Interim Sediment Control
Water Application of Polymers
(1051)

Department of Natural Resources
Conservation Practice Standard

I. Definition

The application of products containing *polymers*[1] to *sediment control structures.*

II. Purpose

The purpose of this practice is to settle out or remove suspended *sediment* from water within sediment control structures.

III. Conditions Where Practice Applies

This practice shall be used with self-contained sediment control structures, on a temporary basis for construction sites, in an emergency for post-construction sites and only continually at sites holding an individual permit, if needed to improve the sediment removal efficiency of the structure. Polymers shall not be directly applied to *surface waters of the state*. Sediment control structures may be within, or discharge to, surface waters of the state.

IV. Federal, State and Local Laws

Water applications of polymer shall comply with all federal, state, and local laws, rules or regulations governing polymers. The operator is responsible for securing required permits. This standard does not contain the text of the federal, state, or local laws governing polymers.

V. Criteria

A. Toxicity Criteria.

If used in accordance with the use restriction, the polymer mixture shall meet an acceptable level of risk such that the product can be used without significant harm to organisms that inhabit or come in contact with the aquatic environment. Every attempt shall be made to eliminate the use of any chemicals known to be environmentally toxic within a polymer mixture. Polymer mixtures shall be non-combustible.

The manufacturer shall supply toxicity testing data to the Wisconsin Department of Natural Resources (WDNR) based on the polymer mixture, including any binding or buffering agents, catalyst or any other additives.

1. The use of cationic *polyacrylamide* shall be avoided where there is danger of impacting aquatic organisms because its toxicity to aquatic test species occurs at very low concentrations.
2. Anionic polymer mixtures shall have ≤ .05% free acrylamide monomer by weight as established by the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA).
3. Each manufacturer shall provide to the WDNR toxicity information (including acute and chronic water column toxicity test data) from a certified lab, as defined in ch. NR 149 Wis.Adm.Code, for the polymer mixture.

   This data shall include all raw and statistical data regarding death, sub-lethal observations such as immobility, and any other test observations. *Standardized toxicity testing* procedures should be used and referenced. A *use restriction* will be calculated by WDNR using the information in Appendix I.
4. Users of polymer mixtures shall obtain and follow all *Material Safety Data Sheet (MSDS)* requirements, manufacturer's recommendations, and WDNR use restrictions.

B. Application Criteria

1. Maximum application rates, per storm event, in pounds per acre-feet shall be the lesser of WDNR's use restriction multiplied by 1.35 or the manufacturer's recommended application rate (1.35 is a conversion factor that is used to change the use restriction from ppm to an application rate in pounds per acre-feet).

[1]Words in the standard that are shown in italics are described in IX. Definitions. The words are italicized the first time they are used in the text.

2. Neither the manufacturer's written application rate recommendations, nor the application rate shall exceed the WDNR use restriction. The manufacturer or distributor shall provide for the applicator:

   a. Labels affixed to the polymer mixture containers that indicate the recommended application rate and the maximum application rate based on the use restriction.

   b. A product expiration date for the polymer mixture based on product expiration dates of the polymer.

   c. General written application methods.

   d. Written instructions to provide proper safety, storage, and mixing of their product.

3. The application method shall provide for uniform distribution of the product in the sediment control structure and shall consist of either:

   a. Passive Applications*:* Polymers applied by non-mechanically dosing the sediment-laden inflow prior to it entering the impoundment area of the sediment control structure. The manufacturer shall base passive application rates on the dissolution rate and/or the dead storage volume of the sediment control structure.

   or

   b. Active or Mechanical Applications*:* Polymer applied by mechanically or hydraulically mixing directly into a sediment control structure.

4. The applicator of the polymer mixture shall at the time of application, document the following:

   - Name of applicator
   - Application rate in pounds per acre-feet of stormwater runoff
   - Date applied
   - Product type
   - Weather conditions during application
   - Method of application

   Copies of this documentation shall be entered into the contractor's monitoring log or a project diary and made available upon request.

C. Product Approval Criteria

The manufacturer shall certify, through independent sampling and test results, that their product performs as per the following requirements. (The product approval process is depicted in flow chart form in Figure 1.)

1. The toxicity information required in section V.A.3. of this standard shall be reviewed by the WDNR and used to generate a written product use restriction for the polymer mixture. Appendix I outlines the information that needs to be submitted as a part of this review, and states where they must be submitted.

2. Polymer mixtures shall achieve ≥ 95% sediment reduction as measured by the standpipe method outlined in Appendix II.

3. Performance criteria - active and passive applications shall be field tested and submitted separately:

   a. The performance of polymer mixtures shall be verified and field-tested in a body of water that is not discharging directly into the waters of the state. The body of water shall be a minimum of 1/3-acre surface area and an average depth of at least 3 feet.

   b. The total suspended solids prior to the polymer treatment must be tested and verified by an independent testing lab, and must have a minimum value of 800 ppm or equivalent N*ephelometric Turbidity Units (NTU)* and be visibly turbid. The relationship between total suspended solids (TSS) and NTU is site-specific and the derivation of a unique TSS-NTU relationship shall be conducted for each sediment control structure. A minimum of two samples per acre-foot of water shall be taken from random locations within the test site.

   c. Within 48 hours from the initial treatment of the water body, the total suspended solids must have a maximum of 80 ppm, or equivalent NTU.

   d. Testing sites may not be used for subsequent testing for a period of 3 months from the time of initial application.

e. The Wisconsin Department of Transportation (WisDOT) shall be notified at least 7 days prior to testing, and WisDOT and/or WDNR staff shall be allowed to monitor any such testing.

4. The WisDOT Erosion Control Storm Water/Product Acceptability List Committee will review and approve products as per the process set forth in WisDOT's Product Acceptability List (PAL).

5. The polymer mixture must be resubmitted if any portion of the mixture is altered subsequent to its approval. Such alterations may include:

   a. The amendment of base polymers and/or any other additives

   b. The ratios of individual components

VI. Considerations

The following are additional recommendations, which may enhance the use of, or avoid problems with, the practice.

A. When using products in impoundments immediately adjacent to, or within waters of the state, consider using products for which the manufacturer's recommended application rate is considerably lower than the use restriction.

B. The applicator should use the least amount of polymer mixture to achieve optimal performance.

C. Polymer mixtures should be applied in conjunction with other erosion control BMPs and under an erosion and sediment control or stormwater management plan.

D. Test the pH of the water in the sediment control structure and follow the manufacturer's recommended pH range for their polymer mixture, as pH will impact the effectiveness of polymer mixtures.

E. Ethylene glycol, propylene glycol or any other known environmental toxicants should not be included in the polymer mixture.

F. Care must be taken to prevent spills of polymer mixtures. Follow the manufacturer's recommended cleanup procedures in the event of a spill.

G. Inhaling granular polymer may cause choking or difficulty breathing. Persons handling and mixing polymer should use personal protective equipment of a type recommended by the manufacturer.

H. Polymer mixtures combined with water are very slippery and can pose a safety hazard.

I. Polymer mixtures should be considered as an aid to removing solids from dredge slurries.

J. Where polymer mixtures are used with sediment control structures in the stream, such as during bridge construction, the structure should not be removed until the water is clarified. If the resulting sediment floc is more than a half a foot deep it should be excavated or filtered out.

VII. Specifications

Erosion and sediment control and stormwater management plans specifying polymer mixtures for sediment control shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

VIII. Operation and Maintenance

Sediment levels on the bottom of the sediment control structure shall be monitored to measure the loss of storage capacity over time due to enhanced sedimentation by the polymer mixture.

IX. Definitions

Material Safety Data Sheets (MSDS) (V.A.3) Provide basic information on a material or chemical product intended to help someone work safely with the material. This includes a brief synopsis of the hazards associated with using a material, how to use it safely, and what to do if there is an emergency. The retail distributor and/or manufacturer as per OSHA's Hazard Communication Standard, 29 CFR 1910.1200, must provide MSDS, with the purchase of potentially hazardous products.

Nephelometric Turbidity Units (NTU) (V.C.3.b) A measure of the amount of light scattered by suspended and dissolved materials in the sample.

Polyacrylamide (V.A.1) A generic term for polymers made up of many repeating units of the monomer acrylamide (a simple organic compound).

Polymer (I) Polymers are materials that are either natural or synthetic and that have a chain of carbon molecules that are identical, repeating units. Polymers can be positively charged (cationic), negatively charged (anionic) or have no charge (non-ionic).

Polymer Mixture (V.A) Any reference to polymer mixtures refers to the whole manufactured product, including the polymer and any additives. Additional calcium or lime may be added as a buffering agent without being considered part of the whole manufactured product.

Sediment (II) refers to settleable soil, rock fragments and other solids suspended in runoff.

Sediment control structure (I.) A sediment control structure is an impoundment designed to intercept and detain sediment carried in runoff, prior to the runoff reaching the main channel of a waterway or body of water. Placement of these structures must be outside of the main channel of a waterway and shall not span opposing stream banks in channelized flow. The sediment control structure must provide for dedicated sediment storage to at least a depth of two feet, such that the sediment will not be subject to re-suspension during high velocity flow conditions.

Impoundments may be created by a cofferdam, turbidity barrier, earthen berm, sheet piling, self-contained filtering systems or similar material. Examples include properly maintained construction or post-construction sediment ponds, discharging directly or eventually to a water body. They may also include surface water impoundments that are immediately adjacent to a waterway, whose function is to treat stormwater or dredging material. Another potential application is to isolate localized areas surrounding bridge and culvert construction.

Standardized toxicity testing (V.A.2) Examples of such include, but are not limited to, those outlined in the *State of Wisconsin Aquatic Life Toxicity Testing Methods Manual* (Fleming, et.al, 1996) or *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms* (Lewis, et.al, 1994). The WDNR use restriction shall be developed from this data.

Surface Waters of the State (III) "Surface" refers to the sub portion of the waters of the state that discharge at the surface. Waters of the state, as defined by s. 283.01(20), Wis. Stats means those portions of Lake Michigan and Lake Superior within the boundaries of Wisconsin, all lakes, bays, rivers, streams, springs, ponds, wells, impounding reservoirs, marshes, water courses, drainage systems and other surface water or groundwater, natural or artificial, public or private within the state or under its jurisdiction, except those waters which are entirely confined and retained completely upon the property of the person.

Use Restriction (V.A.2) Identifies the concentration below which a product is not expected to cause acute toxicity in the aquatic environment.

X. References

Voluntary Use Of Polymers In DNR Programs (A Field Guide) For copies of this companion document contact Mary Anne Lowndes, Water Resources Engineer Bureau of Watershed Management 101 S. Webster St., Box 7921, Madison, WI 53707-7921 Phone (608) 261-6420 MaryAnne.Lowndes@dnr.state.wi.us

Fleming, K., P. Hubbard, N. Krause, R. Masnado, D. Piper, W. Repavich, G. Searle, S. Thon, "State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, Edition 1." Bureau of Watershed Management, Wisconsin Department of Natural Resources, Madison, 1996 (WI. PUBL-WW-033-96).

Lewis, P.A., D.J. Klemm, J.M. Lazorchak, T.J. Norberg-King, W.H. Peltier, and M.A. Heber, "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, 3rd Edition." Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Cincinnati, OH, 1994 (EPA/600/4-91/002).

Roa-Espinosa, A., Bubenzer, G.D. and Miyashita, E., "Sediment and Runoff Control on Construction Sites Using Four Application Methods of Polyacrylamide Mix." National Conference on Tools for Urban Water Resource Management and Protection, Chicago, pp. 278, February 7-10, 2000.

Roa, A., "Are there Safety Concerns or Environmental Concerns with PAM?" Dane County Land Conservation Department, 1997.

Sojka, R.E. and Lentz, R.D., "A PAM Primer: A brief history of PAM and PAM related issues." Kimberly, ID: USDA-ARS Northwest Irrigation and Soils Research Lab, 1996. http://kimberly.ars.usda.gov/pamprim.ssi

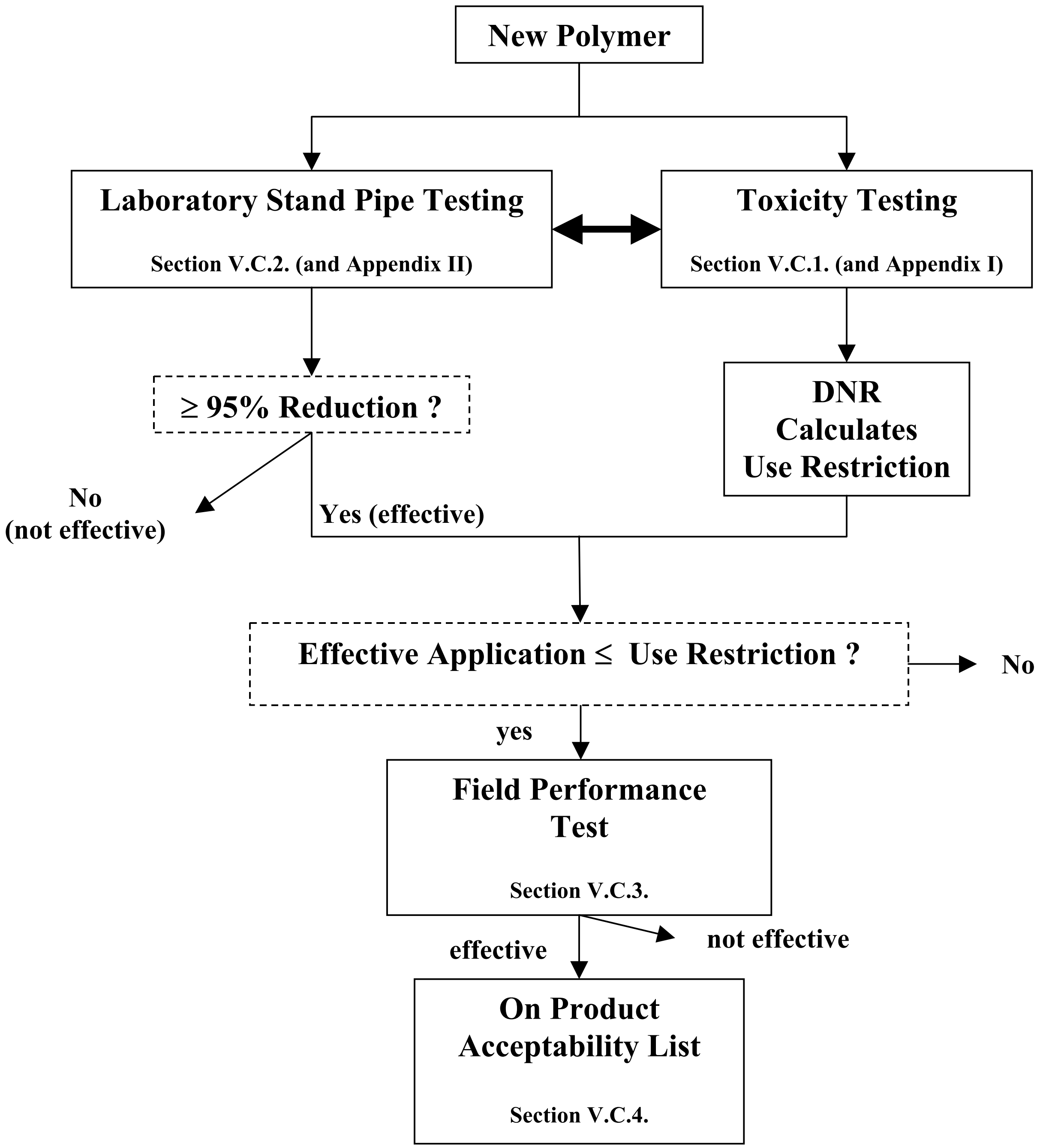
Wirtz, J, R., "The Pros and Cons of the Use of Anionic Polyacrylamides to Control Erosion and Sedimentation in the Lake Mendota Priority Watershed". University of Wisconsin-Madison, MS Thesis, 2000.

WisDOT's Product Acceptability List (PAL). State DOT web site: http://www.dot.wisconsin.gov/business/engrserv/pal.htm Questions regarding product approvals may be sent to:

New Products Engineer, WisDOT, Technology Advancement, 3502 Kinsman Blvd., Madison, WI 53704.

FIGURE I

POLYMER APPROVAL PROCESS



APPENDIX I

REQUIRED TOXICITY INFORMATION FOR WDNR REVIEW

Toxicity information shall be reviewed by the WDNR and will be used to generate a written product use restriction for the polymer. With Chapter 1.7 of the *Whole Effluent Toxicity Program Guidance Document* (Fleming et. al., 2000) as a basis, the following toxicological information/data is required:

a. Manufacturer of the polymer.
b. Chemical name of the polymer.
c. Active Ingredient(s) (if not proprietary information).
d. Chemical Abstracts Service (CAS) #(s) of the polymer and/or active ingredients.
e. Material Safety Data Sheet (MSDS) and/or official toxicity test results listing available aquatic life toxicity data for the WHOLE PRODUCT. Toxicity data for active ingredients is not acceptable for use in calculating a use restriction. The following types of data is acceptable:

Species	Endpoint of Concern
Ceriodaphnia dubia (Cladoceran)	48-hour LC_{50} or EC_{50}/IC_{25}
Daphnia magna (Cladoceran)	48-hour LC_{50} or EC_{50}/IC_{25}
Lepomis macrochirus (Bluegill Sunfish)	96-hour LC_{50} or EC_{50}/IC_{25}
Pimephales promelas (Fathead Minnow)	96-hour LC_{50} or EC_{50}/IC_{25}
Oncorhynchus mykiss (Rainbow Trout)	96-hour LC_{50} or EC_{50}/IC_{25}

LC_{50} = the estimated concentration of polymer that would cause 50% mortality to the test population following the given time period

EC_{50} = the estimated concentration of polymer that would cause a given effect in 50% of the test population following a given time period

IC_{25} = the estimated concentration of polymer that would cause a 25% reduction in some biological measurement of the test population following a given time period

NOTE: To calculate a use restriction it is necessary to have data from at least one of the cladoceran species and at least one of the fish species (according to NR 106.10(1)).

f. Complete listing of toxicity test conditions. Examples to follow include Tables 11 – 14 in Weber (1993).
g. Standardized test methodology (name of a specific method & its reference may be listed for this, such as "Acute Toxicity Test Procedures for *Daphnia magna*" in Weber (1993). If a modification to a standardized method was used, provide the reference of the specific method along with a specific listing of and reasons for the modifications).
h. Any noted observations from the toxicity tests.

Toxicity test results shall be submitted to: Water Quality Standards Section, WDNR, 101 South Webster Street, P.O. Box 7921, Madison, WI 53707, as one prequalification for field testing.

References:

Weber, C. 1993. *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, 4th Edition*. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Cincinnati, OH. EPA/600/4-90/027F.

Fleming, K., S. Geis, E. Korthals, R. Masnado, G. Searle. 2000. *Whole Effluent Toxicity Program Guidance Document, Revision #3*. Wisconsin Department of Natural Resources, Chapter 1.7.

APPENDIX II

LABORATORY STANDPIPE TEST METHODOLOGY

1. Place 40 grams of oven dried "soil" in 2 liters of distilled water within a 2 liter graduated cylinder with stopper. The 40 grams of "soil" represents a "realistic" runoff suspended solids load of 20,000 mg/L (20,000 mg/L x 2 L) according to data collected from commercial and residential construction sites (Owens, et. al. 2000). Repeat a minimum of four times so that there are a minimum of five replicates. The "soil" used in the standpipe test may be characterized by one of the following three options:

   Clays — A clay "soil" is characterized as having greater than 20% of its particles < 2 μm in size. This option is appropriate for those seeking approval* of a polymer for use in any soil condition (clay, silt, or other).

   Silts — A silt "soil" is characterized as having less than 20% of its particles < 2 μm in size AND greater than 20% of its particles 2-25 μm in size. This option is appropriate for those seeking approval* of a polymer for use only in silt soils. The 2-25 μm size is representative of fine to medium silt soils.

   Site-Specific — Use of a site-specific "soil" provides an alternative for those seeking approval* of a polymer that may be customized for optimum performance (in both terms of suspended sediment removal and amount of polymer used) at a particular site. The results of a mechanical soil analysis characterizing the site soil sample particle size composition must be provided. The results of this analysis should be submitted with the results of the standpipe test entered on the "Standpipe Test Data Sheet." This option is provided since each site will have at least slight differences, if not significant differences, in soil chemical and physical characteristics. These differences may influence the effectiveness of any given polymer.

   Indicate which "soil" type is used in the standpipe test on the data sheet under "√ Soil Type Used."

   * Note that final approval of a polymer is granted only after it is demonstrated through both the standpipe and field tests that the polymer is effective and can be effectively applied.

2. Mix the solutions by completely inverting each graduated cylinder 3 times.

3. Add polymer mixture to each graduated cylinder. The volume and concentration of polymer added is the manufacturer's or supplier's choice, but must include a set volume and a gradient of "low" to "high" concentrations. The volume and each polymer concentration must be recorded on the data sheet. The purpose is to determine the lowest polymer mixture concentration needed to achieve effective removal of suspended solids. Ultimately the least amount of polymer mixture needed to achieve optimal performance should be used in the field.

   A minimum gradient of five polymer mixture concentrations is used to achieve the above stated purpose. The purpose of the five concentration gradient is to attempt to pinpoint the concentration that achieves optimal removal of suspended solids (i.e. least amount of polymer mixture required to remove a minimum of 95% of the suspended solids). This gradient should be sufficiently wide to show a range of effectiveness in removing suspended solids (with at least one, but preferably more, meeting the 95% removal level). A second goal of using a minimum of five concentrations is to avoid the occurrence of false negative outcomes in the polymer approval process. By having more concentrations across a gradient it is more likely to find truly effective concentrations that are less than the use restriction value. As is graphically depicted in Figure I, a polymer mixture will not be approved for field testing, and thus for inclusion on the PAL if its effective concentration (as determined in this laboratory stand pipe test) is greater than the use restriction value.

4. Mix the solutions by completely inverting each graduated cylinder 3 times.

5. Let the solution in each graduated cylinder settle for 5 minutes.

6. Determine the percent suspended solids reduction in each graduated cylinder as follows:

   a. Heat/dry one evaporating or drying dish at 103 – 105 °C for 1 hour for each graduated cylinder. Store the dishes in a desiccator until needed (steps b).
   b. Weigh a dish out to at least one, and preferably more decimal points. Record this weight on the data sheet.
   c. Collect 20 ml from within one of the graduated cylinders at the 1 liter mark and place in a preweighed evaporating or drying dish (from step a). Repeat steps b and c for each of the other graduated cylinders.
   d. Evaporate and dry each of the 20 ml samples from step b at 98 °C for at least 1 hour.
   e. Cool each dish with sample in a desiccator to balance temperature
   f. Weigh each dish with sample. Record this weight on the data sheet.
   g. Subtract the weight of the dried dish (from step b) to determine the weight of the solids from the sample. Record this weight on the data sheet.

- These methods follow, with slight modification, those of Standard Methods 2540 B. (1989).

7. The polymer passes this effectiveness test if it achieves ≥ 95 % reduction of suspended solids. Thus, **≥ 95 % reduction is achieved if the weight of the solids from the sample is ≤ 0.2 mg.**

$$\frac{2000\text{ ml}^{1}}{1000\text{ mg/L}^{2}} = \frac{20\text{ ml}^{3}}{X^{4}} \quad ; \qquad X = 10\text{ mg/L}$$

^{1} = volume of solution in the cylinder
^{2} = suspended solids concentration in the cylinder at ≥ 95 % reduction
^{3} = volume of sample taken from 1 L mark of the cylinder
^{4} = sample solids concentration needed to achieve ≥ 95 % reduction

$$\frac{10\text{ mg}}{\text{L}} \times \frac{\text{L}}{1000\text{ ml}} \times \frac{20\text{ ml}}{} = \mathbf{0.2\text{ mg}}$$

8. A photocopy of the completed data sheet should be sent to the following address for WisDOT review: New Products Engineer, WisDOT, Technology Advancement, 3502 Kinsman Blvd., Madison, WI 53704.

References:

Owens, D.W., P. Jopke, D.W. Hall, J. Balousek, and A. Roa. 2000. *Soil erosion from two small construction sites, Dane County, Wisconsin*. U.S. Geological Survey Fact Sheet FS-109-00, 4 p.

Standard Methods Committee. 1989. 2540 Solids. In L.S. Clesceri, A. E. Greenberg, and R.R. Trussell, eds., *Standard Methods for the Examination of Water and Wastewater, 17th Edition*. American Public Health Association, Washington, DC. pp. 2-72 - 2-73.

STANDPIPE TEST DATA SHEET

Date(s): ________________

Testing Laboratory: ____

Analyst(s) Initials: ____

Polymer Name: ____

Manufacturer Name: ____

Volume of Polymer Mixture Used: ____________________________

√ Soil Type Used: ☐ Clay ☐ Silt ☐ Site-Specific Soil (mechanical analysis results enclosed)

Polymer Mixture Concentration (mg/L or % solution)	Weight of Evaporating/Drying Dish		Final Weight of Solids Sample
	Pre	With Sample	

Which polymer mixture concentration(s) achieved effective (≥ 95%) reduction of suspended solids (i.e. final weight ≤ 0.2 mg solids)?

________ ________ ________ ________ ________

Notes/Comments:

Please send a photocopy of this completed data sheet to:
New Products Engineer, WisDOT, Technology Advancement, 3502 Kinsman Blvd., Madison, WI 53704.