

## **ATTACHMENT 2 TO APPENDIX F**

### **Phosphorus and Nitrogen Reduction Credits for Selected Enhanced Non-Structural BMPs**

The permittee shall use the following methods to calculate phosphorus and nitrogen (nutrients) load reduction credits for the following enhanced non-structural control practices implemented in the Watershed:

- 1) Enhanced Sweeping Program;
- 2) Catch Basin Cleaning;  
and
- 3) Organic Waste and Leaf Litter Collection program

The methods include the use of default nutrient reduction factors that EPA has determined are acceptable for calculating nutrient load reduction credits for these practices.

The methods and annual nutrient load export rates presented in this attachment are for the purpose of counting load reductions for various BMPs treating storm water runoff from varying site conditions (i.e., impervious or pervious surfaces) and different land uses (e.g. industrial and commercial) within the impaired watershed. Tables 2-1 and 2-2 below provide annual phosphorus and nitrogen load export rates by land use category for impervious and pervious areas. The estimates of annual phosphorus load and load reductions resulting from BMP implementation are intended for use by the permittee to measure compliance with its Phosphorus Reduction Requirement under the permit. The estimates of annual nitrogen load and load reduction resulting from BMP implementation are intended for use by the permittee to track and account for nitrogen load reductions in accordance with Appendices F and H in the permit.

Examples are provided to illustrate use of the methods. In calculating phosphorus and nitrogen export rates, the permittee shall select the land use category that most closely represents the actual use for the area in question. For watersheds with institutional type uses, such as government properties, hospitals, and schools, the permittee shall use the commercial land use category for the purpose of calculating phosphorus and nitrogen loads. Table 2-3 provides a crosswalk table of land use codes between land use groups in Tables 2-1 and 2-2, and the codes used by Mass GIS. For pervious areas, permittees should use the appropriate value for the hydrologic soil group (HSG) if known, otherwise, assume HSG C conditions.

**Alternative Methods and/or Nutrient Reduction Factors:** A permittee may propose alternative methods and/or nutrient reduction factors for calculating nutrient load reduction credits for these non-structural practices. EPA will consider alternative methods and/or nutrient reduction factors, provided that the permittee submits adequate supporting documentation to EPA. At a minimum, supporting documentation shall consist of a description of the proposed method, the technical basis of the method, identification of alternative nutrient reduction factors, supporting calculations, and identification of references and sources of information that support the use of the

alternative method and/or factors in the Watershed. If EPA determines that the alternative methods and/or factors are not adequately supported, EPA will notify the permittee and the permittee may receive no nutrient reduction credit other than a reduction credit calculated by the permittee following the methods in this attachment for the identified practices.

**Table 2-1: Proposed average annual distinct P Load export rates for use in estimating P Load reduction credits in the MA 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:			
<ul style="list-style-type: none"> <li>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.</li> <li>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.</li> </ul>			

- 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 MA 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 nitrogen 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 nitrogen loading.
- Impervious surfaces within the forest land use category are typically roadways adjacent to forested pervious areas.

**Table 2-3: Crosswalk of Mass GIS land use categories to land use groups for P load calculations**

Mass GIS Land Use LU_CODE	Description	Land Use group for calculating P Load - 2013/14 MA MS4
1	Crop Land	Agriculture
2	Pasture (active)	Agriculture
3	Forest	Forest
4	Wetland	Forest
5	Mining	Industrial
6	Open Land includes inactive pasture	open land
7	Participation Recreation	open land
8	spectator recreation	open land
9	Water Based Recreation	open land
10	Multi-Family Residential	High Density Residential
11	High Density Residential	High Density Residential
12	Medium Density Residential	Medium Density Residential
13	Low Density Residential	Low Density Residential
14	Saltwater Wetland	Water
15	Commercial	Commercial
16	Industrial	Industrial
17	Urban Open	open land
18	Transportation	Highway
19	Waste Disposal	Industrial
20	Water	Water
23	cranberry bog	Agriculture
24	Powerline	open land
25	Saltwater Sandy Beach	open land
26	Golf Course	Agriculture
29	Marina	Commercial
31	Urban Public	Commercial
34	Cemetery	open land
35	Orchard	Forest
36	Nursery	Agriculture
37	Forested Wetland	Forest
38	Very Low Density residential	Low Density Residential
39	Junkyards	Industrial
40	Brush land/Successional	Forest

**(1) Enhanced Sweeping Program:** The permittee may earn a phosphorus and/or nitrogen reduction credit(s) for conducting an enhanced sweeping program of impervious surfaces. Table 2-4 below outlines the default nutrient removal factors for enhanced sweeping programs. The credit shall be calculated by using the following equations:

$$\text{Phosphorus Credit}_{P \text{ sweeping}} = IA_{\text{swept}} \times PLER_{IC\text{-land use}} \times PRF_{\text{sweeping}} \times AF \text{ (Equation 2-1)}$$

$$\text{Nitrogen Credit}_{N \text{ sweeping}} = IA_{\text{swept}} \times NLER_{IC\text{-land use}} \times NRF_{\text{sweeping}} \times AF \text{ (Equation 2-2)}$$

**Where:**

- Credit<sub>sweeping</sub> = Amount of nutrient load removed by enhanced sweeping program (lb/year)
- IA<sub>swept</sub> = Area of impervious surface that is swept under the enhanced sweeping program (acres)
- PLER<sub>IC-land use</sub> = Phosphorus Load Export Rate for impervious cover and specified land use (lb/acre/yr) (see Table 2-1)
- NLER<sub>IC-land use</sub> = Nitrogen Load Export Rate for impervious cover and specified land use (lb./acre/yr.) (see Table 2-2)
- PRF<sub>sweeping</sub> = Phosphorus Reduction Factor for sweeping based on sweeper type and frequency (see Table 2-4).
- NRF<sub>sweeping</sub> = Nitrogen Reduction Factor for sweeping based on sweeper type and frequency (see Table 2-4).
- AF = Annual Frequency of sweeping. For example, if sweeping does not occur in Dec/Jan/Feb, the AF would be 9 mo./12 mo. = 0.75. For year-round sweeping, AF=1.0<sup>1</sup>

As an alternative, the permittee may apply a credible sweeping model of the Watershed and perform continuous simulations reflecting build-up and wash-off of phosphorus or nitrogen using long-term local rainfall data.

**Table 2-4: Nutrient reduction efficiency factors for sweeping impervious areas**

Frequency <sup>1</sup>	Sweeper Technology	PRF <sub>sweeping</sub>	NFR <sub>sweeping</sub>
2/year (spring and fall) <sup>2</sup>	Mechanical Broom	0.01	0.01
2/year (spring and fall) <sup>2</sup>	Vacuum Assisted	0.02	0.02
2/year (spring and fall) <sup>2</sup>	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

<sup>1</sup>For full credit for monthly and weekly frequency, sweeping must be conducted year round. Otherwise, the credit should be adjusted proportionally based on the duration of the sweeping season (using AF factor).

<sup>2</sup> In order to earn credit for semi-annual sweeping the sweeping must occur in the spring following snow-melt and road sand applications to impervious surfaces and in the fall after leaf-fall and prior to the onset to the snow season.

**Example 2-1: Calculation of enhanced sweeping program credit (Credit<sub>P sweeping</sub>):** A permittee proposes to implement an enhanced sweeping program and perform weekly sweeping from March 1 – December 1 (9 months) in their Watershed, using a vacuum assisted sweeper on 20.3 acres of parking lots and roadways in a high-density residential area of the Watershed. For this site the needed information to calculate the phosphorus load reduction credit is:

$$\begin{aligned}
 IA_{\text{swept}} &= 20.3 \text{ acres} \\
 PLER_{\text{IC-HDR}} &= 2.32 \text{ lb/acre/yr (from Table 2-1)} \\
 PRF_{\text{sweeping}} &= 0.08 \text{ (from Table 2-4)} \\
 AF &= (9 \text{ months} / 12 \text{ months}) = 0.75
 \end{aligned}$$

Substitution into equation 2-1 yields a Credit<sub>sweeping</sub> of 3.2 pounds of phosphorus removed per year.

$$\begin{aligned}
 \text{Credit}_{\text{sweeping}} &= IA_{\text{swept}} \times PLE_{\text{land use}} \times PRF_{\text{sweeping}} \times AF \\
 &= 20.3 \text{ acres} \times 2.32 \text{ lbs/acre/yr} \times 0.08 \times 0.75 \\
 &= \mathbf{2.8 \text{ lbs/yr}}
 \end{aligned}$$

The corresponding **nitrogen** load reduction credit (Credit<sub>N sweeping</sub>) for the same sweeping program in the specified LPCP area is calculated as follows:

$$\begin{aligned}
 IA_{\text{swept}} &= 20.3 \text{ acres} \\
 NLER_{\text{IC-HDR}} &= 14.1 \text{ lb./acre/yr. (from Table 2-2)} \\
 NRF_{\text{sweeping}} &= 0.08 \text{ (from Table 2-4)} \\
 AF &= (9 \text{ months} / 12 \text{ months}) = 0.75
 \end{aligned}$$

Substitution into equation 2-2 yields a Credit<sub>sweeping</sub> of 17.2 pounds of nitrogen removed per year.

$$\begin{aligned}
 \text{Credit}_{\text{N sweeping}} &= IA_{\text{swept}} \times NLER_{\text{land use}} \times NRF_{\text{sweeping}} \times AF \\
 &= 20.3 \text{ acres} \times 14.1 \text{ lbs./acre/yr.} \times 0.08 \times 0.75 \\
 &= \mathbf{17.2 \text{ lbs./yr.}}
 \end{aligned}$$

**(2) Catch Basin Cleaning:** The permittee may earn phosphorus and/or nitrogen reduction credit(s) by removing accumulated materials from catch basins (i.e., catch basin cleaning) in the Watershed such that a minimum sump storage capacity of 50% is maintained throughout the year. The credits shall be calculated by using the following equations:

$$\text{Credit}_{P\text{ CB}} = \text{IA}_{\text{CB}} \times \text{PLER}_{\text{IC-land use}} \times \text{PRF}_{\text{CB}} \quad \text{(Equation 2-3)}$$

$$\text{Credit}_{N\text{ CB}} = \text{IA}_{\text{CB}} \times \text{NLER}_{\text{IC-land use}} \times \text{NRF}_{\text{CB}} \quad \text{(Equation 2-4)}$$

**Where:**

- $\text{Credit}_{\text{CB}}$  = Amount of nutrient load removed by catch basin cleaning (lb/year)
- $\text{IA}_{\text{CB}}$  = Impervious drainage area to catch basins (acres)
- $\text{PLER}_{\text{IC-land use}}$  = Phosphorus Load Export Rate for impervious cover and specified land use (lb/acre/yr) (see Table 2-1)
- $\text{NLER}_{\text{IC-land use}}$  = Nitrogen Load Export Rate for impervious cover and specified land use (lb./acre/yr.) (see Table 2-2)
- $\text{PRF}_{\text{CB}}$  = Phosphorus Reduction Factor for catch basin cleaning (see Table 2-5)
- $\text{NRF}_{\text{CB}}$  = Nitrogen Reduction Factor for catch basin cleaning (See Table 2-5)

**Table 2-5: Nutrient reduction efficiency factors for semi-annual catch basin cleaning**

Frequency	Practice	PRF <sub>CB</sub>	NRF <sub>CB</sub>
Semi-annual	Catch Basin Cleaning	0.02	0.06

**Example 2-2: Calculation for catch basin cleaning credit (Credit<sub>CB</sub>):**

A permittee proposes to clean catch basins in their Watershed (i.e., remove accumulated sediments and contaminants captured in the catch basins) that drain runoff from 15.3 acres of medium-density residential impervious area. For this site the needed information to calculate the phosphorus load reduction credit is:

$$\begin{aligned} I_{CB} &= 15.3 \text{ acre} \\ PLE_{IC-MDR} &= 1.96 \text{ lbs/acre/yr (from Table 2-1)} \\ PRF_{CB} &= 0.02 \text{ (from Table 2-5)} \end{aligned}$$

Substitution into equation 2-3 yields a Credit<sub>P CB</sub> of 0.6 pounds of phosphorus removed per year:

$$\begin{aligned} \text{Credit}_{P_{CB}} &= I_{CB} \times PLE_{IC-MDR} \times PRF_{CB} \\ &= 15.3 \text{ acre} \times 1.96 \text{ lbs/acre/yr} \times 0.02 \\ &= \mathbf{0.6 \text{ lbs/yr}} \end{aligned}$$

**Note: the same methodology is applicable for calculating the nitrogen load reduction credit (Credit<sub>N CB</sub>).**

**(3) Enhanced Organic Waste and Leaf Litter Collection program:** The permittee may earn a phosphorus and/or nitrogen reduction credit(s) by performing regular gathering, removal and disposal of landscaping wastes, organic debris, and leaf litter from impervious surfaces from which runoff discharges to the TMDL waterbody or its tributaries. In order to earn this credit (Credit<sub>leaf litter</sub>), the permittee must gather and remove all landscaping wastes, organic debris, and leaf litter from impervious roadways and parking lots at least once per week during the period of September 1 to December 1 of each year. Credit can only be earned for those impervious surfaces that are cleared of organic materials in accordance with the description above. The gathering and removal shall occur immediately following any landscaping activities in the Watershed and at additional times when necessary to achieve a weekly cleaning frequency. The permittee must ensure that the disposal of these materials will not contribute pollutants to any surface water discharges. The permittee may use an enhanced sweeping program (e.g., weekly frequency) as part of earning this credit provided that the sweeping is effective at removing leaf litter and organic materials. The Credit<sub>leaf litter</sub> shall be determined by the following equation:

$$\text{Credit}_{P_{\text{leaf litter}}} = (IA_{\text{leaf litter}}) \times (PLE_{IC\text{-land use}}) \times (0.05) \quad \textbf{(Equation 2-5)}$$

$$\text{Credit}_{N_{\text{leaf litter}}} = (IA_{\text{leaf litter}}) \times (NLER_{IC\text{-land use}}) \times (0.05) \quad \textbf{(Equation 2-6)}$$

**Where:**

- Credit<sub>leaf litter</sub> = Amount of nutrient load reduction credit for organicwaste and leaf litter collection program (lb/year)
- IA<sub>leaf litter</sub> = Impervious area (acre) in applicable watersheds that are subject to enhanced organic waste and leaf litter collection program
- PLE<sub>IC-land use</sub> = Phosphorus Load Export Rate for impervious cover and specified land use (lbs./acre/yr.) (see Table 2-1)

NLER<sub>IC-land use</sub> = Nitrogen Load Export Rate for impervious cover and specified land use (lbs./acre/yr.) (see Table 2-2)  
 0.05 = 5% nutrient reduction factor for organic waste and leaf litter collection program in the Watershed

**Example 2-3: Calculation for organic waste and leaf litter collection program credit**

**(Credit<sub>leaf litter</sub>):** A permittee proposes to implement an organic waste and leaf litter collection program by sweeping the parking lots and access drives at a minimum of once per week using a mechanical broom sweeper for the period of September 1 to December 1 over 12.5 acres of impervious roadways and parking lots in an industrial/commercial area of the Watershed. Also, the permittee will ensure that organic materials are removed from impervious areas immediately following all landscaping activities at the site. For this site the needed information to calculate the Credit<sub>leaf litter</sub> for phosphorus is:

Watershed Area = 12.5 acres; and  
 PLER<sub>IC-commercial</sub> = 1.78 lbs/acre/yr (from Table 2-1)

Substitution into equation 2-5 yields a Credit<sub>leaf litter</sub> of 1.1 pounds of phosphorus removed per year:

$$\begin{aligned} \text{Credit}_{\text{leaf litter}} &= (12.5 \text{ acre}) \times (1.78 \text{ lbs/acre/yr}) \times (0.05) \\ &= 1.1 \text{ lbs/yr} \end{aligned}$$

**Note:** The same methodology is applicable for calculating the nitrogen load reduction credit (Credit<sub>N leaf litter</sub>) for the specified organic waste leaf litter collection program.

**Associated Street/Pavement Cleaning Credit:**

The permittee also may earn a nutrient reduction credit for enhanced sweeping of roads and parking lot areas (i.e., Credit<sub>sweeping</sub>) for the three months of use. Using equation 2-1, Credit<sub>sweeping</sub> is:

$$\begin{aligned} \text{Credit}_{\text{sweeping}} &= \text{IA}_{\text{swept}} \times \text{PLER}_{\text{IC-land use}} \times \text{PRF}_{\text{sweeping}} \times \text{AF} \quad \text{(Equation 2-1)} \\ \text{IA}_{\text{swept}} &= 12.5 \text{ acre} \\ \text{PLE}_{\text{IC-commercial}} &= 1.78 \text{ lbs/acre/yr (from Table 2-1)} \\ \text{PRF}_{\text{sweeping}} &= 0.05 \text{ (from Table 2-3)} \\ \text{AF} &= 3 \text{ mo./12 mo.} = 0.25 \end{aligned}$$

Substitution into equation 2-1 yields a Credit<sub>P sweeping</sub> of 0.28 pounds of phosphorus removed per year.

$$\begin{aligned} \text{Credit}_{\text{P sweeping}} &= \text{IA}_{\text{swept}} \times \text{PLE}_{\text{IC-commercial}} \times \text{PRF}_{\text{sweeping}} \times \text{AF} \\ &= 12.5 \text{ acre} \times 1.78 \text{ lbs/acre/yr} \times 0.05 \times 0.25 \\ &= \mathbf{0.3 \text{ lbs/yr}} \end{aligned}$$