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TRANSMITTAL LETTER

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Revisions to
Design Manual, Part 2
Highway Design
March 2025 Edition, Change No. 14

INFORMATION AND SPECIAL INSTRUCTIONS:

Incorporate the attached revisions into the March 2015 Edition of Publication 13M.

These updates should be effective as soon as practical without affecting letting schedules, but no later than July 1, 2026.

TABLE OF CONTENTS

-Updated for consistency with the revisions made as described below.

CHAPTER 6 PEDESTRIAN FACILITIES AND THE AMERICANS WITH DISABILITIES ACT

-Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*, Chapter 13, Pedestrian Facilities, and all related Appendices.

CHAPTER 14 COST ESTIMATING

-Refer to Publication 352, *Estimating Manual*.

CHAPTER 18 TEMPORARY ROADS AND BRIDGES

-Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*, Chapter 9, Maintenance and Protection of Traffic.

Any comments or questions regarding the above revisions should be directed to the Highway Design and Technology Division, Bureau of Design and Delivery.

CANCEL AND DESTROY THE FOLLOWING:

Table of Contents – all pages
Chapter 6 – all pages
Chapter 6 Appendices – all pages
Chapter 14 – all pages
Chapter 18 – all pages

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Design Manual Part 2 Highway Design

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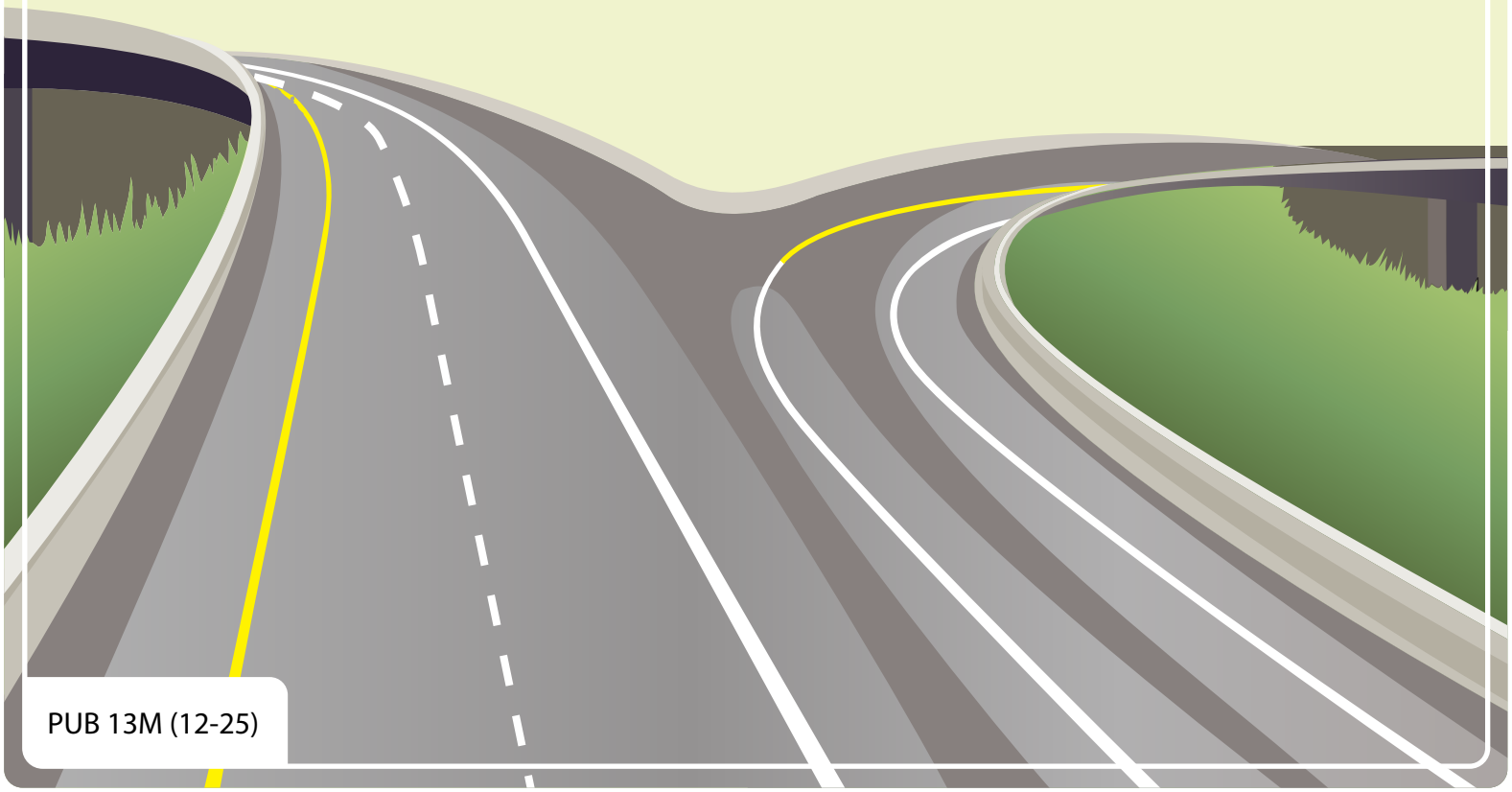

PUB 13M (12-25)

DESIGN MANUAL, PART 2
HIGHWAY DESIGN

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Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*.

CHAPTER 2

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Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*.

CHAPTER 3

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Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*, Chapter 6, Intersections and Driveways.

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Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*, Chapter 7, Grade Separations and Interchanges.

CHAPTER 5

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Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*, Chapter 20, Lighting.

CHAPTER 6

PEDESTRIAN FACILITIES AND THE AMERICANS WITH DISABILITIES ACT

Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*, Chapter 13, Pedestrian Facilities.

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Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*, Chapter 10, Drainage Design and Related Procedures.

CHAPTER 11

PAVEMENT DESIGN

11.0 INTRODUCTION

The policies, guidelines and procedures for the construction, restoration, rehabilitation, resurfacing and reconstruction of pavement structures for all Department projects shall conform to the current Publication 242, *Pavement Policy Manual*.

CHAPTER 12

GUIDE RAIL, MEDIAN BARRIER AND ROADSIDE SAFETY DEVICES

Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*, Chapter 12, Roadside Design.

CHAPTER 13

EROSION AND SEDIMENT POLLUTION CONTROL AND POST CONSTRUCTION STORMWATER MANAGEMENT

13.0 INTRODUCTION

Pennsylvania's Clean Streams Law of 1937 (Act 394), as amended, prohibits the discharge to the waters of the Commonwealth of any pollutive materials whether from industrial or domestic sources. It also allows the Pennsylvania Department of Environmental Protection (PA DEP) to regulate any activity which creates a danger of pollution or has a potential for pollution. Pennsylvania's programs for the control of erosion and sediment pollution and for post-construction stormwater management have been adopted under the authority of 25 PA Code Chapter 102 (Erosion and Sediment Control). To explain the requirements of these programs pursuant to Chapter 102, PA DEP published in April 1990 an implementation manual titled, "Erosion and Sediment Pollution Control Program Manual" (updated in March 2000 and again in March 2012); and in December 2006 published, "Pennsylvania Stormwater Best Management Practices." Other related programs adopted by PA DEP are Chapter 105 (Dam Safety and Waterway Management) and Chapter 106 (Flood Plain Management) regulations. Pertinent regulations regarding the Storm Water Management Act of 1978 (Act 167) are addressed in Section 13.7.

Also, as stipulated in the Federal-Aid Policy Guide, 23 CFR 650, Subpart B, it is the policy of the Federal Highway Administration (FHWA) that Federal-aid highways and highways constructed under the direct supervision of FHWA shall be located, designed, constructed and operated according to standards that minimize erosion and sediment damage to the highway and adjacent properties and abate pollution of surface and ground water resources.

Water pollution degrades surface waters making them unsafe for drinking, fishing, swimming, and other activities. As authorized by the Federal Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or human-made ditches. In most cases, the NPDES permit program is administered by authorized states. Since its introduction in 1972, the NPDES permit program is responsible for significant improvements to our Nation's water quality. Section 13.6.C discusses the NPDES permit program for Pennsylvania in greater detail.

Soil erosion is the process by which the land surface is worn away by the action of wind, water, ice and gravity. Under natural conditions, erosion occurs at a very slow and uniform rate and is a vital requirement in maintaining environmental balance. Sedimentation is the process involving the gravitational deposit of transported material in flowing or standing water. Erosion and sedimentation are normal geologic processes and are a matter of concern when accelerated by highway related activities. Such activities include the removal of the natural protective vegetative cover, the disturbance of the soil or other significant changes in topography.

The disturbance of land during construction is frequently accompanied by sudden, drastic increases in soil erosion. This accelerated erosion can be minimized by prudent scheduling of construction activities. Control measures can reduce sediment production. PA DEP's Chapter 102 regulations require that all persons proposing or conducting earth disturbance activities to develop, implement and maintain erosion and sediment pollution control measures to minimize the potential for accelerated erosion and sedimentation and to manage post-construction stormwater. Section 13.1 provides highlights of the Chapter 102 regulations.

13.1 CONSIDERATIONS RELEVANT TO CONSTRUCTION

Effective erosion control planning begins during the preliminary design phase of highway project development. Control of construction activities and knowledge of the soils encountered are basic to determine measures for preventing erosion and the movement of sediment. Control measures shall be designed to fit the environment, topography, soils, rainfall, land use and construction schedules. A highway location selected with consideration of the problems associated with these basic elements can greatly reduce erosion problems during and after construction.

Prevention of sediment pollution of waterways involves the following principles: (1) schedule construction activities to reduce soil area exposed; (2) control erosion at the source; (3) control water that flows across the right-of-way and (4) perform timely seeding and mulching operations to stabilize disturbed areas as soon as possible. The key to controlling sediment pollution is to control soil erosion at the source.

Special precautions should be taken in the use of construction equipment to prevent operations which promote erosion. Wheel tracks from heavy equipment are vulnerable to erosion from the concentration of water. Fording of streams with equipment shall be kept to a minimum and, where required, shall be performed in accordance with the requirements of Chapter 10, Drainage Design and Related Procedures, and regulatory permit requirements. Regulatory permit requirements take precedence over any design manuals.

Embankment slopes that encroach on or near stream channels should be adequately protected against erosion. Where possible, a protective buffer of vegetative cover should be preserved or established between the top of cuts or bottom of fills and the adjacent ditch or drainage way. The buffer area should be identified on the typical sections and plans and protected from construction activity.

Borrow pits and waste disposal areas should be selected with full consideration of erosion control requirements during borrow or disposal operations and during the final treatment or restoration of the area. Wherever located, special precautions shall be taken to control erosion and sediment problems and off-site effects. The disposal of waste in wetlands or in the flood channel area of any stream is prohibited. Regardless of the responsibility of the selection of borrow areas, plans of operation and of restoration, cleanup, shaping, seeding and mulching shall be approved by the Engineer.

Plans for the control of runoff must include measures to keep sediment from entering waterways before borrow or disposal operations begin. Diversion channels and sediment traps or sediment basins may be used for this purpose. Topsoil from the borrow pit area shall be salvaged for use in restoring the borrow area. Topsoil from a waste area should also be salvaged if it is needed for restoration. Stockpiled topsoil shall be protected from erosion. Final restoration of borrow and waste disposal areas shall include grading, establishment of vegetative cover and other treatments that blend the area into the surrounding landscape. The restored areas shall be well drained, unless approval is given to convert the pit area into wetlands or lakes for fish and wildlife, recreation, stock water or irrigation. Erosion and sediment pollution control shall be provided and maintained at wetland mitigation sites until they become established.

Where practical, erosion and sediment pollution control measures, also referred to as best management practices (BMPs), should be located within the normal right-of-way. However, when necessary, additional right-of-way acquisition may be required and shall be considered prior to completion of the right-of-way plans. If erosion and sediment pollution control measures will be removed during the construction contract, a temporary area for construction may be utilized. The control of the water across the right-of-way shall be completed prior to or concurrent with clearing and grubbing for the roadway. This may require offsetting the culverts from the natural drainage course to transport the water across the work area. All earth ditches or channels shall be stabilized before use to prevent erosion. Runoff from work areas shall be collected and controlled prior to entering a natural watercourse. All water originating outside of the project should be kept separate from that originating within the construction area.

Accelerated erosion can be minimized by the use of the following: (1) slopes which are rounded and blended into the natural terrain; (2) drainage channels properly designed with regard to location, width, depth, slope alignment and protective treatment; (3) proper facilities for ground water interception; (4) dikes; (5) berms and other protective devices; (6) protective ground covers and plantings and (7) properly designed sedimentation removal devices.

Erosion and sediment pollution control BMPs should be indicated on the construction drawings, as required, and so located that they do not interfere with the normal construction operations. The use of several smaller BMPs off the main stream has the advantage of not interfering with fish life and has less detrimental consequences in case of failure or overtopping of BMPs, since failure from overtopping is not likely to occur at all of the small BMPs simultaneously. BMPs located within a waterway may require a Chapter 105 permit from PA DEP.

Most erosion and sediment pollution control BMPs will be temporary, since most of the soil erosion occurs only during construction. Permanent detention basins provided for stormwater management purposes may be used as sediment basins during highway construction. Those basins located in a regulated watershed pursuant to the Storm

Water Management Act shall be designed and constructed in accordance with the standards of the individual watershed stormwater management plans. In some special cases, a multipurpose detention basin may be installed to provide water quality and wildlife habitat enhancements. Permanent erosion and sediment pollution control BMPs shall have a plan of maintenance. Temporary erosion and sediment pollution control BMPs shall be cleaned and maintained to assure proper functioning for the expected period of use. Some basins or ponds, because of size or location, may require protective fencing to limit unauthorized access.

Erosion and sediment pollution control BMPs shall be provided for all phases of construction activities including those items which are not normally specified in construction drawings. These BMPs also may be required for testing operations such as those for archeology and drilling.

13.2 SEEDING AND MULCHING STABILIZATION

Seeding with various grass or grass and leguminous plant mixtures is necessary to restore vegetative cover to soil surfaces exposed during excavation operations. Restoring the vegetative cover with deep-rooted, long lived and persistent adapted plant species is the most effective measure to prevent extensive soil erosion and any accompanying sedimentation loss and deposit in undesired areas. The use of permanent or temporary seeding or temporary mulching must be anticipated during earthwork operations.

A. Standard Highway Seeding Mixtures. Publication 408, *Specifications,* Section 804 lists several standard seeding mixture formulas which should be used on typical construction slopes for highway construction projects. A general description and guideline for their use is as follows:

1. Formula B. This is a refined lawn type, sod forming grass formula containing a large percentage of Kentucky bluegrasses with perennial ryegrass and red fescues. This mixture is generally used on non-steep surfaces where a more highly maintained and mowed surface, such as a lawn, is desired. Use only on areas which have topsoil.

2. Formula C. This is a mixture of predominantly crownvetch (leguminous plant) with a nurse crop of annual ryegrass. The ryegrass will hold the soil in place until the slower growing crownvetch establishes itself. This mixture is generally used on slopes steeper than 1V:3H where mowing is not anticipated or desired. Crownvetch is the state's official Soil Conservation Plant. Crownvetch will normally hinder the invasion of adjacent native vegetation for many years. Topsoil application is not necessary in areas to receive Formula C. Do not use within 20 ft of areas where evergreen trees, shrubs, seedlings or vines are to be planted.

Although this plant species is good for erosion control, Formula C has the capability of moving beyond the right-of-way. It can "creep" over and shade out other low growing vegetation. It can also cling to low hanging branches and onto right-of-way fence. The Pennsylvania Department of Conservation and Natural Resources (DCNR) considers Formula C to be a problematic, invasive plant in certain areas when it establishes outside of the right-of-way into residential and agricultural properties or other native plant communities.

3. Formula D. This is a rougher grass type, sod forming mixture containing a large percentage of tall and fine fescues. This mixture is generally used on most highway slope areas not receiving Formula C where mowing may or may not be designated. In non-mowed areas, this formula will eventually allow invasion and succession by adjacent native woody plants or wildflowers. Normally used in drainage channels or swales requiring permanent seeding.

4. Formula E. This is a 100% crop of annual ryegrass which is generally used to quickly stabilize exposed soil surfaces since it generally germinates within 2 weeks when climate conditions are favorable. Since the life cycle of this grass averages 1 to 2 years, this formula is considered most often for temporary use on unfinished graded areas during construction.

5. Formula L. This is a fine textured, sod forming mixture of hard fescue, red fescue with a nurse crop of annual ryegrass. This mixture can be used on low maintenance slope areas which will not be normally mowed and on flatter areas which will not receive more than 2 mowing cycles per year. Mixture should not be used where mowing height will be less than 6 in. Cutting less than 6 in is severely detrimental to establishment. Mixture has limited seedhead production and is not very adaptive to consistently wet soil conditions.

6. Formula W. This is a rough textured blend of tall fescue and birdsfoot trefoil (leguminous plant) with a nurse crop of redtop. This formula can be used on a wide assortment of conditions ranging from fairly dry to fairly wet soils where non-mow conditions are desired such as wetland replacement areas or wildlife habitat areas. This formula will eventually allow the desired invasion and succession of adjacent native plant material.

All areas of use for each seed formula will be shown on applicable typical sections and on the tabulation sheets.

Crownvetch crowns or potted plants can be used in lieu of Formula C seeding where a more positive and earlier establishment of crownvetch cover is essential or where successful seeding is questionable such as top of cut slopes or in areas of poor, erosive soil. Space plants 3 ft × 3 ft in a diamond pattern or under extreme conditions, 2 ft × 2 ft. Show areas of use and spacing on applicable Typical Sections and on the Tabulation Sheets. Potted plants of flatpea may also be used in this way to establish a quicker vegetative cover.

Other seeding formulas for various specialty areas such as wetland replacements, wildlife habitat areas, wildflower establishment or other soil conservation areas can be developed on a project by project basis.

Permanent soil protection and drainage facilities should be completed as early as practical, particularly diversion channels and similar controls that will divert runoff from work areas and unprotected soil. Areas of bare soil and the length of their exposure to erosion processes should be minimized by the following:

1. Temporary Seeding. When project areas are constructed in a rough graded condition and erosion may be accelerated, or establishment of a temporary vegetative cover on exposed soil areas is desired, specify Formula E, according to Section 804 and mulch according to Publication 408, *Specifications,* Section 805. Mulch alone (such as wood chips, straw, hay or other approved material) can be used to protect constructed slopes and other bare areas brought to finished grade when seeding operations are unfavorable. In all cases, temporary seeding and/or mulching will be installed on all disturbed areas where additional grading, topsoiling, etc. will not occur for 20 or more days.

2. Permanent Seeding. When project areas are constructed to finished grade and seeding operations are required within the dates specified in Publication 408, *Specifications,* Section 804.3(a), specify Formulas B, C, D, W, L or other approved seed formulas to minimize erosion by timely scheduling and limiting the work areas. Immediately begin permanent seeding and mulching operations as ground surfaces are brought to final grade.

Limit the use of sod to situations where new construction adjoins established lawns or other fine turf or where the immediate establishment of vegetative cover is required (i.e., between sidewalks and curb).

All seeding, soil supplements and mulching items shall be placed in accordance with the requirements of Publication 408, *Specifications,* Sections 804 and 805 or other approved special provisions.

B. Other Soil Conservation Seed Mixtures. Seeding mixtures of soil conservation type plantings for areas within the right-of-way limits other than typical highway construction slopes can include other seed types than the specified seed formulas listed in Publication 408, *Specifications*. These areas could include habitat replacement areas, wetlands, ponds, dam or stream banks, dikes, spillways, spoil areas, borrow pits or other special areas affected by the highway construction.

Some persistent type species for consideration are:

Legumes		Grasses
Crownvetch	Tall Fescue	Redtop
Birdsfoot Trefoil	Deertongue	Switchgrass
Flatpea	Big Bluestem	Fine Fescues
Showy Tick Trefoil	Little Bluestem	Indiangrass

Other useful species include: Weeping Lovegrass and Perennial Ryegrass.

Recommended Seed Varieties

* Indiangrass - 'Rumsey', 'Holt' or 'Lometa'
* Tall Fescue - 'Kentucky 31' for low maintenance sites, turf-type varieties for high maintenance sites. If endophyte - free tall fescue is desired, use 'Johnstone ', 'Barcel ' or 'Festorina'.
* Perennial Ryegrass - Any fine-leaf turf-type variety
* Fine Fescue - Any named variety
  Redtop - Common seed, 'Streaker' or other named varieties
  Switchgrass - 'Blackwell' for droughty site, 'Shelter' for habitat, 'Cave-in-Rock ' for forage, 'Alamo'
  Deertongue - 'Tioga'
* Birdsfoot Trefoil - Any two of the following: 'Empire ', 'Norcen', 'Leo', 'Maitland' or 'Dawn'
  Flatpea - 'Lathco'
  Weeping Lovegrass - Common seed or 'Morpa'
* Crownvetch - 'Penngift'
  Big Bluestem - 'Niagara' or 'Kaw'
  Little Bluestem - 'Aldous', 'Camper' or 'Blaze'

* Use named varieties that originated in Pennsylvania or Northeastern United States whenever possible since they are generally more resistant to unfavorable soil conditions than are varieties of the same plant kind that originated in Midwest or western states.

C. General Design Guidelines.

1. Lespedeza species are often recommended in various literature as a good cover and food source for wildlife. However, Lespedeza species are not recommended for use in Pennsylvania due to survival limitations caused by varying climate conditions and its limited seed production.

2. Simple mixtures are easier to seed, establish and manage than complex mixtures containing 6 or more species.

3. Most species used for conservation plantings will only root where pH soil conditions are within a range of 5.5 to 7.0 and sufficient fertility is available to support plant growth.

4. For best results, seed in spring during March, April and May.

5. Grasses generally require 4-5 weeks of growth prior to hard frosts in order to survive winter conditions.

6. Legumes generally require 10-12 weeks to produce a seedling large enough to survive winter conditions. Seed legumes before July 15th in northern and western Pennsylvania and before August 15th in southeastern Pennsylvania. If seeding is necessary later than these dates, specify at least 30-35% or more of the legume seed to contain hard seed.

7. Inoculate legume seeds immediately prior to seed application with a selected culture of nitrogen fixing bacteria.

D. Species Guidelines (Also see Table 13.1):

1. Birdsfoot Trefoil (Lotus corniculatus):

a. Does not spread vegetatively from roots but spreads readily from seed. Perennial legume, deep rooted, long lived, prolific seed producer. Adaptable to wide range of soil types and moisture requirements. Will tolerate imperfectly drained soils.

b. Adapted over the entire state, except in the extreme southeast, where crown and root rot may injure stands.

c. Establishment can be suppressed by excessive competition from associated species.

d. Showy yellow flowers during summer.

e. Provides good food source and cover for many types of wildlife.

2. Perennial Ryegrass (Lolium perenne) and Annual Ryegrass (Lolium multiflorum):

a. Substitute approved perennial ryegrass varieties for annual ryegrass in most mixtures, since the vigorous annual ryegrass can prevent or retard the longer-lived but slower establishing grasses or legumes from becoming established.

b. Rye grasses germinate and establish relatively quickly if soil and climate conditions are optimum.

c. Use "turf" type varieties of perennial ryegrass.

3. Redtop (Agrostis alba):

a. Do not exceed recommended application rates. Seeds are very small and numerous. Excessive seeding rate can retard or suppress establishment of more persistent species in a mixture. Rapid germination under good conditions.

b. Creeping growth habit forming a coarse, loose turf, short lived.

c. Very adaptable to poor soil and wet or dry soils.

4. Weeping Lovegrass (Eragrostis curvula):

a. Short lived, perennial, "warm season" grass, often winter kills under Pennsylvania conditions. Drought resistant. Tolerant to low pH and aluminum soils such as reclaimed strip mined soils where high-sulfur material has been unearthed.

b. Useful in mixtures since it furnishes a quick cover until slower growing species such as deertongue can become established. Will not establish as quickly as ryegrass or some cereal grains.

c. Do not exceed recommended application rate since seeds are very small and numerous. Excessive seeding rate can suppress other specie development.

5. Switchgrass (Panicum virgatum):

a. Range type, bunch perennial "warm season" grass. Long-lived and deep rooted with good tolerance to relatively low soil pH and low fertility.

b. May often require 2-3 years or more to develop an acceptable dense vegetative cover.

c. Good for mine spoil areas and wildlife habitat replacement areas.

d. Compatible with Birdsfoot Trefoil.

6. Deertongue (Panicum clandestinum):

a. Do not plant in mixtures with Tall Fescue, Fine Fescues, Kentucky Bluegrass, Redtop, Reed Canarygrass, Annual or Perennial Ryegrasses, Crownvetch or Flatpea since it will not tolerate competition from these species.

b. May often require 2-3 years or more to develop an acceptable dense vegetative cover.

c. Seed 2-3 years old if of high vigor often germinates more readily than seed from previous years harvest.

d. Stratification of seed for 3-4 weeks at a temperature of 35-45 °F is often helpful in breaking seed dormancy.

e. Perennial "warm season" grass, useful in acid or infertile soils and droughty and moist soils.

f. Compatible with Birdsfoot Trefoil.

7. Crownvetch (Coronilla varia):

a. Perennial legume, somewhat slow to establish. Once established, it is a long lived, very vigorous grower and tends to dominate stands because of its ability to produce new plants from its roots.

b. Suppresses invasion of other plant species. Will "climb" onto fences and other low vegetation within reach.

c. Can also be planted using potted plants and crowns.

d. Herbaceous top growth dies back to ground each year.

e. Does best in a well-drained soil with pH of 6.0 or above, but has also been successfully established in soils with a pH as low as 5.4.

8. Flatpea (Lathyrus sylvestris):

a. Perennial, persistent, long lived, legume. Provides a dense mat of foliage.

b. Once established, it is very vigorous and spreads by underground rhizomes. Normal two year establishment.

c. Suppresses other invasive vegetation.

d. May also be planted using potted plants.

e. Food source and cover plant for many types of wildlife.

f. Herbaceous top growth dies back to ground each year.

g. Requires a well-drained soil with pH of 6.0 or above.

9. Tall Fescue (Festuca arundinacea):

a. Aggressive, deep rooted, tufted, long lived perennial.

b. Grows well on wet, poorly drained soil but also on drier soils and soils of low fertility. Withstands hot, dry weather.

c. Spreads by short underground stems.

10. Fine Fescues (Festuca spp):

a. Fine fescues include Creeping Red, Chewings, Hard and Sheep fescue.

b. Finest leaf of any lawngrass. Blends well with most other "cool-season" grasses.

c. Usually used in combination with another grass and a legume for soil conservation purposes.

d. Tolerates a wide range of light conditions from full sun to fairly dense shade.

e. Tolerates dry soils but does poorly on saturated soils. Performs well on roadsides with infrequent high mowing.

f. Not overly competitive in seedling stage. Fairly rapid germination and seedling establishment.

11. Big Bluestem (Andropogan gerardi)

a. Tall growing, perennial, deep rooted, vigorous bunch grass, sod forming. More drought tolerant than other "warm season" grasses. Grows 3 to 6 ft tall.

b. Grows well on most soil types but can be used on excessively drained soil with low water holding capacity. Good tolerance to low pH and low fertility. Can be used on coal waste areas or strip-mined soils.

c. Generally takes 2 years to reach its maximum growth potential because of slow germination and seedling growth.

d. Seed is chaffy and will not flow well unless debearded. Specify 'Debearded' seed only. (Note: There are several specially designed seedbox seeders that will accommodate 'fluffy' seed.)

e. Important forage grass in the Midwest prairie states.

f. Wildlife use by songbirds and white-tailed deer for food and for nesting and escape cover.

Refer to Table 13.2 for various seed mixtures recommended for permanent cover for soil conservation planting areas.

Other seed mixtures than those listed in Table 13.2 may also be developed for selected areas but shall be approved by the Bureau of Project Delivery, Highway Delivery Division, Highway Design and Technology Section.

Refer to Table 13.3 for various specialty soil conservation areas where the recommended seed mixtures listed in Table 13.2 can be used.

Refer to Table 13.4 to convert the seeding rates listed in Table 13.2 to lb/1000 SY which is the standard area measurement for Department seeding applications.

TABLE 13.1
SPECIES FOR EROSION CONTROL AND SOIL CONSERVATION PLANTINGS

SPECIES	GROWTH HABIT[1]	TOLERATES					PERSISTENCE[3]	MINIMUM SEED SPECIFICATIONS[5]				
		WET SOIL	DRY SITE	LOW FERTILITY	ACID SOIL (Ph 5-5.5)[2]	ALUMINUM[3]		PURITY (%)	READY GERM (%)	HARD SEED (%)	TOTAL GERM (%)	SEEDS/lb (1000's)
Warm-Season Grasses												
Deertongue grass	bunch	yes	yes	yes	yes	H	L	95	75	—	75	250
Weeping lovegrass	bunch	no	yes	yes	yes	M	S to M	97	75	—	75	1500
Switchgrass	bunch	yes	yes	yes	yes	M	L	95	75	—	75	390
Big Bluestem	bunch	yes	yes	yes	yes	M	L	60 PLS				150
Cool-Season Grasses												
Tall fescue	bunch	yes	no	yes	no	L	M to L	95	80	—	80	227
Redtop	sod	yes	yes	yes	yes	L	M	92	80	—	80	5000
Fine fescues	sod	no	no	yes	no	L	L	95	80	—	80	400
Perennial ryegrass	bunch	yes	no	no	no	L	S to M	95	85	—	85	227
Annual ryegrass	bunch	yes	no	yes	no	L	S	95	85	—	85	227
Legumes												
Crownvetch	sod	no	yes	yes	no	L	L	98	40	30	70	120
Birdsfoot trefoil	bunch	yes	no	yes	yes	L	L	98	60	20	80	400
Flatpea	sod	no	no	yes	yes	L	L	98	55	20	75	10

NOTES

[1] Growth habit refers to the ability of the species either to form a dense sod by vegetative means (stolons, rhizomes, or roots) or to remain in a bunch or single plant form. If seeded heavily enough, even bunch formers can produce a very dense stand. This is sometimes called a sod but not in the sense of a sod formed by vegetative means.

[2] Once established, plants may grow at somewhat lower pH, but cover generally is only adequate at pH 6.0 or above.

[3] Tolerance to aluminum is relative. Soil and spoils must be limed to a pH of 5.5 to 5.7 to eliminate possible aluminum and manganese toxicity. Tolerance ratings: H = high; M = medium; L = low.

[4] Persistence under favorable conditions: L = long duration; M = moderate duration; S = short duration (1 year or less).

[5] MINIMUM SEED SPECIFICATIONS ARE TRULY MINIMUM, AND SEEDLOTS TO BE USED FOR REVEGETATION PURPOSES SHOULD EQUAL OR EXCEED THESE STANDARDS. Thus, deertongue grass should germinate 75% or better. Crownvetch should have at least 40% readily germinable seed and 30% hard seed. Commonly, seedlots are available that equal or exceed the minimum specifications. Remember that disturbed sites are adverse for plant establishment. Ready germination refers to seed that germinates during the period of the germination test and that would be expected, if conditions are favorable, to germinate rapidly when planted. The opposite of ready germination is dormant seed, of which hard seed is one type.

TABLE 13.2
RECOMMENDED SEED MIXTURES FOR PERMANENT COVER FOR SOIL CONSERVATION PLANTINGS

MIXTURE NUMBER	SPECIES	SEEDING RATE (lb/acre) PLS**	
		MOST SITES	ADVERSE SITES ****
1***	tall fescue, or	60	75
	fine fescue	35	40
	plus redtop*, or	3	3
	perennial ryegrass	15	20
2	birdsfoot trefoil, plus	6	10
	tall fescue, plus	30	35
	redtop*	3	5
3	birdsfoot trefoil, plus	6	10
	crownvetch, plus	10	20
	tall fescue	20	30
4	flatpea, plus	20	30
	tall fescue, or	20	30
	perennial ryegrass	20	25
5	tall fescue, plus	40	60
	fine fescue	10	15
6	deertongue grass, plus	15	20
	weeping lovegrass*, plus	1	1
	birdsfoot trefoil	6	10
7	switchgrass, or Big Bluestem	15	20
	plus		
	weeping lovegrass*, plus	1	1
	birdsfoot trefoil	6	10

**** Soil conditions that are very acidic, infertile, severely eroded or possibly toxic and where liming, fertilization or other seedbed preparations are difficult to accomplish.

*** This mixture suitable for frequent mowing. Do not cut shorter than 4 in.

** PLS means Pure Live Seed. PLS is the product of the percentage of pure seed times percentage germination divided by 100. For example, to secure the actual planting rate for switchgrass, divide 12 lb PLS by the PLS percentage shown on the seed tag. Thus, if the PLS content of a given seed lot is 35%, divide 12 PLS by 0.35 to obtain 34.3 lb of seed (35 percent PLS), the amount of seed required to plant 1 acre. All mixtures in Table 13.2 are shown in terms of PLS.

* Keep seeding rate of that recommended in table. These species have many seeds per pound and are very competitive. To seed small quantities of small seeds such as weeping lovegrass and redtop, dilute with dry sawdust, sand, rice hulls, buckwheat hulls, etc.

TABLE 13.3
SOIL CONSERVATION PLANTING AREAS

SEED MIXTURE APPLICATION, TYPE OF AREA	TABLE 13.2 SEED MIXTURE NUMBERS
Slopes and banks (non-mowed)	
(a) Well-drained	4 or 7
(b) Variable drainage	2 or 3
Slopes and banks (mowed)	
(a) Well-drained	1 or 5
Gullies and eroded areas	2, 3 or 7
Conservation structures	
(a) Sod waterways, spillways and other frequent water flow areas	1 or 2
(b) Drainage ditches	
(1) shallow, less than 3 ft	1 or 2
(2) deep, non-mowed	3
(c) Pond banks, dikes, levees, dams, diversion channels and occasional water flow areas	2 or 3
Sanitary landfill areas	2, 3, 6 or 7
Strip-mine spoils, mine wastes, fly ash, slag, settling-basin residues and other severely disturbed areas	2, 3, 4, 6 or 7

TABLE 13.4
SEEDING APPLICATION RATE CONVERSION CHART
1 acre = 43,560 SF = 4,840 SY

lb/acre	lb/1,000 SY	lb/acre	lb/1,000 SY
1	0.25 (4 oz)	15	3
2	0.5 (8 oz)	20	4
3	0.6 (10 oz)	25	5
4	0.8 (13 oz)	30	6.25
5	1	35	7.25
6	1.25	40	8.25
8	1.75	50	10.5
10	2	60	12.5
12	2.5		

Seeding design selections are also controlled by several physical and chemical factors which must be considered prior to selecting a seed mixture. Some design considerations are as follows:

1. Soil analysis including composition, acidity, fertility, moisture content or any toxic properties.

2. Site conditions such as full sun, partial or heavy shade as well as directional slope exposures.

3. Slope criteria including steepness, embankment (fill) or cut surfaces.

4. Desired long term or short term longevity of selected plants including plant specie competition from species in the mixture and from adjacent vegetation.

5. Anticipated maintenance requirements.

A logical guideline procedure for seeding design would include:

1. Carefully analyze any limiting site factors, both physical and chemical.

2. Select an appropriate combination of adaptable plant species.

3. Select an appropriate set of establishment procedures consistent with the needs of the plant species to be seeded and the need to overcome any limiting site factors.

4. Only use seed of proper plant species or varieties of high germination capacity and vigor.

The proper use of lime and fertilizers and the addition of various soil amendments can rectify many unfavorable soil conditions and result in establishing an adequate vegetative cover with desired species.

E. Specification Preparation and Approvals. Seeding specifications for soil conservation plantings shall be prepared to include the following format: (1) soil supplements, (2) specie selections, (3) purity and germination percentages, (4) application rates and (5) construction requirements.

Refer to Figure 13.1 for seeding special provision format.

All seeding specifications and proposed seeding locations for soil conservation plantings shall be approved by the Bureau of Design and Delivery, Highway Design and Technology Division.

F. Seed Quality. All seed sold in Pennsylvania must, by law, have a tag or label listing the tested percentages of pure seed, inert matter, crop seed and weed seed as well as germination percentage and test date. Seed with a test date older than nine months should not be used.

Certified seed is the best assurance of obtaining seed of high physical quality and known genetic identity especially for named varieties. For erosion control and conservation plantings, seed should be high in germination and purity rates.

PLS (Pure Live Seed) is a method of defining the planting quality of chaffy seeds such as various wildflowers and switchgrass. The PLS number is calculated by multiplying the % of pure seed by the % of germination and then dividing by 100. Example: 72% pure seed × 85% germination ÷ 100 = 61% PLS. This allows the amount of seed required to be adjusted to compensate for low purity and germination (see Table 13.2 note for an example of how the seed application rate is adjusted for the desired PLS number).

Generally "common seed" or seed of unknown genetic origin can be used for soil conservation plantings if certified seed is not available.

FIGURE 13.1
SPECIAL PROVISION FORMAT FOR SPECIAL SEEDING MIXTURES

SAMPLE SPECIAL PROVISION

Item 9804 - ×××× - Seeding and Soil Supplements - (Insert appropriate name)

DESCRIPTION - This work is furnishing and placing seed and soil supplements of the type specified.

MATERIALS -

(a)	Pulverized Agricultural Limestone	Section 804.2(a)1
(b)	Commercial Fertilizer	Section 804.2(a)2
(c)	Slow-Release Nitrogen Fertilizer	Section 804.2(a)3
(d)	Inoculant (When Applicable)	Section 804.2(c)
(e)	Seed Formula	

SEEDING RATE lb/1000 SY	MIN% PURITY/GERMINATION	MAX% WEED SEED

(Insert Desired Seed Formula)

Seed to meet applicable requirements of Section 804.2(b) for seed tests, PA Dept of Agriculture regulations, PA Seed Act of 1965, Act No. 187 and delivery of seed to work area.

CONSTRUCTION -

Loosen or roughen soil surface on all areas to receive seed to a depth of at least 2 in.

Apply soil supplements in accordance with Section 804.3(c). Prior to project completion apply slow-release nitrogen fertilizer to soil surface.

When applicable, inoculate leguminous seed in accordance with Section 804.3(d).

Apply seed in accordance with Section 804.3(e). Spread seed where indicated and at the specified rate within the following dates, or as directed.

(Insert Desired Seeding Dates)

Follow Sections 804.3(i) and (j) for liability and maintenance requirements.

Mulch seeded area with straw in accordance with Section 805.

MEASUREMENT AND PAYMENT -

(a) Seeding and Soil Supplements. Pound.
(b) Mulching. Section 805.4(a).

Some seeds, generally unscarified seeds of legumes such as crownvetch, birdsfoot trefoil and flatpea may have a watertight seedcoat. The seedcoat is eventually broken by either frost action or microbial action and germination will then produce a seedling. Seeds impervious to water are termed hard seed. The percentage of hard seeds in a given lot is added to the percentage of readily germinating seed to yield the total germination percentage. Legume seed lots should contain a certain minimum amount of hard seed as an insurance factor.

G. Seed Bed Preparation. Prior to seed application, soil supplements such as pulverized agricultural limestone and various fertilizer applications are required to prepare the area to be seeded.

Formula E does not normally require any applications of soil supplements. However, separate applications of lime, fertilizer or both may be necessary to establish the temporary grass cover in certain situations where anticipated soil conditions would not be conducive to good grass germination and growth.

Formulas B, C, D, L and W require soil supplement applications as specified in Publication 408, *Specifications,* Section 804.

Special soil conditions may require altering the standardized soil supplement application rates. All revisions shall be approved by the Bureau of Project Delivery.

Finished slopes should be seeded and mulched in increments of approximately 15 ft with permanent in-season seeding at the full application rates specified for soil supplements, seed and mulch. If out-of-season seeding is approved, apply either the full specified quantities for supplements, seed and mulch or apply full supplements and 50% of the seed application rate to be followed by the remaining 50% within the next seeding dates. Full mulch rate applications will be required for each seeding application to prevent soil erosion until seed germinates.

H. Mulching. All seeded areas should be mulched with an appropriate approved mulch to reduce the potential for erosion while the seeds germinate. Mulch also aids seed germination by conserving moisture in the soil, encouraging water infiltration and helping to regulate soil temperature from excessive exposure to the sun's heat.

Several mulch materials such as straw, hay, wood fiber, pellet mulch and bonded fiber matrixes are approved for use with seeding operations. Wood chips have also been successfully used in some conservation type seeding areas if application depths are strictly followed.

1. Straw. This material is one of the most preferred and one of the least expensive mulches for most seeding operations. Use on all topsoiled areas. Straw needs to be secured in place with either approved mulch control binders or mulch control netting to prevent loss of material by natural winds or breezes caused by vehicular movement.

2. Hay. This material is more adaptable to steeper slope conditions than straw but is more apt to introduce undesirable weed seeds. This application may have wide use for development of wildlife habitat areas where it helps to introduce more diverse plant types. Use on untopsoiled areas. Hay needs to be secured in place with either approved mulch control binders or mulch control netting to prevent loss of material by wind.

3. Wood Fiber. This material is applied with hydraulic mulching/seeding equipment and after drying, provides a thin protective cover. Wood fiber does not provide as much erosion protection or moisture retention for seed germination as straw or hay. The wood fiber must adhere to the soil surface and its protective longevity is less than other mulches. Use on areas where fire hazard potential for straw or hay is high or where a less conspicuous mulch appearance is desired. No weed seeds are introduced with this material.

4. Wood Chips. Placing wood chips in thin mulch layers not deeper than 2 in has been successfully used in conservation type seeding areas. Thicker mulch layers of 3 in, 4 in or deeper can be used without seed in temporary areas to provide erosion control until the permanent soil surface is prepared.

5. Pellet Mulch. This mulch is compressed pellets of shredded recycled paper which lose their pellet shape and adhere to other pellets, after water application, to form a thin protective cover. Pellet mulch is best used on flatter areas where a more refined turf grass, such as a lawn, is desired. Pellet mulch will not blow away.

Pellets are applied using rotary or drop-spreader equipment; therefore, slope steepness must be considered. No weed seeds are introduced with this material.

6. Bonded Fiber Matrix (BFM). This mulch is composed of fibrous material bonded together with adhesive agents to form a continuous, porous, erosion resistant protective cover which also adheres to the soil surface. BFM must be applied using hydro-mulching/seeding equipment and is applied at higher rates than standard wood fiber mulch. Generally use BFM on steep slopes where access and soil preparation is difficult. Use also on flatter areas where tacked straw or hay are prone to blow away or as an alternate to erosion control mats or blankets on slopes. Avoid using in direct water flow areas such as ditches, channels and swale centerlines, etc.

All areas of mulch use for seeding will be shown on the applicable typical sections and on the tabulation sheets.

Apply mulches at the rates specified in Publication 408, *Specifications,* Section 805.

13.3 OTHER STABILIZATION METHODS

A. Discussion. In most flat slope areas and areas where water generally does not have a concentrated flow, applying only mulch to the seeded area will be sufficient to provide the initial protection until the grass cover is established. On steeper slope areas, highly erodible soils, and drainage channels, other erosion control material will be necessary to provide the required protection to the seed and soil. Erosion control mats and blankets are commonly used for these applications. Turf reinforcement mats can artificially reinforce or augment the grass surface to permanently increase or enhance its resistance to erosion, and reduce the risk of grass failure due to localized poor cover establishment.

On the other hand, there are situations where grass establishment is not the most appropriate or, perhaps, cost-effective means of stabilization. Acceptable non-vegetated stabilization options are listed below.

Design guidance for all of the stabilization measures listed below can be found in Publication 584, *PennDOT Drainage Manual*, Chapter 8, Open Channels and Chapter 12, Erosion and Sediment Pollution Control.

B. Approved Measures.

1. Rolled Erosion Control Products (RECPs). Most provide temporary stabilization. Turf reinforcement mats are considered long-term, permanent stabilization measures.

- **a.** Mulch Control Netting.
- **b.** Open Weave Textile.
- **c.** Erosion Control Blanket.
- **d.** Turf Reinforcement Mat.

2. Spray on Mulches. Method of applying mulch (usually also seed and fertilizer) as a spray from a hydraulic tanker truck.

3. Geocell Slope Confinement. Cellular HDPE material that is typically used to stabilize steep side slopes.

4. Articulated Concrete Block Revetment System (ACBR). Interlocking or tied blocks of concrete used to permanently stabilize slopes.

5. Gabions. Wire baskets filled with stone or riprap that can be stacked and somewhat deformed, if necessary.

13.4 EROSION CONTROL MEASURES

A. Discussion. Erosion control measures, or Best Management Practices (BMPs) are used to prevent the erosion of earth by the forces in stormwater runoff. Erosion of unstabilized and unprotected earth can occur very easily. The previous section dealt primarily with protecting disturbed slopes while vegetation is being established or where vegetation alone is not sufficient. Most of the erosion control BMPs in this section are associated with the protection of slopes or channels receiving concentrated flow, such as from an upstream channel, pipe, or culvert.

B. Approved Measures. A number of erosion control BMPs that are appropriate for use on highway projects have been approved by the Department. The list below contains the names and brief descriptions of some of these approved BMPs. Additional information on these devices can be found in Publication 584, *PennDOT Drainage Manual*, Chapter 8, Open Channels and Chapter 12, Erosion and Sediment Pollution Control. Plan drawing details for most of the BMPs are located in the Publication 72M, *Roadway Construction Standards*; these should be included in the Erosion and Sediment Pollution Control (ESPC) Plan.

1. Channel Lining. Flexible (grass, RECPs, rock, etc.) or rigid (concrete) materials used to protect the underlying soil from erosion. Publication 584, *PennDOT Drainage Manual*, Chapter 8, Open Channels contains relevant design procedures and information.

2. Paved Energy Dissipator. Section of concrete channel lining containing partially embedded stones designed to dissipate energy in channels with velocities greater than 14 ft/s.

3. Rock Apron. Used to prevent scour and dissipate energy at pipe or channel outfalls where anticipated discharge velocities do not exceed 14.5 ft/s and where the apron can be installed on a level grade.

4. Rock Basin or Rock Energy Dissipator. Pre-formed scour holes that are used to dissipate energy and control erosion at pipe outlets where outlet velocities exceed the allowable limits of the soil or channel lining, but are 19 ft/s or less.

5. Stilling Well. Concrete energy dissipator constructed below grade at the outlet end of pipes and culverts.

6. Temporary Slope Pipe Drain. Installed to transport stormwater runoff safely down the face of a cut or fill slope to a stabilized area. Should be used prior to the installation of permanent facilities and/or growth of adequate ground cover on the slopes.

7. Diversion Ditch. Any type of channel that is constructed above a disturbed area to intercept and convey offsite runoff or runoff from undisturbed areas away from unstabilized areas.

C. Design Flows. In general, the temporary erosion control BMPs listed above must be designed to resist erosion for the 2-year storm event. Exceptions to this must be made for disturbances within Special Protection Watersheds (SPW) and for measures that will become permanent stormwater management or drainage facilities. Channels within a SPW must be provided with temporary lining able to resist erosion for the 5-year storm event. Permanent channel lining in any watershed must be resistant to erosion for the 10-year storm event, at a minimum. Temporary pipes, and outlet protection for temporary pipes, must be designed for the 2-year storm event (5-year storm event for SPW). Permanent outlet protection shall be designed for the maximum anticipated velocity from the discharging pipe.

13.5 SEDIMENT POLLUTION CONTROL DEVICES

A. Discussion. Sediment pollution control devices, which are also referred to as BMPs, are installed in and around construction sites to prevent sediments from being transported away from the site. Sediments can be carried off site by stormwater runoff and wind, or they can be attached to construction vehicles and deposited on roads adjacent to or near the site. Some sediment control BMPs temporarily hold runoff to allow sediments to settle out by gravity. Other BMPs filter runoff by straining sediment-laden water through a fine medium, such as filter fabric or gravel. The type of BMP used depends on the specific area of application.

B. Approved Devices. A number of sediment pollution control BMPs that are appropriate for use on highway projects have been approved by the Department. The list below contains the names and brief descriptions of the approved BMPs. Additional design and plan information on the devices listed in this section can be found in Publication 584, *PennDOT Drainage Manual*, Chapter 12, Erosion and Sediment Pollution Control. Plan drawing details for most of the BMPs are located in the Publication 72M, *Roadway Construction Standards*; these should be included in the ESPC Plan.

1. Rock Construction Entrance. Used to remove mud from the tires of construction vehicles leaving the site. Required whenever vehicular access onto unpaved areas is necessary.

2. Rock Filter Outlet. Used to replace damaged sections of silt barrier fence or to fill in space between the end of a section of silt barrier fence and a slope.

3. Compost Filter Sock. A perimeter control device that filters runoff in the form of sheet flow. Use at the bottom of disturbed slopes that would normally drain across the right-of-way line or into a channel. Consists of compost material wrapped in a geotextile container.

4. Compost Filter Berm. Same as compost filter sock, except that the compost is mounded instead of being wrapped in a geotextile container.

5. Silt Barrier Fence. Same application as a compost filter sock. Geotextile fabric is fastened to stakes that are driven vertically into the ground.

6. Heavy Duty Silt Barrier Fence. Should be used when slope lengths exceed the capacity of standard silt barrier fence. Fabric is reinforced with wire mesh backing and metal posts are used instead of wood stakes.

7. Vegetated Filter Strip. Well-established perennial grassy area located below a disturbed area used to remove sediment from runoff prior to it reaching receiving waters.

8. Pumped Water Filter Bag. Used to filter out sediments from water pumped from excavation holes associated with bridge piers and abutments. Also used to dewater trenches and filter water pumped from sediment traps and basins.

9. Storm Inlet Protection. Used to filter or settle out sediment in runoff from disturbed areas before it enters the storm sewer. Includes inlet filters, traps, and berms.

10. Rock Barrier. Temporary stone dam installed across a channel to remove sediment originating from flow in the channel before vegetation is fully established.

11. Sediment Trap. Temporary storage area used to detain sediment-laden runoff from small, disturbed areas. Types include embankment, Type M inlet, and riser sediment traps.

12. Sediment Basin. Large ponding area used to detain sediment-laden runoff from large, disturbed areas.

13.6 PREPARATION AND PROCESSING OF EROSION AND SEDIMENT POLLUTION CONTROL PLANS

A. Plan Preparation. In order to minimize accelerated erosion and to control sediment pollution during highway construction, proper preparation and adherence to implementation of the scheduled sequence of operation of ESPC Plans is of primary importance.

Erosion and sediment pollution control should be initially considered in the preliminary design stage and plans fully developed during the final design stage of a highway project.

The purpose of the ESPC Plan is to identify potential erosion problems and to define effective and economical measures to be used in conjunction with construction activities to minimize erosion and sediment pollution. The ESPC Plans for a project shall be prepared and processed in accordance with Publication 14M, Design Manual, Part

3, *Plans Presentation,* Chapter 6. All erosion and sediment pollution control BMPs shall be indicated by the applicable symbols presented in Publication 14M, Design Manual, Part 3, *Plans Presentation,* Chapter 13.

An ESPC Plan, as applied to Department projects, shall consist of three parts: (1) maps and drawings showing the topography of the area, the proposed alteration to the area and the erosion and sediment pollution control BMPs; (2) a narrative report describing the project and indicating the purpose and the engineering assumptions and calculations for control BMPs; and (3) detailed instruction in the contract proposal and/or the plan, as extracted from the narrative report data, to define staging, sequencing and scheduling of earthmoving activities and the installation of the erosion and sediment pollution control BMPs. The staging should be determined on the basis of such factors as: (1) drainage divide, (2) grade line direction, (3) efficient and economical construction operation, (4) earthwork balancing, (5) protection of traffic, and (6) maintenance consideration.

The following references located in Publication 584, *PennDOT Drainage Manual*, is useful information for developing PennDOT ESPC Plans:

- Chapter 8 – Design procedure and guidance for channel lining
- Chapter 12 – Design guidance for approved BMPs
- Chapter 12, Appendix B – Recommended notes for ESPC Plans
- Chapter 12, Appendix C – Recommended standards for ESPC Plans

B. Implementation and Maintenance. Implementation of the ESPC Plan on the project site and maintenance of BMPs thereafter are the responsibilities of the party performing the work, which is either the Department or the contractor. Every ESPC Plan shall contain a sequence of earthwork activities that includes installation and removal of all proposed temporary and permanent BMPs. The contractor will be responsible for implementing the plan per this sequence. Contractors shall also be notified of their responsibilities, which include but are not limited to the following:

- Ensure that the ESPC Plan is properly and completely implemented in accordance with the drawings and the technical specifications.

- Perform maintenance inspections on all BMPs after each rainfall event and, at a minimum, on a weekly basis, and document the inspections using inspection log sheets. All preventative and remedial work must be performed immediately.

- Obtain approval from the appropriate county conservation district or PA DEP regional office if deviation from the ESPC Plan is necessary or desired.

- Maintenance of all permanent BMPs becomes the responsibility of the owner in perpetuity upon completion of construction and acceptance by owner, subject to the terms of the warranty period specified in the contract documents.

- Fines and related costs resulting from the contractor's failure to provide adequate protection against soil erosion and for any violations of the Clean Streams Law and the rules and regulations promulgated thereunder shall be borne by the contractor.

These responsibilities and others specific to the project shall be described in the ESPC Plan. Maintenance instructions for each BMP to be used on a project must be provided on the plan.

C. Other Necessary Actions for Project Compliance. To assure compliance with regulatory requirements and to provide additional emphasis on erosion and sediment pollution control, necessary actions should be taken to comply with the following:

1. The ESPC Plans should be judiciously developed and implemented in accordance with the procedures and criteria specified in Publication 584, *PennDOT Drainage Manual*, Design Manuals, and Publication 72M, *Roadway Construction Standards*. If the proposed measures and facilities deviate from the specified procedures or criteria, it should be demonstrated that the alteration shall also result in prevention of accelerated erosion and sedimentation.

In general, only one ESPC Plan needs to be developed throughout the life of a project. This plan would normally cover all staged earthmoving activities. However, on major highway projects, it may be necessary to develop two or more control plans to address earthmoving activities which will occur before or after the prime construction project, or to be performed by a separate contractor or consultant.

2. A National Pollutant Discharge Elimination System (NPDES) permit is required for those highway projects in which the total project earth disturbance area is equal to or greater than 1 acre. In Pennsylvania, the NPDES permit program is delegated to and administered by PA DEP. PA DEP has delegated the management of the NPDES program to most of the County Conservation Districts. PA DEP and County Conservation Districts jointly regulate construction activities utilizing existing state regulations concerning erosion control and NPDES permits to implement the Federal requirements.

The 1972 amendments to the Federal Water Pollution Control Act (Clean Water Act or CWA) prohibit the discharge of any pollutant to Navigable Waters of the United States from a point source unless the discharge is authorized by a NPDES permit. The U.S. Environmental Protection Agency (EPA) has promulgated rules for the NPDES permit process:

- Phase I: Established in 1990, Phase I addresses discharges from large construction activities disturbing 5 acres or more of land.

- Phase II: Established on December 8, 1999, Phase II covers small construction activities that result in a land disturbance of equal to or greater than 1 acre and less than 5 acres. Site activities disturbing less than 1 acre are also to be regulated as a small construction activity if they are part of a larger common plan of development or sale with a planned disturbance of equal to or greater than 1 acre and less than 5 acres.

PA DEP issues two types of NPDES permits for Stormwater Discharges Associated with Construction Activities – a General Permit (PAG-2) and an Individual Permit. PAG-2 covers most projects; however, an Individual Permit is needed for projects in "special protection" watersheds (high quality, exceptional value, and exceptional value wetlands). Copies of the NPDES permit application forms, instructions, and other related documents are available through PA DEP's website (www.dep.pa.gov).

Each local municipality and county involved shall be notified, pursuant to Act 14, P.L. 834, to the effect that an application for the NPDES has been filed with PA DEP and the documentation of this notification included in the application submitted. No permit application fee is required for any application submitted by the Department. The NPDES shall be processed by the Engineering District through the County Conservation District, or PADEP, according to the established procedure. If construction of the project can not be completed within the time limit normally specified in a permit, a longer time limit to cover the entire construction period should be requested when the permit application is submitted.

3. An NPDES permit is not required for those highway projects which involve a total project earth disturbance area of less than 1.0 acre. However, the erosion and sediment pollution control measures and plans must comply with PA DEP's Chapter 102 regulations.

4. Best Management Practices (BMPs) must be utilized for all earth disturbances, regardless of area. Standards for the BMPs are contained in Publication 584, *PennDOT Drainage Manual*, Chapter 12.

5. A written ESPC Plan must be prepared for projects that disturb 5000 ft^2 or more. (Note: Two additional conditions which may require a written plan are listed in PA Code Section 102.4(b)(2).)

6. An Erosion and Sediment Control Permit is required for roadway maintenance projects that disturb 25 acres or more.

7. Special protection BMPs are required when earth disturbance activities may result in a discharge into a water classified under Chapter 93 of the PA Code as High Quality (HQ) or Exceptional Value (EV), including EV wetlands.

8. The current standard special provisions for the ESPC, as indicated in the Department's Contract Management System, should be included in all applicable contract proposals.

9. The necessary ESPC practices must be fully implemented and monitored during the construction of the highway project.

10. One copy of the ESPC Plan should be sent by the Engineering District to the Central Office, Bureau of Design and Delivery, Highway Design and Technology Division for information and review at the time the plan is submitted to the County Conservation District.

11. The County Conservation Districts have been delegated responsibilities for PA DEP's Erosion and Sediment Control Program. Under this program, authority is delegated to Conservation Districts at three different levels: Level I, Level II, and Level III. Level I delegation (four counties) includes providing information on PA DEP's Erosion and Sediment Control Program, the review and processing of Erosion and Sediment Control Permit applications, and the review of Erosion and Sediment Control Plans. Level II delegation (51 counties) includes Level I responsibilities, plus responsibilities of complaint investigation and site inspections. Level III delegation (10 counties) includes Level I and II responsibilities, plus enforcement responsibilities such as administrative hearings, equity actions, summary or misdemeanor actions, and assessment of civil penalties.

In addition to the Erosion and Sediment Control Program, 60 Level II and III Conservation Districts are also delegated responsibilities for processing National Pollutant Discharge Elimination System (NPDES) Permits for Stormwater Discharges Associated with Construction Activities. (Note: Philadelphia County does not have a County Conservation District.)

12. During construction, it is encouraged that PA DEP's Area Office staff be contacted to assist in implementing the erosion and sedimentation control measures and facilities. All significant changes, additions and/or deletions to the plans approved with a permit which will affect erosion and sediment pollution controls shall be approved by PA DEP prior to construction.

13. Generally, individual PennDOT construction projects will be issued one NPDES permit for the entire project, and this permit will apply inclusively to borrow and spoil areas.

14. NPDES permits are issued during the final design phase.

15. After spoil and borrow areas are identified, and before any earth moving activities occur in them, ESPC Plans must be submitted and approved. Once approved, these ESPC Plans automatically become amendments to the project's original NPDES permit.

16. Since there is only one NPDES permit issued to PennDOT for the entire project, if this permit is violated and subsequently suspended or revoked, that action will affect the entire project.

13.7 ANTIDEGRADATION AND POST CONSTRUCTION STORMWATER MANAGEMENT POLICY

A. Introduction. The Department performs a broad spectrum of activities to maintain and improve the state's highway system. Construction activities involving earth disturbance often result in the need to manage stormwater runoff. A comprehensive approach is necessary to address the challenges associated with managing stormwater runoff from linear highway systems. The Department employs an "E^5" strategy for addressing stormwater management issues. The goal is to integrate each of the E^5 components into the overall design process to achieve a more sustainable and efficient program:

- **E**xamine site characteristics and stormwater management needs early in the design process.
- **E**ngage PA DEP through pre-application meetings.
- **E**ncourage low impact practices for preventing runoff.
- **E**valuate new technologies and assess the performance of existing ones in the field.
- **E**ducate Department staff, consultants, and contractors on stormwater policy and implementation.

B. Definitions.

1. 3R Projects. The term 3R stands for resurfacing, restoration, and rehabilitation. 3R projects typically involve pavement improvement work (short of full-depth replacement) and targeted safety improvements. 3R projects generally involve retention of the existing three-dimensional alignment.

2. Antidegradation Best Available Combination of Technologies (ABACTs). Defined in 25 PA Code Chapter 102. Environmentally sound and cost effective treatment, land disposal, pollution prevention and stormwater reuse BMPs that individually or collectively manage the difference in the net change in stormwater volume, rate, and quality for storm events up to and including the 2-year/24-hour storm when compared to the stormwater rate, volume and quality prior to the earth disturbance activities to maintain and protect the existing quality of receiving surface waters of this Commonwealth.

3. Best Management Practices (BMPs). Defined in 25 PA Code Chapter 102. Activities, facilities, measures, planning or procedures used to minimize accelerated erosion and sedimentation and manage stormwater to protect, maintain, reclaim, and restore the quality of waters and the existing and designated uses of waters within this Commonwealth before, during, and after earth disturbance activities.

4. Combined Sewer Systems (CSSs). Defined by 25 PA Code Chapter 92a. A sewer system that has been designed to serve as both a sanitary sewer and a storm sewer.

5. Degradation. For HQ and EV watersheds, degradation is an adverse effect that results in a negative change in the existing water quality of the receiving surface water. For non-HQ and non-EV watersheds, it is a negative change in the existing or designated in-stream water use or the level of water quality necessary to protect the use.

6. Disturbed Area. Defined in 25 PA Code Chapter 102. Unstabilized land area where an earth disturbance activity is occurring or has occurred.

7. Ephemeral Stream. Defined in 25 PA Code Chapter 89. A water conveyance which lacks substrates associated with flowing waters and flows only in direct response to precipitation in the immediate watershed or in response to melting snowpack and which is always above the local water table.

8. Evapotranspiration (ET). The sum of evaporation and plant transpiration of water. Evapotranspiration accounts for a significant portion of the rainfall that is lost (not returned to streams via surface runoff) in Pennsylvania watersheds. The amount of evapotranspiration is influenced mostly by the types of vegetation and land use in a watershed. Because water transpired through leaves comes from the roots, plants with deep reaching roots can more constantly transpire water. Thus, herbaceous plants transpire less than woody plants because herbaceous plants usually lack a deep taproot. Also, woody plants keep their structure over long winters while herbaceous plants must grow up from seed in the spring in seasonal climates and will contribute almost nothing to evapotranspiration in the spring.

9. Impaired Stream. A surface water that does not meet the water quality criteria for its designated or existing use under 25 PA Code Chapter 93. Streams are examined for four main uses: water supply, aquatic life, recreation, and fish consumption. PA DEP monitors surface waters for biology, chemistry, and physical habitat using methods outlined in the approved 2015 Assessment Methodology. Impaired waters are listed in Categories 4 and 5 of Pennsylvania's Integrated Water Quality Monitoring and Assessment Report.

10. Impervious Area. A surface that is compacted or covered with a layer of material so that it is resistant to infiltration by water, including but not limited to structures and buildings; non-porous asphalt and concrete; gravel roads, driveways and parking areas; land areas covered with significantly compacted and unvegetated soil such as dirt roads, driveways and parking/storage areas; and other surfaces routinely used for vehicle parking and movement.

11. Infiltration. The process by which surface water penetrates through the ground surface into the soil. The soil texture and structure, vegetation types and cover, water content of the soil, soil temperature, and rainfall intensity all play a role in controlling infiltration rate and capacity. For example, coarse-grained sandy soils have large spaces between each grain and allow water to infiltrate quickly. Vegetation creates more porous

soils by both protecting the soil from pounding rainfall (which can close natural gaps between soil particles) and loosening soil through root action.

12. Long Term Control Plan. A plan developed by municipalities and/or municipal authorities designed to mitigate the impact of combined sewer system discharges and meet water quality standards.

13. Municipal Separate Storm Sewer System (MS4). Defined by 25 PA Code Chapter 92a (and paraphrased here). A separate storm sewer (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, human-made channels or storm drains) which is owned or operated by a public body (created by or under State law) having jurisdiction over disposal of sewage, industrial wastes, stormwater or other wastes; that discharges to surface waters of this Commonwealth; is designed or used for collecting or conveying stormwater; is not a combined sewer; and is not part of a publicly owned treatment works.

14. Net Change. Refers to the change from pre-development to post-development conditions.

15. New Construction. Roadways that are built on a new alignment.

16. Non-discharge Alternative. Defined in 25 PA Code Chapter 102. Environmentally sound and cost-effective BMPs that individually or collectively eliminate the net change in stormwater volume, rate and quality for storm events up to and including the 2-year/24-hour storm when compared to the stormwater rate, volume and quality prior to the earth disturbance activities to maintain and protect the existing quality of the receiving surface waters of this Commonwealth.

17. Off-site Discharge. An off-site discharge is a stormwater discharge to a non-surface water such as a swale, ephemeral channel, or ground surface via level spreader, that will flow through a property or properties not owned by the Department prior to reaching a surface water. This definition applies to both construction and post-construction discharges.

18. Pre-development. Refers to runoff condition that exists onsite immediately before the planned project occurs. Pre-development is not intended to be interpreted as the period before any human-induced land disturbance activity has occurred.

19. Post Construction Stormwater Management (PCSM). Defined in 25 PA Code Chapter 102. Management of stormwater associated with a project site after the earth disturbance activity has been completed and the project site is permanently stabilized. The term "post-construction" is used to differentiate PCSM from discharges during construction. Erosion and sediment pollution control (ESPC) plans are required for most construction projects to show that runoff from disturbed areas during construction is properly managed. PCSM deals with runoff from the project after the earth disturbance is completed and the site has been stabilized.

20. Post-development. Refers to runoff condition that exists onsite after the earth disturbance activity has been completed and the project site is permanently stabilized.

21. Reconstruction. Roadways that are rebuilt primarily along the existing alignment. Reconstruction normally involves full-depth pavement replacement. Other work that would fall into the category of reconstruction would be adding lanes adjacent to an existing alignment, changing the fundamental character of the roadway (e.g., converting a two-lane highway to a multi-lane divided arterial) or reconfiguring intersections and interchanges.

22. Riparian Buffer. A vegetated area that plays a key role in maintaining water quality and providing nutrients in associated streams, rivers and lakes, thus providing economic and environmental benefits. It is simply defined as "A BMP that is an area of permanent vegetation along surface waters," in 25 PA Code Chapter 102.

23. Riparian Forest Buffer. Defined in 25 PA Code Chapter 102. A type of riparian buffer that consists of permanent vegetation that is predominantly native trees, shrubs and forbs along surface waters that is maintained in a natural state or sustainably managed to protect and enhance water quality, stabilize stream channels and banks, and separate land use activities from surface waters.

24. Road Maintenance Activity (RMA). Earth disturbance activities within the existing road cross-section, as defined in 25 PA Code Chapter 102. Guidance on the types of work that meet the definition can be found in Publication 584, *PennDOT Drainage Manual*, Chapter 12, Appendix E.

25. Special Protection Waters. Antidegradation requirements in Pennsylvania provide protection to waterbodies in discrete levels or tiers based on their existing uses, level of water quality, and environmental characteristics. The standard level of protection given to all waterbodies is to protect and maintain their designated and existing uses. A special level of protection is afforded to waterbodies with High Quality and Exceptional Value existing or designated uses, which is to protect existing water quality. These waterbodies are often referred to as Special Protection Waters.

26. Stormwater Control Measure (SCM). A technique, measure, or structural control that is used for a given set of conditions to manage stormwater runoff quantity, minimize erosive conditions, and improve effluent quality in a cost-effective manner.

27. Surface Waters. Defined in 25 PA Code Chapter 102. Perennial and intermittent streams, rivers, lakes, reservoirs, ponds, wetlands, springs, natural seeps, and estuaries, excluding water at facilities approved for wastewater treatment such as wastewater treatment impoundments, cooling water ponds, and constructed wetlands used as part of a wastewater treatment process.

28. Thermal Impact. Defined in 25 PA Code Chapter 96. The threshold for a thermal impact to the water quality of a receiving surface water is more than two degrees Fahrenheit change during a one-hour period in mean water temperature. The water quality criteria do not preclude the allowance of a reasonable mixing zone if there is no significant effect on the ambient temperature of the stream outside the mixing zone.

29. Total Maximum Daily Load (TMDL). Defined by 25 PA Code Chapter 96. The sum of individual waste load allocations for point sources, load allocations for nonpoint sources and natural quality and a margin of safety expressed in terms of mass per time, toxicity or other appropriate measures. It is the amount of pollutant loading that a waterbody can assimilate and meet water quality standards. The TMDL process is a planning tool to develop pollution reduction goals that will improve impaired waters to meet water quality standards.

C. Design Standards and Calculations. A quantitative PCSM analysis is required whenever a project must obtain a permit under 25 PA Code Chapter 102 (herein referred to as Chapter 102) or it is within a watershed with an approved and current Act 167 Stormwater Management Plan (SMP). Three key measures are used to assess the potential for impacts from stormwater runoff – rate, volume, and quality. The goal of PCSM is to prevent or minimize any increase in the quantity (rate and volume) of runoff while also minimizing the factors affecting the quality. Commonly cited concerns related to potential effects of roadway runoff on water resources are:

- Stream channel erosion and flooding resulting from increases in runoff rate and volume.
- Water quality impacts to streams from particulates, floatables, hydrocarbons, and deicing materials.
- Thermal impact on streams from heat transfer, base flow reduction, and loss of riparian buffer vegetation.

The PCSM design standards for Department projects address these concerns and are consistent with Chapter 102, which states that PCSM for any project must maintain and protect existing water quality and existing and designated uses by maintaining the site hydrology and water quality, and erosive impacts of the conditions prior to initiation of any earth disturbance activities. Section 102.8.b of Chapter 102 states PCSM "shall be planned and conducted to the extent practicable" in accordance with these eight items:

- Preserve the integrity of stream channels and maintain and protect the physical, biological and chemical qualities of the receiving stream.
- Prevent an increase in the rate of stormwater runoff.
- Minimize any increase in stormwater runoff volume.
- Minimize impervious areas.
- Maximize the protection of existing drainage features and existing vegetation.

- Minimize land clearing and grading.
- Minimize soil compaction.
- Utilize other structural or nonstructural BMPs that prevent or minimize changes in stormwater runoff.

Each of these items should be considered throughout the planning and design stages. Guidelines on PCSM calculations and assumptions are as follows.

1. Runoff Volume. The net difference in runoff volume from pre- to post-construction conditions for the 2-year, 24-hour storm event should be managed for each point of interest, as defined in Section 13.7.C.6. All non-structural SCMs should first be evaluated and applied to the extent practicable. Other SCMs utilizing infiltration, evapotranspiration, or managed (slow) release must then be evaluated for potential volume reduction "credits." Important cover condition assumptions are explained in Section 13.7.C.4.

2. Peak Rate of Runoff. In the absence of an approved and current watershed-based Act 167 SMP, post-construction peak rates should be controlled to pre-construction peak rates for the 2-, 10-, 50- and 100-year, 24-hour storm events. The cumulative effect of the project on peak flows on the surface water hydrology will be the basis for determining the extent to which SCMs are needed to control rates. Peak rates should be evaluated at each point of interest. As noted in Section 13.7.D, the release rate standards from an approved and current Act 167 SMP are applicable to any portion of a project located within that watershed.

3. Water Quality. The quantitative water quality goal for each surface water is to achieve no net change (i.e., increase) in pollutant loads for storms up to and including the 2-year/24-hour storm. DEP requires analysis of three pollutant constituents: Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN). The Pennsylvania Stormwater Best Management Practices Manual recognizes these three constituents as surrogates for other pollutants that occur in lesser concentration but can also impact water quality. Pollutant loads are calculated for pre- and post-construction conditions and SCMs are used to eliminate increases. DEP published new guidelines for water quality calculations in December 2019 with the reissuance of PAG-02. The guidelines include land cover pollutant concentrations and median outflow pollutant concentrations for various SCM types. Calculations must be demonstrated in the Quality Worksheet of PA DEP's PCSM Spreadsheet, which can be downloaded using the following link:
http://files.dep.state.pa.us/Water/BPNPSM/StormwaterManagement/ConstructionStormwater/DEP_PCSM_Spreadsheet.xlsb

Chapter 102 regulations also require an analysis of potential thermal impacts. While no quantitative analysis is required, a description of how thermal impacts were avoided, minimized, or mitigated must be provided. Strategies to reduce the potential for thermal impacts include:

- Limit the use of curb and gutter sections to the extent practicable.
- Utilize vegetated channels in lieu of storm sewer to the extent practicable.
- Consider vegetated islands in lieu of concrete islands.
- Maintain naturally occurring vegetation (i.e., buffer zones, including wetland and riparian) along streams, rivers and other surface waters for shading and thermal protection.

Although the use of vegetated swales for stormwater conveyance is preferred, storm sewers are buried and generally stay cool; thus, a significant amount of heat loss can take place in a long sewer run before the runoff reaches the surface water.

4. Existing Cover Conditions. The soil-cover complex is an important variable in calculating runoff quantities from a drainage area. Coarser textured soils will generally produce less runoff than finer textured soils. Undeveloped and densely vegetated land cover will produce lower runoff quantities compared to developed and sparsely vegetated land cover.

In Section 102.8(g)(2) of Chapter 102, criteria are given related to land cover assumptions for calculating pre-development runoff volume and water quality. New construction, which means new and relocated roadway projects shall apply these criteria, which are:

- 20% of disturbed impervious areas is computed as meadow cover in good condition.
- All non-forested disturbed pervious areas are computed as meadow cover in good condition.

In accordance with Chapter 102, these criteria shall not be applied to reconstruction and 3R projects (see Definitions in Section 13.7.B). DEP specifically exempts projects that are centered around the existing highway from these criteria by including the phrase, "except for repair, reconstruction or restoration of roadways or rail lines," with criteria above. Not to be confused with Chapter 102 *road maintenance activities*, which are altogether exempt from Chapter 102 permit requirements, these projects shall use the actual existing soil-cover complexes to compute pre-development runoff volumes, including for water quality.

Chapter 102 does allow for exceptions to the former assumption (related to existing impervious areas) if the "existing site contains impervious area and the existing site conditions have public health, safety or environmental limitations." To be exempted, it must be demonstrated that "it is not practicable to satisfy the requirement" and "the stormwater volume reduction and water quality treatment will be maximized to the extent practicable."

Actual existing cover conditions should always be used for peak rate calculations.

5. Discharge Point. Chapter 102 permits require identification of all "discharge points" during and post construction. A discharge point (DP) is equivalent to an MS4 outfall or observation point; the difference is that MS4 outfalls are limited to U.S. Census Urbanized Areas. A DP is herein defined as a location in which runoff from an area of earth disturbance does one of the following:

- Concentrates and drains into a surface water within the right-of-way.
- Discharges through a flow dispersion SCM (e.g., level spreader) prior to draining into a surface water within the right-of-way.
- Leaves the legal right-of-way via waters of the Commonwealth other than surface waters (e.g., human-made drainage ditches, natural ephemeral channels).
- Enters an MS4 that is not operated by the Department.

Pipes that discharge to a waterbody through a bridge abutment or wall of a culvert are DPs. Bridge scuppers are also DPs, but they can be counted as one instead of each individually. Each swale, ditch, or gutter should be mapped as separate DPs, even when they are near each other, such as around bridges. For example, if there are ditches that discharge to a stream in four quadrants of a bridge, each ditch outlet to the stream should be mapped as a DP. Per DEP's instructions, DPs must be identified and labeled sequentially on the plan using three numerical digits, starting with 001.

Sheet flow that originates as sheet flow from the land surface and drains directly into a surface water is not considered a DP. Culverts that convey a stream or other waterbody are not, by themselves, a DP. A daylighted pavement underdrain is also not to be counted as a DP.

6. Point of Analysis. A point of analysis (POA) is where stormwater quantity and quality are analyzed to demonstrate control and management in accordance with Section 102.8(g) of Chapter 102. A POA is located at the receiving surface water and may be within the right-of-way (onsite) or outside of the right-of-way (offsite). When it is located onsite, a POA is also a DP. The net stormwater volumes, peak rates, and pollutant loads resulting from roadway improvements and any proposed stormwater control measures are calculated at the POA.

A single POA is sufficient for watercourses with drainage areas of at least 1.0 mi^2. When runoff from the project area enters the watercourse at multiple locations, the POA is the point furthest downstream that receives runoff from the project site.

It may be appropriate to establish more than one POA for watercourses with drainage areas less than 1.0 mi^2. A "10% rule" may be used as a starting point. If the project site area is less than 10% of the watercourse's drainage area, a single POA will normally be adequate. Otherwise, multiple POAs may be more appropriate, and the project area to any POA should generally not exceed 10% of the watercourse's drainage area.

A POA is also established for each lake, pond, and wetland receiving runoff from earth disturbance areas of the project. A wetland that is regularly flooded by an adjacent watercourse does not require its own POA.

Regardless of the numerical runoff standards being applied or where the POA is located, the integrity of stream channels must be preserved, and the physical, biological and chemical qualities of the receiving stream must be maintained and protected. The key is looking at post-construction stormwater runoff quantities, locations, and characteristics, coupled with the size, sensitivity, and orientation of receiving surface waters. The analysis should allow the designer to draw conclusions about the effects that stormwater discharges from the project site will have on receiving surface waters or discharges from the right-of-way.

Significant changes in drainage area characteristics to a DP contributing to an offsite POA may indicate the need for further evaluation at the DP. For example, if the proposed peak flow rate to an ephemeral stream is significantly higher compared to the existing condition, an evaluation of the stability of the channel and potential effects of spillover into properties adjacent to the channel downstream may be warranted. The channel pathway below the DP to the nearest stable outflow should be evaluated for accelerated erosion during a 10-year, 24-hour storm event. In cases where an increase is necessary and it causes a significant encroachment onto private property, the Department may wish to obtain an express easement from the property owner for the affected areas.

D. Act 167 SMPs and Municipal Ordinances. State highway projects must be designed in accordance with the standards of Act 167 SMPs that are current and approved by PA DEP. These SMPs are normally developed at the county level and then are reviewed and approved by PA DEP. Municipalities within the boundaries of the watershed(s) in the SMP subsequently adopt stormwater ordinances based on the model stormwater ordinance in the SMP. The Department is not required to comply with local stormwater ordinances, including ordinances adopted under an Act 167 SMP. Consistency only with the SMP approved by PA DEP is required. Additionally, since Act 167 requires that SMPs be periodically reviewed and revised at least every five years, consistency with the SMP is only required if it has been revised in accordance with the Act. However, the Department strives to maintain good relations with local municipalities and, on a case-by-case basis, will incorporate provisions in local ordinances when feasible and practicable. Municipal stormwater ordinances should be used to design SCMs on a project only when directed by the Department.

If consistency with an approved and current Act 167 SMP is not practicable, the design standards in Section 13.7.C shall be applied, and the SMP should be followed to the extent practicable.

PA DEP's eMapPA website is useful for determining if all or a portion of a project is within a watershed or county with an approved Act 167 SMP. The most current information for approved Act 167 SMPs is provided through PA DEP's website: https://www.dep.pa.gov/Business/Water/CleanWater/StormwaterMgmt/Pages/Act-167.aspx.

E. Special Protection Surface Water Discharge Analysis. For portions of projects that discharge to special protection surface waters (HQ, EV), failure to eliminate the net change in runoff volume or rate for the 2-year, 24-hour storm will require the use of ABACT BMPs as part of the Chapter 102 permit. To satisfy the special protection surface water discharge requirements, non-discharge alternatives must be implemented to the extent practicable if they exist. If non-discharge alternatives do not exist, then the net change must be managed using ABACT BMPs. ABACT is defined in Section 13.7.B. The analysis should also affirm that the chosen ABACT BMPs fully manage the net change. The analysis is summarized in the Chapter 102 permit.

F. Impaired Surface Waters. PA DEP has an ongoing program to assess the quality of surface waters in Pennsylvania, identify those that are not attaining designated and existing uses, and designate those non-attaining surface waters as "impaired." Assessments are performed for four protected uses of surface waters: aquatic life, potable water, recreation, and fish consumption. For example, the assessment of the aquatic life use is a measure of the health of the aquatic communities such as benthic macroinvertebrates (insects, worms, crustaceans) and fish. An impaired waterbody with respect to aquatic life use means that the overall aquatic community (fish, macroinvertebrates, plants, and algae) is not healthy and there are pollutants or pollution that needs to be minimized

or eliminated to return the waterbody to a healthy condition. Reasons for an impairment may be one or more point sources, like industrial or sewage discharges, or non-point sources, like abandoned mine lands, agricultural runoff, or urban runoff. Examples of the pollutants that can cause impairment are metals, pH, mercury or siltation.

To the extent practicable, when a project is within an impaired watershed, the stormwater design should reduce the sources and pollutant loads that potentially contribute to the impairment. Chapter 102 permits require evaluation of non-discharge alternatives (see definitions) for discharges to surface waters impaired for siltation, suspended solids, turbidity, water/flow variability, flow modifications/alterations, or nutrients. If non-discharge alternatives do not exist, the net change must be managed using ABACT BMPs.

G. Municipal Separate Storm Sewer Systems (MS4). The Department is required to obtain an NPDES permit as a state entity that designs, builds and maintains stormwater conveyance systems in support of transportation systems. The regulated features are Municipal Separate Storm Sewer Systems (MS4s) within U.S. Census urbanized areas that discharge to waters of the U.S. The Department's MS4 covers "conveyance systems owned and/or operated by PennDOT which are designated or used for collecting or conveying stormwater associated with PennDOT roads, highways, bridges and related structures." This includes SCMs which are legally considered appurtenances to PennDOT's conveyance or drainage systems and vehicle maintenance and operation facilities (e.g., stockpiles, county maintenance facilities, etc.). Activities involving MS4 should be coordinated with BOMO.

H. Riparian Buffers. PennDOT projects frequently involve stream crossings that result in earth disturbance within riparian buffers. Chapter 102 includes regulatory requirements for riparian buffers. Act 162 of 2014 amended the Pennsylvania Clean Streams Law to establish methods that can be used to meet riparian buffer requirements for NPDES permits (not all Chapter 102 permits). When read together, Chapter 102 and Act 162 provide the regulatory framework for riparian buffer requirements associated with NPDES permits.

The scope of projects subject to the riparian buffer regulatory requirements of Act 162 and Chapter 102 is relatively limited. The underlying Chapter 102 requirements related to riparian buffers are mandatory only for projects that discharge to surface waters with an HQ or EV designated use. Therefore, riparian buffer requirements only apply to projects requiring an Individual NPDES Permit with earth disturbance activities within 150 feet of a river, stream, creek, lake, pond, or reservoir with an HQ or EV designated use. Other Chapter 102 permits are not covered by Act 162.

PA DEP's published guidance on riparian buffer equivalency and offsetting and the Department's Publication 783, *Environmental Permitting Handbook*, contain useful information on determining applicability and designing the necessary SCMs to satisfy the regulations.

I. Stormwater Control Measures. A stormwater control measure (SCM) is a technique, measure, or structural control that is used for a given set of conditions to manage the quantity and improve the quality of stormwater runoff in a cost-effective manner. In the past, these were often referred to as stormwater best management practices (BMPs). Project-specific conditions and limitations will often dictate the type, number, and size of SCMs that are proposed to manage stormwater for a given project. Detailed information regarding the design, siting, risk considerations, and maintenance of SCMs is contained in Chapter 14 of Publication 584, *PennDOT Drainage Manual*, and Publication 888, *Stormwater Control Measures Maintenance Manual*.

1. Approved SCMs. The following list includes SCMs that are approved for use on PennDOT projects.

Non-Structural SCMs

- Minimize Compaction
- Preserve Trees and Re-vegetate Using Native Species
- Impervious Disconnection
- Slope Roughening

Restoration SCMs

- Riparian Buffer Restoration
- Landscaping and Planting
- Soil Amendment Restoration
- Stream Restoration and Stabilization

Structural SCMs

- Vegetated Swale
- Bioretention
- Vegetated Filter Strip
- Media Filter Drain
- Subsurface Infiltration Trench
- Infiltration Detention Basin
- Infiltration Berm
- Wet Detention Basin
- Stormwater Wetland
- Dry Detention Basin
- Dry Ultra-Extended Detention Basin
- Level Spreader and Flow Dispersion
- Regenerative Step Pool

2. SCMs Requiring Special Approval. These SCMs cannot be proposed for implementation within Department right-of-way without prior approval from the District Stormwater Maintenance Coordinator.

- Street Sweeping (non-structural)
- Permeable Pavement
- Constructed Stormwater Filter
- Manufactured Treatment Devices
- Subsurface Detention Storage

J. Soil Profile and Infiltration Testing. One of the primary PCSM objectives is to manage the net change in runoff volume from pre- to post-construction conditions. Meeting this objective requires a thorough evaluation of the project site for opportunities to include infiltration SCMs. A preliminary site evaluation for infiltration capabilities must be conducted early in the design process to identify areas suitable or unsuitable for infiltration SCMs. Such an evaluation should be conducted by a professional(s) experienced in soil classification, geology, and the design of infiltration SCMs. Appropriate steps are as follows.

1. Evaluate Existing Features.

a. Perform an initial desktop investigation documenting existing conditions at the site (e.g., soil types, karst, surface waters).

b. Review the proposed plan improvements (e.g., locations of cut/fill, utilities, new pavement).

c. Identify potential infiltration SCM locations and testing locations and conduct a site visit that includes surface and shallow depth field observation.

2. Preliminary Testing.

a. Perform at least one infiltration test for every 40,000 ft^2 outside of the roadway cross-section and within the project site boundary (minimum of 4 tests).

b. Collect soil profile data or a soil characterization test pit/bore hole within 100 ft of all infiltration tests to demonstrate that testing was performed in infiltration-conducive soil horizons.

When infiltration is not feasible, it is incumbent on the PCSM Plan preparer to demonstrate that environmental or public safety limitations exist that preclude the use of infiltration SCMs.

If potential areas have been identified, a preliminary plan shall be developed including location(s) and type(s) of the proposed infiltration SCM(s), bottom elevations and a preliminary grading design. Those areas must then be explored to find infiltration SCM design saturated hydraulic conductivity rates.

Section 14.19 of Publication 584, *PennDOT Drainage Manual*, contains additional information regarding procedures for soil characterization and infiltration testing.

K. SCM Inventory Data. The Bureau of Maintenance and Operation (BOMO) maintains an inventory of Department owned SCMs. The data in this inventory serves as the basis of the Department's SCM maintenance program. The inventory contains numerous data fields for each SCM that provides information on an SCM's type, location, age, treatment capabilities, and inspection needs. Any new SCMs designed for a Department project must be added to the inventory to ensure the SCM is properly tracked, inspected, and maintained. The PCSM Plan designer is responsible for submitting new SCM data with the PCSM Plan. The procedure is as follows.

1. PCSM Plan designer completes the SCM inventory spreadsheet in conjunction with the PCSM Plan submission in Final Design.

2. Upon approval of the Chapter 102 permit Notice of Termination, the District Stormwater Maintenance Coordinator (or designee) updates the SCM inventory spreadsheet as necessary to reflect any changes to the design during construction.

3. BOMO reviews the final data and assigns an SCM identification code to begin the post-construction phase of SCM tracking, inspection and maintenance.

L. PCSM Plan. A PCSM Plan is required for all Department projects that require a Chapter 102 permit and SCMs are implemented. In accordance with Publication 14M, Design Manual Part 3, *Plans Presentation*, Chapter 6, the PCSM Plan shall be handled as an "Also Included" Plan. Note that on projects that do not require a Chapter 102 permit, any information for SCMs included in the project may be incorporated into the Construction Plan - a separate PCSM Plan is not required. All standards for PCSM Plan drawings are contained in Publication 14M, Design Manual Part 3, *Plans Presentation*, Chapters 6 and 15. These standards are based upon the requirements in Chapter 102. Each PCSM Plan must be accompanied by supporting calculations.

M. PCSM on Non-Chapter 102 Permit Projects. A PCSM analysis involving quantitative runoff calculations and SCM design is typically only required for projects with a Chapter 102 permit or Act 167 SMP requirements. However, other PA DEP permits also require compliance with Chapter 102. Specifically, this section addresses PCSM requirements for a project that meets the following criteria:

- Less than 25 acres of Road Maintenance Activity (RMA) - no E&S Permit (102.5.b)
- Less than 1 acre of non-RMA earth disturbance - no NPDES permit (102.5.a)
- Includes earth disturbance that is not RMA
- Requires a 25 Pa Code Chapter 105 (Water Obstruction and Encroachment) permit

Section 102.8 in Chapter 102 describes the requirements for PCSM. It states new PA DEP permits that require compliance with Chapter 102 must develop a written PCSM Plan. All Chapter 105 permits require compliance with Chapter 102, as they must have a written ESPC Plan (Section 105.13.g). Chapter 102 RMAs, however, do not require compliance with Section 102.8, even if a Chapter 105 permit is required; the non-RMA areas must comply.

Examples of projects that typically meet the criteria described above include:

- Rehabilitation or replacement of stream crossings
- Slide repair adjacent to a surface water
- Safety improvements that encroach upon a floodway or floodplain or impact wetlands

A common characteristic of these types of projects is that they have a negligible change in stormwater runoff. Therefore, SCMs are often not necessary to achieve compliance with Chapter 102. The requirements can be satisfied by including a narrative in the report for the ESPC Plan that describes how the items in Section 102.8.b of Chapter 102 have been considered. Each surface water that receives runoff from the project should be addressed separately. Additional guidance on satisfying Chapter 102 requirements related to PCSM for these types of projects can be found in Chapter 14 of Publication 584, *PennDOT Drainage Manual*.

N. Off-site Discharges. Some areas within the limits of earth disturbance of a project may not have direct access to surface waters to discharge stormwater runoff. Off-site stormwater discharges are those that do not reach a surface water prior to leaving the legal right-of-way. The Department is expected to secure an easement (e.g., common law or express) providing legal authority for the off-site discharge, unless waived by the property owner. When construction activities will not result in a change in volume or peak rate of stormwater runoff (for all storm events) to existing swales, ditches, storm sewers or similar structures, the existing common law easement can be relied upon.

An express easement should be evaluated when there will be a change in volume or rate of stormwater (for all storm events). The Department is not required to provide or identify its legal right to discharge stormwater in order to obtain a Chapter 102 permit.

The Department must evaluate the effect construction and post-construction stormwater discharges may have on accelerated erosion to down slope or adjacent properties, regardless of whether there are increases in the volume or peak rate of stormwater discharges from a project site. Documentation must be provided that demonstrates that the discharge will not cause accelerated erosion on the properties along the flow path to a surface water.

The following information must be provided with the permit:

- On the ESPC Plan and PCSM Plan drawings, identify all properties and property owners that will or may receive off-site stormwater discharges from the project site until discharges reach surface waters.
- On the ESPC Plan and PCSM Plan drawings, identify the flow path from discharge point to the confluence with a surface water. In addition, identify the soil types, erodibility factors and vegetative cover of the flow path.
- In the written narrative portion of the ESPC Plan and PCSM Plan, provide an analysis that demonstrates that the proposed volume and peak rate of stormwater discharging to the flow path will avoid, minimize, or mitigate accelerated erosion or sedimentation for storm events up to and including the 10-year/24-hour storm.

If stormwater discharges will enter a municipal separate storm sewer system (MS4) or a combined sewer system with combined sewer overflows (CSOs), and there will be an increase in runoff volume or peak rate, the Department must provide written consent from the MS4 or CSO permittee before a Chapter 102 permit can be issued.

CHAPTER 14

COST ESTIMATING

Refer to Publication 352, *Estimating Manual*.

CHAPTER 15

RESERVED FOR FUTURE USE

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CHAPTER 16

BICYCLE FACILITIES

Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*, Chapter 14, Bicycle Facilities.

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CHAPTER 17

EMERGENCY ESCAPE RAMPS

Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*, Chapter 23, Emergency Escape Ramps.

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CHAPTER 18

TEMPORARY ROADS AND BRIDGES

Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*, Chapter 9, Maintenance and Protection of Traffic.

CHAPTER 19

CONSIDERATIONS FOR ALTERNATIVE TRANSPORTATION MODES

Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*.

CHAPTER 20

WILDLIFE CROSSINGS

Refer to Publication 13, Design Manual Part 2, *Contextual Roadway Design*, Chapter 21, Wildlife Crossings.

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