# Design Specifications and Nutrient Accounting for

# Street Sweeping & Storm Drain Cleaning

## Summary

### Description:

Storm Drain Cleaning is defined as the practice of periodic removal of **gross solids** ~~material~~ and associated material from storm drain catch basins. **Gross solids** ~~Material~~ may include organic debris, litter, or coarse sediments. Associated material may include finer sediments. **The combined** material may be collected from unaltered catch basins, or catch basins with a **gross solids** ~~material~~ collection device installed. These devices are designed to alter catch basins to store more material than unaltered catch basins.

Street Sweeping is the practice of periodically cleaning roadway surfaces that have curb and gutter and collecting the sweepings.

To determine the nutrient removal credit, the weight of **combined** material collected is converted to a representative weight of nitrogen and phosphorus removed from the system.

The intent of this document is to provide guidance and the associated credit calculations on Street Sweeping and Storm Drain Cleaning as methods of reducing nutrient loads.

### Utility:

The practice is potentially useful in any stormwater collection setting involving structural inlets and curb and gutter and may also provide ancillary pollutant removal benefits. Credit is directly quantified, proportional to the amount of material collected. Targeted placement of collection devices in storm drains receiving the greatest material loads can increase practice efficiency.

### Applicability

This practice applies toward compliance with Existing Development Stormwater rules and may be implemented by credit seeking entities. Credit can be given for storm drain cleaning and street sweeping that is new or improved since the baseline period of the applicable nutrient strategy.

### Credit Overview

The weight of freshly collected material is measured directly or is determined indirectly by its relationship to the average weight of the contents of a full collection vehicle. 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.

## Practice Design and Implementation

### Qualifying Conditions and Limitations

#### Applicability

This practice applies toward compliance with Existing Development rules and may be implemented by credit seeking entities including local governments and state or federal parties. Credit can be given for storm drain cleaning and street sweeping that is new or improved since the baseline period of the applicable nutrient strategy. Use in new development settings would require adoption of the practice by the NC Division of Energy, Mineral and Land Resources stormwater permitting program.

#### Preconditions

* Streets swept must have curb and gutter.

#### Practice Constraints

* This nutrient reduction practice does not include credit for materials from annually-based streetside leaf pickup or instream devices.
* A storm drain material collection system will not be placed in a manner which inhibits the passage of aquatic organisms in intermittent or perennial streams, particularly during low flow conditions.

### Design Guidance

#### Required Elements

None.

#### Recommended Elements

* Consider developing a collection program guide, if one does not currently exist. 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 installing collection devices 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.
* Collection devices may be commercially available proprietary devices, each with its own manufacturer guidelines for installation, maintenance, and operation. Entities are responsible for evaluating any device used for flooding or other safety concerns.
* Avoid installing collection devices at low points in the storm drain system that are more likely to have localized flooding.

### Installation/Implementation

#### Required Elements

None.

#### Recommended Elements

Evaluate and follow the manufacturers' guidelines for storm drain material collection devices and street sweeping equipment.

### Operation and Maintenance

#### Required Elements

* The weight of collected solids will be determined by direct weighing of collected 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.
* Solids will be stored and disposed of in a manner approved by the NC Division of Waste Management that prevents them and associated nutrients from reaching surface waters.

#### Recommended Elements

* Consider establishing a standard operating procedure regarding staff training, prioritizing locations, collection methods, frequency, tracking, reporting, verification, disposal, equipment maintenance, and other program elements discussed below.
* More frequent collection from a given drain or street may yield greater annual biomass as well as preserve higher unit-mass nutrient concentrations if a program is interested in evaluating nutrient content.
* Collection frequency may need to be optimized in relation to tree canopy, operating costs, staff costs, return on investment for equipment, flooding, street sweeping, and resident complaints.
* Research suggests collection devices be inspected (and potentially maintained and emptied) quarterly and before and after major rain events such as tropical storms. These inspections will help determine potential flooding concerns and help adjust collection frequency for installed devices. A program may develop a record of seasonal accumulation with which it then designs a modified field-checking and harvesting schedule.
* Entities are encouraged to follow manufacturers operation and maintenance guidelines for installed devices.

### Credit Award and Renewal

This is a retrospective credit that will be calculated and totaled for the year. Baseline material collection must be taken into account. To receive nutrient reduction credit, the entity seeking credit will submit annual records to DWR which include:

1. An estimate of the annual weight of any collected material at baseline.
2. The annual weight of material collected for the reporting year.
3. The difference between annual weight collected (#2 above) and baseline (#1 above), resulting in the net annual weight of material used to calculate nutrient credit.
4. The reporting year’s nutrient credit based on the calculation in Section III.
5. The type of vehicle and its average weight of the contents of a full truck, if that was used to determine #2 above.

Custom conversion factors of 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.

## Nutrient Credit Estimation

### 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 sediments. Throughout this practice, weight always refers to the collected weight, which may be wet.

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.

### Calculation Instructions

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

RC = W x F

Where:

* RC = Reduction credit (lbs of nutrient) RCN or RCP
* W = Weight of collected material (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.
* F = Conversion factor (lbs nutrient/lbs debris) FN or FP (Table 1)

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

## Supporting Technical Information

### Reductions Obtained

Data in Raleigh NC showed collection from one installed device could range from 500 to 1,400 pounds per year of freshly collected debris, translating to approximately 12-33 lbs of nitrogen and 1-3 lbs of phosphorous per year per device installed.

### Example Calculation

### Example 1: Orangeville has installed 30 material collection devices in storm drains throughout town. On a regular basis throughout the year, the town collects material from these storm drains. Orangeville sweeps its downtown streets on a weekly basis when it can, and sweeps some of it neighborhoods a few times a year. All the streets swept have curb and gutter.

### The material collected from both practices is deposited at their facility management yard, on a pervious area that does not drain directly to a stream or storm drain. When the material has drained it is taken to a yard waste disposal site. Orangeville’s reporting method is topnotch so they know that they have collected 27 full vacuum truckloads of material through the storm drain cleaning process this year, and 30 full truckloads of material using the sweeper truck.

Before the baseline period Orangeville would collect material from some storm drains but not on a regular basis. Because Orangeville is only collecting material from storm drains it has installed collection devices in since the baseline period, it does not have to develop an estimate of its baseline activity.

To determine the average weight of collected material in a full truckload, Orangeville weighed the contents of five truckloads of each type of truck used, and determined average weight of debris in a full vacuum truck is 1,000 pounds and a full sweeper truck is 700 pounds.

The weight used to determine the nutrient credit is the # of truckloads multiplied by the average weight of one truckload: 27 \* 1,000 = 27,000 pounds of debris from stormdrains and 30 \* 700 = 21,000 pounds of debris from street sweeping.

27,000 + 21,000 = 48,000 pounds of total collected debris.

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

RCN = 48,000 pounds debris \* 0.023 lbs TN/pounds debris = 1,104 lbs TN

RCP = 48,000 pounds debris \* 0.002 lbs TP/pounds debris = 96 lbs TN

**Example 2 - Mixed Street Sweeping and Collection Devices: The Town of Moccasin** has purchased an attachment for its AST sweeper truck that allows it to vacuum out storm drains while it is out sweeping streets that have curb and gutter. It also has another vacuum truck that sometimes goes out and cleans out storm drains. Moccasin purchased and installed a few storm drain collection devices into storm drains around town to test them locally, for their budget office. If it sees an increase in material collected, which then translates to an increase in N and P credit, it may be able to purchase more. Moccasin has always collected material from its storm drains and using its records it has estimated that during the baseline period and before, it collected about 20,000 pounds of material a year.

Since town staff combines its street sweeping with its storm drain cleaning, it can use the weight of all material collected to determine its nutrient credit. Like Orangeville, Moccasin dumps all its 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 (average weight of one load = 700 pounds) and 60 storm drain vacuum truckloads (average weight of one load = 900 pounds).

Total pounds of debris collected = 40\*700 + 60\*900 = 82,000 pounds debris

Subtract the baseline annual weight of debris: 82,000 - 20,000 = 62,000

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

RCN = 62,000 pounds debris \* 0.023 lbs TN/pounds debris = 1,426 lbs TN

RCP = 62,000 pounds debris \* 0.002 lbs TP/pounds debris = 124 lbs TN

### Credit Basis and Relative Confidence

Storm Drain Cleaning

Using a Confidence Evaluation Matrix (see references), relative confidence in the reductions estimated for Storm Drain Cleaning only is High. This is a qualitative review of the studies meant to guide further research. The studies supporting this practice have high levels of confidence in the loading source, study location sites, real-world adaptation, nutrient measurements, and data quality, but only two replicates of each device were conducted with only a partial of year of monitoring.

This credit is based on studies by Rogers et al. (2017). Four Piedmont and Coastal Plain cities were used with drainage basins incorporating high and low density housing as well as urban/downtown sites. Municipal officials assisted with site selection. Only one type of storm drain inlet was used. This established loading rates.

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.

Street Sweeping

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 combined practice replaces the need for the above range of assumptions with direct weighing of collected material. Key assumptions required for this direct measurement of combined 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) and inlet debris 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.

The confidence evaluation interval for both methods is medium with high and medium levels of applicability study factors, medium and low levels of data scope and depth study factors, and high and low levels of data quality - low levels found in the number of studies categories.

Combined

Given the assumptions made for each street sweeping practice, the local data and the practicality of implementation, the combined storm drain cleaning/street sweeping practice is most useful to North Carolina.

### 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, whether or not collection devices are involved, include staff time such as field verification of sites, monitoring, maintenance, collection, sweeping, weighing, and disposal. Vacuum trucks and 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.

Installing collection devices will increase the amount of material collected, which may help improve the returns per unit labor. As a collection program progresses and gathers data, its records may help fine tune the collection (storm drains and sweeping) frequency of any site and the location of installed devices, improving efficiency and thereby reducing costs.

### Risks and Benefits

Potential benefits of storm drain cleaning and street sweeping beyond nutrient credit include: reduced flooding, reduced property damage, 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.

For installed collection devices in storm drains, the potential risks may include increased flooding with poor placement or collection schedules.

### References & Resources

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

Division of Water Resources Confidence Evaluation Matrix. 2015.

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)

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

### Credit Development Documentation

NCSU recommends the above conversion factors be used to provide nutrient credits for debris collected from storm drain cleaning and/or 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 inserts or street sweepers.

(See the following Memo from Waickowski, 2018. If the linked pdf below does not open, it can also be found in the References PDF sent out with the email.)

