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Implications of Slope Limitations

Vermont Stormwater Management Manual Update, Meeting #6

Shelburne, Vermont Town Offices

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Non-Structural Practices with Slope Limitations

- Non-structural practice performance is highly dependent on slope:
  - Disconnection (rooftop and non-rooftop)
  - Filter strips and vegetated buffers
  - Grass channels
  - Reforestation / revegetation
  - Soil restoration

Current Criteria/Limitations

- Non-structural practice performance is highly dependent on slope:
  - Disconnection (rooftop and non-rooftop): ≤5% over length of disconnection, length = contributing area/13.3 (based on 1000 sq ft treated by 75 ft length)
  - Filter strips and vegetated buffers: ≤ 5% average over buffer length, max contributing length (75’ impervious; 150’ pervious), minimum length = 50’
  - Grass channels: 10 minute residence time, v ≤ 1.0 fps, d ≤ 4 inches
  - Reforestation / revegetation : N/A
  - Soil restoration: N/A

Filter Strips and Vegetated Buffers

- Runoff – as sheet flow from adjacent surfaces – is directed to vegetated surfaces where it is treated through filtration and infiltration.
- Runoff can be directed towards filter strips and/or undisturbed natural areas.
- Examples:
  - *Vermont*
  - *Maryland*
  - *New York*
  - *Nashville, TN*

Filter Strips and Vegetated Buffers: Approaches to Application

State (date of manual)	Practice name / ID	Approach	Manual link
Vermont (2002)	Stream Buffer, Credit 4	Optional credit available to applicants. Area draining by sheet flow to buffer is subtracted from total site area in the WQv calculation. Impervious area draining to stream buffer contributes to REv (under the Percent Area method).	http://www.vtwaterquality.org/stormwater/docs/sw_manual-vol1.pdf
Maryland (2009)	Sheetflow to Conservation Areas, N-3	Standard practice. Up to 1" may be applied towards meeting the rainfall target for contributing areas. Minimum 20,000 ft^2 easement-protected conservation area required.	http://www.mde.maryland.gov/programs/Water/StormwaterManagementProgram/MarylandStormwaterDesignManual/Documents/www.mde.state.md.us/assets/document/Design Manual Chapter 5 03 24 2009.pdf
New York (2010)	Sheetflow to Riparian Buffers or Filter Strips, Section 5.3.2, practice RR-2	GSI (RR) practice. Areas draining by sheet flow to a riparian buffer or filter strip are subtracted from the site's impervious total (Rv calculation) when computing WQv. If the area draining contains impervious surface, the Rv value is reduced for the impervious as well.	http://www.dec.ny.gov/docs/water_pdf/swdm2010chptr5.pdf
Nashville TN (2012)	Sheet Flow, GIP-09	Standard GI practice. Design variants include vegetated filter strips and disconnection to conserved open space. RR credit of 50-75%; restoration/ amendment required for full credit on C-D soils	https://www.nashville.gov/Water-Services/Developers/Low-Impact-Development.aspx

Filter Strips and Vegetated Buffers: Key Design Criteria

State (date of manual)	Practice name / ID	Minimum Buffer Width (ft)	Contributing Length (ft)	Disconnection Area Slope	Other
Vermont (2002)	Stream Buffer, Credit 4	50	150 (pervious) 75 (impervious)	5.0% or less	Runoff shall enter buffer as sheet flow Stream buffers shall remain undisturbed Disconnection credits OR this credit may be claimed
Maryland (2009)	Sheetflow to Conservation Areas, N-3	50 (100 ft. required for max. credit of 1.0" off P_E)	150 (pervious) 75 (impervious)	5.0% or less Level-spreading devices allowed on steeper slopes	Minimum buffer area = 20,000 ft^2 Conservation areas may include existing natural resources, created or restored resources, or both Conservation easement required
New York (2010)	Sheetflow to Riparian Buffers or Filter Strips, Section 5.3.2, practice RR-2	50 for 0-8% slope; 75 for 8-12% slope; 100 for 12-15% slope	150 (pervious) 75 (impervious)	15% or less	Design variants: Riparian buffer or grass filter strip (amended soils and dense turf cover) In HSG C and D, buffer length should be increased by 15%-20% respectively Average contributing slope shall be 3% maximum unless a flow spreader is used
Nashville TN (2012)	Sheet Flow, GIP-09	35 for 1-4% slope; 50 for 4-6% slope.	150 (pervious) 75 (impervious)	2-6%; first 10 ft. of filter must be 2% or less	Design variants: disconnection to vegetated filter strips or to conserved open space Easement required if conserved open space Pea gravel diaphragm required @ slope top Especially encouraged for areas <5,000 ft^2

Filter Strips and Vegetated Buffers: Key Design Criteria – Steeper Slopes

State (date of manual)	Practice name / ID	Minimum Buffer Width (ft)	Contributing Length (ft)	Disconnection Area Slope	Other
Maine (2010)	Vol 3 Chapter 5 Vegetated Buffers	**35** (HSG A, forested, single residential SF lot) – **240** (HSG D, 9-15% slope, per acre impervious	150 (pervious) 75 (impervious) 150+ (impervious for buffer with stone bermed level spreader)	15% or less (20% or less for buffer downhill of a road)	Five buffer types: Adjacent to Residential, Largely Pervious or Small Impervious Areas; Buffer with Stone Bermed Level Lip Spreader (for larger impervious); Downhill of a Road; Ditch Turnout; Downgradient of a Single Family Residential Lot Forest and Meadow variants of each buffer type (shorter flow path length for forest) Areas designated as buffers must be identified on site plans and protected from disturbance by deed restrictions and covenants Vol 2 of manual offers buffer sizing adjustments for meeting P allocations in lake watersheds
Vermont Credit 7 Watershed Hydrology Protection Credit **(2011)**	Disconnection Adjacent to Downhill Side of the Road (uncollected runoff)	55 (forested) 80 (meadow)	<20	30% or less	High elevation projects (over 1,500 ft) Contributing watershed must remain 90% forested Strategies for managing runoff and groundwater bypass required Stream buffers shall be maintained (min. 50 ft on 0-10% slope) except for stream crossings Disconnections not allowed on wetland soils No requirement to otherwise account for HSG Level spreader stone berms must meet peak flow (10-year, 24-hour storm <0.25 cfs per foot length of level spreader lip) and design reqs (constructed along the contour, 1 ft. high / 2 ft. across top, 2:1 side slopes)
		75 (forested) 100 (meadow)	>20		
	Disconnection via Level Spreader (collected runoff from ditches)	150 (forested) 200 (meadow)	n/a	30% or less	

Maine Buffer with Stone Berm

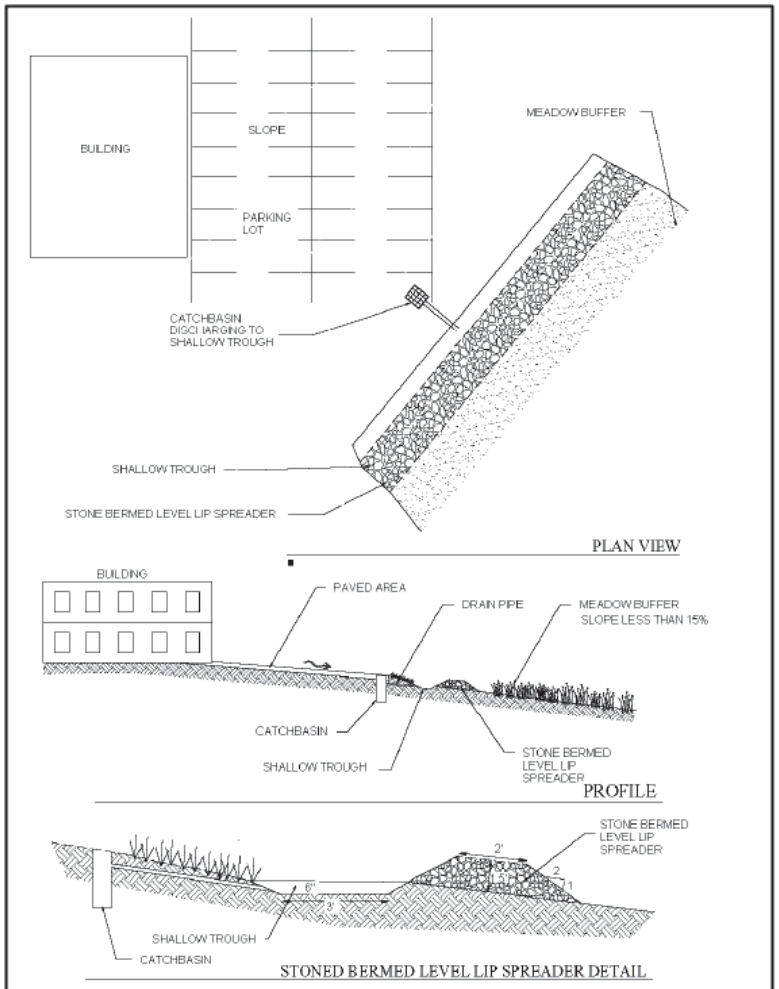

FIGURE 5-2. BUFFER WITH STONE BERMED LEVEL LIP SPREADER

Maine Vegetated Buffer Guidance

Derived using a 1.25” storm, with a max flow rate of < 0.009 cfs/foot

Table 5-4
Required Berm and Flow Path Length of a Buffer with 0-8% Slope and a Stone Bermed Level Lip Spreader

Hydrologic Soil Group	Length of Flow Path through Buffer (feet)	Berm Length for a Forested Buffer (feet)		Berm Length for a Meadow Buffer (feet)	
		Per acre of impervious area	Per acre of lawn	Per acres of impervious area	Per acre of lawn
Soil Group A	75	75	25	125	35
	100	65	20	75	25
	150	50	15	60	20
Soil Group B	75	100	30	150	45
	100	80	25	100	30
	150	65	20	75	25
Soil Group C sandy loam or loamy sand	75	125	35	150	45
	100	100	30	125	35
	150	75	25	100	30
Soil Group C silt loam, clay loam or silty clay loam	100	150	45	200	60
	150	100	30	150	45
Soil Group D non-wetland	150	150	45	200	60

Maine Vegetated Buffer Guidance

Table 5-5
Required Berm and Flow Path Length of a Buffer with 9-15% Slope and a Stone Bermed Level Lip Spreader

Hydrologic Soil Group	Length of Flow Path through Buffer (feet)	Berm Length for a Forested Buffer (feet)		Berm Length for a Meadow Buffer (feet)	
		Per acre of impervious area	Per acre of lawn	Per acre of impervious area	Per acre of lawn
Soil Group A	75	90	30	150	42
	100	78	24	90	30
	150	60	18	72	24
Soil Group B	75	120	36	180	54
	100	96	30	120	36
	150	78	24	90	30
Soil Group C sandy loam or loamy sand	75	150	42	180	54
	100	120	36	150	42
	150	90	30	120	36
Soil Group C silt loam, clay loam or silty clay loam	100	180	54	240	72
	150	120	36	180	54
Soil Group D non-wetland	150	180	54	240	72

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What if maximum slope was raised to 15%?

- Rooftop and non-rooftop disconnection options:
  - Increase flowpath of disconnection, or
  - Decrease allowable flow length of contributing area
  - Eliminate all together (use filter strip or grass channel criteria)
- Filter Strips and Buffers
  - Some variation on Maine criteria
- Grass Channels
  - Maintain 10 minute minimum residence time
  - Increase allowable velocity of WQ_v event
- Reforestation and Soil Amendments???

Questions / Discussion