New Hampshire Department of Environmental Services
Generic QAPP for Fluvial Morphology Data Collection
Appendix D
Representative Pebble Count Procedures

Representative pebble counts in support of fluvial geomorphology data collection generally follow the Wolman pebble count procedure, which is used to measure the diameter of the intermediate axis of 100 bed particles (pebbles) along transects across a stream channel. The data yields a size distribution of streambed material. In this method, the observer measures the sizes of random bed particles using a ruler or gravelometer. A step-toe procedure is used to select particles for measurement. The method outlined here is used for Phase 3 assessments. Pebble counts conducted in Phase 2 assessments utilize a slightly modified version of this procedure, as defined in the Vermont Agency of Natural Resources Stream Geomorphology Assessment Protocols.

Phase 3R assessments

For a reach or site in which a pebble count is to be conducted, one person should perform the pebble count of 100 particles. An assessment is typically conducted over a 20 to 30 bankfull width length of stream. Where possible, the pebble count should proceed proportionally through different types of bed features (riffles, pools, runs, bars) that are present in a given reach or segment. For example, if 75% of the reach length is composed of riffles and 25% of pools, then about 75 pebbles should be measured at riffles, and about 25 in pools, to sum to 100 samples. Pebbles should be measured at standardized intervals along the sample route. At each location where a pebble is selected, the observer should avert their eyes and select the first pebble encountered with the index finger beside your big toe.

Steps

1. Select a river or stream reach that is 20 to 30 bankfull channel widths in length.

2. Determine the percentage of the reach length comprised of different feature types (i.e., riffles, pools).

3. Configure the particle sampling locations and transects so that each of the different features types present (i.e., riffles, pools) are sampled on a proportional basis, as described in the introduction to this section. Proportional sampling is important, as pools often contain finer particles than riffles, where the particles are coarser. This procedure ensures a careful representation of the streambed particle distribution in the reach of interest.

4. Start the pebble count at the bankfull elevation on one streambank. While averting your eyes, pick up the first pebble that you touch with your index finger beside your big toe.

5. Measure the b-axis of the selected pebble (Figure 1) with either a ruler, or through the hole in the gravelometer the pebble fits through. Record the data on a form or

in a field notebook (example provided as Figure 2). Pebbles measured on transects within each feature type are recorded separately (thus, data from transects in riffles are kept separate from data in pools). If the pebble is embedded or is too large to move, measure the shortest axis visible with a ruler. Bed particles smaller than gravel (< 0.1 inch) are placed into the sand or silt/clay categories by the feel of the material when rubbed between the index finger and thumb. As this is sometimes necessary, it is important that individuals who have experience conducting pebble counts and encounter these situations perform the assessment. When completed with the measurement, the pebble should be placed back on the bed in the approximate location in which it was picked up.

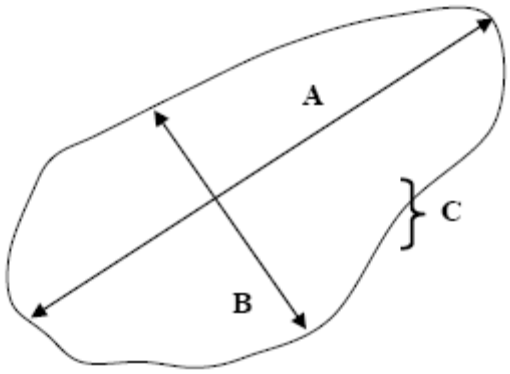

Figure 1. The "b" axis of a bed particle (pebble), representing width is what is measured. In this diagram, "a" represents the length, and "c" represents the thickness. (Courtesy: Vermont Stream Geomorphic Assessment Handbook.)

6. Establish a transect by taking a step into the water, in a direction perpendicular to the main flowline, and repeat the process above. Then, take another step across the stream, perpendicular to the main flowline and repeat the process until you reach the opposite bankfull elevation. Start a new transect at a location across the channel that will provide the desired representation in Step 3, and repeat the process. Collect 100 pebble measurements.

7. The segmented data can then be combined to produce a total for assessed reach characterization purposes.

*Additionally, if desired, greater precision in selecting pebbles for measurement can be achieved by setting up a measuring tape across the channel on a transect, and then selecting equidistant locations along the tape for measurement. Then, the pebble along the transect at that location is picked up and assessed. Data is otherwise collected and recorded as described in the steps above.

**The total number of pebble measurements is 100. As the locations and number of transects will be known, 100/number of transects can provide the number of measurements per cross-section and therefore, the spacing on each.

In consideration of the reach of river in which the pebble count will be performed, if you suspect that you will encounter areas with deep pools such that accurate characterization of bed material will not be possible with this method (i.e., it is too deep to reach down and pick up a pebble), then you may need to adjust the reach area in which the pebble count is conducted. If this is not possible within the study area, then a bed sampler may

need to be used for sample collection in support of sieve analysis, and thus, this pebble count procedure will not be used.

Phase 3S assessments

Pebble counts are also performed in Phase 3S assessments. The purpose of such assessments is to support an analytical design approach for restoration projects. Thus, while the basic approach to pebble counts is similar to those conducted in Phase 3R, additional considerations and need for detail exist given the need to support shear stress and hydrologic modeling. When performing a pebble count in a Phase 3S assessment, variations on the procedure include the following, at a minimum:

1. Restoration projects, particularly where hydraulic modeling may be involved, may require greater than 100 pebble measurements to increase the precision of the particle size distribution. Up to several hundred could be needed in the largest applications.

2. If the bed in the reach contains very coarse particles (i.e., dominantly boulders and cobbles), a larger step spacing compared to normal will be required to minimize the chances of counting the same particle more than once.

By its nature, Phase 3S assessments are designed to be used in situations where detailed field data collection (both in terms of topography and bed material) is required to support hydraulic modeling for projects. Site-specific situations in large-scale projects may require additional variation on the procedures outlined here. Bunte and Abt (2001) provide a detailed discussion on multiple field methods of particle size distribution determination that can aid in making appropriate selections that support a particular project objective if extremely detailed data collection is required.

Material	Size Range (mm)		Size Range(in)		Count
silt/clay	0	0.062	0.000	0.002	
very fine sand	0.062	0.125	0.002	0.005	
fine sand	0.125	0.25	0.005	0.010	
medium sand	0.25	0.5	0.010	0.020	
coarse sand	0.5	1	0.020	0.039	
very coarse sand	1	2	0.039	0.079	
very fine gravel	2	4	0.079	0.157	
fine gravel	4	6	0.157	0.236	
fine gravel	6	8	0.236	0.315	
medium gravel	8	11	0.315	0.433	
medium gravel	11	16	0.433	0.630	
coarse gravel	16	22	0.630	0.866	
coarse gravel	22	32	0.866	1.260	
very coarse gravel	32	45	1.260	1.772	
very coarse gravel	45	64	1.772	2.520	
small cobble	64	90	2.520	3.543	
medium cobble	90	128	3.543	5.039	
large cobble	128	180	5.039	7.087	
very large cobble	180	256	7.087	10.079	
small boulder	256	362	10.079	14.252	
small boulder	362	512	14.252	20.157	
medium boulder	512	1024	20.157	40.315	
large boulder	1024	2048	40.315	80.630	
very large boulder	2048	4096	80.630	161.260	
bedrock					
		Total Particles:			

Figure 2. Particle size classes used in a pebble count.

References

Bunte, K., Abt, S.R. 2001. Sampling surface and subsurface particle-size distributions in wadable gravel- and cobble-bed streams for analyses in sediment transport, hydraulics, and streambed monitoring. Gen. Tech. Rep. RMRS-GTR-74. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 428p.

Rosgen, D. 1996. *Applied River Morphology*. Pagosa Springs, CO: Wildland Hydrology.

Wolman, M.G. 1954. A method of sampling coarse river-bed material. *Transactions, American Geophysical Union*, 35(6):951-956.