Appendix A:
Protocols
Riparian Permanent Plots – 2005 field work

Ecosystems Section, Watershed Management Division
Seattle Public Utilities
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David Chapin
Todd Bohle

1. Introduction

This document describes protocols to be used in establishing and sampling riparian permanent plots in the Cedar River Watershed (CRW) downstream of Chester Morse Lake during 2005. These protocols are based on those used in 2003 to sample riparian plots in the upper CRW (upstream of Chester Morse Lake) but differ slightly.

2. Site Selection

A total of 30 permanent plots at 15 sites are to be established in 2005. Preferably each site will consist of two plots on opposite banks of the stream, but in order to distribute plots across the desired cover type strata, some plots may not be paired. Streams selected for the 2005 field work include the mainstem Cedar River, Taylor Creek, Rock Creek, Webster Creek, and Williams Creek.

2.1. Stratification

Sites will be selected along low gradient, moderately to unconfined reaches along these streams. Each reach is defined as continuous stream within Geomorphic Map Units (GMU) 8 through 13. These GMUs represent reaches that are likely to have plane-bed and forced pool-riffle morphologies. Sampling is limited to this stratum of stream reach because:

- sampling time and resources were limited, it was decided to focus on one stratum of stream/channel type;
- low gradient, moderately to unconfined reaches typically show the most variability in riparian conditions;
- stream – riparian interactions are greatest in low gradient, unconfined reaches; and
- fish use of these reaches are generally higher than in high gradient reaches.

Sites will be stratified into four stand types. At least five plots will be established to represent each of the following stand types::

- hardwood dominated (> 70 percent hardwood trees).
- mixed hardwood-conifer (< 70 percent hardwood or conifer)

- conifer dominated – stem exclusion (> 70 percent conifer, with little understory development)
- conifer dominated – differentiated (> 70 percent conifer, understory well developed).

In addition to these four strata, an additional shrub stratum may be sampled, which is defined as tree canopy closure less than 30 percent, and the stand is shrub dominated.

2.2. Site Selection Within Each Reach

Within a reach, sites will be selected by measuring the entire reach length in the GIS and selecting random distances within the reach length using the Microsoft Excel spreadsheet random number generator. The random number will be used to define how far upstream from the reach's lower end a site will be located. These randomly selected locations will be compared with a classified remote sensing image (MASTER hyperspectral data) and aerial photographs to determine the stand type in which the plot occurs. To ensure an equal distribution among stand types, plots in over-represented strata will be randomly selected and their location again randomly selected, until each stand type has at least five plots. A GIS point shape file will be developed in ArcGIS to store the pre-selected sites. Way-points uploaded to a GPS unit and labeled aerial photographs will be used to locate the pre-selected sites in the field. *(Note: site selection will be conducted by SPU.)*

2.3. Final Site and Plot Locations

Upon reaching the preselected location of the site by orientation, the center of the plot edge along the stream bank will be then randomly established by walking along the bank upstream a distance determined by the "watch" technique. The "watch" technique is where one observer looks at his/her watch and another observer says "stop" at an arbitrary time – the location of the second hand is the number chosen. This is to reduce any possible bias in selection of the exact plot baseline center.

Plots will be established on opposite banks in line perpendicular to the stream bank (unless designated as non-paired plots). In some cases, a plot center might be moved up- or downstream due to features that made the plot difficult to sample, such as a cliff; consequently, paired plots may not be exactly opposite one another. Plot locations on the aerial photo will be corrected as needed based on the final plot location, and a GPS location will be taken at the center of the plot edge along the stream.

3. Plot Design and Establishment

3.1. Plot Design

Plots will be 20x45 meters with the long axis perpendicular to the stream bank and with the edge of the plot aligned along the stream bank (see Figure 1 at end of document). Each plot will be further divided into 5 subplots extending away from the stream bank. Subplots will include one 5x20 meter plot on the stream edge (i.e., at bankfull) and four 10x20 meter plots progressing away from the stream, numbered 1 through 5 progressing upslope. This sampling design was developed to allow analysis of gradients away from the stream channel and in relation to different fluvial geomorphic surfaces and associated disturbance regimes.

3.2. Setting up Plots

At the plot center along the stream bank, compass bearings of the stream bank will be taken up and down stream and averaged (accounting for the 180 degree difference). The plot centerline bearing will be established as the bearing perpendicular to the average stream bank bearing. The centerline bearing will be used to calculate plot aspect, since hill slope direction is nearly, if not exactly, perpendicular to the stream bank within the plots.

Along the centerline bearing, a 5 ft long PVC pipe will be set in the ground at 5 meters distance from the bankfull edge (see Figure 1 at end of document). The bankfull edge is typically the line of permanent vegetation (i.e., the "ordinary high water mark"). Since the top of the bank can often be a terrace or sometimes a hillslope, vegetation is probably the best field indicator of the edge of frequent flooding. Two additional pieces of PVC pipe will be established at a 10 meter distance up- and downstream from the centerline PVC post just established. Putting the PVC monument posts 5 meter in from the bank, rather than at the plot edge, is to reduce the chances of disturbance to the PVC posts by stream flow or bank erosion.

From the PVC at the 5 meter mark on the plot centerline, a fiberglass measuring tape will be strung away from the stream bank along the centerline bearing. At sequential 10 meter distances, pink flagging will be hung on a branch or stick along the centerline to mark subplot boundaries. At a slope distance 45 meters from the bank full mark along the centerline, a 5 ft PVC will be set in the ground. From this point, two additional PVC pipes will be set in the ground at the plot upslope corners (i.e., 10 meters up- and downstream on a bearing perpendicular to the centerline). From these plot corners, fiberglass measuring tapes will be strung along the plot edge to the stream bank, connecting to the previously established PVC pipes 5 meters in the from the bank. Flagging will be hung at 10 meter intervals to mark subplot boundaries. PVC posts will be previously painted red or pink on the top end and labelled with the date, plot number, and post location relative to (1) upstream, downstream, or center; and (2) upslope or downslope.

3.3. Witness Trees

Three witness trees will be established at the upslope-center post for purposes of relocating and reestablishing the plots in the future. To establish the PVC pipe at this location more securely, it is to be placed over a piece of rebar driven into the ground. Trees used as witness trees should be larger, dominant trees and spaced in different quadrants (not necessarily in the plot). Tree diameter, species, distance (ft), and bearing to the PVC post will be recorded. The witness tree number, distance, and bearing will be etched onto a soft aluminum tag and nailed to the tree.

3.4 Photographs

Photographs will be taken with a digital camera with a wide angle lens setting (generally the widest angle on most automated digital cameras with a zoom lens). Five photographs will be taken, one for each subplot. For subplot #1 (the one along the stream bank), the photograph will be taken from the center of the stream channel toward the plot in line with the plot centerline. For subplots #2 through #5, the photographs will be taken at the downslope side of the subplot along the centerline looking upslope .

4. Sampling

4.1. Trees and snags

All trees in the plot greater than or equal to 5 in diameter breast height (dbh) will be identified to subplot location, and species; measured for dbh, estimated for crown ratio (crown as percent of height), and put in a crown class (Table 4-1). All trees in the upstream half of the plot will be tagged with numbered aluminum tags. If the number of trees in the upstream plot half is less than 25, trees in the downstream plot half will also be tagged. Height (estimated), dbh, and decay class of all snags greater than 5 in dbh will be recorded (Table 4-2).

Heights of three trees in each crown class will be measured with a laser rangefinder and recorded by tree number. Typically 10-12 trees will be measured for height. Cores of at least two dominant trees measured for height in each of plots 2 and 3 and plots 4 and 5 will be collected and stored temporarily in straws. The cores will be protected from damage (stored in a cardboard tube) and delivered to SPU within one week of being collected. SPU will subsequently mount cores in grooved wooden blocks, sanded, and read to determine tree age. All cored trees are to be included in the sample of trees measured for height.

Table 4-1. Tree crown classes to be used in CRW 2005 riparian plot sampling.

Code	Name	Description
Is	Isolated	Tree crowns receive full light from above and all sides. Usually the general level of the canopy is not evident.
Do	Dominant	Trees with crowns that extend above the general level of the trees immediately around the measured trees. They are somewhat taller than the codominant trees, and have well-developed crowns, which may be somewhat crowded on the sides, receiving full light from above and partly from the side.
Co	Codominant	Trees with crowns forming the general level of the trees immediately around the measured trees. The crown is generally smaller than those of the dominant trees and is usually more crowded on the sides, receiving full light from above and little from the sides.
In	Intermediate	Trees with crowns below, but extending into, the general level of the trees immediately around the measured trees. The crowns are usually small and quite crowded on the sides, receiving little direct light from above but none from the sides.
Ov	Overtopped	Trees with crowns entirely below the general level of the trees around the measured trees, receiving no direct light either from above or from the sides.

Table 4-2. Description of snag decay classes to be used in CRW 2005 riparian plot sampling.

	Stage of Decay				
Snag Characteristic	**I**	**II**	**III**	**IV**	**V**
Bark	Tight, Intact	50% loose of missiong	75% Missing	75% Missing	75%+ Missing
Limbs & Branches	All present	Few limbs, no fine branches	Limb stubs only	Few or no stubs	None
Top Breakage	May be present	May be present	~1/3	~1/3 to 1/2	~1/2+

Sapwood condition	Sound, incipient decay, hark, original color	Advanced decay, fibrous, firm to solft, light brown	Fibrous, soft, light to reddish brown	Cubical, soft reddish to dark brown	
Sapwood decay	None to incipient	None to incipient	None to 25%	25%+	50%+ Advanced
Heartwood condition	Sound, hard, original color	Sound at base, incipient decay in outer edge of upper bole, hard, light to redish brown	Incipient decay at base, advanced decay throughtou upper bole, fibrous, hard to firm, reddish brown	Advanced decay at base, sloughing from upper bole, fibrous to cubical, soft, dark reddish brown	Sloughing, cubical, soft, dard brown, OR fibrous, very soft dard reddish brown, encased inhardened shell
Bole form	Intact	Intact	Mostly intact	Losing form, soft	Form mostly lost

4.2. Shrubs

Cover of "low shrubs" (all shrub species,vine maple less than 6 ft high, and sword fern) will be measured along the centerline using the line-intercept method. The beginning and end distance of continuous interception by each shrub species along the fiberglass measuring tape used to mark the centerline will be recorded. Due to the often dense and overlapping shrub cover, interception distance will be recorded only to the nearest 10 cm.

In the case of vine maple greater than 6 ft high, shrub cover across a two meter wide belt transect running down the subplot centerline will be estimated for each subplot. Thus, cover of vine maple less than 6 ft high will be recorded as "low shrub", and that greater than 6 ft high as "tall shrub."

4.3. Herb

Note: The consultant will not need to sample herb cover. Herb cover will be measured by SPU at a later time, when herbaceous plant phenology is more advanced.

Herb cover will be measured within a 1 m^2 quadrat in each subplot. The 1 m^2 quadrat will be located along the upstream side of the centerline in the middle of the subplot. The quadrat will be framed on two sides by a 2-meter folding, wooden measuring ruler and on a third side by the centerline tape. The upslope edges of the quadrats will be set at the 2.5, 10, 20, 30,and 40 m marks on the centerline for Subplots 1, 2, 3, 4, and 5, respectively.

Within each quadrat, the cover of all herb and fern species (including swordfern) will be estimated according to modified Daubenmire cover classes (Table 4-3) and recorded. In addition to herb cover, cover by moss, duff, wood (> 5 in diameter), rock, mineral soil, and tree bole (including large exposed roots) will be estimated and recorded.

Table 4-3. Modified Daubenmire cover classes for estimating herb cover in riparian plots.

	Cover Class						
	1	2	3	4	5	6	7

Percent cover range	< 1	1-5	6-25	26-50	51-75	76-95	96-100

4.4. Other Species

All herb and shrub species observed in the plot but not recorded in the shrub and herb sampling will be recorded as "other species." Although a reasonably thorough survey of each plot for additional species is intended, some rare species of small stature may possibly be overlooked.

Note: The consultant will only need to record shrubs as "other species", as herbs will be recorded at a different time.

4.5. Saplings

Saplings are defined here as stems of tree species less than 5 in dbh. Saplings will be recorded by subplot, species, size class, and the substrate on which they were growing: Size classes are:

- class 1 = between 0.5 and 4.5 ft high (seedlings < 0.5 ft high are not counted);
- class 2 = greater than 4.5 ft height and less than 3 in dbh;
- class 3 = greater than 4.5 ft height and between 3 and 5 in dbh.

Substrate classes are mineral soil/duff, stumps, and coarse woody debris (greater than 5 in diameter).

The areas sampled for samplings can vary, depending on the density of saplings. In most plots, the whole plot will be sampled, but if the density of saplings is estimated to be greater than 200 total saplings/plot , only the upstream half of the plot need be sampled. If class 1 saplings (particularly western hemlock) are greater than 400 class 1 saplings/plot , an area consisting of a 2 meter wide belt running down the center of the plot (perpendicular to the stream bank) may be sampled for this size class (i.e., 1/10 of a plot). Area sampled for each plot (and size class) will be noted to allow scaling up to a standard plot and subplot area. All subplots in each plot must have the same size of area sampled.

4.6. Coarse Woody Debris

Coarse woody debris (CWD) is defined as wood pieces greater than 5 in diameter and 36 in length. The centerline and two transects perpendicular to the centerline will be sampled for coarse wood (See Figure 1). The two perpendicular transects will be the boundaries between subplots 2 and 3 and between subplots 4 and 5. Thus, a total of 85 m of transect will be sampled for CWD (45 m centerline plus 2 x 20 meter subplot boundaries). Sampling of CWD consists of measuring the diameter, estimating the length, and recording decay class of any wood (greater than 5 in diameter) intercepted by the sample transects. Diameter will be measured at the point of interception. Decay class of CWD will be ccording to the scheme in Table 4-4.

Table 4-4. Decay classes for sampling coarse woody debris in riparian plots.

	Stage of Decay				
Snag Characteristic	**I**	**II**	**III**	**IV**	**V**
Bark	Intact	Intact	Trace	Absent	Absent
Twigs	Present	Absent	Absent	Absent	Absent

Texture	Intact	Intact to partially soft	Hard, large pieces	Soft, blocky pieces	Soft, powerdy
Shape	Round	Round	Round	Round to oval	Oval
Color of Wood	Original	Original	Original to faded	Light brown to faded or reddish brown	Faded to light yellow or gray, or red brown to dark brown
Portion of tree bole on ground	None; Tree elevated on supports	Parts touch; tree still elevated on supports, but sagging	Tree sagging near ground, or bole on ground	All of tree on ground, or partially below ground	All of tree on ground or below ground
Invading roots	None	None	In sapwood	In heartwood	In heartwood

4.7. Canopy Closure

Canopy closure will be measured in two locations in each plot, defined by the intersection of the centerline with the boundaries between plots 2 and 3 and between plots 4 and 5. Canopy closure will be measured with a spherical densiometer (Robert E. Lemmon, Bartlesville, OK), following the standard protocol provided with the densiometer, with one exception: instead of facing north, east, south, and west while making the measurements, the observer faces in opposite directions along the centerline (i.e, upslope and downslope) and along the perpendicular transect (i.e., upstream and downstream). Counts of dots in open sky are generally made (since the amount of open sky is less than canopy), but percent canopy closure will be ultimately calculated.

4.8. Elevation Profile

An elevation profile of the plot will be made along the plot centerline. The elevation data will be collected using standard level survey methods with a hand level and a stadia rod (in decimal units of feet):

- The hand level is placed on a unipod to maintain a consistent instrument height.
- Measurements (to the nearest tenth of a foot) are taken at the plot edge (i.e., bankfull), at each of the subplot boundaries, and at any noticeable changes in elevation or slope.
- Bankfull of each of the two plots that is measured at a site is assigned an arbitrary elevation of 0.0 ft and marked with a short piece of flagged rebar.

Elevation data from the two plots and the stream will be combined to provide a profile of the valley floor and any adjacent valley wall included in the two plots. The slope of each subplot will be determined from the elevation data. Subplot elevation is calculated as the average of the elevations along its centerline boundaries.

4.9. Stream Data

Some basic data on stream attributes will be collected at each site, but no attempt will be made to thoroughly characterize stream characteristics. The following stream data are to be collected:

- Gradient – measure with a Suunto clinometer or laser rangefinder (units = percent); the average of upstream and downstream measurements are to be recorded.
- Substrate – the dominant and subdominant (in terms of cover) substrate size will be estimated using the following definitions: sand = < 2mm; gravel = 2 to 64 mm; cobble = 64 to 256 mm; and boulder = 256 to 4096 mm.

- Canopy closure – using a sphericial densiometer as described in Section 4.7. Measurements are made facing upstream, downstream, toward left bank, and toward right bank
- Stream Cross Section – following the same methods described in Section 4.9 for the elevation profile, a cross section of the stream bed will be made made. Elevations are surveyed for bankfull, thalweg (more than one if multiple channels), and gravel bars. The stream profile thus provided bankfull depth and width. (*Note: The consultant will not have to survey the stream profile on the Cedar River plots; all other streams are generally less than 10 m wide).*

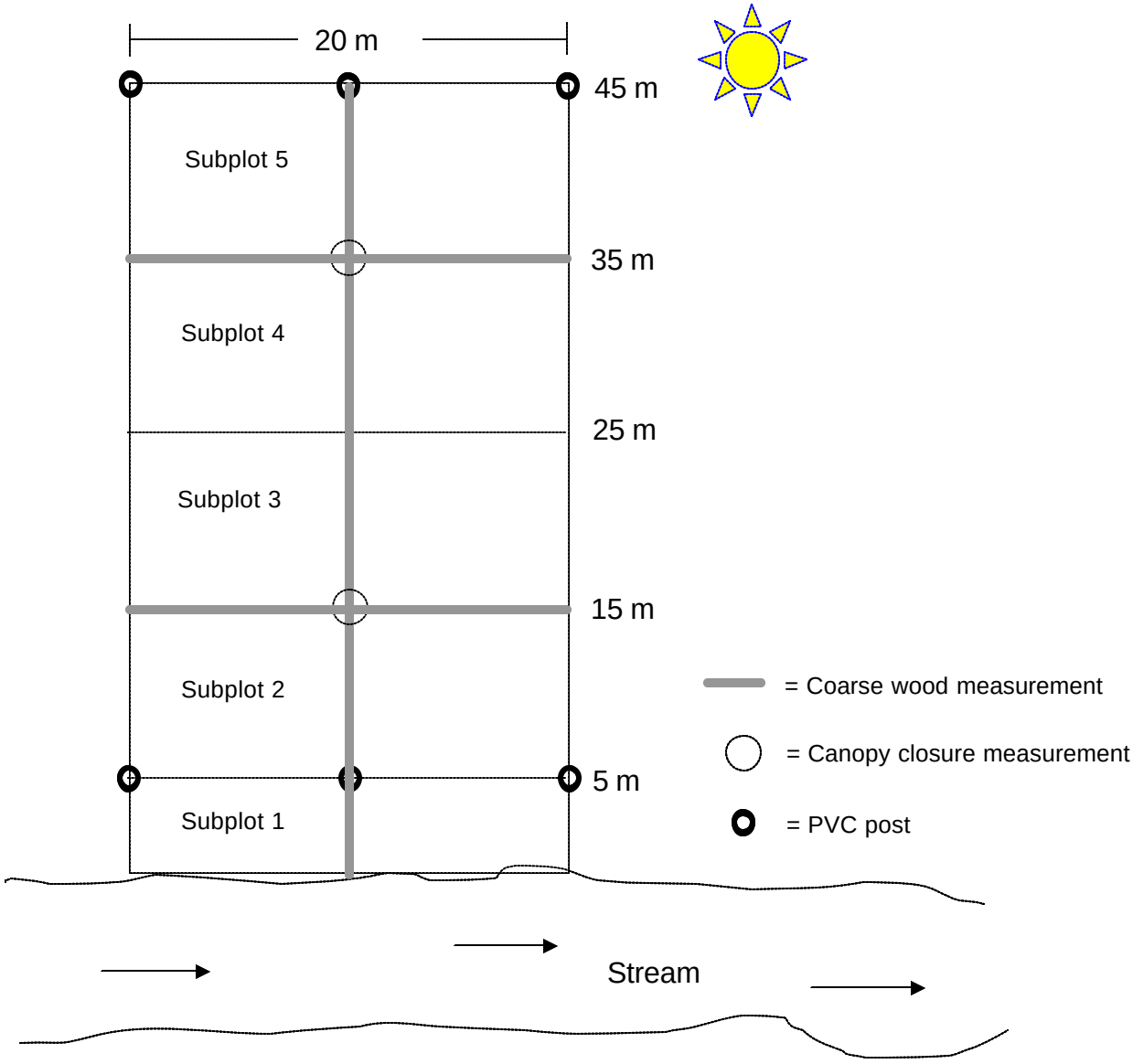

Figure 1. Riparian plot layout.