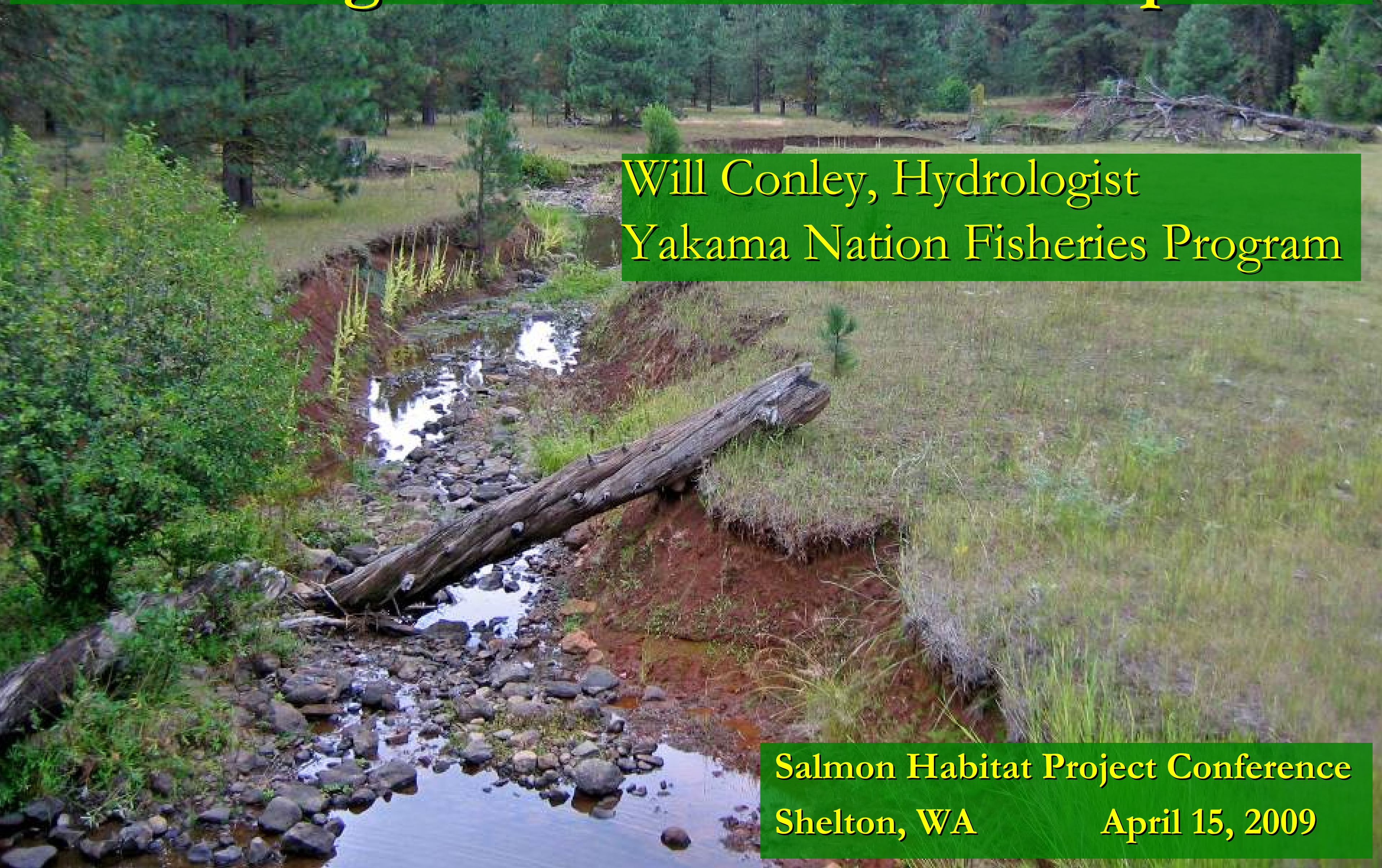
Reversing Channel Incision and Enhancing Steelhead Habitat in Tepee Cr



Will Conley, Hydrologist
Yakama Nation Fisheries Program

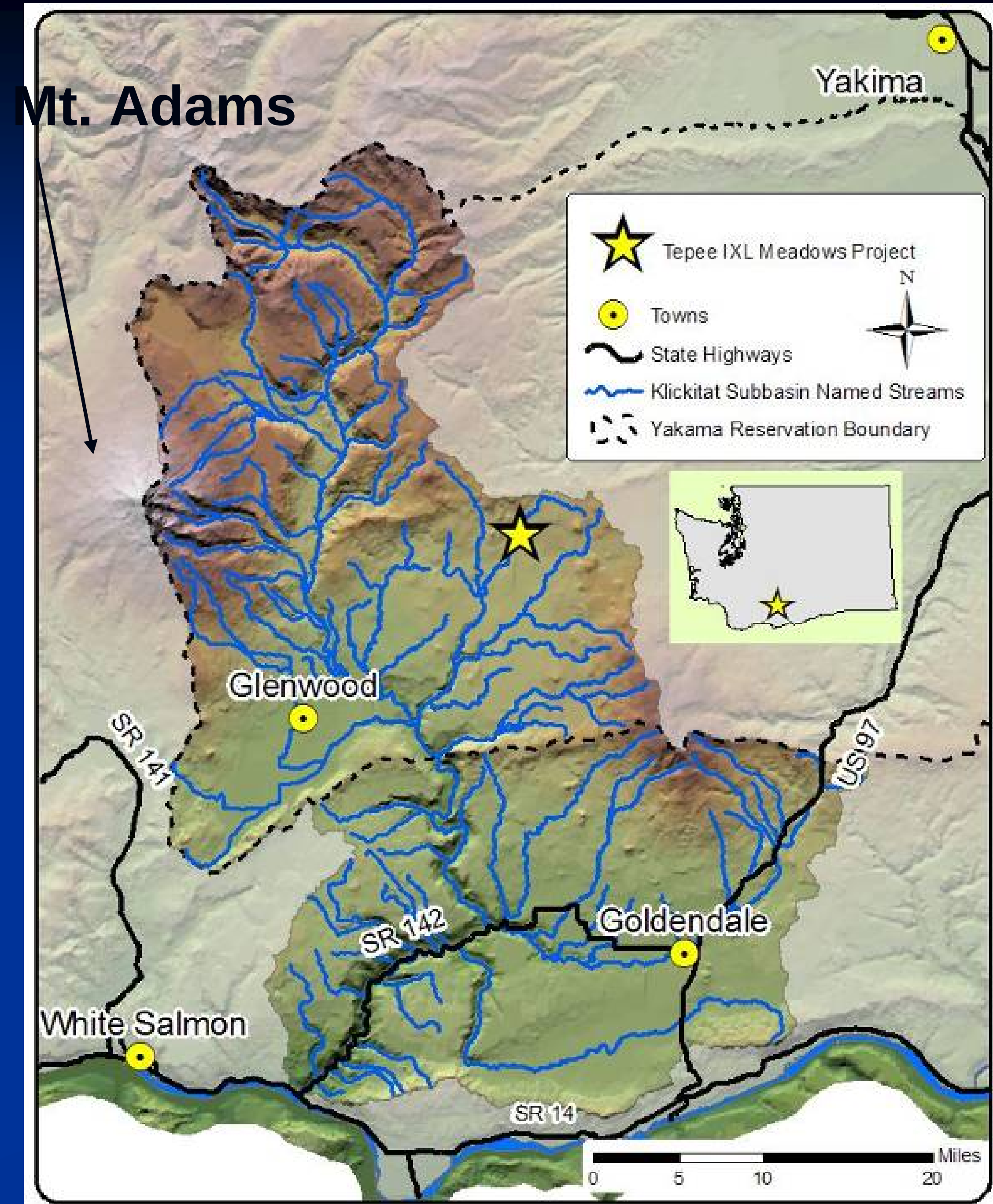
Salmon Habitat Project Conference
Shelton, WA April 15, 2009

Outline

- Background
- Design
- Implementation
- Results
- Insights
  - Bed Material
  - Average Gradient
  - Materials Salvage
- Cost / Acknowledgements
- Special Features…

Location

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



Setting

- Forested watershed (3000-4000’)
- Basal geology is Grande Ronde basalt (CRB group)
- Hard parent materials and low to moderate relief = very limited bedload supply
- Contributing drainage area of 8.4 square-miles
- Project reach is at 2965’ elevation
- Cohesive soils / banks (Aquandic Haploxeralfs)
- Prevailing texture is clay loam

Fisheries Significance

- Habitat for Middle Columbia River steelhead (ESA-“threatened”)
- 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 <u>rearing conditions are poor and limiting</u>
- Reach is located within one of the top priority areas of the Klickitat Salmon Recovery Strategy

Problem

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

Goals

- Restore water table / floodplain storage
- Enhance in-channel habitat conditions for 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 (pre-project)
- Peak-flow hydrology is driven by rain-on-snow events
- Base flow (for years when it exists) = 10-12 gpm
  - $Q_2 : Q_{base} \sim 1 : 6,200$

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

Conceptual:

- Import gravels to raise the bed elevation to restore inundation frequency to the pre-disturbance floodplain
- Build "immature" (higher W/D) cross-section and allow stream to adjust

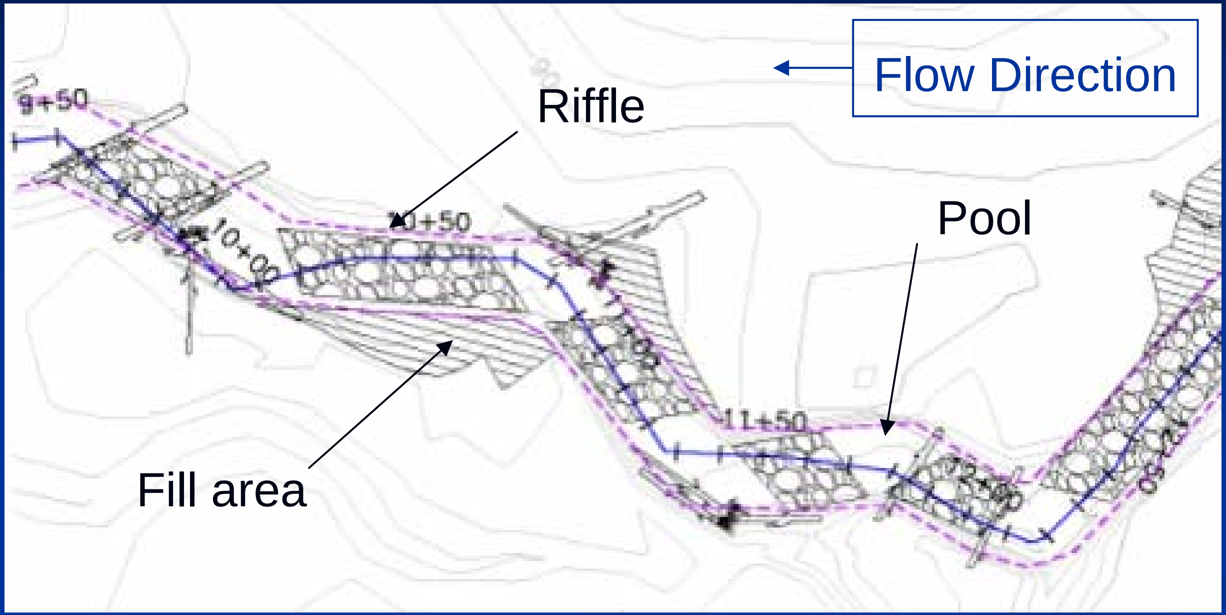
Parameters:

Design dimensions were modeled iteratively in HEC-RAS

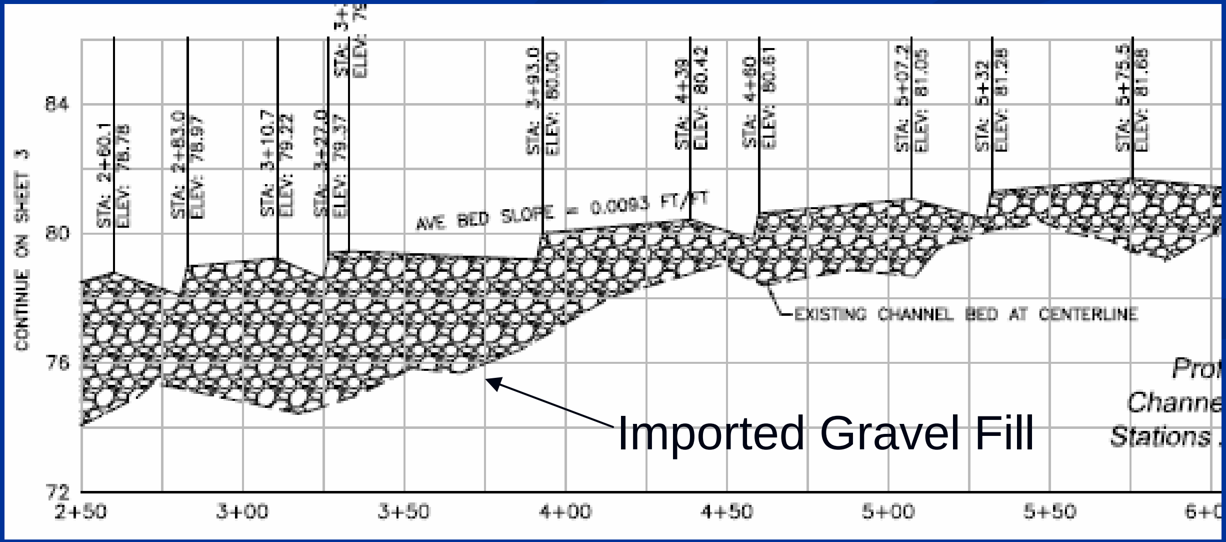
- average slope (0.0093 ft/ft)
- bankfull area = 19.7 ft^2
- bankfull top width = 18.4 ft

30% drawings for fit-in-the-field

Plan View



Profile View



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Sequencing

Implemented over two field seasons:

- Fall 2006
    - All riffles roughed-in
    - Downstream grade control completed
    - All LWD and rock material delivered to site
    - Roughly half of the LWD jams completed
    - Temporary erosion control measures implemented
- Maximum discharge over winter 2006/2007 = 143 cfs
- July 2007
    - Final grading on pools and riffles
    - LWD jams and floodplain LWD completed
    - Revegetation and weed control completed
    - Fence construction completed
    - Access routes rehabilitated

Implementation

- A 140’ coarsened riffle (0.03 ft/ft) was constructed at the downstream end of the reach for grade-control
- 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’
- Overall reach lengthened to 1990’
- 28 LWD jams constructed along channel margins
- Numerous floodplain LWD placements constructed
- Removed 2 culverts and related fill from an abandoned cross-valley road alignment

Downstream Grade Control

Gradation Table
Grade Control Stone

Percent Smaller Than	Diameter (in)
100	16
90	12
50	10
30	8
15	7

140' roughened channel subreach (0.03 ft/ft) to transition to untreated downstream reach

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Typical Riffle Fill: Before & After

STA 6+35

Elevation of constructed bank toe / channel invert

Gradation Table
Imported Gravel

Percent Smaller Than	Diameter (in)
100	4.0
84	1.6
50	0.7
16	0.2

$D_{84} / D_{100} = 0.4$

$D_{84} / D_{16} = 8.0$

$D_{84} / D_{50} = 2.3$

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Typical Riffle Fill and LWD: Under Construction

STA 20+90

(IXL Road Crossing – upstream end of project reach)

Culvert outlets backwatered to improve fish passage

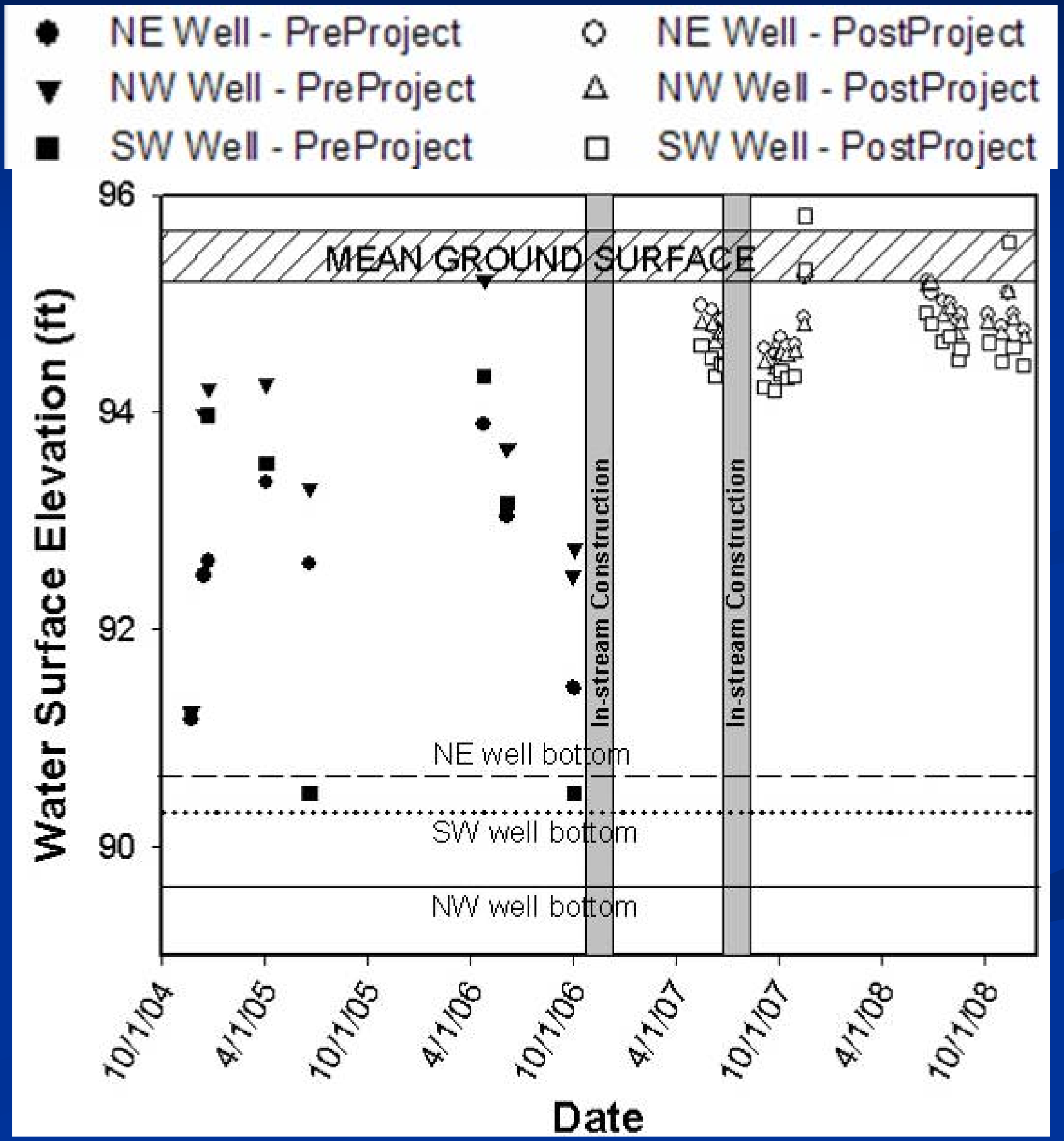
Results

- Flow Duration: perennial pools maintained both years since construction
- 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 ft^2 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

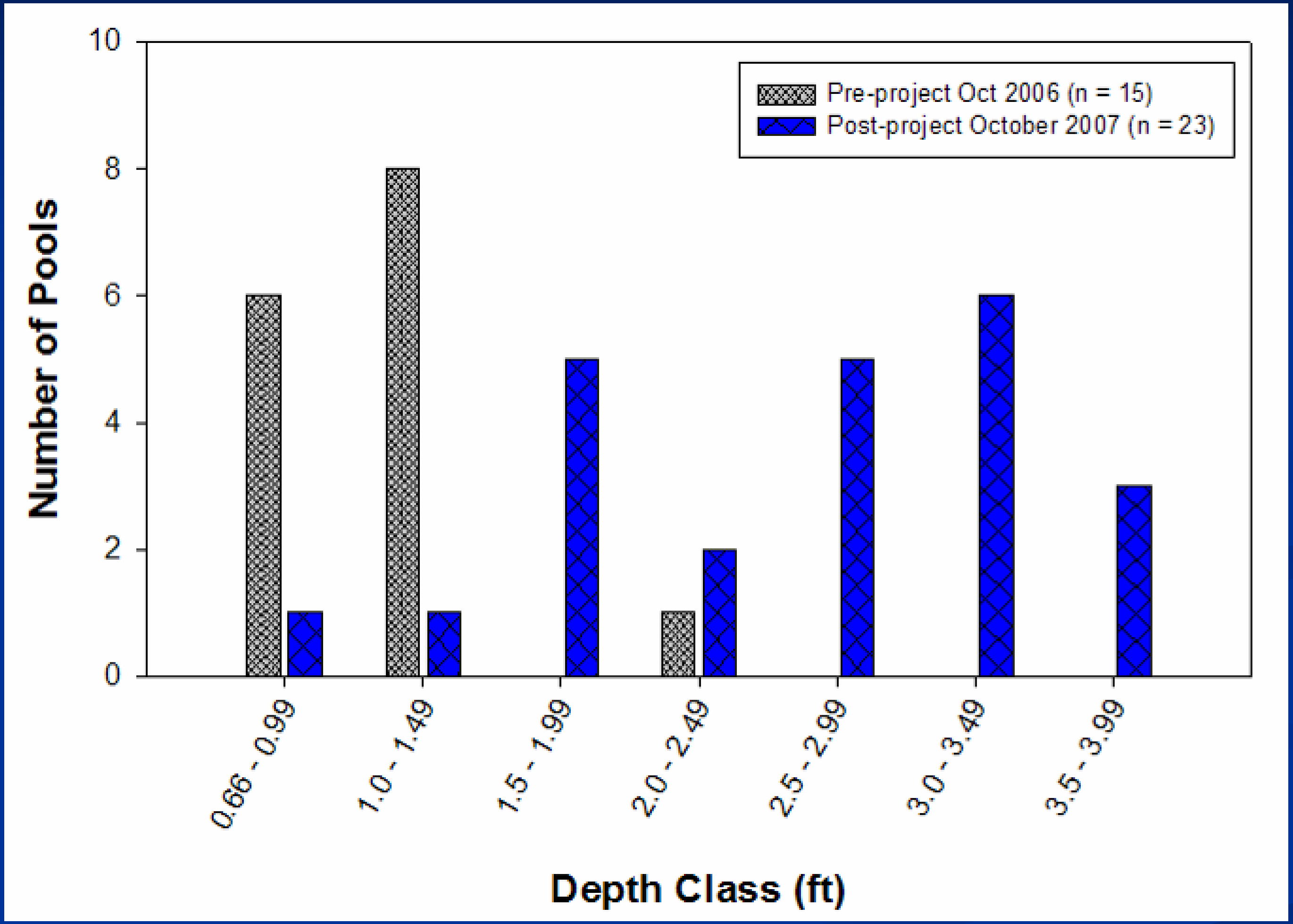
Groundwater

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

One of two steelhead redds observed in project reach in 2007

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Bed Material: Pre-Project

colluvial armor; clasts >40mm
mostly sub-angular

bi-modal distribution;
very high fines content

Bed Material: Sourcing

Crushed vs. Alluvium:

- Which is more like the bed material in the stream?
  - Bed material in Tepee Creek is mostly sub-angular (<40 mm is somewhat sub-rounded)
  - Commercially available alluvium is rounded to well-rounded
- Consider:
  - Ethics of becoming party to floodplain gravel mining
  - Burning additional fossil fuels to haul
  - Project Goals: NOT trying to improve spawning habitat (rearing-limited)
- In the case of Tepee Creek, the costs of hauling alluvium from the Yakima R. floodplain were unjustified

Bed Material: Design

- Size distribution should balance:
  - stability - porosity

Gradation Table
Imported Gravel

Percent Smaller Than	Diameter (in)
100	4.0
84	1.6
50	0.7
16	0.2

$D_{84} / D_{100} = 0.4$

$D_{84} / D_{16} = 8.0$

$D_{84} / D_{50} = 2.3$

- Consider:
  - Ambient passage conditions
  - Temperature vs dissolved oxygen trade-offs
    - D.O. recovers faster than temperature
    - Erred on side of too porous, hence lower potential for adverse temperature and stability effects

Bed Material: Delivery

- End-dump directly to stream or stockpile on-site?
  - f (cost, access, disturbance tolerance)
- Sorting in box of truck during hauling
  - Haul gradations separately and mix on site if necessary
- Inspect material before and during hauling
  - Spend as much time as necessary at source to get distribution right

Bed Material: Observations

- Soil plugs in subgrade of riffle crests:
  - Do increase residual pool depths
  - Are as-yet untested in live-bed conditions
- Riffle porosity inversely correlated with:
  - Amount of tracking by equipment
  - Ambient moisture conditions at time of construction
- Fish passage through constructed riffles
  - Is comparable to ambient conditions
- Macroinvertebrate response very positive
- Steelhead and resident trout spawning observed
- Dissolved Oxygen
  - Appears to be an issue where known groundwater inputs occur

Flow Through Riffles

Threshold for wetting

10/30/08
Surface flow at control
~ 0.56 cfs**

11/4/08
Top-to-bottom surface flow
~ 1.90 cfs**

* STA 13+20 is one of four controls that has a "plug" of native soil in the subgrade

** adult passage and spawning throughout project is comparable to untreated reaches (median spawning flow = 12.6 cfs)

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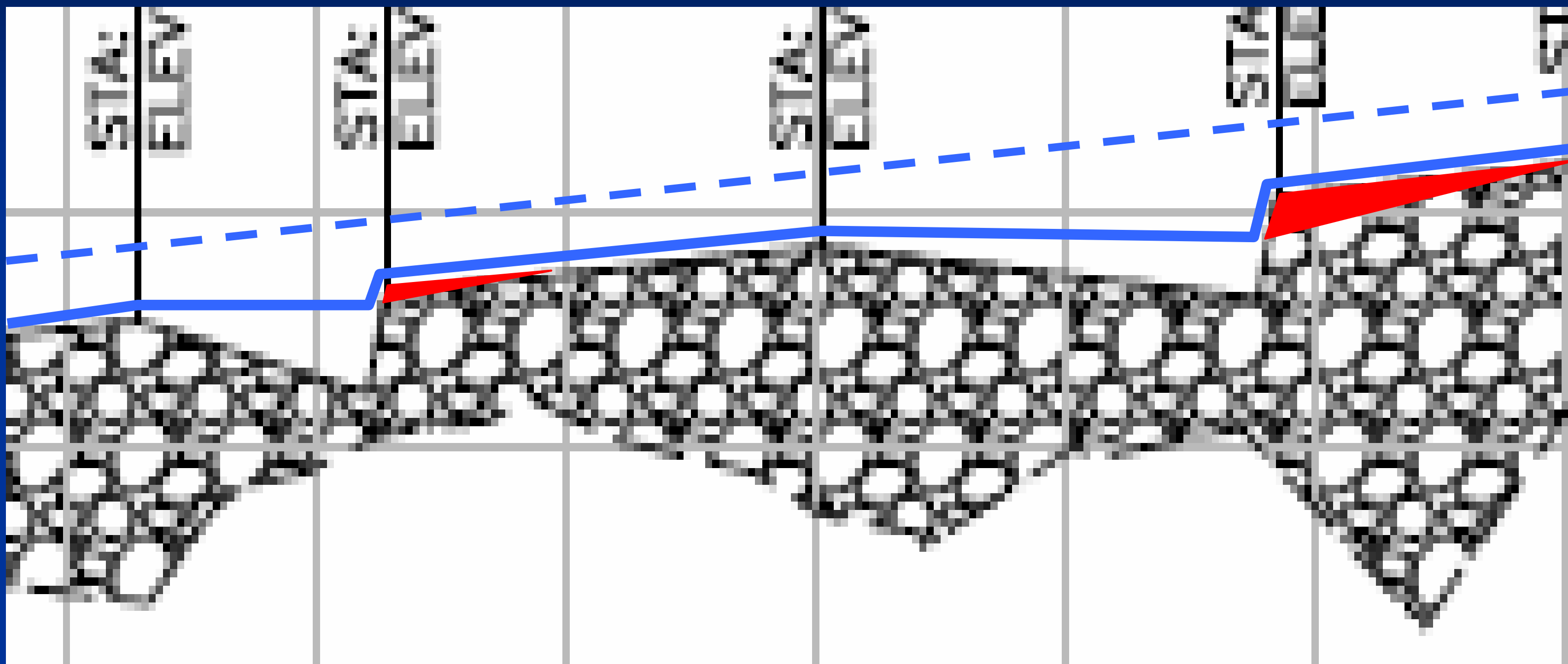
Flow Through Riffles (cont'd)

Q < 0.5 cfs

- No subgrade "plug" in either control
- Both stations have comparable cross-sectional fill areas
- STA 2+70 constructed under wetter ambient conditions than 15+80 (i.e. more intrusion of native fines into fill during construction)

The Thing About Average Gradient…



- Medium to high flows: OK because energy line and bed slope are more or less parallel
- Low flows: energy line is stepped which (in the absence of further treatment) causes headcutting of riffle toes

Implementing Average Gradient

Basically three approaches:

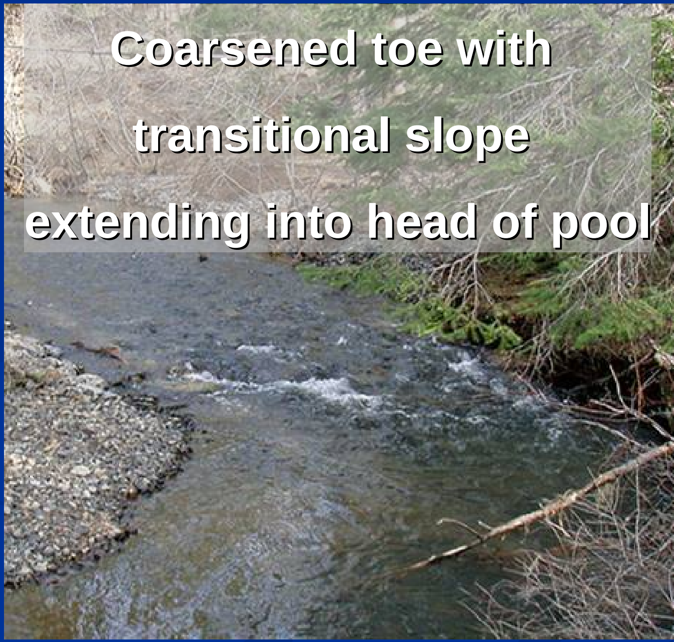
- Extend riffle downstream into pool

  and / or

- Transition slope into head of pool

  and / or

- Harden / armor riffle toe
  - coarsen bed material
  - add a log drop (only done in one place)



Native Material Salvage

Expensive (adds equipment time)

Vegetation: sod and shrubs

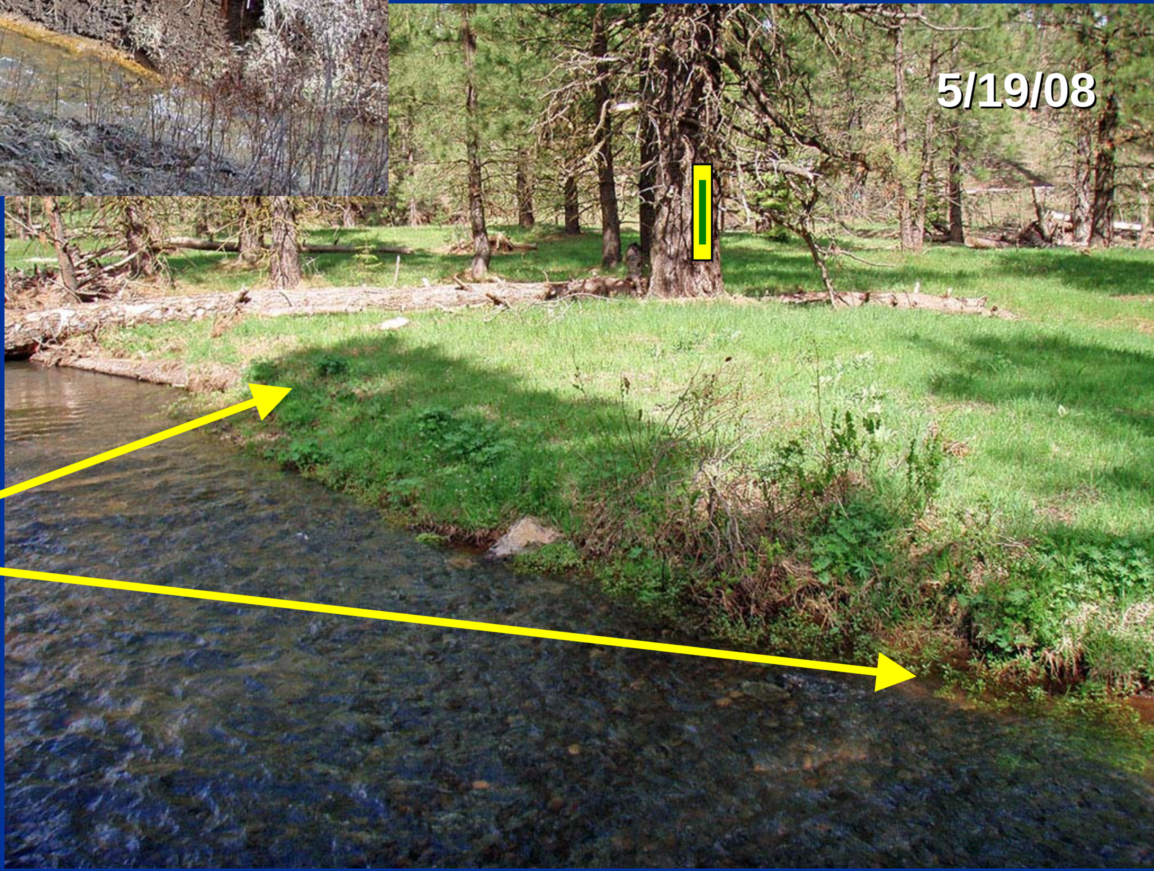
- VERY effective

Gravels

- Mostly window-dressing (in Tepee Creek)

Sod salvage and gravel filling

STA 14+80



Salvaged sod and shrubs used along bank

Ineffective areas intentionally left unfilled

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

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Weeds

- Two bull thistle (*Cirsium vulgare*) individuals observed pre-project
- Thousands of bull thistle rosettes and scores of stalks in first growing season

- Intensive manual pulling in first season (August 2007)
- Virtually no subsequent control required

How Much to "Finish"?

- Build-out pools or leave under-filled?
- Rough-in riffles or finely-grade?
- Trick-out your LWD jams or get primary members placed and secured?
- It's all a matter of $$$$$

Cost

Materials (delivered; 40.9%)	
- rock	$100,013
- LWD	$ 40,500
- revegetation* and erosion control	$ 5,087
- cable, clamps, and anchors	$ 3,354
- fencing materials	$ 1,420
Construction** (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"

** hourly contract

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

A Few Nuggets of Restoration Wisdom…

(rolling with the punches)

If your project is within a commercial timber sale boundary, it's a fair bet the loggers don't care as much about what the stream looks like as you.

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When the grazing permittee (in clear violation of his permit) throws a salt block out next to the creek you began restoring the previous fall, don't be afraid to take matters into your own hands….

(some people just don't get it)

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Pay attention to signs

(keeping in mind that the sign, itself, is not always safe)

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No matter how far out of harm's way you think you placed your saw,

your excavator operator may prove you wrong

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For More Information

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

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