



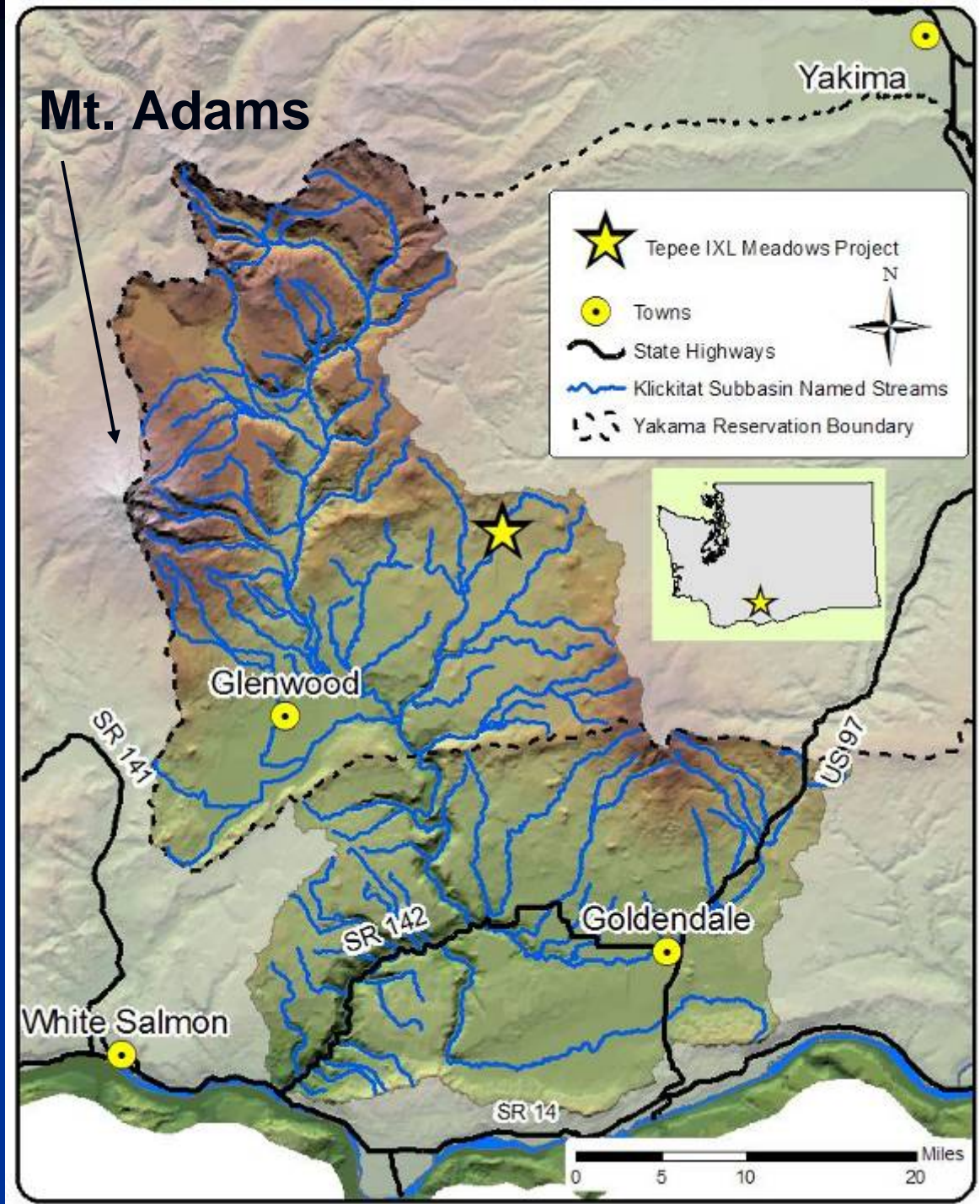
Bringing the Bottom-Up: Restoring Floodplain Connectivity in Tepee Creek

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River Restoration Northwest
Stream Restoration Design Symposium
February 7, 2008

Location

- Klickitat River tributary
- south-central Washington State
- east-slope of Cascade Mountains
- 22 miles due east of Mt. Adams
- within Yakama Nation Reservation



Setting

Watershed

- forested (3000-4000')
- Basal geology is Grande Ronde (CRB group) basalt
- Hard parent materials and low to moderate relief = very limited bedload supply

Site

- 2965' elevation
- Cohesive soils / banks (Aquandic Haploxeralfs)
 - thin (4") A horizon = ~20% clay
 - multiple B_t horizons (14"-65") = 30 – 38% clay
 - prevailing texture is clay loam
- Incised within historic planform

Fisheries Significance

- Habitat for ESA-listed (“threatened”) Middle Columbia River steelhead
- Tepee Creek accounts, on average, for 6.3% of the total observed spawning in the Klickitat subbasin
- Extensive reaches are incised and intermittent. Spawning habitat is marginal and rearing conditions are poor
- Reach is located within one of the top priority areas of the Klickitat Salmon Recovery Strategy

Problem

- Limited rearing and spawning habitat
- Stranding issues
- Project reach dried-up in 4 out of 5 years preceding project implementation
- Field indicators and hydraulic modeling indicate that project reach was incised 3 to 4 feet within its former floodplain

Cause of Incision

- Capture of a forest road 1/2 mile downstream channelized the Tepee Creek causing subsequent headward incision
- Increased peak flows associated with upstream road densities (hydrologic modeling suggests 7.3% increase for a 2.5-year storm)

Goals

- Increase flow duration / increase floodplain storage
- Enhance in-channel habitat conditions for spawning and rearing steelhead
- Restore suitability of valley bottom for medicinal and traditional food plants

Project Team

- Will Conley – YN Fisheries Program

- Project Management
- Design
- Construction Oversight



- Mike McAlister, PE - Interfluve, Inc

- Design
- Construction Oversight



- Mike Brunfelt - Interfluve, Inc

- Design
- Construction Oversight

Hydrology

- Ungaged
- Contributing drainage area of 8.4 square-miles
- Peak-flow hydrology is driven by rain-on-snow events
- Base flow (for years when it exists) = 10-12 gpm

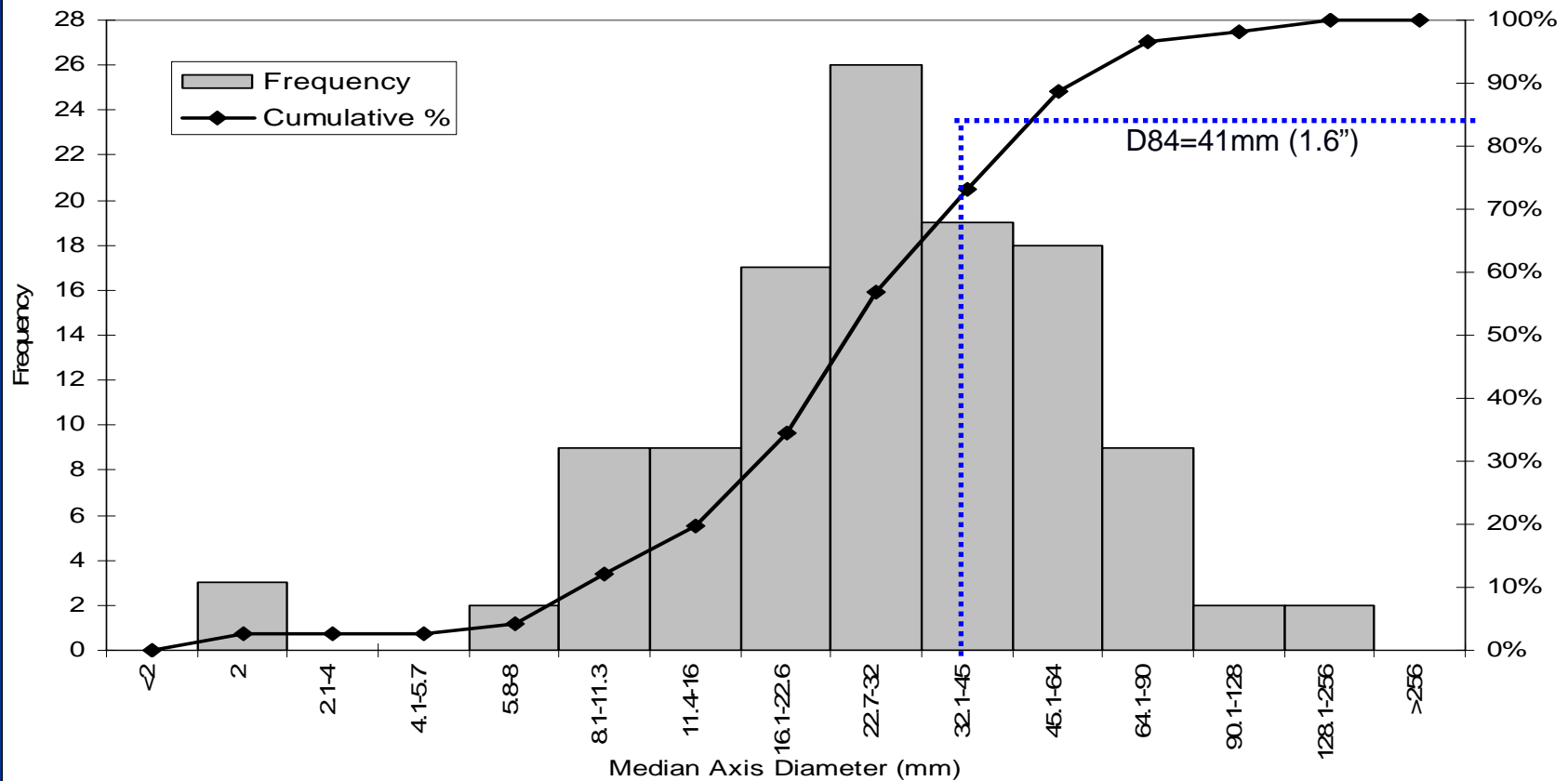
| Recurrence Interval (yrs) | Region 6 USGS Equation Results | |
|------------------------------|--------------------------------|------------------------------|
| | Discharge (cfs) ^a | Discharge (cfs) ^b |
| 2 | 112.8 | 165.2 |
| 10 | 331.4 | 414.2 |
| 25 | 496.4 | 585.1 |
| 50 | 643.8 | 730.5 |
| 100 | 816.9 | 895.7 |

^a using 17.4" MAP correlated with HEC-HMS model

^b using 27.6" MAP from nearby RAWS station

Design Pool/Riffle Substrate

**Pebble Count
Surficial Grain Size Analysis**



Design

Conceptual:

Import gravels to raise the bed elevation to restore overbank flow frequency to the pre-disturbance floodplain

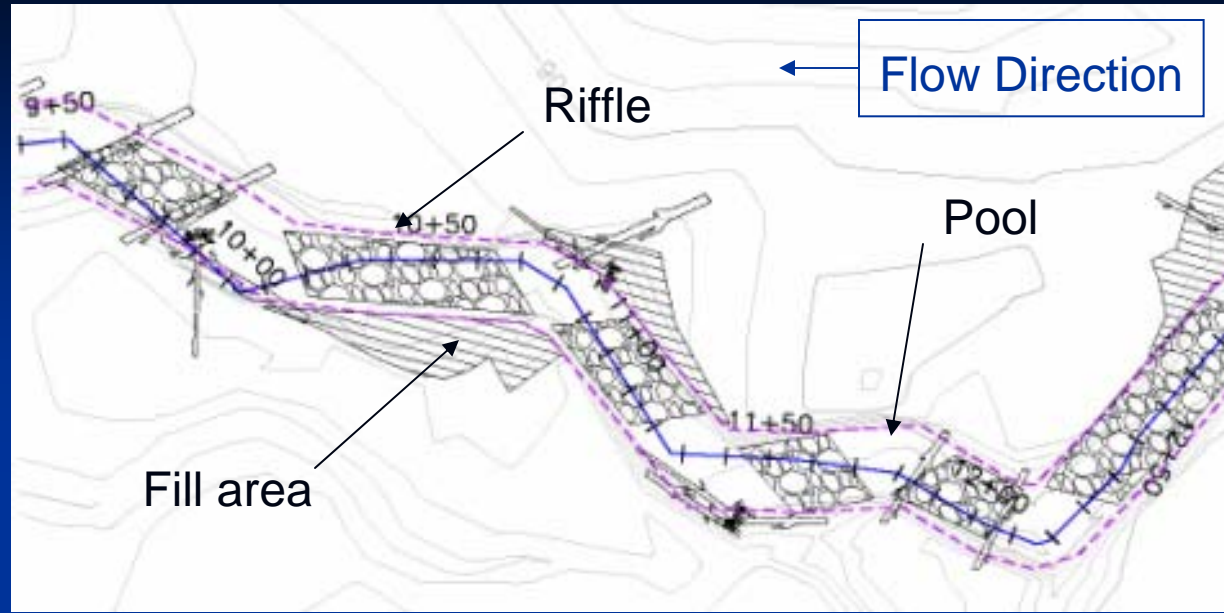
Process:

- HEC-RAS was used to develop typical design dimensions were developed to restore overbank access at the 1.5-year flow (approximately 80 cfs)
- Design dimensions were cross-checked for with nearby analogues and regional geometry equations (Castro and Jackson 2001)
- Average slope
- 30% Drawings / Fit-in-the-field

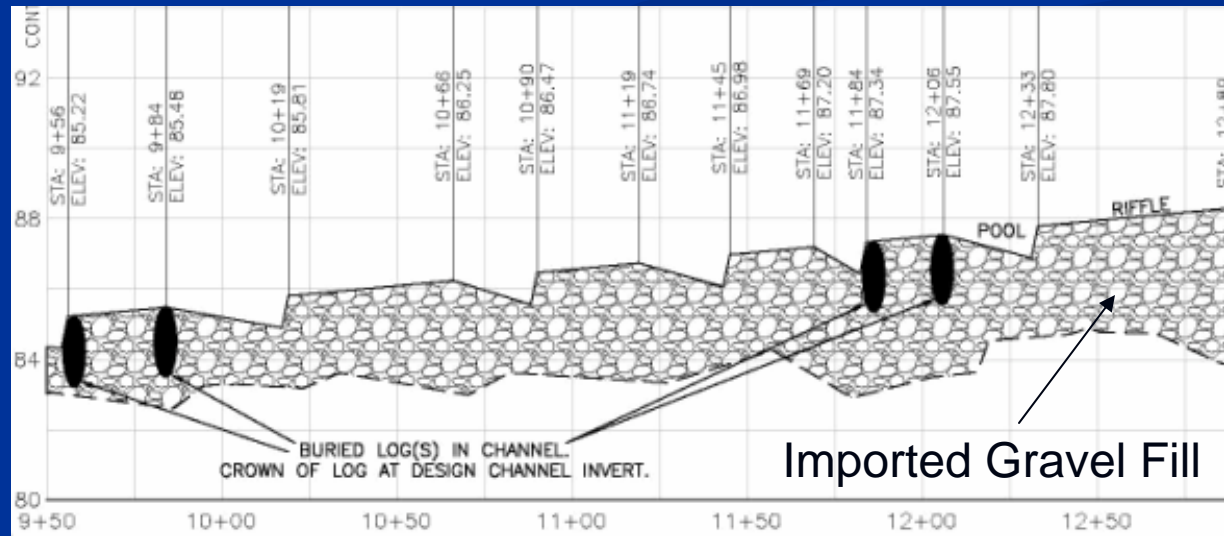
Design Parameters

- Longitudinal profile slope = 0.93% (0.0093 ft/ft)
- 2:1 sideslope (horizontal : vertical)
- Bankfull cross-sectional area = 19.7 ft²
- Bankfull top width = 18.4 ft
- Hydraulic radius = 1.04 (depth = 1.36 ft)

Plan View



Profile View



Implementation

- A 140' **coarsened riffle** (3%) was constructed at the downstream end of the reach
- Ninety-five feet of new channel constructed
- Reconnected 135' of historic channel
- Imported gravel to raise bed elevation (~3") and **reconstruct pool/riffle** sequences along 1850'
- Riffles were constructed on an **average slope** of 0.93% with a bankfull width of 18.4'
- Overall reach lengthened to 1990'

Implementation (cont'd)

- 28 LWD jams constructed along channel margins to maintain pool depths, provide cover, and restrict bank erosion
- Numerous LWD placements constructed on floodplain
- Salvaged existing vegetation (sod mats and shrubs)
- Salvaged alluvial gravels (where they were present)
- Removed 2 culverts and related fill from an abandoned cross-valley road alignment

Sequencing / Staging

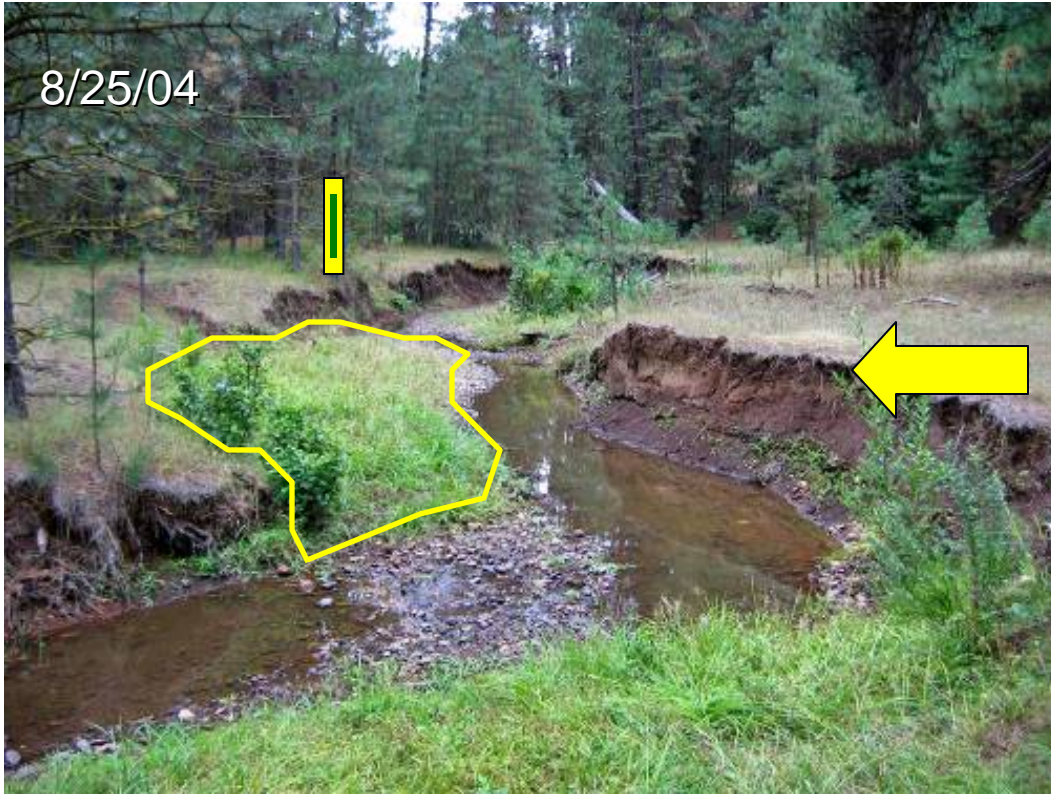
Implemented over two field seasons:

- Construction of riffles, downstream grade control, and roughly half of the LWD jams was completed in Fall 2006
- Maximum discharge over winter 2006/2007 = 143 cfs
- Finishing work on pools and riffles, floodplain treatments, LWD jams, revegetation, and fence construction was completed during Summer 2007

Disclaimer

Some trees were felled to create equipment access. However, the majority of the riparian logging in the following photos was part of a commercial timber sale and not affiliated with the restoration project.

8/25/04



STA 10+80

Several locations within the reach showed signs of recovery prior to project

10/2/07

“Immature” cross-section constructed to minimize bed shear in near term and allow deposition to create inset channel



8/25/04



STA 2+20
(upper half of
grade control riffle)

8/7/07



8/25/04



STA 2+70
(immediately upstream of
grade control riffle)

4/5/07



8/7/07



8/25/04



STA 4+50

8/7/07



8/25/04



STA 6+60

Elevation of constructed bank toe / channel invert

8/7/07



STA 13+40

4/5/07



There's more than meets the eye....

STA 13+40
Under construction
10/20/06

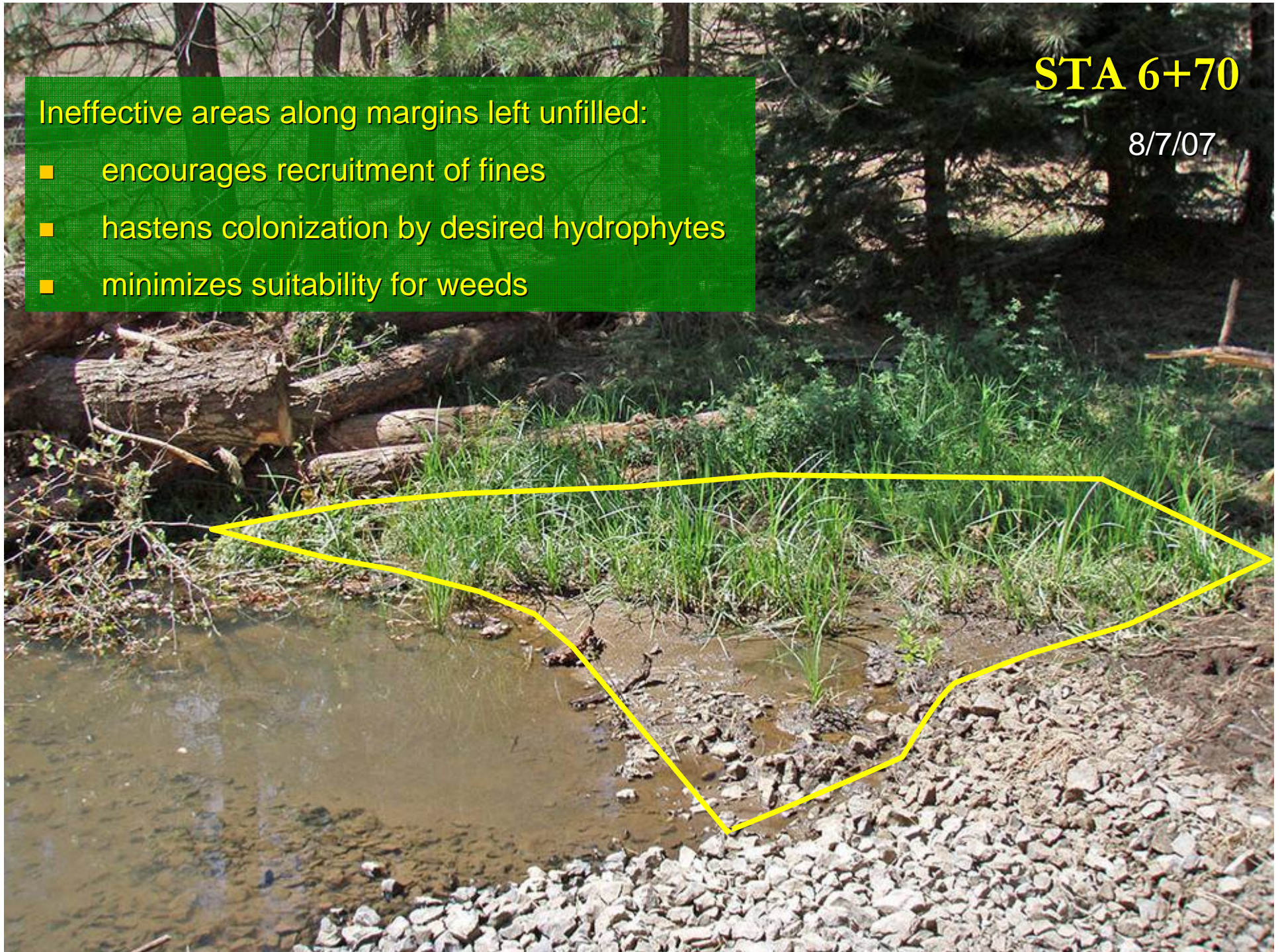


STA 6+70

8/7/07

Ineffective areas along margins left unfilled:

- encourages recruitment of fines
- hastens colonization by desired hydrophytes
- minimizes suitability for weeds



Sod salvage and gravel filling





3/20/03

20 2:15 PM



8/25/04

STA 12+80

Surface water maintained
through growing season



10/2/07

4/5/07



Upper Overflow Channel

Jam 1

- Roughness to prevent capture
- Constructed to be porous

8/7/07



8/25/04



IXL Road Crossing (STA 20+90)



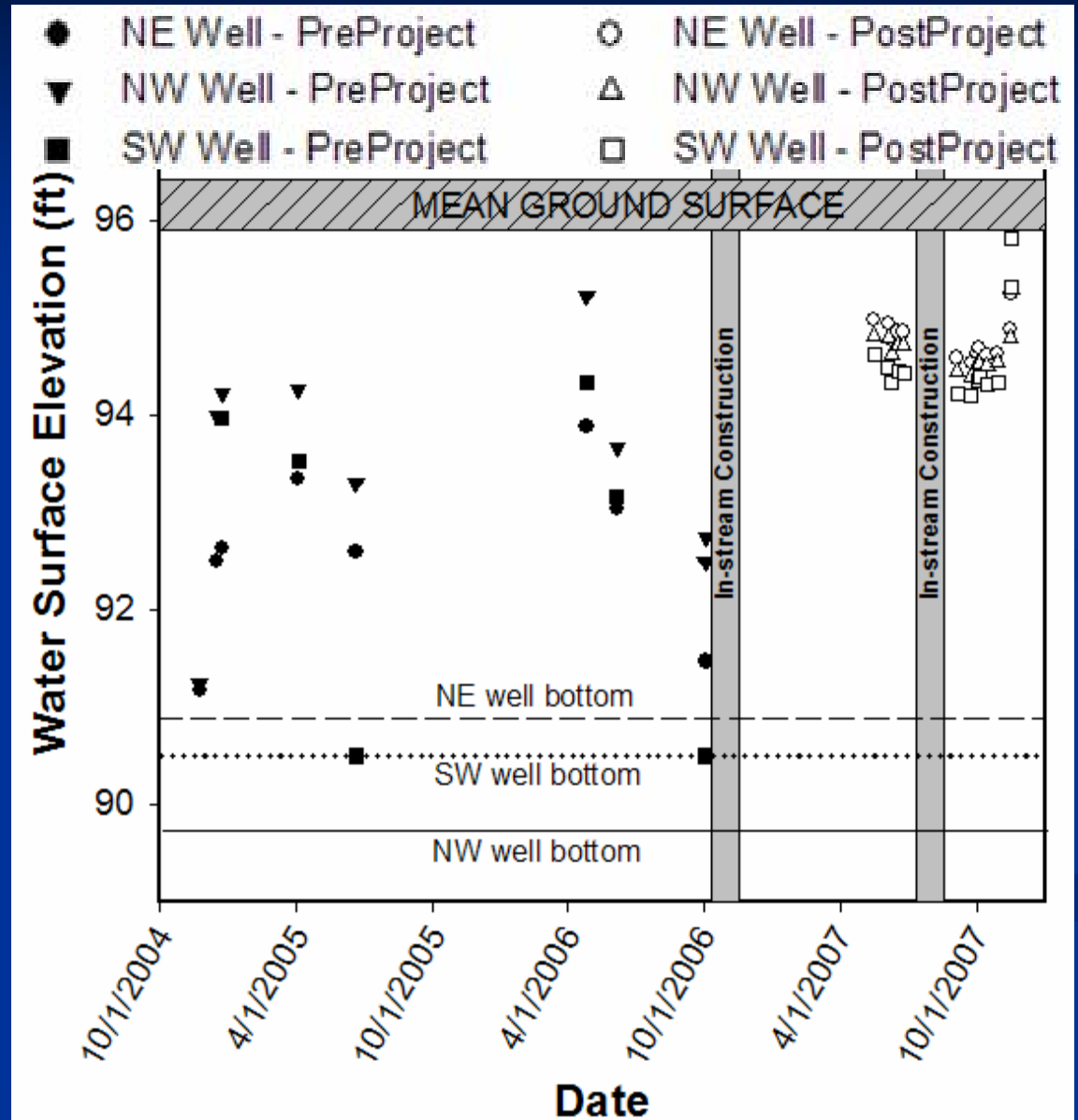
Culvert outlets backwatered to
improve fish passage

4/5/07

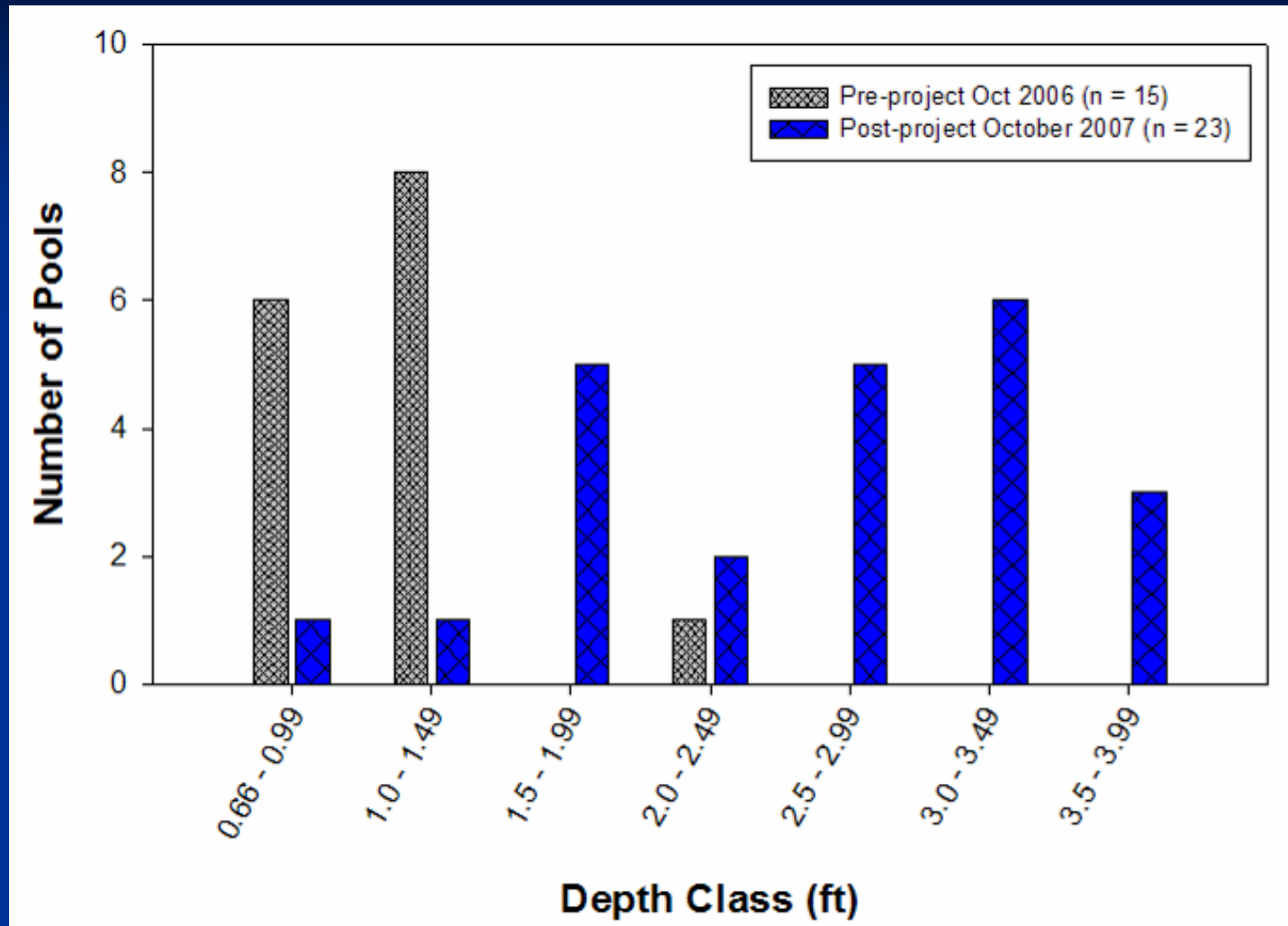
Groundwater Monitoring

Post-project:

- 2' – 4' increase in summer/fall water table
- 1.8' increase in the average annual water table
- Less variability between and amongst wells



Residual Pool Depths



Note: because some pools were under-filled during construction, the median value for residual depths under equilibrium conditions is anticipated to be 2.0' - 2.49'

Steelhead Spawning

A photograph of a stream with a yellow dashed oval highlighting a spawning redd in the rocky bed. The stream is shallow and clear, showing a bed of rocks and pebbles. The water is a light greenish-brown color. The banks are rocky and have some sparse vegetation. A large log is visible in the foreground, partially submerged in the water. The text "Steelhead Spawning" is overlaid in yellow on a grey background at the top of the image.

One of two steelhead redds observed within project reach

Tepee Creek – IXL Meadows:

Results (through first year)

- Groundwater: 2 - 4' increase in summer water table
- High Flow Access: at bankfull or lower flows to four side channels totaling 835 lineal feet
- Pools: increased from 15 to 23 (65%); greater depths & cover
- Wetlands: ~3100 ft² of emergent wetland created
- Riparian Vegetation: Rapid recovery, particularly of salvaged plant materials
- Spawning: Two steelhead redds observed
- Rearing: 2x – 3x increase in juvenile *O. mykiss* abundance
- Macroinvertebrates: Rapid colonization by multiple species of caddisflies and mayflies

Cost

Materials (40.9%)

| | |
|-------------------------------------|-----------|
| - rock | \$100,013 |
| - LWD | \$ 40,500 |
| - revegetation* and erosion control | \$ 5,087 |
| - cable, clamps, and anchors | \$ 3,354 |
| - fencing materials | \$ 1,420 |

Implementation (32.7%) \$120,334

Planning, Design, and Oversight (26.4%) \$ 97,226

TOTAL (~\$185/l.f.) \$367,934

* Salvage and placement of sod mats and shrubs is incorporated under "construction"

Acknowledgements

- WA State Salmon Recovery Funding Board
 - materials and construction \$188,192
- Bonneville Power Administration (BPA)
Klickitat Watershed Enhancement Project
 - materials, planning, design, & oversight \$139,092
- The Yakama Nation (in-kind)
 - LWD \$ 40,650
- Ralph Kiona, Watershed Technician priceless

For More Information

http://www.ykfp.org/klickitat/KWEP_TepeeIXL.htm

