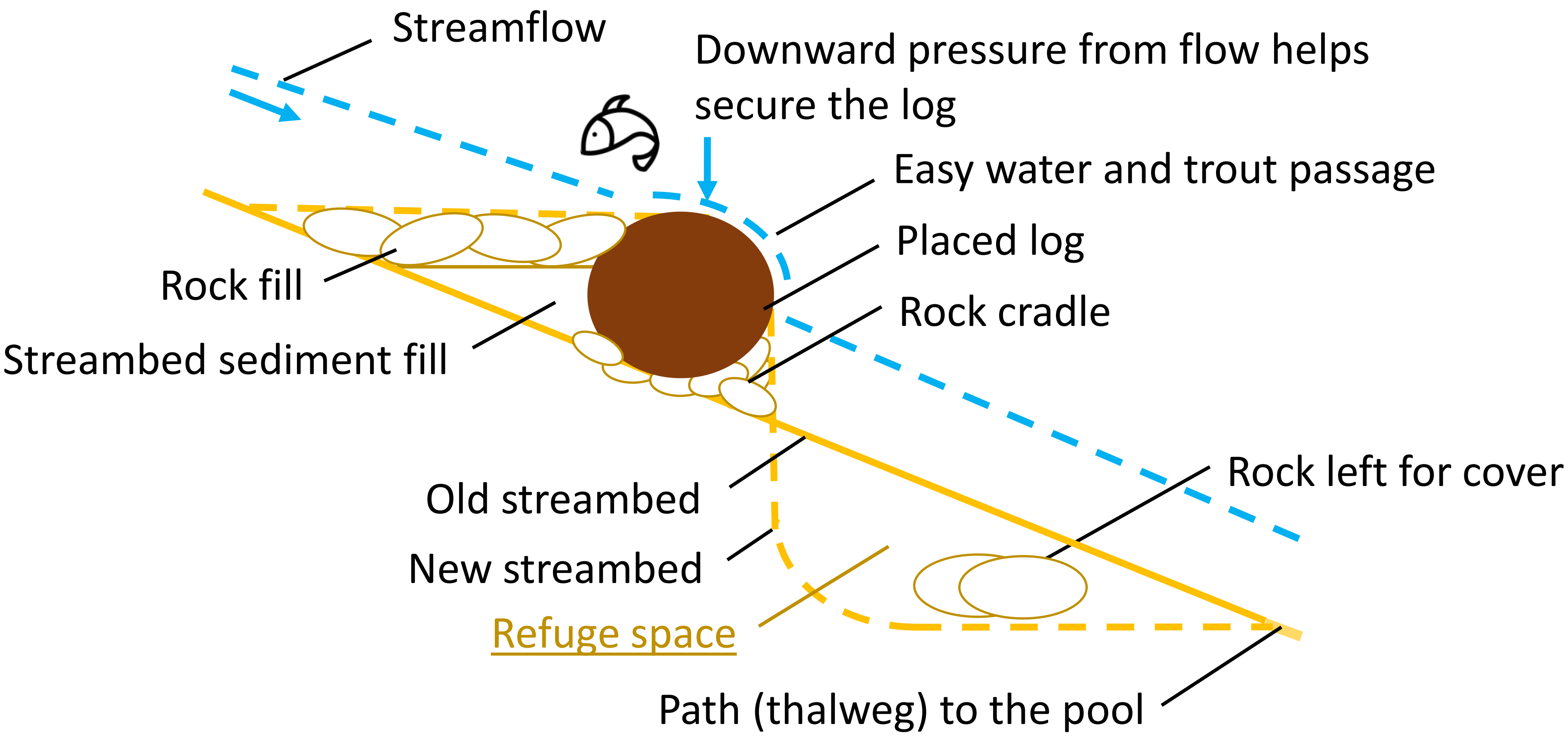
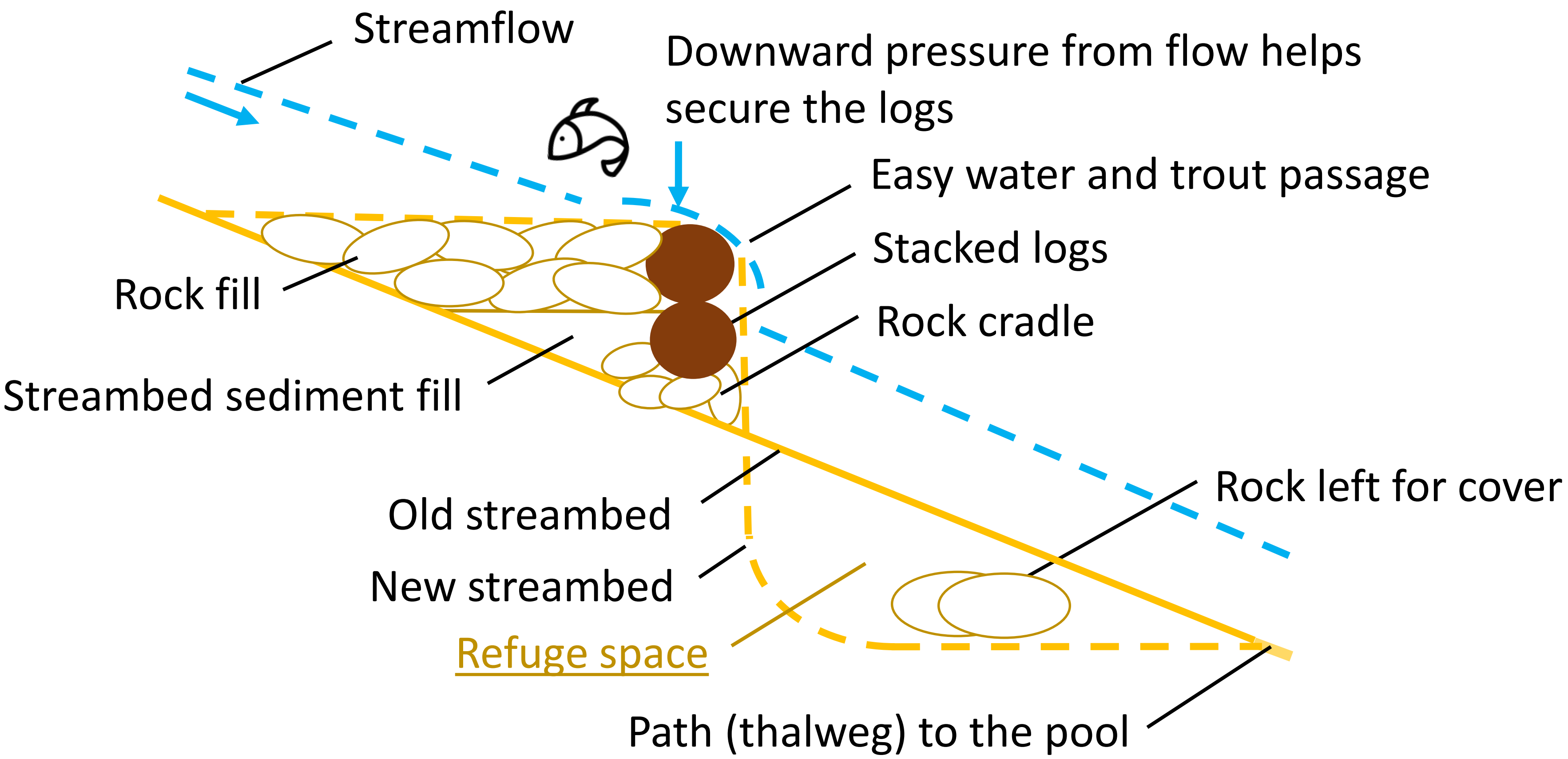

Trout Refuge Space
Considering Plunge Pool Installation
Prepared for the Upper Dolores Stream Protection Working Group,
November 30, 2022, Raymond Rose and Duncan Rose

Plunge pool configuration, one log



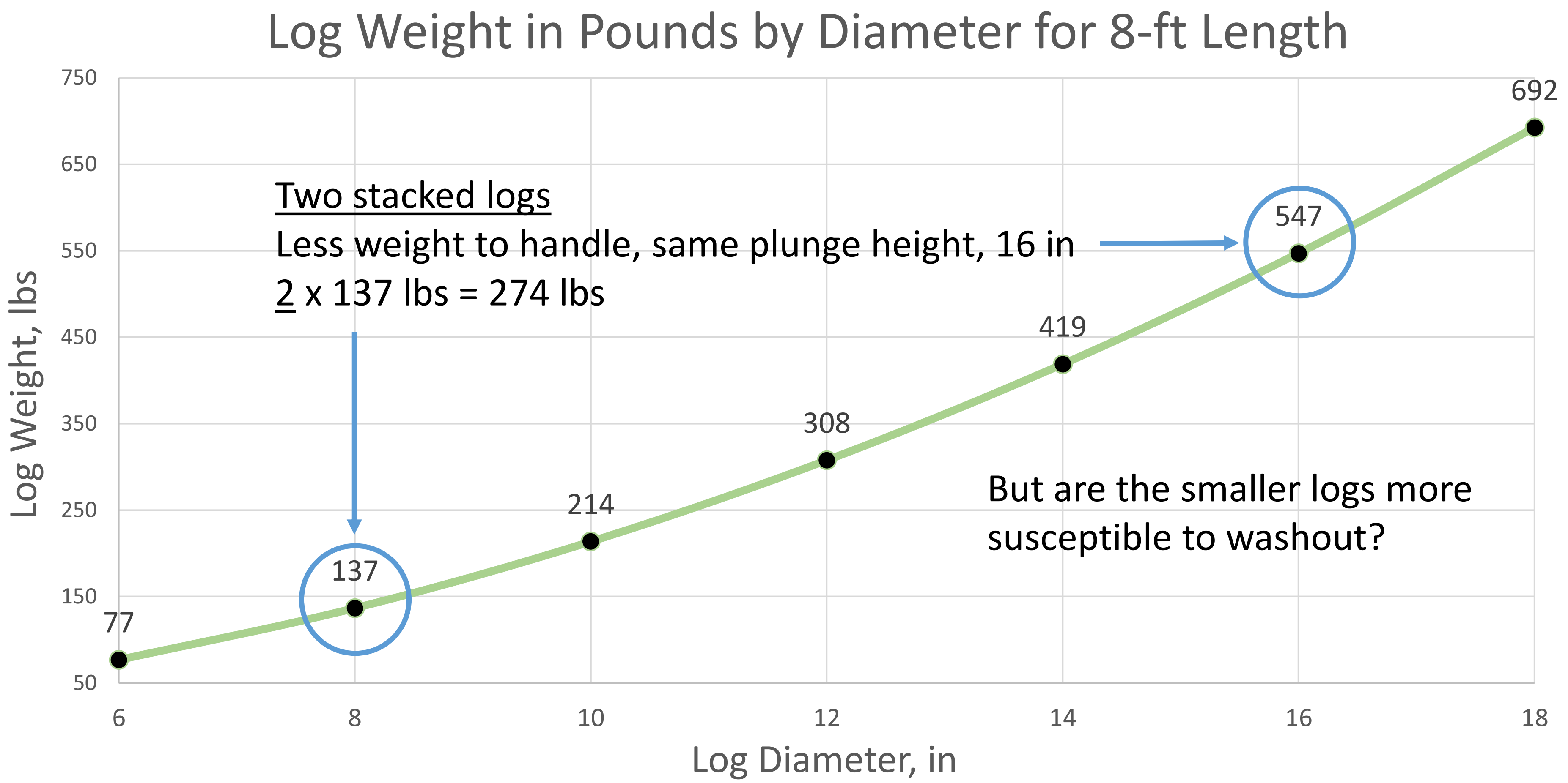
Plunge pool configuration, <u>two</u> logs



The math

- Streamflow at the top of a log placed across a stream has potential energy.
- The amount depends on log diameter; that is, PE = water mass x log diameter (x gravity constant).
- Using a 16-inch-diameter log produces twice the potential energy of an 8-inch log.
- Potential energy converts to kinetic when streamflow plunges over the log.
- Streamflow's kinetic energy increases with flow velocity squared; that is, KE = ½ water mass x flow velocity squared.
- So, 10 cfs streamflow has 100 times the kinetic energy of 1 cfs. (10 squared = 100; 1 squared = 1)
- A placed log and high flows produce the greatest scouring.
- Doubling the log diameter doubles the high flow scouring.
- Key is balancing desired scouring against the possibility of log washout.

Considerations in log weight management



Based on 49 lbs/cf from https://sherrilltree.com/log-weight-chart

Studies

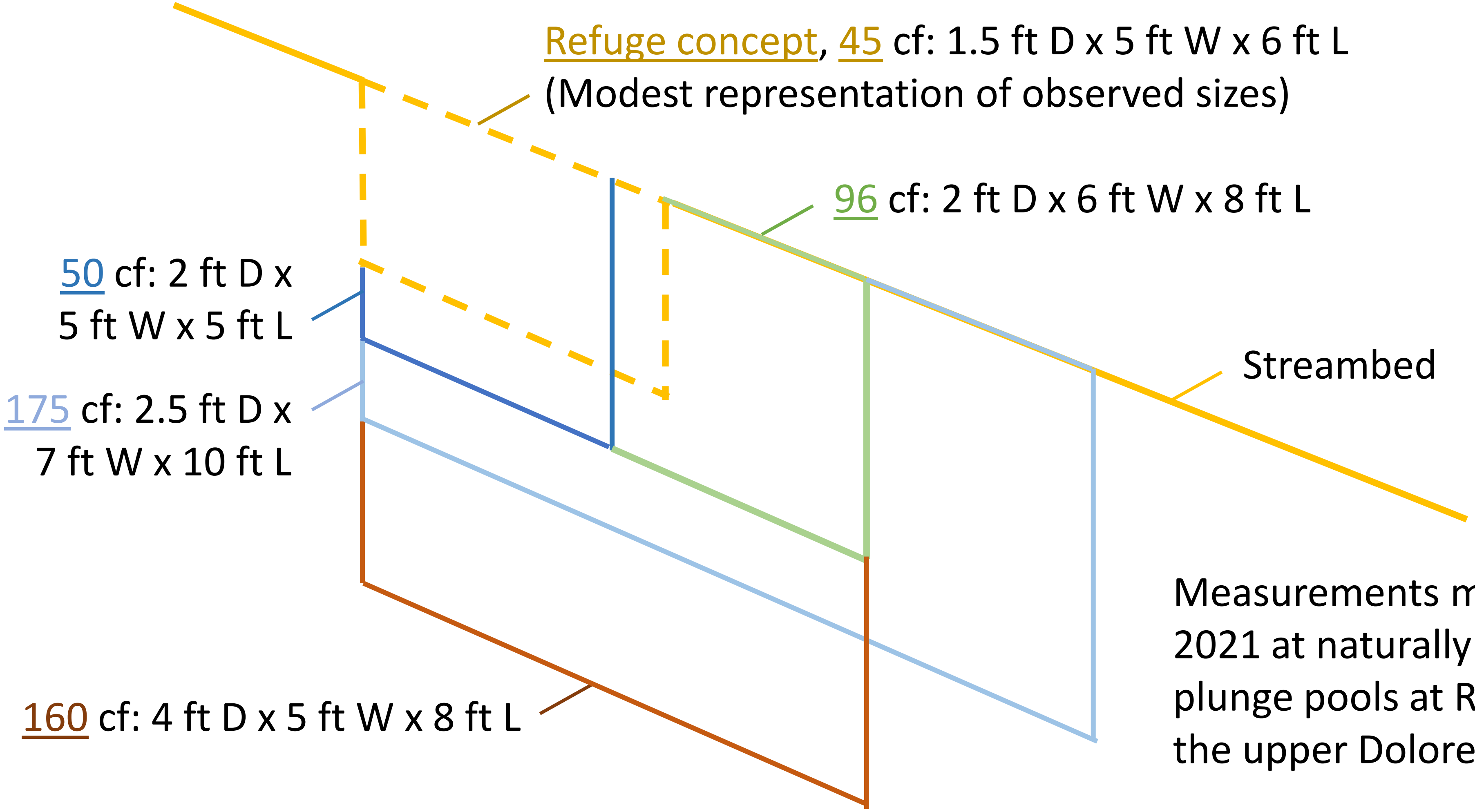
- Log plunges constructed at 79 sites developed pools of 1.5-ft depth or greater [1].
- They roughly doubled trout numbers and biomass in the stream habitats [1], while potentially functioning also as refuge spaces for low flow conditions.
- The most cost-effective installations were at first order streams [1].
- Largest rises in numbers and biomass were at streams with >3% slopes [1], as at Dolores tributaries.
- Plunges increased the streambank storage of water, which irrigated and improved vegetation covers [1].
- Deep pools provide important winter shelters for trout [2].
- Log and rock diagonal deflectors and rock plunges consistently failed to generate deep pools [1, 3].
- Log plunges hosted more trout biomass than rock plunges [3] because they had greater volumes.

1. Binns, H. A., 1999, "A Compendium of Trout Stream Habitat Improvement Projects Done by the Wyoming Game and Fish Department, 1953-1998," Fish Division, Wyoming Game & Fish Department, Cheyenne.
2. Brown, R. S. and W. C. Mackay, 1995, "Fall and Winter Movements of and Habitat Use by Cutthroat Trout in the Ram River, Alberta, *Transactions of the American Fisheries Society*, 124:873-885.
3. Hogle, J. S., 1993, "Salmonid Habitat and Population Characteristics Related to Structural Improvements in Wyoming Streams," Master's Thesis, University of Wyoming, Laramie.

Installation

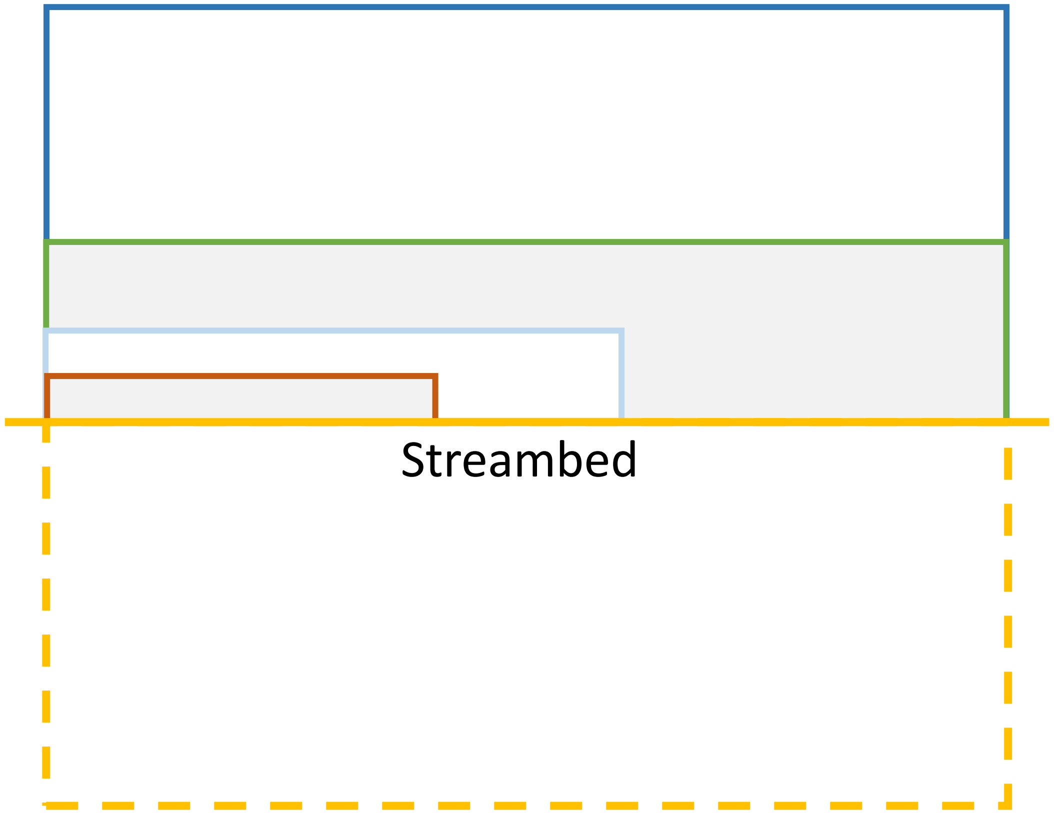
- Width. The log(s) placed across the stream from *bank to bank* would establish refuge across the full width of the stream.
- Level. The log(s) installed *level* would enable flow evenly across its length, maximizing the refuge width and volume that results from scouring.
- Backfill. Filled *behind* with stream sediment and rock to the top of the log(s) would help secure it and maximize water passage in low flows.

Refuge concept & observed plunge pools sizes



Measurements made in May 2021 at naturally occurring plunge pools at Ryman Creek in the upper Dolores River basin

Cross-section of stream and refuge concept



June, highest flow, 10 cfs, 15 in D x 5 ft W

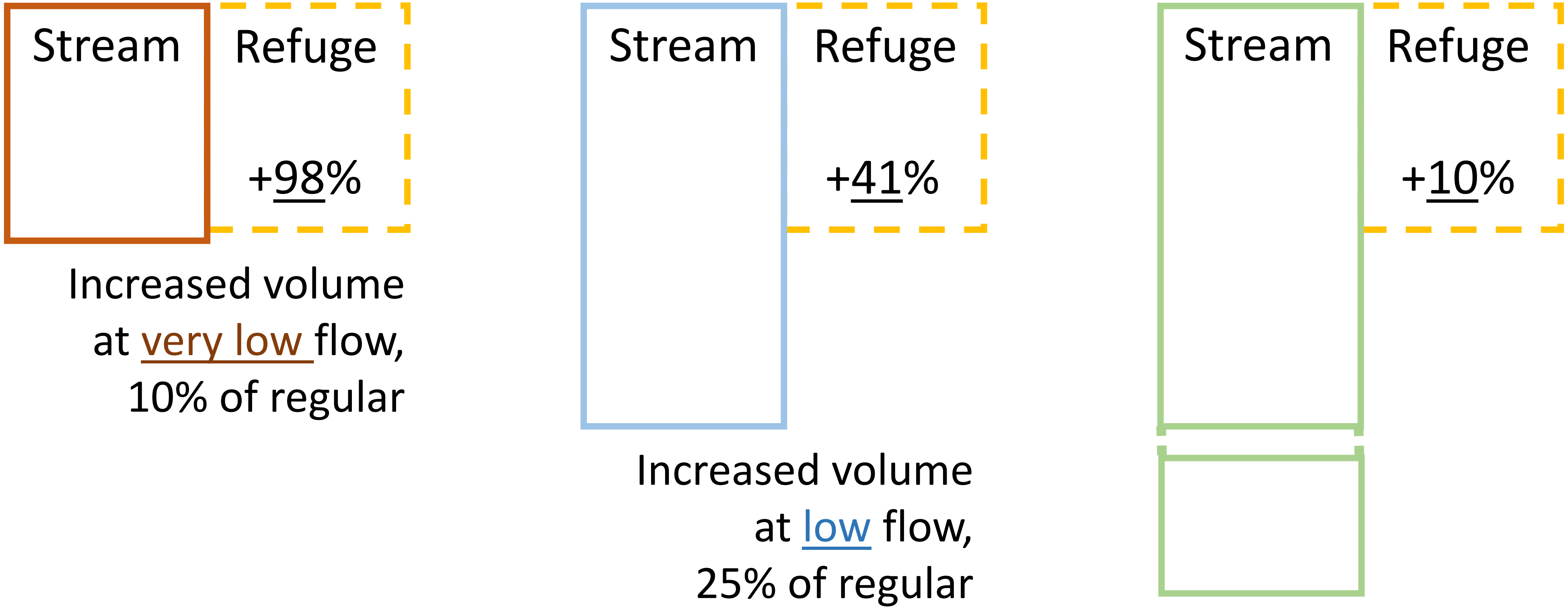
August, regular flow, 3 cfs, 7 in D x 5 ft W

August, low flow, 0.75 cfs, 3 in D x 3 ft W
August, very low flow, 0.3 cfs, 2 in D x 2 ft W

Refuge concept: 18 in D x 5 ft W (x 6 ft L, 45 cf)
Individual plunge pool size
Equivalent to 6 submerged 55-gal drums

Sizes are representative of the small streams
Wildcat and Ryman in the upper Dolores basin

Potential percent volume increase, Wildcat



Increased volume
at regular flow,
StreamStats

Refuge concept in August flow conditions,
lower 2 mi, plunge pools and pond, 2700 cf

Questions, testing

- Can logs of the size preferred for resilience be safely and adequately handled despite weight?
- Can logs be moved without significant damage to the riparian area, streambank, and streambed?
- What construction features are most secure against high flows (for example, log size, log and rock placement)?
- What elevation drop (structure height) gives sufficient scouring? How soon after placement?
- Will trout use the refuge spaces? Can valuable numbers survive there temporarily in low flows?