Clean Sweep

Recommendations for New and Updated Credits for Street Cleaning in New Hampshire

Technical Memorandum

September 1 , 2022

PREP Piscataqua Region Estuaries Partnership
UNH Stormwater Center

Contents

1. Executive Summary

This technical memorandum summarizes the recommendations of an expert panel to update New Hampshire's current Enhanced Street/Pavement Cleaning credit (USEPA 2017) and create a new measured credit for organic matter collection. The intention for these new and modified credits is to provide communities, consulting engineers, and technical assistance providers with the tools and incentives to reduce Total Nitrogen (TN) and Total Phosphorus (TP) loading associated with these nonstructural Best Management Practices (BMPs) under the National Pollutant Discharge Elimination System Stormwater Permit Program for NH (USEPA, 2017).

Issued in January 2017, New Hampshire's current Small Municipal Separate Storm Sewer System (MS4) General Permit (USEPA 2017) describes tracking and accounting metrics to quantify nutrient and sediment pollutant loading for different land uses. Under this permit, municipalities may earn TN or TP reduction credits through enhanced cleaning of impervious surfaces or by gathering, removing, and properly disposing of organic matter. However, these credits do not offer the sufficient return on the investment required to maintain such programs, and the current standard of street cleaning practice in the Great Bay Watershed is low (Town of Exeter 2015, University of Florida 2019). At the same time, a growing body of science suggests that enhanced street cleaning practices can achieve pollutant reductions far beyond what is currently recognized in New Hampshire's existing credit programs (Tetra Tech 2020).

Updates to the Great Bay Total Nitrogen General Permit and a new MS4 permit for New Hampshire are anticipated to include these credit options in the near future. Together, they represent opportunities for broadening the use of non-structural control credits. If accepted by state and federal regulators, the recommendations in this memorandum will generate two options for obtaining credit for street cleaning under the state's permits. Through the first option, permittees can receive credit by measuring the amount of organic matter collected throughout the year—an approach pioneered in Minnesota (Minnesota Pollution Control Agency 2022). The second option would allow permittees to use an updated version of the model that informs New Hampshire's current Enhanced Street/Pavement Cleaning Program. This would offer credit for municipal sweeping efforts depending on the technology used, frequency of cleaning, seasonality, and location. Permittees could use either option to receive credit, but not both, within one reporting year. The U.S. Environmental Protection Agency, Region 1, has endorsed piloting these credits to provide insight into, and the adaptive improvement of current credits into the next New Hampshire and Massachusetts Small MS4 General Permits.

Both options, but in particular the measured approach, would increase the amount of the credit permittees can earn through implementation of these BMPs beyond what is currently possible. By providing two options, the panel hopes to give permittees the flexibility they need to pursue credit in the way that best suits their objectives and resources, while creating incentives for them to conduct street cleaning when and where it will have the greatest water quality benefit.

The interim between summer 2022 and the release of the new MS4 permit offers municipalities and the State of New Hampshire a unique opportunity to test these recommendations and collect data to assess their feasibility. As a result, the panel recommends that these proposed updates to New Hampshire's current credit programs be subject to adaptation when, and if, new science and data become available. They also offer a list of research topics that could support improvement of either credit in the future. (See Appendix B.)

This memorandum was generated by the Clean Sweep Project, which used an expert panel process to develop consensus-based recommendations to modify pollutant load reductions for street cleaning BMPs in ways supported by existing science and data. (See Appendix C for an overview of Clean Sweep.) The project was modeled after Credit for Going Green, a similar initiative that used techniques from the Chesapeake Bay to develop pollutant reduction performance curves for using restored or constructed buffers to meet in-stream pollution reduction targets. Clean Sweep is sponsored by the U.S. Environmental Protection Agency, the Piscataqua Region Estuaries Partnership, and the Town of Durham, New Hampshire. The project team gratefully acknowledges the contributions of time and expertise from members of the expert panel and advisory committee.

2. Definition of Terms

This memorandum uses the following definitions for key terms.

- **AF**: Annual Frequency of sweeping. For example, if sweeping does not occur in December, January, or February, the AF would be 9 months /12 months, or 0.75. For year-round sweeping, AF would be 1 or something less than 1.
- ***Area:*** measured amount of street surface swept
- ***Credit:*** Estimated pollutant load reduction given for the application of BMPs, such as street cleaning, under the NPDES Stormwater Permit Program and other efforts to manage stormwater
- ***Credit sweeping:*** Amount of nutrient load removed by enhanced sweeping program (lbs/year)
- ***Delivery coefficient factor:*** Number between 0 and 1 that the measurement of collected TN or TP is multiplied by to account for natural attenuation of nutrients between the street and the receiving water body
- ***Dry mass:*** Mass of sweepings with all water removed, determined by oven drying a subsample and multiplying the wet mass of the sweeper load by the ratio of the dry mass to wet mass of the subsample
- ***Efficiency:*** Ability to decrease the nutrient load export rate
- ***IA swept:*** Area of impervious surface that is swept under the enhanced sweeping program (acres)
- ***Length (or lane miles) swept:*** Linear distance traveled by a sweeper with an assumed width of eight feet.
- ***Total Nitrogen concentration from mass:*** Ratio of TN to dry mass of sweepings, expressed in mg/kg and taken from the 25th percentile of the Minnesota data set
- ***NLER IC-land use***: Nitrogen (TN) Load Export Rate for impervious cover and specified land use (lb/acre/yr) (Table 2-2)
- ***NRF sweeping:*** Nitrogen (TN) Reduction Factor for sweeping based on sweeper type and frequency (Table 2-4)
- ***Percent moisture:*** Mass of water divided by total wet mass of subsample.
- ***Performance***: Ability of a Best Management Practice (BMP), such as street cleaning, to remove TN, TSS, and/or TP
- ***Phosphorus concentration from mass:*** Ratio of phosphorus to dry mass of sweepings, expressed in mg/kg and taken from the 25th percentile of the Minnesota data set

- ***PLER IC-land use***: Phosphorus (TP) Load Export Rate for impervious cover and specified land use (lb/acre/yr) (Table 2-1)
- ***PRF sweeping***: Phosphorus (TP) Reduction Factor for sweeping based on sweeper type and frequency (Table 2-4)
- ***Sweeper width:*** Measurement of a street sweeper from side to side, often assumed to be eight feet
- ***Wet mass:*** Raw mass of street sweepings, including any moisture

3. About the Expert Panel and Its Process

Clean Sweep applied the FAST expert panel process (Houle et al., 2019), which creates a structure to synthesize the opinions of a group of authorities on a subject around which there had been uncertainty due to insufficient and/or unattainable data because of physical constraints or lack of resources. This panel included state and regional regulators, experts in the field of watershed hydrology and stormwater management, a stormwater consultant, and representatives of New Hampshire and Massachusetts municipalities. The panel's focus and work was guided by an advisory committee, which was comprised of similar stakeholders, including some from Vermont and Minnesota. (For an overview of panelists and advisory committee members and their roles in the Clean Sweep project, see Appendix D.)

The advisory committee's charge to the panel was to characterize street sweeping and leaf collection as separate best management practices (BMPs) for reducing nutrient loading in urban stormwater runoff; identify which aspects of these BMPs overlap in practice and in terms of current crediting in New Hampshire; and ultimately make recommendations to update these programs in keeping with existing science and in support of communities getting maximum, appropriate credit for these practices. The panel was supported by a core team, which provided technical guidance and support for project coordination, facilitation, and product development.

To meet their charge, panelists reviewed and enhanced a synthesis of relevant literature and emerging regulatory strategies in Wisconsin, Vermont, and Minnesota (see Appendix E), and compared the crediting programs in these states (see Appendix F). Ultimately, they determined that New Hampshire's current crediting approaches did not offer sufficient incentive for robust and effective street cleaning programs, and there was significant opportunity for change based on existing science.

The panel held six meetings to assess potential changes and make recommendations for change. These discussions, as well as further review of additional scientific and regulatory resources, helped them identify potential modifications to New Hampshire's current street sweeping program that would allow permittees to fulfill the upper boundaries of performance and therefore be eligible for maximum credit under New Hampshire's MS4 permit. They also provided guidance for adapting the organic matter collection credit pioneered in Minnesota (Minnesota Pollution Control Agency 2022) for use in New Hampshire.

4. Key Decisions

The options for credit recommended in this memorandum reflect panel decisions related to topics for which there was sufficient existing data, as well as others for which further research or data collection may be warranted. This section provides an overview of these decisions.

1. **Create two options for permittees:** The panel recommended adapting New Hampshire's current Enhanced Street/Pavement Cleaning credit ***and*** establishing a new measured credit for organic matter collection. This decision was based on deliberations of the merits and limitations of both approaches and the ways they overlap. While the measured approach presented the prospect of significantly more credit, to apply it in New Hampshire would rely on practices unfamiliar to its communities and would, initially, be based on Minnesota data. The more familiar, model-based option offers little credit as written, however, the panel saw opportunities to change the model's parameters and increase the amount of credit allowable. Ultimately, they felt having two options would give communities the flexibility to design street cleaning programs to meet their objectives and resources.

2. **Use Minnesota's Street Sweeping Credit Calculator as the basis to develop a similar program in New Hampshire.** Minnesota's program was a compelling model for three primary reasons. It is based on a rigorous study conducted by Tetra Tech and the University of Minnesota (Hobbie et al., 2020); results of this study have been integrated into the state's stormwater program (Minnesota Pollution Control Agency 2022); and the state is working with permittees to facilitate its implementation. This provided enough of a foundation to pilot a version of this approach in New Hampshire. The only significant difference would be to omit the modeling option outlined in Minnesota's approach, given the panel's decision to adapt New Hampshire's model-based, street cleaning credit.

3. **Use Minnesota data to develop a measured credit:** Given the lack of relevant data from New Hampshire, the panel assessed the feasibility of using data from Minnesota's Developing a Street Sweeping Credit for Stormwater Phosphorus Source Reduction Final Report (Hobbie et al., 2020) as a basis for the credit. In response to sample calculations using this data for frequent sweeping (19 times annually) and infrequent sweeping (four times annually in times of high deposition), the panel was concerned that awarding more credit for infrequent collection could disincentivize more frequent collection. However, they appreciated the caution inherent in Minnesota's conservative use of the 25th percentile TP and TN concentrations (as opposed to, for example, the median or mean) in collected organic material to estimate TP and TN recovered through sweeping. Given the low standard of practice in New Hampshire, they thought the suggested interval for infrequent collection would be an improvement. Ultimately, they felt comfortable starting

with Minnesota data, but underscored it would be important to assess data collected by New Hampshire communities piloting this approach.

4. **Do *not* use a delivery coefficient factor in New Hampshire's measured credit program.** A primary concern was related to the fate in transport of TN or TP. The current assumption in the Minnesota approach is that all TP removed from the street would have reached receiving waters. There is no science to fully describe this dynamic in New Hampshire, and several panelists felt this assumption could lead to over crediting, i.e., not all TN and TP in collected organic matter was destined for receiving waters. To balance concerns about over crediting in their state, Minnesota adopted conservative loading rates, using the 25th percentile, rather than a mean or median concentration of TP, in collected organic material. This decision was sufficiently cautious for the panel *not* to recommend the application of a delivery coefficient factor—a multiplier less than one to account for TN and TP in collected organic matter that would not reach receiving waters—for New Hampshire.

5. **Allow for a range of acceptable technologies in the current, model-based street cleaning credit:** The panel agreed that a range of technologies should be allowable in the updated credit, and that a mechanical sweeper represented minimal effort and the use of additional technology, e.g., a vacuum assisted sweeper, should be recognized as a maximum effort. This decision reflected the panel's focus on making changes consistent with the different goals and resources of communities.

6. **Identify a minimum, medium, and maximum sweeping effort in the current, model-based street cleaning credit:** The panel defined 1) minimum effort as sweeping at least two times annually (as in the current credit); 2) medium effort as sweeping *every other* week in the fall (September to December); and 3) maximum effort as monthly sweeping with *weekly* sweeping in the fall (September to December) and early spring.

7. **Simplify the location parameter and accommodate seasonal changes in TN and TP loading in the model-based street cleaning credit:** The panel recommended using medium density residential impervious cover (IC) land use to generate a pollutant load to which to apply the NRF/PRF value. They believe this represents the majority of land use available for sweeping in most New Hampshire communities. For seasonal leaf collection (i.e., intensive weekly sweeping in times of high organic material deposition), the panel recommended an additional 10% removal factor—a 5% increase over the existing enhanced leaf collection credit— to better reflect removals demonstrated in recent literature (Tetra Tech 2020).

5. New: Measured Organic Matter Collection Credit

Municipal responsibility

Permittees who choose to use this approach would receive credit for organic matter that is collected from impervious surfaces. Under the proposed credit, they would have the option for tracking TN and TP reductions from street sweeping activities with some ability to use locally derived data (see calculation steps below). These were adopted from the approach developed and used in Minnesota. (See Appendix G for a summary of Minnesota's approach.)

How credit would be calculated (For example credit calculations, see Appendix I.)

Step 1) Determine the dry mass of sweeping matter collected, using Equation 1.

Equation 1: $Dry\ Mass\ (lb) \ = \ Wet\ Mass\ (lb)\ *\ (1 - Percent\ Moisture\ Content\ )$

If percent moisture content is known, it may be input into Equation 1 in decimal form, otherwise apply a seasonally averaged percent moisture content developed from the University of Minnesota dataset for the appropriate season (Table 1).

Step 2) Determine the TN or TP load removed by multiplying the dry mass determined in Step 1 and the seasonal TN or TP concentration, using Equation 2.

Equation 2: TN or TP Removed (lb) = $Dry\ Mass(lb\ *\ TN\ or\ TP\ \ Concentration\ (mg/kg) * 1 \times 10^{-6}$

Apply the TN or TP concentration from the University of Minnesota dataset for the appropriate season (Table 1).

Table 1			
Season	Average Moisture Content	TP Concentration from Mass (mg/kg)	TN Concentration from Mass (mg/kg)
Fall (Sept - Dec)	0.48	857	2,762
Non-fall (Jan - Aug)	0.22	414	994

6. Update to Current Model-Based Street Cleaning Credit

New Hampshire's current Enhanced Street/Pavement Cleaning credit was introduced in Appendix F of New Hampshire's (USEPA 2017) and Massachusetts' (USEPA 2016) MS4 permits. (See Appendix H for a synthesis of New Hampshire's program.) The panel recommends the following modifications to New Hampshire's current credit:

- Municipalities track and receive credit for area or lane miles swept, sweeper type, and sweeping frequency. (The current credit requires municipalities to also track *land use* in the watershed area swept.)

- Adopt *medium density residential land use loading values for IC* and add an option for tracking lane miles. If permittees can differentiate area and land use, those values could be utilized. (See Tables 3-1 and 3-2 in Appendix F and Attachment 3 of New Hampshire's MS4 permit.) For those who lack this capacity, the panel recommends the default medium density residential land use as it represents most of the potential sweeping routes.

- Municipalities can use mechanical broom and vacuum sweepers, which include true vacuum, vacuum assisted, and regenerative air sweepers. (The current credit includes three technology options.)

- Municipalities can use one of two options for sweeping frequency to characterize minimum and maximum effort. (See Table 3). (The current credit has three frequency options.)

How credit would be calculated (For example credit calculations, see Appendix I.)

Under this modified version of New Hampshire's Enhanced Street/Pavement Cleaning Program, permittees could earn a TN and TP reduction credit for conducting a municipal sweeping program. The credit would calculated by using the following equations and values in Table 3:

Equation 3: Credit TP Sweeping (lb/yr) =

$$Impervious\ Area\ (ac)\ *\ TP\ Load\ Reduction\ Factor\ (PRF)\ of\ Sweeper\ Type\ *\ PLER\ IC\ land\ use\ (lb/ac/year)$$

Equation 4: Credit TN sweeping (lb/yr) =

$$Impervious\ area\ (ac)\ *\ TN\ Load\ Reduction\ Factor\ (NRF)\ of\ Sweeper\ Type\ *\ NLER\ IC\ land\ use\ (lb/ac/year)$$

PRF/NRF credits range from a minimum effort (0.01 - 0.02) to a medium effort (0.15), and a maximum effort (up to 0.25) depending on the municipal program approach.

Table 3: Updated Parameters for New Hampshire's Model-based Credit for Street Cleaning			
Parameter	Minimum Effort	Medium effort	Maximum Effort
Frequency	Up to 2 times per year in any season. NRF/PRF = 0.01 for a mechanical sweeper and 0.02 for a vacuum.	Every other week in the fall (Sept. to Dec.). NRF/PRF = 0.15	Monthly routine maintenance with more intensive (weekly) in Fall (Sept. to Dec.) and early spring. NRF/PRF = 0.25 with enhanced leaf collection. Assumes a vacuum sweeper (defined above), but may be combined with other efforts.
Location and seasonality	To accommodate seasonal increases in TN and TP and simplify the location parameter: 1) Use medium density residential IC land use, which integrates the majority of likely land uses. 2) For intensive (weekly) fall sweeping in times of high organic material deposition, offer a 10% additional removal factor. This is a 5% increase over the enhanced leaf collection credit in the current model and better reflects removals in the recent literature. (Synonymous with maximum effort.)		

For the area conversion from lane miles, sweeper width is assumed to be eight feet. This method, since it is based on the least informative inputs, is necessarily conservative and will likely result in less credit than the measured approach.

7. Considerations When Applying the Credits

The relationship between seasonality and nutrient loading has been incorporated in the measured approach based on recent research from the U.S. Geological Survey and University of Minnesota (Selbig 2016, Hobbie et al., 2020). This work demonstrated a pronounced difference in moisture content and TN and TP concentration depending on the season.

The measured approach is designed to represent two periods of street sweeping throughout the year: fall leaf collection and non-fall collection. The current model-based approach does not differentiate between seasons and is likely too conservative.

Adoption of the proposed measured organic collection credit and updated model-based street cleaning credit will allow permittees more flexibility in reporting and potentially greater accuracy when leaf collection is a major component of sweeping. Clean Sweep partners will pilot the measured approach in New Hampshire communities in 2022 and 2023.

The U.S. Environmental Protection Agency has commended the recommendations and the Clean Sweep approach. In a letter dated August 15, 2022, they observed: "The piloting of these methods will provide insight and adaptive improvement of the new credits and offer opportunities to validate the approaches for future use throughout New England. Information gained during the piloting of the new credits could allow EPA R1 to integrate these credits, or an iteration of these credits, into the next New Hampshire and Massachusetts Small MS4 General Permits." (See Appendix J.)

8. Appendices

The measured approach is designed to represent two periods of street sweeping throughout the year: fall leaf collection and non-fall collection. The current model-based approach does not differentiate between seasons and is likely too conservative.

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8. Appendices

Appendix A: References

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Appendix B: Suggested Areas of Future Research

Ground truth Minnesota data for New Hampshire: The panel recommends pilot studies with a level of analysis sufficient to validate that data collected in New Hampshire for percent moisture and other variables are consistent with those used for Minnesota's calculations.

Citizen collection programs & loading: Both the expert panel and the advisory committee acknowledge growing interest in, and adoption, of leaf bagging and composting programs and other citizen-based efforts. Given the panel's focus on municipal street cleaning, this was beyond its purview. However, the panel feels there is value in synthesizing science and data to support the contribution of such programs to load reductions in relation to street cleaning efforts. In relation to this, the panel suggested studies to better characterize the relative loading from different types of landscapes and impervious cover.

Nutrient loading rates associated with different land uses: The panel recommends studies to better characterize the nutrient loading rates associated with different land uses in general, and in different seasons.

Tree canopy: The extent and composition of tree canopy can influence the nutrient load associated with organic matter deposition. For example, areas where the canopy is more extensive may contribute to higher nutrient loads. Likewise, different tree species may be associated with higher loading, or they may drop their leaves at different times, which could influence appropriate timing of collection. While there is relevant research underway and municipal capacity for canopy assessment is increasing, the panel did not feel that science currently existed to support the integration of this into recommendations in this report. Research questions to help address could include the following:

- How does the extent of canopy influence potential nutrient loading?
- How do different tree species (and composition of canopy) influence potential nutrient loading?
- What are the influences of climate change on the leaf drop of representative tree species in New Hampshire?

Lane miles: The panel considered whether the width of lane miles used in the current model-based street sweeping credit adequately reflected the potential nutrient loading and therefore potential credit. However, new data and more modeling would be required to decide whether, for example, the width could be expanded to represent a greater area or whether parking restrictions should be coordinated with sweeping.

Seasonality: The panel acknowledged that the concentration embedded in the current model-based street sweeping credit was based on data that wasn't entirely collected in the fall, and that seasonality is not represented well. Future versions of the model could address this with new data and more modeling.

Location of sweeping and phosphorus loading: The release of legacy phosphorus from retention ponds is a growing issue. Research is underway to clarify whether sweeping upstream of those ponds can remove sources of phosphorus that would otherwise wash into the pond. If so, the efficiency of ponds should be adjusted to account for less phosphorus available for removal.

Relative loading by watershed type: Panelists suggested there was potential for enrichment factors for base loading rates to be created for different watershed types based on existing data from Minnesota and Wisconsin.

Clean Sweep

This project will develop consensus-based recommendations for pollutant load reductions for street sweeping BMPs. Our goal is to ensure that the credit received under regulatory permits issued by the NPDES Stormwater Permit Program is commensurate with the latest science. The team will develop a technical memorandum and other outreach products to share these recommendations with communities, regulators, consultants, and others in the Piscataqua Region Watershed in fall 2022.

Why this project

Urban stormwater is one of the fastest growing sources of pollution in communities nationwide. In New Hampshire, local governments have raised concerns about meeting pollutant reduction goals for total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS). Street sweeping and seasonal leaf collection are nonstructural best management practices (BMPs) that historically have received inconsistent pollutant removal credit under regulatory permits. However, recent science and data indicate these BMPs may be much more effective at removing pollutants than previously expected, especially at certain times of the year. This project will provide regulators and communities with science-based recommendations to quantify the water quality benefits of these BMPs.

Our approach

We will use the expert panel process FAST, an iterative, weight-of-evidence approach to synthesizing expert opinion and reaching general agreement around science based recommendations for resource management. This process was refined in the Credit for Going Green project, which developed pollutant reduction performance curves for restored or constructed buffers,so that they could receive pollutant removal credits under New Hampshire's regulatory permits. This process will be supported by an advisory committee, composed of municipal representatives, regulators, and consultants, as well as an expert panel of scientists in the fields of hydrology, fate and transport of urban pollutants, and engineering.

Project partners

University of New Hampshire Stormwater Center (UNHSC)

Piscataqua Region Estuaries Partnership (PREP)

Roca Communications

Advisors

New Hampshire Department of Environmental Services

United States Environmental Protection Agency Region 1

City of Dover (and municipalities to be determined)

Consultant Engineers

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This project is sponsored by the US Environmental Protection Agency, PREP, and the Town of Durham, N.H.

Appendix D: Clean Sweep Roles, Responsibilities, Timeline

Participant	Role	Responsibilities
Core Team		
James Houle, Director, University of New Hampshire Stormwater Center	Technical lead, panel chair	Oversee advisory engagement of committee and expert panel, development of products, and sharing of results
Abigail Lyon, Technical Assistance Program Manager, Piscataqua Region Estuaries Partnership	Project lead, fiscal agent	Oversee additional stakeholder engagement, project budget, and reporting
Elizabeth Buschert, Project Manager, University of New Hampshire Stormwater Center	Technical support	Conduct literature analysis, develop synthesis, and provide technical support
Dolores Leonard, Principal Roca Communications	Group process, products	Support core team in convening and facilitating advisory committee and expert panel and in developing final products.
Lola Jalbert Combs, Assistant Producer, Roca Communications	Meeting support, products	Support core team in convening and facilitating advisory committee and expert panel and in developing final products
Advisory Committee: Frame questions for panel, suggest panelists, provide feedback on progress and input on final products. Participation includes three virtual meetings and responding to email requests for input. Up to 10 hour time commitment.		
Bill Boulanger, Deputy Director of Community Services, City of Dover, N.H.	Committee member	Advise on municipal level needs, interests, and applicability
David Bowley, Utilities Systems Manager, University of New Hampshire	Committee member	Advise on needs, interests, and applicability within a large scale, non municipal setting.
Zach Henderson, Water Resources Technical Manager, Woodard & Curran	Committee member	Advise on BMP design and implementation
Caroline Kendall, Town Administrator, Town of Rollinsford, N.H.	Committee member	Advise on municipal level needs, interests, and applicability
James McCarty, GIS Manager, City of Portsmouth, N.H.	Committee member	Advise on municipal level needs, interests, and applicability
Randy Neprash, Stantec, National Municipal Stormwater Association	Committee member	Advise on municipal level needs, interests, and applicability, as well as credit design & implementation in other regions.
James Pease, Analyst-Biologist, VT Dept. of Environmental Conservation	Committee member	Advise on state level policy interests and perspectives
Sally Soule, Coastal Watershed Supervisor, N.H. Dept. of Environmental Services	Committee member	Advise on state level policy interests and perspectives
April Talon, Town Engineer, Town of Durham, N.H.	Committee member	Advise on municipal level needs, interests, and applicability

Newton Tedder, U.S., Environmental Engineer, MS4 Permit Writer, U.S. Environmental Protection Agency, Region 1	Committee member	Advise on federal level policy interests and perspectives
Michelle Vuto, Environmental Engineer, U.S. Environmental Protection Agency, Region 1	Committee member	Advise on federal level policy interests and perspectives

Participant	Role	Responsibilities
Expert Panel: Develop science-based recommendations to inform changes to NH's approach to crediting street weeping and/or leaf collection.		
Bill Boulanger, Deputy Director of Community Services, City of Dover, N.H.	Panelist	Provide firsthand experience with application of BMPs at municipal scale and perspectives on changes to these BMPs considered by the panel.
Ted Diers, Administrator, N.H. Dept. of Environmental Services	Panelist	Provide perspective on state level policy interests and perspectives
Sarah Hobbie, Distinguished McKnight University Professor, Dept. of Ecology, Evolution, and Behavior, University of Minnesota	Panelist	Provide scientific expertise and understanding on how changes to BMPs could impact water quality impacts
James Houle, Director, University of New Hampshire Stormwater Center	Panel Chair	Provide perspective on engagement of committee and expert panel, development of products, and sharing of results,
James McGonagle, Commissioner of Public Works, Newton, MA	Panelist	Provide firsthand experience with application of BMPs at municipal scale and perspectives on changes to these BMPs considered by the panel.
Theresa McGovern, Director of Water Resources at VHB	Panelist	Provide firsthand experience with application of BMPs and to the extent possible, changes to these BMPs considered by the panel.
Bill Selbig, Research Hydrologist, Upper Midwest Water Science Center	Panelist	Provide scientific expertise and understanding on how changes to BMPs could impact water quality impacts
Sally Soule, Coastal Watershed Supervisor, N.H. Dept. of Environmental Services	Committe e member	Provide perspective on state level policy interests and perspectives
Mark Voorhees, Environmental Engineer, U.S. Environmental Protection Agency, Region 1	Panelist	Provide perspective on federal level policy interests and perspectives
Michelle Vuto, Environmental Engineer, U.S. Environmental Protection Agency, Region 1	Panelist	Provide perspective on federal level policy interests and perspectives
Gretchen Young, Environmental Projects Manager, City of Dover, N.H.	Panelist	Provide firsthand experience with application of BMPs at municipal scale and perspectives on changes to these BMPs considered by the panel.

Timeline

Summer 2021

Project Launch

- Advisory committee convenes (2 virtual meetings)
- Questions for panel framed
- Panelists confirmed
- Literature review finalized

Fall 2021

Panel Convenes

- Questions reviewed, decision points identified
- Literature review updated
- Deliberative discussions
- Email reports to advisory committee (input optional)

Spring 2022

Final Product Development

- Draft panel recommendations outlined
- Draft curves, use cases, & technical memo generated
- Panel review
- Advisory committee review (by email)
- Draft outreach materials
- Advisory committee review (by email)
- Products finalized

Summer 2022

Rollout

- Final advisory committee meeting to share & discuss products
- Products shared online and in events, including meetings of the Seacoast Stormwater Coalition

Appendix E: Clean Sweep Synthesis of Literature and Other Resources

Tetra Tech Literature Reviews

- Street sweeping: extended / summary
- Leaf collection: extended / summary

New Hampshire Resources

- Integrated memo on NH leaf collection & street sweeping crediting programs.
- Total Maximum Daily Load (TMDL) Report for 44 Bacteria Impaired Waters in New Hampshire
- Joint Adaptive Management Plan

Vermont Resources

- Vermont crediting information
- Vermont literature review
- Clean Sweep Webinar: Recording. Presentation: Vermont Clean Streets
- VT ski soils and runoff on page 72. It states: "Both logging and ski slopes were assumed to have a curve number equivalent to lawn in fair condition. Thus, for B/C soils, the equivalent curve number would be 74."
- Study from S Burlington. The issue with this study is that the P-load calculated from the measured leaf mass was close to the TMDL target for the City (114 vs 135) and if we added in the CB cleaning they would meet the target using the current practices.
- Sorenson, J.R., Pease, J.M., Foote, J.K., Chalmers, A.T., Ainley, D.H., and Williams, C.J., in review, Estimated Phosphorus Load Reductions from Leaf Litter Removal in the Lake Champlain drainage area, Vermont: U.S. Geological Survey Scientific Investigations Report 2021–####, 50 p.
- Sorenson, J.R., Pease, J.M., Foote, J.K., Chalmers, A.T., Ainley, D.H., and Williams, C.J., in review, Data supporting phosphorus load-reduction estimates from leaf-litter removal in central and northwestern Vermont: U.S. Geological Survey data release,

Minnesota Resources

- Street Sweeping: Minnesota Stormwater Manual
    - Street Sweeping SOP
- Street Sweeping Phosphorus Credit Calculator: User Guide - Minnesota Stormwater Manual

- Developing a Street Sweeping Credit for Stormwater Phosphorus Source Reduction
- Minnesota Street Sweeping Phosphorus Load Credit Development
- Clean Sweep Webinar: Recording. Presentations: Minnesota Street Sweeping
- Evaluation of leaf removal as a means to reduce nutrient concentrations and loads in urban stormwater (Summer phosphorus concentration estimates from residential areas detailed in Figure 3)

Massachusetts

- USGS report looking at materials on streets before and after regenerative-air removal of 32 elements (including total P) in Cambridge, MA

Wisconsin resources

- Interim Municipal Phosphorus Reduction Credit for Leaf Management Programs
- Evaluation of leaf removal as a means to reduce nutrient concentrations and loads in urban stormwater
- Reducing Leaf Litter Contributions of Phosphorus and Nitrogen to Urban Stormwater through Municipal Leaf Collection and Street Cleaning Practices
- Leachable phosphorus from senesced green ash and Norway maple leaves in urban watersheds
- Roger Bannerman's data analysis on lawns as a source of phosphorus
- Reducing Leaf Litter Contributions of Phosphorus and Nitrogen to Urban Stormwater through Municipal Leaf Collection and Street Cleaning Practices (Selbig).

Rhode Island resources

- Analysis performed on behalf of RIDOT to evaluate cost-effectiveness of sweeping vs. structural controls

General

- World Sweeper
- Adopt-A-Drain
- Leave the Leaves to Benefit Wildlife | Xerces Society

Appendix F: Summary of Credit Programs in New Hampshire, Minnesota & Vermont

Calculating Credit: What is the Best Option for New Hampshire?

February 11, 2022

Why this Memo?

This memo is intended to support the Clean Sweep Advisory Committee's discussion of the pros and cons of a model-based or measured approach to assigning credit for a new BMP focused on organic matter removal. This memo compares the municipal responsibilities and calculation methods for New Hampshire's current model-based approach with Minnesota's Street Sweeping Credit Calculator—which gives municipalities the option to use a measured approach—and the new approach used in Vermont. The memo also provides a comparison of the credits that theoretically would be awarded for each approach using data collected in Minnesota.

I. Minnesota's Street Sweeping Credit Calculator

Municipal responsibility

Municipalities have three options to track phosphorus reductions from street sweeping:

1. Measure dry mass of sweepings **and** either record season swept or measure organic matter content
2. Measure wet mass of sweepings **and** record either season swept **or** report some combination of season swept, organic matter content, and percent moisture
3. Track lane miles swept

How credit is calculated

In the first two scenarios, phosphorus removal is calculated using the following equations:

- *Phosphorus Removed = Dry Mass * Phosphorus Concentration from Mass (mg/kg)*
- *Dry Mass (lb) = Wet Mass (lb) * 100/ (Dry Basis Moisture Content + 100)*

Values for average seasonal percent moisture and phosphorus concentration are taken from University of Minnesota (UNM) study data in Table 1 below. (Note: this is not average P concentration, but rather the 25% percentile P concentration, making this a conservative estimate of P removal.) This reflects the distinct differences in moisture content and phosphorus concentration the UMN study found in sweepings collected during fall leaf drop and those collected the rest of the year. Fall designation is not month-specific, which allows for reporting of leaf collection whenever leaf drop occurs.

Table 1

Season	Average Percent Moisture	Phosphorus Concentration from Mass (mg/kg)
Fall	0.48	857.0
Non-fall	0.22	413.6

In the last scenario (lane miles swept), phosphorus removal is calculated using this formula:
*Phosphorus Removed = Length Swept * Sweeper Width * Areal Phosphorus Removal*

Sweeper Width is assumed to be 8.5 feet and Areal Phosphorus Removal (APR) is set at 0.00017 pounds per acre per pass. (Note: the APR is set based on the P8 model.) The set APR value was derived from 10 years of simulated street sweeping in a Minnesota community. This method, since it is based on the least informative inputs, is necessarily conservative and will likely result in the smallest amount of credit.

II. New Hampshire Modeling Method for Sweeping & Leaf Collection

Municipal responsibility

Municipalities must track area swept, land use, sweeper type, and sweeping frequency.

How credit is calculated

Under the New Hampshire Enhanced Street/Pavement Cleaning Program, permittees may earn a phosphorus or a nitrogen reduction credit for conducting an enhanced cleaning program of impervious surfaces. The credit is calculated by using the following equations:

- Credit P sweeping (lb/year) = impervious area swept (acres) * P load export rate of land use (lb/acre/year) * P reduction efficiency factor of sweeper type * annual frequency

- Credit N sweeping (lb/year) = impervious area swept (acres) * N load export rate of land use (lb/acre/year) * N reduction efficiency factor of sweeper type * annual frequency

Technology allowed include mechanical broom sweepers, vacuum assisted sweepers, and high-efficiency regenerative air-vacuums. Sweeping frequency can be twice annually (spring & fall), monthly, or weekly.

Under New Hampshire's Enhanced Organic Matter and Leaf Litter Collection Program, permittees may earn phosphorus and nitrogen reduction credits by performing regular gathering, removal, and proper disposal of landscaping wastes, organic debris, and leaf litter from impervious surfaces within applicable watershed areas (i.e., Lake Phosphorus Control Plan area or Great Bay watershed). The permittee may use an enhanced sweeping program (e.g., weekly) as part of earning this credit provided the sweeping is effective at removing leaf litter and organic material. Credit is calculated with these equations:

- Credit P leaf litter (lb/year) = (IA leaf litter acres) * P load export rate of land use (lb/acre/year) * 0.05
- Credit N leaf litter (lb/year) = (IA leaf litter acres) * N load export rate of land use (lb/acre/year) * 0.05

To receive credit, municipalities gather and remove landscaping wastes, organic debris, and leaf litter from impervious roadways and parking lots at least once a week between September 1 and December 1 each year; immediately following any landscaping activities in the applicable watershed and at additional times necessary to ensure removal of all aforementioned materials at least once a week; and ensure disposal of these materials will not contribute pollutants to any surface water discharge. (More information about these credits and calculations are here.)

III. VT Modeling Method for Sweeping*

Municipal Responsibility

Municipalities must track area swept, land use, watershed swept, percent tree canopy cover over sidewalks and streets, presence of curb and gutter, sweeping frequency, and sweeper type.

How credit is calculated

Permittees may earn phosphorus credit for street sweeping of impervious surfaces, calculated with the following formula:

Credit P sweeping (lb/year) = area swept (acres) * P export rate for watershed and land use swept (lb/acre/year) * P reduction factor

This P credit is only valid if the following conditions are met:

- Streets swept have curb and gutter
- Percent tree canopy cover of roads and sidewalks in the area swept is greater than 4%
- Streets are swept at least four times in the fall to pick up leaves

The P reduction factor is prorated based on the percent canopy cover of the area swept and the maximum credit given is 25% for areas with 40-45% canopy cover.

** Vermont is updating their street sweeping credit but has not yet published a final report, this summary is our best understanding of their new guidelines but may not reflect all details.*

IV. Comparison

In order to evaluate the difference between the calculation methods, a comparison was conducted using examples from the MN calculator training. These areas were then modeled according to the current NH crediting approach, outlined in appendix F of the NH MS4 permit.

Results

This exercise demonstrated large differences in pollutant load reduction between the modeled and measured approaches. All modeling results (NH, VT and MN) lead to much lower calculated reductions for total phosphorus. On the low end the measured results lead to 12-30 times more credit then the VT and NH methods respectively. On the upper end the measured results lead to 21-50 times more credit then the VT and NH methods respectively. We will discuss these methods and the differences in load reduction at the February 15 Clean Sweep Expert Panel Meeting.

Example 1 Frequent Sweeping					
	Method	Information required for calculation	Sweeper type	Number of times route was swept	Calculated annual P credit (lbs)
Modeled Approach	NH	area swept, type of sweeper, land use, times swept per year	Regenerative air	19	1.32
	VT	area swept, area P export rate, sweeping frequency, canopy cover, curb and gutter, sweeper type	Regenerative air	19	4.50
	MN 3	curb miles	Regenerative air	19	0.02
Measured Approach	MN 1	dry mass of sweepings, percent organic matter of sweepings	Regenerative air	19	31.99
	MN 1	dry mass of sweepings, time of year swept	Regenerative air	19	19.34
	MN 2	wet mass of sweepings, percent organic matter of sweepings, time of year swept	Regenerative air	19	31.28
	MN 2	wet mass of sweepings, time of year swept	Regenerative air	19	19.09

Example 2 Infrequent Sweeping					
	Method	Information required for calculation	Sweeper type	Number of times route was swept	Calculated annual P credit (lbs)
Modeled Approach	NH	area swept, type of sweeper, land use, times swept per year	Mechanical/Regenerative (mix)	4	0.41
	VT	area swept, area P export rate, sweeping frequency, canopy cover, curb and gutter, sweeper type	Mechanical/Regenerative (mix)	4	NA
	MN 3	curb miles	Mechanical/Regenerative (mix)	4	0.01
Measured Approach	MN 1	dry mass of sweepings, percent organic matter of sweepings	Mechanical/Regenerative (mix)	4	
	MN 1	dry mass of sweepings, time of year swept	Mechanical/Regenerative (mix)	4	50.14
	MN 2	wet mass of sweepings, percent organic matter of sweepings, time of year swept	Mechanical/Regenerative (mix)	4	
	MN 2	wet mass of sweepings, time of year swept	Mechanical/Regenerative (mix)	4	52.46

Example 1 (top): TP credits from sweeping activities on one 10 mile long, frequently swept sweeper route with 15% canopy cover using all three modeling approaches (New Hampshire's current credit, Vermont's new credit, and Minnesota's option 3) as well as four variations of Minnesota's measured approach.
Example 2 (bottom): TP credit from a less frequently swept 22 mile long sweeper route with 22% canopy cover calculated using the same methods.

Appendix G: Summary of Minnesota's Credit Calculator

Minnesota Street Sweeping Credit Calculator Memo

Updated July, 15, 2022

Why this Memo?

This memo is intended to support the Clean Sweep Expert Panel as they consider the potential application of Minnesota's Street Sweeping Credit Calculator in New Hampshire. It summarizes how credit is allocated according to the state's user guide and this video.

Minnesota municipalities have three options to track phosphorus reductions from street sweeping:

1. Measure dry mass of sweepings **AND** either record season swept or measure organic matter content
2. Measure wet mass of sweepings **AND** record either season swept **OR** report some combination of season swept, organic matter content, and percent moisture
3. Track lane miles swept

In the first two scenarios, phosphorus removed is calculated using the following equations (also see flow chart on page 2):

i) Phosphorus Removed = Dry Mass * Phosphorus Concentration from Mass (mg/kg)

ii) Phosphorus Concentration = 0.044 + 0.0018 * Organic Matter %
Dry Mass = (Wet Mass * 100)/(Dry Basis Moisture Content % + 100)

Values for average percent moisture and phosphorus concentration from mass are taken from University of Minnesota (UNM) studyxx data in Table 1. This reflects the distinct differences in moisture content and phosphorus concentration the UMN study found in sweepings collected during fall leaf drop and sweepings collected during the rest of the year.

Table 1

Season	Dry Basis Moisture Content (%)	Phosphorus Concentration from Mass (mg/kg)
Fall	90.46	857.0
Non-fall	27.76	413.6

- Note the NH adaptation to the MN method uses average seasonal Percent Moisture content converted from the Dry Basis Moisture Content as Percent Moisture content is a more commonly used measure.

The fall designation is flexible rather than month-specific, which allows for reporting of leaf collection whenever the autumn leaf drop occurs.

In the last scenario phosphorus removed is calculated using the formula

Phosphorus Removed = Length Swept x Sweeper Width * Areal Phosphorus Removal

Where Sweeper Width is assumed to be 8.5 feet and Areal Phosphorus Removal (APR) is set at 0.00017 pounds per acre per pass. The set APR value was derived from 10 years of simulated street sweeping in a Minnesota community using the P8 model. This method, since it is based on the least informative inputs, is necessarily conservative and will likely result in the smallest amount of credit.

Appendix H: Summary of New Hampshire's Current Street Sweeping Credit

New Hampshire Enhanced Street/Pavement Cleaning & Leaf Collection Credit Memo Revised *11/1/21*

Why this Memo?

This memo is intended to support deliberations of the Clean Sweep Expert Panel by summarizing how credit is allocated under New Hampshire's Enhanced Street/Pavement Cleaning and Organic Matter and Leaf Litter Collection programs.

Contents

I. Street Sweeping Credit Program Summary

Under the New Hampshire Enhanced Street/Pavement Cleaning Program, permittees may earn a phosphorus (Table 2-1) or a nitrogen reduction credit (Table 2-2) for conducting an enhanced cleaning program of impervious surfaces. The credit is calculated by using the following equations:

- *Equation 2-1:* Phosphorus Credit P sweeping = IA swept * PLER IC-land use * PRF sweeping * AF
- *Equation 2-2:* Nitrogen Credit N sweeping = IA swept * NLER IC-land use * NRF sweeping * AF

Definition of Terms

- *Credit sweeping:* Amount of nutrient load removed by enhanced sweeping program (lbs/year)
- *IA swept:* Area of impervious surface that is swept under the enhanced sweeping program (acres)
- *PLER IC-land use*: Phosphorus Load Export Rate for impervious cover and specified land use (lb./acre/yr.) (Table 2-1).
- *NLER IC-land use*: Nitrogen Load Export Rate for impervious cover and specified land use (lb./acre/yr.) (Table 2-2).
- *PRF sweeping*: Phosphorus Reduction Factor for sweeping based on sweeper type and frequency (Table 2-4).
- *NRF sweeping:* Nitrogen Reduction Factor for sweeping based on sweeper type and frequency (Table 2-4).
- *AF* = Annual Frequency of sweeping. For example, if sweeping does not occur in Dec/Jan/Feb, the AF would be 9 months /12 months = 0.75. For year-round sweeping, AF=1.01
- *Efficiency:* Ability to decrease the nutrient load export rate

A. Factors Influencing Credit

Type of Technology Used

- Mechanical broom sweepers: An older technology, less costly, generally less effective with regard to dirt removal.
- Vacuum assisted sweepers: Brooms place refuse in the path of a vacuum intake, which transports the dirt to a hopper. Overall efficiency is generally higher than that of mechanical broom sweepers, especially for smaller particles.
- High-efficiency regenerative air-vacuum: The highest efficiency sweeper and the most costly.

Frequency of Sweeping

- Twice annually, in spring and fall
- Monthly: PRF and NFR is reduced by the ratio of # months swept / 12
- Weekly

Impact of Technology & Frequency on Efficiency

Table 2-4: Nutrient reduction efficiency factors for sweeping impervious areas ($PRF_{sweeping}$ & $NRF_{sweeping}$)

Frequency[1]	Sweeper Technology	$PRF_{sweeping}$	$NFR_{sweeping}$
2/year (spring and fall)[2]	Mechanical Broom	0.01	0.01
2/year (spring and fall)[2]	Vacuum Assisted	0.02	0.02
2/year (spring and fall)[2]	High-Efficiency Regenerative Air-Vacuum	0.02	0.02
Monthly	Mechanical Broom	0.03	0.03
Monthly	Vacuum Assisted	0.04	0.04
Monthly	High Efficiency Regenerative Air-Vacuum	0.08	0.08
Weekly	Mechanical Broom	0.05	0.06
Weekly	Vacuum Assisted	0.08	0.07
Weekly	High Efficiency Regenerative Air-Vacuum	0.10	0.10

B. Example Credit Calculations

The following is an example of an application to NH's Enhanced Street/Pavement Cleaning Program for a phosphorus load reduction credit (Credit P sweeping): The permittee proposes an enhanced street/pavement cleaning program, including monthly cleanings from March 1 to December 1 (9 months), using a high efficiency, regenerative air-vacuum assisted sweeper on 20.3 acres of parking lot and roadway in a high-density residential (HDR) area of the Lake Phosphorus Control Plan (LPCP) area. For this site, the information needed to calculate the **phosphorus** load reduction is:

- IA swept = 20.3 acres
- PLER IC-HDR = 2.32 lb./acre/yr. (from Table 2-1)
- PRF sweeping = 0.08 (from Table 2-4 above)
- AF = (9 months / 12 months) = 0.75

Applying these values to equation 2-1 yields a credit of 2.8 pounds of phosphorus removed per year.

IA swept 20.3 acres * PLER IC-HDR 2.32 lbs./acre/yr * PRF sweeping 0.08 * AF 0.75 = Phosphorus Credit P sweeping 2.8 lbs./yr.

In the same LPCP area, the following information is needed to calculate nitrogen load reduction credit:

- IA swept = 20.3 acres
- NLER IC-HDR = 14.1 lb./acre/yr. (from Table 2-2)

- NRF sweeping =0.08 (from Table 2-4)
- AF (9 months / 12 months): 0.75

Applying these values to equation 2-2 yields a credit of 17.2 pounds of nitrogen removed per year.

IA swept 20.3 acres x NLER IC-HDR 14.1 lb./acre/yr. x NRF sweeping .08 x AF 0.75 = Nitrogen Credit N sweeping 17.2 lbs./yr.

C. Questions for the Clean Sweep Expert Panel to Consider

Clean Sweep will engage an Expert Panel to 1) consider whether the NH program (as outlined above) adequately reflects the science on nutrient load reductions associated with street sweeping and 2) make recommendations to update the crediting system based on what they determine. It is important for panelists to understand, for example, the type of data municipalities can realistically collect or whether there is flexibility to adapt the crediting process to consider other factors beyond land use, frequency, and technology type. We hope the panel will consider questions like the following:

- What is flexible with respect to the credit calculation process? E.g.: Could additional or different technologies or frequencies be added? Are there factors used in other states that could be considered? Are sweeping activities, and the current credits associated with them, realistic in winter months in the Northeast?

- Are there areas of the NH Enhanced Street/Pavement Cleaning Program that require clarification and/or would benefit from closer examination from a scientific perspective? E.g.: Should deposition areas be solely related to roadways or parking lots or should they expand to adjacent land use areas? What role should curb lines or sweeping medians play in assigning credit? Should we assume loading rates are consistent and uniform across seasons?

- What units make the most sense to collect from a municipal perspective? E.g.Do municipalities measure sweeping in acres? Are there policies (e.g., parking restrictions to facilitate sweeping) that could be considered in the credit calculation process?

2. Organic Matter and Leaf Litter Collection Program Summary

Under New Hampshire's Enhanced Organic Matter and Leaf Litter Collection Program, permittees may earn phosphorus and nitrogen reduction credits by performing regular gathering, removal and proper disposal of landscaping wastes, organic debris, and leaf litter from impervious surfaces within applicable watershed areas (i.e., Lake Phosphorus Control Plan area or Great Bay watershed). The permittee may use an enhanced sweeping program (e.g., weekly frequency) as part of earning this credit provided the sweeping is effective at removing leaf litter and organic materials. Credit is calculated with the following equations:

- Equation 2-6: Credit P leaf litter (lbs/year) = (IA leaf litter(acres)) x (PLER IC-land use(lb/ac/year)) x (0.05)

- Equation 2-7: Credit N leaf litter (lbs/year) = (IA leaf litter(acres)) x (NLER IC-land use(lb/ac/year)) x (0.05)

Definitions

- *Credit leaf litter*: Amount of nutrient load reduction credit for organic waste and leaf litter collection program (lb. /year)
- *IA leaf litter*: Impervious area (acre) in applicable watersheds that are subject to enhanced organic waste and leaf litter collection program
- *PLER IC-land use*: Phosphorus Load Export Rate for impervious cover and specified land use (lbs./acre/yr.) (see Table 2-1)
- *NLER IC-land use*: Phosphorus Load Export Rate for impervious cover and specified land use (lbs./acre/yr.) (see Table 2-1) 0.05 = 5% nutrient reduction factor for organic waste and leaf litter collection program in the applicable watershed

A. Factors Influencing Credit

- **Frequency & timing:** To receive credit, permittees must gather and remove all landscaping wastes, organic debris, and leaf litter from impervious roadways and parking lots at least once a week between September 1 and December 1 each year.
    - To receive credit, permittees must remove landscaping wastes, organic debris, and leaf litter immediately following any landscaping activities in the applicable watershed and at additional times necessary to ensure removal of all aforementioned materials at least once a week.

- **Disposal:** To receive credit, permittees must ensure that disposal of these materials will not contribute pollutants to any surface water discharges.

B. Example Credit Calculations

The permittee proposes an enhanced sweeping program to address leaf litter collection for 12.5 acres of impervious roadways and parking lots in an industrial/commercial part of an LPCP area. They intend to sweep the parking lots and access drives at a minimum of once a week, using a mechanical broom sweeper for the period of September 1 to December 1. They will ensure that organic materials are removed from impervious areas immediately following all landscaping activities in the area.

For this site, the needed information to calculate the Credit leaf litter for phosphorus is:

- IA leaf litter = 12.5 acres
- PLER IC-commercial = 1.78 lbs./acre/yr. (from Table 2-1)

Applying these values to equation 2-6 yields:
Credit P leaf litter = (12.5 acre) x (1.78 lbs./acre/yr.) x (0.05) = 1.1 lbs. P/yr.

For the same site, the following information is needed to calculate credit for nitrogen:
IA leaf litter = 12.5 acres
NLER IC-commercial = 15.0 lbs/acre/yr (from Table 2-2)

Applying these values to equation 2-7 yields:
Credit N leaf litter =(12.5 acre) x (15.0 lbs./acre/yr.) x (0.05) = 9.4 lbs. N/yr.

C. Associated Street/Pavement Cleaning Credit

The permittee also may earn an additional phosphorus reduction credit for enhanced cleaning of roads and parking lot areas (i.e., Credit P sweeping) for using a mechanical broom sweeper weekly during a three-month leaf litter collection program. Using equation 2-1, Credit P sweeping is:

Credit P sweeping = IA swept x PLER IC-land use x PRF sweeping x AF (Equation 2-1)

- IA swept = 12.5 acre
- PLE IC-commercial = 1.78 lbs./acre/yr. (from Table 2-1)
- PRF sweeping = 0.05 (from Table 2-4) AF = 3 mo./12 mo. = 0.25

Applying these values to equation 2-1 yields a Credit P sweeping of 0.3 pounds of phosphorus removed per year.

Credit P sweeping = IA swept x PLER IC-commercial x PRF sweeping x AF = 12.5 acre x 1.78 lbs./acre/yr. x 0.05 x 0.25 = 0.3 lbs. P/yr.

III. Tables 2-1, 2-2, & Consolidated

Table 2-1: Average annual distinct phosphorus (P) load export rates for use in estimating P load reduction credits in the NH MS4 Permit

Phosphorus Source Category by Land Use	Land Surface Cover	P Load Export Rate, lbs./acre/year	P Load Export Rate, kg/ha/yr.
Commercial (COM) and Industrial (IND)	Directly connected impervious	1.78	2.0
	Pervious	See* DevPERV	See* DevPERV
Multi-Family (MFR) and High-Density Residential (HDR)	Directly connected impervious	2.32	2.6
	Pervious	See* DevPERV	See* DevPERV
Medium -Density Residential (MDR)	Directly connected impervious	1.96	2.2
	Pervious	See* DevPERV	See* DevPERV
Low Density Residential (LDR) - "Rural"	Directly connected impervious	1.52	1.7
	Pervious	See* DevPERV	See* DevPERV
Highway (HWY)	Directly connected impervious	1.34	1.5
	Pervious	See* DevPERV	See* DevPERV
Forest (FOR)	Directly connected impervious	1.52	1.7
	Pervious	0.13	0.13
Open Land (OPEN)	Directly connected impervious	1.52	1.7
	Pervious	See* DevPERV	See* DevPERV
Agriculture (AG)	Directly connected impervious	1.52	1.7
	Pervious	0.45	0.5
*Developed Land Pervious (DevPERV) HSG A	Pervious	0.03	0.03
*Developed Land Pervious (DevPERV) – HSG B	Pervious	0.12	0.13
*Developed Land Pervious (DevPERV) – HSG C	Pervious	0.21	0.24
*Developed Land Pervious (DevPERV) – HSG C/D	Pervious	0.29	0.33
*Developed Land Pervious (DevPERV) – HSG D	Pervious	0.37	0.41

Notes:

- For pervious areas, if the hydrologic soil group (HSG) is known, use the appropriate value from this table. If the HSG is not known, assume HSG C conditions for the phosphorus load export rate.
- Agriculture includes row crops, actively managed hay fields, and pasture lands. Institutional land uses, such as government properties, hospitals and schools, are to be included in the commercial and industrial land use grouping for the purpose of calculating phosphorus loading.
- Impervious surfaces within the forest land use category are typically roadways adjacent to forested pervious areas.

Table 2-2: Average annual distinct nitrogen (N) load export rates for use in estimating N load reduction credits in the NH MS4 Permit

Nitrogen Source Category by Land Use	Land Surface Cover	N Load Export Rate, lbs./acre/year	N Load Export Rate, kg/ha/yr.
Commercial (COM) and Industrial (IND)	Directly connected impervious	15.0	16.9
	Pervious	See* DevPERV	See* DevPERV
All Residential	Directly connected impervious	14.1	15.8
	Pervious	See* DevPERV	See* DevPERV
Highway (HWY)	Directly connected impervious	10.5	11.8
	Pervious	See* DevPERV	See* DevPERV
Forest (FOR)	Directly connected impervious	11.3	12.7
	Pervious	0.5	0.6
Open Land (OPEN)	Directly connected impervious	11.3	12.7
	Pervious	See* DevPERV	See* DevPERV
Agriculture (AG)	Directly connected impervious	11.3	12.7
	Pervious	2.6	2.9
*Developed Land Pervious (DevPERV) HSG A	Pervious	0.3	0.3
*Developed Land Pervious (DevPERV) – HSG B	Pervious	1.2	1.3
*Developed Land Pervious (DevPERV) HSG C	Pervious	2.4	2.7
*Developed Land Pervious (DevPERV) – HSG C/D	Pervious	3.1	3.5
*Developed Land Pervious (DevPERV) – HSG D	Pervious	3.6	4.1

Notes:

- For pervious areas, if the hydrologic soil group (HSG) is known, use the appropriate value from this table. If the HSG is not known, assume HSG C conditions for the phosphorus load export rate.
- Agriculture includes row crops. Actively managed hay fields and pasture lands. Institutional land uses such as government properties, hospitals and schools are to be included in the commercial and industrial land use grouping for the purpose of calculating phosphorus loading.
- Impervious surfaces within the forest land use category are typically roadways adjacent to forested pervious areas.

Consolidated Table

Land Use Code	Description	Pollutant Load Export Rate (lbs/acre/yr)	TSS	TP	TN
	Residential	DCIA (IC)	439.0	1.93	14.1
		Pervious (Non-IC)	see devperv	see devperv	see devperv
	Commercial/Institutional	DCIA (IC)	377.4	1.78	15.1
		Pervious (Non-IC)	see devperv	see devperv	see devperv
	Industrial	DCIA (IC)	377.4	1.78	15.1
		Pervious (Non-IC)	see devperv	see devperv	see devperv
	Transportation	DCIA (IC)	1480.1	1.34	10.2
		Pervious (Non-IC)	see devperv	see devperv	see devperv
	Open Space	DCIA (IC)	649.5	1.52	11.3
		Pervious (Non-IC)	see devperv	see devperv	see devperv
	Agriculture	DCIA (IC)	649.5	1.52	11.3
		Pervious (Non-IC)		1.03	2.6
	Forest	DCIA (IC)	649.5	1.52	11.3
		Pervious (Non-IC)		0.13	0.5
	Surface Water	DCIA (IC)	NA	NA	NA
		Pervious (Non-IC)	NA	NA	NA
	Wetlands	DCIA (IC)	NA	NA	NA
		Pervious (Non-IC)	NA	NA	NA
	Developed Pervious				
	HSG A	Pervious (Non-IC)	6.9	0.03	0.3
	HSG B	Pervious (Non-IC)	29.0	0.12	1.2
	HSG C	Pervious (Non-IC)	59.8	0.21	2.4
	HSG D	Pervious (Non-IC)	91.2	0.37	3.6

Appendix I: Example Credit Calculations

Example 1: Measured Organic Matter Collection Credit

Treesville—a beautiful, but *fictional* New Hampshire town—wanted to receive more credit for its leaf collection activities. Last year, they tracked the mass of material collected by their mechanical broom sweeper. They swept twice, the “minimum” effort, and collected 5,708 lbs of material in the spring and 5,840 lbs in the fall.

To calculate Treesville’s credit using the **measured organic matter collection** approach, the following measurements were needed:

- Wet mass of material collected
- Month in which organic matter was collected

The following information was also required to calculate the credits:

- Average percent moisture content (Table 1)
- TN concentration from mass (Table 1)
- TP concentration from mass (Table 1)

Table 1

Season	Average Percent Moisture	TP Concentration from Mass (mg per kg)	TN Concentration from Mass (mg per kg)
Fall (Sept - Dec)	0.48	857	2,762
Non-fall (Jan - Aug)	0.22	414	994

Seasonal TN and TP load reductions are derived from wet mass collected using the factors represented in Table 1. Alternatively, users can calculate their own percent moisture values developed from sub sample analysis from field collections where:

$$\textit{Percent Moisture (\%)} = \frac{\textit{Mass of Water in Subsample}}{\textit{Total mass of water and solids in subsample}} * 100$$

Credit Calculation Steps

Step 1) Calculate the dry mass of material collected in the fall and “non-fall” using Equation 2 and values from Table 1:

Equation 2: $dry\ mass = wet\ mass * (1 - percent\ moisture\ as\ a\ decimal)$

Non fall collected dry mass = $5708lb * (1 - 0.22) = 4500lb$

Fall Collected dry mass = $5840 * (1 - 0.48) = 3000lb$

Step 2) Calculate the TN and TP credit using Equation 1 and values from Table 1:

Equation 1:

$TN\ or\ TP\ credit = dry\ mass\ (lbs) * TN\ or\ TP\ concentration\ (mg/kg) * 10^{-6}$*(kg/mg)*

Non fall TP credit = $4500 * 141 * 10^{-6}$ = 1.8 lbs

To prevent mixing up fall and non fall credit, it is helpful to make a table (Figure 1).

Figure 1: Seasonal Measured Credit Calculations in Different Seasons

Wet mass (lbs)	Time of year collected	Seasonal avg. dry moisture content (%)	Calc. dry mass (lbs)	TN Con (mg/kg)	TP Conc. (mg/kg)	TN Calc. Credit	TP Calc. Credit
Municipality	Municipality	Table 1	Equat. 2	Table 1	Table 1	Equat. 1	Equat. 1
5708	Not Fall	0.22	4500	994	413.6	4.4	1.8
5840	Fall	0.48	3000	2762	857	8.4	2.6
Total						**12.8**	**4.4**

After calculating TN and TP credits for material collected during the fall and the non fall, Treesville would receive credit for 12.8 lbs of TN and 4.4 lbs of TP removed for the year. Note that the credit for TN using this approach is roughly 10 times more than Treesville would have received had they applied the model-based approach with a minimum level of effort. If the town chose to sweep more frequently, particularly in the fall, they could have received more credit.

Example 2: Model-based Street Cleaning Credit

Treesville sweeps their streets twice a year with a mechanical broom sweeper—once in the fall and once in the spring. The sweeper travels 9.5 miles on its route. Since they do not track mass collected, and they only sweep twice a year, they can only pursue the "low effort," model-based street cleaning credit.

To calculate the **modeled** credit, they need the following information:

- Acreage swept by sweeper: Assuming the sweeper clears an 8ft wide path on its 22 mile route it covers 9.2 acres $9.5mi \; * \; \frac{5280ft}{mi} * 8ft \; * \; \frac{1ac}{43560sq\,ft}$
- Type of sweeper: mechanical broom, therefore the sweeper PRF/NRF is 0.01 (Table 3)
- TP land export rate: 1.96 lb/ac/yr (Table 3)
- TN land export rate: 14.1 lb/ac/yr (from Table 3)

Table 3: Updated Parameters for New Hampshire's Model-based Credit for Street Cleaning			
Parameter	Minimum Effort	Medium effort	Maximum Effort
Frequency	Up to twice per year in any season. NRF/PRF = 0.01 for mechanical sweeper and 0.02 for vacuum.	Every other week in the fall (September to December). NRF/PRF = 0.15	Monthly routine maintenance with more intensive (weekly) in Fall (September. to December.) and early spring. NRF/PRF = 0.25 with enhanced leaf collection. Assumes a vacuum sweeper (defined above), but may be combined with other efforts.
Location & seasonality	**To accommodate seasonal increases in TN and TP and simplify the location parameter:** 3) Use the medium density residential IC land use, which integrates the most conservative TP and TN loading rates of all land uses in the current model. 4) For intensive weekly sweeping during the fall in times of high organic material deposition, offer a 10% additional removal factor. This is a 5% increase over the existing enhanced leaf collection credit in the current model and better reflects removals in recent literature. (This is synonymous with maximum effort.)		

Credit Calculation Steps

Step 1) Calculate area swept:

$$Area\ swept\ (acres) \;=\; lane\ miles\ swept \;*\; \frac{5280\ ft}{mi} \;*\; \frac{1\ acre}{43560\ sq\ ft}$$

Step 2) Calculate TP credit using Equation 3:

Equation 3: Credit TP = area swept * TP load export rate * TP reduction factor (PRF) of sweeper type.

TP credit = $9.2ac \; * \; 0.01 \; * \; \frac{1.96lbs}{ac \cdot yr} = \frac{0.18lbs}{yr}$

Step 2) Calculate annual TN credit using Equation 4:

Equation 4: Credit TN = area swept * TN load export rate * TN reduction factor (PRF) of sweeper type.

TN credit = $9.2ac \ * \ 0.01 \ * \ \frac{41.1lbs}{ac \cdot yr} = \frac{1.3lbs}{yr}$

Example 3: Comparison of Different Levels of Effort for Model-based Street Cleaning Credits

Figure 2 compares credit received by applying the model-based street cleaning approach in three towns using different levels of effort.

Figure 2: Model Credit Calculations for Towns Using Different Levels of Effort

Modeled Inputs (from Permittee)			**Credit Calculation**					
	lane miles	**times swept**	**area swept (ac)**	**TN export rate lb/ac/yr**	**TP export rate lb/ac/yr**	**PRF/NRF**	**TN CREDIT lbs/yr**	**TP CREDIT lbs/yr**
				Table 3	Table 3	Table 3	Equation 4	Equation 3
Minimum Effort Town	9.5	twice	9.21	14.1	1.96	0.01	**1.3**	**0.18**
Medium Effort Town	9.5	6 times in fall	9.21	14.1	1.96	0.15	**19**	**2.7**
Maximum Effort Town	9.5	more than monthly	9.21	14.1	1.96	0.25	**32**	**4.5**

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August 15, 2022

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RE: EPA Support on 2021-2022 Clean Sweep Panel Process Results for Adaptive Management Plans for the Great Bay Total Nitrogen General Permit

EPA Region 1 (R1) commends the University of New Hampshire Stormwater Center and Piscataqua Region Estuaries Partnership for a successful Clean Sweep Panel process for developing enhanced and updated street sweeping credits for municipalities. The panel process has again demonstrated an excellent model for leveraging both regional and national subject matter experts on a specific topic for developing new approaches for stormwater management backed by the latest research.

The Clean Sweep Panel developed two alternative options for obtaining pollution reduction credits for street cleaning. Through the first option, permittees could receive credit by measuring the amount of organic matter collected throughout the year—an approach pioneered in Minnesota (Minnesota Pollution Control Agency 2022). The second option would allow permittees to use an updated version of the model that specifies New Hampshire's current Enhanced Street/Pavement Cleaning Program credits. This would offer credit for municipal sweeping efforts depending on the technology used, frequency of cleaning, seasonality, and location.

The Great Bay Total Nitrogen General Permit in New Hampshire represents adaptive implementation opportunities for broadening the use of non-structural nitrogen control credits. EPA looks forward to implementation of the two alternative options developed by the panel for obtaining credit for street cleaning under the adaptive management plans adopted by Great Bay permitted municipalities. The Great Bay municipalities with adaptive management plans could use either option to receive credit, but not both, within a single reporting year. EPA R1, through this communication, supports the use of these alternative methods.

The piloting of these methods will provide insight and adaptive improvement of the new credits and offer opportunities to validate the approaches for future use throughout New England. Information gained during the piloting of the new credits could allow EPA R1 to integrate these credits, or an iteration of these credits, into the next New Hampshire and Massachusetts Small MS4 General Permits. Overall, enhanced street sweeping credits will hopefully incentivize municipalities to modernize street sweeping programs throughout the Great Bay watershed and help make progress towards pollution reductions in Great Bay. We look forward to continued collaboration and analysis of the pilot's results.

Sincerely,

Melville P. Coté, Jr., Chief
Surface Water Protection Branch
Water Division

cc: Abigail Lyon, Region Estuaries Partnership—Via Email
Sally Soule, New Hampshire Department of Environmental Services—Via Email

Appendix K: Ground Truthing Minnesota Data for New Hampshire, an Addendum to the Clean Sweep Technical Memo

February 27, 2023

Contents

1. Summary

In *Clean Sweep: Recommendations for New and Updated Credits for Street Cleaning in New Hampshire,* an expert panel recommended updating the state's model-based street/pavement cleaning credit and creating a new, "measured" option that offers credit for the amount of organic matter collected. This addendum summarizes a pilot study conducted by the University of New Hampshire (UNH) Stormwater Center to provide local data to ground truth the utility of the panel's recommendations.

Overall, the pilot's results supported the adoption of Minnesota's street sweeping nutrient and moisture content values in New Hampshire and provided promising preliminary results for a volume-based credit. This effort was made possible with support from the Piscataqua Region Estuaries Partnership, the Town of Durham, the City of Dover, and UNH's Facilities Division.

2. Option 1: Organic Matter Collection Credit (Measured Approach)

To receive the proposed credit, communities first track the mass of sweepings and time of year they are collected. Then, to determine pounds of Total Phosphorus (TP) and Total Nitrogen (TN) removed, they use a series of conversion factors based on moisture and nutrient content typical for organic matter in that season. These conversion factors are based on the street sweeping credit recently adopted by Minnesota. That credit is based on a rigorous study in the Minneapolis/St. Paul Metropolitan Area, conducted by the University of Minnesota and the Minnesota Pollution Control Agency.

The Minnesota credit (and the ones proposed for New Hampshire) rely on three conversion factors from the Minnesota study: average moisture content, and TP and TN concentrations. Each of these have two values depending on whether the material was collected in the fall or during the rest of the year (Table 1).

Table 1: MInnesota-based Conversion Factors			
Season	**Average Moisture Content**	**TP Concentration from Mass (mg/kg)**	**TN Concentration from Mass (mg/kg)**
Fall (Sept to Dec)	0.48	857	2,762
Non-fall (Jan to Aug)	0.22	414	994

Since these conversion factors are based on research conducted in Minnesota, the Clean Sweep expert panel recommended a study to assess whether moisture content and TP and TN concentrations in New Hampshire are comparable. In response, the UNH Stormwater Center ground truthed the Minnesota conversion factors using local data. As a secondary aim, they tried to establish average bulk density by looking at the relationship between measured mass and measured volume. This analysis was based on subsamples from 27 sweeper loads provided by the City of Dover, which did ten intensive days of sweeping in the fall of 2022 (Table 2).

Table 2: Sample Collection in Partnership with Dover				
Days	**Sweeper Man Hours**	**Estimated Cubic Yards Collected**	**Measured Wet Weight Collected (lbs)**	**Subsamples Analyzed**
10	144	228	83,520	27

Samples were analyzed for TP, TN, and moisture content. The results, and the corresponding values from the Minnesota study, are shown in Table 3, with first quartile results for the TP and TN concentrations. (Minnesota's credit uses the first quartile of the TP dataset, which their study found to be conservative, a conclusion supported by the Clean Sweep expert panel.)

Table 3: Analysis of New Hampshire Samples			
	Average Percent Moisture Content	**TP concentration from mass (mg/kg)**	**TN concentration from mass (mg/kg)**
MN data (fall)	48%	857*	2,762*
Dover data (fall)	42%	1,003*	2,900*
			* first quartile

The moisture content and TP and TN concentrations of the New Hampshire samples were similar to Minnesota values. While the study only looked at fall sweepings, its results do not raise concerns that New Hampshire values would differ greatly from those in Minnesota. For further confirmation, a similar study could be repeated in the spring or summer.

To support the secondary aim of the study, the UNH Stormwater Center team also analyzed sweeper subsamples for wet and dry bulk density. (The volume of material in the hopper was estimated before weighing.) Using hopper volume and wet bulk density, the research team calculated hopper mass and plotted that against the measured hopper mass. (See Figure 1.)

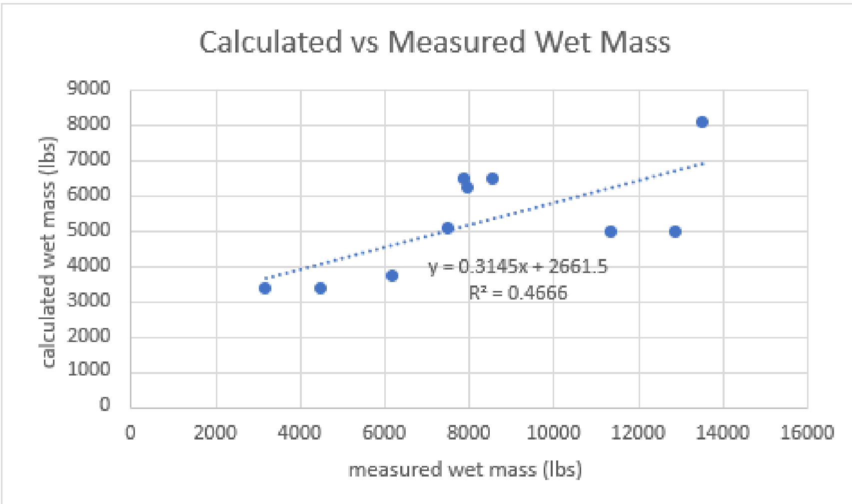

Figure 1: Calculating the Wet Mass

The relationship between calculated and measured wet mass is not perfect, but reasonable, given the variability of environmental data. While the measured credit currently could be applied now using mass, additional research to explore the relationship between mass and volume may allow the credit to be calculated from sweeping volume. Given that many communities are not able to measure mass of sweepings easily, an option based on volume would greatly expand the usability of the new credit. While not the focus of this study, the Measured Approach gives substantially more credit than the current sweeping credit and better reflects the latest research on the effectiveness of organic matter cleanup (Table 4).

Table 4. Estimated Credit for Measured Approach, Based on Pilot

Wet Mass Collected (lbs)	Season	% Moisture	Dry Weight (lbs)	TP conc from mass (mg/kg)	TP removed	TN conc from mass (mg/kg)	TN removed
4480	Fall	0.48	2330	857	2	2762	6.4
11340	Fall	0.48	5897	857	5.1	2762	16.3
12900	Fall	0.48	6708	857	5.7	2762	18.5
13520	Fall	0.48	7030	857	6	2762	19.4
7960	Fall	0.48	4139	857	3.5	2762	11.4
7500	Fall	0.48	3900	857	3.3	2762	10.8
3200	Fall	0.48	1664	857	1.4	2762	4.6
7900	Fall	0.48	4108	857	3.5	2762	11.3
8540	Fall	0.48	4441	857	3.8	2762	12.3
6180	Fall	0.48	3214	857	2.8	2762	8.9
83520	Fall	0.48	43430	857	**37.2**	2762	**120**

Option 2: Updated Street Cleaning Credit (Model-Based Approach)

New Hampshire's current street sweeping regulations require communities to track multiple parameters, are inflexible around sweeping timing, and provide relatively little credit. That credit is determined by a model that requires inputs of sweeper type, land use, area swept, and annual frequency of sweeping. Tracking miles swept in each land use area is not always simple given that one route may pass through different land uses. Further, the annual frequency of sweeping is based on the number of months of sweeping, which makes it difficult to determine credit for intensive or intermittent sweeping. To qualify for additional credit for enhanced organic matter collection, communities must sweep at least weekly from September to December, even after leaf and organic matter collection activities are complete.

The revised credit proposed by the Clean Sweep expert panel simplifies the current model and only requires tracking of lane miles and frequency. Other parameters are determined by fitting a sweeping program into three categories of effort: minimal, medium, and maximum (Table 5).

Table 5: Updated Parameters for New Hampshire's Model-based Credit for Street Sweeping

Parameter	Minimum Effort	Medium Effort	Maximum Effort
Frequency	Up to 2 times per year in any season. NRF/PRF* = 0.01 for a mechanical sweeper and 0.02 for a vacuum.	Every other week in the fall (Sept. to Dec.). NRF/PRF = 0.15	Monthly routine maintenance with more intensive (weekly) in Fall (Sept. to Dec.) and early spring. NRF/PRF = 0.25 with enhanced leaf collection. Assumes a vacuum sweeper (defined above), but may be combined with other efforts.
Location and seasonality	To accommodate seasonal increases in TN and TP and simplify the location parameter: 1) Use medium density residential impervious cover land use, which integrates the majority of likely land uses. 2) For intensive (weekly) fall sweeping in times of high organic material deposition (leaf fall), offer a 10% additional removal factor. This is a 5% increase over the enhanced leaf collection credit in the current model and better reflects removals in the recent literature. (Synonymous with maximum effort.)		

The UNH Stormwater analysis was primarily concerned with ground truthing the proposed measured credit, but also tracked lane miles swept. This made it possible to calculate the annual sweeping credit with both the current and proposed model (Table 6). Since Dover did not track land use along all sweeper routes, it was necessary to assume a medium density residential land use. Also, since their intensive sweeping was in the fall, the annual frequency is two out of 12 months of the year.

The updated model gives substantially more credit for the same effort and better reflects the latest research on the effectiveness of organic matter cleanup. It is also a better fit for the metrics tracked by municipalities and the current sweeping practices.

Table 6: 2022 Dover Sweeping Example									
	Lane Miles	**Impervious area (acres)**	**Annual Frequency**	**PRF***	**PLER * (lb/ac/yr)**	**NRF***	**NLER * (lb/ac/yr)**	**TP credit (lb/yr)**	**TN credit (lb/yr)**
Old Model	13.68	13.27	0.17	0.01	1.96	0.01	14.1	**0.04**	**0.31**
New Model	13.68	13.27	NA	0.15	1.96	0.15	14.1	**3.9**	**28.06**

****NLER IC-land use***: Nitrogen (TN) Load Export Rate for impervious cover and specified land use (lb/acre/yr)

PLER IC-land use: Phosphorus (TP) Load Export Rate for impervious cover and specified land use (lb/acre/yr).

NRF sweeping: Nitrogen (TN) Reduction Factor for sweeping based on sweeper type and frequency.

PRF sweeping: Phosphorus (TP) Reduction Factor for sweeping based on sweeper type and frequency