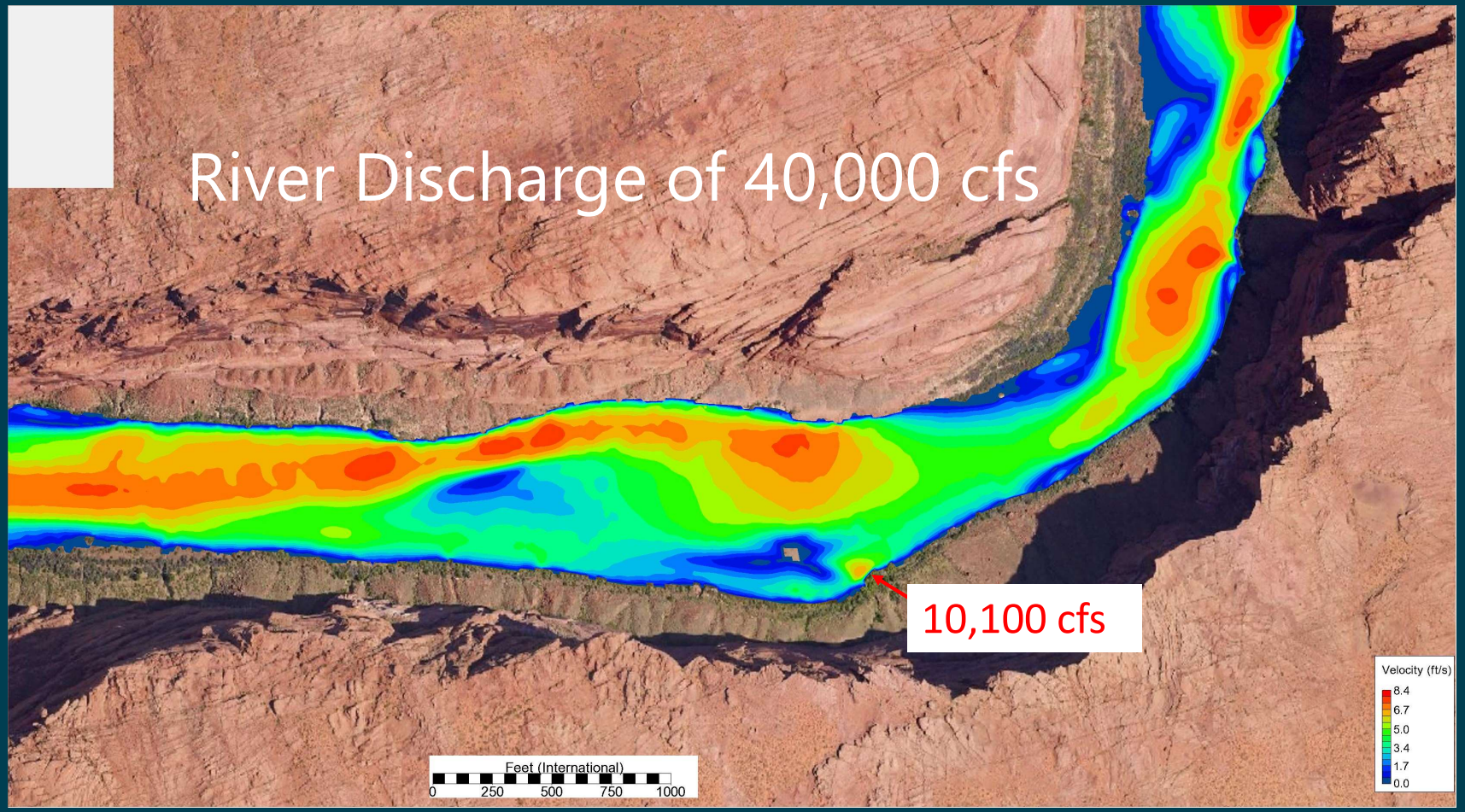
Velocity Results: Existing Conditions



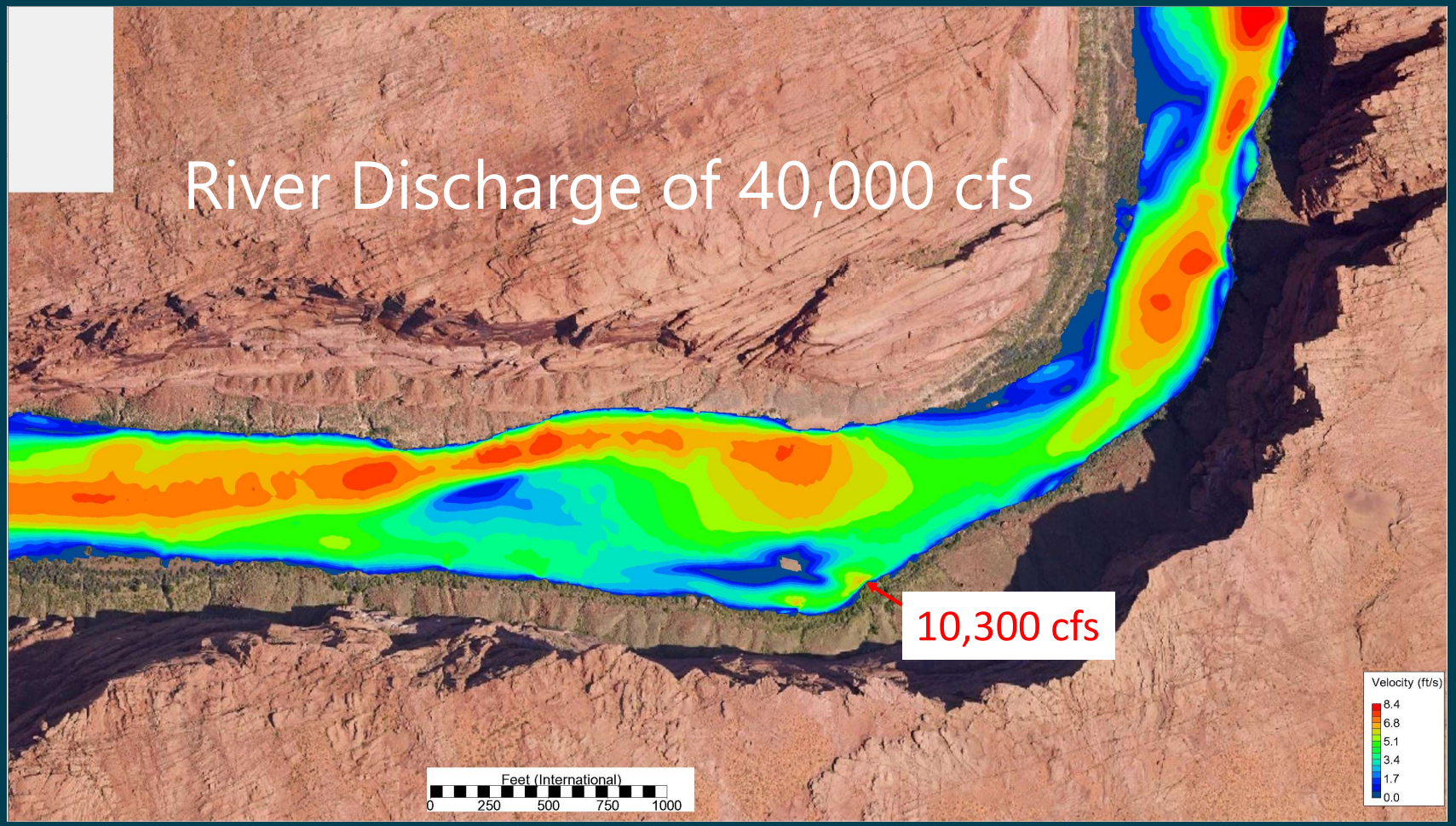
Velocity Results: Proposed Conditions Phase 3



Velocity Results: Existing Conditions



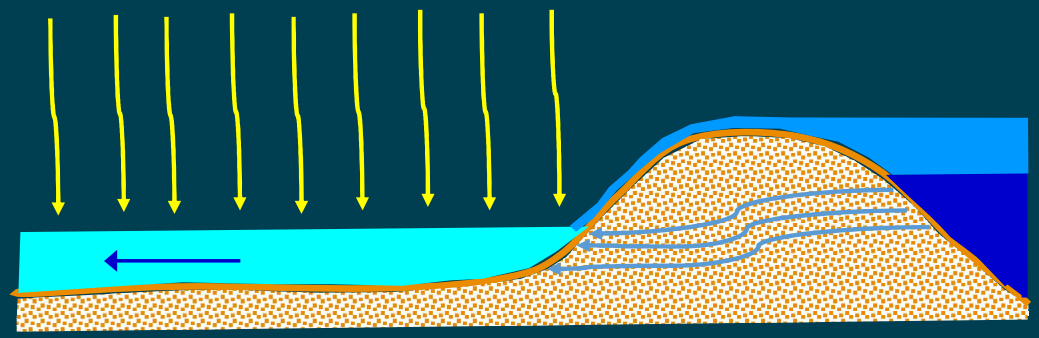
Velocity Results: Proposed Conditions Phase 2



Thermal Regime Factors

Atmospheric conditions
- Solar radiation
- Air temperature
- Wind speed & humidity
- Precipitation
- Evaporation & condensation

Topography
- Shading
- Geology
- Aspect
- Latitude
- Altitude

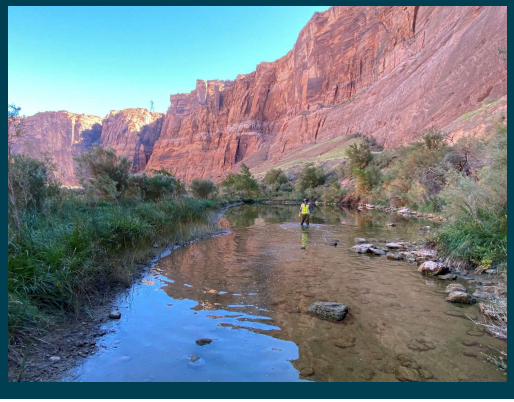
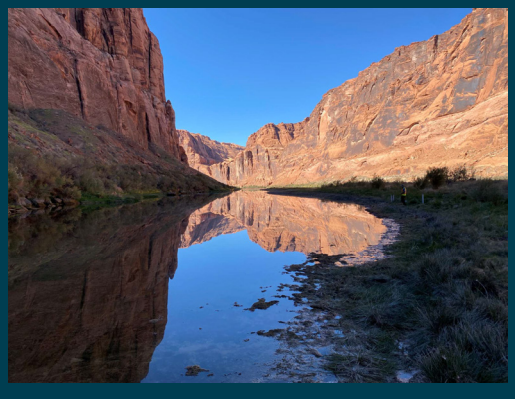


Streambed
- Sediment
- Porosity
- Aspect
- Hyporheic exchange

Stream discharge
- Volume of water
- Groundwater inflow rate
- Surface inflow rate
- Outflow rate

Conclusions

- The low levels of Lake Powell have allowed river water temperatures to increase during summer
- In the absence of a side channel connection with the sloughs, summer water temperatures increase significantly more than in the river channel


Conclusions

- The proposed new alternative would allow water temperatures in the upper and lower sloughs to approximate water temperatures in the adjacent Colorado River
  - Hand-held tools would be used to implement Phase 1

  - Small mechanized equipment would be used to implement Phases 2 and 3

  - Only natural materials would be used (sand, gravel, cobbles)

Conclusions

- The excavated side channels of the proposed new alternative are expected to be sustainable
  - Some widening of the side channels may occur during high river discharge, but the gravel bar has been armored for more than half a century
  - Large boulders or bedrock (if present) would prevent deeper channel excavation
  - Rare rock falls from the left canyon wall could fill portions of the side channel


Questions?
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