APPENDIX A
STREAMBED MATERIAL ANALYSIS METHODS

Many methods are used to determine streambed material particle size and gradation. Several methods are discussed in this appendix.

Sand Gauge Reference Card - This method is best suited for sandy channel bottoms. The reference cards are small laminated plastic cards showing samples of different sand gradations. The samples are labeled, typically as coarse sand, medium sand, fine sand, etc. The card is placed on the streambed and the bed material is visually matched with a sample. The sand classification is considered to be the sample that best matches the sand.

Laboratory Sieve Test - This procedure is best suited for non-cohesive gravel, sand, and silt channel bottoms. Fine materials such as silt should not comprise more than ¼ of the sample. The method is to take a representative sample and perform American Association of State Highway and Transportation Officials (AASHTO) Test T-27 "Sieve Analysis of Fine and Coarse Aggregates." ODOT uses this method to test asphalt concrete aggregate, Portland cement concrete aggregate, and road base aggregate. Equipment to test samples with particle size gradations of 1-1/2 inch or less is fairly common throughout the state. A 33 pound sample, minimum, would be needed for a single test of bed material with a 1-1/2 inch maximum size. Smaller samples are used for finer materials. For example, an 11 pound sample (minimum) is adequate for bed material with a ¾ inch maximum size.

Wire Screen Method – This method is best suited for gravel channel bottoms. A wire screen with a square 1-inch mesh opening size is placed on the channel bottom. The gravel size is visually estimated using the mesh opening size as a reference. For example, a pebble that fills about ¼ of the mesh opening has a diameter of approximately ½ inch. Photographs of the screen over the bed material are a useful reference when discussing particle size and gradation.

Pebble Count Method – This is the best method for stream bottoms with larger stone sizes such as boulders, cobbles, gravels, etc. The pebble count method is a field method for determining the particle size distribution or gradation of streambed material. To determine the gradation, 100 particles are randomly selected for measurement. To avoid potential bias, the actual particle picked up for measurement must be selected on the "first blind touch", rather than seen and selectively picked up. The intermediate axis of the particle is measured. The measured particle sizes are then grouped together according to the sizes shown in Table 1. The pebble count data is then plotted on a log-normal graph as shown in the example. The D_{50} size or other required particle size is selected from the graph.

Table 1: Particle Class vs. Size

Particle Class	Size (inches)
Silt/Clay	Less than 0.002
Fine Sand	0.002 – 0.01
Medium Sand	0.01 – 0.02
Coarse Sand	0.02 – 0.04
Very Coarse Sand	0.04 – 0.08
Fine Gravel	0.08 – 0.32
Medium Gravel	0.32 – 0.63
Coarse Gravel	0.63 – 1.26
Very Coarse Gravel	1.26 – 2.51
Small Cobbles	2.51 – 5.0
Large Cobbles	5.0 – 10.1
Small Boulders	10.1 –20.2
Medium Boulders	20.2 – 40.3
Large Boulders	40.3 – 80.6
Very Large Boulders	80.6 – 161

Pebble Count Example

This example illustrates how to determine the particle size distribution or gradation of streambed material from a pebble count. Table 2 summarizes the raw data that was obtained by measuring the intermediate axis of 100 randomly selected particles in the field.

Table 2: Pebble Count Data

Count No.	Size (inches)	Count No.	Size (inches)	Count No.	Size (inches)	Count No.	Size (inches)	Count No.	Size (inches)
1	5	21	7/8	41	11/16	61	2 3/8	81	1 3/4
2	3	22	4	42	2 5/8	62	1	82	2
3	4 5/8	23	15/16	43	2	63	14	83	3 1/8
4	2	24	3 3/4	44	1 13/16	64	3/4	84	1 9/16
5	1	25	1 1/4	45	1 9/16	65	1 1/2	85	2 3/8
6	4 1/2	26	1 1/8	46	3	66	3 1/4	86	1 1/8
7	7 1/2	27	3 1/4	47	2 1/4	67	7/8	87	3 3/8
8	1 7/8	28	2	48	5/8	68	2 3/16	88	1 3/16
9	1 5/8	29	1 9/16	49	8	69	2	89	2 1/4
10	2 3/16	30	3	50	1 1/4	70	1 11/16	90	3/4
11	1 13/16	31	2 1/4	51	1 7/8	71	11/16	91	1 7/8
12	4 1/2	32	1 3/4	52	2 1/4	72	3 1/4	92	7/8
13	2 3/8	33	2 1/2	53	7/8	73	15/16	93	2 1/16
14	1 1/2	34	3 3/16	54	2 3/4	74	2 1/4	94	1 5/8
15	1 1/4	35	1 3/8	55	1 3/4	75	5/8	95	5 1/8
16	4 1/8	36	1	56	2 3/8	76	1 3/8	96	1 1/2
17	1 3/8	37	8	57	1 1/8	77	3 3/8	97	3 3/4
18	1 3/4	38	2 1/4	58	1 5/8	78	5/16	98	1
19	2 1/4	39	3/4	59	3	79	11/16	99	2 1/2
20	1 11/16	40	1 1/2	60	2 1/4	80	2 7/16	100	1 1/4

The raw data is then separated into the various particle classes in order to determine the particle size distribution shown in Table 3.

Table 3: Particle Size Distribution

Particle Class	Size (inches)	Count	Percent Total	Percent Cumulative
Silt/Clay	Less than 0.002	0	0	
Fine Sand	0.002 – 0.01	0	0	
Medium Sand	0.01 – 0.02	0	0	
Coarse Sand	0.02 – 0.04	0	0	
Very Coarse Sand	0.04 – 0.08	0	0	
Fine Gravel	0.08 – 0.32	1	1	1
Medium Gravel	0.32 – 0.63	2	2	3
Coarse Gravel	0.63 – 1.26	24	24	27
Very Coarse Gravel	1.26 – 2.51	47	47	74
Small Cobbles	2.51 – 5.0	20	20	94
Large Cobbles	5.0 – 10.1	5	5	99
Small Boulders	10.1 – 20.2	1	1	100
Medium Boulders	20.2 – 40.3	0	0	
Large Boulders	40.3 – 80.6	0	0	
Very Large Boulders	80.6 – 161	0	0	

The data listed in Table 3 is summarized in Table 4. A curve through the data points listed in Table 4 is shown in Figure 1. The D_{50} or other particle sizes of interest can be obtained from Figure 1. For example the D_{50} is 1.8 inches.

Table 4: Particle Size vs. Percent Finer

Particle Size (inches)	Percent Finer
14	100
10.1	99
5.0	94
2.51	74
1.26	27
0.63	3
0.32	1

Figure 1: Stream Bed Gradation Curve