Rhode Island Department of Environmental Management
Office of Water Resources
235 Promenade Street, Providence RI 02908

Standard Operating Procedure for Measurement of Substrate Size Distribution, Benthic Algae and Plant Cover by Modified Pebble Count

SOP-WR-W-45

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DISTRIBUTION

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Title: Standard Operating Procedure for Measurement of Substrate Size Distribution, Benthic Algae and Plant Cover by Modified Pebble Count
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1. APPLICABILITY

This SOP applies to all Office of Water Resources (OWR) staff involved in collecting substrate size distribution, benthic algae, and plant cover measurements in shallow, wadeable stream reaches using a modified pebble count. Exemption from the use of this SOP for project work shall be allowed for reasons of inapplicability determined by management discretion.

2. PURPOSE

This SOP establishes a standardized method for performing semi-quantitative field measurements of substrate size distribution, benthic algae, and plant coverage in wadeable streams using a viewing bucket and modified pebble count. It sets a consistent protocol to ensure the quality of OWR's data collection—resulting in improved uniformity, reproducibility, verifiability, and defensibility of the data, as well as increased program credibility.

3. DEFINITIONS

3.1 RIDEM – Rhode Island Department of Environmental Management

3.2 OWR – Office of Water Resources

3.3 SOP – Standard Operating Procedures

3.4 Benthic algae – Micro- and macroalgae growing on the bottom of a stream or lake

3.4.1 Macroalgae – Algae that have either a large colonial structure or a plant like structure visible to the naked eye

3.4.2 Microalgae – Algae that are either unicellular or colonial without structure visible to the naked eye

3.5 Plant matter – Any plant-like matter, vascular or non-vascluar

3.5.1 Vascular plants lack vascular tissue to transport water and materials, which limits their size to less than 20 cm. Plants appear leafy but lack true stems, roots, and leaves. Includes mosses, liverworts, and hornworts.

3.6 Wadeable stream – Perennial streams 1st through 4rd order draining a watershed area of at least 0.5mi^2 and with a maximum depth less than or equal to 1.0m.

3.6.1 Perennial stream – A stream with continuous flow year-round under typical conditions

3.7 Riffle – A section of stream characterized by shallow, fast-flowing water with the water surface broken by the presence of rocky substrate

3.8 Pool – A section of stream characterized by deep, slow-moving water with the surface not broken by the presence of rocky substrate

3.9 Run – A section of stream that is characterized by fast-flowing water with the surface not broken by the presence of rocky substrate

3.10 Riparian area – The area of land immediately adjacent to the stream

3.11 QA – Quality Assurance refers to a systematic process to ensure production of valuable, accurate, reliable, reproducible and defensible environmental data.

3.12 QC – Quality Control refers to the activities performed to affirm production of valuable, accurate, reliable, reproducible and defensible environmental data.

3.13 QI – Quality Improvement refers to any act or process performed to enhance the value, accuracy, reliability, reproducibility or defensibility of environmental data collected by RIDEM OWR.

3.14 Pebble – Stone riverbed material.

4. RESPONSIBILITIES

4.1 TRAINING

Any RIDEM/OWR personnel collecting substrate size distribution, benthic algae, and plant cover measurements with a modified pebble count for a RIDEM project or program should have completed RIDEM's Quality System Awareness Training Program with appropriate documentation from the Quality Assurance Manager. This training ensures the field analyst recognizes the importance of proper data collection and management and he/she comprehends the significance of the environmental decisions that may be made with the data. It is suggested that field analysts have also completed the USEPA Water Quality Standards Academy Basic Course and Supplemental Topic Modules online, but additional special training or certification is not required.

To properly perform the modified pebble count, the field analyst must be familiar with and comply with the data collection techniques stated in this SOP. The field analyst is required to read and understand this SOP. The field analyst should complete and submit any required training forms and/or field assessments for project and/or program QAPPs to document proficiency with this procedure. Any field analyst not familiar with performing the modified pebble count should be assisted by OWR staff who are accustomed to performing the procedure.

4.2 RESPONSIBILITIES OF FIELD ANALYST

The field analyst is responsible for checking the required equipment in the Sampling Center at the beginning of the sampling event before taking measurements in the field. The field analyst is responsible for ensuring that all supplementary equipment (waders/hip boots, etc.) is present and in working condition. The field analyst is also responsible for using best professional judgment to determine if site conditions are safe for performing the procedure. The field analyst is accountable for employing proper measurement procedures and data recording in accordance with this SOP.

4.3 RESPONSIBILITIES OF PROJECT OR PROGRAM MANAGER

The project or program manager is responsible for providing the materials, resources, and/or guidance necessary to perform the measurements in accordance with this SOP. The project manager is responsible for ensuring that the field analyst performs the modified pebble count in accordance with this SOP and that any additional, project-specific requirements are communicated to the project team. The project manager will determine and communicate with field analysts what procedures and order of procedures are to be accomplished during each sampling event at each sampling location. Further, the project manager shall ensure annual review and periodic revisions to this SOP as necessary to reflect current needs and standards as well as renew this SOP every five years.

5. GUIDELINES AND PROCEDURES

5.1 REQUIRED MATERIALS

The following materials are necessary for this procedure:

- Metric Ruler (Similar to Fisher Scientific Item S40641P)
- Datasheet (Figure 1)
- Clipboard
- Pencil or Rite in the Rain Pen (Similar to Forestry Suppliers Item 49237)
- Waders, hip or knee boots
- 2 - Handheld Tally Counter (Similar to Grainger Item 2PAU4)
- Arm-length puncture resistant gloves (Similar to Grainger 1AHG1)
- Tape Measure

Figure 1. Viewing Bucket Datasheet for Monitoring Section Sampling Events

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Pebble Count Sampling Datasheet

Site Number:		**Station Name**				**Town:**	
Date:		**Military Time:**			**Collectors:**	**WBID:**	
Meter #				**Pictures:**			
Max Depth:		ft		**Lat/Long**			
Weather:	**Clear**	**Overcast**		**Sunny**			
(Circle)		**Raining**	**Windy**		**Partly Cloudy**		
Comments/ Notes:							

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Site Number: _____ **Stream Segment:** _____

PEBBLE COUNT PARTICLE SIZE

Particle Size	Description	Tally	Total
Sand	<2mm		
Gravel	2-16mm		
Course Gravel	16-64mm		
Cobble	64-256mm		
Boulder	>256		

50? **YES** **NO**

PEBBLE COUNT PLANTS

Rank	Description	Tally	Total
0	No visual evidence		
1	Some <5% coverage		
2	5-25% coverage		
3	>25% coverage		

Page 3

Site Number: _____ **Stream Segment:** _____

PEBBLE COUNT MICROALGAE

Rank	Description	Tally	Total
0	No visual evidence		
1	Substrate slimly, biofilm not visible; Green coloration		
2	Thin layer present		
3	0.5-1mm		
4	1-5mm		
5	5-20mm		
6	2cm		

PEBBLE COUNT MACROALGAE

Rank	Description	Tally	Total
0	No visual evidence		
1	Some <5% coverage		
2	5-25% coverage		
3	>25% coverage		

5.2 PROPER USE OF VIEWING BUCKET AND PERFORMANCE OF PEBBLE COUNT

For most purposes, the modified pebble count is used specifically for in situ benthic algae cover measurements taken directly in the field, in wadeable streams. This method does not require sample containers or preservation.

5.2.1 RECORDING PARAMETER UNITS

The following units should be used when recording measurements taken with the viewing bucket:

Macroalgae percent cover..... rank tally

Microalgae mat depth……..rank tally

Plant matter mat depth…….....rank tally

Substrate size…...……rank tally

5.3 FIELD MEASUREMENT PROCEDURES

5.3.1 DETERMINE FIELD PROCEDURE SCHEDULE

Prior to departure, the project manager will communicate with the field analysts what procedures should be accomplished for each sampling trip to the sampling location and the order the field procedures should be completed. Prior to performing this analysis, the field analyst should ensure the pebble count is taken in the correct order. This procedure may disrupt sediment, fish and benthic organisms, which can interfere with other field procedures and sample collections in streams. Pebble count measurements should be taken after these samples have been collected. However, pebble count measurements should be taken before any sampling procedure or activity that may disturb bottom sediments to avoid increasing turbidity at the location. The field analyst should note any disturbance to the bottom sediment in the Comment/Notes section of the field datasheet (Figure 1) or appropriate field notebook.

5.3.2 ESTABLISH TRANSECTS

The field analyst will establish three (3) transects running diagonal across the stream. The field analyst should observe the location of riffles, runs, and pools along the stream segment. The field analyst should locate transects in areas with runs and riffle, if present, and avoid locations with large pools.

The transects should be approximately at a 45º angle to the right bank (Figure 2). The field analyst should observe the amount of shade and, using best professional judgment, locate the transects to capture the

range of shade conditions available (Figure 2) and substrate conditions (Figure 3). The location of the transects should not overlap another transect on any part of the transect.

Figure 2. Appropriate establishment of transects

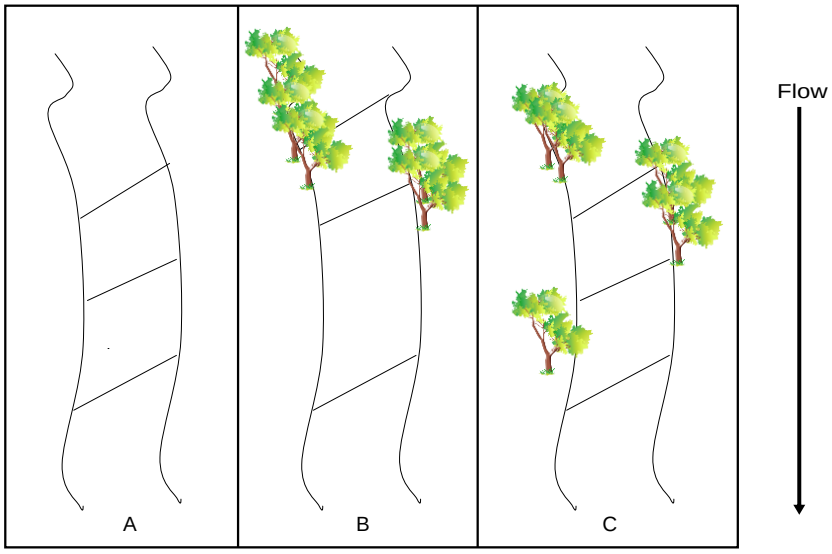
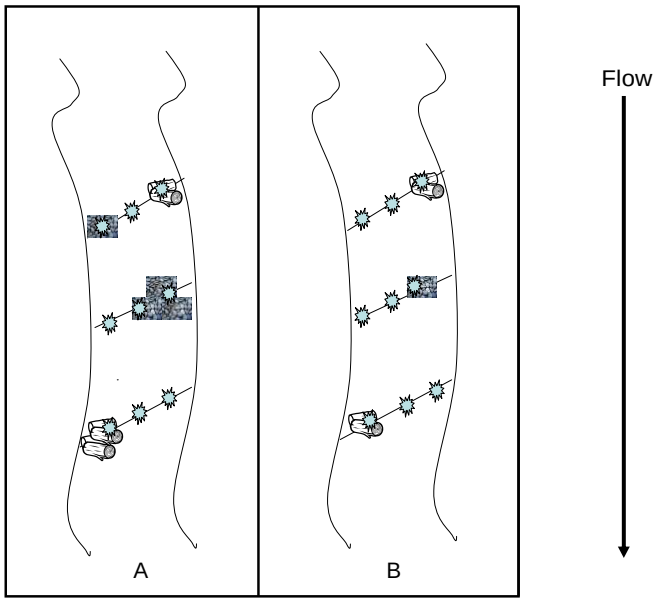


Figure 3. Appropriate establishment of sampling points



5.3.3 TAKING SUBSTRATE AND BENTHIC ALGAE MEASUREMENTS WITH THE MODIFIED PEBBLE COUNT METHOD

Sites with sharp objects, especially trash, or particularly murky water will not be sampled using the modified pebble count method. The goal is to assess a minimum of 50 pebbles. If 50 pebbles are not encountered, additional transects will be established upstream using the guidelines in Section 5.3.2 and traveled until 50 pebbles are encountered and assessed. If 50 pebbles are not encountered after 25 m of the stream reach have been assessed, then the procedure will be discontinued. For every pebble measured by the field analyst, the record field analyst will count the total number of pebbles assessed using the second handheld tally counter.

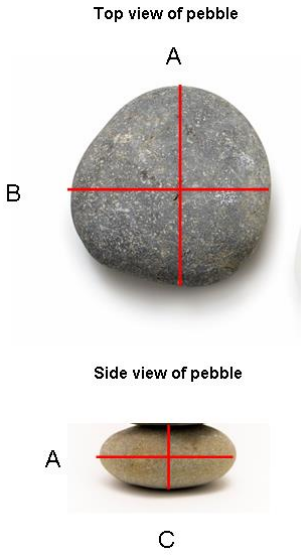
- Carefully enter the stream at the most downstream transect at the left bank when facing upstream. It is important to begin at the left bank, because it is the most downstream station. By starting at the most downstream sampling point, the possibility for disruption of sediment and obscuring the bottom of the stream will be minimized.

- The field analyst should visually check the stream bottom for any sharp items or trash. If any dangerous items are encountered, the field analyst should move another pace upstream.

- If the stream bottom conditions are safe, the field analyst should avert their eyes, select a randomly-sized pebble from the stream bottom, and remove it from the stream bottom.

- The field analyst will measure the intermediate axis of the pebble with the ruler (Figure 4, Axis B). The field analyst will say aloud the measurement. The recording field analyst will mark a tally in the substrate size column.

Figure 4. Intermediate axis of pebble



- The field analyst will observe the growth of plants, macroalgae, and microalgae (Figure 6, 7, 8). In this case, macroalgae is considered filamentous algal growth and stonewort species.

- The plant matter and macroalgae will be ranked using the scale below. A separate rank for each type of growth will be observed by the field analyst and said aloud for the recording analyst to mark on the field sheet.

    - 0=no plant matter or macroalgae present
    - 1=some (<5% coverage) present
    - 2=5-25% coverage of the substratum
    - 3=>25% coverage of substratum

- The microalgae will be ranked using the scale below. The rank for will be observed by the field analyst and said aloud for the recording analyst to mark on the field sheet.

    - 0=substratum is rough with no apparent growth
    - 1=substrate slimy, but biofilm is not visible (tracks CAN NOT be drawn with fingernail or edge of ruler or greenish color to surface)
    - 2=thin layer visible (tracks CAN be draw in biofilm)
    - 3=accumulation to thickness of 0.5-1mm
    - 4=accumulation to thickness of 1-5mm
    - 5=accumulation to thickness of 5-20mm
    - 6=accumulation to thickness of >2cm

- After ranking the growth, the field analyst will take another pace upstream and repeat the above procedure along the entire viewing bucket transects.

6. QUALITY CONTROL

6.1 QUALITY CONTROL

Due to the disruptive nature of this analysis, quality control will be assessed by the having a second field crew repeat the measurements of the entire procedure at 10% of stream segments at a later date, when financial and manpower resources allow. This will give a measure of bias for the procedure.

6.2 QUALITY ASSURANCE PLANNING CONSIDERATIONS

The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. Unless specified otherwise

in a site or project-specific work plan, Quality Assurance Project Plan (QAPP), Quality Assurance Program Plan (QAPP) or laboratory Quality Assurance Manual (QAM), all data collected following the protocols set forth in this document will be collected in accordance with the minimum QAQC requirements of Section 6.1. Further quality assurance requirements will be defined in project specific work plans and may include duplicate or replicate measurements or confirmatory analyses.

7. REFERENCES

Bevenger, G.S. and R.M. King. 1995. A pebble count procedure for assessing watershed cumulative effects. USDA Forest Service Research Paper: RM-RP-319.

VTDEC. 2012. Modified Pebble Count – RIFFLE Habitat. Vermont Department of Environmental Conservation.

Wetzel, R.G. 2001. *Limnology: Lake and River Ecosystems*, 3rd ed. San Diego: Academic Press, 1006 pp.

Wolman, M.G. 1954. A method of sampling coarse river-bed material. Am.Geophys Union. 35(6):951-956.

Figure 6. Macroalgae Examples

Tolypella sp.

http://www.globaltwitcher.com/photo_info.asp?photoid=31466

Nitella sp.

http://www.awc-america.com/plant_id_utility/plants/nit.html

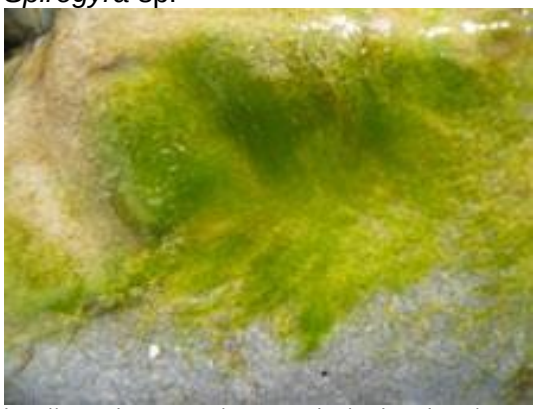
Chara sp.

http://images.mitrasites.com/chara-(alga).html

Spirogyra sp.

http://www.buzzle.com/articles/what-is-spirogyra.html

Spirogyra sp.



http://www.doc.govt.nz/conservation/native-plants/freshwater-algae/

Vaucheria sp.

http://www.keweenawalgae.mtu.edu/gallery_pages/xanthophytes.htm

Figure 7. Microalgae Examples

Didymosphenia geminata (INVASIVE-NOT FOUND IN RI)

http://blogs.app.com/enviroguy/2012/05/03/
damaging-rock-snot-infesting-the-delaware-river/

Gomphoneis sp

http://www.doc.govt.nz/conservation/
native-plants/freshwater-algae/

Microalgae

http://www.darbynelson.com/blog/whats-in-your-lake-lake-ecology-101-periphyton/

Figure 8. Examples of Plant Growth

http://www.jimmccormac.blogspot.com

http://www.squirrelsview.blogspot.com

Fontinalis sp.

http://www.ecy.wa.gov/programs/wq/plants/plantid2/photopages/fontinalis.html

Fontinalis sp.

http://www.aphotoflora.com/moss_fontinalis_squamosa_alpine_water_moss.html

Fontinalis sp.

http://www.aphotoflora.com/moss_fontinalis_squamosa_alpine_water_moss.html