Chapter 5 – Vegetated Buffers

Buffer strips are natural, undisturbed strips of natural vegetation or planted strips of close-growing vegetation adjacent to and downslope of developed areas. As stormwater runoff travels over the buffer area, vegetation and the organic duff layer slow the runoff, trapping particulate pollutants and allowing time for infiltration. Buffers are also effective for phosphorus removal when designed in accordance with this manual. The effectiveness of buffers for pollutant removal depends on the:

- flow path length
- slope of the buffer,
- level spreader berm length (if needed),,
- organic duff layer thickness and structure,
- mineral soil structure, including the consistency, bulk density and depth to restrictive layer or seasonal groundwater table,
- size of the drainage area and,
- type and density of vegetation (resistance to overland flow).

The flow distribution of water to a buffer is critical to its effectiveness. Water should not be allowed to concentrate from uneven runoff distribution, or the buffer will be short-circuited. However, the irregular surface micro-topography of an undisturbed buffer will provide small areas within which runoff can pool, infiltrate and reduce the runoff.

Buffers are used to treat runoff from relatively small amounts of impervious area, as typically found in residential developments and small commercial and industrial sites. This type of BMP requires minimal maintenance and provides an aesthetically pleasing area. This chapter is set up to present general design, construction and maintenance criteria applicable to all buffers, followed by specific design criteria for four different BMP buffers, each of which is appropriate for specific situations.

Size Suitability: Buffers should be directly adjacent to and downhill of the area being treated and the runoff must enter the buffer as sheet flow.

- *Drainage Area:* The required size and type of buffer used is dependent on the size and land use of the area draining to it. Generally speaking, the smaller the area draining to a buffer, the more effective it will be.
- *Location:* Buffers are located downslope of developed areas and along waterways. They should be located directly adjacent to areas for which they are providing treatment. Use of buffers may be limited by location of septic areas, building sites, roads, and driveways. Site planning should provide for the location of buffers as part of the overall development scheme, with consideration of the design criteria listed below. In lake watersheds requiring phosphorus controls, preliminary planning will need to determine the allowable phosphorus export from the site.
- *Maximum Slope:* The buffer's slope must be less than 15% to be included in the calculation of buffer flow path length. Areas with slopes greater than 15% are too steep to be effective as a treatment buffer but should be left undisturbed. The buffer must have a relatively uniform slope so that stormwater does not concentrate in channels. A buffer slope in excess of 15% may be used if it has been evaluated using a site specific hydrologic buffer design model approved by the DEP, and measures have been included to ensure that runoff remains well-distributed as it passes through the buffer.
- *Topography:* The topography of a buffer area must be such that stormwater runoff will not concentrate as it flows across a buffer, but will remain well distributed. Flow paths of runoff through a buffer must not converge, but must be essentially parallel or diverging. This should be confirmed in the field for each area designated as a buffer.

- *Soil Type:* The hydrologic soil group within the buffer may be established from medium intensity maps as adopted by the Natural Resources Conservation Service of the U.S. Department of Agriculture. The hydrologic soil types have been identified in Table 5-1 for soils in Maine. However, the on-site soils for a buffer should always be field evaluated with hand auger borings by a professional soil scientist to confirm the soil type and texture when the accuracy of the survey map for the location of the buffer is a concer
- *Soil Restrictions:* A buffer meeting this standard is not allowed on Hydrologic Soil Group D soils except that a forested buffer is allowed if the D soils in a buffer are not wetland soils. On a case-by-case basis, hydrologic D soils that are wetlands may be allowed if the buffer is forested; the organic duff is of high quality (granular structure) at least 4" thick; and, on a slope of at least 3 percent. Also on a case-by-case basis, Hydrologic D soils buffers that are not presently forested or not having a suitable organic duff layer may be allowed provided that they are on a slope of at least 3 percent; will be improved by the creation of an artificial duff layer; will increase the depth of organic duff; and/or, will improve the quality of the mineral soils (lower bulk density, create good soil structure, increase depth to restrictive layer or seasonal groundwater table, create pit and mound topography, and/or densely vegetate the area). Note: a DEP permit may be required for hydrologic D soils that are part of a wetland.
- *Soil quality:* The most effective buffers have thick organic duff layers (if forested) and soils with good permeability due to good granular soil structure, low bulk density, and a depth to any restrictive layer of at least 12 inches.
- *Separation from Streams:* The length of a buffer can only be counted up to a perennial stream channel or other drainage ways. Only continuous flow path lengths may be counted for treatment.

Buffer Design: Adapt the development layout to maximize the flow path length within a buffer.

- *Field Evaluation:* The surface and subsurface condition of a proposed buffer should be determined in the field prior to being incorporated into a design. The surface evaluation is to assure that runoff flowing through the buffer will stay as sheet flow for its entire length. Pit and mound topography is advantageous in that the pits trap and hold runoff water allowing more time for it to infiltrate into the soil, provided that the pits do not connect allowing for concentrated flow. A subsurface evaluation should be conducted by a soil scientist to determine the condition of soils throughout the buffer. Soil characteristics that should be evaluated include organic duff thickness and structure, soil texture, structure, consistency and depth to any restrictive layer and/or groundwater table. On a case-by-case basis, high quality buffers (both soils and vegetation), may be allowed a reduced flow path length.
- *Distribution of Runoff over the Buffer:* To be treated, runoff must enter the buffer as sheet flow and cannot be allowed to channelize. Buffers will not treat shallow concentrated or channelized flow. In most cases wooded and non-wooded natural buffers take advantage of the natural micro topography, (the small depressions and mounds of natural ground) to store runoff and allow for maximum infiltration.
- *Pretreatment for Buffers:* To prevent a heavy sediment loading from damaging the buffer during construction, sites that will have areas of bare soil for a long time cannot utilize this BMP without first pre-treating the runoff with a sediment control BMP.
- *Re-stabilization of Buffers:* If a buffer has been used to trap sediment during construction, the sediment must be removed and the original topography, ground cover and vegetation reestablished. Otherwise, sediment accumulations may cause runoff to concentrate in certain locations. It is advisable to protect buffer strips with wood waste sedimentation barriers during the construction process.
- *Buffer Dimensions:* Buffer flow path length depends to some extent on the proposed layout, and may be limited by the location of roads, driveways, building sites, and septic system locations. Overall site design and individual lot configurations can be manipulated to maximize buffer flow path length while minimizing interference with developed areas. The

longer the buffer flow path length, the more effective the buffer is. Only continuous flow path length may be counted. A second buffer separated from the first by a developed area may not be included. The level spreader length will vary depending on the soil type and vegetative cover of the buffer. Buffer sizing is addressed under each of the four buffer BMPs discussed in this manual. Use the buffer sizing tables in this chapter to size buffers to meet BMP standards. When used to meet phosphorus allocations in lake watersheds, adjust the sizing to the buffers in accordance with Volume II of this BMP manual.

- *Buffer Sizing:* Sizing depends only on the soil type, slope and vegetative cover type of a buffer. For each type of buffer, tables indicate the required buffer flow path length based on these factors. Buffers must be located downhill of the entire developed area for which it is providing stormwater treatment, such that all runoff from the entire developed area has a flow path through the buffer at least as long as the required length of flow path.
- *Soil Variability:* If more than one soil type is found in a buffer, the required sizing of the buffer must be determined as a weighted average, based on the percentage of the buffer in each soil type. Alternative sizing may be allowed if it is determined by a site-specific hydrologic buffer design model approved by the DEP.
- *Buffer Modification:* On a case-by-case basis, the minimum buffer depth width or length of level spreader required for specific soil types may be reduced if the quality of the buffer soil (organic duff thickness and structure, soil structure, bulk density, and depth to restrictive layer or seasonal groundwater table) and vegetation is very high. Also, on a case-by-case basis, reduced buffer depth width or reduced level spreader length for specific soil types may be allowed on buffers of low or average quality that are proposed to be improved to a very high quality status (create an artificial duff layer, lower bulk density of upper soil horizons, create good soil structure, increase depth to restrictive layer or seasonal groundwater table, create pit and mound topography, densely vegetate the area).
- *Deed Restrictions and Covenants:* Areas designated as buffers must be identified on site plans and protected from disturbance by deed restrictions and covenants.

Vegetative cover: The vegetative cover type of a buffer must be either forest or meadow. In most instances the sizing of a buffer varies depending on vegetative cover type.

- *Forest Buffer*: A forest buffer must have a well distributed stand of trees with essentially complete canopy cover, and must be maintained as such. A forested buffer must also have an undisturbed layer of duff covering the mineral soil. Activities that may result in disturbance of the duff layer are prohibited in a buffer.
- *Meadow Buffer*: A meadow buffer must have a dense cover of grasses, or a combination of grasses and shrubs or trees. A buffer must be maintained as a meadow with a generally tall stand of grass, not as a lawn. It must not be mown more than twice per calendar year. If a buffer is not located on natural soils, but is constructed on fill or reshaped slopes, a buffer surface must either be isolated from stormwater discharge until a dense sod is established, or must be protected by a three inch layer of erosion control mix or other wood waste material approved by the DEP before stormwater is directed to it. Vegetation must be established using an appropriate seed mix.
- *Mixed Meadow and Forest Buffer*: If a buffer is part meadow and part forest, the required sizing of a buffer must be determined as a weighted average, based on the percentage of meadow and the percentage of forest.

Maintenance: Buffers should be inspected annually for evidence of erosion or concentrated flows through or around the buffer. All eroded areas should be repaired, seeded and mulched.

- *Mowing:* Meadow buffers may be mown no more than twice per year. They may not be maintained as a lawn.
- *Access and Use:* Buffers should not be traversed by all-terrain vehicles or other vehicles. Activities within buffers should be conducted so as not to damage vegetation, disturb any organic duff layer, or expose soil.

- *Model Maintenance Plan:* The following techniques should be followed to maintain the integrity of buffers from initial planning through post-construction:
    - *Planning Stage:*
        - ✓ Require buffer limits on all clearing/grading and erosion control plans.
        - ✓ Record all buffer boundaries on official maps and site plans.
        - ✓ Clearly establish acceptable and unacceptable uses for the buffer, and include these uses in deed restrictions and conservation easements.
        - ✓ Establish clear vegetation targets and management rules for the buffer.
        - ✓ Provide incentives for owners to protect buffers through perpetual conservation easements rather than deed restrictions.
    - *Construction Stage:*
        - ✓ Pre-construction stakeout of buffers to define the Limit of Disturbance (LOD).
        - ✓ Set LOD based on drip-line of the forested buffer.
        - ✓ Familiarize contractors with LOD and buffer limit.
        - ✓ Mark the LOD with barriers or signs to exclude construction equipment.
    - *Post-Development Stage:*
        - ✓ Mark buffer boundaries with permanent signs (or fences) describing use.
        - ✓ Educate property owners/homeowner associations on the purpose, limits and allowable uses of the buffer.
        - ✓ Conduct periodic "buffer walks" to inspect the condition of the buffer network.
        - ✓ Replant unused meadow buffers with trees and shrubs, if possible.

Table 5-1 - Hydrologic Soil Groups for Maine Soils

This table provides information on the hydrologic soil series recognized in Maine and is current as of January 1, 2016. It is understood that these ratings may, and some probably will, change over time and with better data. The USDA - NRCS (Natural Resources Conservation Service) should be contacted for more accurate information.
http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

HSG A	HSG A/D	HSG B	HSG B/D	HSG C	HSG C/D	HSG D
Adams	Au Gres	Agawam	Atherton	Becket	Boothbay #	Abram
Colton	Bucksport	Allagash	Belgrade	Chesuncook *	Buxton #	Aurelie
Croghan	Chocorua	Bangor	Charles	Conant	Chesuncook **	Bemis
Danforth	Kinsman	Berkshire	Cornish	Dixfield *	Dixfield **	Benson
Deerfield	Markey	Caribou	Elmwood +	Elliottsville	Dixmont	Biddeford
Eldridge	Moosabec	Charlton	Fredon	Howland *	Easton	Brayton
Enchanted	Naskeag	Fryeburg	Halsey	Linneus	Howland **	Burnham
Hermon	Naumburg	Hadley	Limerick	Mapleton	Lamoine	Cabot
Hinckley	Rifle	Hartland	Lovewell +	Marlow	Leicester	Canaan
Mahoosuc	Scarboro	Nicholville ^	Medomak	Melrose	Perham **	Canandaigua
Masardis	Searsport	Machias ^	Ninigret +	Paxton	Pushaw	Colonel
Merrimac	Sebago	Madawaska ^	Podunk +	Penquis	Ragmuff **	Creasey
Skowhegan	Togus	Monadnock	Raynham	Perham *	Peru **	Daigle
Stetson	Vassalboro	Ondawa	Red Hook	Peru *	Skerry *	Gouldsboro
Sunday	Walpole	Salmon	Roundabout	Plaisted	Surplus **	Hogback
Udipsamments	Waskish	Sheepscot ^	Rumney	Ragmuff *	Washburn	Hollis
Windsor			Saco	Rawsonville	Woodbridge	Knob Lock
			Scio +	Sisk		Lyman
			Sutton +	Skerry **		Monarda
			Swanton	Suffield		Monson
			Whately	Surplus *		Peacham
			Winooski +	Tunbridge		Pillsbury
			Wonsqueak	Winnecook		Ricker
						Ridgebury
	Soils (with *) are HSG C or C/D depending on depth to Cd (C horizon with a dense unconsolidated material) and depth to water table - (with **) most commonly HSG C/D					Saddleback
						Scantic
						Saugatuck
	Soils (with +) are HSG B or B/D if aquic-redox is within 60cm					Schoodic
						Swanville
	Soils (with ^) are HSG B if water table is below 60cm and Ksat of lower horizon greater than 10					Telos
						Thorndike
	Soils (with #) are HSG C - or C/D if aquic-redox is within 60cm					Westbury
						Whitman

5.1- Buffer Adjacent to Residential, Largely Pervious or Small Impervious Areas

This buffer type is used for small developments where runoff enters the buffer as sheet flow without the aid of a level spreader. It may only be used when it is located immediately downhill of the developed area and runoff enters as sheet flow. This design is not appropriate for treating large impervious areas because, even if pavement is graded evenly, it is likely that some concentration of runoff will occur as the stormwater travels across large areas of pavement. Only runoff from the following areas may be treated using this type of buffer:

- A developed area with less than 10% imperviousness where the flow path over the portion of the developed area for which treatment is being used does not exceed 150 feet; or
- An impervious area of less than one acre, where the flow path across the impervious area does not exceed 100 feet.

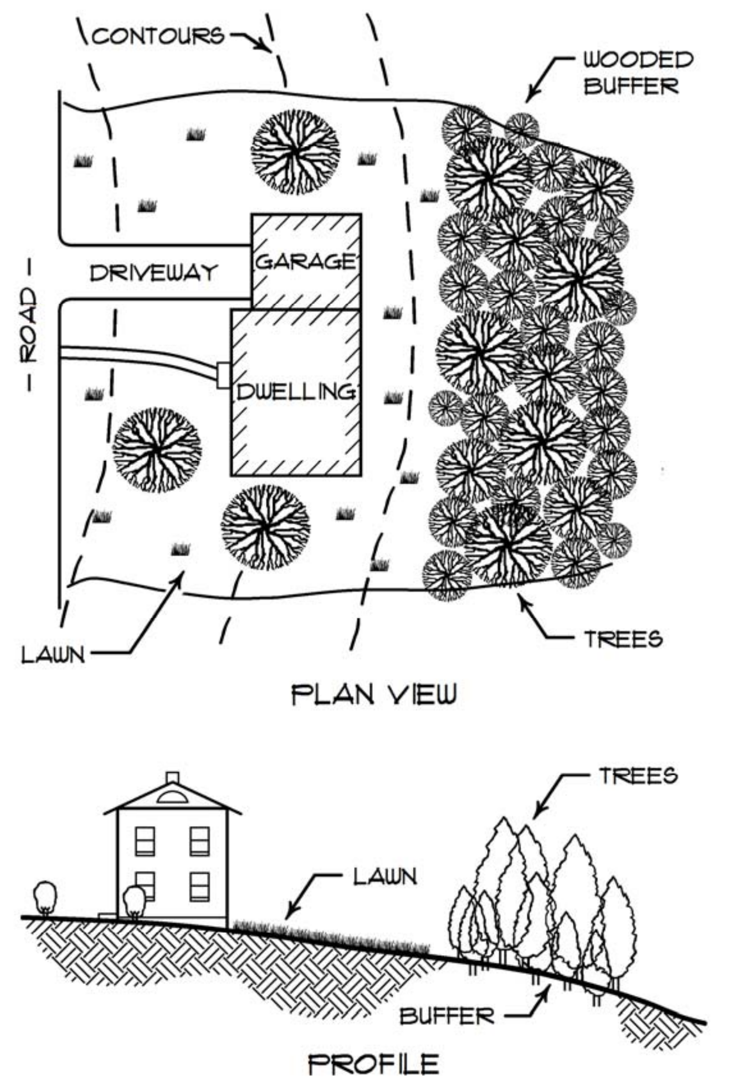

Figure 5.1 - Buffer Adjacent to a Small Impervious Area

In addition to the general design and construction criteria provided in this Chapter 5, the design and construction of a buffer adjacent to residential, largely pervious or small impervious areas must follow the criteria presented Table 5.2:

Table 5.2
Buffer Flow Path Length Downgradient of Residential, Largely Pervious or Small Impervious Areas (feet)

	0-8% Slope		**9-15% Slope**	
Hydrologic Soil Group	Forested Buffer	Meadow Buffer	Forested Buffer	Meadow Buffer
A	45	75	54	90
B	60	85	72	102
C Loamy Sand or Sandy Loam	75	100	90	120
C Silty Loam, Clay Loam or Silty Clay Loam	100	150	120	180
D Non-Wetland	150	N/A	180	N/A

Table 5-3 indicates the buffer flow path length for single family residential lots and can only be used for a residential lot that is a minimum of one acre or only when a portion of the lot and house is draining to the buffer. The buffer must be located immediately downhill of the developed area without any road pavement.

Table 5.3
Buffer Flow Path Length Downgradient of a Single Family Residential Lot (feet)

	0-15% Slope	
	Forested Buffer	Meadow Buffer
A	35	50
B	45	60
C Loamy Sand or Sandy Loam	50	70
C Silty Loam, Clay Loam or Silty Clay Loam	70	100
D Non-Wetland	100	N/A

5.2 - Buffer with a Stone Bermed Level Lip Spreader

In this type of buffer, runoff is directed behind the stone berm, which is constructed along the contour at the upper margin of a buffer area. The runoff then spreads out behind the berm so that it seeps through the entire length of the berm and is evenly distributed across the top of a buffer as sheet flow. Figure 5-2 shows a typical buffer with stone bermed level lip spreader. This type of buffer must be used when treating stormwater runoff from any of the following:

- An impervious area greater than one acre;
- Impervious areas where the flow path across the impervious area exceeds 150 feet; or
- Developed areas, including lawns and impervious surfaces, where runoff is concentrated, intentionally or unintentionally, so that it does not run off in well-distributed sheet flow when it enters the upper end of a buffer, except that road ditch runoff may be treated using a ditch turn out buffer.

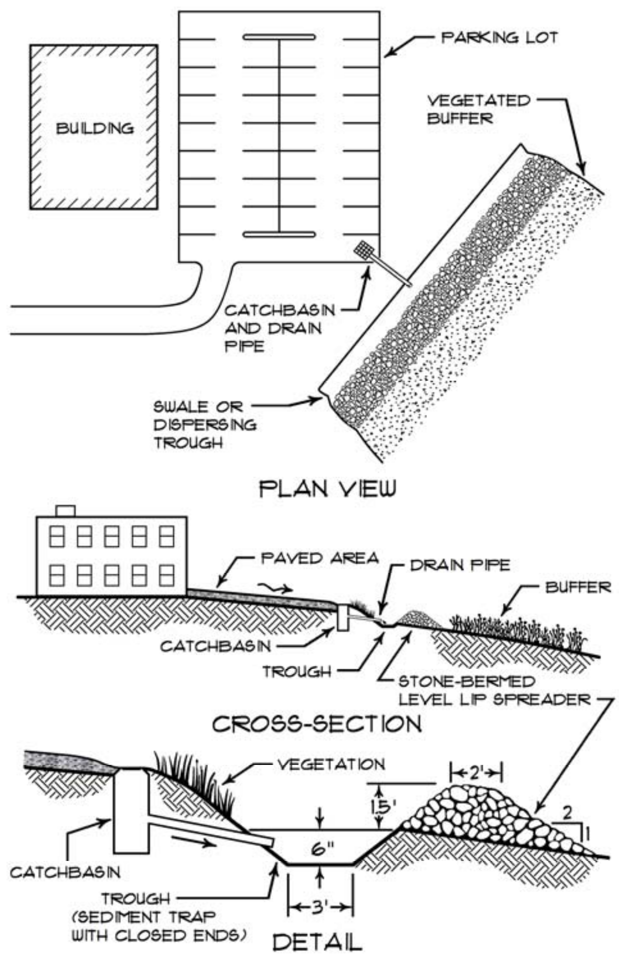

Figure 5.2 – Buffer with a Stone Berm Level Spreader

In addition to the general design and construction criteria provided in the beginning of this Chapter, the following criteria must also be applied in the design and construction of a buffer with a stone bermed level lip spreader.

Distribution of runoff to a Level Lip Spreader: A turnout should extend into the side ditch or cut slope in a manner that it intercepts the ditch runoff that carries it into the buffer area. The buffer end of the turnout must be level and equipped with a stone bermed level lip spreader.

- *Stone Berm Specifications:* The berm must be well-graded and contain some small stone and gravel so that flow through the berm will be restricted enough to cause it to spread out behind the berm. The stone berm must be at least 1.5 feet high and 2.0 feet across the top with 2:1 side slopes constructed along the contour and closed at the ends. Unless otherwise approved by the DEP, the design must include a shallow, 6-inch deep trapezoidal trough with a minimum bottom width of three feet, and with a level downhill edge excavated along the contour on the uphill edge of the stone berm.

- *Stone Size:* The stone must be coarse enough that it will not clog with sediment. Stone for stone bermed level lip spreaders must consist of sound durable rock that will not disintegrate by exposure to water or weather. Fieldstone, rough quarried stone, blasted ledge rock or tailings may be used. The rock must be well graded with a median size of approximately 3 inches and a maximum size of 6 inches per Table 5.4.

Table 5.4
Berm Stone Size

Sieve	% by Weight Passing
12 in.	100%
6 in.	84-100%
3 in.	68-83%
1 in.	42-55%
No. 4	8-12%

- *Buffer Length:* The size of a buffer area below a stone bermed level lip spreader varies with the size and imperviousness of the developed area, and the type of soil, the slope, and the vegetative cover type of the buffer. Table 5.5 indicates the required berm length per acre of impervious area and lawn draining to a buffer.

Table 5.5
Berm and Flow Path Length per Acre of Impervious area

Hydrologic Soil Group	Length of Flow Path in Buffer (feet)	Berm Length (feet)							
		0-8% Slope				9-15% Slope			
		Per Acre of Impervious Area		Per Acre of Lawn		Per Acre of Impervious Area		Per Acre of Lawn	
		FB	**MB**	**FB**	**MB**	**FB**	**MB**	**FB**	**MB**
A	75	75	125	25	35	90	150	30	42
	100	65	75	20	25	78	90	24	30
	150	50	60	15	20	60	72	18	24
B	75	100	150	30	45	120	180	36	54
	100	80	100	25	30	96	120	30	36
	150	65	75	20	25	78	90	24	30
C Loamy Sand or Sandy Loam	75	125	150	35	45	150	180	42	54
	100	100	125	30	35	120	150	36	42
	150	75	100	25	30	90	120	30	36
C Silty Loam, Clay Loam or Silty Clay Loam	100	150	200	45	60	180	240	54	72
	150	100	150	30	45	120	180	36	54
D Non-Wetland	150	150	200	45	60	180	240	54	72

FB = Forest Buffer **MB** = Meadow Buffer
NOTE: *These tables were developed using a 1.25 inch, 24 hour storm of type III distribution, giving a maximum unit flow rate of less than 0.009 cfs per foot.*

5.3 - Buffer Adjacent to the Downhill Side of a Road

A buffer adjacent to the downhill side of a road may only be used when the runoff from the road surface and shoulder sheets immediately into the buffer, and the road is parallel to the contour of the slope. In no instance may runoff from other areas be directed to these buffers. Figure 5.3 shows a typical buffer adjacent to the downhill side of a road. In addition to the general design and construction criteria provided in the beginning of this Chapter, the following criteria must also be applied in the design and construction of buffers adjacent to the downhill side of a road.

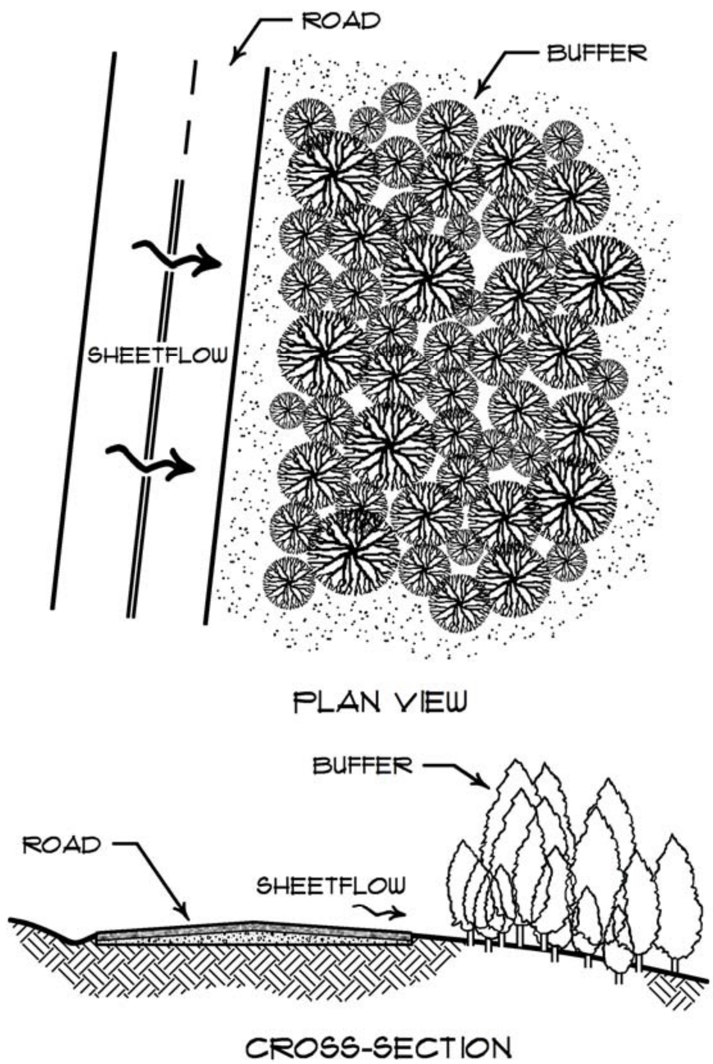

Figure 5.3 – Buffer Downhill of a Road

- *Soil Type:* The buffer design and sizing does not vary with soil type or slope, except that these buffers cannot be used when slopes exceed 20% or on wetland soils.
- *Inclusion of In-slope: The in-slope of the road (the vegetated area between the pavement edge and the buffer edge) may be included as part of a meadow buffer only if it is designed and constructed to allow infiltration which includes, but is not limited to, the in-slope fill material being a sandy loam or* coarser soil texture; having slopes no steeper than 4:1; and maintaining the buffer area as a meadow buffer.
- *Sizing:* Sizing depends only on the vegetative cover type and the number of travel lanes draining to the buffer. Table 5.6 indicates the required buffer flow path length based on the number of travel lanes and whether the buffer is forested or meadow.

Table 5.6
Buffer Flow Path Length Downgradient of Road (feet)

	Forested Buffer	***Meadow Buffer***
One Travel Lane	*35*	*50*
Two Travel Lanes	*55*	*80*

5.4 - Ditch Turnout Buffer

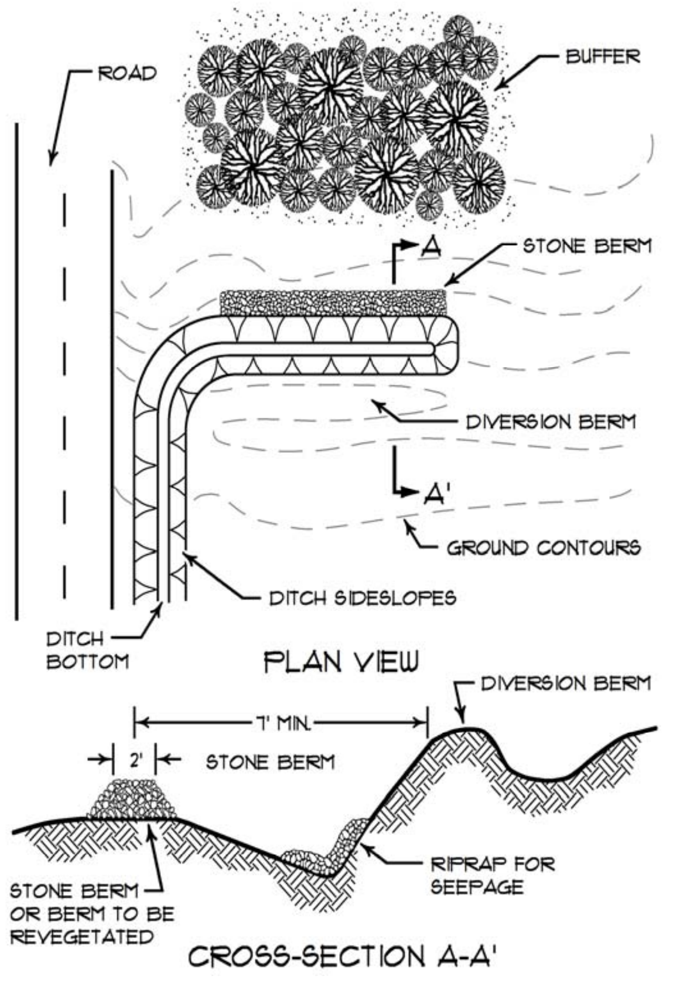

Figure 5.4 – Ditch Turnout Buffer

A ditch turnout buffer is used to divert runoff from a roadside ditch into a buffer. It consists of a combination of check dams and bermed level lip spreaders that divert concentrated ditch flows into a buffer as sheet flow. Runoff backs up behind the check dam and is directed over a stone berm that spreads flows out so that it is evenly distributed across the top of a buffer as sheet flow. Figure 5-4 shows a typical ditch turn-out buffer. In addition to the general design and construction criteria provided in the beginning of this Chapter, the following criteria must also be applied in the design and construction of a ditch turnout buffer.

Drainage Area: No areas other than the road surface, road shoulder and road ditch may be directed into the buffer. No more than 400 feet of road and ditch may be treated in any ditch turnout buffer, and no more than 250 feet may be treated if more than one travel lane is draining to the ditch. If two travel lanes drain to the ditch, as in the case of a super-elevated road, the length of flow path indicated for 400 feet of road must be used, but no more than 250 feet of ditch may drain to each turnout.

- *Distribution of Runoff Over the Buffer:* The turnout should extend into the side ditch or cut slope in a manner that it intercepts the ditch runoff and carries it into the buffer area. The buffer end of the turnout must be level and equipped with a stone bermed level lip spreader.
- *Stone Berm Specifications:* The stone berm to which the ditch turn-out delivers the runoff must be at least 20 feet in length and must be constructed along the contour. It must be at least one- foot high and two feet across the top with 2:1 side slopes.
- *Stone Size:* The stone must be coarse enough that it will not clog with sediment. Stone for stone bermed level lip spreaders must consist of sound durable rock that will not disintegrate by exposure to water or weather. Fieldstone, rough quarried stone, blasted ledge rock or tailings may be used. The rock must be well graded with a median size of approximately 3 inches and a maximum size of 6 inches. See Table 5.4 above.
- *Buffer Length:* The required size of a buffer area below the turnout's stone bermed level lip spreader varies with the type of soil, the slope, the vegetative cover and the length of road ditch. See Table 5.7 below.

Table 5.7 ***Buffer Flow Path Length per Length of Road or Ditch (feet)***					
		0-8% Slope		**9-15% Slope**	
Hydrologic Soil Group	Length of Road or Ditch (feet)	Forested Buffer	Meadow Buffer	Forested Buffer	Meadow Buffer
A	200	50	70	60	84
	300	50	85	60	102
	400	60	100	72	120
B	200	50	70	60	84
	300	50	85	60	102
	400	60	100	72	120
C Loamy Sand or Sandy Loam	200	60	100	72	120
	300	75	120	90	144
	400	100	N/A	120	N/A
C Silty Loam, Clay Loam or Silty Clay Loam	200	75	120	90	144
	300	100	N/A	120	N/A
D Non-Wetland	200	100	150	120	180