WISCONSIN DEPARTMENT OF NATURAL RESOURCES

TECHNICAL STANDARD

FLOW-WEIGHTED COAGULANT DOSING OF STORM WATER WET DETENTION PONDS

1013

DEFINITION

Flow-weighted *coagulant*[1] dosing for a *wet detention pond* is the practice of installing and operating an automated system to inject aluminum-based coagulant on a flow-weighted basis to the wet detention pond inlet(s) during runoff events.

PURPOSE

The purpose of this practice is to increase the capture of pollutants to meet non-agricultural storm water performance standards and total maximum daily load (TMDL) wasteload allocations. The technical standard includes a method for estimating total suspended solids and total phosphorus removal during an average rainfall year.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to discharges from separate storm sewer systems serving urban areas where an advanced level of treatment would facilitate meeting water quality standards. This practice may be used to retrofit existing ponds or be used in conjunction with WDNR Technical Standard 1001 Wet Detention Pond.

The criteria in this standard applies to existing or proposed wet detention ponds that meet the following conditions:

- Operated and maintained by an entity capable of supporting the operation of the practice long-term.

Note: It is anticipated that most entities using this technical standard will be units of government or other institutions.

- Provide at least 4 feet (1.2 meters) of depth from the permanent pool surface to the top of existing sediment at system initiation, and
- Have adequate access for sampling of the inlet(s), outlet(s), and maintenance activities including sediment removal.

This practice does not apply to:

- Lakes, natural ponds, landscape ponds, wildlife ponds, wastewater lagoons, or other ponds not designed and maintained for the purpose of storm water treatment.
- Wet ponds within navigable waterbodies, except where credit is allowed under s. NR 151.003, Wis. Adm. Code.
- Water-applied *additives* during land disturbing construction activities—see Technical Standard 1051.

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

- Post-construction application of coagulants to the surface of ponds. See WDNR Technical Standard 1014 *Episodic* Coagulant Dosing for Maintenance of Wet Detention Ponds.

CRITERIA

General Criteria

Laws and Regulations. Comply with all federal, tribal, state, and local laws, rules, or regulations. This standard does not contain the text of federal, tribal, state, or local laws.

Permitting. Identify and obtain applicable permits prior to implementing this practice.

Sampling Methods. Some of the steps below require acquiring water samples. Detailed instructions are not included in this standard. See the references section for links to instructions and how-to videos unless otherwise specified.

Design Parameters.

Conduct influent storm water jar testing prior to designing a flow-weighted dosing system:

- Collect runoff samples for jar testing as close to the actual *facility* inflow location(s) as possible:
  - Use an automated sampler using manufacturer's recommendations and methods described in WA Dept. of Ecology's "Automatic Sampling for Stormwater Monitoring" standard operating procedure.[2] Adjust automatic sampler intake to avoid capturing bedload.
  - Collect a flow proportional composite sample from a minimum of 3 rain events. Sample rain events that are forecasted to be between 0.25 and 2.5 inches (7.62 and 76.2 centimeters) in a 24-hour period. Sample at least one rain event between May 1 and October 15 when leaves are not falling. Sample at least one rain event during the time period of leaf accumulation, typically between September 15 and November 15. If possible, sample the event that occurs when the most leaves are present in the street. Allow at least 3 days of dry weather between sampling events.
  - Collect flow-weighted samples to represent a composite goal of 80% or more of the total volume from the runoff event.
  - Collect enough influent water to satisfy the volume requirements for jar testing both a control (untreated) and 3 concentrations of each coagulant tested. Generally, 0.40 gallons (1.5 liters) per jar test is required for analytical testing.
  - Process and preserve the composite water samples as required by the laboratory conducting the jar testing.
- Select coagulants that will be evaluated during jar testing.
  - Consult with WDNR if the influent water pH is below 6.5 as an additional monitoring or safeguards may be needed. Safeguards could include coagulants with a lower pH impact or the use of a buffering agent.
  - Aluminum (Al)-based coagulants, such as aluminum sulfate (alum), polyaluminum chloride (PAC) and aluminum chlorohydrate (ACH), may be used provided all of the following are true:
    - Jar testing of the site's storm water produces *floc* and will not lower the pH below 6.0 standard units at the proposed dosage.
    - The settling pond is capable of settling the floc between the inlet and the outlet for the range of flows the system is designed to handle. This is assumed to be the case for ponds designed for at least 60% TSS reduction or 5 hours retention time unless there is short-circuiting between the inlet and outlet. In cases with

[2] Links are provided in the references section.

inadequate separation between inlet and outlet, a baffle may be needed in order to increase retention time.

  - Coagulant products are NSF/ANSI/CAN 60 certified for use in potable water treatment.

- Evaluate potential coagulants and doses using collected runoff jar testing. Recommended jar testing procedures are described in Attachment 1.

Prepare a preliminary design report that summarizes the following information:

- The proposed treatment location(s). Show the existing or proposed wet detention pond characteristics and dimensions on a map with inlet and outlet locations.
- A description and map of contributing drainage areas and any other storm water control practices upstream of the facility.
- The proposed owner/operator of the system.
- Jar testing procedures and field notes.
- Analytical results and conclusions, including recommendations for coagulant compounds and dosing concentrations.
- Append documentation of pollutant modeling for the watershed using an *approved model* for use in predicting pollutant reductions.
- Where applicable also include for hydrologic and hydraulic modeling for the wet detention pond.
- Estimated design storm, peak design water flow rate, average annual water volume treated, peak coagulant dose (typically between 5 and 7.5 mg/L[3] as Al), average annual coagulant volume, and average annual floc volume.
- Estimated pond permanent pool volume (PPV), residence time required based on jar testing floc settling time, and peak design water flow rate.
- Expected approach to dispose of consolidated wet floc. Either dredging or pumping to the sanitary sewer system or dewatering on-site and trucking/use or disposal of the dewatered floc off-site.

Obtain concurrence from WDNR on the preliminary design report.

Use jar testing results to design a system that provides all the following capabilities:

- Locates the discharge of coagulant-containing water far enough from the wet detention pond outlet for the floc to settle before water discharges from the facility to waters of the state.
- Provides a dosing system that accomplishes the following:
  - Treats inflow water during runoff events up to the *maximum design treatment flow* rate.
  - Provides a system shut-off or bypass flow option for flows larger than the maximum design treatment flow rate, including safe passage of the 100-year, 24-hour design storm.
  - Doses the coagulant at the design dosing rate with equipment that can be calibrated and adjusted. If a buffering agent is needed, provide similar dosing equipment for the buffering agent.
  - Provides *rapid mixing* of the coagulant within the water.
  - Provides sufficient heating or winterization to enable operation in the early spring (after the pond thaws) and late fall (before pond freezes).
- Provides a control system that accomplishes the following:

[3]Concentration values shown in metric units only for simplicity—1 mg/L = 2.72 lbs/acre-ft.

  - Automatically notifies operators if the coagulant level is low or power is lost.
  - Measures storm water inflow rate and cumulative flow volume on a continuous basis.
  - Measures coagulant feed rate and cumulative coagulant volume on a continuous basis.
  - Monitors facility influent and effluent pH on a continuous basis with meters that are calibrated and maintained per the manufacturer's instructions.
  - Automatic operation of the coagulant treatment system to maintain the same design coagulant/aluminum dose over the full range of design water flow rates by the equipment and a programmable logic controller (PLC). Provide Supervisory Control and Data Acquisition (SCADA) system (or equal) for automatic and remote operation of the coagulant treatment system.
  - Provides an automated shutdown and notification system if conditions are not suitable for treatment (e.g., equipment malfunction) or outside of acceptable design parameters (e.g., pH less than 6.0). System will automatically or manually be re-enabled when the pH increases to an acceptable level (e.g., pH greater than 6.2).
  - Provides an automatic stop to coagulant addition if the inflow water flow rate exceeds the peak design water flow rate. Provides for automatic or manual re-enabling when the water flow rate decreases to an acceptable level (e.g., water flow rate is lower than the peak design water flow rate).
- Provides a secure building or other space, while maintaining compliance with existing building codes that includes the following features:
  - Adequate space for pump(s), piping, controls, operations, and miscellaneous appurtenances.
  - Climate control.
  - Adequate power and communications service including remote monitoring compatible with the local platform.
  - Maintenance and delivery access.
  - Coagulant storage, with any required secondary containment, sufficient to treat the flows during an average one-month period in conditions appropriate for the selected coagulant. Ensure the tank materials and fittings are compatible with the chemical(s) being stored.
  - Health and safety provisions and equipment.
- Provides a wet detention pond that:
  - Includes at least 3 feet (0.9 meters) of permanent pool depth above the sediment storage area.
  - Has sufficient sediment storage volume to accommodate the planned floc accumulation and removal frequency.
  - A wet pond designed for 60% or greater TSS control per an approved modelling approach. A wet pond sized to provide at least 5 hours residence time for floc settling is also acceptable. The minimum residence time can be calculated by dividing the volume of the permanent pool, excluding the sediment storage volume, by the maximum design treatment flow rate.
  - Has safe access for pond effluent monitoring/sample collection.
  - Includes or maintains existing forebay(s) for inlets with coagulant dosing. When retrofitting existing ponds, adding new forebays is not required.
  - Does not contain aerators or fountains that may cause resuspension of floc and sediment. Fountains or aerators must follow Technical Standard 1001.

Calculate the expected treatment benefits of the system considering the following:

- The anticipated loading, as determined via an approved model, for the drainage area conditions after accounting for any upstream pollution control practices.
- For phosphorus removal, treatment is not expected to reduce the outfall concentration to less than 0.05 mg/L on an annual average basis. The outlet value of 0.05 mg/L total phosphorus (TP) can be compared to the average annual influent TP concentration generated by an approved model.
- For TSS removal, treatment is not expected to reduce the outfall concentration to less than 6 mg/L on an annual average basis. This can be compared to the average annual influent TSS concentration generated by an approved model to estimate an average annual TSS load reduction.
- The annual average pollutant reductions should be prorated if the maximum design treatment flow rate is less than the 1-year, 24-hour rainfall event. Prorating should account for the portion of the annual average rainfall identified in s. NR 151.12 (1) (b), Wis. Adm. Code, that is less than or equal to the maximum design treatment flow rate occurring during the anticipated operating period for the system. The anticipated operating period may be assumed to be 100% of the annual average rainfall included in the non-winter season if the maximum design treatment flow rate is at least as great as the flow expected during the 1-year, 24-hour rainfall event and the system is heated to allow operation during the full non-winter season.
- During time periods when coagulant dosing is offline, pollutant removal due to Stokes' Law settling may be assumed for water flowing through the settling pond. Example pollutant removal calculations are provided in Attachment 2.

Prepare and submit a safety plan for material handling, and spill control/containment procedures.

Provide updates from the preliminary design report to your storm water permit contact at the WDNR.

CONSIDERATIONS

The following are not required under this technical standard but are recommendations and reminders of commonly overlooked measures that may be required under other rules, laws, and regulations:

- Where the receiving water is listed as impaired for any of the ingredients in the coagulants considered (i.e., chloride), include the pollutant of concern in jar testing measurements. Evaluate alternative coagulants and include a written justification if the coagulant containing a pollutant of concern is proposed within the preliminary design report.
- Adjust jar testing sampling protocol for systems with multiple inlets. If multiple inlets will be treated, consider the size and watershed characteristics for each inlet.
    - In situations where the watershed characteristics (e.g., land use, size, soil type, tree canopy) differ substantially, sample and test multiple inlets.
    - If the watershed characteristics are substantially similar, jar test sampling of a single inlet may be acceptable.
    - If there will be inlets to a settling pond that are not treated by the flow-weighted dosing system, then sampling and testing of these inlets are not required.
- If location-specific constraints preclude the use of automated sampling, the project proponent may propose an alternate sampling methodology for review by the WDNR. Any manual sampling methodology must include flow measurement and multiple samples per event. The sampling plan must explain how discharge throughout the majority of the rain event is captured.
- If possible, sample at least one event in early spring when chloride levels would be expected to be highest.

- Use of coagulants other than those listed in the Criteria section or products that contain both a listed coagulant and other ingredients, such as buffers, requires pre-approval. The coagulant proposed should form a bond with phosphorus that is stable under anoxic conditions when pH is between 6.0 and 9.0 standard units. Use NSF/ANSI/CAN 60 certified products.
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- See WDNR Technical Standard 1001 Wet Detention Pond for liner requirements.
- If an operator believes that their system is providing a higher level of pollution removal than estimated via modeling, they may opt to conduct continuous influent and effluent monitoring. Two years of continuous influent and effluent monitoring may be used to document actual pollutant removal for the purposes of TMDL compliance.
- Pollution control credit for untreated inlets may be taken for the traditional settling achieved by the pond, as calculated by an approved model. Prorate the overall pollution control credit for the facility by runoff volume from each inlet, based on the enhanced settling credit for runoff from treated inlet(s) and the traditional settling credit for untreated inlet(s).
- Use of the system during spring blossoming and fall leaf drop periods is highly recommended if weather conditions do not limit operation.
- If the dosing system, excluding the pond, is not heated to allow operation to occur from the time the pond is ice-free in the spring to ice development on the surface of the pond in early winter, then the credit must be prorated to only account for the portion of the annual average rainfall identified in s. NR 151.12 (1) (b), Wis. Adm. Code, that occurs within the anticipated operating period for the system.
- Integrate chloride reduction practices or chloride content mitigation practices into upstream watershed planning to reduce resuspension potential.
- Cost effectiveness is typically more favorable for urban drainage areas over 50 acres.

PLANS AND SPECIFICATIONS

Prepare plans and specifications in accordance with the criteria of this standard. Provide materials specifications, construction requirements, locations, sizes and elevations of all components of the practice to allow for project acceptance by the owner upon completion.

Include the following start-up tasks in the specifications:

- Confirm system components are installed per specifications, calibrated, and tested;
- Confirm all components and systems are working properly and that operation and maintenance information for components are delivered to the owner or appended to the operations and maintenance manual;
- Develop as-built plans; and
- Confirm automated notification/warning systems (SCADA) work.

OPERATIONS AND MAINTENANCE

Develop and implement an operation and maintenance plan that is consistent with the purposes of this practice, the treatment practice's intended life, safety requirements and the criteria for its design. The operation and maintenance plan will include:

- Owner and responsible party for the treatment system;
- Staff, by title, responsible for system operation and maintenance. Confirm staff are trained in system operation;

- Written description of the system and its operation;
- Frequency, procedures, and timing of remote or in-person operational checks and inspections for both dry and wet-weather conditions;
- Equipment calibration requirements and procedures;
- Expected responses to alarms;
- Safety procedures for materials handling and storage, equipment malfunctions, and other safety related matters, including the following:
    - Safety, security, and access requirements for the system;
    - Material safety data sheets for all onsite chemicals;
    - Spills procedures and reporting;
- Anticipated floc removal or sediment dredging frequency, frequency of depth measurements necessary to identify when removal is required. A summary of anticipated disposal options and associated sediment testing requirements according to ch. NR 528, Wis. Adm. Code;
- Winter shut-down timing and procedures. Timing may be based on observed weather conditions and forecasted weather conditions;
- Spring start-up timing and procedures. Timing may be based on observed weather conditions and forecasted weather conditions;
- Jar testing requirements for changes in coagulants or significant changes in the influent concentrations of TP;
- Append as-built drawings or note locations where drawings can be accessed;
- Records required to be kept, including monitoring information required by permit.

Maintain the following records and submit them as required by the operator's WPDES permit:

- Dates of operation, including spring start-up, outages, and winter shutdown;
- Equipment calibration dates and methods;
- Water flow volume treated;
- Coagulant quantities purchased and used annually;
- Inspection logs and required maintenance, calibration, and repairs of all components;
- Floc accumulation monitoring and disposal;
- Monitoring records;
- Logs of any alarms triggered by the system and response actions taken;
- Spills;
- Daily outlet pH recordings (daily min and max).

Report on facility operations with the annual report for the owner.

REFERENCES

ASTM D2035-19 Standard Practice for Coagulation-Flocculation Jar Test of Water, March 1, 2019.

Edwards, T.K., and Glysson, D.G., 1999, Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chap. C2, 89 p., https://pubs.usgs.gov/twri/twri3-c2/.

Erickson, A.J., Weiss, P.T., Gulliver, J.S. (2013). Water Sampling Methods. In: Optimizing Stormwater Treatment Practices. Springer, New York, NY. https://doi.org/10.1007/978-1-4614-4624-8_1 online chapter: https://stormwaterbook.safl.umn.edu/sampling-methods.

U.S. EPA (2002) Urban stormwater BMP performance monitoring. 821-B-02-001, http://epa.gov/waterscience/stormwater/monitor.htm. U.S. Environmental Protection Agency, Washington, DC, https://www3.epa.gov/npdes/pubs/montcomplete.pdf.

Washington State Department of Ecology Standard Operating Procedure for Automatic Sampling for Stormwater Monitoring Version 1.2 Automatic Sampling for Stormwater Monitoring

Wisconsin Department of Natural Resources, Additives webpage https://dnr.wisconsin.gov/topic/Wastewater/Additives.html.

Wisconsin Department of Natural Resources, Low Impact Discharge General Permit WI-0066575-01-0 https://dnr.wisconsin.gov/sites/default/files/topic/Wastewater/LowImpactDischargeGP_WI-0066575-01-0_FINAL.pdf.

GLOSSARY

Additive – Any substance, typically a commercial product, which is added to water to remove or trap a pollutant and has the potential to be directly or indirectly discharged to surface water and may cause toxicity to fish and aquatic organisms.

Approved model – A computer model that is used to predict pollutant loads from urban lands and has been approved by the applicable regulatory authorities. WinSLAMM and P8 are examples of models that may be used to verify that a wet detention pond design meets the desired pollutant reduction.

Coagulant – Additive used to neutralize charged particles to promote bonding substances into settleable solids and/or larger settleable solids.

Episodic dosing – Applying an additive directly to the surface of a wet detention pond intermittently and not related to runoff events (see DNR Technical Standard 1014 - Episodic coagulant dosing for maintenance of storm water wet detention ponds).

Facility – For the purposes of this standard, facility includes a wet detention pond and associated infrastructure including inlet sewer, outlet structure, outlet sewer, and any coagulant treatment system appurtenances such as mixing chamber, chemical storage building, chemical feed pumps, controls, monitoring equipment, and other similar items.

Floc – A loosely clumped mass of fine particles.

Flocculation – A physical process using a flocculant and mixing to enhance agglomeration or collection of smaller floc particles into larger, more easily settleable particles.

Maximum design treatment flow rate – The maximum design treatment flow rate is the maximum flow rate the system is capable of treating, typically equal to or greater than the peak flow from the 1-year, 24-hour design storm. During flow rates in excess of the maximum design treatment flow, the dosing system is shut down or bypassed.

Rapid Mixing – A mechanical process of agitating the coagulant with the storm water at the point of injection to enhance floc formation.

Wet detention pond – A permanent pool of water with designed dimensions, inlets, outlets, and storage capacity, constructed to collect, detain, treat and release storm water runoff.

Attachment 1

Storm Water Jar Testing Protocol for
Application of Coagulants to Storm Water Ponds

Introduction

The purpose of the jar testing process is to:

1) Select a coagulant with optimal floc-forming characteristics and pollutant removal performance under the weather conditions seen throughout the year.
2) Determine a coagulant's impact on treated water's chemistry and potential need for buffering coagulants.
3) Determine an optimal coagulant concentration dosing level to achieve optimal pollutant removal.

The testing protocol is described below.

Coagulant Testing Protocol

Laboratory Procedures

Once at the laboratory, split the influent water samples (using a churn splitter) for coagulant testing. A churn splitter is used so that a homogenous aliquot is achieved for each testing jar. Each jar will need to hold a minimum of 0.26 - 0.53 gallons (1-2 liters) of sample water for the analyses listed below. This means that the field-collected water sample must total a minimum of 1.1 - 2.1 gallons (4 to 8 liters) per coagulant tested. (NOTE: Verify the volume with the laboratory as being adequate to analyze the parameter list.) For each coagulant to be tested, split the influent water sample into four jars representing:

(1) Influent water (no coagulant)
(2) Influent water with coagulant added at three different doses (to achieve a predetermined lower, medium and higher active ingredient concentration; different active ingredient concentrations of the same coagulant may be tested for different sampling events)

Specific Laboratory Steps

(1) Label each 1-2-liter container:
    a. Unique ID #
    b. "Influent Water" or coagulant name and % active ingredient
    c. % active ingredient dose by weight
    d. Date/test start time
(2) Add the field sample to churn splitter.
(3) Fill 4 containers with 0.26 - 0.53 gallons (1-2 liters) of influent water.
(4) Conduct listed analysis of Influent Water container (No coagulant) and pH and temperature of remaining 3 containers (as shown in Table 1 below).
(5) Place containers for coagulant treatment on stirring plates or equally effective mixing devices.
(6) Stir for about 30 seconds before adding coagulant, simulating the expected mixing intensity of the facility, as determined by the designer.
(7) Add the measured dose of coagulant to each of 3 containers (one container for each aluminum concentration). Continue stirring for the design mixing contact time after adding coagulant.

NOTE: The conversion between a concentration ‘as Al’ and the quantity of product added to each container must be calculated for each product used because the aluminum concentration varies between products and manufacturers.

(8) Record time coagulant added to container.

(9) After turning off stirring:

a. Measure pH of 3 coagulant treated containers

b. Measure temperature

c. Photograph

(10) Extract aliquots from influent water jar for analytical measurements per Table 1. For obtaining sample water from the coagulant treatment jars, pipet required volumes from middle to top of the water column at approximately the same depth for each jar. Do not extract water from the floc layer at the top or bottom of the jar.

Table 1: Required Analytes and Photos

Timing	Influent Water Jar (No coagulant)	Each Coagulant-Treated Jar
Before coagulant	pH Temperature Alkalinity Total P Dissolved P TSS Sulfate Total Al Dissolved Al Chloride Photo	
After coagulant and stirring		pH Temperature
After time period corresponding to basin residence time		pH Temperature Alkalinity Floc depth Total P Dissolved P TSS Sulfate Total Al Dissolved Al Chloride Photo

(11) Conduct remaining analytical tests at time interval shown on Table 1 at a minimum. Additional test times may be added, however additional test times will require a larger volume in each test jar.

(12) Monitor the floc settling visually and record observations of floc accumulation with a photograph of all jars lined up after at least 24 hours, but no more than 30 hours.

(13) Optional: Continue to monitor floc generation and setting rate beyond the time frame specified in the previous step if additional information on floc accumulation and consolidation is desired.

a. Floc from various tests may be combined for monitoring over the course of the testing and evaluation period. Clean water above floc may be decanted and floc placed in smaller graduated cylinders and allowed to settle for better visualization of relative floc accumulation and consolidation.

b. Measure the depth/volume of the accumulated floc on a regular basis (recommended weekly). Estimate the floc that may be generated by a treatment system based on the volume of treated water and accumulated floc.

Documentation and Recording Results

For each sampled runoff event, document analytical results to include:

(1) Sample site description including watershed size, land use, photograph(s) of sample site, a map of watershed.

(2) Description of each sampled event including date, nearest rain gauge with start/stop time and rain depth of event, runoff period (start/stop times or best estimate), and total volume of sample collected, names of field staff, any observation notes of runoff quality (such as odor, oil sheen, etc.).

(3) Laboratory Analytical Results: For each parameter, report analyte concentration and % change from the influent water. Note any laboratory comments on QA/QC exceedances and/or errors. Also, note each parameter's level of detection and any results at less than detection recorded.

(4) Note the approximate quantity of water treated and when or if the floc resulting from the treatment was included in the floc generation and settling evaluation.

Attachment 2
Example Calculations of Pollution Removal Credit for Flow-Weighted Coagulant Dosing

Introduction

The information below converts the concepts in the technical standard into equations and provides an example calculation. Based on a review of literature and monitoring records from flow-weighted coagulant dosing elsewhere in the country, 'floor' concentrations have been identified. A floor concentration is the lowest concentration of a pollutant that is consistently observed in the facility effluent. A value of 0.05 mg/L has been identified for TP and 6 mg/L for TSS.

Inputs Required

For TP:

- Determine the following values using an approved model and the rainfall period identified in s. NR 151.12 (1) (b), Wis. Adm. Code, for the closest rainfall location after accounting for any upstream pollution control practices. The winter period for the rainfall record may be excluded.
  - No-controls flow-weighted annual average influent concentration (No Controls TP in mg/L),
  - Annual average influent volume (AAIV), and
  - Proportion of the AAIV expected to be treated (Portion Dosed), accounting for storms less than or equal to the maximum design treatment flow rate. If all storms in an average annual year, excluding winter season, are expected to be treated, then Portion Dosed = 1.
  - Percent TP reduction compared to no controls for the settling pond (Settling only TP in % reduction from no controls) assuming no coagulant dosing.
- Determine the average annual TP concentration (Floor TP in mg/L) anticipated at the outlet of the settling pond after dosing. Assume a value of 0.05 mg/L unless WDNR concurs with using a different value based on site-specific and coagulant-specific information.

For TSS:

- Determine the anticipated no-controls influent load (No Controls TSS in lbs/year), as determined via an *approved model,* for the land uses in the drainage area after accounting for any upstream pollution control practices.
- Determine the anticipated with-controls % TSS reduction, as determined via an approved model, without coagulant dosing (Settling Only TSS).
- Determine the average annual TSS concentration (Floor TSS in mg/L) anticipated at the outlet of the settling pond after dosing. Assume a value of 6 mg/L unless WDNR concurs with using a different value based on site-specific and coagulant-specific information.

Equations

Estimate the expected treatment benefits of the system considering the following:

- Calculate the expected TP removal (TP Reduction in % reduction from no controls) using the following equation:

$$TP\ Reduction\ = \frac{(No\ Controls\ TP\ -\ Floor\ TP)}{No\ Controls\ TP} x\ Portion\ Dosed$$

$$+\ Settling\ only\ TP\ Reduction\ x\ (1\ -\ Portion\ Dosed)$$

- Calculate the expected TSS removal (TSSR in % reduction from no controls) using the following equation:

$$TSS\ Reduction = \frac{(No\ Controls\ TSS\ -\ Floor\ TSS)}{No\ Controls\ TSS}\ x\ Portion\ Dosed$$

$$+\ Settling\ only\ TSS\ Reduction\ x\ (1 -\ Portion\ Dosed)$$

<u>Example Calculation for TSS and TP % reductions from no-controls</u>

A wet pond serving 100 acres of Medium Density Residential land use and 100 acres of park land use is being designed for a watershed that does not have any upstream best management practices (BMPs). The settling pond is designed per WDNR Technical Standard 1001 to get 74% TSS removal. The pond is located in Dane County, so the Madison 1981 rainfall file was used during modeling and design. The winter season dates for that year are March 12 and December 2. The system is expected to be started on April 15 and be shut down on October 15. The maximum design treatment flow rate would not be exceeded in the average year.

The pond was modeled in WinSLAMM for settling only and the following values were obtained from the detailed output:

No Controls TP = 0.7295 mg/L[4]

Floor TP = 0.05 mg/L

No Controls TSS = 161 mg/L

Floor TSS = 6 mg/L

Average Annual Influent Volume Treated: 3,493,715 cf

Total Annual Influent Volume: 4,251,000 cf

Portion Dosed = 0.82

Settling-only TP Reduction = 51%

Settling-only TSS Reduction = 74%

The expected TP and TSS removal are calculated as:

$$TP\ Reduction\ = \frac{0.7295\ -\ 0.05}{0.7295} x\ 0.82\ +\ 0.51\ x\ (1\ -\ 0.82)\ =\ 0.86\ (86\%\ TP\ reduction)$$

$$TSS\ Reduction\ =\ \frac{(161 -\ 6\ )}{161}\ x\ 0.82\ +\ 0.74\ x\ (1\ -\ 0.82)$$

$$=\ 0.92\ (92\ \%\ TSS\ reduction)$$

[4] Concentration values shown in metric units only for simplicity—1 mg/L = 2.72 lbs/acre-ft.