APPENDIX F REQUIREMENTS OF APPROVED TOTAL MAXIMUM DAILY LOADS

Chloride TMDLs

Beaver Brook[1]; Dinsmore Brook[2]; North Tributary to Canobie Lake[3]; Policy-Porcupine Brook[4]

- Municipalities: Derry, Londonderry, Salem and Windham; and non-traditional and transportation MS4s discharging to these waterbodies
- Water Quality Goal of TMDLs: The goal for these TMDL is for the chloride concentrations in the affected water bodies to meet State of New Hampshire surface water quality criteria for Class B waterbodies. According to Env-Ws 1703.21, the water quality criteria for chloride in nontidal Class B waterbodies to protect aquatic life is that concentrations should not exceed 860 mg/L for acute exposures or 230 mg/L for chronic exposures. Acute aquatic life criteria are based on an average concentration over a one-hour period and chronic criteria are based on an average concentration over a period of four days (EPA, 1991) The frequency of violations for either acute or chronic criteria should not be more than once every three years, on average (EPA, 1991).
- Goal of the Implementation Plan: To meet the load allocations as determined by NHDES through reduced deicing loads.
- Measures to address the TMDLs: Permittees that operate regulated MS4s located within these municipalities that discharge to the identified impaired waters must reduce chloride discharges to support achievement of the WLA included in the approved TMDLs. For this purpose, the permittee shall develop a Salt Reduction Plan that includes specific actions designed to achieve salt reduction on municipal roads and facilities, and on private facilities that drain to the MS4. The Salt Reduction Plan shall be completed within one (1) year of the effective date of the permit and shall include, at a minimum:

For municipally maintained surfaces:

(i) Tracking of the amount of salt applied to all municipally owned and maintained surfaces and reporting of salt use beginning in the year 1 annual report;
(ii) Planned activities for salt reduction on municipally owned and maintained surfaces, which may include but are not limited to:

- Operational changes such as pre-wetting, pre-treating the salt stockpile, increasing plowing prior to de-icing, monitoring of road surface temperature, etc.;
- Implementation of new or modified equipment providing pre-wetting capability, better calibration rates, or other capability for minimizing salt use;

[1] Total Maximum Daily Load (TMDL) Study For Waterbodies in the Vicinity of the I-93 Corridor from Massachusetts to Manchester, NH: Beaver Brook in Derry and Londonderry, NH (2008)
[2] Total Maximum Daily Load (TMDL) Study For Waterbodies in the Vicinity of the I-93 Corridor from Massachusetts to Manchester, NH: Dinsmore Brook in Windham, NH (2008)
[3] Total Maximum Daily Load (TMDL) Study For Waterbodies in the Vicinity of the I-93 Corridor from Massachusetts to Manchester, NH: North Tributary to Canobie Lake in Windham, NH (2008)
[4] Total Maximum Daily Load (TMDL) Study For Waterbodies in the Vicinity of the I-93 Corridor from Massachusetts to Manchester, NH: Policy-Porcupine Brook in Salem and Windham, NH (2008)

• Training for municipal staff and/or contractors engaged in winter maintenance activities;
• Adoption of guidelines for application rates for roads and parking lots (see NHDES, Chloride *Reduction Implementation Plan for Dinsmore Brook, App. J and K* (February 2011), http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-11-13.pdf ; *Winter Parking Lot and Sidewalk Maintenance Manual (Revised edition June 2008)* http://www.pca.state.mn.us/publications/parkinglotmanual.pdf; and the application guidelines on page 17 of *Minnesota Snow and Ice Control: Field Handbook for Snow Operators (September 2012)* http://www.mnltap.umn.edu/publications/handbooks/documents/snowice.pdf for examples);
• Regular calibration of spreading equipment;
• Designation of no-salt and/or low salt zones;
• Public education regarding impacts of salt use, methods to reduce salt use on private property, modifications to driving behavior in winter weather, etc.; and
• Measures to prevent exposure of salt stockpiles (if any) to precipitation and runoff; and

(iii) An estimate of the total tonnage of salt reduction expected by each activity and calculations demonstrating that implementation of the Salt Reduction Plan will meet the WLA of the relevant TMDL; and
(iv) A schedule for implementation of planned activities including immediate implementation of operational and training measures, continued annual progress on other measures, and full implementation of the Plan within three years of permit effective date.

For privately maintained facilities that drain to the MS4:

(i) Identification of private parking lots with 10 or more parking spaces draining to the MS4;
(ii) Requirements for private parking lot owners and operators and private street owners and operators (1) that any commercial salt applicators used for applications of salt to their parking lots or streets be trained and certified, and (2) to report annual salt usage within the municipal boundaries (either townwide, or within the area draining to the MS4).

The permittee may rely on state programs in compliance with this requirement as follows:

• If the state of NH enacts a mandatory statewide training and certification requirement for commercial salt applicators, permittees shall not be required to establish local regulations, ordinances or other requirements to mandate use of certified operators, but may rely on the state program in compliance with this requirement;
• To the extent that the state of NH operates a voluntary training and certification program for commercial salt applicators, permittees may meet this permit condition by establishing local requirements for use of state-certified applicators.

Should the state discontinue its existing training and certification program and not institute an equivalent program, the permittee shall identify an equivalent training or certification program and/or conduct its own training and certification program; and

•To the extent that the state of NH operates a salt usage reporting system for commercial salt applicators, the permittee may require reporting to the appropriate state entity in lieu of collecting salt usage data itself. Should the state discontinue its salt usage reporting system, the permittee shall collect data on salt usage from commercial salt applicators and report such data in its annual report beginning in the year 1 annual report.

(iii) Requirements for new development and redevelopment to minimize salt usage, and to track and report amounts used to the municipality

Bacteria TMDLs

1. Hampton/Seabrook Harbor[5]

- Municipalities: Hampton and Seabrook; and non-traditional and transportation MS4s discharging to these waterbodies
- Water Quality Goal of TMDL: The goal for this TMDL is for the bacteria concentrations throughout Hampton/Seabrook Harbor to meet the water quality standards for the designated uses of the water body that are affected by bacteria. These uses include shellfishing, primary contact recreation (swimming), and secondary contact recreation (boating). The water quality standard is the most stringent for shellfishing: a geometric mean for fecal coliform of less than 14 MPN/100 ml and a 90th percentile of less than 43 MPN/100 ml as determined using National Shellfish Sanitation Program (NSSP) protocols (RSA 485A: 8, V; ISSC, 1999). A 47 percent reduction in the total bacteria loading is necessary to meet the TMDL.
- Goal of the Implementation Plan: To remove all human sources of bacteria to the estuary to the extent practicable.

2. Little Harbor[6]

- Municipalities: New Castle, Portsmouth and Rye; and non-traditional and transportation MS4s discharging to these waterbodies
- Water Quality Goal of the TMDL: The goal for this TMDL is for the bacteria concentration in the Little Harbor assessment unit to meet the water quality standards for the designated uses of the water body that are affected by bacteria. These uses include shellfishing, primary contact recreation (swimming), and secondary contact recreation (boating). The water quality standard is the most stringent for shellfishing: a geometric mean for fecal coliform of less than 14 MPN/100 ml and a 90th percentile of less than 43 MPN/100 ml as determined using National Shellfish Sanitation Program (NSSP) protocols (RSA 485A: 8, V; ISSC, 1999). The bacteria load to Little Harbor must be reduced by 12 percent to achieve the goal of the TMDL.
- Goal of the Implementation Plan: To achieve water quality standards for bacteria in the Little Harbor assessment unit and to characterize the bacteria concentrations and bacteria sources in the Berrys Brook/ Witch Creek assessment unit.

3. Bacteria Impaired Waters Statewide (Table F-1)[7] and 58 Beach Bacteria Impaired Waters (Table F-2)[8]

- Municipalities: see Tables F-1 and F-2; includes non-traditional and transportation MS4s discharging to these waterbodies
- Water Quality Goal of the TMDL: The goal for this TMDL is for the bacteria concentration in each waterbody to meet the water quality standards for the designated uses of the water body that are affected by bacteria. These uses include shellfishing, primary contact recreation (swimming), and secondary contact recreation (boating). The relevant water quality

[5] Hampton/Seabrook Harbor Bacteria TMDL, May 2004
[6] Little Harbor Bacteria TMDL, June 2006
[7] Final Report New Hampshire Statewide TMDL for Bacteria Impaired Waters (2010)
[8] Final Report TMDL Report for 58 Bacteria Impaired Waters in New Hampshire (2011)

standard for each waterbody is set forth in Tables F-1 and F-2. The WLA for MS4 discharges is set at the relevant water quality standard, although compliance with the TMDL will be based on ambient water quality and not water quality at the point of discharge (i.e., end of pipe). TMDL at 35. Tables F-1 and F-2 also identifies the estimated bacteria load reduction to each waterbody that is required to achieve the goal of the TMDL.

- Goal of the Implementation Plan: The implementation plan incorporated within the TMDL Report provides general guidance for addressing water pollution caused by pathogenic bacteria in New Hampshire's surface waters. It recommends that implementation be conducted on a watershed basis and that more specific watershed plans be developed, where appropriate, to focus and prioritize appropriate restoration measures.

Measures to address 3 Bacteria TMDLs listed above:

The operators of MS4s listed above or in Tables F-1 or F-2 shall complete a water quality response plan (WQRP) consistent with Part 2.2.2.a.ii and implement the WQRP consistent with the requirements and schedules in Part 2.2.2.b. and Part 2.2.2.c. with respect to reduction of bacteria discharges from the MS4; however, the additional and modified BMPs included in the WQRP (see Part 2.2.2.a.ii.) shall include, at a minimum, the following BMPs:

i. Public Education (Part 2.3.2): The permittee shall post information about proper management of pet waste in areas discharging to any waterbody with an approved TMDL for Bacteria. The permittee shall disseminate educational materials to dog owners at the time of issuance or renewal of a dog license, or other appropriate time. Education materials shall describe the detrimental impacts of improper management of pet waste, requirements for waste collection and disposal, and penalties for non-compliance The permittee shall also provide information to owners of septic systems about proper maintenance in any catchment that discharges to a water body impaired for bacteria.

ii. Good House Keeping (Part 2.3.7.1.d) the permittee shall increase the frequency of street sweeping in areas that discharge to any waterbody with an approved bacteria TMDL to at least two times per year.

iii. Illicit Discharge (Part 2.3.4): The permittee shall implement the illicit discharge program required by this permit. Catchments draining to any waterbody with an approved bacteria TMDL shall be designated either Problem Catchments or HIGH priority in implementation of the IDDE program.

The permittee may choose to address all discharges to bacteria impaired waters (with and without an approved applicable TMDL) in the same water quality response plan consistent with Part 2.2.2. Where there is a discharge to waterbodies with approved bacteria TMDLs, the assessment required in Part 2.2.2.c. shall include the identification and implementation, if necessary, of additional BMPs to achieve bacteria reductions consistent with the WLA in the applicable approved TMDL.

Lake and Pond Phosphorus TMDLs

Baboosic Lake, Country Pond, Dorrs Pond, Flints Pond, Greenwood Pond, Halfmoon Pond, Hoods Pond, Horseshoe Pond, Nutt Pond, Pine Island Pond, Robinson Pond, Sebbins Pond, Showell Pond, Stevens Pond

- Municipalities: Amherst, Bedford, Derry, Hollis, Hudson, Kingston, Manchester, Merrimack, Raymond, Sandown, other municipalities with MS4 discharges to these waterbodies and non-traditional and transportation MS4s discharging to these waterbodies
- Water Quality Goal of the TMDL is to establish Total Phosphorus (TP) loading targets that, if achieved, will result in consistency with the State of New Hampshire Water Quality criteria Env-Ws 1703.14. Water quality that is consistent with state standards is, a priori, expected to protect designated uses. The lake phosphorus TMDLs were developed with the following objectives:

  • Describe potential sources and estimate the existing phosphorus loading to the lake;
  • Estimate the loading capacity;
  • Allocate the load among sources;
  • Provide alternate allocation scenarios;
  • Suggest elements to be included in an implementation plan;
  • Suggest elements to be included in a monitoring plan;
  • Provide reasonable assurances that the plans will be actedupon; and
  • Describe public participation in the TMDL process.

- Goal of the Implementation Plan: provide recommendations for future BMP work and necessary water quality improvements. The recommendations are intended to provide options of potential watershed and lake management strategies that can improve water quality to meet target loads.
- Measures to address the TMDLs: Permittees that operate regulated MS4s located within these municipalities that discharge to the identified impaired waters must reduce phosphorus discharges to support achievement of the WLA included in the approved TMDLs.

To address phosphorus, the permittee shall develop a Phosphorus Control Plan (PCP) designed to reduce the amount of phosphorus in stormwater discharges from its MS4 to the impaired waterbody or its tributaries consistent with assumptions and requirements of the WLA for the phosphorous loadings published in the applicable phosphorus TMDL (see Table F-3 for TMDL names and links to applicable phosphorus TMDLs). Table F-3, Appendix F provides the estimated baseline watershed phosphorous loads and respective percent reductions necessary for each municipality to be consistent with the assumptions and requirements of the WLA[9]

i. The permittee shall develop a Phosphorous Control Plan (PCP) as part of its written SWMP and update the PCP in annual reports pursuant to Part 4.4 of the Draft Permit. The PCP shall describe measures the permittee will undertake to reduce the amount of phosphorous in MS4 discharges.

ii. The PCP shall be implemented in accordance with the following schedule and contain the following elements:

a. PCP Implementation Schedule – The permittee shall complete the implementation of its PCP as soon as possible but no later than the end of the permit term. The permittee shall achieve phosphorous reductions consistent with the WLA presented on Table F-3

b. PCP Component Development Schedule

PCP Component	**Completion Date**
Cost and funding source assessment	1 year after effective date
Legal Analysis	1 year after effective date
Estimation of phosphorus loadings and reductions	2 years after effective date
Scope of PCP	2 years after effective date
Description of planned nonstructural controls	2 years after effective date
Description of planned structural controls	2 years after effective date
Implementation schedule	2 years after effective date
Inventory and priority ranking of locations for structural retrofits	3 years after effective date
Evaluation of performance of structural and non-structural measures implemented	5 years after effective date

c. Description of PCP Components

Cost and funding source assessment – The permittee shall estimate the cost for implementing its PCP and describe known and anticipated funding mechanisms. The permittee shall describe the steps it will take to implement its funding plan. This may include but is not limited to conceptual development, outreach to affected parties, and development of legal authorities.

Legal Analysis- The permittee shall develop and implement an analysis that identifies existing regulatory mechanisms available to the MS4 such as by-laws and ordinances and describe any changes to the MS4's bylaws and ordinances that may be necessary to

[9] The estimated loadings and required phosphorus mass reductions and percent reductions presented in Table F-3 apply to the entire watershed land area that drains to the impaired waterbody, and represent phosphorous loadings from regulated and unregulated stormwater discharges, nonpoint sources, and illicit discharges. Therefore, the permittee is not responsible for satisfying the entire reduction assigned to its municipality through implementation of its PCP by controlling its MS4 discharges. Rather, the permittee's PCP shall support achievement of the WLA by reducing phosphorus loading from its MS4 areas in concert with phosphorus reductions achieved by others, both within and exclusive of EPA or state permitting programs.

effectively implement the PCP. This may include the creation or amendment of financial and regulatory authorities. The permittee shall implement identified regulatory changes by the end of the permit term.

Estimate of baseline phosphorus loadings and reductions –

Table F-3 contains the percent phosphorus reduction required to meet the WLA for the watershed of each impaired waterbody, as well as an estimate of the baseline watershed phosphorus load (in mass/yr) for each watershed. The permittee can choose to use this baseline phosphorus loading estimate for its PCP as its Phosphorus Reduction Requirement or calculate an updated baseline load consistent with methodologies used by the applicable TMDL or a method consistent with Attachment 1 to Appendix F. The permittee may choose to update its baseline phosphorus load if:

i) The permittee would like to take advantage of updated land use information or impervious cover information for better quantifying phosphorus loads from impervious areas that will receive treatment;

ii) Only a portion of the watershed is located within the permittee's municipal boundaries;

iii) The permittee chooses to implement the PCP for those portions of the municipality within the impaired waterbody's watershed that is a regulated MS4 (located in an urbanized area) and areas draining to the MS4 area as delineated in Part 2.3.4.6. of the Draft Permit

If the permittee chooses to calculate an updated baseline phosphorus load, the watershed percent phosphorus reduction in Table F-3 shall be applied to the baseline phosphorus load calculated by the permittee for the purposes of calculating the necessary phosphorus reduction in mass/yr to support achievement of the WLA for the applicable TMDL; this is known as the Phosphorus Reduction Requirement.

Scope of the PCP - Based on the calculation of baseline phosphorus loadings above, the permittee shall describe the area in which the permittee plans to implement the PCP.

Description of planned non-structural controls – The permittee shall describe the non-structural stormwater control measures to be implemented to support the achievement of the required phosphorus reductions. The description of non-structural controls shall include the planned measures, the areas where the measures will be implemented, and the annual phosphorus reductions that are expected to result from their implementation. Annual phosphorus reduction from non-structural BMPs shall be calculated consistent with Attachment 2 to Appendix F.

Description of planned structural controls – The permittee shall describe the structural stormwater control measures necessary to support achievement of the required phosphorus reductions. The description of structural controls shall include the planned measures, the areas where the measures will be implemented, and the annual phosphorus reductions in units of mass per year that are expected to result from their implementation. Structural measures to be implemented by a third party may be included in a municipal PCP. Annual phosphorus reduction from structural BMPs shall be calculated consistent with Attachment 3 to Appendix F.

Inventory and priority ranking of locations for structural retrofits – The permittee shall develop a priority ranking of areas and infrastructure within the municipality for potential implementation of phosphorus control practices. The ranking shall be developed through the use of available screening and monitoring results collected during the permit term either by the permittee or another entity and the mapping required pursuant to Part 2.3.4.6. of the Draft Permit. The permittee shall also include in this prioritization a detailed assessment of site suitability for potential phosphorus control measures based on soil types and other factors. The permittee shall coordinate this activity with the requirements of Part 2.3.6.8.b. of the Draft Permit. A description and the result of this priority ranking shall be included in the PCP.

Implementation Schedule – A schedule for implementing the BMPs, including, as appropriate: funding, training, purchasing, construction, inspections, monitoring, and other assessment and evaluation components of implementation. Implementation of planned BMPs must begin upon completion of the Plan, and all non-structural BMPs shall be fully implemented within three years of the permit effective date unless the permittee can document that such implementation is infeasible. Where planned structural BMP retrofits or major drainage infrastructure projects are expected to take additional time to construct, the permittee shall within 3 years of the effective date of the permit have a schedule for completion of construction as soon as possible, including identification of funding source.

Performance Evaluation – The permittee shall evaluate the effectiveness of the PCP by tracking the phosphorus reductions achieved through implementation of structural and non-structural BMPs. Phosphorus reductions shall be calculated consistent with Attachment 2 (non-structural BMP performance) and Attachment 3 (structural BMP performance) to Appendix F for all BMPs implemented to date[10]. Calculated total phosphorus reductions in unit of mass per year shall be subtracted from the applicable baseline phosphorus load given in Table F-3 or calculated by the permittee consistent with Attachment 1 to Appendix F. The permittee shall also certify in its Performance Evaluation that all structural and non-structural BMPs implemented for phosphorus reduction credits are properly implemented, maintained and inspected according to manufacturer design or specifications.

As an alternative to tracking phosphorus reductions as described above, the permittee may choose to evaluate the effectiveness of the PCP through monitoring or other means. In this case, the permittee shall develop a rigorous monitoring plan or other assessment plan the permittee will use to evaluate the effectiveness of the PCP in meeting the assumptions and requirements of the WLA. The permittee must submit the alternative analysis plan in writing to EPA for approval prior to implementation. The alternative analysis plan can be submitted to EPA at any time. If EPA denies the request, EPA will send a written explanation of the denial. Until the approval of an alternative analysis plan the permittee shall track phosphorus reductions through the methods described above and consistent with Attachment 2 and 3 to Appendix F.

iii. Permittees subject to phosphorus reduction requirements shall highlight in their annual report all control measures implemented during the reporting period or planned to be implemented in the upcoming reporting period to control the phosphorus and report the associated load reductions achieved in the previous reporting period.

[10] Annual phosphorus reductions from structural BMPs installed in the impaired lake watershed prior to the effective date of this permit shall be calculated consistent with Attachment 3 to Appendix F and applied to the overall phosphorus reduction calculated in the Performance Evaluation.

iv. Permittees that are located within the Great Bay Watershed and subject to Part 2.2.3 of the permit shall also track nitrogen reductions from selected structural BMPs chosen as part of the PCP. Nitrogen reductions shall be calculated with a methodology consistent with Attachment 1 to Appendix H and tracked along with total phosphorus reductions[11].

Mercury Impaired Waters Statewide[12]

- Pollutant: Mercury
- Municipalities: All
- Water Quality Goal of the TMDL: To reduce atmospheric deposition sources of mercury to achieve water quality standards for mercury in all surface waters.
- Measures to address the TMDL: None required.

[11] Total nitrogen reductions through the implementation of BMPs are for informational purposes only and there is no associated required nitrogen load reduction specified by this permit.

[12] Northeast Regional Mercury TMDL (2007)

NH Small MS4 General Permit

Table F-1. MS4s subject to Statewide Bacteria TMDL

Primary Town	Watershed	Waterbody Name	Impairment	% Reduction to meet TMDL: Single Sample	% Reduction to meet TMDL: Geometric Mean	Criteria/WLA: Single Sample	Criteria/WLA: Geometric Mean	Beach (Y/N)	Class	Designated Use
AMHERST	Merrimack River	BABOOSIC LAKE	Escherichia coli	95%	no data	126	406	N	B	PCR
		BABOOSIC LAKE - TOWN BEACH	Escherichia coli	70%	27%	47	88	Y	B	PCR
		SOUHEGAN RIVER	Escherichia coli	86%	67%	126	406	N	B	PCR
BEDFORD	Merrimack River	PATTEN BROOK	Escherichia coli	80%	85%	126	406	N	B	PCR
		RIDDLE BROOK	Escherichia coli	35%	54%	126	406	N	B	PCR
CHESTER	Salmon Falls - Piscataqua Rivers	TOWLE BROOK - TO PANDOLPIN DAM	Escherichia coli	71%	71%	126	406	N	B	PCR
DERRY	Merrimack River	ISLAND POND - CHASE'S GROVE	Escherichia coli	52%	complies	47	88	Y	B	PCR
		BEAVER LAKE - GALLIEN'S BEACH	Escherichia coli	78%	55%	47	88	Y	B	PCR
		HOODS POND - TOWN BEACH	Escherichia coli	94%	69%	47	88	Y	B	PCR
		RAINBOW LAKE - KAREN-GENA BEACH	Escherichia coli	78%	47%	47	88	Y	B	PCR
		BEAVER BROOK	Escherichia coli	complies	29%	126	406	N	B	PCR
DOVER	Salmon Falls - Piscataqua Rivers	SALMON FALLS RIVER	Enterococcus	93%	71%	35	104	N	B	PCR
		COCHECO RIVER	Enterococcus	96%	82%	35	104	N	B	PCR
		BELLAMY RIVER SOUTH[1]	Enterococcus	86%	22%	35	104	N	B	PCR
		DOVER WWTF SZ-NH	Enterococcus	84%	66%	35	104	N	B	PCR
		BELLAMY RIVER NORTH	Fecal Coliform	83%	55%		14	N	B	Shell
		BELLAMY RIVER SOUTH[2]	Fecal Coliform	80.5%	55.6%		14	N	B	Shell
		COCHECO RIVER - WATSON-WALDRON DAM POND	Escherichia coli	complies	11%	126	406	N	B	PCR
		COCHECO RIVER - CENTRAL AVE DAM	Escherichia coli	62%	34%	126	406	N	B	PCR
		BELLAMY RIVER - SAWYERS MILL DAM POND	Escherichia coli	80%	20%	126	406	N	B	PCR
		FRESH CREEK POND	Escherichia coli	38%	26%	126	406	N	B	PCR
		BLACKWATER BROOK-CLARK BROOK	Escherichia coli	44%	72%	126	406	N	B	PCR
		COCHECO RIVER	Escherichia coli	17%	30%	126	406	N	B	PCR
		REYNERS BROOK	Escherichia coli	79%	78%	126	406	N	B	PCR
		COCHECO RIVER	Escherichia coli	complies	44%	126	406	N	B	PCR
		INDIAN BROOK	Escherichia coli	50%	65%	126	406	N	B	PCR
		BERRY BROOK	Escherichia coli	80%	52%	126	406	N	B	PCR
		JACKSON BROOK	Escherichia coli	59%	76%	126	406	N	B	PCR
		BELLAMY RIVER	Escherichia coli	78%	54%	126	406	N	B	PCR
		VARNEY BROOK - CANNEY BROOK	Escherichia coli	96%	no data	126	406	N	B	PCR
		GARRISON BROOK	Escherichia coli	91%	complies	126	406	N	B	PCR

Table F-1. MS4s subject to Statewide Bacteria TMDL

Primary Town	Watershed	Waterbody Name	Impairment	% Reduction to meet TMDL		Criteria/WLA		Beach	Class	Designated
				Single Sample	Geometric Mean	Single Sample	Geometric Mean	(Y/N)		Use
DURHAM	Salmon Falls - Piscataqua Rivers	OYSTER RIVER	Enterococcus	84%	50%	35	104	N	B	PCR
		ADAMS POINT SOUTH - COND APP[1]	Enterococcus	89%	complies	35	104	N	B	PCR
		CROMMENT CREEK	Fecal Coliform	67.3%	4.4%		14	N	B	Shell
		ADAMS POINT SOUTH - COND APP[2]	Fecal Coliform	46%	complies		14	N	B	Shell
		ADAMS POINT TRIB	Fecal Coliform	98%	61%		14	N	B	Shell
		OYSTER RIVER MOUTH	Fecal Coliform	68%	10.6%		14	N	B	Shell
		OYSTER RIVER	Escherichia coli	88%	61%	126	406	N	B	PCR
		BEARDS CREEK	Escherichia coli	80%	83%	126	406	N	B	PCR
		OYSTER RIVER	Escherichia coli	73%	complies	126	406	N	B	PCR
		LONGMARSH BROOK - BEAUDETTE BROOK	Escherichia coli	67%	no data	126	406	N	B	PCR
		HAMEL BROOK	Escherichia coli	80%	81%	126	406	N	B	PCR
		COLLEGE BROOK	Escherichia coli	81%	79%	126	406	N	B	PCR
		RESERVOIR BROOK	Escherichia coli	82%	86%	126	406	N	B	PCR
EXETER	Salmon Falls - Piscataqua Rivers	EXETER RIVER - EXETER RIVER DAM I	Escherichia coli	79%	84%	126	406	N	B	PCR
		EXETER RIVER	Escherichia coli	10%	57%	126	406	N	B	PCR
		NORRIS BROOK	Escherichia coli	94%	66%	126	406	N	B	PCR
GOFFSTOWN	Merrimack River	GLEN LAKE - PUBLIC (STATE OWNED) BEACH	Escherichia coli	8%	no data	47	88	Y	B	PCR
		NAMASKE LAKE	Escherichia coli	83%	complies	126	406	N	B	PCR
		HARRY BROOK	Escherichia coli	complies	13%	126	406	N	B	PCR
		CATAMOUNT BROOK	Escherichia coli	86%	no data	126	406	N	B	PCR
GREENLAND	Salmon Falls - Piscataqua Rivers	UNKNOWN RIVER - WINNICUT RIVER DAM POND	Escherichia coli	74%	38%	126	406	N	B	PCR
		WINNICUT RIVER-BARTON BROOK-MARSH BROOK-THOMPSON BROOK	Escherichia coli	83%	no data	126	406	N	B	PCR
		HAINES BROOK	Escherichia coli	80%	62%	126	406	N	B	PCR
		SHAW BROOK	Escherichia coli	87%	85%	126	406	N	B	PCR
		UNNAMED BROOK	Escherichia coli	98%	68%	126	406	N	B	PCR
HAMPSTEAD	Merrimack River	WASH POND - TOWN BEACH	Escherichia coli	71%	no data	47	88	Y	B	PCR
		SUNSET LAKE - SUNSET PARK BEACH	Escherichia coli	54%	complies	47	88	Y	B	PCR

NH Small MS4 General Permit

Table F-1. MS4s subject to Statewide Bacteria TMDL

Primary Town	Watershed	Waterbody Name	Impairment	% Reduction to meet TMDL: Single Sample	% Reduction to meet TMDL: Geometric Mean	Criteria/WLA: Single Sample	Criteria/WLA: Geometric Mean	Beach (Y/N)	Class	Designated Use
HAMPTON	Salmon Falls - Piscataqua Rivers	HAMPTON RIVER MARINA SZ	Enterococcus	57%	no data	35	104	N	B	PCR
		TAYLOR RIVER	Fecal Coliform	35.5%	complies		14	N	B	Shell
		HAMPTON FALLS RIVER	Fecal Coliform	36.3%	complies		14	N	B	Shell
		TAYLOR RIVER (LOWER)	Fecal Coliform	1%	complies		14	N	B	Shell
	Coastal Impaired Segments	ATLANTIC OCEAN - HAMPTON BEACH STATE PARK BEACH	Enterococcus	75%	complies	35	104	Y	B	PCR
HAMPTON FALLS	Salmon Falls - Piscataqua Rivers	TAYLOR RIVER	Fecal Coliform	69%	26%		14	N	B	Shell
HOLLIS	Merrimack River	SILVER LAKE - STATE PARK BEACH	Escherichia coli	90%	complies	47	88	Y	B	PCR
		WITCHES BROOK	Escherichia coli	87%	78%	47	153	N	A	PCR
HOOKSETT	Merrimack River	MERRIMACK RIVER	Escherichia coli	98%	39%	126	406	N	B	PCR
HUDSON	Merrimack River	ROBINSON POND	Escherichia coli	57%	3%	126	406	N	B	PCR
		ROBINSON POND - TOWN BEACH	Escherichia coli	95%	76%	47	88	Y	B	PCR
		LAUNCH BROOK	Escherichia coli	75%	50%	126	406	N	B	PCR
KINGSTON	Merrimack River	COUNTRY POND - LONE TREE SCOUT RESV. BEACH	Escherichia coli	37%	complies	47	88	Y	B	PCR
		GREAT POND - KINGSTON STATE PARK BEACH	Escherichia coli	56%	no data	47	88	Y	B	PCR
		GREAT POND - CAMP BLUE TRIANGLE BEACH	Escherichia coli	56%	19%	47	88	Y	B	PCR
LEE	Salmon Falls - Piscataqua Rivers	LITTLE RIVER	Escherichia coli	complies	59%	126	406	N	B	PCR
		LAMPREY RIVER	Escherichia coli	12%	15%	126	406	N	B	PCR
		OYSTER RIVER	Escherichia coli	92%	94%	47	153	N	A	PCR
		OYSTER RIVER - CHELSEY BROOK	Escherichia coli	92%	91%	47	153	N	A	PCR
MADBURY	Salmon Falls - Piscataqua Rivers	JOHNSON CREEK - GERRISH BROOK	Escherichia coli	55%	73%	126	406	N	B	PCR
		BELLAMY RIVER - KELLY BROOK - KNOX MARSH BROOK	Escherichia coli	92%	75%	47	153	N	A	PCR
MANCHESTER	Merrimack River	MERRIMACK RIVER - AMOSKEAG DAM	Escherichia coli	83%	complies	126	406	N	B	PCR
		CRYSTAL LAKE-TOWN BEACH	Escherichia coli	56%	no data	47	88	Y	B	PCR
		COHAS BROOK - LONG POND BROOK	Escherichia coli	63%	53%	126	406	N	B	PCR
		UNNAMED BROOK - FROM PINE ISLAND POND TO MERRIMACK RIVER	Escherichia coli	99%	33%	126	406	N	B	PCR
		MERRIMACK RIVER	Escherichia coli	94%	36%	126	406	N	B	PCR
MERRIMACK	Merrimack River	NATICOOK LAKE - WASSERMAN PARK BEACH	Escherichia coli	78%	complies	47	88	Y	B	PCR
		MERRIMACK RIVER	Escherichia coli	87%	complies	126	406	N	B	PCR
		SOUHEGAN RIVER	Escherichia coli	80%	34%	126	406	N	B	PCR
		SOUHEGAN RIVER	Escherichia coli	complies	3%	126	406	N	B	PCR
		PENNICHUCK BROOK - WITCHES BROOK	Escherichia coli	45%	68%	47	153	N	A	PCR
		MERRIMACK RIVER	Escherichia coli	54%	complies	126	406	N	B	PCR

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Table F-1. MS4s subject to Statewide Bacteria TMDL

Primary Town	Watershed	Waterbody Name	Impairment	% Reduction to meet TMDL		Criteria/WLA				
				Single Sample	Geometric Mean	Single Sample	Geometric Mean	Beach (Y/N)	Class	Designated Use
MILFORD	Merrimack River	SOUHEGAN RIVER - MCLANE DAM	Escherichia coli	86%	78%	126	406	N	B	PCR
		PURGATORY BROOK	Escherichia coli	55%	36%	126	406	N	B	PCR
		SOUHEGAN RIVER	Escherichia coli	75%	67%	126	406	N	B	PCR
		GREAT BROOK - OX BROOK	Escherichia coli	complies	39%	126	406	N	B	PCR
		SOUHEGAN RIVER	Escherichia coli	86%	50%	126	406	N	B	PCR
MILTON	Salmon Falls - Piscataqua Rivers	MILTON POND - MILTON POND REC AREA BEACH	Escherichia coli	76%	no data	47	88	Y	B	PCR
		DAMES BROOK	Escherichia coli	25%	20%	126	406	N	B	PCR
NASHUA	Nashua River	NASHUA RIVER - JACKSON PLANT DAM POND	Escherichia coli	92%	no data	126	406	N	B	PCR
		NASHUA RIVER	Escherichia coli	94%	complies	126	406	N	B	PCR
		NASHUA RIVER	Escherichia coli	92%	no data	126	406	N	B	PCR
	Merrimack River	MERRIMACK RIVER	Escherichia coli	72%	25%	126	406	N	B	PCR
		SALMON BROOK - HASSELLS BROOK - OLD MAIDS BROOK - HALE BROOK	Escherichia coli	92%	no data	126	406	N	B	PCR
		SALMON BROOK	Escherichia coli	96%	90%	126	406	N	B	PCR
		MERRIMACK RIVER	Escherichia coli	96%	35%	126	406	N	B	PCR
NEW CASTLE	Coastal Impaired Segments	ATLANTIC OCEAN - NEW CASTLE BEACH	Enterococcus	86%	complies	35	104	Y	B	PCR
NEWINGTON	Salmon Falls - Piscataqua Rivers	PICKERING BROOK[1]	Enterococcus	98%	63%	35	104	N	B	PCR
		GREAT BAY - COND APPR[1]	Enterococcus	68%	complies	35	104	N	B	PCR
		ADAMS POINT MOORING FIELD SZ	Enterococcus	89%	complies	35	104	N	B	PCR
		U LITTLE BAY (SOUTH)[1]	Enterococcus	89%	complies	35	104	N	B	PCR
		U LITTLE BAY (NORTH)[1]	Enterococcus	89%	28%	35	104	N	B	PCR
		PICKERING BROOK[2]	Fecal Coliform	94%	68%		14	N	B	Shell
		FABYAN POINT	Fecal Coliform	67.2%	complies		14	N	B	Shell
		GREAT BAY - COND APPR[2]	Fecal Coliform	79.9%	24.1%		14	N	B	Shell
		U LITTLE BAY (SOUTH)[2]	Fecal Coliform	51.7%	complies		14	N	B	Shell
		LOWER LITTLE BAY	Fecal Coliform	53%	4%		14	N	B	Shell
		LOWER LITTLE BAY GENERAL SULLIVAN BRIDGE	Fecal Coliform	47.4%	complies		14	N	B	Shell
		U LITTLE BAY (NORTH)[2]	Fecal Coliform	47.4%	complies		14	N	B	Shell
NORTH HAMPTON	Coastal Impaired Segments	ATLANTIC OCEAN - STATE BEACH[1]	Enterococcus	86%	complies	35	104	Y	B	PCR
		ATLANTIC OCEAN - STATE BEACH[2]	Fecal Coliform	90%	65%		14	Y	B	Shell
PELHAM	Merrimack River	LONG POND - TOWN BEACH	Escherichia coli	78%	26%	47	88	Y	B	PCR
		BEAVER BROOK	Escherichia coli	63%	21%	126	406	N	B	PCR
		BEAVER BROOK - TONYS BROOK	Escherichia coli	50%	66%	126	406	N	B	PCR
PLAISTOW	Merrimack River	KELLY BROOK - SEAVER BROOK	Escherichia coli	80%	59%	126	406	N	B	PCR

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Table F-1. MS4s subject to Statewide Bacteria TMDL

Primary Town	Watershed	Waterbody Name	Impairment	% Reduction to meet TMDL		Criteria/WLA		Beach	Class	Designated
				Single Sample	Geometric Mean	Single Sample	Geometric Mean	(Y/N)		Use
PORTSMOUTH	Salmon Falls - Piscataqua Rivers	LOWER PISCATAQUA RIVER - SOUTH	Enterococcus	74%	complies	35	104	N	B	PCR
		LOWER SAGAMORE CREEK	Enterococcus	98%	no data	35	104	N	B	PCR
		SOUTH MILL POND	Enterococcus	83%	28%	35	104	N	B	PCR
		NORTH MILL POND	Enterococcus	96%	95%	35	104	N	B	PCR
		PICKERING BROOK	Escherichia coli	80%	59%	126	406	N	B	PCR
		SAGAMORE CREEK	Escherichia coli	80%	50%	126	406	N	B	PCR
		LOWER HODGSON BROOK	Escherichia coli	98%	90%	126	406	N	B	PCR
		UPPER HODGSON BROOK	Escherichia coli	80%	81%	126	406	N	B	PCR
		PAULS BROOK - PEASE AIR FORCE BASE	Escherichia coli	49%	54%	126	406	N	B	PCR
		BORTHWICK AVE TRIBUTARY	Escherichia coli	76%	72%	126	406	N	B	PCR
		NEWFILEDS DITCH	Escherichia coli	80%	86%	126	406	N	B	PCR
ROCHESTER	Salmon Falls - Piscataqua Rivers	SALMON FALLS RIVER - BAXTER MILL DAM POND	Escherichia coli	97%	83%	126	406	N	B	PCR
		COCHECO RIVER - CITY DAM[1]	Escherichia coli	12%	9%	126	406	N	B	PCR
		COCHECO RIVER - GONIC DAM POND	Escherichia coli	28%	45%	126	406	N	B	PCR
		AXE HANDLE BROOK - HOWARD BROOK	Escherichia coli	complies	20%	126	406	N	B	PCR
		COCHECO RIVER	Escherichia coli	64%	57%	126	406	N	B	PCR
		COCHECO RIVER	Escherichia coli	79%	75%	126	406	N	B	PCR
		WILLOW BROOK	Escherichia coli	78%	81%	126	406	N	B	PCR
ROLLINSFORD	Salmon Falls - Piscataqua Rivers	SALMON FALLS RIVER - SOUTH BERWICK DAM	Escherichia coli	complies	20%	126	406	N	B	PCR
		FRESH CREEK - TWOMBLY BROOK	Escherichia coli	85%	18%	126	406	N	B	PCR
		ROLLINS BROOK	Escherichia coli	69%	70%	126	406	N	B	PCR
		FRESH CREEK	Escherichia coli	61%	81%	126	406	N	B	PCR

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Table F-1. MS4s subject to Statewide Bacteria TMDL

Primary Town	Watershed	Waterbody Name	Impairment	% Reduction to meet TMDL		Criteria/WLA				
				Single Sample	Geometric Mean	Single Sample	Geometric Mean	Beach (Y/N)	Class	Designated Use
RYE	Salmon Falls - Piscataqua Rivers	WITCH CREEK[1]	Enterococcus	35%	complies	35	104	N	B	PCR
		BERRYS BROOK[1]	Enterococcus	42%	no data	35	104	N	B	PCR
		WITCH CREEK[2]	Fecal Coliform	57.4%	25.3%		14	N	B	Shell
		BERRYS BROOK[2]	Fecal Coliform	90.8%	72.4%		14	N	B	Shell
		BERRY'S BROOK	Escherichia coli	96%	80%	126	406	N	B	PCR
		UNNAMED BROOKS - TO ATLANTIC OCEAN AT CONCORD POINT	Escherichia coli	80%	complies	126	406	N	B	PCR
		ATLANTIC OCEAN - PIRATES COVE BEACH	Enterococcus	78%	complies	35	104	Y	B	PCR
		ATLANTIC OCEAN - CABLE BEACH	Enterococcus	39%	complies	35	104	Y	B	PCR
		ATLANTIC OCEAN - SAWYER BEACH[1]	Enterococcus	35%	no data	35	104	Y	B	PCR
		ATLANTIC OCEAN - JENNESS BEACH	Enterococcus	72%	complies	35	104	Y	B	PCR
		BASS BROOK BEACH OUTFALL AREA[1]	Enterococcus	26%	no data	35	104	N	B	PCR
		ATLANTIC OCEAN - BASS BEACH[1]	Enterococcus	50%	complies	35	104	Y	B	PCR
		ATLANTIC OCEAN - SAWYER BEACH[2]	Fecal Coliform	90%	40%		14	Y	B	Shell
		BASS BROOK BEACH OUTFALL AREA[2]	Fecal Coliform	92%	no data		14	N	B	Shell
		ATLANTIC OCEAN - BASS BEACH[2]	Fecal Coliform	93%	78%		14	Y	B	Shell
SALEM	Merrimack River	CAPTAIN POND - CAPTAIN'S BEACH	Escherichia coli	complies	1%	47	88	Y	B	PCR
		CAPTAIN POND - CAMP OTTER SWIM AREA BEACH	Escherichia coli	51%	no data	47	88	Y	B	PCR
SANDOWN	Salmon Falls - Piscataqua Rivers	EXETER RIVER	Escherichia coli	82%	57%	126	406	N	B	PCR
SEABROOK	Salmon Falls - Piscataqua Rivers	SEABROOK HARBOR BEACH	Enterococcus	73%	complies	35	104	Y	B	PCR
		CAIN'S BROOK	Escherichia coli	90%	93%	126	406	N	B	PCR
		CAIN'S BROOK	Escherichia coli	88%	77%	126	406	N	B	PCR
	Coastal Impaired Segments	ATLANTIC OCEAN - SEABROOK TOWN BEACH	Enterococcus	91%	complies	35	104	Y	B	PCR
SOMERSWORTH	Salmon Falls - Piscataqua Rivers	SALMON FALLS RIVER - LOWER GREAT FALLS DAM	Escherichia coli	92%	no data	126	406	N	B	PCR
		SALMON FALLS RIVER	Escherichia coli	complies	11%	126	406	N	B	PCR
		SALMON FALLS RIVER	Escherichia coli	97%	complies	126	406	N	B	PCR

1 also listed for Fecal Coliform impairment

2 also listed for Enterococcus impairment

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Table F-2. MS4s subject to Beach Bacteria TMDL

Primary Town	Watershed	Waterbody Name	Assessment Unit #	Impairment	% Reduction to meet TMDL	
					Single Sample[1]	Geometric Mean
BEDFORD	Merrimack River	MCQUADE BROOK	NHRIV700060905-13	E coli	complies	98%
DOVER	Salmon Falls - Piscataqua River	SALMON FALL RIVER	NHEST600030406-01	Fecal colilform	46%	81%
		COCHECO RIVER	NHEST600030608-01	Fecal colilform	62%	81%
		UPPER PISCATAQUA RIVER-NH-NORTH	NHEST600031001-01-01	Fecal colilform	62%	81%
		UPPER PISCATAQUA RIVER-NH-SOUTH	NHEST600031001-01-03	Fecal colilform	11%	70%
DURHAM	Salmon Falls - Piscataqua River	LITTLEHOLE CREEK	NHRIV600030902-11	E coli	60%	42%
FARMINGTON	Salmon Falls - Piscataqua River	MAD RIVER	NHRIV600030601-08	E coli	complies	31%
GREENLAND	Salmon Falls - Piscataqua River	WINNICUT RIVER	NHEST600030904-01	Fecal colilform	complies	27%
		NORTON BROOK	NHRIV600030901-06	E coli	no data	83%
		FOSS BROOK	NHRIV600030904-05	E coli	no data	95%
HOOKSETT	Merrimack River	MESSER BROOK	NHRIV700060802-09	E coli	52%	59%
LEE	Salmon Falls - Piscataqua River	WENDYS BROOK	NHRIV600030902-16	E coli	98%	99%
MANCHESTER	Merrimack River	UNNAMED BROOK - TO PISCATAQUOG RIVER	NHRIV700060607-35	E coli	94%	98%
		RAYS BROOK	NHRIV700060802-15	E coli	no data	92%
NASHUA	Nashua River	NASHUA RIVER - NASHUA CANAL DIKE	NHIMP700040402-03	E coli	complies	50%
NORTH HAMPTON	Salmon Falls - Piscataqua River	CHAPEL BROOK	NHEST600031002-03	Fecal colilform	no data	7%
PORTSMOUTH	Salmon Falls - Piscataqua River	UPPER SAGAMORE CREEK	NHEST600031001-03	Fecal colilform	22%	69%
		UPPER SAGAMORE CREEK	NHEST600031001-03	Enterococcus	no data	100%
ROCHESTER	Salmon Falls - Piscataqua River	ISINGLASS RIVER	NHRIV600030607-10	E coli	41%	30%
RYE	Salmon Falls - Piscataqua River	UNNAMED BROOK TO BASS BEACH	NHEST600031002-04	Fecal colilform	no data	85%
		PARSONS CREEK	NHEST600031002-05	Fecal colilform	no data	80%
SALEM	Merrimack River	ARLINGTON MILL RESERVOIR-SECOND ST BEACH	NHLAK700061101-04-02	E coli	complies	65%
		MILLVILLE LAKE - TOWN BEACH	NHLAK700061102-06-02	E coli	25%	63%
SEABROOK	Salmon Falls - Piscataqua River	MILL CREEK	NHEST600031004-07	Enterococcus	55%	65%
		BLACKWATER RIVER	NHEST600031004-08-04	Enterococcus	complies	29%
		CAINS BROOK - NOYES POND	NHIMP600031004-06	E coli	5%	37%
		UNNAMED BROOK TO CAINS MILL POND	NHRIV600031004-21	E coli	no data	97%
SOMERSWORTH	Salmon Falls - Piscataqua River	WILLAND POND	NHLAK600030405-03	E coli	34%	98%

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Table F-3. MS4s subject to a Lake PhosphorusTMDL

Water Body Name	Primary Town	Total Drainage Area (ha)	Modeled Baseline Watershed TP Load (kg/yr)	Target Watershed TP Load (WLA) (kg/yr)	% Reduction In TP Watershed Load	TMDL Link
Baboosic Lake	Amherst	676.0	120.3	67.5	44%	Baboosic TMDL
Horseshoe Pond	Merrimack	55.9	41.5	10.0	76%	Horseshoe TMDL
Nutt Pond	Manchester	261.0	98.2	28.7	71%	Nutt TMDL
Pine Island Pond	Manchester	6011.0	2212.5	591.0	73%	Pine Island TMDL
Robinson Pond	Hudson	501.0	97.4	51.1	48%	Robinson TMDL
Sebbins Pond	Bedford	93.0	16.0	5.7	64%	Sebbins TMDL
Showell Pond	Sandown	63.1	19.2	5.9	69%	Showell TMDL
Stevens Pond	Manchester	275.8	62.0	31.0	50%	Stevens TMDL
Hoods Pond	Derry	1602.0	816.3	162.0	80%	Hoods TMDL
Halfmoon Pond	Kingston	53.5	12.1	3.2	74%	Halfmoon TMDL
Greenwood Pond	Kingston	134.9	43.8	13.4	69%	Greenwood TMDL
Flints Pond	Hollis	477.0	85.8	51.6	40%	Flints TMDL
Dorrs Pond	Manchester	594.0	169.6	64.2	62%	Dorrs TMDL
Country Pond	Kingston	3590.0	538.7	258.5	52%	Country TMDL
Governors Lake	Raymond	251.7	43	22.7	47%	Governors TMDL

Note: All values from Table 6-1 in applicable TMDL

ATTACHMENT 1

ATTACHMENT 1 TO APPENDIX F

Method to Calculate Baseline Watershed (Watershed) Phosphorus Load

The methods and annual phosphorus export load rates presented in Attachments 1, 2 and 3 are for the purpose of measuring load reductions for various stormwater BMPs treating runoff from different site conditions (i.e. impervious or pervious) and land uses (e.g. commercial, industrial, residential). 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.

This attachment provides the method to calculate an updated baseline phosphorus load discharging in stormwater for the impaired watershed. This method shall be used to calculate the following annual phosphorus loads:

1) Watershed Phosphorus Load;
2) Watershed Phosphorus Pounds Reduction (Phosphorus Reduction Requirement); and
3) BMP Load.

The **Watershed Phosphorus Load** is a measure of the annual phosphorus load discharging in stormwater from the impervious and pervious areas of the impaired watershed.

The **Watershed Phosphorus Pounds Reduction** referred to as the permittee's **Phosphorus Reduction Requirement** represents the required reduction in annual phosphorus load in stormwater to meet the WLA for the impaired watershed. The percent phosphorus reduction for each watershed (identified in Appendix F, Table F-3) is applied to the Watershed Phosphorus Load to calculate the Phosphorus Pounds Reduction.

The **BMP Load** is the annual phosphorus load from the drainage area to each proposed or existing BMP used by permittee to claim credit against its Phosphorus Reduction Requirement. The BMP Load is the starting point from which the permittee calculates the reduction in phosphorus load achieved by each existing and proposed BMP. Attachments 2 and 3 to Appendix F provide the methods for calculating annual phosphorus load reductions for enhanced non-structural BMPs and structural BMPs, respectively.

Examples are provided to illustrate use of the methods. Table 1-1 below provides annual phosphorus load export rates by land use category for impervious and pervious areas. The permittee shall select the land use category that most closely represents the actual use of the watershed. For pervious areas, if the hydrologic soil group (HSG) is known, use the appropriate value. If the HSG is not known, assume HSG D conditions for the phosphorus load export rate. 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 loads. Table 1-2 provides a crosswalk table of land use codes between Table 1-1, the TMDL Reports and the codes used by NH Granit.

<u>(1) Watershed Phosphorus Load:</u> The permittee shall calculate the **Watershed Phosphorus Load** by the following procedure:

1) Determine the total area (acre) associated with the impaired watershed;

2) Sort the total area associated with the watershed into two categories: total impervious area (IA) and total pervious area (PA);

3) Calculate the annual phosphorus load associated with impervious area (Watershed P Load $_{IA}$) and the pervious area (Watershed P Load $_{PA}$) by multiplying the IA and PA by the appropriate land use-based phosphorus load export rate provided in Table 1-1; and

4) Determine the Watershed Phosphorus Load by adding the Watershed Site P Load $_{IA}$ to the Watershed Site P Load $_{PA}$.

<u>Example 1-1 to determine Watershed Phosphorus Load:</u>
Watershed A is 15.11 acres, with 11.0 acres of industrial area (e.g. access drives, buildings, and parking lots), 3.0 acres of medium-density residential pervious area (HSG A/B), and 4.0 acres of unmanaged wooded area.

The **Watershed Phosphorus Load** = (Watershed Load $_{IA}$) + (Watershed Load $_{PA}$)

<u>Where:</u>
Watershed P Load $_{IA}$ = ($IA_{INDUSTRIAL}$) x (impervious cover phosphorus export loading rate for industrial use (Table 1-1))
= 11.0 acre x 1.8 lbs/acre/year
= 19.9 lbs P/year

Watershed P Load $_{PA}$ = (PA_{MDR}) x (pervious cover phosphorus export loading rate for HSG A/B (Table 1-1)) + (PA_{FOREST}) x (pervious cover phosphorus export loading rate for forest (Table 1-1))
= 3.0 acre x 0.2 lbs/acre/year + 4.0 acre x 0.1 lbs/acre/year
= 1.0 lbs P/year

The Baseline Watershed Phosphorus Load = 19.9 lbs P/year + 1.0 lbs P/year
= **20.9 lbs P/year**

<u>(2) Watershed Phosphorus Pounds Reduction (Phosphorus Reduction Requirement):</u> The Watershed Phosphorus Reduction requirement is the amount of reduction in annual phosphorus load (in pounds) that the permittee is required to achieve in the Watershed. The permittee shall calculate the **Phosphorus Pounds Reduction** by multiplying the **Watershed Phosphorus Load** by the applicable percent phosphorus reduction for that watershed specified in Table F-3 (Appendix F).

Example 1-2 to determine Watershed Phosphorus Pounds Reduction:
Table F-3 identifies Watershed A's percent phosphorus reduction as 65%; therefore the Watershed Phosphorus Pounds Reduction is:

Phosphorus Pounds Reduction = (Watershed Phosphorus Load) x (0.65)
= (20.9 lbs P/year) x (0.65)
= **13.6 lbs P/year**

(3) BMP Load: To estimate the annual phosphorus load reduction that a storm water BMP can achieve, it is first necessary to estimate the amount of annual phosphorus load that the BMP will receive or treat (BMP Load).
For a given BMP:

1) Determine the total drainage area to the BMP;

2) Distribute the total drainage area into impervious and pervious subareas by land use category;

3) Calculate the phosphorus load for each land use-based impervious and pervious subarea by multiplying the subarea by the appropriate phosphorus load export rate provided in Table 1-1; and

4) Determine the total annual phosphorus load to the BMP by summing the calculated impervious and pervious subarea phosphorus loads.

Example 1-3 to determine phosphorus load to a proposed BMP: For the same 15.11 acre Watershed A as specified in Example 1-1, a permittee is proposing a storm water infiltration system that will treat runoff from 8.23 impervious acres, 1.51 acres of landscaped MDR pervious area and 0.57 acres of the wooded area. The drainage area information for the proposed BMP is:

BMP Subarea ID	Land Use Category	Cover Type	Area (acre)	P export rate (lbs P/acre/year)*
1	industrial	impervious	8.23	1.8
2	MDR	pervious	1.51	0.2
3	forest	pervious	0.57	0.1

*From Table 1-1

The phosphorus load to the proposed BMP (BMP Load) is calculated as:

BMP Load = ($IA_{INDUSTRIAL}$ (acre) x P export rate) + (PA_{MDR} x P export rate) + (PA_{FOREST} x P export rate)
= (8.23 x 1.8) + (1.51 x 0.2) + (0.57 x 0.1)
= 15.17 lbs P/year

Table 1-1. Annual phosphorus load export rates

Phosphorus Source Category by Land Use	**Land Surface Cover**	**Phosphorus Load Export Rate, lbs/ac/yr**	**Phosphorus Load Export Rate, kg/ha/yr**
Commercial (Com) and Industrial (Ind)	Impervious	1.8	2.0
	Pervious	See *DevPERV	See *DevPERV
Multi-Family (MFR) and High-Density Residential (HDR)	Impervious	2.3	2.6
	Pervious	See *DevPERV	See *DevPERV
Medium -Density Residential (MDR)	Impervious	2.0	2.2
	Pervious	See *DevPERV	See *DevPERV
Low Density Residential (LDR) - "Rural"	Impervious	0.9	1.0
	Pervious	0.2	0.2
Highway (HWY)	Impervious	1.3	1.5
	Pervious	See *DevPERV	See *DevPERV
Forest (For)	Impervious	0.9	1.0
	Pervious	0.1	0.1
Agriculture (Ag)	Cover Crop/Grazing	0.7	0.8
	Row Crop	2.0	2.2
	Hayland- no manure	0.4	0.4
*Developed Land Pervious (DevPERV)- HSG A/B	Pervious	0.2	0.2
*Developed Land Pervious (DevPERV) – HSG C	Pervious	0.4	0.5
*Developed Land Pervious (DevPERV) - HSG D	Pervious	0.7	0.8

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 D 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 1-2. Crosswalk table for land use codes

EPA Land Use Codes	ENSR-LRM Land Use[1]	Granit Land Use Codes
Commercial (Com) and Industrial (Ind)	Urban 4	Industrial/commercial
		Mixed urban
Multi-Family (MFR) and High-Density Residential (HDR)	Urban 2	Residential
Medium -Density Residential (MDR)		
Low Density Residential (LDR) - "Rural"	Urban 1	
Highway (HWY)	Urban 3	Transportation/roads
		Railroads
		Auxiliary Transportation
Forest (For)	Forest 1-4	Forested
Agriculture (Ag)	Agric 1 - 5	Farmsteads
*Developed Land Pervious (DevPERV)-Hydrologic Soil Group A/B	Open 1	Open wetlands
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C	Urban 5	Idle/open
	Open 2, 3	Playing fields/recreational
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group D		

[1]Taken from TMDL Reports

ATTACHMENT 2

ATTACHMENT 2 TO APPENDIX F

Phosphorus Reduction Credits for Selected Enhanced Non-Structural BMPs in the Watershed

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

1) Enhanced Sweeping Program;
2) Catch Basin Cleaning;
3) No Application of Fertilizers Containing Phosphorus; and
4) Organic Waste and Leaf Litter Collection program
5) Elimination of illicit connections.

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

The methods and annual phosphorus export load 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. Table 2-1 below provides annual phosphorus 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.

Alternative Methods and/or Phosphorus Reduction Factors: A permittee may propose alternative methods and/or phosphorus reduction factors for calculating phosphorus load reduction credits for these non-structural practices. EPA will consider alternative methods and/or phosphorus 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 phosphorus 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 phosphorus reduction credit other than a reduction credit calculated by the permittee using the default phosphorus reduction factors provided in this attachment for the identified practices.

Table 2-1. Phosphorus load export rates by land cover

Phosphorus Source Category by Land Use	Land Surface Cover	Phosphorus Load Export Rate, lbs/ac/yr	Phosphorus Load Export Rate, kg/ha/yr
Commercial (Com) and Industrial (Ind)	Impervious	1.8	2.0
	Pervious	See *DevPERV	See *DevPERV
Multi-Family (MFR) and High-Density Residential (HDR)	Impervious	2.3	2.6
	Pervious	See *DevPERV	See *DevPERV
Medium -Density Residential (MDR)	Impervious	2.0	2.2
	Pervious	See *DevPERV	See *DevPERV
Low Density Residential (LDR) - "Rural"	Impervious	0.9	1.0
	Pervious	See *DevPERV	See *DevPERV
Highway (HWY)	Impervious	1.3	1.5
	Pervious	See *DevPERV	See *DevPERV
Forest (For)	Impervious	0.9	1.0
	Pervious	0.1	0.1
Agriculture (Ag)	Cover Crop/Grazing	0.7	0.8
	Row Crop	2.0	2.2
	Hayland- no manure	0.4	0.4
*Developed Land Pervious (DevPERV)- HSG A/B	Pervious	0.2	0.2
*Developed Land Pervious (DevPERV) – HSG C	Pervious	0.4	0.5
*Developed Land Pervious (DevPERV) - HSG D	Pervious	0.7	0.8

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 D 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.

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

$$\text{Credit}_{\text{sweeping}} = \text{IA}_{\text{swept}} \times \text{PLE}_{\text{IC-land use}} \times \text{PRF}_{\text{sweeping}} \quad \textbf{(Equation 2-1)}$$

Where:

$\text{Credit}_{\text{sweeping}}$ = Amount of phosphorus load removed by enhanced sweeping program (lbs/year)

IA_{swept}	=	Area of impervious surface that is swept under the enhanced sweeping program (acres)
$PLE_{IC\text{-}land\ use}$	=	Phosphorus Load Export Rate for impervious cover and specified land use (lbs/acre/yr) (see Table 2-1)
$PRF_{sweeping}$	=	Phosphorus Reduction Factor for sweeping based on sweeper type and frequency (see Table 2-2).

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 using long-term local rainfall data.

Table 2-2. Phosphorus reduction efficiency factors ($PRF_{sweeping}$) for sweeping impervious areas

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

[1] 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.
[2] 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 ($Credit_{sweeping}$): A permittee proposes to implement an enhanced sweeping program and perform weekly sweeping from April 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 is:

IA_{swept} = 20.30 acres
$PLE_{IC\text{-}HDR}$ = 2.3 lbs/acre/yr (from Table 2-1)
$PRF_{sweeping}$ = 0.08 (from Table 2-2) x (9 months / 12 months)
= 0.06

Substitution into equation 2-1 yields a $Credit_{sweeping}$ of 2.8 pounds of phosphorus removed per year.

$Credit_{sweeping}$ = IA_{swept} x $PLE_{land\ use}$ x $PRF_{sweeping}$
= 20.30 acres x 2.3 lbs/acre/yr x 0.06
= 2.8 lbs/yr

(2) Catch Basin Cleaning: The permittee may earn a phosphorus reduction credit, Credit $_{CB}$, 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 credit shall be calculated by using the following equation:

$$Credit_{CB} = IA_{CB} \times PLE_{IC\text{-}land\ use} \times PRF_{CB}$$ **(Equation 2-2)**

Where:

$Credit_{CB}$ = Amount of phosphorus load removed by catch basin cleaning (lbs/year)

IA_{CB} = Impervious drainage area to catch basins (acres)

$PLE_{IC\text{-}and\ use}$ = Phosphorus Load Export Rate for impervious cover and specified land use (lbs/acre/yr) (see Table 2-1)

PRF_{CB} = Phosphorus Reduction Factor for catch basin cleaning (see Table 2-3)

Table 2-3. Phosphorus reduction efficiency factor (PRF_{CB}) for semi-annual catch basin cleaning.

Frequency	Practice	PRF_{CB}
Semi-annual	Catch Basin Cleaning	0.02

Example 2-2: Calculation for catch basin cleaning credit ($Credit_{CB}$):

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 (acre) of medium-density residential impervious area. For this site the needed information is:

IA_{CB} = 15.3 acre

$PLE_{IC\text{-}MDR}$ = 2.0 lbs/acre/yr (from Table 2-1)

PRF_{CB} = 0.02 (from Table 2-3)

Substitution into equation 2-2 yields a $Credit_{CB}$ of 0.6 pounds of phosphorus removed per year:

$Credit_{CB}$ = $IA_{CB} \times PLE_{IC\text{-}MDR} \times PRF_{CB}$
= 15.3 acre x 2.0 lbs/acre/yr x 0.02
= 0.6 lbs/yr

(3) No Application of Fertilizers Containing Phosphorus: If a permittee has historically and regularly used fertilizer containing phosphorus in its Watershed, the permittee may earn a phosphorus reduction credit by not applying fertilizers that contain phosphorus to managed and landscaped pervious areas from which runoff discharges to the TMDL waterbody in the Watershed. The application of any fertilizers containing phosphorus in the Watershed at any time during the reporting year by the permittee or any contractor or subcontractor acting on behalf of the permittee shall preclude the permittee from earning this credit for the reporting year. The permittee must provide written certification to EPA annually that no fertilizers containing phosphorus have been applied by the permittee or its agents (including contractors and subcontractors) to any area in the Watershed in order to earn the credit (Credit $_{\text{no P fertilizer}}$). The Credit $_{\text{no P fertilizer}}$ shall be determined using the following equation:

Credit $_{\text{no P fertilizer}}$ = (Watershed Area) x (PLE $_{\text{land use}}$) x (0.33) **(Equation 2-3)**

Where:

Credit $_{\text{no P fertilizer}}$	= Amount of phosphorus load reduction credit for not applying fertilizers containing phosphorus (lbs/year)
Watershed Area	= All managed and landscaped pervious areas from which runoff discharges to the TMDL waterbody in the Watershed (acre)
PLE $_{\text{PC-land use}}$	= Phosphorus Load Export Rate for pervious cover and specified land use (lbs/acre/yr) (see Table 2-1)
0.33	= 33% phosphorus reduction factor for not applying fertilizers containing phosphorus

Example 2-3: Calculation for no phosphorus fertilizer credit (Credit $_{\text{no P fertilizer}}$): A permittee has the option of applying phosphorus free fertilizer to the lawns and landscaped areas of a multi-family residential area. The area discharging to the waterbody consists of 9.07 acres of pervious area and 1.18 acre of unmanaged woodland. The HSG for the pervious multi-family residential area is unknown (assume HSG D). For this site the needed information to calculate the Credit $_{\text{no P fertilizer}}$ is the:

Watershed Area = 9.07 acres; and
PLE $_{\text{PC-HSG D}}$ = 0.7 lbs/ac/yr (from Table 2-1)

Substitution into equation 2-3 yields a Credit $_{\text{no P fertilizer}}$ of 2.1 pounds of phosphorus removed per year.

Credit $_{\text{no P fertilizer}}$ = (9.07 acres) x (0.7 lbs/acre/yr) x (0.33)
= 2.1 lbs/yr

(4) Enhanced Organic Waste and Leaf Litter Collection program: The permitee may earn a phosphorus reduction credit 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 in the Watershed. In order to earn this credit (Credit $_{\text{leaf litter}}$), the permittee must gather and remove all landscaping wastes, organic debris, and leaf litter from all impervious roadways and parking lots at least once per week during the period of September 1 to December 1 of each year. 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 $_{\text{leaf litter}}$ shall be determined by the following equation:

$Credit_{leaf\ litter}$ = (Watershed Area) x ($PLE_{IC\text{-}land\ use}$) x (0.05) **(Equation 2-4)**

<u>Where:</u>

$Credit_{leaf\ litter}$	= Amount of phosphorus load reduction credit for organic waste and leaf litter collection program (lbs/year)
Watershed Area	= All impervious area (acre) from which runoff discharges to the TMDL waterbody in the Watershed
$PLE_{IC\text{-}land\ use}$	= Phosphorus Load Export Rate for impervious cover and specified land use (lbs/acre/yr) (see Table 2-1)
0.05	= 5% phosphorus reduction factor for organic waste and leaf litter collection program in the Watershed

<u>Example 2-4: Calculation for organic waste and leaf litter collection program credit ($Credit_{leaf\ litter}$):</u> 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 $Credit_{leaf\ litter}$ is:

Watershed Area = 12.5; and
$PLE_{IC\text{-}commercial}$ = 1.8 lbs/acre/yr (from Table 2-1)

Substitution into equation 2-4 yields a $Credit_{leaf\ litter}$ of 1.1 pounds of phosphorus removed per year:

$Credit_{leaf\ litter}$ = (12.5 acre) x (1.8 lbs/acre/yr) x (0.05)
= 1.1 lbs/yr

The permittee also may earn a phosphorus reduction credit for enhanced sweeping of roads and parking lot areas (i.e., $Credit_{sweeping}$) for the three months of use. Using equation 2-1, $Credit_{sweeping}$ is:

$Credit_{sweeping}$ = IA_{swept} x $PLE_{IC\text{-}land\ use}$ x $PRF_{sweeping}$ **(Equation 2-1)**
IA_{swept} = 12.5 acre
$PLE_{IC\text{-}commercial}$ = 1.8 lbs/acre/yr (from Table 2-1)
$PRF_{sweeping}$ = 0.05 (from Table 2-2) x (3 months / 12 months)
= 0.0125

Substitution into equation 2-1 yields a $Credit_{sweeping}$ of 0.28 pounds of phosphorus removed per year.

$Credit_{sweeping}$ = IA_{swept} x $PLE_{IC\text{-}commercial}$ x $PRF_{sweeping}$
= 12.5 acre x 1.8 lbs/acre/yr x 0.0125
= 0.28 lbs/yr

(5) Elimination of Illicit Connections and Discharges: The permitee may earn a phosphorus reduction credit by eliminating illicit connections from discharging to the TMDL waterbody in the Watershed. In order to earn this credit ($Credit_{illicit}$), the permittee must provide documentation of how the discharge was disconnected and eliminated to the TMDL waterbody as part of the PCP. Only illicit connections that contain untreated wastewater are eligible for a phosphorus reduction credit. The $Credit_{illicit}$ shall be determined by using Equation 2-5, detailed below. The discharge flow is estimated using metered household water use, or can be estimated based on the number of occupants and an average water use of 60 gallons/day. The permittee may select an area specific average occupant water use for use in calculating the nitrogen reduction if the permittee documents the basis for deviating from 60 gal/day in their PCP.

$Credit_{illicit}$ = (Discharge flow) (Water use factor)x ($TP_{illicit}$) x (conversion factor)
(Equation 2-5)

Where:

$Credit_{illicit}$	= Amount of phosphorus load reduction credit for elimination of illicit discharge (lbs/year)
Discharge Flow	= Estimate of discharge flow (gallons/day)
Water use factor	=0.9 (assume 90% of water used goes to sanitary sewer)
$TP_{illicit}$	= 5.3 mg/L (phosphorus concentration in sewerage[1])
Conversion factor	= 0.00304 (factor to convert credit to lbs/day)

Example 2-5: Calculation for illicit disconnection credit ($Credit_{illicit}$): A permittee identifies an illicit connection from a single family home in the Watershed Area and works with the offending discharger to eliminate the illicit connection. The household has an average daily water use of 150 gallons/day.

Substitution into equation 2-5 yields a $Credit_{illicit}$ of 2.2 pounds of phosphorus removed per year:

$Credit_{illicit}$ = (150 gal/day) (0.9) x (5.3 mg/L) x (0.00304)
= 2.2 lbs/yr

Example 2-5a: Calculation for illicit disconnection credit when household water use is not known: A permittee identifies an illicit connection from a single family home in the Watershed Area and works with the offending discharger to eliminate the illicit connection. The household has 5 occupants.

Calculation of discharge flow:

Discharge Flow = (5 occupants) x (60 gallons per occupant/day)
= 300 gallons / day

[1]Heufelder, 2006, Evaluation of Methods to Control Phosphorus in Areas Served by Onsite Septic System, Environment Cape Cod.

Substitution into equation 2-5 yields a $Credit_{illicit}$ of 4.4 pounds of phosphorus removed per year:

$Credit_{illicit}$ = (300 gal/day) x (0.9) x (5.3 mg/L) x (0.00304)
= 4.4 lbs/yr

ATTACHMENT 3

ATTACHMENT 3 TO APPENDIX F

Methods to Calculate Phosphorus Load Reductions for Structural Storm Water Best Management Practices in the Watershed

This attachment provides methods to determine design storage volume capacities and to calculate phosphorus load reductions for the following structural Best Management Practices (structural BMPs) for a Watershed:

1) Infiltration Trench;
2) Infiltration Basin or other surface infiltration practice;
3) Bioretention Practice;
4) Gravel Wetland System;
5) Porous Pavement;
6) Wet Pond or wet detention basin;
7) Dry Pond or detention basin; and
8) Water Quality Swale.

Methods and examples are provided in this Attachment to calculate phosphorus load reductions for structural BMPs for the four following purposes:

1) To determine the design volume of a structural BMP to achieve a known phosphorus load reduction target when the contributing drainage area is 100% impervious;
2) To determine the phosphorus load reduction for a structural BMP with a known design volume when the contributing drainage area is 100% impervious;
3) To determine the design volume of a structural BMP to achieve a known phosphorus load reduction target when the contributing drainage area has impervious and pervious surfaces; and
4) To determine the phosphorus load reduction for a structural BMP with a known design volume when the contributing drainage area has impervious and pervious surfaces.

The methods and annual phosphorus export load 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. commercial and institutional). The estimates of annual phosphorus load and load reductions by BMPs are to demonstrate compliance with the permittee's Phosphorus Reduction Requirement under the permit.

For each structural BMP type identified above, long-term cumulative performance information is provided to calculate phosphorus load reductions or to determine needed design storage volumes to achieve a specified reduction target (e.g., 65% phosphorus load reduction). The performance information is expressed as cumulative phosphorus load removed (% removed) depending on the physical storage capacity of the structural BMP (expressed as inches of runoff from impervious area) and is provided at the end of this Attachment (see Tables 3-1 through 3-18 and performance curves Figures 3-1 through 3-17). Multiple tables and performance curves are provided for the infiltration practices to represent cumulative phosphorus load reduction performance for six infiltration rates (IR), 0.17, 0.27, 0.53, 1.02, 2.41, and 8.27 inches/hour. The permittee may use the performance curves provided in this attachment to interpolate phosphorus load removal reductions for field measured infiltration rates that are different than the infiltration rates used to develop the performance curves. Otherwise, the permittee shall use the performance curve for the IR that is nearest, but less than, the field measured rate.

EPA will consider phosphorus load reductions calculated using the methods provided below to be valid for the purpose of complying with the terms of this permit for BMPs that have not been explicitly modeled if the desired BMP has functionality that is similar to one of the simulated BMP types. Please note that only the surface infiltration and the infiltration trench BMP types were simulated to direct storm water runoff into the ground (i.e., infiltration). All of the other simulated BMPs represent practices that have either under-drains or impermeable liners and therefore, are not hydraulically connected to the sub-surface soils (i.e., no infiltration). Following are some simple guidelines for selecting the BMP type and/or determining whether the results of any of the BMP types provided are appropriate for another BMP of interest.

Infiltration Trench is a practice that provides temporary storage of runoff using the void spaces within the soil/sand/gravel mixture that is used to backfill the trench for subsequent infiltration into the surrounding sub-soils. Performance results for the infiltration trench can be used for all subsurface infiltration practices including systems that include pipes and/or chambers that provide temporary storage. Also, the results for this BMP type can be used for bio-retention systems that rely on infiltration when the majority of the temporary storage capacity is provided in the void spaces of the soil filter media and porous pavements that allow infiltration to occur.

Surface Infiltration represents a practice that provides temporary surface storage of runoff (e.g., ponding) for subsequent infiltration into the ground. Appropriate practices for use of the surface infiltration performance estimates include infiltration basins, infiltration swales, rain gardens and bio-retention systems that rely on infiltration and provide the majority of storage capacity through surface-ponding.

Bio-filtration is a practice that provides temporary storage of runoff for filtering through an engineered soil media. The storage capacity is typically made of void spaces in the filter media and temporary ponding at the surface of the practice. Once the runoff has passed through the filter media it is collected by an under-drain pipe for discharge. Depending on the design of the filter media manufactured or packaged bio-filter systems such as tree box filters may be suitable for using the bio-filtration performance results.

Gravel Wetland performance results should be used for practices that have been designed in accordance or share similar features with the design specifications for gravel wetland systems provided in the most recent version of *the New Hampshire Stormwater Manual* (http://des.nh.gov/organization/divisions/water/stormwater/manual.htm. Retrieved 12/14/12)

Porous Pavement performance results represent systems with an impermeable under-liner and an under-drain. *If porous pavement systems do not have an impermeable under-liner so that filtered runoff can infiltrate into sub-soils then the performance results for an infiltration trench may be used for these systems.*

Extended Dry Detention Pond performance results should only be used for practices that have been designed in accordance with the design specifications for extended dry detention ponds provided in the most recent version of *the New Hampshire Stormwater Manual* (http://des.nh.gov/organization/divisions/water/stormwater/manual.htm. Retrieved 12/14/12)

Water Quality Wet Swale performance results should only be used for practices that have been designed in accordance with the design specifications for a water quality wet swale provided in the most recent version of *the New Hampshire Stormwater Manual* (http://des.nh.gov/organization/divisions/water/stormwater/manual.htm. Retrieved 12/14/12)

Alternative Methods:

A permittee may propose alternative long-term cumulative performance information or alternative methods to calculate phosphorus load reductions for the structural BMPs identified above or for other structural BMPs not identified in this Attachment.

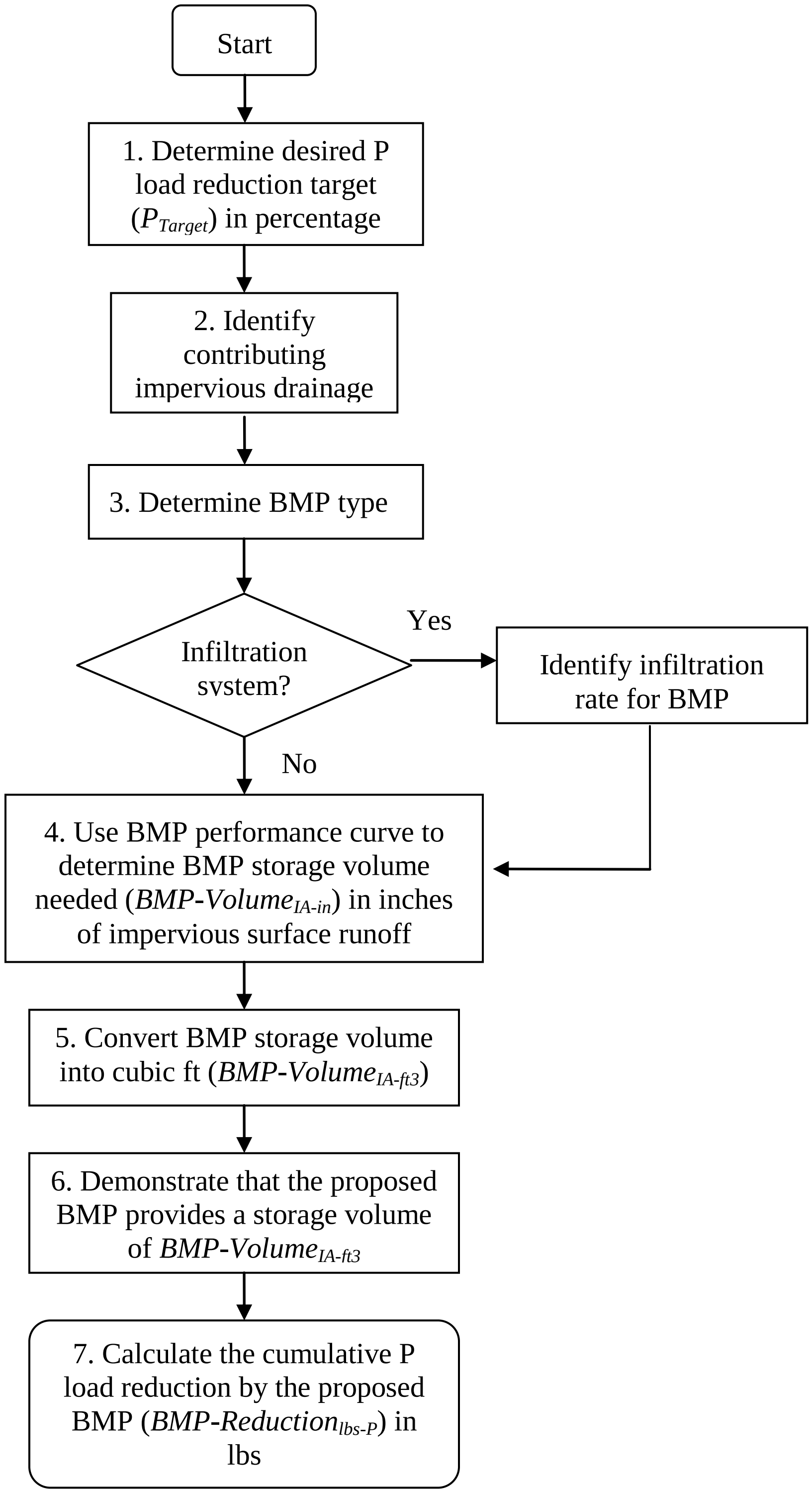
EPA will consider alternative long-term cumulative performance information and alternative methods to calculate phosphorus load reductions for structural BMPs provided that the permittee provides EPA with adequate supporting documentation. At a minimum, the supporting documentation shall include:

1) Results of continuous BMP model simulations representing the structural BMP, using a verified BMP model and representative long-term (i.e., 10 years) climatic data including hourly rainfall data;
2) Supporting calculations and model documentation that justify use of the model, model input parameters, and the resulting cumulative phosphorus load reduction estimate; and
3) Identification of references and sources of information that support the use of the alternative information and method.

If EPA determines that the long-term cumulative phosphorus load reductions developed based on alternative information are not adequately supported, EPA will notify the permittee in writing, and the permittee may receive no phosphorus reduction credit other than a reduction credit calculated by the permittee using the default phosphorus reduction factors provided in this attachment for the identified practices. The permittee is required to submit to EPA valid phosphorus load reductions for structural BMPs in the Watershed in accordance with the submission schedule requirements specified in the permit and Appendix F.

(1) Method to determine the design volume of a structural BMP to achieve a known phosphorus load reduction target when the contributing drainage area is 100% impervious:

Flow Chart 1 illustrates the steps to determine the design volume of a structural BMP to achieve a known phosphorus load reduction target when the contributing drainage area is 100% impervious.



Flow Chart 1. Method to determine BMP design volume to achieve a known phosphorous load reduction when contributing drainage area is 100% impervious.

1) Determine the desired cumulative phosphorus load reduction target (P_{target}) in percentage for the structural BMP;

2) Determine the contributing impervious drainage area (IA) in acres to the structural BMP;

3) Determine the structural BMP type (e.g., infiltration trench, gravel wetland). For infiltration systems, determine the appropriate infiltration rate for the location of the BMP in the Watershed;

4) Using the cumulative phosphorus removal performance curve for the selected structural BMP (Figures 3-1 through 3-18), determine the storage volume for the BMP (BMP-Volume $_{IA\text{-}in}$), in inches of runoff, needed to treat runoff from the contributing IA to achieve the reduction target;

5) Calculate the corresponding BMP storage volume in cubic feet (BMP-Volume $_{IA\text{-}ft^3}$) using BMP-Volume $_{IA\text{-}in}$ determined from step 4 and equation 3-1:

BMP-Volume $_{IA\text{-}ft^3}$ = IA (ac) x BMP-Volume $_{IA\text{-}in}$ x 3630 ft^3/ac-in **(Equation 3-1)**

6) Provide supporting calculations using the dimensions and specifications of the proposed structural BMP showing that the necessary storage volume, BMP-Volume $_{IA\text{-}ft^3}$, determined from step 5 will be provided to achieve the P_{Target}; and

7) Calculate the cumulative phosphorus load reduction in pounds of phosphorus (BMP-Reduction $_{lbs\text{-}P}$) for the structural BMP using the BMP Load (as calculated from the procedure in Attachment 1 to Appendix F) and P_{target} by using equation 3-2:

BMP-Reduction $_{lbs\text{-}P}$ = BMP Load x (P_{target} /100) **(Equation 3-2)**

Example 3-1: Determine design volume of a structural BMP with a 100% impervious drainage area to achieve a known phosphorus load reduction target:

A permittee is considering a surface infiltration practice to capture and treat runoff from 2.57 acres of impervious area that will achieve a 70% reduction in annual phosphorus load. The infiltration practice would be located adjacent to the impervious area. The permittee has measured an infiltration rate (IR) of 0.39 inches per hour (in/hr) in the vicinity of the proposed infiltration practice. Determine the:

A) Design storage volume needed for an surface infiltration practice to achieve a 70% reduction in annual phosphorus load from the contributing drainage area (BMP-Volume $_{IA\text{-}ft^3}$); and

B) Cumulative phosphorus reduction in pounds that would be accomplished by the BMP (BMP-Reduction $_{lbs\text{-}P}$)

Solution:

1) Contributing impervious drainages area (IA) = 2.57 acres

2) BMP type is a surface infiltration practice (i.e., basin) with an infiltration rate (IR) of 0.39 in/hr

3) Phosphorus load reduction target (P_{target}) = 70%

4) The performance curve for the infiltration basin (i.e., surface infiltration practice), Figure 3-8, IR = 0.27 in/hr is used to determine the design storage volume of the BMP (BMP-Volume $_{IA-in}$) needed to treat runoff from the contributing IA and achieve a P_{target} = 70%. The curve for an infiltration rate of 0.27 in/hr is chosen because 0.27 in/hr is the nearest simulated IR that is less than the field measured IR of 0.39 in/hr. From Figure 3-8, the BMP-Volume $_{IA-in}$ for a P_{target} = 70% is 0.36 in.

5) The BMP-Volume $_{IA-in}$ is converted to cubic feet (BMP-Volume $_{IA-ft^3}$) using Equation 3-1:

BMP-Volume $_{IA-ft^3}$ = IA (acre) x BMP-Volume $_{IA-in}$ x 3,630 ft^3/acre-in
BMP-Volume $_{IA-ft^3}$ = 2.57 acre x 0.36 in x 3,630 ft^3/acre-in
= **3,359 ft^3**

6) A narrow trapezoidal infiltration basin with the following characteristics is proposed to achieve the P_{Target} of 70%:

Length (ft)	Design Depth (ft)	Side Slopes	Bottom area (ft^2)	Pond surface area (ft^2)	Design Storage Volume (ft^3)
355	1.25	3:1	1,387	4,059	3,404

The volume of the proposed infiltration practice, 3,404 ft^3, exceeds the BMP-Volume $_{IA-ft^3}$ needed, 3,359 ft^3 and is sufficient to achieve the P Target of 70%.

7) The cumulative phosphorus load reduction in pounds of phosphorus for the infiltration practice (BMP-Reduction $_{lbs-P}$) is calculated using Equation 3-2. The BMP Load is first determined using the method in Attachment 1 to Appendix F.

BMP Load = IA x impervious cover phosphorus export loading rate for commercial use (see Table 1-1 from Attachment 1 to Appendix F)
= 2.57 acres x 1.8 lbs/acre/yr
= 4.63 lbs/yr

BMP-Reduction $_{lbs-P}$ = BMP Load x (P_{target} /100)
BMP-Reduction $_{lbs-P}$ = 4.63 lbs/yr x (70/100)
= **3.24 lbs/yr**

<u>Alternate Solution:</u> Alternatively, the permittee could determine the design storage volume needed for an IR = 0.39 in/hr by performing interpolation of the results from the surface infiltration performance curves for IR = 0.27 in/hr and IR = 0.52 in/hr as follows (replacing steps 3 and 4 on the previous page):

4 alternative) Using the performance curves for the infiltration basin (i.e., surface infiltration practice), Figures 3-8, IR = 0.27 in/hr and 3-9, IR = 0.52 in/hr, interpolate between the curves to determine the design storage volume of the BMP (BMP-Volume $_{IA\text{-}in}$) needed to treat runoff from the contributing IA and achieve a P $_{target}$ = 70%.

First calculate the interpolation adjustment factor (IAF) to interpolate between the infiltration basin performance curves for infiltration rates of 0.27 and 0.52 in/hr:

$$IAF = (0.39 - 0.27)/ (0.52 - 0.27) = 0.48$$

From the two performance curves, develop the following table to estimate the general magnitude of the needed storage volume for an infiltration swale with an IR = 0.39 in/hr and a P $_{target}$ of 70%.

Table Example 3-1. Interpolation Table for determining design storage volume of infiltration basin with IR = 0.39 in/hr and a phosphorus load reduction target of 70%.

BMP Storage Volume	% Phosphorus Load Reduction IR = 0.27 in/hr ($PR_{IR=0.27}$)	% Phosphorus Load Reduction IR = 0.52 in/hr ($PR_{IR=0.52}$)	Interpolated % Phosphorus Load Reduction IR = 0.39 in/hr ($PR_{IR=0.39}$) **$PR_{IR=0.39}$= IAF($PR_{IR=0.52}$ – $PR_{IR=0.27}$) + $PR_{IR=0.27}$**
0.3	64%	67%	65%
0.4	74%	77%	75%
0.5	79%	82%	80%

As indicated from Table Example 3-1, the BMP-Volume $_{IA\text{-}in}$ for $PR_{IR=0.39}$ of 70% is between 0.3 and 0.4 inches and can be determined by interpolation:

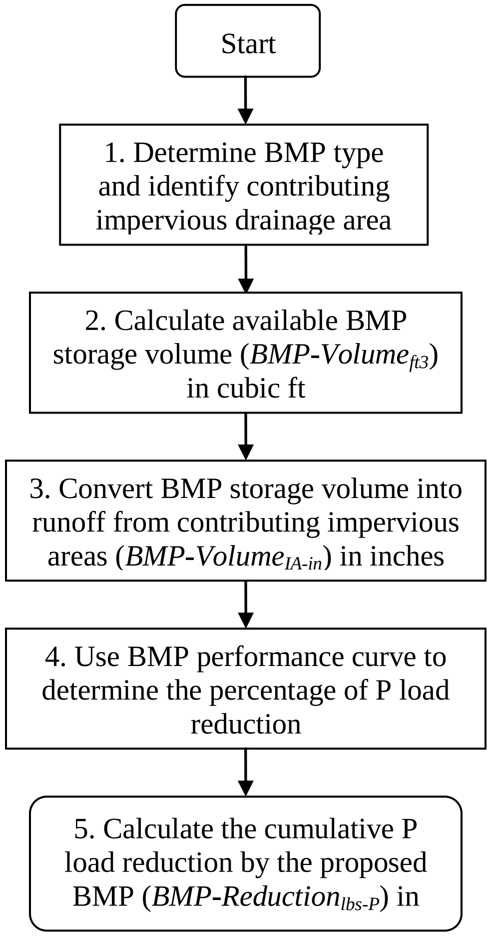
$$\text{BMP-Volume}_{IA\text{-}in} = (70\% - 65\%)/ (75\% - 65\%) \times (0.4 \text{ in} - 0.3 \text{ in}) + 0.3 \text{ in}$$
$$= 0.35 \text{ inches}$$

5 alternative) Convert the resulting BMP-Volume $_{IA\text{-}in}$ to cubic feet (BMP-Volume $_{IA\text{-}ft^3}$) using equation 3-1:

$$\text{BMP-Volume}_{IA\text{-}ft^3} = 2.57 \text{ acre} \times 0.35 \text{ in} \times 3{,}630 \text{ ft}^3/\text{acre-in}$$
$$= 3{,}265 \text{ ft}^3$$

(2) <u>Method to determine the phosphorus load reduction for a structural BMP with a known design volume when the contributing drainage area is 100% impervious:</u>

Flow Chart 2 illustrates the steps to determine the phosphorus load reduction for a structural BMP with a known design volume when the contributing drainage area is 100% impervious.



Flow Chart 2. Method to determine the phosphorus load reduction for a BMP with a known design volume when contributing drainage area is 100% impervious.

1) Identify the structural BMP type and contributing impervious drainage area (IA);

2) Document the available storage volume (ft^3) of the structural BMP (BMP-Volume $_{ft}{}^3$) using the BMP dimensions and design specifications (e.g., maximum storage depth, filter media porosity);

3) Convert BMP-Volume $_{ft}{}^3$ into inches of runoff from the contributing impervious area (BMP-Volume $_{IA\text{-}in}$) using equation 3-3:

BMP-Volume $_{IA\text{-}in}$ = BMP-Volume $_{ft}{}^3$/ IA (acre) x 12 in/ft x 1 acre/43560 ft^2
(Equation 3-3)

4) Determine the % phosphorus load reduction for the structural BMP (BMP Reduction $_{\%\text{-P}}$) using the appropriate BMP performance curve (Figures 3-1 through 3-18) and the BMP-Volume $_{\text{IA-in}}$ calculated in step 3; and

5) Calculate the cumulative phosphorus load reduction in pounds of phosphorus for the structural BMP (BMP Reduction $_{\text{lbs-P}}$) using the BMP Load as calculated from the procedure in Attachment 1 to Appendix F and the percent phosphorus load reduction (BMP Reduction $_{\%\text{-P}}$) determined in step 4 by using equation 3-4:

BMP Reduction $_{\text{lbs-P}}$ = BMP Load x (BMP Reduction $_{\%\text{-P}}$/100) **(Equation 3-4)**

Example 3-2: Determine the phosphorus load reduction for a structural BMP with a known storage volume capacity when the contributing drainage area is 100% impervious:

A permittee is considering a bioretention system to treat runoff from 1.49 acres of impervious area. Site constraints would limit the bioretention system to have a surface area of 1200 ft^2 and the system would have to be located next to the impervious drainage area to be treated. The design parameters for the bioretention system are presented in Table Example 3-2.

Table Example 3-2. Design parameters for bioretention system for Example 3-2

Components of representation	Parameters	Value
Ponding	Maximum depth	6 in
	Surface area	1200 ft^2
	Vegetative parameter[a]	85-95%
Soil mix	Depth	30 in
	Porosity	40%
	Hydraulic conductivity	4 inches/hour
Gravel layer	Depth	8 in
	Porosity	40%
	Hydraulic conductivity	14 inches/hour
Orifice #1	Diameter	6 in

[a] Refers to the percentage of surface covered with vegetation

Determine the:

A) Percent phosphorus load reduction (BMP Reduction $_{\%\text{-P}}$) for the specified bioretenion system and contributing impervious drainage area; and

B) Cumulative phosphorus reduction in pounds that would be accomplished by the bioretention system (BMP-Reduction $_{\text{lbs-P}}$)

Solution:

1) The BMP is a bioretention system that will treat runoff from 1.49 acres of impervious area (IA = 1.49 acre);

2) The available storage volume capacity (ft^3) of the bioretention system (BMP-Volume $_{\text{BMP-ft}^3}$) is determined using the surface area of the system, depth of ponding, and the porosity of the filter media:

Solution continued:

BMP-Volume $_{BMP\text{-}ft^3}$ = (surface area x pond maximum depth) + ((soil mix depth + gravel layer depth)/12 in/ft) x surface area x gravel layer porosity)
= (1,200 ft^2 x 0.5 ft) + ((38/12) x 1,200 ft^2 x 0.4)
= 2,120 ft^3

3) The available storage volume capacity of the bioretention system in inches of runoff from the contributing impervious area (BMP-Volume $_{IA\text{-}in}$) is calculated using equation 3-3:

BMP-Volume $_{IA\text{-}in}$ = (BMP-Volume $_{ft^3}$/ IA (acre) x 12 in/ft x 1 acre/43560 ft^2
BMP-Volume $_{IA\text{-}in}$ = (2120 ft^3/1.49 acre) x 12 in/ft x 1 acre/43560 ft^2
= 0.39 in

4) Using the bioretention performance curve shown in Figure 3-13, a **51%** phosphorus load reduction (BMP Reduction %-P) is determined for a bioretention system sized for 0.39 in of runoff from 1.49 acres of impervious area; and

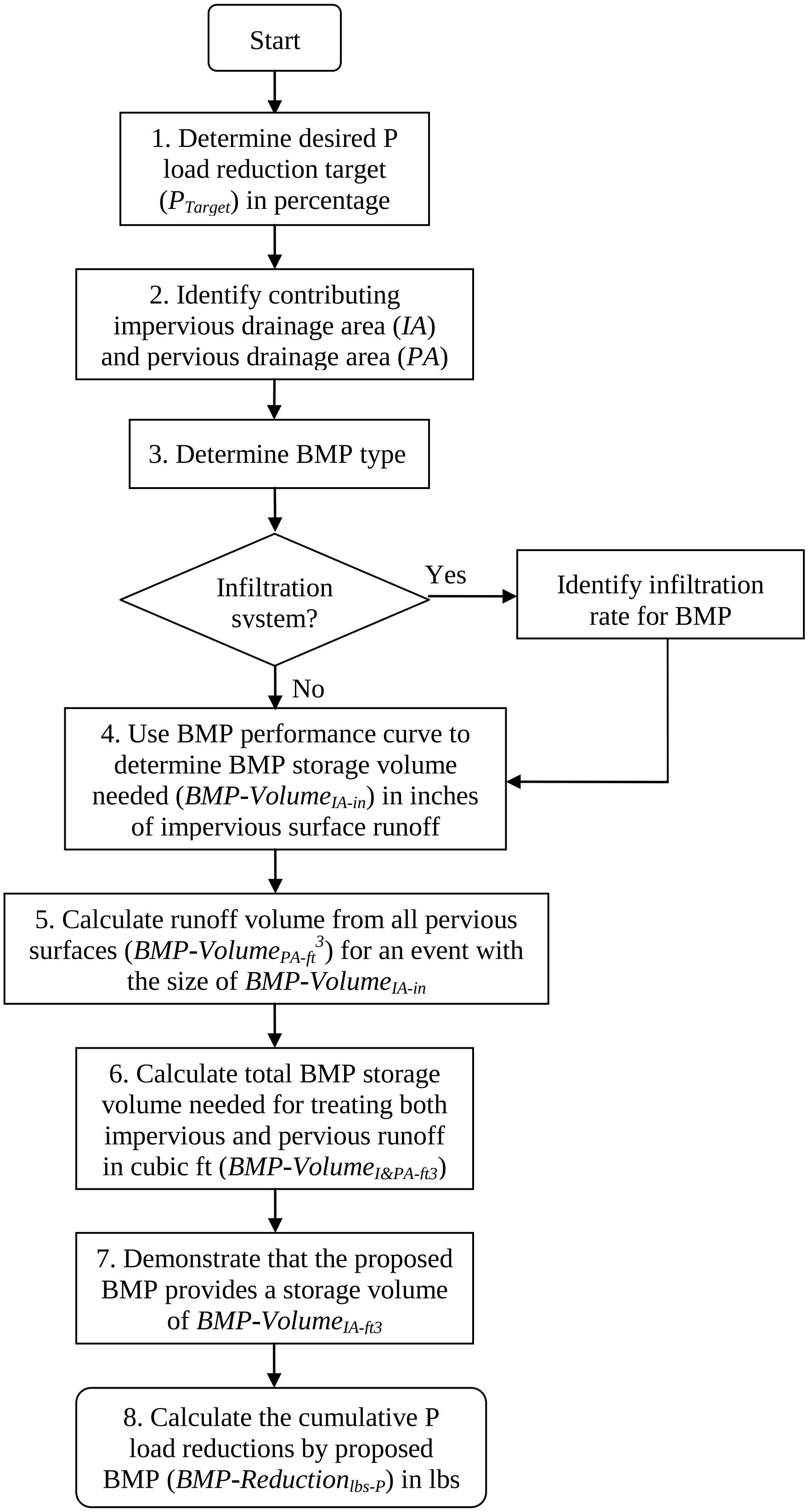
5) Calculate the cumulative phosphorus load reduction in pounds of phosphorus for the bioretention system (BMP Reduction $_{lbs\text{-}P}$) using the BMP Load as calculated from the procedure in Attachment 1 to Appendix F and the BMP Reduction $_{\%\text{-}P}$ determined in step 4 by using equation 3-4. First, the BMP Load is determined as specified in Attachment 1:

BMP Load = IA (acre) x impervious cover phosphorus export loading rate for industrial use (see Table 1-1 from Attachment 1 to Appendix F)
= 1.49 acres x 1.8 lbs/acre/yr
= 2.68 lbs/yr

BMP Reduction $_{lbs\text{-}P}$ = BMP Load x (BMP Reduction $_{\%\text{-}P}$/100)
BMP Reduction $_{lbs\text{-}P}$ = 2.68 lbs/yr x (51/100)
= **1.37 lbs/yr**

(3) Method to determine the design storage volume of a structural BMP to achieve a known phosphorus load reduction target when the contributing drainage area has impervious and pervious surfaces:

Flow Chart 3 illustrates the steps to determine the design storage volume of a structural BMP to achieve a known phosphorus load reduction target when the contributing drainage area has impervious and pervious surfaces.



Flow Chart 3. Method to determine the design storage volume of a BMP to reach a known P load reduction when both impervious and pervious drainage areas are present.

1) Determine the desired cumulative phosphorus load reduction target (P_{target}) in percentage for the structural BMP;

2) Characterize the contributing drainage area to the structural BMP by identifying the following information for the impervious and pervious surfaces:

Impervious area (IA) - Area (acre) and land use (e.g., commercial)

Pervious area (PA) – Area (acre) and runoff depths based on hydrologic soil group (HSG) and rainfall depth. Table 3-3-1 provides values of runoff depth from pervious areas for various rainfall depths and HSGs. Soils are assigned to an HSG on the basis of their permeability. HSG A is the most permeable, and HSG D is the least permeable. HSG categories for pervious areas in the Watershed shall be estimated by consulting local soil surveys prepared by the National Resource Conservation Service (NRCS) or by a storm water professional evaluating soil testing results from the Watershed. If the HSG condition is not known, a HSG D soil condition should be assumed.

Table 3-3-1. Developed Land Pervious Area Runoff Depths based on Precipitation depth and Hydrological Soil Groups (HSGs)

Rainfall Depth, Inches	Runoff Depth, inches		
	Pervious HSG A/B	Pervious HSG C	Pervious HSG D
0.10	0.00	0.00	0.00
0.20	0.00	0.01	0.02
0.40	0.00	0.03	0.06
0.50	0.00	0.05	0.09
0.60	0.01	0.06	0.11
0.80	0.02	0.09	0.16
1.00	0.03	0.12	0.21
1.20	0.04	0.14	0.39
1.50	0.11	0.39	0.72
2.00	0.24	0.69	1.08

Notes: Runoff depths derived from combination of volumetric runoff coefficients from Table 5 of *Small Storm Hydrology and Why it is Important for the Design of Stormwater Control Practices*, Pitt, 1999 and using the Stormwater Management Model (SWMM) in continuous model mode for hourly precipitation data for Boston, MA, 1998-2002.

C) Determine the structural BMP type (e.g., infiltration trench, gravel wetland). For infiltration systems, determine the appropriate infiltration rate for the location of the BMP in the Watershed.

D) Using the cumulative phosphorus removal performance curve for the selected structural BMP, determine the storage volume capacity of the BMP in inches needed to treat runoff from the contributing impervious area (BMP-Volume $_{IA-in}$);

E) Using Equation 3-5 below and the pervious area runoff depth information from Table 3-3-1, determine the total volume of runoff from the contributing pervious drainage area in cubic feet (BMP Volume $_{PA-ft^3}$) for a rainfall size equal to the sum of BMP Volume $_{IA-in}$, determined in step 4. The runoff volume for each distinct pervious area must be determined.

BMP-Volume $_{PA\ ft^3} = \sum$ (PA x (runoff depth) x 3,630 ft^3/acre-in)$_{(PA1,\ldots PAn)}$ **(Equation 3-5)**

F) Using equation 3-6 below, calculate the BMP storage volume in cubic feet (BMP-Volume $_{IA\&PA-ft^3}$) needed to treat the runoff depth from the contributing impervious (IA) and pervious areas (PA).

BMP-Volume $_{IA\&PA-ft^3}$ = BMP Volume $_{PA-ft^3}$ + (BMP Volume $_{IA-in}$ x IA (acre) x 3,630 ft^3/acre-in) **(Equation 3-6)**

G) Provide supporting calculations using the dimensions and specifications of the proposed structural BMP showing that the necessary storage volume determined in step 6, BMP- Volume $_{I\&PA-ft^3}$, will be provided to achieve the P $_{Target}$; and

H) Calculate the cumulative phosphorus load reduction in pounds of phosphorus (BMP-Reduction $_{lbs-P}$) for the structural BMP using the BMP Load (as calculated from the procedure in Attachment 1 to Appendix F) and the P $_{target}$ by using equation 3-2:

BMP-Reduction $_{lbs-P}$ = BMP Load x (P $_{target}$ /100) **(Equation 3-2)**

Example 3-3: Determine the design storage volume of a structural BMP to achieve a known phosphorus load reduction target when the contributing drainage area has impervious and pervious surfaces

A permittee is considering a gravel wetland system to treat runoff from a high-density residential site. The site is 7.50 acres of which 4.00 acres are impervious surfaces and 3.50 acres are pervious surfaces. The pervious area is made up of 2.5 acres of lawns in good condition surrounding cluster housing units and 1.00 acre of stable unmanaged woodland. Soils information indicates that all of the woodland and 0.50 acres of the lawn is hydrologic soil group (HSG) B and the other 2.00 acres of lawn are HSG C. The permittee wants to size the gravel wetland system to achieve a cumulative phosphorus load reduction (P $_{Target}$) of 55% from the entire 7.50 acres. Determine the:

A) Design storage volume needed for a gravel wetland system to achieve a 55% reduction in annual phosphorus load from the contributing drainage area (BMP-Volume $_{IA\&PA-ft^3}$); and

B) Cumulative phosphorus reduction in pounds that would be accomplished by the BMP (BMP-Reduction $_{lbs-P}$)

.

Solution:

1) The BMP type is gravel wetland system.

2) The phosphorus load reduction target (P $_{Target}$) = 55%.

Solution continued:

3) Using the cumulative phosphorus removal performance curve for the gravel wetland system shown in Figure 3-14, the storage volume capacity in inches needed to treat runoff from the contributing impervious area (BMP Volume $_{IA-in}$) is 0.71 in;

4) Using equation 3-5 and the pervious runoff depth information from Table 3-3-1, the volume of runoff from the contributing pervious drainage area in cubic feet (BMP Volume $_{PA-ft^3}$) for a rainfall size equal to 0.71 in is summarized in Table Example 3-3-B.

As indicated from Table 3-3-1, the runoff depth for a rainfall size equal to 0.71 inches is between 0.6 and 0.8 inches and can be determined by interpolation (example shown for runoff depth of HSG C):

Runoff depth (HSG C) = (0.71 – 0.6)/(0.8 – 0.6) x (0.09 in – 0.06 in) + 0.06 in
= 0.07 inches

Table Example 3-3-B. Runoff contributions from pervious areas for high density residential site

ID	Type	Pervious Area (acre)	HSG	Runoff (in)	Runoff = (runoff) x PA (acre-in)	Runoff = Runoff (acre-in) x 3630 ft^3/acre-in (ft^3)
PA1	Grass	2.00	C	0.07	0.14	508
PA2	Grass	0.50	B	0.01	0.0	0.0
PA3	Woods	1.00	B	0.01	0.0	0.0
Total	-----	**3.50**	-----	-----	**0.14**	**508**

5) Using equation 3-6, determine the BMP storage volume in cubic feet (BMP-Volume $_{IA\&PA-ft^3}$) needed to treat 0.71 inches of runoff from the contributing impervious area (IA) and the runoff of 0.14 acre-in from the contributing pervious areas, determined in step 5 is:

BMP Volume$_{IA\&PA-ft^3}$ = BMP Volume $_{PA\ ac-in}$ + (BMP Volume $_{IA-in}$ x IA (acre)) x 3,630 ft^3/acre-in)
BMP Volume$_{IA\&PA-ft^3}$ = (508 ft^3+ (0.71 in x 4.00 acre)) x 3,630 ft^3/acre-in
= 10,817 ft^3

6) Table Example 3-3-C provides design details for of a potential gravel wetland system (based on Volume 2, Chapter 4 of the New Hampshire Stormwater Manual).

Solution continued:

Table Example 3-3-C. Design details for gravel wetland system

Gravel Wetland System Components	Design Detail	Depth (ft)	Surface Area (ft^2)	Volume (ft^3)
Sediment Forebay	**10% of Treatment Volume**			
Pond area	----	1.33	896	1,192
Wetland Cell #1	**45% of Treatment Volume**	---------------	-------------------	---------------
Pond area	----	2.00	1,914	3,828
Gravel layer	porosity = 0.4	2.00	1,914	1,531
Wetland Cell #2	**45% of Treatment Volume**	---------------	------------------	---------------
Pond area	----	2.00	1,914	3,828
Gravel layer	porosity = 0.4	2.00	1,914	1,531

The total design storage volume for the proposed gravel wetland system identified in Table Example 3-3-C is 11,910 ft^3. This volume is greater than 11,834 ft^3 ((BMP-Volume $_{IA\&PA-ft^3}$), calculated in step 6) and is therefore sufficient to achieve a P $_{Target}$ of 55%.

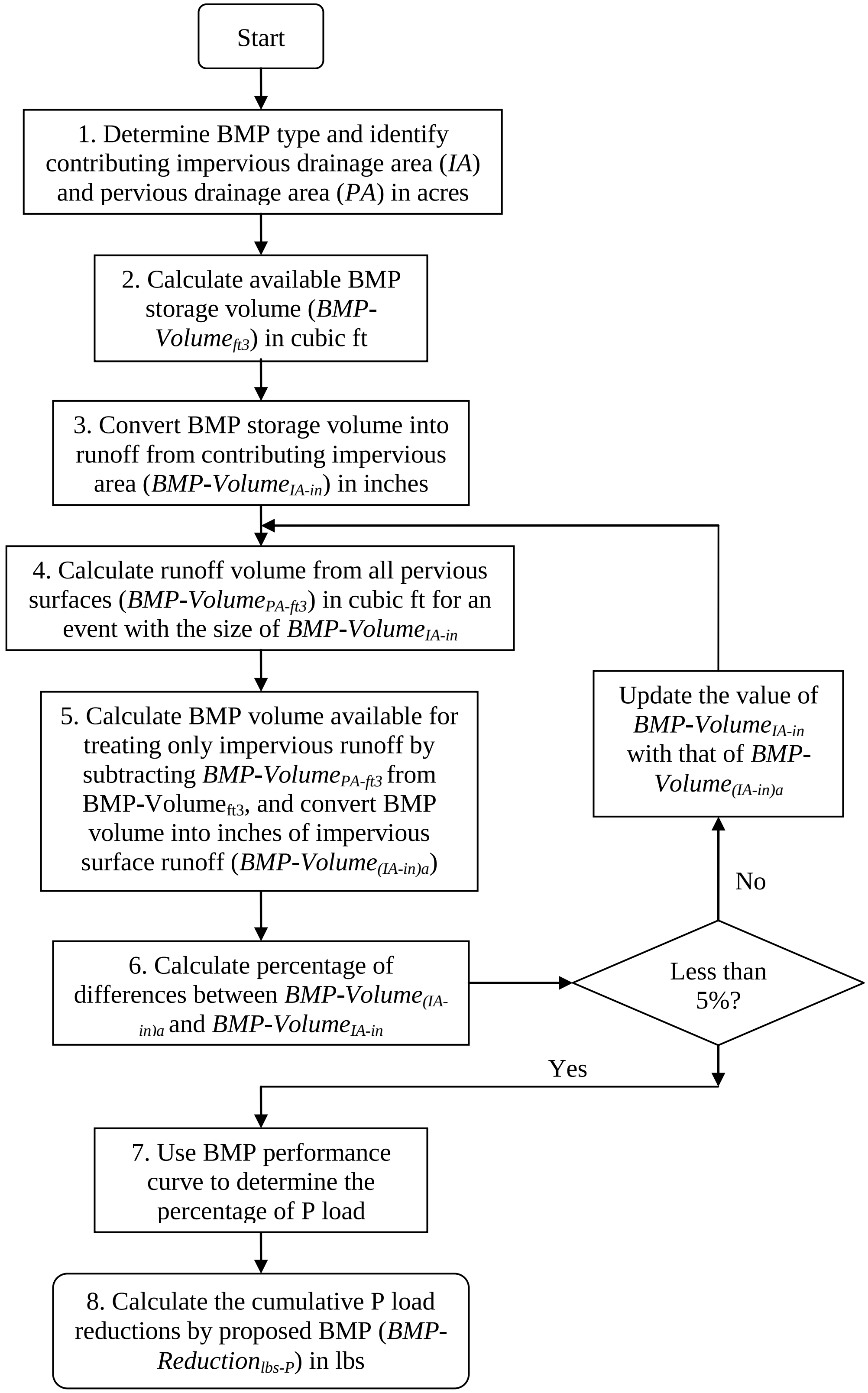
7) The cumulative phosphorus load reduction in pounds of phosphorus (BMP-Reduction $_{lbs-P}$) for the proposed gravel wetland system is calculated by using equation 3-2 with the BMP Load (as determined by the procedure in Attachment 1 to Appendix F) and the P $_{target}$ = 55%.

BMP-Reduction $_{lbs-P}$ = BMP Load x (P $_{target}$ /100) (**Equation 3-2**)

Using Table 1-1 from Attachment 1 to Appendix F, the BMP Load is calculated:
BMP Load = (IA x impervious cover phosphorus export loading rate for HDR)
+ (PA $_{HSG\ B}$ x pervious cover phosphorus export loading rate for HSG B)
+ (PA $_{HSG\ C}$ x pervious cover phosphorus export loading rate for HSG C)
= (4.00 acre x 2.3 lbs/acre/yr) + (1.50 acre x 0.2 lbs/acre/yr) + (2.00 acre x 0.5 lbs/acre/yr)
= 9.69 lbs/yr
BMP-Reduction $_{lbs-P}$ = BMP Load x (P $_{target}$ /100)
BMP-Reduction $_{lbs-P}$ = 10.5 lbs/yr x 55/100
= **5.78 lbs**

(4) Method to determine the phosphorus load reduction for a structural BMP with a known storage volume when the contributing drainage area has impervious and pervious surfaces:

Flow Chart 4 illustrates the steps to determine the phosphorus load reduction for a structural BMP with a known storage volume when the contributing drainage area has impervious and pervious surfaces.



Flow Chart 4. Method to determine the phosphorus load reduction for a BMP with known storage volume when both pervious and impervious drainage areas are present.

1) Identify the type of structural BMP and characterize the contributing drainage area to the structural BMP by identifying the following information for the impervious and pervious surfaces:

Impervious area (IA) – Area (acre) and land use (e.g., commercial)

Pervious area (PA) – Area (acre) and runoff depth based on hydrologic soil group (HSG) and size of rainfall event. Table 3-3-1 provides values of runoff depth for various rainfall depths and HSGs. Soils are assigned to an HSG based on their permeability. HSG categories for pervious areas in the Watershed shall be estimated by consulting local soil surveys prepared by the National Resource Conservation Service (NRCS) or by a storm water professional evaluating soil testing results from the Watershed. If the HSG condition is not known, a HSG D soil condition should be assumed.

2) Determine the available storage volume (ft^3) of the structural BMP (BMP-Volume $_{ft^3}$) using the BMP dimensions and design specifications (e.g., maximum storage depth, filter media porosity);

3) To estimate the phosphorus load reduction of a BMP with a known storage volume capacity, it is first necessary to determine the portion of available BMP storage capacity (BMP-Volume $_{ft^3}$) that would treat the runoff volume generated from the contributing impervious area (IA) for a rainfall event with a depth of *i* inches (in). This will require knowing the corresponding amount of runoff volume that would be generated from the contributing pervious area (PA) for the same rainfall event (depth of *i* inches). Using equation 3-6a below, solve for the BMP capacity that would be available to treat runoff from the contributing imperious area for the unknown rainfall depth of *i* inches (see equation 3-6b):

$$\text{BMP-Volume}_{ft^3} = \text{BMP-Volume}_{(IA\text{-}ft^3)i} + \text{BMP-Volume}_{(PA\text{-}ft^3)i}$$ **(Equation 3-6a)**

Where:

BMP-Volume $_{ft^3}$	=	the available storage volume of the BMP
BMP-Volume $_{(IA\text{-}ft^3)i}$	=	the available storage volume of the BMP that would fully treat runoff generated from the contributing impervious area for a rainfall event of size *i* inches
BMP-Volume $_{(PA\text{-}ft^3)i}$	=	the available storage volume of the BMP that would fully treat runoff generated from the contributing pervious area for a rainfall event of size *i* inches

Solving for BMP-Volume $_{(IA\text{-}ft^3)i}$:

$$\text{BMP-Volume}_{(IA\text{-}ft^3)i} = \text{BMP-Volume}_{ft^3} - \text{BMP-Volume}_{(PA\text{-}ft^3)i}$$ **(Equation 3-6b)**

To determine BMP-Volume $_{(IA\text{-}ft^3)i}$, requires performing an iterative process of refining estimates of the rainfall depth used to calculate runoff volumes until the rainfall depth used results in the sum of runoff volumes from the contributing IA and PA equaling the available BMP storage capacity (BMP-Volume $_{ft}{}^3$). For the purpose of estimating BMP performance, it will be considered adequate when the IA runoff depth (in) is within 5% IA runoff depth used in the previous iteration.

For the first iteration (1), convert the BMP-Volume $_{ft}{}^3$ determined in step 2 into inches of runoff from the contributing impervious area (BMP Volume $_{(IA\text{-}in)1}$) using equation 3-7a.

BMP-Volume $_{(IA\text{-}in)1}$ = (BMP-Volume$_{ft}{}^3$/ IA (acre)) x (12 in/ft /43,560 ft^2/acre) **(Equation 3-7a)**;

For iterations 2 through n (2…n), convert the BMP Volume $_{(IA\text{-}ft}{}^3{}_{)2...n}$, determined in step 5a below, into inches of runoff from the contributing impervious area (BMP Volume $_{(IA\text{-}in)2\ldots n}$) using equation 3-7b.

BMP-Volume $_{(IA\text{-}in)2...n}$ = (BMP-Volume $_{(IA\text{-}ft}{}^3{}_{)2...n}$ / IA (acre)) x (12 in/ft /43,560 ft^2/acre) **(Equation 3-7b)**;

4) For 1 to n iterations, use the pervious runoff depth information from Table 3-3-1 and equation 3-8 to determine the total volume of runoff (ft^3) from the contributing PA (BMP Volume $_{PA\text{-}ft}{}^3$) for a rainfall size equal to the sum of BMP-Volume $_{(IA\text{-}in)1}$, determined in step 3. The runoff volume for each distinct pervious area must be determined.

BMP Volume $_{(PA\text{-}ft}{}^3{}_{)1...n}$ = ∑ ((PA x (runoff depth)$_{(PA1,\ PA2..PAn)}$ x (3,630 ft^3/acre-in) **(Equation 3-8)**

5) For iteration 1, estimate the portion of BMP Volume that is available to treat runoff from only the IA by subtracting BMP-Volume $_{PA\text{-}ft}{}^3$, determined in step 4, from BMP-Volume $_{ft}{}^3$, determined in step 2, and convert to inches of runoff from IA (see equations 3-9a and 3-9b):

BMP-Volume $_{(IA\text{-}ft}{}^3{}_{)2}$ = ((BMP-Volume$_{ft}{}^3$- BMP Volume $_{(PA\text{-}ft}{}^3{}_{)1}$) **(Equation 3-9a)**

BMP-Volume $_{(IA\text{-}in)2}$ = (BMP-Volume $_{(IA\text{-}ft}{}^3{}_{)2}$/IA (acre)) x (12 in/ft x 1 acre/43,560 ft^2) **(Equation 3-9b)**

If additional iterations (i.e., 2 through n) are needed, estimate the portion of BMP volume that is available to treat runoff from only the IA (BMP-Volume $_{(IA\text{-}in)3..n+1}$) by subtracting BMP Volume $_{(PA\text{-}ft}{}^3{}_{)2..n}$, determined in step 4, from BMP Volume $_{(IA\text{-}ft}{}^3{}_{)3..n+1}$, determined in step 5, and by converting to inches of runoff from IA using equation 3-9b):

6) For iteration a (an iteration between 1 and n+1), compare BMP Volume $_{(IA\text{-}in)a}$ to BMP Volume $_{(IA\text{-}in)a\text{-}1}$ determined from the previous iteration (a-1). If the difference in these values is greater than 5% of BMP Volume $_{(IA\text{-}in)a}$ then repeat steps 4 and 5, using BMP Volume $_{(IA\text{-}in)a}$ as the new starting value for the next iteration (a+1). If the difference is less than or equal to 5 % of BMP Volume $_{(IA\text{-}in)a}$ then the permittee may proceed to step 7.

7) Determine the % phosphorus load reduction for the structural BMP (BMP Reduction $_{\%\text{-P}}$) using the appropriate BMP performance curve and the BMP-Volume $_{(IA\text{-}in)n}$ calculated in the final iteration of step 5; and

8) Calculate the cumulative phosphorus load reduction in pounds of phosphorus for the structural BMP (BMP Reduction $_{lbs\text{-}P}$) using the BMP Load as calculated from the procedure in Attachment 1 to Appendix F and the percent phosphorus load reduction (BMP Reduction $_{\%\text{-P}}$) determined in step 7 by using equation 3-4:

BMP Reduction $_{lbs\text{-}P}$ = BMP Load x (BMP Reduction $_{\%\text{-P}}$/100) **(Equation 3-4)**

Example 3-4: Determine the phosphorus load reduction for a structural BMP with a known design volume when the contributing drainage area has impervious and pervious surfaces

A permittee is considering an infiltration basin to capture and treat runoff from a portion of the Watershed draining to the impaired waterbody. The contributing drainage area is 16.55 acres and is 71% impervious. The pervious drainage area (PA) is 80% HSG D and 20% HSG C. An infiltration basin with the following specifications can be placed at the down-gradient end of the contributing drainage area where soil testing results indicates an infiltration rate (IR) of 0.28 in/hr:

Structure	Bottom area (acre)	Top surface area (acre)	Maximum pond depth (ft)	Design storage volume (ft^3)	Infiltration Rate (in/hr)
Infiltration basin	0.65	0.69	1.65	48,155	0.28

Determine the:

A) Percent phosphorus load reduction (BMP Reduction $_{\%\text{-P}}$) for the specified infiltration basin and the contributing impervious and pervious drainage area; and

B) Cumulative phosphorus reduction in pounds that would be accomplished by the BMP (BMP-Reduction $_{lbs\text{-}P}$)

Solution:

1) A surface infiltration basin is being considered. Information for the contributing impervious (IA) and pervious (PA) areas are summarized in Tables Example 3-4-A and Example 3-4-B, respectively.

Table Example 3-4-A Impervious area characteristics

ID	Land use	Area (acre)
IA1	Industrial	11.75

Table Example 3-4-B Pervious area characteristics

ID	Area (acre)	Hydrologic Soil Group (HSG)
PA1	3.84	D
PA2	0.96	C

Solution continued:

2) The available storage volume (ft^3) of the infiltration basin (BMP-Volume $_{ft}{}^3$) is determined from the design details and basin dimensions; BMP-Volume $_{ft}{}^3$ = 48,155 ft^3.

3) To determine what the BMP design storage volume is in terms of runoff depth (in) from IA, an iterative process is undertaken:

Solution Iteration 1

For the first iteration (1), the BMP-Volume$_{ft}{}^3$ is converted into inches of runoff from the contributing impervious area (BMP Volume $_{(IA\text{-}in)1}$) using equation 3-5a.

BMP Volume $_{(IA\text{-}in)1}$ = (48,155 ft^2/ 11.75 acre) x (12 in/ft /43,560 ft^2/acre)
= 1.13 in

4-1) The total volume of runoff (ft^3) from the contributing PA (BMP Volume $_{PA\text{-}ft}{}^3$) for a rainfall size equal to the sum of BMP Volume $_{(IA\text{-}in)1}$ determined in step 3 is determined for each distinct pervious area identified in Table Example 3-4-B using the information from Table 3-3-1 and equation 3-5. Interpolation was used to determine runoff depths.

BMP Volume $_{(PA\text{-}ft}{}^3{}_{)1}$ = ((3.84 acre x (0.33 in) + (0.96 acre x (0.13 in)) x 3,630 ft^3/acre-in
= 5052 ft^3

5-1) For iteration 1, the portion of BMP Volume that is available to treat runoff from only the IA is estimated by subtracting the BMP Volume $_{(PA\text{-}ft}{}^3{}_{)1}$, determined in step 4-1, from BMP Volume$_{ft}{}^3$, determined in step 2, and converted to inches of runoff from IA:

BMP Volume $_{(IA\text{-}ft}{}^3{}_{)\,2}$ = 48,155 ft^3 – 5052 ft^3
= 43,103 ft^3

BMP Volume $_{(IA\text{-}in)\,2}$ = (43,103 ft^3/11.75 acre) x (12 in/ft x 1 acre/43,560 ft^2)
= 1.01 in

6-1) The % difference between BMP Volume $_{(IA\text{-}in)\,2}$, 1.01 in, and BMP Volume $_{(IA\text{-}in)1}$, 1.13 in is determined and found to be significantly greater than 5%:

% Difference = ((1.13 in – 1.01 in)/1.01 in) x 100
= 12%

Therefore, steps 4 through 6 are repeated starting with BMP Volume $_{(IA\text{-}in)\,2}$ = 1.01 in.

Solution Iteration 2

4-2) BMP-Volume $_{(PA\text{-}ft}{}^3{}_{)2}$ = ((3.84 acre x 0.21 in) + (0.96 acre x 0.12 in)) x 3,630 ft^3/acre-in
= 3,358 ft^3

5-2) BMP-Volume $_{(IA\text{-}ft}{}^3{}_{)\,3}$ = 48,155 ft^3 – 3,358 ft^3
= 44,797 ft^3

BMP-Volume $_{(IA\text{-}in)\,3}$ = (44,797 ft^3/11.75 acre) x (12 in/ft x 1 acre/43,560 ft^2)
= 1.05 in

Solution continued:

6-2) % Difference = ((1.05 in – 1.01 in)/1.05 in) x 100
= 4%

The difference of 4% is acceptable.

7) The % phosphorus load reduction for the infiltration basin (BMP Reduction $_{\%\text{-P}}$) is determined by using the infiltration basin performance curve for an infiltration rate of 0.27 in/hr and the treatment volume (BMP-Volume $_{\text{Net IA-in}}$ = 1.05 in) calculated in step 5-2 and is **BMP Reduction $_{\%\text{-P}}$ = 93%**.

The performance curve for IR = 0.27 is used rather than interpolating between the performance curves for IR = 0.27 in/hr and 0.52 in/hr to estimate performance for IR = 0.28 in/hr. An evaluation of the performance curves for IR = 0.27 in/hr and IR = 0.52 in/hr for a design storage volume of 1.05 in indicate a small difference in estimated performance (BMP Reduction $_{\%\text{-P}}$ = 93% for IR = 0.27 in/hr and BMP Reduction $_{\%\text{-P}}$ = 95% for IR = 0.52 in/hr).

8) The cumulative phosphorus load reduction in pounds of phosphorus (BMP-Reduction $_{\text{lbs-P}}$) for the proposed infiltration basin is calculated by using equation 3-2 with the BMP Load (as determined by the procedure in Attachment 1 to Appendix F) and the P $_{\text{target}}$ of 93%.

BMP-Reduction $_{\text{lbs-P}}$ = BMP Load x (P $_{\text{target}}$ /100) **(Equation 3-2)**

Using Table 1-1 from Attachment 1, the BMP load is calculated:

BMP Load = (IA x impervious cover phosphorus export loading rate for industrial)
+ (PA $_{\text{HSG D}}$ x pervious cover phosphorus export loading rate for HSG D)
+ (PA $_{\text{HSG C}}$ x pervious cover phosphorus export loading rate for HSG C)
= (11.75 acre x 1.8 lbs/acre/yr) + (3.84 acre x 0.7 lbs/acre/yr)
+ (0.96 acre x 0.4 lbs/acre/yr)
= 24.22 lbs/yr

BMP-Reduction $_{\text{lbs-P}}$ = 24.22 lbs/yr x 93/100 = **22.52 lbs**

Table 3-1

Infiltration Trench (IR = 0.17 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	14.7%	27.6%	48.6%	64.1%	74.9%	82.0%	91.6%	95.4%
Cumulative Phosphorus Load Reduction	18%	33%	57%	73%	83%	90%	97%	99%

Figure 3-1

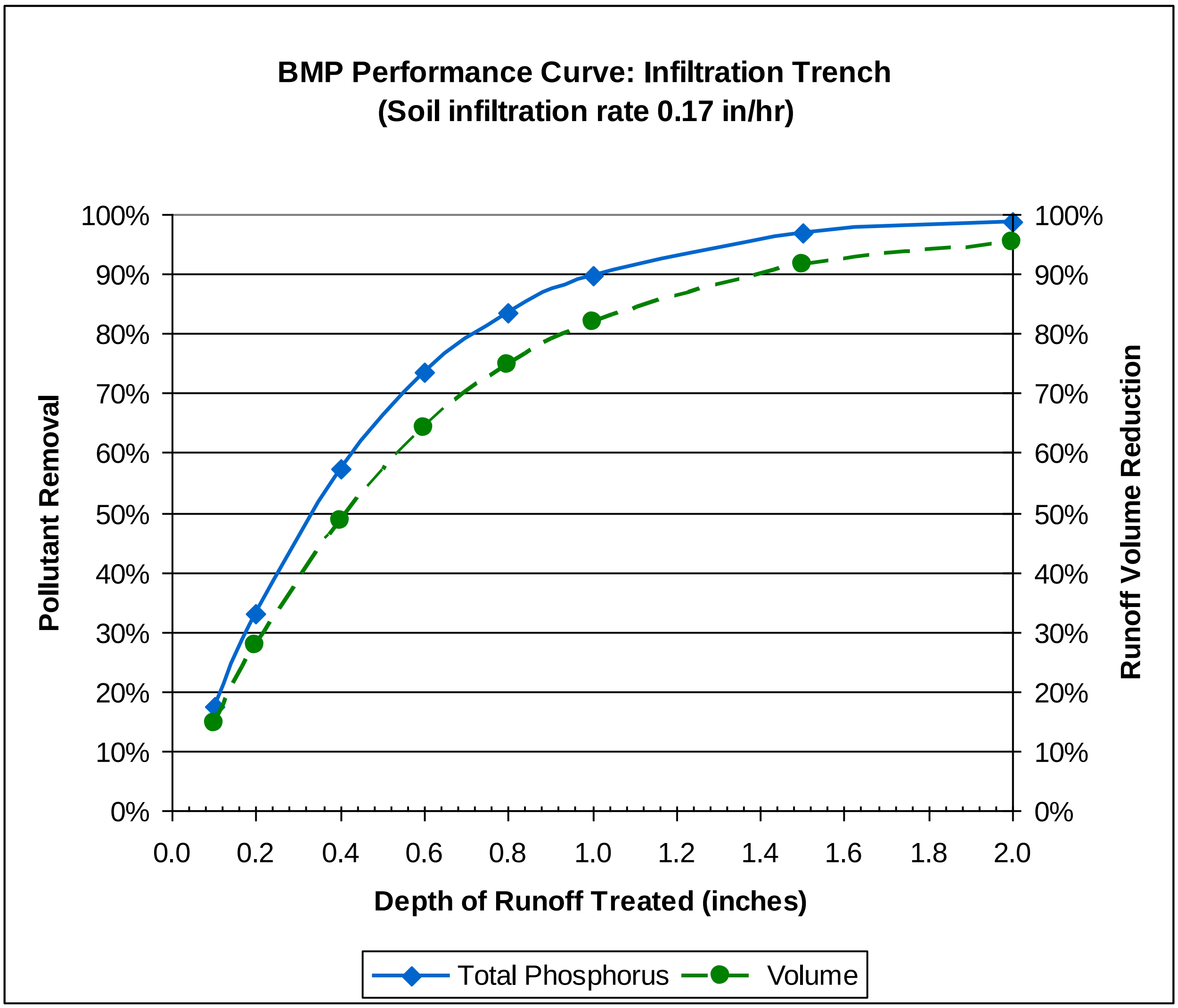


Table 3-2

Infiltration Trench (IR = 0.27 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	17.8%	32.5%	55.0%	70.0%	79.3%	85.2%	93.3%	96.3%
Cumulative Phosphorus Load Reduction	20%	37%	63%	78%	86%	92%	97%	99%

Figure 3-2

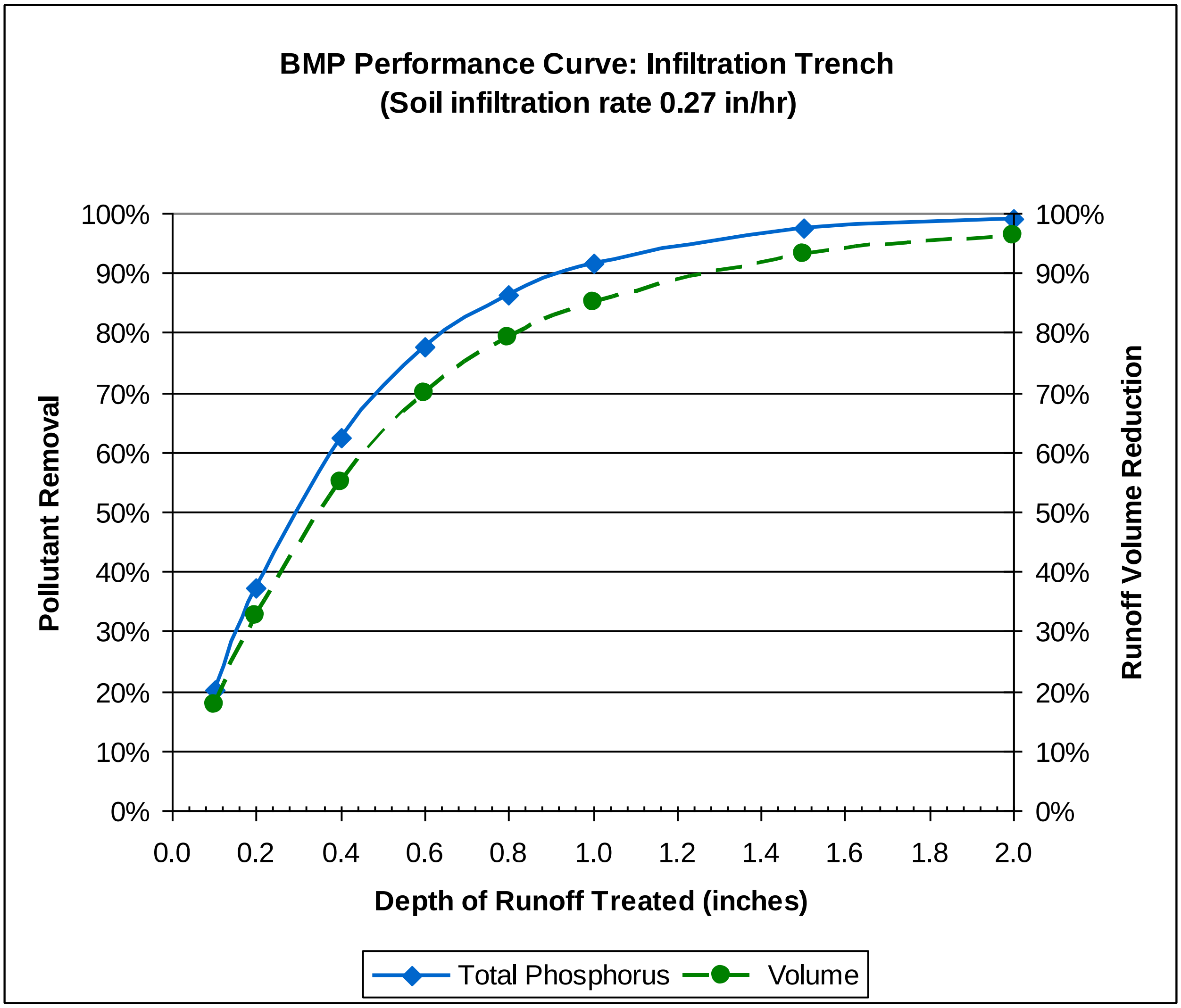


Table 3-3

Infiltration Trench (IR = 0.52 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	22.0%	38.5%	61.8%	75.7%	83.7%	88.8%	95.0%	97.2%
Cumulative Phosphorus Load Reduction	23%	42%	68%	82%	89%	94%	98%	99%

Figure 3-3

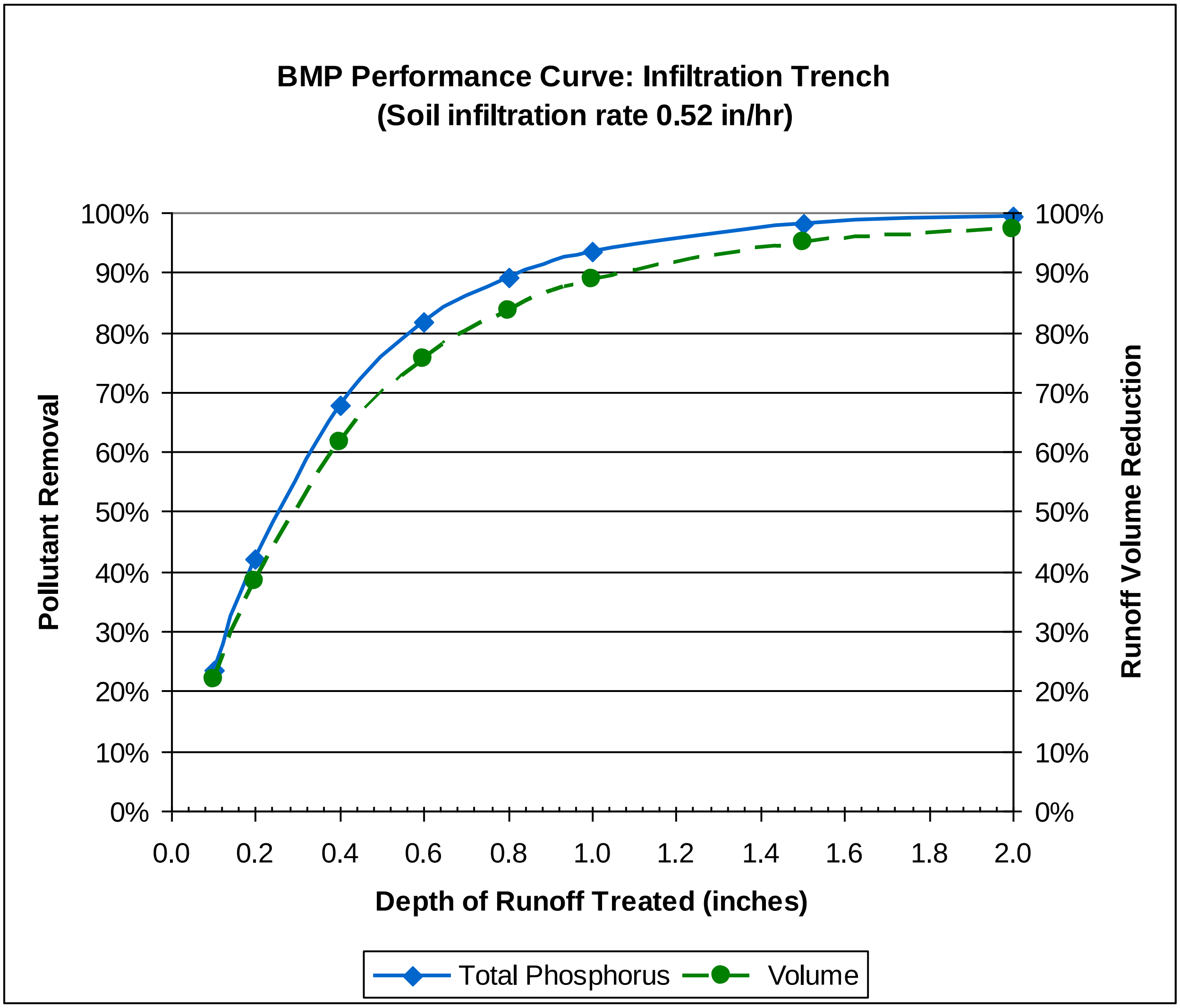


Table 3-4

Infiltration Trench (IR = 1.02 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	26.3%	44.6%	68.2%	81.0%	88.0%	92.1%	96.5%	98.3%
Cumulative Phosphorus Load Reduction	27%	47%	73%	86%	92%	96%	99%	100%

Figure 3-4

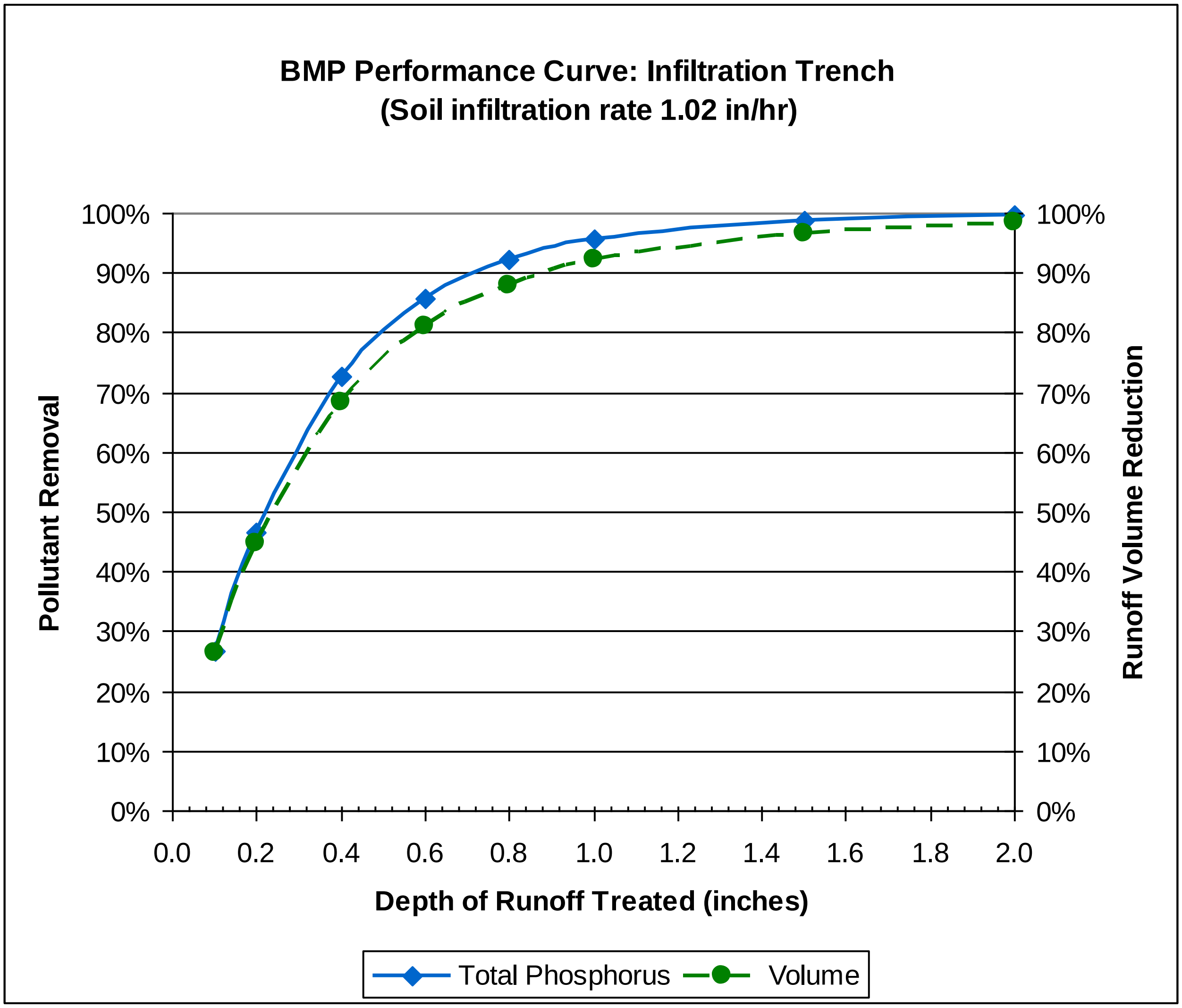


Table 3-5

Infiltration Trench (IR = 2.41 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	34.0%	54.7%	78.3%	88.4%	93.4%	96.0%	98.8%	99.8%
Cumulative Phosphorus Load Reduction	33%	55%	81%	91%	96%	98%	100%	100%

Figure 3-5

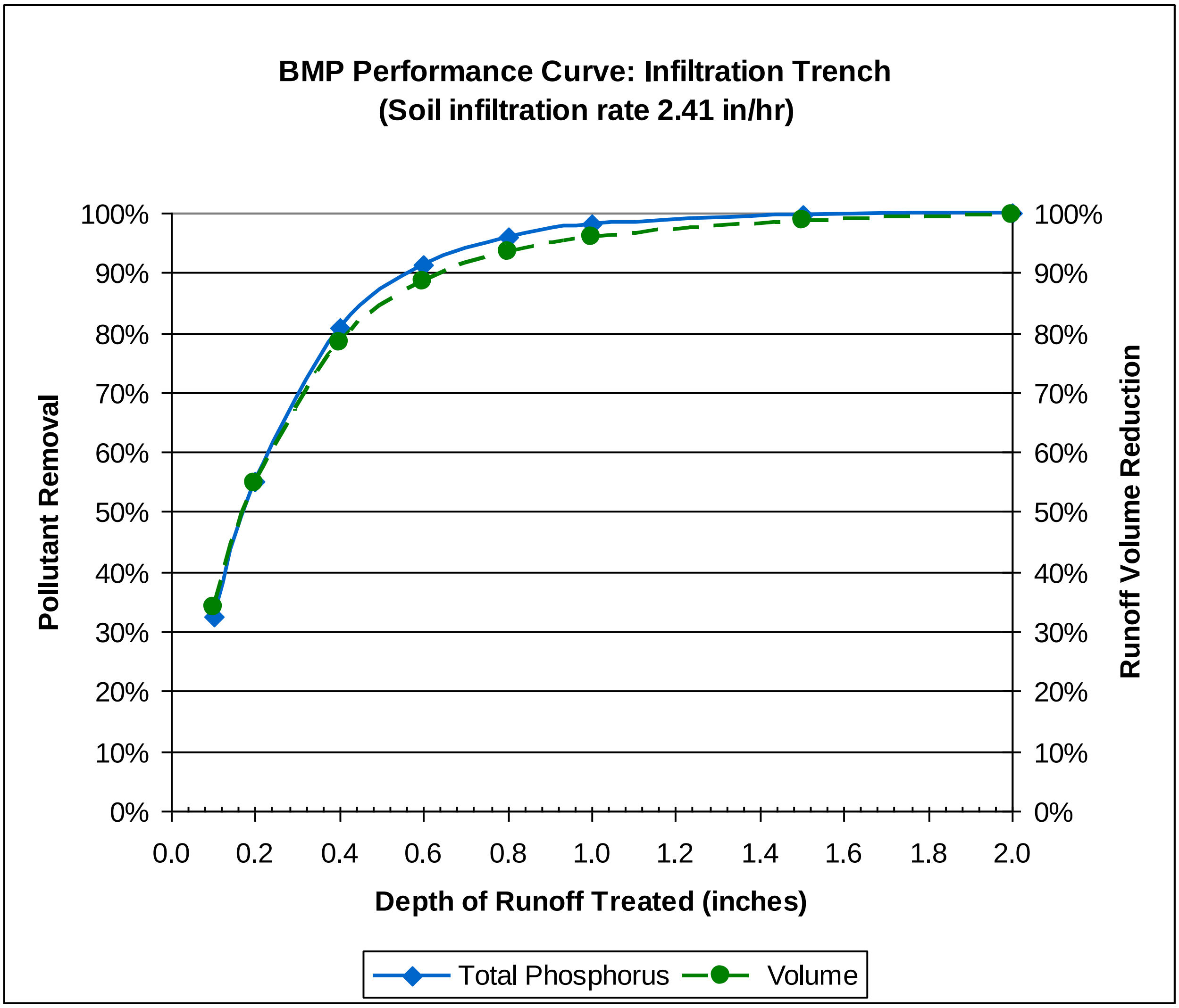


Table 3-6

Infiltration Trench (8.27 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	53.6%	76.1%	92.6%	97.2%	98.9%	99.5%	100.0%	100.0%
Cumulative Phosphorus Load Reduction	50%	75%	94%	98%	99%	100%	100%	100%

Figure 3-6

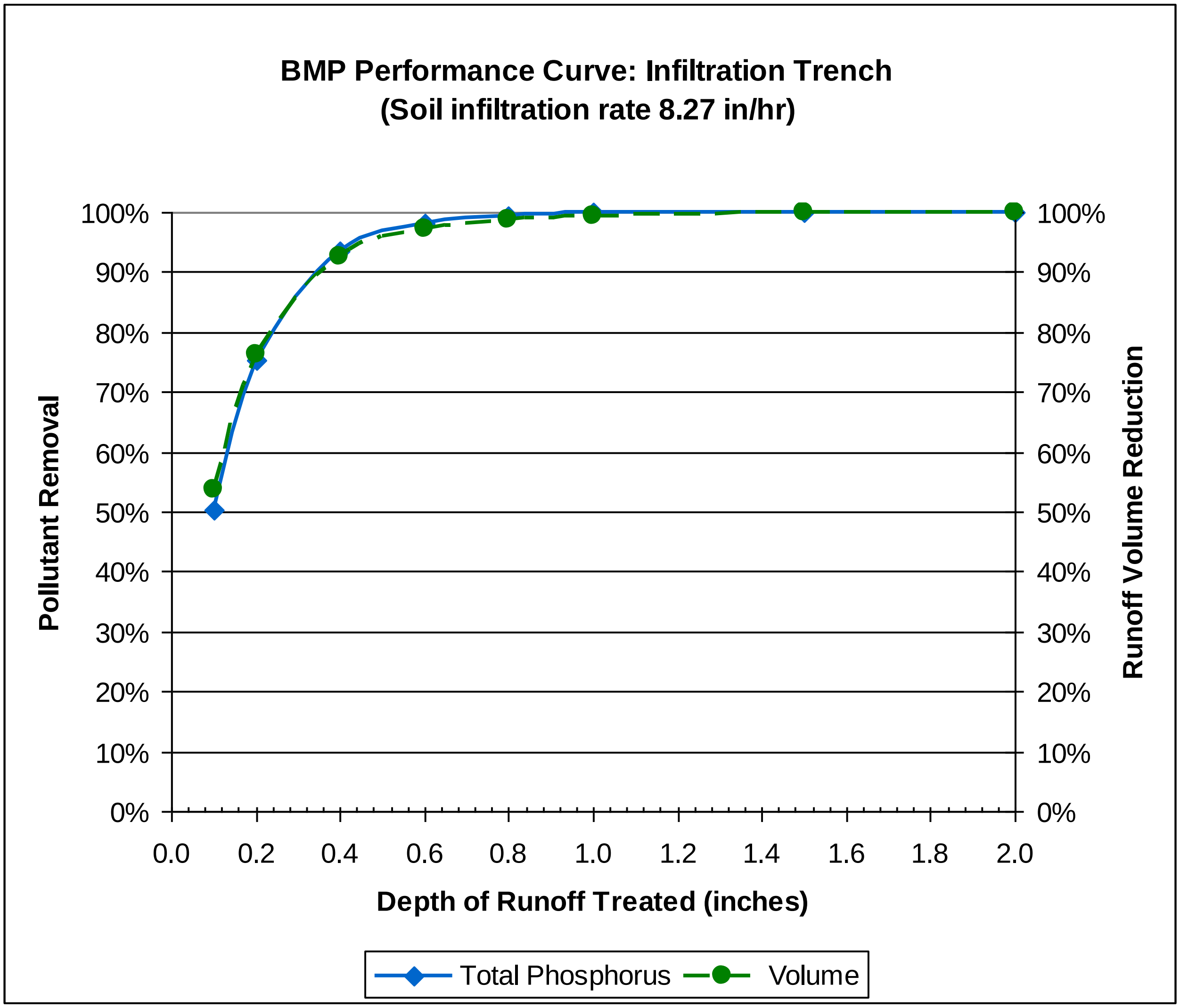


Table 3-7

Infiltration Basin (0.17 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	13.0%	24.6%	44.2%	59.5%	70.6%	78.1%	89.2%	93.9%
Cumulative Phosphorus Load Reduction	35%	52%	72%	82%	88%	92%	97%	99%

Figure 3-7

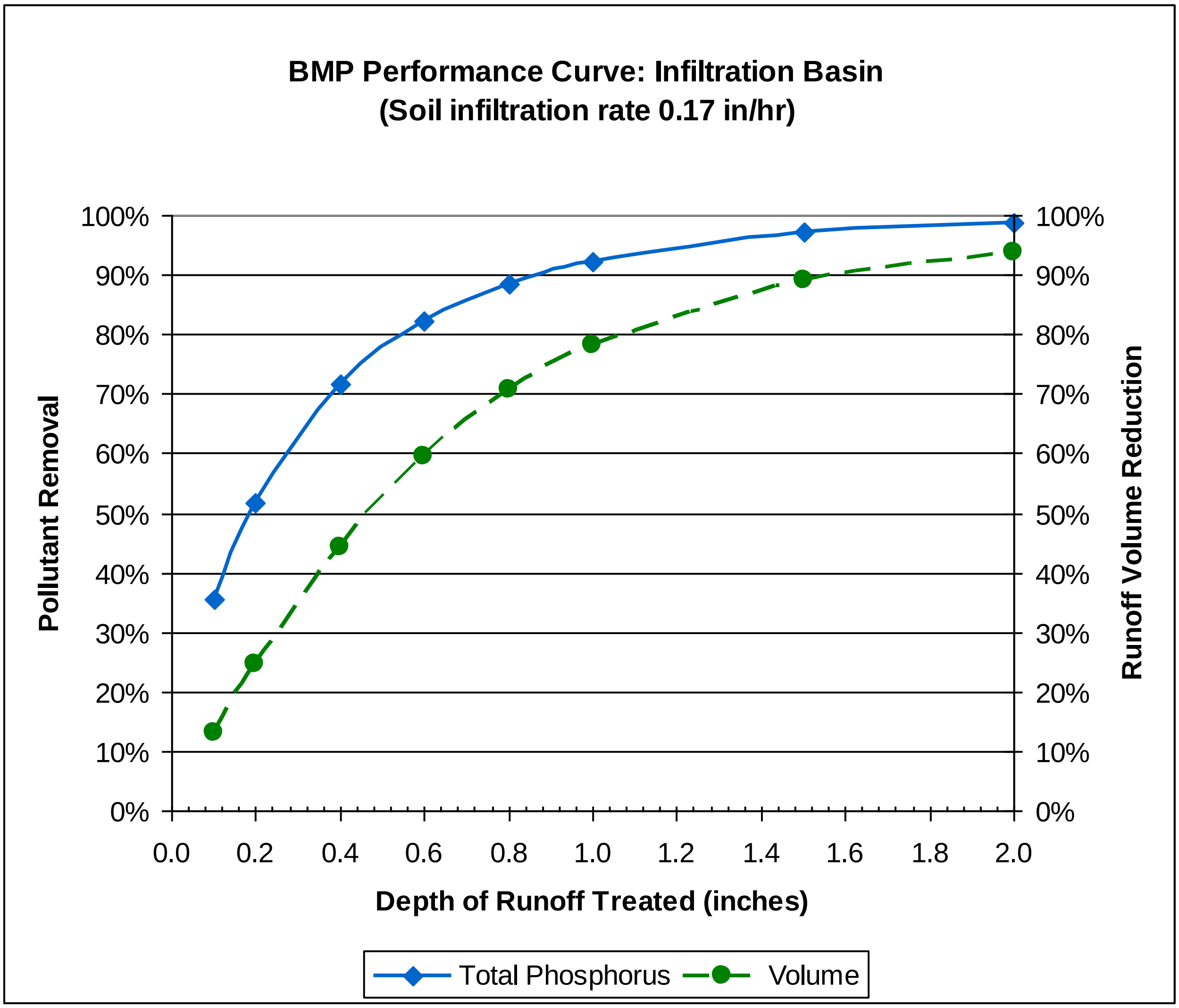


Table 3-8

Infiltration Basin (0.27 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	16.3%	29.8%	51.0%	66.0%	76.0%	82.4%	91.5%	95.2%
Cumulative Phosphorus Load Reduction	37%	54%	74 %	85%	90%	93%	98%	99%

Figure 3-8

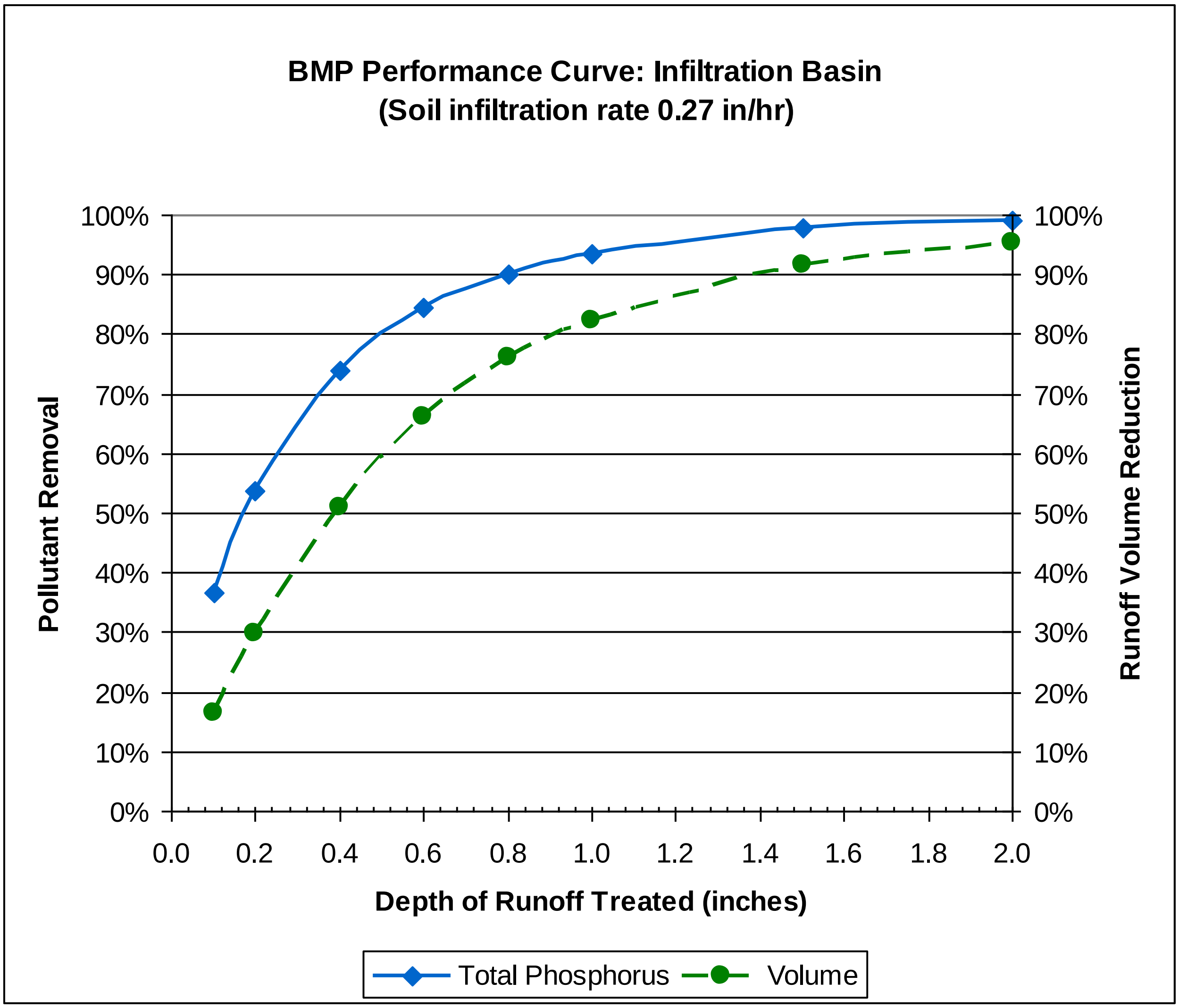


Table 3-9

Infiltration Basin (0.52 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	20.2%	35.6%	58.0%	72.6%	81.3%	86.9%	94.2%	96.7%
Cumulative Phosphorus Load Reduction	38%	56%	77%	87%	92%	95%	98%	99%

Figure 3-9

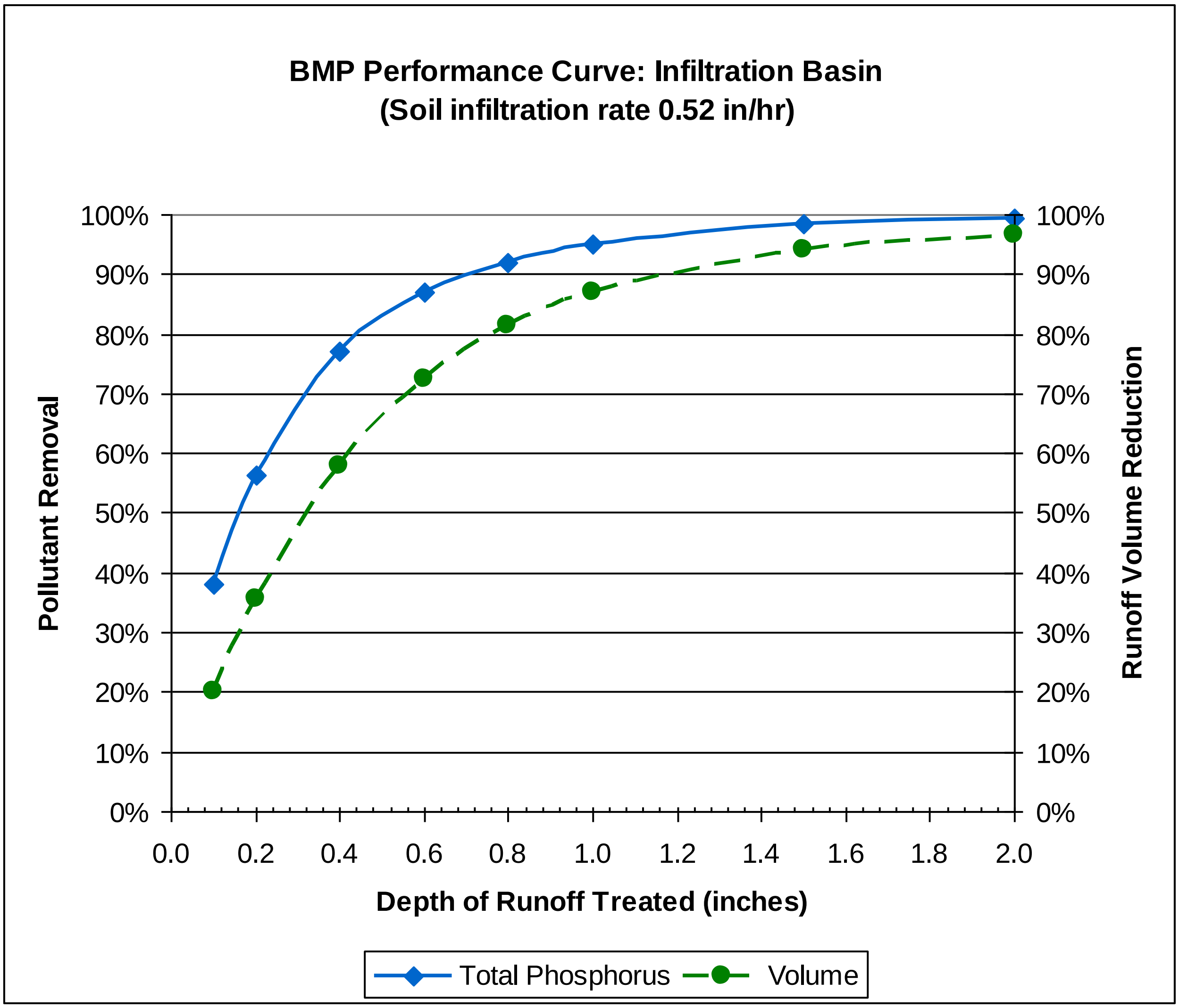


Table 3-10

Infiltration Basin (1.02 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	24.5%	42.0%	65.6%	79.4%	86.8%	91.3%	96.2%	98.1%
Cumulative Phosphorus Load Reduction	41%	60%	81%	90%	94%	97%	99%	100%

Figure 3-10

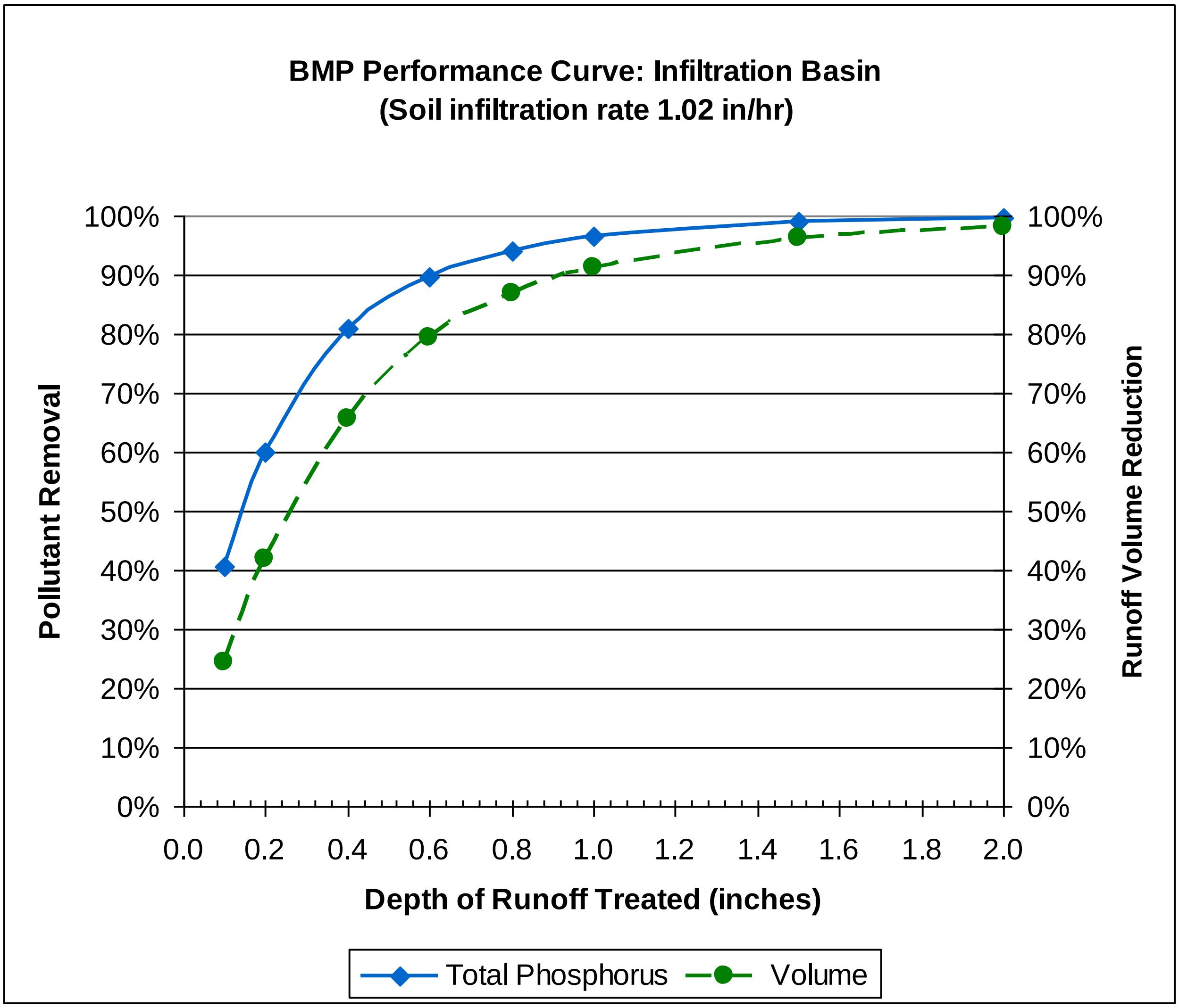


Table 3-11

Infiltration Basin (2.41 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	32.8%	53.8%	77.8%	88.4%	93.4%	96.0%	98.8%	99.8%
Cumulative Phosphorus Load Reduction	46%	67%	87%	94%	97%	98%	100%	100%

Figure 3-11

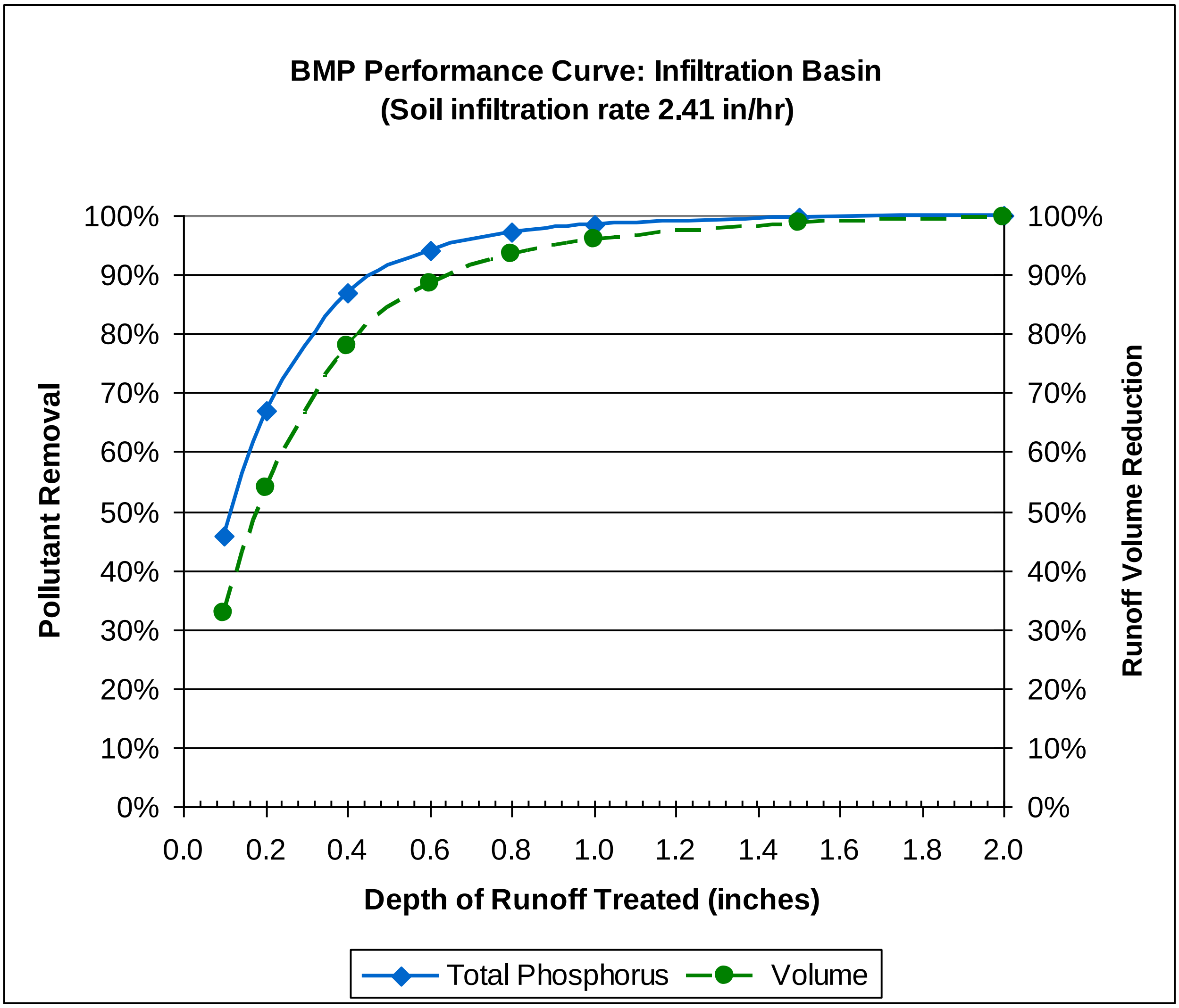


Table 3-12

Infiltration Basin (8.27 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	54.6%	77.2%	93.4%	97.5%	99.0%	99.6%	100.0%	100.0%
Cumulative Phosphorus Load Reduction	59%	81%	96%	99%	100%	100%	100%	100%

Figure 3-12

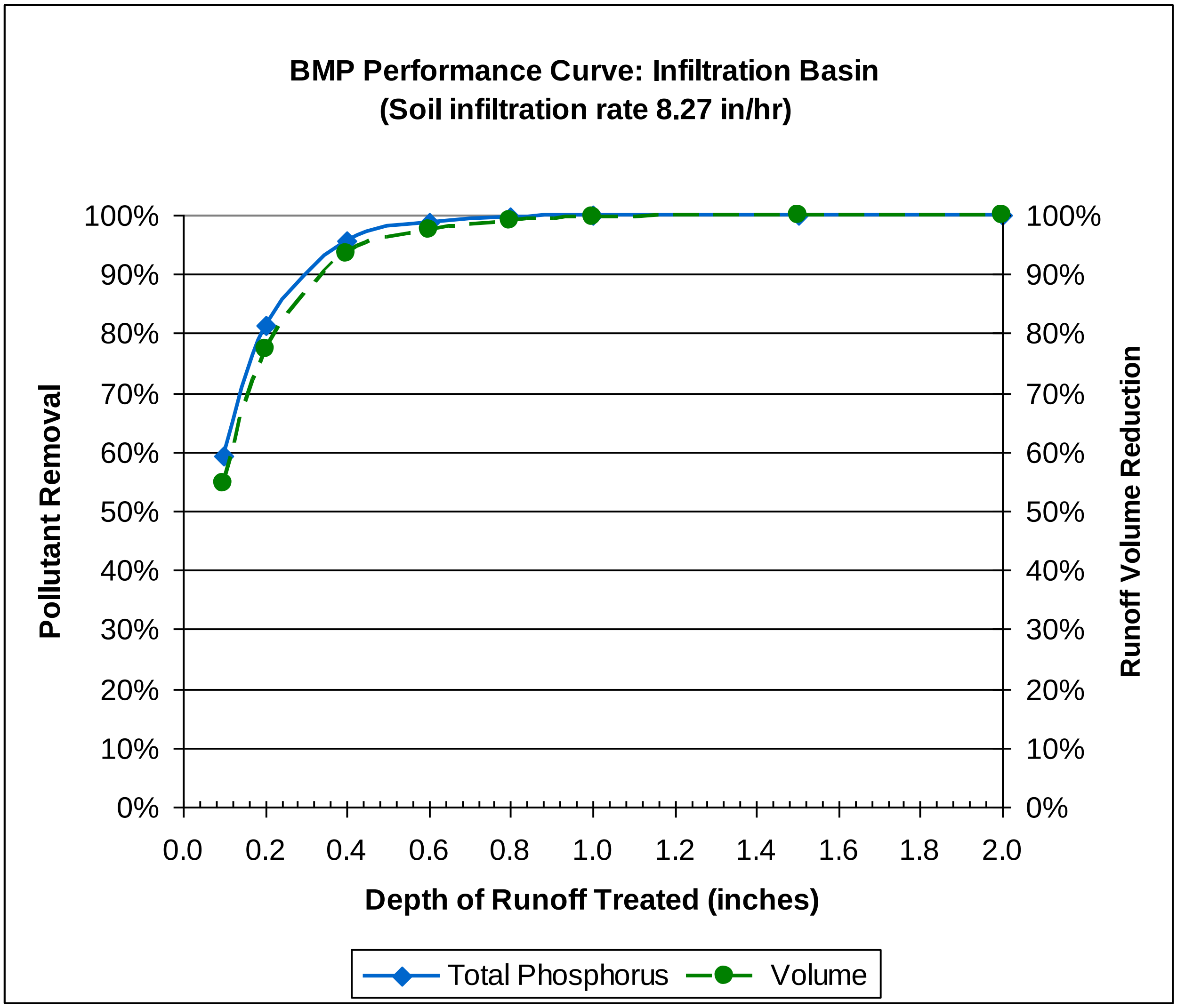


Table 3-13

Bioretention BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Cumulative Phosphorus Load Reduction	19%	34%	53%	64%	71%	76%	84%	89%

Figure 3-13

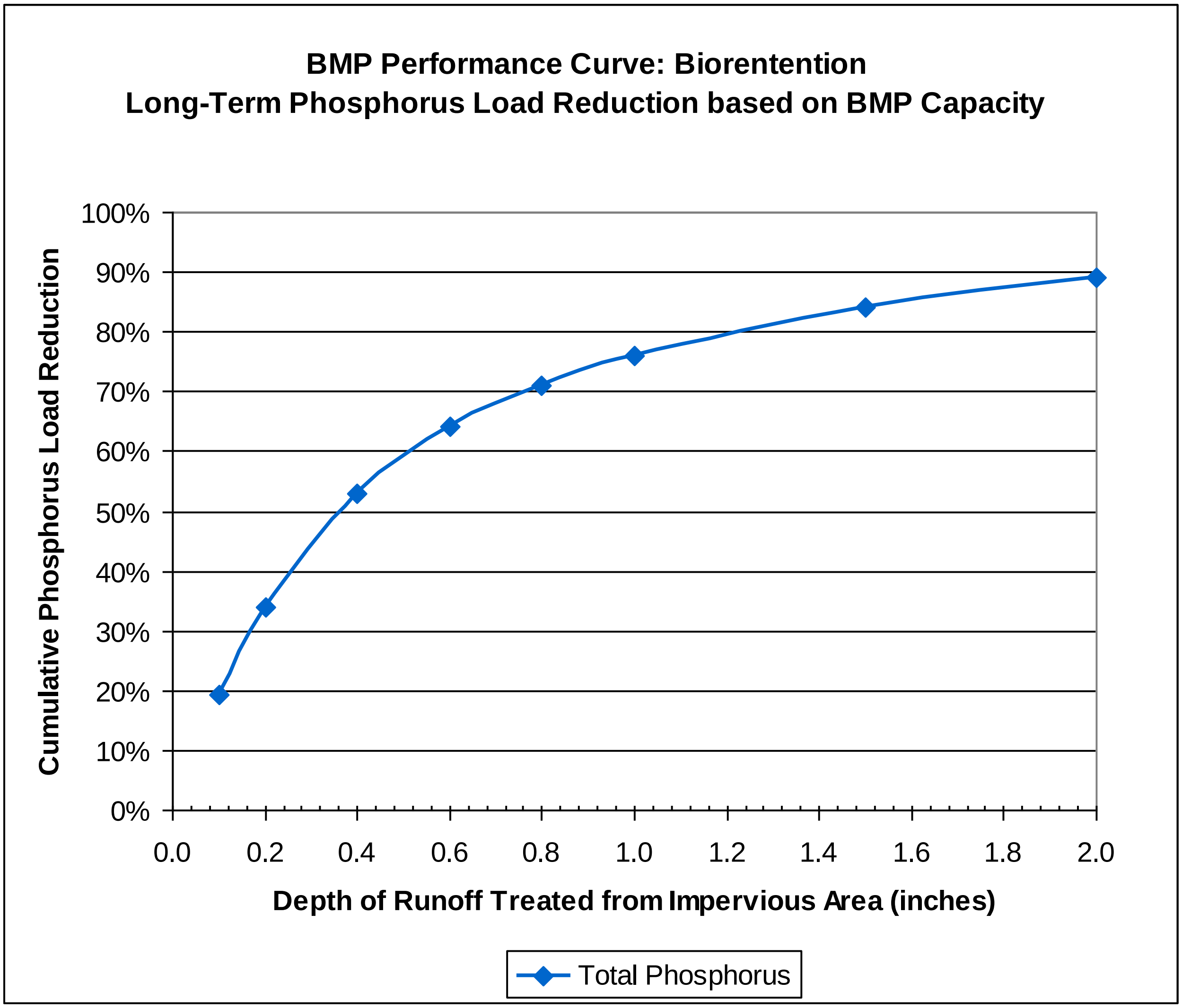


Table 3-14

Gravel Wetland BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Cumulative Phosphorus Load Reduction	19%	26%	41%	51%	57%	61%	65%	66%

Figure 3-14

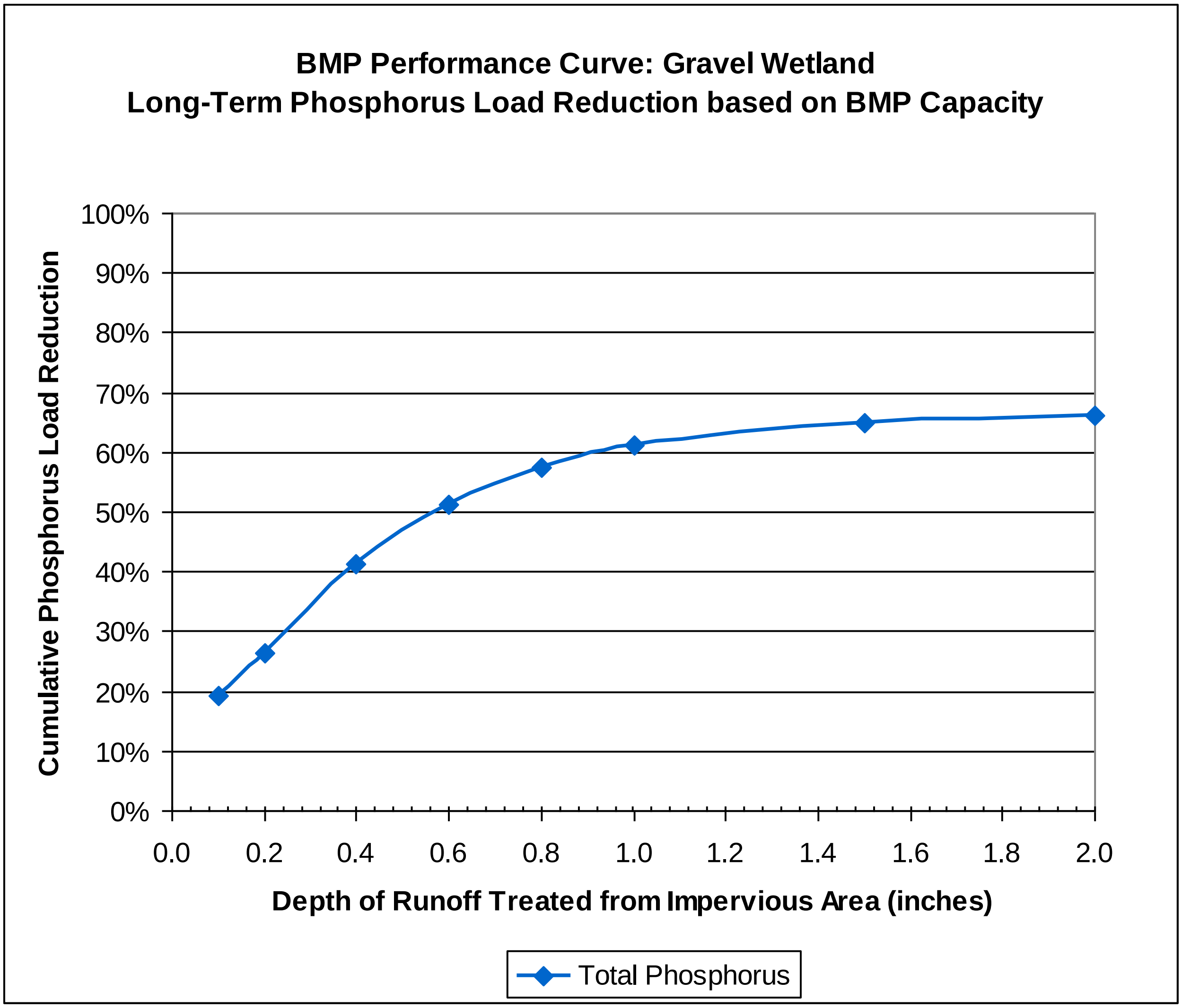


Table 3-15

Porous Pavement BMP Performance Table: Long-Term Phosphorus Load Reduction				
BMP Capacity: Depth of Filter Course Area (inches)	12.0	18.0	24.0	32.0
Cumulative Phosphorus Load Reduction	62%	70%	75%	78%

Figure 3-15

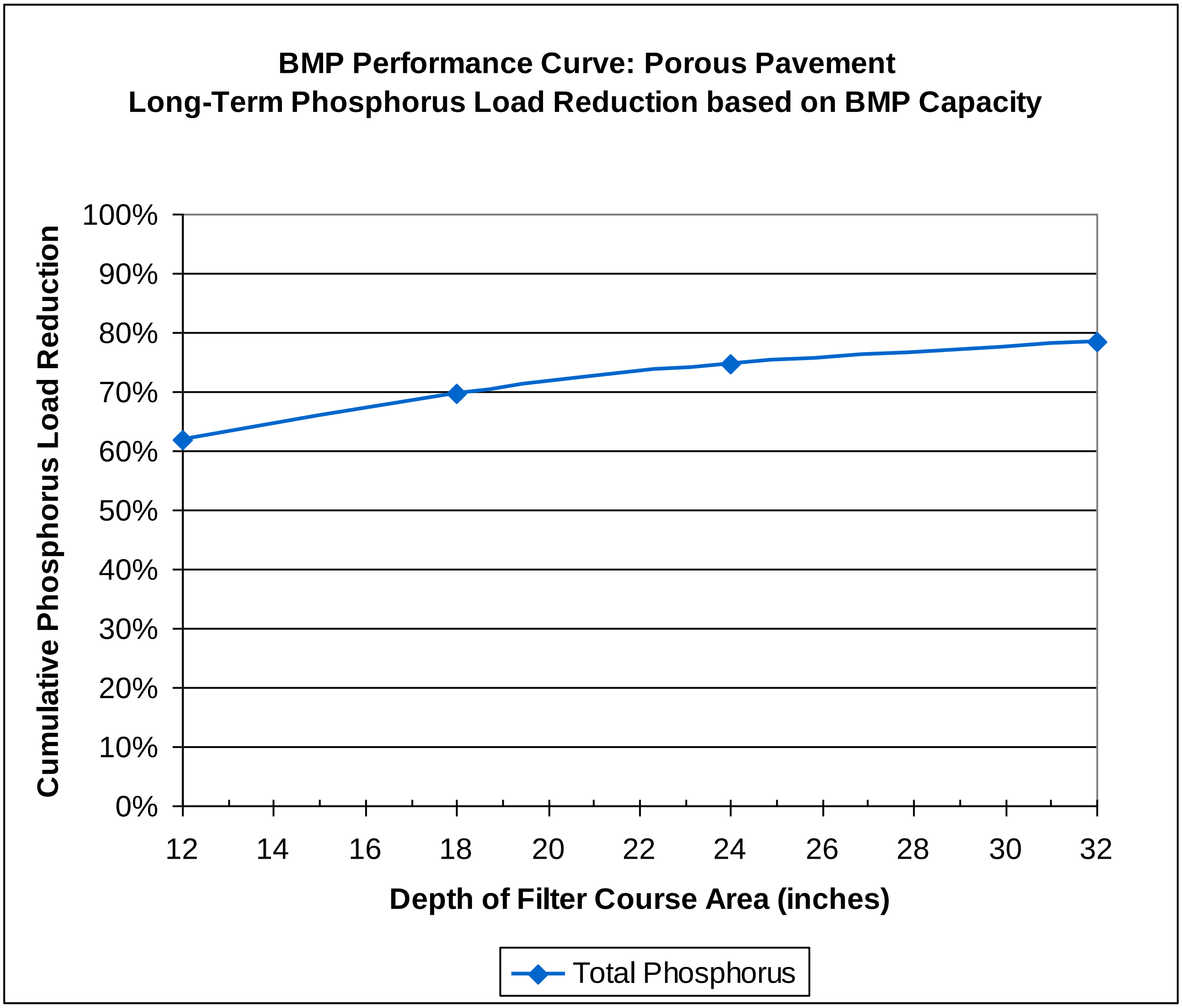


Table 3-16

Wet Pond BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Cumulative Phosphorus Load Reduction	14%	25%	37%	44%	48%	53%	58%	63%

Table 3-17

Dry Pond BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Cumulative Phosphorus Load Reduction	3%	6%	8%	9%	11%	12%	13%	14%

Figure 3-16

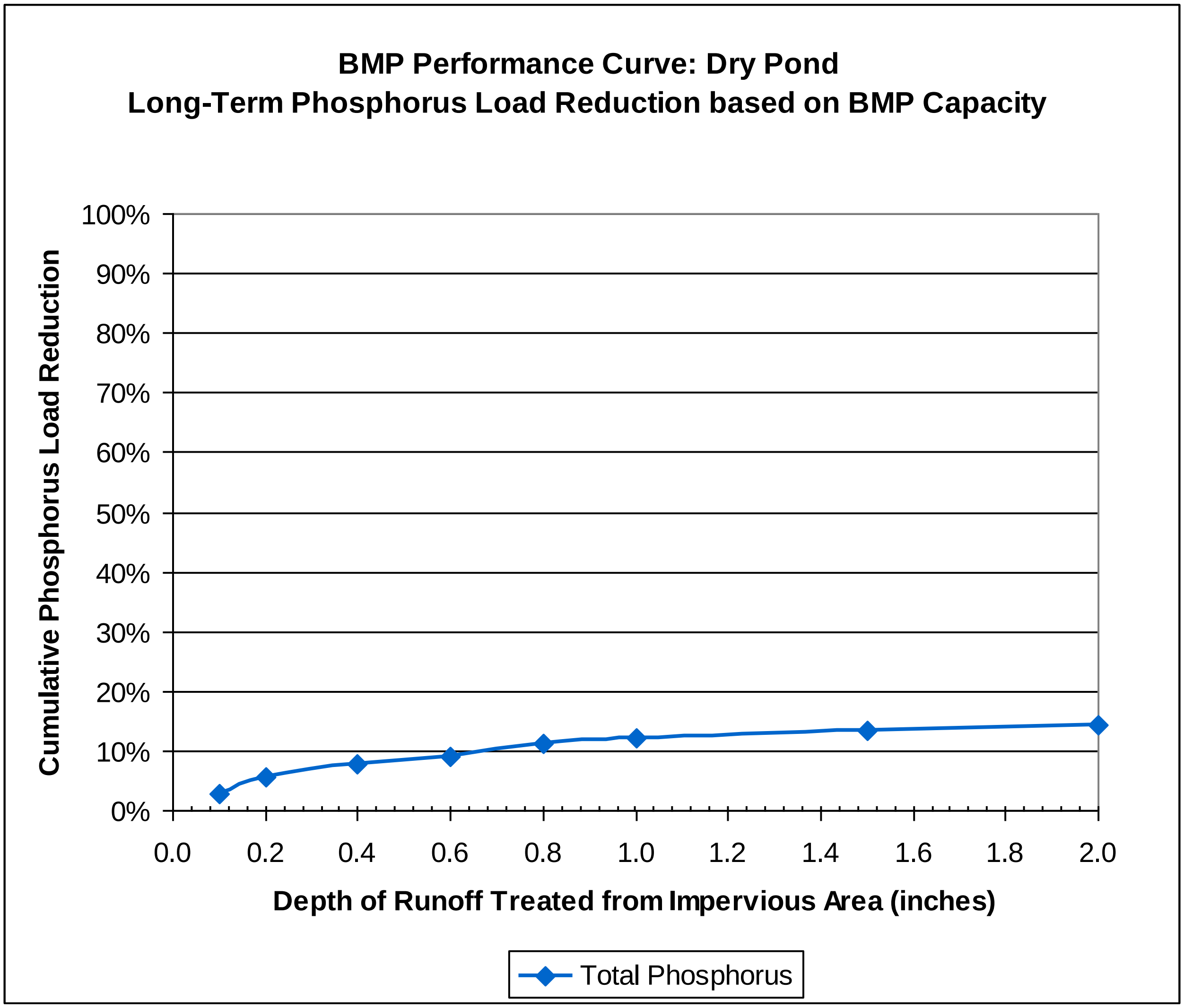


Table 3-18

Grass Swale BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Cumulative Phosphorus Load Reduction	2%	5%	9%	13%	17%	21%	29%	36%

Figure 3-17