2005 Bank Stabilization Project Plan: Rack Creek

Seattle Public Utilities, Cedar River Watershed
Todd Bohle
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1. Project Overview

Bank erosion along 150 feet of Rack Creek below the 200 road represents a chronic source of fine sediment that is delivering directly to critical bull trout habitat. In addition, the road was within the inner zone of the riparian corridor, preventing the establishment and recruitment on natural vegetation and LWD. To restore the natural processes within this reach, a two-phased project was initiated in 2004. During the first phase, approximately 375 feet of road adjacent to lower Rack Creek (per FPA 2410140) was realigned. The second phase, scheduled for the summer of 2005, will include removal of approximately 2,500 yd^3 of fill and alluvium, the creation of a 10 foot wide floodplain and 10 foot wide bench, placing LWD throughout the active channel and floodplains, and planting native vegetation throughout.

2. Goals

Reduce chronic habitat degradation in the lower 800 feet of Rack Creek associated with encroachment, fill failures, and surface erosion associated with the 200 road. Improve associated bull trout spawning and rearing habitat.

3. Objectives

- 3.1. Minimize erosion to approximately 150 feet of stream bank adjacent to 200 road while protecting the aquatic productive capacity of the site.
- 3.2. Minimize delivery of fine sediment from the 200 road and associated surface erosion from exposed and oversteepened fill material.
- 3.3. Enhance riparian conditions and restore diversity and natural riparian processes within riparian corridor.

4. Design Criteria

- 4.1. Bank toe woody material shall resist buoyancy and shear forces up to and including those that occur during a 100-year recurrence interval flow.
- 4.2. Planting on floodplain, bench, and bench faces shall have 80% cover and survival at the end of second year.
- 4.3. Plant native vegetation that will promote soil stability, minimize surface erosion, and provide functional LWD in the future.
- 4.4. Scour pools created by each LWD jam shall be an average of 120 ft^3 in volume or within 10 feet of a major jam element.
- 4.5. Promote storage of cobble and large gravel necessary for bull trout rearing.
- 4.6. Floodplain surfaces will be stable and promote the establishment of native vegetation.

5. Reach Conditions and Failure Assessment

Extensive chronic erosion of the road fill immediately downstream of the 200 rd bridge is indicated by the approximately 250 lineal feet of bank sloughing observed within and below the project site. Relevant reach characteristics used to develop restoration designs are in Table 1. Due to past attempts to stabilizing the banks with riprap, large 5ft plus diameter boulders are strewn throughout this reach, further constricting flow and creating a boulder cascade morphology through the steepest (middle) portion of this reach. While riprap is serving to armor the bank in some locations, in many instances the riprap and toe of the slope has been completely undermined, resulting in probable future large scale sloughing and erosion. An assessment of the probable failure mechanisms is summarized in the Table 2 below.

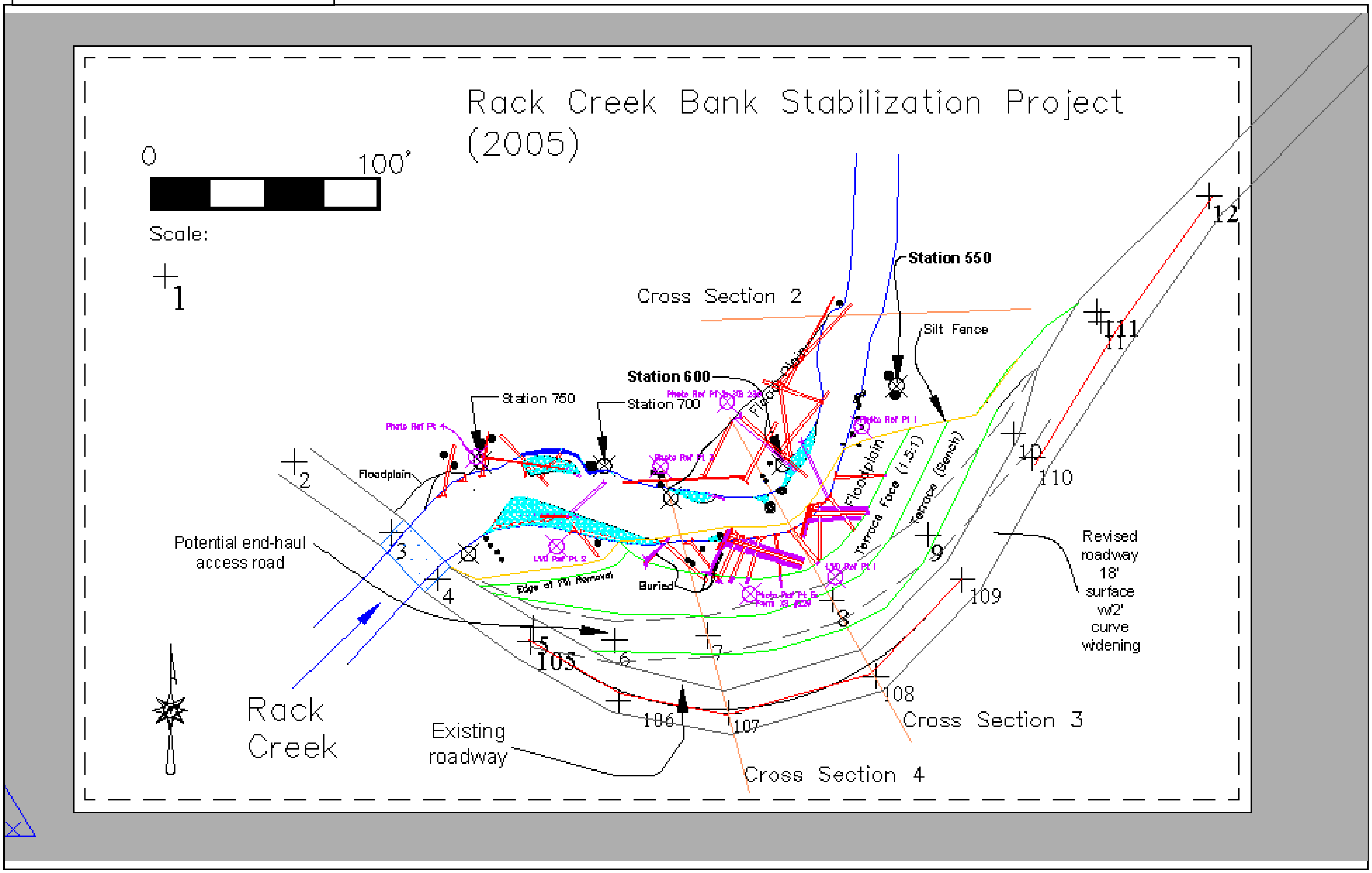
Table 1: Site Characteristics of Rock Creek below the 200 road bridge

Site Elevation	1600 ft
Reach Length	768 ft
Slope	5.1 %
Bankfull Width	20.7 ft
Bankfull Depth	5.0 ft
Channel Type	Plane bed, boulder cascade
Bank Sloughing/Erosion (Lineal Feet)	249.8 (16 %)
Undercut bank (lineal feet)	35 (2.2 %)
Pool Frequency: Unit Pools	3.4 / 100m
Pool Frequency: Pocket Pools	3.0 / 100m
LWD Frequency:	19.2 / 100m
LWD Volume (m^3):	2.36 / 100m
Active Channel Substrate (Dominant/Subdominant)	Cobble/gravel

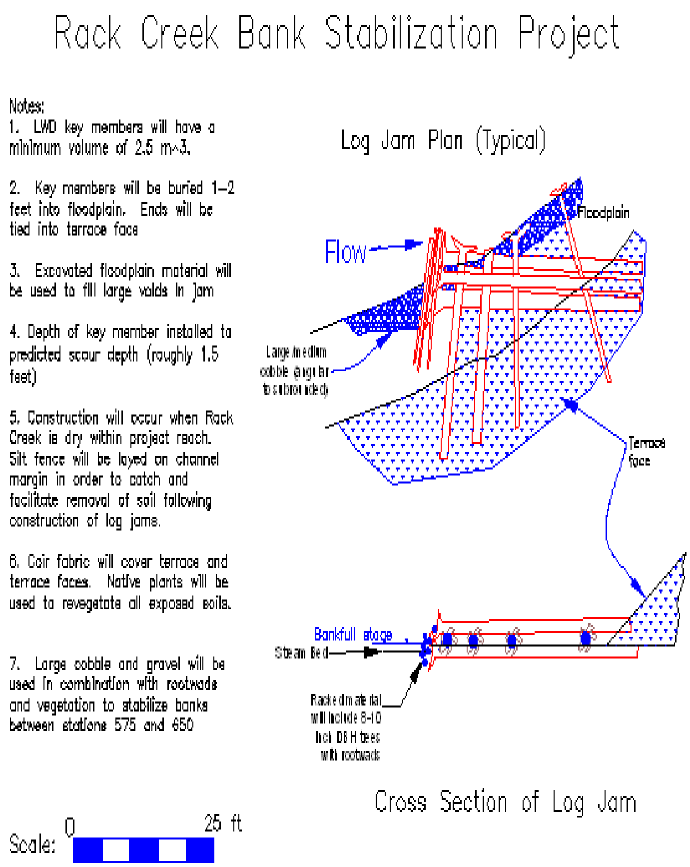
Table 2: Failure Mechanisms, habitat considerations and technical solutions to ongoing Rack Creek bank erosion processes.

Mechanism of Failure	Probable Site/Reach Based Causes	Habitat Considerations	Technical Solutions
Toe Erosion	Reduced vegetative bank structure from road encroachment; along a bend	Removal of large trees and installation of riprap has greatly limited stream-side cover and riparian benefits. Riprap has also prevented creation of overhanging streambanks for cover.	Realign 200 road and create floodplain to reduce constriction and promote flow dispersal during high flows. Revegetate floodplain and bench surfaces with native trees and shrubs.
Fill Failure	Oversteepened fill and lack of root structure	Increased surface erosion and bank failures could contribute to smothering of bull trout spawning habitat in downstream low gradient reach.	Same as above
Constriction Scour	Poorly designed upstream bridge crossing	Energy has resulted in undermining of riprap. Scoured sediments likely deposited immediately downstream.	Replace bridge with one having appropriate cross sectional geometry and area. Place large rootwads at bends to reduce high velocities.
Jet Scour	Abrupt channel bend, resulting in energy sink	Same as Constriction scour	Place large rootwads at bends to reduce high velocities.

Drawing : Plan

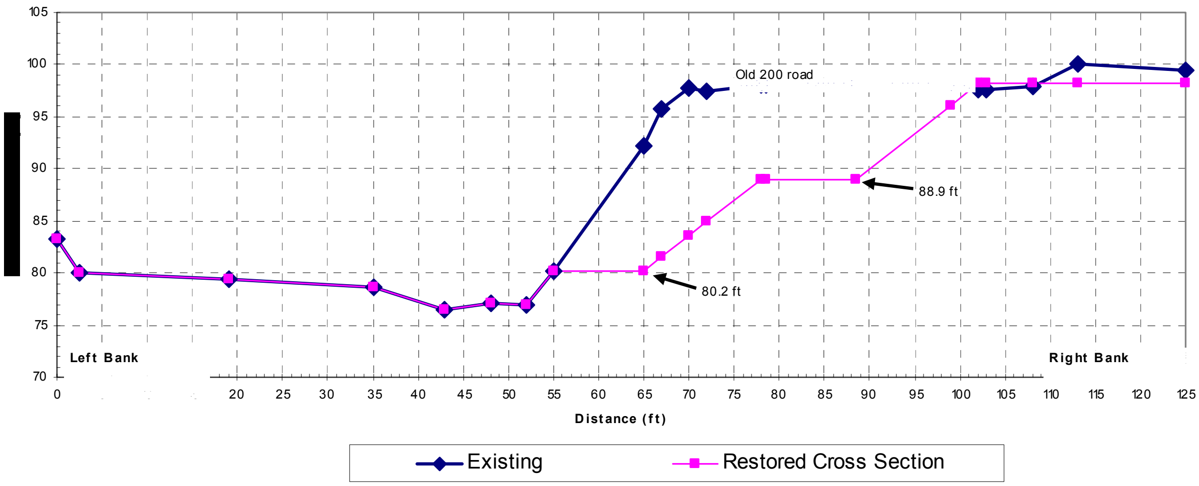


Design Typical:

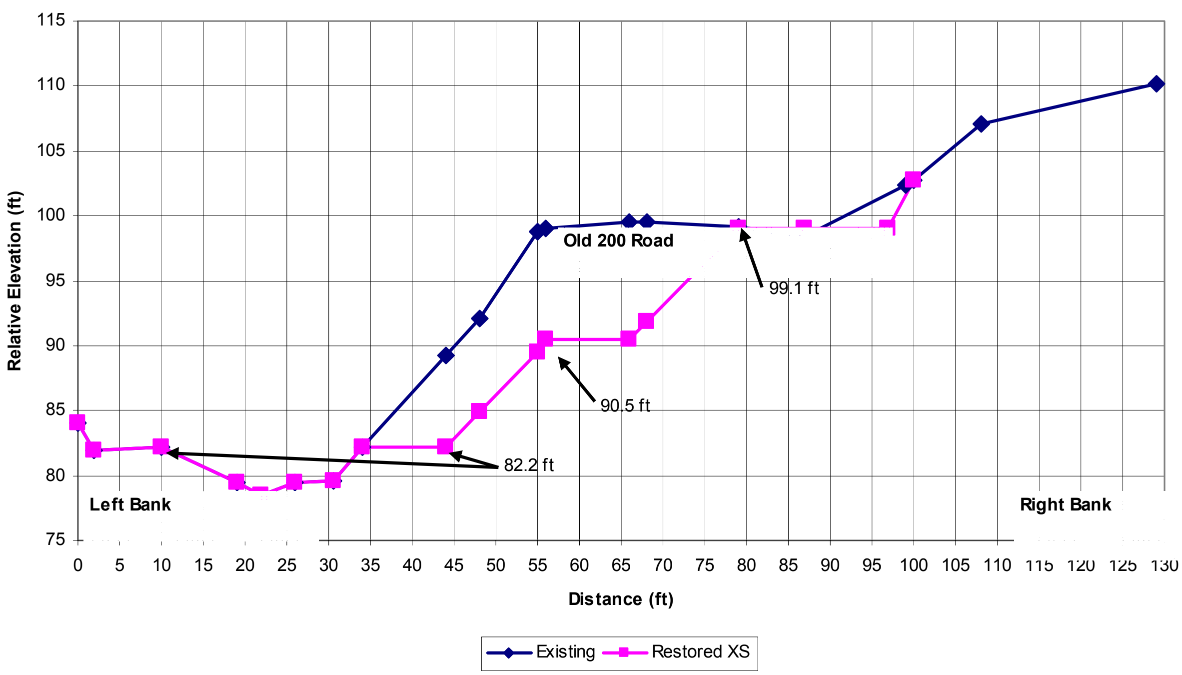


Cross Sections within project reach (locations shown on plan sketch)

Rack Creek: XS #3



Rack Creek: Cross Section 4



6. Materials and Cost Estimates

Worksheet 1: Floodplain construction and LWD placement

Rack Creek Cost Estimate 2005 work Revised 8-12-05

Bank Stabilization

Items of Work	Quantity	Units				Total Cost
Dump Trucks-Haul	2200	CY	1 trips/hr	220	$65	$14,300
Excavator Work	2 1/2 weeks		hours	80	$100	$8,000
LWD staging			hours	30	$78	$2,340
Mobilization			1/2 day	5	$178	$890
Archeological Monitoring	Time and expenses			5.4 days		$ 1,794.00
Silt Fence (materials)						
Silt Fence Installation (EarthCorps)						In Kind
erosion control matting						$ 500.00
Hydro-Todd	60		hours	30	$ 65.00	$ 1,950.00
Projected total expense						**$29,774**
Budget						$ 21,570.00
Balance						**$ (8,204.00)**

LWD Placement

LWD transport (from 105 road)	Excavators	hours	20	$100	$2,000
	Trailor or trash truck (guess)	hours	8	$78	$624
LWD Staging		hours	8	$78	$624
Site Prep (tree cutting)		hours	3	$65	$195
Crane (LWD Installation)		hours	12		$ 3,944.00
LWD Repositioning (by Earth Corps)		day	1		in kind
Water Truck (fire precaution)	?				
Mobilization of Portapotty		hours	1	$65	$65
Personnel (Hydrology)		hours	26	$65	$1,690
Floodplain-LWD Jam Installation					
Excavator		hours	40	$100	$4,000
Personnel		hours	40	$65	$2,600
Round Rock					$ 700.00
Projected total expense					**$13,142**
Budget					$ 21,161.00
Balance					**$ 8,019.00**

Materials and Cost Estimates (continued):

Worksheet 2: Revegetation
Project Site: Rack Creek Revegetation Plan
Area (sq ft): **7500**
Site Characteristics: North aspect; full to partial shade; moist site; fine grained soils. Upper bench fairly welled drained.

species

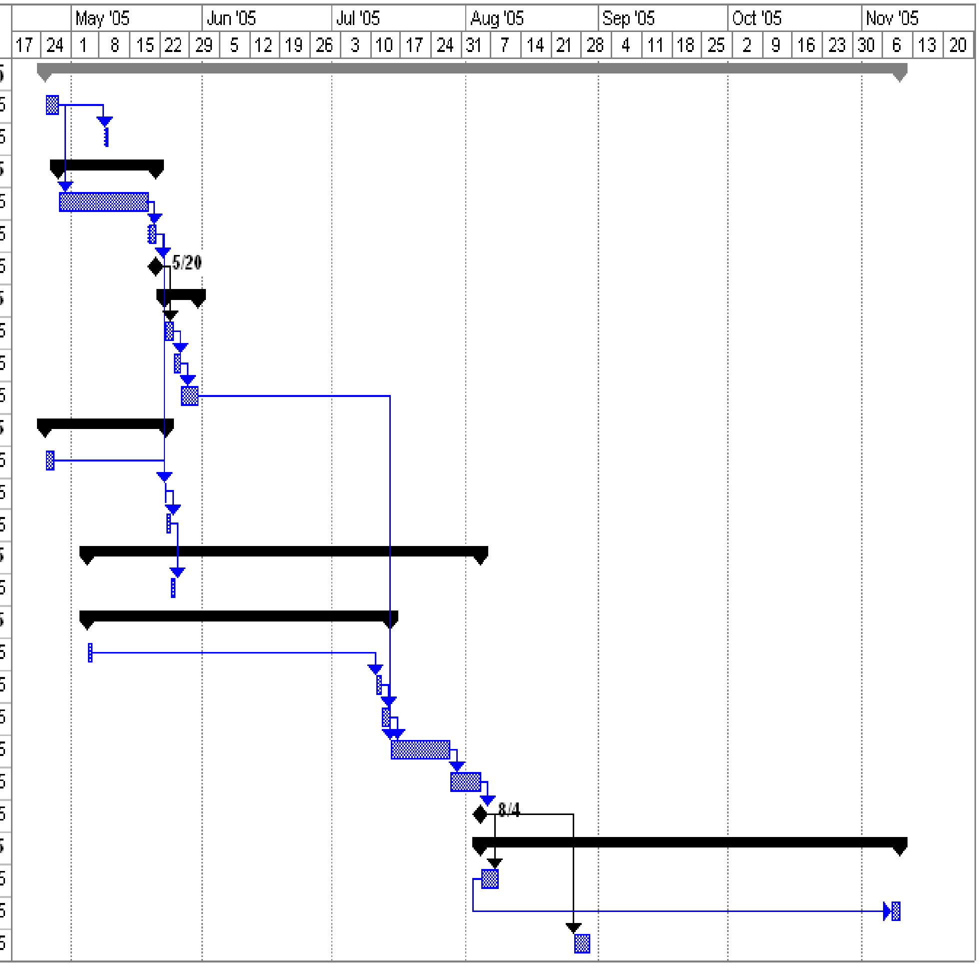
shrubs		
Douglas hawthorn		
Black twinberry		
Indian plum		
Swamp gooseberry		
Salmonberry		
Red elderberry		
Common snowberry		
trees		
Western Red Cedar	Black cottonwood	Red alder
Western Hemlock	Douglas Fir	
willow and cornus		
Cornus sericea	Redosier dogwood	
Salix lucida	Pacific willow	

	number	cost
Trees (9' spacing)	93	$ 254.63
Shrubs (4' spacing)	376	$ 1,015.63
Willow and Cornus (3' spacing)	365	$ 291.67
	total:	**$ 1,561.92**

assumes 1 gallon containers for trees and shrubs; willow and cornus either stakes or plugs
trees: $2.75 ea
shrubs: $2.70 ea
willow and cornus: $0.80 ea

7. Time Line

ID	Task Name	Duration	Start	Finish
0	**Rack Ck Bank Stabilization**	**143 days**	**Mon 4/25/05**	**Wed 11/9/05**
1	Project Design	3 days	Mon 4/25/05	Wed 4/27/05
2	Site Review	4 hrs	Mon 5/9/05	Mon 5/9/05
3	**Permits**	**17 days**	**Thu 4/28/05**	**Fri 5/20/05**
4	HPA-Permit Review	15 days	Thu 4/28/05	Wed 5/18/05
5	Permit Revisions	2 days	Thu 5/19/05	Fri 5/20/05
6	Approved Permit	0 days	Fri 5/20/05	Fri 5/20/05
7	**LWD Mobilization**	**6 days**	**Mon 5/23/05**	**Mon 5/30/05**
8	LWD Relocation -Scope	2 days	Mon 5/23/05	Tue 5/24/05
9	LWD Relocation- Contract	2 days	Wed 5/25/05	Thu 5/26/05
10	LWD Relocation -Transport	2 days	Fri 5/27/05	Mon 5/30/05
11	**Monitoring**	**20.5 days**	**Mon 4/25/05**	**Mon 5/23/05**
12	Monitoring Strategy	2 days	Mon 4/25/05	Tue 4/26/05
13	Pre-Project Monitoring	4 hrs	Mon 5/23/05	Mon 5/23/05
14	Site Layout -Field Demarcation	1 day	Mon 5/23/05	Tue 5/24/05
15	**Implementation**	**65.5 days**	**Thu 5/5/05**	**Thu 8/4/05**
16	Erosion BMP's in Place	1 day	Tue 5/24/05	Wed 5/25/05
17	**LWD Placement (reach)**	**50.5 days**	**Thu 5/5/05**	**Thu 7/14/05**
18	Field Review w/ contractors	1 day	Thu 5/5/05	Thu 5/5/05
19	Contracts	1.5 days	Mon 7/11/05	Tue 7/12/05
20	Implementation	2 days	Tue 7/12/05	Thu 7/14/05
21	Floodplain Construction	10 days	Thu 7/14/05	Thu 7/28/05
22	Log Jam Installation	5 days	Thu 7/28/05	Thu 8/4/05
23	End Construction	0 days	Thu 8/4/05	Thu 8/4/05
24	**Post-Project Work**	**69.5 days**	**Thu 8/4/05**	**Wed 11/9/05**
25	Soil Erosion Mitigation	2 days	Thu 8/4/05	Mon 8/8/05
26	Revegetation	2 days	Tue 11/8/05	Wed 11/9/05
27	Post-Project Monitoring	2 days	Fri 8/26/05	Mon 8/29/05



8. Monitoring Plan

The fundamental goal of project effectiveness monitoring, using a comparison of pre- and post-treatment conditions, is to assess if the LWD structures and constructed floodplain has had the prescribed physical effects on aquatic habitat structure and physical processes. Project monitoring will focus on a few key parameters which serve as either direct indicators of project success or as measures of channel processes needed to understand trends in channel conditions and reasons for project success or failure. Key indicators of success, identified and discussed more thoroughly in the Draft Aquatic Restoration Strategic Plan (2006), include lineal feet of bank sloughing, pool frequency and volume, and LWD frequency and volume. In addition, a channel profile survey, permanent cross sections, particle size distributions, and documenting wood functions and movement are also needed to understand trends in channel conditions and assess the stability of wood with respect to size and placement strategies (e.g., single pieces, multiple piece jams, rootwads). Table 3 summarizes the processes we are striving to either maintain or restore and the parameters used to assess them.

Table 3: Key processes which will be directly and indirectly monitored using one or more parameters.

Process	**Parameter**	**Unit of Measure**	**Time Interval**
Pool Formation	Pool Frequency	Pools/100 m	Years 1, 2, and 5, 10 and 20 (and after >10 year recurrence interval flow if possible)
	Pool Volume	m^3 / 100 m	
Wood Stability	Wood position	Distance along channel	
	Wood Angle	Angle	
	Wood Function	Key functions include: Pool formation, storage of sediment and wood, and bank protection	
	LWD frequency	Frequency of pieces >10 cm diam and 2 m length per 100 m	
	LWD Key Piece Volume	Volume of LWD pieces > $1m^3$ per 100 m	
	Decay Class	Categories 1-5	
Sediment Storage	Longitudinal Profile	Ft/ft	
	Wolman Pebble Counts	Assess trends in bed particle size distribution (D50 and D84) of active channel within project reach.	
	2 permanent cross sections within the project site	Bankfull cross sectional area	
Habitat quality	Undercut bank	Lineal feet of cover	
	Bank Sloughing	Lineal feet of eroding bank	
LWD Recruitment Potential and	Vegetative cover and survival of conifer seedlings	Percent cover	Year 2

Using well established stream survey protocols (CRW Stream Inventory Handbook, 2003; J:\SSW\WS541\Secure\Hydrology\Protocols\Stream Inventory\Final Verision 1.0), standard methods will be used to monitor habitat elements. Habitat data to be collected includes the following: Habitat Unit (type, length, width), Pool forming factors, Pool max and crest depths, Pocket pool (max depth and forming factor), Substrate particle size, and Banks (Length of sloughing and undercutting). Using these protocols, Rack Creek will be inventoried throughout the reach between station 400 ft and the 200 rd bridge. The completion of this inventory will provide data needed to assess the status of habitat conditions following the restoration effort.

<u>LWD Stability and Functions</u>
As wood stability is strongly linked with function and hydraulic effectiveness, the movement of LWD within the reach will be tracked. This effort will also provide information on the size and placement of pieces which resulted in the greatest hydraulic effectiveness and stability. To facilitate tracking of individual pieces, each piece greater than 10cm diameter and 2 m in length within the bankful zone (in addition to those pieces placed on the floodplain) will be tagged in 2 planes using numbered aluminum tags. For each piece, observations and measurements of the following attributes will be made:

LWD Dimensions: Midpoint diameter (nearest inch), length (tenths of feet)
Orientation: 0° (pointing upstream parallel to bankful) to 180° (pointing downstream parallel to bankful).
Reach position: Reference point, distance, azimuth (+/- 0 to 180°)
Age of trees growing on wood? 0, 1-2, 2-5, 5-10, >10
Origin? Placed, Streamside, Non-streamside, Fluvial, Unknown
Rootwads and Rootwads Attached? *Rootwads (for pieces w/ less than 2 m long boles):* Yes/No *Qualifying pieces w/ attached rootwads:* Yes/No
Decay Class: 1 through 5 based on presence of bark and twigs, texture, shape and wood color. Based on TFW Ambient Monitoring Protocol (1994)from Robison and Beschta (1991).
Wood Functions *Pool Type:* plunge (step), flow constriction, flow deflection, none *Sedimentation:* upstream bar, downstream bar, lateral bar, island, none *Erosion:* causing bank erosion, stabilizing bank, n/a *Wood debris:* forming logjam, currently trapping flotsam, future trap, none
Key stability factor (holding wood in place): Bank, rootwad, partially buried in bank, partially buried in substrate, pinned(boulder, trees, bedrock), cabled, none
Trapping Small LWD and Organic Matter: Areal extent of small LWD (<10 cm diameter and 2 m in length)

Using permanent markers (5 ft rebar and white pvc) stationed at approximately stations 600 and 710 feet upstream of Chester Morse Lake, distance and direction (from true north) to the center of each piece of LWD will be made using a standard tape (to the nearest tenth of a foot) and compass . Orientation of each piece will also be documented relative to the nearest bankful edge. Orientation (angle to the nearest 5 degrees) along the piece will be measured while looking from the widest to the narrowest end. In addition, trees pointed upstream (crown pointing upstream) parallel to the bankfull edge have an orientation of 0 degree's while those pointing directly downstream parallel to bankful have an orientation of 180's. Finally, positive angles will be assigned to trees pointing towards the northeast and southeast quadrants and negative angles for trees pointing towards the southwest and northwest quadrants.

9. Adaptive Management Plan

Question	Indicator and Comparison	Trigger Point	Possible Actions	Who Will Respond
Primary Adaptive Management Questions (those used to evaluate success of key project objectives):				
Has road realignment and bank stabilization reduced fine sediment delivery to Rack Creek from road and bank erosion processes?	Reduction in predicted delivery of road-generated fine sediment (Tons/yr/mi^2) from road segments within the Rack Creek project site. WARSEM (WA Road Surface Erosion Model, 2003) will be used to predict fine sediment delivery from road surface erosion associated with pre and post project conditions.	Reduction in predicted road-generated fine sediment delivery of less than 50% by 2007.	Conduct site assessment to evaluate appropriateness of model assumptions and indications of sediment delivery. May also evaluate road improvement BMPs relative to road attributes critical to sediment generation and delivery.	SPU lead hydrologist and Operations Manager
	Pre- and post-project comparison of lineal feet of bank sloughing within project site.	Reduction in lineal feet of sloughing of less than 50% by 2025 or following a greater than 10 year recurrence interval flow.	Assess trigger mechanisms contributing to bank sloughing. Consider additional restoration treatments which would address the underlying processes.	SPU lead hydrologist and Operations Manager
Have the wood placement strategies resulted in stable, functional pieces within the project site?	Extent of post-project remobilization of placed LWD greater than 10 feet downstream.	More than 25% of placed LWD has been transported greater than 10 ft by 2025 or following a greater than 10 year recurrence interval flow.	Assess trigger mechanisms contributing to significant movement of placed LWD. Consider additional restoration treatments which would address the underlying processes (e.g. upstream sediment supply or altered reach hydraulics).	SPU lead hydrologist
	Extent of current LWD functionality within the active channel.	Less than 50% of placed LWD providing pool formation, sediment or wood storage, and bank protection functions by 2025 or following a greater than 10 year recurrence interval flow.	Assess trigger mechanisms contributing to a lack of LWD functionality. Consider additional restoration treatments which would address the underlying processes.	SPU lead hydrologist

Question	Indicator and Comparison	Trigger Point	Possible Actions	Who Will Respond
Have we successfully reestablished native vegetation within the project site?	Percent cover of native understory species where exposed soils occurred within the project site.	Less than 80% cover at year 2 (2007).	Assess trigger mechanisms contributing to a lack of cover. Consider additional restoration treatments which would address the underlying processes (e.g. floodplain scour or terrace erosion) as well as additional planting.	SPU lead hydrologist with assistance from SPU riparian and upland plant specialists.
Secondary Adaptive Management Questions (**those used to evaluate trends in habitat recovery associated with project implementation):**				
Has the large woody debris placed within the active channel improved the quality of instream habitat for Bull Trout?	Pre- and post-project comparison of pool frequency and volumes.	Pool frequency of less than 0.5 per channel width and pool volumes (associated with the 2 jams)of less than 120 ft^3 (3.4 m^3) by 2025 or following a greater than 10 year recurrence interval flow	Assess trigger mechanisms contributing to low pool frequencies or volumes. Consider additional restoration treatments which would address the underlying processes.	SPU lead hydrologist
	Pre- and post-project comparison of LWD frequency.	LWD piece frequency between 29-63 per 100 m by 2025 or following a greater than 10 year recurrence interval flow	Assess trigger mechanisms contributing to low LWD frequencies. Consider additional restoration treatments which would address the underlying processes.	SPU lead hydrologist
	Pre- and post-project comparison of particle size distributions within the active channel.	Reduction in median particle size (D50) of sediment within the active channel through the project reach by 2025 or following a greater than 10 year recurrence interval flow	Assess trigger mechanisms contributing to a lack of fining of active channel substrate. Consider additional restoration treatments which would address the underlying processes (e.g. upstream sediment supply, a change in upstream hydraulics or movement and export of LWD).	SPU lead hydrologist