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NORTH CAROLINA
Environmental Quality

MEMORANDUM
October 29, 2019

To: Interested Parties
From: Linda Culpepper, Director, Division of Water Resources LC
Subject: Approval of *Street Sweeping Nutrient Reduction Practice*

I received and have reviewed the practice description entitled "Design Specifications and Nutrient Accounting for *Street Sweeping*," dated October 14, 2019. I approve the use of this practice as specified therein toward compliance with Existing Development Stormwater rules, and where it may be allowed by other rules in the future, under Division nutrient strategies. This practice adds to the toolbox of management options contributing to more cost-effective water quality restoration in the state.

I understand that this nutrient reduction practice has been developed by the Division's Nonpoint Source Planning Branch in consultation with subject matter experts, vetted through the Nutrient Scientific Advisory Board (NSAB), made available for public comment, and that the final product was endorsed by the NSAB at its October 4, 2019 meeting.

Subject to changes in governing nutrient strategy regulations, this practice may be revised in the future through Director approval.

cc: Jim Gregson
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Design Specifications and Nutrient Accounting for Street Sweeping

I. Summary

A. Description:

Street Sweeping is the practice of periodically cleaning roadway surfaces that have curb and gutter and collecting the sweepings. These sweepings or gross solids may include organic debris, litter, and a range of sediment sizes.

To determine the nutrient removal credit for the practice, the weight of combined material prevented from entering the stormwater system is converted to a representative weight of nitrogen and phosphorus, totaled annually, and compared to an estimate of amounts collected during a strategy's baseline time period.

The intent of this document is to provide approved practice standards and associated credit calculations on Street Sweeping as a method of reducing nutrient loads. Information about other practices can be found on the Division of Water Resources Nutrient Practices and Crediting website.

B. Utility

The practice is potentially useful in any stormwater collection setting with curb and gutter and provides ancillary pollutant removal and aesthetic benefits. Targeting under-maintained areas with higher rates of debris accumulation may provide the greatest practice efficiencies.

C. Applicability

This practice applies toward compliance with Existing Development stormwater rules and may be implemented by local and state/federal governments subject to these rules. Credit can be given for improvements in street sweeping results since the baseline time period of the applicable nutrient strategy as specified in strategy Purpose and Scope rules. This practice is not available for credit toward New Development nutrient reduction requirements.

D. Credit Overview

The fresh weight of material prevented from entering the stormwater system is measured directly, or determined indirectly by its relationship to the average weight of the contents of a collection vehicle combined with tracking of number of vehicle loads, and tallied over the course of a year, or by the amount of material kept out of the stormwater system by other means. The conversion factors of **0.023 lb TN and 0.002 lb TP** per pound of material are applied to the collected weight to determine the weight of N and P removed from the system. Annual values are then reduced by estimates of mass collected during the strategy baseline time period to establish net annual credit.

II. Practice Design and Implementation

A. Qualifying Conditions and Limitations

1. Applicability

This practice applies toward compliance with Existing Development rules and may be implemented by parties with stormwater system maintenance responsibility, including local governments and state or federal parties. Credit can be given for street sweeping that is new or improved since the baseline time period of the applicable nutrient strategy as specified in strategy Purpose and Scope rules. Use in new development settings would require adoption of the practice by the NC Division of Energy, Mineral and Land Resources stormwater permitting program. This practice cannot currently be used for credit toward New Development nutrient reduction requirements.

2. Preconditions

- Streets swept must have curb and gutter.

3. Practice Constraints

- This nutrient reduction practice does not include credit for materials from autumn-based streetside leaf pickup or instream devices.

B. Design Guidance

1. Required Elements

None.

2. Recommended Elements

- Consider developing or refining a street sweeping standard operating procedure for internal training purposes. This may include collection method, frequency, routes, weighing method, and disposal method. See the Operation and Maintenance Section for more information.
- To maximize cost effectiveness, consider sweeping, in locations that receive the greatest amount of organic matter. Locations may include drainage areas with the greatest tree canopy or the highest sediment or debris loads and may be influenced by tree canopy area, leaf area index, tree species, and stormwater flow.

C. Installation/Implementation

1. Required Elements

None.

2. Recommended Elements

Follow manufacturers' guidelines for street sweeping equipment.

D. Operation and Maintenance

1. Required Elements

- The weight of solids prevented from entering the system will be determined by direct weighing of material or indirectly by determining the average weight of the contents of a full collection vehicle, based on a representative number of samples, and then recording the number of loads collected each year, or through other means of recordkeeping. Partially full vehicles may be assigned a proportional weight of material. Drying the material before weighing is not required.
- Solids will be stored and disposed of in a manner that prevents material and associated nutrients from reaching surface waters through surface flow.

2. Recommended Elements

- Consider establishing a standard operating procedure regarding staff training, prioritizing locations, frequency, tracking, reporting, verification, disposal, equipment maintenance, and other program elements discussed below.
- More frequent collection from a high-accumulation street may provide proportionally greater nutrient yield per unit of material, as a result of higher unit-mass nutrient concentrations in fresher material, if a program is interested in evaluating nutrient content.
- Sweeping frequency may need to be optimized in relation to tree canopy, operating costs, staff costs, return on investment for equipment, and resident complaints.
- Parties are encouraged to follow manufacturers operation and maintenance guidelines for street sweeping vehicles.

E. Credit Award and Renewal

This is a results-based credit that will be calculated based on the mass of material prevented from entering the stormwater system, totaled for the year. Results are credited relative to the extent and character of the practice during a nutrient strategy's baseline time period. Baseline material collection must be determined using available program data. To receive nutrient reduction credit, the party will submit annual records to DWR which include:

1) The data supporting the calculations described in Section III;
2) The calculations themselves, including as applicable, specifics of the truckload averaging method; and
3) The corresponding nutrient credit results.

Custom conversion factors for material weight to nutrient mass may be developed based on laboratory analysis and proposed for use in place of the factors provided. Contact DWR if you are interested in developing custom conversion factors.

III. Nutrient Credit Estimation

A. Credit Method Description

The credit calculation involves applying N and P mass conversion factors to the collected weight of material, regardless of solids composition which can include organic matter, litter, moisture content, and coarse and fine sediments. Throughout this practice, weight always refers to the collected weight in its natural form.

The most direct measurement of collected weight is to weigh each truckload. Another method is to determine the average weight of material in a full truckload based on a reasonable number of sampling events and then record how many truckloads of that type are collected during the year. In addition, if applicable, the weight of material that has been stopped from entering the system due to local policy, can be included in the determined weight.

B. Calculation Instructions

The following equation will be used to determine N and P removal credit for a given collection.

$RC = W \times F$

Where:

- RC = Reduction credit (lbs of nutrient) RC_N or RC_P
- W = Weight of material prevented from entering the stormwater system (lbs of debris)
  W may be determined directly by weighing each truckload, or by determining the average weight of collected debris of a full truckload and scaling the weight of material based on the proportion of a full load, or determined indirectly by recordkeeping of the amount of material kept out of the stormwater system by other means.
- F = Conversion factor (lbs nutrient/lbs debris) F_N or F_P (Table 1)

Table 1: Collected Debris Weight Nutrient Conversion Factors (F) (Waickowski, 2018)
F_N = 0.023 lb TN / lb collected debris
F_P = 0.002 lb TP / lb collected debris

IV. Supporting Technical Information

A. Reductions Obtained

Nutrient reduction is directly correlated to weight of debris collected, which increases with mileage swept.

B. Example Calculation

Example 1 - The Town of Moccasin has been sweeping its streets for many years now and has a relatively accurate assessment of the streets which it swept before the baseline time period and the increased mileage it now sweeps. By weighing current collection truckloads, it has determined its baseline annual weight collected was 20,000 lbs.

Moccasin stores all its collected material on a pervious surface, keeps track of the number of truckloads from different types of trucks, and has the average weight of a single full truckload of material from each of the different trucks used.

This past year, Moccasin collected 40 sweeper truckloads. The average weight of one truck load = 700 pounds, therefore Moccasin has collected 40 x700 or 28,000 lbs of debris.

This becomes the weight of debris that has been stopped from entering the stormwater system.

Annual weight of material prevented from entering the system = 28,000 lbs.

Annual weight of material collected at baseline = 20,000 lbs.

Current annual weight minus baseline annual weight = 5,000 lbs.

Using the conversion factors found in IIIB, Moccasin claims the following credits.

RC_N = 5,000 pounds debris * 0.023 lbs TN/pounds debris = 115 lbs TN

RC_P = 5,000 pounds debris * 0.002 lbs TP/pounds debris = 10 lbs TP

C. Credit Basis and Relative Confidence

Using a Confidence Evaluation Matrix, a qualitative review of the studies meant to guide further research (NCDWR, 2018), relative confidence in the reductions estimated for Street Sweeping is High. The studies supporting this practice have high levels of confidence in the loading source, study location sites, nutrient measurements, real-world adaptation, and data quality. They have a medium level in confidence for study diversity and availability, and a low level of confidence for sampling scheme and frequency.

Previous studies, Donner (2016) and Stack et al (2013), assigned nutrient content based on % organic matter and % sediment found in the collected samples. Waickowski (2015) determined the relative nutrient content based on the entire collected debris sample. While assignment of different conversion factors for organic and mineral fractions was considered technically preferable, in practice it appeared that separation of these fractions for weighing would prove practically infeasible.

Previous discussions of nutrient crediting for Street Sweeping involved a credit design that relied on the use of Advanced Sweeper Technology (AST) such as Regenerative-Air Sweepers or Vacuum Assisted Sweepers, tracking of the miles swept, an assumed nutrient loading rate for roads, and differences in fractional nutrient capture based on the frequency of sweeping, which is how the Chesapeake Bay watershed program estimates nutrient credit. Credit assignment relied on additional implementation assumptions that included dry roads, access to curbs without parked cars, frequency of sweeping, and use of AST.

The NC practice replaces the need for the above range of assumptions with direct weighing of collected material. Key assumptions required for this direct measurement of materials approach include: within-year variations in material moisture content are adequately captured in the single conversion factor values based on study sample population sizes; and material composition differences between street sweepings (regardless of sweeper type) are also sufficiently minor to allow use of the single conversion factor values employed. These assumptions rely on in-state research involving a large number of observations across a set of Piedmont and Coastal Plain sites involving a range of drainage catchment characteristics and seasons.

D. Cost Analysis

Costs were not included in the scope of the studies used. The following qualitative factors may be worth considering in undertaking this practice. Costs incurred from any collection program include staff time for monitoring, maintenance, collection, sweeping, weighing, and disposal. Street sweepers, their purchase, operation and maintenance, are a significant program cost. Already owning this equipment is a distinct advantage in set up cost. Some communities may find private contractors an economically viable alternative.

E. Risks and Benefits

Potential benefits street sweeping beyond nutrient credit include: reduced customer complaints, reduced litter, increased awareness of system problems, reduced toxic inputs from urban watersheds and reduced organic matter and sediment in streams which can reduce scouring and improve habitat.

F. References & Resources

Donner S, Frost B, Goulet MH et.al. 2016. Recommendations of the Expert Panel to define Removal Rates for Street and Storm Drain Cleaning Practices. Final Report.

NC Division of Water Resources Confidence Evaluation Matrix. 2018. https://deq.nc.gov/about/divisions/water-resources/planning/nonpoint-source-management/nutrient-offset-information

Rogers LR, Carey ES, Waickowski SE 2017. Gross Solids and Catch Basin Inserts: A Comparison of Multiple Products - Evaluation of Gross Solids Proprietary Devices.

Rubin, Robert. 2017. Trashguard trial data in Raleigh NC neighborhood. Unpublished.

Stack B, Law N, Drescher S 2013. Gross solids Characterization Study in the Tred Avon Watershed, Talbot County, MD. Prepared by the Center for Watershed Protection as fulfillment of the Chesapeake and Atlantic Coastal Bay Trust Fund 14-11-1415 TRF08 and Tred Avon Local Implementation Grant FY 2011.

Tetra Tech. 2013. North Carolina Piedmont Nutrient Load Reducing Measures Technical Report. Report Submitted to Division of Water Resources, 7 September 2013.

Waickowski SE 2015. Gross Solids in Urban Catch Basins: A Pollutant Accounting Opportunity? (Master's thesis). Retrieved from http://www.lib.ncsu.edu/resolver/1840.16/10611

Waickowski SE 2018. Concentrations for Nutrient Credits for Storm Cleaning and Street Sweeping (Memo)

G. Credit Development Documentation

NCSU recommends the above conversion factors be used to provide nutrient credits for debris collected from street sweeping. Data used to formulate these concentrations were collected from sweep-able streets in NC and are not dependent upon the capture efficiency of street sweepers. (Waickowski, 2018).